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DRAFT REPORT ON

WATER USE AND MANAGEMENT PLAN
BAKER LAKE MARSHALLING AREA
MEADOWBANK GOLD PROJECT

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1.0 INTRODUCTION

This document presents the water use and management plan for the Baker Lake Marshalling Area, a component of Meadowbank Mining Corp's Ltd's Meadowbank Gold Project. This document provides the details necessary to fulfill the NIRB Requirement #12 for an A-Type Water License for the Meadowbank Gold Project.

This report provides a summary of the following information for the proposed water management plan:

- A discussion of the available background information;
- A summary of site conditions and of the water management objectives;
- A description of the water use, the management plan and the associated facilities;
- An operations, maintenance and water quality monitoring plan;
- A closure and reclamation plan; and
- An adaptive management strategy.

2.0 BACKGROUND INFORMATION

Meadowbank Mining Corp, formerly known as Cumberland Resources Ltd. (Cumberland) is currently proposing to develop a mine located in the Kivalliq region (Nunavut, Canada), approximately 70 km north of the hamlet of Baker Lake. Cumberland has been actively exploring the Meadowbank area since 1995. Engineering, environmental baseline studies and community consultations have paralleled these exploration programs and have been integrated to form the basis of this water management plan.

As part of this project, a site near the hamlet of Baker Lake will be developed as a transfer point for project materials prior to land shipment to the Meadowbank mine site. It will include facilities for barge off-loading, dry freight storage and marshalling operations, access roads, and storage for bulk fuel, ammonium nitrate and explosives. A fuel tank farm will be constructed to receive bulk shipments of diesel fuel and to provide sufficient above-ground fuel storage capacity required annually to operate the Meadowbank project.

Golder Associates Ltd. (Golder) is developing the water use and management plan (WMP) for this facility, as summarized in this document.

2.1 Marshalling Area Design Layout

The proposed site for the Baker Lake marshalling area and storage facilities is located approximately 0.75 km east of the Baker Lake hamlet (Figure 1) at latitude 64°18’ North and longitude 95°57’ West. The marshalling area is bounded to the north by a proposed access road and to the south by Baker Lake. The marshalling area is approximately 900 metres long and 180 metres wide, covering an area of approximately 16.1 ha. Fuel tanks are to be located in a bermed fuel storage area northeast of the marshalling area. An explosives storage area is located further to the northeast. It is understood that the temporary storage of explosives (primers and detonation supplies) is required in Baker Lake as a transition point between shipment from the south to the Meadowbank site, even if only overnight. Explosives are to be stored in approved magazines for this transition. This proposal was approved in concept by NRCan during the EIS approval process. NRCan is the regulatory body for explosives storage and handling. It is further understood that explosives will be flown directly to the mine site once suitable airport capabilities are available. Figure 2 presents the layout of the proposed marshalling area.

3.0 SITE CONDITIONS

3.1 Topography and Lake Bathymetry

The proposed marshalling area is located on a low terrace, parallel to the shoreline at Baker Lake, and is about 180 metres wide. The topography at the marshalling area and the surrounding area generally has low relief with elevations ranging from 0 to 60 metres above the shoreline of Baker Lake, as shown in Figure 3. The area of the dry freight storage is located on a 5 to 10% slope towards Baker Lake. The fuel tank and explosives storage area is located on the upslope terrain, on a gradual slope (2 to 4%) towards Baker Lake. The ground rises from the shoreline at slopes between 5 to 20%. Gently sloping, well-drained, generally uniform blankets of marine gravels and sands (beach deposits) are present along the shore of Baker Lake under most of the proposed site. Current site layout indicates that the marshalling area infrastructure is generally located 5 meters above sea level (masl).

The bathymetry of Baker Lake at the proposed marshalling area was previously presented in a Golder report, dated February 7, 2007 (Golder Associates Ltd., 2007). Water depths offshore reach approximately 5 to 10 m within a distance of 100 to 180 m from the shore. The bathymetry indicates that the lake adjacent to the proposed marshalling area has a moderately sloped bottom near the shoreline.

3.2 Geology

The regional surficial geology is characterized by sandy till, bedrock outcrops, felsenmeer (ice-shattered bedrock), and shallow lakes; the topography is generally dependent on the bedrock structure. Glacial till is the predominant soil type, although a zone of marine reworking could be present up to an elevation of approximately 100 to 200 masl. Marine beach deposits are commonly found on the north shore of Baker Lake. These deposits manifest themselves as beaches, bars, spits, and ice-pushed ridges.

The marshalling area location is underlain by mineral soil comprising various proportions of silts, sands and gravels and frost-susceptible glacial till overlying weathered bedrock. The mineral soil thickness ranges from typically less than 1.4 m thick in the fuel tank farm area to more than 2 m in the dry freight storage area. The glacial till comprises a matrix of fine grained soil with coarse angular gravel, cobble and boulder particles.

The ground is generally frozen at shallow depth (less than 2 m) and the bedrock is also generally encountered at shallow depth (less than 2 m).

The area is characterized by the following key features.

- Frozen ground was generally encountered at shallow depths (less than 2 m) over the east part of the site, in the area of the proposed fuel tank farm (Golder Associates Ltd., 2004; Golder Associates Ltd., 2005).

- Bedrock was generally encountered at shallow depths (less than 2 m) over the west part of the site, in the area of the proposed dry freight storage, and also to the north, in the area of the proposed explosives storage.

- Approximately 5% of the surface area of the dry freight storage is bedrock outcrop.

- Approximately 60% of the surface area of the proposed fuel tank farm comprises bedrock outcrop.

- A top layer of organic material (primarily green moss), and organic soil covers the site. This top layer is approximately 150 mm thick.

- A layer of grey to black, medium sand is present below the organic layer, over most of the site. It was not observed at the push tug barge landing, or in the explosives storage area.

- In the test pit excavated in the area of the push tug barge landing, neither frozen ground nor bedrock was encountered.

3.3 Flora and Fauna

The site is covered by low-lying tundra vegetation, primarily a spongy, green moss and organic material. There are no trees or shrubs.

Fish found in Baker Lake include lake cisco, lake trout, lake whitefish and round whitefish. Lake cisco is thought to be the most abundant species in Baker Lake (Meadowbank Gold Project Baseline Aquatic Ecosystem Report, 2005).

3.4 Climate

There is a long-term Environment Canada climate station at Baker Lake, referred to as Baker Lake A. Climate normals for this station indicate that the daily mean temperature, on an annual basis, varies between -32.2 and 11.4 degrees Celsius. A maximum daily temperature of 16.7 degrees has been recorded in the month of July and a minimum daily temperature of -35.8 degrees has been recorded in the month of January. Average annual precipitation is 268.7 mm. Annual total rainfall is 156.7 mm and annual total snowfall is 130.7 cm.

Hourly precipitation data were obtained for the Baker Lake A station for the period from 1963 to 2006. The data were analyzed and daily rainfall and daily snowfall estimates for the 2, 10, 50, and 100-year wet years were estimated using the following distributions: Three Parameter Lognormal (3P-LN), General Extreme Value (GEV), and the Log Pearson III (LP3). The precipitation estimates from the three distributions were then compared to the measured data. A visual and numerical assessment of the fit of the measured data to each distribution was completed and a best fit distribution was selected. Table 1 presents the results of the data analysis as daily rainfall and snowfall events for the 10-year and 100-year return period.

TABLE 1: Extreme Daily Rainfall and Snowfall Data

	10-year	**100-year**
Daily Rainfall (in mm) (1951-2006)	38.7	58.4
Daily Snowfall (in cm) (1951-2006)	17.6	31.3

Hourly wind data were also obtained for the Baker Lake A station for the period from 1963 to 2006. Analysis using the same methods as described above for the precipitation data provided estimates for the 10, 100 and 1000-year hourly wind speed for each major direction. Table 2 presents the hourly wind speed estimates.

Snowmelt is a significant component to consider for the design of water management facilities. Snowmelt occurs primarily during the spring freshet, extending approximately from mid-May through June. During this period, the most rapid melt is from mid-May to mid-June, with an average weekly snowmelt at the Baker Lake snow course station of 20.8 mm water.

TABLE 2: Hourly Wind Speed Estimates for Baker Lake A (1963-2006)

	10-Year (km/hr)	100-Year (km/hr)	1000-Year (km/hr)
N	72	82	91
NE	54	61	67
E	62	71	77
SE	63	72	83
S	52	65	77
SW	49	64	80
W	68	101	149
NW	77	98	120

3.5 Permafrost

The Baker Lake marshalling area lies within the zone of continuous permafrost. Thermistors installed at the Meadowbank mine site indicate that the permafrost is on the order of 400 m to 500 m in thickness. It is expected that the permafrost thickness at the Baker Lake site would be similar to that at the Meadowbank mine site. However, permafrost might not be encountered in some sections of the proposed marshalling area owing to its proximity to the lake. It is likely that the permafrost table will be depressed to some degree beneath and adjacent to Baker Lake.

3.6 Subsurface Conditions

The site is underlain by at least 1.5 m of wet, fine grained soils, typically well above optimum water content conditions, which is consistent with frost–susceptible, ice-rich soils. However, there are isolated areas of non frost-susceptible granular soils and weathered bedrock outcrops within the marshalling area.

Test pits were excavated in the area of the proposed marshalling area (Golder Associates Ltd., 2005). Results indicated that the soil topography was generally composed of:

- a saturated, organic layer up to 0.2 m thick;
- up to 0.7 m thickness of brown sandy gravel; and
- saturated grey brown sand and silt layer up to 1.5 m thick.

