Report to:

CROWFLIGHT MINERALS INC.

Bucko Lake Nickel Project
Tailings Disposal Alternatives

Document No. 0651790100-REP-T0001-00

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BUCKO LAKE NICKEL PROJECT TAILINGS DISPOSAL ALTERNATIVES

JANUARY 2007

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1.0 INTRODUCTION

1.1 BACKGROUND

Exploration activities on the Bucko Lake Nickel Project site near the town of Wabowden, Manitoba (Appendix A) have been conducted since 1959. These have included numerous ground mapping, geophysical and diamond drilling programs and airborne geophysical surveys. Delineation and in-fill diamond drilling has totaled approximately 75,000 metres. A three-compartment vertical shaft was excavated to a depth of approximately 330 metres below surface with an additional 900 metres of horizontal exploration drifting having taken place from this shaft. The nickel deposit at the site was first discovered by Falconbridge in 1964. Between 1971 and 1972, an all-weather access road was developed and a three compartment shaft was sunk to the 305 m level (1000 Level). Approximately 915 m of drifting, in the hangingwall, was completed on the 1000 Level and an underground diamond drill program consisting of 12,739 m of coring in 61 holes was completed. The shaft was sunk in the footwall gneisses although the exploration drifting crossed through the mineralization-hosting ultramafic unit into the hangingwall gneisses where the bulk of the development occurred. The mineralized zone was intersected by the drift at the extreme south end of the zone but no substantial development was completed within the body. In 1974 the shaft was capped, allowed to flood and the site demobilized. By late 1974 the property had become dormant. Recent exploration drilling on the property by Crowflight Minerals Inc. (Crowflight) in partnership with Falconbridge has delineated a mineral resource containing primarily nickel with minor concentrations of by-product copper, cobalt, platinum group elements and gold.

Crowflight is proposing to develop the Bucko Lake Nickel Project by way of a 1,000 tonne per day underground mine and surface milling and concentrator plant. Surface installations are to include various support infrastructure, a tailings impoundment area (TIA), and other associated mining facilities.

Crowflight proposes to use Bucko Lake, adjacent to the proposed mine, as the tailings impoundment area (TIA). Bucko Lake is a small, shallow headwater lake in the Grass River watershed system. Bucko Lake drains to Rock Island Lake through an extensive, approximate 4 kilometre wetland that is unnamed, but referred to in this report as Bucko Creek. Rock Island Lake drains to Halfway Lake and then on to the Grass River. Although Bucko Lake currently supports populations of two minnow species, it does not directly support fish populations that sustain, or have the potential to sustain, a fishery of any sort. Bucko Lake has been identified by Wardrop as the most suitable site for disposal of the tailings from the Bucko Mine. Bucko Lake provides the most environmentally and structurally secure disposal option given the characteristics of the tailings to be generated from the development of the Bucko Deposit and local terrain conditions within reasonable proximity to the mine.

1.2 SCOPE OF WORK

In June, 2005 Golder Associates submitted preliminary concepts for sub-aqueous tailings disposal in Bucko Lake and for land-based disposal of conventional wet tailings. This report expands on the Golder study and provides comments as well as the associated capital cost for the option alternatives. The disposal alternatives presented in this report were based on the available information for the Bucko Lake site.

Approximately half the tailings produced in milling 1,685,000 tonnes of ore will be used as cemented backfill in the mine underground, with the balance of tailings being disposed of in the tailings impoundment area (TIA). The estimated volume of tailings disposal capacity required was approximated at 601,000 m^3 assuming a void ratio of 1.0 and specific gravity of 2.8.

This report thoroughly evaluates the environmental, engineering, and economic merits of the various tailings disposal alternatives at a conceptual design level. Detailed design efforts will be directed to the selected disposal alternative. The tailings disposal alternatives and conceptual designs for each disposal option are discussed in Section 4.0 of this report with the siting options for each alternative discussed in Section 5.0. A capital cost comparison for each disposal option is presented in Section 6.0 with an evaluation and comparison of each option provided in Section 7.0.

2.0 REGIONAL CONDITIONS

2.1 EXISTING LAND USE

The Bucko Lake Nickel Project site was previously used for various exploration activities. The property is serviced by an access road. Hydro and telephone service to the site was provided during the 1971-72 period of mine operation. The lines were removed when the mine was closed, although the remnant right-of-way remains.

The Inco-Canadian Royalties Joint Venture (J.V.) is present contiguous to the west of the Bucko Lake property. The Falconbridge-Crowflight J. V. occupies the areas contiguous to the NE and SW. The site is bounded by railway tracks and Highway 6 to the north.

The Community of Wabowden is located approximately 5 kilometres to the north. Wabowden consists of approximately 500 people and was founded in 1913 during construction of the Hudson Bay railway. The Wabowden community wastewater treatment lagoons are located adjacent to the creek that flows between Bucko Lake and Rock Island Lake. There is no residential land use on Bucko Lake and limited use on Rock Island Lake, with only a single household located on the shore of Rock Island Lake, downstream of Bucko Lake. A communications tower also is located adjacent to Bucko Creek.

2.2 EXISTING ENVIRONMENT

Environmental management issues associated with the proposed Bucko nickel mine and mill project, as proposed, are primarily associated with aquatic resources. The mine and mill facility will be established on a previously disturbed site; the access road exists, only requiring upgrading; and, a power supply line can be installed along the previous power line corridor, which is also a disturbed area. The only terrestrial resource for which there is a potential concern for adverse effects is woodland caribou, specifically the Wabowden herd which uses the muskeg-island habitat to the east of the site as summer calving habitat. Impacts on caribou only become an issue of concern if it becomes necessary to significantly expand the footprint of terrestrial disturbance beyond the area of historic disturbance.

The following summary of existing environmental conditions in the Bucko Lake Nickel Project area was drawn from the Environment Act Proposal for the project (Wardrop 2006).

2.3 CLIMATE

The Bucko Lake Nickel Project is situated in the Sipiwesk Lake Ecodistrict, which is a warmer more humid subdivision of the High Boreal Ecoclimatic Region having short cool summers and long very cold winters. Climate data for Thompson, Manitoba, the closest meteorologic station to Wabowden, are summarised in Table 2.1.

Table 2.1: Long term mean climate data for Thompson, Manitoba. (Environment Canada, Canadian Climate Normals – 1971-2000)

Month	Daily Average Temperature (°C)	Rainfall (mm)	Snowfall (cm)	Precipitation (mm)	Wind Speed (km/h)	Most Frequent Direction
Jan	-24.9	0.1	21.1	18.2	10.3	W
Feb	-20.4	0.2	18.0	15.9	10.6	W
Mar	-12.9	0.8	21.6	20.6	11.6	NE
Apr	-2.2	6.2	20.8	26.0	13.1	NE
May	6.5	33.0	12.0	44.4	13.2	NE
Jun	12.6	67.9	1.4	69.4	12.2	NE
Jul	15.8	86.1	0	86.1	11.0	W
Aug	14.1	73.7	0.1	73.9	10.7	W
Sep	7.2	58.5	3.9	62.4	11.5	W
Oct	0	19.9	22.1	41.4	11.4	W
Nov	-12.0	1.6	35.0	32.8	10.5	W
Dec	-22.0	0.2	30.2	26.3	9.5	W
Year	-3.2	348.2	186.2	517.4	11.3	W

The 2005 open water season was much wetter than average, with actual precipitation between May and October about twice the long term mean (Table 2.2). June and July were particularly wet.

Table 2.2: Comparison of 2005 open water season precipitation (mm) with long term mean precipitation at Thompson A meteorologic station. Data from Environment Canada (2006).

Month	Mean	2005
May	44.4	90.8
June	69.4	154.8
July	86.1	209.7
August	73.9	119.4
September	62.4	106.5
October	41.4	38.8
Total	377.6	720.0

The climate in the Bucko Lake area poses problems with construction, freezing of pipelines, potential for deep or total freezing of Bucko Lake itself, and freezing and desiccation of tailings area embankment fills. These problems could be overcome with appropriate engineering; however the climate impacts the economics for all tailings disposal options. This is of particular concern the larger the civil construction involved.

2.4 GEOLOGY

The Bucko Lake property is underlain by Archean gneisses and Proterozoic ultramafic intrusive rocks. The Archean migmatite gneisses have been subdivided into granite gneiss, amphibole gneiss and amphibolite. Granitic gneisses are primarily quartz and potassium feldspar with less than 25% mafic minerals. Amphibole gneisses are 25% to 50% amphibole with the remainder quartz and feldspar. Amphibolites contain more than 60% amphibole.

