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FINAL REPORT
DETAILED DESIGN OF CENTRAL DIKE
MEADOWBANK GOLD PROJECT
VOLUME 2

Submitted to:

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APPENDIX V

SPECIFICATIONS

PREPARED FOR:

PREPARED BY:

D	16/MAR/07	ISSUED FOR TENDER	AS	TLE
C	21/FEB/07	DRAFT - ISSUED FOR CLIENT REVIEW	AS	HH
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1.0 SCOPE

This Specification provides general administrative requirements related to the Central Dike, Stormwater and Saddle Dams construction for Meadowbank Mining Corporation (MMC) at Meadowbank Gold Project site in Nunavut, Canada.

This Specification will be revised when the form of contract for the work is selected.

2.0 GENERAL

The Meadowbank Gold Project is located approximately 70 km north of Baker Lake, Nunavut. Tailings generated at the site shall be stored in the basin formed by dewatering the northwest arm of Second Portage Lake. The Tailings Storage Facility (TSF) shall be bounded by a series of dikes: Central Dike, Stormwater Dike and Saddle Dams.

The Central Dike and Saddle Dams are permanent structures. The Stormwater Dike acts to divide the TSF north to south for a two year time period.

The Central Dike shall be constructed 'in the dry', after drawing down the water in the northwest arm of Second Portage Lake. The dike shall be constructed in three stages: Stage 1 shall be constructed in Year -1 of the mine life to a crest elevation of 120 meters above sea level (masl), Stage 2 construction shall occur in Year 3, raising the dam to the final crest elevation of 140 masl and Stage 3 construction shall occur in Year 5, raising the dam to crest elevation 147 masl. At closure a 1 m thick rockfill cap shall be placed to a final crest elevation of 148 masl.

The Central Dike shall be constructed in horizontal lifts of a downstream rockfill shell with an upstream bituminous liner bedded on filter material. The liner shall be anchored into a trench excavated through soil to bedrock. A grout curtain in bedrock shall be constructed below the trench. A layer of uncompacted glacial till shall be placed on the upstream face of the liner as erosion protection.

The Saddle Dams along the south side of the tailings facility shall be constructed by dumping a 30 m wide rockfill along the alignment, resloping the upstream face, excavating a trench to bedrock along the upstream toe and the installation of an impermeable element.

The Stormwater Dike and the Saddle Dams do not form part of the scope of work for this Contractor; information is provided for discussion with potential Contractors for the future work.

2.1 General Site Conditions

A summary of the subsurface conditions is presented in Golder Associates March 2007 Meadowbank Gold Project Central Dike Detailed Design Report.

2.2 Definitions

Work	• All activities associated with the construction of the Central Dike, Stormwater Dike and Saddle Dams including quality control and instrumentation installation.
Manager	• Meadowbank Mining Corporation (MMC) responsible for providing items noted in the contract package as being supplied by MCC, obtaining all relevant permits, and providing the contactor reasonable access to the general open areas surrounding the work site.
Contractor	• A construction contracting company to be selected by MCC to carry out the Central Dike Construction Work. • Responsible to provide all other items and incidentals not supplied by the Manager to bring the construction work or additional work as requested by the Manager to final completion. • Contractor is responsible for proper construction of the work including any work performed by its Sub Contractors. • Shall provide survey control and Quality Control (QC) for the work it undertakes. • Reports to CM.
Engineer	• Golder Associates Ltd. (Golder).
Construction Manager (CM)	• Represents the Manager on site and has the authority to direct all aspects of the work. Responsible for all project communications, arranging daily and weekly meetings as required, holding problem resolution meetings for resolution of Quality Assurance and Quality Control QA/QC issues.

Quality Assurance Manager	• Represents the Engineer on site and has the authority to approve aspects of the work as following the design intent and specifications. • Responsible for performing tasks outlined in Specification 1000-07 QC Requirements. • QA manager has authority to stop any aspects of work that is not in compliance with the QA/QC Plan. • Work that has been stopped because of non-compliance with the QA/QC Plan shall resume only after a plan for corrective action prepared by the Contractor has been approved by the CM.
Approval	• A written engineering or geotechnical opinion, concerning the progress and completion of the Work.
Quality Assurance (QA)	• Planned and systematic activities that provide adequate confidence to the Owner and various stakeholders that quality control is being implemented effectively.
Quality Control	• A planned system of inspection and testing carried out according to accepted standard specifications to ensure the quality of construction work.
Ice-rich Soil:	• Frozen soils that contain more than 10 percent visible ice and/or have a moisture content greater than 30%. • Normally ice lenses are present.
Ice-poor Soil:	• Frozen soils that contain less than 10 percent visible ice and have a moisture content less than 30%. • No visible ice lensing.
Rockfill:	• Rock material meeting the design specification.
Coarse Filter	• Material produced from crushing of rockfill and meeting the design specification.
Fine Filter	• Material produced from crushing of rockfill and meeting the design specification.
Glacial Till	• Glacial till soil consisting of clay, silt, and sand with gravel and cobble and meeting the design specification. Till and glacial till used are interchangeably.
Work Completion Report	• Summary report prepared by Contractor.

2.3 Codes and Regulations

Work shall conform to, but not limited to the requirements of the latest editions of the following standards and codes which are part of this Specification:

ASTM D422	Test Method for Particle-Size Analysis of Soils.
ASTM D1140	Test Method for Amount of Material in Soils Finer Than the No.200 (75 µm) Sieve.
ASTM D698	Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3).
ASTM D1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
ASTM C136	Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D2216	Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
ASTM D2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depths).
ASTM D1556	Test Method for Density of Soil in Place by the Sand-Cone Method.
ASTM D 422	Particle-Size Analysis of Soils.
ASTM D 1140	Materials Finer than No. 200 Sieve.
ASTM D 4318	Liquid Limit, Plastic Limit and Plasticity Index of Soils.
ASTM D2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depths).
CSA A23.2-1-C	Sampling Plastic Concrete.
CSA A23.2-3-C	Making and Curing Concrete Compression and Flexural Test Specimens.
CSA A23.2-12-C	Slump and Slump Flow of Concrete.
CSA A23.2-1-C	Making and Curing Compression Test Specimens of No-Slump Concrete.
Mine Health and Safety Act (Nunavut).	
Mine Health and Safety Regulations (Nunavut).	

ASTM: American Society for Testing and Materials.

CSA: Canadian Standards Association.

Codes specific to the liner installation are provided in Bituminous Liner Specification 1000-04. QC Plan details are presented in QC Requirements Specification 1000-07.

3.0 EXECUTION

The Central Dike construction package includes work to be carried out by both MMC and the Contractor. The following describes the scope of work and defines work to be carried out by each of MMC and the Contractor, and presents the expected sequencing of the work.

3.1 Scope of work

The scope of work is presented in the construction Drawings listed in Table 2 and the Specifications listed in Table 3. A plan for mine development is presented in Table 4. A general description of the Central Dike construction includes the following:

- Central Dike
    - Removal of lake bed sediments and foundation preparation;
    - Cutoff trench excavation;
    - Foundation site investigation;
    - Lean concrete mat foundation construction;
    - Drilling and grouting for the grout curtain;
    - Bituminous liner placement;
    - Placement of glacial till fill in the excavation;
    - Rockfill shell placement;
    - Coarse and fine filter placement;
    - Placement of glacial till fill along upstream face of liner; and
    - Instrumentation, installation and monitoring.

3.2 Sequencing Description

The following describes the expected general sequence for Central Dike construction and indicates work which is the responsibility of MMC and work which is the responsibility of the Contractor.

3.2.1 MMC Work Concurrent with Contractor Work

MMC shall supply, place and compact rockfill directly from the pit excavations or stockpiles.

MMC or Contractor shall conduct a site investigation prior to the excavation of the cutoff trench.

3.2.2 Contractor Work

The following work can be carried out by the Contractor:

- Foundation preparation;
- Cutoff trench excavation and bedrock surface preparation;
- Lean concrete mat foundation;
- Drilling and Grouting;
- Coarse and fine filter placement and compaction;
- Bituminous liner placement;
- Backfilling cutoff trench with glacial till;
- Glacial till placement on upstream face; and
- Instrumentation installation and monitoring.

4.0 MEETINGS

Weekly progress meeting shall be held and chaired by the CM and shall be attended by all parties. Minutes of meetings shall be prepared and distributed by the CM.

Other meetings may be called as required by the CM.

5.0 ENVIRONMENTAL ISSUES

The Contractor and his Sub Contractors are entirely responsible for prevention of pollution and other environmental problems related to the construction activities of the Central Dike construction.

The Contractor and his Sub Contractors shall incorporate environmental considerations while developing and implementing his own work procedures.

A draft copy of the Contractor's site specific Environmental Management plan (EMP) shall be prepared and submitted to the CM for review a minimum of 1 month prior to mobilization to Meadowbank. The CM and MMC shall review and provide comments on the draft Environmental Management Plan to the Contractor.

The Contractor must have a MMC approved EMP prior to mobilization to the site.

The Contractor must maintain an up to date and approved EMP covering all work activities being conducted throughout the Work.

Any spill or environmental concern shall be reported immediately to the CM.

6.0 HEALTH AND SAFETY

The Contractor is entirely responsible for the Health and Safety (H&S) at the work site.

The Contractor and his Sub Contractors shall incorporate H&S considerations while developing and implementing their own work procedures.

The Contractor shall also comply with relevant H&S regulations and MMC H&S protocols and procedures.

The Contractor shall comply with any additional MCC H&S Safety Plan.

The Contractor shall observe the regulations, procedures and restriction for the ingress to the construction area.

The Contractor shall prepare and submit to the CM for review and approval a site-specific health and safety plan that compiles with MMC regulations and in addition covers any additional health and safety requirements specifically related to the Contractor's work. Following approval of the plan, the plan shall be implemented.

A draft copy of the Contractor's site specific H&S plan shall be prepared and submitted to the CM for review a minimum of 1 month prior to mobilization to Meadowbank. The CM and MCC shall review and provide comments on the draft H&S plan to the Contractor.

The Contractor must have a MMC approved H&S Plan covering all work activities being conducted throughout the Work.

Any accident, near accident or H&S concern shall be reported immediately to the CM.

7.0 COOPERATION

The Contractor and his Sub Contractors shall cooperate with other parties to allow time and provide a safe work conditions to carry out any site visit required to check environmental or H&S concerns, perform control surveys and QA/QC operations. The Contractor and his Sub Contractors shall provide labour and equipment as required to contain and/or clean any environmental spills.

8.0 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

Access to the site shall be provided by the CM. The Contractor shall not have sole access to the Work area and must be prepared to share and coordinate activities and access with others, through the CM. The Contractor shall coordinate with the CM the location of any staging areas, temporary facilities, haul roads or access roads.

8.1 Power Supply

The contractor shall provide any temporary power required for the Work.

8.2 Construction Water

Water for dust control, moisture conditioning material to be placed as fill, and for maintaining in-place fill soils shall be obtained by the Contractor. The Contractor must supply all the pumps and tanks necessary. Water shall be available at a location determined by the CM.

8.3 Dust Control

During performance of the Work defined by the Specifications or any related operations, the Contractor shall control dust emissions.

8.4 Surface Water Control

The Contractor is responsible for controlling surface water and protecting Work from damage caused by this water.

8.5 Work Area

The Contractor shall:

- Store and dispense fuel, lubricating oils, and chemicals in such a manner to prevent or contain spills and prevent materials from entering local streams or groundwater according to applicable regulatory requirements;
- Maintain copies of Material Safety Data Sheets (MSDS) on file at the site for all hazardous materials; and
- Avoid damaging instrumentation or instrumentation cables, such piezometers, used at the site.

8.6 Traffic Control

MCC mine heavy equipment and haulage traffic has the right of way at all times.

The Contractor shall provide a flag person or persons at intersections with limited visibility and heavy traffic.

9.0 MOBILIZATION AND DEMOBILIZATION

Comprises mobilization to the mine of all materials, supplies, equipment and tools required to carry out the Work. It includes demobilization out of the mine of all remaining materials, equipment, and tools, hauled on site by the Contractor to carry out the Work.

All the means of transportation shall be the exclusive responsibility of the Contractor. MMC shall not provide any transportation service to or within the mine.

The Contractor is solely responsible for the planning and mobilization of materials and construction equipment, in accordance with the construction schedule. It is also the responsibility of the Contractor that Sub Contractors and their transportation equipment comply with the same safety regulations as the Contractor.

It is required that all Contractor's and Sub Contractor's equipment to be used in the Work pass a technical inspection conducted by MMC Operations' personnel.

Upon completion of the Work, the Contractor shall remove any temporary structure built during the work and/or shall require or remove any temporary construction that he may have installed during the Work.

The Contractor shall comply with all regulations at MCC regarding mobilization towards and within the mine.

10.0 SUBMITTALS

The Contractor must submit the following information to the CM:

With Bid:

- Summary of Company Experience;
- Resumes of Proposed Contractor's Superintendent, Grouting and Drilling Operations Manager, Drillers, Grouting Operators, Concrete Foreman, Bituminous Liner Installation Supervisor, Bituminous Liner Master Seamer and other key personnel;
- A proposed schedule; and
- Minimum equipment list, identifying the minimum equipment proposed to complete the Work.

Prior to Mobilization:

- Site-specific Environmental Management Plan;
- Site-specific Health and Safety Plan;
- Description outlining the proposed methods for conducting the Work, including excavation, drilling, grouting, concrete placement, earthwork;
- QC Plan; and
- Revised schedule.

During Construction:

- Maintain an up-to-date construction schedule;
- Maintain an up-to-date Environmental Management Plan covering all aspects of the Work; and
- Maintain an up-to-date Health and Safety Plan covering all aspects of the Work.

11.0 COMPLETION OF THE WORK

Immediately upon completion of the work the Contractor shall prepare the Work Completion Report (WCR) that shall include as minimum the following:

- Descriptive report;
- Original Construction Record;
- Copies of Meeting minutes, Field Change Notices (FCN), Site Instructions (SI), Request for information (RFI), and any other format that has been part of the Work;
- Original protocols of field or lab tests, duly signed by both parities (Contractor and Site Engineer) in hard copy and results in electronic copy;
- As Built drawings based on as-built survey information for foundation preparation, placement for each construction material, and instrumentation installation layout in electronic AutoCAD and hard copy format;
- Liner installation as-built panel layout drawings in electronic AutoCAD and hard copy format;
- Calculation sheets for actual quantities of work executed, duly signed by both parities (Contractor and Site Engineer);
- Liquidation of the Work;
- Installation details of instrumentation in electronic and hard copy format; and
- Final Safety Report.