The bedrock was encountered in these test pits at a maximum depth of 2 m. Frozen ground was also encountered to a maximum depth of 1.2 m. Seepage was observed in the test pits at the west side of the dry freight storage area. Higher flows were observed in the lower elevations, near the lake shore.

Test pits were also excavated in the area of the proposed fuel tank farm (Golder Associates Ltd., 2005). Results indicated that the soil topography was generally composed of:

- a saturated, organic layer up to 0.2 m thick;
- up to 0.7 m thickness of brown gravely sand; and
- saturated, grey brown, sand and silt layer up to 0.7 m thick.

The site was underlain by bedrock at shallow depths in areas where topsoil and/or overburden soils were encountered. The bedrock was encountered in these test pits to a maximum depth of 1.4 m. No standing water was observed in the test pits, however, seepage flows occurred in some areas.

3.7 Water Quality

Baseline water quality for surface flow at the marshalling area was not known at the time of writing this report.

Information on the water quality of Baker Lake can be found in the baseline aquatic ecosystem report (Meadowbank Gold Project Baseline Aquatic Ecosystem Report, 2005). The water quality of Baker Lake water closely resembles distilled water, with many conventional water chemistry parameters at or below detection limits[1]. Water chemistry is generally homogenous. The water column is generally well mixed and notable differences in water quality parameters with difference in depth or geographic location were not expected and were not detected. In the summer, some vertical stratification in temperature can be observed because of the deep depth of the lake and the higher salinity in the bottom water. Maximum surface temperature of 15.5°C and high dissolved oxygen concentration have been recorded in mid-August.

[1] The baseline indicates that the following conventional water chemistry parameters, nutrients, organic parameters and total metals concentrations were below Health Canada drinking water guidelines and/or the CCME (2002) aquatic life guideline: pH, TDS, TSS, hardness, ammonia nitrogen, total phosphorus, total dissolved phosphorus, aluminium, lead, copper, mercury, nickel, zinc, cadmium, chromium and arsenic.

4.0 WATER MANAGEMENT

This water management plan is for the marshalling area, the fuel storage area and the explosives storage area. The following sections present the water management objectives and strategies, standards and design criteria and water usage parameters.

4.1 Water Management Objectives and Strategies

A water management plan for the proposed Baker Lake marshalling area and storage facilities is needed to minimize impact on the aquatic ecosystem of the adjacent Baker Lake. The primary objectives of the water management plan are to:

1. Minimize impacts of the proposed marshalling area and storage facilities on the quantity of surface water.

2. Minimize impacts of the proposed marshalling area and storage facilities on the quality of surface and groundwater.

A key component to these objectives is the division of surface water into two components, namely contact and non-contact water. Contact water is defined as any water that may be physically or chemically affected by the activities that will take place within the marshalling area and storage facilities. Non-contact water is defined as any water that has not been physically or chemically affected by the marshalling area and storage facilities activities.

The water management strategies to implement these objectives are:

- All contact water will be intercepted, contained, analysed and then would be discharged to the receiving environment provided the water quality meets the discharge criteria limits. If required, the contact water would be treated prior to discharge.

- Implement measures to reduce the quantity of clean runoff water to treat. Namely, non-contact water originating from areas external to the marshalling area and storage facilities activities will be intercepted and directed away from the marshalling area by means of diversion channels and routed to Baker Lake. Non-contact water from within the marshalling area will also be directed to Baker Lake.

- Monitor the quality of contact water discharges to the receiving environment.

- Minimize sediment and pollutant mobilization by implementing best management practices (BMPs) during construction and operation of the facility.

- Adjust water management practices through adaptive management based on the monitoring results of the discharge quality and the discharge criteria.

4.2 Water Management Standards and Design Criteria

4.2.1 Standards

The minimum standards incorporated into water management planning activities will be developed based on applicable federal and territorial environmental legislation including:

- *Canadian Environmental Protection Act*;
- *Fisheries Act*; and
- Canadian Environment Quality Guidelines.

4.2.2 Design Criteria

The various components of the water management system will be designed to meet the design criteria described below.

4.2.3 Water Management Facilities

Table 3 summarizes the preliminary design criteria that will be used in the design of water management facilities:

TABLE 3: Preliminary Design Criteria for the Water Management Facilities

Aspect	Component	Design Criteria	Comments/Assumptions
Runoff Collection	Channel Capacity for Non-Contact Water	100-year, 24-hour peak storm runoff rate	
	Channel Capacity for Contact Water	100-year, 24-hour peak storm runoff rate	
	Channel Capacity for Internal Contact Water	10-year, 24-hour peak storm runoff	Contact water collection ditch with no chance of overflow outside of the marshalling area
	Channel Freeboard	0.3 m	

Aspect	Component	Design Criteria	Comments/Assumptions
	Contact Water Storage Capacity	1:100 year 24-hour rainfall runoff volume in addition to maximum operating storage volume (average year climate conditions)	Contact Water Storage will retain contact water for water quality monitoring and treatment, if necessary, prior to discharging it to Baker Lake. It will also act as a sediment control pond reducing total suspended solids (TSS) levels.
	Contact Water Storage freeboard	0.3 m	
	Contact Water Storage Pumping Capacity	Total contact water storage capacity volume within a one week period	
	Sediment Control	Fisheries and Oceans Land Development Guidelines for the Protection of Aquatic Habitat (1992)	

4.2.4 Water Usage

Table 4 summarizes the preliminary design criteria that will be used to estimate the necessary quantities for various water usages:

TABLE 4: Preliminary Design Criteria for Water Usage

Aspect	Component	Design Criteria	Comments/Assumptions
Water Usage	Number of people on site	2	Assumed based on discussion with Cumberland
	Potable water usage	negligible (assume 10 L/per capita/day)	Drinking water will come from the Baker Lake hamlet. Domestic wastewater will be treated at the Baker Lake hamlet wastewater treatment system
	Truck Wash	none	truck washing will be completed at the Meadowbank mine site (Cumberland, pers. comm.)
	Dust Control	1000 L/day	Assumed

5.0 WATER USE AND MANAGEMENT SYSTEMS

This section contains a description of the proposed water use and management systems for the operational phase of the Baker Lake marshalling area and storage facilities. The water management systems include the contact water diversion system, the non-contact water diversion system and contact water storage and treatment system.

The proposed water management systems were developed considering storm drainage design principles for cold regions. Control and prevention of water freezing within and adjacent to drainage structures must be considered in the detailed engineering design.

5.1 Water Usage

The primary water usage on site is for dust control measures. Dust control measures are assumed to use approximately 1000 L/day of water to be sourced when possible from the sediment pond on site, with make-up volumes obtained from Baker Lake. Runoff from dust control applications will be to a contact water storage pond.

Other water usage requirements are for drinking water. It is assumed that the drinking water consumed at the marshalling area by staff personnel is negligible and will be sourced in the hamlet of Baker Lake and delivered to the marshalling area. The domestic wastewater production from the marshalling area is also assumed to be negligible.

Truck wheel wash will occur at the mine site only. No freshwater requirements for the truck wash will be needed at the marshalling.

5.2 Non-Contact Water Diversion System

The water management plan provides for the diversion and discharge of non-contact water directly to Baker Lake. There are two types of non-contact water in this plan.

The first type of non-contact water is from runoff external to the marshalling area. A non-contact water diversion channel system will collect runoff draining an area of approximately 99.2 ha north and above the marshalling area, and route it directly to Baker Lake. Channels located on the north side of the various access roads will convey flow westward along the access roads. Culverts will be installed at road crossings. At the west end of the marshalling area, non-contact water will then be routed south directly to Baker Lake in a proposed channel, as shown on Figure 2.

The second type of non-contact water originates from within the marshalling area. It is runoff that has not been affected by traffic or other activities. The current site layout includes a non-contact area of approximately 7 ha situated upslope and north of any storage areas or marshalling activities. A non-contact water diversion channel and culvert will collect this runoff for direct discharge to Baker Lake through a proposed culvert, as shown on Figure 2.

A portion of the proposed town access road from the Baker Lake hamlet is located directly north of the marshalling area. Some of the runoff from the road will also be directed towards the non-contact water systems. The following best management practices (BMPs) would be used during construction and operation to prevent sediments from reaching the non-contact water diversion channels.

- Plastic Covering or Erosion Control Mats: Exposed soils will be covered with a plastic covering or with erosion control mats.

- Silt Fencing: Silt fencing will be placed along the edges of all areas where soils are disturbed until completion of all construction activities. Silt fences will follow the contour as much as possible.

- Sediment Barriers in Drainage Courses: Sediment barriers constructed of riprap and drain rock will be provided in existing and constructed channels to retain sediment.

- Stabilized Construction Entrances/Exits: All traffic on and off of the site will be restricted to stabilized construction entrances/exits to minimize tracking of sediment onto public roads and right-of-ways. Traffic within the site will also be limited to stabilized construction roads. If any sediment is transported onto a public road surface, the road shall be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by shovelling or sweeping.

- Waterbars: Waterbars will be used along construction access roads to minimize erosion of the road surface. Waterbars will be provided on all roads with slopes greater than 2%.

- Stockpile Protection: All material stockpiles will be covered in plastic when not in active use. All material stockpiles larger than 10 m^3 in size will also be contained within a continuous silt fence.