The Archean gneisses were intruded by Aphebian ultramafic sills including the Bucko Lake ultramafic which hosts the nickel mineralization on the Property. The Bucko Lake ultramafic sill is on the northeast flank of the Resting Lake intrusion and is entirely within granodiorite gneiss. It is a linear body, 22 metres wide at the south end, gradually increasing to over 150 metres wide at the north end. The Bucko Lake Sill has been traced about 800 m north-south and dips steeply (75° to 80°) to the east. The ultramafic body is complexly folded in the form of a synform with a fold axis plunging steeply to the south. Both limbs of the folded sill face east suggesting that the west limb has been duplicated by faulting.

The Bucko Lake ultramafic sill is primarily peridotite and dunite with lesser amounts of olivine orthopyroxenite, poikilitic harzburgite, orthopyroxenite and amphibole bearing peridotite. Contacts of the ultramafic rocks with the surrounding country rocks are usually obscured by alteration, shearing or late stage pegmatite dikes. Blocks of amphibolite rich gneiss called plagioclase amphibole, ranging from a few meters to over 30 metres in width, occur in the northern part of the ultramafic sill. The larger xenoliths occur within a distinct bulge or keel in the footwall of the ultramafics adjacent to the Hinge Zone. These blocks appear to be xenoliths of country rock incorporated into the sill during its emplacement.

The sill has undergone two stages of metasomatic alteration. First was the serpentinization of the olivine with concurrent alteration of the orthopyroxene to anthophyllite, tremolite and phlogopite. The second stage of alteration, which is superimposed on the serpentinized ultramafics, occurs as envelopes around pegmatite dikes and fractures. The envelopes range from centimetres to metres in width and consist of an outer zone of anthophyllite, talc and tremolite, a central zone of fibrous tremolite and an inner zone of phlogopite and minor anthophyllite.

2.5 SOIL CONDITIONS

Bucko Lake is surrounded generally by low lying swampy ground, with very little relief. Soil conditions around Bucko Lake generally consist of peat and sandy till. Some bedrock outcrop is visible at the south end of the lake and throughout the site.

Bucko Lake is at an approximate elevation of 229 metres. The lake is underlain by one to two metres of mixed humus materials, mud and silt over a layer of glacial tills ranging from 0 to 100 metres in thickness overlying the bedrock.

To date there has been no surface geotechnical work done to determine the soil strength and suitability, locate potential construction borrow sources, determine an overburden profile for the project site, or determine regional ground water table profiles for the purpose of construction outside of the previously disturbed mine site area.

2.6 AQUATIC RESOURCES

The mine site is located adjacent to Bucko Lake, a small, shallow headwater lake in the Grass River system. Bucko Lake drains to Rock Island Lake via an unnamed creek that is referred to in this report as Bucko Creek. Rock Island Lake drains to Halfway Lake and then on to the Grass River.

2.6.1 BUCKO LAKE MORPHOLOGY AND HYDROLOGY

The bathymetry of Bucko Lake was sounded on August 24th, 2005. The lake is shallow (Z_{max}= 2.0 m). The majority of the Bucko Lake shoreline is of shallow slope fine-grained sediments vegetated with emergent *Typha* and *Scirpis*, including the shoreline fronted by the mine site, accounting for the absence of near shore depth soundings. Short sections of the shoreline on the south-east side of the lake and a small central island are bedrock controlled.

Morphometric and related hydrologic data for Bucko Lake and watershed are summarized in Table 2.3. In the absence of hydrometric measurements for Bucko Lake, the annual mean outflow was approximated using the annual mean watershed runoff. Runoff was estimated using the watershed area of 10.3 km^2, determined from a 1:50 000 scale NTS series topographic map and average precipitation for the Thompson A meteorological station. Runoff was assumed to occur in the period between April 1 and October 31, with half the snowmelt running off in April and the balance in May. Runoff coefficients of 0.5 were used for April and May with a coefficient of 0.3 used for the other runoff months.

Table 2.3: Morphometric and hydrologic characteristics of Bucko Lake and its watershed.	
Surface Area	920,636 m^2
Nominal volume	1,269,935 m^3 during open water 662,315 m^3 under maximum ice cover
Mean Depth	1.4 m
Maximum Depth	2.0 m
Watershed area	10.3 km^2
Annual precipitation	517 mm
Annual watershed runoff	2,340,000 m^3
Lake residence time	0.5 y

2.6.2 *Bucko Creek Morphology and Hydrology*

Bucko Creek flows from Bucko Lake through an extensive wetland to Rock Island Lake. Bucko Creek was visually surveyed along its eight identifiable reaches in September 2000, primarily for the purpose of evaluating the potential for fish passage between Bucko and Rock Island lakes. Bucko Creek is a low gradient/low velocity stream, falling only 5 metres over its 4.3 kilometre length. Precipitation during the open water season of 2005 was substantially higher than the long-term average, yet no measurable velocity was evident in Bucko Creek on any of May 19, July 20, or September 19. Evidently, much of the flow percolates through the wetland vegetation and peat rather than flowing in a defined open channel.

2.6.3 *Fish Habitat in Bucko Lake*

The Department of Fisheries and Oceans Habitat Conservation and Protection Guidelines (1994) define fish habitat as:

> “freshwater, estuarine and marine environments that directly or indirectly support fish stocks or fish populations that sustain, or have the potential to sustain, subsistence, commercial or recreational fishing activities.”

Although Bucko Lake currently supports populations of two minnow species, it does not directly support populations that sustain, or have the potential to sustain, a fishery of any sort as noted above. The survey of the connecting stream between Bucko and Rock Island lakes in autumn 2000 identified a reach where the stream channel disappears into the bog. There is no evidence that fish from downstream lakes, such as Northern Pike, would be able to access Bucko Lake for spawning or as a foraging area. This opinion is supported by the absence of any predatory fish species in Bucko Lake when fished in 2000, and by a high relative abundance of minnow species, which is consistent with an absence of predators.

Although there is no evidence that fish can or do move into Bucko Lake from downstream lakes to feed or spawn, Bucko Lake is part of a larger hydrologic system that extends through Rock Island Lake and down the Grass River. Some component of this hydrologic regime needs to be maintained, as do nutrient flow and water quality, to protect downstream fish stocks. In this regard, Bucko Lake could be considered as indirectly supporting fish stocks that can or do sustain fishing activities. As such, Bucko Lake appears to fall in the category of Class 3 Habitat, which requires a minimum level of protection (DFO 1994). The habitat has a low productive capacity, does not and could not directly support a fishery, and there is no reasonable potential for enhancement. Any contribution to downstream fish production would be of a non-critical nature. Based on the benthic invertebrate data, the Bucko Creek wetland is an important source of allochthonous (i.e., originating outside the lake) organic matter whereas primary productivity in Bucko Lake does not appear to be a significant source of energy for Rock Island Lake.

Any use of Bucko Lake for tailings disposal would be subject to satisfying the No Net Loss policy of the Department of Fisheries and Oceans (DFO) through the development and implementation of a fish habitat compensation plan along with commitments and demonstrated capability to prevent adverse changes to the downstream hydrologic regime and water quality in downstream water bodies. In this regard, use of Bucko Lake for tailings disposal will not result in a net adverse effect on fish or fish habitat. Fish habitat protection measures associated with the use of Bucko Lake as a TIA are focused on maintenance of a high quality discharge from the TIA and minimising disruption of the downstream hydrologic regime.

2.7 Species at Risk

The woodland caribou (*Rangifer tarandus*) is the only species at risk known to occur in the study area. Woodland caribou are listed as threatened under the Manitoba Endangered Species Act and the boreal population also is classified as threatened by COSEWIC. The Wabowden herd is one of 14 recognised herds in Manitoba and one of four considered to be “high risk” (Schindler 2005) primarily due to the impacts of forest harvest and forest fires.

Among important study findings of relevance to the Bucko Nickel Project was the identification of summer and winter range areas adjacent to (winter) or including (summer) the Bucko mine site. The repeated use of the treed muskeg islands in the area east of Rock Island and Bucko Lakes, despite the proximity of this area to the Wabowden townsite, is believed to be a survival adaptation (Elliot 1997). The area is inaccessible to humans for most of the year, and particularly during the spring and summer calving and rearing period, because of extensive standing water in the large string bog complexes. This habitat also is believed to provide natural protection from predators, because these areas may naturally support low numbers of predators (Thomas and Armbruster 1996), the caribou may have a mobility advantage, and the standing water may provide an auditory alarm (Hirai 1998). The treed islands surrounded by the bog also afford excellent visibility of approaching predators. Of these range areas, protection of the summer range is the primary concern, as this range includes the calving habitat used by cows in the spring and summer period.

3.0 TAILINGS PROPERTIES

The waste tailings volume increases from the original solid volume in the course of milling due to the addition of water and decrease in density due to metal removal and the introduction of void spaces between the particles. Approximately half the tailings produced in milling 1,685,000 tonnes of ore will be used as cemented backfill in the mine underground, with the balance of tailings requiring disposal in a TIA. The estimated volume of tailings disposal capacity required is approximately 601,000 m^3, assuming a specific gravity of 2.8 and void ratio of 1.0 and a solids content of 74%.

