MEADOWBANK
MINING CORPORATION

MEADOWBANK GOLD PROJECT

MINE WASTE & WATER MANAGEMENT

AUGUST 2007

EXECUTIVE SUMMARY

Meadowbank Mining Corp (MMC), formerly Cumberland Resources Ltd. (Cumberland), has decided to develop the Meadowbank Gold Project. The mine property is located in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake on Inuit-owned surface lands. MMC has been actively exploring the Meadowbank area since 1995.

The Meadowbank Gold Project is subject to the environmental review and related licensing and permitting processes established by Part 5 of the Nunavut Land Claims Agreement. This report presents the Mine Waste and Water Management Plan for the Project and forms a component of the documentation series that has been produced during environmental review and permitting process.

A pre-fabricated, modular-type accommodation complex is planned to house personnel during mine operations. The accommodation complex will be supported with a sewage treatment plant, solid waste disposal, and potable water treatment plant. Fresh water for site use will be pumped from Third Portage Lake. Solid waste from the accommodation camp, kitchen, shops, and offices will be burned in a diesel-fired waste incinerator. Non-salvageable, non-hazardous solid waste will be buried in one of two solid waste landfills. Hazardous waste will be stored on site in secure facilities until they can be transported to other provincial or territorial jurisdictions for recycling or disposal.

The Meadowbank Gold Project consists of several gold-bearing deposits: Vault, Portage and Goose Island. A series of dikes will be required to isolate the mining activities from neighbouring lakes. The dikes will be constructed using materials produced during mining or by stripping from the footprint of the waste rock storage areas.

Waste rock from the Portage and Goose Island pits will be stored in the Portage Rock Storage Facility. The storage area will be constructed to minimize the disturbed area, and will be capped with a layer of non-acid-generating rock to constrain the active layer within relatively inert materials. The control strategy to minimize the onset of oxidation and the subsequent generation of acid mine drainage includes freeze control of the waste rock through permafrost encapsulation and capping with an insulating convective layer of neutralizing ultramafic rock. The waste rock below the capping layer is expected to freeze, resulting in low rates of ARD generation in the long term.

Waste rock from the Vault Pit will be stored in the Vault Rock Storage Facility. Current geochemical predictions indicate that a capping layer will not be required over this area. An adaptive management plan will include monitoring of water quality during operations to confirm modelling predictions, and to allow adjustments to the closure plan as required. The waste rock is expected to eventually freeze.

Tailings will be stored in Second Portage Arm. Initially the tailings will be deposited in a subaqueous environment, but the majority of tailings will be deposited subaerially. A Reclaim Pond will be operated within the Tailings Storage Facility. The control strategy to minimize water infiltration into the Tailings Storage Facility and the migration of constituents out of the facility includes freeze control of the tailings through permafrost encapsulation. A 2-m thick dry cover of acid-neutralizing ultramafic rockfill will be placed over the tailings as an insulating convective layer to confine the permafrost active layer within relatively inert materials. The potential for groundwater contamination to occur as a result of seepage from the Tailings Storage Facility is considered to be low.

The water management objectives for the Project are to minimize potential impacts to the quantity and quality of surface water and groundwater resources at the site. Diversion ditches will be constructed to avoid the contact of clean runoff water with areas affected by the mine or mining activities. Contact water originating from affected areas will be intercepted, collected, conveyed to central storage facilities for re-use in process, or decant to treatment (if needed) prior to release to receiving lakes. The uncontrolled release of contact water to the neighbouring lakes is not anticipated.

During Years 1 to 5, site contact water from the Portage mine area will be attenuated in the Portage Attenuation Pond located in a basin at the northwest end of Second Portage Arm. Contact water collected within the Attenuation Pond will be used to satisfy mill process water make-up requirements with any excess water treated, if required, and discharged to Third Portage Lake. Reclaim water from the TSF will also be available to meet the process water demand, with excess water being returned to the Reclaim Pond.

In Year 6, the main basin will become filled with tailings, and tailings deposition will commence in the northwest basin until the end of mining operations. At this time the former Portage Attenuation Pond will be used as the Reclaim Pond, and freshwater make-up to mill will be sourced from mill area runoff supplemented by pumping from either Third Portage Lake or the flooded pit lakes.

Vault Lake will be dewatered in Year 4 to provide attenuation storage for site contact water from the Vault mine area prior to release to Wally Lake. The Vault Attenuation Pond will be operated such that the annual volume of water collected within the pond will be decanted during the open water period. This limits the amount of water that will be stored over the winter period and maximizes the storage capacity available for the spring freshet.

Following completion of mining in the respective pits, the pits will be filled with water from Third Portage Lake or Wally Lake over a period of several years. The Reclaim Pond will remain in place until mining has been completed. At this time, excess reclaim water will be drained to the Portage or Goose Island pit lakes, which will be isolated from the receiving lakes by the dewatering dikes. Reclaim water will be treated, if necessary, prior to discharge to the pit lakes. If required, treatment will be in-situ (within the Reclaim Pond) or via a water treatment plant converted from the Process Plant.

Water management during closure and reclamation will involve maintaining surface water diversions to prevent clean runoff water from coming into contact with areas affected by the mine or mining activities. The water management facilities, including the dewatering dikes, attenuation ponds, water collection systems (sumps and ditches), and treatment plants (if necessary), will be required to remain in place until mine closure activities are completed and monitoring results demonstrate that water quality conditions are acceptable for discharge of all contact water to the environment without further treatment.

All infrastructure that may be maintained for mine operations, closure and reclamation including the airstrip, roads, storage pads, quarries, granular borrow areas (if present), ditches and sumps will be re-contoured and/or surface treated according to site specific conditions to minimize wind blown dust and erosion from surface runoff, and enhance the development site area for revegetation and wildlife habitat.

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PROJECT LOCATION MAP

SECTION 1 • INTRODUCTION

Meadowbank Mining Corporation (MMC), formerly Cumberland Resources Ltd. (Cumberland), is proposing to develop the Meadowbank Gold Project located approximately 70 km north of Baker Lake in Nunavut. This report presents the proposed Mine Waste and Water Management Plan for the Project.

The site is located in an arctic environment and is underlain by continuous permafrost. The proposed mine will generate approximately 182 Mt of mine waste rock, and 22 Mt of tailings from the following deposits:

- Vault (intermediate volcanic rocks)
- North Portage (iron formation, intermediate volcanic, and ultramafic rocks)
- Third Portage (iron formation, intermediate volcanic, and ultramafic rocks)
- Goose Island (iron formation, intermediate volcanic and ultramafic rocks).

The ultramafic rocks are acid-neutralizing (non-PAG) with a buffering capacity of up to five times that of the other rock types. A portion of the intermediate volcanic rocks from the Vault and Portage deposits are potentially acid-generating (PAG). All remaining waste rock types and the tailings are also PAG.

Several options for the storage of mine waste rock and tailings were evaluated using decision matrices, and preferred sites were selected. Waste rock from the Portage and Goose Island open pits will be stored in an area to the north of Second Portage Arm and to the west of the Vault Haul Road. It is proposed that each rock storage facility is constructed as a cell, or series of cells, such that the interior of each cell is composed of any PAG and/or metal leaching (ML) waste, and the exterior of each cell is composed of non-PAG waste. The rock storage facility will be capped at closure with a layer of non-PAG ultramafic rock to constrain the active layer within relatively inert materials, and will be regraded to encourage runoff from the facility. The PAG waste rock is expected to freeze, resulting in low rates of acid rock drainage (ARD) generation in the long term.

Waste rock from the Vault Pit will be stored in an area to the west of the pit. The Vault Rock Storage Facility (RSF) will be regraded at closure to encourage runoff and to provide a final shape consistent with the surrounding topography. The water seepage from the Vault RSF area is expected to be of suitable quality to allow discharge to the environment without treatment (Golder 2007l), and capping of this facility is therefore not proposed.

Tailings will be stored in northwest arm of Second Portage Lake, which is currently underlain by a talik that extends through the permafrost to the underlying groundwater system. Tailings will be placed as thickened slurry. A Reclaim Pond will be operated within the Tailings Storage Facility (TSF).

Thermal modelling indicates that the tailings will freeze in the long term, and that the talik that currently exists below Second Portage Arm will freeze before seepage from the TSF reaches the groundwater below the permafrost. Therefore, the potential for groundwater contamination to occur as a result of seepage from the TSF is considered to be low. A 2-m thick dry cover of non-PAG ultramafic rockfill will be placed over the tailings at closure to promote the development of the permafrost active layer within relatively inert materials. The cover design may include a layer of finer grained material as an insulating layer.

A water management plan for contact and diverted water is presented. The plan proposes diversions to avoid the contact of clean runoff water with areas affected by the mine or mining activities. Contact water originating from mine-affected areas will be intercepted, collected, conveyed to central storage facilities, and decanted to treatment, if needed, or to receiving lakes. Portions of the dewatered Vault Lake and Second Portage Arm will serve as the central water attenuation storage facilities.

A site water balance model was prepared to identify the water sources and their relative contribution and to evaluate proposed water management infrastructure.

SECTION 2 • BACKGROUND INFORMATION

2.1 PROJECT DESCRIPTION

The Meadowbank Gold Project consists of several gold-bearing deposits within reasonably close proximity to one another. The four main deposits are: Vault, Portage (including the Third Portage deposit, and the Bay Zone, Connector and North Portage deposit), and Goose Island (Figure 2.1).

The Third Portage deposit is located on a peninsula, and extends northward under Second Portage Lake and southward under Third Portage Lake. The North Portage deposit is located on the northern shore of Second Portage Lake. The Third Portage deposit, Bay Zone, Connector Zone, and North Portage deposit will be mined from a single pit, termed the Portage pit, which will extend approximately 2 km in a north-south direction. The Goose Island deposit lies approximately 1 km to the south of the Third Portage deposit, and beneath Third Portage Lake. The Vault deposit is located adjacent to Vault Lake, approximately 6 km north from the Portage deposits.

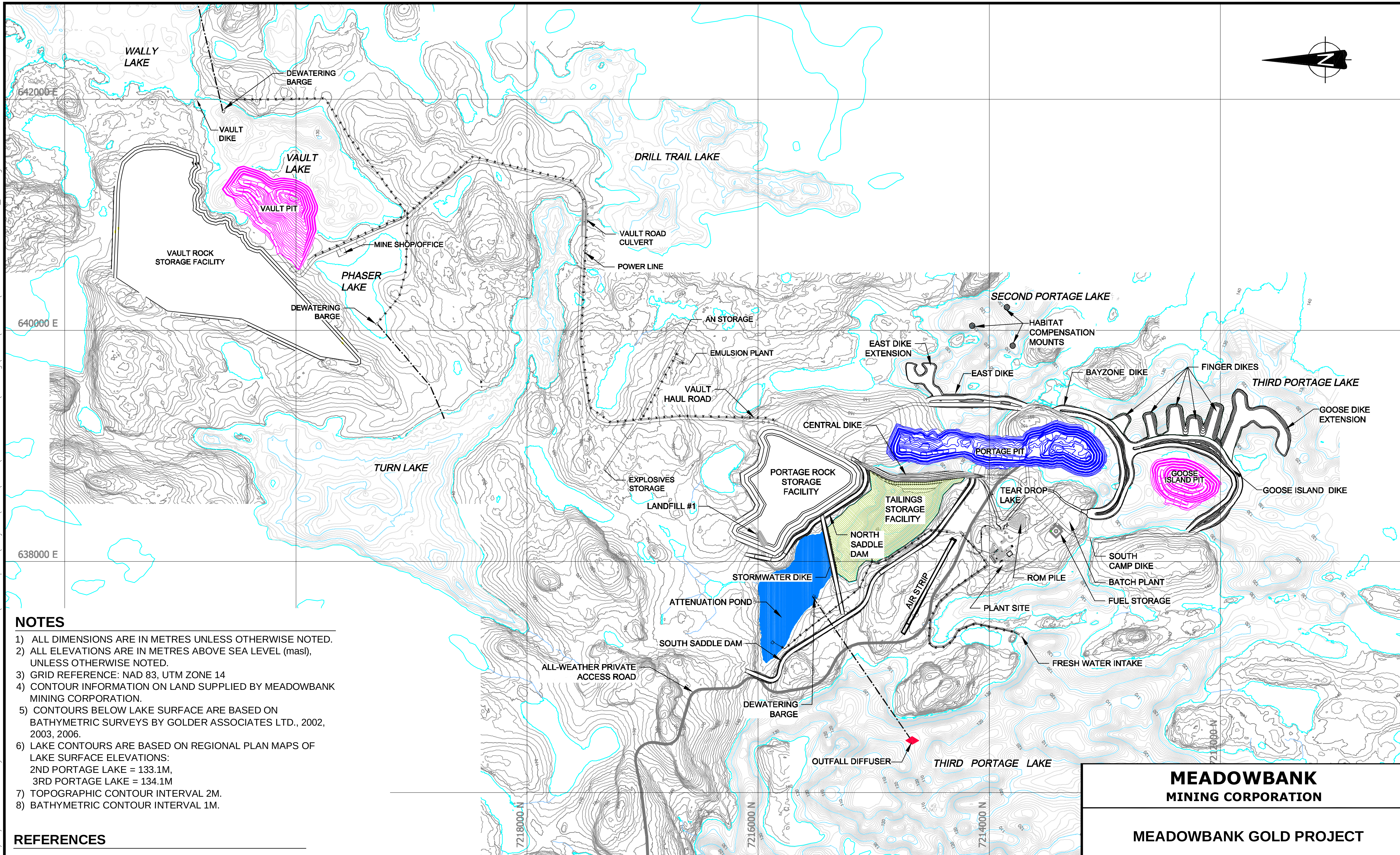
Mining will be primarily a truck-and-shovel open pit operation. A series of dewatering dikes will be required to isolate the mining activities from the lakes. The dikes will be constructed using materials produced during mining or by stripping from the footprint of the RSF areas.

2.2 MINING PLAN

The current mining plan indicates that approximately 22 Mt of ore will be mined over a nominal mine life of 8 years. The operation will generate approximately 182 Mt of mine waste rock and, approximately 22 Mt of tailings will be produced.

The mine plan has been used to prepare a materials balance, as shown in Table 2.1. This balance indicates the distribution of the following categories of materials by rock type:

- mine rock for general construction;
- mine rock for dike construction;
- mine rock for capping; and
- mine rock to RSFs.



REVISION DATE: 07/08/21 11:30AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\Drafting\FINAL\Doc.500\061413089-1400-FIG_2_1.dwg

NOTES

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (masl), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14
4) CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
5) CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD., 2002, 2003, 2006.
6) LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATIONS:
   2ND PORTAGE LAKE = 133.1M,
   3RD PORTAGE LAKE = 134.1M
7) TOPOGRAPHIC CONTOUR INTERVAL 2M.
8) BATHYMETRIC CONTOUR INTERVAL 1M.

REFERENCES

1) AMEC AMERICAS LTD., DRAWING NUMBER A1-131395-100-C-0001 (100-C-0001.DWG), MEADOWBANK FEASIBILITY STUDY, APRIL 2005.

0 300 600 900 1200 1500
Scale in Metres

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GENERAL SITE PLAN	FIGURE 2.1

Table 2.1: Meadowbank Mined Tonnages and Volumes

		Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Total
PORTAGE PIT	Intermediate Volcanic (kt)	455.6	745.2	6,911.3	2,456.5	1,958.1	2,454.0	955.6	0.0	0.0	0.0	15,936.3
	Ultramafic (kt)	234.3	488.6	7,350.6	5,060.2	4,748.3	4,720.8	1,538.5	0.0	0.0	0.0	24,141.3
	Iron Formation (kt)	412.7	1,577.2	11,697.0	2,708.1	4,026.4	7,482.2	2,264.7	0.0	0.0	0.0	30,168.4
	Quartzite (kt)	0.0	42.6	21.6	0.0	285.3	562.8	22.0	0.0	0.0	0.0	934.4
	Till (kt)	623.9	1,215.4	2,070.5	0.0	756.6	1,431.2	21.3	0.0	0.0	0.0	6,118.9
	Total Waste (kt)	1,726.5	4,069.1	28,051.0	10,224.8	11,774.8	16,651.0	4,802.1	0.0	0.0	0.0	77,299.3
	Ore (kt)	110.7	387.0	2,604.8	2,510.3	1,914.2	2,524.7	1,126.1	0.0	0.0	0.0	11,177.8
	Waste Destination	1, 2, 5, 6	1, 2, 3, 5, 6, 11, 13	3, 4, 5, 6, 12	2, 4, 6, 9, 12, 13	6, 7*, 9, 11, 12	6, 7*, 9	6, 7*, 9, 10, 13	6	6	6	
GOOSE ISLAND PIT	Intermediate Volcanic (kt)	0.0	0.0	0.0	5,713.2	3,212.1	565.2	0.0	0.0	0.0	0.0	9,490.5
	Ultramafic (kt)	0.0	0.0	0.0	9,278.7	7,504.1	986.8	0.0	0.0	0.0	0.0	17,769.6
	Iron Formation (kt)	0.0	0.0	0.0	1,638.7	1,579.3	738.9	0.0	0.0	0.0	0.0	3,956.9
	Quartzite (kt)	0.0	0.0	0.0	2,080.5	442.7	0.0	0.0	0.0	0.0	0.0	2,523.2
	Till (kt)	0.0	0.0	0.0	3,045.1	0.0	0.0	0.0	0.0	0.0	0.0	3,045.1
	Total Waste (kt)	0.0	0.0	0.0	21,756.3	12,738.2	2,290.9	0.0	0.0	0.0	0.0	36,785.3
	Ore (kt)	0.0	0.0	0.0	592.2	1,188.3	466.8	0.0	0.0	0.0	0.0	2,247.3
	Waste Destination				2, 4, 6, 9, 12, 13	6	6					
VAULT PIT	Intermediate Volcanic (kt)	0.0	0.0	0.0	0.0	0.0	5,210.5	25,892.4	21,958.3	14,397.1	748.5	68,206.8
	Ultramafic (kt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Iron Formation (kt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Quartzite (kt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Till (kt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total Waste (kt)	0.0	0.0	0.0	0.0	0.0	5,210.5	25,892.4	21,958.3	14,397.1	748.5	68,206.8
	Ore (kt)	0.0	0.0	0.0	0.0	0.0	111.0	1,976.4	3,102.5	3,102.5	175.9	8,468.3
	Waste Destination						8	8	8	8	8	8

Waste Destination Codes:

1	East Dike - 1.0 Mt	8	Vault Rock Storage Facility - 68.2 Mt
2	Roads, Foundations, misc. - 1.5 Mt	9	Finger Dikes and Finger Dike Extension - 7.8 Mt
3	Bay Zone Dike - 1.7 Mt	10	Habitat Compensation Mounts - 0.08 Mt
4	Goose Island Dike - 4.1 Mt	11	Stormwater Dike, Vault Dike - 0.77 Mt
5	East Dike Extension - 0.6 Mt	12	South Saddle Dam, North Saddle Dam - 2.3 Mt
6	Portage Rock Storage Facility - 62.8 Mt	13	Central Dike - 3.4 Mt
7	Portage Pit Backfill - 22.8 Mt	*	Till will not be backfilled into Portage Pit

2.3 PIT SLOPE DESIGN CRITERIA

The pit slope design criteria are documented in the following support documents:

- *Pit Slope Design Criteria for the Portage and Goose Island Deposits* (Golder, 2007a); and
- *Technical Memorandum on Vault Pit Slope Design Criteria* (Golder, 2004) (Appendix A of this document).

2.3.1 Development of Slope Design Criteria

Slope design criteria were developed based on a series of geotechnical data collection programs that began in the summer of 1995, and continued through 2006. The programs involved the collection of oriented and non-oriented geotechnical data from boreholes drilled for exploration and geotechnical purposes. Geotechnical mapping of trenches at Third Portage and Vault was also undertaken. Laboratory investigations included strength testing on 36 samples of rock core collected from the drilling program and fault gouge characterization. In addition to the collection of data relating to rock mass, permafrost investigations were conducted including hydraulic conductivity testing, installation of thermistor cables in specific boreholes to establish the characteristics of the baseline thermal regime, and electromagnetic surveys and surface geomorphologic and periglacial studies.

The geotechnical data were used to classify the rock mass according to internationally accepted rock mass classification systems (RMR_{76} and Q). The orientation data were used to define a series of structural domains for each deposit based upon continuous structural elements (rock foliation and stratigraphic contacts) and discontinuous structures (joints). The structural domains were sub-divided into design sectors on the basis of wall orientations within each of the domains. The bench face and inter-ramp angles within each of the design sectors were formulated to minimize significant structurally controlled failures based on kinematic and pseudo-probabilistic analyses. The rock is expected to exhibit sufficient rock strength to preclude the development of overall rock mass failure mechanisms.

Of specific concern for the Portage and Goose Island deposits is the risk associated with the presence of dewatering dike structures directly above the pits. Recent investigations (Golder, 2007a) have shown that using the current setback of 70 to 80 m between the toe of the dewatering dike and the pit wall, and the most conservative estimate of rock strength (0% rock bridges in the pit wall), a factor of safety of 1.3 (consistent with the Canadian Dam Association (CDA) Dam Safety Guidelines, 1999) can be achieved if groundwater in the pit slopes is depressurized. Using more reasonable estimates of the pit wall strength (5 to 25% rock bridging) the same factor of safety can be achieved without depressurizing the pit slope.

Since the presence of rock bridging cannot be verified until mining begins and rock exposures can be mapped, a program of installing horizontal or vertical de-watering or de-pressurization wells will be undertaken. Other possible mitigation measures that may be considered include: installation of pumping wells; and enhanced freezing. During operations, a detailed slope monitoring program will be implemented, which may include geotechnical mapping, installation of slope monitoring prisms, as well as piezometer and thermistor installations. If the monitoring can confirm whether a sufficient percentage of rock bridging is occurring in a given slope, then a decision can be made to reduce slope depressurization measures.

2.4 SITE CONDITIONS

2.4.1 Climate

The Meadowbank region is located within a low Arctic ecoclimate described as one of the coldest and driest regions of Canada. Arctic winter conditions occur from October through May, with temperatures ranging from +5°C to -40°C. Summer temperatures range from -5°C to +25°C with isolated rainfall increasing through September (Table 2.2).

Table 2.2: Estimated Average Monthly Climate Data – Meadowbank Site

Month	Max. Air Temp. (°C)	Min. Air Temp. (°C)	Rainfall (mm)	Snowfall (mm)	Total Precip. (mm)	Lake Evap. (mm)	Min. Relative Humidity (%)	Max. Relative Humidity (%)	Wind Speed (km/h)	Soil Temp. (°C)
January	-29.1	-35.5	0	11.2	11.2	0	67.1	75.9	16.3	-25.5
February	-27.8	-35.2	0	10.5	10.5	0	66.6	76.5	16.0	-28.1
March	-22.3	-30.5	0.1	14.6	14.6	0	68.4	81.4	16.9	-24.9
April	-13.3	-22.5	2.3	16.7	19.0	0	71.3	90.1	17.3	-18.1
May	-3.1	-9.9	9.8	11.3	21.1	0	75.7	97.2	18.9	-8.0
June	7.6	0.0	14.5	3.9	18.4	8.8	62.6	97.2	16.4	2.0
July	16.8	7.2	36.7	0.0	36.7	99.2	47.5	94.3	15.1	10.5
August	13.3	6.4	45.5	0.9	46.4	100.4	59.2	97.7	18.4	9.3
September	5.7	0.9	30.1	8.8	38.9	39.5	70.8	98.6	19.3	3.6
October	-5.0	-10.6	3.5	30.3	33.8	0.1	83.1	97.4	21.4	-2.8
November	-14.8	-22.0	0	23.6	23.6	0	80.6	91.1	17.9	-11.7
December	-23.3	-29.9	0	15.0	15.0	0	73.3	82.7	17.7	-19.9

Note: Rounding of monthly averages has occurred. Temperatures and precipitation were estimated based on site data (1997 to 2004). Snowfall is based on adjusted Baker Lake data (1946 to 2004). Adjusted small lake evaporation was estimated from pan evaporation data (2002 to 2004). Mean soil temperature is reported by AMEC to be measured at a depth between 0.2 m and 0.3 m below ground surface, but should be confirmed. Installation details such as slope aspect, surficial cover, site drainage, and annual snow cover are not available.
Source: AMEC 2003, 2005a and 2005b.

The long-term mean annual air temperature for Meadowbank is estimated to be approximately -11.1°C. Air temperatures at the Meadowbank area are, on average, about 0.6°C cooler than Baker Lake air temperatures, and extreme temperatures tend to be larger in magnitude. This climatic difference is thought to be the effect of a moderating maritime influence at Baker Lake.

The prevailing winds at Meadowbank for both the winter and summer months are from the northwest. A maximum daily wind gust of 83 km/h was recorded on 21 May 2002. Light to moderate snowfall is accompanied by variable winds up to 70 km/h, creating large, deep drifts and occasional whiteout conditions. Skies tend to be more overcast in winter than in summer.

Monthly rainfall, snowfall, and total precipitation values shown in Table 2.2 were adjusted for undercatch using the values reported by Environment Canada for Baker Lake. The resulting adjusted mean annual rainfall, snowfall, and precipitation totals for Meadowbank are 142.5, 146.8, and 289.2 mm, respectively. Meadowbank total annual rainfall averaged 85% of the Baker Lake total for the common period of record.

2.4.2 Permafrost

The Meadowbank Gold Project is located in the area of continuous permafrost, as shown on Figure 2.2.

Lake ice thicknesses of between 1.5 m and 2.5 m have been encountered during geotechnical investigations in mid to late spring. Taliks (areas of unfrozen ground) are expected where water depth is greater than about 2 to 2.5 m. It is possible that ice thickness will be greater than that reported above during the mid-winter period; however, no data relating to ice thickness currently exists for the mid-winter period.

Based on thermal studies and measurements of ground temperatures (Golder, 2003a), the depth of permafrost at site is estimated to be in the order of 450 to 550 m, depending on proximity to lakes. The depth of the active layer ranges from about 1.3 m in areas with shallow overburden, up to about 4 m adjacent to lakes. The depth of the permafrost and active layer will vary based on proximity to lakes, overburden thickness, vegetation, climate conditions, and slope direction.

Based on ground conductivity surveys and compilation of regional data, the ground ice content is expected to be low. Locally on land, ice lenses and ice wedges are present, as indicated by ground conductivity, and by permafrost features such as frost mounds. These areas of local ground ice are generally associated with low-lying areas of poor drainage.

2.4.2.1 Second Portage Lake Talik

A talik (zone of permanently unfrozen ground) exists below Second Portage Arm, and is expected to extend to the base of the permafrost. Thermistors have been installed in numerous boreholes (see Figure 2.3 for locations); the inferred thermal regime beneath the Second Portage Arm, based on measurements from these instruments, is shown in Figure 2.4.

2.4.2.2 Vault Lake Talik

Due to the size of Vault Lake, the underlying talik is expected to be closed or confined within the permafrost. This means it does not extend to the deep groundwater flow regime, because the size and depth of the lake is not sufficient for an open talik to develop. Much of the lake is less than 2 m in depth; consequently it freezes to the bottom during winter.

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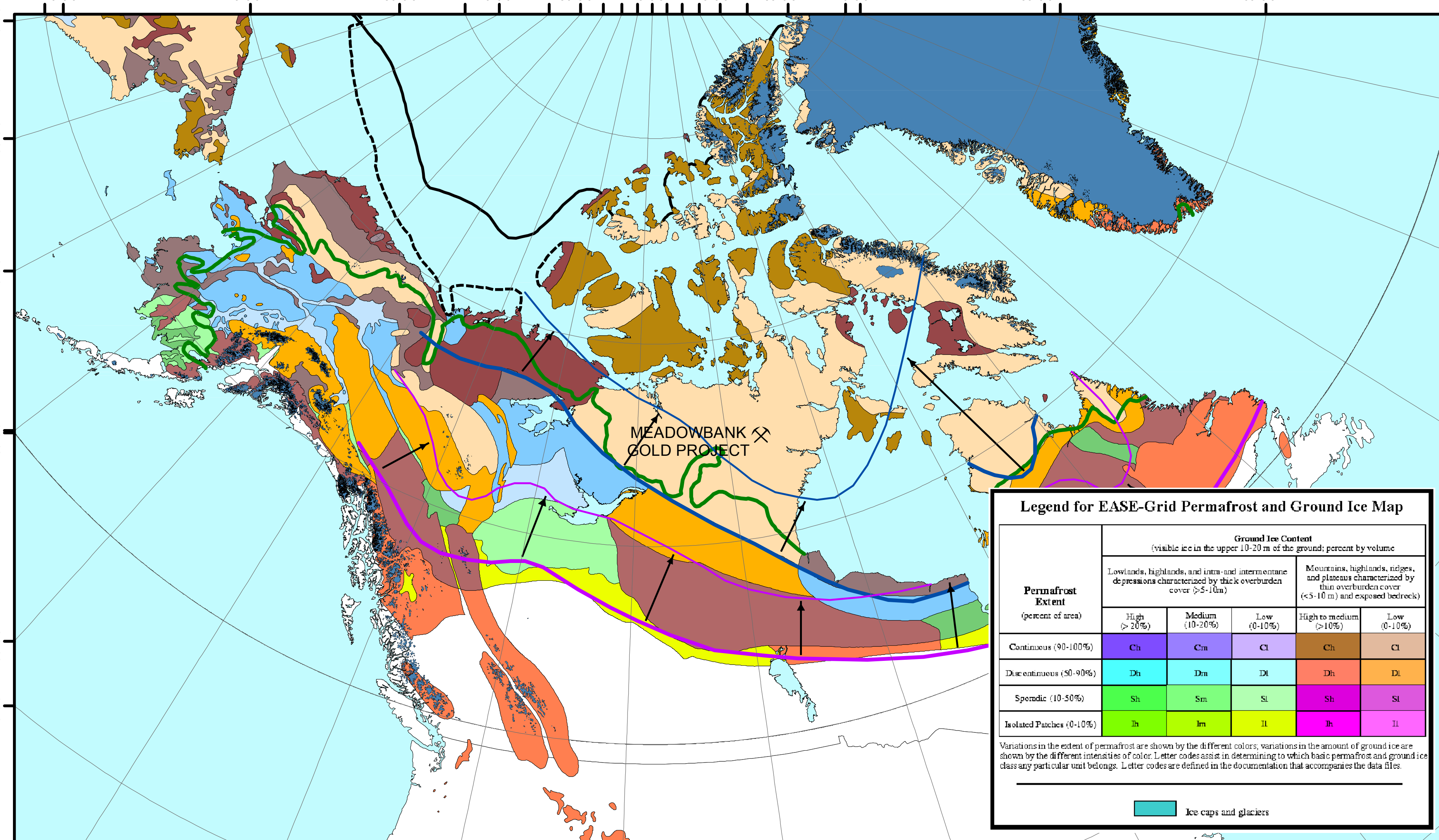

LEGEND

- TREELINE
- SEA-ICE EDGE LIMIT
- SUBSEA PERMAFROST LIMIT
- SOUTHERN BOUNDARY OF DISCONTINUOUS PERMAFROST - PRESENT
- SOUTHERN BOUNDARY OF DISCONTINUOUS PERMAFROST - PREDICTED
- SOUTHERN BOUNDARY OF CONTINUOUS PERMAFROST - PRESENT
- SOUTHERN BOUNDARY OF CONTINUOUS PERMAFROST - PREDICTED
- PREDICTED MOVEMENT OF PERMAFROST BOUNDARIES

NOTES

1) PROJECTION: LAMBERT AZIMUTHAL EQUAL AREA

0 300 600 900 1,200 1,500

Scale in Kilometres

REFERENCES

1) BROWN, J., O.J. FERRIANS JR., J.A. HEGINBOTTOM, AND E.S. MELNIKOV. 1998. CIRCUM-ARCTIC MAP OF PERMAFROST AND GROUND-ICE CONDITIONS. BOULDER, CO: NATIONAL SNOW AND ICE DATA CENTER/WORLD DATA CENTER FOR GLACIOLOGY. DIGITAL MEDIA.
2) PREDICTED PERMAFROST BOUNDARIES BASED ON WOO ET AL., 1992.

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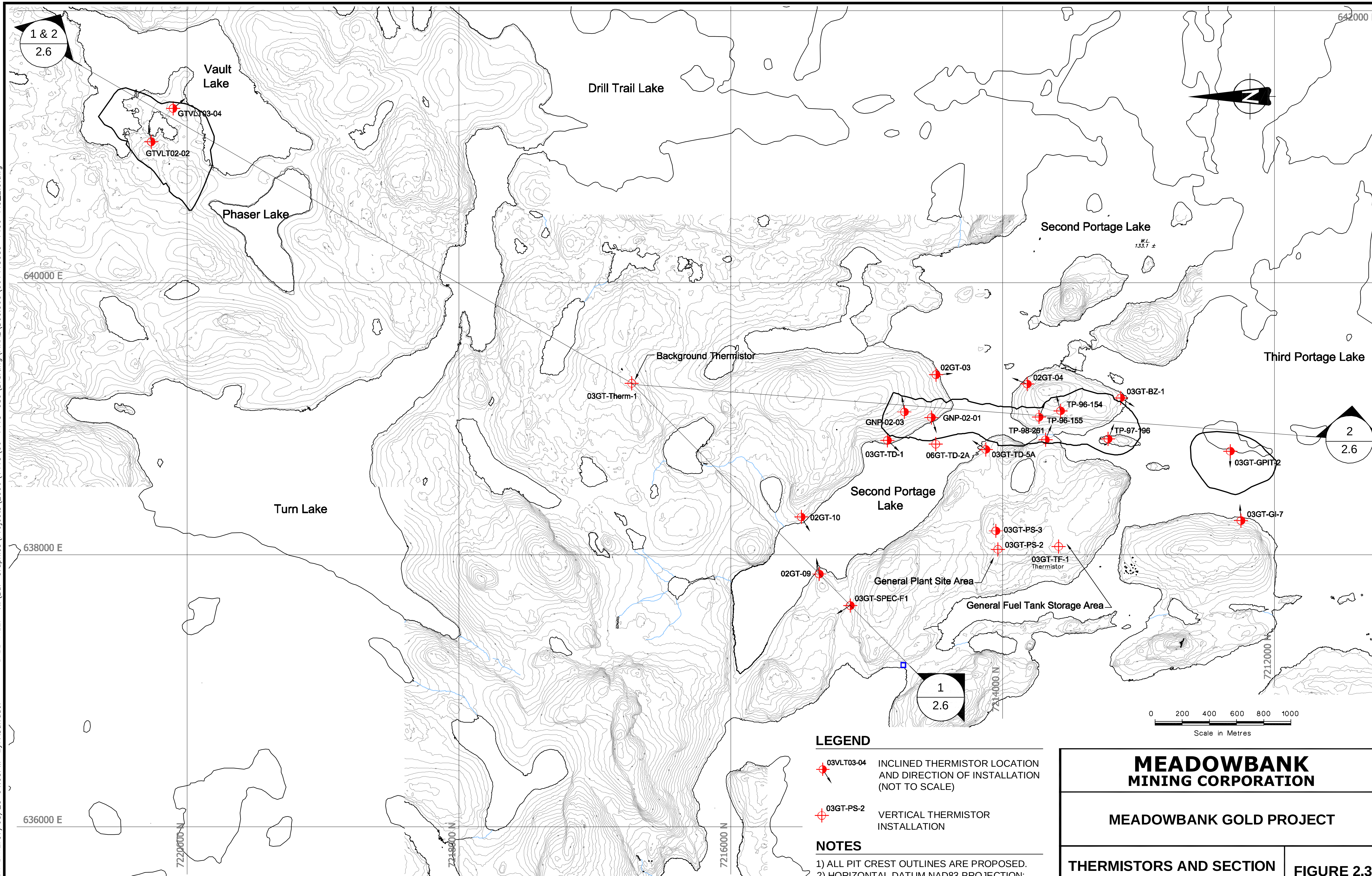
PERMAFROST MAP OF CANADA

FIGURE 2.2



LEGEND

03VLT03-04 — INCLINED THERMISTOR LOCATION AND DIRECTION OF INSTALLATION (NOT TO SCALE)

03GT-PS-2 — VERTICAL THERMISTOR INSTALLATION

NOTES

1) ALL PIT CREST OUTLINES ARE PROPOSED.
2) HORIZONTAL DATUM NAD83 PROJECTION: UTM ZONE 14N

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THERMISTORS AND SECTION LOCATION PLAN

FIGURE 2.3

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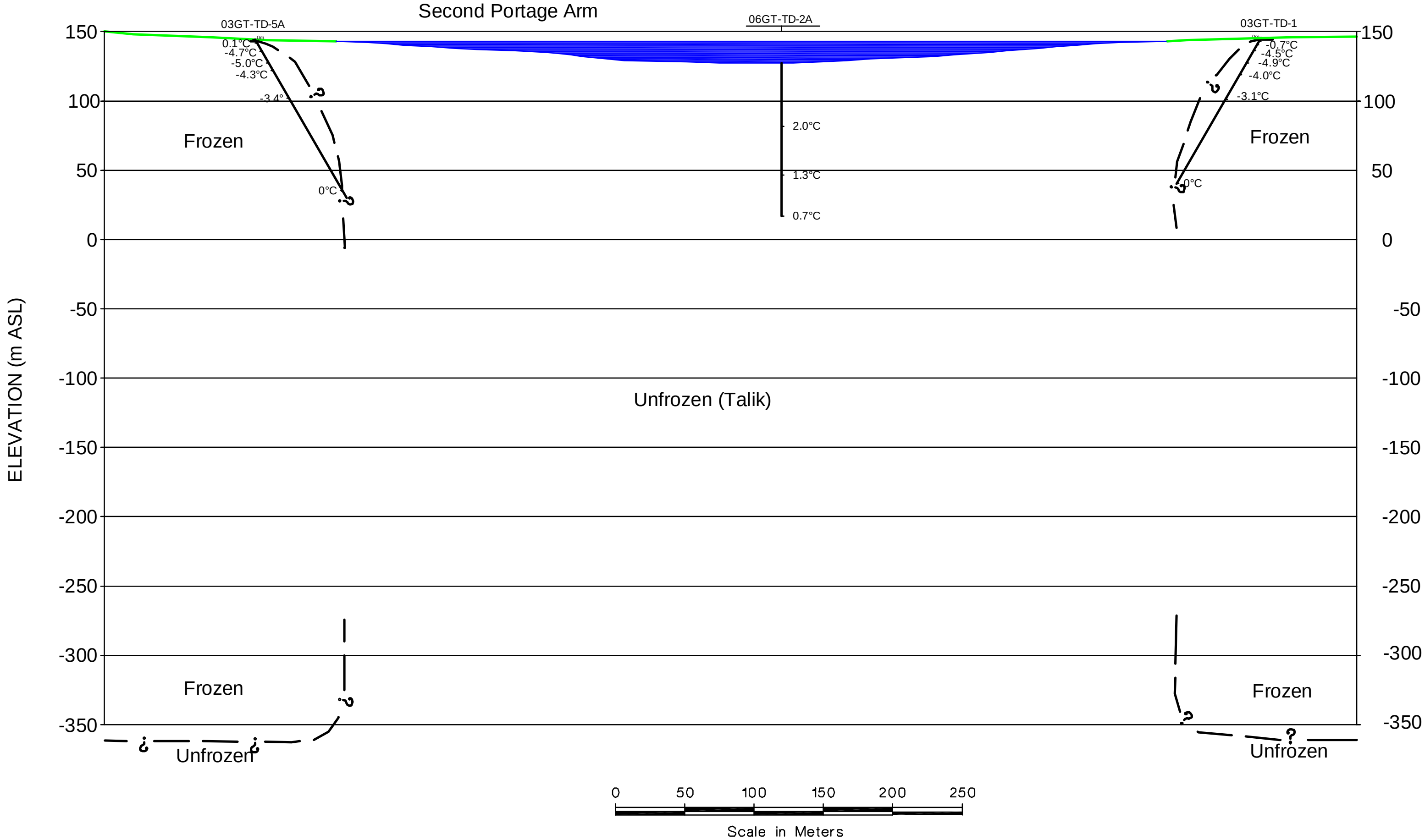

LEGEND

— —? — Inferred Permafrost Boundary

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BASELINE THERMAL CONDITION BELOW SECOND PORTAGE ARM

FIGURE 2.4

2.4.2.3 Impact of Global Warming on Site Conditions

A report titled "Implications of Global Warming and the Precautionary Principle in Northern mine Design and Closure" (BGC, 2003) was prepared for Indian and Northern Affairs Canada, and provides guidance relevant to mine design in Nunavut.

This report suggests that globally the average temperature may increase by about 2°C by 2100 due to global warming. However, the report also states that the increase may be double the global average for sites located at 50°N, and may be 3.5 times greater for sites located at 80°N. In a more recent study, the Intergovernmental Panel on Climate Change (IPCC, 2007) projected the maximum average air temperature to increase by 6.4°C by 2100 for a site located at 65°N latitude.

Table 2.3 presents a summary of reported climate change predictions used on a number of northern projects that have been reported in the engineering and scientific literature.

Table 2.3: Summary of Reported Climate Change Rates Used in Northern Projects Engineering Studies

Reference	Increase in MAAT by Year 2100 (°C)	Notes
INAC (2003)	5.5	Used in Meadowbank DEIS for site at 65° North Latitude
Hayley (2004)	4.7	Used in design studies for the Inuvik Regional Health Center. Reported as increase of 0.47°C per decade.
Hayley and Cathro (1996)	5.0	Used for Raglan Dam analyses.
Mackenzie Valley Land & Water Board (2002)	3.0	Used for the Ekati mine expansion
Diavik	3.2	Used for the Processed Kimberlite Containment Facility Design
Burn (2003)	6.0	For use in the Western Arctic for pipeline design projects. Reported as increase of 1.75°C over a 29 year period
IPCC (2003)	0.8-5.2	Predicted range for change in the global average surface air temperature

Based on Table 2.3, a climate warming trend of 6.4°C over 100 years is considered to be a conservative upper estimate of the climate change rate for the project area and is consistent with predicted and recommended climate change trends for projects in the north.

By the middle of the 21st century, the effect of temperature change is predicted to reduce near-surface permafrost by 12% to 15% once equilibrium conditions become established under the new temperatures. The predicted increase in active layer thickness of 15% to 30% will reach equilibrium relatively much faster (NRC, 2004).

Studies indicate that the boundaries of discontinuous and continuous permafrost are expected to move northward due to global warming (Woo et al., 1992) (Figure 2.2). Predictions based on a warming of 4°C to 5°C over the next 50 years (NRC, 2004) (approximately double the rate predicted above) suggests that the Meadowbank property would remain within the zone of continuous permafrost, but the active layer thickness would be expected to increase, and the total thickness of permafrost may slowly reduce in time.

2.4.3 Groundwater

2.4.3.1 Current and Projected Groundwater Use

Groundwater sources from either the active layer or from the deep groundwater regime below the permafrost are not presently utilized for drinking water at the project site. This is likely due to the presence of deep permafrost, the seasonal nature of the active layer, and the availability of good quality surface drinking water sources in the vicinity of the project site. Furthermore, it is unlikely that the groundwater in the shallow active layer would be utilized in the future because of its seasonal nature and low yields. Deep groundwater may be utilized in the future, but the likelihood of this is considered low because there are abundant sources of good quality surface water.

2.4.3.2 Hydro-stratigraphy and Groundwater Flow

Predictions of hydro-stratigraphy and groundwater flow at the site are based on hydraulic conductivity testing at the site, and on a regional groundwater model developed for the site. The groundwater model incorporates both the Second Portage and Bay Zone faults (Figure 2.5).

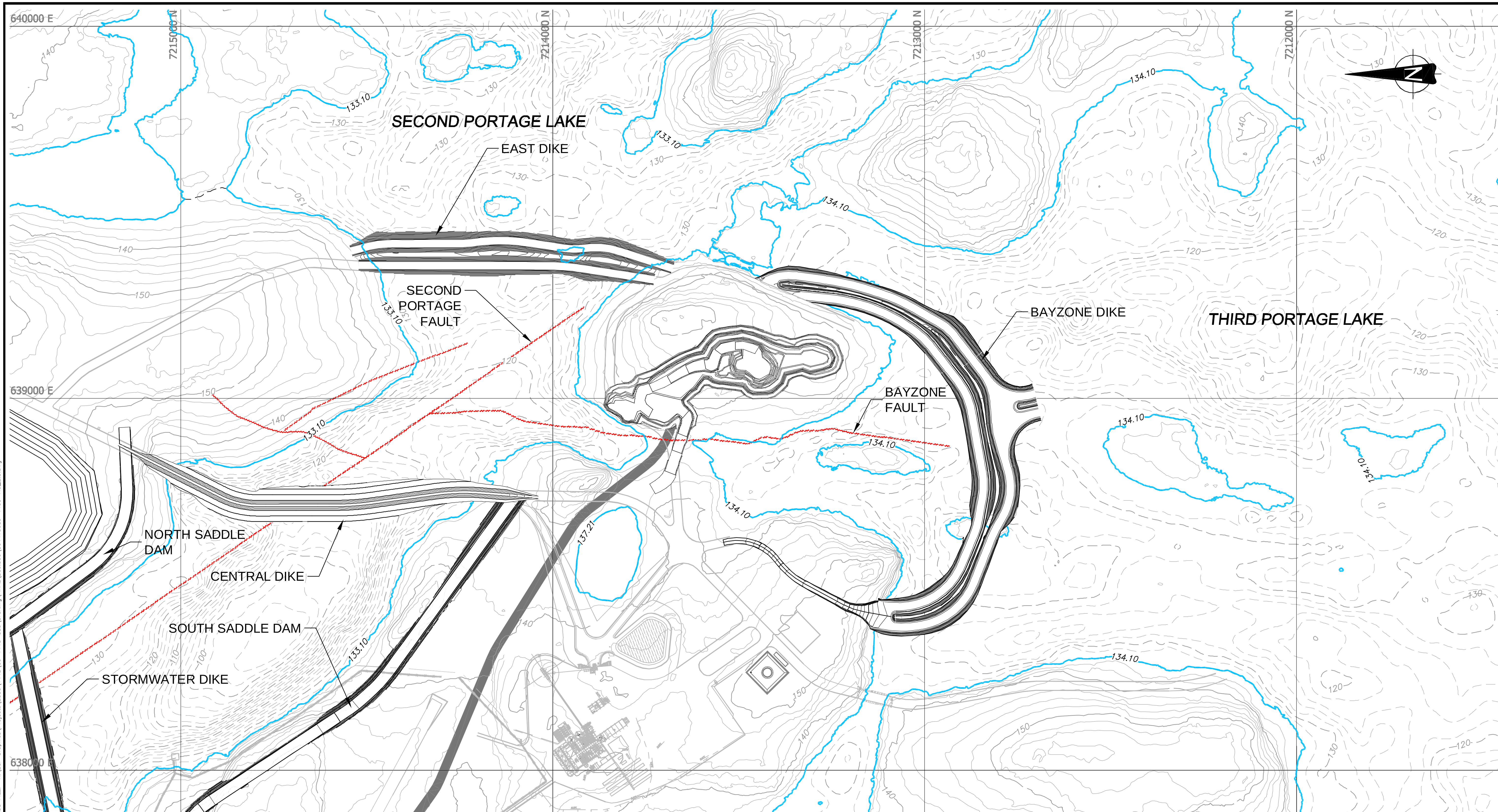
Additional information regarding existing groundwater model are provided in the following support documents:

- *Updated Predictions of Brackish Water Upwelling in Open Pits with Mining Rate of 8500 TPD, Meadowbank Project, Nunavut* (Golder, 2007b); and
- *Pit Slope Design Criteria for the Portage and Goose Island Deposits* (Golder, 2007a).

2.4.3.3 Input Parameters

The following input parameters were used in the groundwater model:

- the hydraulic conductivity (K) of bedrock was assumed to decrease with depth (Table 2.4);
- permafrost is present below land and small lakes to depths of 450 to 550 m. For this assessment, an average permafrost thickness of 500 m was assumed. Permafrost was assumed to be a no-flow boundary;
- The deep groundwater flow regime is connected by taliks beneath large lakes. The lakes were assumed to act as specified head boundaries equivalent to the elevations of the water levels in the lakes; and
- based on results of packer testing (Golder, 2006), the fractured rock zone associated with the Second Portage fault appears to have higher hydraulic conductivity than the surrounding bedrock. Results of this testing suggest that the fractured rock zone is approximately 5 m wide and has a hydraulic conductivity of 1 x 10^{-5} m/s.



LEGEND

- LAKE SHORELINE CONTOUR
- LAND - BASED MAJOR CONTOUR
- LAND - BASED MINOR CONTOUR
- PIT DESIGN MAJOR CONTOUR
- PIT DESIGN MINOR CONTOUR
- BATHYMETRY MAJOR CONTOUR
- BATHYMETRY MINOR CONTOUR
- INFERRED LOCATION OF FAULTS

NOTES

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (masl), UNLESS OTHERWISE NOTED.
3) GRID REFERENCE: NAD 83, UTM ZONE 14.
4) CONTOUR INFORMATION ON LAND SUPPLIED BY CUMBERLAND RESOURCES LTD.
5) CONTOUR BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD., 2002, 2003, 2006. CONTOURS INTERVAL= 2m.
6) BATHYMETRY CONTOUR DATA SUBJECT TO FUTURE UPDATE.
7) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS:
   2nd PORTAGE LAKE= 133.1m,
   3rd PORTAGE LAKE= 134.1m.

0 100 200 300 400 500
Scale in Metres

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INFERRED LOCATIONS OF FAULTS

FIGURE 2.5

Table 2.4: Variation in Hydraulic Conductivity (K) with Depth

Depth below Ground (m)	K (m/s)	
	Measured	Assumed in the Model
0-30	$7x10^{-7}$	$7x10^{-7}$
30-60	$2x10^{-7}$	$2x10^{-7}$
60-90	$3x10^{-8}$	$8x10^{-8}$
90-120	$4x10^{-8}$	$4x10^{-8}$
120-160	$3x10^{-8}$	$3x10^{-8}$

There does not appear to be discernable difference in the hydraulic conductivity of the various rock types. Ultramafic rocks at a given depth have similar hydraulic conductivity to those of the intermediate volcanics at the same depth. The hydraulic conductivity of the shallow exfoliated and weathered bedrock, regardless of rock type, is generally higher than the deeper, less fractured rock.

The calculated geometric mean of the result of packer tests conducted over the depth interval from 60 m to 90 m was actually lower than the value calculated from the test interval from 90 m to 120 m (3×10^{-8} m/s for the interval from 60 m to 90 m compared to 4×10^{-8} m/s for the interval from 90 m to 120 m depth). This may result from the limited data for the deeper portions of the rock combined with the relative imprecision of K values determined from packer tests. In the model, the hydraulic conductivity was assumed to decrease with depth over these two intervals (Table 2.4). At depths greater than 160 m, it is expected that hydraulic conductivity values would be less than those shown in Table 2.4.

Two main faults are present in the Portage deposit area. These are the Bay Zone Fault and an associated splay, and the Second Portage Fault. To provide conservative predictions of groundwater inflows and brackish water upwelling, the Bay Zone Fault was assumed to have a hydraulic conductivity equal to the Second Portage Fault with a value of $1x10^{-5}$ m/s. The Bay Zone Fault and associated splay trend in a roughly north-south direction along the western margin of the Third Portage deposit. The Second Portage fault trends to the northwest, roughly parallel to the orientation of the Second Portage Lake (Figure 2.5).

2.4.3.4 Shallow Groundwater Flow Regime

The hydraulic conductivity of the till overburden was characterized by falling head tests and was found to be between 3×10^{-4} and 1×10^{-7} meters per second (m/s); with the higher values for boulder till, and lower for sandy clay till.

From late spring to late summer, when temperatures are above 0°C, the active layer thaws. Groundwater in the active layer would flow to local depressions and ponds that drain to Second and Third Portage lakes, or would flow directly to Second and Third Portage lakes.

Permafrost reduces the hydraulic conductivity of the rock by at least one to two orders of magnitude (Anderson and Morgenstern, 1973; Burt and Williams, 1976). Consequently, the permafrost in the rock at the Meadowbank Gold Project site would be of a very low permeability compared to that of the unfrozen rock. The shallow groundwater flow regime will therefore have little to no hydraulic connection with the groundwater regime located below the deep permafrost.

2.4.3.5 Deep Groundwater Flow Regime

In areas of continuous permafrost, the deep groundwater regime is connected by taliks (unfrozen ground) located beneath large lakes. Taliks exist beneath lakes that do not freeze to the bottom in winter. If a lake is large enough, the talik extends down to the deep groundwater regime. At the Meadowbank Gold Project, analyses have predicted that open taliks extending to the deep groundwater regime will occur beneath lakes that do not freeze to the bottom in winter, when the diameter is in the order of 570 m or greater for round lakes, or the width is at least 320 m for elongated lakes. Based on these analyses, open taliks exist beneath Third Portage Lake, Second Portage Lake, and Second Portage Arm. These analyses also suggest that the talik beneath Vault Lake does not extend to the deep groundwater flow regime because this lake is relatively shallow and much of the lake freezes to the bottom in winter.

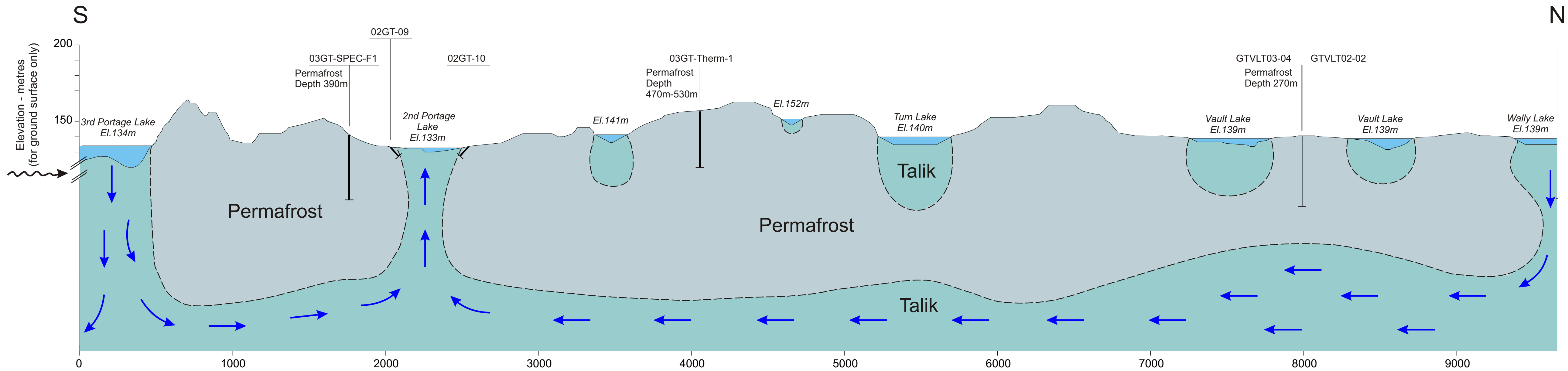
The elevation of the water levels in lakes that have open taliks provides the driving force (hydraulic head) for the deep groundwater flow. The presence of the thick and low permeability permafrost beneath land located between large lakes results in negligible recharge to the deep groundwater flow from these areas. Smaller lakes have isolated, or closed, taliks that do not extend down to the deep groundwater regime and thus do not influence the groundwater flow in the deep regime. Consequently, recharge to the deep groundwater flow regime is limited to the open taliks beneath large lakes. Generally groundwater will flow from higher elevation lakes to lakes located at lower elevations. This concept is illustrated in Figure 2.6.

The driving force or hydraulic head for the deep groundwater regime is the water levels in large lakes that extend down to the deep groundwater regime. The Meadowbank Gold Project is located close to the surface water divide between the Back River basin, which flows north and northwest towards the Arctic Ocean; and the Thelon River basin, which flows east to southeast into Hudson Bay. Consequently, on a regional scale, groundwater from the north-western side of Third Portage Lake would flow in a northwest direction, and groundwater from the southeast end of Third Portage and Second Portage Lakes would flow in a southeast direction. However, on a local scale, groundwater flows from a higher elevation lake located to the east to the northwest portion of Second Portage Lake (Second Portage Arm).

Simulations performed with the regional groundwater model representing baseline conditions suggest that Second Portage Lake predominantly acts as a regional groundwater discharge zone (Figure 2.7). Second Portage Lake acts primarily as a groundwater discharge zone except for a small portion in the southern end of the lake where groundwater is predicted to flow from Second Portage to Tehek Lake. The primary source of groundwater discharge to Second Portage Lake is flow from a lake located to the northeast of Second Portage Lake. The groundwater fluxes to and from Second Portage Lake, as predicted by the model, are summarized in Table 2.5.

Table 2.5: Baseline Estimate of Groundwater Flux

	Flux (m^3/d)
Second Portage to Tehek Lake	1.3
A lake located northeast of Second Portage Lake (141 m elev.)	5.7
Third Portage Lake to Second Portage Lake	1.0
A lake located northwest of Second Portage Lake to Second Portage Lake	0.2
A lake located northeast of Second Portage Lake (144 m elev.)	0.4



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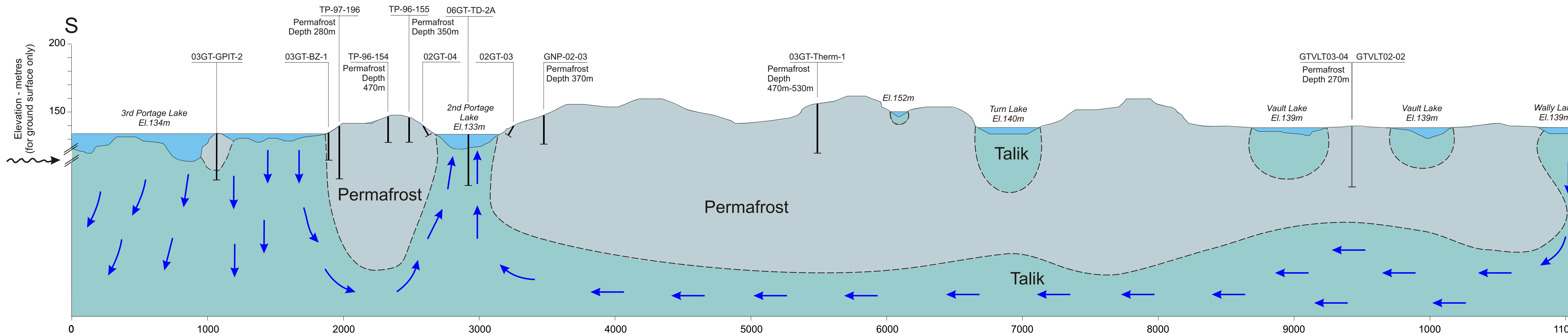
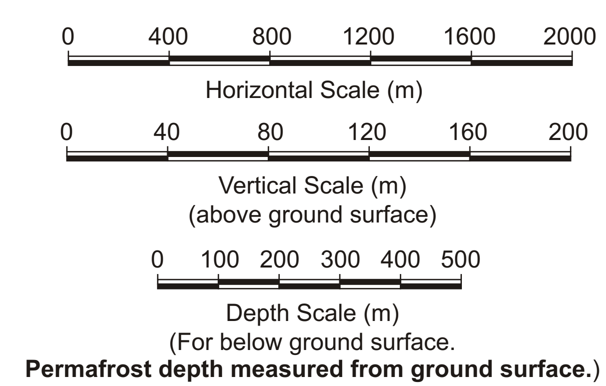


2 / 2.3 SECTION



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MEADOWBANK PROJECT BASELINE PERMAFROST AND GROUNDWATER CONDITIONS

FIGURE 2.6

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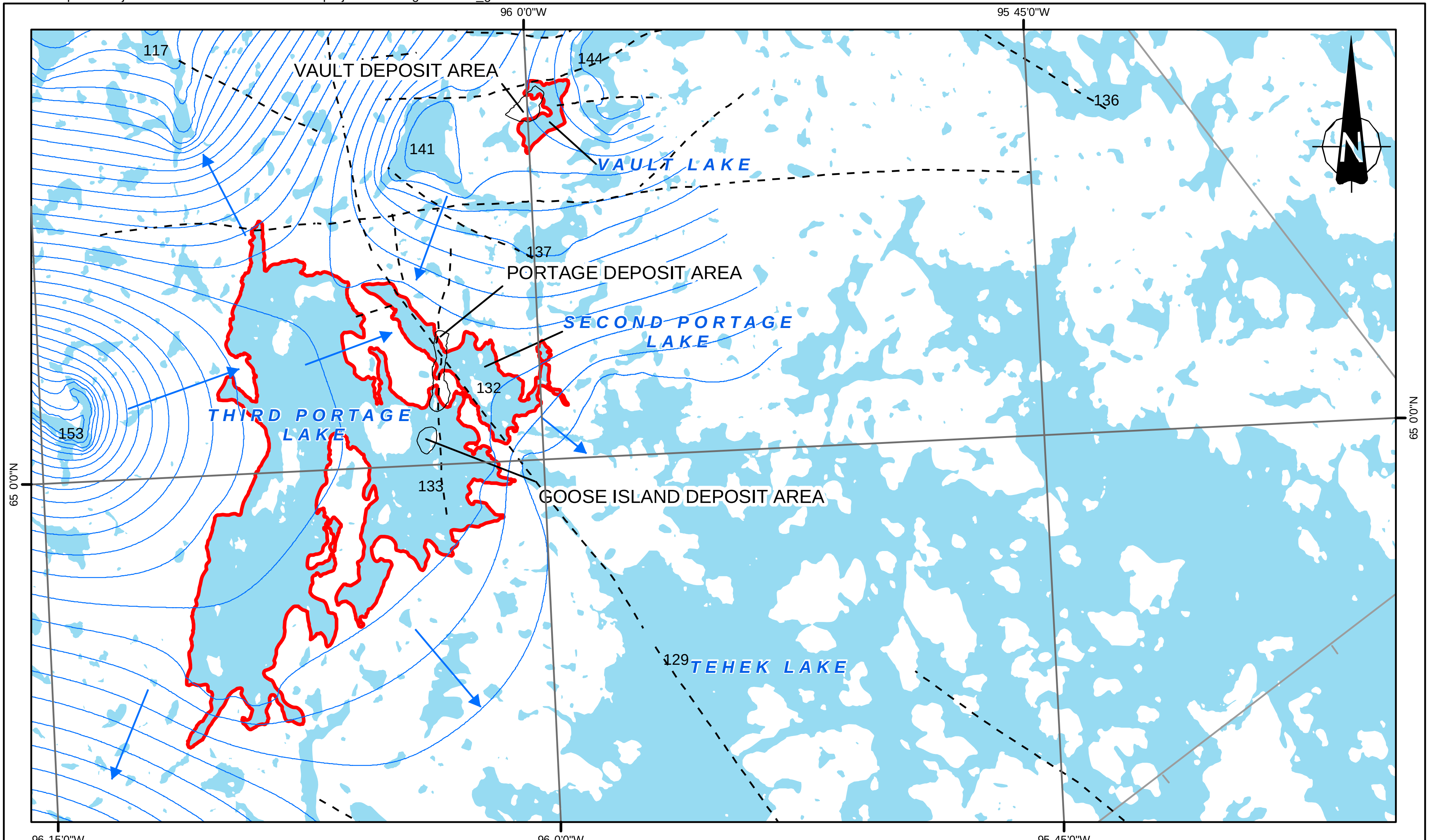

LEGEND

- PROPOSED OPEN PIT CREST
- GROUNDWATER CONTOUR (1 M INTERVAL)
- GROUNDWATER FLOW LINE
- APPROXIMATE FAULT LOCATION
- 133 WATERBODY (ELEVATION IN MASL)

0 1250 2500 3750 5000 6250

Scale in Metres

REFERENCES

LAKE ELEVATIONS TAKEN FROM: DISTRICT OF KEEWATIN, NORTHWEST TERRITORIES, DEPARTMENT OF ENERGY, MINES AND RESOURCES, MAPSHEETS 66A/16, 56E/04, 66H/01, 56D/13

DATUM: NAD83 PROJECTION: UTM ZONE 14

PROJECT

MEADOWBANK MINING CORPORATION

TITLE

MEADOWBANK GOLD PROJECT

GROUNDWATER FLOW FROM HIGHER ELEVATION LAKES TO LOWER ELEVATION LAKES

FIGURE 2.7

2.4.3.6 Groundwater Salinity and Freezing Point Depression

Based on data from other sites in the Canadian Shield it is expected that the salinity of the groundwater will increase with depth. Water samples collected from monitoring wells installed in the talik beneath Second Portage and Third Portage lakes to depths of up to 212 m have chloride concentrations up to 845 mg/L and total dissolved solids (TDS) values up to 1,335 mg/L. This represents a salinity of 1.5, where salinity is equal to approximately 1.8 times the chloride concentration (in parts per thousand). Water samples collected from a number of large lakes in the area (Azimuth, 2003) have chloride concentrations of less than 1 mg/L. By comparison, sea water has chloride concentrations of approximately 19,000 mg/L.

The maximum increase in the rate of TDS of chloride concentrations with depth that have been observed in the Canadian Shield by Frape and Fritz (1997) would result in a chloride concentration of around 2,000 mg/L at 550 m depth, which is the estimated maximum depth of permafrost at the site. This is equivalent to a salinity of approximately 4, and would result in an approximate 0.1°C depression of the freezing point. This in turn would represent an approximate 1% reduction in the thickness of permafrost due to the hydrochemical talik.

At 150-m depth, the Frape and Fritz profile predicts a TDS of 1,680 mg/L which is higher than measured on site at the same depth. Therefore, the use of the Frape and Fritz profile to estimate the chloride concentration at 550 m depth is considered conservative in that it likely overestimates the chloride concentration and the freezing point depression. Consequently, there is not expected to be a depression of the freezing point within the permafrost for the existing conditions, and freezing point depression is not considered in the characterization of the shallow or deep groundwater flow regime.

SECTION 3 • GEOCHEMISTRY

The relative potentials of the rock types to generate ARD or metal leaching (ML) were evaluated through both static and kinetic testing (Golder 2005a, and 2005b). The implications for potential use as construction rock are presented in Table 3.1.

Table 3.1: Summary of Geochemistry Considerations

Open Pit	Material Type	Potential for ARD	Potential for ML	Restrictions for Storage or use in Construction
All Pits	Overburden	None	Low	None
	Tailings	High	High	Requires measures to control ARD
Portage & Goose	Ultramafic & Mafic Volcanic	Very low	Low	May require collection and treatment of drainage
	Intermediate Volcanics	Variable (65% low; 35% uncertain to high)	Moderate	Requires measures to control ARD
	Iron Formation	High	High under ARD conditions Low under neutral conditions	Requires measures to control ARD
	Quartzite	High	Low	Co-disposal with ultramafic/mafic volcanic or cap/water cover
Vault	Intermediate Volcanics	75% low; 25% uncertain to high	Variable (low to moderate)	May require collection and treatment of drainage

SECTION 4 • CONTROL STRATEGIES FOR ACID MINE DRAINAGE IN COLD REGIONS

The generation of metal leachate in acidic drainage is a concern for mining projects. In evaluating the potential control strategies for the disposal of the mine waste at the Meadowbank Gold Project, consideration was given to control strategies that are effective in cold regions. A discussion of the alternative control strategies considered for the Meadowbank Gold Project is summarized below.

Common control strategies for the prevention or reduction of acid mine drainage in cold regions are:

1. control of acid generating reactions;
2. control of migration of contaminants; and
3. collection and treatment.

In assessing the overall control strategies for the Meadowbank Gold Project, emphasis has been placed on methods that satisfy (1) and (2) in the above list, which then has an impact on (3) by potentially reducing the requirements for these activities. Table 4.1 presents various acid mine drainage control strategies.

The Meadowbank Gold Project is located within the zone of continuous permafrost, and has a mean annual air temperature of about -11.1°C. Based on thermal data collected from the site since 1996, the project area is underlain by permafrost to depths between 450 and 550 m. In developing the Mine Waste and Water Management Plan for the project, freeze control and climate control strategies have been adopted.

Freeze control strategies rely on the immobilization of pore fluids to control acid mine drainage reactions, and the potential migration of contaminated porewater outside of the storage facility. The climate conditions at the Meadowbank Gold Project site are amenable to freeze control strategies, and hence should be taken advantage of. In addition to immobilization of pore fluids, permafrost can reduce the hydraulic conductivity of materials by several orders of magnitude. Consequently, freeze control strategies are effective methods for preventing the migration of contaminants through materials.

According to Dawson and Morin (1996), freeze control strategies can only be effective if sufficient quantities of non-acid-generating waste rock are available for use as a cover and insulation protection. Based on the production forecast schedule for the Meadowbank Gold Project (Table 2.1), there will be sufficient ultramafic rock available to provide cover over the Portage RSF and TSF.

Table 4.1: Acid Mine Drainage Control Strategies of the Arctic

Strategy	Tailings	Waste Rock
Freeze Controlled	Total or perimeter freezing options can be considered Can freeze up to greater than 15 m annually if freezing in thin layers Process chemicals could cause high unfrozen water contents	Requires considerable volumes of non-acid waste rock for insulation protection Better understanding of air and water transport through waste rock required for reliable design
Climate Controlled	May not be a reliable strategy for saturated tailings	Requires control of convective air flow through waste rock, infiltration control with modest measures and temperature controls Better understanding of waste rock air, water, and heat transport for reliable design
Engineered Cover	Special consideration for freeze-thaw effects Availability and cost of cover materials are major impediments	
Subaqueous Disposal	Special considerations for winter ice conditions and pipeline freeze-up	Very difficult to dispose of waste rock beneath winter ice
Collection and Treatment	Costly to maintain at remote locations Long term maintenance cost	
Segregation and Blending	Tailings are normally geochemically homogeneous	May be very effective Research and development on-going

Reference: (MEND 1.61.2, 1996)

Climate control strategies rely on cold temperatures to reduce the rate at which oxidation occurs. The low net precipitation in permafrost regions limits infiltration of water into waste rock and tailings disposal areas. Consequently, the climate of the Meadowbank Gold Project area will act as a natural buffer to the production of acid mine drainage and metal leachate. Climate control strategies are best applied to materials placed at a low moisture content to reduce the need for additional controls on seepage and infiltration. This strategy is considered to be effective for waste rock, but not tailings. Therefore, the arid climate at the Meadowbank Gold Project is also suited for climate control strategies for use with the RSFs.

SECTION 5 • MINE WASTE ROCK STORAGE

Waste rock from the open pit mines not used for site development purposes will be trucked to mine waste rock storage areas until the end of mine operations. Near to the end of the Portage Pit mining operations, excess waste rock will also be placed within the Portage Pit to be submerged during pit flooding (subaqueous disposal).

Due to the distance between the Portage mining area and the Vault mining area, two waste rock storage facilities (RSFs) are required. Waste rock from the Portage and Goose Island pits will be stored in a storage facility located near to these pits (Portage RSF), while waste rock from the Vault open pit will be stored in a separate storage facility adjacent to the Vault Pit (Vault RSF). Further details on the RSF site selection process is provided in Appendix F.

5.1 WASTE ROCK PROPERTIES

The quantities of waste rock to be excavated during mining of the open pits are summarized in Table 5.1. Table 5.2 provides estimates of waste rock and till quantities to be used for construction, placed back into the Portage Pit during operations, or placed in the Portage RSF. Some geotechnical properties of the major waste rock types, based on laboratory tests, are summarized in Table 5.3.

Table 5.1: Quantities of Waste Rock Types

Rock Storage Facility	Rock Type	Quantity
Portage	Ultramafic and Mafic Volcanic	23.9 Mt (12.6 Mm^3)
	Intermediate Volcanics	14.9 Mt (7.9 Mm^3)
	Iron Formation	14.8 Mt (6.7 Mm^3)
	Quartzite	1.9 Mt (1.0 Mm^3)
	Till (Option 1)[a]	7.3 Mt (3.8 Mm^3)
	Till (Option 2)[a]	6.9 Mt (3.6 Mm^3)
Vault	Intermediate Volcanics	68.2 Mt (35.9 Mm^3)

[a]Option depends upon amount of till for required for construction of Saddle Dam and Stormwater Dike filters.

Source: Amec, 2005b.

Table 5.2: Estimated Waste Rock Quantities to Portage Rock Storage Facility

Item	Tonnes Rock	Tonnes Till[a]		Volume Rock (m^3)	Volume Till[a] (m^3)	
		Option 1	Option 2		Option 1	Option 2
Total waste rock and overburden produced from Portage and Goose Island pits	104,921,000	9,164,000	9,164,000	52,772,000	4,823,000	4,823,000
Less: waste rock back into Portage Pit	22,856,000	-	-	11,475,000	-	-
Less: waste rock and overburden used for construction, including dikes, roads, airstrip, mill foundations, tailings and dike capping; and fish habitat	29,115,000	1,832,000	2,264,000	14,490,000	964,000	1,192,000
Waste rock and overburden to be stored in Portage RSF	52,950,000	7,332,000	6,900,000	26,807,000	3,859,000	3,362,000

[a]Option depends upon amount of till for required for construction of Saddle Dam and Stormwater Dike filters.

Table 5.3: Waste Rock Geotechnical Properties

Rock Type	Specific Gravity (t/m^3)	Unconfined Compressive Strength (MPa)	ISRM Grade	ISRM Description
Intermediate Volcanic (Portage)	2.89	51 to 148 (Avg. 94)	R3 to R4	Medium to Strong
Intermediate Volcanic (Vault)	2.75			
Iron Formation	3.44	137 to 248 (Avg. 175)	R4 to R5	Strong to Very Strong
Quartzite	2.70	70 to 140 (Avg. 107)	R4	Strong
Ultramafic	2.91	40 to 92 (Avg. 66)	R2 to R4	Weak to Strong
Ultramafic (serpentinized)		Avg. 32		

5.2 WASTE ROCK MANAGEMENT

Waste rock within the RSFs will be disposed of on land using a total freezing control strategy. As shown in Table 3.1, the waste types that will report to the RSFs show variable ARD potentials, some of which will require control measures. To address this, it is proposed that each RSF be constructed as a cell, or series of cells, such that the interior of each cell is composed of any potentially acid generating (PAG) and/or metal leaching (ML) waste, and the exterior of each cell is composed of non-PAG (NPAG) waste, as shown conceptually on Figure 5.1. The limits of each cell will be defined by a low berm, prior to, or concurrent with, placing material within the cell. Based on the results of thermal modelling, it is expected that the material within the RSFs will freeze within two years of placement (BGC, 2004).

Dumping of waste rock within the Portage RSF will commence closest to the Portage Pit and will proceed westward during development of the mine. Certain waste types, such as ultramafic rock to be used for reclamation and capping purposes, will be assigned to specific rock storage locations for later use. Dumping of waste rock within the Vault RSF will commence closest to the Vault Pit and will proceed in a north-westerly direction during development of the pit.

As a further ARD control measure, the Portage RSF will be capped with a 2-m thick cover of acid-buffering UM rock at closure. The depth of cover was selected based on thermistor data, which indicates the depth of thaw (active layer depth) to be on the order of 1.5 m. The cover material would be coarse to allow the development of convective cooling during winter, and insulation through trapped air within voids during summer. Given the high evaporation rate and low annual average precipitation at the site, the average annual infiltration into the pile is expected to be low.

The Vault RSF is not expected to require capping, as the bulk of the material from this deposit is NPAG.

For additional information regarding the proposed waste rock management strategies refer to support document *Meadowbank Gold Project Operational ARD/ML Sampling and Testing Plan* (MMC, 2007a).

5.3 WASTE ROCK STORAGE DIMENSIONS

Table 5.4 summarizes the physical dimensions and aspects of the Portage and Vault RSFs.