The Contractor shall demonstrate compliance with all legal, tax, social security and other obligations required by MMC. Submittal of such documents shall be attached to each payment.

12.0 SITE INSPECTION

A compulsory site inspection shall be held for all bidders. It is essential for all contractors intending on submitting a bid to attend this inspection. Contractors shall provide the following minimum PPE for each staff member attending the meeting:

- Steel toe boots;
- Reflective vest;
- Hard hat;
- Safety glasses;
- Hearing protection;
- Gloves; and
- Appropriate winter climate protection.

13.0 MEASUREMENT AND PAYMENT

Details on measurement and payment for bidding purposes will be added at a later date.

14.0 PRELIMINARY LIST OF QUANTIITES

For bidding purposes, a list of quantities associated with the work proposed in this document is provided in Table 1. The scope of work for this contract will only be the Stage 1 construction.

TABLE 1: Central Dike Construction - Preliminary Quantities for Bidding Purposes

Material	Construction			Total
	Stage 1	Stage 2	Stage 3	
Excavation	145 262 m^3	17 232 m^3	-	167 923 m^3
Rockfill Intermediate Volcanic	189 041 m^3	747 349 m^3	-	992 078 m^3
Rockfill Ultramatic and Quartzite	51 364 m^3	233 801 m^3	318 417 m^3	603 582 m^3
Uncompacted till in trench and along upstream face	201 532 m^3	-	-	201 532 m^3
Fine Filter	12 271 m^3	8 139 m^3	7 584 m^3	35 700 m^3
Coarse Filter	12 271 m^3	8 139 m^3	7 584 m^3	27 994 m^3
Liner	21 542 m^2	36 679 m^2	16 535 m^2	74 756 m^2

15.0 REFERENCE DRAWINGS AND SPECIFICATIONS

TABLE 2: Central Dike Construction - List of Drawings

Drawing	Number	Title	Revision
4000	00	LOCATION MAP AND DRAWING INDEX	B
4000	01	OVERALL SITE PLAN	B
4000	02	BOREHOLE LOCATIONS PLAN	B
4000	03	GEOLOGIC SECTION ALONG DIKE ALIGNMENT	B
4000	04	PROPOSED DIKE FOOTPRINT SHOWING BATHYMETRY CONTOURS	B
4000	05	PROPOSED DIKE LAYOUT SHOWING SOIL THICKNESS	B
4000	07	CONSTRUCTION STAGING OVERVIEW	B
4000	08	EXCAVATION PLAN STAGE 1	B
4000	09	EXCAVATION PLAN STAGE 2 AND 3	B
4000	10	GROUTING PLAN AND LINER DETAILS	B
4000	12	STAGE 1 PLAN	B
4000	13	STAGE 1 SECTIONS	B
4000	14	STAGE 2 PLAN	B
4000	15	STAGE 2 SECTIONS	B
4000	16	STAGE 3 PLAN	B
4000	17	STAGE 3 SECTIONS	B
4000	18	STORMWATER DIKE AND SADDLE DAM LAYOUT	A
4000	19	CONSTRUCTION STAGING OVERVIEW – STORMWATER DIKE	A
4000	20	CONSTRUCTION STAGING OVERVIEW – SADDLE DIKE	A
4000	21	ROCKFILL PLACEMENT – PLAN	A
4000	22	ROCKFILL REGRADING – PLAN	A
4000	23	EXCAVATION PLAN	A
4000	24	CENTRAL DIKE INSTRUMENTATION – PLAN LOCATIONS	A
4000	25	CENTRAL DIKE INSTRUMENTATION – TYPICAL SECTION	A

TABLE 3: Central Dike Construction - List of Specifications

Specification Number	Title	Revision
1000-01	Administration	D
1000-02	Earthworks	D
1000-03	Lean Concrete Mat	D
1000-04	Bituminous Liner	D
1000-05	Drilling and Grouting	D
1000-06	Instrumentation Installation	D
1000-07	QC Requirements	D
1000-08	Care of Water	D
1000-09	Anchor Bars	D

TABLE 4: Mine Development Plan

Year	Key Issues
-2 and -1	• Stripping at Third Portage peninsula for construction materials • Construct East Dike and Bay Zone dikes • Begin constructing Goose Island Dike as construction material becomes available • Lower water level behind East and Bay Zone dikes • Construct plant site
1	• Commence mining of Portage Pit, south end • Portage pit water pumped to water sump at process plant • Continue and complete construction of Goose Island Dike. Dewater behind dike. Commence stripping of overburden materials
2	• Commence mining at Goose Island Pit • Portage and Goose Island Pit waters, and plant site and airstrip runoff to be directed to attenuation pond, or pumped to water sump at process plant for use as process water as required before discharge of excess to attenuation pond

Year	Key Issues
3-4	• Portage and Goose Island Pit waters, and plant site runoff waters, pumped to water sump at process plant for monitoring and treatment and use as process water as required before discharge of excess to attenuation pond. • Begin construction of Vault haul road • Construct Vault Dike and dewater Vault Lake
5	• Complete mining of Goose Island Pit, and start abandonment • Goose Island Pit is available for storage of pit water • Pump pit water from Portage Pit to Goose Island Pit for early flooding, water quality monitoring, and in-pit treatment as required. Small quantity to be pumped to the process plant for treatment and use as process water • Begin mining northward at Portage Pit towards North. Selective placement of waste rock into south end of Portage Pit, or into Goose Island Pit. Selective placement of Ultramafic rock at Portage RSF for future use during closure. • Commence mining at Vault
6-7	• Continue and complete mining of Portage Pit (north end) • Continue mining of Vault Pit • Continue pumping Portage Pit water to Goose Island Pit lake until Portage Pit is mined-out then allow pits to fill • Monitor water quality within flooded pits, treating in-situ as required and/or pumping to process plant for use as process water
8	• Complete mining in Vault • Continue pumping Portage Pit water to Goose Island Pit lake until Portage Pits are mined-out, then allow pits to fill • Monitor water quality within flooded pits treating in-situ as required and/or pumping to process plant for use as process water • Continue Goose Island Pit flooding, monitoring and water treatment; commence Portage Pit flooding, monitoring and water treatment.
9	• Mining complete, start final closure and restoration • Commence Vault Pit flooding.

PREPARED FOR

PREPARED BY:

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1.0 SCOPE

This Specification provides the technical information for the earthworks construction for the Central Dike, Stormwater Dike and Saddle Dams for Meadowbank Mining Corporation (MMC) at Meadowbank mine in Nunavut Province of Canada.

2.0 GENERAL

The Contractor shall carry out foundation preparation, excavation and fill placement in accordance with the Drawings and Specifications, using ground support and water control measures required for safe and effective operation. If the Contractor fails to comply with such requirements, the CM may direct the suspension of work until the requirements have been met to the satisfaction of the CM.

The Contractor shall provide, operate and maintain temporary drainage and pumping systems as required to direct water away from the surface excavation areas as specified in Care of Water Specification 1000-08.

2.1 Access

Access to the Work will be provided by the CM as presented on the Drawings. The Contractor shall not have unrestricted access to the Work area and must be prepared to share and coordinate activities and access with others, through the CM. The Contractor shall not construct any staging areas, temporary facilities or access roads without the approval of the CM.

2.2 Waste Soil and Rock

Waste soil and rock shall be disposed of inside the tailings impoundment and outside the footprint of the fill required for the dam or in other areas designated by the CM.

This waste includes foundation preparation stripping and oversized or unsuitable material from the fill placement.

Disposal materials shall not be piled higher than the crest of the Central Dike or Saddle Dams or Stormwater Dike.

Disposal materials shall not be spoiled as to adversely affect tailings in the impoundment.

2.3 Borrow Sources

2.3.1 Rockfill Material and Cap Material

Rockfill shall be supplied by MMC.

2.3.2 Filters

Filter materials are stockpiled in the crusher area. Filter gradation shall be tested against rockfill gradation for filter compatibility.

2.3.3 Glacial Till

The primary Glacial till material borrow source is stripping of pit areas. Prior to approval of a borrow source, the gradation of the glacial till shall be checked for compatibility with the specifications and approved by the Engineer. Other borrow sites may be considered subject to gradation.

3.0 MATERIALS

3.1 Rockfill IV

Select Intermediate Volcanic Rockfill will be used in the downstream shell as shown on Drawings:

- Rockfill IV consisting of sound, hard, durable, well graded rock fragments free from snow, ice, frozen chunks, organic matters, debris and other deleterious materials.

3.2 Rockfill UM+Q

Ultra Mafic and Quartzite rockfill will be placed as capping materials.

Rockfill UM+Q material shall consist of sound, hard, durable, well graded rock fragments free from snow, ice, frozen chunks, organic matters, debris and other deleterious materials.

3.3 Coarse Filter

Coarse filter will be placed between fine filter and rockfill.

- Coarse filter shall fall within the gradation limits in place as shown below in Table 1 and shall be free of clay, organic matters, debris, cinders, ash, refuse, snow, ice and other deleterious material.

TABLE 1: Gradation Limits for Coarse Filter

Grain Size (mm)	Percent Passing by Mass (%)
305	100-90
152	100-50
76.2	92-33
25.4	44-7
12.7	22-5
4.75	10-3

3.4 Fine Filter

Fine filter will be used as a transition material between the Bituminous liner and coarse filter for the Central Dike.

- The fine filter shall fall within the gradation limits in place as shown below in Table 2 and shall be free of organic material, debris, cinders, ash, refuse, snow, ice and, other deleterious material to the satisfaction of the Engineer.

TABLE 2: Gradation Limits for Fine Filter

Grain Size (mm)	Percent Passing by Mass (%)
76.2	100
25.4	100-68
12.7	75-56
4.75	55-40
2	43-30
0.425	23-10
0.075	8-5

3.5 Glacial Till

Glacial till material will be used on the upstream face of the Central Dike overlying the bituminous liner and as backfill in the cutoff trench.

- Glacial till shall be unfrozen silty sand and gravel. The material shall have a suitable moisture content to obtain sufficient compaction, as determined by the QA Manager.

- Glacial till shall be free of organic material, debris, cinders, ash, refuse, snow, ice and, other deleterious materials subject to approval of the Engineer.

- The glacial till gradation shall be tested in the field and shall meet the following:

    - Maximum particle size of 150 mm.

4.0 EXECUTION

4.1 Examination

The Contractor shall, prior to commencing construction, thoroughly examine other work upon which this Work is dependent and report deficiencies, propose adjustments to the CM, and obtain written authorization before proceeding.

4.2 Topography Survey and Initiation

Before initiating the work the Contractor shall carry out a topographic survey of the work areas to establish the base plans for layout and quantity calculations. The Contractor should submit the complete reports of his surveys and topography measurements to the CM within 1 week of completing the survey.

The Contractor is responsible for the correctness and exactness of his work.

4.3 Foundation Preparation

The CM will determine the extent and type of work required for foundation preparation. The Contractor shall prepare the foundations for the lean concrete mat and for dam fills (rockfill, filter, glacial till) as shown on the drawings and as directed by the Engineer. Fill and concrete placement shall not be permitted until preparation of the work has been accomplished to the Satisfaction of the Engineer.

4.3.1 Preparation for Dam Footprint

Foundation preparation shall be carried out in the footprint of the Central Dike, as indicated on the Drawings, and includes:

- Rough grading of the foundation surface by removing boulders protruding more than 150 mm above the ground and scalping tops of hummocks, to form a smooth surface;
- Removal of lake bed sediments; and
- Removal of all dry, fibrous organic material and other unsuitable materials as directed by the Engineer.

Foundation preparation material shall be carried out using conventional machines and disposed of in areas designated by the CM. Material disposed of within the impoundment shall only be placed upstream of the final dam fill section footprint.

4.3.2 Preparation for Lean Concrete Mat

Foundation preparation for the Lean Concrete Mat shall include cleanup of the bottom of the excavation, including brushing and sluicing, pressure washing of the exposed surface using a pressure washer capable of operating at 1400 kPa, and using air pressure equipment capable of producing 700 kPa air pressure through a 25 mm diameter nozzle,

treating irregularities such as cracks, faults, fractures, weak bedrock zones, filling such areas with dental concrete or slush grout.

Treatment of irregularities may include using jackhammers, hydraulic breakers, air and water jets, hand-tools and brushes. Irregularities are defined as thin, fractured or crushed layers of rock, weathered contacts between different types of rock, infilled seams, or similar features encountered during excavation, or weaknesses exposed during pressure washing. Such materials shall be excavated to a depth generally 3 times the width of the feature, and shall be replaced with shotcrete or dental concrete.

Pressure washing and compressed air jetting shall be carried out to prepare the rock surface such that it is clean and totally exposed with no remnants of soil, loose rock, or debris. Compressed air and pressure washing shall be carefully applied to the rock surface to remove all loose and disturbed material, but care shall be taken to ensure that high pressure air or water is not directed into joints such that blocks of competent bedrock are broken out.

Scaling and chiselling may be required as directed by the CM, using an excavator with rock breaker, jackhammer, or other equipment. Repeated scaling may be required. All broken and loosened rock material shall be removed.

All excavation shall be carried out using methods to avoid overbreak and preserve the foundation rock in sound condition, without shattering or splitting or opening up cracks or seams in the rock.

All depressions or overhangs in which backfill materials cannot be properly compacted shall be filled with dental concrete or shotcrete.

Concrete, slush grout and shotcrete shall not be subjected to traffic for at least 48 hours after application.

4.4 Excavation

The cutoff trench construction may require an open cut excavation through frozen foundation soils using drilling and blasting methods to establish a trench with dimensions specified in the Drawings. Excavate the cutoff trench in accordance with drawings and this specification.