3.1 TAILINGS CHARACTERIZATION

Testing of the tailings was completed by Canadian Environmental and Metallurgical Inc. in Burnaby, BC under the direction of Stephen Day at SRK Consulting Inc. Based on acid-base accounting, the tailings are expected to be acid generating with a negative net neutralization potential (Table 3.1). Consequently, the tailings need to be managed, both during operation and perpetually after mine closure, in a manner that does not promote sulphide oxidation and the resultant acid generation.

Consequently, the storage of tailings needs to be managed in a manner that does not promote sulphide oxidation and resultant acid generation. This objective is the primary criterion for evaluation of tailings disposal alternatives, because, with the exception of this potential to generate acid under oxidizing conditions, the tailings leachate and wastewater are expected to comply with the Manitoba Water Quality Standards Objectives and Guidelines (MSWQSOG; Williamson 2002) on the basis of tailings wastewater characterization (Wardrop 2006). Effective control of acid generation should therefore prevent any adverse effects on downstream water quality, both during operations and after mine closure.

Table 3.1: Tailings sample acid generation potential assays.		
Parameter	**Tailings sample**	**Duplicate**
Paste pH	8.2	8.2
Carbon (Total %)	0.13	-
CO_2 (%)	0.32	-
$CaCO_3$ NP	7.3	-
S (Total, %)	1.45	-
S (SO_4, %)	0.08	-
S ($S^{-2,}$ %)	1.37	-
AP	42.81	-
NP	38.5	38.4
Net NP	-4.3	-
Fizz Test	None	None

Sulphate-sulphur amalysed by sodium carbonate leach.

AP = Acid potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(total)-S(SO_4).
NP = Neutralization potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material.

NET NP = NP-AP

Carbonate NP is calculated from CO_2 originating from carbonates and is expressed in kg $CaCO_3$/tonne

4.0 TAILINGS DISPOSAL ALTERNATIVES

Common alternatives for mine tailings disposal fall into three general categories:

- In-mine disposal – placement of wet mine tailings, or some form of dewatered tailings paste, in mined out underground workings or open pit(s) from which the mined ore originated, or to a previously mined area;
- Sub-areal or land based tailings impoundment – placement of the wet tailings, or some form of dewatered tailings paste, into a constructed surface containment impoundment developed on land. The containment may entirely consist of constructed containment or use a combination of local natural topographic relief (e.g., a valley) and constructed containment; and,
- Sub-aqueous tailings storage – underwater disposal in an existing water body (pond, lake or ocean) or in a constructed waterbody.

All three tailings disposal alternatives are theoretically possible at the Bucko Lake Nickel Project site. The requirements and opportunities for the application of these disposal approaches are discussed below.

4.1 UNDERGROUND DISPOSAL

As a means by which to reduce the surface impact of mine tailings disposal, it is common for mine-milling-concentrator operations to attempt to return as much of the tailings produced as possible to the mine in the form of cemented backfill in mined-out stopes or active mines and/or disposal in the underground workings of abandoned mines. Crowflight has proposed to use approximately 50% of the tailings production from the Bucko Lake mine as cemented backfill in the mined-out stopes of the Bucko mine. As it is not possible to accommodate all of the tailings produced in the underground mine workings and as no additional underground disposal options have been identified, this necessitates the selection of a surface disposal approach for the balance of the tailings.

4.2 LAND BASED TAILINGS IMPOUNDMENT AREA

Land-based tailings disposal (LBTD) can be developed to handle conventional wet tailings or paste tailings. Wet tailings typically have a water content of about 25%. Paste tailings, which have been partially dewatered or thickened to a paste, typically have a water content in the range of 10% to 20%.

4.2.1 LAND BASED TAILINGS DISPOSAL OPTION – CONVENTIONAL WET TAILINGS PLACEMENT

Surface tailings disposal of conventional slurry tailings requires an area that can adequately and securely contain the slurry and allow for reuse/recirculation of the contained water. Typically, the preferred land-based containment site would be in a large valley or surface depression where a single constructed embankment dam, along with the natural topography, is necessary to provide complete and secure containment. The terrain in the area surrounding the Bucko Lake Nickel Project is generally flat. This topography, combined with poor drainage, creates a situation where any natural depressions are occupied by an existing lake or pond system. Consequently, a LBTD approach at the site requires reliance upon constructed containment.

Suitably sized surface areas for constructed containment occur in the extensive low-relief wetland and muskeg areas to the south and east of the mine site. Construction of such ring-dyke systems is capital intensive. This cost is projected to be particularly high in the Bucko Lake area as the ground conditions for containment embankment construction are poor. In addition to the actual tailings containment dyke, any LBTD system for conventional tailings is likely to require, at a minimum, one or more ancillary storage ponds to handle upset conditions and a settling pond for the reduction of suspended solids concentrations prior to effluent discharge.

Tailings from the Bucko Deposit are potentially acid generating (Section 3.0). Control of acid generation, both during operation and closure, requires that tailings be kept isolated from oxidising conditions. During operations, this can be achieved by keeping the tailings underwater. In the LBTD system this requires that containment embankments be constructed as water-holding structures, which may be achieved using compacted clay cores or a synthetic liner. The estimated total volume of soil and clay based on a tailings impoundment area footprint of 224,000 square metres and the preliminary embankment cross section recommended by Golder (2005) for the Bucko operation is approximately 269,280 cubic metres of soil and clay fill. Clay construction material is not locally available, which thereby necessitates the use of a synthetic liner system in the embankments.

Closure of a LBTD facility for acid generating tailings requires that the tailings containment embankments be kept in an operational state and the provision of either a continuous water cover or the installation of an engineered cover system to prevent oxidation of sulphides in the tailings. Maintaining the embankments of the LBTD system in an operational state in perpetuity will require the provision of sufficient capital in a closure fund to finance periodic inspections, maintenance, and repairs. Long term changes in climate conditions are of particular concern under this alternative because of the poorly drained soil conditions and the potential for foundation subsidence. This is a long-term risk consideration for any LBTD facility at the Bucko site.

Maintenance of a perpetual water cover for a LBTD facility at Bucko using natural processes is not possible because there would be no contributing watershed for the basin. The provision of a pumped water cover in perpetuity also is not practical. Installation of a capital-intensive engineered cover system to limit oxygen diffusion into the tailings pile is therefore necessary for closure of a LBTD for conventional tailings at the Bucko Project.

4.2.2 *Land Based Tailings Disposal Option - Paste Tailings Placement*

Paste tailings are tailings that have been sufficiently dewatered to remove excess process water from conventional wet tailings. The resulting paste mixture has a high viscosity and resistance to flow and greatly reduces bleed water with little or no segregation at the end of the discharge pipe. The practicality of thickening the tailings is governed by the ability to pump the paste to the tailings impoundment area.

Paste tailings is a relatively new technology in the mining industry but has gained wider acceptance in recent years. The advantage of using paste tailings technology primarily benefits non-acid generating tailings management facilities. Typical conventional wet tailings storage areas require extensive perimeter embankments constructed to contain wet tailings. Paste tailings do not exhibit critical flow and may not need extensive containment embankments. The paste tails can be “stacked” on land at gentle sloping angles for long term storage. Unfortunately, the full advantage of stacking paste tails on land is generally not realizable for acid-generating tailings such as will be the product of the Bucko operation. Perimeter containment remains necessary to collect and control and surface runoff

Nevertheless, some advantages of paste technology may still be realized if applied at the Bucko Lake project. The estimated total volume of paste tailings disposal capacity is 480,800 cubic metres assuming a void ratio of 0.6, a specific gravity of 2.8, and a solids content of 82 percent. This would mean a reduction in volume of fill material required for construction of the containment embankments. It is estimated that approximately 161,160 cubic metres of earth fill material is required for embankment construction for the paste tailings impoundment area, or a 40% reduction from fill requirement under the wet tailings storage scenario. In addition, stacked paste tailings have an angle of repose of approximately 10 percent which may slightly reduce the footprint of the tailings impoundment area.

Paste tailings has an other advantage in that it may reduce certain environmental risks of tailings storage. Design and construction of a tailings impoundment area for a northern climate can be extremely challenging, especially if the containment is intended to be conventional wet tailings. Paste tailings have a reduced water content such that seepage beneath or through the embankments can be greatly reduced or eliminated. In the event of an embankment breach, the risk to the environment from the escape of paste tailings may be significantly less when compared to wet tailings, as there is little or no water for transportation and the tailings do not “flow” like wet tailings. Despite this potential for greater stability, a post closure monitoring program is still required to monitor long term stability of the stacked paste piles and containment embankments.