5.3 Contact Water Collection System

Contact water will be collected in a system of diversion channels and directed to contact water storage ponds as shown on Figure 2. The current site layout shows that a total area of approximately 8.4 ha will contribute to contact water runoff that will be routed into two water storage ponds located in the southeast and southwest corners of the marshalling area.

The east contact water storage pond, located in the southeast corner of the marshalling area, will receive contact water from the explosives storage area and the portion of the marshalling area east of the access road junction with the dry freight storage area. The catchment area is approximately 4.8 ha. The water accumulated within the fuel tank storage area will not contribute directly to the pond. A pump system will release the water accumulated within the berms surrounding the fuel tank storage area to the contact water diversion channels reporting to the east storage pond in a controlled manner when capacity is available in the east storage pond and water quality is acceptable for discharge. During the detailed engineering phase, a water balance will be necessary to confirm whether the berm storage capacity and timing of discharge can accommodate the water volumes discussed above and remain in compliance with regulatory storage capacity requirements for emergency fuel spills. Grading work will be done upslope (north) of the fuel tank berms to prevent the water accumulation upslope from the berms.

The west contact water storage pond, located in the southwest corner of the marshalling area, will receive contact water from the ammonium nitrate storage area and the portion of the dry freight storage area west of the access road junction with the dry freight storage area. The catchment area is approximately 3.6 ha.

Slope protection will be installed along the southern border of the marshalling area, to protect the main contact water infrastructure (channels, storage ponds and the marshalling area fill) against ice and wave run-up from Baker Lake. The conceptual slope protection design is discussed in the following section.

The best management practices (BMPs) elaborated above would be used during construction and operations to prevent or minimize sediments reaching the contact water diversion channels.

5.4 Contact Water Storage and Treatment System

Contact water will be routed to two storage ponds located on the southeast and southwest corners of the marshalling area. The role of these storage ponds is to retain the contact water for water quality monitoring and treatment, if necessary, prior to discharging it to Baker Lake. The storage ponds will also act as sedimentation ponds for the contact water. For water quality monitoring purposes, the storage ponds will have the capacity to store a volume equivalent to a week of peak snowmelt during an average year plus runoff from the 1:100-year 24-hour peak storm event.

6.0 INFRASTRUCTURE SIZING

This section presents the conceptual designs for the water management infrastructure described in the previous section.

The design of water management infrastructure must recognize the potential challenges presented by ice-rich ground including icing, localized thawing, local ground instabilities, subsidence and transport of fine-grained soils. The detailed design and maintenance procedures for the water management infrastructure will take into consideration these challenges by incorporating design features such as adjusting the alignment of channels to take advantage of favourable foundation conditions, oversizing of the drainage infrastructure, provision of training berms instead of, or in combination with, channels, as well as lining and insulation of channels to prevent sedimentation and permafrost degradation.

6.1 Contact Water Collection System and Non-Contact Water Diversion System

The contact water and non-contact water channels are sized to accommodate the peak runoff from a 1:100-year 24-hour storm. Although no specific overburden information has been collected along the proposed channel alignments, properly designed excavated channels are considered feasible. The detailed design for these channels will take into consideration items such as ice-rich ground and the presence of bedrock.

Channel alignments are to be located, where possible, in favourable ground with a ditch invert at or above existing grade to avoid potential construction and operation constraints associated with channels located in the active layer (found within 2 m of surface). When this is not possible, the channel 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 that will allow for the addition of insulated channel lining materials where required. Figure 4 shows typical channels sections for excavation in ice-rich or ice-poor till.

Runoff was estimated using the SCS Method. A curve number (CN) of 91 was used for the marshalling area for estimating runoff from gravel areas. For natural ground areas, a CN of 85 was used for estimating runoff on land with limited infiltration potential and shallow bedrock.

For practical purposes, channels with a minimum uniform bed width of 0.5 m and 2H:1V side slopes have been assumed, and minimum depths are adjusted to suit discharge requirements. The minimum longitudinal slope of the channels is 0.2% to prevent sedimentation, and rock lining will be placed and sized accordingly in sections where the flow velocity is expected to be high. Specific channel configurations will be developed during the detailed engineering design. Table 5 and 6 present the preliminary design parameters for the diversion channels and culverts. These parameters have been selected in order to provide flexibility during detailed engineering design and adaptability in response to unforeseen construction conditions.

TABLE 5: Channel Sizing Parameters

Channel	Bed Slope (m/m)	Side slope S	Length (m)	D_1 (m)	D_2 (m)	D_3 (m)	D_{50} (mm)	W_1 (m)	W_2 (m)	W_3 (m)
NC 1	0.044	2H:1V	788	1.50	2.0	0.3	150	1.0	2	1.5
NC 2	0.009	2H:1V	675	1.50	2.0	0.3	100	1.0	2	1.5
NC 3	0.080	2H:1V	200	2.00	2.0	0.3	300	2.0	2	1.5
NC 4	0.010	2H:1V	390	1.00	2.0	0.3	100	1.0	2	1.5
NC 5	0.012	2H:1V	475	1.00	2.0	0.3	100	0.5	2	1.5
NC 6	0.034	2H:1V	445	1.00	2.0	0.3	100	0.5	2	1.5
C 1	0.062	2H:1V	680	1.00	2.0	0.3	100	0.5	2	1.5
C 1a	0.017	2H:1V	175	1.00	2.0	0.3	100	0.5	2	1.5
C 2	0.034	2H:1V	380	1.00	2.0	0.3	100	0.5	2	1.5
C 3	0.021	2H:1V	140	1.00	2.0	0.3	100	0.5	2	1.5
C 4	0.002	2H:1V	210	1.00	2.0	0.3	100	1.0	2	1.5
C 5	0.002	2H:1V	220	1.00	2.0	0.3	100	1.0	2	1.5
C 6	0.002	2H:1V	260	1.00	2.0	0.3	100	1.0	2	1.5
C 7	0.025	2H:1V	285	1.00	2.0	0.3	100	0.5	2	1.5

Parameters assume Figure 4, section A, apply
All channels assumed a manning's n of 0.025
S – Side slope
D_1 – Channel Depth
D_2 – Over-excavation and replacement with compacted till depth
D_3 – Liner thickness
D_{50} – Median diameter of lining or rock protection (suggested)
W_1 – Width of Channel bed
W_2 – Width of over-excavation bed
W_3 – Width of pre-construction active layer

TABLE 6: Culvert Sizing Parameters

	Assumed Slope (m/m)	Internal Diameter (mm)	Length (m)
Cul 1	0.044	1200	15
Cul 2	0.050	300	40
Cul 3	0.077	450	25
Cul 4	0.010	900	25
Cul 5	0.010	900	35
Cul 6	0.075	450	120
Cul 7	0.040	600	25
Cul 8	0.070	900	75
Cul 9	0.015	450	65

6.2 Contact Water Storage and Treatment System

The preliminary design of the two contact water storage ponds is based on the assumption that all drainage is by gravity. As such, no intermediate sumps are required for the purpose of pumping water against natural gradient. Pumps will be required in the contact water storage ponds to discharge the treated contact water from the ponds to Baker Lake.

The contact water storage ponds are sized to store the runoff volume from a 1:100-year 24-hour peak storm event (58.4 mm of rain), in addition to the maximum operating storage volume from snowmelt for average year conditions (20.8 mm of snowmelt in a week). Additionally, each pond will be divided lengthwise into two sections to allow for the possibility to route and store in each section the inflow volumes from one week of snowmelt. Figure 5 shows the contact water storage ponds with the partial divider. This design will provide flexibility to optimize operation of the pond.

The storage pond volumes and pumping capacities are provided as preliminary estimates and should be updated based on the final design of the marshalling area and storage facilities. Conservative estimates were derived to allow for flexibility during detailed engineering design and to provide adaptability in response to unforeseen construction conditions. Additionally, should the final design volume be significantly higher than the volume estimated below, alternative options are available:

- The conceptual storage ponds design proposes an excavated structure. Construction of embankments could provide additional volume.

- Additional smaller storage ponds could be constructed at each facility.

Table 7 summarises the storage and pumping requirements for the two proposed storage ponds.

TABLE 7: Storage and Pumping Requirements

Description	Tributary Area (ha)	Storage Volume (m^3)	Preliminary Sizing[a] L[b] x W[b] x D (m)	Pump Rate (L/s)
East Contact Water Storage Pond	5.9	4,963	200 x 20 x 2.5	8.2
West Contact Water Storage Pond	3.6	3,038	151 x 17 x 2.5	5.0

a - Including a 0.5 m sediment allowance and a 0.3 m freeboard.
b- Top width and length of a trapezoidal shaped storage pond

Pumps are sized to pump the water volume equivalent to the total contact water storage capacity within a one week period. The resulting conceptual design pump rate is 8.2 L/s for the east contact water storage pond and 5.0 L/s for the west contact water storage pond.

6.3 Fill Slope Protection

The fill slope protection will be riprap placed on the lake side of the marshalling area fill, running parallel to the shoreline to protect the contact water diversion channel, water storage ponds and marshalling area fill from wind waves and ice runup. Riprap erosion protection will be placed on the lake ward side slope of the marshalling area and graded to a maximum slope of 4H:1V. It is proposed to use the following conservative minimum and maximum stone weight and dimension for the riprap:

- Minimum stone weight of 1,723 kg
- Maximum stone weight of 5,170 kg
- Minimum stone dimension of 1.0 m
- Maximum stone dimension of 2.6 m

Specific riprap configurations will be developed during the detailed engineering design.