The excavated trench base shall be prepared to a suitable bedrock surface, as set out in Section 4.3.2 and approved by the Engineer, prior to concrete placement. The minimum depth of the cutoff trench is to bedrock.

Trench wall stability is the responsibility of the Contractor.

At least 30 days prior to commencing work, the Contractor shall submit to the CM the proposed methods for excavation of each part of the Works, including sequencing and stages of protection of excavated surfaces and water handling.

The Contractor shall lay out each excavation subject to inspection by the CM, prior to commencing any excavation.

The Contractor shall not initiate excavation of any part of the Work until the proposed methodology and construction sequence has been approved by the CM.

Surface excavation work may begin only after the necessary infiltration and runoff control measures have been completed in accordance with Care of Water Specification 1000-08, and the necessary equipment, elements and materials for protection of surface excavations are available at that site.

The Contractor shall take the necessary precautions to obtain regular and stable excavation surfaces, which follow the boundary lines and grades shown on the drawings. For such purpose, the Contractor shall implement when required by the Engineer, controlled blasting techniques, such as pre-splitting and smooth blasting, to reduce to a minimum the fracturing of the rock beyond the design excavation limits.

Whenever close to advancing excavations, the Contractor shall use appropriate excavation methods and take necessary precautions to avoid damage or disturbance of the rock mass to be excavated at a later time. Any damage caused as a result of negligence by the Contractor shall be repaired at his expense and to the satisfaction of the Engineer.

4.4.1 Excavating by Blasting

The Contractor shall submit for approval of the Engineer, no less than 30 days prior to starting excavation works, the excavation procedure including blasting patterns, charge densities and other blasting techniques. The Contractor shall advise the engineer at least

six hours in advance of his intentions to blast as to allow the Engineer to verify the blasting patterns and its potential effects on other work areas as well permit the Contractor sufficient time to program and control the use of transmission/receiving radio signals, which maybe hazardous to electrically controlled blasting. The Contractor shall provide the following information prior to each blast:

- Number, diameter, depth and bearing of drill holes for the blasting;
- Location and blasting pattern shown on plan and cross section drawings at an adequate scale;
- Type, density, weight and specific power of the explosive, cartridge dimensions and length of holes;
- Distribution scheme of delays, indicating blasting sequence and microdelay intervals proposed for each group of holes; and
- Type and source of ignition.

If the Engineer considers at any time, the excavation methods adopted by the Contractor unsatisfactory, resulting in the excessive overbreak or likely to cause damage to nearby structures, excavations or in situ rock beyond the design excavation lines, the Contractor shall adopt revised methods, techniques and procedures to achieve the required results, regardless of approval by the Engineer of initial methods. All costs of adopting such alternate methods, techniques and procedures shall be at the expense of the Contractor. The approval of the Engineer of the blasting procedures does not relieve the Contractor of his responsibility on the effects that such blasts may have upon the work.

All operations in connection with transporting, storage and use of explosives shall be subject to the rules and regulations of governing authorities and performed using experienced and licensed personnel.

4.4.2 Vibrations Control

Vibrations induced by blasting must not alter the natural state of rock beyond the excavation limits nor the previously grouted rock, fills or already-placed concrete of any permanent structure. The Contractor shall therefore permanently monitor and not surpass the following maximum instantaneous explosive charge, as deduced from the equation:

$$SD = D/(w)^{1/2}$$

Where:

SD = Scaled distance
D = Blasting distance, in feet, to the nearest structure requiring protection
w = Maximum instantaneous charge, in pounds

The SD relation will equal 50 when the blasting distance to the structure requiring protection is less than 50 m; when greater, the SD relation to deduce the maximum instantaneous charge will be 65.

4.4.3 Dimensional Tolerances

All excavations shall be completed to be within 0.2 m horizontally and vertically of specified lines and grades unless otherwise approved by the Engineer.

4.5 Fill Placement

Fill placement shall be to the lines, grades and cross-sections shown on drawings using only suitable materials approved by the Engineer.

The Contractor shall demonstrate equipment suitability, methods of working, rate of progress and quality of work during the initial stages of the Work. In the event that the work performance is unsatisfactory for either quality or schedule requirements, the Contractor shall immediately implement such changes as are required to ensure the required quality and scheduled completion of the Work.

The Contractor shall prevent the accumulation of water, snow, ice or other deleterious material(s) on the surface of the fill or foundations.

The Contractor shall prevent placement of material on any part of the foundation until the foundation has been inspected and approved in writing by the Engineer.

The Contractor shall cease material placement when satisfactory work cannot be carried out due to rain, snow, unsatisfactory materials or any other unsatisfactory conditions.

The Contractor shall remove any embankment or foundation material that has been damaged by rain, seepage or any other cause and replace with satisfactory material as specified herein before placing succeeding layers.

The Contractor shall prevent the mixing of the materials from adjoining zones.

The Contractor shall place materials so that each area is homogeneous, free of horizontal stratification, lenses, pockets, ruts or layers of material of different texture or grading not conforming to the requirements specified for the material of each zone.

The Contractor shall transport, dump and spread materials in such a manner as to avoid segregation before compaction; and shall place material that conforms, after placement, to the grading requirements as specified.

The Contractor shall prevent accumulations of oversized stones, particularly between different material zones and abutment contacts and replace with suitable materials as specified herein.

The Contractor shall load transport, unload, store, and any additional handling as necessary to ensure required fill placement and compaction in the specific area.

4.5.1 Dimensional Tolerances

All rockfill shall be completed to be within 0.2 m horizontally and vertically of specified lines and grades unless otherwise approved by the Engineer.

All filter material shall be completed to within 0.1 m horizontally and vertically of specified lines and grades unless otherwise approved by the Engineer.

All glacial till material shall be completed to within 0.5 m horizontally and vertically of specified lines and grades unless otherwise approved by the Engineer.

4.6 Fill Compaction

The Contractor shall compact each material lift before placement of the subsequent lift.

The Contractor shall carry out compaction by rolling over large surfaces and execute turns carefully to obtain uniform compaction. One passage of the roller over the entire area being compacted will constitute a pass and successive passes shall overlap the previous pass by at least 600 mm.

If the compaction of a lift or a portion of lift is insufficient due to either lack of overlapping or rolling, or to excessive lift thickness, or to excess or deficient moisture content, improve the condition of the fill in accordance with the requirements specified

herein and re-compact the lift. If the additional work cannot provide satisfactory results, remove and waste such lift, or its portion, and provide new material.

If compaction of a material cannot be achieved due to the use of improper compaction equipment, immediately replace such equipment with equipment suitable for compaction of the material.

The Contractor shall suspend compaction of the fill materials when weather conditions result in an increase in moisture content of the materials above the limits as directed by the Engineer.

4.6.1 Glacial Till

The maximum uncompacted horizontal lift thickness is 1000 mm for the Central Dike and 500 mm perpendicular to the slope for the Stormwater Dike and Saddle Dams.

No compaction has been specified for the Glacial till placed at the Central Dike.

Compaction of the till placed along the upstream slope of the Saddle Dam and Stormwater Dike shall be to 95% Standard Proctor dry density.

4.6.2 Fine Filter

The maximum uncompacted horizontal lift thickness shall be 300 mm for the Central Dike and 300 mm perpendicular to the slope for the Stormwater Dike and Saddle Dams.

Compaction of the Fine filter shall be to 95% Standard Proctor dry density.

The Contractor shall compact material in pockets and depressions in the foundation with jumping jacks and heavy plate tampers, or similar small size compaction equipment approved by the Engineer.

4.6.3 Coarse Filter

The maximum uncompacted horizontal lift thickness shall be 500 mm for the Central Dike and 500 mm perpendicular to the slope for the Stormwater Dike and Saddle Dams.

Compaction of the coarse filter shall be carried out using a 10 tonne smooth drum vibratory roller compactor with a minimum 4 passes.

The Contractor shall compact material in pockets and depressions in the foundation with jumping jacks and heavy plate tampers, or similar small size compaction equipment approved by the Engineer.

4.6.4 Rockfill UM+Q

The maximum uncompacted horizontal lift thickness shall be 1000 mm.

Compaction of the rockfill shall be carried out using a 10 tonne smooth drum vibratory roller compactor with a minimum 6 passes.

The Contractor shall avoid nesting of oversize stones and shall ensure that no significant voids exist in this zone.

4.6.5 Rockfill IV

The maximum un-compacted horizontal lift thickness shall be 1000 mm on the upstream wedge and 2000 mm on the downstream wedge as shown on the Drawings.

Compaction of the rockfill shall be carried out using a 10 tonne smooth drum roller vibratory compactor with a minimum 6 passes.

The Contractor shall avoid nesting of oversize stones and shall ensure that no significant voids exist in this zone.

5.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of Work, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

6.0 QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA)

- The Contractor shall provide Quality Control (QC), including survey, inspection and materials testing as required in the QC Requirements Specification 1000-07.

- QA inspection and testing shall be carried out by the QA Manager to confirm the Contractors QC including whether the specified foundation condition, gradation, compaction, and moisture content of fill materials, construction grades and limits are being attained.

- The Contractor shall perform all necessary inspection, sampling and testing in borrow areas and processed material stockpiles, as applicable, to ensure that only materials of specified composition, gradation and moisture content are supplied to the Work site.

- The Contractor shall provide facilities and labour as required to assist in taking samples and conducting tests.

PREPARED FOR:

PREPARED BY:

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1.0 SCOPE

This Specification covers the placement of cast-in-place concrete required in the Meadowbank Central Dike construction, as shown on Drawings and described herein.

The Contractor shall provide all products, equipment, machinery, labour, services and supervision required to carry out the work, including, but not limited to, the following:

- Formwork and design of formwork;
- Concrete construction joints;
- Concrete placement;
- Curing and protection;
- Finishing, encasements and concrete fill;
- Repair of surface defects in concrete;
- Casting of concrete items supplied by others; and
- Clean-up.

2.0 GENERAL

3.0 STANDARDS AND CODES

All work shall conform to the requirements of the following standards, except where this Specification differs from those Standards and Codes, in which case the requirements of this Specification shall take precedence:

3.1 Canadian Standards Association (CSA) Standards

CSA-A3000-03: Cementitious Materials Compendium.

CSA-A23.1/A23.2-04: Concrete Materials and Methods of Concrete Construction.

3.2 SITE CONDITIONS

The Contractor shall coordinate the location of all items to be built-in which are to be supplied by the Owner or other contractors. If required, the Contractor also shall coordinate his work with that of other contractors and the Owner's own forces working at the same location.

3.3 Materials

Unless otherwise specified on the Drawings, or directed by the CM the Contractor shall supply the following materials.

- Cement: Type GU Cement. Supply cement from one manufacturing source throughout the Contract to ensure consistent quality and compatibility with all concrete materials.

- Admixtures: Obtain all admixtures from the same manufacturer to ensure compatibility between air-entraining agent, superplasticizer, and water-reducing agent. Conduct tests and trial mixes to verify that admixtures are compatible with all mix ingredients. Unless otherwise specified, provide liquid type admixtures.

- Water: Supply, install, operate and maintain a satisfactory system for water supply for concrete manufacture. Use fresh, clean water, which is free from injurious amounts-of oil, silt, soluble chlorides, organic matter, acids, alkalis and other deleterious substances, and conforms to CSA A23.1. Submit details of the method by which the Contractor proposes to ensure a satisfactory and adequate supply of water for concrete production and curing. Provide a backup water supply system.

- Fine Aggregates: Consisting of natural or crush rock or a combination conforming to all requirements of CSA-A23.1.

- Coarse Aggregates: Consisting of natural gravel, crushed rock or a combination of both, conforming to requirements of CSAA23.1.

- Concrete Mix: Concrete shall meet the requirements of CSA A23.1 and the following criteria:

    - 10 MPa compressive strength at 28 days;
    - 20 mm maximum nominal aggregate size; and
    - 100 mm +/- 30 mm slump.

4.0 SUBMITTALS

The Contractor shall submit the following for acceptance by the Owner.

4.1 Cementitious Materials

Submit details of the source of cement and manufacturer's recent test data at least 10 days prior to the laboratory trial mix program.

4.2 Mix Design

Proportion concrete mixes in accordance with CSA A23.1. Select proportions to provide the necessary placeability, density, strength, durability properties required.

Submit test results for the mix design being proposed at least 10 days prior to field testing. Test results to include proportions of ingredients, slump, density, yield, air content, 7 day, and 28 day compressive strengths. Submit test results of laboratory trial mixes used to develop the proposed mix design. Submit mix designs including the results of laboratory and field trial mixes.

4.3 Aggregates

Name the source of concrete aggregates which is to be used for the work.

Prior to delivering any concrete aggregate to the batch plant location, submit the results of the aggregate tests. Submit results of tests conducted during progress of the work within 24 hours after completion of the specified test.

4.4 Batch Plant

Submit at least 30 days prior to the field trial mix program a detailed description of the proposed batch plant including location, equipment and layout, production capacity, measures for temperature control of concrete, central mixers, delivery equipment and water supply system.

Engage a CSA certified concrete testing laboratory or equivalent to verify that the batch plant equipment have been calibrated and meets the requirements of CSA-A23.1. Submit copies of the certificate of accuracy at least 15 days prior to any concrete batching operations.

4.5 Concrete Placement

Submit details of procedures and equipment for hot and cold weather concreting.

Submit a concrete placing schedule at least 10 days prior to the first scheduled pour. Update schedules as required during the project.

4.6 Concrete Finishing, Curing and Repairs

Submit at least 30 days prior to concrete placement, a detailed description of the proposed equipment and procedure for placing, consolidating and finishing concrete.

Submit details of proposed concrete curing procedures and protection to be provided.

Submit a detailed description of the proposed procedure and materials for repairing defects in the concrete at least 48 hours prior to undertaking this work.

4.7 Concrete Forms

Allow completed concrete forms to be inspected and approved at least 24 hours prior to ordering concrete.

5.0 EXECUTION

5.1 Preparation

Prior to placing new concrete adjacent to or on existing work the Contractor shall:

- Remove all debris and foreign matter from the substrate;
- Pressure-wash the surfaces to be bonded with new concrete, and provide SSD condition to all bonding surfaces;
- Remove all ponding water from the bedrock surface prior to concrete pour;

- Apply cement slurry bond coat per CSA A23.1 immediately before concrete placement. Do not allow slurry coat to dry; and
- Formwork placement required prior to concrete pour.