The additional processing equipment required to produce paste tailings is capital intensive and costs more to operate than storage of wet tailings due to increased infrastructure, increased pumping costs, and additional process water treatment. The infrastructure required for paste processing would include deep cone thickeners and additional pumping equipment. Process water extracted from tailings due to the dewatering process would likely require treatment through a conventional water treatment facility.

4.2.3 *Land Based Tailings Containment Design Considerations*

Preliminary earth fill embankment geometry based on information provided by Golder (2005) has been recommended for conventional wet tailings storage. The recommended earth fill embankments have side slopes of 3:1 and a total height of 6 metres. This would be a reasonable preliminary cross section for an earth fill embankment for conventional wet tailings storage. The estimated total volume of soil required, based on a tailings impoundment area footprint of 224,000 square metres and the preliminary embankment cross section recommended by Golder (2005) is approximately 269,280 cubic metres of earth fill. This disposal option would require a large footprint (approximately 0.5 kilometre by 0.5 kilometre) for the final tailings impoundment reservoir. Additional areas will be disturbed for construction material borrow sources and access road construction.

Sourcing of 269,280 cubic metres of suitable earth fill for embankment construction will require further investigation to identify and evaluate suitable borrow locations. Alternatively, rock fill could be used. Waste rock from mining operations may be available for embankment construction should this waste rock be determined to be of a non-acid generating nature and should it be available in the quantities required at the time required taking into account the relative timelines of mine development and tailings dam construction. In the event that suitable waste rock is not available when the embankment construction is scheduled, then rock fill would have to be quarried from local near-surface sources. The use of rock fill would decrease the side slope requirement of the embankments requiring less overall material for construction. It is estimated that side slopes of 2:1 could be used for a rock fill embankment requiring a total volume of 195,840 cubic metres.

Foundation soils under the embankments would require evaluation for potential seepage under the embankments and their ability to support the long term stability of the impoundment. Peaty or organic soils would require removal under the embankments and the existing site soils may require stabilization techniques for embankment and haul road construction. A post closure long term monitoring program for the containment embankments and cover system would have to be implemented for this option.

The land based option requires a large land area for the tailings impoundment, construction haul/access roads, and borrow source. This land area is estimated at approximately 22.4 hectares for the LBTD alternative with an additional 13 hectares of land required for earth fill embankment borrow source (assuming a 2 metre depth of cut). In total, clearing, grubbing and grading of existing forest land would therefore be in excess of 35 hectares for the earth fill embankment borrow source and tailings impoundment area.

If rock fill is to be used for embankment construction it is estimated that 150,646 cubic metres of solid rock would have to be quarried for construction. The volume of rock fill calculated assumes a 30 percent rock expansion factor. This would require in excess of 3 hectares of quarry area for rock fill embankments assuming a 5 metre vertical rock cut.

A LBTD impoundment would be expected to control seepage into the surrounding environment to prevent ARD effects. Given that unstable or permeable foundation and embankment fill soils are likely to be encountered at the site, this land-based TIA would require the following special design considerations to provide adequate seepage control:

- Slurry trench cut off wall
- Concrete cut off wall and liner
- Continuous Liner System

Slurry Trench Cut Off Wall

One approach is to install a slurry trench cut off wall, which involves the excavation of a trench down the center of the embankment cross section through the underlying highly impermeable soil or competent bedrock. The trench is then backfilled with an impermeable slurry of bentonite or grout to obtain a water tight curtain around the tailings impoundment area. This method is highly cost intensive, difficult to construct in northern climates, and design is dependant on exiting site conditions.

Concrete Cut Off Wall and Liner

Alternatively, a concrete cut-off wall and liner could be installed. This design requires excavating the overburden soils at the embankment wall location down to a design depth. The embankment wall is then constructed to its final design height. At the toe of the upslope face a concrete wall is cast on underlying impermeable soil or competent bedrock to cut off flow beneath the liner. The upslope dam wall face is then clad with a synthetic liner. Upon completion of the liner installation, the remainder of the excavation is backfilled up to the original ground elevation. Finally the remainder of the dam wall between the natural ground elevation and the design height receives a soil cover and cladding of rip-rap to protect the liner. This method is cost intensive, difficult to construct in northern climates, extremely difficult or impossible to construct at depth below the water table, and design is highly dependant on existing site conditions.

Continuous Liner System

This method involves installing an engineered continuous liner (i.e., high density poly-ethylene or geosynthetic clay liner) over the entire tailings impoundment area to provide containment. The liner would provide seepage protection through underlying permeable soils and embankments.

4.3 SUB-AQUEOUS TAILINGS DISPOSAL OPTION

4.3.1 *SUB-AQUEOUS TAILINGS DISPOSAL – GENERAL CONSIDERATIONS*

Sub-aqueous disposal (SATD) of potentially acid-generating mine tailings is an established best management practice for the long-term prevention of acid rock drainage. SATD is a common practice in Canada. The climate and terrain are well suited to this deposition style, and if designed appropriately, SATD provides the best long-term closure solution for mine waste.

SATD works by preventing the geochemical reactions that pose a long term threat to water (surface and groundwater) contamination from starting, thereby offering a pro-active rather than a reactive mitigation strategy (SRK 2005). Provided the tailings can be kept covered with at least 30 centimetres of stagnant water, the water cover will provide a large enough oxygen barrier that the tailings cannot oxidize and start potentially harmful geochemical reactions. Since water is not stagnant, and tailings can be re-suspended by wave action, the rule of thumb is to ensure a minimum water cover of at least 100 centimetres (SRK 2005). Therefore, any lake considered for SATD must have sufficient volume to contain the tailings while ensuring a minimum 1 metre water cover.

5.0 ALTERNATIVE TIA SITES

Potential alternative sites for the LBTD and SATD are detailed below.

5.1 SITES FOR THE LBTD FACILITY

Considerations for siting a LBTD at the Bucko Lake project include:

- Avoidance of existing developments (e.g., Hudson Bay Railway, Town of Wabowden and related facilities);
- Location on lands demonstrated to not have mineral development potential in order to ensure future access for extraction;
- Avoidance of encroachment on Woodland Caribou habitat, and particularly on the summer calving habitat east of the mine site;
- Foundation conditions for embankments that are as competent as is available within the vicinity of the mine site; and,
- Minimise distance from mine site, particularly for control of construction material hauling costs but also for management of tailings and reclaim water pumping costs (set at 2 kilometres).

Given these criteria, available sites for a LBTD are limited to an area extending approximately 2 kilometres immediately south of the mine site. Development to the west of the site is restricted by the Town of Wabowden and the Hudson Bay Railway and by known and suspected mineral development potential. Development to the east is limited by the Woodland Caribou habitat, and particularly by the summer calving habitat, and by mineral development potential. The area south of the mine site remains within the winter and summer range of woodland caribou but minimises interaction with the critical summer calving habitat east of the site.

Within the area available for LBTD siting, foundation conditions are considered to be sufficiently similar that no comparison of specific locations is necessary at this stage of alternatives consideration.

5.2 SITES FOR THE SATD FACILITY

Bucko Lake was the only waterbody considered for SATD. Three other lakes occur within 5 kilometres of the mine site (Bowden Lake, Rock Island Lake, and an un-named lake east of Rock Island Lake). However Bucko Lake is most isolated from downstream waterbodies and both Bowden Lake and Rock Island Lake would be unacceptable choices on both social and environmental grounds. The un-named lake offers no advantage over Bucko Lake and has the disadvantages of longer pumping distance, a need to develop an access road, tailings and reclaim lines to the lake through woodland caribou habitat, and a shorter distance to the next downstream lake (less isolated).

Bucko Lake has sufficient capacity to contain all of the tailings generated by the project, is separated from the next downstream lake by over 4 kilometres of wetland, and is not accessible to sport fish in downstream waterbodies (Wardrop 2006).

During operation of the TIA, discharge from Bucko Lake would be controlled through two concrete weirs and directed into Bucko Creek via a secondary polishing pond. The polishing pond provides the capacity for final settling of suspended solids before effluent release to the receiving environment as well as the ability to apply specific treatment for the management of effluent quality during process upsets. A conceptual design and layout for the concrete weirs and polishing pond is provided in Appendix A.

Due to the flat topography at the headwater of Bucko Creek, relatively long earth fill embankments would have to be constructed. The selected tailings impoundment system would comprise two embankments, one at the outlet of Bucko Lake and the other downstream of the outlet to contain the polishing pond. The design volumes and capital cost estimate associated with constructing these embankments were based on the following assumptions:

- Based on the anticipated foundation conditions and available construction material, side slopes for the embankments are anticipated to be shallow, on the order of 3 Horizontal to 1 Vertical (3H:1V);
- Embankments would be approximately 375 metres and 250 metres long for the lake outlet and polishing ponds, respectively; and,
- Two small, concrete control weirs would be constructed at the outlets of Bucko Lake and the polishing pond.