7.0 OPERATIONS, MAINTENANCE, AND WATER QUALITY MONITORING PLAN

The proposed water management plan must recognize the potential challenges of storm drainage in cold regions. An operations and maintenance plan for the site is presented in this section. It includes recommendations on the type and frequency of operations and monitoring events.

A water quality monitoring plan is also presented to provide a mechanism 1) to track the chemistry of the water contained in the storage ponds and in the fuel tank storage areas, and 2) to identify if water treatment is required prior to discharge to Baker Lake.

7.1 Operations and Maintenance

Operations and maintenance activities are described for each major water management facility in the following sections.

7.1.1 Contact and Non-Contact Water Diversion Channels

The preliminary design of the diversion channels is based on the assumption that all drainage can be achieved by gravity flow. As a result, the diversion channels are considered low maintenance infrastructure. However, they will require regular monitoring to identify any issues with regards to:

- The configuration or structure of the channel etc., due to localized thawing, local ground instabilities, subsidence and transport of fine-grained soils; and
- The free flow of water, due to an accumulation of ice, sediments and other debris.

Monitoring activities will consist of visual inspections to identify sediment or debris accumulation or damage to channel structures. Particular attention to culverts and the inlet and outlet structures will be required.

The regular monitoring program during the snowmelt and ice-free season is based on a schedule of: weekly monitoring during periods of high flow of the freshet (from mid-May through June) and bi-weekly during the remainder of the summer and fall period (July through October) prior to the fall freeze up. Additional monitoring should be planned after heavy or prolonged rainfall.

Maintenance operations will consist of cleaning accumulated sediments from the channels and culverts, and repair to damaged areas. Removed sediments will be disposed of at a suitable handling facility.

7.1.2 Contact Water Storage Ponds

The preliminary design of the retention ponds is based on the assumption that all inflows to the ponds are achieved by gravity. Pond discharge will be provided by a pump system.

Operation of the storage ponds is designed to accommodate the total volume from the 1:100-year 24-hour storm runoff in addition to the storage volume for one week of the peak snowmelt rate during average year climate conditions. The storage pond divider is designed to provide, in each section the storage pond, volume for one week of snowmelt. The storage ponds are also designed to provide storage capacity for accumulated sediments.

Water from the storage pond will be pumped and discharged to Baker Lake. During spring freshet (from mid-May through June), it is proposed to fill each section separately and pump each section weekly, provided that water quality monitoring results demonstrate satisfactory water quality. Should the 100-year rainfall occur during the spring freshet, the entire pond volume will be filled. This will provide as much temporary storage capacity as possible for runoff generated by extreme runoff events, potential breakdowns or power failures. The ponds should also be pumped on a bi-weekly basis between July and October.

Monitoring activities will include visual inspections to identify damage to both pond structure on a bi-weekly basis between April and October. Should damage to the structure be found, appropriate repairs will be done within one week. In early October, or just prior to freeze-up, the ponds should be emptied and sediments cleaned out in preparation for the following year. Removed sediments will be disposed of at a suitable handling facility.

7.1.3 Storage Pond Pump System

The storage pond pump system (pump and connected piping) is designed to provide dewatering capacities for the pond volume within a one week period, provided the discharged water is of suitable quality. Pumps will be operated based on the quality and volume of water accumulated within the pond. Successful operation of the storage pond pump system is considered critical to the water management plan. As a result, downtime due to failures will be avoided by ensuing redundant pumps are always available on site.

Monitoring activities will consist of visual and mechanical inspections to identify when repairs are required for the pump system. Particular attention will be required to ensure that no water freezes in the pump system. As a result, no water will be allowed to sit in the pumps or piping system when temperatures are near, or below, +1 degrees Celsius.

In October, or just prior to freeze-up, the pond will be emptied and the pumps and piping will be drained for the winter to avoid breaks due to water freezing inside the pumps or piping system. The pumps will be stored in a heated enclosure. Prior to the snowmelt period, the pumps will be maintained and repaired when necessary to ensure availability.

7.2 Water Quality Monitoring

All contact water surface runoff from the marshalling area and storage facilities will be directed to the storage ponds. The water quality within the ponds will be monitored to assure that the water discharged meets applicable water quality standards. Table 8 summarizes the monitoring locations, monitoring frequencies, monitoring method, constituents of potential interest, and action plan outlining contingencies in case of non-compliance.

Runoff water from within the containment wall at the fuel tank storage area will be collected in a sump within containment designed to capture petroleum products following spills. Water collected in the sump will be released in a controlled manner to the east storage pond when capacity is available in the east storage pond and water quality is acceptable for discharge. Monitoring the water quality at the containment sump will provide capacity for the identification of oil/grease from leaks or spills.

TABLE 8: Summary of Storage Pond Water Quality Monitoring Plan and Flow Monitoring Plan

Component	Parameters	Monitoring locations	Monitoring frequency	Monitoring methods	Potential Exceedance	Mitigation
Pond water quality	Regular monitoring program: TSS, oil/grease, ammonia; Event monitoring program: MSDS	All ponds	Regular monitoring program: monitoring during ice-free seasons: weekly mid-May through June, bi-weekly July through October or prior to discharge; Event monitoring program as needed	Regular monitoring program: unfiltered surface grab samples; Event monitoring program: as required	TSS, oil/grease, mill reagents, ammonium nitrate, fuel	Sediment control structures within channels and surface diversions and settling within the pond to reduce TSS; Unintended releases from spills, accidents, and malfunctions mitigation from Spill Contingency Plan, Emergency Response Plan, Accidents and Malfunctions plan with monitoring and treatment prior to discharge to Baker Lake
Fuel storage containment sump	Oil/grease	Containment sump	Monitoring during ice free seasons: bi-weekly mid-May through June, and monthly July through October or prior to discharge(?)	Unfiltered surface grab samples	Fuel, oil/grease	Discharge to East contact water storage pond at the marshalling area;Petroleum products in the pond will be addressed using the spill response procedures including booms to localize the contamination, absorbant material (spill kit) to collect the contaminant and removal from the pond for disposal. Unintended releases from spills, accidents, and malfunctions at the storage area will use mitigation from Spill Contingency Plan, Emergency Response Plan, Accidents and Malfunctions plan

7.2.1 Monitoring location

The current marshalling area design calls for two ponds located at the southwest and southeast corner of the marshalling area (see Figure 2) and containment capacity at the fuel tank storage area. The monitoring locations in the ponds will be marked by a highly visible stake that will define the exact location of the collection point. The location of each monitoring point will depend upon access and will be determined in the field following construction of the storage ponds. Monitoring at the fuel tank storage area is located at the containment sump.

7.2.2 Monitoring frequency

The Baker Lake marshalling area and storage facilities water quality monitoring plan has two primary strategies:

(a) a regular monitoring program to track the normal water chemistry of contact water from the facility prior to discharge; and
(b) an event monitoring program to track the impacts of accidental spills particularly during the period of ice free water.

Table 9 summarizes the ponds monitoring schedule during ice free periods.

TABLE 9: Regular and Event Based Monitoring Schedule

Regular Monitoring Schedule		**Event Monitoring Schedule**
Mid-May though June	July through October	Following Spill events
Weekly for the contact water storage ponds Bi-weekly for the fuel storage containment sump	Bi-weekly for the contact water storage ponds Monthly for the fuel storage containment sump	As required

Regular monitoring program

The storage ponds are sized to accommodate 1:100 year 24-hour storm runoff in addition to the maximum operating storage volume for the average year climate conditions. To accommodate the potential of unanticipated storm events and in order to maintain capacity in the pond, water will need to be periodically discharged to Baker Lake. The regular monitoring program is designed to provide systematic monitoring during the ice-free season following a schedule of:

- weekly monitoring during periods of high flow of the freshet (approximately from mid-May through June); and
- bi-weekly monitoring during the remainder of the summer prior to the fall freeze or prior to discharge (approximately from July through October).

The regular monitoring program for the containment sump within the fuel storage area is designed to provide systematic monitoring of oil and grease during the ice-free season following a schedule of:

- bi-weekly monitoring during periods of high flow of the freshet (approximately from mid-May through June); and
- monthly monitoring during the remainder of the summer prior to the fall freeze (approximately from July through October).

Event monitoring

It is unlikely that the chemical load derived from the marshalling area and storage facilities, with the possible exception of suspended particulates such as clay and fine grained sediments, will be significant. In the case of any spills, accidents, and potential malfunctions, appropriate remediation responses will be initiated as outlined in the following documents: Spill Contingency Plan, Emergency Response Plan, and Accidents and Malfunctions (refer to Section 7.3). It is recommended that the storage ponds be sampled following any accidental release and remediation efforts to:

- confirm the efficacy of the cleanup effort; and
- identify the need, if any, for special handling or treatment of the storage pond water.

The containment sump at the fuel storage area will be monitored for oil and grease following a release either from leakage from piping or storage vessels or from spills.

7.2.3 Monitoring parameters

Proposed parameters for monitoring are specific for the regular and the event monitoring programs. The parameters of concern for the regular monitoring program for the marshalling area include total suspended solids (TSS), oil/grease and ammonia. Although the final marshalling area design is not yet completed, it is anticipated that a portion of the marshalling area may be gravel and that another portion may remain uncompacted soil and till. The choice of TSS and oil/grease is based upon the potential for runoff to erode soil and vehicular traffic to generate a residuum of petroleum products. The choice of ammonia is to address the potential release of ammonium nitrate from the exposives storage area.