If form oil is used to coat forms, the Contractor shall ensure that it is not present on concrete reinforcement.

5.2 Placing Concrete

The Contractor shall strictly follow the requirements of CSA A23.1 for placing concrete.

Obtain written approval of Owner prior to placing concrete.

All concrete shall be placed as close as possible to its final position. All concrete shall be placed and mechanical vibrators utilized. Vibrators shall not be used to cause concrete to flow horizontally or on slopes. Prevent segregation, loss of ingredients, or damage by exposure to the elements.

Completely discharge and place concrete no later than 90 minutes after the cement has been mixed with the water. The time between batching and complete discharge is also reduced to 60 minutes when the ambient air temperature exceeds 25^{o}C.

Where concrete is placed on a sloping surface, the Contractor shall commence placing at the lower end of the slope. Perform the placing of concrete as a continuous operation until the placement unit section is completed. Use a concrete placing rate which ensures that each layer being placed is placed while the previous layer is soft or plastic so that the two layers can be made monolithic by penetration of the vibrators, and which prevents the formation of cold joints

Use equipment for placing of such size, design, and condition so as to ensure an even supply of concrete at the point of delivery. Ensure that the equipment is equipped with the devices necessary to permit the prompt and complete discharge of concrete without segregation and with the required slump. In particular, if bottom-dump buckets are used, provide a positive means of regulating the amount and rate of concrete deposition in each dumping position. Concrete shall not be dropped from a height greater than 3.0 m. Where concrete is transported through a drop pipe in this manner, the concrete shall be fed into the pipe on surface in such a way as to prevent blockages or the pipe becoming full at any point.

The lean concrete pad must be minimum 300 mm thick. Finished concrete surface shall be within 12 mm of design elevation.

5.2.1 Cold Weather Concreting

Cold weather requirements in accordance with CSA A23.1 apply when the air temperature is at or below 5°C, or is forecast to fall below 5°C within 24 hours of placing.

When concrete is to be placed in cold weather, ensure that all materials and equipment needed for adequate protection and curing is on hand and ready for use before concrete placement is started. Obtain prior approval for the proposed enclosures, equipment and procedures for cold weather concreting.

Do not place concrete against any surface which has a temperature of less than 5°C. Remove all snow and ice. Preheat such surfaces for 24 hours or as required to obtain surface temperatures of 5°C minimum, whichever is longer, prior to placing concrete.

Design and construct heating and hoarding protection measures including heated enclosures, coverings, insulation, or a suitable combination of these methods in accordance with CSA A23.1.

Inspect heating and hoarding measures at least every 4 hours to ensure that enclosure, coverings and insulation are in place, there is adequate heater fuel, and the specified temperatures are being maintained.

Ensure that a sufficient number of adequately sized and properly vented heaters are provided. Do not place heaters at locations which may cause rapid drying of freshly placed concrete. Use fans to ensure that warm air is constantly circulated within the enclosure. Do not use tiger torches or other open flame burners as heaters. Provide an access strip of at least 1500 mm in width between the work and the nearest heater. Do not discharge the heater exhaust directly onto the work area.

5.3 Finishes

Concrete finishes shall be screened and floated to achieve a flat surface. No special finish is required.

6.0 CURING AND PROTECTION

All concrete shall be properly cured in accordance with CSA A23.1. Ensure that all material and equipment required for curing and protection are on hand at the worksite prior to placing any concrete. Immediately after finishing, the concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical damage.

Continuously moist cure all concrete for a minimum duration of 7 consecutive days at a minimum temperature of 10°C. Continuously moist cure concrete by covering with absorptive mat or fabric kept wet by using a system of perforated pipes, mechanical sprinklers, porous hoses, or by other methods which keep all surfaces continuously wet. For formed surfaces leave forms in position and keep such forms continuously wet.

6.1 Clean-up

The work area shall be maintained in a neat condition and all waste, deleterious and extraneous materials shall be removed as they accumulate.

7.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of works, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

8.0 QUALITY CONTROL (QC)

The Contractor shall be responsible for ensuring that the Work is constructed in accordance with the Drawings and Specifications.

Quality assurance services shall be provided by the Owner. The use of such services does not relieve the Contractor of his Quality Control responsibility to furnish work in compliance with the Contract Documents.

The Contractor shall perform all necessary testing as per CSA23.1/A23.2 to confirm the concrete material and construction meet specifications. Concrete testing shall be performed by technicians and lab certified to CSA A283 standards.

The Contractor shall advise the Owner at least 24 hours in advance of concrete pouring operations to allow for required quality control tests and for assignment of personnel.

To facilitate inspection and testing services, the Contractor shall furnish qualified personnel as necessary to obtain and handle samples on site or at the source of material.

Record the following information on the delivery tickets for each batch of concrete from the batching plant. Provide the delivery tickets to the Owner at the placement point as soon as the batch is delivered.

- Slip serial number and date.
- Specified 28 day strength.
- Type of cement and list of all admixtures.
- Time of loading or first mixing of cement, and water.
- Time the load arrived at the placement point.
- Time the discharge of load was started.
- Time the discharge of load was completed.
- Concrete temperature during placing.

Provide Owner access to aggregate source, stockpiles and batch plant for the purpose of materials sampling and inspection.

Provide suitable for sampling of the materials from each of the weight scales. Ensure all necessary platforms, tools and equipment for obtaining samples are furnished. Temporarily cease batching for a short interval when directed to allow for sampling of the materials.

Compressive strength test cylinders shall be nominal 100 mm diameter by 200 mm. Plastic concrete for casting test cylinders shall be obtained at the point of concrete placement. Cylinders shall be field cured.

One compressive strength test shall consist of testing minimum three cylinders of which one shall be tested at 7 days, and 2 shall be tested at 28 days. Not less than one strength test shall be made for each day in which concrete is placed or every 50 m^3, whichever governs.

Specified compressive strength shall be based on 28 day strengths for concrete. Test results shall be evaluated in accordance with CSA A23.1.

Slump tests in accordance with CSA A23.2-5C prior to placement until consistent results meeting the specified requirements are obtained, and whenever a strength test or air content test is taken. The sample shall be taken at the point of concrete placement

The concrete temperature at placing shall be determined by placing a thermometer in the concrete after sampling at the point of concrete placement.

9.0 QUALITY ASSURANCE (QA)

QA monitoring and testing will be carried out by the Engineer through his QA Representative, to satisfy himself and MMC that the Work is being carried out in accordance with the Drawings and Specifications. Results of QA testing will not be withheld from the Contractor.

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PREPARED BY:

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1.0 SCOPE

This Specification defines the requirements for installation of the Coletanche Bituminous ES3 liner for the Central Dike, Stormwater Dike and Saddle Dams construction for Meadowbank Mining Corporation (MMC) at Meadowbank Gold Project site in Nunavut, Canada.

The scope of work covered by this technical specification shall include:

- Ordering Coletanche Bituminous ES3 liner;
- Receiving and unloading rolls of Coletanche Bituminous ES3 Liner at the mine site;
- Preparing a suitable temporary storage area for the rolls of Coletanche Bituminous ES3 Liner, and protecting the rolls while they are in temporary storage;
- Transporting the rolls of Coletanche Bituminous ES3 liner from the temporary storage area to the installation sites;
- Placing the ES3 in accordance with the Manufacturer's instructions and this technical specification, to the lines, grades and dimensions shown on the drawings, or as designated by the Engineer for the Central Dike construction;
- Providing all materials, equipment and labour force required to position and assemble the liner as shown on the drawings;
- Carrying out all the non-destructive and destructive tests required in the technical specifications, employing industry standard techniques and equipment;
- Clean up of the site; and
- Preparation of pre-installation and as-built panel layout drawings, in AutoCad drawing format.

2.0 GENERAL

2.1 Abbreviations

The abbreviations listed below, where read in these Specifications, shall have the following meaning:

ASTM	American Society for Testing and Materials
CEBTP	Centre Expérimental de Recherches et D'Etudes du Bâtiment et des Travaux Publics
DGS	European Commission Research Directorate-General
EN	European Standard (European Committee for Standardization)
FTMS	Federal Test Method Standard
GRI	Geosynthetic Research Institute
NFP	Norme Francaise
QA	Quality Assurance
QC	Quality Control

2.2 Manufacturer's Qualifications

The Manufacturer of the liner shall be Coletanche.

2.3 Contractor's Qualifications

The Contractor installing the liner shall employ qualified personnel, experienced in deploying, welding, and patching ES3 liner.

The Manufacturer's representative shall be on site to oversee the liner installation.

2.4 Sampling, Testing and Reporting

The Contractor shall cooperate with the Owner and the Engineer in providing samples for testing, allowing access for Quality Assurance testing, and providing results of Quality Control testing in a prompt manner.

2.5 Codes and Standards

The publications listed below form part of this Specification. Each publication shall be the latest revision and addendum in effect on the date of award of the Contract unless noted otherwise. Except as modified by the requirements specified herein or the details of the Drawings, Work included in this Specification shall conform to the applicable provisions of these publications.

2.5.1 ASTM Standards

D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
D792	Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1204	Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
D1505	Test Method for Density of Plastics by the Density-Gradient Technique
D1693	Test Method for Environmental Stress-Cracking of Ethylene Plastics
D3083	Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining (Withdrawn 1998)
D3776	Test Method for Mass per Unit Area (Weight) of Woven Fabric
D3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D4073	Standard Test Method for Tensile-Tear Strength of Bituminuous Roofing Membranes
D4354	Practice for Sampling of Geosynthetics for Testing
D4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
D5147	Sampling and Testing Modified Bituminous Sheet Material
D5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D5617	Test Method for Multi-Axial Tension Test for Geosynthetics
D5721	Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
D7056	Standard Test Method for Determining the Tensile Shear Strength of Pre-Fabricated Bituminous Geomembrane Seams

2.5.2 Other Standards

GRI GM 11	Accelerated Weathering of Geomembranes Using a Fluorescent UVA Device
NFP 84503	Bi-Axial Tensile Strength
NFP 84507	Static Puncture Resistance
NFP 84523	Hydrostatic Puncture Resistance
CEBTP No. 6327.7.390	Stress Relaxation with Time
NFP 84515	Coefficient of Flow
EN 495-2	Angle of Internal Friction
NFP 84350	Delamination
NFP 84104	Creeping at Hot Temperatures
DGS/VS4/No. 949	Potable Water Suitability

2.5.3 Ordering Coletanche ES3 Liner

Coletanche ES3 liner shall be ordered from Soprema Inc.

2.6 Delivery of Rolls to Site, Temporary Storage and Handling

2.6.1 Information from Manufacturer

The Manufacturer shall provide labels on each roll of liner which shall include the following information:

- Name of manufacturer;
- Type of liner;
- Roll identification number and shipping weight;
- Thickness, length and width;
- Manufacturer's approved QC stamp and technician's signature; and
- Location and type of any flaws.

Welding primer and Mastic material shall be accompanied by an indelible label bearing the brand name, manufacturer's mark number, and directions for storage.

Labels shall be clearly visible and legible after rolls have been stored on site.

2.6.2 Delivery to Site, Temporary Storage, Protection and Handling

The Contractor shall coordinate delivery of the ES3 to site in sea containers and upon arrival on site shall:

- Prepare a suitable temporary storage area for the sea containers; and
- Prepare an 'As-Received' inventory of the rolls of ES3, a copy of which must be provided to the Engineer.

The Contractor shall be responsible for:

- Protection of the rolls on site prior to placement; and
- Transportation of the rolls from the temporary storage location to the installation location.

The Contractor shall assume responsibility for the protection and handling of each roll from time of unloading out of the sea container until it is installed at the Central Dike. Any rolls found damaged upon unloading from the container shall be reported to the Construction Manager. All handling of rolls shall be done using a hydraulic beam, as supplied by Coletanche or approved equivalent, or with a full length pin inserted in the liner steel roll mandrill. Use of forklifts or other means is specifically forbidden.

Welding primer and mastic materials will be delivered in original sealed containers, with an indelible label bearing the brand name, manufacturer's mark number, and directions for storage. These materials shall be stored at the same location as the rolls of ES3, or other location as approved by the Engineer.

While in temporary storage, the rolls shall be strapped so that no damage occurs to the outer wraps on each roll and so that straps do not damage adjacent rolls. Rolls shall be supported so that no penetrating stresses are induced in the membrane and so that the rolls cannot move during transportation.

Unload all materials at a location on the site where only one handling step is required to take each roll to its position for laying out. Handle in such a way that no contact is made.

Store rolls no more than 5 rolls high, on a smooth, dry, clean, flat surface, and cover them. Protect from heat sources, solvents, dirt, debris, rodents, and other conditions which would affect the performance of the materials. Keep manufacturer's labels intact. Cover liner during storage.

2.7 Acceptance of Liner

The Contractor is in charge of the transportation to the work area of the ES3 rolls and installation of the ES3 until the final acceptance of the work by the Engineer. This acceptance will only be authorized upon receipt of all required QC documentation.

No covering or backfilling over the ES3 shall be carried out until the Engineer has approved the liner installation. The acceptance may be issued for completed areas of liner, prior to completing the entire liner installation, at the discretion of the Engineer.

3.0 PRODUCTS

3.1 ES3 Liner Materials

The liner materials shall be ES3 elastomeric bituminous geomembrane liner as manufactured by Coletanche. The liner must meet or exceed the characteristics indicated by the properties listed in Table 1.