The primary containment dyke and control weir will be left in place after closure to ensure that a minimum water cover of 1 metre is maintained over the tailings.

6.0 ALTERNATIVES COST COMPARISON

The estimated costs for all disposal options discussed in previous sections of this report have been considered. A detailed cost break down is provided in Appendix B and costs for each alterative are summarized in Table 6.1

Based on the capital cost estimates provided in Table 6.1, the most cost effective disposal option for construction of the TIA is sub-aqueous disposal into Bucko Lake. The conceptual cost analysis Includes closure costs, quality control and construction monitoring costs, construction costs, and long term monitoring costs associated with the TIA.

Table 6.1: Conceptual Estimated Capital Cost Analysis for Tailings impoundment area Disposal Options. See Appendix B for detailed cost estimates.

Description	Total Estimated Capital Cost
LBTD for Conventional Wet Tailings Rock Fill Embankment With Concrete Cut Off Wall	$17,281,760.00
LBTD for Paste Tailings Rock Fill Embankment With Concrete Cut Off Wall	$14,864,320.00
LBTD for Conventional Wet Tailings Rock Fill Embankment With Slurry Trench Wall	$21,107,360.00
LBTD for Paste Tailings Rock Fill Embankment With Slurry Trench Wall	$18,689,920.00
LBTD for Conventional Wet Tailings Rock Fill Embankment With Continuous Liner	$19,097,360.00
LBTD for Paste Tailings Rock Fill Embankment With Continuous Liner	$16,679,920.00
Sub-Aqueous Disposal – Bucko Lake	$2,234,625.00

7.0 SELECTION OF PREFERRED ALTERNATIVE

7.1 CEAA Operational Policy Statement on Alternative Assessment

The Canadian Environmental Assessment Agency (CEAA) issued an Operational Policy Statement in 1998 that provides clarification and guidance on how to deal with alternatives assessment (CEAA 1998). Under this guideline document there are various levels of alternative assessment. Tailings disposal alternatives for the Bucko Lake Nickel Project can be classified in terms of the guidelines associated with “Alternative means of carrying out a project”. In summary, the guideline document defined that “alternative means” are the various ways in which a component of the project can be carried out, and that are technically and economically feasible. In identifying alternative means, the proponent should:

- Develop criteria to determine the technical and economic feasibility of the alternative means;
- Describe each alternative in sufficient and appropriate detail; and,
- Identify those alternative means that are technically and economically feasible.

The proponent should identify those elements of each alternative means that could produce potential adverse environmental effects. Then, in identifying a preferred means, the proponent should:

- Base the decision on a relative consideration of potential adverse environmental effects, and on technical and economic feasibility.
- Determine and apply criteria that identify alternative means as unacceptable on the basis of significant adverse environmental effects.
- Determine criteria to examine the adverse environmental effects of each remaining alternative means to identify a preferred alternative.

The advantages and disadvantages of land-based tailings disposal are detailed in Section 7.2 with sub-aqueous tailings disposal considered in Section 7.3.

7.2 Advantages and Disadvantages of Land Based Tailings Disposal

Land based disposal for the Bucko Lake Mine tailings poses many environmental, long term stability, monitoring, economic, and construction concerns with few advantages. These are detailed below for the conventional wet tailings disposal and paste tailings disposal approaches and consider both the operating and the closed-out phases of the project.

7.2.1 Conventional Wet Tailings

Advantages

Operation

- Effluent quality – routine operations - provided a water cover can be maintained, and under normal operating conditions, TIA effluent quality should meet MWQSOG based on tailings wastewater characterization to date without additional treatment other than settling of suspended solids;
- Water cover over wet tailings placement can be maintained to prevent acid-generation during normal operations – a best management practice.

Closure

- LBTD of conventional wet tailings offers no advantages over the other disposal approaches.

Disadvantages

Operation

- Terrestrial habitat disturbance – involving some 35+ hectares of winter and/or summer range for Woodland Caribou, a Species at Risk. This is a permanent habitat loss/disturbance;
- Effluent quality – upset conditions - limited pond volume of constructed TIA may make it difficult to deal with upset conditions, leading to degradation of effluent quality and potential suspension of operations pending restoration of normal operating conditions;
- Capital-intensive disposal approach due to requirement for seepage control through embankments and foundations.

Closure

- Terrestrial habitat disturbance persists after closure.
- Engineered infiltration/diffusion barrier necessary for cover at closure for control of ARD as water cover cannot be maintained.
    - High capital cost;
    - Less effective than water cover. Engineered cover can generally reduce infiltration by about 80%, such that a small quantity of potentially acidic seepage may be generated.

- o Limited performance history for previous barrier installations (less than 40 years) – uncertain/unknown performance in perpetuity. May require replacement or major repair at some time in the future (i.e., 100+ years);
- o Foundation conditions – long-term stability of foundation conditions beyond a 100 year design life difficult to assure, particularly given the difficult soil conditions at the site;
- o Embankment failure would compromise ARD control and cause significant adverse environmental impact.

7.2.2 PASTE TAILINGS DISPOSAL

OPERATION

Advantages

- Some reduction in material requirements for embankment construction and corresponding small reduction in TIA footprint in comparison to conventional wet tailings;
- Provision of effective control of sulphide mineral oxidation - limited performance history indicates acceptable control of oxidation can likely be achieved during operation. Control is less certain than for the water cover approach.

Disadvantages

- Terrestrial habitat disturbance – involving some 35+ hectares of winter and/or summer range for Woodland Caribou, a Species at Risk. This is a permanent habitat loss/disturbance;
- Highest overall engineering and capital cost for construction;
- Effluent quality – primary effluent issue is management of water removed from tailings in preparation of paste – in the absence of detailed design work, may require treatment to achieve acceptable quality for discharge;
- Additional cost for paste production and pumping facility (may offset embankment savings);
- Additional wet tailings and wastewater storage is necessary to manage process upsets.

CLOSURE

Advantages

- A potential but as yet unproven advantage of paste tailings disposal is the low permeability of the paste that may limit oxidation of the tailings pile without a requirement for expensive impoundment liners or covers.

- Resistance of the paste to flow reduces the potential adverse environmental impact of an impoundment failure.

Disadvantages

- Terrestrial habitat disturbance persists after closure.
- Post-closure performance of non-covered paste tailings in perpetuity is uncertain/unknown due to short history of application;
    - Specific closure requirements uncertain – may require infiltration/diffusion to address perpetual control requirement;
    - Limited performance history for previous barrier installations (less than 40 years) – uncertain/unknown performance in perpetuity although may be more secure than over conventional tailings placement;
    - Engineered cover and impoundment seepage controls may be necessary to provide sufficient security of closure;
    - Additional research is required before approach can be applied with confidence. This research is more appropriately conducted at a larger, long-life mine.
- Security/stability of containment at closure
    - Difficult to ensure security/stability of significant engineered earth fill structures constructed in wetland/swamp for more than a 100 year design life. Embankment failure may compromise ARD control although to a lesser extent than for conventional tailings disposal
- Above risks/uncertainties will require a large contingency bond to be posted at close-out to ensure potential future monitoring/maintenance/repair/mitigation costs are covered. This is an inappropriate burden to place on a relatively short-term mining project.

A long term monitoring program would need to be implemented to periodically inspect the TIA and determine the integrity of the containment embankments for safety considerations. The final closure of the tailings facility would include a cost intensive engineered cover system that would encapsulate the tailings for long term storage.

The LBTD options are the most cost intensive solutions to tailings management and include large-scale civil construction projects which would be disruptive to the surrounding environment. Cost of the LBTD option would increase the overall capital cost of the project by approximately 30%.

7.3 Sub-Aqueous Tailings Disposal Option Considerations

Sub-aqueous disposal (SATD) of potentially acid-generating mine tailings is an established best management practice for the long-term prevention of acid rock drainage. SATD is a common practice in Canada. The climate and terrain is well suited to this deposition style and, if designed appropriately, SATD provides the best long-term closure solution for mine waste (SRK 2005).

SATD works by preventing the geochemical reactions that pose a long term threat to water (surface and groundwater) contamination from starting, thereby offering a pro-active rather than a reactive mitigation strategy (SRK 2005). Provided the tailings can be kept covered with at least 30 cm of stagnant water, the water cover will provide a large enough oxygen barrier that the tailings cannot oxidize and start potentially harmful geochemical reactions. Since water is not stagnant, and tailings may be re-suspended by wave action, the rule of thumb is to ensure a minimum water cover of at least 100 cm (SRK 2005). Therefore, any lake considered for SATD must have sufficient volume to contain the tailings while ensuring a minimum 1 m water cover.