Table 5.4: Details of Proposed Rock Storage Facilities

Descriptors	Portage Rock Storage Facility	Vault Rock Storage Facility
Approximate storage volume	32 Mm^3	36 Mm^3
Approximate crest elevation	210 m	176 m
Approximate height	67 m	30 m
Maximum elevation of adjacent topography	192 m	190 m
Approximate footprint area	73 ha	191 ha
Approximate surface area	80 ha	195 ha

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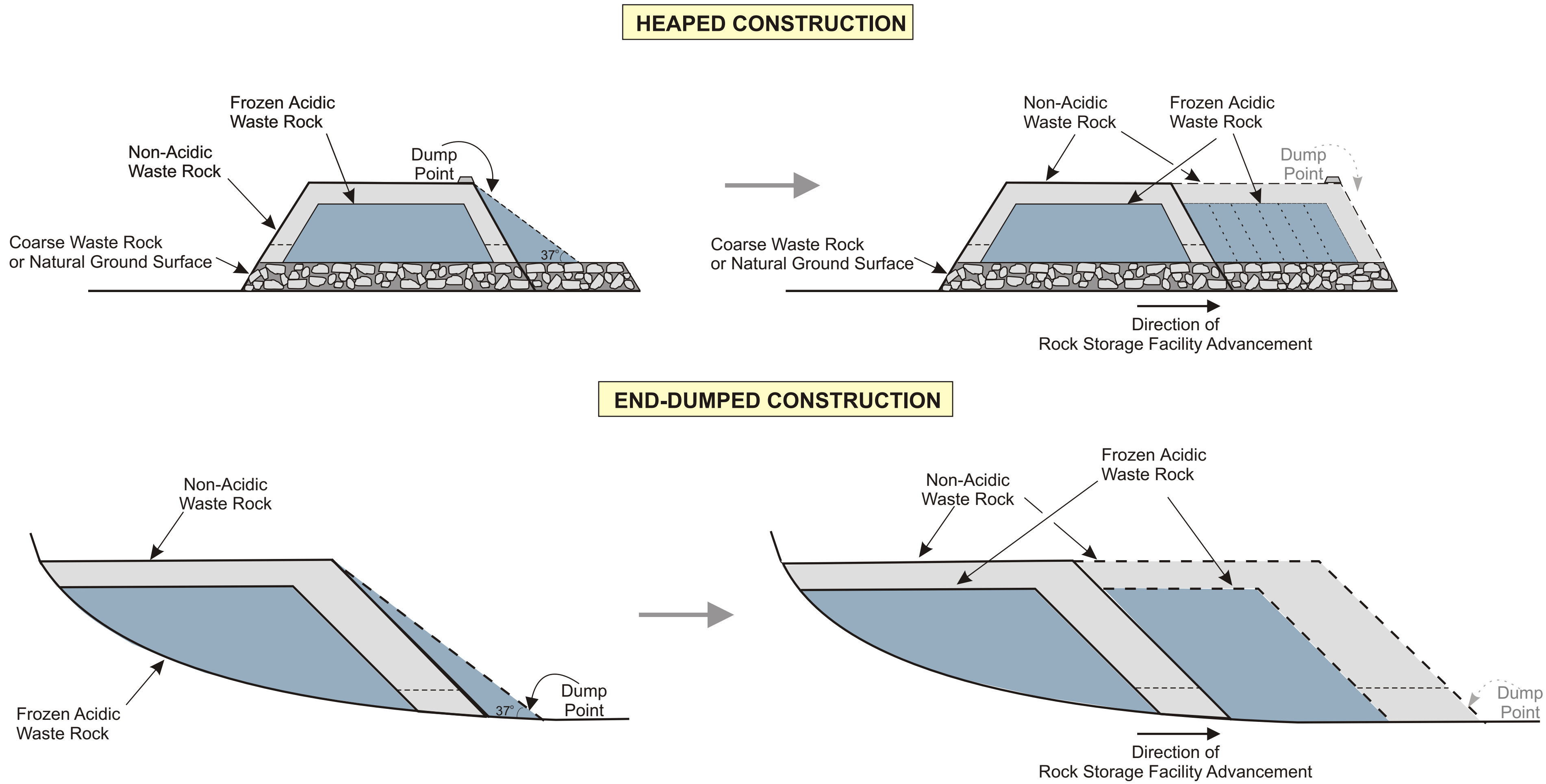

Not to Scale

Reference: MEND 1.61.2, 1996

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WASTE ROCK STORAGE FACILITY CONSTRUCTION METHODS

FIGURE 5.1

SECTION 6 • TAILINGS

Tailings are the processed material by-product of the gold recovery process. Tailings will be first processed through a cyanide destruction circuit before being pumped to the Tailings Distribution Box where it is combined with the treated sewage from the Sewage Treatment Plant before being pumped to the TSF.

Tailings will be deposited into the northwest arm of Second Portage Lake, commencing from the eastern end of the TSF near the Central Dike. Over the life of the mine, the deposition of tailings will advance slowly westward (Golder, 2007c). This tailings deposition strategy will result in the Second Portage Arm being filled with tailings at the end of the mine life. Initially, a basin at the northwest end of the facility will be operated as an attenuation storage pond, while the Reclaim Pond is operated within the TSF. Later in mine life, the attenuation basin will become the Reclaim Pond, and contact water will be diverted to the Goose Island and Portage pit lakes to assist with reflooding.

Additional information regarding the TSF is provided in the following support documents:

- *Meadowbank Gold Project Integrated Report on Evaluation of Tailings Management Alternatives* (Cumberland, 2007); and
- *Detailed Design of Central Dike, Meadowbank Gold Project* (Golder, 2007c)

6.1 TAILINGS PROPERTIES

Properties of the tailings relevant to the design of the TSF are presented in Table 6.1.

Table 6.1: Relevant Data for Tailings Storage Facility

Property	Value
Mine design life	8 yrs
Mill production (solids)	8,500 t/d
Ore processed (In-pit Reserves)	22 Mt
- Goose Island pit (S.G. = 3.09)	2.2 Mt
- Vault pit (S.G. = 2.96)	8.5 Mt
- Portage pits (S.G. = 3.28)	11.3 Mt
Average specific gravity of ore	3.1 t/m^3
Assumed void ratio (unfrozen)	1.38
Assumed dry density (unfrozen)	1.45 t/m^3
Assumed moisture content (by weight)	40%
Volume of tailings (no ice entrapment)	22 Mt (15 Mm^3)

6.2 TAILINGS MANAGEMENT STRATEGIES

Due to the arid climate and permafrost environment, tailings will be disposed of in a manner that encourages total freezing as a control strategy. Given the length of time that water at the site is ice-covered, subaerial disposal is preferred. This will allow the tailings to be frozen in thin layers rather than one thick layer in order to maximize the total frozen thickness. The tailings will eventually become encapsulated by permafrost; thus limiting oxygen diffusion and water infiltration into the pile, and the generation of acid mine drainage.

Although freezing of the tailings is predicted and expected, the tailings will be covered with a minimum 2 m thickness of non-acid generating ultramafic waste rock as a secondary preventive measure. The depth of cover was selected based on thermistor data, which indicates the depth of thaw (active layer depth) to be on the order of 1.5 m. This cover thickness is consistent with other cover designs over reactive tailings in the north. In addition to providing a layer to limit the depth of potential frost penetration into reactive tailings pile, the layer will also serve the following beneficial purposes:

- the cover will reduce the potential for wind blown tailings;
- the cover will be composed of acid buffering waste rock; and
- the cover will contribute to shedding of water from the surface of the tailings, and consequently will limit infiltration of water into the tailings pile.

The beneficial effects of the cover layer will provide an alternative and preventive strategy for the management of the TSF in the event that permafrost develops more slowly than predicted.

For additional information regarding the proposed tailings management strategies refer to the following support documents:

- *Meadowbank Gold Project Operational ARD/ML Sampling and Testing Plan* (MMC, 2007a); and
- *Detailed Design of Central Dike, Meadowbank Gold Project* (Golder, 2007c).

6.3 TAILINGS FREEZEBACK

Simplified thermal modelling of the proposed tailings deposit in the northwest arm of Second Portage Lake was carried out to predict the range of time required to freeze the tailings and into the underlying talik (Golder, 2007c). The thermal model was intended to simulate evolution of the foundation and tailings temperature during operations and after closure through a phased approach that included the following:

- estimation of thermal properties of the foundation and tailings materials;
- calibration of temperature at the bottom of the lake and deep foundation from measured temperature data from piezometers installed to a depth of 96 m from the lake bottom;
- determination of a regional geothermal gradient from site thermistor data;
- development of a surface temperature function from daily site climate data;

- development of a simplified model to evaluate the model sensitivity to different thermal properties;
- development of a 1-D model based upon the tailings deposition plan to assess the temperature profile across the tailing during the several deposition stages; and
- evaluation of a long term case to assess tailings and foundation temperature over 100 years assuming an increase in average temperatures of 6.4°C due to global warming.

The model results indicate that the degree of freezing, time to reach fully frozen tailings, and the depth of the frozen foundation beneath the tailing pile would depend upon the placement of the tailings and the duration of the exposure of the tailings to air temperature. Under all scenarios modelled and with a global warming rate of 6.4 ºC applied gradually and at a linear rate over the 100 years of model simulations, the entire tailings body and the underlying foundation to a depth of 14 m are predicted to be completely frozen within 10 years after end of operations.

A more detailed description of the thermal modelling of the TSF and of the Central Dike is presented in the Final Report on Detailed Design of Central Dike (Golder, 2007c).

6.3.1 Effect of Groundwater Flow on Freezing of Tailings

During mine operations, Second Portage Lake will continue to act primarily as a discharge zone until the elevation of the water table within the tailings is greater than that of the surrounding lakes. The results of modelling indicate the discharge rate to have very low velocity, possibly resulting in a slightly reduced rate of freezing of the tailings. A coupled seepage-thermal model has not been developed for the tailings deposit to evaluate the magnitude of this impact. However, when modelling the seepage through the Central Dike, it was assumed that the tailings deposit, Central Dike, and foundation soils would not be frozen in order to predict the maximum seepage rates from within the TSF (Golder, 2007c). The model (which assumed the tailings were deposited instantaneously as a thawed mass to the full depth) suggested this could be similar to assuming advective heat flow preventing freezing of the tailings until the tailings basin has been fully filled by end of mine life. These are conservative assumptions, as it is expected that the climate conditions at site will result in freezing of these components. Consequently, seepage through the Central Dike is likely to be less than predicted by the modelling (see Section 6.4 below). The closure case modelled considered a Reclaim Pond at the northwest end of the TSF, and full saturated tailings to an elevation of 146 m, with the Portage Pit Lake at elevation 134.1 m. The results for this case indicated a very low seepage flux from the pond through the saturated tailings and into the pit lake.

At the end of mining, the water within the Reclaim Pond will be treated, if necessary, and discharged. The tailings surface will be then contoured and capped with a 2-m thick layer of acid-buffering UM rock to avoid accumulation of water on the tailings surface.

A numerical method for considering the coupled convective seepage flow with the conductive heat flow is presented in Domenico and Schwartz (1990). Based on the relationship they present, and on the properties assumed for the thermal and groundwater flow analyses, the temperature distributions predicted by the thermal modelling of the TSF are similar to those predicted by the heat transport equation in regional groundwater flow. This is intuitively reasonable, considering the low seepage flux associated with the regional groundwater flow system. Consequently, the effect of the regional groundwater flow on the length of time predicted for freezing of the tailings is expected to be minimal. A deposition strategy that optimizes the freezing of the tailings during placement will have the effect of reducing the time required to freeze the deposited tailings. Other mitigation measures to encourage freezing of the tailings might include the use of passive thermosyphons.

6.3.2 Monitoring of Tailings Freezeback

During the development and mining of the deposits, an adaptive management plan will be implemented with respect to monitoring of the TSF. The plan will involve the installation of a series of thermistors at prescribed locations around the facility. During the operational phase, it is expected that a number of test pad stratigraphies will be developed to assess various cover designs, and to determine the most appropriate design for the actual site conditions. Such an approach has been used previously at northern mines such as Nanisivik where 5 test pads were evaluated.

The thermistors will be installed in boreholes drilled around the perimeter of the facility, and inclined at angles towards the facility so as to penetrate the talik beneath the facility. The purpose of the perimeter thermistors will be to monitor the talik temperatures as freezing progresses. The thermistors will be monitored during the operational period. The results will be used to evaluate the predicted thermal response of the facility with the actual thermal response. This will allow adjustments to the tailings deposition plan to be made during the operational period to optimize the rate at which the tailings and talik freeze.

In addition to the perimeter thermistors, installation of thermistors within boreholes drilled from the surface of the tailings will be undertaken. These installations would take place as the TSF is filled with tailings. Initially, some of the installations may be ‘sacrificial’; in other words installations that are installed early in the life of the TSF may become covered as the facility is filled. The rationale behind installing such thermistors is to monitor the thermal conditions within and beneath the TSF from a very early stage in the facility’s life. As the TSF reaches final elevation, thermistors will be installed from the final tailings surface, and directly into the underlying bedrock. These will likely be on the order of 50 m to 75 m in length, with nodes placed at intervals to monitor temperatures within the tailings and within the bedrock. The thermistors will be monitored with time, and the results will be compared with the predicted temperatures and freeze back rates.

It is expected that the proposed monitoring program will provide the data required to validate the predictions of freeze-back within the tailings. Field hydraulic conductivity testing of bedrock has shown the measured permeability to be very low, on the order of 10^{-8} m/s to 10^{-9} m/s. Modeling has shown that the rate of advance of the freezing front penetration through the TSF and into the bedrock will be greater than the rate of advective transport of constituents out of the TSF. Consequently, the tailings and any constituent release are predicted to be encapsulated by permafrost, based on the current available data. If it is determined by monitoring during operations that the tailings are freezing at lower rates than predicted, then mitigation procedures would be implemented.

A number of mitigation measures are available to control ground temperature and to enhance freezing. These include the use of passive or active thermosyphon systems. Passive systems rely on natural (or wind induced) ventilation while active systems rely on forced ventilation or circulation of refrigerants through a heat exchanger. The passive systems utilizing natural circulation are less costly, and are easily implemented, consisting essentially of an air convection pile, or pipe, that is open to the atmosphere. Heat is exchanged by convective circulation resulting from the cold air from the surface environment sinking within the open pipe, and warm air inside the pipe rising. These systems can also be closed systems having some internal fluid that is used as the heat transfer medium. Active (forced ventilation) systems utilize pumps and refrigerants to achieve the same cooling effect but at an accelerated rate. Both systems are used reliably in northern climates to preserve or promote freezing. As indicated above, the tailings will also be covered with a minimum 2 m thickness of non-acid generating ultramafic waste rock, which will provide an alternative and preventive strategy for the management of the TSF in the event that permafrost develops more slowly than predicted.

The design for the operational period of the mine does not consider climate change as the TSF will be operated over a short period of time; approximately 8 years. However, in the long term, the most successful strategy for managing the site will be to minimize the infiltration of water into the system, and more importantly to minimize the flux through the system. The current plan to cover the TSF will contribute to this strategy by shedding water from the surface of the facility.

6.4 TAILINGS SEEPAGE

During operation, the basin into which tailings will be deposited will be a local groundwater discharge area as the water level in the tailings will be below that of Second Portage Lake. As the Portage Pit is excavated however, it will become a regional hydraulic sink in the area. Any seepage into the talik beneath the tailings area will be directed towards the Portage Pit where it will be captured during the open pit operations and redirected back to the TSF.

As indicated on Figure 2.5, two main faults are present in the Portage deposit area. These are the Bay Zone Fault and an associated splay, and the Second Portage Fault. The Bay Zone Fault and associated splay trend in a roughly north-south direction along the western margin of the Third Portage deposit, while the Second Portage fault trends to the northwest underneath the Central Dike and TSF, roughly parallel to the orientation of the Second Portage Lake. In order to reduce the risk of potential seepage through the Second Portage Fault, bedrock grouting will be carried out beneath the Central Dike (Golder, 2007c).

Throughout operation, the proposed tailings deposition plan will result in the development of a tailings beach starting on the upstream slope of the Central Dike and progressively advancing to the west, away from the Central Dike and open pit (Golder, 2007c). In addition, the tailings deposited closest to the dike are expected to begin to freeze early in the operation. This will act to increase the potential seepage pathway and reduce seepage-flux through the Central Dike and foundation materials.

At closure, the tailings surface will be contoured or shaped and capped with a minimum 2-m thick layer of acid-buffering UM rock to avoid accumulation of water on the tailings surface. The thickness of capping will be such as to promote active layer development within the acid-buffering capping layer, and promote the development of permafrost within the tailings. During the post-closure period, the tailings are predicted to freeze with time, resulting in permafrost encapsulation. Until the tailings are frozen, tailings porewater seepage is expected to report to the Portage Pit Lake, which will be isolated from the adjacent Third Portage Lake until monitoring indicates the pit lake water quality achieves acceptable levels to allow removal of sections of the Goose Island Dike.

Post-closure tailing porewater seepage through or underneath the Central Dike would only occur under a positive hydraulic gradient or until the freezing front has penetrated into the tailings down to the level of the Portage Pit Lake. Thermal modelling of tailings freeze-back indicates that for the base case considered this would take place in about 10 to 15 years following mine operations. The model also indicated that the effects of global warming would not prevent freezing of the tailings or foundation of the Central Dike over the 100 year period of the model (Golder, 2007c). This model uses the conservative assumption that the tailings are deposited instantaneously, and that no freezing of the tailings occurs during operations. In addition, once re-watering of the pits has been completed, the lake elevation adjacent to the Central Dike will be at approximately 134 meters above sea level. Consequently, there will not be a hydraulic gradient driving seepage toward the lake.

Once freezing has developed into the upper portion of tailings, migration of constituents into the talik can only occur by diffusion. Diffusive transport is calculated to require more than $1x10^6$ years for 1% of the initial constituent concentration to reach the deep regional groundwater system. Freezing to the base of the tailings is predicted to occur approximately 10 to 15 years following mine operations. The rate of advance of the freezing front into the talik beneath the Second Portage Lake is therefore expected to exceed the rate of advance of diffusive transport, eventually encapsulating any constituents.

6.4.1 Monitoring of Tailings Seepage

Following dewatering of Second Portage Arm, several investigative procedures will be utilised to identify the location and hydraulic properties of faults that are present beneath the North Arm or Second Portage Lake including mapping of exposed bedrock, testing and monitoring during installation of the grout curtain in the Central Dike, and geophysical logging and packer testing in boreholes (MMC, 2007f). If the testing interval indicates a zone of enhanced permeability then these zones will be sealed.

The results of the above investigations will be used to site monitoring wells and thermistors that will be installed within the dike, and between the Central Dike and crest of the Portage Pit. The wells will be used, together with other wells installed in the area of the TSF, to monitor groundwater quality and the effectiveness of the grout curtain in preventing the flow of contaminants from the TSF through the faults. Thermal data will be monitored to evaluate and freeze back of the TSF, and of the Central Dike and foundation.

If it is determined that the quality of the water does not meet criteria as established during the water licensing process, then mitigation measures would be undertaken. The potential mitigation action would be dependent on observed flow rates and water quality data, but might include the following (Golder, 2007d):

- installation of an additional grout curtain between the downstream toe of the dike and the crest of the pit; and

- if, during monitoring, it is found that the freeze-back of the dike and tailings deposit are occurring at a rate less than predicted, then enhancement by artificial freezing methods may be considered.

Additional information regarding the prevention and mitigation of potential seepage from the TSF can be found following supporting documents:

- *Meadowbank Gold Project Fault testing and Monitoring Plan* (MMC, 2007f); and,
- *Mitigative Measures for Potential Seepage from Tailings Facility* (Golder, 2007d).

SECTION 7 • TAILINGS DEPOSITION PLAN

The objectives of the tailings deposition plan for the TSF are to (Golder, 2007c):

- define a deposition sequence based on proposed Central Dike alignment with sufficient capacity to store the life of mine tailings plus a contingency while maintaining the required setback from the Portage Pit;
- define a deposition sequence that allows the basin to be partitioned and a portion of the TSF to be operated as a storm water attenuation pond for at least 4 years;
- define a deposition sequence that maintains a reclaim pond with sufficient depth for efficient operation of the reclaim barge near the west side of the impoundment;
- define the staged construction schedule for the dikes so that adequate freeboard is maintained within the impoundment;
- define a deposition sequence that creates a tailings surface that will require the minimum earthworks during closure and if possible will allow covering of some portion of the tailings surface during operations; and
- define a deposition sequence that promotes freezing of the tailings during the operating period.

The tailings deposition plan has been developed assuming that tailings will be discharged into the southern portion of the TSF to the maximum elevation prior to tailings being discharged into the northern basin. This will maximize the time that the northern part of the basin can be used as the Portage Attenuation Pond. Once the southern area is filled, the reclaim barge will be moved into the northern area, and tailings deposition continued into that basin. While the northern area is operated, the southern area will be allowed to freeze, and the rockfill cover placed starting from the Central Dike and working to the north.

The main components of the TSF are shown on Table 7.1 and Figure 7.1. Figure 7.1 corresponds approximately to Year 3 of operations. The storage capacity of the tailings basin, Attenuation/Reclaim Pond, and total basin capacity are shown on Figure 7.2. The operational management strategy for the TSF is presented in Figures 7.3 to 7.8.

Additional information regarding the tailings deposition plan can be found in Appendix G and the supporting document *Detailed Design of Central Dike, Meadowbank Gold Project* (Golder, 2007c).

Table 7.1: Summary of Tailings Storage Facility Development

Year	Key Issues
-2 and -1	• Stripping at Third Portage peninsula for construction materials • Construct East and Bay Zone dikes • Dewater inside East and Bay Zone dikes to Third Portage Lake • Begin constructing Goose Island Dike if construction material becomes available • Construct Central Starter and Stormwater dikes. Apply surfacing material on East and Central Starter dikes
1	• Commence mining of Portage Pit, south end • Operate separate Reclaim and Portage Attenuation ponds • Runoff from Portage RSF and Landfill directed to Portage Attenuation Pond • Portage Pit water and plant site and airstrip runoff directed to Portage Attenuation Pond, or pumped to water sump at Process Plant for use as process make-up water as required before discharge of excess to Portage Attenuation Pond • Monitor water quality within Portage Attenuation Pond, treating in–situ if required prior to decant of excess to Third Portage Lake and/or pumping to Process Plant for use as make-up water • Continue and complete construction of Goose Island Dike. Dewater to Third Portage Lake • Begin construction of North Saddle Dam
2	• Commence mining at Goose Island Pit • Raise Central Dike from El. 120 masl to El. 140 masl and apply surfacing material • Continue and complete construction of North Saddle Dam • Goose Island Pit water directed to Portage Attenuation pond, or pumped to water sump at Process Plant for use as process make-up water as required before discharge of excess to Portage Attenuation Pond
3	• Construct South Saddle Dam and Stormwater Dike filter • Begin mining northward at Portage Pit
4	• Dewater Vault Lake to Wally Lake and commence mining of Vault Pit • Complete mining of Goose Island Pit and commence pit reflooding
5	• Raise Central Dike from El. 140 masl to 147.0 masl and apply surfacing material • Portage Pit water (until completion of mining) and plant site and airstrip runoff to be directed to Portage Attenuation pond, or pumped to water sump at Process Plant for use as process make-up water as required before discharge of excess to Portage Attenuation Pond or Goose Island Pit to assist with reflooding • Complete mining of Portage Pit and commence pit reflooding • Excess water from Portage Attenuation Pond may be directed to Goose Island and Portage pits to assist with reflooding
6-7	• Continue mining of Vault Pit • Commence deposition of tailings in Northwest Basin on Second Portage Arm. Portage Attenuation and Reclaim ponds combine • Runoff from Portage Rock Storage Facility and Landfill directed to Reclaim Pond
8	• Complete mining at Vault • Reclaim Pond water treated if necessary and discharged to Goose Island or Portage pit lakes to assist with reflooding • Mining complete, start final closure and reclamation

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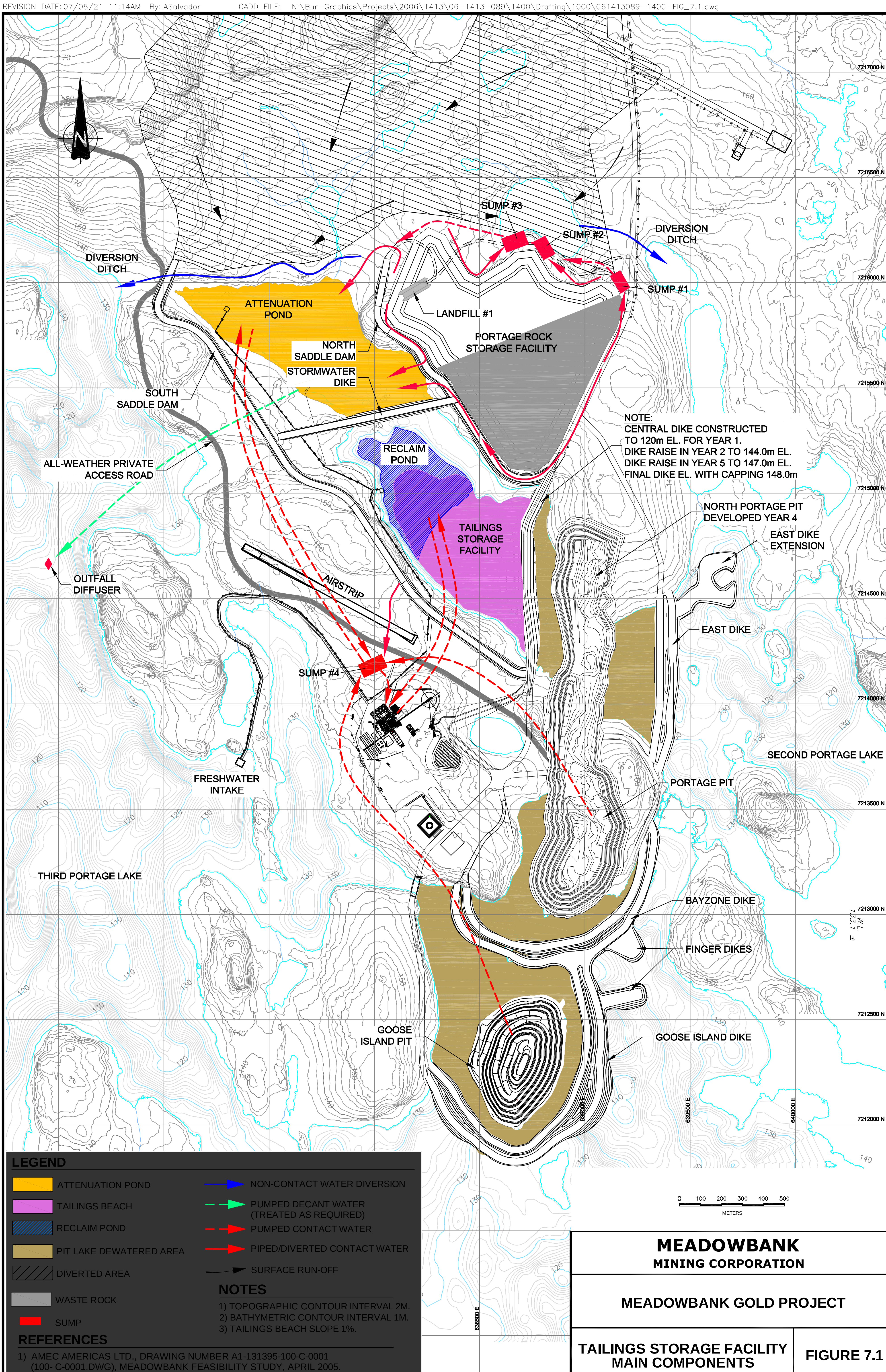

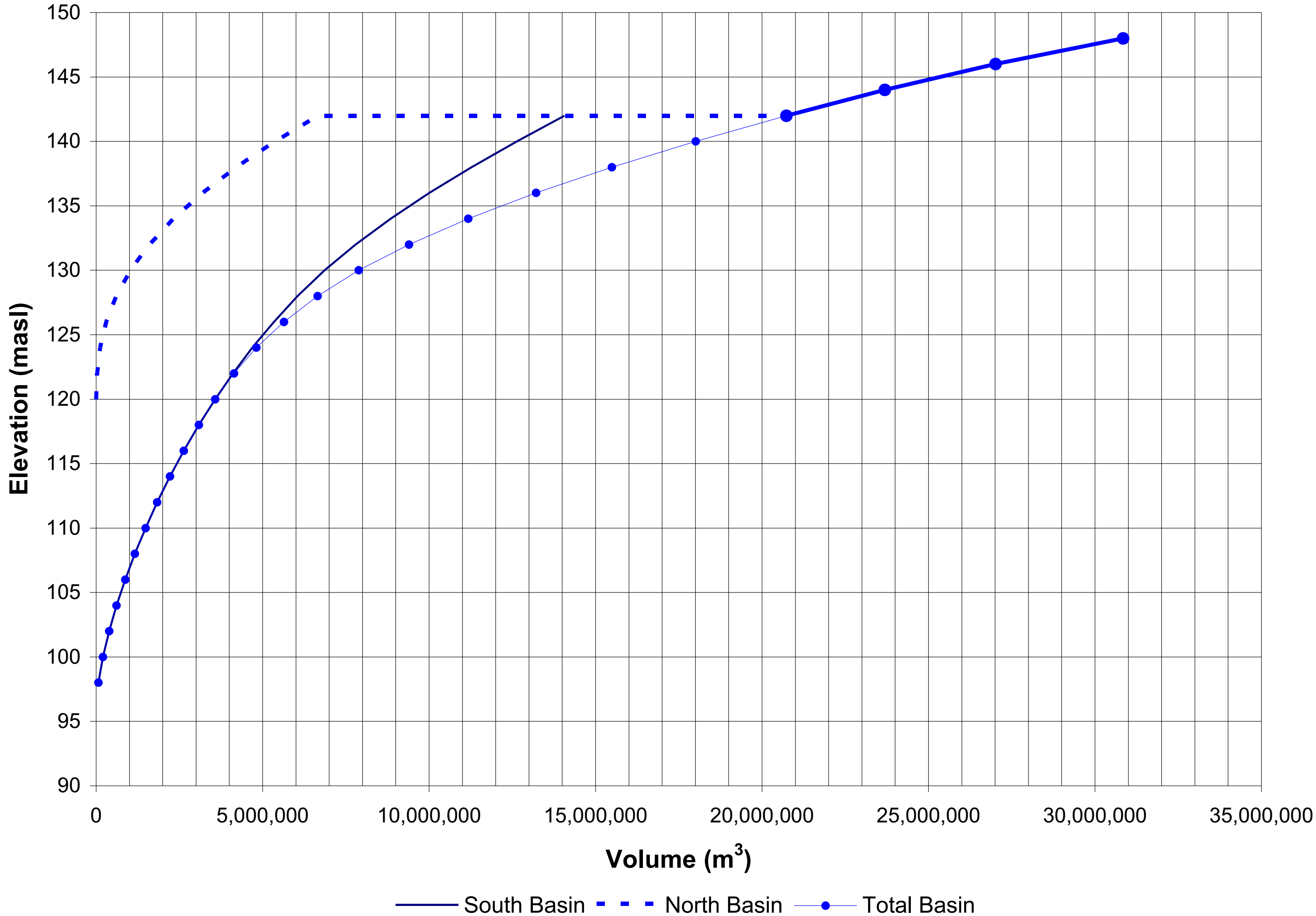

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TAILINGS STORAGE FACILITY STAGE STORAGE VOLUME CURVE

FIGURE 7.2

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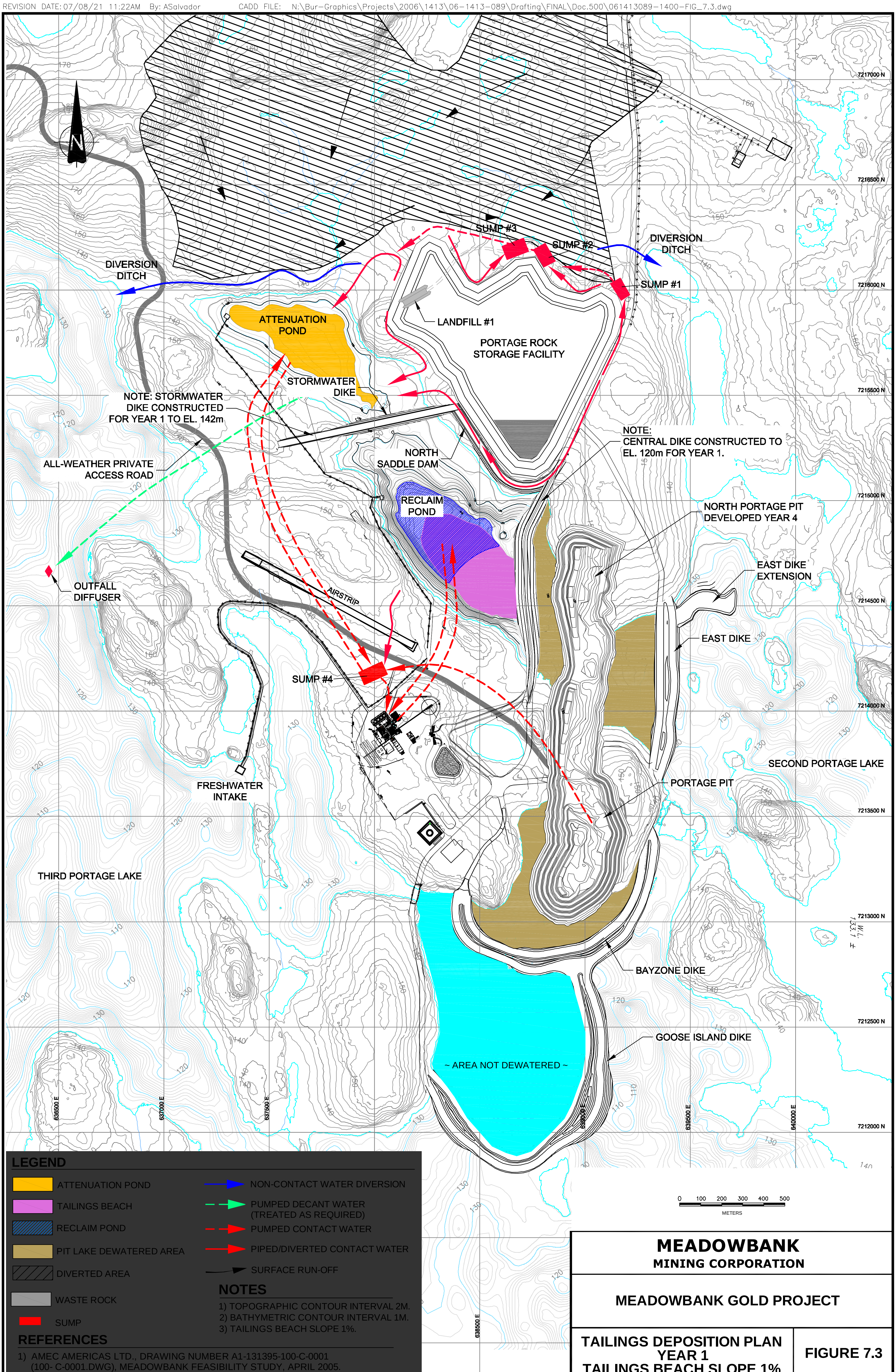

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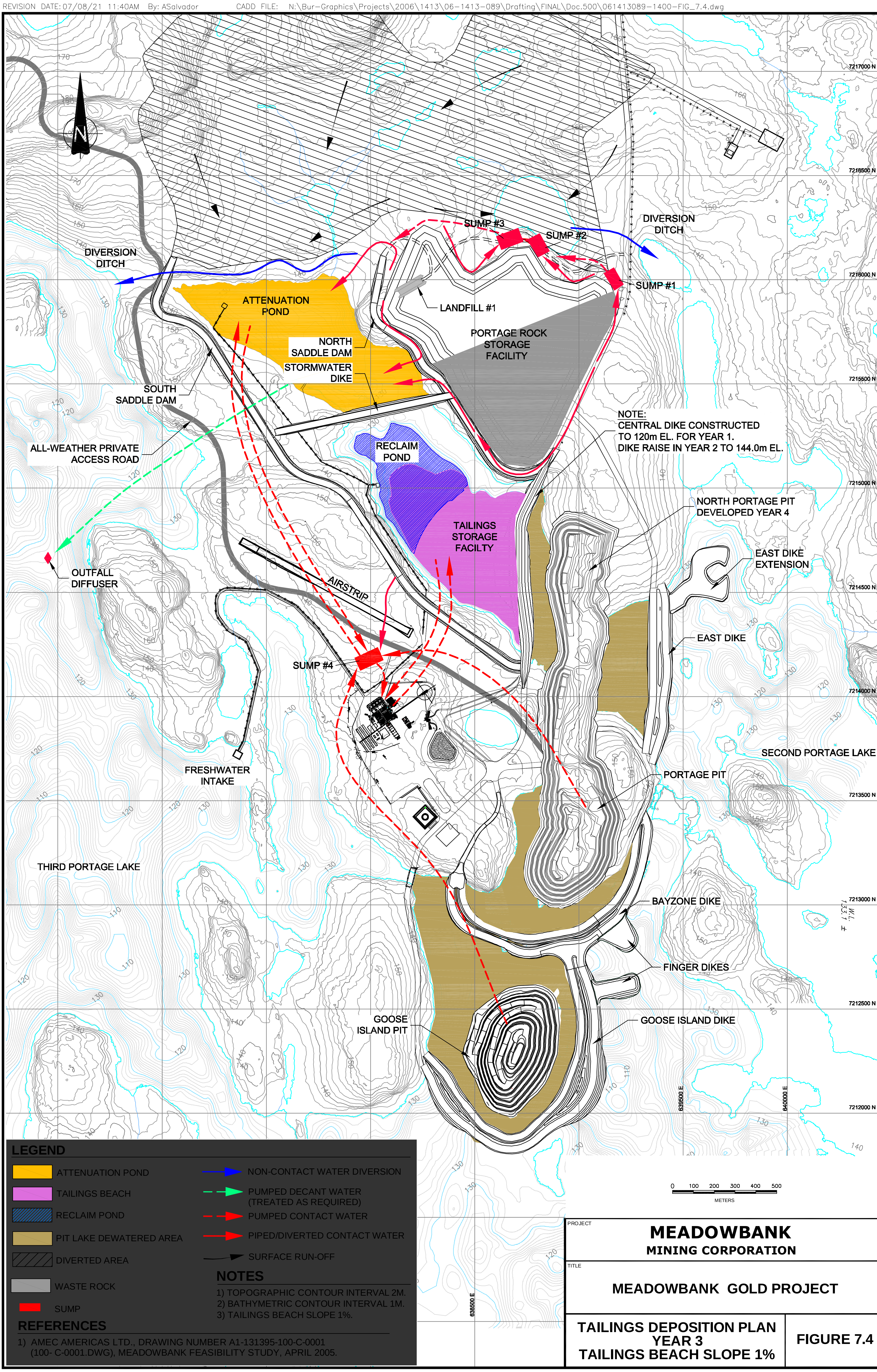

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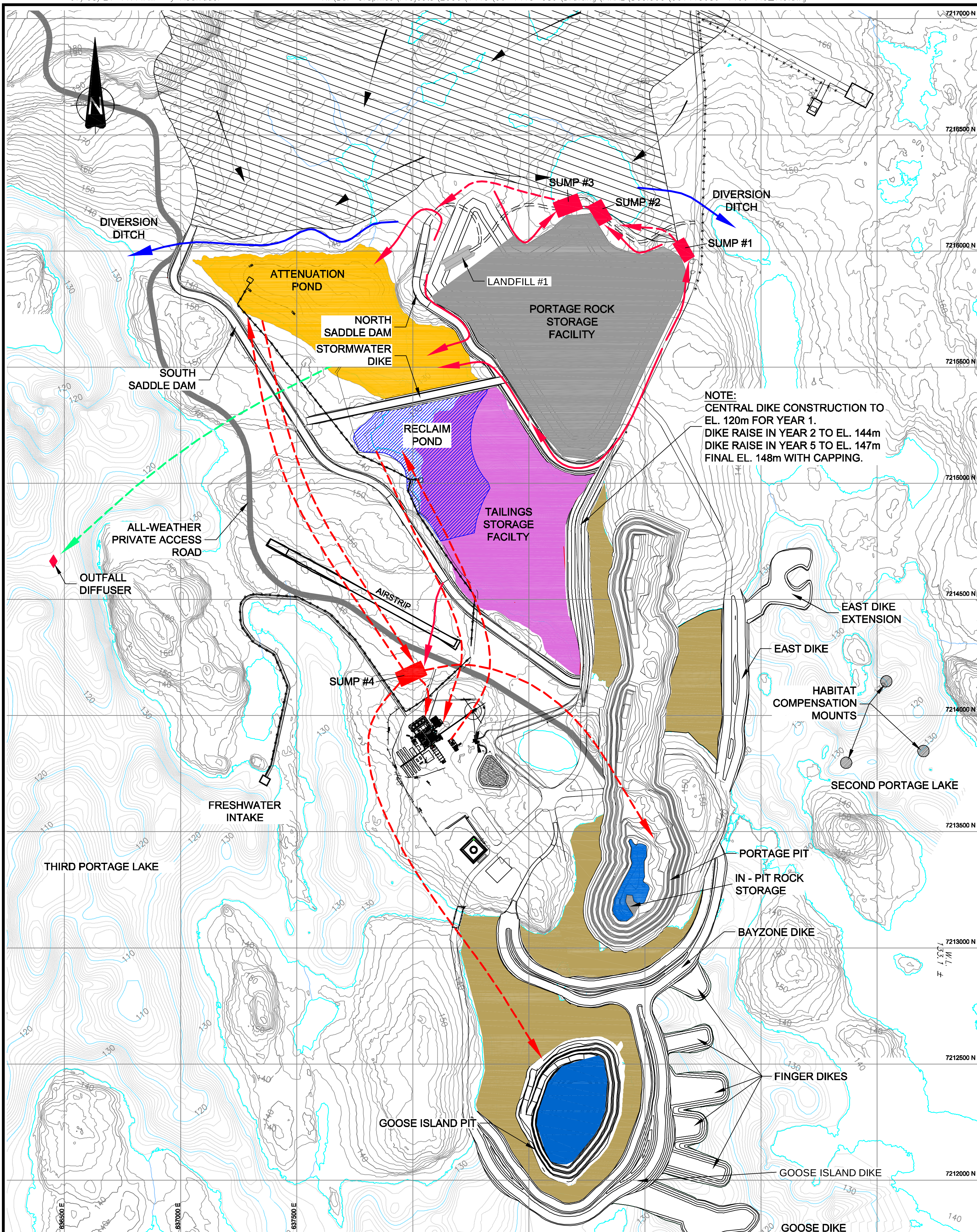

LEGEND

- ATTENUATION POND
- TAILINGS BEACH
- RECLAIM POND
- PIT LAKE DEWATERED AREA
- DIVERTED AREA
- WASTE ROCK
- PIT RE-WATERING
- SUMP
- NON-CONTACT WATER DIVERSION
- PUMPED DECANT WATER (TREATED AS REQUIRED)
- PUMPED CONTACT WATER
- SURFACE RUN-OFF

NOTES

1) TOPOGRAPHIC CONTOUR INTERVAL 2M.
2) BATHYMETRIC CONTOUR INTERVAL 1M.
3) TAILINGS BEACH SLOPE 1%.

REFERENCES

1) AMEC AMERICAS LTD., DRAWING NUMBER A1-131395-100-C-0001 (100- C-0001.DWG), MEADOWBANK FEASIBILITY STUDY, APRIL 2005.

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TAILINGS DEPOSITION PLAN YEAR 5 TAILINGS BEACH SLOPE 1%

FIGURE 7.5

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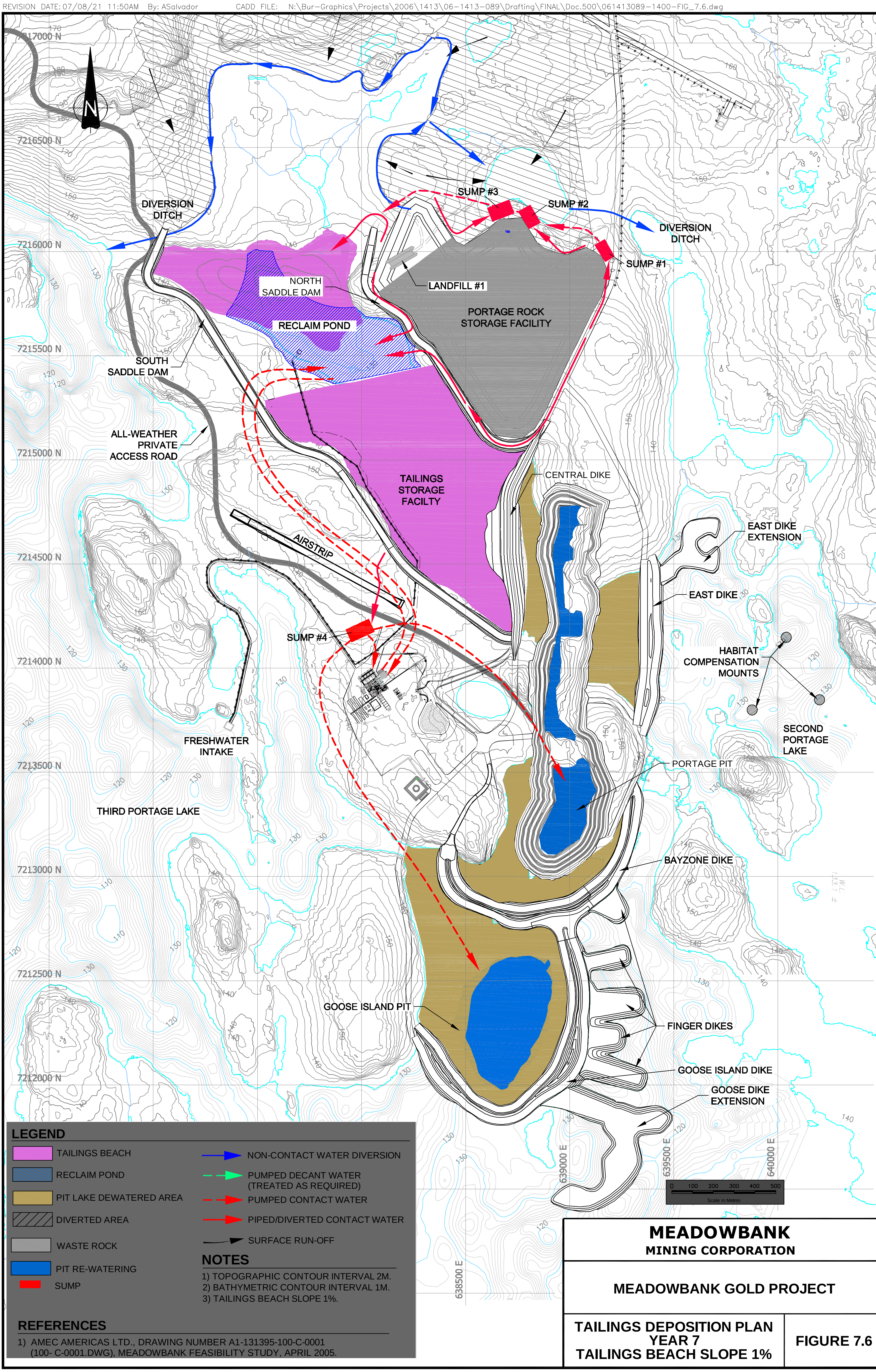

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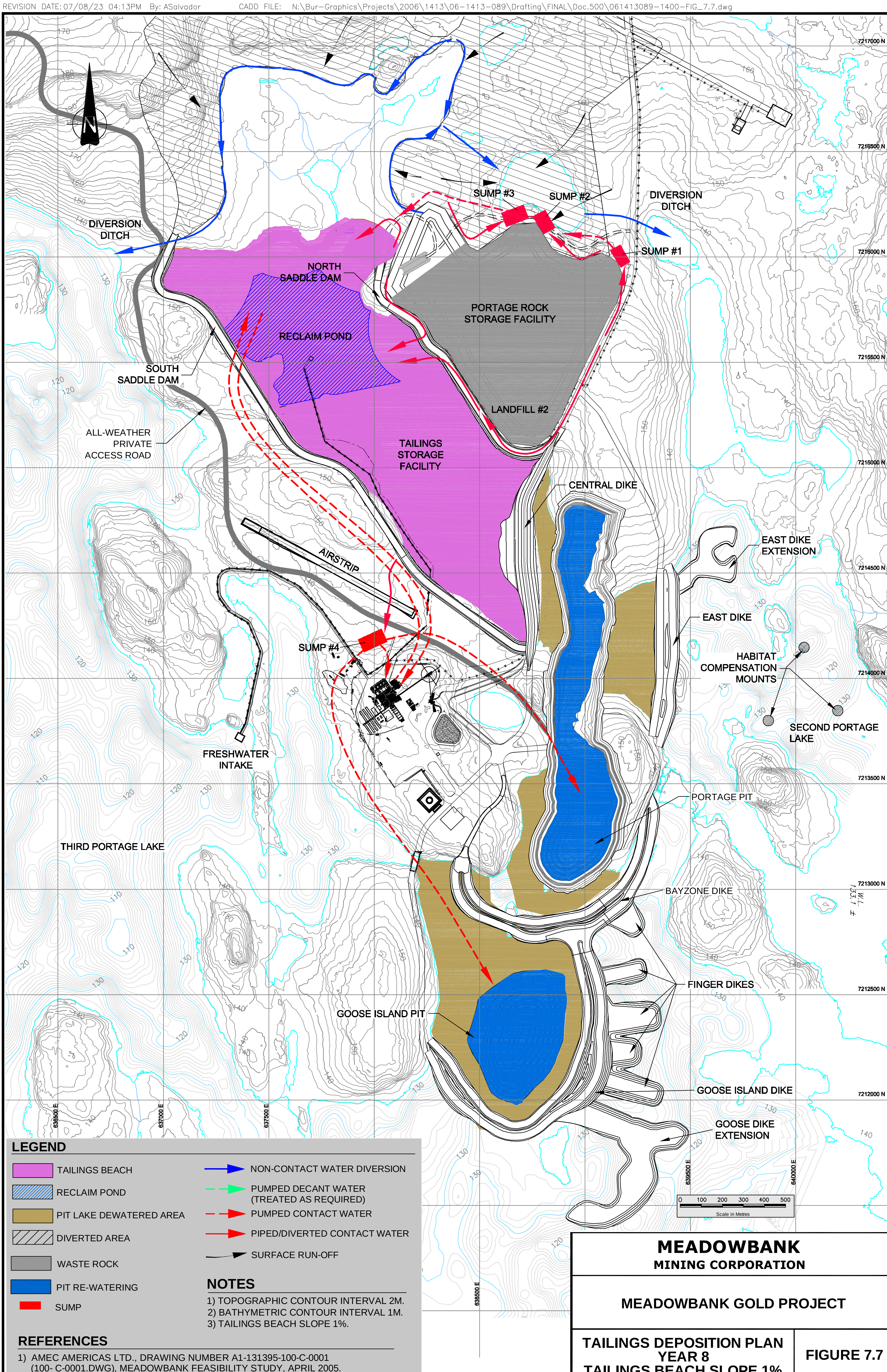

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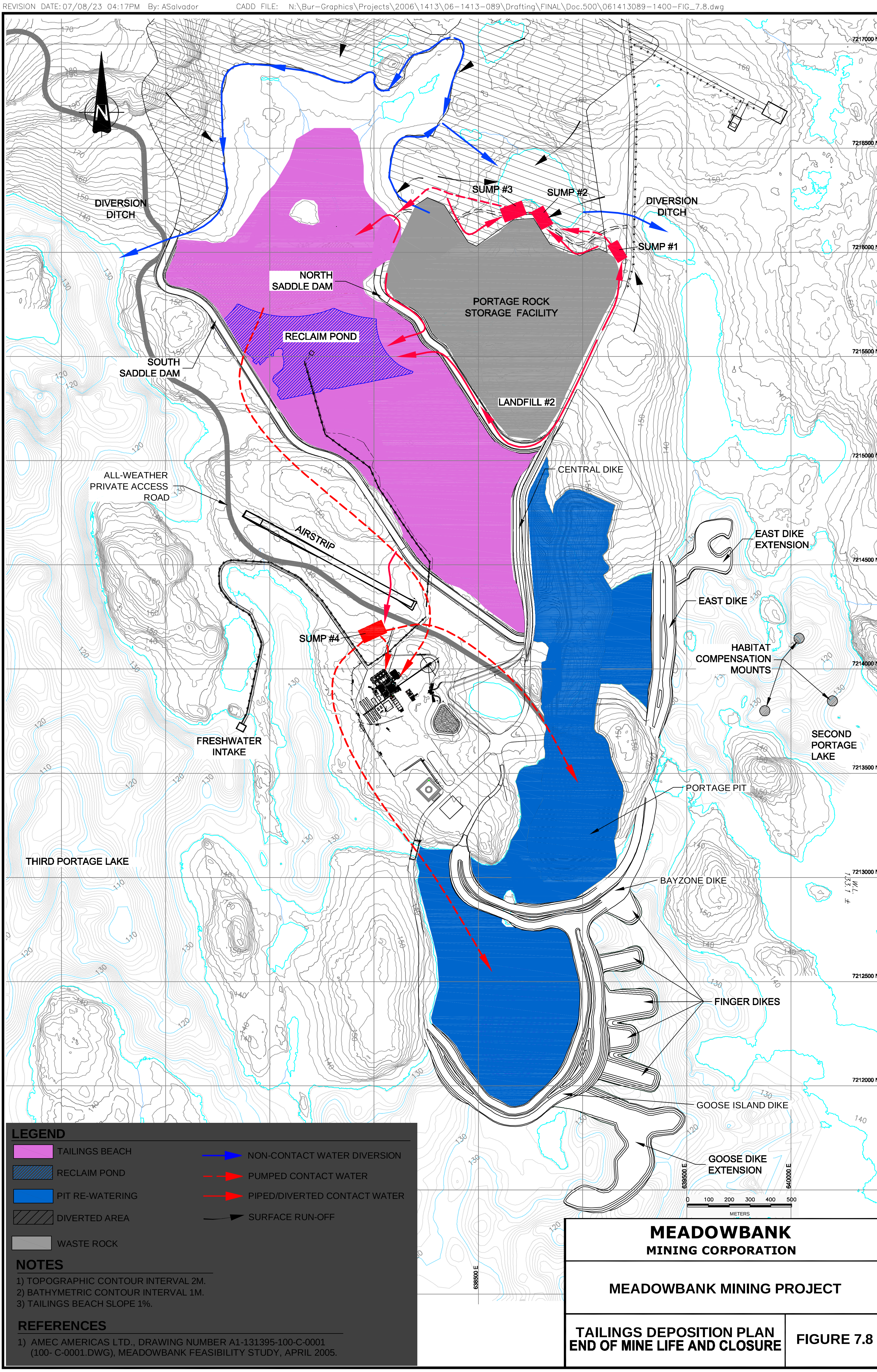


7.1 TAILINGS STORAGE FACILITY CAPACITY

As mill processing rates and tailings characteristics are liable to fluctuate over the life of the mine, the design of the TSF and tailings deposition plan were completed to provide additional contingency for potential variations in design parameters including mill process rates, tailings beach slopes, ice entrapment, and tailings in-situ densities (Golder, 2007c).

Tailings deposition plans have been prepared for two tailings beach slopes (0.5% and 1.0%) at mill processing rates of 7,500 t/day (Golder, 2007c) and 8,500 t/day (Appendix G). The plans, which include a 20% tailings bulking factor due to ice entrapment, indicate that the proposed TSF has sufficient capacity to store the expected tailings volume over the life of mine.

It is likely that some ice will be trapped in the tailings as a result of tailings transport water freezing before it reaches the Reclaim Pond. The quantity of ice trapped will depend on the tailings beach management, but volumes of up to 30% have been reported by some mines in similar environments. The impact of varying proportions of entrapped ice on the storage capacity of the TSF is presented in Figure 7.9. The figure indicates that the entrapment of 30% ice in the tailings would result in the final height of the TSF increasing by about 3.5 m relative to the height that would be required if no ice is entrapped. This increase would require minor extensions of containment berms and would have a negligible impact on the visibility of the TSF.

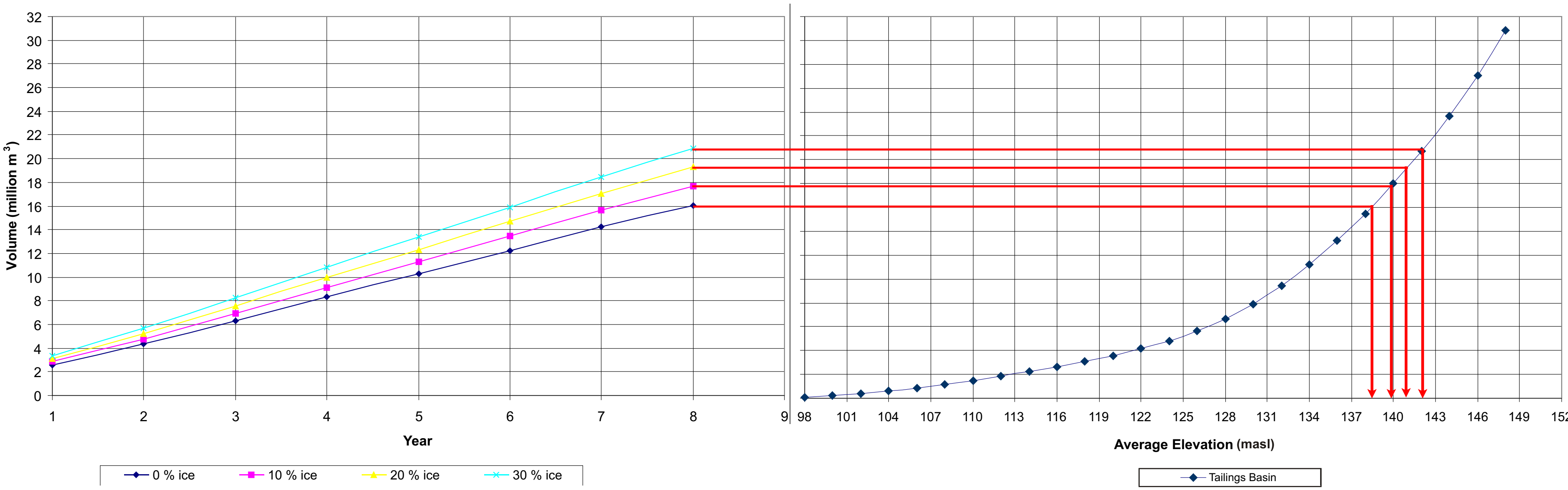
The impact of possible ice entrapment on the final elevation of the TSF is summarized in Table 7.2. As indicated above, the tailings deposition plans assumed a 20% bulking factor for ice. While the actual amounts of ice entrapment will not be known until the commencement of operation of the TSF, ice entrapment can be managed to a large degree by effective beach management and through the implementation of appropriate operational strategies. It should be noted however that the tailings deposition plans were developed assuming a relatively low tailings in-situ density, and therefore, additional storage contingency may be available within the TSF. All the same, an advantage of the current facility layout relative to other possible storage areas is that increases in storage volume requirements can be accommodated by relatively small increases in the final tailings surface elevation, while maintaining a low overall profile relative to the surrounding terrain.

Table 7.2: Average Tailings Surface Elevation for Various Amounts of Ice Entrapment

Proportion of Entrapped Ice (%)	Final Elevation of Tailings (m)
0	138.5
10	140
20	141
30	142

Additional fill to the TSF may include lake bottom sediment generated during stripping of mining areas and the Central and Stormwater dike footprints. The thickness of sediments may range from centimetres to several metres. Other projects in the north have reported soft sediments of up to about 4 metres. Assuming a 1 m to 2 m average sediment thicknesses, the estimated potential volumes range from about 0.7 Mm^3 to 1.4 Mm^3, or approximately 2% to 4% of the total capacity of the TSF to elevation 148 m (see Section 8.1, Figure 7.2).

DRAWING DATE: 11-Jul-07 COREL FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\1400\Drafting\1000\FIGURE 7.9.cdr



NOTE

FOR COMPARATIVE PURPOSES ONLY.
FINAL TAILINGS ELEVATIONS ARE AVERAGES ONLY AND DO NOT REFLECT POTENTIAL ELEVATION VARIATIONS ACROSS THE BASIN

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TAILINGS STORAGE FACILITY STORAGE VOLUME AS A FUNCTION OF ICE CONTENT 8500tpd MILL PROCESS RATE	FIGURE 7.9

SECTION 8 • OVERBURDEN MATERIALS

8.1 LAKE BOTTOM SEDIMENTS

The lake bottoms are expected to consist of soft lake bottom sediments, referring to fine grained sediments that typically accumulate, underlain by till or other overburden materials, and then bedrock. The thickness of soft lake bottom sediments is expected to be variable, and may range from a few centimetres up to several meters, as suggested by geophysical surveys. Other projects in the north have reported soft sediments up to about 4 m in thickness. These sediments will need to be removed to beyond the footprint of the Central and Stormwater dikes and the open pits after the lakes have been drawn down. A range in potential volumes has been provided in Table 8.1, assuming 1 and 2 m average sediment thicknesses.

Table 8.1: Estimate of Lake Bottom Sediment Volumes

	Approximate Footprint Area (m^2)	Volume (m^3) (assuming 1 m average thickness)	Volume (m^3) (assuming 2 m average thickness)
Central Dike	110,000	110,000	220,000
Stormwater Dike	60,000	60,000	120,000
Goose Island pit	200,000	200,000	400,000
Portage Pit (includes Bay Zone & Connector Zone)	300,000	300,000	600,000
Total	670,000	670,000	1,340,000

Note: Volumes are based on plan areas of pits and dike below lake level where soft sediments may be present, and not on total footprint areas.

The sediments will be exposed and allowed to freeze, before being excavated with conventional equipment. Ripping or blasting may be required to loosen the materials, depending on the nature of the sediments and the time for which they are exposed to freezing conditions.

Lake bottom sediments will only be removed from the footprint area of the Central and Stormwater dikes (Golder, 2007c). The proposed construction methodology for the Dewatering Dikes does not include the removal of lake bottom sediments (Golder, 2007e). Within the Central Dike footprint, lake bottom sediments will be stripped to expose the till foundation and will be disposed of immediately upstream of the Central Dike. Stripped lake bottom sediments from the Stormwater Dike foundation will be placed downstream of the dike. The stripped material from the dike foundations will be placed on to dewatered lake bottom sediments and some may flow into the Reclaim Pond. This is not expected to affect water quality of the Reclaim Pond as the volume of sediments is small compared to the size of pond. Initial tailings deposit will be from the upstream face of Central Dike on the area of lake bottom sediment disposal from the Central Dike construction.

It is recognized that the lake bottom sediments may introduce TSS into the water column during the advancement of the rockfill berms during Dewatering Dike construction. It is planned to use silt curtains to manage TSS during embankment rock placement (Golder, 2007e). Such methods to manage TSS during embankment construction are routinely used at other mining operations in the north. The water depths in the vicinity of the Dewatering Dikes are shallow, generally less than 4 m to 6 m. Much of the East Dike will be constructed through water that is 2 m or less in depth. The fine lake bottom sediments will be displaced or incorporated into the pore space of the rockfill. The displacement or incorporation of the fine lake bottom sediments into the rockfill is not expected to present any significant stability issues especially when the embankment height is low. Through the deepest section of the Goose Island Dike, along its southeast segment, dredging may be necessary. This can be achieved using a crane and clamshell dredging bucket if necessary.

Lake bottom sediments will also be mined as part of development of the open pits. Lake bottom sediments will be mined and are proposed to be placed in the area between the North Portage deposit and the East Dike. One reason for selecting this location is that the sediment may consolidate and could then be accessed in future for a reclamation material. There is no plan to use the soft lake bottom sediments as construction materials.

8.2 TILL

The remainder of the overburden materials on site are a rocky till. Some till will be used in the construction of retaining dikes for water and tailings; the balance may be placed in the RSFs. Till placed in the RSFs will either be mixed with the waste rock, or stockpiled separately for future use (e.g., reclamation). The average till thicknesses throughout the Project area are on the order of 2 to 3 m based on reverse circulation drilling carried out by Cumberland in 2002. Locally, thicknesses may reach up to 18 m.

In general terms, the till can be described as a silty sand/gravel till, having a fines (silt + clay) content between about 30% and 40% based on laboratory grain size analyses. The material also contains up to boulder-sized particles.

The material that has been recovered from beneath the lakes during geotechnical drilling along the proposed dike alignments generally can be described as cobbles and gravel with traces of sand, silt, and clay (Golder, 2006). Locally, samples of sand have been obtained. Samples of clayey sand materials have been recovered using split spoon sampling methods.

Till material stripped during pre-mining development will be used for the construction of the East and Bay Zone dikes. It is estimated that 1.8 Mt of till will be produced during pre-mining activities of Year -2 and Year-1 for use in the construction of the dikes. An additional 2 Mt of till will be stripped during Year 1 activities (Table 2.1). For planning purposes, it has been assumed that only 50% of this material will be suitable for use in the construction of the Dewatering and Central dikes. The corresponds to approximately 0.9 Mt construction till in Year -2 and Year -1, and approximately 1 Mt in Year 1. Quantity estimates indicate that approximately 0.7Mt of till will be required for the construction of the Dewatering and Central dikes prior to start-up, with a further 0.8 Mt required in Year 1. At the time of the preparation of this document, a field program was under way to confirm available till quantities on the Third Portage peninsula for Dewatering Dike construction.

8.3 SEDIMENT ENTRAINMENT DURING DEWATERING

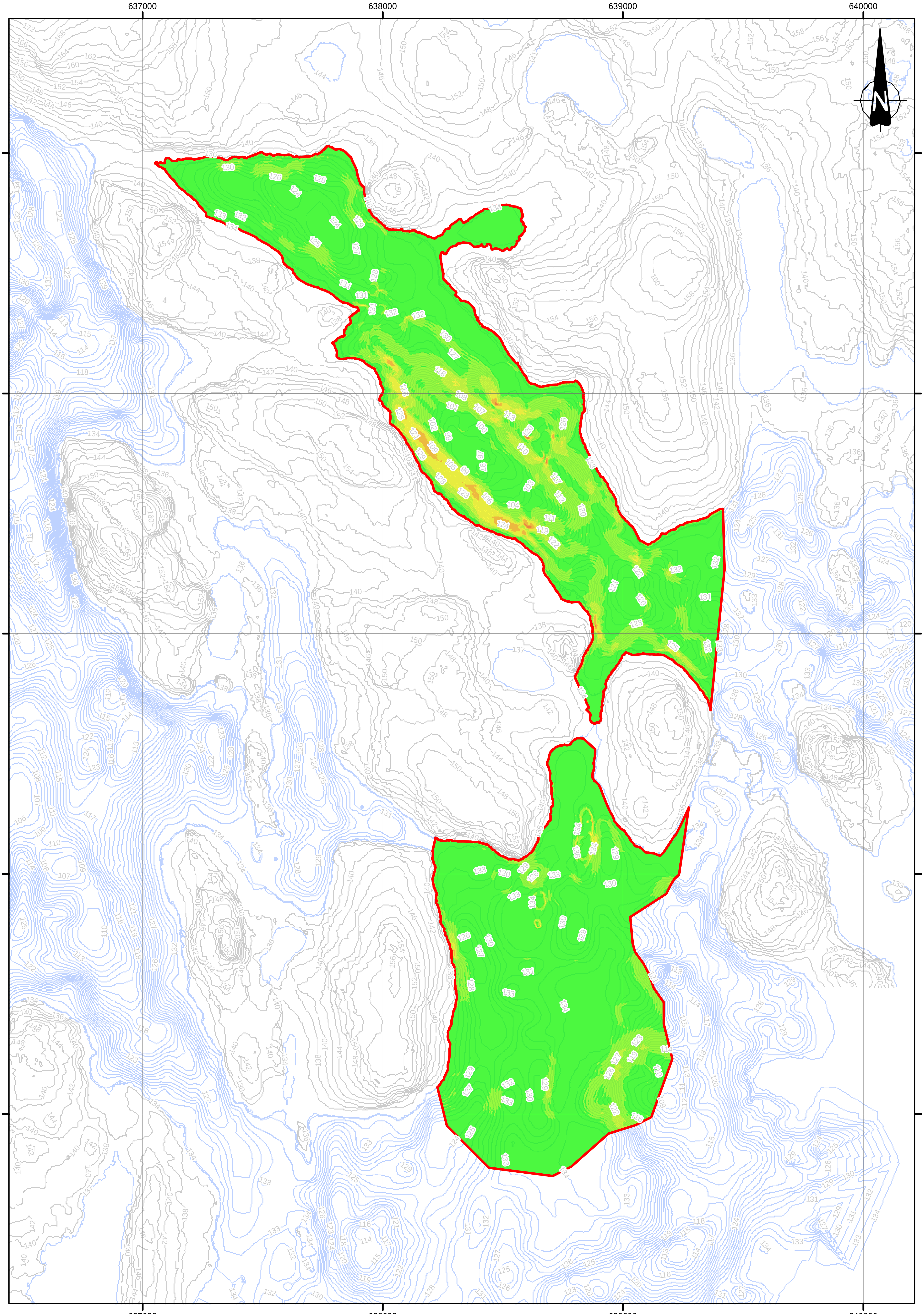
Dewatering of Second Portage Arm, Goose Island pit area, and Vault Lake may expose lake shoals composed of unconsolidated sediments, which may lead to local sedimentation within the impounded water. Proper timing of pumping periods will be used to prevent the discharge of sediment-laden waters to the environment. The introduction of sediments into the water column will depend on the type of material being exposed and the material properties, slope gradient, and rate at which the basin is drawn down. Where submarine slopes are steep, these may be underlain by a thin layer of soft lake bottom sediments overlying till or bedrock. In these areas, slumping may occur as the lake is drawn down. Where submarine slopes are less steep, these may be underlain by thicker sequences of soft lake bottom sediments, which overlie till or bedrock and may be prone to flow. It is not possible to accurately quantify areas that may be prone to slumping or flow. An estimate of areas that may be susceptible to soft sediment displacement and slumping during dewatering activities is shown on Figure 8.1 for the Portage and Goose Island areas and Figure 8.2 for the Vault area. Based on the currently available information, it is not possible to characterize these areas other than in general terms. The extent to which soft sediment flow and slumping occurs will depend on the actual material properties and on the dewatering rates.

Further details on mitigation measures that will be employed to limit the sediment entrainment during dewatering are provided in Section 9.1 of this document.

8.4 SEDIMENT MOBILIZATION DURING PIT FLOODING

During the Environmental Impact Review Process for the Project, Environment Canada expressed concern that the re-flooding of the pit areas may mobilize fine clays and silts which are indicated to be high in metals. It should be noted that it will be several years before the dikes are breached after re-flooding of the pits begins. Consequently, any fine sediments that have potentially been re-mobilized into the water column are expected to have settled out by the time the pit lake areas are reconnected to the surrounding lakes.

Additional information on pit flooding can be found in Section 9.4 and Section 12.5 of this document



LEGEND

PORTAGE AREA

TOPOGRAPHIC CONTOUR (2 M INTERVAL)

BATHYMETRIC CONTOUR (1 M INTERVAL)

SLOPE (DEGREE)

0 - 5	POTENTIAL SOFT SEDIMENT DISPLACEMENT
5 - 10	
10 - 15	
15 - 20	POTENTIAL SLUMPING
20 - 25	
25 - 30	
30 - 35	

0 150 300 450 600 750

Scale in Metres

REFERENCES

1) TOPOGRAPHIC DATA: CUMBERLAND RESOURCES LTD.
2) HORIZONTAL DATUM: NAD83 PROJECTION: UTM ZONE 14N

NOTES

DURING DE-WATERING ACTUAL DISPLACEMENTS WILL DEPEND ON MATERIAL PROPERTIES AND DE-WATERING RATES.

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AREAS OF POTENTIAL SEDIMENT DISPLACEMENT DURING DE-WATERING PORTAGE AREA

FIGURE 8.1

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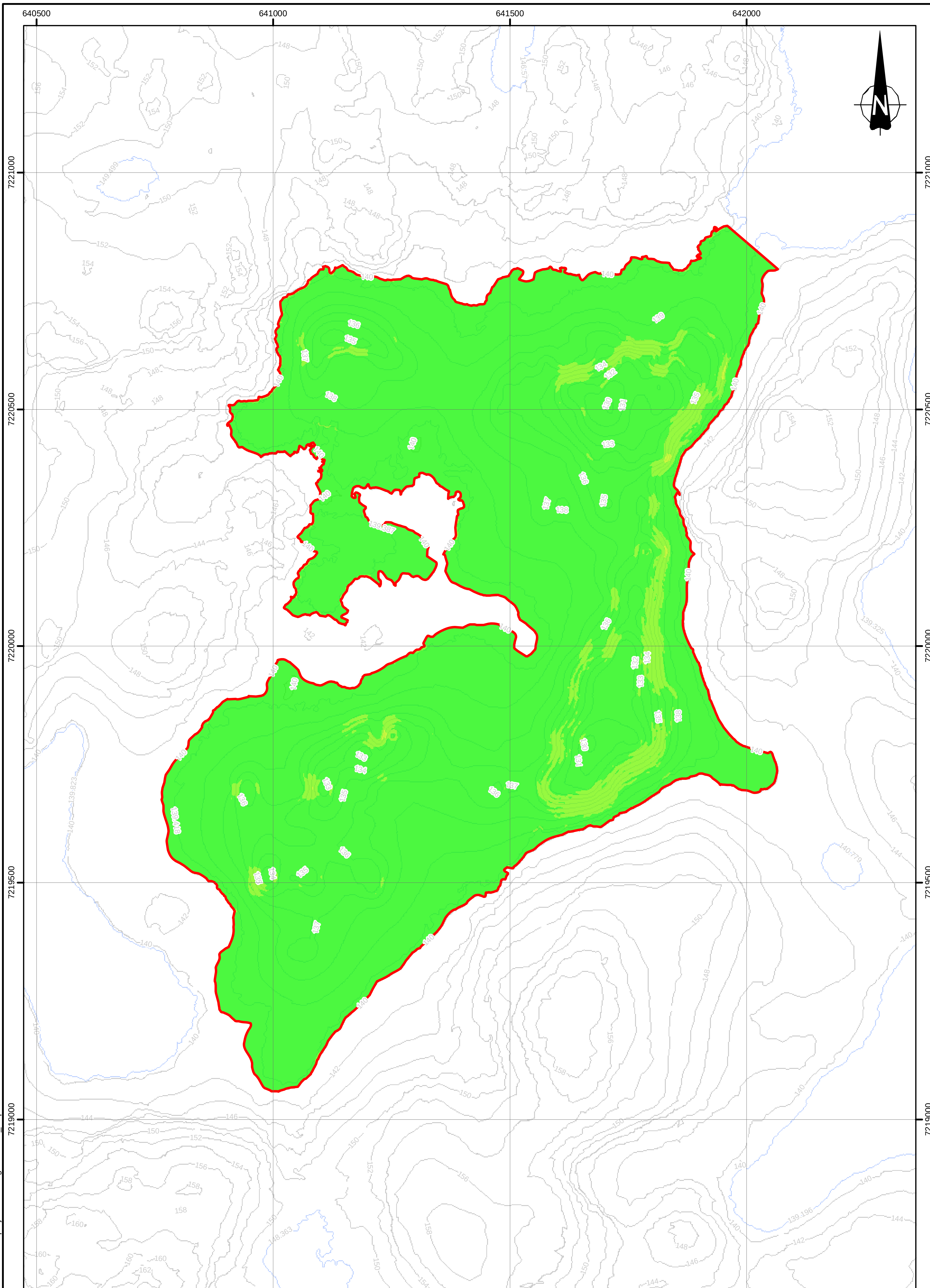

LEGEND

- PORTAGE AREA
- TOPOGRAPHIC CONTOUR (2 M INTERVAL)
- BATHYMETRIC CONTOUR (1 M INTERVAL)

SLOPE (DEGREE)

Slope	
0 - 5	POTENTIAL SOFT SEDIMENT DISPLACEMENT
5 - 10	POTENTIAL SOFT SEDIMENT DISPLACEMENT
10 - 15	POTENTIAL SOFT SEDIMENT DISPLACEMENT
15 - 20	POTENTIAL SLUMPING
20 - 25	POTENTIAL SLUMPING
25 - 30	POTENTIAL SLUMPING
30 - 35	POTENTIAL SLUMPING

0 75 150 225 300 375

Scale in Metres

REFERENCES

1) TOPOGRAPHIC DATA: CUMBERLAND RESOURCES LTD.
2) HORIZONTAL DATUM: NAD83 PROJECTION: UTM ZONE 14N

NOTES

DURING DE-WATERING ACTUAL DISPLACEMENTS WILL DEPEND ON MATERIAL PROPERTIES AND DE-WATERING RATES.

PROJECT

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TITLE

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AREAS OF POTENTIAL SEDIMENT DISPLACEMENT DURING DE-WATERING VAULT AREA

FIGURE 8.2

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SECTION 9 • MINE DEVELOPMENT PLAN

To mine the ore at the deposit areas, three perimeter Dewatering Dikes will first be constructed:

- East Dike;
- Bay Zone Dike; and
- Goose Island Dike.

The typical Dewatering Dike section consists of two rockfill embankments, a till core with a downstream filter zone, a cutoff wall through the till core and foundation soils to the underlying bedrock, and a grout curtain in the bedrock (Golder, 2007e; Figure 9.1).