TABLE 1: Properties of Coletanche ES3 Liner

Property	Standard	Unit	ES3
Unit Weight of Incorporated Non-Woven Geotextile	n/a	g/m^2	300
Nominal Thickness	ASTM D 5199	mm	4.8
Density	ASTM D-792	g/cm^3	1.240
Bitumen	n/a	n/a	SBS-Modified Elastomeric bitumen
Tensile Stress at break	ASTM D 4073	kN/m	32 longitudinal 30 transverse
Elongation at break	ASTM D 4073	%	85 longitudinal 92 transverse
Static puncture	ASTM 4833	N	614
Puncture by aggregates (20/40)	NFP 84507	kN	25
Dimensional stability	ASTM 1204-02	%	-0.10 longitudinal -0.08 transverse
Permeability	-	cm/s	10^{-12}

Property	Standard	Unit	ES3
Stress Relaxation with Time	CEBTP 6327.7.390	-	70% in 3 hours
Stress Cracking Susceptible	ASTM D1693	-	No
Coefficient of Thermal Expansion	ASTM D696	cm/cm/°C	1×10^{-6}
Friction Angle	EN 495-2	degrees	34/32 (sand/crushed gravel)
Potable Water Suitability	DGS/VS4/N0.949	-	Yes

3.2 Primer Material

The primer material shall be Elastocol stick as manufactured by Soprema, or approved equivalent. The primer material shall be a blend of SBS (Styrene Butadiene Styrene) -synthetic rubbers, fast-evaporating solvents and adhesive-enhancing additives. The primer material is required to prime surfaces such as plastic, concrete, or metal in order to improve the adhesion of the Sopraflash Flam Stick. Characteristics of the required primer material are shown in Table 2.

TABLE 2: Properties of Elastocol Stick Primer Material

Property	Unit	Value
Specific gravity at 20°C	kg/l	0.79
Solids by weight	%	24
Viscosity, Brookfield	cP at 25 ° C	200
Flash point (ASTM D-93)	°C	-18
Drying time	Minutes	15 to 60 depending on temperature and thickness

Elastocol stick can be applied with either a brush or roller at the manufacturer's recommended average coverage of about 0.5 litres/m^2.

3.3 Sopraflash Flam Stick

A Sopraflash Flam Stick shall be joined to the lean concrete platform using the Elastocol stick primer material. The Sopraflash Flam Stick shall be a self-adhesive SBS modified bitumen membrane. Characteristics of the required Sopraflash Flam Stick are provided in Table 3.

TABLE 3: Properties of Sopraflash Flam Stick

Property	Standard	SOPRAFLASH System (Minimum Properties)
Base sheet dimensions (m)	-	15 x 1
Strain energy, MD/XD (kN/m)	CAN/CGSB-37.56-M 9th draft	8.4 / 8.3
Breaking strength, MD/XD (kN/m)	CAN/CGSB-37.56-M	18/16
Ultimate elongation, MD/XD (%)	9th draft	55/56
Tear resistance (N)	CAN/CGSB-37.56-M	120
Static puncture (N)	9th draft	380
Dimensional stability, MD/XD (%)	CAN/CGSB-37.56-M	0.1/0.4
Plastic flow (°C)	9th draft	105
Cold bending (°C) –initial –90 days at 70 ºC	CAN/CGSB-37.56-M	-30 -30

The design joint width is 0.5 m and the Sopraflash Flam Stick sheet may be cut in two 0.5 m width sheets.

3.4 Mastic

The mastic used in the liner installation shall be Sopramastic as manufactured by Soprema or approved equivalent. The mastic shall be a solvent-based mastic containing

SBS-modified bitumen, fibres and mineral fillers. Characteristics of the required material are shown in Table 4.

TABLE 4: Properties of Sopramastic

Property	Unit	Value
Specific gravity at 20 °C	kg/l	1.12
Application temperature range	°C	-10 to 35
Solids by weight	%	83
Flash point (ASTM D-93)	C	25
Setting time	Hours	4 to 24 depending on temperature and thickness

3.5 Bedding and Cover Material

ES3 Liner bedding and cover material shall be in accordance with Earthworks Specification 1000-02.

The Contractor shall inspect the surface of the bedding material prior to placing the ES3, to ensure that it is free of significant protrusions or surface irregularities that could cause stress in the liner (see Section 2.7).

4.0 EXECUTION

4.1 Surface Preparation

The Contractor shall not place any ES3 until the Engineer has given written approval that the bedding surface has been prepared according to the Drawings and Specifications. The responsibility for preparation of the bedding surface and for excavation of the anchor and cut-off trenches shall be with the Contractor.

The Contractor must drain and dry the site when required.

Before beginning installation of the ES3, a surface acceptance form, as prepared by the Contractor, must be signed by the Engineer. This acceptance may be segmented in order

to cover only parts of the surface at any one time. No roll shall be installed before the Engineer has signed the surface preparation acceptance form.

4.2 Installation of ES3

4.2.1 Panel Layout Drawing

The Contractor shall provide the Engineer with a proposed panel layout drawing, in AutoCad drawing and hardcopy formats, at least one week prior to placing the ES3. The panel layout drawing shall be based on the actual constructed surface on which the ES3 is to be placed.

The panel layout should minimize the number and length of required seams. In general, horizontal seams will not be allowed on the proposed panel layout for the sloping face sections of the liner installation. The Contractor shall not place any ES3 until the Engineer has given written approval that the proposed panel layout is acceptable.

Following the installation, each roll must be clearly numbered by the Contractor. The location of each roll must be noted on the As-Built panel layout plan. This plan, once completed, will be submitted to the Engineer for approval.

4.2.2 Installation

The Contractor shall install the ES3 using personnel experienced in the deployment and welding of bituminous liners. Alternatively, the Contractor's personnel may work under the on-site supervision of representatives of the Manufacturer who are experienced in this type of installation.

The Contractor shall install the ES3 in accordance with the Manufacturer's instructions, and these Specifications. In order to minimize mechanical damage to the liner during installation:

- The equipment used will not damage the surface to be covered;
- Personnel working with the liner shall wear boots that will not damage the liner; and
- Only all terrain vehicles (ATV) with low pressure tires may traffic on the uncovered surface of the liner.

Following the installation, each in-place roll shall be visually inspected by the Contractor in order to identify any damaged surface or abnormal appearance. Any defect must be repaired promptly by the Contractor. Additionally, the Contractor shall carry out required QC testing and sampling.

4.2.3 Deployment of Rolls

While deploying the rolls the Contractor shall ensure that the rolls are properly aligned, with a minimum overlap of 200 mm. The surface of the bedding material must be clean and dry.

The Contractor shall ensure that sufficient ballast is placed to hold the liner in place, in the event of high winds. The ballast shall comprise sand-filled burlap sacks, or other means which will not cause damage to the ES3.

4.2.4 Cut-off Trench and Concrete Platform Anchorage

Cut-off trenches shall be excavated by the Contractor as indicated on the Drawings. The Contractor shall inspect the trenches prior to installation. Acceptance of the trenches for placement of ES3 shall be included in the surface preparation acceptance form submitted under Section 2.7.

The liner will be anchored to the lean concrete platform at the base of the cut off trench as indicated on the Drawings. Battons in addition to welding the bituminous liner to the concrete shall be installed. The Contractor shall inspect the surface of the concrete platform prior to installation. Acceptance of the liner anchored to the concrete platform shall be included in the surface preparation form submitted under Section 2.7.

4.2.5 Torch Welding

The ES3 shall be welded using propane torches. The torch-welds must be performed according to these Specifications, and the instructions of the Manufacturer.

Ends and overlaps must be welded on a homogeneous and continuous basis, leaving a 6 mm bitumen bead along the seam.

Seams shall be aligned so that a smooth surface is created with a minimum of wrinkles. The area in the immediate vicinity of the seam shall be free of moisture, dust, dirt, debris or any other foreign material.

Attachments to concrete shall be performed by welding the liner directly on the surface previously primed with welding primer material and then installing battons to the liner weld surface.

To the extent possible, welding of seams should be done from the bottom to the top of the slope. No horizontal welds shall be allowed on slopes of greater than 10% incline, except on small, localized patches required to repair defects.

Seams shall be welded as soon as possible after deployment of the liner.

The Contractor shall note the following information for each weld performed:

- Weld identification number;
- Date and time of start and finish of welding;
- Corresponding roll identification numbers of welded sheets; and
- Welder's name.

A copy of this information shall be provided to the Owner for approval.

4.2.6 Cold Temperature Installation

ES3 may be installed in ambient air temperatures as low as -20°C (including wind chill factor). The Contractor shall not install ES3 when the ambient air temperature is lower than -20°C (including wind chill factor) without prior written approval of the Engineer.

4.2.7 Repairs

Seams and defective areas identified during the QC testing and inspections shall be repaired, and the areas re-inspected and re-tested until approved by the Engineer.

The Contractor shall also note the location and type of defect and report in QC document to Engineer.

4.2.8 Sealing to Penetrations of the Liner

The Contractor shall seal the ES3 to any penetrations through the liner. The Contractor shall first apply the welding primer material, and otherwise make the seal in accordance with the Manufacturer's instructions. The Engineer must approve all attachments of the liner to penetrations.

4.2.9 Attaching ES3 to Lean Concrete Platform

It will be necessary to attach the ES3 bituminous liner to the lean concrete platform in the base of the trench. This will require cleaning the surface of the lean concrete platform and joining it to the surface using Elastocol Stick, Sopraflash Flam Stick and Sopramastic all manufactured by Soprema Inc.

The connection between the ES3 and the concrete surface shall be made as indicated on the Drawings, and should be carried out according to the following general procedure.

1. The existing platform shall be cleaned of dirt and dried after grouting has been completed. Inspect the surface which must be straight, uniform and without obvious irregularities which might interfere with attaching it to the ES3. Report any problems with the concrete surface to the Engineer.

2. Using a paint roller, apply Elastocol Stick primer to the cleaned and dry surface. Allow to dry the required time or until the surface feels dry to the touch.

3. Unroll and position the Sopraflash Flam stick until straight. Fold back the first few meters of the Sopraflash Flam Stick to peel the release paper back then position it back down to stick the concrete surface.

4. Roll the top face of the Sopraflash Flam Stick with a steel roller to ensure a good bond to the concrete surface.

5. Finish seam of the Sopraflash Flam Stick to concrete liner with a bead of Sopramastic approximately 6mm wide on the downstream side and along the entire length of the seam to complete the connection. The bead of Sopramastic should be finished with a trowel as soon as possible after installation.

6. Once the Engineer has inspected and approved the Sopraflash Flam Stick and the Sopramastic that have been applied to the concrete surface, install Coletanche ES3 bituminous liner and weld to the top of the Sopraflash Flam Stick.

7. A batten bolted to the concrete platform as shown on the Drawings will be placed over the weld once the weld has been inspected and approved by the Engineer.

4.2.10 Liner Cover Material

The Contractor shall cover the liner with cover material as indicated on the Drawings, and in accordance with Earthworks Specification 1000-02. Any damage to the liner during placement of the cover layer shall be repaired according to the procedures set out in these Specifications, and the Manufacturer's instructions.

4.3 Warranty

Without limiting the provisions of the Contract, the Contractor shall warrant the Work in accordance with the following:

- The liner supplied is suitable for the environmental conditions at the site and the service conditions as described in this Specification.

- The liner supplied meets or exceeds published standards referenced in this Specification.

- The liner is free of defects in material and workmanship.

Warranty shall provide for the total and complete repair or replacement of the defective areas of liner, upon written notification and demonstration by the Owner of the non-conformance of the liner material or installation with these Specifications. The Contractor shall correct defects within 30 days of notification of defect.

The Contractor must guarantee the supply and assembly according to these Specifications for a period of ten (10) years, starting from the date of completion of the installation of the ES3 liner. This guarantee will cover all manufacturing defects and the installation of the ES3 liner. The guarantee shall also cover all defects consequent to inappropriate preparation, levelling, compaction and surfacing of the stratum, anchorage or subsequent back-filling.

5.0 SITE CLEAN-UP

Ensure that all excess of waste materials, debris, sand bags or any other extraneous materials are removed from the site whenever they are no longer required. Upon completion of work in any given area, the Contractor and the Engineer shall examine that area to determine whether all waste and extraneous materials have been removed and that the area has been left in satisfactory clean condition to allow placement of materials on top of the liner.

The polyethylene film and kraft paper which comes off the ES3 liner when it is installed must be collected and disposed of away from the construction works area following MMC site procedures.

6.0 COMPLETION OF THE WORK

The installation of the ES3 liner shall be considered as totally complete when: all required deployment, field seaming, testing and repairs, and site clean-up have been completed by the Contractor; the Contractor has submitted all the required quality control documentation to the Owner; and the Engineer is satisfied that the ES3 liner has been installed in accordance with the above specifications.

6.1 Final Report

A final report shall be prepared by the Contractor and forwarded to the Construction Manager and the Engineer within two (2) weeks following the end of the installation of the liner. This document shall include:

- The Manufacturer's QC certificates for the rolls of ES3 liner;
- As-built panel layout drawings, in AutoCAD and hardcopy formats;
- Roll deployment record;
- Seaming record;
- Repair record;
- QC testing summary; and
- Warranty.

7.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of works, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

8.0 QUALITY CONTROL (QC)

The Manufacturer and the Contractor shall conform to the minimum Quality Control Program detailed in this section.

The Contractor shall provide on-site supervision, equipment and QC testing during the installation period for inspection of the completed liner and seaming of the liner, as required to warrant the entire liner installation. Maintain and clean all equipment on a regular basis to ensure that it is maintained in good working order.

8.1 Schedule of QC Testing

The Manufacturer and the Contractor shall perform QC testing of the type and frequency indicated in Tables 5 and 6.

TABLE 5: Schedule of QC Testing by Manufacturer

Type of Test	Testing Standard[1]	Frequency of Testing	Specified Value
Thickness	D5199	1 per 10 rolls	4.8 mm (min.)
Density	D792	1 per 10 rolls	1.240 g/cm^3
Static puncture	D4833	1 per 10 rolls	614 N (min)
Puncture by aggregates (20/40)	NFP 84507	1 per 10 rolls	25 kN (min)
Dimensional stability	1204-02	1 per 10 rolls	-0.10 % longitudinal (max) -0.08 % transverse (max)
Stress Relaxation with Time	CEBTP 6327.7.390	1 per 10 rolls	70% in 3 hours
Stress Cracking Susceptible	D1693	1 per 10 rolls	No
Coefficient of Thermal Expansion	D696	1 per 10 rolls	1 X 10^{-6} cm/cm/°C (max.)

Notes: 1. Standard is ASTM unless otherwise noted.
2. Vacuum box / Ultrasonic testing shall be done a minimum of once per shift.