The primary potential disadvantage of using an existing lake for tailings disposal is the loss of some, or all, of the contained aquatic habitat. However, a requirement of the Federal government's Metal Mine Effluent Regulation is that compensatory habitat must be developed to, at a minimum, offset the loss of any fish habitat in the lake that may occur during tailings production so there is no net loss of fish or fish habitat and, consequently, no significant adverse effect.

The use of a lake for tailings disposal also has the potential to alter downstream water quality and hydrology. These effects are not restricted to SATD facilities but are an equal concern for LBTD facilities. In either case, downstream effects on water quality or hydrology must be managed within established limits set by regulatory authorities in order to prevent adverse impacts. The Bucko Lake TIA will be operated in a manner that preserves the downstream hydrologic regime and effluent quality is expected to meet the MSWSOG such that downstream water quality will be adversely affected. Consequently, the sub-aqueous disposal option can be developed without having a significant adverse effect on the aquatic environment.

The sub-aqueous disposal option for the Bucko Lake Mine tailings offers many environmental, long term stability, monitoring, economic, and construction advantages.

Some of these advantages are;

- The best long-term prevention of ARD during operation and post-closure;
- Negligible impact on terrestrial habitat and no impact on woodland caribou habitat;
- Greater ability to manage process upsets without affecting project operation OR effluent quality;

- Smallest and most stable containment structures with the lowest potential for adverse effect in the event of a structural failure;
- Lowest overall environmental risk; and,
- Lowest engineering and capital cost for construction and closure.

7.4 Identification of Preferred Tailings Disposal Option

The preferred tailings disposal approach was selected using a ranking matrix that considered the following engineering, environmental, and economic criteria:

- Containment Constructability – assessed on the basis of engineering experience in similar situations;
- Containment Stability/Security at Closure – assessed on the basis of engineering experience in similar situations;
- Net Environmental Impact of Operations on Terrestrial and on Aquatic Resources – based on quantifiable non-mitigable disturbance/destruction of habitat and expected effluent quality;
- Net Environmental Impact on, or Risk to, Terrestrial Resources and Aquatic Resources Following Closure – impacts based on quantifiable non-mitigable disturbance/destruction of habitat and expected effluent quality and risks based on potential consequences of a failure of the disposal option to prevent ARD;
- Capital Cost – based on the cost analysis presented in Appendix B ; and,
- Long-term Closure Cost. – based on the cost analysis presented in Appendix B.

For each criterion, the impact, risk, or cost (as appropriate to the category) of each disposal option was ranked from 1 to 3, with 1 assigned to the option with the lowest impact, risk, or cost; 2 representing an intermediate impact, risk, or cost; and, 3 representing the highest impact, risk, or cost. The cumulative rank for each option was determined by summing the individual scores for that option across the criteria. The option with the lowest cumulative ranking score is therefore the best option based on the evaluation criteria.

Table 5.1. Ranking matrix for tailings disposal alternatives for the Bucko Lake Nickel Project.

			Net Environmental Impact						
	Containment		Operations		Closure		Cost		
TIA Alternative	Construct-ability	Closure Stability	Terrestrial	Aquatic	Terrestrial	Aquatic	Capital	Long-term Closure	Total Score
Land Based Disposal									
Conventional Wet Tailings	3	3	3	1	3	3	2	3	21
Paste Tailings	2	2	2	2	2	2	3	2	17
Sub-aqueous Disposal									
Bucko Lake	1	1	1	1	1	1	1	1	8

The matrix analysis is detailed in Table 5.1, and demonstrates that sub-aqueous disposal is the best alternative on the basis of engineering and environmental considerations and also is the lowest cost disposal option. Although in-lake disposal is the lowest cost option, the same conclusion is reached when cost is removed from the evaluation criteria. Therefore, based on the evaluation of sub-aqueous and land based disposal options and the consideration of factors such as reduction of acid drainage, long term stability, sustainability, and cost, Wardrop recommends the sub-aqueous tailings disposal option. This option is considered a best practice method for tailings disposal and has a far lower capital cost than land based disposal. The submerged option results in less non-mitigable environmental disturbance and less long term environmental risk resulting in the most stable and secure means of long term disposal.

8.0 REFERENCES

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APPENDIX A

PLANS AND CONCEPTUAL DESIGNS

NO.	DESCRIPTION	DATE	ISSUED BY

REVISIONS/ISSUE

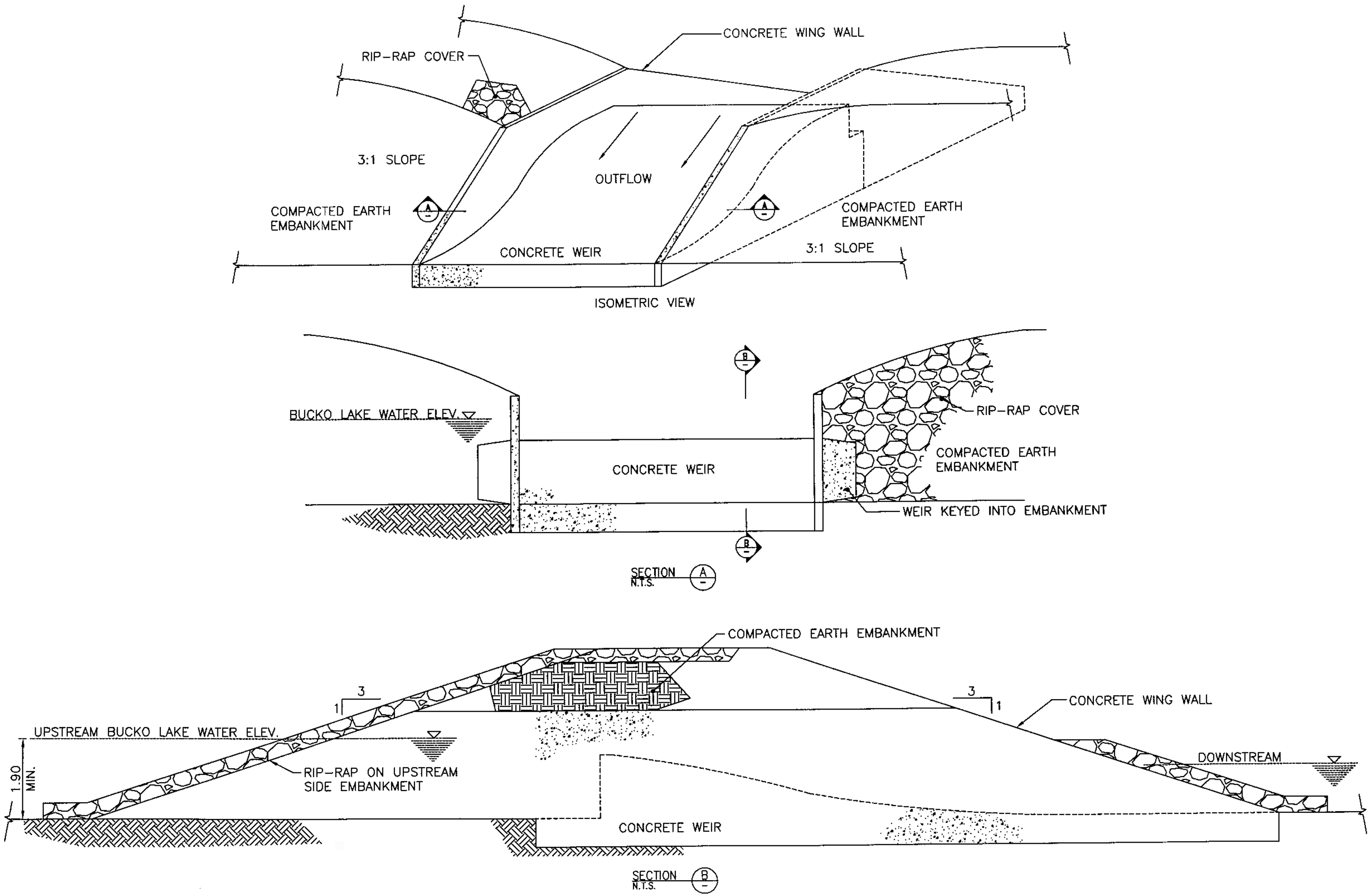
WARDROP | Engineering Inc.

CLIENT
CROWFLIGHT MINERALS INC.

DRAWING DESCRIPTION
LOCATION OF WEIRS ON BUCKO CREEK
FOR LAKE BASED OPTION

DESIGNED BY: C.F.	DRAWN BY: CTW	DRAWING NO.	REV.
CHECKED BY:	DATE: 06.12.18	0651790100-SKT-C0007	A1

A4 (210 x 297)



NO.	DESCRIPTION	DATE	ISSUED BY
A	SECTIONS AND DETAILS	06.12.19	C.T.W.