The Dewatering Dike design concept consists of two parallel rockfill embankment advanced into the water. The rockfill is composed of blasted rock produced by mining operations. A granular filter composed of IV rock is placed between the rock fill embankments, against the pit-side rockfill embankment to prevent movement of the finer fraction of the till core into the rockfill. The space between the granular filter and the upstream rockfill embankment is filled with till placed through water. It is planned that the till core will achieve a relatively low permeability after consolidation and will generally control seepage through the embankment. A 3 to 5 m surcharge layer of rockfill will be placed to consolidate the till core. A cutoff wall will be constructed through the till core and foundation soils beneath the till to bedrock. The cutoff wall may constructed of slurry supported trench with soil-bentonite backfill, slurry supported trench with soil-cement-bentonite backfill, and jet grouting. A grout curtain will be constructed in the near surface fractured bedrock to control seepage and prevent piping of the till core and embankment foundation soils into the open fracture.

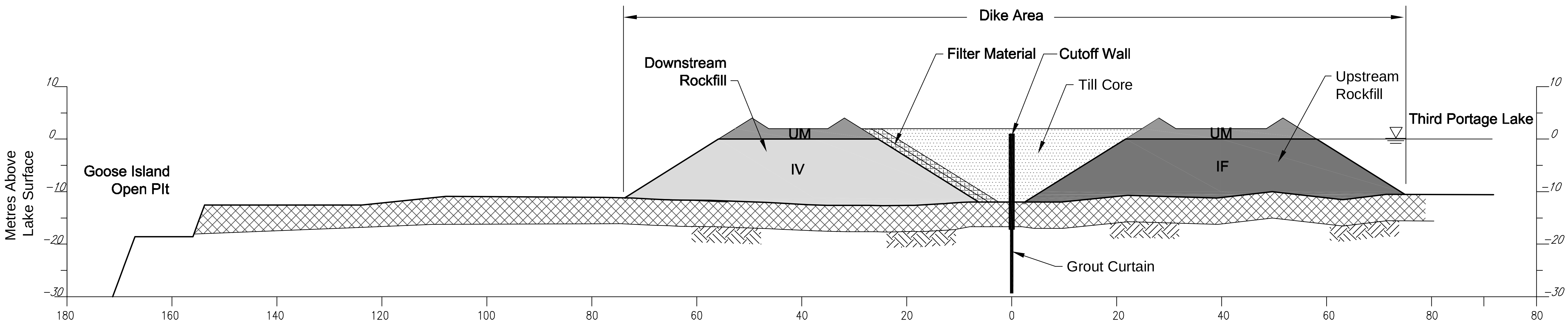
Construction rockfill will initially come from pre-stripping operations and through the development of a starter pit at the Portage deposit. Based on current material balance calculations, sufficient quantities of suitable rockfill and till borrow materials will be available from pre-mining activities.

Additional information on the design of the Dewatering Dikes is provided in the supporting document *Detailed Design of Dewatering Dikes, Meadowbank Gold Project* (Golder, 2007e).

9.1 LAKE DEWATERING

Once construction of the Dewatering Dikes has been completed, dewatering of Second Portage Lake inside the East Dike, and Third Portage Lake inside the Bay Zone and Goose Island dikes, will be accomplished by pumping water west into Third Portage Lake. Dewatering of Vault Lake will be accomplished by pumping water to the northeast into Wally Lake.

Table 9.1 summarizes the estimates of dewatering volumes for the various mining areas based on the results of bathymetry surveys carried out at the site. The dewatering volumes are based on the current dike configurations.



TYPICAL SECTION OF GOOSE ISLAND DIKE

LEGEND

- Till
- Lake Sediment
- IV — Intermediate volcanic run-of-mine waste rock
- IF — Iron Formation run-of-mine waste rock
- UM — Ultramafic and mafic volcanic run-of-mine waste rock

NOTES

1) SECTIONS ARE SHOWN FOR 1.6H:1.0V SIDESLOPES OF ROCKFILL. ACTUAL SLOPES WILL VARY, DEPENDING ON WATER DEPTH, ROCKFILL GRAIN SIZE, AND FOUNDATION CONDITIONS.
2) OVERBURDEN DEPTH HAS BEEN ESTIMATED BASED ON RESULTS FROM THE 2003 GOLDER GEOTECHNICAL DRILLING INVESTIGATIONS. ACTUAL OVERBURDEN DEPTHS WILL VARY.
3) ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
4) CUT OFF EXTENDED 0.5M INTO BEDROCK OR EQUIPMENT REFUSAL.
5) DEPTH OF GROUT CURTAIN TO BE DETERMINED IN THE FIELD.

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ROCK TYPES USED FOR CONSTRUCTION OF ALL WATER RETENTION DIKES

FIGURE 9.1

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Table 9.1: Estimate of Dewatering Volumes

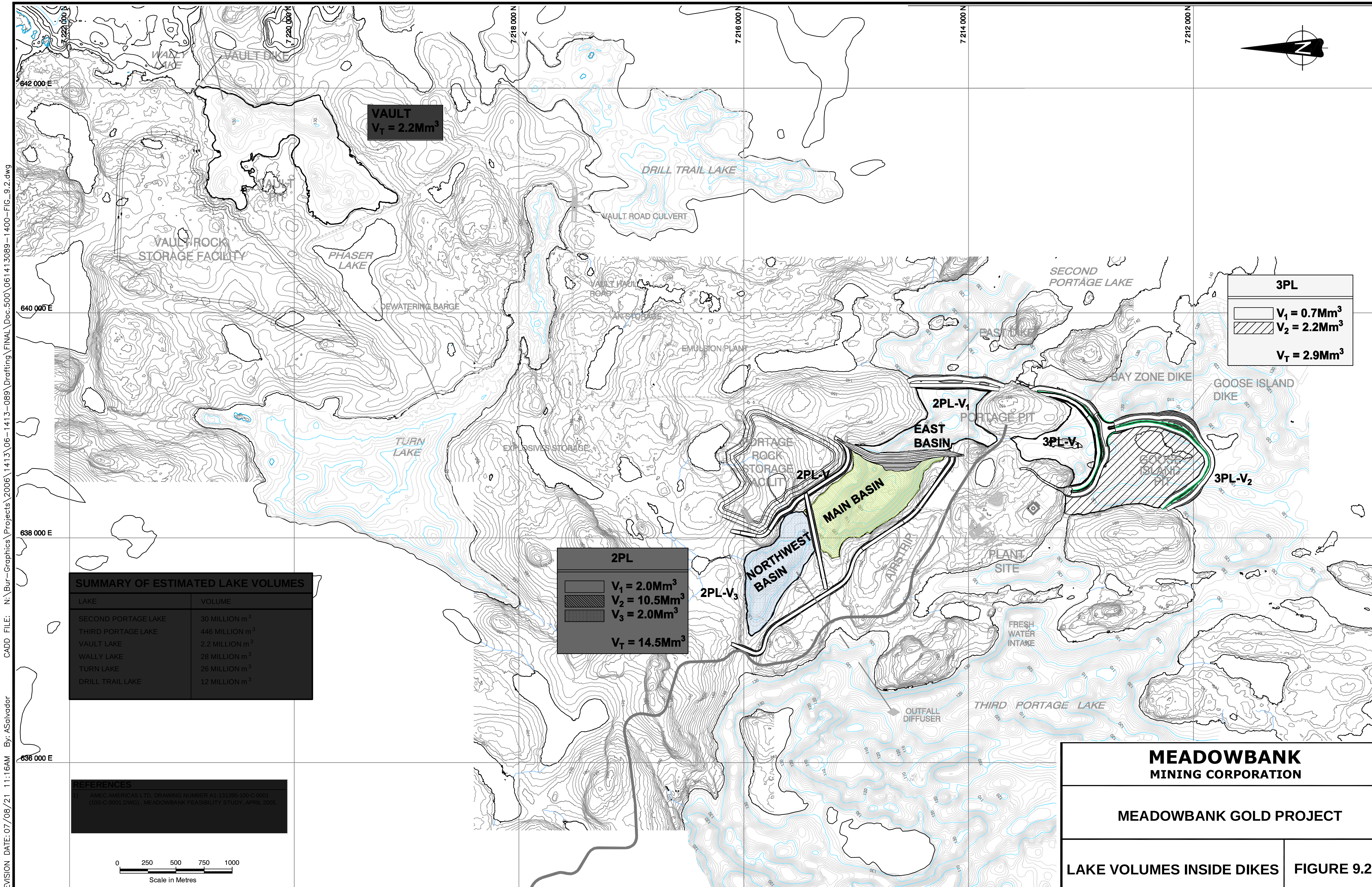
Location	Description	Dewatering Volume (Mm^3)
Second Portage Lake	Dewatering to pit side of East Dike (to El. 105 masl)	13.8
Third Portage Lake	Dewatering to pit side of Bay Zone Dike	0.7
	Dewatering between Bay Zone Dike and pit side of Goose Island Dike	2.2
Vault Lake	Total Vault Lake with the Vault Dewatering Dike	2.2

Prior to the construction of the Central Dike and mining of the Portage pits, Second Portage Lake will require dewatering down to elevation 105 masl within the area bounded by the East Dike. The total lake volume to a lake level elevation of 133.1 m masl is estimated to be 14.5 Mm^3 within the area to the west of the East Dike (Appendix B). The dewatering volume is estimated to be 13.8 Mm^3, excluding the volume of water contained below elevation 105 m masl (~ 745,000 m^3), which will be maintained as a reservoir for make-up water to the mill at start-up. An additional 0.7 Mm^3 will also need to be dewatered from Third Portage Lake inside the Bay Zone Dike (Figure 9.2). The quality of water pumped from each basin will be closely monitored to verify that it is acceptable for release to Third Portage Lake.

Bathymetric data of Second Portage Lake indicates three separate basins; a Northwest Basin (~2.0 Mm^3), the Main Basin (~10.5 Mm^3), and an East Basin (~2.0 Mm^3) (Figure 9.2). A topographical divide exists at approximately 130 masl between the Northwest and Main basins, and at approximately 118 masl between the Main and East basins. A dewatering volume of 13.8 Mm^3 from Second Portage Lake assumes that all of the water from the Northwest Basin drains to the main basin during dewatering. However, the Northwest Basin will be used as a stormwater attenuation facility and source for freshwater make-up to process during early mine operations (until approximately mine year 6). Therefore, pool water may not be pumped from this basin below 130 masl (~1.0 Mm^3) during the dewatering process. Any water stored in this basin during dewatering will be used to supplement freshwater make-up requirements to the mill process at mine start-up.

Pool water will be withdrawn using pumps situated on a barge that is moored near the deepest portion of each basin to optimize withdrawal rate and minimize the risk of entraining sediment (see Section 8.3). In addition, silt curtains will be placed around the pumps to limit the uptake of TSS. With this approach it is anticipated that at about 60% of total pool water volume (~8.3 Mm^3) will be of suitable quality to permit direct discharge to Third Portage Lake without further TSS management. This estimate is consistent with other similar mining operations in the north requiring dewatering of mining areas (R. Eskelson, Diavik, pers. comm.).

Where necessary, additional TSS management practices will be used to ensure pool water meets is acceptable for discharge prior to release to the environment. These practices include a reduction in pumping rates, and the installation of silt curtains and/or baffles in the vicinity of exposed beaches to increase the flow path and residency time within each basin. Alternatively, one or more of the internal basins will be used as internal sedimentation ponds to provide temporary storage of pumped pool water until suitable TSS levels are achieved. As indicated above, the Northwest Basin has a capacity of approximately 1.0 Mm^3 below elevation 130 masl, which may be used for this purpose.


VAULT
V_T = 2.2Mm³
WALLY LAKE
VAULT DIKE
VAULT PIT
VAULT ROCK STORAGE FACILITY
PHASER LAKE
DEWATERING BARGE
DRILL TRAIL LAKE
VAULT ROAD CULVERT
VAULT HAUL ROAD
AN STORAGE
EMULSION PLANT
TURN LAKE
EXPLOSIVES STORAGE
SECOND PORTAGE LAKE
EAST DIKE
BAY ZONE DIKE
GOOSE ISLAND DIKE
2PL-V1
PORTAGE PIT
EAST BASIN
3PL-V1
3PL-V2
GOOSE ISLAND PIT
PORTAGE ROCK STORAGE FACILITY
2PL-V2
MAIN BASIN
NORTHWEST BASIN
2PL-V3
AIRSTRIP
PLANT SITE
FRESH WATER INTAKE
OUTFALL DIFFUSER
THIRD PORTAGE LAKE
3PL
V_1 = 0.7Mm³
V_2 = 2.2Mm³
V_T = 2.9Mm³
2PL
V_1 = 2.0Mm³
V_2 = 10.5Mm³
V_3 = 2.0Mm³
V_T = 14.5Mm³
7 222 000 N
7 220 000 N
7 218 000 N
7 216 000 N
7 214 000 N
7 212 000 N
642 000 E
640 000 E
638 000 E
636 000 E
0 250 500 750 1000
Scale in Metres
MEADOWBANK
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LAKE VOLUMES INSIDE DIKES
FIGURE 9.2
REVISION DATE: 07/08/21 11:16AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\Drafting\FINAL\Doc.500\061413089-1400-FIG_9.2.dwg

[redacted]

9.2 THIRD PORTAGE LAKE OUTLETS

Construction of the East Dike and Bay Zone dikes will isolate and eliminate the westernmost and primary connecting channel (i.e., 50% of current flows) between Third Portage and Second Portage lakes. Without mitigation, the natural flow outlet from Third Portage Lake would be constrained, potential causing higher water levels in Third Portage Lake and increased discharge through the remaining two channels. Dewatering of the northwest arm of Second Portage Lake to Third Portage Lake would exacerbate this problem.

To mitigate the loss of the westernmost connecting channel between Third Portage and Second Portage lakes, it is proposed to that the easternmost channel be modified to handle increased flows and maintain natural lake water levels in Third Portage Lake. A detailed engineering study is currently under way to:

- evaluate alternatives to deepen the easternmost channel;
- prepare, if necessary, a detailed design for easternmost channel modifications;
- develop a monitoring program for channel erosion, verification of the maintenance of water levels in Third Portage Lake; and
- recommend contingencies in the event of channel failure.

The discharge from Second Portage Lake into Tehek Lake during dewatering of Second Portage Arm is projected to increase between 18% and 27% relative to current conditions. Therefore, adverse impacts to stream channel integrity at this location are expected to be negligible.

Further details on the potential impacts of, and mitigation measures for, eliminating the westernmost lake outlet between Third Portage and Second Portage lakes are provided in the following support documents:

- *Meadowbank Gold Project Aquatic Effects Management Program* (Cumberland 2005); and
- *Meadowbank Gold Project No-Net-Loss Plan (NNLP)* (Cumberland 2006).

9.3 MINE OPERATION SEQUENCE

Figures 9.3 to 9.9 illustrate the planned mine development sequence over the operating life. The figures reflect the periods shown in Table 9.2. A cross section through the TSF and Portage RSF post-closure is shown on Figure 9.10. A cross section through the Vault RSF is shown on Figure 9.11.

Table 9.2: Mine Development Sequence

Figure	Year	Key Issues
9.3	-2 and -1	• Stripping at Third Portage peninsula for construction materials • Construct East, Bay Zone, Central Starter and Stormwater dikes. Apply surfacing material on East and Central Starter dikes • Begin construction on East Dike Extension. Begin constructing Goose Island Dike if construction material becomes available • Dewater inside East and Bay Zone dikes to Third Portage Lake • Construct plant site, plant roads and road to ANFO storage
9.4	1	• Commence mining of Portage Pit, south end • Operate separate Reclaim and Portage Attenuation ponds • Runoff from Portage RSF and Landfill directed to Portage Attenuation Pond • Portage Pit water and plant site and airstrip runoff directed to Portage Attenuation pond, or pumped to water sump at Process Plant for use as process make-up water as required before discharge of excess to Portage Attenuation Pond • Monitor water quality within Portage Attenuation Pond, treating in–situ if required prior to decant of excess to Third Portage Lake and/or pumping to Process Plant for use as make-up water • Begin construction of North Saddle Dam. Apply surfacing material on Bay Zone Dike • Continue and complete construction of Goose Island Dike and East Dike Extension. Dewater inside Goose Island Dike to Third Portage Lake. • Dewater behind Goose Island Dike. Commence stripping of Goose Island overburden materials
	2	• Commence mining at Goose Island Pit • Commence construction of Finger Dikes and Goose Island Dike Extension • Raise Central Dike from El. 120 masl to El. 140 masl and apply surfacing material • Continue and complete construction of North Saddle Dam. Apply surfacing material on Goose Island Dike • Selective placement of ultramafic rock at Portage RSF for future use during closure • Continue to operate separate Reclaim and Portage Attenuation ponds • Runoff from Portage RSF and Landfill directed to Portage Attenuation Pond • Portage and Goose Island pit waters, and plant site and airstrip runoff directed to Portage Attenuation pond, or pumped to water sump at Process Plant for use as process make-up water as required before discharge of excess to Portage Attenuation Pond • Monitor water quality within Portage Attenuation Pond, treating in–situ if required prior to decant of excess to Third Portage Lake and/or pumping to Process Plant for use as make-up water

Table 9.2 continued

Figure	Year	Key Issues
9.5	3-4	• Construct South Saddle Dam and Stormwater Dike filter. Continue construction of Finger Dikes and Goose Island Dike Extension • Continue to operate separate Reclaim and Portage Attenuation ponds • Runoff from Portage RSF and Landfill directed to Portage Attenuation Pond • Portage and Goose Island (until completion of mining) pit waters, and plant site and airstrip runoff directed to Portage Attenuation Pond, or pumped to water sump at Process Plant for use as process make–up water as required before discharge of excess to Portage Attenuation Pond • Monitor water quality within Portage Attenuation Pond, treating in–situ if required prior to decant of excess to Third Portage Lake and/or pumping to Process Plant for use as make-up water or to Goose Island Pit to assist with reflooding • Begin mining northward at Portage Pit. Selective placement of waste rock into south end of Portage Pit. Continue selective placement of ultramafic rock at Portage RSF for future use during closure • Construct Vault Haul Road and Vault Dike. Dewater Vault Lake to Wally Lake and commence mining of Vault Pit • Complete mining of Goose Island Pit and commence pit reflooding
9.6	5	• Raise Central Dike from El. 140 masl to 147.0 masl and apply surfacing material • Continue and complete construction of Finger Dikes and Goose Island Dike Extension. Construct Fish Habitat Compensation Mounts in Second Portage Lake • Continue to operate separate Reclaim and Portage Attenuation ponds • Runoff from Portage RSF and Landfill directed to Portage Attenuation Pond • Portage Pit water (until completion of mining) and plant site and airstrip runoff to be directed to Portage Attenuation pond, or pumped to water sump at Process Plant for use as process make-up water as required before discharge of excess to Portage Attenuation Pond or Goose Island Pit to assist with reflooding • Monitor water quality within Portage Attenuation Pond, treating in–situ if required prior to decant of excess to Third Portage Lake and/or pumping to Process Plant for use as make-up water or to Goose Island and Portage pits to assist with reflooding • Continue Goose Island Pit flooding. Complete mining of Portage Pit and commence pit reflooding. • Monitor water quality within flooded pits, treating in–situ if required and/or pumping to Process Plant for use as process water • Continue mining of Vault Pit • Runoff from Vault RSF and Landfill directed to Vault Attenuation Pond • Monitor water quality within Vault Attenuation Pond, treating in–situ if required prior to decant of excess to Wally Lake

Table 9.2 continued

Figure	Year	Key Issues
9.7	6-7	• Continue mining of Vault Pit • Runoff from Vault RSF and Landfill directed to Vault Attenuation Pond • Monitor water quality within Vault Attenuation Pond, treating in–situ if required prior to decant of excess to Wally Lake • Commence deposition of tailings in Northwest Basin on Second Portage Arm. Portage Attenuation and Reclaim ponds combine • Runoff from Portage Rock Storage Facility and Landfill directed to Reclaim Pond • Plant site and airstrip runoff to be directed water sump at Process Plant for use as process make-up water as required before discharge of excess to Goose and Portage pits to assist with reflooding • Continue Portage and Goose Island Pit reflooding. Monitor water quality within flooded pits, treating in–situ if required and/or pumping to process plan for use as process water
9.8	8	• Complete mining at Vault • Runoff from Portage Rock Storage Facility and Landfill directed to Reclaim Pond • Plant site and airstrip runoff to be directed water sump at Process Plant for use as process make-up water as required before discharge of excess to Goose and Portage pits to assist with reflooding • Reclaim Pond water treated if necessary and discharged to Goose Island or Portage pit lakes to assist with reflooding • Continue Portage and Goose Island Pit reflooding. Commence Vault Pit reflooding • Monitor water quality within flooded pits, treating in–situ if required • Mining complete, start final closure and reclamation
9.9	9	• Continue final closure and reclamation • Continue Portage, Goose Island and Vault Pit reflooding

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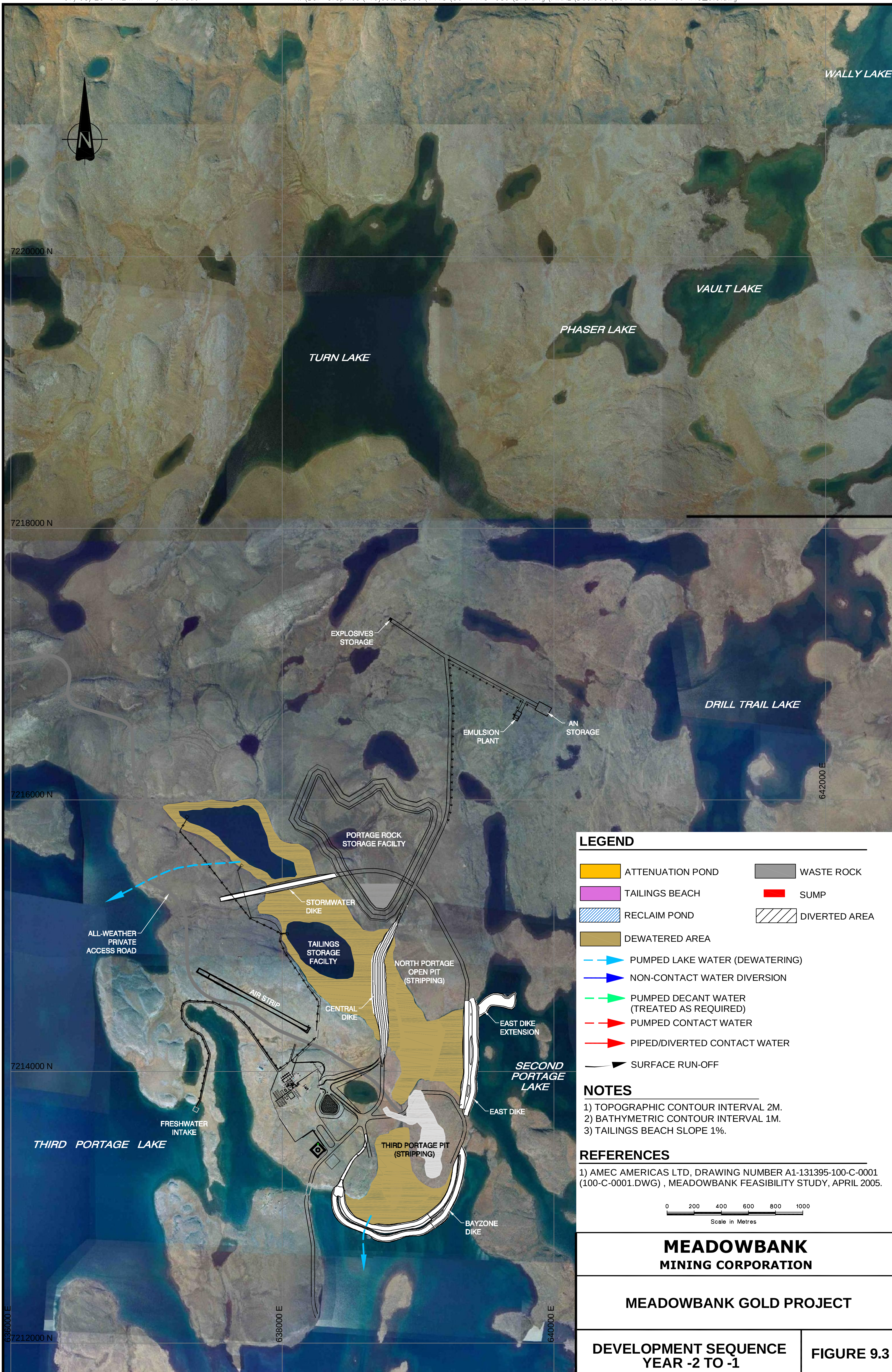

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DEVELOPMENT SEQUENCE YEAR -2 TO -1

FIGURE 9.3

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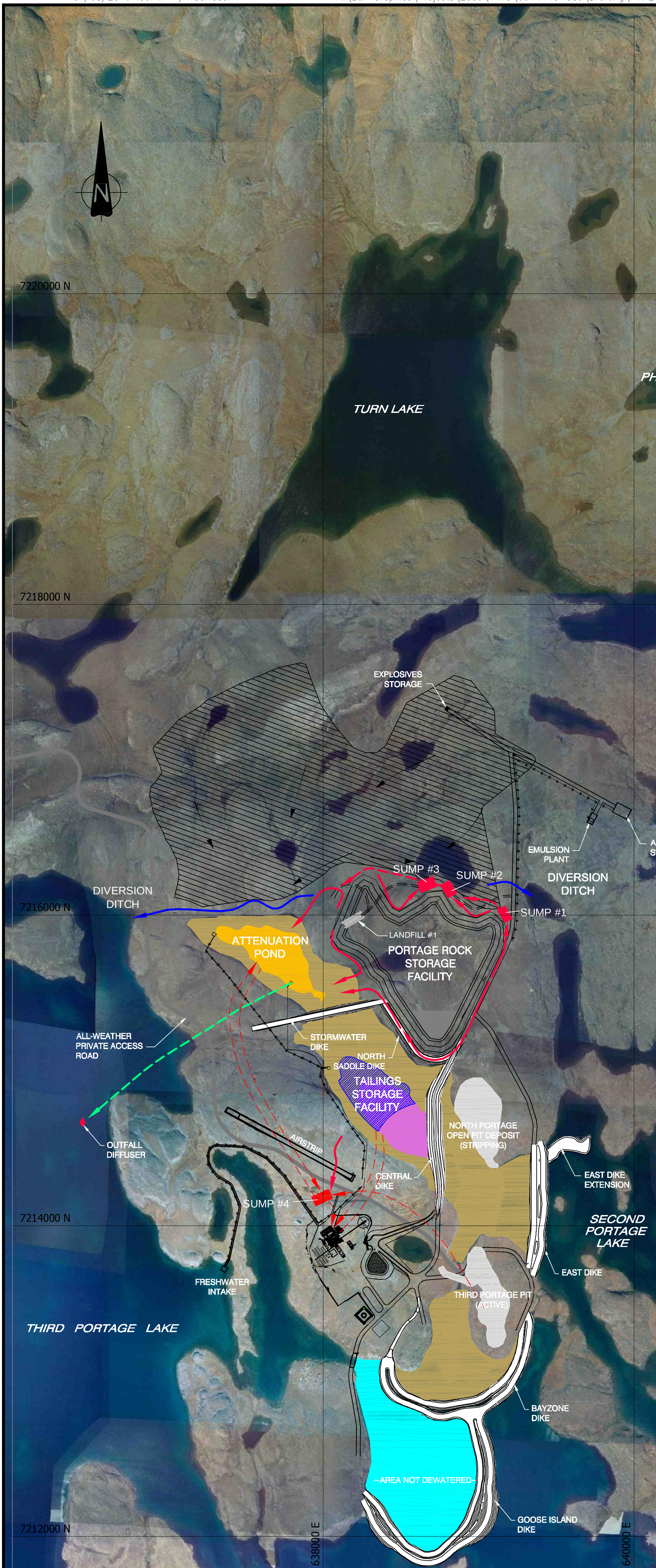

LEGEND

- ATTENUATION POND
- WASTE ROCK
- TAILINGS BEACH
- SUMP
- RECLAIM POND
- DIVERTED AREA
- DEWATERED AREA
- NON-CONTACT WATER DIVERSION
- PUMPED DECANT WATER (TREATED AS REQUIRED)
- PUMPED CONTACT WATER
- PIPED/DIVERTED CONTACT WATER
- SURFACE RUN-OFF

NOTES

1) TOPOGRAPHIC CONTOUR INTERVAL 2M.
2) BATHYMETRIC CONTOUR INTERVAL 1M.
3) TAILINGS BEACH SLOPE 1%.

REFERENCES

1) AMEC AMERICAS LTD, DRAWING NUMBER A1-131395-100-C-0001 (100-C-0001.DWG) , MEADOWBANK FEASIBILITY STUDY, APRIL 2005.

0 200 400 600 800 1000
Scale in Metres

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DEVELOPMENT SEQUENCE YEAR 1	FIGURE 9.4

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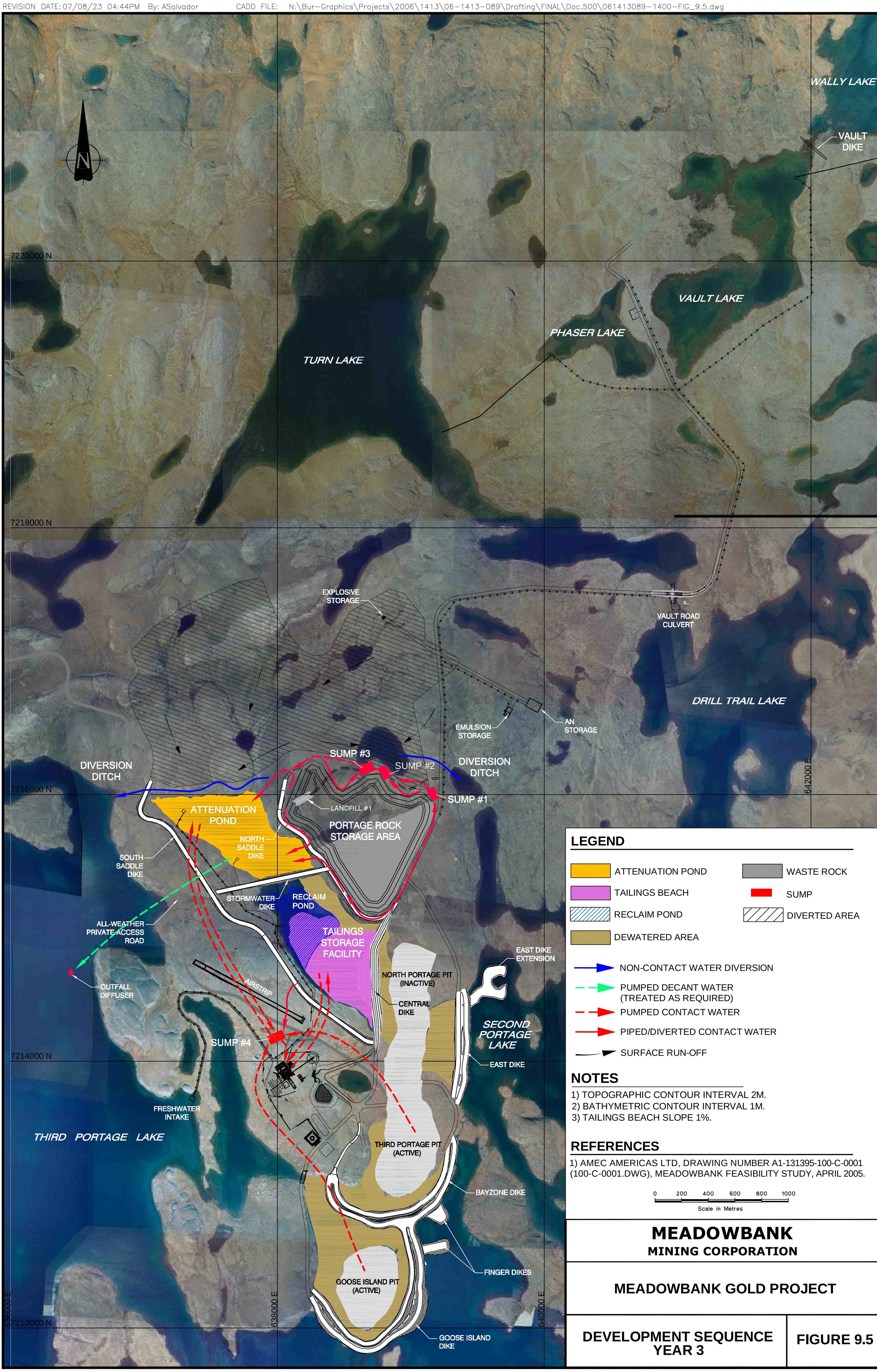

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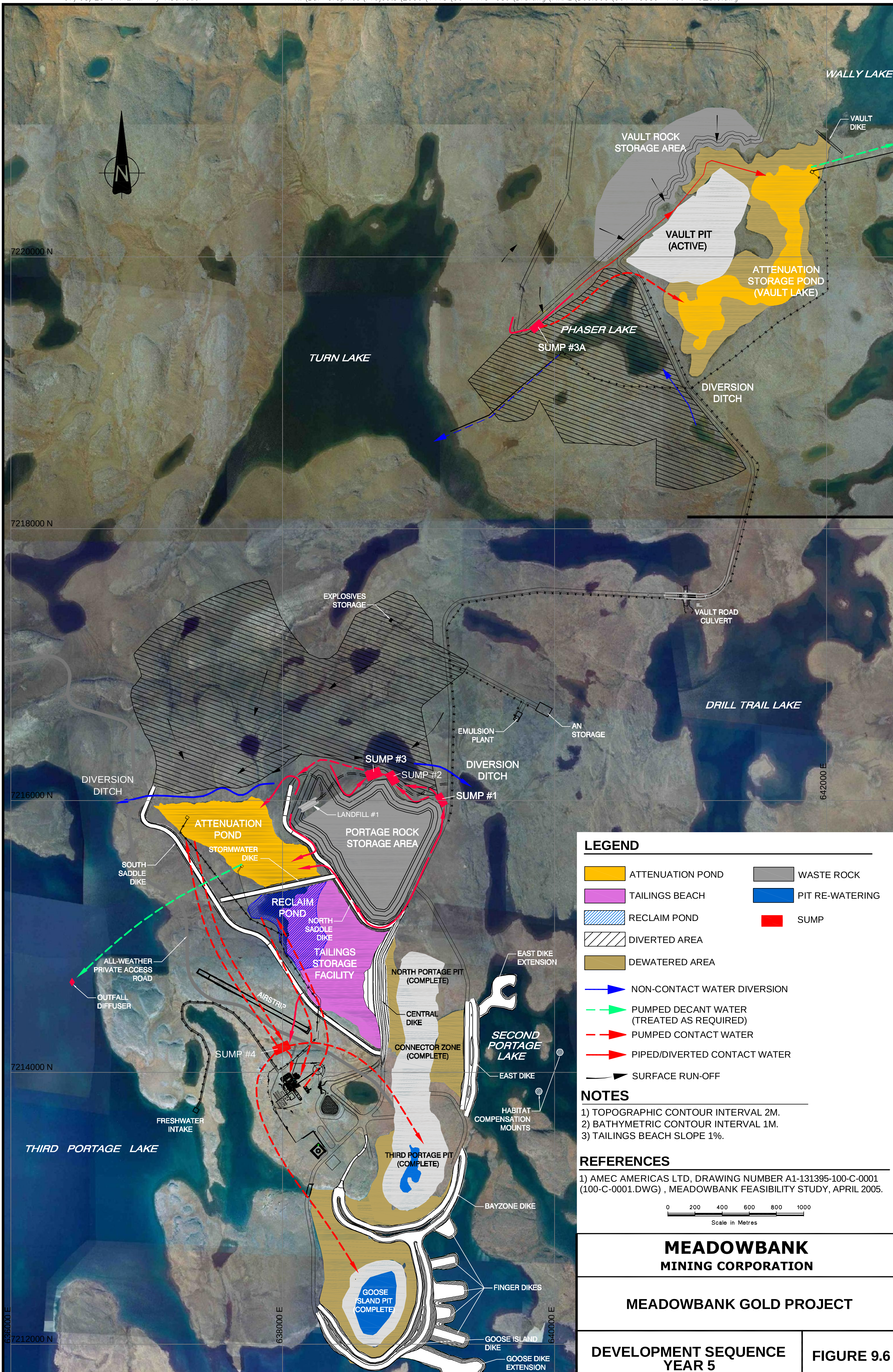

LEGEND

- ATTENUATION POND
- WASTE ROCK
- TAILINGS BEACH
- PIT RE-WATERING
- RECLAIM POND
- SUMP
- DIVERTED AREA
- DEWATERED AREA
- NON-CONTACT WATER DIVERSION
- PUMPED DECANT WATER (TREATED AS REQUIRED)
- PUMPED CONTACT WATER
- PIPED/DIVERTED CONTACT WATER
- SURFACE RUN-OFF

NOTES

1) TOPOGRAPHIC CONTOUR INTERVAL 2M.
2) BATHYMETRIC CONTOUR INTERVAL 1M.
3) TAILINGS BEACH SLOPE 1%.

REFERENCES

1) AMEC AMERICAS LTD, DRAWING NUMBER A1-131395-100-C-0001 (100-C-0001.DWG) , MEADOWBANK FEASIBILITY STUDY, APRIL 2005.

0 200 400 600 800 1000
Scale in Metres

MEADOWBANK
MINING CORPORATION

MEADOWBANK GOLD PROJECT

DEVELOPMENT SEQUENCE YEAR 5

FIGURE 9.6

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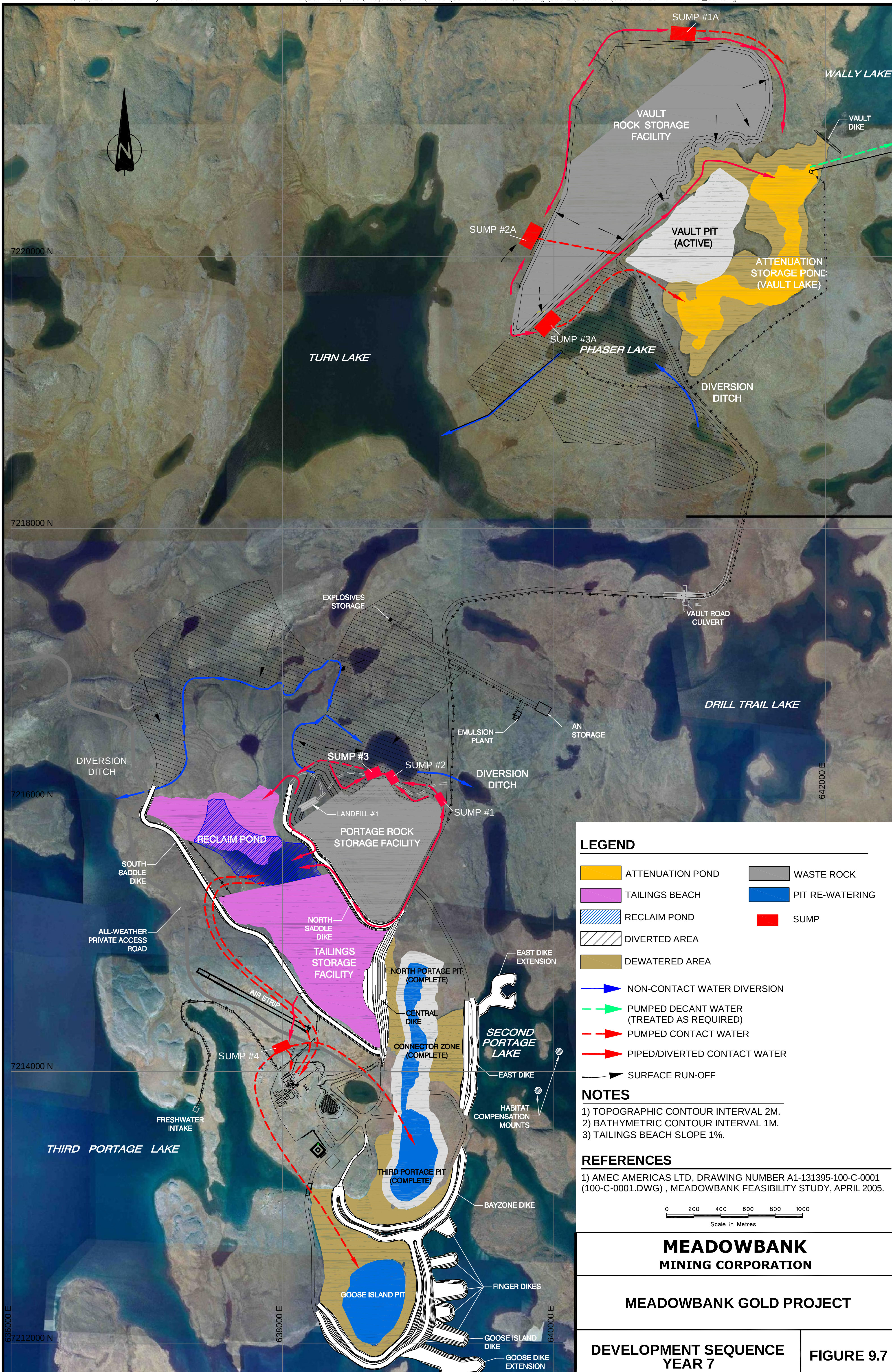

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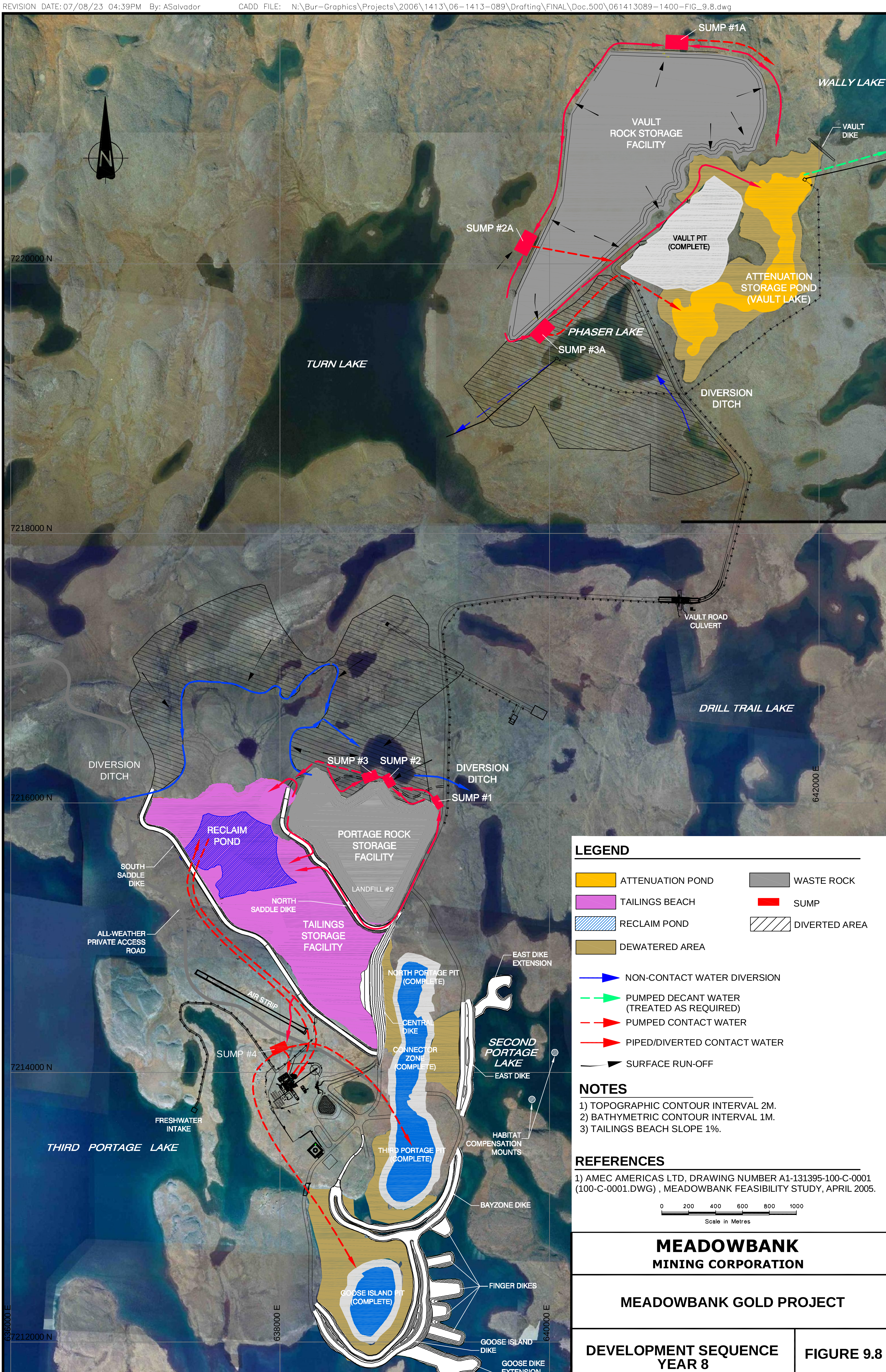

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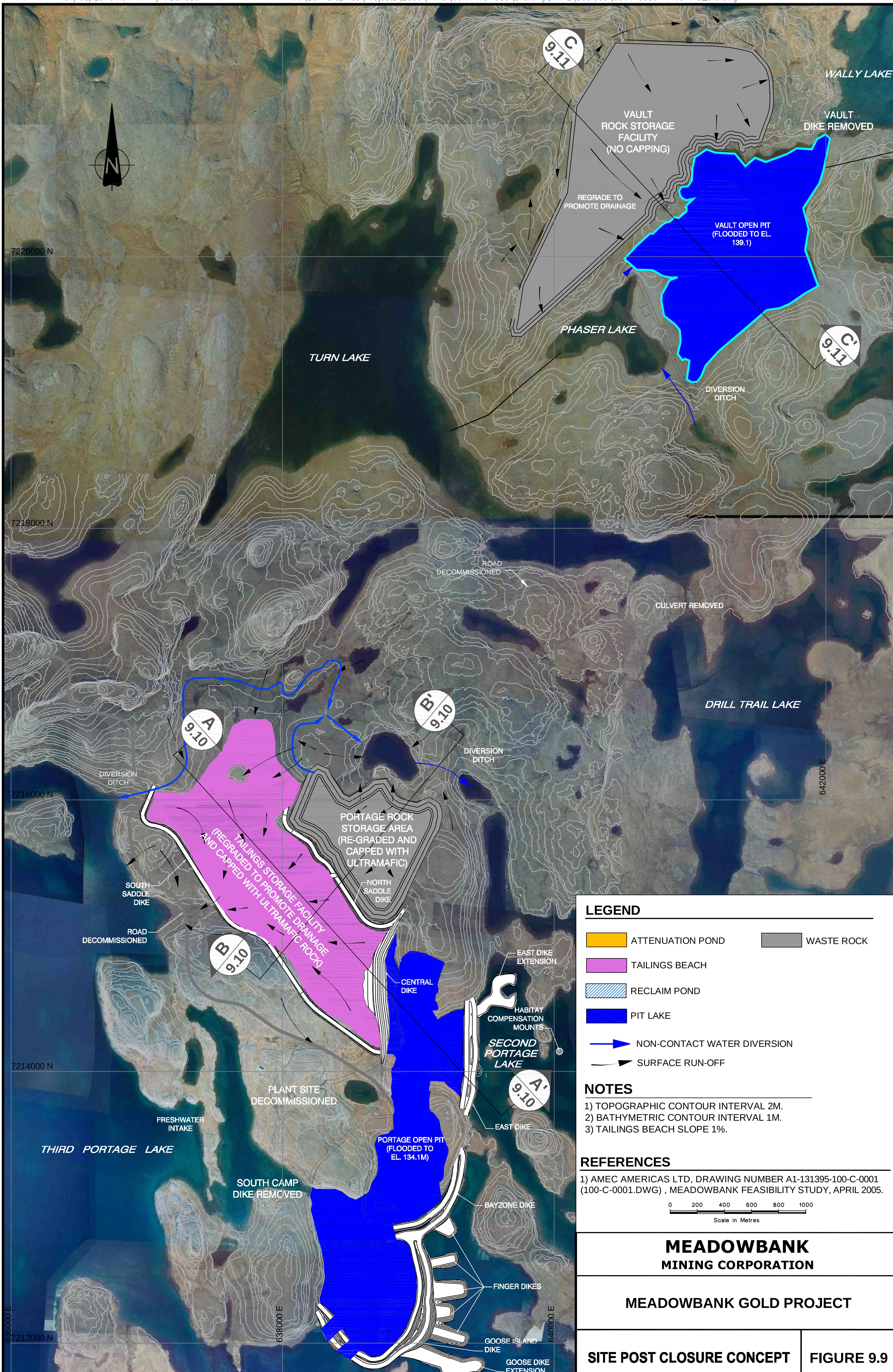
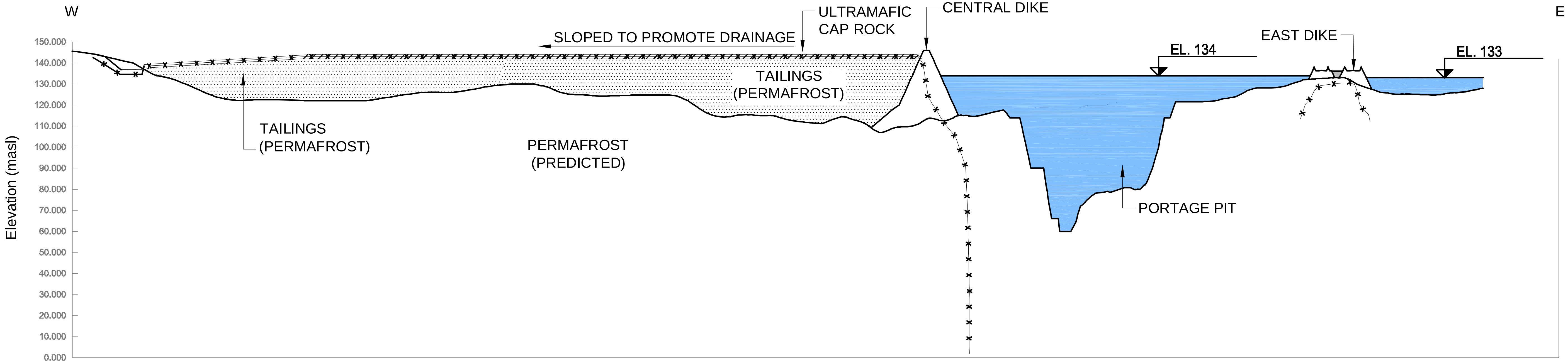
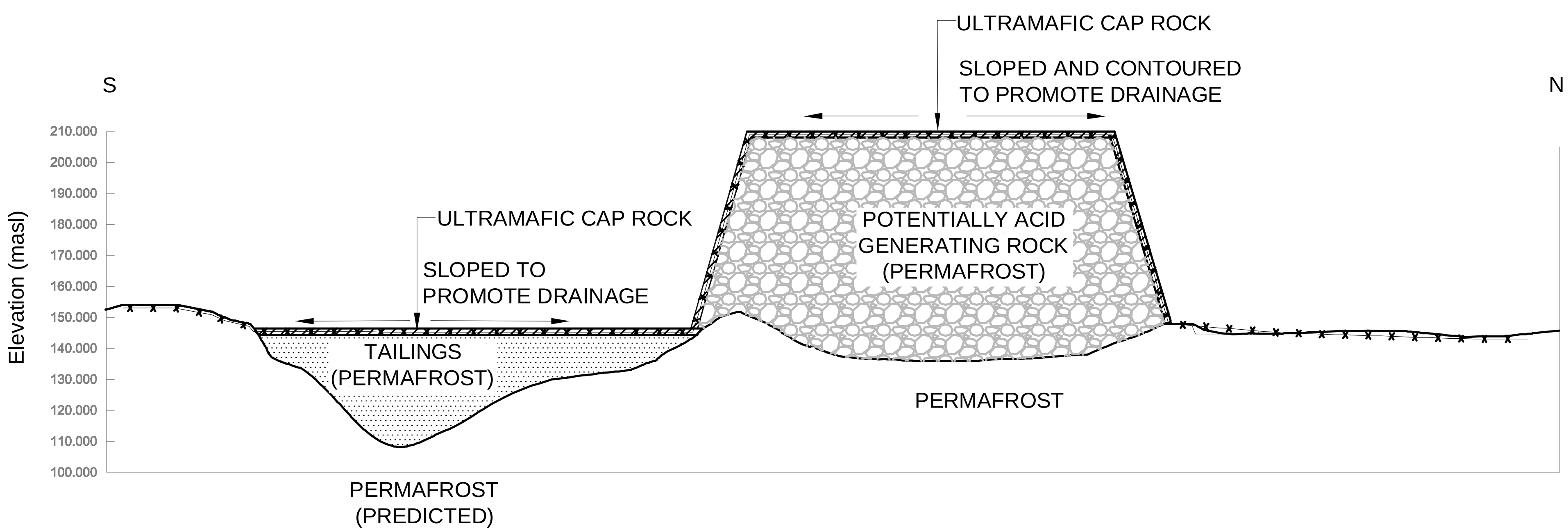




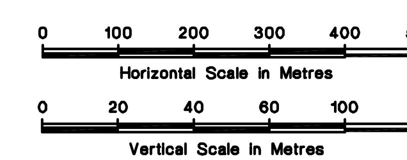
A 9.9

CROSS SECTION A-A'
TAILINGS STORAGE FACILITY



B 9.9

CROSS SECTION B-B'
PORTAGE ROCK STORAGE FACILITY



LEGEND:

-x-x-x-x-x-x- PERMAFROST BOUNDARY (INFERRED)

MEADOWBANK MINING CORPORATION	
MEADOWBANK GOLD PROJECT	
PORTAGE TAILINGS AND ROCK STORAGE CLOSURE DESIGN CONCEPT CROSS SECTION	FIGURE 9.10

REVISION DATE: 07/08/23 04:28PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\Drafting\FINAL\Doc.500\061413089-1400-FIG_9.10.dwg

REFERENCES

1) Amec Americas Ltd., Drawing Number A1-131395-100-C-0001 (100-C-0001.DWG), Meadowbank Feasibility Study, April 2005.

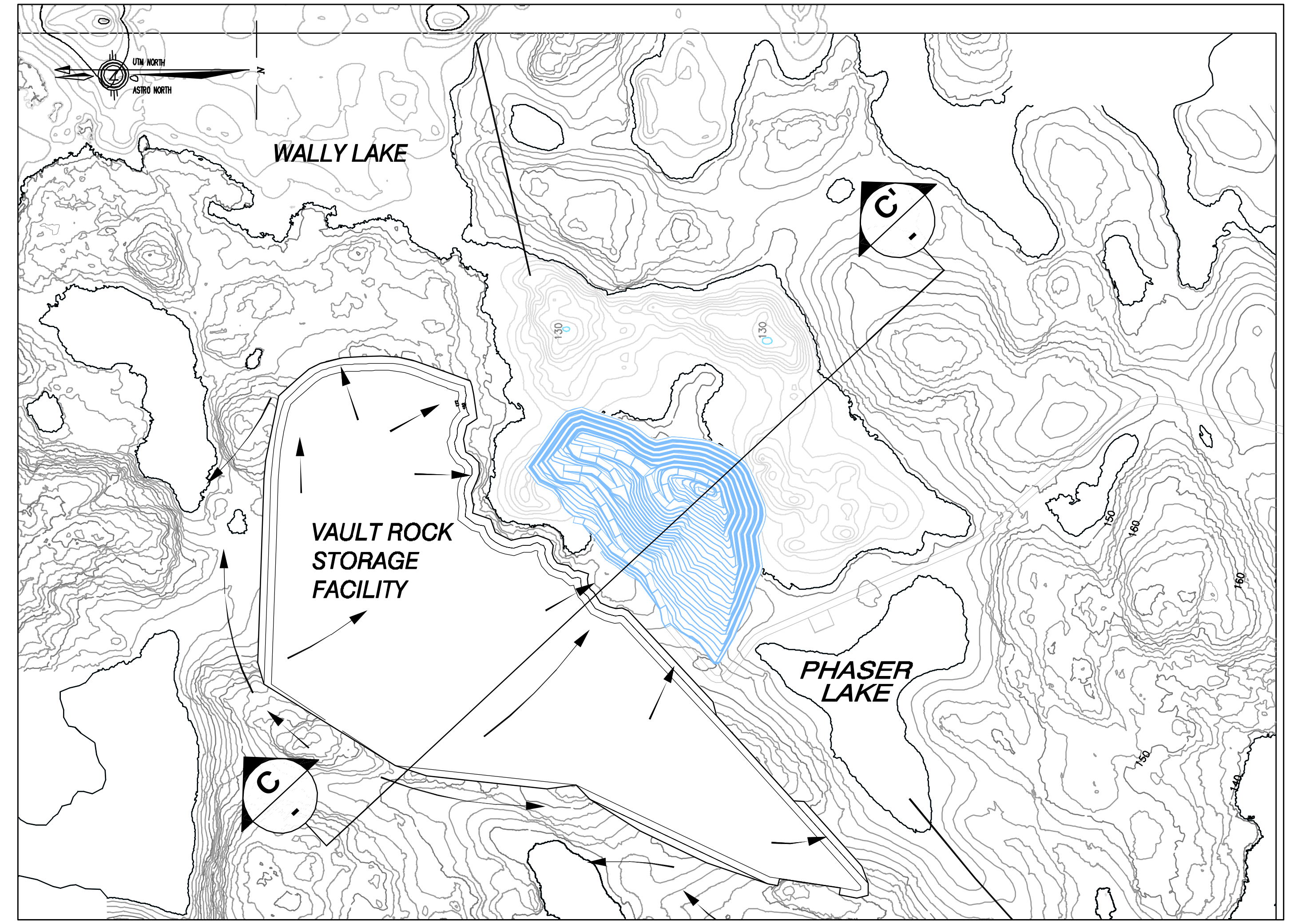
LEGEND:

-x-x-x-x-x- Permafrost Boundary (inferred)

NOTES

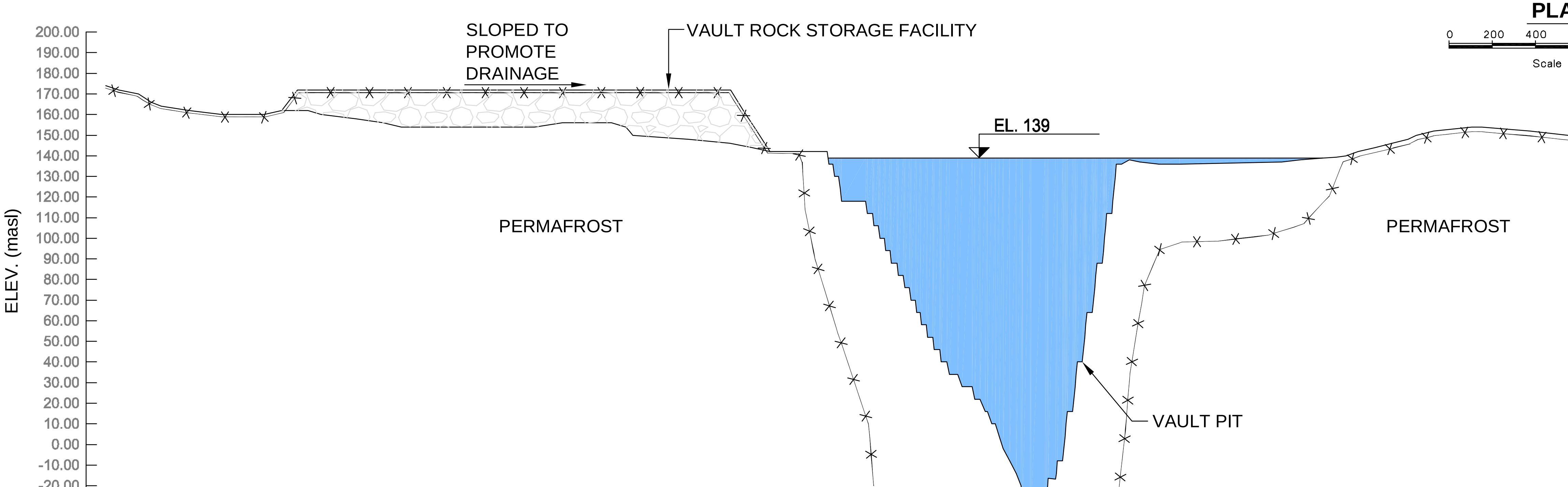
1) Topographic Contours - 2m Interval

2) Bathymetry Contours - 1m Interval



PLAN

0 200 400 600 800 1000
Scale in Meters



C
9.9

CROSS SECTION C-C'
VAULT ROCK STORAGE FACILITY

0 100 200 300 400 500
Horizontal Scale in Meters

0 20 40 60 80 100
Vertical Scale in Meters

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MEADOWBANK MINING CORPORATION	
MEADOWBANK GOLD PROJECT	
VAULT ROCK STORAGE CLOSURE DESIGN CONCEPT CROSS SECTION	FIGURE 9.11

9.4 DIKE BREACHING

Following completion of mining, the pits will be filled with water from Third Portage Lake (Goose and Portage pits) or Wally Lake (Vault Pit) over a period of several years. The Portage and Goose Island pits will be flooded (in the order of 45 Mm^3) over a roughly eight year period and eventually become part of Third Portage Lake. The Vault pit (21.5 Mm^3) will be flooded over a roughly five year period and will eventually become part of Vault Lake.

Since instantaneous breaching of the dikes would cause a significant drawdown of Third Portage and Wally lakes, flooding will be achieved by a combination of seepage, precipitation, and partial re-direction of annual freshet flows from Third Portage and Wally lakes in a controlled action over several years. Following completion of flooding, the Goose Island, Bay Zone and Vault dikes will be breached and pit waters will be allowed to mix with adjacent water bodies provided that pit water quality is sufficiently high and water levels between the pit and the adjacent lake are equal to maintain a water balance. The East Dike will remain as a permanent structure with a 1 metre head difference – with the west side connected to Third Portage Lake at 134.1 masl, and the east side connected to Second Portage lake at 133.1 masl. Studies to examine water quality and effects on fish will be undertaken to demonstrate that no adverse effects will occur before the dikes are breached (Cumberland, 2005).

Dike breaching will involve the removal of portion of the dikes to a minimum depth of 3 m below average lake water level within Third Portage and Wally lakes. Consideration will be given to breach staging, with above water portions of the dike in the breach area removed during winter period when there will be little surface water flow, thereby minimizing the potential release of sediments to the neighbouring lake. The remainder of the breach would be completed during the open water following freshet so as to allow for the deployment of turbidity curtains to control potential releases of sediment. Exposed till surfaces within the breach opening above normal lake water levels will be covered with UM rock, while either UM, IF or IV materials would be used below surface depending upon availability.

Additional information on pit flooding can be found in Section 8.4 and Section 12.5 of this document.

SECTION 10 • WATER MANAGEMENT

10.1 WATER MANAGEMENT OBJECTIVES AND STRATEGIES

The goal of water management is to minimize the impact of the Meadowbank Gold Project on the aquatic ecosystem of the neighbouring lakes, namely Third Portage, Second Portage, Turn, and Wally lakes. The primary objectives of the water management plan are to:

- minimize impacts of the Project on the quantity of surface water; and
- minimize impacts of the Project on the quality of surface and groundwater.

The strategies to implement the above objectives include:

- reduce the intake of fresh water from the neighbouring lakes by recycling and reusing water wherever practicable;
- implement measures to avoid the contact of clean runoff water with areas affected by the mine or mining activities;
- collect, transport, and treat, if necessary, mine water, camp sewage, and runoff water in contact with project activities;
- manage potentially acid-generating or metal-leaching materials;
- monitor quality of discharges; and
- adjust management practices if monitoring results indicate discharge quality does not meet discharge criteria.

Information on surface water quality monitoring and treatment of water on-site can be found in the following supporting documents:

- *Proposed Water Treatment Methods, Meadowbank Gold Project* (Golder, 2007f);
- *Meadowbank Gold Project Operational ARD/ML Sampling and Testing Plan* (MMC, 2007a);
- *Meadowbank Gold project Water Quality and Flow Monitoring Plan* (MMC, 2007g);
- *Sewage Treatment System to be used at Meadowbank Gold Project, Nunavut* (Golder, 2007g);
- *Conceptual Design of the Effluent Outfall Diffuser for Wally Lake* (Golder, 2007h);
- *Assessment of Dilution Potential for the Third Portage Lake Diffuser* (Golder, 2007i); and
- *Proposed Discharge Water Quality Criteria for the Portage and Vault Attenuation Ponds* (Golder, 2007j).

10.2 WATER MANAGEMENT DESIGN CRITERIA

For the purpose of this water management plan, surface water has been grouped into two categories, contact and non-contact water.

Contact water is defined as any water that may have been physically or chemically affected by mining activities. Contact water includes:

- surface runoff from the mining and milling areas;
- groundwater seepage into open pits;
- surface runoff and shallow drainage from rock storage areas;
- surface runoff and shallow drainage from tailings disposal areas;
- transport water from tailings;
- water generated from consolidation of tailings (bleed water); and
- flushing water from tailings distribution lines.

All contact water will be intercepted, contained, analyzed, treated if required, and discharged to the receiving environment when water quality meets discharge criteria.

Non-contact water is limited to runoff originating from areas unaffected by mining activity that does not come into contact with developed areas. Non-contact water will be intercepted and directed away from developed areas by means of natural or man-made diversion channels and allowed to flow to the neighbouring lakes untreated.

The various components of the water management system will be designed to meet the following criteria:

- water management infrastructure along the perimeter of the developed areas must be able to intercept and convey to proper handling facilities contact water from a 1:100-year, 24-hour precipitation event (41 mm of runoff originating from 58.7 mm of precipitation);
- water management infrastructure located within mining affected areas where water has no chance of overflow outside of developed areas should be able to handle the runoff from a 1:10-year, 24-hour precipitation event (approximately 27 mm of runoff from 38.6 mm of precipitation);
- water management infrastructure along the perimeter of the developed areas must be able to divert non-contact water from a 1:100-year, 24-hour precipitation event;
- dewatering capacities for contact water sumps and ponds should be selected to handle the greater of:
  - the average year spring melt (126 mm) volume in a 30-day period; and
  - the 1:100-year, wet-year spring melt (370 mm) volume in a 90-day period;
- in the case of the pit sumps, the pumps must be able to handle the expected maximum monthly flow volume including seepage in addition to spring melt criterion; and
- attenuation ponds should be sized to accommodate the runoff from a 1:100-year, 24-hour precipitation event in excess of their maximum operating storage volume (average year climate conditions), while maintaining a 1 m freeboard before the possibility of a spill to the receiving environment.

10.3 WATER MANAGEMENT SYSTEMS

The development of the proposed water management systems will require the consideration of storm drainage design in cold regions. The importance of control and prevention of icing within and adjacent to drainage structures will be acknowledged in the detailed engineering design of these structures and will include the assessment of the degree of drainage required, hydrologic data, and the effects of, and impacts on, the permafrost thermal regime. Standard techniques for addressing icing of structures and facilities in cold regions will be employed during the design phase of the Project. These will include such standard techniques as avoidance and control and prevention.

The design of the surface water control structures will consider the existing geotechnical surface, subsurface, hydrological, hydrogeological and seasonal temperature conditions such that adequate measures are taken to maximize the interception and collection of contact water from the Project for environmental monitoring, water quality sampling and assessment for treatment prior to discharge to the environment.

The collection of surface water runoff as well as ground water flow from the Project will apply appropriate and cost-effective engineered solutions to minimize soil erosion, sedimentation and seepage loss of collected water from the facilities. Surface contact water will be collected by conventional gravitational means using perimeter drainage ditches and sumps and the collected water will be pumped to an attenuation pond by a mechanical system of pump and surface pipelines.

In areas where fine to coarse grained soils are encountered overlying weathered to intact bedrock, design measures will be taken to limit soil erosion and seepage losses from the drainage ditches and collection sumps using natural means and supplemented using engineered solutions. In areas where the soil and/or bedrock permeability is considered adequate, drainage measures will consider erosion protection and sediment control measures. In areas where the soil and/or bedrock permeability is considered inadequate, additional measures will be considered to limit seepage losses from the water control structures. Depending on the actual ground conditions encountered around the perimeter of the infrastructure development, some engineered solutions that may be considered during detailed design and construction include:

- increase the ditch gradients to minimize ponding of water in the perimeter collection ditches;
- excavation of the drainage ditch inverts and sumps into the underlying intact bedrock;
- provision of perimeter seepage containment by maintaining permafrost conditions down gradient of the water control structures by construction of a thaw stable fill embankment to insulate the ground from seasonal active thaw and to encourage re-freezing of the ground above the drainage ditch inverts;
- provision of positive seepage gradient containment around the water control structures by maintaining groundwater seepage flow from the lake environment towards the perimeter collection system using drainage ditch gradients lower than the lake level; and
- apply surface treatments to the ditch and sump excavation surfaces as necessary to seal the exposed subgrade surface to a condition where the hydraulic conductivity is suitably reduced using engineered materials such as geosynthetic, geomembrane, bentonite, surface grouting, injection grouting and/or concrete applications.

The appropriate and active management of water within the open pits will be a critical component of mining activities as it relates to operational considerations, but also to slope stability. This will be particularly true for the development of stable soil slopes within overburden materials. While allowance will be made for diversion of surface runoff from the perimeter of the pits, there is no plan to include additional drainage benches within the pits; nor is there a requirement. Unlike soil slopes, experience in open pit mining in hard rock has shown that seepage from the pit walls can be allowed to drain over the benches and catch-berms without causing erosion or stability problems. Moreover, the majority of seepage from the pit walls is conveyed to the pit bottom through the blast damaged rock below the bench faces and catch-berms, and only a small portion of the flow actually emanates on the pit wall surface. Consequently, the majority of wall flow would pass beneath any ditches that were established on the individual rock catch-berms. Water inflow to the pits will be collected in sumps, and pumped to the attenuation ponds.

The sumps will generally be operated with a low water level to provide temporary storage capacity for runoff generated by an extreme runoff event, possible breakdowns, or power failures at the pump stations. The pumping equipment and infrastructure will be selected and designed to accommodate the sub-zero temperatures that will prevail during the early and late portion of the open-water season. This may entail heat tracing of the pump intakes and providing self-priming pumps and increased monitoring during these periods. Pumping of the sumps will likely be possible to temperatures of up to -10°C during late winter or early spring. Other options would be to pump the sumps dry prior to freeze-up, or to break and remove ice manually or mechanically. Further standard techniques of control and prevention will be investigated during detailed engineering design of the sumps.

Environmental monitoring of the water control system field performance will be carried out during the regular collection of groundwater and temperature data, and annual geotechnical site inspections completed as part of the environmental monitoring program. Results of the data collection and site inspections will be used to assess and improve where necessary the field performance of the water control structures.

10.4 PORTAGE MINING AND MILLING AREAS

Under full operation, mining in the Portage area will consist of two open pits (Portage and Goose Island), a Rock Storage Facility, a Tailings Storage Facility, a process water Reclaim Pond, an Attenuation Pond, an ore processing mill, and a service complex. The mill and service complex will be located to the west of the Portage Pit, on the area of land separating Third Portage and Second Portage lakes (Figure 2.1).

10.4.1 Water Supply and Distribution

Fresh water for site use will be pumped from an intake barge on Third Portage Lake. The freshwater intake pipe to the barge will be seated on a gravel or small riprap bed that extends into Third Portage Lake along a steep rocky bank. The pipe will run along the bottom either directly on the fine sediment or on a gravel bed. Neither option will adversely affect fish habitat. The intake will be situated at least 1 m off of the bottom to avoid fish habitat and will be fitted with an appropriately sized screen to avoid entrainment of fish.

Heat-traced, insulated piping will extend from the barge to an insulated main storage tank located at the plant site, providing both fire and fresh water storage. Potable water will be drawn from the main storage tank in a skid-mounted chlorination system located in a pre-fabricated structure adjacent to the accommodation camp. The treated potable water will be stored in an insulated water tank. A water distribution pump, also skid mounted, will distribute potable water to the site.

Dust-control water for the Portage mining area will be drawn from the Portage Attenuation Pond in an effort to keep contact water within the mining areas. Dust control water for the haul roads outside the Vault and Portage catchment areas will be drawn from Phaser Lake.

10.4.2 Supernatant Reclaim

The northwest arm of Second Portage Lake (referred to as Second Portage Arm) will be isolated from the rest of Second Portage Lake by the construction of the Central Dike adjacent to the west pit wall of the Portage Pit. Tailings will be deposited to the west of the dike. Any process supernatant seepage and surface water runoff from the tailings will collect within the Reclaim Pond. The South and North Saddle dams will be constructed to allow the pond and tailings surface level to be raised above the current lake level so that sufficient process water volume requirements are maintained as necessary (see Figure 9.5).

The reclaim of supernatant and runoff water from the Reclaim Pond will be achieved using a floating barge, which will be moved progressively during the operation of the TSF. It will probably be necessary to use heated reclaim pumps to ensure operation during the winter. A bubbler system may also be required to keep ice away from the barge.

A retention time of approximately 90 days is required within the Reclaim Pond to allow stabilization of the supernatant chemistry, thereby avoiding large variations in the chemistry of reclaimed water used for ore processing. This corresponds to a Reclaim Pond storage requirement of approximately 550,000 m^3. Additional volume must be allowed for ice in the winter months. Consequently, a supernatant storage volume of around 750,000 m^3 has been adopted for this plan.

10.4.3 Surface Water Management Systems and Activities

The proposed water management plan for the Portage mining area involves (see Figures 9.3 to 9.8) the following activities:

- divert non-contact water from the northern portion of the catchment area around the northwest end of Second Portage Lake towards Third Portage Lake;
- construct dewatering perimeter dikes to allow the dewatering of Second Portage Lake (approximately 14.5 Mm^3 of water) to elevation 105 m for construction of Central Dike and mining of the Portage Pit;
- construct dewatering perimeter dikes to allow the dewatering of the Goose Island area (approximately 2.2 Mm^3 of water) to allow mining of the Goose Island Pit;
- once dewatered, use the western end of Second Portage Lake as an Attenuation Pond;

- collect contact water from the pits, mill site, airstrip, and tailings and RSFs for discharge in the Reclaim or Attenuation ponds, or deactivated pits; and
- monitor the water quality in the Attenuation Pond and treat in-situ, if necessary, prior to decanting excess water to Third Portage Lake or deactivated pits, and/or pumping to Process Plant for use as process make-up water.

The proposed water management plan for the Portage mining and milling area involves the diversion of an area of approximately 267 ha north of the Second Portage Arm catchment to Third Portage Lake in mine operation Years 1 to 5 (see Figure 9.4), and approximately 193 ha during Years 6 to 9 (see Figure 9.7). This will require the construction of approximately a 1,500 m long interceptor ditch during initial site development, and approximately an additional 2,200 m of interceptor ditching prior to Year 6 when the Attenuation and Reclaim ponds combine.

During Years 1 to 5, site contact water from the Portage mine area will be attenuated in the Portage Attenuation Pond located in a basin at the northwest end of Second Portage Lake (see Figure 9.4). The Reclaim Pond will receive little site contact water, and will therefore not have an attenuation function. Contact water collected within the Attenuation Pond will be used to satisfy mill process water make-up requirements with any excess water treated, as required, and discharged to the environment via an effluent pipe and diffuser located within Third Portage Lake. Reclaim water from the TSF will also be available to meet the process water demand, with excess water being returned to the Reclaim Pond.

Operating separate Attenuation and Reclaim ponds in Years 1 to 5 will minimize potential water treatment requirements, and limit the amount of freshwater process make-up sourced from Third Portage Lake. In Year 6, the main basin will become filled with tailings, and tailings deposition will commence in the northwest basin (see Figure 9.7). At this time the former Attenuation Pond will be used as the Reclaim Pond, and freshwater make-up to mill will be sourced from mill and airstrip runoff supplemented by pumping from either Third Portage Lake or the Goose Island and Portage pit lakes.

In Years 1 to 5, the Portage Attenuation Pond will receive runoff and seepage from the Portage RSF, treated runoff from the Portage and Goose Island pits, and runoff originating from the mill and airstrip areas. The Stormwater Dike will be constructed in Year 3 across the northwest basin of Second Portage Arm to allow separation of the Attenuation and Reclaim ponds (see Figure 9.5). This will provide a storage capacity of approximately 2 Mm^3 in the northwest basin, up to the elevation of the current lake level (El. 133.1 masl) (Figure 7.2). Additional volume will be obtained by raising the crest Stormwater Dike crest to 142 masl and allowing some flooding of the surrounding shoreline.