The parameters of concern for the event monitoring program include those elements unique to the material discharged and referenced in the Materials Safety Data Sheets (MSDS). The sump within the containment wall of the fuel storage area will be monitored for oil/grease.

7.2.4 Monitoring methods

Unfiltered surface water grab samples for the regular monitoring program will be collected from the monitoring locations in the storage ponds based upon the monitoring schedule outlined in Table 9. Table 10 summarizes the volume, container type, preservation method, and holding time for each analyte.

TABLE 10: Summary of Analytes for the Regular Monitoring Program (1)

Analyte	Minimum volume	Container	Preservation	Holding Time
TSS	100 ml	Plastic/glass	Cool, 4 ºC	7 days
Oil/grease	1000 ml	Glass	Cool, 4 ºC, H_2SO_4 – pH below 2	28 days
Ammonia	400 ml	Plastic/glass	Cool, 4 ºC, H_2SO_4 – pH below 2	28 days

(1) USEPA Methods for Chemical Analysis of Water and Waste Water, EPA-600/4-79-020.

7.2.5 Action plan outline

Potential exceedences in water quality at the Baker Lake marshalling area storage ponds could include TSS and oil/grease and/or materials delivered to the marshalling area. Potential exceedences from the fuel tank storage area are TSS, oil/grease, and fuel. Potential exceedences for the explosives storage area are nitrtogen species. The regular and event monitoring programs are designed to identify conditions when these parameters exceed the Environmental Guidelines for Industrial Waste Discharge (Nunavut) for the regular monitoring program and exceed CCME guidelines for the event program and trigger contingency plans to reduce the respective concentrations.

Regular monitoring contingencies

Industrial waste discharge guidelines have been used as suggested concentration criteria for TSS, oil/grease and ammonia for lack of site specific concentration guidelines and are shown in Table 11. Design criteria for the Baker Lake marshalling area include mechanisms to reduce the concentrations of these parameters including:

- Best Management Practices (BMPs) such as silt fences within the channels and other structures designed to intercept sediments prior to the storage ponds;
- Sediment settling within the ponds; and
- Booms and/or barriers within the ponds to isolate surface oil films for removal and/or treatment. They will need to be stored on site.

TABLE 11: Water Quality Guidelines for Regular Monitoring Parameters

Parameter	**Effluent Objective [(1)]**
	mg/L
Total suspended solids (TSS)	15
Oil/grease	15
Ammonia	10

(1) Schedule II: Standards for Non-point Sources Discharges, Environmental Guideline for Industrial Waste Discharge, Dept. Sustainable Development, Environmental Protection Service, Nunavut.

Event monitoring contingencies

Elements of concern for the event monitoring program include mill reagents (lime, sodium cyanide, acid, sulphate, flocculants, copper sulphate), fuel, or explosives (ammonium nitrate) from spills, accidents, and potential malfunctions. Each of these accidental releases has specific guidelines that include: mobilization of site equipment to stabilize the release; procedures to contain, neutralize, and dispose of the discharge, and recommendations for monitoring the site following the incident. These guidelines are provided in the:

- Spill Contingency Plan
- Emergency Response Plan
- Accidents and Malfunctions

The event monitoring program is the specific monitoring program for the Baker Lake marshalling area and storage facilities and is intended to identify the presence of contaminants in the pond water for treatment prior to any release from the pond. The specific elements of concern will be based upon the type of release and will use the MSDS data to identify the analytes and monitoring program.

The containment sump monitoring program is intended to:

- identify leakage from piping and /or the storage vessels which will trigger diversion of sump water to contact water facilities and emergency response for site remediation; and,
- monitor treatment after mitigation.

7.2.6 Flow monitoring program

The volume of contact water from the Baker Lake marshalling area will be monitored through the volume of discharge pumped from the storage ponds. The average flow rate, total discharge per event and total cumulative discharge will be recorded and reported annually.

8.0 CLOSURE AND RECLAMATION CONCEPT

This section summarises a preliminary closure and reclamation concept for the Baker Lake marshalling area and storage facilities. All structures, materials and equipment not required for future use by the local community will be dismantled and demobilized from the site. Non-salvageable buildings and structures will be dismantled or demolished and disposed of offsite. Any site roads and storage pads not required for future use will be decommissioned and all drainage courses will be restored to the original locations where topography and slope stability allows. The water management infrastructure such as diversion channels, ponds, or culverts, will be designed to be dismantled and removed to facilitate restoration of the original drainage.

Water management infrastructure, including the contact and non-contact water diversion channels, the storage ponds and fill slope protection will be required to remain in place and operational until the marshalling area 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. It is proposed to maintain operations, monitoring and maintenance activities of the water management infrastructure for five years after closure of the marshalling area. Should water quality monitoring demonstrate that contact water is suitable for direct discharge to Baker Lake, site reclamation could begin earlier than five years.

Once water quality monitoring indicates that the surface runoff is of dischargeable quality, monitoring and treatment of contact water will be discontinued and the marshalling area and storage facilities water management infrastructure will be dismantled.

Assuming no use for the marshalling area and storage facilities infrastructure have been identified by the community of Baker Lake, the proposed closure and reclamation plan for the marshalling area will involve the following key steps:

- Fuel tanks and explosive facilities will be dismantled and removed from site.
- Marshalling area facilities will be dismantled and removed from site.
- Revegetation of the marshalling area, fuel tank storage area, explosive storage area and channels will be completed based on results of field trials during operations.

- Contact and non-contact water diversion channels infrastructure will be filled, and original drainage courses restored where possible once vegetation has been established. Monitoring would continue.

- The pump system will be dismantled and removed from the site.

- The sedimentation pond will be filled and re-vegetated.

Throughout the operational period of the marshalling area, the diversion channels will be maintained over a number of seasons. The water management systems for the closure and reclamation phase will be designed during the detailed design phase of the operations water management systems, but will be modified based on actual performance during the marshalling area operations, providing a flexible and adaptive management strategy for the closure of the water management system.

9.0 ADAPTIVE MANAGEMENT

The water management plan presented here is based on a preliminary design of the marshalling area and storage facilities. Detailed design of water management infrastructure is not possible until the design of the marshalling area and storage facilities is finalized Once the design for the marshalling area and storage facilities is finalized, the water management plan should be reviewed and revised if necessary. To facilitate this review and possible revisions, adaptive management strategies have been used in the preliminary design as follows:

- Conservative estimates have been made for the sizing of water infrastructure, providing adaptability to unforeseen situations during the detailed design and construction phases.

- If the pond design volumes need to be significantly higher than the volumes estimated, the following alternative options are available to modify the design:

  - The conceptual storage ponds design proposes an excavated structure. Construction of embankments could provide additional volume; and
  - Additional smaller storage ponds could be constructed at each storage area/facility.

In addition, adaptive management will be used during operations and closure to optimize the performance of the water management systems as follows:

- The contact water storage ponds design contains two sections, each having the storage capacity for one week of snowmelt for an average year conditions. This allows for treatment or sedimentation to occur in one section at a time while the other still has the capacity to store additional spring freshet or rainfall runoff.

- The proposed monitoring program during operations allows for modifications to the closure and reclamation concept based on actual performance during marshalling area operations.

10.0 CLOSING

The reader is referred to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

We trust the information contained in this draft report meets your requirements at this time. Please feel free to contact us if you need more detailed information on any of the information presented in this draft report.

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YAA/TJ/PWM/JAH/DRW/SAA/VJB/cm/lw
Attachments
O:\Final\2006\1413\06-1413-081\Correspondence\Word Docs\434 8Mar_07 DRPT-Ver B - WMP Baker Lake Marshalling Area.Doc

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, and safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