REVISIONS/ISSUE

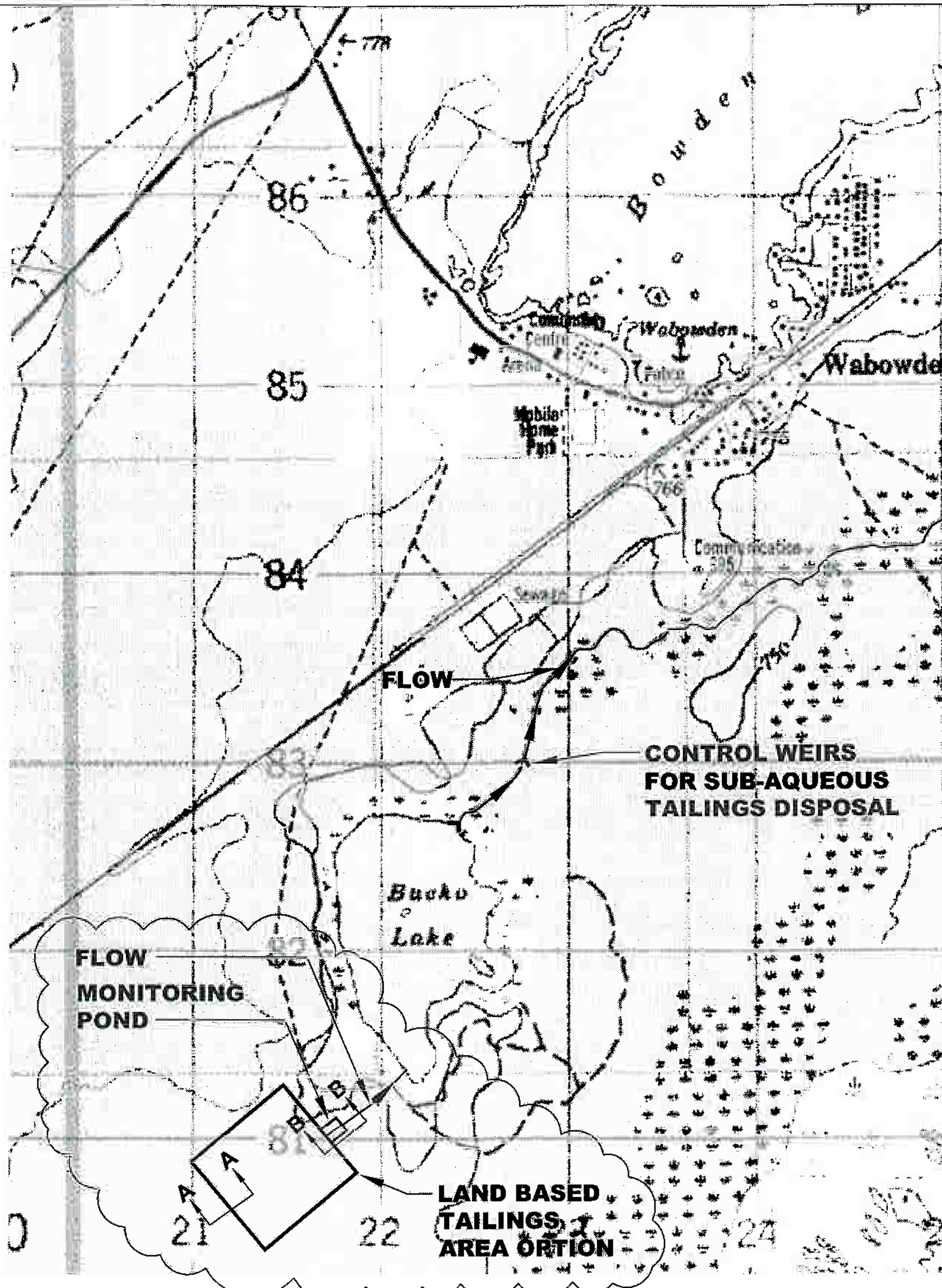
WARDROP | Engineering Inc.

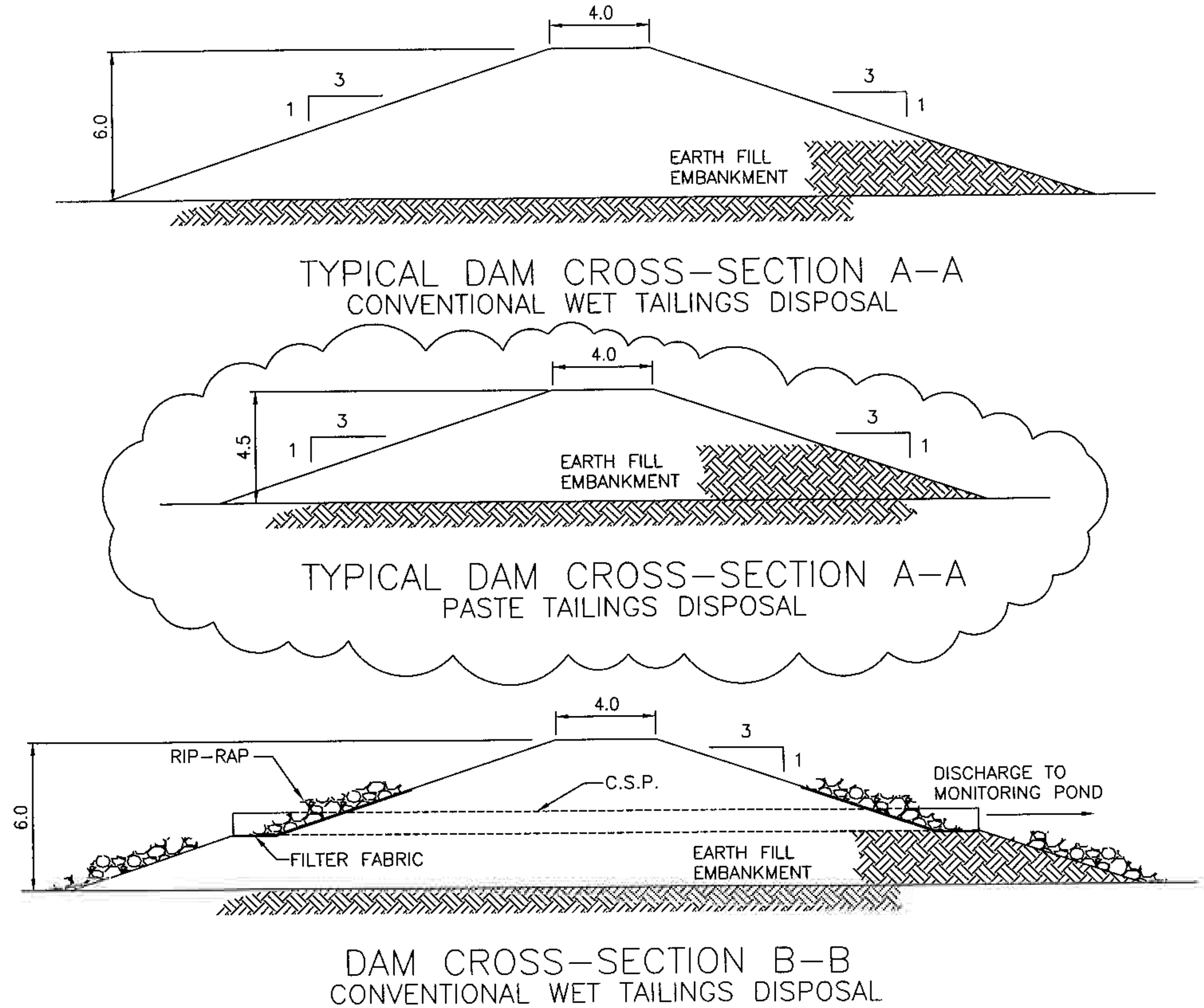
CLIENT
CROWFLIGHT MINERALS INC.

DRAWING DESCRIPTION
WEIR CROSS SECTIONS
LAKE BASED OPTION

DESIGNED BY: C.F.	DRAWN BY: C.T.W.	DRAWING NO. 0651790100-SKT-C0008	REV. A1
CHECKED BY:	DATE: 06.12.19		

B (11" x 17")





NO.	DESCRIPTION	DATE	BY
B	TAILINGS OPTION MOVED	07/01/02	
A	CONCEPTUAL DESIGN	06/12/23	C.F.

REVISIONS/ISSUE

WARDROP | Engineering Inc.

CLIENT: CROWFLIGHT MINERALS LTD.