Collection ditches along the eastern and northern edges of the Portage RSF will direct any contact water toward sumps. These sumps will either be pumped to the Portage Attenuation Pond (Reclaim Pond after Year 5), or will be allowed to drain to the pond by gravity. Contact ditches along the southern and western edges of the RSF will drain to the pond by gravity. It is noted that it may prove difficult to maintain gravity flow in these ditches near the end of the mine life when pond water levels rise above the current Second Portage Lake level (El. 133.1 m). An additional sump to the south of the rock storage area may be necessary at that time.

Pit waters from the Portage and Goose Island pits will be first pumped to a water sump at the Process Plant. The pit water will be treated with lime, if required, and used to meet the process water demand. Any excess treated pit water will be directed to the Portage Attenuation Pond.

Water collected within pit sumps will be pumped from the pits during the period of time that the pits are being mined. After that time, pit water will be permitted to collect naturally within the pits to assist with pit lake reflooding (see Figure 9.7). Following cessation of Goose Island Pit operations in Year 4, and until mining operations cease in the Portage Pit in Year 5, excess Portage Pit water may be redirected to the Goose Island Pit Lake for in-situ water treatment depending upon Process Plant water make-up requirements. The location and size of the pit sumps will vary as the pits are developed.

An interceptor ditch, located to the south of the TSF, will collect water originating from part of the airstrip and mill area and direct it a local sump(s) at the mill site. Runoff from the plant area will also be directed to this sump(s). The water in the sump(s) will be used to satisfy mill make-up requirements, with any excess pumped to the Portage Attenuation Pond, or to the Goose Island and/or Portage pit lakes to assist with pit flooding.

10.5 VAULT MINING AREA

The Vault mining area is located approximately 6 km northeast of the Portage mining and milling area. Activities at this location will be limited to open pit mining, local hauling, and disposal of waste rock, and hauling of ore to the mill at the Portage mining and milling area.

10.5.1 Water Supply and Distribution

Potable water for the local mine shop and office at the Vault mining area will be trucked from the Third Portage Lake water supply.

Dust control water for the Vault mining area will be drawn from the Vault Attenuation Pond in an effort to keep contact water within the mining areas. Dust control water for the haul roads outside the respective Vault and Portage catchment areas will be drawn from Phaser Lake.

10.5.2 Water Management Systems and Activities

The proposed water management plan for the Vault mining area during operation (Figures 9.5 to 9.8) involves the following:

- diverting Phaser Lake non-contact water toward Turn Lake;
- constructing a dike across the outlet of Vault Lake to allow the dewatering of approximately 2 Mm^3 of water;
- using Vault Lake, once dewatered, as an attenuation storage facility;
- collecting contact water from the Vault Pit and RSF and directing it toward the Vault Attenuation Pond; and

- monitoring the water quality in the Attenuation Pond and treating it, if necessary, prior to pumping the water to Wally Lake.

The proposed water management plan for the Vault mining area involves the diversion of approximately 152 ha of the Vault Lake tributary area to Turn Lake. This diversion necessitates the construction, during initial site development, of an interceptor ditch to divert non-contact water from the small unnamed lake to the south of Vault Lake toward Phaser Lake. Interceptor ditches and a sump will be required along the southeast edge of the rock storage facility to direct any contact water away from Phaser Lake and toward Vault Lake. Water collected in the Phaser Lake basin during the spring melt will be drawn down to a maximum elevation of 140 masl over the summer period to minimize impacts to overwintering fish habitat and provide sufficient storage for the following spring freshet and/or extreme runoff events.

In order to restrict the flow of water from Phaser Lake to Vault Lake during significant precipitation events and/or spring melt periods, the Vault access road will be constructed to a minimum elevation of 143 masl. The minimum road embankment elevation is set to provide sufficient capacity within the Phaser Lake basin to contain the 1:100-yr, wet year spring melt (370 mm; 565,000 m^3) with 1 m of freeboard above a Phaser Lake water surface elevation of 140 masl in the absence of pumping. The embankment would be designed to have low permeability, either through the use of native materials, man-made materials such as a geomembrane, or a combination of these. It is anticipated that the embankment will freeze, which will enhance its low permeability design.

After construction of the Vault Dike, the water level in Vault Lake will be lowered to form the Vault Attenuation Pond. To maximize the use of the available storage volume within the existing lake, the Vault Attenuation Pond will be formed by excavating a channel to join two deep depressions within Vault Lake. Consequently, Vault Lake will need to be drawn down to allow excavation of this channel. The total lake volume (lake level elevation of 139 m masl) is estimated to be 2.2 Mm^3. Approximately 0.2 Mm^3 of water will not be pumped out and will remain within the two basins at the north and south end of the lake.

As a basis for the water management plan for Vault Lake, it has been assumed that the Vault Attenuation Pond water level will be operated at or below approximately El. 136 masl to reduce the potential for seepage into the Vault Pit through the active layer. Based on the Vault Lake bathymetry, a storage capacity of approximately 508,000 m^3 is available below elevation 136 m. Consequently, the pond will be managed to allow the collection of runoff water during spring freshet without exceeding this pond level. Water collected within the Vault Attenuation Pond will be treated if required prior to being pumped to Wally Lake during the open water season via an outfall diffuser system.

The potential expansion of the Vault Pit beyond its currently planned footprint may affect the use of Vault Lake as an attenuation storage facility. An alternative would be to use Phaser Lake as an attenuation storage pond by pumping pit water, along with rock storage runoff, to this lake. Another alternative would be to allow Phaser Lake to drain naturally to Vault Lake and have one centralized location within Vault Lake for attenuation and pumping; however, this would result in a greater area contributing to the Vault Attenuation Pond and would necessitate more aggressive dewatering to control the potential risks (seepage and/or overflow and related instabilities) to the adjacent Vault Pit.

The Vault RSF will be surrounded along its western and northern edges by interceptor ditches, which will direct any contact water toward sumps where the water will be pumped to interceptor ditches that drain via gravity to the Vault Attenuation Pond. An interceptor ditch along the eastern edge of the Vault RSF will drain by gravity to the Vault Attenuation Pond. Depending on the mining schedule and timing of the Vault Lake drawdown, it may be necessary to direct runoff from the Vault RSF to local sedimentation ponds, which will subsequently overflow to the Vault Attenuation Pond

Water collected within the Vault Pit sump will be pumped to the Vault Attenuation Pond. The location and size of the pit sumps will vary as the pit is developed.

10.5.3 Haul Roads

A network of haul roads will connect the ore bodies to the RSFs and the Process Plant. The majority of the roadways servicing the Portage mining area are located so that their drainage will be directed towards the proposed contact water management infrastructure. For example, the runoff from the road leading to Goose Island pit from the Process Plant will be collected within either the Goose Island pit sump or the plant site/mill collection sump(s).

Due to the geographic remoteness of the Vault ore body from the Portage mining area, significant sections of haul road will fall outside of the catchment areas serviced by contact water management infrastructure. Based on the proposed diversions, approximately 5 km of the Vault Haul Road will not be serviced by the proposed water management infrastructure at the Vault or Portage mining areas. These sections will drain naturally to a number of different small- and medium-sized lakes. A review of the topography in the vicinity of the Vault Haul Road indicates that, apart from Turn Lake, no significantly large tributary area or waterbody is intercepted. There will be one stream crossing located at the outlet of Turn Lake to Drill Trail Lake, which will be designed so as not to impair water movement out of Turn Lake, or upstream fish movement (Cumberland, 2006). The coarse road subgrade material will likely have an adequate conveyance capacity to pass the small amount of expected runoff across the roadway during summer months.

The approach to water management for these sections of Vault Haul Road will involve the implementation of local best management practices during construction, operation, and closure. Where possible, the road will be constructed of non-reactive waste rock from mining operations. Other best management practices will strive to minimize the amount of runoff originating from the roadways and to prevent the migration of surfacing material from the roadway and crossing. Any areas identified as point sources of runoff originating from the roadway or crossing can be managed locally with silt fences, turbidity curtains, interceptor ditches, rock check dams, and/or small sedimentation ponds.

SECTION 11 • INFRASTRUCTURE SIZING

During the mine construction and operation life, a network of collection and interceptor ditches and sumps will be constructed and maintained to facilitate mine site water management. The following sections provide preliminary infrastructure sizing requirements for the Portage and Vault mining areas based on the water management plan details and design criteria described in Section 10 of this document.

Note that the storage volumes and pumping capacities are provided as a preliminary guide. These will be established during detailed design in conjunction with the mine engineer, based on estimated inflows and the potential to interrupt mining operations at each stage of pit development.

11.1 SUMPS AND PONDS

The preliminary storage and pumping requirements for sumps and ponds in the Portage and Vault areas are shown in Table 11.1 and 11.2, respectively (see Figures 9.3 to 9.8).

Table 11.1: Storage and Pumping Requirements – Portage Area

Description	Tributary Area (ha)	Storage Requirements Storage	Pumping Requirements Pumping (L/sec)
Sump 1 (Portage RSF)[a]	21	8,500	10
Sump 2 (Portage RSF)[a]	31	13,000	15
Sump 3 (Portage RSF)[a]	62	26,000	30
Sump 4 (Mill Area)[b]	331	136,000	165
Portage Pit Sumps[c]	58	24,000	90
Goose Island Pit Sumps[c]	21	9,000	65
Attenuation Pond (to Year 3)[d]	487	961,000	240
Attenuation Pond (to Year 5)[d]	487	1,330,000	240
Attenuation Pond (Year 5)	392	590,000	190
Reclaim Pond (to Year 6)[e]	83	750,000[f]	N/A
Reclaim Pond (Year 6 to Year 8)	313	2,010,000[f]	155

Notes: **a.** Sump 1 assumed to report to Sump 2, which in turn is assumed to report to Sump 3. **b.** Pit, airstrip and mill runoff assumed to report to mill sump(s) for freshwater make-up to process and/or pumping to the Attenuation Pond. Sump 4 may be distributed among a number of sumps. **c.** Will likely be distributed among a number of sumps. **d**. The Attenuation Pond is sized to store runoff from the 1:100 year 24-hr event from tributary area, Portage RSF, and mill sump in addition to its peak annual operating volume under average climate conditions. **e**. Reclaim Pond has no attenuation function to Year 6. **f.** Includes minimum free-water volume of 550,000 m^3 for process reclaim water plus an ice allowance of 200,000 m^3.

Table 11.2: Storage and Pumping Requirements – Vault Area

Description	Tributary Area (ha)	Storage Volume (m^3)	Pump Rate (L/sec)
Sump 1A	40	16,400	20
Sump 2A	26	10,700	15
Sump 3A	25	10,300	15
Vault Pit Sump[a]	42	11,400	35
Attenuation Pond	455	301,000	225
Phaser Lake[b]	152	62,400	75

Note: a. May be distributed among a number of sumps. **b**. Storage and pumping requirement above Phaser Lake water surface El. 140 masl for the 1:100 year 24-hr precipitation event. Vault Haul Road constructed to El. 143 masl to contain the 1:100-yr, wet year spring melt (370 mm; 565,000 m^3) with 1 m of freeboard above El. 140 masl.

The Portage and Vault attenuation ponds are sized to store the runoff volume from the 24-hour, 1:100-year storm event, in addition to their peak annual operating volume under average climate conditions. For the Portage Attenuation Pond, this volume varies with time since the Goose Island Pit is operational between Years 2 and 4 and the Attenuation Pond serves as the Reclaim Pond Year 6 onward.

The Portage Attenuation Pond basin has a capacity of approximately 1,030,000 m^3 to El. 130 masl and should accommodate the storage needs to the end of Year 3. The Stormwater Dike across Second Portage Arm will need to be constructed in Year 3 to an elevation of 142 m. Once the Stormwater Dike has been constructed, the basin will have the capacity to store up to 6.7 Mm^3 if necessary.

The Reclaim Pond (Years 1 through 5) within the main basin of Second Portage Lake will receive little site contact water (runoff) and will therefore not have an attenuation function. The pond must provide a minimum free-water volume (under an ice cover if ice is present) of 550,000 m^3 for process purposes, plus an allowance for winter ice formation of approximately 200,000 m^3, for a total of 750,000 m^3.

Prior to the construction of the Central Dike and mining of the Portage Pit, Second Portage Lake will require dewatering down to elevation 105 masl within the area bounded by the East Dike. The total lake volume to a lake level elevation of 133.1 m masl is estimated to be 14.5 Mm^3 within the area to the west of the East Dike. The dewatering volume is estimated to be 13.8 Mm^3, excluding the volume of water contained below elevation 105 m masl (~ 745,000 m^3) and assuming that water contained in the elevated northwest basin (approximately 2 Mm^3) drains to the main basin during dewatering. An additional 0.7 Mm^3 will also need to be dewatered from Third Portage Lake inside the Bay Zone Dike.

The volume of water below elevation 105 m masl in the main tailings basin is estimated to be 745,000 m^3, which is roughly equal to the process storage requirement of 750,000 m^3 for the winter period. Any volume differences remaining following dewatering could be made up by directly pumping freshwater to the tailings main basin from the northwest basin or from nearby lakes once the first construction phase of the Central Dike has been completed. Alternatively, the freshwater makeup into the milling process could be temporarily increased. Once operational, the Reclaim Pond should maintain a relatively constant volume.

Ice entrapment may increase the tailings volume by up to 30% in the TSF. A 20% ice entrapment of the deposited tailings has been assumed for the purposes of developing the water management plan. This is consistent with planning objectives at other mines in the north. An increase in ice entrapment would result in a decrease in the reclaim water rate and an equivalent increase in the freshwater makeup water rate since less water would be released from the tailings and, hence, less supernatant would be available for reclaim. If less than 20% ice entrapment occurs, the reclaim rate may increase and the freshwater makeup would decrease accordingly.

11.2 INTERCEPTOR CHANNELS

Ditches are sized to accommodate the peak runoff rate from a 1:100-year, 24-hour storm. Although no specific overburden information has been collected along the proposed ditch alignments, properly designed excavated channels are considered feasible.

Attempts will be made to avoid constructing ditches in ice-rich areas where thaw instability is a concern. A variety of mitigation measures are available where ice-rich areas cannot be avoided. For contact water ditches, mitigation may include providing training berms instead of, or in combination with, ditches, and lining and insulating channels with compact till or excess bentonite from the construction of the soil/bentonite cut off wall in the dewatering dikes to prevent sedimentation and permafrost degradation. Where thaw-related impacts affect non-contact water ditches, special care will be taken to ensure linings comprise non-acid-generating and non-metal-leaching granular materials.

Prior to ditch construction, a review of the existing topographic and geotechnical conditions will be carried out to locate, to the extent possible, the channel alignments in favourable ground with a ditch invert at or above the existing grade. If this can not be achieved, the alignment will be located in-ground with shallow excavation into the overburden soil or rock, which may require the excavation and replacement of ice-rich soils with compacted till materials. The channels have been designed as oversized structures, which will allow for the addition of insulated channel lining materials where required.

All water management channels required at closure will have been constructed and maintained throughout the operation life of the mine.

The preliminary requirements of the diversion (non-contact) and collection (contact) in the Vault and Portage areas are shown in Tables 11.3 and 11.4, respectively (see Figures 9.3 to 9.8). For practical purposes, drainage ditches with a minimum uniform base width of 1 m, channel slope of 0.5%, 2H:1V sideslopes, and depths adjusted to suit discharge requirements have been assumed.

Table 11.3: Minimum Interceptor Ditch Requirements – Portage Area

Description	Length (m)	Depth[a] (m)	Lining D_m [b] (mm)
Collection from east perimeter of Portage RSF (to Sump 1)	500	0.75	50
Collection from south perimeter of Portage RSF (to Portage Attenuation/Reclaim Pond)	1,600	0.75	50
Collection from west perimeter of Portage RSF (to Portage Attenuation/Reclaim Pond)	350	0.50	50
Collection from north perimeter of Portage RSF (two ditches to Sumps 2 and 3)	700	0.75	50
Collection from northwest perimeter of Portage RSF (to Portage Attenuation/Reclaim Pond)	650	1.0	100
Diversion from Unnamed Lake North of Portage RSF (non-contact water to 2nd Portage)	300	1.5	150
Diversions to Unnamed Lake north of Portage RSF Year 6 to 8 (non-contact water to 2nd Portage)	1,100	1.0	50
Diversion north of Portage Attenuation Pond to Year 6 (non-contact water to 3rd Portage)	1,500	1.75	150
Diversion north of Reclaim Pond Year 6 to 8 (non-contact water to 3rd Portage)	2,000	1.5	150
Collection from Airstrip (to Sump 4)	400	1.25	100
Collection from south perimeter of Mill area	1,100	0.75	50

Notes: a. Assumes trapezoidal channel with 2H:1V side slopes, 1 m base width, 0.5% longitudinal slope and includes 0.3 m freeboard. **b.** Minimum median size of rock lining material.

Table 11.4: Minimum Interceptor Ditch Requirements – Vault Area

Description	Length (m)	Depth[a] (m)	Lining D_m[b] (mm)
Collections leading to Sumps around Vault RSF (total of six ditches)	4,700	0.75	50
Collection from east perimeter of Vault RSF (to Vault Attenuation Pond)	600	0.75	50
Collection from southeast perimeter of Vault RSF (to Vault Attenuation Pond)	1,700	1.50	100
Diversion from Unnamed Lake (non-contact water to Phaser Lake)	380	1.10	75

Notes: a. Assumes trapezoidal channel with 2H:1V side slopes, 1 m base width, 0.5% longitudinal slope, and includes 0.3 m freeboard. **b.** Minimum median size of rock lining material.

SECTION 12 • WATER BALANCE

A water balance model was developed to assist in the evaluation of the proposed water management infrastructure on a monthly basis over the life of the mine and under closure conditions. The model includes a water balance along with a mass balance of geochemical parameters.

The following section presents the parameters and assumptions adopted in the water balance model along with a summary of the results for both the Vault and Portage mining areas.

12.1 MODEL ASSUMPTIONS

The water balance model was developed to assist in the evaluation of the maximum operating storage volume of the proposed contact water management infrastructure under average year climate conditions over the life the mine and under closure conditions. The model focuses specifically on *contact water* management infrastructure and areas that have been physically or chemically affected by mining activities. Therefore, it is not impacted by water levels in the neighbouring lakes.

The model assumes average year climate conditions. Extreme events were not incorporated into the model as it was assumed that the following contact water management contingencies would be in place:

- The contact water management infrastructure will be designed, sized and operated to intercept and contain extreme event run-off from the mine affected areas as described in Sections 10 and 11 above.
- Any excess contact water would be directed to the TSF or to open pits if available for temporary storage prior to recycle, re-use, and/or treatment (if necessary) and release to the environment. Upon completion of pit operations, excess water would be directed to the pit lakes to assist with reflooding.
- The Portage Attenuation Pond basin has a capacity of approximately 1,030,000 m^3 and should accommodate the contact water storage needs until the end of Year 3. Following the construction of the Stormwater Dike across Second Portage Arm in Year 3, the attenuation pond basin would have the capacity to store up to 6.7 Mm^3 if necessary. Up to the end of Year 5, attenuation water is used to satisfy freshwater make-up requirements to the mill with any excess assumed to be monitored, treated (if necessary) and released to Third Portage Lake or Goose Island pit lakes (after Year 4). Alternatively, excess water can be pumped untreated to the Reclaim Pond for storage and re-use as process supernatant water.
- In Year 6, the Portage Attenuation and Reclaim ponds combine, and the Attenuation Pond becomes a component of the contact water management system managed using the same contingency planning described in Sections 10 and 11 above for the other contact water management infrastructure.

Based on the above, the uncontrolled release of contact water to the neighbouring lakes is not anticipated. The current mine plan allows for storage of excess water and run-off from extreme events within TSF. After Year 4, excess contact water and run-off can also be directed to the Goose Island Pit (or Portage Pit after Year 5) to assist with reflooding.

As indicated previously, one of the strategies of water management on site is to recycle and reuse contact and process water wherever practicable. From a water balance perspective, recycling and reusing excess contact water from extreme run-off events would act to reduce freshwater intake requirements from Third Portage Lake. Any remaining water would be analyzed and treated (if necessary), prior to controlled release to the environment.

A brief description of the input parameters and assumptions used in the water balance model are provided in Tables C.1 to C.9 in Appendix C. Parameters that only affect the model geochemistry computations are identified by note "[geochem]." A simulation calendar correlating the simulation timesteps (in months according to both mine year and calendar year) is presented in Appendix D.

12.2 WATER BALANCE MODEL RESULTS

The results of the site water balance are summarized in Tables 12.1 and 12.2, and in the flow logic diagrams presented in Figures 12.1 to 12.9. Results for mine years 1, 3, 5, 7, and 8 were selected to coincide with those presented in the tailings deposition plan and the mine development plan. Time series of key water management facilities are presented in Figures 12.10 to 12.15.

12.3 PORTAGE

During the first five years of mill operations (Years 1 to 5), the Reclaim Pond will operate at a slight negative water balance, and will require some freshwater, Portage Attenuation Pond water or pit water as make-up to maintain a balance. This is indicated on Figure 12.10 as a reduction in the reclaim rate through the winter period in order to maintain the minimum free water requirements within the Reclaim Pond. In Year 6, the Reclaim and Attenuation ponds combine into a single Reclaim Pond (Figure 12.11).

During the first five years of mill operations (Years 1 to 5), the Portage Attenuation Pond will have to decant between approximately 100,000 and 1,500,000 m^3 of water annually to achieve a target operating volume of 620,000 m^3 (including ice) at the start of winter (Figure 12.11). This assumes that the mill freshwater requirements will be fulfilled from this pond. A minimum volume of approximately 620,000 m^3 (including ice) will satisfy the minimum mill freshwater requirement of 72 m^3/h (hatch, 2007) through the winter.

Flooding of the Goose Island Pit via controlled pumping from Third Portage Lake will commence in Year 4 and continue at an average annual rate of approximately 1.4 Mm^3/yr (pumped June through September) through Year 11 (Figure 12.13). The average annual pumping rate was set to accommodate all of the pit inflows and runoff for eight years, and the mill site runoff from Years 5 to 11 (assuming average annual conditions) to Goose Island Pit without having to decant water to the environment (see Section 12.5). The re-watering volume within the Goose Island Pit dikes, including the mined out pit, is approximately 14.8 Mm^3 assuming the waste rock is not placed inside the diked off area.

Table 12.1: Water Balance Model Summary – Portage Mining and Milling Area[a]

	Year 1		Year 3		Year 5		Year 7		Year 8	
	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)
Reclaim Pond (Mine Year 1 to 6)										
Tails Storage Runoff & Seepage	1,331,500		1,795,600		1,827,600					
Other Areas Runoff	85,700		58,400		20,500					
Direct Precipitation	27,100		34,200		43,500					
Direct Evaporation		32,800		41,800		52,300				
Decant to Attenuation Storage								404,400		
Reclaim Water		1,534,400		1,846,400		1,839,300				
Sub-Total	1,444,300	1,567,000	1,888,200	1,888,200	1,891,600	1,891,600	0	404,400		
Change in Storage	**-122,900**		**0**		**0**		**-404,400**			
Stormwater Attenuation Pond (Reclaim Pond Mine Year 6 to 8)										
Goose Island Pit Runoff & Seepage	6,800		1,235,100							
Portage Runoff & Seepage	393,600		931,800		715,200					
Rock Storage Runoff	9,600		32,400		109,700		109,700		109,700	
Other Areas Runoff	423,900		377,500		305,800		202,200		175,500	
Decant from Reclaim Pond							404,400			
Tails Storage Runoff & Seepage							1,870,200		720,300	
Direct Precipitation	37,800		53,100		37,300		56,900		56,700	
Direct Evaporation		47,200		61,600		45,100		69,300		72,300
Dust Control		12,000		12,000		12,000				
Make-Up Water to Mill		639,800		1,052,400		1,059,600				
Reclaim Water								2,266,000		755,300
Decant to Third Portage Lake		280,900		1,503,700		185,300				
Sub-Total	871,700	979,900	2,629,900	2,629,700	1,168,000	1,302,000	2,643,400	2,335,300	1,062,200	827,600
Change in Storage	**-108,900**		**200**		**-134,000**		**308,100**		**234,600**	
Mill Water Balance										
Ore Water	81,000		107,900		107,900		107,900		36,000	
Reclaim Water	1,534,400		1,846,400		1,839,300		2,266,000		755,300	
Freshwater from Third Portage							632,900		211,000	
Make-up	639,800		1,052,400		1,059,600					
Tailings Transport Water		2,255,100		3,006,800		3,006,800		3,006,800		1,002,300
Sub-Total	2,255,200	2,255,100	3,006,700	3,006,800	3,006,800	3,006,800	3,006,800	3,006,800	1,002,300	1,002,300

Table 12.1 – Continued

	Year 1		Year 3		Year 5		Year 7		Year 8	
	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)	Inflow (m^3/yr)	Outflow (m^3/yr)
Balance	**100**		**-100**		**0**		**0**		**0**	
Goose Island Pit (Reflooding begins Mine Year 4)										
Direct Precipitation					72,700		104,800		110,100	
Other Area Runoff					57,600		121,300		121,600	
Pumped from Portage Pit					0					
Goose Island Pit Runoff & Seepage	6,800		1,235,100		1,052,700		702,100		537,900	
Pumped from Third Portage					1,356,000		1,356,000		1,356,000	
Dewater to Third Portage		1,466,700								
Pumped to Attenuation		6,800		1,235,100						
Evaporation						96,600		128,100		134,400
Sub-Total	6,800	1,473,500	1,235,100	1,235,100	2,539,000	96,600	2,284,200	128,100	2,125,600	134,400
Change in Storage	**-1,466,700**		**0**		**2,442,400**		**2,156,100**		**1,991,200**	
Portage Pit (Reflooding begins Mine Year 5)										
Direct Precipitation					14,800		110,200		133,400	
Other Area Runoff					153,300		111,600		106,400	
Portage Runoff and Seepage	393,600		931,800		715,200		907,600		729,200	
Pumped from Third Portage					3,224,000		3,224,000		3,224,000	
Dewater to Third Portage		4,566,700								
Pumped to Attenuation		393,600		931,800		715,200				
Pumped to Goose						0				
Evaporation						23,700		135,100		163,900
Sub-Total	393,600	4,960,300	931,800	931,800	4,107,300	738,900	4,353,400	135,100	4,193,000	163,900
Change in Storage	**-4,566,700**		**0**		**3,368,400**		**4,218,300**		**4,029,100**	

Notes: a. Based on hydraulic year - October 1 of Mine Year X-1 to September 30 of Mine Year X

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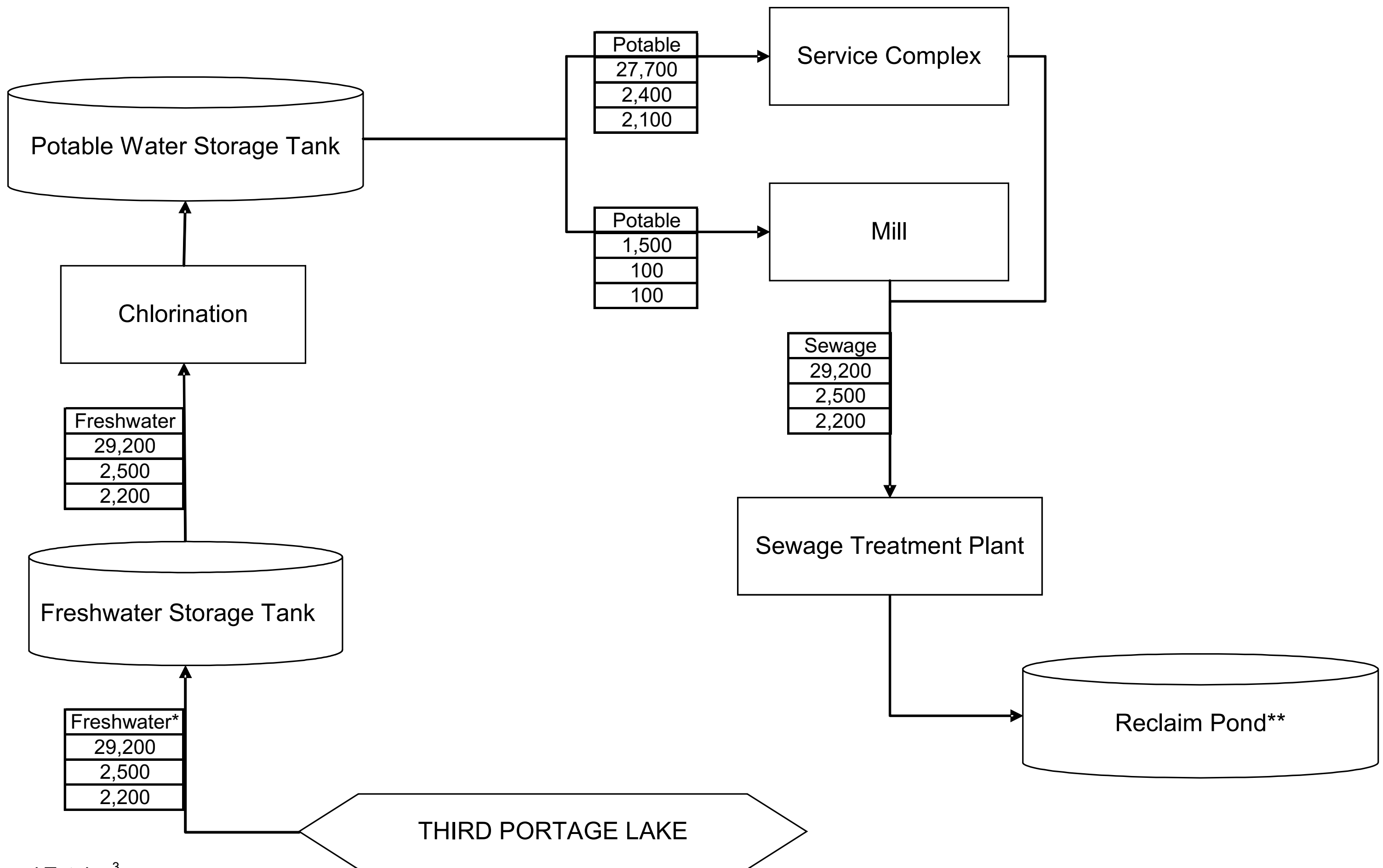

Legend

100,000	Annual Total m^3
10,000	Maximum Monthly Total m^3
0	Minimum Monthly Total m^3

*Freshwater requirements for milling process circuit not shown for clarity (see Figures 12.2-12.6)

**Treated sewage water is not included in the reclaim pond water balance as its contribution to the annual input volume is minimal (<2%; see Figures 12.2-12.5)

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POTABLE WATER BALANCE

FIGURE 12.1

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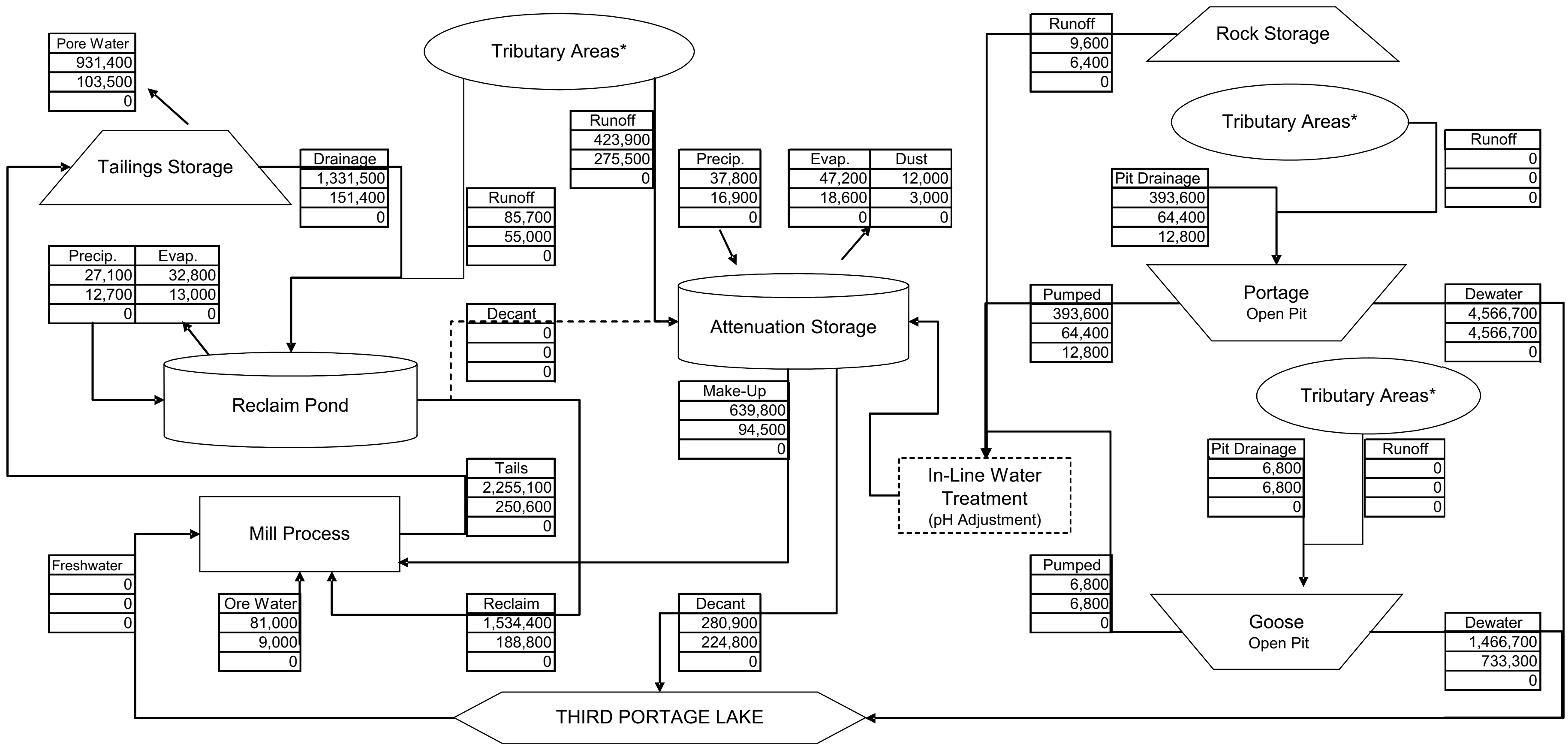

* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly Total m^3
0	Minimum Monthly Total m^3
------------	if required

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PORTAGE LOGIC DIAGRAM
YEAR 1

FIGURE 12.2

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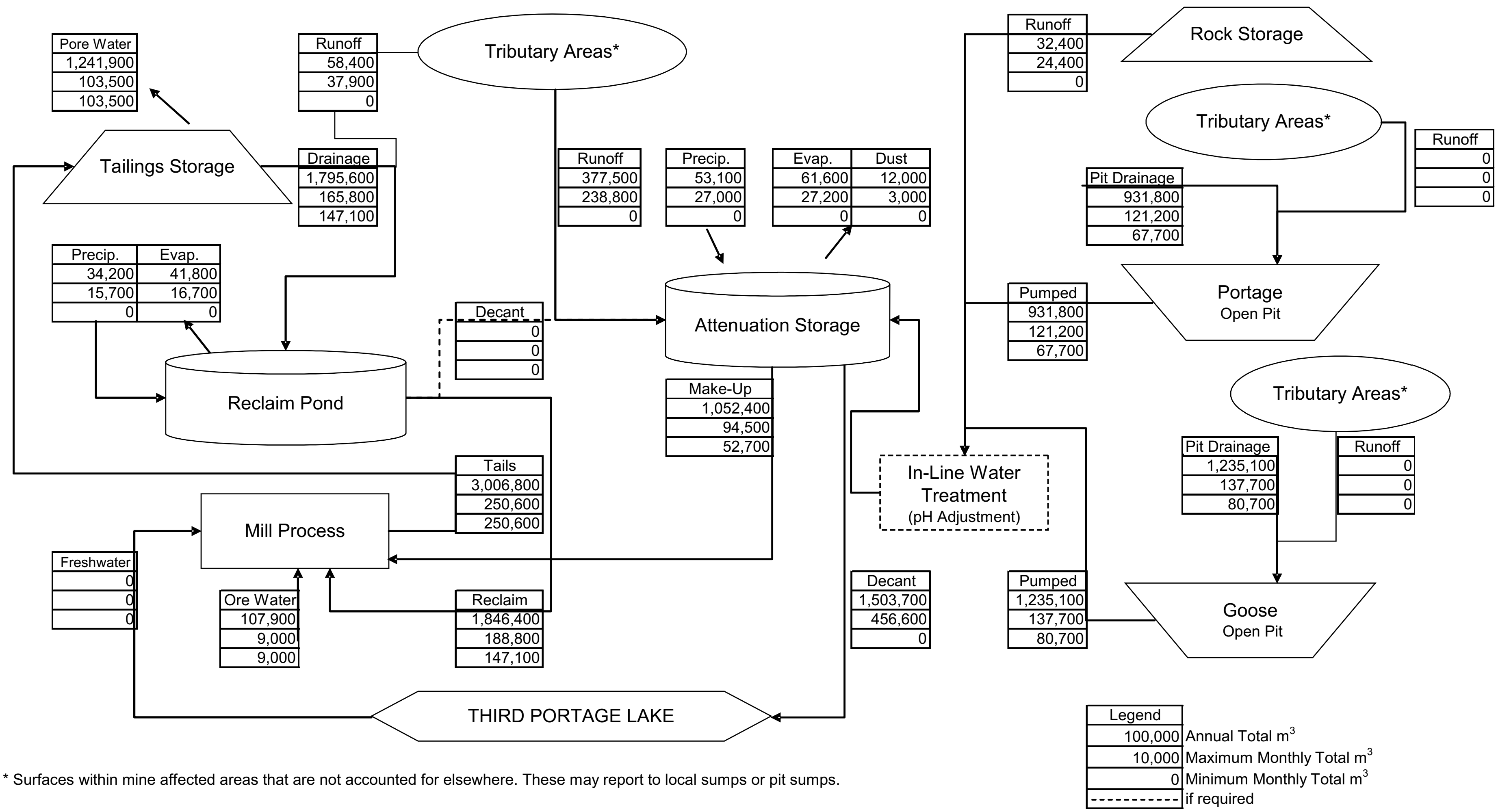

* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.

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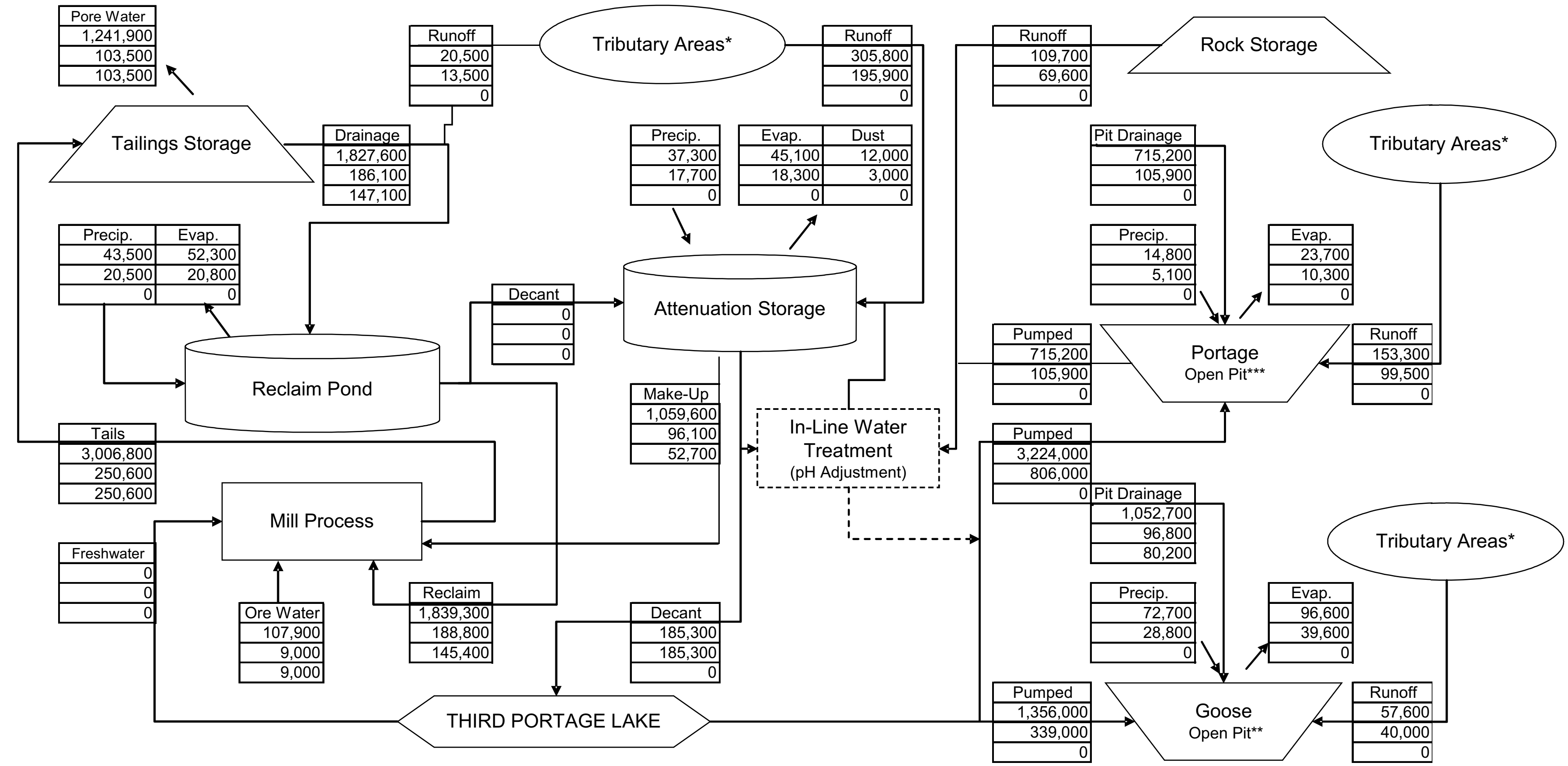
PORTAGE LOGIC DIAGRAM
YEAR 3

FIGURE 12.3



* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.
**Cessation of mining operations in Goose Pit and commencement of pit flooding occurs in Mine Year 4
***Cessation of mining operations in Portage Pit and commencement of pit flooding occurs in Mine Year 5

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly Total m^3
0	Minimum Monthly Total m^3
-----------	if required or optional

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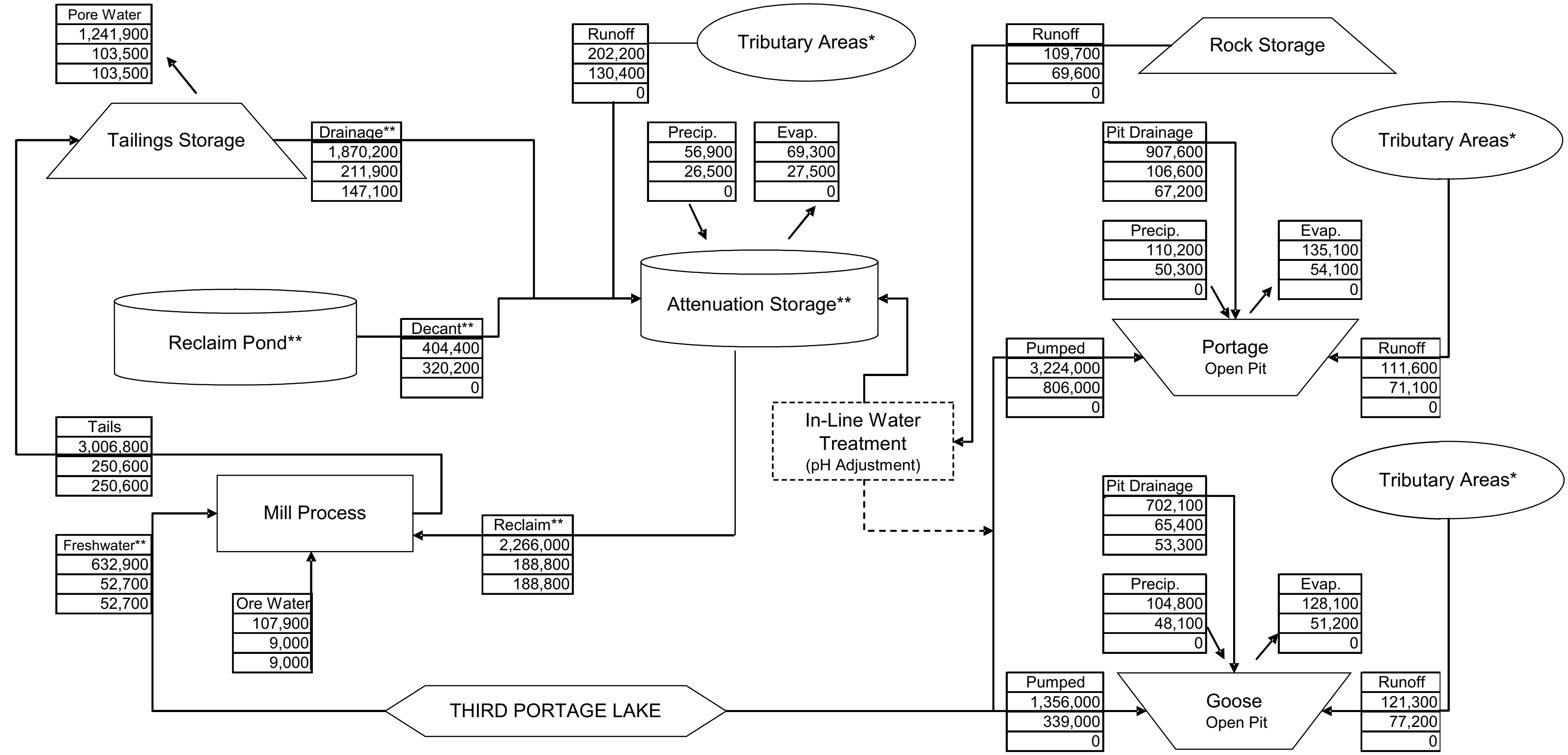
PORTAGE LOGIC DIAGRAM
YEAR 5

FIGURE 12.4



* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.

*Reclaim pond and Attenuation storage start to combine Mine Year 6. Reclaim from Reclaim Pond occurs until Reclaim Pond is closed Reclaim from Attenuation Storage occurs once Reclaim Pond is closed. Dust control, Decant and Make-up from Attenuation Storage occurs until ponds start to combine.

Legend	
100,000	Annual Total m^3
10,000	Maximum Monthly Total m^3
0	Minimum Monthly Total m^3
-----------	if required or optional

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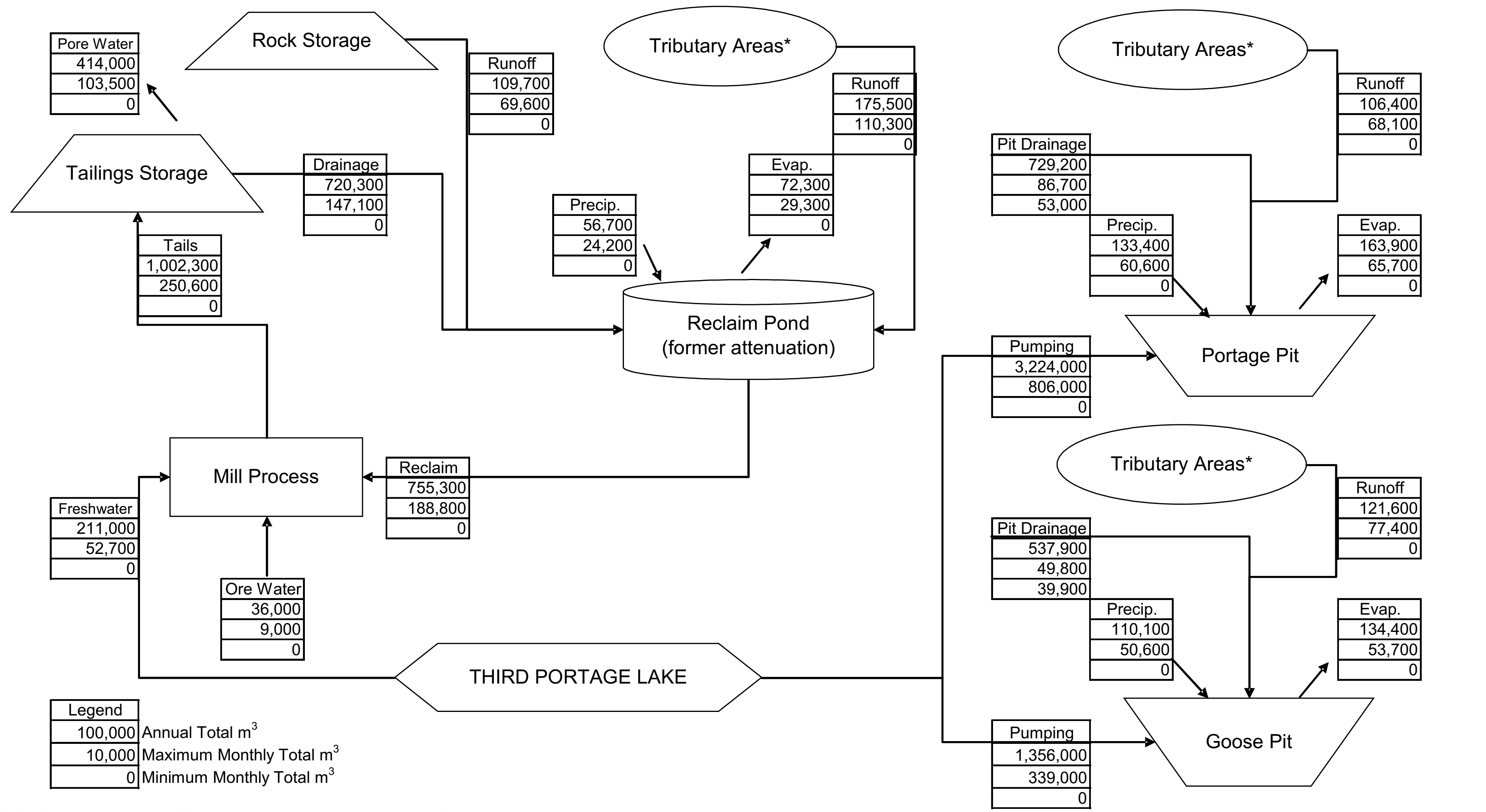
PORTAGE LOGIC DIAGRAM
YEAR 7

FIGURE 12.5



* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.

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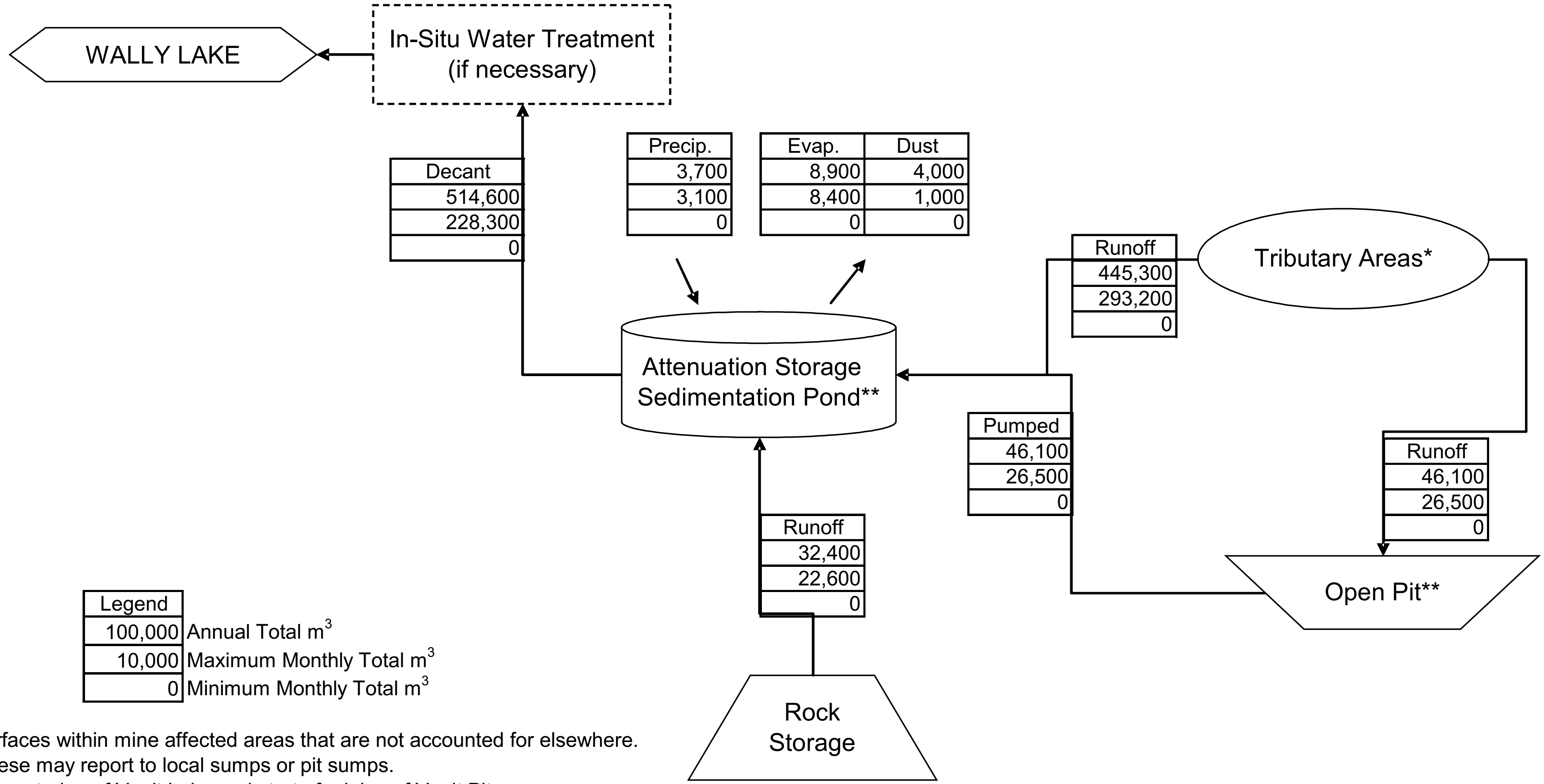
PORTAGE LOGIC DIAGRAM
YEAR 8

FIGURE 12.6



* Surfaces within mine affected areas that are not accounted for elsewhere.
These may report to local sumps or pit sumps.

** Dewatering of Vault Lake and start of mining of Vault Pit occurs in Mine Year 4

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VAULT LOGIC DIAGRAM
YEAR 5

FIGURE 12.7

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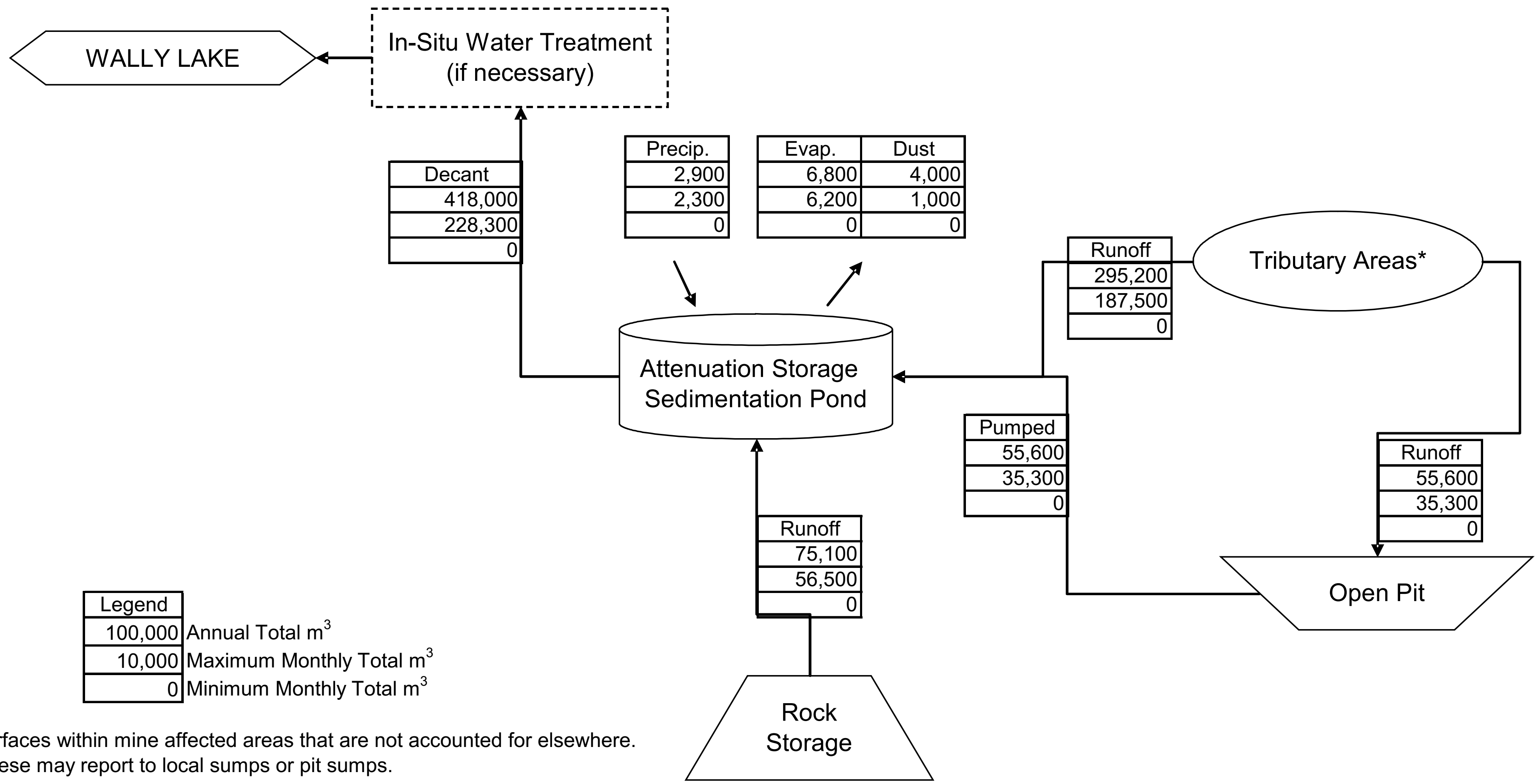

* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.

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MEADOWBANK MINING PROJECT	
VAULT LOGIC DIAGRAM YEAR 7	**FIGURE 12.8**

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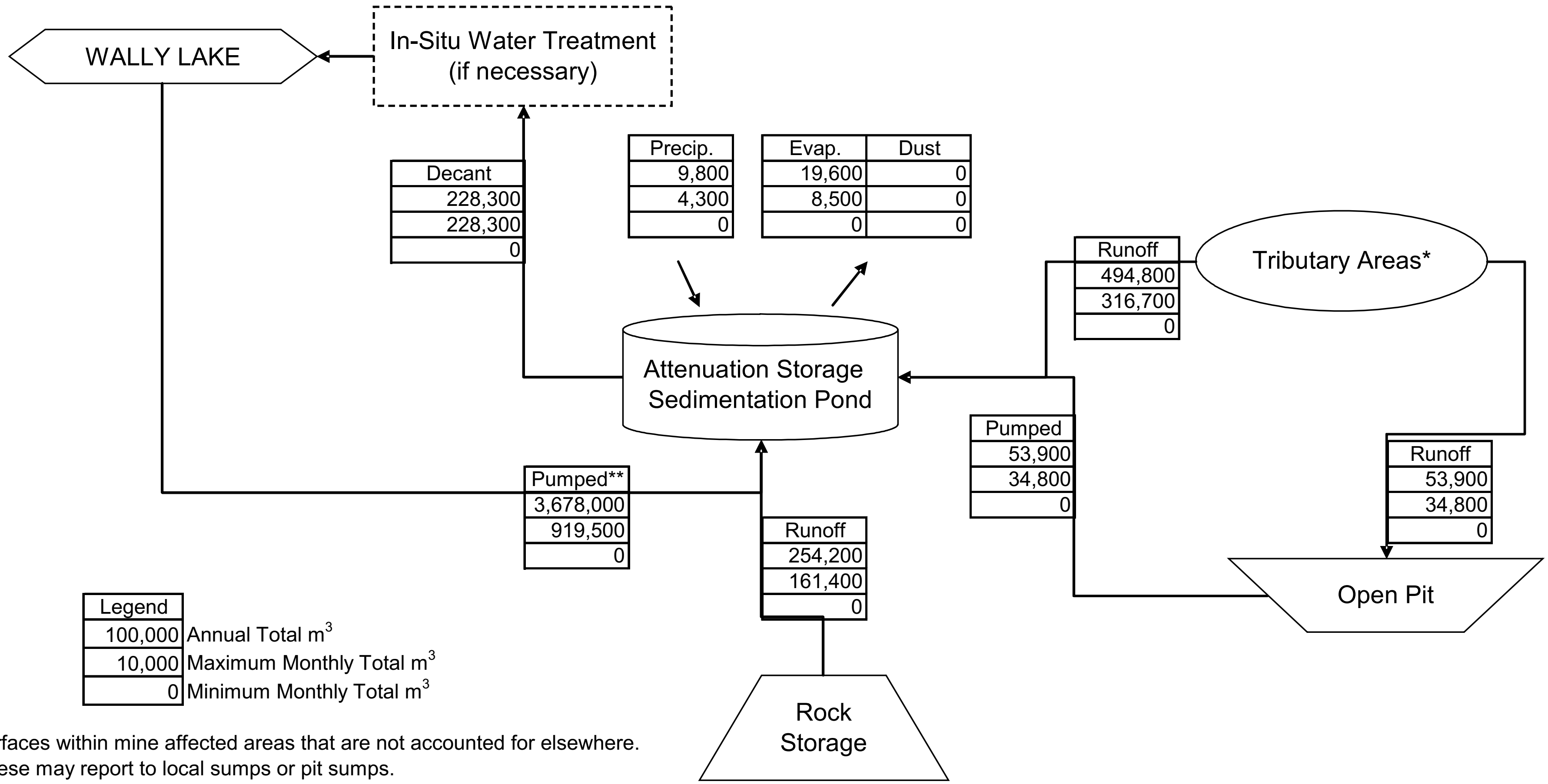

* Surfaces within mine affected areas that are not accounted for elsewhere. These may report to local sumps or pit sumps.

**Reflooding of Vault Lake commences in Mine Year 8

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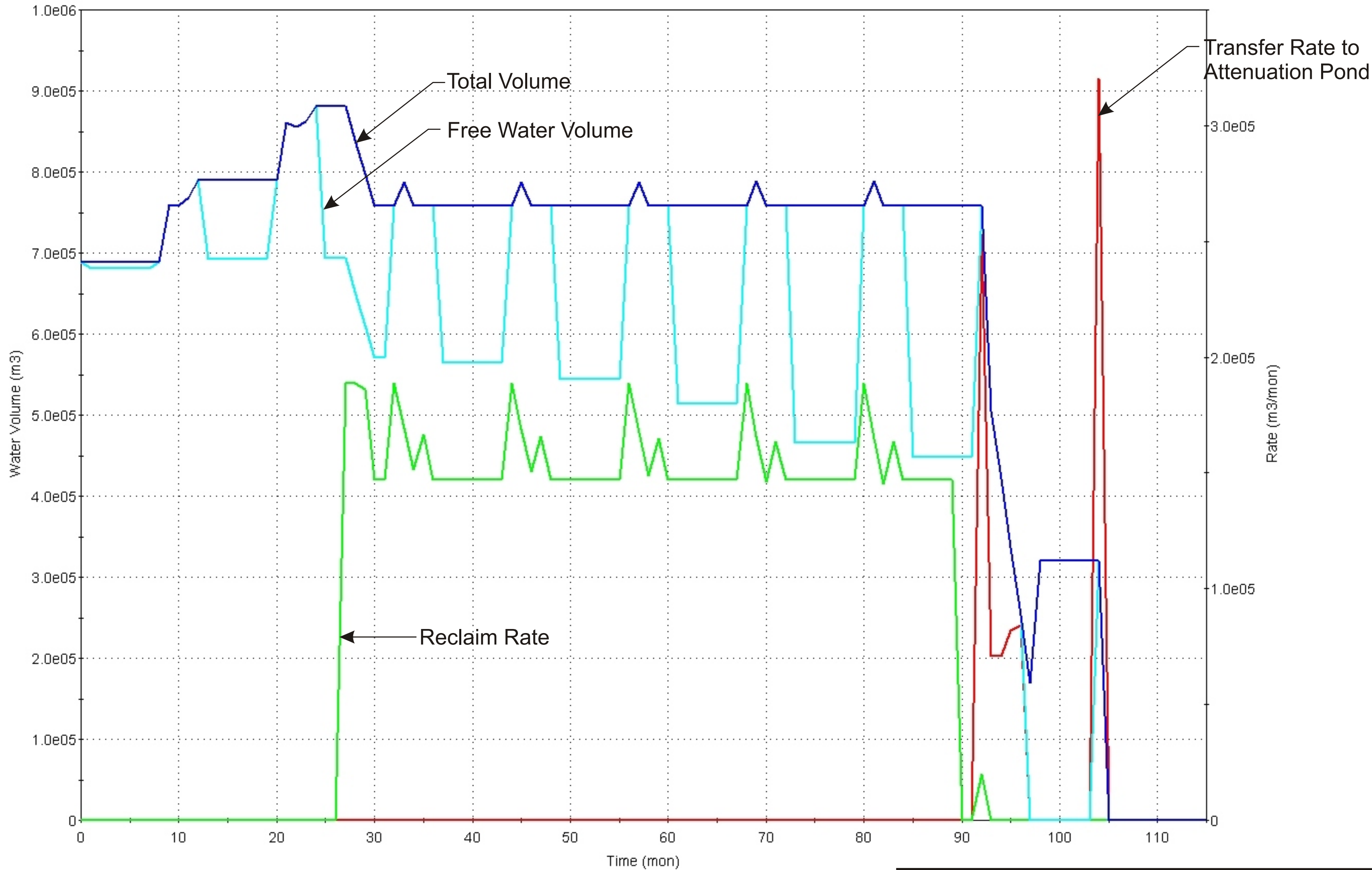
VAULT LOGIC DIAGRAM
YEAR 8

FIGURE 12.9



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PORTAGE RECLAIM POND (YEAR 1 TO 6)	**FIGURE 12.10**

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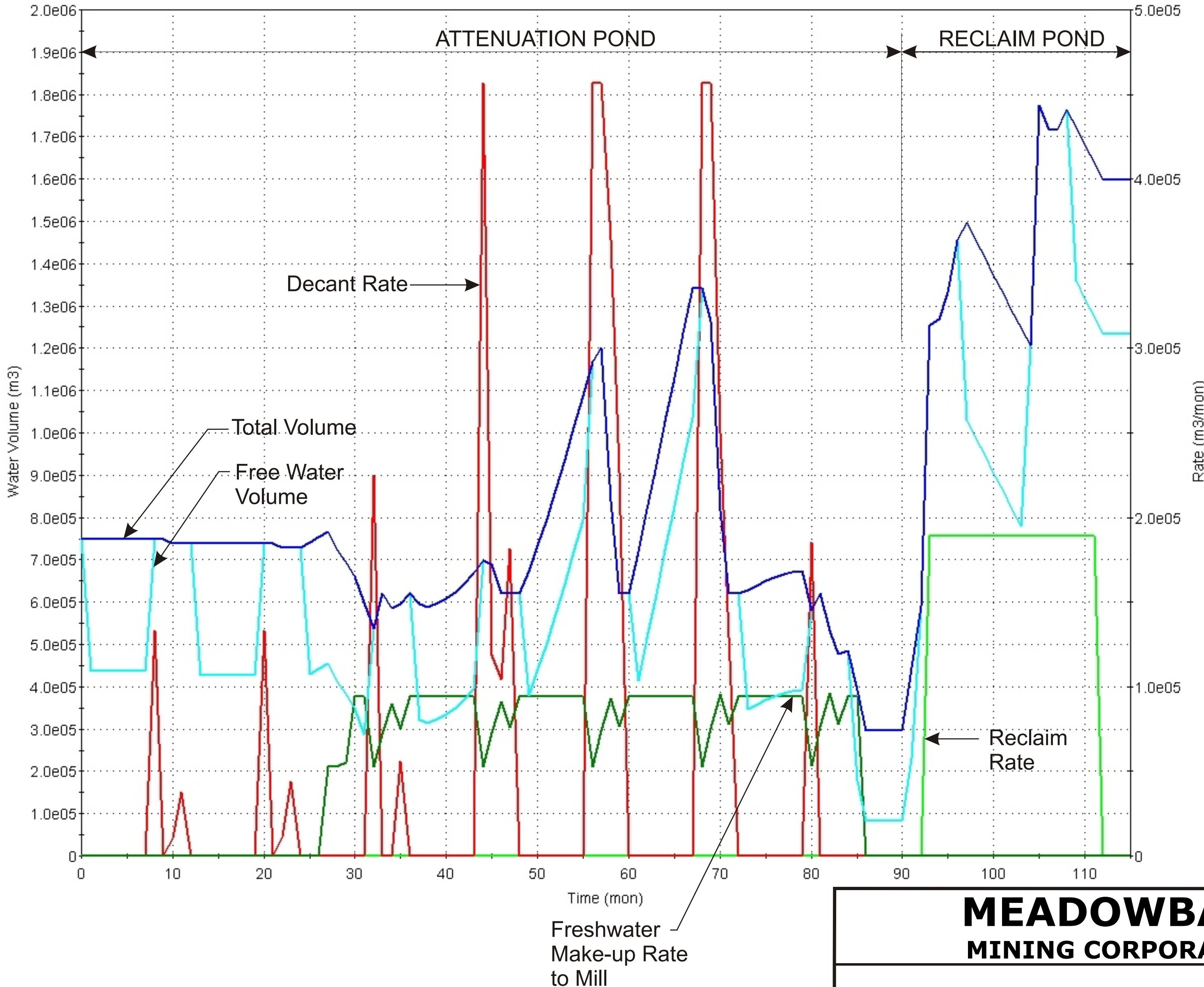

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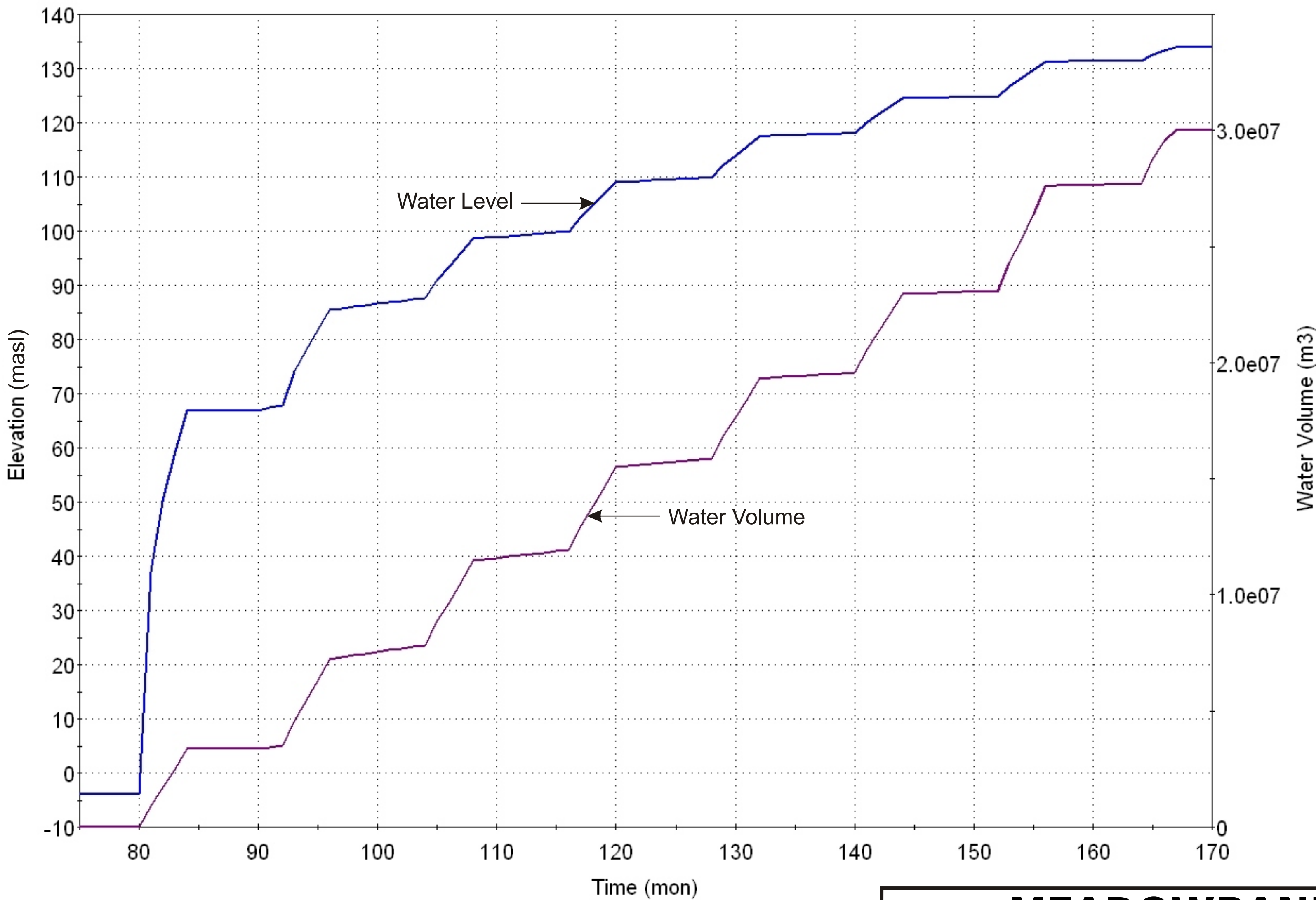
PORTAGE ATTENUATION POND (YEAR -2 TO 6) AND RECLAIM POND (YEAR 6 TO 8)

FIGURE 12.11



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PORTAGE PIT LAKE WATER LEVEL (YEAR 5 TO 12)	**FIGURE 12.12**

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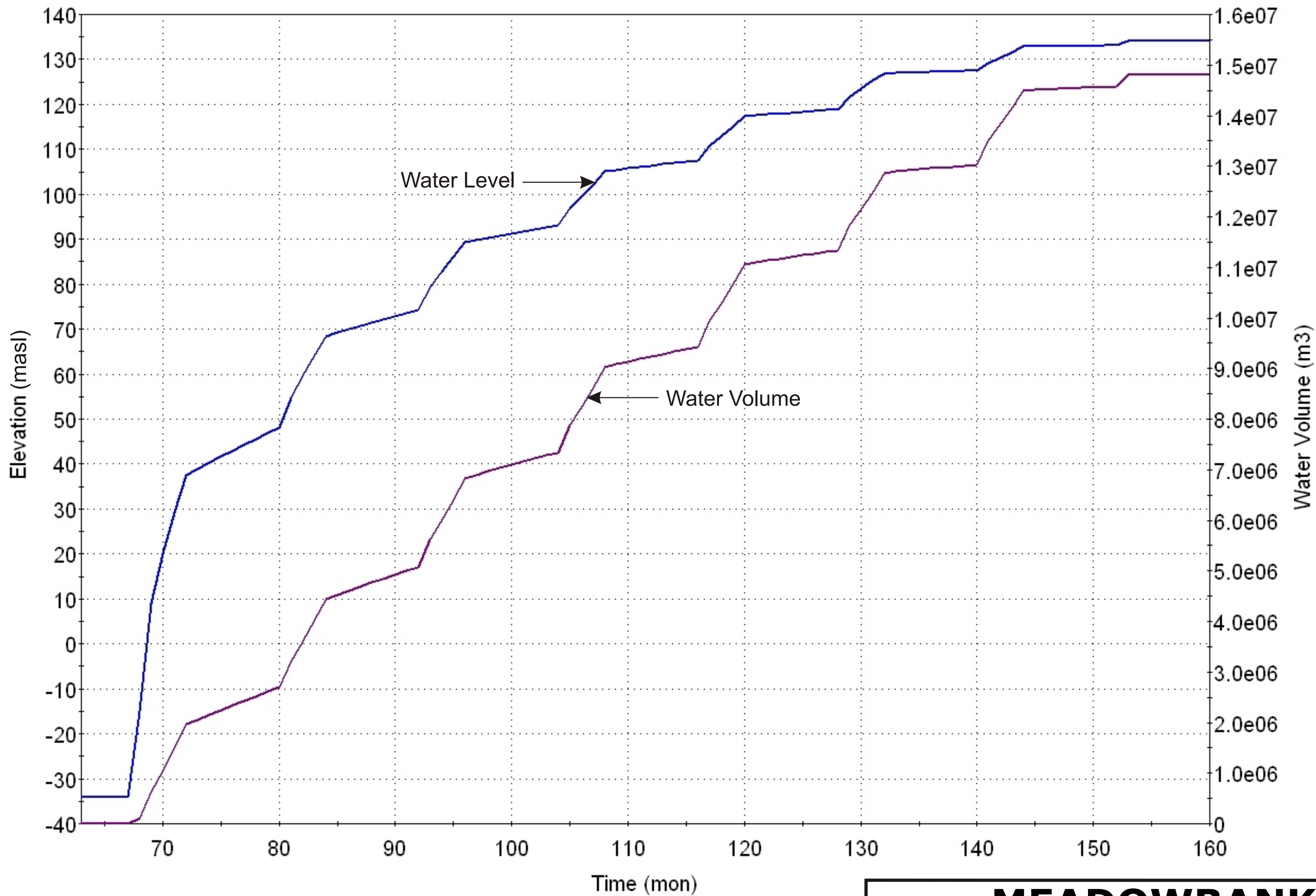

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GOOSE PIT LAKE WATER LEVEL (YEAR 4 TO 11)

FIGURE 12.13

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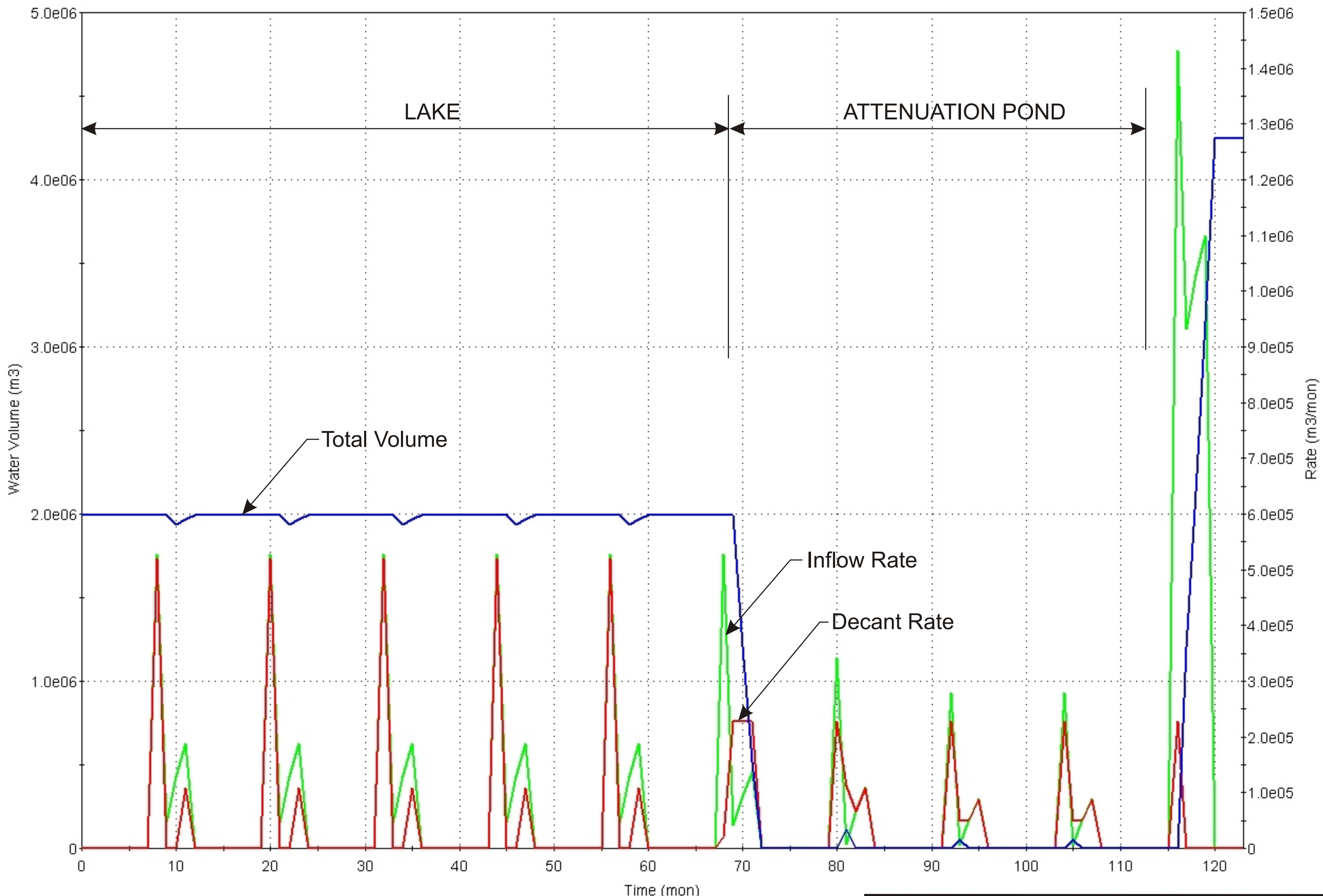

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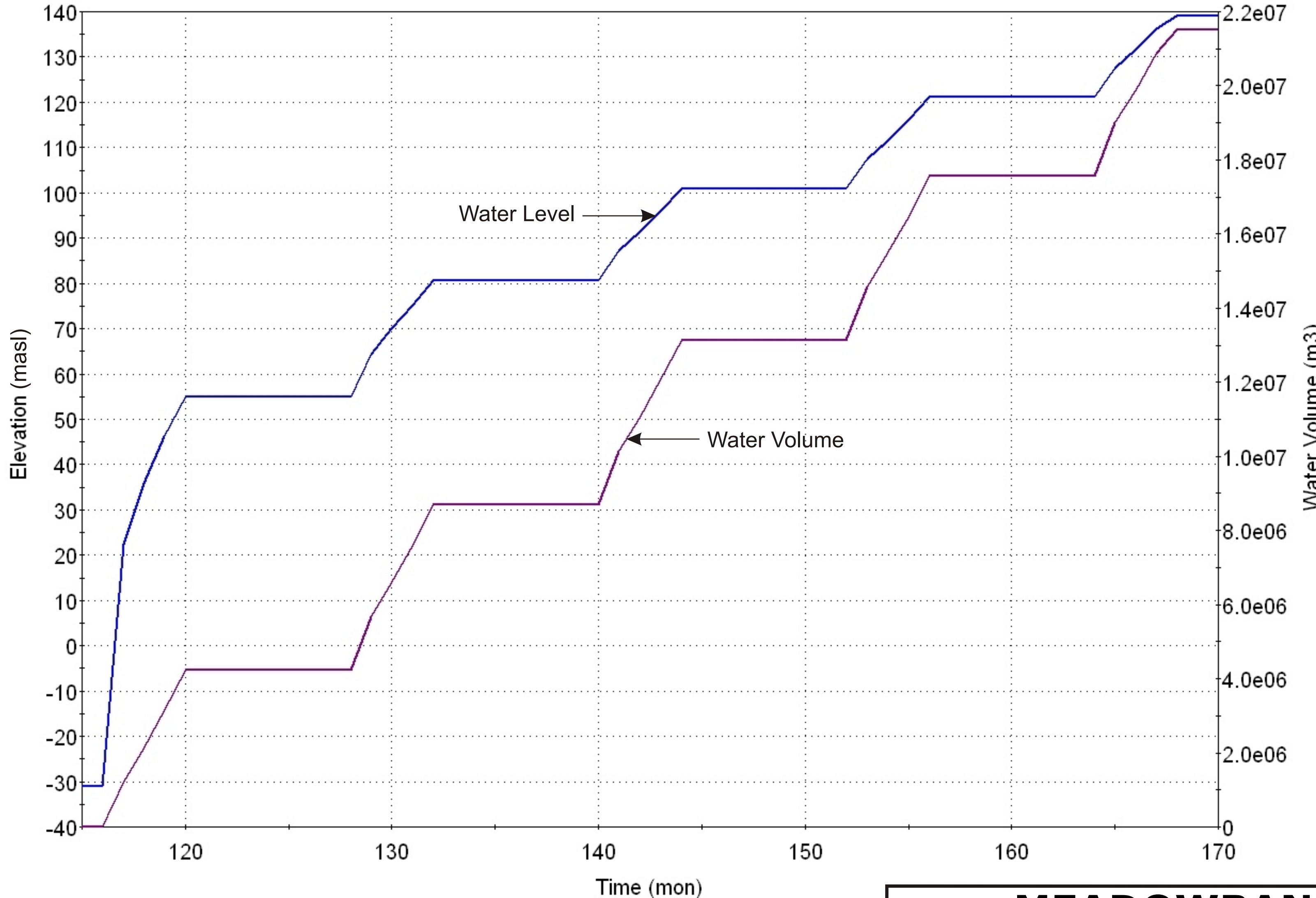
VAULT LAKE (YEAR -2 TO 4) AND ATTENUATION POND (YEAR 4 TO 8)

FIGURE 12.14



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VAULT LAKE WATER LEVEL (YEAR 8 TO 12)	**FIGURE 12.15**

Flooding of the Portage Pit via controlled discharge from Third Portage Lake will commence in Year 5 and continue at an average annual rate of approximately 3.2 Mm^3/yr (pumped June through September) through Year 12 (Figure 12.12). The average annual discharge rate was set to accommodate all of the pit inflows and tributary area runoff for eight years (assuming average annual conditions) without having to decant water to the environment (see Section 12.5). The re-watering volume within the Portage dikes, including the mined out pit, is approximately 30.0 Mm^3.