DRAFT
For Discussion purposes

PROJECT

MEADOWBANK
MINING CORPORATION

TITLE

BAKER LAKE MARSHALLING AREA LOCATION MAP

Golder Associates

PROJECT No. 06-1413-089			FILE No. FIGURE 1	
DESIGN	YAA	28FEB07	SCALE NTS	REV.
CADD	AS	28FEB07	**FIGURE 1**	
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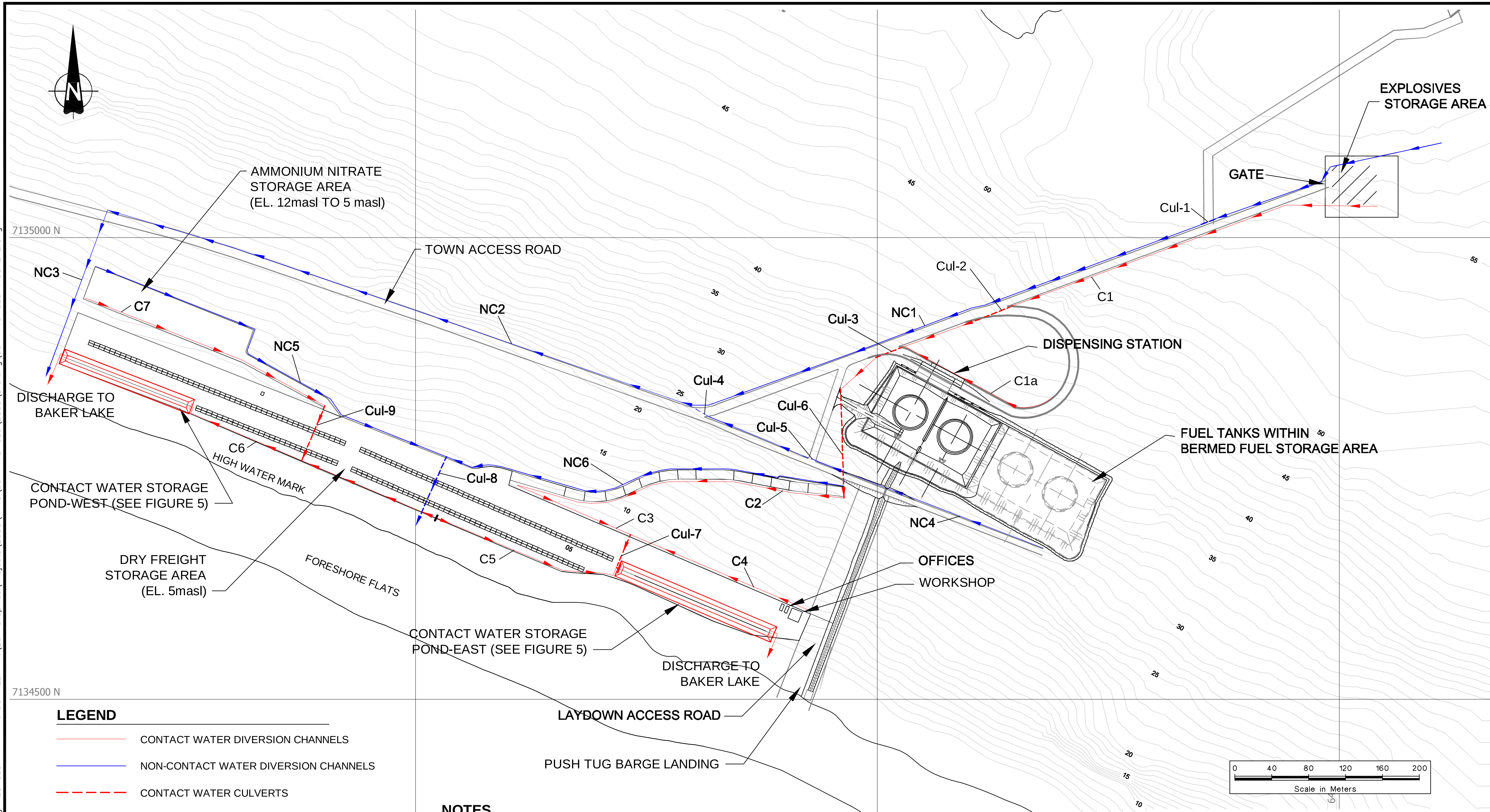
DRAWING DATE: 01-Mar-07 COREL FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\3000\Drafting\FIGURE 1.cdr



LEGEND

CONTACT WATER DIVERSION CHANNELS
NON-CONTACT WATER DIVERSION CHANNELS
CONTACT WATER CULVERTS
NON-CONTACT WATER CULVERTS
ROAD
FENCE FOR THE FUEL TANKS AREA
C1	NAME OF CONTACT WATER CHANNELS
NC1	NAME OF NON-CONTACT WATER CHANNELS
Cul-1	NAME OF CULVERTS

NOTES

1. NORTHING AND EASTING ARE IN METRES REFERENCED TO UTM ZONE 14, NAD83.
2. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES REFERENCED TO GEODETIC DATUM. UNLESS OTHERWISE NOTED.

DRAFT
For Discussion Purposes

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
BAKER LAKE MARSHALLING AREA LAYOUT

Golder Associates

PROJECT No. 06-1413-089		FILE No. 061413089-SK04
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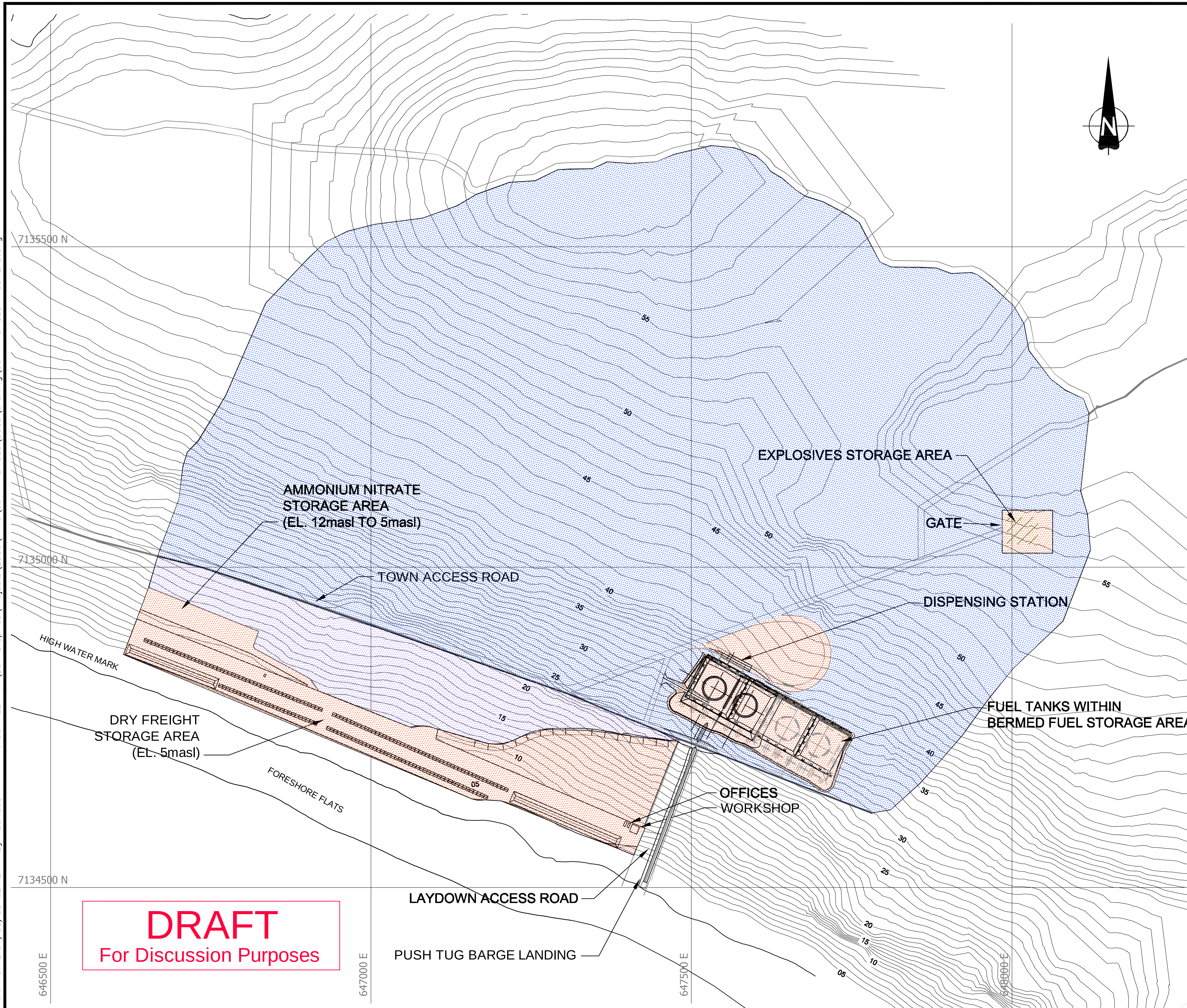

LEGEND

- NON-CONTACT WATER CATCHMENT EXTERNAL TO MARSHALLING AREA
- NON-CONTACT WATER CATCHMENT WITHIN MARSHALLING AREA
- CONTACT WATER CATCHMENT
- FENCE FOR THE FUEL TANKS AREA
- ROAD

NOTES

1. NORTHING AND EASTING ARE IN METRES REFERENCED TO UTM ZONE 14, NAD83.
2. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES REFERENCED TO GEODETIC DATUM, UNLESS OTHERWISE NOTED.