TABLE 6: Schedule of QC Testing by Contractor

Type of Test	Testing Standard[1]	Frequency of Testing	Specified Value
Friction Angle	EN 495-2	2 total	34°/32° (sand/crushed gravel) (min)
Tensile Stress at break	D4073	1 per 10 rolls	32 kN/m longitudinal (min.) 30 kN/m transverse (min.)
Elongation at break	D4073	1 per 10 rolls	85 % longitudinal (min.) 92 % transverse (min.)
Tensile Shear Strength of Bituminous Seams	D7056	1 per 200 m of seam length	15 kN (min.)
Vacuum Box Testing[2]		1 per 100 m of seam length	No defects permitted
Ultrasonic Testing of Seams[2]		1 m per 50 m of seam length	No defects permitted

Notes: 1. Standard is ASTM unless otherwise noted.
2. Vacuum box / Ultrasonic testing shall be done a minimum of once per shift.

8.2 Documentation and Reporting

The Contractor shall prepare and submit the following ES3 liner QC documentation, in electronic and hardcopy formats:

8.2.1 Daily Report

- Summary of work completed.
- List of equipment working on project.
- Number of personnel in each trade.
- Results of QC field and laboratory testing and test data sheets.

- Repair records (including documenting the location of all repairs on layout plan).

- Description of incidents and problems, and steps to solve them and prevent re-occurrence.

8.2.2 Additional Information for Cold Weather Seaming

- Ambient air temperature measured 1 m above liner.

- Method of removing frost from area to be seamed, as well as drying and cleaning of surface.

- Condition of subgrade beneath seamed area.

- Identification of seaming system used, including preheat, seaming rate and use of enclosure.

- Unusual conditions with respect to personnel, equipment, sampling and testing attributes to cold weather.

8.2.3 Weekly Field Summary Report

- Summary of work completed.

- Summary of QC field testing with diagrams showing locations of tests.

- Summary of QC laboratory testing with diagrams showing locations of acquired samples.

8.2.4 Field Inspection of Liner and Testing of Seams

- By Contractor: Carry out inspection of membrane after installation and perform destructive and non-destructive testing of seams in accordance with Section 8.1.

- By Engineer: The Engineer will perform QA inspection and testing of the liner and seams, and will periodically audit the Contractor's QC procedures and documentation. Any deficiencies identified by the Engineer shall be corrected promptly by the Contractor.

The Contractor shall cooperate with the QA Manager, provide access to liner for field sampling and testing and give the QA Manager 4 hours notice of liner seams ready for inspection. The liner shall not be covered before the Inspector has performed tests and given written approval of material and seams.

8.2.5 Flaws in Membrane

Flaws, which shall be repaired, shall not exceed one per 500 m^2. Edge flaws will only be accepted if they do not interfere with the seaming process. Defects such as holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, shall result in rejection of the roll.

PREPARED FOR:

PREPARED BY:

REV.	DATE	REASON FOR REVISION	BY	APP
D	16/MAR/07	ISSUED FOR TENDER	AS	TLE
C	21/FEB/07	ISSUED FOR CLIENT REVIEW	AS	GRB
A	18/FEB/07	ISSUED FOR REVIEW	AS	GRB

TABLE OF CONTENTS

1.0 SCOPE

This Specification describes Drilling and Grouting during the Central Dike construction, which consists of all work required to seal fissures in the bedrock by drilling and grouting holes from a working platform on the crest of the dike into rock formations to provide a seepage cutoff.

Drilling and grouting shall include the following:

- All Works identified on the Drawings.

- Grouting the bedrock along the each dike foundation from the crest of the dike. The scope includes, drilling grout holes, water testing grout holes and pressure injecting grout into grout holes for curtain grouting.

- Curtain grouting shall be the drilling of one or more rows of holes and injecting the specified grout mix into the holes to create a low-permeability curtain. In rock, curtain grouting shall use staged working in the holes and shall use the split-spaced closure method.

2.0 PROVISIONAL EXTENT OF WORK

The spacing, depth, orientation and pattern of grout holes, grout mixes, quantity and type may be varied by the Engineer as a result of conditions revealed as grouting progresses.

Water pressure testing, as directed by the Engineer, shall be used to control the sequence of work. As such, water pressure testing will be carried out before, during and as the curtain is brought to completion.

3.0 GENERAL

3.1 Access

Access to the Work will be provided by the CM as presented on the Drawings. The Contractor shall not have unrestricted access to the Work area and must be prepared to share and coordinate activities and access with others, through the CM. The Contractor shall not construct any staging areas, temporary facilities or access roads without the approval of the CM.

3.2 Storage Area

A storage area for the Contractor will be assigned within 1 kilometer of the abutment of each dike. This area will be unfenced and the Contractor shall institute security measures as required. It is recommended that the Contractor provide security and a fence for the storage area.

3.3 Delivery and Storage of Goods

The Contractor shall be responsible for the correct addressing of all goods and materials for their use on site.

The Contractor shall take delivery of their goods and materials for grouting, and the Contractor shall store them appropriately on site.

3.4 Removal of Refuse

The Contractor shall clean up the work as it progresses, removing debris from the Site to the designated disposal area from day to day. When the work is finished the Contractor shall similarly remove all buildings, tools and machinery which are their property and all rubbish and waste materials and shall leave the site in a neat and orderly condition. Should the Contractor refuse or neglect to comply with this provision the CM shall have the right to do the cleaning and charge the Contractor with the costs thereof.

3.5 Waste Water

Waste water from grouting operations shall be directed to locations approved by the CM. The sizing and maintenance of any sumps or lagoons required to carry out the work shall be the responsibility of the Contractor.

3.6 Standards

The publications listed below form part of this Specification. Each publication shall be the latest revision and addendum in effect on the date of award of the Contract unless noted otherwise. Except as modified by the requirements specified herein or the details of the Drawings, work included in this Specification shall conform to the applicable provisions of these publications.

American Society for Testing Materials (ASTM) Publications

C150	Standard Specification for Portland Cement.
C185	Standard Test Method for Air Content of Hydraulic Cement Mortar.
C191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
C243	Standard Test Method for Bleeding of Cement Pastes and Mortars.
C266	Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gilmore Needles.
C305	Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency.
C349	Standard Test Method for Compressive Strength of Hydraulic-Cement Mortars (Using Portions of Prisms Broken in Flexure).
C494	Standard Specification for Chemical Admixtures for Concrete.
C596	Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
C845	Standard Specification for Expansive Hydraulic Cement.
C940	Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
C941	Standard Test Method for Water Retentivity of Grout Mixtures for Preplaced-Aggregate Concrete in the Laboratory.
C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
C953	Standard Test Method for Time of Setting of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
D2113	Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation.
D4380	Standard Test Method for Density of Bentonitic Slurries.

3.7 Alternative Standards

If the Contractor offers materials which conform to a standard other than that specified then the standard offered shall be equal to or superior, when tested, to the specified

standard and full details of the differences between the standard offered and the standard specified shall be given.

3.8 Grout Under Direction of Engineer

The Contractor shall drill, water pressure test, and grout under the technical direction of the Engineer. Technical direction includes, amongst other things, the sequence of the work, grout pressures and flow rates, and changes to the grout mix. Operation aspects related to the efficiency of the Contractor's operations shall be entirely the Contractor's responsibility.

3.9 Contractor's Supervisory Staff

The Contractor's operations manager shall have at least five years experience of similar work. Their experience record (CV) shall be submitted with the Tender. Once accepted for the work, they shall not be replaced without prior written approval of the CM.

3.10 Contractor's Operatives

Drillers, grouting operators and grouting foremen shall have had at least three (3) years experience of similar work. Their experience records (CV) shall be submitted with the Tender. Once accepted for the work, they shall not be replaced without prior written approval of the CM.

3.11 Electrical Power

The Contractor shall provide generators sufficient for the electrical power needs of the grouting operations.

3.12 Records

The Contractor shall maintain the following records on completion of each shift and submit on a daily basis:

- Drill hole number, length drilled, size and orientation, drills used, and observations on location, estimated quantity of water inflow intercepted, drilling action and zones of hole instability or voids.

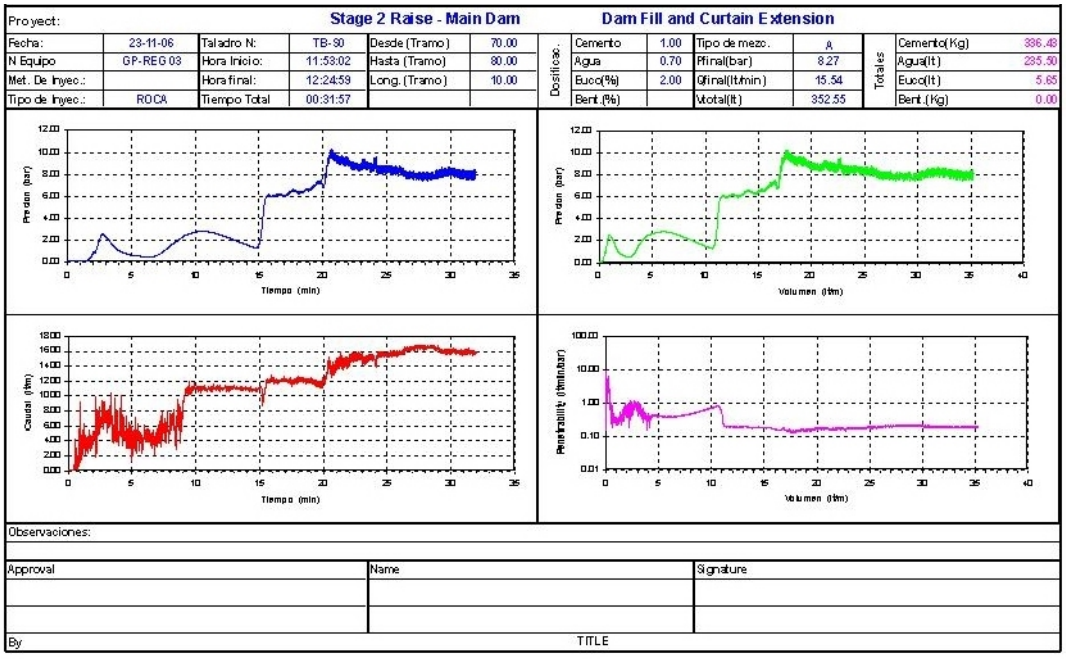
- Orientation survey results for drilled curtain grout holes.

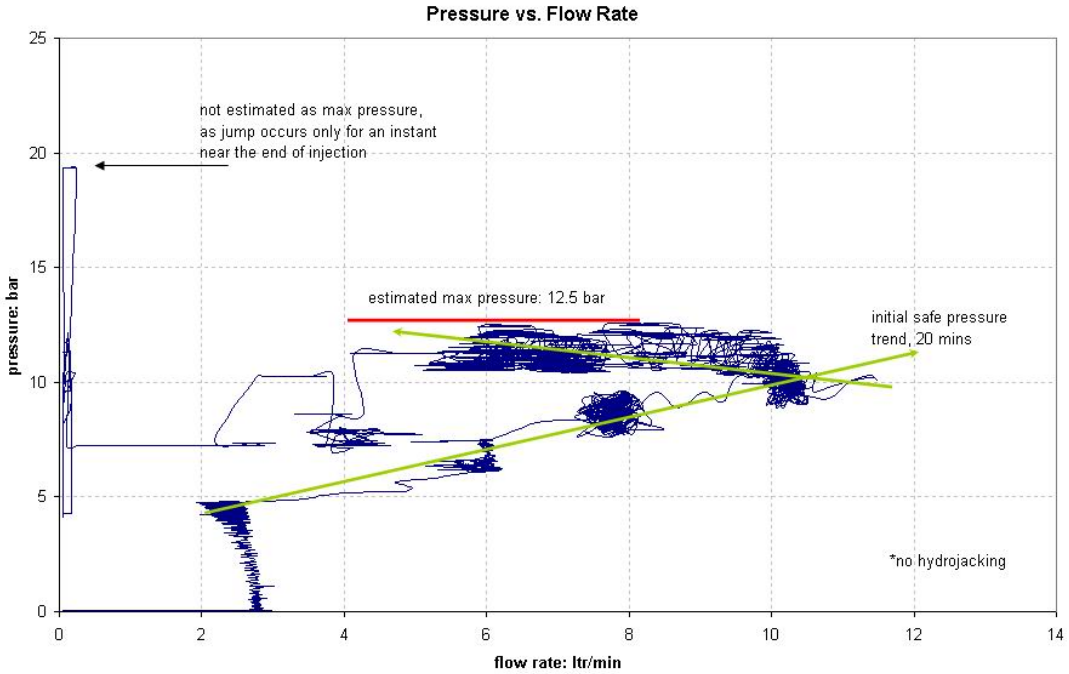
- Grouting records, including quantity, mix, location and injection pressures of all grout placements.

- Results for all grout tests, including details of shift, hole, stage and mix designation for each test. Forms to be used for reporting test results shall be approved by the CM prior to the beginning of field activities.

- Water test and grout injection data comprising record time, pressure, and flowrate for each stage at one second intervals shall be provided to the Engineer as comma separated ("csv") files readable by a personal computer within 12 hours of completion of the shift.

- Graphical records per stage of ground response during grout injection, including one plot showing pressure vs. time, volume vs. time, pressure vs. volume, and penetrability vs. volume, and another plot showing just pressure vs. flowrate as shown on the attached screen dumps below:





4.0 SETTING OUT AND DIMENSIONAL CONTROL

4.1 Hole Locations

Grouting shall be carried out through the dike cutoff wall. The curtain and consolidation grouting centerlines and other key setting out information shall be provided by the Engineer following completion of the cutoff walls.

The Contractor shall set out primary grout holes by survey for the acceptance of the Engineer prior to drilling.

4.2 Permanence of Markings

Holes for grouting, drainage, checking or exploration shall be tagged in a logical and sequential manner for proper identification.

Each tag shall be installed immediately on completion of drilling and shall have a distinctive color and number as approved by the Engineer.

4.3 Grouthole Tolerances

Grout holes shall be collared within 100 mm of nominal location.

Out of tolerance holes shall be backfill grouted and re-drilled at no cost to the CM.