12.4 VAULT AREA

Vault Lake dewatering and mining operations within the Vault Pit commence in Year 4 (Table 12.2). During mining operations, Vault Pit and RSF runoff will be redirected to the Vault Attenuation Pond prior to treatment (if necessary) and discharge to Wally Lake. The Vault Attenuation Pond will be operated such that the annual volume of water collected within the pond on a hydrologic year basis (Oct. 1 through Sept. 30) will be decanted during the open water period between June and September (Figure 12.14). This limits the amount of water that will be stored over the winter period and maximizes the storage capacity available for the spring freshet.

Flooding of the Vault Pit and Attenuation Pond via controlled discharge from Wally Lake will commence in Year 8 and continue at an average annual rate of approximately 3.7 Mm^3/yr (pumped June through September) through Year 12 (Figure 12.15). The average annual pumping rate was set to accommodate all of the pit inflows and tributary area runoff for five years (assuming average annual conditions) without having to decant water to the environment (see Section 12.5). The re-watering volume within the Vault Dike, including the mined-out pit, is approximately 21.5 Mm^3.

Table 12.2: Water Balance Model Summary – Vault Mining Area[a]

	Year 1		Year 3		Year 5		Year 7		Year 8	
	Inflow m^3/yr	**Outflow m^3/yr**	**Inflow m^3/yr**	**Outflow m^3/yr**	**Inflow m^3/yr**	**Outflow m^3/yr**	**Inflow m^3/yr**	**Outflow m^3/yr**	**Inflow m^3/yr**	**Outflow m^3/yr**
Vault Water Attenuation Pond (Reflooding begins Mine Year 8)										
Vault Pit Runoff & Seepage					46,100		55,600		53,900	
Rock Storage Runoff					32,400		75,100		254,200	
Other Areas Runoff					445,300		295,200		494,800	
Direct Runoff					3,700		2,900		9,800	
Direct Evaporation						8,900		6,800		19,600
Dust Control						4,000		4,000		
Decant to Wally Lake						514,600		418,000		228,300
Pumped to Wally Lake									3,678,000	
Sub-Total					**527,500**	**527,500**	**428,800**	**428,800**	**4,490,700**	**247,900**
Change in Storage					**0**		**0**		**4,242,800**	

Notes: a. Based on hydraulic year - October 1 of Mine Year X-1 to September 30 of Mine Year X **b.** Vault Lake dewatered in Mine Year 4.

12.5 TIME PERIOD FOR PIT FLOODING

Table 12.3 summarizes the estimated time period required for flooding of the Vault, Portage and Goose Island deposit areas during closure. The maximum allowable drawdown of the source lakes (Wally and Third) has been assumed to correspond to the water level necessary to maintain a minimum flow equal to the average annual (1:2-year return period) 60-day low flow at the outlet of the lakes over the four summer months (June through September). The low flow rates were computed based on regression curves developed by AMEC (2003).

Table 12.3: Estimate of Pit Re-Watering

Deposit Area	60-Day Low Flow Criteria			
	Required Flood Volume[a] (Mm^3)	Available Annual Flood Volume (Mm^3)	Time to Flood – Full Efficiency (Years)	Time to Flood – 50% Efficiency (Years)
Portage/Goose	44.8	5.3	***8.5***	17.0
Vault	21.5	4.2	***5.2***	10.3

[a]assuming no waste rock will be placed within the dike perimeter

12.5.1 Portage and Goose Island Open Pits

During the closure period, the Goose Island and Portage pits will be filled over a period of about eight to nine years (see Figure 12.12 and 12.13). The pit lake water levels will eventually equilibrate with the adjacent lake elevations.

The walls of the open pits will have been exposed for a number of years during mine operation and some oxidation will have occurred. As the pits flood, the water will contact the oxidized rocks, affecting the water quality by increased concentrations of dissolved metals and lower pH. The water quality within the flooded pits will need to be managed, monitored, and treated (if necessary) until the water is of acceptable quality to be allowed to freely mix with the water in Third Portage Lake.

The volume of the completed Portage and Goose Island open pits between the dikes will be on the order of 45 Mm^3. Instantaneous breaching of the dike would cause a significant drawdown of Third Portage Lake, which would have a significant impact on fish habitat. Therefore, flooding will carried out through a combination of direct seepage, precipitation, and runoff to the Portage Pit Lake area, and re-direction of spring freshet flows from Third Portage Lake. The rate of discharge from Third Portage Lake will be controlled through engineered structures such as siphons, spillway structures, side decant structures, or other designs. Where possible, the water for flooding will be removed from deep areas of Third Portage Lake to avoid the removal of oxygenated surface waters. Water intakes will be properly screened.

The final lake level within the Portage Pit Lake would be equal to that of Third Portage Lake (approximately El. 134.1 masl). Additional information on pit flooding can be found in Sections 8.4 and 9.4 above.

12.5.2 Vault Open Pit

The Vault Pit will be filled at closure and will become part of Vault Lake (see Figure 12.15). In the same manner as for the Portage Pit, the Vault Dike will only be completely removed when it is acceptable for water in the Vault Pit Lake to mix with Wally Lake. The rate of flooding will be determined by the rate of surface runoff and direct precipitation that can be directed into the pit, and by the amount of water that can be redirected from Wally Lake during the spring freshet. The rate of discharge from Wally Lake will be controlled through engineered structures such as siphons, spillway structures, side decant structures, or other designs. Where possible, the water for flooding will be removed from deep areas of Wally Lake to avoid the removal of oxygenated surface waters. Water intakes will be properly screened.

It is expected that flooding of the Vault Pit will take five to six years. The final lake level within the Vault Pit Lake would be equal to that of Wally Lake (approximately El. 139 masl). Additional information on pit flooding can be found in Sections 8.4 and 9.4 above.

SECTION 13 • HYDROGEOLOGY

This section summarizes the estimated water and brackish water upwelling inflows to the pits during mine operations, and the predicted regional groundwater flow directions post mining operations. Additional information can be found Section 2.4.3 above and in the following documentation:

- *Updated Predictions of Brackish Water Upwelling in Open Pits with Mining Rate of 8500 TPD, Meadowbank Project, Nunavut* (Golder, 2007b);
- *Pit Slope Design Criteria for the Portage and Goose Island Deposits* (Golder, 2007a);
- *Items #24A and 37, Predictions of Regional Groundwater Flow Directions after Mine Closure, Meadowbank Project* (Golder, 2005c); and
- *Meadowbank Gold Project Thermal Modelling, Regional Groundwater Regime* (Golder, 2003b).

13.1 PREDICTIONS OF INFLOW QUANTITIES AND BRACKISH WATER UPWELLING

The Meadowbank Gold Project is underlain by deep ancient groundwater (connate water) that is brackish to saline with high TDS and chloride (Cl) concentrations. Excavation of the open pits will induce the upward flow of this deep-seated groundwater and alter the chemistry of the water pumped from the pits. This will only occur where the pits will be hydraulically connected to the deep groundwater by the presence of an open talik. An open talik is not predicted to exist beneath Vault Lake based on the current level of knowledge of the site; consequently, brackish water upwelling within the proposed Vault Pit has not been considered.

A TDS-depth profile for the Meadowbank Gold Project was developed based on deep groundwater samples collected throughout the Canadian Shield including the Meadowbank site itself, Yellowknife, Diavik, and the Lupin mine. This profile was incorporated into the numerical model that was used to predict groundwater inflow to the Portage (Third and North) and the Goose Island pits.

In the model, the hydraulic conductivity of the bedrock to a depth of 160 m was based on tests conducted at the Meadowbank site which indicated a general decrease in hydraulic conductivity with depth (Golder, 2006; Appendix E). At depths greater than 160 m, and to the full 1,000 m depth of the model, the model assumed that the hydraulic conductivity was the same as that measured at 160 m depth (3×10^{-8} m/s). In reality, the hydraulic conductivity would be expected to reduce further with depth as has been observed in similar geologic environments in the Canadian Shield (Stevenson et al., 1996 a & b, Ophori et al. 1996, Ophori and Chan, 1994).

The upper 500 m of the fractured rock zone associated with the Second Portage Fault was assumed to have a hydraulic conductivity of 1×10^{-5} m/s in the model, which was the average hydraulic conductivity measured in six tests conducted in this zone at less than 80 m depth. Over the interval of 500 m to the bottom of the model, the hydraulic conductivity was assumed to be reduced by an order of magnitude to 1×10^{-6} m/s.

In hydraulic testing in fractured rock zones associated with the Bay Zone Fault and fault splay the hydraulic conductivity was found to be similar to the hydraulic conductivity of less fractured bedrock.

However, the Bay Zone Fault is assumed to have a hydraulic conductivity equal to the Second Portage Fault in the model. Assuming a higher hydraulic conductivity in the Bay Zone Fault is conservative for predictions of inflows and brackish water upwelling as more upwelling would occur if the fault is assumed to be more permeable.

Total inflow to the mine from both the Portage and the Goose Island pits is predicted to range from approximately 2,400 to 3,200 m^3/day when the Portage and Goose Island pits are being mined concurrently. These values are higher than previous predictions because the fractured rock zones are explicitly simulated in the current model, whereas previously they were not.

Based on a 5-year mine life, the model predicts that groundwater inflows to the Portage Pit only will range from approximately 1,300 to 1,600 m^3/day. In the Goose Island Pit, groundwater inflows over the 4-year pit life range from 800 to 1,600 m^3/day. Groundwater inflow to drainholes installed in the pit slopes requiring depressurization in the Goose Island Pit is predicted to range from 100 to 900 m^3/day with the maximum predicted inflow in Year 4 when the Goose Island Pit is at its maximum depth. In addition, the model predicts that the average TDS of the groundwater inflow to both pits will range from 1,000 to 2,300 mg/L.

The model predicted inflows and average TDS concentrations are for groundwater inflow only; these estimates do not consider direct precipitation and leakage through the Dewatering Dikes above the cut-off wall in the native till. These components are calculated separately (Golder, 2007e), and the TDS concentration and quantity of the water prior to discharge to the environment are predicted by the site wide water balance model.

Results of sensitivity simulations carried out on the model results indicate that changes in the TDS concentration at all depths in the profile are directly related to the changes in the predicted TDS of mine inflows. For example, if the TDS at all depths in the profile were increased by a factor of three then the TDS concentration of mine inflows would also increase by three times. Actual TDS concentration may be up to 3 times greater than present data indicates; therefore, the TDS of mine inflows could be up to three times higher than the base case.

The sensitivity analyses also indicate that groundwater inflow to the open pits would range from 2,700 to 4,600 m^3/day (up to 40% greater than the base case) if the fault hydraulic conductivities were three times higher. TDS would range from 1,200 to 3,500 mg/L in this scenario (up to 50% higher than the base case).

For additional information regarding predictions of inflow quantities and brackish water upwelling to the pits see the support document *Updated Predictions of Brackish Water Upwelling in Open Pits with Mining Rate of 8500 TPD, Meadowbank Project, Nunavut* (Golder, 2007b).

13.2 POST-OPERATIONS GROUNDWATER FLOW

Upon closure of the mine, the portion of Second Portage Lake west of the Central Dike (Second Portage Arm) will be occupied by tailings. The tailings are expected to freeze over time, and will therefore not be hydraulically connected to the regional flow system. During closure, the dewatered areas within the Dewatering Dikes will be re-flooded. The water quality will be monitored (Cumberland, 2005; MMC, 2007g)and once deemed acceptable for mixing with neighbouring lakes, portions of the Bay Zone and Goose Island dikes will be breached. Modelling results of these conditions suggest that the flooded area between the Central and East dikes will act as a discharge zone in the north and as a recharge zone in the south where water is predicted to flow to the area of Second Portage Lake to the east of the East Dike (Figure 13.1).

The area east of the East Dike will act as a discharge zone in its northern portion, with groundwater flow originating from two lakes to the north and northeast of the project, from Third Portage Lake and from the flooded area between the East and Central dikes. The southern portion of the area east of the East dike will act as a recharge zone with groundwater flow to Tehek Lake, as in the baseline conditions. This pattern of groundwater flow is similar to baseline conditions, but differs in that there is a gradient between the flooded area between the East and Central dikes and the area of Second Portage Lake east of the East Dike.

Overall, the flow to Second Portage Lake is reduced due to the reduction of the total lake area to accommodate the frozen tailings and due to flooding of the area between the Dewatering Dikes to the Third Portage Lake level (approximately 134.1 masl). The flow to Tehek Lake from Second Portage Lake post-operations is predicted to be similar to the baseline values. The model estimates of groundwater fluxes to and from the flooded area between the East and Central dikes and the area of Second Portage Lake east of the East dike are summarized in Tables 13.1 and 13.2.

Table 13.1: Post-Closure Estimated Groundwater Flux – Flooded Area between the Central Dike and East Dike

	Flux (m^3/day)
Flooded Area between the Central Dike and East Dike to Second Portage Lake east of the East Dike	8.0
A lake located north of Second Portage Lake (141 masl elev.) to flooded area between the Central Dike and East Dike	1.0

Table 13.2: Post-Closure Estimated Groundwater Flux – Second Portage Lake East of the East Dike

	Flux (m^3/day)
Second Portage Lake to Tehek Lake	1.1
A lake located north of Second Portage Lake (141 masl elev.) to Second Portage Lake east of the East Dike	1.7
A lake located northeast of Second Portage Lake (144 masl elev.) to Second Portage East of the East Dike	0.1
Third Portage Lake to Second Portage Lake east of the East Dike	0.4
Flooded Area between the Central Dike and East Dike to Second Portage Lake east of the East Dike	8.0

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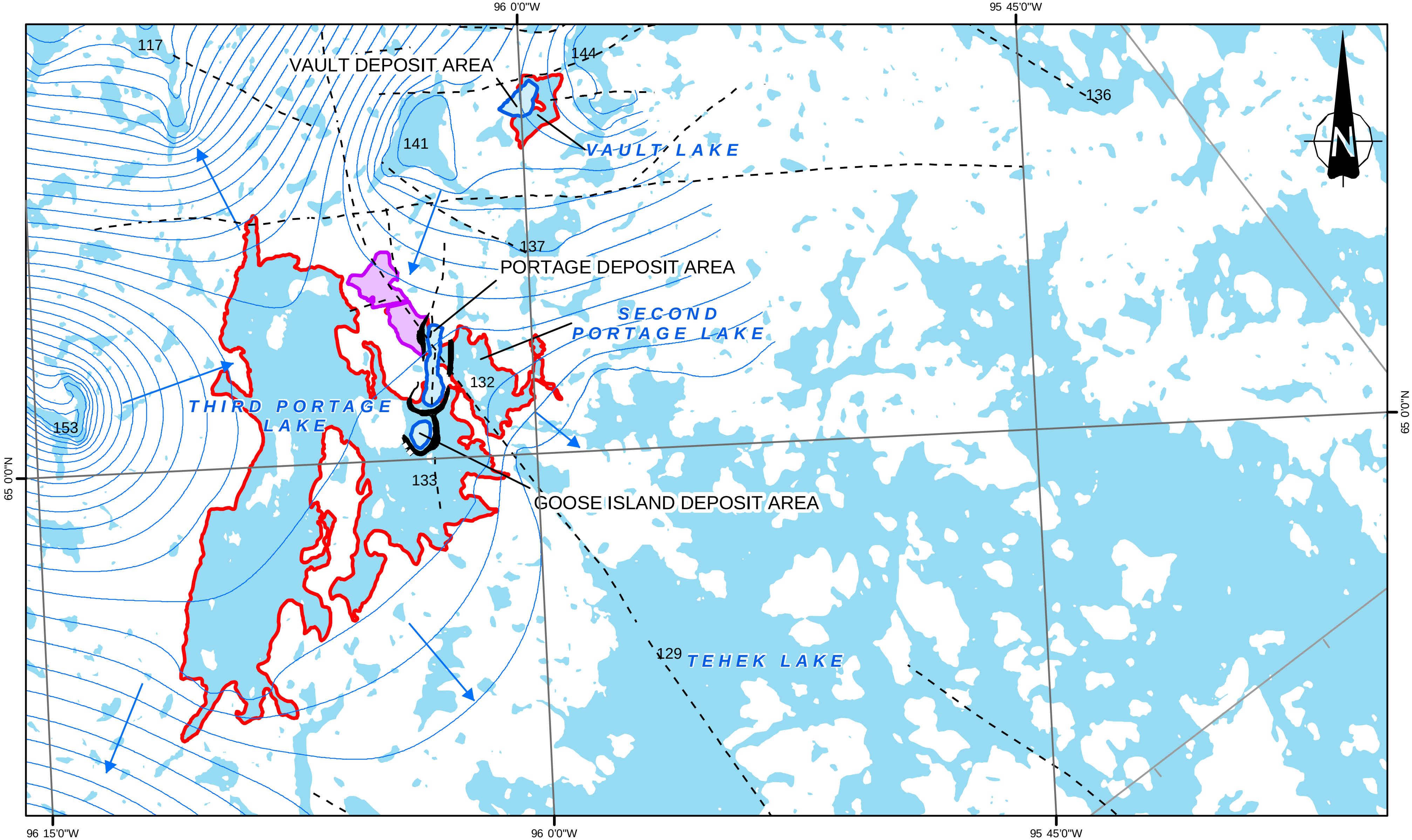

LEGEND

- PROPOSED OPEN PIT CREST
- GROUNDWATER CONTOUR (1 M INTERVAL)
- GROUNDWATER FLOW LINE
- APPROXIMATE FAULT LOCATION
- 133 WATERBODY (ELEVATION IN MASL)

0 1250 2500 3750 5000 6250

Scale in Metres

REFERENCES

LAKE ELEVATIONS TAKEN FROM: DISTRICT OF KEEWATIN, NORTHWEST TERRITORIES, DEPARTMENT OF ENERGY, MINES AND RESOURCES, MAPSHEETS 66A/16, 56E/04, 66H/01, 56D/13

DATUM: NAD83 PROJECTION: UTM ZONE 14

PROJECT

MEADOWBANK MINING CORPORATION

TITLE

MEADOWBANK GOLD PROJECT

REGIONAL GROUNDWATER FLOW - AFTER CLOSURE

FIGURE 13.1

SECTION 14 • SEWAGE AND WASTE DISPOSAL

A pre-fabricated, modular-type accommodation complex for 344 persons is planned to house personnel during mine operations. The accommodation complex will be supported with a sewage treatment plant, solid waste disposal, and potable water treatment plant.

The sewage treatment facilities will be housed in a modular structure adjacent to the camp. Sewage will be collected initially from the accommodation complex during construction, and during operations, from the office area and change room facilities. Grease traps will be provided to handle the flow from the kitchen and shop sewers. The Sewage Treatment Plant will be sized for a minimum workforce of 344 people. Two potential treatment systems are being considered, including a sequencing batch reactor (SBR), and a rotating biological contactor (RBC) (Golder, 2007j).

During the construction phase of the Project before construction of the TSF, treated sewage water will be discharged into Tear Drop Lake, a small shallow (less than 2m deep) and fishless, water body. This water body is located within the mine footprint. Treated water from Tear Drop Lake will be pumped to the TSF via the tailings distribution lines following commissioning of the TSF and the lines. During operations, the effluent will be pumped to the Tailings Distribution Box, then to the TSF. The sewage volume to the TSF is estimated to be a maximum of 2.0% of the total inflow to the TSF. Therefore, the chemical load from sewage water is of low significance relative to that of the tailings water quality and overall mine site water quality. Tailings reclaim water will not be discharged until end of mine life, at which time it will be treated, if necessary, prior to release to the Goose Island or Portage pit lakes.

Further details on the proposed sewage treatment systems are provided in the supporting document *Sewage Treatment to be used at Meadowbank Gold Project, Nunavut* (Golder, 2007j).

Solid waste from the accommodation camp, kitchen, shops, and offices will be burned in a diesel-fired waste incinerator located in a prefabricated structure downwind of the facilities. Waste will be transported by pickup truck and loaded into the incinerator. The materials to be incinerated will be limited to sewage treatment sludge, putrescible waste such as paper, wood and food waste, and used petroleum products such as grease, heavy lubricants and engine oil. The quantity of waste to be incinerated is estimated to be 762 kilograms per day during construction, and 874 kg per day during operations. This includes an allowance of 1.8 kg of sewage sludge per day per person, and a camp size of 300 during construction and 344 during operations.

Non-salvageable, non-hazardous solid waste, including ash from the incinerator, will be buried in one of two solid waste landfills (Golder, 2007k). Landfill #1 will be located adjacent to the Portage RSF and will operate during the first 8 to 9 years of mine construction and operations. Landfill #1 has a planned capacity of 5,000 m^3. Landfill #2, will fill a 4 m deep depression in the top of the Portage RSF and will operate over the last 1 to 2 years of mine operations and into closure. Landfill #2 will have a design capacity of 3,600 m^3 and is planned to accommodate non-hazardous, non-salvageable solid waste derived from mine closure. Both landfills will be capped with 0.3 m to 1m of rockfill and covered with 2 m of acid buffering ultramafic rock prior to grading of slopes. Hazardous waste will be stored on site in secure facilities until they can be transported to other provincial or territorial jurisdictions for recycling or disposal (MMC, 2007b).

Additional information on the landfills and the handling, storage and disposal of hazardous materials are provided in the following supporting documents:

- *Landfill Design and Management Plan, Meadowbank Gold Project* (Golder, 2007k);
- *Meadowbank Gold Project Hazardous Materials Management Plan* (MMC, 2007b);
- *Meadowbank Gold Project Spill Contingency Plan* (MMC, 2007c); and
- *Meadowbank Gold Project Emergency Response Plan* (MMC, 2007d).

SECTION 15 • MONITORING AND CLOSURE

Mine closure and reclamation will utilize currently accepted management practices and appropriate mine closure techniques that will comply with accepted protocols and standards. Closure will be based on project design and operation to minimize the area of surface disturbance, stabilize disturbed land surfaces and permafrost against erosion, and return the land to post-mining uses for traditional pursuits (MMC, 2007e).

Water management during closure and reclamation will involve maintaining surface water diversions to prevent clean runoff water from coming into contact with areas affected by the mine or mining activities. The water management facilities, including the Dewatering Dikes, attenuation ponds, water collection systems (sumps and ditches), and treatment plants (if necessary), will be required to remain in place until mine closure activities are completed and monitoring results demonstrate that water quality conditions are acceptable for discharge of all contact water to the environment without further treatment.

Figure 9.9 shows the post-closure concept for the Meadowbank mine. The waste storage facilities will be progressively closed during mine operations. A dry cover of NPAG UM rock will be placed over PAG waste rock piles and the TSF to confine the permafrost active layer within relatively inert materials. The surfaces of the Portage and Vault RSFs will be contoured to direct drainage to the Reclaim and Vault Attenuation pond areas, respectively (see Figures 9.10 and 9.11).

The Reclaim Pond will remain in place until mining and milling has been completed. At this time, reclaim water will be drained from the TSF and treated, if necessary, prior to discharge to the Goose Island or Portage pit lakes. If necessary, treatment of reclaim water will be completed in-situ or through a water treatment plant converted from the Process Plant. Once drained, the Reclaim Pond area will be filled with acid buffering ultramafic rock, and contoured to promote drainage. Additional surface water collecting within the Reclaim Pond area will be monitored and treated, if necessary, prior to release to the Goose Island or Portage pit lakes. Once monitoring indicates that the runoff water quality is acceptable for mixing with receiving lakes, surface water runoff will be allowed to flow to Third Portage Lake untreated.

An estimated 1.6 Mm^3 of water will be pumped from the Reclaim Pond at the end of mine operations. Water quality predictions indicate that the water may need to be treated for pH adjustment and removal/reduction of arsenic, copper, nickel, ammonia and possibly sulphate. Two contingency treatment options are currently being evaluated (Golder, 2007f) including:

- an in-situ treatment option (Option 1) which applies chemicals such as lime directly to the water in the reclaim pond; and,
- an active treatment option (Option 2) which entails construction of a treatment plant within the mill using equipment for the ore processing stream.

It is expected that treatment of reclaim water, if required, would produce approximately 3,000 m^3 of 30% solids density sludge. The sludge would be tested but is expected to be chemically stable. Sludge disposal options include disposal back into the TSF and eventual cover with acid-buffering

UM rock. The sludge material would freeze along with the underlying tailings. A second option would be to pump the sludge to the base of the Goose Island or Portage pit lakes, similar to current practice for HDS sludge disposal at the Equity Silver mine near Houston, British Columbia. Additional information regarding contingency treatment options for Reclaim Pond water can be found in the support document *Proposed Water Treatment Methods Meadowbank Gold Project* (Golder, 2007f).

Flooding of the Goose Island and Portage pits will commence before the completion of mining activities at Vault. Goose Island Pit will be flooded during Years 4 to 11 and Portage Pit will be flooded during Years 5 to 12. During this period of time, water collecting within the pit lakes will be monitored, and *in-situ* treatment will be applied if required. Once monitoring results demonstrate that the water quality of all contact water is acceptable for discharge to the environment without further treatment, the pit lakes will be hydraulically re-connected with Third Portage Lake.

The Vault Attenuation Pond will be allowed to fill upon cessation of mining activities. Water quality will be monitored, and in-situ treatment will be undertaken if necessary. Once monitoring results demonstrate that the water quality of all contact water is acceptable for discharge to the environment without further treatment, the Vault Dike will be breached, and the reflooded Vault Lake will be hydraulically re-connected with Wally Lake.

All infrastructure that may be maintained for mine operations, closure and reclamation including the airstrip, roads, storage pads, quarries, granular borrow areas (if present), ditches and sumps will be re-contoured and/or surface treated according to site specific conditions to minimize wind blown dust and erosion from surface runoff, and enhance the development site area for revegetation and wildlife habitat. Rock berms will be placed around the perimeters of all pit areas remaining above water following flooding to restrict access and minimize hazards to people and wildlife.

The final Reclamation and Closure Plan for the Project will be developed in conjunction with the mine plan so that considerations for site closure can be incorporated into the mine design. Monitoring will be carried out during all stages of the mine life to demonstrate the safe performance of the mine facilities. If any non-compliant conditions are identified, then maintenance and planning for corrective measures will be completed in a timely manner to ensure successful completion of the Reclamation and Closure Plan. Further details on closure and reclamation planning are provided in the supporting document *Meadowbank Gold Project Preliminary Closure and Reclamation Plan* (MMC, 2007e).

SECTION 16 • REFERENCES

AMEC, 2003. Baseline Hydrology Study, AMEC Earth and Environmental, December 2003 with January 2004 errata sheets.

AMEC, 2005a. Meadowbank Gold Project Hydrologic Monitoring 2004 Draft Data Report. February 2005.

AMEC, 2005b. Meadowbank Gold Project Feasibility Study Report. June 2005.

Anderson, D.M. and N. R. Morgenstern, 1973. Physics, Chemistry and Mechanics of Frozen Ground: A Review, Proceedings of the Second International Conference on Permafrost, Yakutsk, U.S.S.R., National Academy of Sciences, Washington, D.C., p. 257-288. 1973.

Azimuth Consulting Group Inc., 2003. Baseline Aquatic Environmental Assessment Report, Meadowbank Study Area Lakes, Nunavut. Report prepared for Cumberland Resources Ltd. March 2003.

BGC Engineering Incorporated, 2004. Meadowbank Gold Project Preliminary Geothermal and Slope Stability Modelling of Rock Storage Facilities. March 31, 2004.

BGC Engineering Incorporated, 2003. Implications of Global Warming and the Precautionary Principle in Northern Mine Design and Closure. 2003.

Burt, T.P. and P. J. Williams, 1976. Hydraulic Conductivity in Frozen Soils, Earth Surface Processes, Volume 1, John Wiley, p. 349-360. 1976.

CCME (Canadian Council of Ministers of the Environment) 2002. Canadian Environment Quality Guidelines, 2002 update.

CDA (Canadian Dam Association), 1999. Dam Safety Guidelines. January 1999.

Cumberland Resources Ltd., 2007. Meadowbank Gold Project Integrated Report on Evaluation of Tailings Management Alternatives. January 2007.

Cumberland Resources Ltd. (Cumberland), 2006. Meadowbank Gold Project No-Net-Loss Plan (NNLP). November, 2006.

Cumberland Resources Ltd. (Cumberland), 2005. Meadowbank Gold Project, Aquatic Effects Management Program. October 2005.

Dawson and Morin, 1996. Mine Effluent Neutral Drainage (MEND), 1.61.2: Acid Mine Drainage in Permafrost Regions: Issues, Control Strategies and Research Requirements, 1996.

Domenico and Schwartz, 1990. Physical and Chemical Hydrogeology. 1990.

Eskelson, Ray. Diavik. Personal communication regarding the dewatering of mining areas in the north.

Frape, S.K. and Fritz, P. 1997. "Geochemical Trends for Groundwaters from the Canadian Shield". *Saline Water and Gases in Crystalline Rocks*. Editors: Fritz, P. and Frape, S.K. Geological Association of Canada Special Paper 33, p. 19-38. 1997.

Golder Associates Ltd. (Golder), 2007a. Pit Slope Design Criteria for the Portage and Goose Island Deposits, Meadowbank Project, Nunavut. April 5, 2007.

Golder Associates Ltd. (Golder), 2007b. Updated Predictions of Brackish Water Upwelling in Open Pits with Mining Rate of 8500 TPD, Meadowbank Project, Nunavut. July, 2007.

Golder Associates Ltd. (Golder), 2007c. Detailed Design of Central Dike, Meadowbank Gold Project. March 16, 2007.

Golder Associates Ltd. (Golder), 2007d. Mitigative Measures for Potential Seepage from Tailings Facility. August, 2007.

Golder Associates Ltd. (Golder), 2007e. Detailed Design of Dewatering Dikes, Meadowbank Gold Project. March 13, 2007.

Golder Associates Ltd. (Golder), 2007f. Proposed Water Treatment Methods, Meadowbank Gold Project. August, 2007.

Golder Associates Ltd. (Golder), 2007g. Sewage Treatment System to be used at Meadowbank Gold Project, Nunavut. August, 2007.

Golder Associates Ltd. (Golder), 2007h. Conceptual Design of the Effluent Outfall Diffuser for Wally Lake. July 2007.

Golder Associates Ltd. (Golder), 2007i. Assessment of Dilution Potential for the Third Portage Lake Diffuser. August, 2007.

Golder Associates Ltd. (Golder), 2007j. Proposed Discharge Water Quality for the Portage and Vault Attenuation Ponds. August, 2007.

Golder Associates Ltd. (Golder), 2007k. Landfill Design and Management Plan, Meadowbank Gold Project. August, 2007.

Golder Associates Ltd. (Golder), 2007l. Water Quality Predictions, Meadowbank Gold Project, Nunavut. August, 2007.

Golder Associates Ltd. (Golder), 2006. Report on Winter 2006 Second Portage Central Dike Geotechnical Drilling, Hydrogeological, and Televiewer Investigation, Meadowbank Gold Project, Nunavut. July, 2006.

Golder Associates Ltd. (Golder), 2005a. Static Test Results for Overburden, Mine Site Infrastructure Rock, Pit Rock and Tailings, Meadowbank Gold Project, Nunavut, September 2005.

Golder Associates Ltd. (Golder), 2005b. Kinetic Testing Results for Pit Rock and Tailings, Meadowbank Gold Project, Nunavut. October 2005.

Golder Associates Ltd. (Golder), 2005c. Items #24A and 37, Predictions of Regional Groundwater Flow Directions after Mine Closure, Meadowbank Project. October 5, 2005.

Golder Associates Ltd. (Golder), 2004. Vault Pit Slope Design Criteria, Meadowbank Gold Project, Nunavut. January 9, 2004.

Golder Associates Ltd. (Golder), 2003a. Report on Permafrost Thermal Regime Baseline Studies, Meadowbank Project. December 18, 2003.

Golder Associates Ltd. (Golder), 2003b. Meadowbank Gold Project Thermal Modelling, Regional Groundwater Regime. September 2003.

IPCC (Intergovernmental Panel on Climate Change), 2007. Climate Change 2007: The Physical Science Basis.

Meadowbank Mining Corporation (MMC), 2007a. Meadowbank Gold Project Operational ARD/ML Sampling and Testing Plan. August, 2007.

Meadowbank Mining Corporation (MMC), 2007b. Meadowbank Gold Project Hazardous Materials Management Plan. August, 2007.

Meadowbank Mining Corporation (MMC), 2007c. Meadowbank Gold Project Spill Contingency Plan. August, 2007.

Meadowbank Mining Corporation (MMC), 2007d. Meadowbank Gold Project Emergency Response Plan. August, 2007.

Meadowbank Mining Corporation (MMC), 2007e. Meadowbank Gold Project Preliminary Closure and Reclamation Plan. August, 2007.

Meadowbank Mining Corporation (MMC), 2007f. Meadowbank Gold Project Fault Testing and Monitoring Plan. August, 2007.

Meadowbank Mining Corporation (MMC), 2007g. Meadowbank Gold Project Water Quality and Flow Monitoring Plan. August, 2007.

MMER (Metal Mining Effluent Regulations), 2002. SOR/2002-222. June 6, 2002.

NRC (Natural Resources Canada), 2004. National Annual Temperature Scenario: 2050. The Atlas of Canada. Natural Resources Canada. On-line map. Accessed July 2007. Available: http://atlas.gc.ca/site/english/maps/climatechange/scenarios/nationalannualtemp2050/

Ophori, D.U., Brown, A., Chan, T., Davison, C.C., Gascoyne, M., Schier, N.W., Stanchell, F.W., and Stevenson, D.R., 1996. Revised Model of Regional Groundwater Flow in the Whiteshell Research Area. AECL Whiteshell Laboratories, Pinawa, Manitoba. 1996.

Ophori, D.U. and Chan, T. 1994. Regional Groundwater Flow in the Atikokan Research Area; Simulation of 18O and 3H Distributions. AECL-11083. Manitoba. 1994

Stevenson, D.R., Brown, A., Davison, C.C., Gascoyne, M., McGregor, R.G., Ophori, D.U., Scheier, N.W., Stanchell, F.W., Thorne, G.A., and Tomsons, D.K. 1996a. A Revised Conceptual Hydrogeologic Model of a Crystalline Rock Environment, Whiteshell Research Area, Southeastern Manitoba, Canada. AECL-11331, Whiteshell Laboratories, Pinawa, Manitoba. 1996.

Stevenson, D.R., Kozak, E.T., Gascoyne, M., and Broadfoot, R.A. 1996b. Hydrogeologic Characteristics of Domains of Sparsely Fractured Rock in the Granitic Lac du Bonnet Batholith, Southeastern Manitoba, Canada. AECL-11558, Whiteshell Laboratories, Pinawa, Manitoba. 1996.

Woo, M.-K., A. G. Lewkowicz, and W. R. Rouse, 1992. Response of the Canadian Permafrost Environment to Climatic Change. 1992.

APPENDIX A

Vault Pit Slope Design Criteria

TECHNICAL MEMORANDUM

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TO: Mr. Brad Thiele
DATE: January 9, 2004
FROM: Cameron Clayton
JOB NO: 03-1413-427
Reviewed By: Al Chance
Cc: Kerry Curtis
John Hull
Terry Eldridge
EMAIL: cclayton@golder.com
RE: **VAULT PIT SLOPE DESIGN CRITERIA**

1.0 INTRODUCTION

The following memorandum summarises the recommended pit slope design criteria for the Vault Deposit, Meadowbank Gold Project. A Technical Memorandum titled "Pit Slope Design Criteria – Vault Deposit" was prepared previously by Golder, and issued in November of 2002. That report presented slope designs based on geotechnical studies carried out for the project during 2002. The studies included the assessment of oriented structural data collected from three oriented geotechnical boreholes drilled within the proposed open pit limits. At that time, it was envisaged that the Vault open pit would be on the order of 80 m in depth, with a length dimension of about 500 m and a width dimension of about 225 m. The resource estimate for the Vault Deposit increased substantially during ore resource evaluations carried out by Cumberland during the winter of 2002 and spring of 2003. These studies resulted in an expansion of the pit to a possible length dimension of approximately 950 m and a width dimension of approximately 600 m. Furthermore, the overall depth of the pit increased from 80 m to on the order of 150 m to 170 m. The revised deposit and pit geometry prompted the drilling of an additional oriented geotechnical borehole during 2003 within the limits of the expanded pit crest to re-assess the engineering structural model of the previous study in the context of the new pit geometry and design parameters. Data collected from the 2002 and 2003 geotechnical investigations have been used to develop pit slope design criteria for the most recent pit geometry.

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In addition to the oriented borehole data, Cumberland Resources carried out geotechnical data collection from selected non-oriented exploration boreholes during 2002 and 2003. The studies also included the installation of thermistors in 2002 and 2003. Furthermore, laboratory geotechnical testing of rock core samples was carried out.

The pit slope design criteria presented in this report will form the basis for the mine planning of the Vault Deposit. Once the final pit mine plan has been completed based on the designs presented in this memorandum, a pit plan should be produced showing the intersection of major structures with the final pit walls. The design criteria should then be reviewed in the context of the final pit plan.

1.1 Feasibility Design Considerations

The basic design assumptions on which the feasibility pit slope design criteria are based are summarised as follows:

- The Vault pit will be on the order of 150 m to 170 m deep based on contour pit plans and cross sections provided by Cumberland Resources Ltd.
- The Vault Deposit dips at relatively shallow inclinations, less than 30 degrees, to the southeast, and outcrops at surface. Consequently, mining of the deposit will utilize a footwall design approach whereby the ore is excavated parallel to the footwall of the orebody dip.
- The rocks are sufficiently strong that structural features will control bench configurations.
- Faulting, shearing, stratigraphic contacts and foliation are considered to be continuous.
- Joints are considered to have a limited continuity (less than one bench height).
- A Caterpillar 5130 (or equivalent) shovel, having a bucket capacity of about 11 m^3 and a reach of about 14.5 m, will be used for loading. Caterpillar 777 haul trucks will be used to transport waste and ore.
- Mining of ore and waste will be on 6-m-high benches. A multiple-bench configuration within waste can likely be developed on most walls.
- Final bench heights will be on the order of 24 m. In areas of poorer quality rock, such as adjacent to fault zones, increased ravelling will be controlled by limiting bench face angles to shallower dips, and by increasing catch bench widths.
- Where Factors of Safety for wedge failures are reported, a base friction angle of $\phi=36^{\circ}$ has been assumed for discontinuous joint surfaces, and $\phi=26^{\circ}$ has been assumed for foliation, stratigraphic contacts, and fault surfaces. These values are based on field estimates of tilt angles at failure for rock core samples.

2.0 ENGINEERING GEOLOGY OF THE VAULT DEPOSIT

This Technical Memorandum presents feasibility level pit slope design criteria for the proposed Vault Deposit based on the design considerations described above.

In general, the rocks that will be exposed in the pit slopes are expected to be hard and competent. The overall rock quality is classified as good. Consequently, circular type rock mass failures are not expected to develop. Rather, the stability of the slopes is expected to be controlled by the orientation and continuity of the geologic structures exposed in the pit walls.

The rock quality adjacent to the major fault zones is expected to be poor. The rock types that will form the pit walls within the Vault Deposit area are considered sufficiently strong such that overall rock mass failure is not anticipated.

The engineering geological model of the Vault Deposit forms the basis for the development of the slope design criteria.

2.1 Geology

The Meadowbank Project area is underlain by a sequence of Archean greenstone (ultramafic and mafic flow sequences) and metasedimentary rocks which have undergone polyphase deformation resulting in the superposition of at least two major structural events. Enclosed within the greenstone are volcaniclastic sediments, felsic to intermediate flows and tuffs, sediments (greywackes) and oxide iron formations. The sequence also contains sericite schists, which are believed to be altered felsic flows or dykes. The ultramafic rocks are variably altered, containing serpentinite, chlorite, actinolite, and talc.

The general geology of the Vault Deposit area consists predominantly of Intermediate Volcanic rock that has been variably sericitized, chloritized, and silicified. The ore is contained within narrow bands of intermediate volcanic rock that dips toward the southeast and south at inclinations between about 20 degrees and 30 degrees. The proposed pit will consist generally of a southeasterly dipping footwall following the dip of the ore zone, and highwalls excavated along the northeast, southeast and southwest sides of the pit.

The general geology of the Vault Deposit area is shown on Figure 1.

2.1.1 Faulting

Faulting in the Vault area generally takes the form of moderate to high angle, east and south dipping fault zones. In general, the east dipping fault features are inclined at approximately 70 degrees, while the south dipping features are inclined at about 55 degrees. These faults will either intersect the pit walls at high angles, or will dip into the pit walls. Potential wedges formed by the intersection of these through-going continuous features will plunge into the south and southeast pit wall at angles of about 50 degrees. Planar failures will be a factor for south and southwest facing walls where 55 degree south dipping faults will intersect the wall.

2.1.2 Folding and Stratigraphic Orientations

Within the Vault Deposit area, stratigraphy is inclined consistently to the southeast to south at inclinations between about 20 degrees and 30 degrees. Based on the current geological model of the deposit area, the intense isoclinal folding present in the Portage Deposit to the south is absent at the Vault Deposit.

Bedding parallel flexural slip surfaces are associated with the major stratigraphic contacts rather than with individual beds within stratigraphic units.

2.1.3 Deposit Characteristics

The gold mineralization at the Vault Deposit is stratiform, generally contained within narrow bands of intermediate volcanic rock, and dipping parallel to stratigraphy toward the south and southeast.

The rock types that are expected to form the pit walls of the proposed open pit at the Vault Deposit will primarily consist of sequences of intermediate volcanic rock that has been variably sericitized, chloritized, and silicified.

2.1.4 Structural Domains

The Vault Deposit has been subdivided into two Structural Domains based on the results of the oriented drilling, rock mass quality assessments, and on the geologic cross sections. The separation of the Domains has been based on a subtle change in the orientation of the foliation and stratigraphy, as determined from the oriented borehole data, and as indicated by the surface geology plan. This change in orientation of stratigraphy from south dipping to southeast dipping does not appear to be a result of faulting. Based on the oriented drilling, Structural Domain 2 will overly Domain 1 to a depth of between 40 m and 60 m below ground surface, however, the change in Domains is not readily discernible on the geological cross sections. The Domains are shown on Figure 2. A general cross section through the deposit is shown on Figure 3.

Overall pit slope stability will be controlled by the orientation of the main stratigraphic contacts and the major fault structures. Experience at the project site indicates that the main stratigraphic contacts are likely to be continuous through-going features, and that the rock adjacent to the main contact zones is often characterized by a reduction of rock quality and increased fracturing. However, areas of lower rock quality are generally confined to narrow intervals.

Major fault structures are considered to be through-going and continuous, and will therefore influence pit slope stability at the scale of the pit wall height as well as the scale of the bench height.

The Structural Domains for the Vault Deposit are described below.

2.1.5 Structural Domain 1

Structural Domain 1 is exposed at surface on the western side of the deposit.

Based on the oriented geotechnical drilling, the foliation and stratigraphy within Structural Domain 1 are inclined at shallow angles generally to the southeast. Foliation measurements from oriented boreholes indicate the foliation to be inclined to the southeast at angles less than about 20 to 25 degrees. Based on the oriented drilling, Structural Domain 1 dips beneath Domain 2 to the east of the domain boundary between the two. Domain 1 is encountered in the oriented boreholes at a depth of between 40 m and 60 m below ground surface.

A joint set oriented approximately perpendicular to the foliation – an orthogonal joint set – is also present. This joint set strikes parallel to the strike of foliation, but dips perpendicular to the foliation.

The following table summarizes the average structural orientations for this Domain. These are shown stereographically on Figure 4.

Table 2-1: Vault Deposit Structural Domain 1 – Structural Orientations

Type	Dip	Dip Dir.	Comments
Foliation and Contact Surfaces	21°	136°	Continuous
Foliation (minor)	28°	066°	Continuous/Healed
Orthogonal Joint Set	60°	336°	Discontinuous
Conjugate Joint 1 (S/SW Dip)	85°	197°	Discontinuous/Rare
Conjugate Joint 2 (NE Dip)	80°	053°	Discontinuous
East Dipping Fault Parallel Joints	67°	108°	Discontinuous to Continuous
South Dipping Fault Parallel Joints	48°	174°	Discontinuous to Continuous
Flat Joint	13°	330°	Discontinuous
North-South Faults and Shears	70°	090°	Continuous
East-West Faults and Shears	55°	180°	Continuous

2.1.6 Structural Domain 2

Structural Domain 2 overlies Domain 1 and is exposed at surface on the east side of the deposit. The depth of Domain 2 varies from 0 m to between 40 m and 60 m below ground surface based on the oriented drilling.

As with Domain 1, the foliation and stratigraphy within Structural Domain 2 are inclined at shallow angles but generally towards the south. Foliation measurements from oriented boreholes indicate the foliation to be inclined to the south at angles less than about 20 to 25 degrees.

The following table summarizes the general structural orientations for this Domain, which are shown stereographically on Figure 5.

Table 2-2: Vault Deposit Structural Domain 2 – Structural Orientations

Type	Dip	Dip Dir.	Comments
Foliation and Contact Surfaces	23°	164°	Continuous
Foliation (minor)	36°	054°	Continuous/Healed
Orthogonal Joint Set	70°	333°	Discontinuous
Conjugate Joint 1 (S/SW Dip)	84°	209°	Discontinuous
Conjugate Joint 2 (NE Dip)	82°	040°	Discontinuous
Cross Joint	73°	253°	Discontinuous/Healed
East Dipping Fault Parallel Joints	81°	086°	Discontinuous to Continuous
South Dipping Fault Parallel Joints	48°	198°	Discontinuous to Continuous
Flat Joints	10°	335°	Discontinuous
North-South Faults	70°	090°	Continuous
East-West Faults	55°	180°	Continuous

2.1.7 Structural Orientations for Stability Analyses

Due to the minor differences in the orientations of the various discontinuity surfaces between the two Structural Domains, the structural data from both Domains have been combined. In addition to combining the data, it was further processed to remove 'healed', or closed, joint measurements. Finally, qualitative assessments of the reliability of the orientation measurements were used to further refine the data set to exclude orientation data considered to be of 'poor' or 'fair' reliability. The qualitative assessments were based on information gathered during logging of the core, and included comments relating to the quality of the imprint taken, and the distance of the orientation measurement from the last successful imprint. As the distance from an imprint increases, the reliability of the orientation measurement decreases.

The following table summarizes the key structural orientations for the combined data set, which are shown stereographically on Figure 6.

Table 2-3: Vault Deposit Combined Structural Domains

Type	Dip	Dip Dir.	Continuity
Foliation and Contact Surfaces	23°	142°	Continuous
Orthogonal Joint Set	64°	335°	Discontinuous/Irregular
Conjugate Joint 1 (S/SW Dip)	83°	201°	Discontinuous
Conjugate Joint 2 (NE Dip)	82°	042°	Discontinuous
East Dipping Fault Parallel Joints	69°	102°	Discontinuous/Continuous
South Dipping Fault Parallel Joints	45°	181°	Discontinuous/Continuous
North-South Faults	70°	090°	Continuous
East-West Faults	55°	180°	Continuous

3.0 ROCK QUALITY

3.1 Field Estimates of Intact Rock Strength

The results of pre-feasibility study indicated that there are no discernible variations in the field estimates of rock strength across the project area, on the basis of rock hardness estimates. The following table summarizes the results of the field estimates of rock strength for the Vault Deposit based on geotechnical logging of rock core.

Table 3-1: Field Intact Rock Strength Estimates – Vault Deposit

Rock Type	ISRM Rock Hardness	ISRM Description	Range in Uniaxial Compressive Strength (MPa)	Number of Records
Contact Zones	R4	Strong Rock	50 - 100	9
Felsic Volcanics	R3	Medium Strong Rock	25 - 50	16
Iron Formation, (IF)	R4	Strong Rock	50 - 100	21
IF/IV Interbedded	R3	Medium Strong Rock	25 - 50	175
Intermediate Volcanic (IV)	R3	Medium Strong Rock	25 - 50	76
Chlorite/Sericite IV (IVCS)	R3	Medium Strong Rock	25 - 50	2975
Chloritic IV (IVCL)	R3	Medium Strong Rock	25 - 50	204
IVSil	R4	Strong Rock	50 - 100	28
Intermediate Volcanic Tuff	R4	Strong Rock	50 - 100	397
Mafic Dykes	R3	Medium Strong Rock	25 - 50	10
Fault Zones	R3	Medium Strong Rock	25 - 50	402

At the time of writing, a total of 28 rock samples from the project area have been tested for compressive strength. The following table summarizes the results of the testing to date.

Table 3-2: Summary of Average Compressive Rock Strength

Rock Type	Minimum Unconfined Compressive Strength (MPa)	Maximum Unconfined Compressive Strength (MPa)	Average Unconfined Compressive Strength (MPa)	ISRM Grade	Range in Uniaxial Compressive Strength (MPa)
Intermediate Volcanic	51.0	148.3	94	R4	50 - 100
Iron Formation	137.1	248.3	175	R5	100 - 250
Quartzite	69.5	140.1	107	R4	50 - 100
Ultramafic	40.2	91.6	66	R4	50 - 100

Note that the Quartzite and Ultramafic rocks are generally absent in the Vault Deposit area.

In general, the results of the laboratory testing are higher than the field strength estimates.

3.2 Rock Mass Description

The strength of an overall rock mass, and consequently its response to loading, is controlled by:

- the strength of the intact rock;
- the degree of fracturing of the rock mass; and
- the nature of the fracture surfaces.

Since in-situ testing of overall rock mass strength is very expensive, the overall strength of a rock mass is usually characterized by various rock mass classification methods, on the basis of core logging data or surface mapping data.

3.2.1 Rock Mass Classification Based on Drill Core

The results of the analyses of the geomechanical data, and the rock quality ratings for the various rock types in the Vault Deposit area, based on the geotechnical data collection by Cumberland Resources Ltd and by Golder Associates are summarized in the following table. Based on the stereographic analyses, typical joint sets consist of the foliation and orthogonal joint sets, as well as the conjugate and cross joint sets. Consequently, based solely on the contoured stereographic projections of the oriented joint sets, an average Joint Set Number, Jn, of twelve (three sets plus random) might be expected. However, due to the wide spacing and discontinuous nature of the conjugate and cross joint sets, and their absence in some areas and presence in others, a Joint Set Number of nine (three distinct sets) has been used to assess the overall rock mass quality for the deposit area. This compensates to some degree for underestimating of the Joint Set Number during logging of drill core, and for potentially overestimating rock quality based on RQD, which is relatively insensitive to systematic fracture spacing greater than 10 cm.

Table 3-3: Summary of NGI Rock Quality Rating of the Major Rock Types – Vault Deposit

Rock Type	RQD (1)		Jr (1)		Ja (1)		Jn (2)		Jn (3)	Q´ (3)		Rating
	Mean	Med.	Mean	Med.	Mean	Med.	Mean	Med.	Bench Scale	Mean	Med.	
Contact Zones	75.6	79.2	2.2	1.9	1.6	1.33	5.13	4.0	9	11.6	12.6	Good
Felsic Volcanics	97.3	98.7	1.3	1.2	1.1	1.0	2.9	2.0	9	12.8	13.2	Good
Iron Formation, (IF)	88.6	91.0	1.8	1.4	1.1	1.0	3.1	3.0	9	16.1	14.2	Good
IF/IV Interbedded	89.9	93.7	1.9	1.5	1.3	1.3	3.3	3.0	9	14.6	12.0	Good
Intermediate Volcanic (IV)	91.0	98.0	1.6	1.4	1.5	1.4	3.6	3.0	9	10.8	10.9	Good
Chlorite/Sericite IV (IVCS)	89.3	94.7	2.0	1.5	1.3	1.0	3.0	3.0	9	15.3	15.8	Good
Chloritic IV (IVCL)	84.5	90.7	1.8	1.3	1.6	1.2	3.2	3.0	9	10.6	10.9	Good
IVSil	87.2	92.3	1.8	1.4	1.5	1.2	2.4	3.0	9	11.6	12.0	Good
Intermediate Volcanic Tuff	91.0	95.0	2.0	1.6	1.2	1.0	3.2	3.0	9	16.9	16.9	Good
Mafic Dykes	88.4	93.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fault Zones	71.6	78.0	4.6	4.5	2.1	2.0	14.8	15.0	20	7.8	8.8	Fair

(1) Mean and Median geomechanical values based on statistical analysis of geotechnical data collection. Jw and SRF assumed to be 1.0 for rock classification.
(2) Small scale Jn based on geotechnical logging of core.
(3) Bench scale Jn based on stereographic interpretations
(4) Q' calculated using statistical mean and median values for RQD, Jr, and Ja, and bench scale Jn.

4.0 DISCONTINUITY CHARACTERISTICS

4.1 Joint Spacing and Small Scale Joint Surface Characteristics

The mean and median surface characteristics of the main discontinuity types recorded from the oriented geotechnical logging at Vault are summarized in the following table.

Table 4-1: Summary of Discontinuity Surface Characteristics Based on Oriented Drilling

Discontinuity Type	Joint Roughness		Joint Alteration		Records
	Mean	Median	Mean	Median	
Contacts	1.4	1.3	1.7	0.8	10
Faulting (General)	1.0	1.0	4.0	4.0	2
Sheared Surfaces	0.9	0.8	3.9	4.0	10
Foliation (South to Southeast Dipping)	1.2	1.0	1.3	1.0	479
Foliation (East to Northeast Dipping)	1.2	1.0	1.2	1.0	51
Orthogonal Joints	1.8	1.5	1.1	1.0	36
Conjugate Joints	1.7	1.5	1.6	1.0	21
East Dipping Fault Parallel Joints	2.1	2.5	1.3	1.0	18
South Dipping Fault Parallel Joints	1.5	1.0	2.0	2.0	42
Cross Joints	1.7	1.3	1.3	1.0	8
Flat Joints	1.7	1.5	1.0	1.0	20

In addition to the orientation of the rock fabric and major structures relative to the orientation of the proposed pit walls, the actual spacing of the features will affect the ability for wedge and plane failure mechanisms to actually form within the walls of the pit. Deere (1963) and Bieniawski (1974) present a classification of joints based on spacing.

Table 4-2: Rock Mass Description Based on Joint Spacing after Deere (1963) and Bieniawski (1974)

Description	Joint Spacing	Rock Mass Description
Very Wide	>= 3 m	Solid
Wide	1 to 3 m	Massive
Moderately Close	30 cm to 1 m	Blocky/Seamy
Close	5 cm to 30 cm	Fractured
Very Close	<5 cm	Crushed

The average spacing and surface characteristics of the various structural features intersected by the oriented geotechnical boreholes have been estimated and are summarized in the following table. Spacing was determined for each joint set based on the average dip of each set as determined by stereographic analysis, and the total length of core that was oriented.

Table 4-3: Surface Characteristics and Average Spacing of the Main Discontinuities Based on Oriented Drill Core – Vault Deposit

Type	Approx. Spacing (m)	Description*	Grade*
Contacts	>3 to 5 m	Very Wide	Solid
Contact Parallel Faulting/Shearing	>3 to 5 m	Very Wide	Solid
East Dipping Shears	98 m	Very Wide	Solid
South Dipping Shears	32 to 34 m	Very Wide	Solid
Foliation (South to Southeast Dipping)	0.5 to 0.8	Moderately Close	Blocky
Foliation (East to Northeast Dipping)	4.3 to 6.0	Very Wide	Solid
Orthogonal Joints	2.8 to 8.1	Wide to Very Wide	Massive to Solid
Conjugate Joints	1.7 to 7.4	Wide to Very Wide	Massive to Solid
East Dipping Fault Parallel Joints	3.7 to 6.1	Very Wide	Solid
South Dipping Fault Parallel Joints	2.8 to 14.3	Wide to Very Wide	Massive to Solid
Cross Joints	4.4	Very Wide	Solid
Flat Joints	8.3	Very Wide	Solid

* Description and Grade based on Deere (1963) and Bieniawski (1974).

With the exception of the foliation, the main features that will be exposed in the pit walls are expected to have wide to very wide spacing, with stained to slightly altered joint walls, and rough small-scale surface profiles.

4.2 Joint Frictional Strength and Large Scale Joint Roughness

During the 2002 and 2003 engineering field investigations, estimates of the basic frictional strength parameters for smooth joint surfaces in the various rock types were made. This was done by forming a base of two core sticks in a core box and placing a third core stick on top. The core box was then tilted until sliding occurred. The angle at which sliding occurred was recorded. This angle provides a reasonable estimate of the basic friction angle of a smooth joint surface having no surface asperities.

The purpose of the above field test was to arrive at reasonable estimates of basic frictional strength parameters for the various joint surfaces at very low stress levels. The following table summarizes the field estimates of the frictional strength parameters based on the sliding core test.

Table 4-4: Average Angle of Drill Core Sliding

Rock Type	Average Angle of Sliding
Iron Formation	35 degrees
Intermediate Volcanic	38 degrees
Sericitic Intermediate Volcanic	27 degrees
Ultramafic Volcanic	25 degrees

In addition to these measurements from drill core, joint roughness profile mapping of a limited number of joint surfaces exposed in the Third Portage trenches was carried out during 2002. The following table summarizes the field estimates of the joint roughness profile mapping at the Third Portage trenches.

Table 4-5: Average Small and Large Scale Joint Roughness Characteristics from Third Portage Trench

	Average Small Scale Amplitude (mm)	Average Small Scale Joint Roughness Coefficient (JRC)	Average Large Scale Amplitude (cm)	Average Large Scale Joint Roughness (Barton's Jr)
Foliation Joints	3.2	13	2.4	2.7
Orthogonal Joints	4.2	15	7.0	3.0
Conjugate Joints	3.2	11	2.0	2.5
Contact	3.3	11	10.0	2.3

Average first order and second order asperity angles were estimated over the length of each of the joint roughness profiles. The asperity angles were estimated from the joint surface profiles. The asperity angle is the angle of the small-scale asperities on the joint roughness profile. First order asperities represent larger scale (cm to m scale) undulations along a joint surface, while second order asperities represent smaller scale (mm to cm scale) variations along the surface.

At low stress levels, such as those that might be encountered at the scale of a pit bench, the surface asperities will generally remain intact and will thus have the effect of increasing the basic friction angle by approximately the angle of the asperity. Shearing of the first order asperities will be less likely than shearing of the second order asperities, due to the differences in scale.

Based on the above, the following basic joint friction angles have been assumed for the kinematic and pseudo-probabilistic analyses.

Table 4-6: Basic Friction Angles used in Kinematic Analyses

	Basic Friction Angle (degrees)	1° Asperity Angle (degrees)	2° Asperity Angle (degrees)
Foliation Joints and Contacts	26	9	28
Orthogonal Joints	36	15	31
Conjugate Joints	36	7	30
General	36	7	30

The use of the basic friction angle for the analyses provides conservative estimates of the kinematic stability for planar and wedge failure mechanisms, as this angle assumes that the failure surfaces will be planar, smooth, and without any surface asperities. This has been considered in developing the recommended pit slope design criteria.

The basic friction angle used for the foliation surfaces (26 degrees) assumes that these will be generally smooth and planar, or slightly undulating features with some degree of alteration coating (either sericite or cholorite) and few asperities. Consequently, the basic friction angle reported in the table above is the average of the ultramafic and sericitic intermediate volcanic tilt angles reported in Table 4-4.

The basic friction angle used for the orthogonal joints assumes these joints to be generally unaltered with rough, stepped surfaces. Hence, the basic friction angle reported above is the average of the iron formation and intermediate volcanic tilt angles reported in Table 4-4.

The basic friction angle used for the conjugate joints (36 degrees) assumes these joints to be generally unaltered with rough, planar to stepped surfaces. Based on the joint profile mapping at the Third Portage trench, the conjugate joint surfaces tend to have lower small-scale amplitude, Joint Roughness Coefficient, and large-scale amplitude than the orthogonal joint surfaces. Consequently, a basic friction angle lower than that used for the orthogonal joint set is suggested.

For general joint surfaces a basic friction angle equivalent to that of the orthogonal joint set (36 degrees) has been assumed.

4.3 Faulting and Shearing

As described previously, faulting in the Vault deposit area takes the form of high angle (70 degree) east dipping faults and moderate (55 degree) south dipping faults. These are expected to be very widely spaced features. Based on the oriented geotechnical data collection and on the surface geology plan, these features are expected to be very widely spaced, on the order of 30 m to 100 m.

4.4 Stratigraphic Contacts and Foliation

The stratigraphic contacts and foliation are considered to be continuous and through going, reasonably planar structures. Slickensiding and shearing is commonly associated with the foliation surfaces. The foliation surfaces tend to be slightly altered, with occasional coatings. The orientation of the stratigraphy and foliation in the Vault Deposit area is consistent, dipping to the south and southeast at angles less than about 20 to 25 degrees. Based on the geological cross sections, the spacing of contacts is expected to be on the order of 3 m to 5 m, or greater. Slickensiding is typically associated with the foliation surfaces, while intervals of broken core are typically associated with contact zones.

4.5 Jointing

The general orientations of the various joint sets are relatively consistent throughout the project area. In general terms, the foliation and stratigraphy is inclined to the south and southeast; the orthogonal joint set is generally inclined to the north and northwest; shear joints sub-parallel to the main faults dip to the east and to the south; conjugate joints strike generally in an east-west or northeast-southwest direction, and dip to the north or south, or northeast and southwest; cross joint sets strike generally north-south, and dip towards the southwest to northeast. The characteristics of each set are described in greater detail below.

The joint surfaces at the Vault site are expected to be discontinuous, based on surface mapping carried out to date. Consequently, both planar and wedge failure mechanisms formed by these discontinuous surfaces are, themselves, considered to be discontinuous and widely spaced. Therefore, multi-bench scale failures along these surfaces are not anticipated. However, local bench scale failures and ravelling should be expected.

Fault Parallel Joints

Fault parallel joints are sub-parallel to the orientation of the main faults which dip to the east at about 70 degrees, and to the south at about 50 degrees. Based on the geotechnical studies, these joints will be very widely spaced (>3 m). The joint surfaces are expected to be rough and planar to rough and wavy, and may be infilled, or healed, by secondary minerals such as quartz and carbonate. The rough and slightly altered joint surface characteristics of these features suggest that they may be discontinuous.

Orthogonal Joints

Orthogonal joints will strike in approximately the same direction as the main foliation and stratigraphic contacts, but will dip at approximately 90 degrees to the dip of the stratigraphy. The orthogonal joints dip generally to the north and northwest.

Based on the geotechnical studies, the orthogonal joints will be discontinuous, widely (1 m to 3 m) to very widely spaced (>3 m), and confined to individual stratigraphic horizons. As well, the joint surfaces are expected to be rough and planar to rough and wavy, and may be infilled, or healed, by secondary minerals such as quartz and carbonate.

Conjugate Joints

Based on the detailed oriented drilling these features will be wide (1 m to 3 m) to very widely spaced (>3 m) and discontinuous over vertical distances greater than an operating bench height. It is anticipated that their presence will present a limited or low risk of large scale or multi-bench failure. These joint surfaces will likely be rough and planar to rough and wavy. The conjugate joints typically dip at steep inclinations; consequently these will have little influence on wall stability.

Cross Joints

These joints are oriented perpendicular to the strike of bedding and foliation. The cross joints are not expected to be pervasive, but rather will be discontinuous and moderately close to very widely spaced (>3 m) with limited persistence. These joints in general are healed, or closed, and are expected to be rare or absent.

4.6 Summary of Engineering Structural and Rock Mass Quality Model

The following summarizes the important features regarding the engineering structural model for the Vault Deposit area.

- Stratigraphic contacts are considered to be continuous structures. The orientation of the contacts follows the general trend of the overall foliation orientations for the deposit area, which dip at angles less than about 30 degrees to the south and southeast.
- Areas of poorer rock quality and low RQD appear to be associated with bedding parallel shearing and faulting along the major stratigraphic contacts.
- The intermediate volcanic rocks that will form the walls of the Vault Pit are expected to be of good rock mass quality.
- The geometric relationships of the various joint discontinuity features throughout the project area are generally consistent both locally and on a more regional scale.
- Joint features are considered to be discontinuous.

5.0 STABILITY ANALYSIS

5.1 Deterministic Wedge Stability Analysis

A deterministic wedge stability analysis was undertaken based on the main structural orientations in each of the two Structural Domains. For the purposes of the analysis, a friction angle of ϕ=36º has been assumed for discontinuous joint surfaces, and ϕ=26º has been assumed for foliation, stratigraphic contacts, and fault surfaces. As discussed in the preceding Section 4.0, this provides a conservative estimate of wedge stability because joint surface asperities are not considered in the analyses. The stability analyses assume dry conditions to exist.

5.1.1 Domain 1

The following table summarizes the orientations of wedges formed by the intersection of the various structural discontinuities within Domain 1.

Table 5-1: Vault Domain 1 – Wedge Orientations

Type	East Dipping Fault	South Dipping Fault	Fol1	Fol2	Or	CJ1	CJ2	Flat	East Dip
SouthDipFault	**52/153**								
Fol1	N/W	N/W							
Fol2	N/W	22/106							
Or	**49/025**	18/257	06/062						
CJ1	**67/119**	N/W	N/W	21/109	45/282				
CJ2	N/W	**44/133**	N/W	N/W	N/W	N/W			
Flat	11/004	06/266	02/051	11/358	N/W	09/286	N/W		
East Dipping Joints	N/W	**54/163**	N/W	N/W	39/038	N/W	N/W	08/021	
South Dipping Joints	**47/157**	N/W	N/W	05/260	12/253	N/W	**41/134**	05/260	**48/170**

Notes: N/W = No Wedge Formed

The stability of these wedges, based on deterministic methods for dry conditions, is summarized in the following table.

Table 5-2: Vault Domain 1 – Wedge Stability Factors of Safety Matrix

Type	East Dipping Fault	South Dipping Fault	Fol1	Fol2	Or	CJ1	CJ2	Flat	East Dip
SouthDipFault	**0.5**								
Fol1	N/W	N/W							
Fol2	N/W	1.4							
Or	**0.8**	3.3	6.3						
CJ1	**0.4**	N/W	N/W	1.9	1.5				
CJ2	N/W	**1.0**	N/W	N/W	N/W	N/W			
Flat	4.0	7.5	18.8	3.4	N/W	5.0	N/W		
East Dipping Joints	N/W	**0.4**	N/W	N/W	1.6	N/W	N/W	5.4	
South Dipping Joints	**0.7**	N/W	N/W	10.2	5.7	N/W	**1.0**	9.4	**0.5**

Notes: N/W = No Wedge Formed

5.1.2 Domain 2

The following table summarizes the orientations of wedges formed by the intersection of the various structural discontinuities within Domain 2.

Table 5-3: Vault Domain 2 – Wedge Orientations

Type	East Dipping Fault	South Dipping Fault	Fol1	Fol2	Or	CJ1	CJ2	Cross	East Dip
SouthDipFault	**52/153**								
Fol1	N/W	N/W							
Fol2	N/W	23/108							
Or	**55/032**	24/252	04/244						
CJ1	**64/131**	N/W	N/W	16/121	**62/287**				
CJ2	N/W	38/124	17/121	N/W	N/W	38/124			
Cross Joint	24/171	N/W	N/W	11/340	**66/299**	N/W	52/320		
East Dipping Joints	N/W	N/W	N/W	N/W	**64/015**	**74/141**	**81/071**	26/172	
South Dipping Joints	**42/161**	N/W	N/W	15/122	31/256	N/W	20/127	N/W	**44/167**

Notes: N/W = No Wedge Formed

The stability of these wedges, based on deterministic methods for dry conditions, is summarized in the following table.