DRAWING DESCRIPTION: TAILINGS MANAGEMENT AREA
BUCKO LAKE MINE, WABOWDEN, MB
LAND BASED OPTION

DESIGNED BY: C.F.	DRAWN BY: CTW	DRAWING NO.	REV.
CHECKED BY:	DATE: 06.12.20	0651790100-SKT-C0009	B1

APPENDIX B

CONCEPTUAL CAPITAL COST ANALYSIS

Conceptual Cost Analysis of Tailings Management Area
Crowflight Minerals - Bucko Lake Project
Land Based Disposal of Conventional Wet Tailings
Rock Fill Embankment With Slurry Trench Wall

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Site Mob & Demob				$150,000.00
Haul Road Fill	5,000	m^3	$12.00	$60,000.00
Perimeter Embankment Construction (rock fill)	269,280	m^3	$12.00	$3,231,360.00
Site Grading and Stripping	67,200	m^3	$15.00	$1,008,000.00
Site and Borrow Area Clearing and Grubbing	30	Hectare	$4,000.00	$120,000.00
Filter Fabric	61,200	m^2	$5.00	$306,000.00
Slurry Trench Wall Construction				$8,200,000.00
Culvert Installation				$30,000.00
Engineering Costs				$250,000.00
Monitoring Equipment				$250,000.00
QA Construction Supervision				$150,000.00
Monitoring Pond Construction				$1,500,000.00
Long Term Monitoring				$10,000.00
Final Closure Costs				
Engineered Cover System Construction	112,000	m^3	$35.00	$3,920,000.00
Liner	224,000	m^2	$8.00	$1,792,000.00
Engineering				$100,000.00
QA Construction Supervision				$30,000.00
Total Capital Cost				**$21,107,360.00**

Conceptual Cost Analysis of Tailings Management Area
Crowflight Minerals - Bucko Lake Project
Land Based Disposal of Paste Tailings
Rock Fill Embankment With Slurry Trench Wall

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Site Mob & Demob				$150,000.00
Haul Road Fill	5,000	m^3	$12.00	$60,000.00
Perimeter Embankment Construction (rock fill)	161,160	m^3	$12.00	$1,933,920.00
Site Grading and Stripping	67,200	m^3	$15.00	$1,008,000.00
Site and Borrow Area Clearing and Grubbing	30	Hectare	$4,000.00	$120,000.00
Filter Fabric	61,200	m^2	$5.00	$306,000.00
Slurry Trench Wall Construction				$8,200,000.00
Culvert Installation				$30,000.00
Engineering Costs				$250,000.00
Monitoring Equipment				$250,000.00
QA Construction Supervision				$150,000.00
Monitoring Pond Construction				$1,500,000.00
Long Term Monitoring				$10,000.00
Final Closure Costs				
Engineered Cover System Construction	112,000	m^3	$25.00	$2,800,000.00
Liner	224,000	m^2	$8.00	$1,792,000.00
Engineering				$100,000.00
QA Construction Supervision				$30,000.00
Total Capital Cost				**$18,689,920.00**

Conceptual Cost Analysis of Tailings Management Area
Crowflight Minerals - Bucko Lake Project
Land Based Disposal of Conventional Wet Tailings
Rock Fill Embankment With Continuous Liner

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Site Mob & Demob				$150,000.00
Haul Road Fill	5,000	m^3	$12.00	$60,000.00
Perimeter Embankment Construction (rock fill)	269,280	m^3	$12.00	$3,231,360.00
Site Grading and Stripping	67,200	m^3	$15.00	$1,008,000.00
Site and Borrow Area Clearing and Grubbing	30	Hectare	$4,000.00	$120,000.00
Composite Liner	224,000	m^2	$14.00	$3,136,000.00
Bottom Soil Cover	112,000	m^3	$30.00	$3,360,000.00
Culvert Installation				$30,000.00
Engineering Costs				$250,000.00
Monitoring Equipment				$250,000.00
QA Construction Supervision				$150,000.00
Monitoring Pond Construction				$1,500,000.00
Long Term Monitoring				$10,000.00
Final Closure Costs				
Engineered Cover System Construction	112,000	m^3	$35.00	$3,920,000.00
Liner	224,000	m^2	$8.00	$1,792,000.00
Engineering				$100,000.00
QA Construction Supervision				$30,000.00
Total Capital Cost				**$19,097,360.00**

Conceptual Cost Analysis of Tailings Management Area
Crowflight Minerals - Bucko Lake Project
Land Based Disposal of Paste Tailings
Rock Fill Embankment With Continuous Liner

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Site Mob & Demob				$150,000.00
Haul Road Fill	5,000	m^3	$12.00	$60,000.00
Perimeter Embankment Construction (rock fill)	161,160	m^3	$12.00	$1,933,920.00
Site Grading and Stripping	67,200	m^3	$15.00	$1,008,000.00
Site and Borrow Area Clearing and Grubbing	30	Hectare	$4,000.00	$120,000.00
Composite Liner	224,000	m^2	$14.00	$3,136,000.00
Bottom Soil Cover	112,000	m^3	$30.00	$3,360,000.00
Culvert Installation				$30,000.00
Engineering Costs				$250,000.00
Monitoring Equipment				$250,000.00
QA Construction Supervision				$150,000.00
Monitoring Pond Construction				$1,500,000.00
Long Term Monitoring				$10,000.00
Final Closure Costs				
Engineered Cover System Construction	112,000	m^3	$25.00	$2,800,000.00
Liner	224,000	m^2	$8.00	$1,792,000.00
Engineering				$100,000.00
QA Construction Supervision				$30,000.00
Total Capital Cost				**$16,679,920.00**

Conceptual Cost Analysis of Tailings Management Area
Crowflight Minerals - Bucko Lake Project
Land Based Disposal of Conventional Wet Tailings
Rock Fill Embankment With Concrete Cut-Off Wall

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Site Mob & Demob				$150,000.00
Haul Road Fill	5,000	m^3	$12.00	$60,000.00
Perimeter Embankment Construction (rock fill)	269,280	m^3	$12.00	$3,231,360.00
Site Grading and Stripping	224,000	m^3	$12.00	$2,688,000.00
Site and Borrow Area Clearing and Grubbing	30	Hectare	$4,000.00	$120,000.00
Synthetic Liner	61,200	m^2	$12.00	$734,400.00
Filter Fabric	61,200	m^2	$5.00	$306,000.00
Concrete Cut-Off Wall Construction	1,020	m^3	$2,000.00	$2,040,000.00
Culvert Installation				$30,000.00
Engineering Costs				$200,000.00
Monitoring Equipment				$250,000.00
QA Construction Supervision				$120,000.00
Monitoring Pond Construction				$1,500,000.00
Long Term Monitoring				$10,000.00
Final Closure Costs				
Engineered Cover System Construction	112,000	m^3	$35.00	$3,920,000.00
Liner	224,000	m^2	$8.00	$1,792,000.00
Engineering				$100,000.00
QA Construction Supervision				$30,000.00
Total Capital Cost				**$17,281,760.00**

Conceptual Cost Analysis of Tailings Management Area
Crowflight Minerals - Bucko Lake Project
Land Based Disposal of Paste Tailings
Rock Fill Embankment With Concrete Cut-Off Wall

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Site Mob & Demob				$150,000.00
Haul Road Fill	5,000	m^3	$12.00	$60,000.00
Perimeter Embankment Construction (rock fill)	161,160	m^3	$12.00	$1,933,920.00
Site Grading and Stripping	224,000	m^3	$12.00	$2,688,000.00
Site and Borrow Area Clearing and Grubbing	30	Hectare	$4,000.00	$120,000.00
Synthetic Liner	61,200	m^2	$12.00	$734,400.00
Filter Fabric	61,200	m^2	$5.00	$306,000.00
Concrete Cut-Off Wall Construction	1,020	m^3	$2,000.00	$2,040,000.00
Culvert Installation				$30,000.00
Engineering Costs				$200,000.00
Monitoring Equipment				$250,000.00
QA Construction Supervision				$120,000.00
Monitoring Pond Construction				$1,500,000.00
Long Term Monitoring				$10,000.00
Final Closure Costs				
Engineered Cover System Construction	112,000	m^3	$25.00	$2,800,000.00
Liner	224,000	m^2	$8.00	$1,792,000.00
Engineering				$100,000.00
QA Construction Supervision				$30,000.00
Total Capital Cost				**$14,864,320.00**

Conceptual Cost Analysis
Crowflight Minerals Bucko Lake Project
Sub-aqueous Tailings Disposal - Bucko Lake

Description	Estimated Quantity	Units	Cost per Unit	Estimated Cost
Clearing and Grubbing	1	hectare	4000	$4,000.00
Site Grading and Stripping	1875	m^3	$15.00	$28,125.00
Earth Fill Embankment - Primary Containment	40,500	m^3	$25.00	$1,012,500.00
Earth Fill Embankment - Secondary Containment	27,000	m^3	$25.00	$675,000.00
Primary Weir Construction				$110,000.00
Secondary Weir Construction				$110,000.00
Water Diversion Work				$120,000.00
Construction Supervision and QC				$60,000.00
Engineering Fees				$35,000.00
Long Term Monitoring Costs				
Embankment Safety Inspections and Annual Water Testing				$80,000.00
Total Capital Cost				**$2,234,625.00**