0 60 120 180 240 300
Scale in Metres

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
BAKERLAKE MARSHALLING AREA
CONTACT AND NON-CONTACT CATCHMENTS

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-SK05
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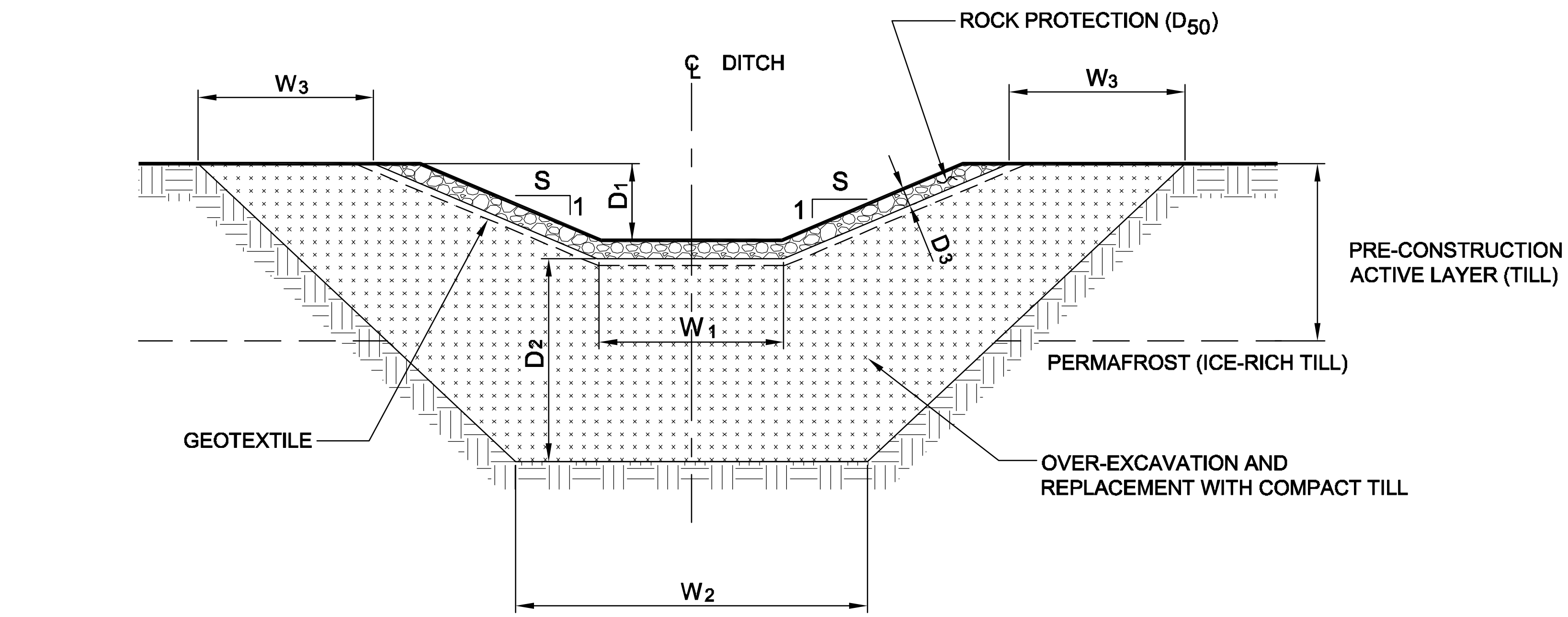
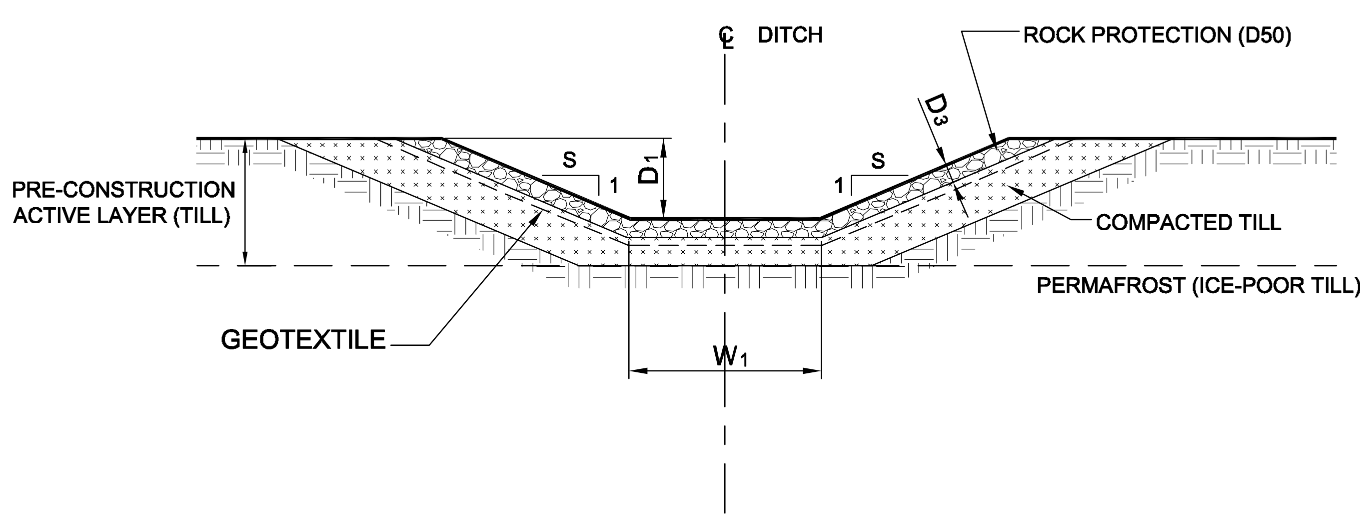
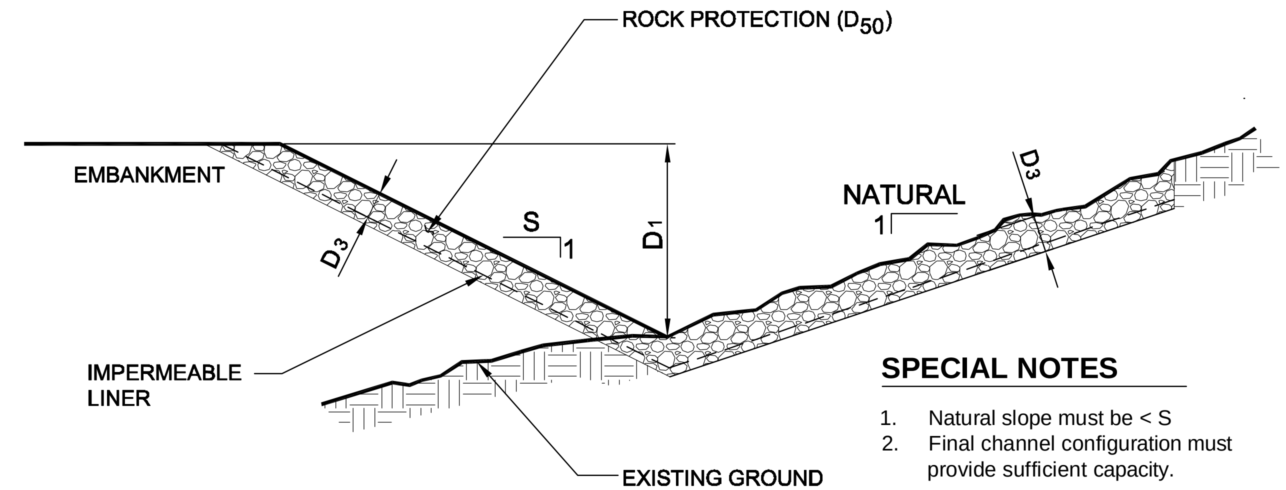


A DRAINAGE CHANNEL WITH EXCAVATION IN ICE RICH TILL



B DRAINAGE CHANNEL WITH EXCAVATION IN ICE-POOR TILL



SPECIAL NOTES

1. Natural slope must be < S
2. Final channel configuration must provide sufficient capacity.

C DRAINAGE CHANNEL WITH INVERT ABOVE GRADE

PROPOSED CHANNEL PARAMETERS

Channel	Bed Slope (m/m)	Side slope S	Length (m)	D_1 (m)	D_2 (m)	D_3 (m)	D_{50} (mm)	W_1 (m)	W_2 (m)	W_3 (m)
NC 1	0.044	2H:1V	790	1.50	2.0	0.3	150	1.0	2	1.5
NC 2	0.009	2H:1V	675	1.50	2.0	0.3	100	1.0	2	1.5
NC 3	0.080	2H:1V	200	2.00	2.0	0.3	300	2.0	2	1.5
NC 4	0.010	2H:1V	390	1.00	2.0	0.3	100	1.0	2	1.5
NC 5	0.012	2H:1V	475	1.00	2.0	0.3	100	0.5	2	1.5
NC 6	0.034	2H:1V	445	1.00	2.0	0.3	100	0.5	2	1.5
C 1	0.062	2H:1V	680	1.00	2.0	0.3	0.4	0.5	0.6	0.7
C1a	0.017	2H:1V	175	1.00	2.0	0.3	0.4	0.5	0.6	0.7
C 2	0.034	2H:1V	380	1.00	2.0	0.3	100	0.5	2	1.5
C 3	0.021	2H:1V	140	1.00	2.0	0.3	100	0.5	2	1.5
C 4	0.002	2H:1V	210	1.00	2.0	0.3	100	1.0	2	1.5
C 5	0.002	2H:1V	220	1.00	2.0	0.3	100	1.0	2	1.5
C 6	0.002	2H:1V	260	1.00	2.0	0.3	100	1.0	2	1.5

0 2 4 6 8 10
Scale in Meters

LEGEND

- S - Side slope (**S** H:1V)
- D_1 - Channel Depth
- D_2 - Over-excavation depth
- D_3 - Rock Protection thickness
- D_{50} - Rock Protection (Medium size)
- W_1 - Width of Channel bed
- W_2 - Width of over-excavation bed
- W_3 - Width of over-excavation on side slopes

NOTES

1. Refer to Figure 2 for channel locations.
2. Final channel configuration must provide sufficient capacity for drainage channels with invert above grade.