Table 5-4: Vault Domain 2 – Wedge Stability Factors of Safety Matrix

Type	East Dipping Fault	South Dipping Fault	Fol1	Fol2	Or	CJ1	CJ2	Cross	East Dip
SouthDipFault	**0.5**								
Fol1	N/W	N/W							
Fol2	N/W	1.4							
Or	**0.7**	2.7	10.5						
CJ1	**0.5**	N/W	N/W	3.4	**0.7**				
CJ2	N/W	1.5	2.4	N/W	N/W	6.0			
Cross Joint	4.0	N/W	N/W	4.7	**0.4**	N/W	1.6		
East Dipping Joints	N/W	N/W	N/W	N/W	**0.5**	**0.3**	**0.1**	5.0	
South Dipping Joints	**0.7**	N/W	N/W	2.3	1.6	N/W	3.4	N/W	**0.7**

Notes: N/W = No Wedge Formed

5.1.3 Wedge Stability Analysis for Combined Domains

The structural orientations determined from the two Structural Domains were combined, and a deterministic wedge stability analysis was carried out using the combined data set.

The following table summarizes the orientations of wedges formed by the intersection of the various structural discontinuities for the combined data set.

Table 5-5: Vault Combined Domains – Wedge Orientations

Type	East Dipping Fault	South Dipping Fault	Fol1	Or	CJ1	CJ2	East Dip
SouthDipFault	**52/153**	N/W					
Fol	N/W	N/W					
Or	**51/027**	17/253	05/063				
CJ1	**66/127**	N/W	N/W	51/282			
CJ2	N/W	40/125	N/W	N/W	54/121		
East Dipping Joints	N/W	**53/161**	N/W	46/035	**67/128**	N/W	
South Dipping Joints	**43/160**	N/W	N/W	17/253	N/W	31/127	**44/170**

Notes: N/W = No Wedge Formed

The stability of these wedges, based on deterministic methods for dry conditions, is summarized in the following table.

Table 5-6: Vault Combined Domains – Wedge Stability Factors of Safety Matrix

Type	East Dipping Fault	South Dipping Fault	Fol	Or	CJ1	CJ2	East Dip
SouthDipFault	**0.5**	N/W					
Fol	N/W	N/W					
Or	**0.8**	3.2	9.1				
CJ1	**0.4**	N/W	N/W	1.21			
CJ2	N/W	1.4	N/W	N/W	2.4		
East Dipping Joints	N/W	**0.4**	N/W	1.1	**0.3**	N/W	
South Dipping Joints	**0.6**	N/W	N/W	3.2	N/W	1.7	**0.5**

Notes: N/W = No Wedge Formed

6.0 PIT SLOPE DESIGN CRITERIA

It is expected that the lower slopes of the south and east walls of the final pit, below a depth of between 40 m and 60 m, will be developed within Domain 1. The upper slopes of the south and east walls of the final pit, from ground surface down to a depth between 40 m and 60 m, will be developed within Structural Domain 2. The west side of the south wall will be in Domain 2. However, the distinction between the two Domains is very subtle; therefore, the two Domains have been considered together for the development of the Design Sectors and the subsequent pit slope design criteria.

6.1 Design Sectors

The Structural Domains have been sub-divided into Design Sectors on the basis of the structural data, and on wall orientations (see Figure 7). The bench face and inter-ramp angles within each of the Design Sectors were formulated to minimize significant structurally controlled failures based on the kinematic and pseudo-probabilistic analyses. The Design Sectors are referenced with respect to Wall Sector Azimuth; the concept of Wall Sector Azimuth is shown on Figure 7.

The following Design Sectors are therefore presented:

- Design Sector 1 – Northeast and North Facing Walls – Sector Azimuth 250° to 175°
- Design Sector 2 – Northwest Facing Walls – Sector Azimuth 175° to 140°
- Design Sector 3 – Northwest and West Facing Walls – Sector Azimuth 140° to 060°
- Design Sector 4 – Southwest Facing Walls – Sector Azimuth 060° to 030°
- Design Sector 5 – South Facing Walls – Sector Azimuth 030° to 340°
- Design Sector 6 – Southeast Facing Walls – Ore Zone – Sector Azimuth 340° to 290°
- Design Sector 7 – East Facing Walls – Ore Zone – Sector Azimuth 290° to 250°

The recommended bench configurations for each Design Sector are discussed below, and are referenced to Wall Sector Azimuths. Within each Design Sector, the first catch bench width below ground surface should be 10 m to accommodate additional ravelling of material from the poorer quality near surface rock.

6.2 Design Sector 1 – Northeast and North Facing Walls – Wall Sector Azimuth 250° through 175°

The slope design configurations for Design Sector 1 will be applicable to pit walls facing to the northeast through north.

Based on the kinematic analyses, potential wedges will be formed by the intersection of the northwest dipping orthogonal joint set and the east dipping joint sets and faults. The wedges formed by the intersection of these features will plunge to the northeast at inclinations of between 40 and 60 degrees. Consequently, where these are undercut by bench faces, local wedge failures can be expected. However, the orthogonal and east dipping joint sets are expected to have wide to very wide spacing. The orthogonal set is expected to be discontinuous. Therefore, wedge failures are expected to be limited to local occurrences.

Within this Design Sector, the south dipping fault structures will dip into the wall at inclinations of 55 degrees or greater. The west dipping fault structures will intersect this wall at a high angle, approximately 90 degrees to the wall face. Where these structures are exposed in the wall additional ravelling of material may occur due to the poorer quality rock associated with these features. This is expected to be limited to localized bench scale occurrences. Due to the favourable orientation of these structures, large scale multi-bench failures are not anticipated. Where the east-west trending, south dipping fault zones are exposed within the pit wall additional ravelling may be expected. Where the north-south trending, east dipping fault zones intersect the pit wall potential gullying may occur along these structures. However, the fault structures are expected to be limited in width, on the order of 3 m to 5 m, and widely spaced on the order of 30 m to 100 m, based on the oriented drilling, and on the geological plan map. These features are expected to have relatively high RQD values on the order of 70% or greater.

The following pit slope configurations are recommended for the south pit wall within Design Sector 1.

Table 6-1: Design Sector 1 Northeast and North Facing Walls – Pit Slope Configurations

Sector 1 Slope Configurations	Applicable Range in Wall Sector Azimuth 250° to 175°
Slope Component	**Intermediate Volcanic Rock**
Bench Height	24 m
Bench Face	70 deg
Catch Bench	10 m
Inter-Ramp	52 deg

6.3 Design Sector 2 – Northwest Facing Walls – Sector Azimuth 175° through 140°

The slope design configurations for Design Sector 2 will be applicable to pit walls facing to the northwest.

Based on the kinematic analyses, the stability of the northwest dipping pit walls will be controlled by potential planar failure along the northeast dipping orthogonal joint set.

Based on the combined structural data set, the orthogonal joint set dips to the northwest at angles of about 64 degrees. The orthogonal joint set is widely spaced and discontinuous. Consequently, planar failures will be limited to local occurrences where these joints are undercut by bench face angles.

Due to the orientation of the orthogonal joint set it may be difficult to consistently achieve bench face angles greater than about 65 degrees, as the rock will tend to break back to the orientation of the orthogonal set. Therefore, design bench face angles have been limited to 65 degrees for this sector. However, due to the wide spacing of the orthogonal set as indicated in the oriented drilling, it may be possible during operations to achieve bench face angles on the order of 70 degrees. The following pit slope configurations are recommended for the south pit wall within Design Sector 2.

Table 6-2: Design Sector 2 North through Northwest Facing Walls – Pit Slope Configurations

Sector 2 Slope Configurations	Applicable Range in Wall Sector Azimuth 175° to 140°
Slope Component	**Intermediate Volcanic Rock**
Bench Height	24 m
Bench Face	65 deg
Catch Bench	10 m
Inter-Ramp	49 deg

6.4 Design Sector 3 – West Facing Walls – Sector Azimuth 140° through 060°

The slope design configurations for Design Sector 3 will be applicable to pit walls facing west.

Potential wedge failures will occur along the line of intersection of the southwest dipping joint set and the northwest dipping orthogonal joint set. These wedges will plunge at angles of about 50 degrees to the west. Based on the geotechnical studies, the joint sets forming these wedges will be widely spaced and discontinuous. Consequently, wedge failures are likely to be limited to small scale local occurrences.

Other potential wedges will be formed by the intersection of the south dipping fault parallel joints and south dipping faults with the orthogonal joint set. However, these plunge at inclinations less than about 20 degrees; consequently, wedge failures are not anticipated associated with these surfaces.

The east-west trending, south dipping faults will intersect the west dipping pit walls at relatively high angles. Increased ravelling and potential gullying could occur associated with the poorer quality rock within these fault zones. The north-south trending, east dipping faults will dip into the west facing pit walls at inclinations of about 70 degrees. Consequently, there is some risk of toppling failure and ravelling to occur where these are exposed within the pit walls. However, these fault zones are expected to be relatively narrow features on the order of 3 m to 5 m, and very widely spaced on the order of 30 m to 100 m. Consequently, it is expected that potential instability related to additional ravelling of material from these fault zones, or related to gullying where these fault zones intersect the pit walls at high angles, can be mitigated during operations.

The following pit slope configurations are recommended for the west facing pit wall within Design Sector 3.

Table 6-3: Design Sector 3 West Facing Walls – Pit Slope Configurations

Sector 3 Slope Configurations	Applicable Range in Wall Sector Azimuth 140° to 060°
Slope Component	**Intermediate Volcanic Rock**
Bench Height	24 m
Bench Face	70 deg
Catch Bench	10 m
Inter-Ramp	52 deg

6.5 Design Sector 4 – Southwest Facing Walls – Sector Azimuth 060° through 030°

The slope design configurations for Design Sector 4 will be applicable to southwest facing pit walls.

Based on the data collected from the oriented geotechnical drilling, the southwest dipping conjugate joint set will dip at high angles, generally greater than about 70 degrees. This joint set will be widely spaced and discontinuous, based on the current information. Consequently, this joint set will not likely contribute to instability in the southwest dipping walls.

The northeast dipping conjugate joint will dip at high angles into the southwest facing wall, generally greater than about 70 degrees. The orientation of this structure could conceivably result in toppling failure. However, this joint set is expected to be widely spaced and discontinuous; therefore, toppling failure will likely be limited to local occurrences.

The south dipping faults and shears, and south dipping fault parallel joint sets will intersect this wall at relatively shallow angles of about 30 degrees to 60 degrees to the strike direction of the wall. Where these structures are undercut there is the potential for increased ravelling of material. However, the south dipping joint set is expected to be widely spaced and discontinuous, while the spacing of the south dipping faults and shears is expected to be on the order of about 30 m. Therefore, ravelling of material is expected to be limited to local occurrences, and only where the strike of the south dipping structures is within about 30 to 40 degrees of the trend of the wall.

The following pit slope configurations are recommended for Design Sector 4. Alternatively, consideration should be given to avoiding this range in wall sector azimuths.

Table 6-4: Design Sector 4 Southwest Facing Walls – Pit Slope Configurations

Sector 4 Slope Configurations	Applicable Range in Wall Sector Azimuth 060° to 030°
Slope Component	**Intermediate Volcanic Rock**
Bench Height	24 m
Bench Face	65 deg
Catch Bench	10 m
Inter-Ramp	49 deg

6.6 Design Sector 5 – South Facing Walls – Sector Azimuth 030° through 340°

The slope design configurations for Design Sector 5 will be applicable to south facing pit walls. This Design Sector will form the transition between the south facing pit walls, and the southeast facing footwall design sector.

Within this Design Sector, plane failures could potentially occur along the south dipping, east-west trending faults and south dipping fault parallel joints. The south dipping joints are inclined at about 45 degrees to the south, and are widely spaced on the order of 3 m to 14 m. The south dipping faults and shears are inclined at about 55 degrees to the south and are expected to be very widely spaced on the order of 30 m to 100 m. The fault and shear structures are expected to be continuous and through-going structures while the south dipping joints are expected to be discontinuous structures.

The following pit slope configurations are recommended for Design Sector 5. The inter-ramp angle has been limited to 42 degrees and bench face angles limited to 55 degrees to avoid undercutting of the south dipping structures. As an alternative to these relatively shallow pit slope configurations, consideration should be given to avoiding this range in wall sector azimuths.

Table 6-5: Design Sector 5 South Facing Walls – Pit Slope Configurations

Sector 5 Slope Configurations	Applicable Range in Wall Sector Azimuth 030° to 340°
Slope Component	**Intermediate Volcanic Rock**
Bench Height	24 m
Bench Face	55 deg
Catch Bench	10 m
Inter-Ramp	42 deg

6.7 Design Sector 6 – Southeast Facing Walls – Sector Azimuth 340° through 290°

The slope design configurations for Design Sector 6 will be applicable to the ore zone, which dips to the southeast at inclinations of about 20 to 25 degrees.

The approach to mining of the Vault Deposit will be to mine to the footwall of the mineralization. This will result in a footwall slope configuration whereby the dip of the orebody is followed by the excavating equipment. The concept of mining to the footwall of the deposit is shown on Figure 8.

Potential wedges will be formed by the intersection of the northeast and southwest dipping conjugate joint sets. However, the factor of safety associated with these wedges is about 2.4. Furthermore, the joints comprising these wedges are expected to be widely spaced and discontinuous features. Therefore, these wedges are not expected to contribute to large scale instability.

Potential wedges will be formed by the intersection of the northeast dipping joint set, and the south dipping joints, faults, and shears. The factors of safety for these wedges are greater than about 1.4, based on the deterministic wedge stability analyses. Consequently, failure of these wedges is not expected.

Potential wedges will be formed by the intersection of the southwest dipping conjugate joints and the east dipping faults and shears, and east dipping, fault parallel joints. However, the southwest dipping joint sets are expected to be widely spaced and discontinuous. Therefore, wedge failures will likely be limited to local occurrences.

Potential wedge structures may be formed by the intersection of the south dipping faults and shears, and south dipping joints and the east dipping faults and shears, and east dipping joints. The faults and shears are expected to be generally narrow features, on the order of 3 m to 5 m width, and spaced on the order of 30 m to 100 m, while the joints are expected to be discontinuous, and spaced on the order of 3 m to 14 m. Consequently wedge failures will likely be limited to local occurrences.

The following pit slope configurations are recommended for Design Sector 6. Where haul road cuts are made in the footwall, these should be undertaken using controlled blasting methods to minimize disturbance to the rock mass.

Table 6-6: Design Sector 6 Footwall Design – Ore Zone

Location	Slope Configuration	
Ore	**Non-benched Footwall Slope**	Parallel to Ore, Foliation, and Stratigraphy

In some cases, benching will be desirable to provide access. The ore zone, foliation, and stratigraphy within this Sector are inclined at shallow angles to the southeast. Based on the oriented geotechnical drilling, and on the engineering geology model for the deposit, stratigraphy and foliation will dip towards the southeast at average inclinations of about 20 to 25 degrees, but in some cases steeper than this and in other cases shallower. Based on the estimates of joint frictional strength described in Section 4.1, foliation and contact surfaces are expected to have a base friction angle, ϕ_b, of about 26 degrees, with second order asperity angles of about 9 degrees. Accounting for the second order asperity angles, a friction angle of 35 degree might be expected along these surfaces, under dry well drained conditions. For a factor of safety of 1.3 against planar failure along these through-going and continuous features, a friction angle of 28 degrees against planar failure under dry, drained conditions should be assumed. Therefore, where the dip of the ore, foliation, and stratigraphy is less than about 28 degrees, benching within the footwall will be possible, with bench faces on the order of 65 degrees, assuming dry, well drained conditions. Where the dip of the foliation and stratigraphy exceeds 28 degrees, then benching parallel to the orientation of stratigraphy and foliation will be required.

As an alternative to benching in the footwall, rock fill could be placed on the footwall slope in areas where the dip of the ore zone, foliation and stratigraphy is less than 30 degrees. The rock fill should be a granular, free draining material. Haul road widths should be three times the width of the largest vehicle using the roads. Safety berms will be required along the road edges, and should be 1/3 the height of the tire of the largest vehicle using the roads.

Table 6-7: Footwall Access Ramps

Footwall Slope Configuration	Ramp Type	Face Angle	Comments
Access ramps where dip of ore, foliation and contacts is less than 28 degrees	Road Cut	65°	Avoid undercutting wedges formed by south and east dipping faults and shears, plunging to southeast. Where these occur, limit road cut face angle to 40 degrees
	Fill	~1.5H:1V (angle of repose)	Granular, free draining material
Access ramps where dip of ore, foliation and contacts exceeds 28 degrees	Road Cut	Parallel to dip of contacts	Avoid undercutting of southeast dipping foliation and contact surfaces by excavating parallel to dip. Benched footwall slopes will be required to avoid undercutting structure.
	Fill	n/a	Fill not feasible on footwall slopes exceeding 28 degrees

6.8 Design Sector 7 – East Facing Transition Walls – Sector Azimuth 290° through 250°

The slope design configurations for Design Sector 7 will be applicable to the southeast and east facing pit walls. Sector 7 will form a transition between the footwall design configuration for the ore zone, and the southwest pit wall.

The stability of the benches within this wall sector azimuth will be dependent on the orientation of the southeast dipping ore, foliation, and stratigraphy, and the east dipping fault structures, and east dipping joints. Based on the geological interpretation, the east dipping fault structures are inclined generally at about 70 degrees towards the east. Based on the geological interpretation, and on the oriented geotechnical drilling, the east dipping joints structures will be inclined at about 69 degrees. The joint surfaces are expected to be discontinuous and spaced on the order of 4 m to 6 m. It is likely that bench faces within this wall sector will break back to the orientation of the east dipping joint surfaces. The fault and shears are expected to be spaced on the order of 30 m to 100 m.

Potential wedges will be formed by the intersection of the northeast and southwest dipping conjugate joint sets. However, the factor of safety associated with these wedges is about 2.4. Furthermore, the joints comprising these wedges are expected to be widely spaced and discontinuous features. Therefore, these wedges are not expected to contribute to large scale instability.

Potential wedges will be formed by the intersection of the northeast dipping joint set, and the south dipping joints, faults, and shears. The factors of safety for these wedges are greater than about 1.4, based on the deterministic wedge stability analyses. Consequently, failure of these wedges is not expected.

Potential wedges will be formed by the intersection of the southwest dipping conjugate joints and the east dipping faults and shears, and east dipping, fault parallel joints. However, the southwest dipping joint sets are expected to be widely spaced and discontinuous. Therefore, wedge failures will likely be limited to local occurrences.

As the footwall design transitions into the benched pit walls, overall pit slope angles will increase, predicated on not undercutting the orientation of the ore, foliation, and stratigraphy, and the east dipping faults and shears. Consequently, through this transition range, bench face angles have been limited to 65 degrees.

The following pit slope configurations are recommended for Design Sector 7.

Table 6-8: Design Sector 7 East Facing Transition Wall – Pit Slope Configurations

Sector 7 Slope Configurations	Applicable Range in Wall Sector Azimuth 290° to 250°
Slope Component	**All Rock Types**
Bench Height	24 m
Bench Face	65 deg
Catch Bench	10 m
Inter-Ramp	49 deg

7.0 OVERBURDEN SLOPES

7.1 On-Land Overburden Slopes

Based on grain size analyses of till samples, the on-land overburden at the Vault Deposit consists of a silty sand and gravel till. Based on casing depths, the on-shore thicknesses will generally range from about 0 metres up to about 4 m, with local thicknesses up to about 9 m.

It will likely be possible to excavate slopes on the order of 1.5H:1V and 2H:1V within these materials, provided they are well drained.

A 10 metre wide bench should be left between the crest of the pit and the toe of the overburden slopes to allow for the excavation of a drainage ditch at the toe of the slope, and to retain any unstable material within the overburden slopes. Un-benched slope heights within the overburden materials should be restricted to a maximum of 10 m. Overburden slopes higher than 10 m should incorporate an intermediate catch-bench. A minimum catch-bench width of 3 m to 4 m can be assumed where slope heights are greater than 10 m.

7.2 Off-Shore Overburden Slopes

The thicknesses of overburden off-shore will be variable. Based on casing depths, the off-shore overburden thicknesses will generally be thicker than the on-shore materials, ranging from about 2 m up to about 10 m locally.

There have been no grain size analyses of the off-shore overburden materials at the Vault Deposit. Future field investigations should attempt to obtain representative samples of the off-shore overburden materials for testing. However, at this time it is expected that the off-shore overburden material will be similar to that encountered on-shore, with the exception of a layer of fine grained lake bottom sediments.

The current plan for the mining of the Vault Deposit will involve draining a portion of the lake to allow expansion of the pit crest eastward. During operations, two basins within the current Vault Lake will be used as an attenuation storage pond. This pond will likely be located to the east of the final pit crest area. The water surface will be to the east and on the order of 3 m to 4 m below the proposed pit crest. The proximity of the pond to the final pit crest will vary on the order of 60 m to several hundred metres. Slope de-watering measures will likely be required in the upper benches adjacent to the water attenuation storage pond. Water inflow to the put could potentially occur along the east-west and north-south trending fault structures where these intersect the storage pond.

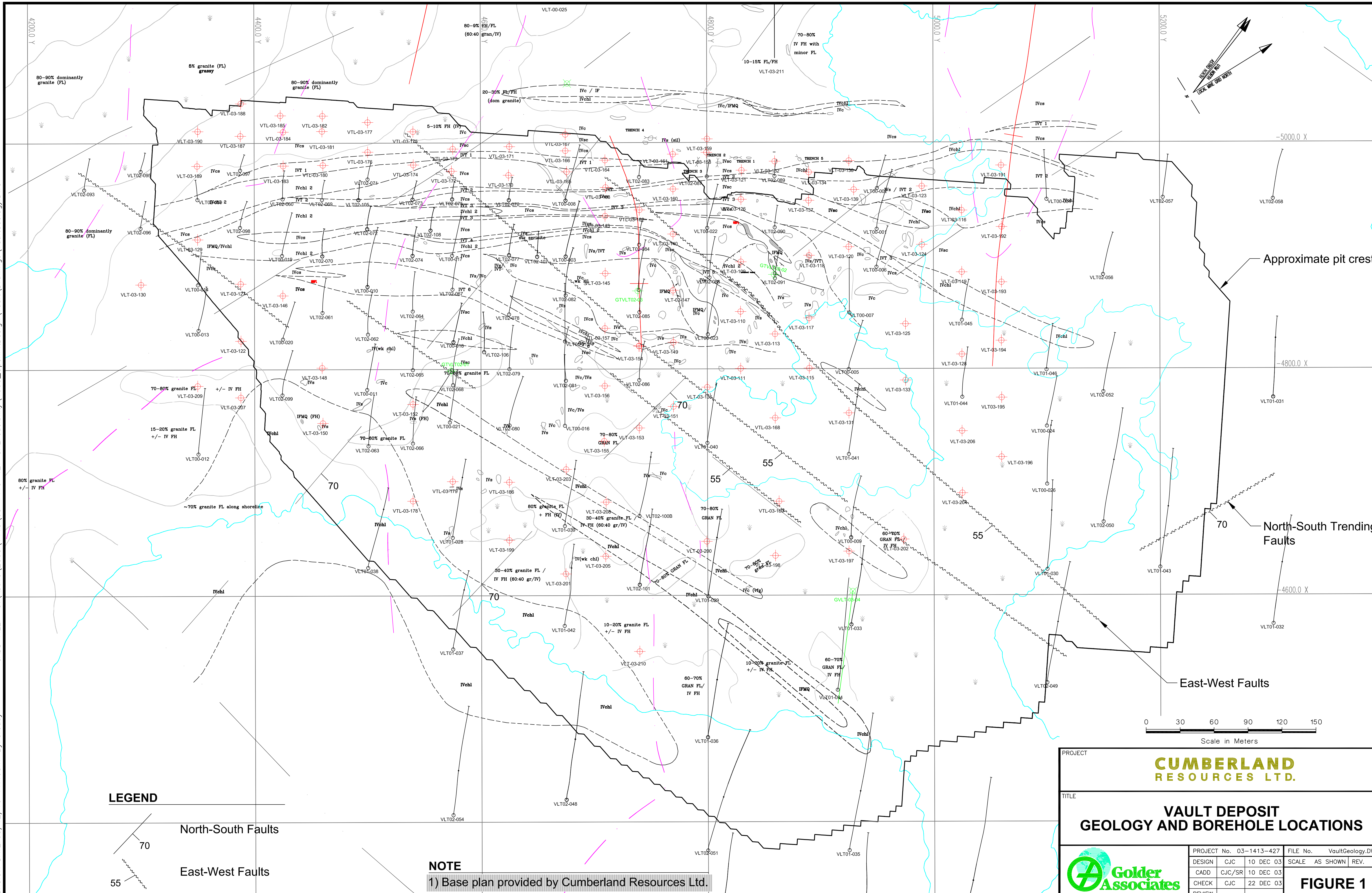
Where the soils and the depth of the active layer extend below the lake level, it is assumed that the soils will be sealed, or that a cut-off trench will be installed in the soils to prevent high groundwater inflows into the pit. The stability of these soils will be largely dependent upon the groundwater pressures that will exist within the soils, which will in turn be dependent upon the method of sealing the groundwater inflows. It is likely that relatively steep slopes can be excavated in these tills, provided that seepage is adequately cut-off and that the overburden slopes are adequately drained. However, the lake bottom fine sediments could be problematic, and consideration should be given to removing these from the pit crest areas.

8.0 CLOSURE

The slope design configurations presented in this report are considered achievable provided a high degree of care and attention during drilling and blasting operations is applied. It is expected that the rocks at the Meadowbank Project site will be amenable to both pre-split, and trim and buffer controlled blasting techniques.

It is expected that once the final mine plan has been completed, a pit plan will be produced showing the intersection of the major structures with the final pit walls. The design criteria should then be reviewed in the context of the final pit plan and wall intersections.

We trust the above meets your requirements at this time.



PROJECT

CUMBERLAND RESOURCES LTD.

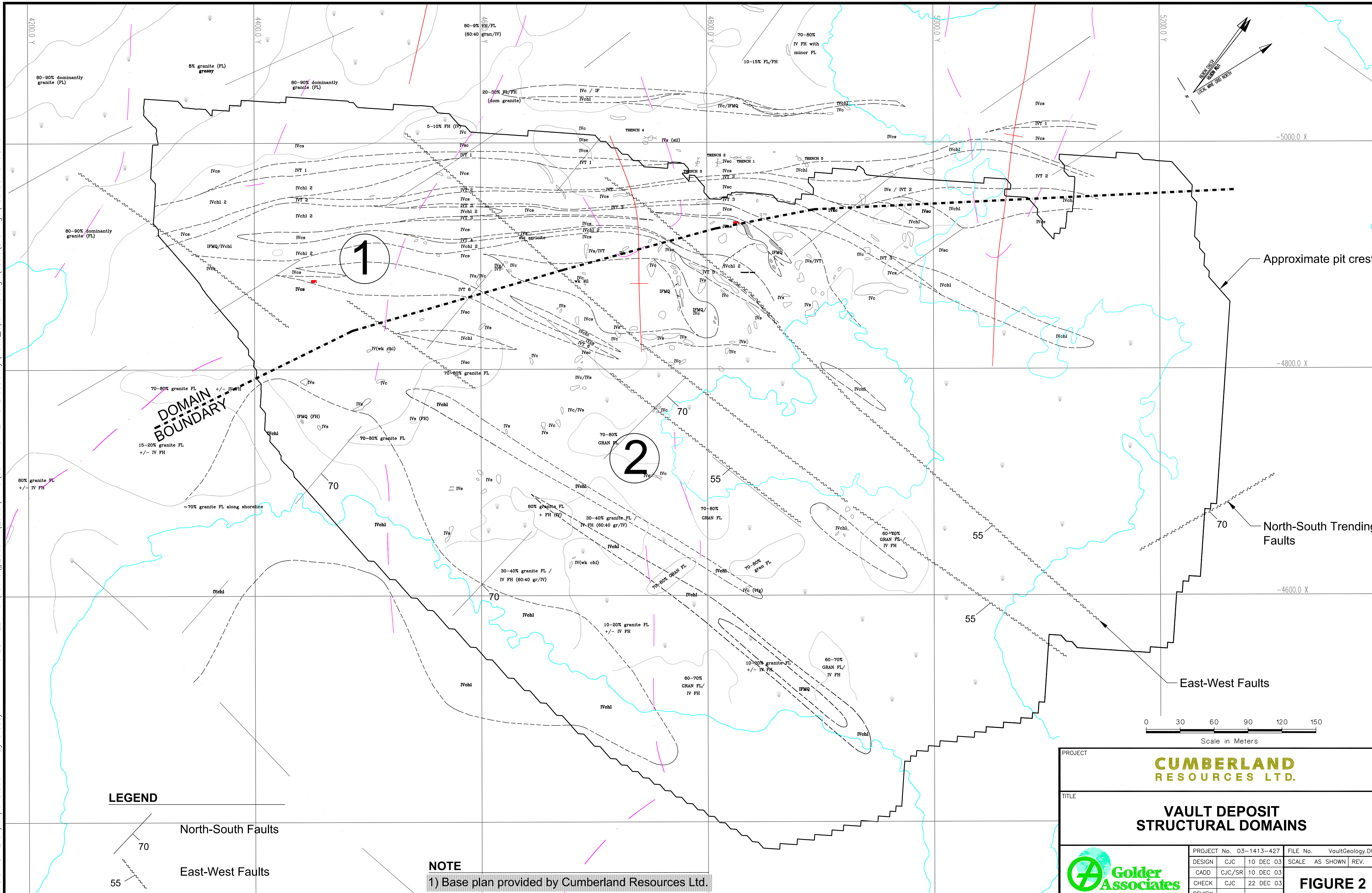
TITLE

VAULT DEPOSIT
GEOLOGY AND BOREHOLE LOCATIONS

Golder Associates

PROJECT No.	03-1413-427		FILE No.	VaultGeology.DWG
DESIGN	CJC	10 DEC 03	SCALE AS SHOWN	REV. A
CADD	CJC/SR	10 DEC 03		
CHECK	CJC	22 DEC 03		
REVIEW				

FIGURE 1


DOMAIN BOUNDARY
1
2
Approximate pit crest
North-South Trending Faults
East-West Faults
70
55
Scale in Meters
0 30 60 90 120 150
LEGEND
North-South Faults
East-West Faults
NOTE
1) Base plan provided by Cumberland Resources Ltd.
PROJECT
CUMBERLAND RESOURCES LTD.
TITLE
VAULT DEPOSIT STRUCTURAL DOMAINS
Golder Associates
PROJECT No. 03-1413-427
FILE No. VaultGeology.DWG
DESIGN CJC 10 DEC 03
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CHECK CJC 22 DEC 03
REVIEW
SCALE AS SHOWN
REV. A
FIGURE 2
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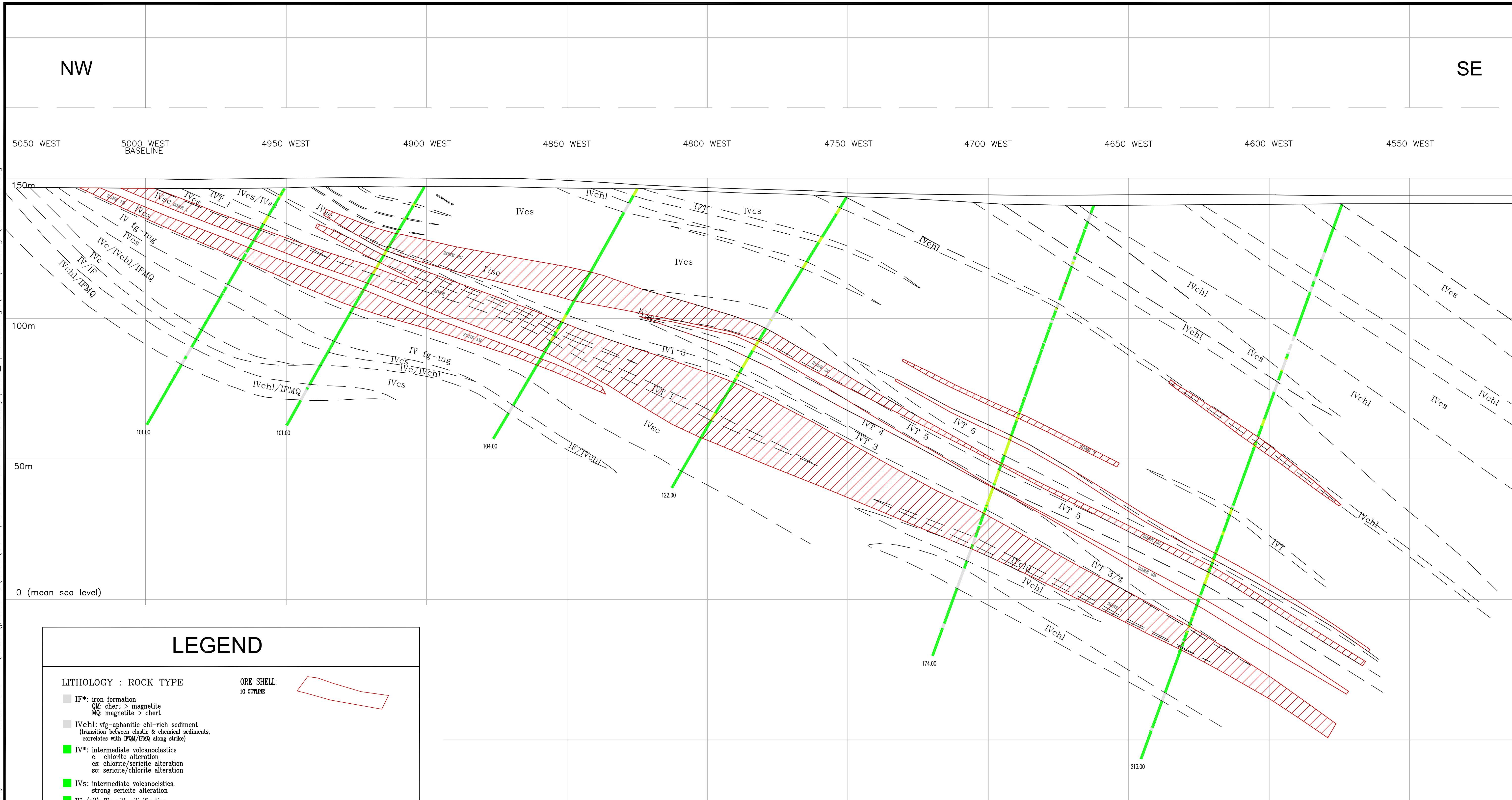
By: sreddy
REVISION DATE: 04/01/5 8:36am



LEGEND

LITHOLOGY : ROCK TYPE

- IF*: iron formation
  - QM: chert > magnetite
  - MQ: magnetite > chert
- IVchl: vfg-aphanitic chl-rich sediment (transition between clastic & chemical sediments, correlates with IFQM/IFMQ along strike)
- IV*: intermediate volcanoclastics
  - c: chlorite alteration
  - cs: chlorite/sericite alteration
  - sc: sericite/chlorite alteration
- IVs: intermediate volcanoclstics, strong sericite alteration
- IVs (sil): IVs with silicification
- IVT: tuffaceous intermediate volcanoclstics (grain size > 2mm)
- IVA: intermediate polymictic agglomerate, fragments & clasts > 4cm
- QIVT: quartz-eye volcanic tuff
- QV: quartz vein
- FD: felsic dyke
- QFP: quartz-feldspar porphyry
- UM*: ultramafic volcanics
  - A: actinolitic
  - S: serpentinized
  - V: massive flow
  - f: foliated

ORE SHELL: 1G OUTLINE

NOTE

1) Base plan provided by Cumberland Resources Ltd.

PROJECT	CUMBERLAND RESOURCES LTD.
TITLE	TYPICAL CROSS SECTION SECTION 4675N

Golder Associates

PROJECT No.	03-1413-427	FILE No.	V4675n01
DESIGN	CJC	10 DEC 03	SCALE NTS REV. A
CADD	CJC/SR	10 DEC 03	
CHECK	CJC	07 JAN 04	FIGURE 3
REVIEW			

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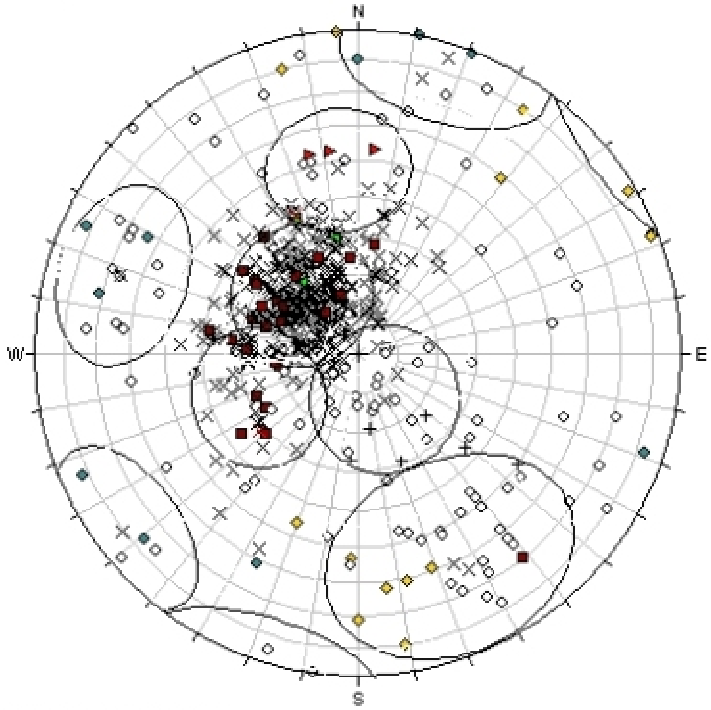
By: sreddy

REVISION DATE: 04/01/5 8:47am

Vault Deposit



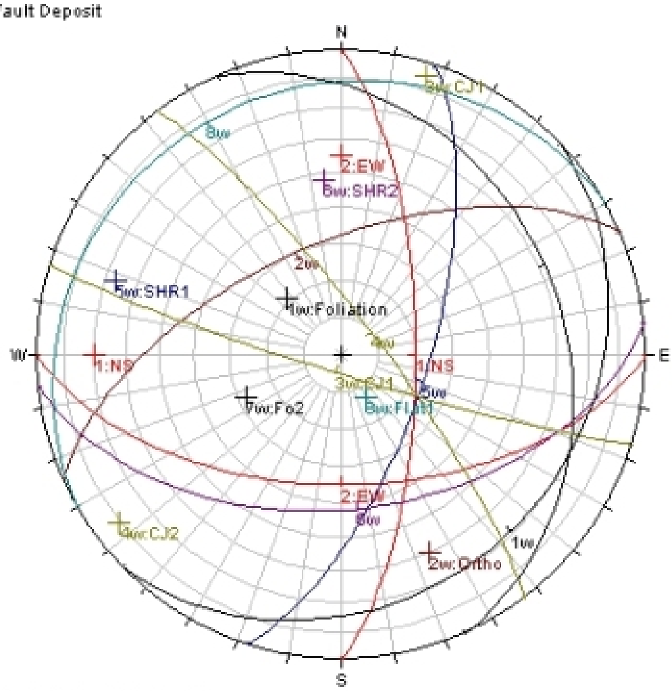
TYPE

- BD [34]
- CJ [10]
- CO [3]
- FLT [2]
- FO [449]
- JN [125]
- OR [13]
- SHR [3]
- VN [11]

Equal Area
Lower Hemisphere
650 Poles
604 Entries

Domain 1 Greater than 60m

Vault Deposit



Orientations

ID		Dip / Direction
1		70 / 090
2		55 / 180
1	w	21 / 136
2	w	60 / 336
4	w	80 / 053
5	w	67 / 108
6	w	48 / 174
7	w	28 / 066
8	w	13 / 330
3	w	85 / 197

Equal Area
Lower Hemisphere
650 Poles
604 Entries

Domain 1 Greater than 60m

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
VAULT DEPOSIT
DOMAIN 1
STRUCTURAL ORIENTATIONS

Golder Associates

PROJECT No.	03-1413-427		FILE No. DOMAIN
DESIGN	CJC	19SEP03	SCALE / REV.
CADD	SS	19SEP03	
CHECK	CJC	19SEP03	**FIGURE 4**
REVIEW			

REVISION DATE:19-SEP-03 BY: COREL FILE:N:\Bur-Graphics\Projects\2003\1413\03-1413-427\Drafting\corel\Domain.cdr

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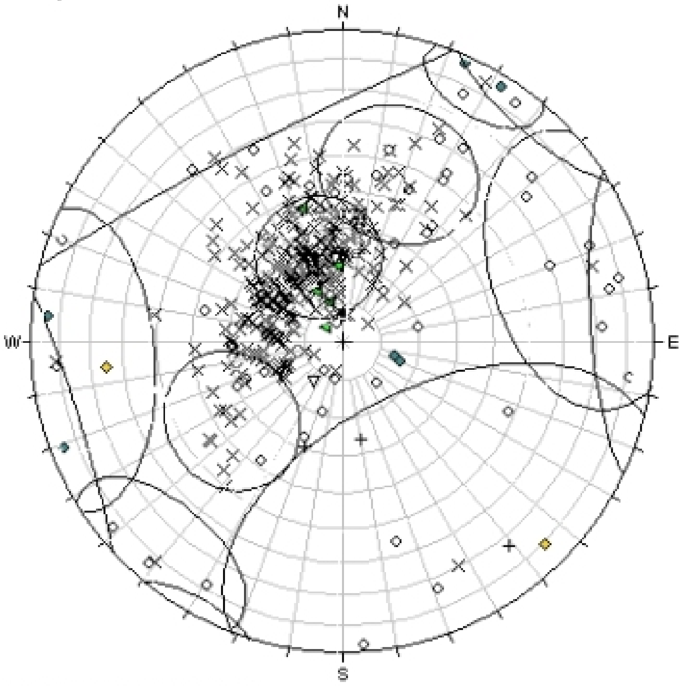


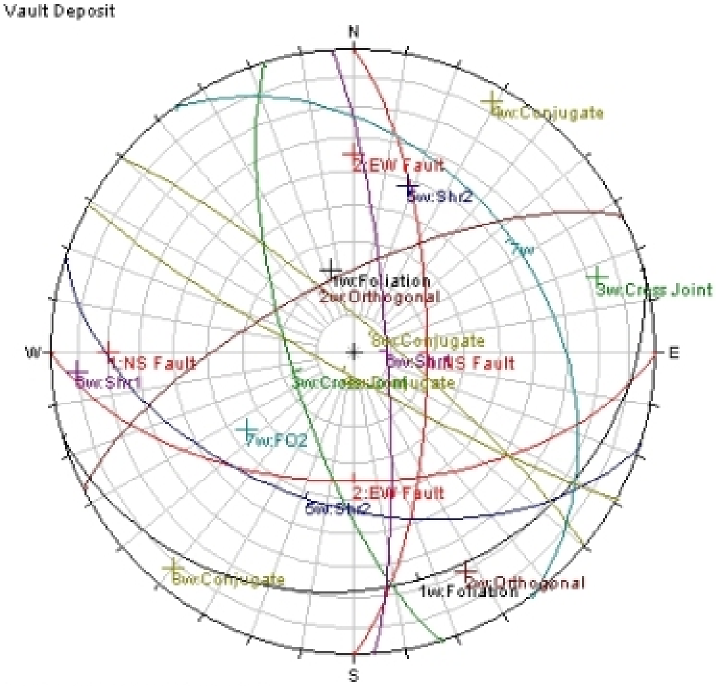
TYPE

◆	CJ [6]
◀	CO [5]
×	FO [330]
○	JN [57]
◆	OR [2]
▽	SHR [7]
+	VN [3]

Equal Area
Lower Hemisphere
410 Poles
392 Entries

Domain 2 Less than 60 m depth

Vault Deposit



Orientations

ID		Dip / Direction
1		70 / 090
2		55 / 180
1	w	23 / 164
3	w	73 / 253
5	w	48 / 198
6	w	81 / 086
7	w	36 / 054
4	w	84 / 209
8	w	82 / 040
2	w	70 / 333

Equal Area
Lower Hemisphere
410 Poles
392 Entries

Domain 2 Less than 60 m depth

REVISION DATE:19-SEP-03 BY: COREL FILE:N:\Bur-Graphics\Projects\2003\1413\03-1413-427\Drafting\corel\Domain.cdr

PROJECT
CUMBERLAND RESOURCES LTD.

TITLE
VAULT DEPOSIT DOMAIN 2 STRUCTURAL ORIENTATIONS

Golder Associates

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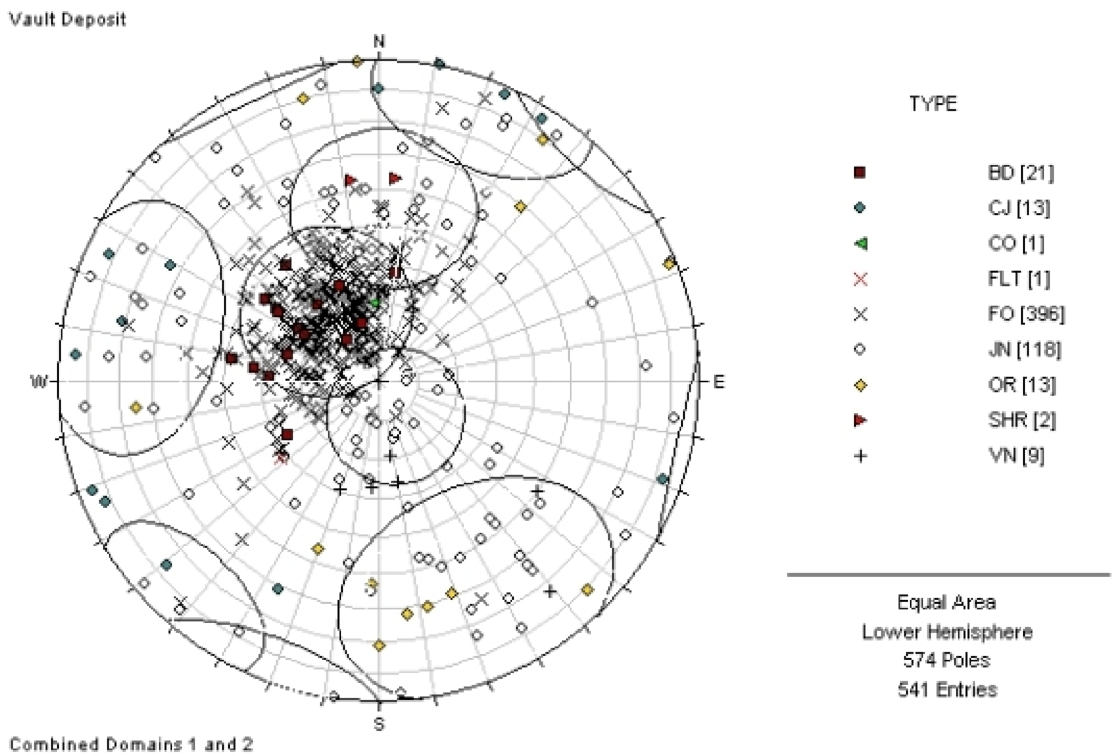
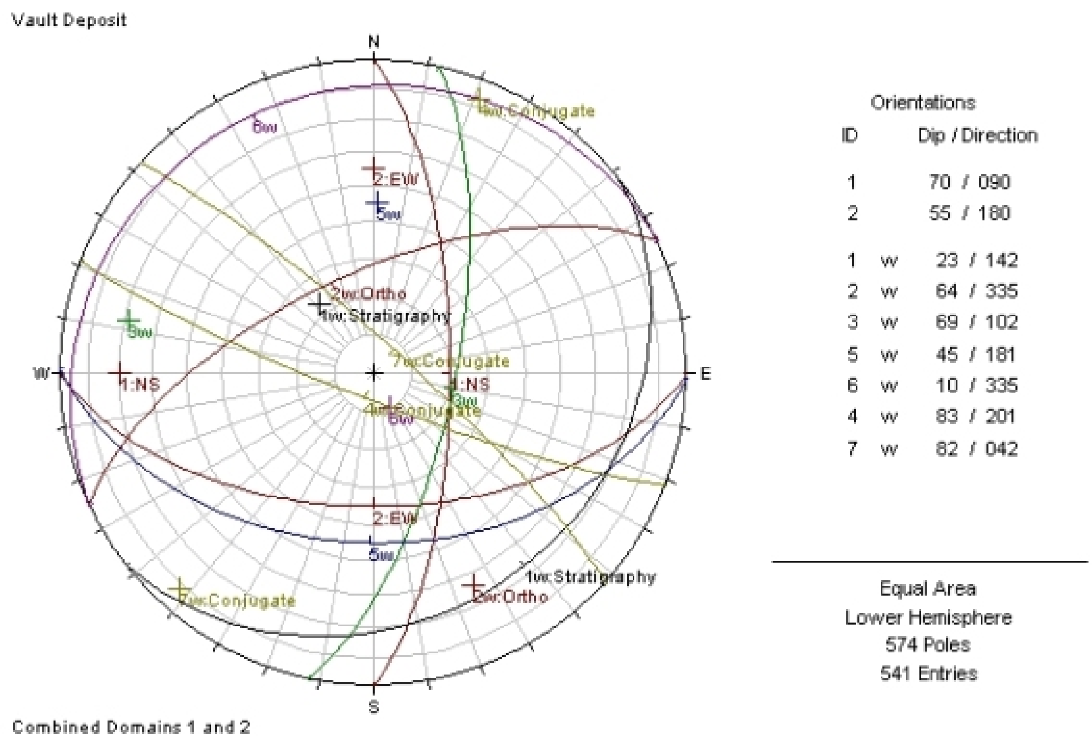
CHECK	CJC	19SEP03		
REVIEW				





PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

VAULT DEPOSIT COMBINED DOMAIN DATA

Golder Associates

PROJECT No.		03-1413-427	FILE No. DOMAIN	
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CADD	SS	19SEP03	**FIGURE 6**	
CHECK	CJC	19SEP03		
REVIEW				

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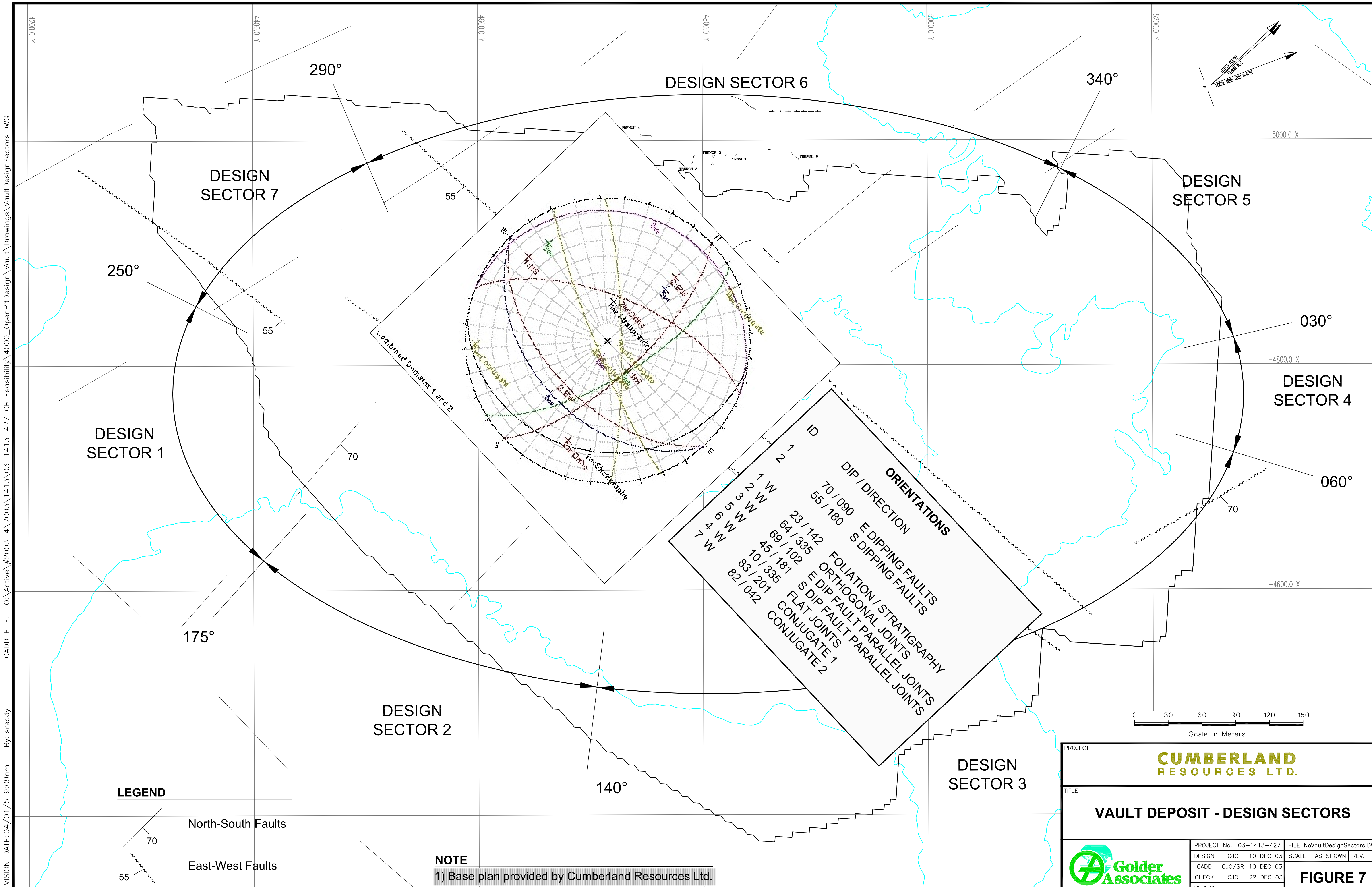
DESIGN SECTOR 1
DESIGN SECTOR 2
DESIGN SECTOR 3
DESIGN SECTOR 4
DESIGN SECTOR 5
DESIGN SECTOR 6
DESIGN SECTOR 7
290°
340°
030°
060°
140°
175°
250°
55
70
-5000.0 X
-4800.0 X
-4600.0 X
4200.0 Y
4400.0 Y
4600.0 Y
4800.0 Y
5000.0 Y
5200.0 Y
TRENCH 1
TRENCH 2
TRENCH 3
TRENCH 4
TRENCH 5
Combined Domains 1 and 2
ORIENTATIONS
ID
DIP / DIRECTION
1 70 / 090 E DIPPING FAULTS
2 55 / 180 S DIPPING FAULTS
1 W 23 / 142 FOLIATION / STRATIGRAPHY
2 W 64 / 335 ORTHOGONAL JOINTS
3 W 69 / 102 E DIP FAULT PARALLEL JOINTS
5 W 45 / 181 S DIP FAULT PARALLEL JOINTS
6 W 10 / 335 FLAT JOINTS
4 W 83 / 201 CONJUGATE 1
7 W 82 / 042 CONJUGATE 2
0 30 60 90 120 150
Scale in Meters
LEGEND
North-South Faults
East-West Faults
NOTE
1) Base plan provided by Cumberland Resources Ltd.
PROJECT
CUMBERLAND RESOURCES LTD.
TITLE
VAULT DEPOSIT - DESIGN SECTORS
Golder Associates
PROJECT No. 03-1413-427
FILE NoVaultDesignSectors.DWG
DESIGN CJC 10 DEC 03
CADD CJC/SR 10 DEC 03
CHECK CJC 22 DEC 03
REVIEW
SCALE AS SHOWN
REV. A
FIGURE 7
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REVISION DATE: 04/01/5 9:09am

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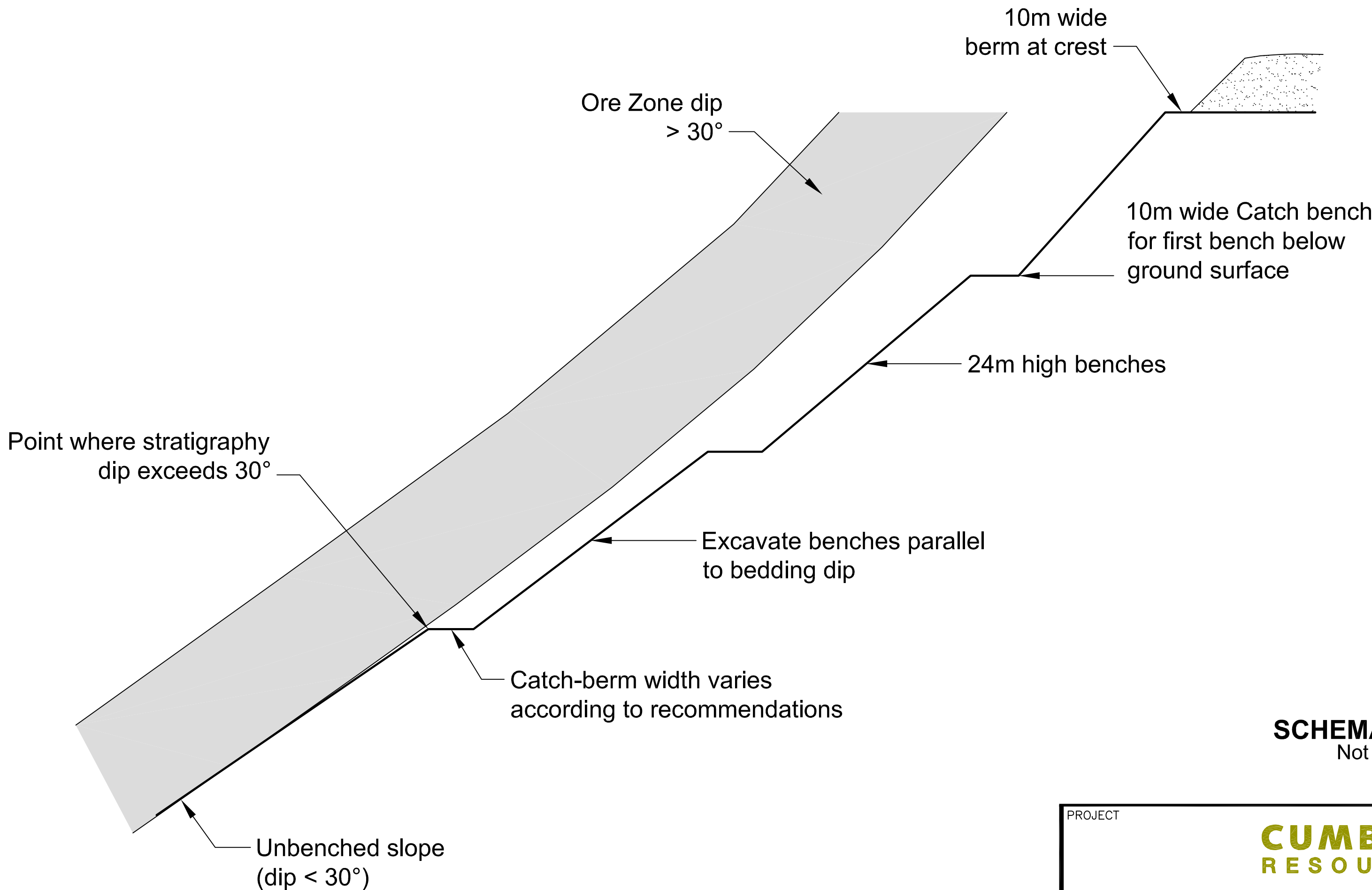

SCHEMATIC ONLY
Not to Scale

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Golder Associates	PROJECT No. 03-1413-427		FILE No. Fig6FootwallDesign	
	DESIGN	CJC	07JAN04	SCALE NTS REV. A
	CADD	NV	07JAN04	FIGURE 8
	CHECK	CJC	07JAN04	
	REVIEW			

APPENDIX B

Water Volume and Stage Storage Volume Curves

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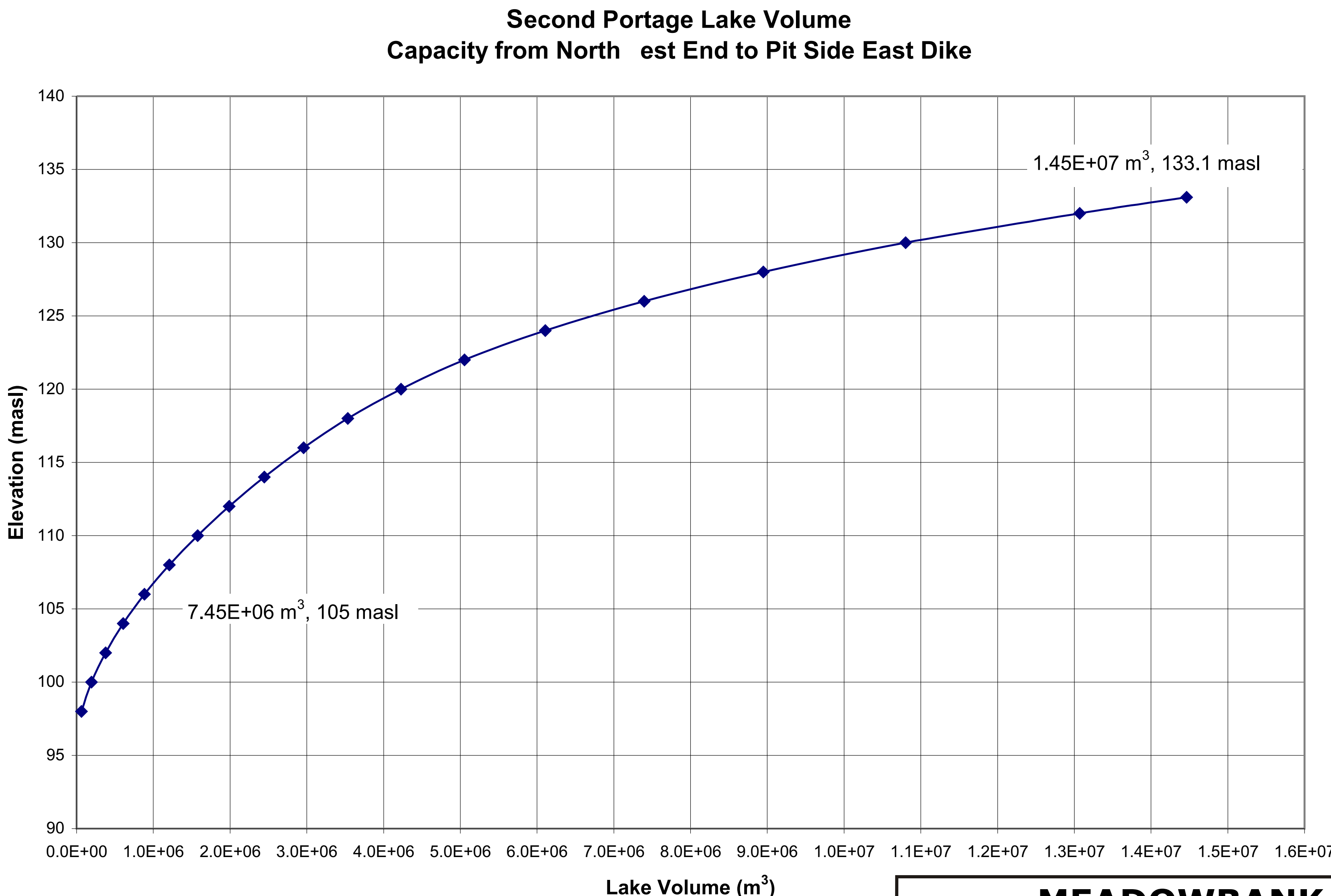
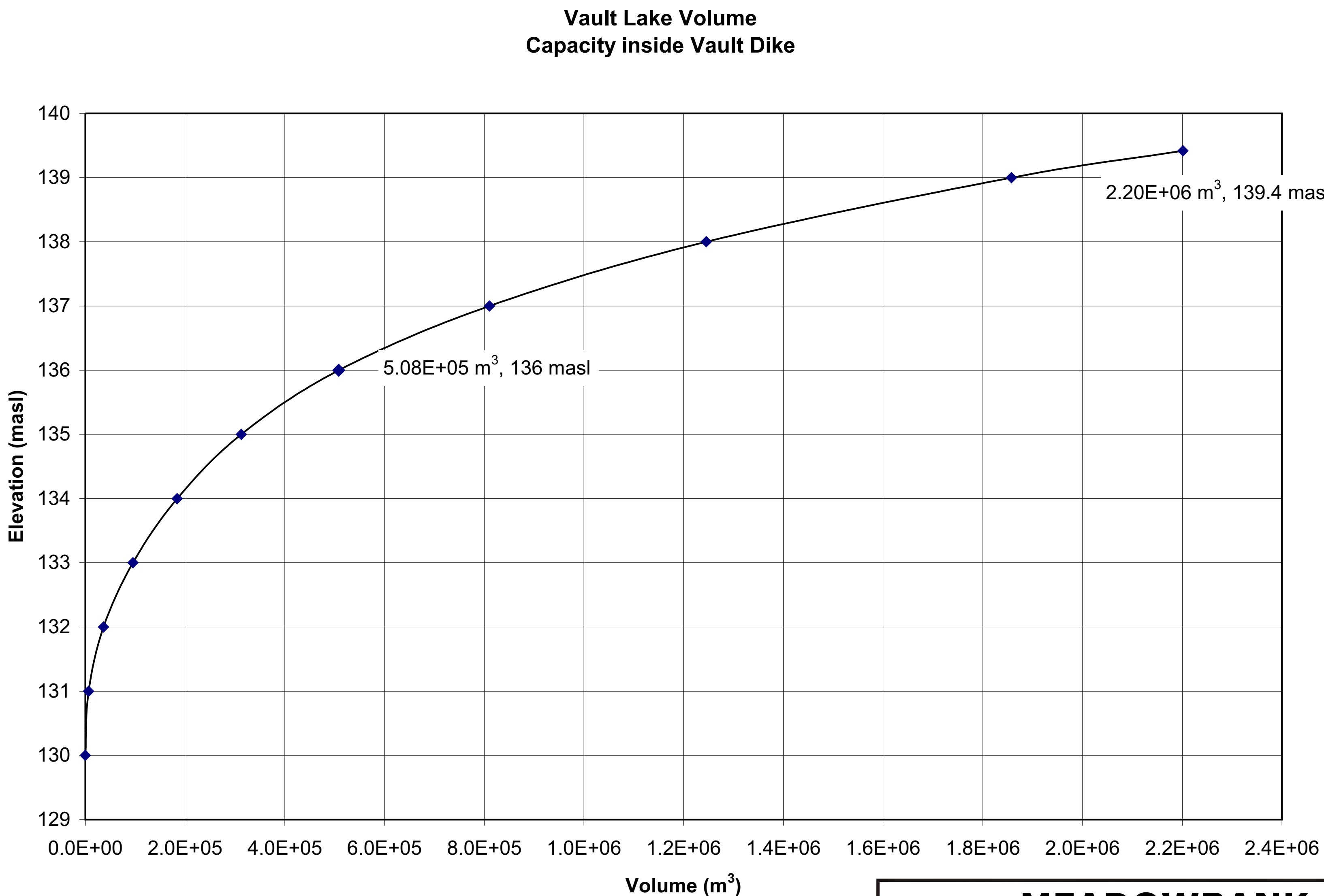


MEADOWBANK MINING CORPORATION	
MEADOWBANK MINING PROJECT	
SECOND PORTAGE LAKE ARM VOLUME INSIDE EAST DIKE	FIGURE B-1

DRAWING DATE: 10-Jul-07 COREL FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\1400\Drafting\1000\vault lake.cdr



MEADOWBANK
MINING CORPORATION

MEADOWBANK MINING PROJECT

VAULT LAKE
VOLUME INSIDE VAULT DIKE

FIGURE B-2

APPENDIX C

Water Balance Model Assumptions

Table C.1: Water Balance Model Assumptions – General

Property	Value	Source	Comment/Assumptions
Time Step	1 month	Golder	Runoff generation based on monthly precipitation totals. Water quality regulations are generally based on mean monthly water quality
Simulation Start	Oct 1, Yr -2 (month 0)	Golder	Model is based on hydrologic year (October 1 to September 30)

Table C.2: Water Balance Model Assumptions – Mill/Process

Property	Value	Source	Comment/Assumptions
Active Life, i.e., mill operational from / to	Jan. 1, Yr 1 Jan 31, Yr 8	Golder	Mill is active from start of Yr 1 (month 27) to Yr 8 (month 111)
Feed Rate	354.2 t/hr	MMC	Mass including water
Feed Moisture Content	3.36%	Hatch 2007	Percentage by weight
Solids Specific Gravity	3.10	Hatch 2007	
Tails Solids Content	50.8%	Hatch 2007	Slurry to TSF
Maximum Reclaim Rate	258.5 m^3/hr	computed	Based on 20% bulking of settled tails due to ice entrapment and a corresponding water content of 40% (Ww/Ws)
Min. Freshwater Make-Up Rate to Process	72.2 m^3/hr	Hatch 2007	
Potable Freshwater Rate to Mine	3.3 m^3/hr	Hatch 2007	Approximately 230 L/person/day assuming a workforce of 344

Table C.3: Water Balance Model Assumptions – Climate/Runoff Generation

Property	Value	Source	Comment/Assumptions
Precipitation	285 mm/yr	AMEC 2003	1:2 year return period annual precipitation; equal to average conditions Deterministic modelling uses the 1:2 year total. Probabilistic modelling samples the annual total based on the frequency analysis (between 1:100yr dry and 1:100yr wet) presented by AMEC (2003)
Sublimation	9 mm/mo	Golder	Applied over 8 winter months (Oct. to May). Assumed 48% of annual snowfall of 149 mm (AMEC 2003).
Evapotranspiration	80 mm/yr	Golder	Monthly distribution as per site measured pan evaporation rates
Lake Evaporation	258.4 mm/yr	AMEC 2003	Applied to attenuation storage ponds
Terrestrial Runoff	133 mm/yr	computed	Terrestrial runoff = precip. – sublimation - evapotranspiration Precipitation from October to May stored and released in June over a period of one month. Equivalent to a 47% runoff coefficient. Seepage to or from groundwater stores assumed negligible due to permafrost

Table C.4: Water Balance Model Assumptions – Rock Storage Facilities

Property	Value	Source	Comment/Assumptions
Infiltration (shallow)	0, 65 & 80% of total runoff	Golder	Infiltration 0% (winter), 65% (June freshet) or 80% (summer) of total available runoff. Assumed shallow infiltration which reports to base of pile in same month. Surface runoff = total runoff less infiltration. [geochem].
Surface Runoff	Total less Infiltration	Golder	
Water Retention	1%	Golder	Assumed percentage of infiltrated water by volume retained in rock piles until capping
Pile Area Growth Rate		Golder	Linear, assumed to reach final surface area at half their active life [geochem]
Vault RSF Final Area	191 ha	Golder	Footprint area
Vault RSF Active Life	Month 72 to 111	Golder	Pile is active from Oct 1, Yr 4 to Jan 31, Yr 8
Portage RSF Final Area	82.4 ha	Golder	Footprint area
Portage RSF Active Life	Month 27 to 64	Golder	Pile is active from Jan 1, Yr 1 to Feb 28, Yr 4
Portage Pit Rock Dump Final Area	10 ha	Golder	Footprint area
Portage Pit Rock Dump Active Life	Month 54 to 78	Golder	Pile is active from Apr1, Yr 3 to Apr 30, Yr 5
Pile Water Content	10%	Golder	Volumetric content [geochem]

Table C.5: Water Balance Model Assumptions – Attenuation/Storage Ponds

Property	Value	Source	Comment/Assumptions
Ice Thickness	1.5 m	Golder	Average value over pond surface areas, assumed to form November and thaw June.
Dust Control Vault	4,000 m^3/yr	Golder	1000 m^3/mon from June to September, otherwise 0 m^3/month; assumed that the entire volume applied is evaporated.
Dust Control Portage	12,000 m^3/yr	Golder	3000 m^3/mon from June to September, otherwise 0 m^3/month; assumed that the entire volume applied is evaporated.
Initial Water Volume Portage Attenuation Pond	750,000 m^3	Golder	Assumes a portion of water in northwest basin of Second Portage Arm is not dewatered
Target Water Volume Portage Attenuation Pond	620,000 m^3	computed	At the start of winter (including ice) to satisfy the minimum mill freshwater requirement of 72 m^3/hr through the winter.
Min. Free Water Portage Reclaim Pond	558,000 m^3	computed	For mill reclaim/operation, excluding ice. Equal to 90 days X maximum reclaim rate of 258.5 m^3/hr. Water age of 60 to 90 days recommended for reclaim.
Pumping / Treatment		Golder	Any pumping to receiving environment or treatment facility occurs over the four summer months (June to September).
Seepage		Golder	Seepage to or from ponds through Taliks assumed negligible.

Table C.6: Water Balance Model Assumptions – Tributary Areas

Property	Value	Source	Comment/Assumptions
Vault Area	607 ha	Golder	Natural drainage area to Vault dike of 556 ha + 56 ha affected by north end of rock storage pile.
Vault Diversion	152 ha	Golder	Natural areas to the south of "Vault Lake" that drain to Phaser Lake and which could be diverted away from the attenuation storage.
Portage Area	506 ha	Golder	Natural drainage area to Second Portage Arm and Central Dike.
Mill Area	58 ha	Golder	Area of mill which does not naturally drain to Second Portage Arm is collected and directed to Portage attenuation ponds.
Goose Island Pit Area	95 ha	Golder	Area within dikes and to height of land to the west excluding pit footprint. Assumed that runoff from within these areas is collected and directed to the Portage Attenuation Pond. It may be possible, depending on the water quality, to direct some non-contact water from within these areas directly to the receiving environment.
Portage Pit Area	177 ha	Golder	
Portage Diversion	267 ha (Year 1 to 6), 193 ha (Year 6 onwards)	Golder	Natural area to the northwest of Second Portage Arm that can be intercepted via an interceptor ditch and diverted away from the attenuation storage.
Haul Road		Golder	Dust control for haul roads outside of Vault or Portage tributary areas is clean lake water. Assume all dust control water evaporates.

Table C.7: Water Balance Model Assumptions – Tailings Disposal Facility

Property	Value	Source	Comment/Assumptions
Ice Bulking	20%	Golder	Expected range 10 to 30%
Solids Specific Gravity	3.10	Hatch 2007	
Settled Solids Content	71.4%	computed	Ws/(Ws+Ww)
Void Ratio	1.25	computed	Vv/Vs
Water Content	40%	computed	Ww/Ws, assumes voids saturated with ice
Infiltration (shallow)	0, 15 & 40% of total runoff	Golder	Infiltration = 0% (winter), 15% (June freshet) and 40% (summer). Assumed shallow infiltration which reports to base of tailings in same month. Surface runoff = total runoff less infiltration [geochem].
Surface Runoff	0, 85 & 60%	Golder	
Active Life - to / from	Jan. 1, Yr 1 Jan 31, Yr 8	MMC	Pile is active from start of Yr 1 (month 27) to Yr 8 (month 111) – same as mill
Water Content of Exposed Tails	10 and 32%	Golder	Volumetric content assuming 40% void ratio and 25% or 80% saturation respectively for the surface runoff layer or infiltration active layer [geochem].
Surface Area of Exposed Tailings		Golder	Varies with time – deposition plan.

Table C.8: Water Balance Model Assumptions – Open Pits

Property	Value	Source	Comment/Assumptions
Vault Dike Seepage Flux	5.87E-3 L/s/m	Golder	Most likely value - range of 6E-4 to 1.5E-2 L/s/m used in probabilistic simulation.
Portage and Goose Dike, Fault and Groundwater Seepage Flux	varies	Golder	Based on model results. Varies with pit development
Portion of Dewater to Attenuation (initial dewatering of lakes or portion thereof)	0%	Golder	Assume dewatering of lakes within dikes can be managed to eliminate need for centralized treatment i.e., use local sumps for sedimentation before discharging.
Growth Rate of Pit Footprints	Linear	Golder	Pits are assumed to reach their final footprint in 12 months.
Growth Rate of Pit Surface Area	Linear	Golder	Pits assumed to reach their final surface area at the end of their life [geochem].
Runoff Volume	computed	Golder	Computed based on pit footprint (in plan).
Seepage Volume	varies	Golder	All seepages (through dikes, faults and groundwater) assumed to produce and release year round.
Pit Wall Water Content	2.8%	Golder	Volumetric content [geochem].

Note: Other pit parameters see Table C.9.