5.0 MATERIALS

5.1 Cement

Cement shall be supplied from one manufacturing source throughout the Contract to ensure consistent quality and compatibility with all concrete materials.

Cement used in grouting shall be Type III, high early strength Portland cement as per ASTM C150 or C595. Cement shall be supplied in standard bags on pallets.

Cement shall be less than 3 months old at the time of use in grout unless approved by the Engineer. Cement that has become partially hydrated during storage shall not be used in grout.

5.2 Superplasticizer

Superplasticizer shall be a high-range water-reducing admixture used as a dispersion agent and shall comply with ASTM C494 Type F. Trials are required on site to verify satisfactory performance of specific superplasticizers with the cement used for grouting. Superplasticizer shall be:

Glenium 3030 NS supplied by:
BASF Admixtures Inc.
1800 Clark Boulevard, Brampton, Ontario
Tel: 800-387-5862
Fax: 905-792-0651

or similar, subject to satisfactory grout stability and viscosity being obtained as determined by the Engineer.

5.3 Bentonite

Bentonite shall be finely ground (less than 200-mesh), premium grade sodium cation montmorillonite (Wyoming sodium bentonite) and shall met all current AP Standard 13A specifications. A suitable material is:

QUIK-GEL, supplied by
Baroid, Industrial Drilling Products
Houston, TX
(Tel: 281-871-4612)

5.4 Other Admixtures or Modifiers

Other additives could be required, such as accelerators, retarders, inert fillers, volcanic ash or expanders. Such materials shall be products of proven quality and shall be subjected to the same field trial requirements as other mixes.

Prior to mobilization, all other grout additives shall be proposed by Submittal to the Engineer for approval.

Trial mixes at Site will be required to determine the actual mix proportions and requirements for use.

5.5 Water

Water used in grout mix preparation shall be fresh, clean water from a local source which is free from injurious amounts of oil, silt, soluble chlorides, organic matter, acids, alkalis and other deleterious substances, and conforms to ASTM 1602.

5.6 Materials Storage

The Contractor shall store cement, superplasticizer and bentonite in weathertight buildings or containers to provide protection from rain, dampness, and contamination.

6.0 EQUIPMENT

6.1 Rock Drills

Drilling equipment shall be capable of installing/retrieving steel casing through cutoff and overburden materials and a minimum 200 mm into bedrock, to a depth of 50 m. Steel casing may be replaced by PVC or other casing following completion of installation.

Drilling equipment shall also be capable of drilling grout holes through the installed casing a further 100 m into bedrock. Grout holes in bedrock shall have a minimum internal diameter of 50 mm.

Drilling equipment shall be capable of installing/retrieving casing and drilling grout holes inclined vertically through to horizontally. All steel casing must be retrieved following the completion of grouting activities.

Water or foam flush shall be used as appropriate. Dry drilling (air flush) shall not be carried out.

6.2 Grout Mixers

Grout mixers shall be of the high-speed, high-shear ("colloidal") type operating at a mixing speed of more than 1500 rpm, capable of thoroughly mixing the water, cement, bentonite and superplasticizers into a stable colloidal suspension. The nominal required capacity is 200 liters of grout per batch.

Grout mixers shall be equipped with bag-splitters so that grout is mixed using whole bags of cement. Grout mixers shall be equipped with water meters for batching the mix water.

Paddle mixers shall not be used.

6.3 Grout Holding Tanks (Agitators)

Grout holding tanks shall be of about 500 liter capacity and equipped with paddles rotating at about 100 revolutions per minute. The lowest paddle shall be set within about 50 mm of the base of the tank.

Holding tanks shall be provided with a 0.15 mm sieve to screen solids or hardened grout from being discharged into the holding tank by the grout return line.

6.4 Grout Pumps

Grout pumps shall be of the variable speed, progressing cavity (Moyno or Mono) type with a maximum delivery pressure of 20 bars at a sustained flowrate of 15 liters/minute. The rotation speed of each progressive cavity pump shall be controlled by a dial-pot voltage regulator (*i.e*. rate of injection shall be controlled by the rotation speed of the pump, not by re-circulation lines and valves).

Piston pumps (even if fitted with pressure surge chambers) shall not be used for grout injection.

6.5 Grout Pipes

Pipes and hoses used to circulate grout from holding tank to point of injection shall have a maximum internal diameter of 25 mm and shall be rated for a safe working pressure of at least 30 bar. There shall be no sudden reductions in pipe diameter that might cause grout blockages. Fittings and connections on grout pipes and hoses shall be rated to 30 bar safe working pressure and shall include safety chains.

6.6 Valves

Valves to be used in-line with the injection lines shall be of the diaphragm type.

Plug cock valves and ball valves shall only be used for fully-open/fully-closed functions.

6.7 Single Packers

Provide single packers for pressure grouting.

Single packers shall be capable of isolating a part of a grout hole to enable only the lower portion of the hole to be pressure grouted.

Single packers shall be sized by the Contractor based on the Contractor’s choice of grout hole diameter and method of drilling.

In general pneumatic packers shall be used for down hole work. Mechanical packers shall be used for grout injection at the top of the hole during consolidation grouting.

The maximum allowable leakage of grout past the packer shall be 0.1 liter/minute at a grout pressure of 20 bar at ground surface.

6.8 Double Packers

Double packers shall be provided for water tests. Double packers shall be capable of isolating a 2 m long portion of the grout hole and allowing water to be pumped into that isolated section. The supply of water to the injection point shall not be subject to significant head loss below the hole collar.

Double packers shall be sized based on the Contractor's choice of grout hole diameter and method of drilling. Double packers shall be actuated by compressed nitrogen and the required compressed gas supplies, lines, regulators and pressure gauges shall be supplied by the Contractor.

When sealing a section of grout hole the actuation pressure shall be at least 10 bar greater than the pressure used in the water test.

6.9 Pressure Transducers

Pressure transducers shall be of 25 bar maximum pressure and of the 4-20 mA type. Transducers shall have an accuracy of better than 1% FSD. Pressure transducers shall be mounted on the grout line tee at the hole collar, and shall be protected from the grout using an in-line gauge saver. Only one hole shall be monitored with each pressure transducer.

6.10 Pressure Gauges

Bourdon-type pressure gauges shall be provided at each grout pump discharge and at each hole collar. Gauges shall be protected from grout using gauge savers independent of those used for the pressure transducers. Gauges shall have a minimum face diameter of 75 mm and shall be available with a 25 bar maximum pressure range.

6.11 Flowmeters

Flowmeters shall be of the electromagnetic type. Flowmeters shall have a full scale capacity of 100 liters per minute and shall be capable of resolving flows as low as 0.3 liter/min with an accuracy of ± 0.1 liter/minute. The flowmeters shall provide an electronic signal of the 4-20 mA type.

6.12 Calibration Checks

Pressure transducers and pressure gauges shall be calibrated against a reference pressure gauge every week, or more frequently if the Engineer instructs.

Flowmeters shall be calibrated every week.

Pressure transducers, pressure gauges and flowmeters shall be re-calibrated if deviations are greater than ± 5%.

6.13 Recording Equipment

The output of the pressure transducer (pressure) and flowmeters (flowrate, total injected volume) shall be recorded and displayed on a data acquisition system, with the display visible close to the hole collar and adjacent to the pressure control valve. Graphical output capabilities shall be the same as those presented in Section 3.12.

Data acquisition systems shall record time, pressure, and flowrate for each grout stage at one second intervals and these records shall be provided to the Engineer as comma separated (“csv”) files readable by a personal computer within 12 hours of completion of the shift.

Data acquisition systems shall also provide a RS232 output of pressure and flowrate to enable the Engineer to carry out real-time analysis of ground response to grout, if required, by connecting a laptop computer to the data acquisition system.

6.14 Uninterruptible Power Supplies and Electrical Protection

Data acquisition systems shall be powered by uninterruptible power supplies with surge and spike suppression.

Flowmeters and pressure transducer shall be protected from electrical power surges and voltage spikes.

6.15 Shelters

Temporary portable shelters shall be provided to protect data acquisition systems from rain, sun, snow, wind and freezing temperatures.

6.16 Radios

The Contractor shall provide sufficient handheld radios so that grouting operators can communicate with the grout mixing station and with the grouting operations supervisor.

6.17 Equipment Reliability

It is essential that grouting of a hole or stage of a hole should continue smoothly until refusal of grout occurs. If grouting is interrupted through equipment breakdown or other delays, grouting of that hole and stage shall be terminated, if required by the Site Engineer, and all operations carried out in connection with that hole or stage as applicable shall not be measured for payment. The Contractor shall provide stand-by equipment of the same type as that specified above to allow the grouting program to continue uninterrupted.

6.18 Other Equipment

The Contractor shall provide hoses, pipes, wrenches, valves and all other equipment and small tools necessary for the drilling and grouting.

6.19 Spares

The Contractor shall provide sufficient spares so that all their equipment can be readily kept in full working order.

In particular, a sufficient number of mixers shall be available, ready for immediate use, to produce grout at rates required by the hole or holes being grouted and without interruption due to mixer breakdown.

6.20 Water Pressure Testing Equipment

Water pressure testing shall be carried out using equipment dedicated to water testing and independent of the grouting operations.

The pump for water pressure testing shall be the same type as used for grouting. The monitoring equipment shall be as specified in Sections 6.9 to 6.15. Data files shall be provided to the Engineer on completion of the testing.

6.21 Grouting Testing Equipment

Per operating mix plant, provide one Marsh Funnel, five 500 mL graduated plastic cylinders, one mud balance, one Lombardi cohesion plate, and two thermometers for use by the Engineer for quality control testing of the grouts.

7.0 GROUTING OF ROCK

7.1 Methodology

Grouting of rock foundations will comprise of drilling and grouting of the curtain using the split-spaced closure method. Primary hole spacing shall be 6m or as directed by the Engineer.

Curtain and consolidation grouting will generally be upstage with packer, unless ground conditions require downstage working. If downstage working is required, it shall be instructed by the Engineer. Stages shall be 5 m length unless directed otherwise by the Engineer.

7.2 Performance Criterion

The cutoff shall have a target hydraulic conductivity of 2 LU (1 LU=$1x10^{-7}$m/s) with no single test greater than 4 LU as determined by water pressure testing in boreholes drilled into the installed grout curtain.

7.3 Drilling

The Contractor shall drill holes at the cutoff wall at locations as directed by the Engineer.

Holes through the cutoff wall shall be cased with Sch. 40 steel pipe socketed 200 mm minimum into rock. Steel casing may be replaced by PVC or other casing following completion of installation.

7.4 Grout Hole Orientation Surveys

The Contractor shall perform 3-dimensional downhole orientation surveys at 3 m intervals in all completed curtain grout holes using Sperry-sun or approved equivalent equipment.

Data records shall be provided to the Engineer within 12 hours of completing the survey.

7.5 Replacement of Misaligned Holes

Any curtain grout hole that deviates more than 1 m from the intended location at the hole bottom shall be re-drilled at the Contractor's expense.

Misaligned grout holes shall be backfilled with thick grout at least 12 hours before commencing water testing or grouting of the replacement hole.

7.6 Restriction on Drilling

Holes may not be drilled within 8 m of a grouted hole until after 8 hours has elapsed after completion of grouting of that hole. If frequent communication between holes occurs, the minimum working distance requirements may be increased by the Engineer.

All primary holes can be drilled as most convenient. No secondary hole shall be drilled until its adjacent primary holes have been grouted.

7.7 Protection and Cleaning of Drill Holes

Remove from drill holes cuttings, sediments, sludge and other loose material. Protect cleaned holes from becoming clogged or obstructed using standpipes, rubber stoppers or similar means, until the holes are completely grouted. Drill holes shall be re-cleaned at no cost to the CM if clogging or obstruction occurs.

Grout hole casing should be protected against damage prior to grouting.

7.8 Removal of Water from Grout Holes

The Contractor shall have an airline on site of sufficient capacity to be capable of blowing water or unset grout out of grout holes by the airlift technique. Water or unset grout shall be blown out of grout holes as required by the Site Engineer at no cost to the CM.

7.9 Upstage Working

Upstage working shall comprise drilling the grout hole to full depth, washing and cleaning the hole, setting the packer at the top of the lowest stage, then grouting that stage. Provided that the target injection pressure is attained with grout refusal, grouting may continue by moving the packer to the next stage above after 10 minutes has elapsed and continuing to inject grout.

If the target pressure mentioned in Section 7.18, Pressure Control, is not attained or, if the final grout flowrate when the volume limit of 5000 liters is reached is greater than 5 liters per minute, then work shall stop on that hole until 6 hours have elapsed.

7.10 Downstage Working

Downstage working shall comprise drilling the depth of a grout stage, washing and cleaning the hole, seating the packer at surface, injecting the grout, removing the packer, and washing the hole, completing these six operations before commencing the next stage.

Work shall commence in the stage nearest the surface and shall proceed down the hole until the final depth is reached.

At least 8 hours shall elapse between completing a stage and commencement of work on the next deeper stage.

After completion of the final stage, the hole shall not be washed and instead backfilled with grout.

7.11 Split Spacing

The process of progressively closing a grout curtain by locating, drilling and grouting holes approximately at the midpoint between two other holes previously drilled and

grouted. The spacing of the holes drilled and grouted may vary considerably from section to section, depending on conditions encountered.

7.12 Closure Sequencing

Higher sequence holes shall not be started until both the adjacent prior holes have been completed. For example, a secondary hole shall not be drilled until grouting has been completed on both the adjacent primary holes.

7.13 Water Pressure Testing

A water pressure test consists of measuring the rate at which water is accepted by bedrock for five periods of five minutes each. The pumping pressures to be used shall be supplied by the Engineer prior to testing.

Water pressure tests shall be carried out on 5m long stages of cleaned grout holes. Generally, water pressure tests will be carried out in selected holes prior to grouting and in secondary holes to determine the adequacy of the grout curtain. Water pressure tests will be carried out independent of grouting operations.

The location and number of water pressure tests shall be instructed by the Engineer. No such test shall be performed adjacent to a borehole grouted less than 8 hours previously.