DRAFT
For Discussion Purposes

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
BAKER LAKE MARSHALLING AREA
TYPICAL DIVERSION CHANNEL

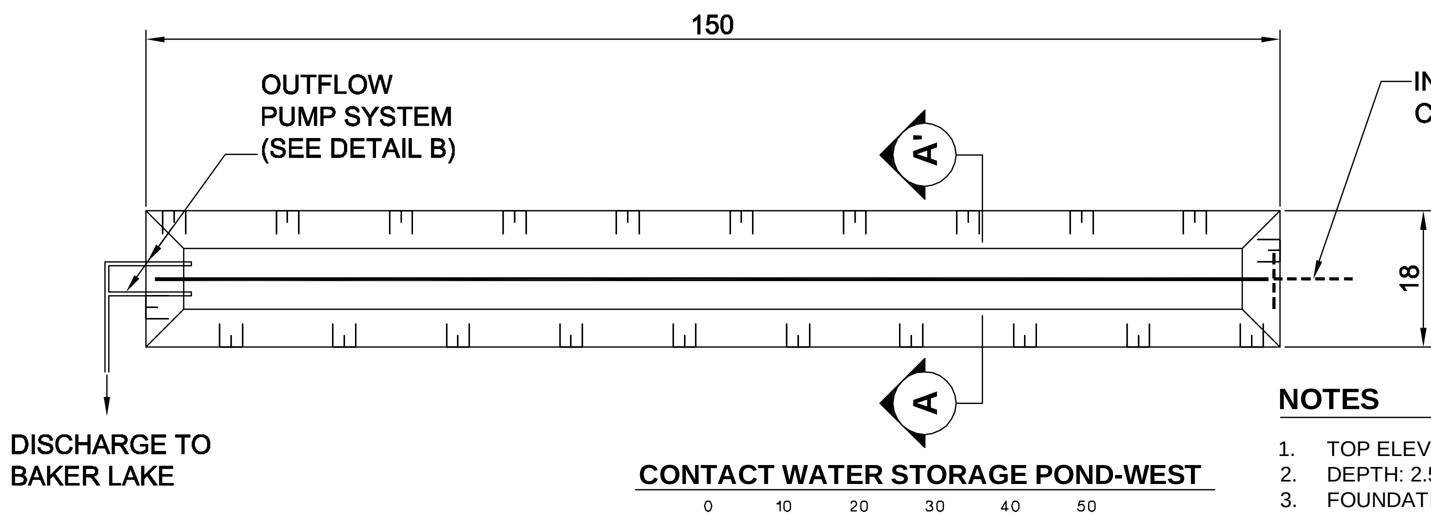
Golder Associates

PROJECT No.	06-1413-089		FILE No. 061413089-3000-A_04	
DESIGN	YAA	23FEB07	SCALE NTS	REV. -
CADD	AS	23FEB07		
CHECK			**FIGURE 4**	
REVIEW				

CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\3000\Drafting\06-1413-089-FIGURE 4.dwg

REVISION DATE: 07/03/08 02:02PM By: ASalvador

REVISION DATE: 07/03/08 01:20PM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\3000\Drafting\06-1413-089-FIGURE 5.dwg

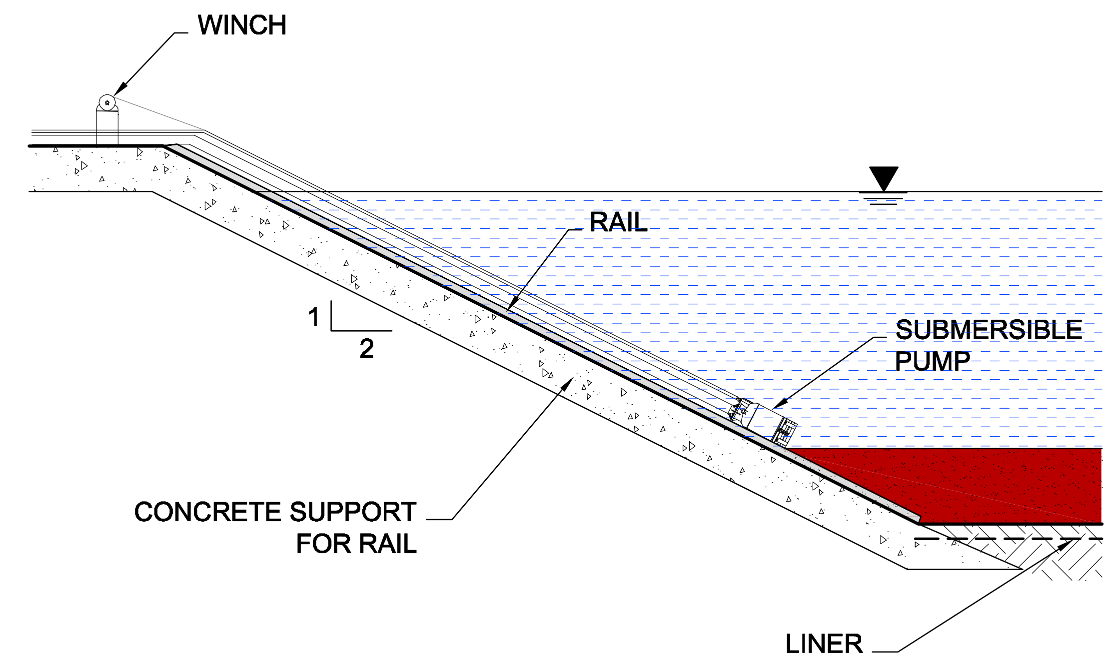


CONTACT WATER STORAGE POND-WEST

0 10 20 30 40 50
Scale in Meters

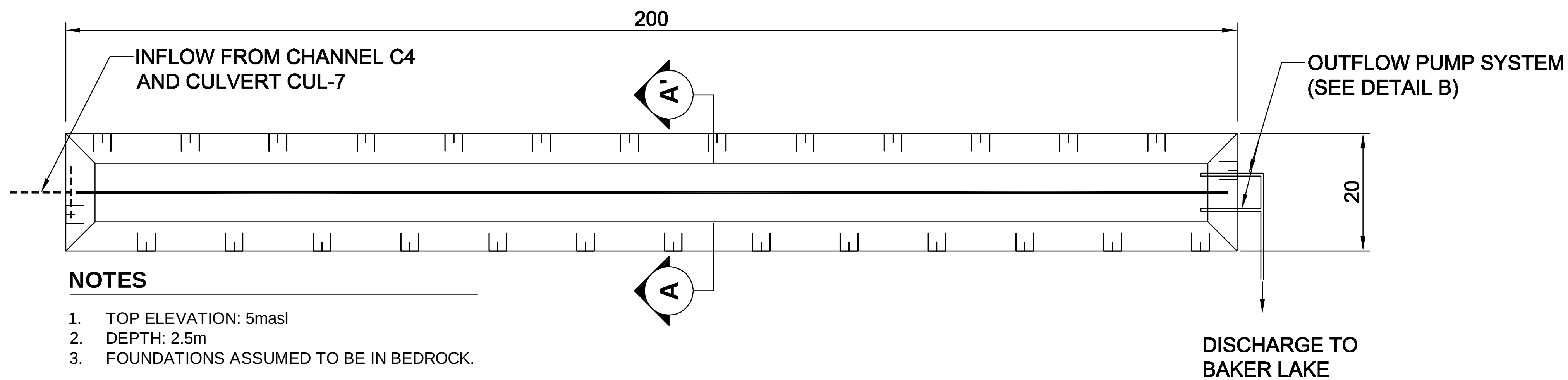
NOTES

1. TOP ELEVATION: 4.5masl
2. DEPTH: 2.5m
3. FOUNDATIONS ASSUMED TO BE IN BEDROCK.



B DETAIL OF SUBMERSIBLE PUMP AND RAIL

0 0.5 1 1.5 2 2.5
Scale in Meters

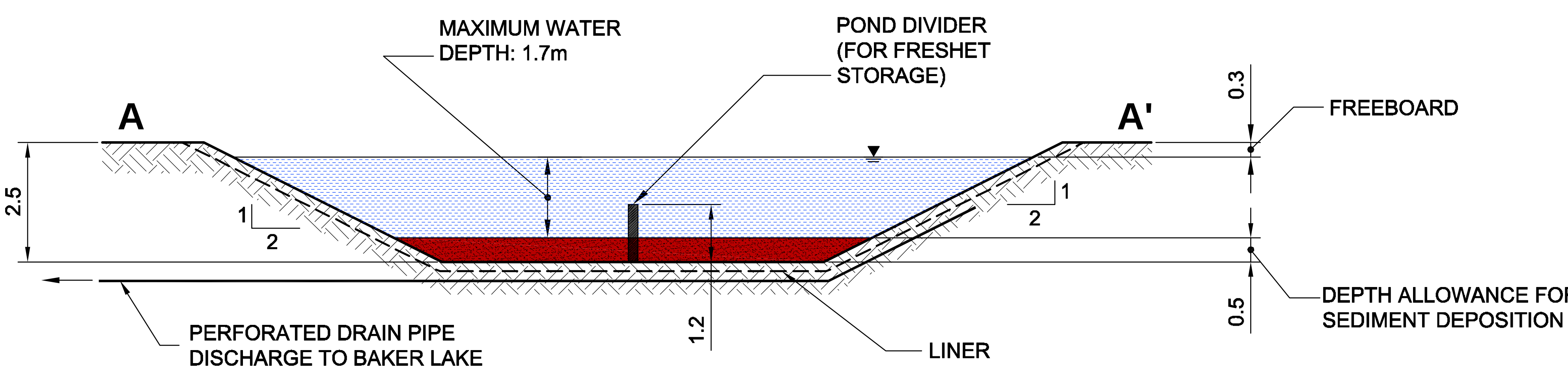


NOTES

1. TOP ELEVATION: 5masl
2. DEPTH: 2.5m
3. FOUNDATIONS ASSUMED TO BE IN BEDROCK.

CONTACT WATER STORAGE POND-EAST

0 10 20 30 40 50
Scale in Meters



A SECTION A-A' (TYPICAL SECTION)

0 1 2 3 4 5
Scale in Meters

DRAFT
For Discussion Purposes

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
BAKER LAKE MARSHALLING AREA
CONTACT WATER POND

Golder Associates

PROJECT No. 06-1413-089		FILE No. 061413089-3000-A_04
DESIGN	YAA	23FEB07
CADD	AS	23FEB07
CHECK		
REVIEW		

SCALE AS SHOWN REV. –

FIGURE 5