Table C.9: Water Balance Model Assumptions – Open Pit Parameters (By Pit)

Parameter Pit	Vault[a]	Goose	North Portage (East Dike)	Third Portage (Bay Zone)
Final Footprint (m^2)[b]	418,077	214,838	189,305	378,358
Exposed Footprint (m^2)[c]	4,729	0	7,354	8,743
Final Surface Area (m^2)[b] [geochem]	583,754	328,394	274,786	546,687
Exposed Surface Area (m^2)[c] [geochem]	47,299	0	10,500	9,745
Groundwater Seepage Rate (m^3/day)	N/A	Varies	Varies	Varies
Dike Seepage Rate (m^3/day)	0	Varies	Varies	Varies
Fault Seepage Rate (m^3/day)	N/A	N/A	Varies	
Dike Width[d] [geochem] (m)	35	70	60	55
Dike Length[d] [geochem] (m)	0	2,475	840	1,449
Dike Rockfill [geochem] (m^3)	0	663,186	123,596	240,778 / 120,389[e]
Dike Surface Area[d] [geochem] (m^2)	0	173,250	50,400	79,700
Lake Dewatering Volume (m^3)	$2.0x10^6$	$2.2x10^6$[f]	$13.0x10^6$[g]	$0.7x10^6$[h]
Lake Dewatering Period (mo)	Jun. to Sept. Yr 4	Aug. to Oct. Yr 1	Aug. to Oct. Yr -1	Aug. to Oct. Yr -1
Active Period	Oct. Yr 4 to Jan. Yr 8	Jan. Yr 2 to Feb. Yr 4	Apr. Yr 3 to Dec. Yr 4	Jan. Yr 1 to Apr. Yr 5
Lake Flooding Volume (m^3)	$21.5x10^6$	$14.8x10^6$	$30.0x10^6$	
Flooding Period	Jun. to Sept. Yr 8 to 12	Jun. to Sept. Yr 4 to 11	Jun. to Sept. Yr 5 to 12	

Notes: **a**. Vault groundwater seepage assumed to be zero due to presence of isolated Talik. **b.** Ultimate operational footprint (in plan) and surface area (including walls) of pits. **c.** Exposed footprint (in plan) and surface area (including walls) of pits once flooded. **d**. Length, width and plan area of dike producing surface runoff and infiltration to the pits **e.** Rockfill volume subject to water on upstream side is less when Goose Island comes on-line. **f.** Between Goose Island and Bay Zone dikes. **g.** - Second Portage Lake volume west of East Dike less volume remaining in Portage Attenuation pond. **h.** Third Portage Lake volume north of Bay Zone Dike.

APPENDIX D

Water Balance Simulation Calendar

Table D1: Model Simulation Calendar – Presented in Hydrologic Years (Oct. 1 to Sept. 30), Simulation Timestep = 1 month

Mine Year	Month											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
-2	0	1	2	3	4	5	6	7	8	9	10	11
-1	12	13	14	15	16	17	18	19	20	21	22	23
1	24	25	26	27	28	29	30	31	32	33	34	35
2	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59
4	60	61	62	63	64	65	66	67	68	69	70	71
5	72	73	74	75	76	77	78	79	80	81	82	83
6	84	85	86	87	88	89	90	91	92	93	94	95
7	96	97	98	99	100	101	102	103	104	105	106	107
8	108	109	110	111	112	113	114	115	116	117	118	119
9	120	121	122	123	124	125	126	127	128	129	130	131
10	132	133	134	135	136	137	138	139	140	141	142	143
11	144	145	146	147	148	149	150	151	152	153	154	155

APPENDIX E

Summary of Hydraulic Conductivity Testing

Table E.1: Summary of Hydraulic Conductivity Values Determined from Packer Tests

BH No.	Downhole Depth Interval		Test Type[a]	K (m/s)	Rock Unit/ Comments
	From (m)	To (m)			
TP98-258	18.5	173.0	FH	1×10^{-7}	Intermediate volcanic Highly fractured
	18.5	38.0	FH	6×10^{-7}	Intermediate volcanic Broken core 30.5-31.9 m
	30.5	31.9	FH	5×10^{-6}	Intermediate volcanic Broken core
	39.5	173.0	FH	3×10^{-9}	Iron formation
	75.5	173.0	CH	4×10^{-9}	Ultramafic Bay Zone Fault 82.33 – 88.1
	96.5	173.0	FH	5×10^{-9}	Ultramafic
	150.5	173.0	FH	2×10^{-8}	Intermediate volcanic/iron formation
TP98-261	9.5	152	FH	1×10^{-9}	Quartzite Highly fractured
	22.5	152	FH	2×10^{-9}	Intermediate volcanic/ultramafic
	42.5	152	FH	3×10^{-9}	Intermediate volcanic/Iron Formation
	63.5	152	FH	2×10^{-9}	Ultramafics Bay Zone Fault 73.5-76.8 m
	81.5	152	FH	4×10^{-9}	Intermediate vol./Iron Formation/ultramafic
TP98-265	18.5	50	CH	6×10^{-7}	Int. volcanic/Iron Formation Highly fractured
	18.5	101	CH	3×10^{-7}	Int. volcanic/Iron Formation Highly fractured
	51.5	101	FH	5×10^{-9}	Int. volcanic/Iron Formation
	90.5	101	FH	3×10^{-8}	Int. volcanic/ultramafic Bay Zone Fault 92.87 – 93.22 m
02GT-01	7.5	9.5	FH	2×10^{-6}	Intermediate Volcanic
	7.5	9.5	CH	4×10^{-7}	Intermediate Volcanic
02GT-02	10.5	12.5	FH	4×10^{-7}	Intermediate Volcanic
02GT-03	1.8	3.1	FH	3×10^{-4}	Boulder Till
	9.5	14.5	FH	No recovery	Intermediate Volcanic
	17.5	30	FH	No recovery	Intermediate Volcanic
02GT-04	3.5	8.5	FH	Data unreliable	Till
	6.5	8.5	CH	2×10^{-8}	Intermediate Volcanic
	9.5	17.5	FH	3×10^{-7}	Intermediate Volcanic
	18.5	29.5	FH	2×10^{-8}	Intermediate Volcanic
O2GT-05	15	17	FH	3×10^{-5}	Intermediate Volcanic
02GT-07	5.8	7.1	FH	1×10^{-7}	Sandy Clay Till
	13.5	15.5	FH	1×10^{-6}	Quartzite

BH No.	Downhole Depth Interval		Test Type[a]	K (m/s)	Rock Unit/ Comments
	From (m)	To (m)			
02GT-08	10.5	12.5	FH	1×10^{-4}	Intermediate to Felsic volcaniclasitics
	11.5	17	FH	7×10^{-5}	Intermediate to Felsic volcaniclasitics
	13.5	17	FH	3×10^{-6}	Granite
02-GT-09	24.5	30.5	FH	2×10^{-8}	Ultramafic volcanic
02-GT-10	15.5	28	FH	3×10^{-7}	Intermediate volcanic
	21.5	30	FH	1×10^{-9}	Intermediate volcanic
02GT-11	25	27	FH	3×10^{-5}	Ultramafic volcanic
	22	27	FH	2×10^{-5}	Ultramafic volcanic
NP02-401	135	158	FH	2×10^{-6}	Intermediate Volcanic
	129	158	FH	3×10^{-9}	Intermediate Volcanic
	66	158	FH	5×10^{-7}	Intermediate Volcanic
NP02-412	31	39	FH	9×10^{-6}	Ultramafic Second Portage Fault
	40	69	FH	3×10^{-6}	Intermediate volcanic Second Portage Fault
GT02-NP-1	25.5	111	FH	3×10^{-9}	Iron Formation/ Ultramafic/Intermediate Volcanic
	55.5	111	FH	5×10^{-9}	
	73.5	111	FH	4×10^{-9}	6 m Iron Formation/Chloritic Intermediate Volcanic
	88.5	111	FH	2×10^{-8}	Chloritic Intermediate Volcanic
GT02-NP-2	12	16.5	FH	3×10^{-8}	Mafic
	25.5	30	FH	2×10^{-8}	Quartzite/Mafic Volcanic
	31.5	42	FH	2×10^{-8}	Ultramafic
	64.5	81	FH	2×10^{-8}	Ultramafic/Fault
	87	109.5	FH	3×10^{-9}	Iron Formation/Intermediate Volcanic/Ultramafic
	99	109.5	FH	8×10^{-9}	Ultramafic
06GT-TD1	44.5	67	RH/CH	$>3 \times 10^{-5}$	Quartzite with some soft infill – possibly lake bed sediments
	60.5	83.5	RH/CH	$>3 \times 10^{-5}$	Intermediate Volcanic/Quartzite
	80.5	113	RH/CH	5×10^{-6}	Lower fault to good Quartzite
	98.5	113	RH/CH	1×10^{-5}	Quartzite
	109.5	144	RH/CH	2×10^{-6}	Quartzite/Intermediate Volcanic
	139.5	174	RH/CH	5×10^{-8}	Quartzite/Wacke/Ultramafic
	172.5	204	RH/CH	3×10^{-9}	Intermediate Volcanic
06GT-TD2A	43.5	60	RH/CH	3×10^{-6}	2×10^{-7}
	58.5	81	RH/CH	2×10^{-7}	Intermediate Volcanic/Quartzite
	79.5	105	RH/CH	3×10^{-7}	Quartzite/Intermediate Volcanic/Ultramafic
	103.5	135	RH/CH	2×10^{-7}	Quartzite
	133.5	165	RH/CH	3×10^{-7}	Quartzite, 0.3 m sand seam

BH No.	Downhole Depth Interval		Test Type[a]	K (m/s)	Rock Unit/ Comments
	From (m)	To (m)			
	163.5	201	RH/CH	6×10^{-8}	Intermediate Volcanic
06GT-TD3	25.5	45	RH/CH	2×10^{-5}	Intermediate Volcanic
	43.5	66	RH/CH	1×10^{-5}	Intermediate Volcanic
	64.5	81	RH/CH	6×10^{-7}	Intermediate Volcanic/Iron Formation
	79.5	96	RH/CH	1×10^{-6}	Intermediate Volcanic
	94.5	117	RH/CH	3×10^{-6}	Quartzite/Intermediate Volcanic

Notes: a. FH = falling head, CH = constant head, RH = rising head

APPENDIX F

Waste Storage Facility Site Selection

ROCK STORAGE FACILITIES

The following summarizes the strategy for selecting the locations of the waste rock storage facilities. Additional information of the selection process can be in the report entitled “Evaluation of Waste Rock Management Alternatives, Meadowbank Project, Nunavut,” (Golder, 2005); an appendix to the “Project Alternatives Report” (Cumberland, 2005).

Due to the distance between the Portage mining area and the Vault mining area, two waste rock storage facilities are required. One facility would be near the Vault open pit to accommodate waste rock generated from mining at this location; the second would be near the Portage pits (North Portage and Third Portage) and Goose Island pit.

SITE SELECTION CRITERIA FOR WASTE ROCK STORAGE FACILITIES

The selection of an appropriate site for the rock storage facilities followed a decision matrix approach, whereby a series of selection criteria were developed to describe environmental, operational, and economic factors. This enabled a comparison to be made between the relative importance of these factors for the different sites.

Site Selection Process

The primary objectives established for the waste rock storage facility (or facilities) were to:

- avoid disposal of waste rock into fish bearing waters
- minimize potential long-term environmental impacts (including ARD generation, metal leaching, seepage to the underlying groundwater regime)
- maximize ease of water management during operation
- maximize ease of decommissioning/closure
- minimize the catchment area impacted
- minimize dust generation
- minimize visual impact
- minimize areas of lakes impacted
- minimize footprint area (to reduce the volume of affected runoff)
- minimize the potential for geotechnical hazards (including slope instability, seismic risk)
- minimize haul costs.

Site Selection Criteria

The process used to select waste rock storage facilities involved:

- identifying potential locations

- developing a site specific, decision matrix model to evaluate, rank, and select the best overall facility or facilities.

The decision matrix model considered factors in three primary categories: environmental, operational, and economic.

Each category was further subdivided to consider various components. Within each category, individual sub-indicators were assigned weight values based on subjective estimates of relative importance, so that the sum of the weights would contribute to the overall option weightings, according to the values shown in Table F.1.

Table F.1: Weighting Factors used in Decision Matrix

Factor	Contribution to Overall Weighting
Environmental	50%
Operational	30%
Cost	20%

This approach, sometimes known as a Multiple Accounts Analysis (MAA), is commonly used as a decision-making tool for the selection of waste management facilities. Environmental factors were judged as being the most important, and were therefore assigned the highest overall weighting.

PORTAGE ROCK STORAGE FACILITY OPTIONS

Four areas on the north side of Second Portage Lake were considered as potential waste rock storage areas (see Figure F.1). The weighted scores for the various options are summarized in Table F.2. The full decision matrix is presented in the “Project Alternatives Report” (Cumberland. 2005).

The options were allocated a score for each of the sub-indicators to show the relative difference between options. Weighted scores were derived by multiplying the allocated scores by the individual sub-indicator weighting values and summing the totals. The highest score indicates the most desirable option. On this basis, the preferred location for the RSF in the Portage area is Option A (north of Second Portage Lake with a small footprint).

REFERENCES

1) AMEC AMERICAS LTD., Drawing # A1-131395-100-C-0001 (100-C-0001.DWG), Meadowbank Feasibility Study, April 2005

MEADOWBANK
MINING CORPORATION

MEADOWBANK GOLD PROJECT

PORTAGE ROCK STORAGE OPTIONS

FIGURE F.1

Table F.2: Summary of Weighted Scores for Rock Storage Facility Options

Option	Description	Weighted Score
A	North from Second Portage Lake – small footprint	560
B	Northwest from Portage Lake – large footprint	459
C	East from Vault Haul Road – small footprint	436
D	East from Vault Haul Road – large footprint	355

Note: The highest score indicates the most desirable option.

The facility is expected to eventually freeze, resulting in a reduction in the rates of acid mine drainage (AMD) over the long-term. This methodology is a common strategy used in cold climates and takes advantage of permafrost and the local climate conditions. The site will be progressively reclaimed and capped with a convective insulating layer of acid-neutralizing ultramafic rock.

VAULT WASTE ROCK STORAGE FACILITY OPTIONS

The Vault facility was selected based on the same criteria presented for the Portage facility. There are few suitable locations for a waste rock storage facility near the Vault pit owing to the presence of numerous lakes adjacent to Vault Lake and the lack of topographical relief in the immediate area, which limits the height to which a rock storage facility could be constructed without becoming visible at great distance from the site. In addition, placing waste rock in areas south of Vault Lake would affect a sub-watershed that does not drain toward the Vault open pit. Alternatives that were considered, but were rejected, are listed below:

- On-land storage to the east of Vault Lake. This alternative was rejected due to the distance from the deposit area, which would result in an increase in the overall footprint area for the mine development, as well as an increase in haulage costs. The additional distance for haulage would require the construction of additional roads. Increased traffic would result in increased levels of particulate matter (including dust and exhaust) to the atmosphere to be transported and deposited elsewhere.
- South of the Vault deposit. This alternative was rejected as it placed the waste rock material within a catchment area and sub-watershed that previously remained unaffected.
- Disposal into Wally Lake. This alternative was rejected because there is no convincing evidence to suggest that placing the Vault waste rock material in a submerged environment will have less impact than placing it on land. Placing the waste rock into Wally Lake would unnecessarily impact fish habitat within that lake.

The best alternative for the storage of the waste rock from the Vault pit is on a broad area of land immediately to the west of the open pit area. A cover layer of non-PAG rock is predicted not to be required at the Vault waste rock storage facility because the bulk of this rock is considered to be non-PAG. The drainage from the rock pile will be monitored during operations to verify predictions.

APPENDIX G

Tailings Deposition Plan for 8500 tpd Mill Process Rate

INTRODUCTION

The objectives of the Portage Tailings Storage Facility (TSF) tailings deposition plan are to:

- Define the alignment of the Central Dike that will create an impoundment with capacity to store the life of mine tailings plus a contingency while maintaining the required setback from the Portage Pit.
- Define a deposition sequence that allows the basin to be partitioned and a portion of the TSF to be operated as a storm water attenuation pond for at least 4 years.
- Define a deposition sequence that maintains a tailings pond with sufficient depth for efficient operation of the reclaim barge near the west side of the impoundment.
- Define the staged construction schedule for the dikes so that adequate freeboard is maintained within the impoundment.
- Define a deposition sequence that creates a tailings surface that will require the minimum earthworks during closure and if possible will allow covering of some portion of the tailings surface during operations.
- Define a deposition sequence that promotes freezing of the tailings during the operating period.

DESCRIPTION OF THE FACILITY

The TSF will be located in the "2nd Portage Lake" area. The basin will be created by construction of the Central Dike at the southern limit of the impoundment. The storm water dike will divide the impoundment into two basins, with the northern basin being used as the attenuation pond. Saddle Dams will be constructed on the western perimeter and combined with a rockfill berm used as the tailings and water reclaim pipeline berm. The layout of the TSF is shown on Figure G-1.

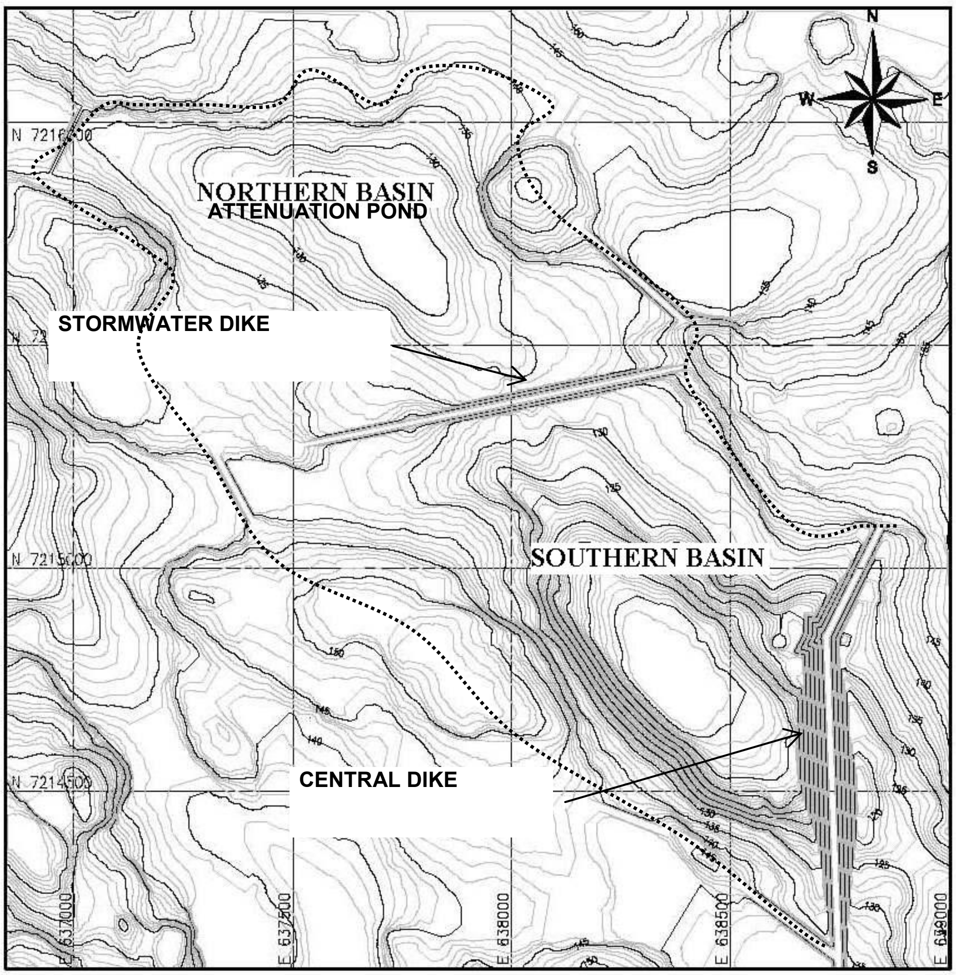


Figure G-1: Meadowbank Gold Project - TSF Layout

DESIGN CRITERIA AND PARAMETERS

The design criteria and parameters used in the development of the tailings deposition plan are summarized in Table G-1.

Table G-1: Tailings Deposition Plan Design Criteria

Design Criteria	Unit	Value
1. Start of operation		February 2009 (winter season)
2. Life Of Mine	year	8
3. Initial Pond Volume	m^3	750,000 (pond for winter operation)
4. Operating Pond		
Average range of pond volume (pond volume increased through winter to minimize ice entrainment in beach) Autumn to Winter Spring to Summer	 m^3 m^3	 750,000 (6,100 m^3/day over 90 days period, plus 200,000 m^3 for ice build-up) 550,000 (6,100 m^3/day over 90 days period)
Location		Western end of the TSF, moving towards NW during operation (pushed away from Central Dike)
5. Discharge lines		
System		ON/OFF
Quantity		Redundant pipelines required to allow uninterrupted operation during winter
6. Discharge Points		
Autumn to Winter		Spigots operated in sequence starting at spigot furthest from Process Plant and retreating towards the Process Plant.
Spring to Summer		Unrestricted, used to maintain pond location
7. Average Settled Dry Density	t/m^3	1.16 to 1.45 (average 1.31[1])
8. Tailings Production Rate		
Total Weight per day	t/day	8,500
Tailings slurry solids concentration	%	50.8
9. Total Required Capacity	Mt	22.0
10. Tailings Slopes		
Average tailings beach	%	0.5 to 1.0
Sub aqueous	%	5.0
11. **Ice Bulking Volume Factor**	%	20

[1] Average dry density assuming 20% bulking of tailings due to ice entrapment

GENERAL ASSUMPTIONS

The tailings deposition plan has been developed assuming that tailings will be discharged into the southern portion of the TSF to the maximum elevation prior to tailings being discharged into the northern basin. This will maximize the time that the northern part of the basin can be used as the Portage Attenuation Pond. Once the southern area is filled, the reclaim barge will be moved into the northern area, and tailings deposition continued into that basin. While the northern area is operated, the southern area will be allowed to freeze, and the rockfill cover placed starting from the Central Dike and working to the north.

Deposition plans were developed for two tailings beach slopes, 0.5% and 1.0%. A steeper tailings beach slope reduces the capacity of a basin, and therefore requires higher containment structures. The results of the deposition plan for the 1.0% beach slope were therefore used to determine the Central Dike alignment relative to the required setback from the Portage Pit crest. For the alignment selected, the Central Dike can be raised at least 3 m using downstream construction methods to provide additional storage capacity while maintaining the specified 60 m setback from the pit.

A flatter tailings beach slope creates a shallower pond that is more difficult to manage. The results of the deposition plan for the 0.5% beach slope were used to define the tailings pond location for reclaim barge operation.

Periodic topographic surveys of the tailings beach and bathymetric surveys of the tailings pond will provide information on beach and underwater slopes and average settled density for use in refining the deposition plan during operations.

The conceptual closure plan considers that the surface of the tailings will be shaped to promote surface runoff and then covered with a layer of rockfill. The thickness of the rockfill will be selected such that the active layer will be within the rockfill and, once frozen the tailings will remain frozen. To minimize the earthworks required at the end of the mine life, the deposition plan has been developed to create a surface that drains towards the left abutment of the Stormwater Dike. On closure, the tailings can be covered with rockfill and a pond maintained against the Saddle Dam. The collected water can be tested, and treated or released depending on quality. Once the water collecting in the pond is demonstrated to be of suitable quality for release, the Saddle Dam can be removed and a permanent channel carrying surface runoff to Third Portage Lake can be constructed.

DISCHARGE POINTS

The discharge points are located strategically around the perimeter of the TSF to push the supernatant pond towards the barges location. Figure G-2 shows the spigots location used in the deposition model.

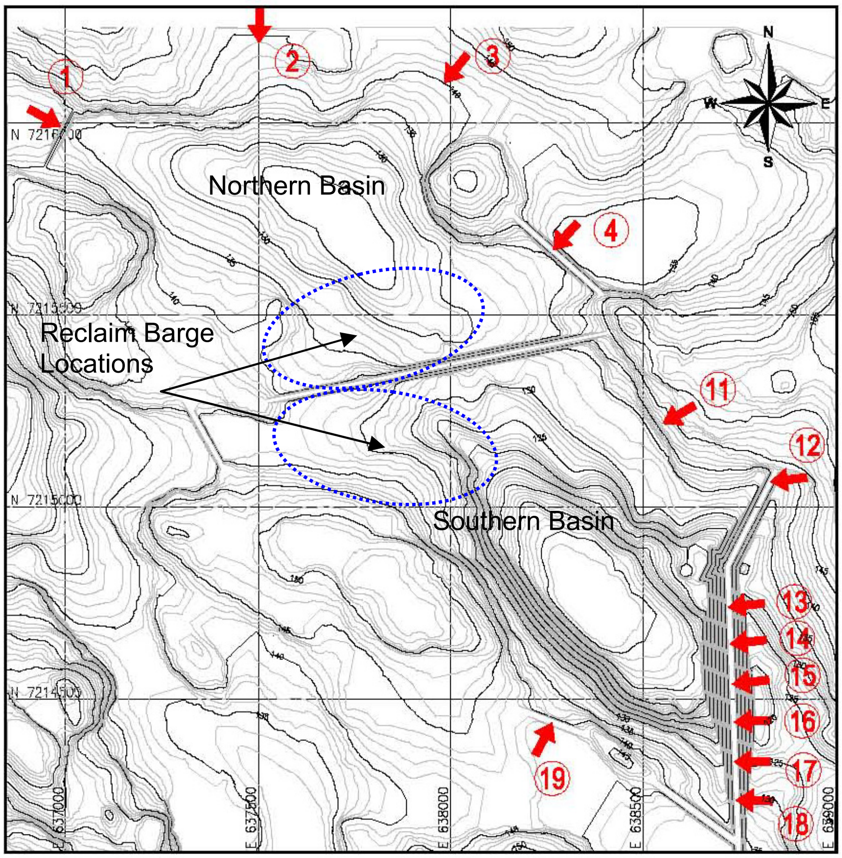


Figure G-2: Spigot Locations for Tailings Deposition Model

To minimize the effort required to change spigots during the winter, the spigots will be used for the maximum time possible at a location and will be operated in sequence from the furthest from the Process Plant to the nearest to the Process Plant. Spigots will be changed either by opening the valve for the new spigot and closing the valve to the old spigot, or by shutting down the pipeline and installing an elbow and spigot line at the next discharge location.

During the summer, the spigots will be operated as required to localize the pond at the reclaim barge location.

TAILINGS DEPOSITION PLAN

Tailings Beach Slope 0.5%

Table G-2 provides the sequence of discharge for a beach tailings slope of 0.5%.

Table G-2: Tailings Deposition Plan - Sequence of Operation - 0.5% Beach Slope

Southern Basin - 0.5% Tailings Beach Slope

General Data						
Tailings slope:			**Supernatant Pond:**			
Beach:	0.5	%	Summer season:	0.50	Mm^3	(May to October)
Below Water:	5.0	%	Winter Season:	0.75	Mm^3	(November to April)
Av. TailingsDry Density:	1.31	t/m^3				
Tailings Producttion:	8,500	tpd				
	6,489	m^3/day				
Beginning of Operation:	1-Feb-09	(dd-mm-yy)	Note (1): Refers to tailings elevation at the end of the considered discharging period			

Discharge Sequence	Tailings Discharge Spigot	Elev. (1)	Area	Volume	Accum. Volume	Ending Discharge	Period of Operaton Days	Months	Years	Supernatant Pond Elev.	Area	Embankment or Location
#	#	m a.s.l.	(m^2)	(m^3)	(m^3)	(dd-mm-yy)	-	-	-	(m a.s.l.)	(m^2)	-
n/a	n/a	n/a	n/a	0	0	31-Jan-09	0	0.0	0.00	106.4	139,242	
1	13	108.00	55,055	175,805	175,805	27-Feb-09	27	0.9	0.07	107.7	144,932	Main Dam
2	14	110.00	88,217	264,757	440,562	8-Apr-09	68	2.3	0.19	109.3	135,798	Main Dam
3	15	111.00	65,548	76,297	516,859	20-Apr-09	80	2.7	0.22	110.1	135,368	Main Dam
4	16	114.00	128,288	497,895	1,014,754	6-Jul-09	156	5.2	0.43	112.5	127,729	Main Dam
5	14	114.70	123,923	196,409	1,211,163	5-Aug-09	187	6.2	0.51	113.6	135,152	Main Dam
6	15	115.70	147,924	174,418	1,385,581	1-Sep-09	214	7.1	0.59	114.2	126,151	Main Dam
7	16	117.00	158,009	208,038	1,593,619	3-Oct-09	246	8.2	0.67	115.1	126,369	Main Dam
8	13	117.70	136,508	282,683	1,876,302	16-Nov-09	289	9.6	0.79	116.5	146,153	Main Dam
9	14	119.00	184,709	267,437	2,143,739	27-Dec-09	330	11.0	0.91	117.5	128,016	Main Dam
10	15	120.50	189,427	237,850	2,381,589	2-Feb-10	367	12.2	1.01	118.7	135,793	Main Dam
11	16	121.70	205,672	263,494	2,645,083	14-Mar-10	408	13.6	1.12	119.4	130,047	Main Dam
12	17	122.70	215,351	259,997	2,905,080	23-Apr-10	448	14.9	1.23	120.3	159,272	Main Dam
13	13	122.70	133,773	166,319	3,071,399	19-May-10	473	15.8	1.30	121.3	150,593	Main Dam
14	15	123.80	219,246	203,275	3,274,674	19-Jun-10	505	16.8	1.38	121.7	130,201	Main Dam
15	13	124.30	183,320	221,615	3,496,289	23-Jul-10	539	18.0	1.48	122.7	146,667	Main Dam
16	15	125.30	194,617	167,857	3,664,146	18-Aug-10	565	18.8	1.55	123.2	140,549	Main Dam
17	13	125.80	206,718	250,925	3,915,071	26-Sep-10	602	20.1	1.65	124.1	147,519	Main Dam
18	14	126.70	253,153	244,427	4,159,498	3-Nov-10	647	21.6	1.77	124.7	138,716	Main Dam
19	15	127.80	267,300	288,832	4,448,330	17-Dec-10	687	22.9	1.88	125.4	138,444	Main Dam
20	16	129.00	277,782	263,148	4,711,478	27-Jan-11	728	24.3	1.99	126.2	147,990	Main Dam
21	17	130.10	287,617	259,995	4,971,473	8-Mar-11	768	25.6	2.10	126.8	147,762	Main Dam
22	13	129.50	176,107	189,763	5,161,236	6-Apr-11	797	26.6	2.18	127.6	170,207	Main Dam
23	15	130.40	253,261	155,933	5,317,169	30-Apr-11	821	27.4	2.25	127.8	154,011	Main Dam
24	13	130.80	248,644	268,875	5,586,044	10-Jun-11	862	28.7	2.36	128.7	164,267	Main Dam
25	15	131.60	236,485	181,991	5,768,035	8-Jul-11	890	29.7	2.44	128.9	156,865	Main Dam
26	13	132.00	265,702	259,554	6,027,589	17-Aug-11	930	31.0	2.55	129.8	166,882	Main Dam
27	14	132.80	325,679	239,287	6,266,876	23-Sep-11	967	32.2	2.65	130.3	164,587	Main Dam
28	15	133.60	339,407	245,381	6,512,257	31-Oct-11	1,005	33.5	2.75	130.7	162,819	Main Dam
29	16	134.60	359,412	267,650	6,779,907	11-Dec-11	1,046	34.9	2.87	131.3	173,365	Main Dam
30	17	135.30	377,159	179,666	6,959,573	8-Jan-12	1,074	35.8	2.94	131.5	170,613	Main Dam
31	13	134.40	226,898	196,787	7,156,360	7-Feb-12	1,104	36.8	3.03	132.0	186,932	Main Dam
32	15	135.40	359,831	166,570	7,322,930	4-Mar-12	1,130	37.7	3.10	132.3	192,903	Main Dam
33	13	135.30	290,118	231,364	7,554,294	9-Apr-12	1,166	38.9	3.19	132.7	197,227	Main Dam
34	15	136.40	417515	298,467	7,852,761	25-May-12	1,212	40.4	3.32	133.1	199,329	Main Dam
35	13	136.50	335080	262,491	8,115,252	4-Jul-12	1,252	41.7	3.43	133.8	208,763	Main Dam
36	14	137.20	464585	275,485	8,390,737	16-Aug-12	1,295	43.2	3.55	134.1	198,828	Main Dam
37	15	137.90	467974	256,943	8,647,680	24-Sep-12	1,334	44.5	3.66	134.4	198,747	Main Dam
38	16	138.70	486705	288,579	8,936,259	8-Nov-12	1,379	46.0	3.78	134.8	196,386	Main Dam
39	19	138.30	231523	243,176	9,179,435	15-Dec-12	1,416	47.2	3.88	135.4	222,686	SW Saddle Dam
40	13	138.50	264912	243,834	9,423,269	22-Jan-13	1,454	48.5	3.98	135.7	198,310	Main Dam
41	19	139.00	279719	240,757	9,664,026	28-Feb-13	1,491	49.7	4.08	135.9	190,446	SW Saddle Dam
42	13	139.30	317206	257,186	9,921,212	9-Apr-13	1,530	51.0	4.19	136.3	186,525	Main Dam
43	11	138.70	146206	267,530	10,188,742	20-May-13	1,572	52.4	4.31	137.3	251,858	Natural ground - Impact on Diversion Dike
44	13	140.30	368739	277,199	10,465,941	1-Jul-13	1,614	53.8	4.42	137.5	233,386	Main Dam
45	16	141.30	281686	256,923	10,722,864	10-Aug-13	1,654	55.1	4.53	137.5	220,069	Main Dam
46	19	141.00	265859	283,559	11,006,423	23-Sep-13	1,698	56.6	4.65	137.9	227,672	SW Saddle Dam
47	11	140.10	192308	268,100	11,274,523	3-Nov-13	1,739	58.0	4.76	138.5	233,057	Natural ground - Impact on Diversion Dike
48	12	141.90	301168	233,746	11,508,269	9-Dec-13	1,775	59.2	4.86	138.8	238,993	Main Dam
49	13	142.30	400140	322,829	11,831,098	28-Jan-14	1,825	60.8	5.00	138.9	212,644	Main Dam
50	16	143.10	232130	181,715	12,012,813	25-Feb-14	1,853	61.8	5.08	139.0	226,318	Main Dam
51	11	141.70	204218	283,749	12,296,562	10-Apr-14	1,897	63.2	5.20	139.8	257,597	Natural ground - Impact on Diversion Dike
52	12	143.50	392827	278,288	12,574,850	23-May-14	1,939	64.6	5.31	140.0	234,962	Main Dam
53	13	143.50	338274	214,040	12,788,890	24-Jun-14	1,972	65.7	5.40	140.1	203,389	Main Dam
54	17	143.50	98348	41,972	12,830,862	1-Jul-14	1,979	66.0	5.42	140.2	224,789	Main Dam
55	19	143.50	214898	219,052	13,049,914	4-Aug-14	2,013	67.1	5.51	140.4	221,253	SW Saddle Dam

Northern Basin - 0.5% Tailings Beach Slope

General Data						
Tailings slope:			**Supernatant Pond:**			
Beach:	0.5	%	Summer season:	0.50	Mm^3	(May to October)
Below Water:	5.0	%	Winter Season:	0.75	Mm^3	(November to April)
Av. TailingsDry Density:	1.31	t/m^3				
Tailings Producttion:	8,500	tpd				
	6,489	m^3/day				
Beginning of Operation:	5-Aug-14	(dd-mm-yy)	Note (1): Refers to tailings elevation at the end of the considered discharging period			

Discharge Sequence	Tailings Discharge				Accum. Volume	Ending Discharge	Period of Operaton			Supernatant Pond		Embankment or Location
	Spigot	Elev. (1)	Area	Volume			Days	Months	Years	Elev.	Area	
#	#	m a.s.l.	(m^2)	(m^3)	(m^3)	(dd-mm-yy)	-	-	-	(m a.s.l.)	(m^2)	-
n/a	n/a	n/a		0	0	5-Aug-14	0	0.0	0.00	130.5	220,056	-
1	1	139.00	95,861	1,904,144	1,904,144	25-May-15	293	9.8	0.80	135.0	222,301	NW Saddle Dam
2	3	138.00	149,837	349,323	2,253,467	18-Jul-15	347	11.6	0.95	136.1	251,381	Potential NE Saddle Dam
3	1	140.50	318,952	424,636	2,678,103	21-Sep-15	413	13.8	1.13	136.4	201,887	NW Saddle Dam
4	3	140.00	242,850	447,230	3,125,333	29-Nov-15	482	16.1	1.32	137.6	242,231	Potential NE Saddle Dam
5	1	141.50	268,177	236,239	3,361,572	5-Jan-16	518	17.3	1.42	137.7	210,049	NW Saddle Dam
6	3	140.90	276,202	278,948	3,640,520	17-Feb-16	561	18.7	1.54	138.3	218,976	Potential NE Saddle Dam
7	2	142.00	392,836	491,473	4,131,993	3-May-16	637	21.2	1.74	138.9	196,101	Natural ground
8	1	143.00	219,962	210,356	4,342,349	4-Jun-16	669	22.3	1.83	139.2	221,222	NW Saddle Dam
9	3	143.00	302,002	449,083	4,791,432	12-Aug-16	738	24.6	2.02	140.1	255,610	Potential NE Saddle Dam
10	1	144.00	298,061	252,543	5,043,975	20-Sep-16	777	25.9	2.13	140.2	210,439	NW Saddle Dam
11	4	142.20	99,780	339,075	5,383,050	11-Nov-16	830	27.7	2.27	141.1	329,741	NE Saddle Dam

Cumulative volumes indicated in the table above correspond separately to southern and northern basins. The sequence of tailings deposition is shown schematically on Drawings G- 01 to 04.

The struck level curve for the TSF is shown in Figure G-3.

Tailings Beach Slope 1%

Table G-3 provides the sequence of discharge for a beach tailings slope of 1%, as follows:

Table G-3: Tailings Deposition Plan - Sequence of Operation – 1.0% Beach Slope

Southern Basin - 1% Tailings Beach Slope

General Data						
Tailings slope:			**Supernatant Pond:**			
Beach:	1.0	%	Summer season:	0.50	Mm^3	(May to October)
Below Water:	5.0	%	Winter Season:	0.75	Mm^3	(November to April)
Av. TailingsDry Density:	1.31	t/m^3				
Tailings Producttion:	8,500	tpd				
	6,489	m^3/day				
Beginning of Operation:	1-Feb-09	(dd-mm-yy)	Note (1): Refers to tailings elevation at the end of the considered discharging period			

Discharge Sequence	Tailings Discharge Spigot	Elev. (1)	Area	Volume	Accum. Volume	Ending Discharge	Period of Operaton Days	Months	Years	Supernatant Pond Elev.	Area	Embankment or Location
#	#	m a.s.l.	(m^2)	(m^3)	(m^3)	(dd-mm-yy)	-	-	-	(m a.s.l.)	(m^2)	-
n/a	n/a	n/a	n/a	0	0	31-Jan-09	0	0.0	0.00	106.4	139,242	
1	13	108.00	52,334	165,265	165,265	25-Feb-09	25	0.8	0.07	107.4	142,575	Main Dam
2	14	110.00	79,778	205,116	370,381	29-Mar-09	57	1.9	0.16	108.7	135,036	Main Dam
3	15	111.00	64,547	78,120	448,501	10-Apr-09	69	2.3	0.19	109.2	129,482	Main Dam
4	16	114.00	115,787	373,619	822,120	6-Jun-09	127	4.2	0.35	111.2	125,517	Main Dam
5	14	114.70	114,506	239,287	1,061,407	13-Jul-09	164	5.5	0.45	112.6	132,554	Main Dam
6	15	115.70	123,264	114,130	1,175,537	31-Jul-09	181	6.0	0.50	112.9	124,445	Main Dam
7	16	117.00	133,028	121,782	1,297,319	18-Aug-09	200	6.7	0.55	113.5	125,904	Main Dam
8	13	117.70	127,567	344,572	1,641,891	11-Oct-09	253	8.4	0.69	115.5	144,993	Main Dam
9	14	119.00	162,814	212,301	1,854,192	12-Nov-09	286	9.5	0.78	116.3	133,238	Main Dam
10	15	120.50	177,811	247,390	2,101,582	20-Dec-09	324	10.8	0.89	117.0	128,719	Main Dam
11	16	121.70	175,942	119,204	2,220,786	8-Jan-10	342	11.4	0.94	117.4	129,007	Main Dam
12	17	122.70	191,225	195,111	2,415,897	7-Feb-10	372	12.4	1.02	118.3	133,585	Main Dam
13	13	122.70	153,359	359,872	2,775,769	3-Apr-10	428	14.3	1.17	119.9	142,147	Main Dam
14	15	124.30	171,404	229,866	3,005,635	9-May-10	463	15.4	1.27	120.3	129,717	Main Dam
15	13	125.00	186,473	353,197	3,358,832	2-Jul-10	518	17.3	1.42	121.8	140,043	Main Dam
16	15	126.00	121,070	134,921	3,493,753	23-Jul-10	538	17.9	1.48	122.0	137,300	Main Dam
17	17	127.00	87,322	50,611	3,544,364	31-Jul-10	638	21.3	1.75	122.2	136,884	Main Dam
18	13	128.00	239,434	644,596	4,188,960	7-Nov-10	653	21.8	1.79	124.4	140,614	Main Dam
19	14	128.50	142,536	99,487	4,288,447	22-Nov-10	679	22.6	1.86	124.6	140,491	Main Dam
20	15	130.00	147,877	165,802	4,454,249	18-Dec-10	727	24.2	1.99	124.8	138,695	Main Dam
21	16	131.30	259,162	315,224	4,769,473	5-Feb-11	776	25.9	2.13	125.8	148,248	Main Dam
22	13	130.80	201,717	357,767	5,127,240	1-Apr-11	831	27.7	2.28	126.9	159,746	Main Dam
23	15	131.60	128,629	56,800	5,184,040	9-Apr-11	840	28.0	2.30	127.0	158,226	Main Dam
24	13	132.00	240,322	291,962	5,476,002	24-May-11	885	29.5	2.42	127.9	162,283	Main Dam
25	14	132.80	233,149	157,757	5,633,759	18-Jun-11	909	30.3	2.49	128.2	159,856	Main Dam
26	15	133.60	201,714	133,177	5,766,936	8-Jul-11	930	31.0	2.55	128.4	161,428	Main Dam
27	13	135.30	338,316	894,676	6,661,612	23-Nov-11	1,067	35.6	2.92	130.6	163,666	Main Dam
28	16	135.30	71,172	84,252	6,745,864	6-Dec-11	1,080	36.0	2.96	130.6	163,666	Main Dam
29	15	136.40	187,612	161,294	6,907,158	31-Dec-11	1,105	36.8	3.03	130.8	165,946	Main Dam
30	13	136.50	299,116	336,932	7,244,090	21-Feb-12	1,157	38.6	3.17	131.6	174,545	Main Dam
31	14	137.20	244,522	125,382	7,369,472	11-Mar-12	1,177	39.2	3.22	131.8	177,170	Main Dam
32	15	137.90	227,789	139,668	7,509,140	2-Apr-12	1,198	39.9	3.28	131.9	180,307	Main Dam
33	16	138.70	229,359	126,329	7,635,469	21-Apr-12	1,218	40.6	3.34	132.0	184,722	Main Dam
34	13	139.30	398,347	947,359	8,582,828	14-Sep-12	1,364	45.5	3.74	133.8	204,917	Main Dam
35	19	139.00	158,233	270,602	8,853,430	26-Oct-12	1,405	46.8	3.85	134.0	195,205	SW Saddle Dam
36	11	138.70	187,397	526,721	9,380,151	15-Jan-13	1,486	49.5	4.07	135.7	224,625	SE Saddle Dam - Impact on Diversion Dike
37	13	140.30	216,100	180,769	9,560,920	12-Feb-13	1,514	50.5	4.15	135.8	215,941	Main Dam
38	16	141.30	125,417	195,694	9,756,614	14-Mar-13	1,544	51.5	4.23	135.8	215,941	Main Dam
39	19	141.00	188,101	265,545	10,022,159	24-Apr-13	1,585	52.8	4.34	136.1	201,307	SW Saddle Dam
40	11	140.10	219,884	305,443	10,327,602	10-Jun-13	1,632	54.4	4.47	136.9	213,027	SE Saddle Dam - Impact on Diversion Dike
41	13	143.00	330,695	570,022	10,897,624	6-Sep-13	1,720	57.3	4.71	137.2	198,915	Main Dam
42	19	144.00	301,188	626,377	11,524,001	12-Dec-13	1,817	60.6	4.98	138.0	232,560	SW Saddle Dam
43	11	142.50	227,184	469,305	11,993,306	22-Feb-14	1,889	63.0	5.18	138.9	223,298	SE Saddle Dam - Impact on Diversion Dike
44	12	145.00	158,348	205,104	12,198,410	25-Mar-14	1,921	64.0	5.26	139.0	228,993	Main Dam
45	13	145.00	263,643	290,044	12,488,454	9-May-14	1,965	65.5	5.38	139.0	220,400	Main Dam
46	19	146.00	342,150	553,081	13,041,535	2-Aug-14	2,051	68.4	5.62	139.5	211,743	SW Saddle Dam
47	11	145.00	262,107	596,299	13,637,834	2-Nov-14	2,143	71.4	5.87	140.7	213,507	SE Saddle Dam - Impact on Diversion Dike

Northern Basin - 1% Tailings Beach Slope

General Data						
Tailings slope:			**Supernatant Pond:**			
Beach:	1.0	%	Summer season:	0.50	Mm^3	(May to October)
Below Water:	5.0	%	Winter Season:	0.75	Mm^3	(November to April)
Av. TailingsDry Density:	1.31	t/m^3				
Tailings Producttion:	8,500	tpd				
	6,489	m^3/day				
Beginning of Operation:	3-Nov-14	(dd-mm-yy)	Note (1): Refers to tailings elevation at the end of the considered discharging period			

Discharge	Tailings Discharge				Accum.	Ending	Period of Operaton			Supernatant Pond		Embankment
Sequence	Spigot	Elev. (1)	Area	Volume	Volume	Discharge	Days	Months	Years	Elev.	Area	or Location
#	#	m a.s.l.	(m^2)	(m^3)	(m^3)	(dd-mm-yy)	-	-	-	(m a.s.l.)	(m^2)	-
n/a	n/a	n/a		0	0	3-Nov-14	0	0.0	0.00	130.5	220,056	
1	1	139.00	212,048	872,399	872,399	18-Mar-15	134	4.5	0.37	132.5	222,908	NW Saddle Dam
2	3	138.00	150,655	625,763	1,498,162	22-Jun-15	231	7.7	0.63	134.4	274,989	Potential NE Saddle Dam
3	1	140.50	174,638	229,941	1,728,103	28-Jul-15	266	8.9	0.73	134.5	233,643	NW Saddle Dam
4	3	140.00	211,675	381,924	2,110,027	25-Sep-15	325	10.8	0.89	135.5	256,986	Potential NE Saddle Dam
5	1	141.50	189,329	167,433	2,277,460	20-Oct-15	351	11.7	0.96	135.5	224,675	NW Saddle Dam
6	3	140.90	245,851	220,502	2,497,962	23-Nov-15	385	12.8	1.05	136.0	234,544	Potential NE Saddle Dam
7	2	142.00	269,427	522,166	3,020,128	12-Feb-16	465	15.5	1.28	136.7	217,362	Natural ground
8	1	143.00	138,058	162,093	3,182,221	8-Mar-16	490	16.3	1.34	136.8	218,830	NW Saddle Dam
9	3	143.00	229,850	340,940	3,523,161	29-Apr-16	543	18.1	1.49	137.5	224,734	Potential NE Saddle Dam
10	1	144.00	177,784	153,558	3,676,719	23-May-16	567	18.9	1.55	137.6	220,556	NW Saddle Dam
11	4	142.20	133,181	624,112	4,300,831	27-Aug-16	663	22.1	1.82	139.3	304,715	NE Saddle Dam
12	2	145.00	284,472	453,118	4,753,949	5-Nov-16	733	24.4	2.01	139.7	254,745	Natural ground
13	3	145.00	118,932	131,388	4,885,337	25-Nov-16	753	25.1	2.06	139.7	241,278	Potential NE Saddle Dam

Cumulative volumes indicated in the table above correspond separately to southern and northern basins.

The sequence of tailings deposition is shown schematically on Drawings G - 05 to 08.

The struck level curve for the TSF is shown in Figure G-3.

CONCLUSIONS

A summary of the main parameters for the tailings deposition plan are shown on Table G-4 for the 0.5% beach slope and Table G-5 for the 1.0% beach slope.

Table G-4: Main Results - 0.5% Tailings Beach Slope- Summary

DESCRIPTION	Unit	Value
Maximum Tailings Elevation:		
Southern Basin		
Against Main Dam (Spigot 12 to 18)	m a.s.l.	143.50
Against SW Saddle Dam (Spigot 19)	m a.s.l.	143.50
Near Diversion Dike (Spigot 11)	m a.s.l.	141.70
Northern Basin:		
Against NW Saddle Dam (Spigot 1)	m a.s.l.	144.00
Against Natural Ground (Spigot 2)	m a.s.l.	142.00
Against Potential NE Saddle Dam (Spigot 3)	m a.s.l.	143.00
Against NE Saddle Dam (Spigot 4)	m a.s.l.	142.20
Maximum Pond Elevation:		
Southern Basin	m a.s.l.	140.40
Northern Basin	m a.s.l.	141.10
Maximum Stored Volume:		
Southern Basin	Mm^3	13.05
Northern Basin	Mm^3	5.38
Total	Mm^3	18.43
Operating Period (approximate)		
Southern Basin	during (years)	5.51
Northern Basin	during (years)	2.27
Total	years	7.79

Table G-5: Main Results - 1% Tailings Beach Slope - Summary

DESCRIPTION	Unit	Value
Maximum Tailings Elevation:		
Southern Basin		
Against Main Dam (Spigot 12 to 18)	m a.s.l.	145.00
Against SW Saddle Dam (Spigot 19)	m a.s.l.	146.00
Near Diversion Dike (Spigot 11)	m a.s.l.	145.00
Northern Basin:		
Against NW Saddle Dam (Spigot 1)	m a.s.l.	144.00
Against Natural Ground (Spigot 2)	m a.s.l.	145.00
Against Potential NE Saddle Dam (Spigot 3)	m a.s.l.	145.00
Against NE Saddle Dam (Spigot 4)	m a.s.l.	142.20
Maximum Pond Elevation:		
Southern Basin	m a.s.l.	140.70
Northern Basin	m a.s.l.	139.70
Maximum Stored Volume:		
Southern Basin	Mm^3	13.64
Northern Basin	Mm^3	4.89
Total	Mm^3	18.52
Operating Period (approximate)		
Southern Basin	during (years)	5.87
Northern Basin	during (years)	2.06
Total	years	7.93

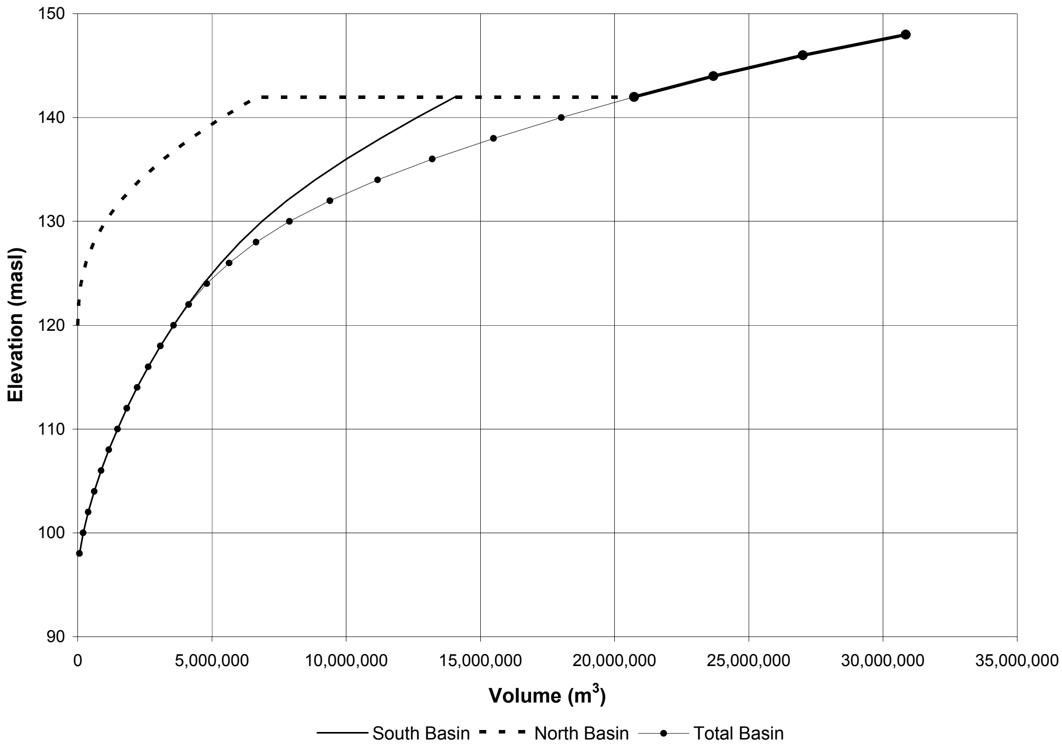
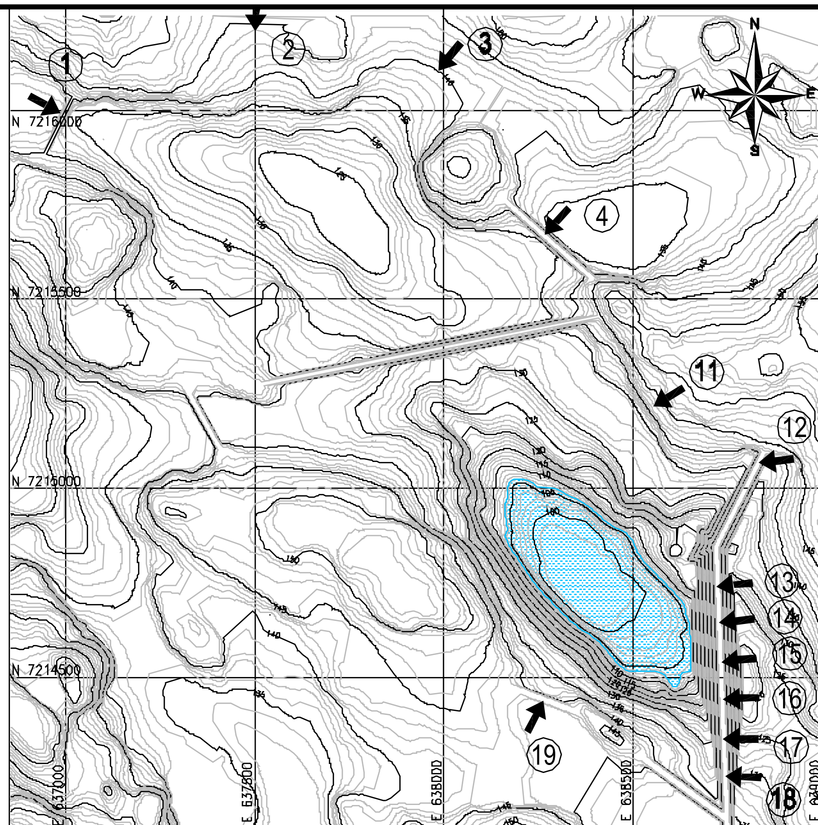
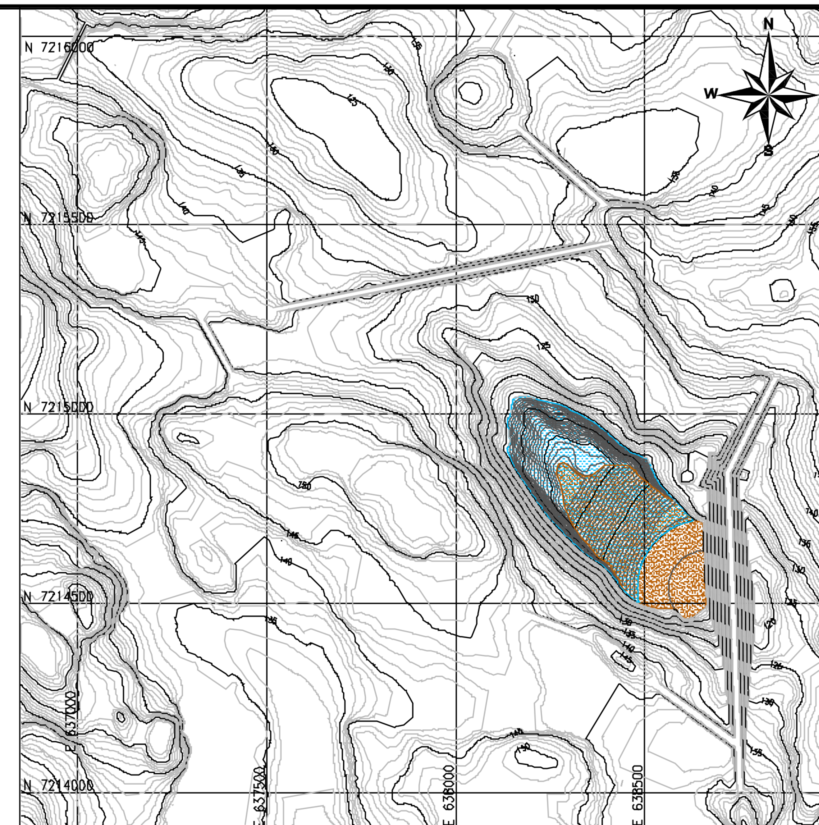


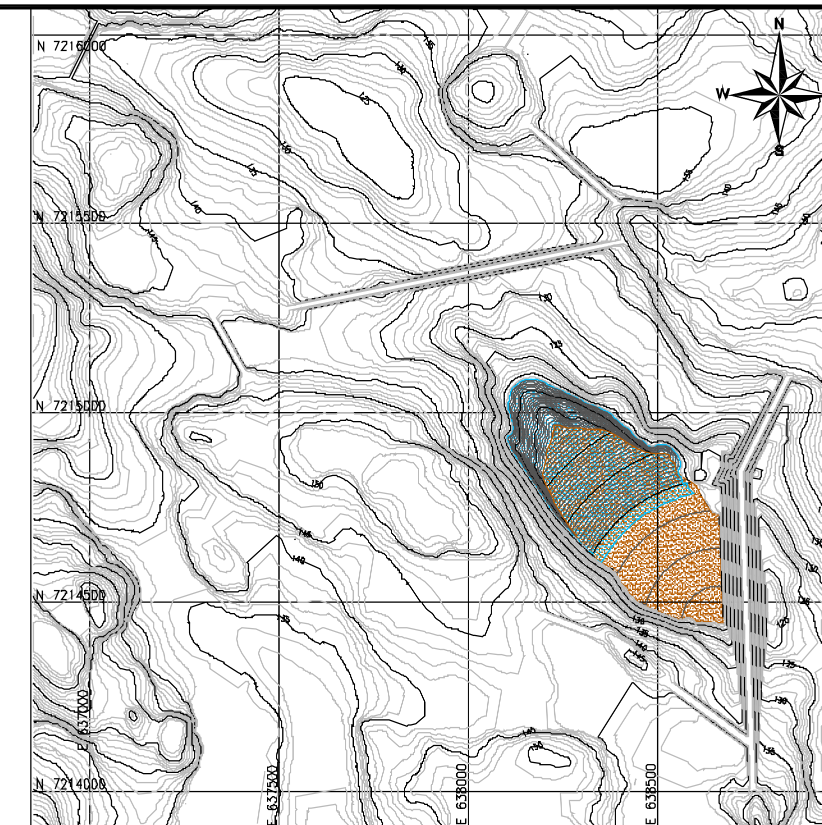
Figure G-3: Struck Level Curve for TSF



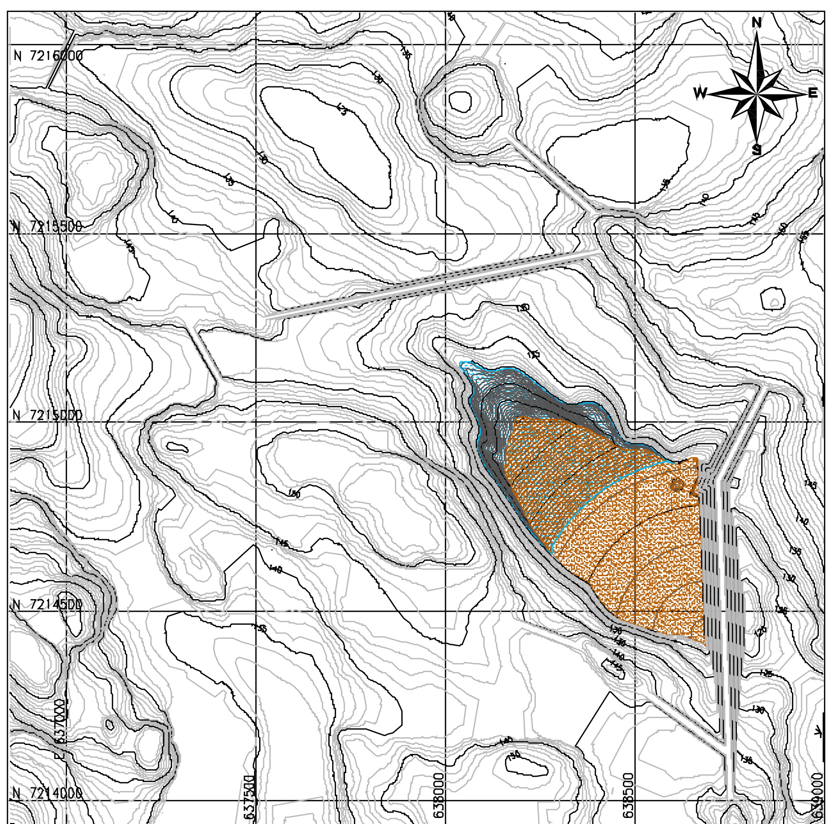
BASE TOPOGRAPHY, SPIGOTS LOCATION AND INITIAL POND



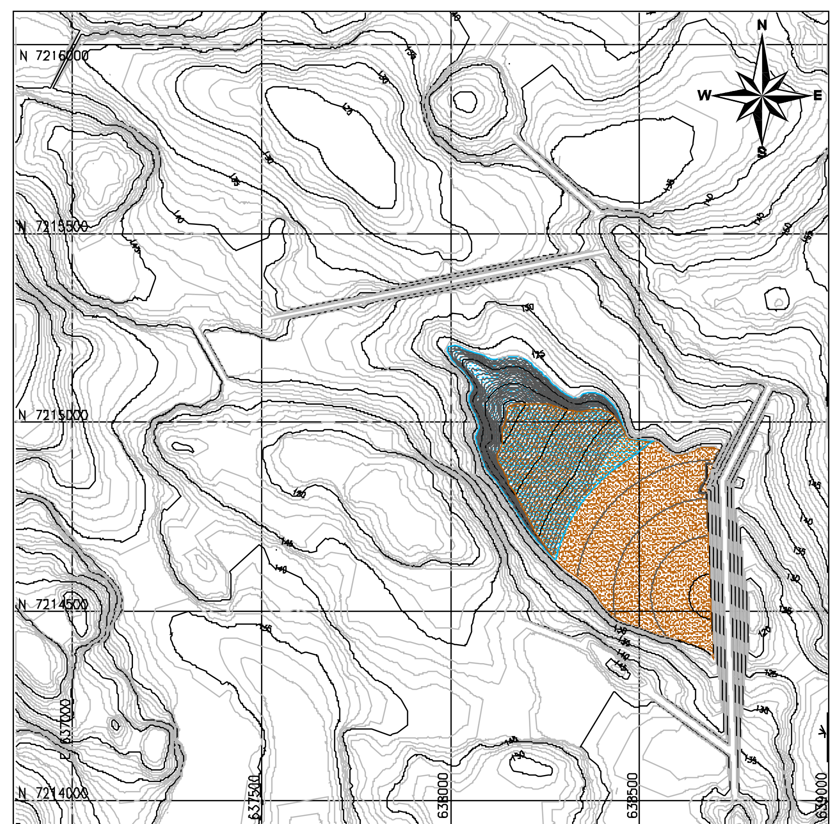
DISCHARGE OPERATING PERIOD: WINTER	from	18-APR-09	STAGE # 3 SOUTH
	to	01-MAY-09	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	111.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.08	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	0.52	
SUPERNATANT POND ELEVATION	m a.s.l.	110.1	
ACTIVE SPIGOTS DURING THE PERIOD		13,14,15	
POND AREA	ha	13.53	
TAILINGS BEACH AREA	ha	3.54	



DISCHARGE OPERATING PERIOD: SUMMER	from	01-OCT-09	STAGE # 7 SOUTH
	to	05-NOV-09	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	117.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.21	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	1.59	
SUPERNATANT POND ELEVATION	m a.s.l.	115.1	
ACTIVE SPIGOTS DURING THE PERIOD		16,14,15,16	
POND AREA	ha	12.63	
TAILINGS BEACH AREA	ha	7.63	



DISCHARGE OPERATING PERIOD: WINTER	from	23-MAR-10	STAGE # 11 SOUTH
	to	08-MAY-10	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	121.7	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.26	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	2.65	
SUPERNATANT POND ELEVATION	m a.s.l.	119.4	
ACTIVE SPIGOTS DURING THE PERIOD		13,14,15,16	
POND AREA	ha	13.00	
TAILINGS BEACH AREA	ha	13.22	



DISCHARGE OPERATING PERIOD: SUMMER	from	04-OCT-10	STAGE # 16 SOUTH
	to	02-NOV-10	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	125.3	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.17	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	3.66	
SUPERNATANT POND ELEVATION	m a.s.l.	123.2	
ACTIVE SPIGOTS DURING THE PERIOD		17,13,15,13,15	
POND AREA	ha	14.05	
TAILINGS BEACH AREA	ha	15.75	

NOTES:
1. THE DAM ALIGNMENTS SHOWN ARE INDICATIVE ONLY.
2. THE DAM FOOTPRINTS SHOWN PERTAIN TO THE ESTIMATED MAXIMUM CREST ELEVATIONS. THE CONSTRUCTION OF THE DAMS WILL BE STAGED OR DEFERRED.
3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m^3 HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
"WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

(X) SPIGOTS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

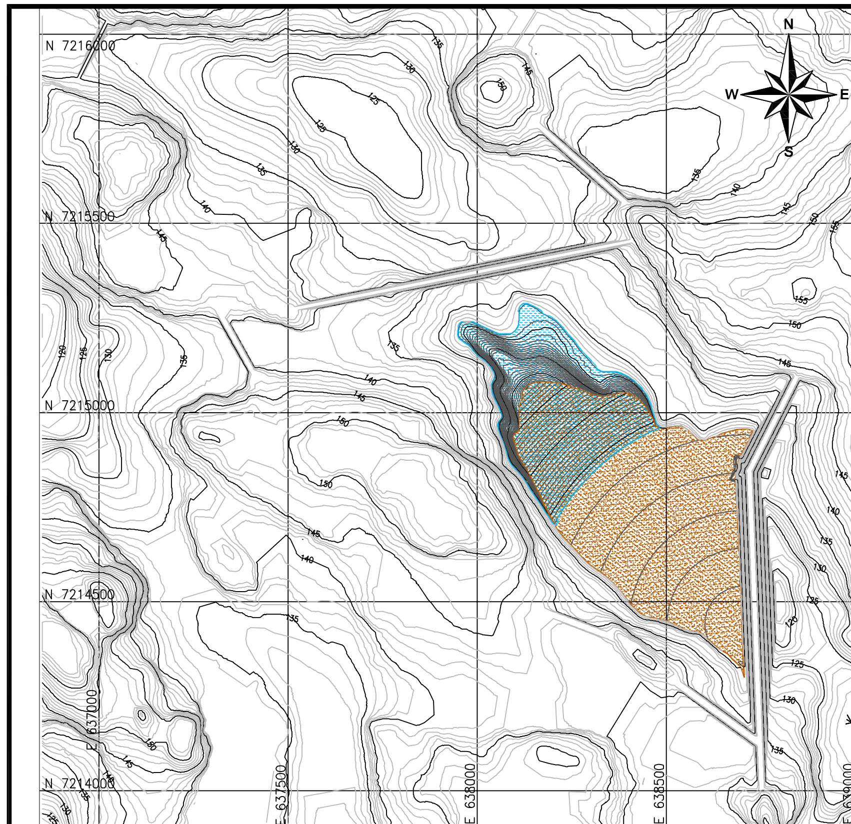
MEADOWBANK
MINING CORPORATION

TITLE

MEADOWBANK GOLD PROJECT
TAILING DEPOSITION PLAN
CASE 1: TAILINGS BEACH SLOPE 0.5%

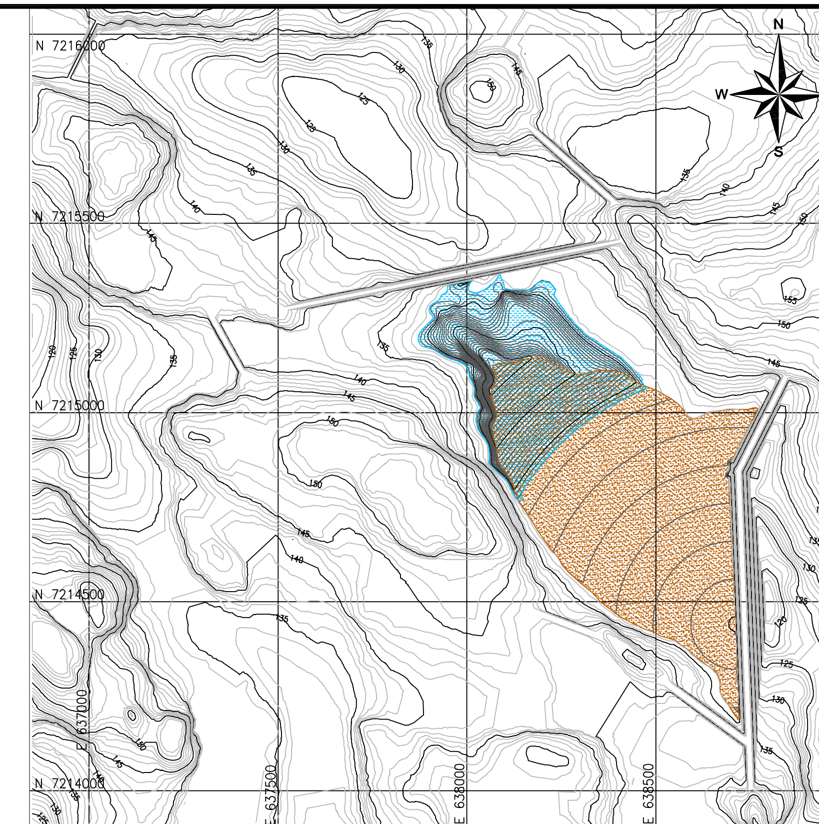
PROJECT No.	06-1413-089		FILE No.	061413089-6000-01
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-01	
CHECK	M.M.	FEBRUARY 07		
REVIEW	C.A.	FEBRUARY 07		

REVISION DATE: 07/07/05 05:05PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-01.dwg

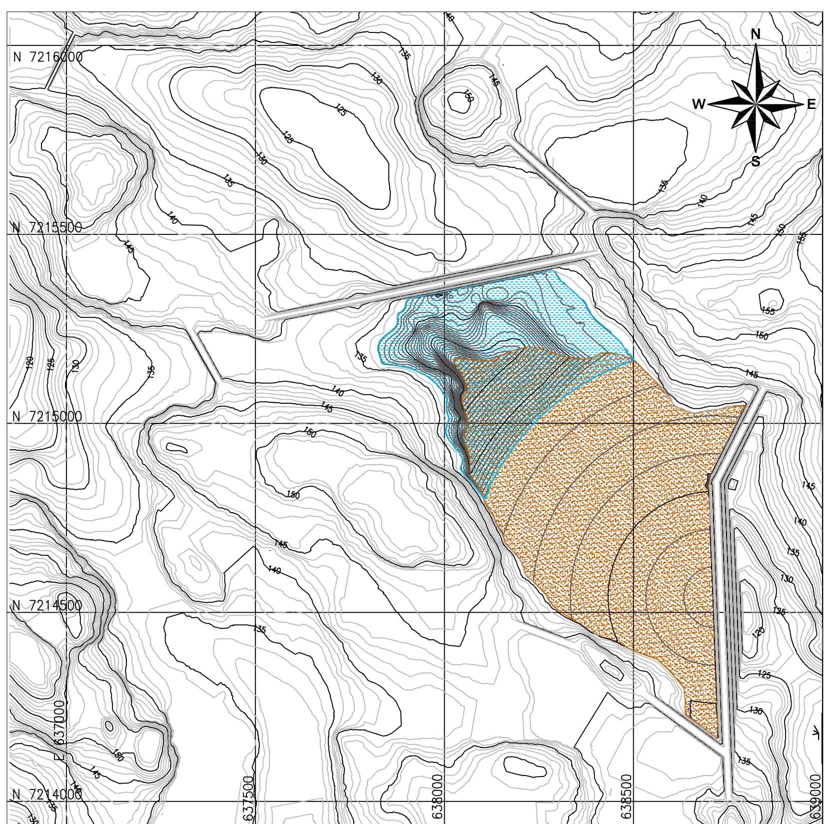


DISCHARGE OPERATING PERIOD:	WINTER	from	19-MAR-11	STAGE #
		to	03-MAY-11	20
FINAL DISCHARGE POINT ELEVATION		m a.s.l.	129.0	SOUTH
PARTIAL STORED TAILINGS VOLUME		Mm^3	0.26	
CUMULATIVE STORED TAILINGS VOLUME		Mm^3	4.71	
SUPERNATANT POND ELEVATION		m a.s.l.	126.2	
ACTIVE SPIGOTS DURING THE PERIOD			13,14,15,16	
POND AREA		ha	14.79	
TAILINGS BEACH AREA		ha	19.97	

DISCHARGE OPERATING PERIOD:	SUMMER	from	04-OCT-11	STAGE #
		to	04-NOV-11	25
FINAL DISCHARGE POINT ELEVATION		m a.s.l.	131.6	SOUTH
PARTIAL STORED TAILINGS VOLUME		Mm^3	0.18	
CUMULATIVE STORED TAILINGS VOLUME		Mm^3	5.77	
SUPERNATANT POND ELEVATION		m a.s.l.	128.9	
ACTIVE SPIGOTS DURING THE PERIOD			13,14,15,16	
POND AREA		ha	15.68	
TAILINGS BEACH AREA		ha	21.89	



DISCHARGE OPERATING PERIOD:	WINTER	from	14-MAR-12	STAGE #
		to	29-APR-12	29
FINAL DISCHARGE POINT ELEVATION		m a.s.l.	134.6	SOUTH
PARTIAL STORED TAILINGS VOLUME		Mm^3	0.27	
CUMULATIVE STORED TAILINGS VOLUME		Mm^3	6.78	
SUPERNATANT POND ELEVATION		m a.s.l.	131.3	
ACTIVE SPIGOTS DURING THE PERIOD			13,14,15,16	
POND AREA		ha	17.33	
TAILINGS BEACH AREA		ha	29.05	



DISCHARGE OPERATING PERIOD:	SUMMER	from	12-SEP-12	STAGE #
		to	02-NOV-12	34
FINAL DISCHARGE POINT ELEVATION		m a.s.l.	136.4	SOUTH
PARTIAL STORED TAILINGS VOLUME		Mm^3	0.30	
CUMULATIVE STORED TAILINGS VOLUME		Mm^3	7.85	
SUPERNATANT POND ELEVATION		m a.s.l.	133.1	
ACTIVE SPIGOTS DURING THE PERIOD			17,13,15,13,15	
POND AREA		ha	19.93	
TAILINGS BEACH AREA		ha	36.49	

DISCHARGE OPERATING PERIOD:	WINTER	from	22-MAR-13	STAGE #
		to	10-MAY-13	38
FINAL DISCHARGE POINT ELEVATION		m a.s.l.	138.7	SOUTH
PARTIAL STORED TAILINGS VOLUME		Mm^3	0.29	
CUMULATIVE STORED TAILINGS VOLUME		Mm^3	8.94	
SUPERNATANT POND ELEVATION		m a.s.l.	134.8	
ACTIVE SPIGOTS DURING THE PERIOD			13,14,15,16	
POND AREA		ha	19.63	
TAILINGS BEACH AREA		ha	46.46	

NOTES:
1. THE DAM ALIGNMENTS SHOWN ARE INDICATIVE ONLY.
2. THE DAM FOOTPRINTS SHOWN PERTAIN TO THE ESTIMATED MAXIMUM CREST ELEVATIONS. THE CONSTRUCTION OF THE DAMS WILL BE STAGED OR DEFERRED.
3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
"WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

MEADOWBANK
MINING CORPORATION

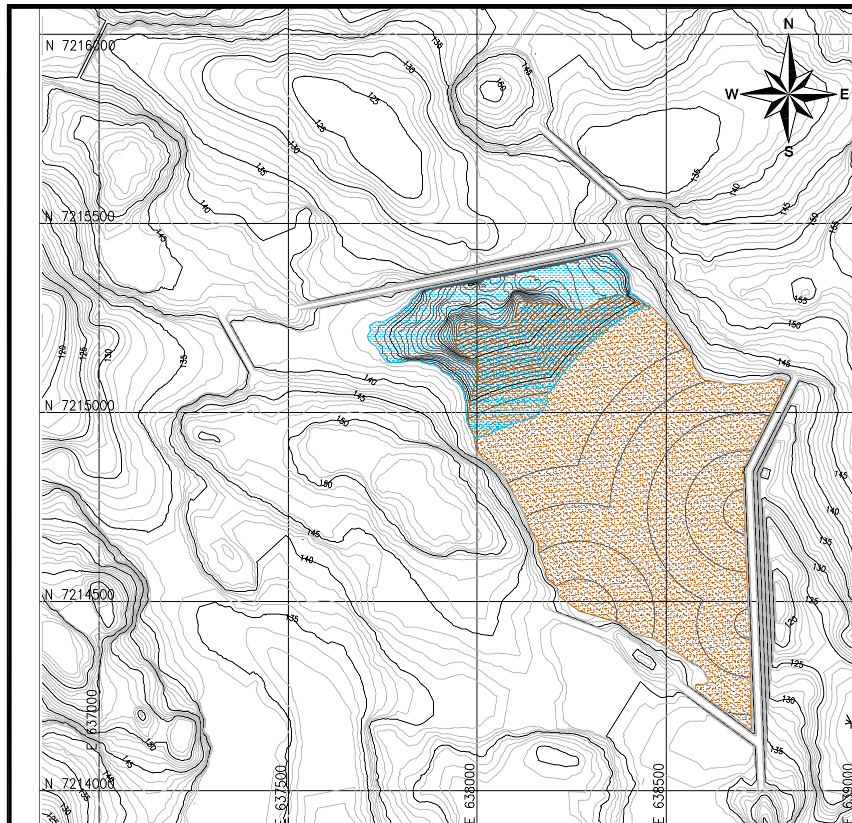
TITLE

MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION (2 OF 8)
CASE 1 : TAILINGS BEACH SLOPE 0.5%

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-6000-02
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-02	
CHECK	M.M.	FEBRUARY 07		
REVIEW	C.A.	FEBRUARY 07		

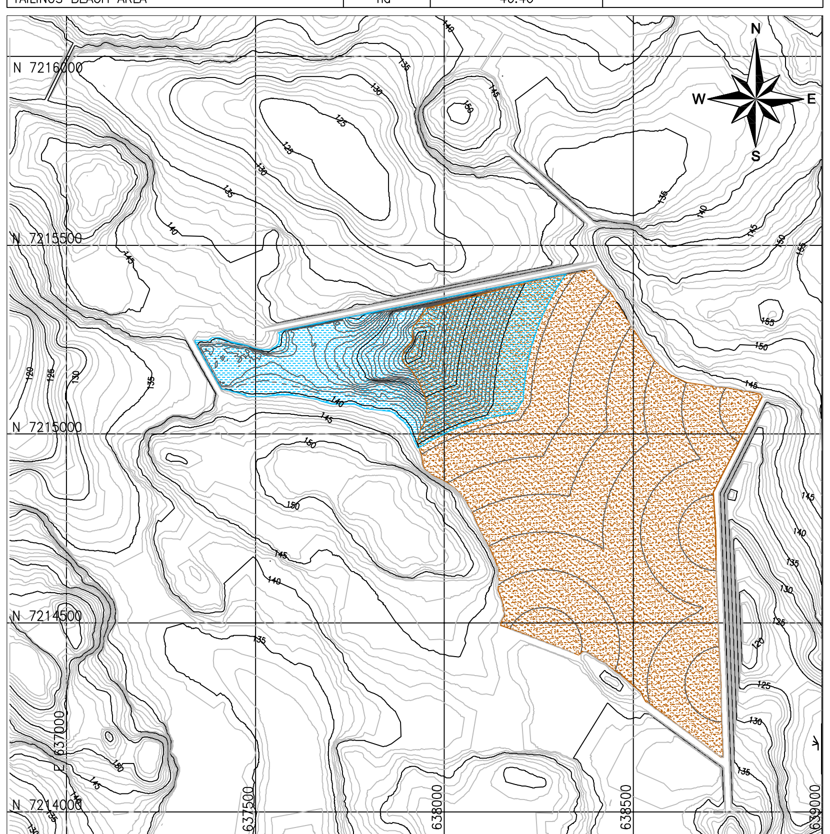
REVISION DATE: 07/07/05 05:11PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-02.dwg



DISCHARGE OPERATING PERIOD: SUMMER	from	15-SEP-13	STAGE #
	to	29-OCT-13	42
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	139.3	SOUTH
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.26	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	9.92	
SUPERNATANT POND ELEVATION	m a.s.l.	136.3	
ACTIVE SPIGOTS DURING THE PERIOD		19,13,19,13	
POND AREA	ha	18.65	
TAILINGS BEACH AREA	ha	46.46	

DISCHARGE OPERATING PERIOD: WINTER	from	19-MAR-14	STAGE #
	to	07-MAY-14	46
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	141.0	SOUTH
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.28	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	11.01	
SUPERNATANT POND ELEVATION	m a.s.l.	137.9	
ACTIVE SPIGOTS DURING THE PERIOD		11,13,16,19	
POND AREA	ha	22.76	
TAILINGS BEACH AREA	ha	47.92	

DISCHARGE OPERATING PERIOD: SUMMER	from	29-SEP-14	STAGE #
	to	30-OCT-14	50
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	143.1	SOUTH
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.18	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	12.01	
SUPERNATANT POND ELEVATION	m a.s.l.	139.0	
ACTIVE SPIGOTS DURING THE PERIOD		11,12,13,16	
POND AREA	ha	22.63	
TAILINGS BEACH AREA	ha	57.69	



DISCHARGE OPERATING PERIOD: WINTER	from	23-MAR-15	STAGE #
	to	29-APR-15	55
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	143.5	SOUTH
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.22	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	13.05	
SUPERNATANT POND ELEVATION	m a.s.l.	140.4	
ACTIVE SPIGOTS DURING THE PERIOD		11,12,13,17,19	
POND AREA	ha	22.12	
TAILINGS BEACH AREA	ha	57.69	

NOTES:

1. THE DAM ALIGNMENTS SHOWN ARE INDICATIVE ONLY.
2. THE DAM FOOTPRINTS SHOWN PERTAIN TO THE ESTIMATED MAXIMUM CREST ELEVATIONS. THE CONSTRUCTION OF THE DAMS WILL BE STAGED OR DEFERRED.
3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER. "WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

MEADOWBANK
MINING CORPORATION

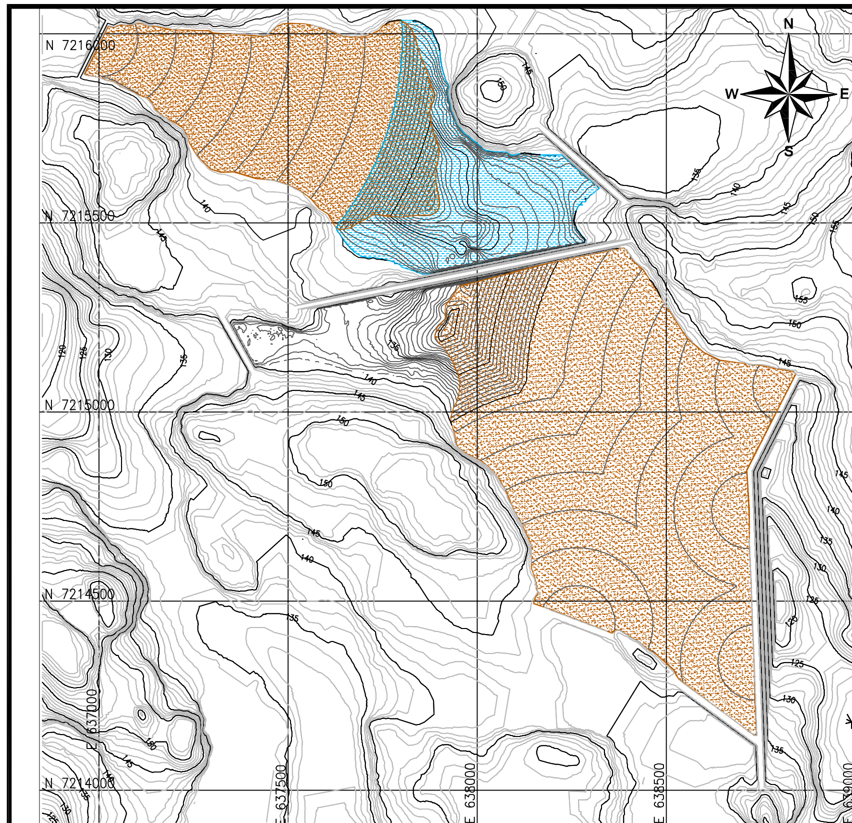
TITLE

MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION (3 OF 8)
CASE 1: TAILINGS BEACH SLOPE 0.5%

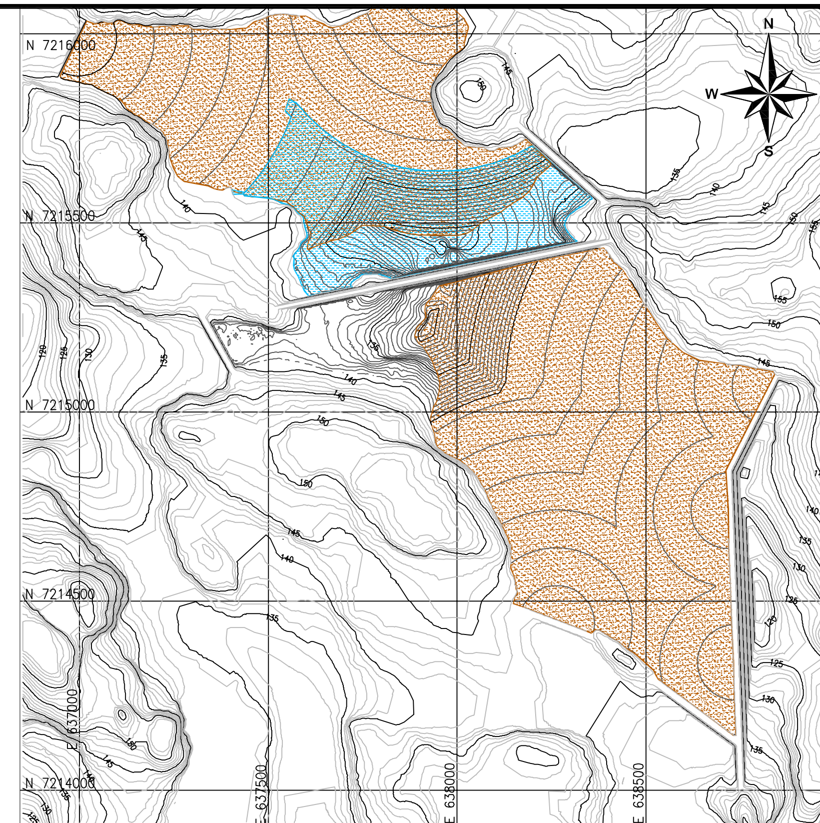
Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-6000-03
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-03	
CHECK	M.M.	FEBRUARY 07		
REVIEW	C.A.	FEBRUARY 07		

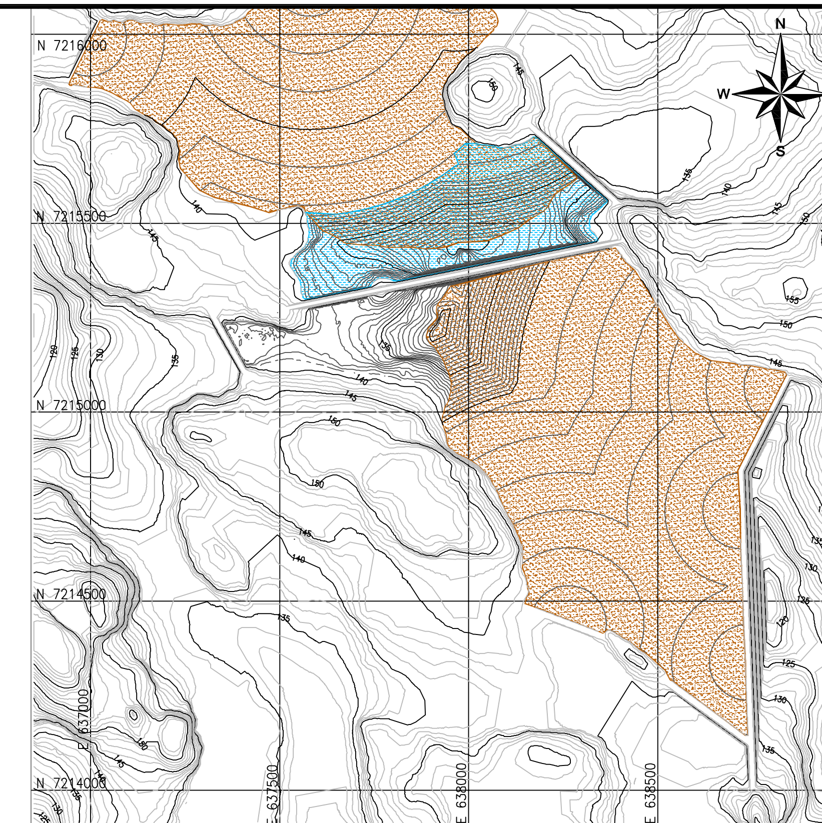
REVISION DATE: 07/07/05 05:17PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-03.dwg



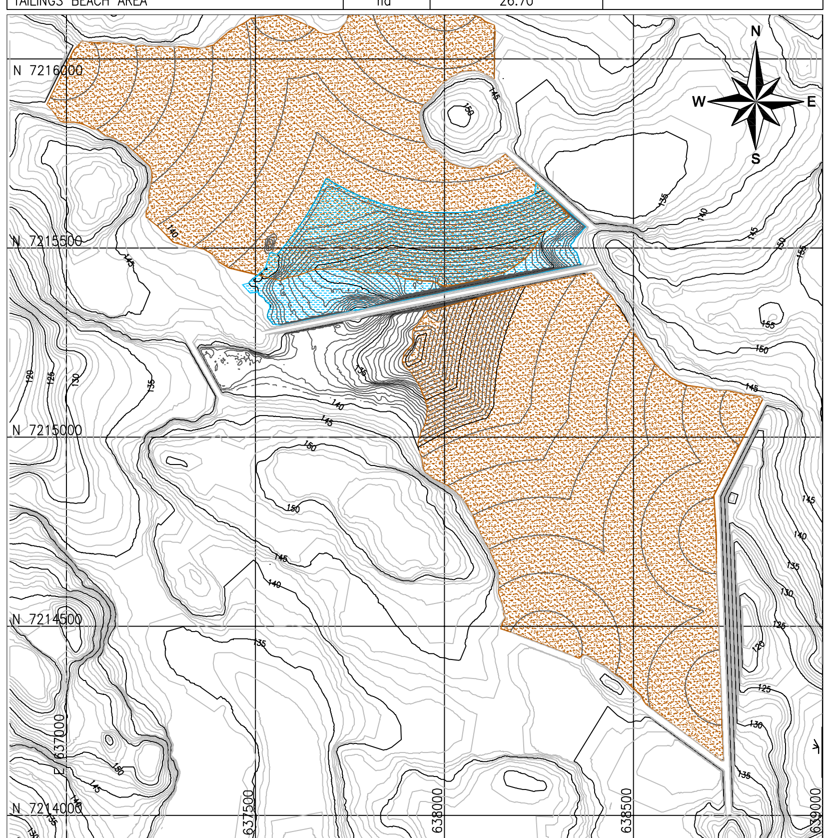
DISCHARGE OPERATING PERIOD: WINTER	from	30-APR-15	STAGE # 1 NORTH
	to	27-MAR-16	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	139.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	1.90	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	1.90	
SUPERNATANT POND ELEVATION	m a.s.l.	135.0	
ACTIVE SPIGOTS DURING THE PERIOD		1	
POND AREA	ha	22.00	
TAILINGS BEACH AREA	ha	26.70	



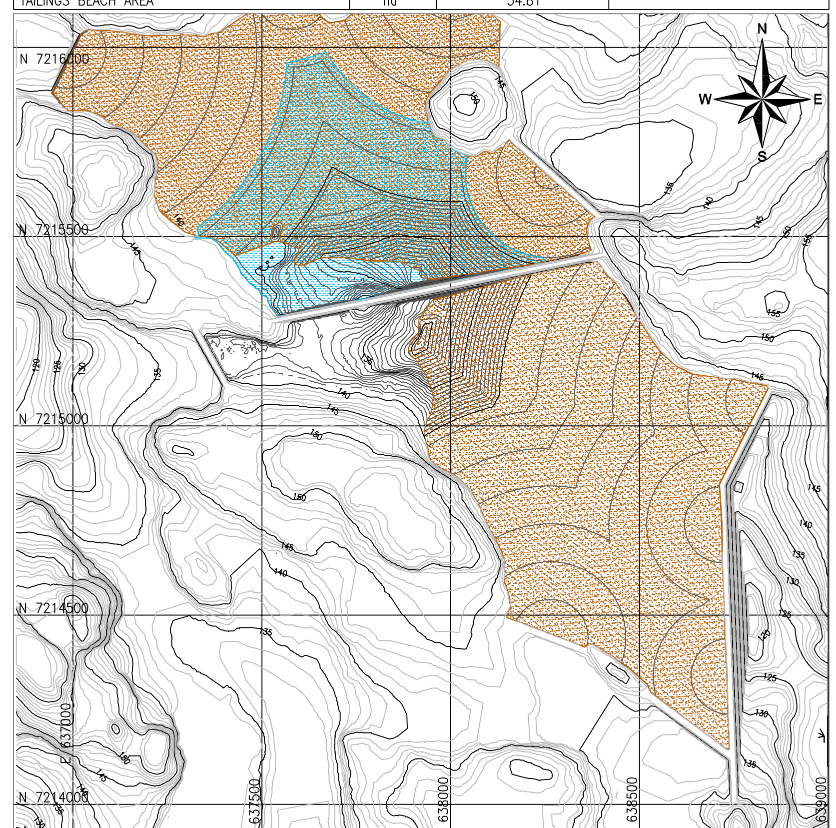
DISCHARGE OPERATING PERIOD: SUMMER	from	11-AUG-16	STAGE # 4 NORTH
	to	27-OCT-16	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	140.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.45	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	3.13	
SUPERNATANT POND ELEVATION	m a.s.l.	137.6	
ACTIVE SPIGOTS DURING THE PERIOD		3,1,3	
POND AREA	ha	24.22	
TAILINGS BEACH AREA	ha	34.81	



DISCHARGE OPERATING PERIOD: WINTER	from	26-JAN-17	STAGE # 7 NORTH
	to	21-APR-17	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	142.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.49	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	4.13	
SUPERNATANT POND ELEVATION	m a.s.l.	138.9	
ACTIVE SPIGOTS DURING THE PERIOD		1,3,2,	
POND AREA	ha	19.61	
TAILINGS BEACH AREA	ha	45.31	



DISCHARGE OPERATING PERIOD: SUMMER	from	15-AUG-17	STAGE # 10 NORTH
	to	27-SEPT-17	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	144.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.25	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	5.04	
SUPERNATANT POND ELEVATION	m a.s.l.	140.2	
ACTIVE SPIGOTS DURING THE PERIOD		1,3,1	
POND AREA	ha	21.04	
TAILINGS BEACH AREA	ha	52.52	



DISCHARGE OPERATING PERIOD: WINTER	from	28-SEPT-17	STAGE # 11 NORTH
	to	25-NOV-17	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	142.2	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.34	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	5.38	
SUPERNATANT POND ELEVATION	m a.s.l.	141.1	
ACTIVE SPIGOTS DURING THE PERIOD		4	
POND AREA	ha	32.97	
TAILINGS BEACH AREA	ha	33.81	

NOTES:

1. THE DAM ALIGNMENTS SHOWN ARE INDICATIVE ONLY.
2. THE DAM FOOTPRINTS SHOWN PERTAIN TO THE ESTIMATED MAXIMUM CREST ELEVATIONS. THE CONSTRUCTION OF THE DAMS WILL BE STAGED OR DEFERRED.
3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
   "WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
   0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

SUPERNATANT POND

TAILINGS

20 10 0 10 20

SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

MEADOWBANK
MINING CORPORATION

TITLE

MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION PLAN (4 OF 8)
CASE 1 : TAILINGS BEACH SLOPE 0.5%

Golder Associates

PROJECT No.		06-1413-089	FILE No. 061413089-6000-04
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-04
CHECK	M.M.	FEBRUARY 07	
REVIEW	C.A.	FEBRUARY 07	

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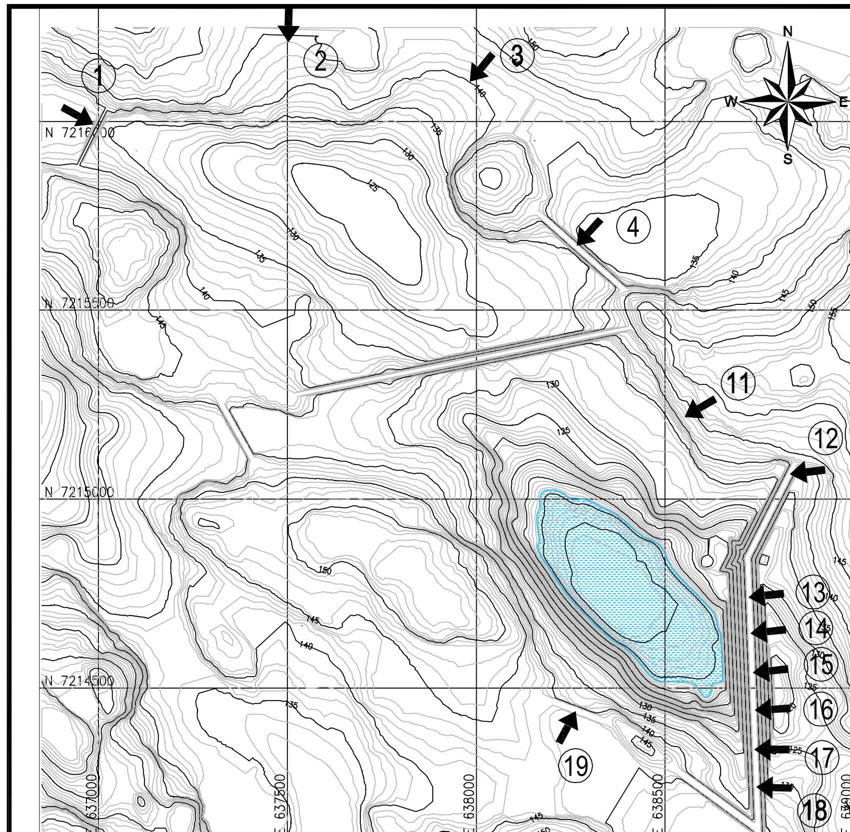
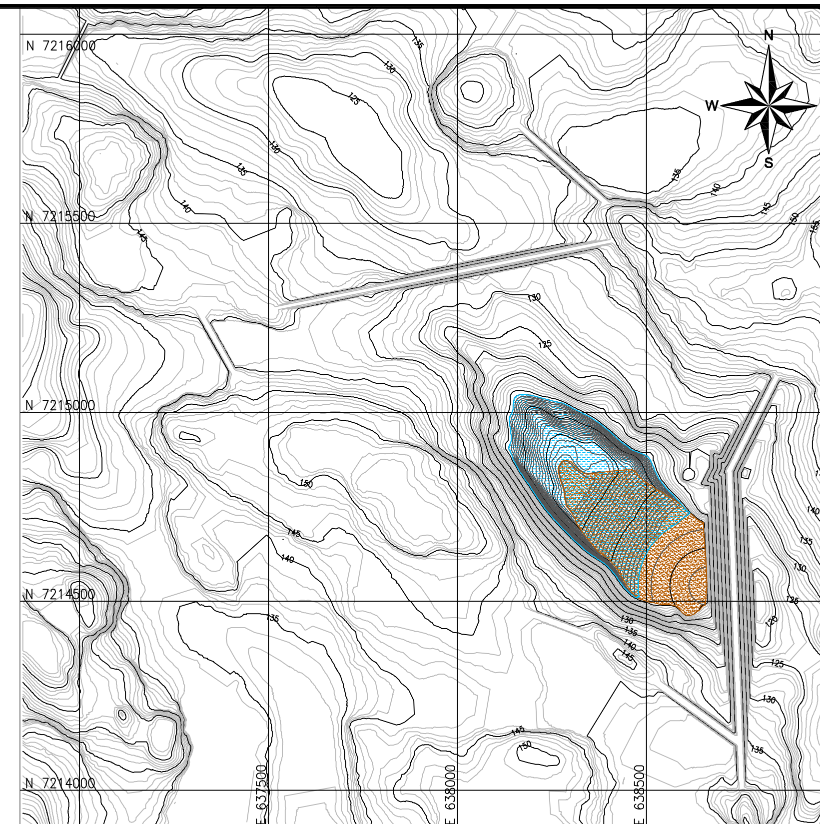
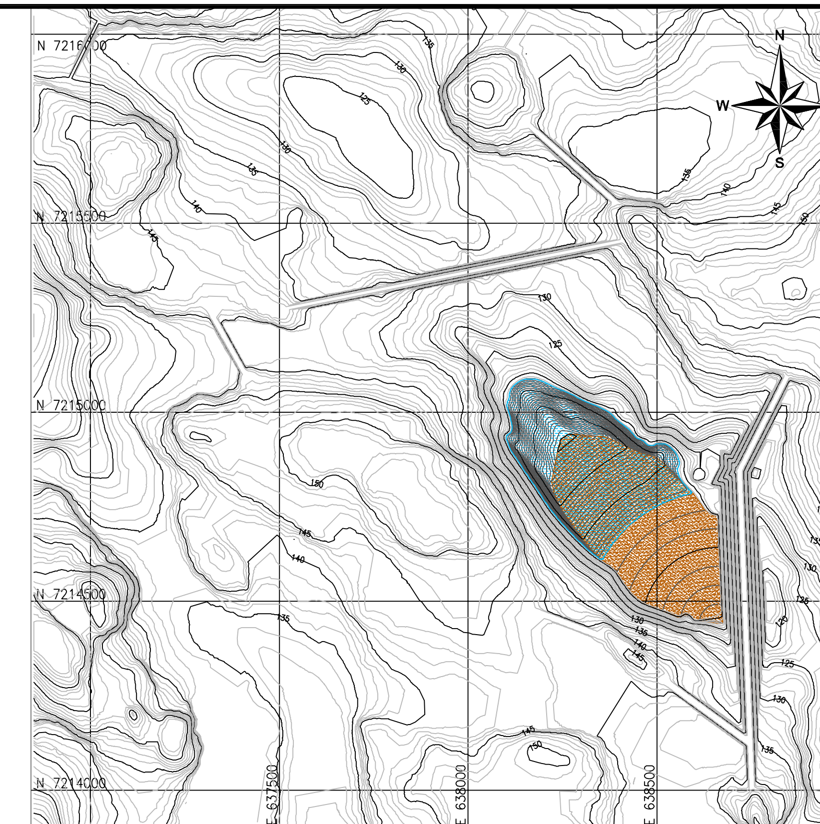
REVISION DATE: 07/07/05 05:22PM By: ASalvador



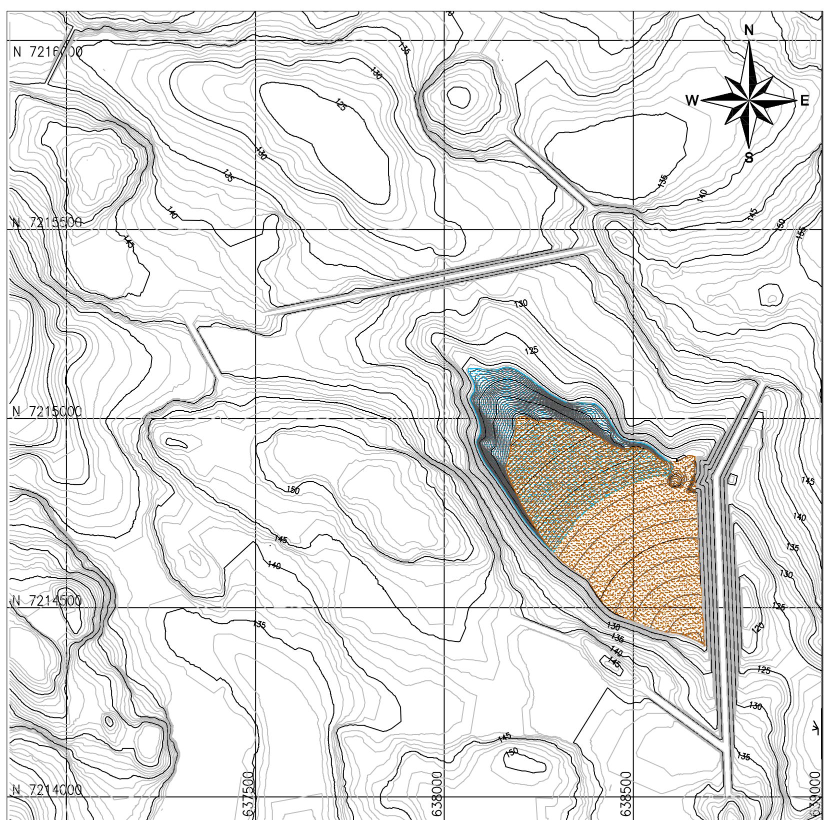
BASE TOPOGRAPHY, SPIGOTS LOCATION AND INITIAL POND



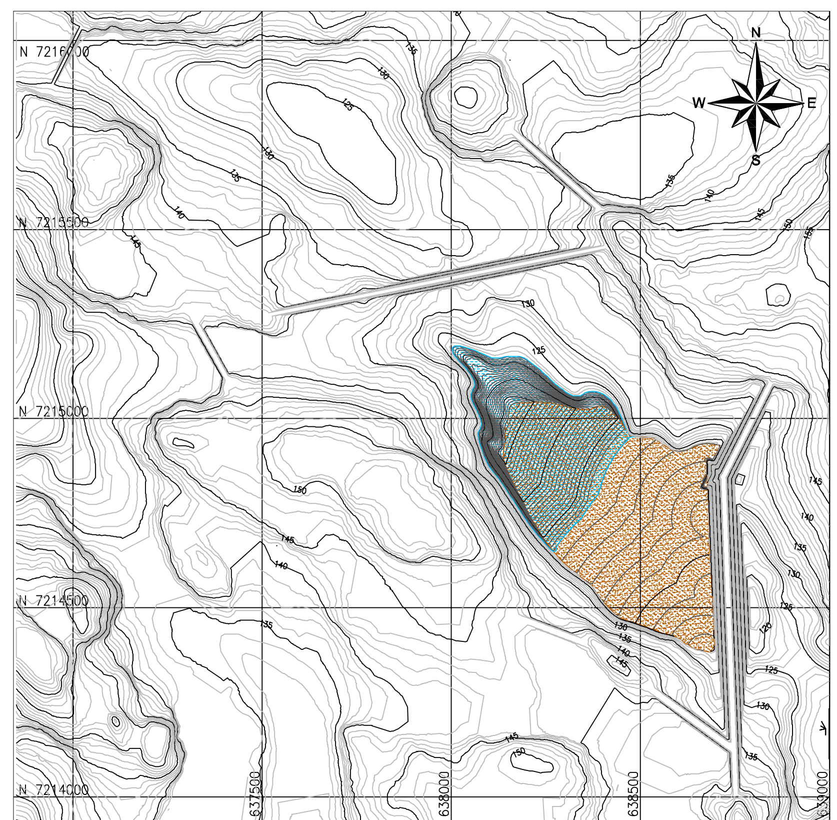
DISCHARGE OPERATING PERIOD: WINTER	from	06-APR-09	STAGE # 3 SOUTH
	to	19-APR-09	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	111.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.08	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	0.45	
SUPERNATANT POND ELEVATION	m a.s.l.	109.2	
ACTIVE SPIGOTS DURING THE PERIOD		13-14-15	
POND AREA	ha	12.94	
TAILINGS BEACH AREA	ha	3.52	



DISCHARGE OPERATING PERIOD: SUMMER	from	25-AUG-09	STAGE # 7 SOUTH
	to	14-SEP-09	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	117.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.12	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	1.30	
SUPERNATANT POND ELEVATION	m a.s.l.	113.5	
ACTIVE SPIGOTS DURING THE PERIOD		16,14,15,16	
POND AREA	ha	12.59	
TAILINGS BEACH AREA	ha	7.39	



DISCHARGE OPERATING PERIOD: WINTER	from	23-FEB-10	STAGE # 12 SOUTH
	to	28-MAR-10	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	122.7	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.20	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	2.42	
SUPERNATANT POND ELEVATION	m a.s.l.	118.3	
ACTIVE SPIGOTS DURING THE PERIOD		13,14,15,16,17	
POND AREA	ha	13.35	
TAILINGS BEACH AREA	ha	12.00	



DISCHARGE OPERATING PERIOD: SUMMER	from	04-OCT-10	STAGE # 17 SOUTH
	to	12-OCT-10	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	127.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.05	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	3.54	
SUPERNATANT POND ELEVATION	m a.s.l.	122.2	
ACTIVE SPIGOTS DURING THE PERIOD		13,15,13,15,17	
POND AREA	ha	13.68	
TAILINGS BEACH AREA	ha	15.83	

NOTES:
1. THE DAM ALIGNMENTS SHOWN ARE INDICATIVE ONLY.
2. THE DAM FOOTPRINTS SHOWN PERTAIN TO THE ESTIMATED MAXIMUM CREST ELEVATIONS. THE CONSTRUCTION OF THE DAMS WILL BE STAGED OR DEFERRED.
3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
"WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

(X) SPIGOTS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

MEADOWBANK
MINING CORPORATION

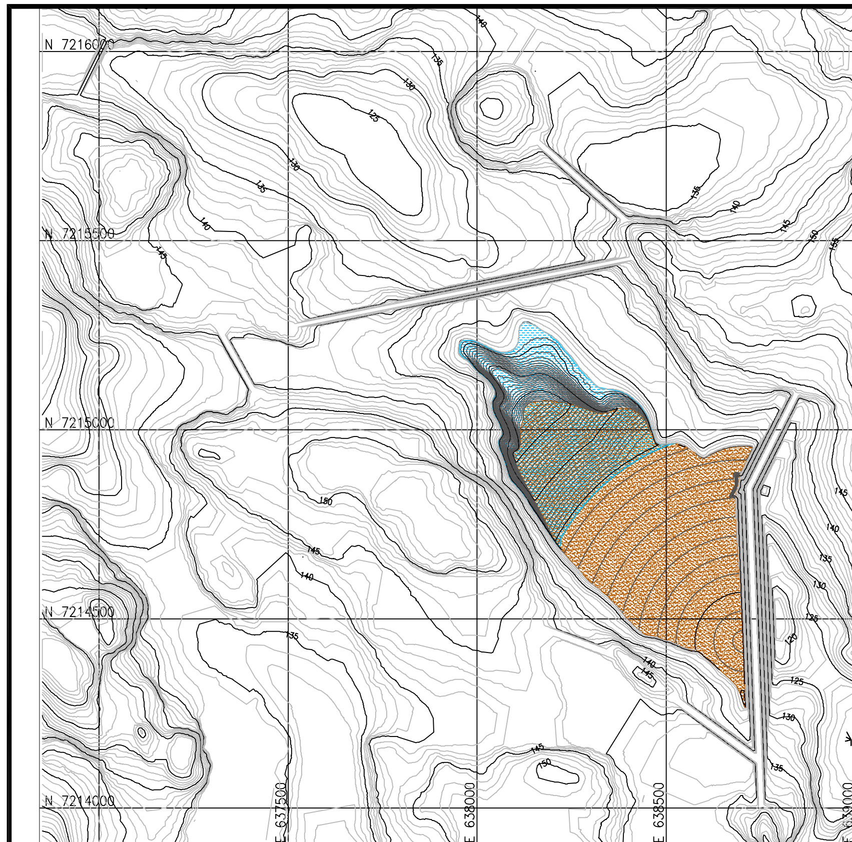
TITLE

MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION PLAN (5 OF 8)
CASE 2 : TAILINGS BEACH SLOPE 1%

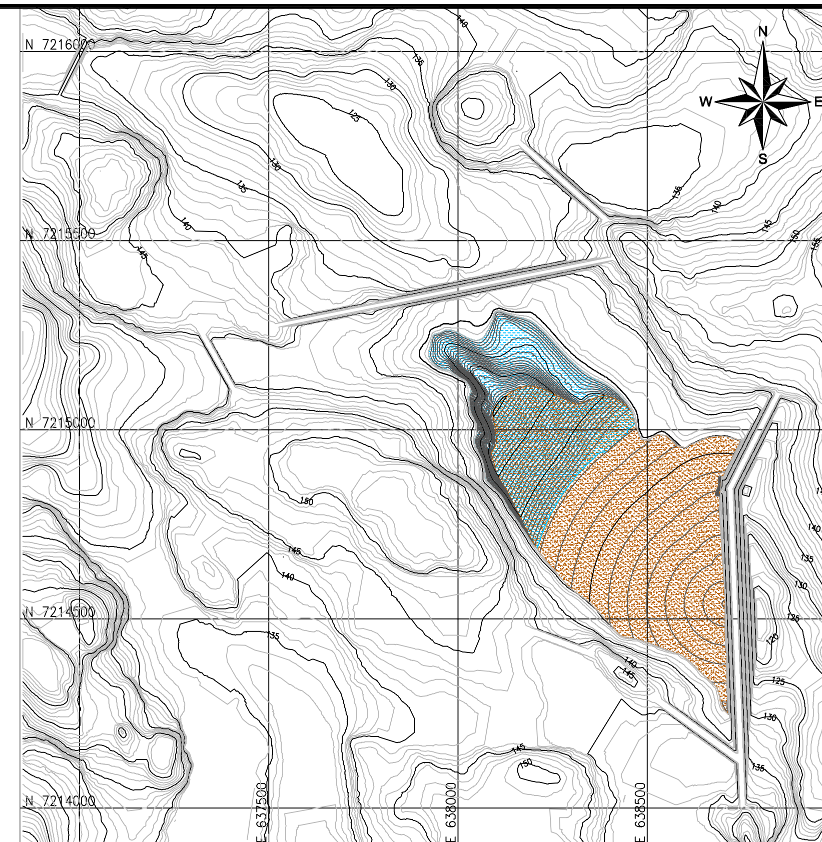
Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-6000-05
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-05	
CHECK	M.M.	FEBRUARY 07		
REVIEW	C.A.	FEBRUARY 07		

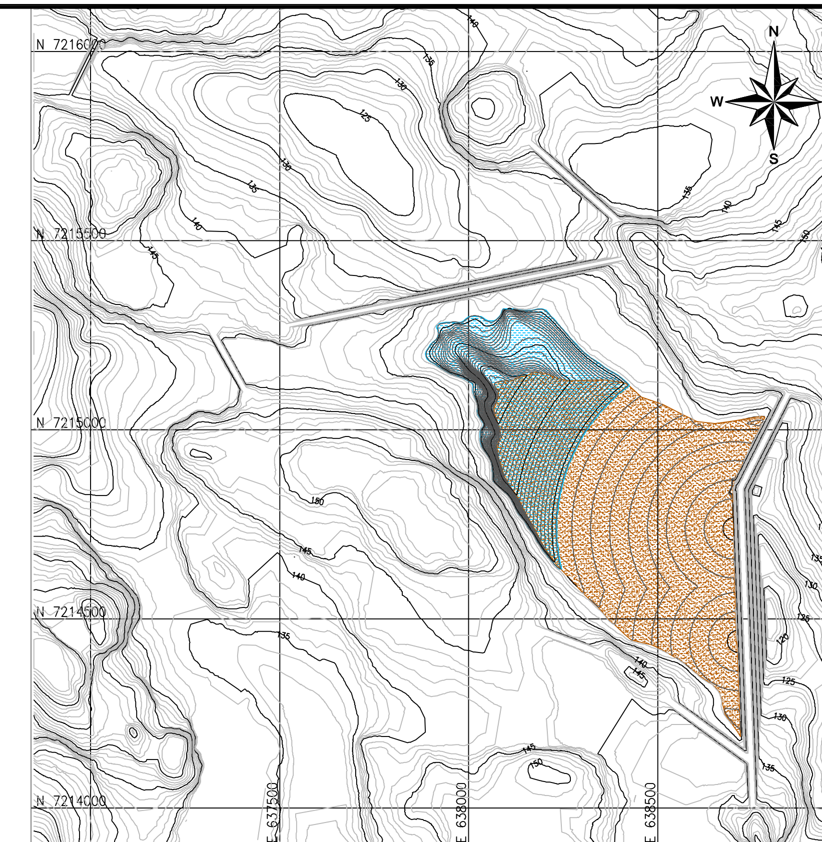
REVISION DATE: 07/07/05 05:25PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-05.dwg



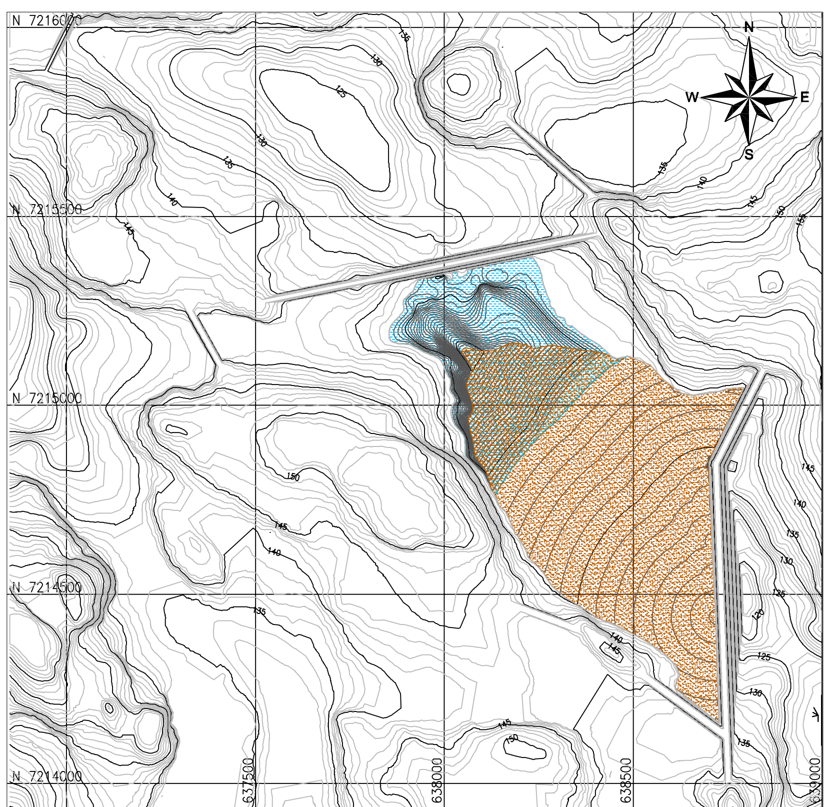
DISCHARGE OPERATING PERIOD: WINTER	from / to	21-MAR-11 / 14-MAY-11	STAGE # 21 SOUTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	131.3	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.32	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	4.77	
SUPERNATANT POND ELEVATION	m a.s.l.	125.8	
ACTIVE SPIGOTS DURING THE PERIOD		13,14,15,16	
POND AREA	ha	14.82	
TAILINGS BEACH AREA	ha	19.91	



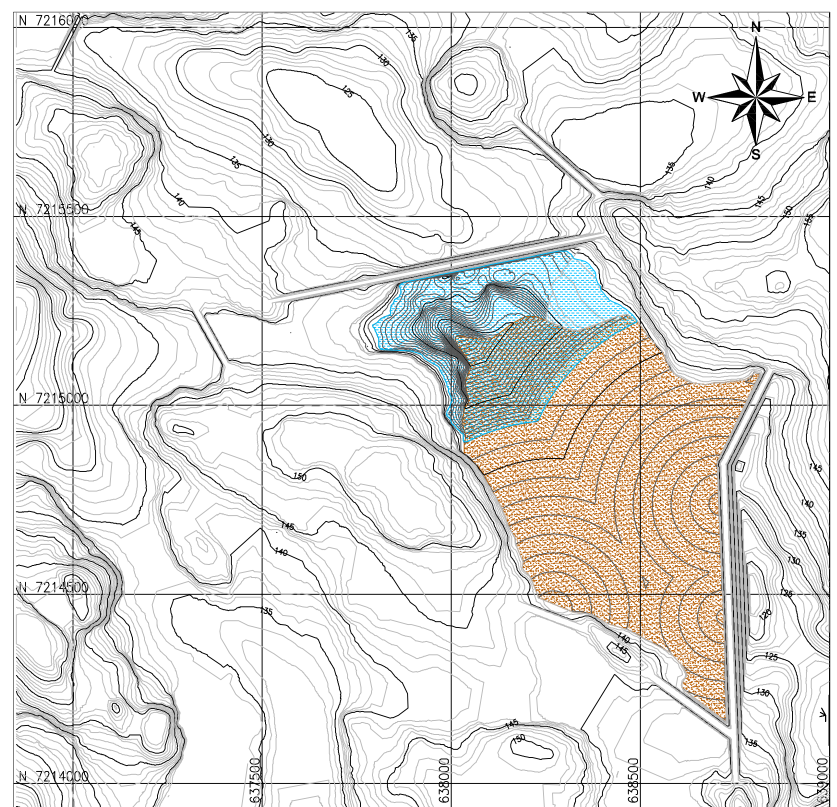
DISCHARGE OPERATING PERIOD: SUMMER	from / to	13-OCT-11 / 04-NOV-11	STAGE # 26 SOUTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	133.6	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.13	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	5.77	
SUPERNATANT POND ELEVATION	m a.s.l.	128.4	
ACTIVE SPIGOTS DURING THE PERIOD		13,15,13,14,15	
POND AREA	ha	16.14	
TAILINGS BEACH AREA	ha	22.72	



DISCHARGE OPERATING PERIOD: WINTER	from / to	09-APR-12 / 23-APR-12	STAGE # 28 SOUTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	135.3	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.08	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	6.75	
SUPERNATANT POND ELEVATION	m a.s.l.	130.6	
ACTIVE SPIGOTS DURING THE PERIOD		13,16	
POND AREA	ha	16.36	
TAILINGS BEACH AREA	ha	28.52	



DISCHARGE OPERATING PERIOD: SUMMER	from / to	14-SEP-12 / 25-SEP-12	STAGE # 33 SOUTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	138.7	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.13	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	7.64	
SUPERNATANT POND ELEVATION	m a.s.l.	132.0	
ACTIVE SPIGOTS DURING THE PERIOD		15,13,14,15,16	
POND AREA	ha	18.47	
TAILINGS BEACH AREA	ha	33.64	



DISCHARGE OPERATING PERIOD: WINTER	from / to	11-MAR-13 / 26-APR-13	STAGE # 35 SOUTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	139.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.27	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	8.85	
SUPERNATANT POND ELEVATION	m a.s.l.	134.0	
ACTIVE SPIGOTS DURING THE PERIOD		13,19	
POND AREA	ha	19.52	
TAILINGS BEACH AREA	ha	41.36	

NOTES:
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2. THE DAM FOOTPRINTS SHOWN PERTAIN TO THE ESTIMATED MAXIMUM CREST ELEVATIONS. THE CONSTRUCTION OF THE DAMS WILL BE STAGED OR DEFERRED.
3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
"WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

MEADOWBANK
MINING CORPORATION

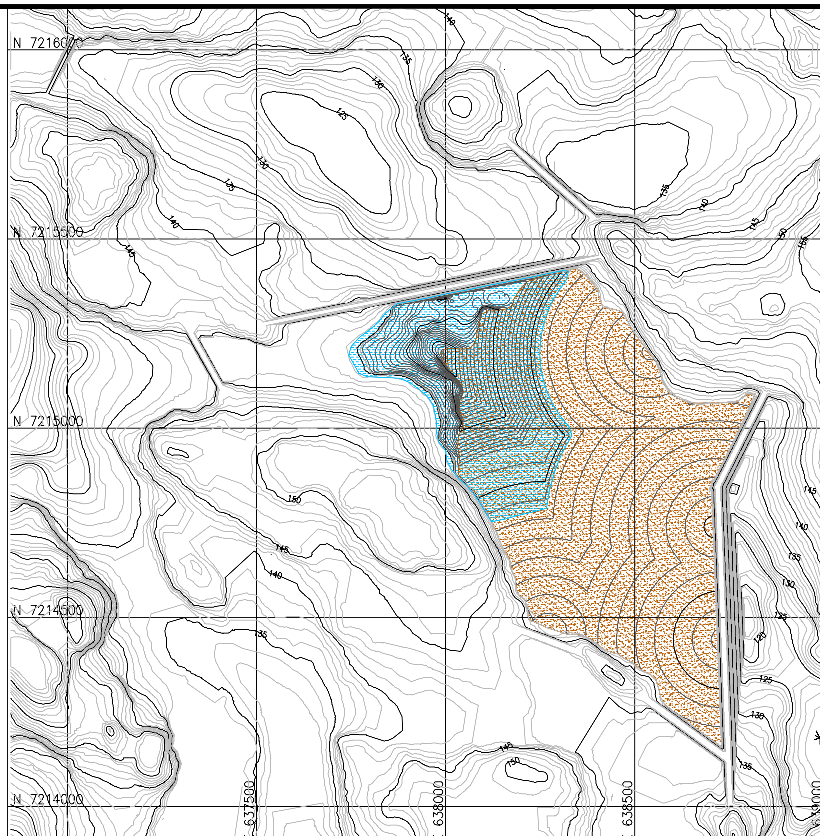
TITLE

MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION PLAN (6 OF 8)
CASE 2 : TAILINGS BEACH SLOPE 1%

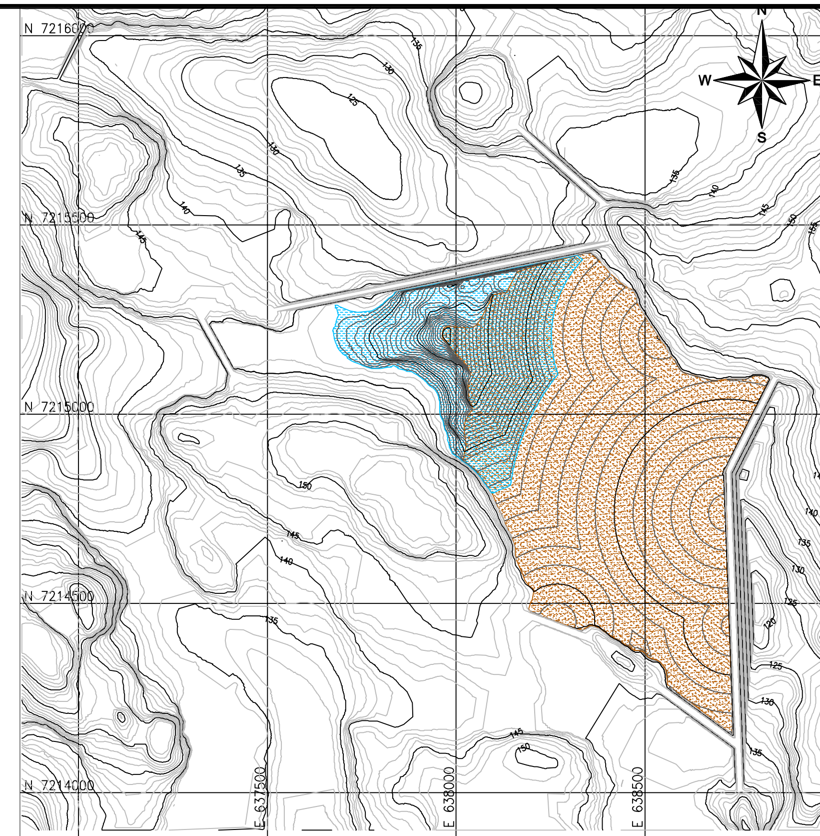
Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-6000-06
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-06	
CHECK	M.M.	FEBRUARY 07		
REVIEW	C.A.	FEBRUARY 07		

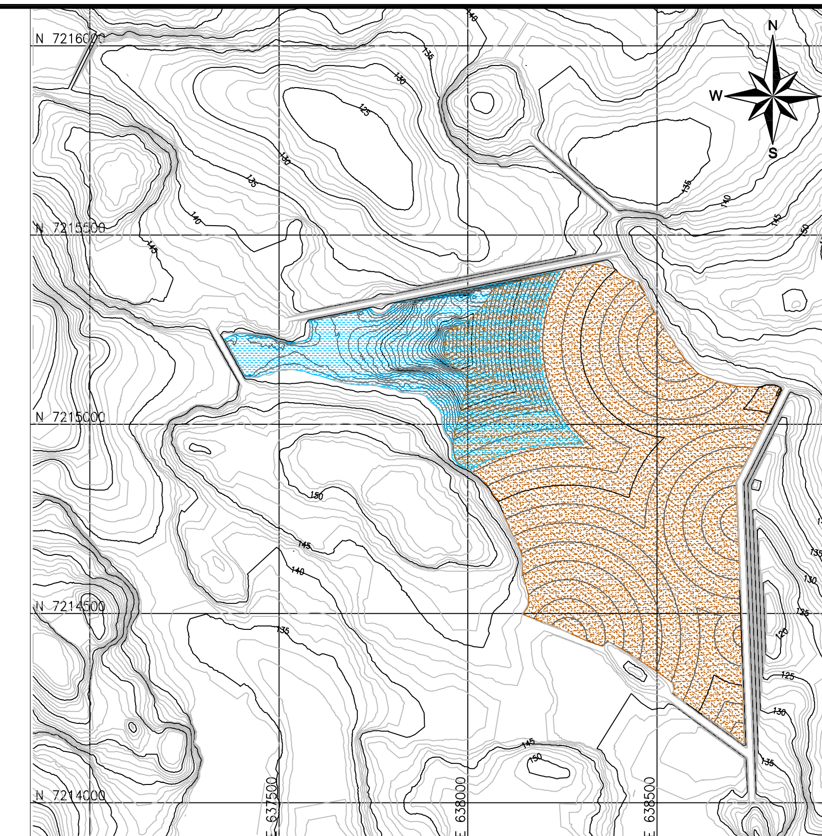
REVISION DATE: 07/07/05 05:29PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-06.dwg



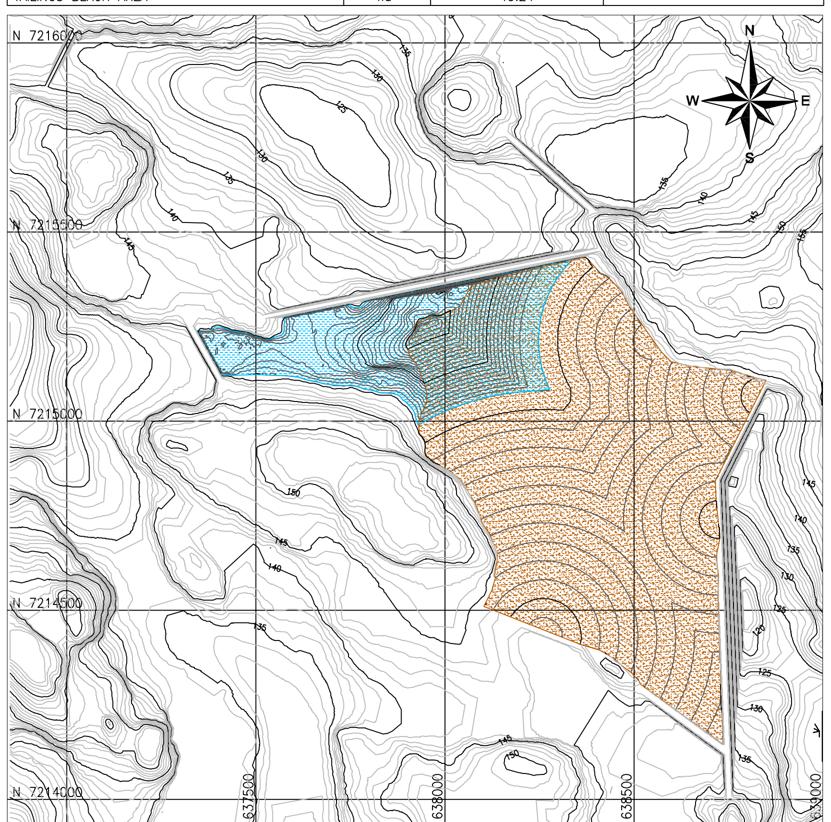
DISCHARGE OPERATING PERIOD: SUMMER	from	28-AUG-13	STAGE #
	to	01-OCT-13	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	141.3	38
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.20	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	9.76	SOUTH
SUPERNATANT POND ELEVATION	m a.s.l.	135.8	
ACTIVE SPIGOTS DURING THE PERIOD		11,13,16	
POND AREA	ha	21.59	
TAILINGS BEACH AREA	ha	43.24	



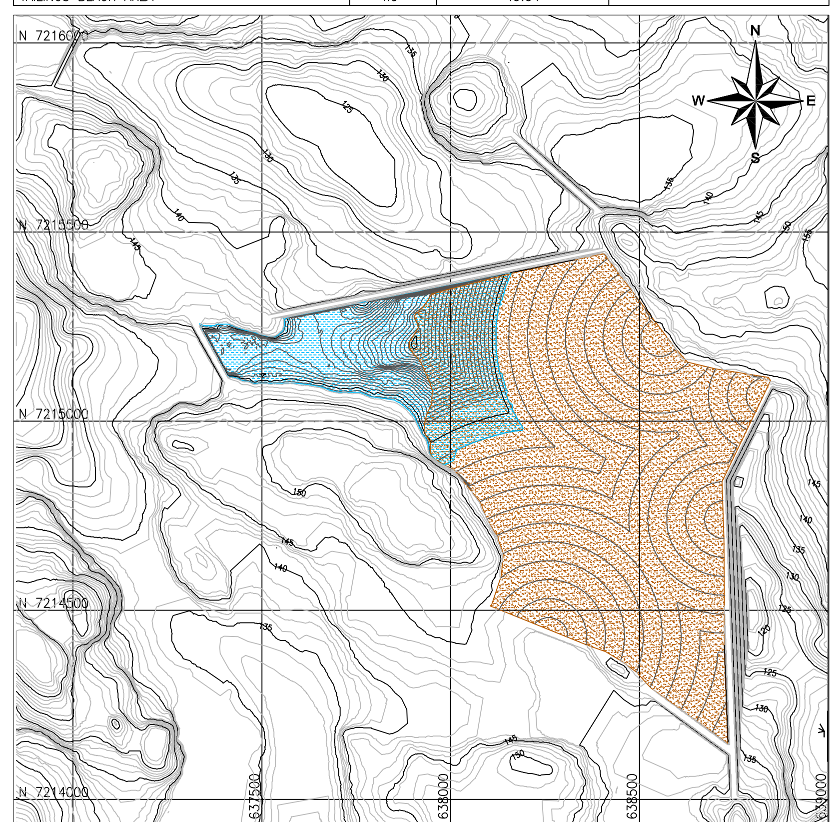
DISCHARGE OPERATING PERIOD: WINTER	from	09-JAN-14	STAGE #
	to	18-APR-14	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	143.0	41
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.57	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	10.90	SOUTH
SUPERNATANT POND ELEVATION	m a.s.l.	137.2	
ACTIVE SPIGOTS DURING THE PERIOD		19,11,13	
POND AREA	ha	19.89	
TAILINGS BEACH AREA	ha	49.04	



DISCHARGE OPERATING PERIOD: SUMMER	from	06-AUG-14	STAGE #
	to	26-OCT-14	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	142.5	43
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.47	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	11.99	SOUTH
SUPERNATANT POND ELEVATION	m a.s.l.	138.9	
ACTIVE SPIGOTS DURING THE PERIOD		19,11	
POND AREA	ha	22.23	
TAILINGS BEACH AREA	ha	54.03	



DISCHARGE OPERATING PERIOD: WINTER	from	22-JAN-15	STAGE #
	to	27-APR-15	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	146.0	46
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.55	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	13.04	SOUTH
SUPERNATANT POND ELEVATION	m a.s.l.	139.5	
ACTIVE SPIGOTS DURING THE PERIOD		12,13,19	
POND AREA	ha	21.17	
TAILINGS BEACH AREA	ha	58.43	



DISCHARGE OPERATING PERIOD: SUMMER	from	28-APR-15	STAGE #
	to	10-AUG-15	
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	145.0	47
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.60	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	13.64	SOUTH
SUPERNATANT POND ELEVATION	m a.s.l.	140.7	
ACTIVE SPIGOTS DURING THE PERIOD		11	
POND AREA	ha	21.35	
TAILINGS BEACH AREA	ha	61.20	

NOTES:

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3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
   "WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
   0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT

MEADOWBANK
MINING CORPORATION

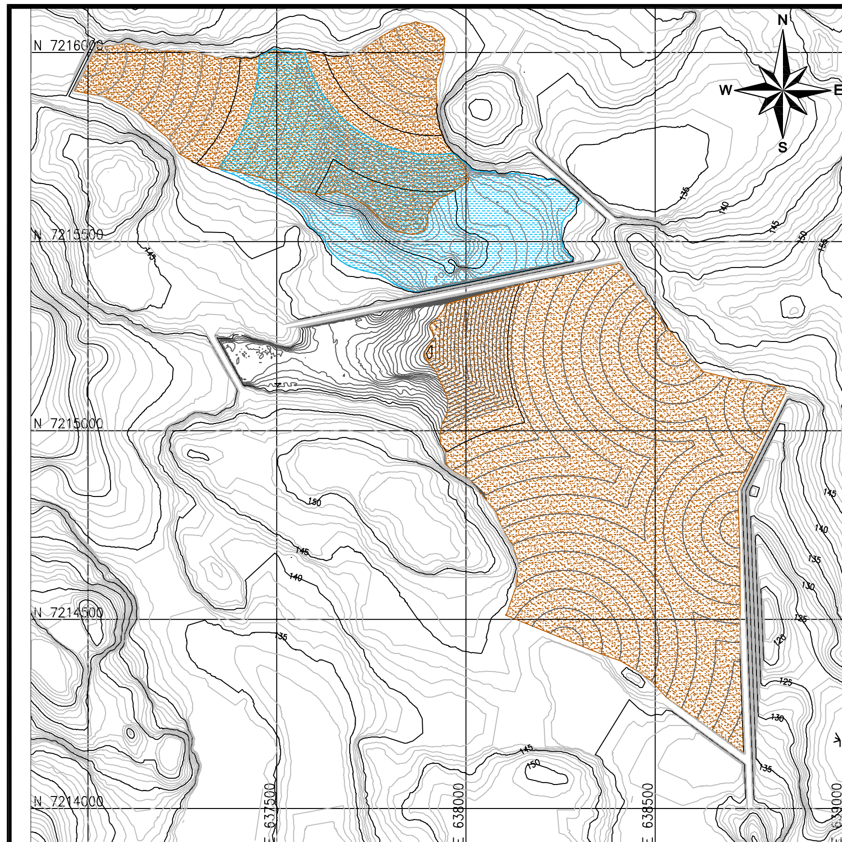
TITLE

MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION PLAN (7 OF 8)
CASE 2 : TAILINGS BEACH SLOPE 1%

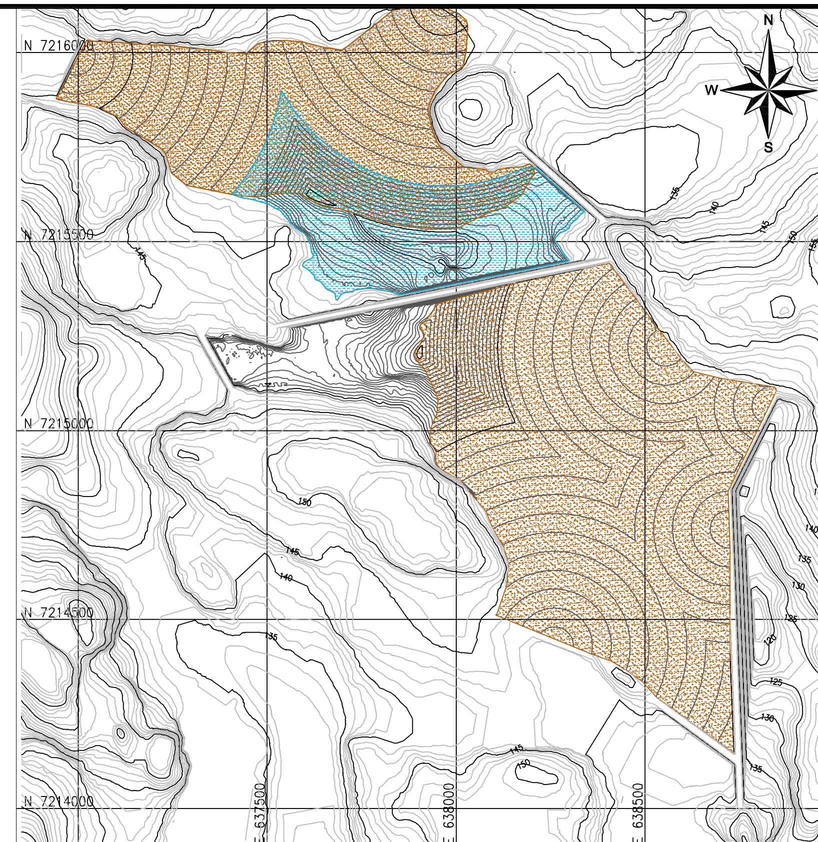
PROJECT No.	06-1413-089		FILE No.	061413089-6000-07
DESIGN	M.B.	FEBRUARY 07	SCALE INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-07	
CHECK	M.M.	FEBRUARY 07		
REVIEW	C.A.	FEBRUARY 07		

Golder Associates

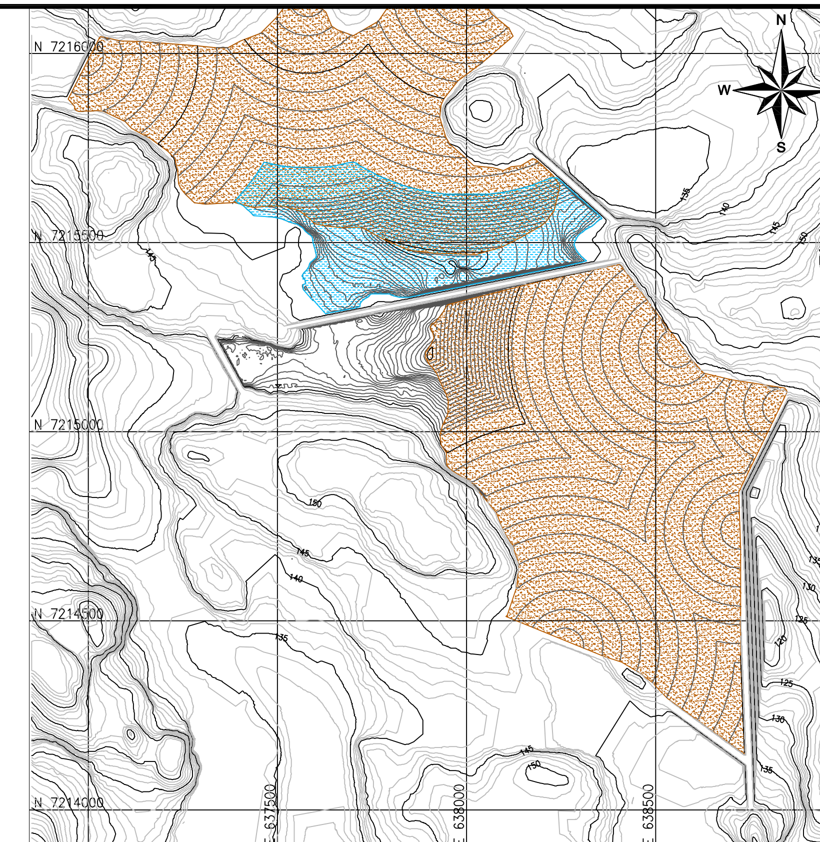
REVISION DATE: 07/07/06 08:29AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-07.dwg



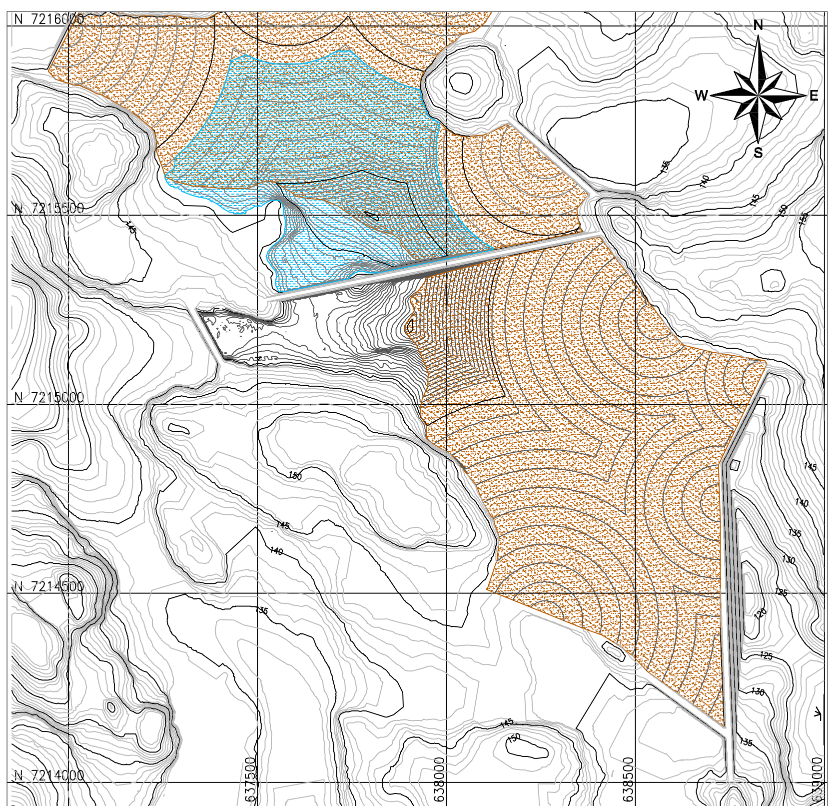
DISCHARGE OPERATING PERIOD: WINTER	from / to	11-JAN-16 / 28-APR-16	STAGE # 2 NORTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	138.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.63	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	1.50	
SUPERNATANT POND ELEVATION	m a.s.l.	134.4	
ACTIVE SPIGOTS DURING THE PERIOD		1,3	
POND AREA	ha	27.49	
TAILINGS BEACH AREA	ha	17.69	



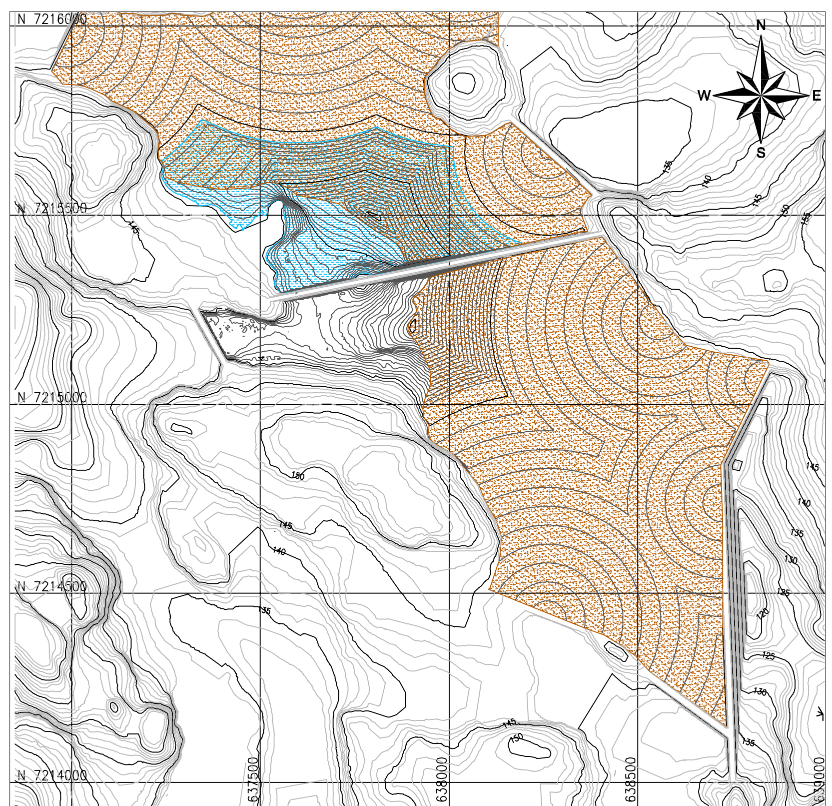
DISCHARGE OPERATING PERIOD: SUMMER	from / to	12-SEP-16 / 20-OCT-16	STAGE # 6 NORTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	140.9	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.22	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	2.50	
SUPERNATANT POND ELEVATION	m a.s.l.	136.0	
ACTIVE SPIGOTS DURING THE PERIOD		1,3,1,3	
POND AREA	ha	23.45	
TAILINGS BEACH AREA	ha	31.53	



DISCHARGE OPERATING PERIOD: WINTER	from / to	17-FEB-17 / 17-APR-17	STAGE # 9 NORTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	143.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.34	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	3.52	
SUPERNATANT POND ELEVATION	m a.s.l.	137.5	
ACTIVE SPIGOTS DURING THE PERIOD		2,1,3	
POND AREA	ha	22.47	
TAILINGS BEACH AREA	ha	40.65	



DISCHARGE OPERATING PERIOD: SUMMER	from / to	15-MAY-17 / 31-AUG-17	STAGE # 11 NORTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	142.2	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.62	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	4.30	
SUPERNATANT POND ELEVATION	m a.s.l.	139.3	
ACTIVE SPIGOTS DURING THE PERIOD		1,4	
POND AREA	ha	30.47	
TAILINGS BEACH AREA	ha	35.05	



DISCHARGE OPERATING PERIOD : WINTER	from / to	19-NOV-17 / 11-DEC-17	STAGE # 13 NORTH
FINAL DISCHARGE POINT ELEVATION	m a.s.l.	145.0	
PARTIAL STORED TAILINGS VOLUME	Mm^3	0.13	
CUMULATIVE STORED TAILINGS VOLUME	Mm^3	4.89	
SUPERNATANT POND ELEVATION	m a.s.l.	139.7	
ACTIVE SPIGOTS DURING THE PERIOD		2,3	
POND AREA	ha	24.12	
TAILINGS BEACH AREA	ha	48.66	

NOTES:
1. THE DAM ALIGNMENTS SHOWN ARE INDICATIVE ONLY.
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3. AN AVERAGE TAILINGS DRY DENSITY OF 1.31 t/m HAS BEEN ASSUMED. THE ESTIMATED MAXIMUM REQUIRED TAILINGS VOLUME IS 18.2 Mm^3
4. THE CONFIGURATION OF TAILINGS AND POND SHOWN AT EACH STAGE CORRESPONDS TO THE END OF THE SEASON.
5. "SUMMER" SEASON: MAY TO OCTOBER.
"WINTER" SEASON: NOVEMBER TO APRIL.
6. SUPERNATANT POND VOLUME: 0.75 Mm^3 WINTER
0.55 Mm^3 SUMMER.
7. SUBAQUEOUS TAILINGS SLOPE: 5%.
8. CONTOURS: MAJOR INTERVAL 5m, MINOR INTERVAL 2m. ALL ELEVATIONS IN METERS ABOVE SEA LEVEL.
9. GRID REFERENCE NAD83 UTM ZONE 14.

SYMBOLS

SUPERNATANT POND

TAILINGS

20 10 0 10 20
SCALE 1:1000

NOT FOR CONSTRUCTION

STAMP

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
TAILINGS DEPOSITION PLAN (8 OF 8)
CASE 2 : TAILINGS BEACH SLOPE

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-6000-08	
DESIGN	M.B.	FEBRUARY 07	SCALE	INDICATED	REV. A
CADD	R.A./C.S.	FEBRUARY 07	G-08		
CHECK	M.M.	FEBRUARY 07			
REVIEW	C.A.	FEBRUARY 07			

REVISION DATE: 07/07/05 05:42PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\6000\Drafting\Rev B\061413089-6000-08.dwg