7.14 Grout Mix

The following grout mixes are proposed to initiate the grouting program:

Mix A

Water	70 liters
Cement	100 kg
Bentonite	0.0 kg
Superplasticizer	400 ml (0.9%)
Marsh Cone	30 secs (nominal)

Mix B

Water	70 liters
Cement	100 kg
Bentonite	0.0 kg
Superplasticizer	0 ml
Marsh Cone	35 secs (nominal)

Mix C

Water	70 liters
Cement	100 kg
Bentonite	0.6%
Superplasticizer	0 ml
Marsh Cone	45 secs (nominal)

Mix D

Water	70 liters
Cement	100 kg
Bentonite	1.2%
Superplasticizer	0 ml
Marsh Cone	60 secs (nominal)

The above quantities shall be adjusted to match the cement weight such that the mix comprises a unit number of bags of cement.

Mixing shall be carried out by first introducing the water into the mixer followed by the superplasticizer and the dry bentonite. The water bentonite mixture shall be thoroughly mixed for three minutes before the cement is added. Mixing shall then continue for sufficient time to give a stable, uniform slurry.

Grout shall be continuously agitated during pumping and grouting.

7.15 Trial Mixes

The grout mixes given in Section 7.14, Grout Mixes, are provisional mixes. Trials shall be carried out using the mixers and a standard batch size to verify that the mix gives the required grout quality. The Engineer shall require changes to the mix if required so that the specified grout viscosity and bleed parameters are obtained.

All grout shall have less than 5% bleed (Bleed shall be measured over a two-hour period and shall comprise the decantation of clear water at the top of a 500 ml grout cylinder).

7.16 Modifying Grout During Injection

The grout mix may be modified as grouting of a hole progresses depending on ground response and as directed by the Site Engineer. Mix A shall generally be used.

Modifications will most likely occur if high take zones are encountered and will likely comprise first the omission of the superplasticizer from the grout mix (to achieve an approximately 35 second March cone grout), followed by an increase in bentonite content using the previously established standard mixes as per Section 7.14, Grout Mixes.

Possible modified mixes shall be batched and tested prior to the start of grouting.

7.17 Grout Injection

The rate of injection shall be controlled by the rotation speed of the pump (*i.e.* using a dial-pot voltage regulator to vary or control the rotational speed of the positive displacement helical screw).

Pumping of the grout mix shall be at a steady flow rate of no more than 2 liters/meter/minute, which results in a gradual pressure increase as the mix penetrates into rock discontinuities.

The Contractor shall inject grout at the pressures and mix proportions as specified by the Engineer.

The Contractor shall grout continuously until grout refusal occurs or the instructed volume limit of 5000 liters for that stage is reached.

Grout refusal for a given stage shall be a flow rate of less than 2.5 liter per minute per 5 m stage and measured over a 10 minute period (or 0.5 Lpm/metre for 10 minutes) at the target pressures for the stage, as directed by the Engineer.

Any sudden loss of pressure or a sudden increase in grout take shall be immediately reported to the Engineer.

7.18 Pressure Control

Grout injection shall be carried out by pressure control.

Grout shall be injected at a flow rate of 2 liters/metre/minute or less until the target pressure is reached, at which time the flowrate shall be progressively reduced to maintain the target pressure with continued grout injection until refusal, as defined above.

Injection pressures shall be measured at the hole collar.

Initial specified target pressures are:

Vertical depth below bedrock surface	Collar Pressure
>35 m	20.0 bar
30 – 35 m	17.5 bar
25 – 30 m	15.0 bar
20 – 25 m	12.5 bar
15 – 20 m	10.0 bar
10 – 15 m	7.5 bar
5 – 10 m	5.0 bar
0 – 5 m	2.5 bar

Target pressures shall be evaluated by the Engineer based on the results of the water pressure tests and the ground response to grout and the target pressures shall be modified to suit the ground conditions.

7.19 Grout Volume Limit

The maximum volume of grout injected per 5m stage shall be 5000 liters unless otherwise instructed by the Engineer.

7.20 Communication Between Grout Holes

Grouting of any hole resulting in connection to an un-grouted hole shall be immediately reported to the Engineer. Multi-point injection shall then proceed in the connected holes.

8.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of Work, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

9.0 QUALITY CONTROL (QC)

The Contractor shall be responsible for his own quality control testing to ensure that the Work is constructed in accordance with the Drawings and Specifications.

10.0 QUALITY ASSURANCE (QA)

QA monitoring and testing will be carried out by the Engineer through his QA Representative, to satisfy himself and MMC that the Work is being carried out in accordance with the Drawings and Specifications. Results of QA testing will not be withheld from the Contractor.

PREPARED FOR:

PREPARED BY:

D	16/MAR/07	ISSUED FOR TENDER	AS	TLE
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REV.	DATE	REASON FOR REVISION	BY	APP

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1.0 SCOPE

This specification describes the requirements for installation of new instrumentation for the Central Dike, Stormwater Dike and Saddle Dams together with the equipment and application software for the data acquisition, transmission and processing system. Instrumentation will be supplied by the Contractor. Care shall be taken to not damage previously installed instrumentation during construction. The scope of work for instrumentation of the Central Dike includes:

- Supply and installation of vibrating wire piezometers, specifically "Model 4500MLP Piezometer" by Geokon;
- Supply and installation of settlement monuments and prism along crest of the Dike;
- Supply and installation of thermistors strings; and
- Supply and installation of prefabricated cabin for housing the instrumentation terminal and data acquisition equipment.

Geotechnical instrumentation of the Saddle Dams and the Stormwater Dike will be carried out in subsequent stages of construction.

2.0 GENERAL

2.1 Definition

Whenever the terms accuracy, sensitivity and reproducibility appear in the text, the following definitions should be understood:

Accuracy:	Degree of approximation of a measurement to the true value of the quantity measured.
Sensitivity:	Minimum unit of pressure or deformation to be detected by a system of measurement.
Reproducibility:	Degree of approximation to the arithmetic average of each one of a series of similar measurements.

2.2 Location and Installation Procedures for Instrumentation

The locations for the Dike instrumentation are shown on the Drawings. Installation procedures are provided in this Section. The location of all instruments and installation will be subject to approval by the CM.

Installation of the instruments shall be carried out in accordance with the Drawings and Specifications, the instructions of the equipment manufacturer, or as directed by the CM. The Contractor shall be responsible for proper installation, correct operation, monitoring and maintenance of the instrumentation during the construction period.

The Contractor shall take readings of each instrument to verify its correct functioning, and shall take an initial set of readings immediately after its installation. Fill shall not be placed over the instruments or leads until the instruments have been tested and the initial readings have been taken.

All cable conduits shall be marked with identification tags at intervals of 15 m, or closer if required. In addition, each instrument shall be marked with the identification given to it on the Drawings. Cable conduits shall be installed in maximum practicable lengths to minimize joints. Any necessary cutting, splicing and coupling shall be performed in accordance with the recommendations of the manufacturer.

Open ends of all incomplete lines of tubing, conduits and casing shall be sealed to keep the insides of tubes, conduits and casings free from foreign matter.

No traffic or equipment shall pass over any part of any instrument, leads or connections until at least 600 mm thickness of compacted material cover has been installed. The Contractor shall be responsible for protection of all instruments, leads and connections from damage and displacement during the progress of the Work, and shall provide markers and barricades as necessary.

2.3 Electrical Protection and Safety

The Contractor shall connect new and existing instrumentation to the data acquisition system and shall confirm that such system provides the following minimum protection to all electrical equipment:

- Over-voltage peak suppressor.
- Alternating current filter to eliminate interference.
- Grounding system for lightning protection.

2.4 Instrument Cabinets and Accessories

The Contractor shall supply all cabinets, supports and accessories necessary for installation and protection of instruments.

All cabinets and support structures shall be protected from corrosion and shall be finished and painted.

2.5 Voltage and Electrical Frequency

Facilities requiring permanent electrical power, including battery rechargers, shall be configured to operate at 110 V alternating current at 60 Hz.

3.0 EQUIPMENT AND INSTALLATION

3.1 Grout Mix

The vibrating wire piezometer, inclinometers and thermistors shall be installed using the following grout mix:

Water	660 liters
Cement	100 kg
Bentonite	41 kg
Marsh Cone	55 secs (nominal)

The above quantities shall be adjusted to match the cement weight such that the mix comprises a unit number of bags of cement.

Mixing shall be carried out by first introducing the water into the mixer followed by the cement. The water cement mixture shall be thoroughly mixed before the bentonite is added. Mixing shall continue until a stable, uniform slurry is achieved.

Grout shall be continuously agitated during pumping and grouting.

3.2 Geokon Multi-Level Vibrating Wire Piezometers (MLP)

3.2.1 General

Vibrating wire piezometers shall include all equipment, leads, connection boxes, tubes, fluids, soil-bentonite grout, grout pump, grout tremie pipe, conduits and accessories necessary for installation and operation. The piezometer, leads and connection boxes shall be provided by Geokon Inc. Data reading shall be carried out manually during construction of the Work and automatically thereafter.

Each MLP shall be capable of measuring piezometric pressure over a range between 0 and 350KPa, with a resolution of 0.025%, and accuracy of 0.1% over its entire range.

The spring loaded mechanism of the MLP shall be suitable for a nominal borehole size of 100 mm.

The connector boxes shall have capacity for simultaneous installation of all leads from the piezometer shown on the Drawings.

3.2.2 Installation

MLP shall be installed according to the manufacturer's instructions, within the Dike fill and foundation at elevations shown on the Drawings or as directed by the CM. For at least 24 hours prior to installation, the piezometer shall be immersed in de-aired water and shall be kept immersed in accordance with the manufacturer's instructions.

Prior to installation of MLP, a 100 mm borehole shall be drilled at the location and to the elevations shown on the Drawings. After the spring has been triggered the hole shall be grouted with cement-bentonite.

Leads from the instruments to the connector boxes shall be routed through PVC conduits installed into trenches, as shown on the Drawings or as required by the CM. The PVC conduit shall be protected from impact and damage during construction by hand-tamped sand backfill.

The Contractor shall complete installation of the piezometers by connecting the leads to the connector boxes within the instrumentation Cabin.

3.3 Themistor Strings

3.3.1 General

Thermsitor strings shall include all equipment, leads, connection boxes, conduits and accessories necessary for installation and operation. Data reading shall be carried out manually during construction of the Work and automatically thereafter. Each thermistor string shall have the following:

- Length of each thermistor cable as shown on Drawings;
- Node located on each thermistor string as shown on Drawings;
- Cable to be heavy duty, direct burial rated 22 gauge, water-blocked instrumentation cable;
- Thermistor to be rated for a temperature range of at least -50^{o}C to 50^{o}C; and
- Thermistor to be accurate to within 0.2^{o}C.

The connector boxes shall have capacity for simultaneous installation of all thermistor leads shown on the Drawings.

3.3.2 Installation

Themistor string shall be installed according to the manufacturer's instructions, within the Dike fill and foundation at elevations shown on the Drawings or as directed by the CM.

Leads from the instruments to the connector boxes shall be routed through PVC conduits installed into trenches, as shown on the Drawings or as required by the CM. The PVC conduit shall be protected from impact and damage during construction by hand-tamped sand backfill.

The Contractor shall complete installation of the thermistor string by connecting the lead to the connector boxes within the instrumentation Cabin.

3.4 Survey Monuments and Survey Prisms

3.4.1 General

Survey monuments shall be installed on the crest of the Dike, as shown on the Drawings. Each survey monument shall be equipped with a pin or point, to facilitate reading by total station equipment. Readings shall be taken manually.

3.4.2 Installation

The survey pins shall be installed in drilled holes, and grouted with cement grout in accordance with Specification Anchor Bars 1000-09.

3.5 Instrumentation Cabins

The Contractor shall install instrumentation cabin at the location shown in the Drawings or as required by the CM. Such cabins shall be skid-mounted prefabricated units suitable for relocation.

Two weeks prior to installation, the Contractor shall submit details of the proposed cabins.

3.6 Data Acquisition and Processing Equipment

3.6.1 Scope

The Contractor shall supply the data acquisition system and processing system for the instrumentation. The contractor shall train the personnel selected by the CM to handle and operate the equipment and software.

3.6.2 Functional Requirements

Acquisition, verification, processing and display of the data obtained from the geotechnical instruments.

Sequential data recording complete with date and time, to allow retrieval of all data from any time.

3.6.3 Data Acquisition and Storage Unit

The data acquisition and storage unit will receive data from the geotechnical instrumentation at time intervals selected by the operator. The unit shall be installed within the instrumentation cabin. Data shall be stored for subsequent transfer to a computer for processing. Data shall be recorded with corresponding legend, date and time.

3.6.4 Computer Equipment and Software

The Contractor shall provide a PC notebook computer system and a colour printer completed with system software and specialized software used for data transfer, evaluation, storing, processing and display.

4.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of works, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

5.0 QUALITY CONTROL (QC)

The Contractor shall be responsible for his own QC testing to ensure that the Work is constructed in accordance with the Drawing and Specifications.

6.0 QUALITY ASSURANCE (QA)

QA monitoring and testing will be carried out by the Engineer through his QA Representative, to satisfy himself and MMC that the Work is being carried out in accordance with the Drawings and Specifications. Results of QA testing will not be withheld from the Contractor.

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1.0 SCOPE

This Specification defines the requirements for a Quality Control (QC) Requirements for the Central Dike, Stormwater Dike and Saddle Dams construction for Meadowbank Mining Corporation (MMC) at Meadowbank Gold Project site in Nunavut, Canada.

This specification includes:

- Minimum quality control site inspections and testing requirements; and
- Sample checklists for quality control of the major construction activities.

2.0 GENERAL

2.1 Definitions

Inspection and Testing Agency	The company, partnership, or corporation retained to perform the inspections and tests required to determine and verify compliance of the Work with the requirements of this Specification.
Quality Assurance (QA)	Planned and systematic activities that provide adequate confidence to the Owner and various stakeholders that quality control is being implemented effectively.
Quality Control (QC)	A planned system of inspection and testing carried out according to accepted standard specifications to ensure the quality of construction work.
Quality Plan (QP)	Document prepared by Contractor outlining Contractor's approach for quality control during construction.

2.2 Codes

Applicable Codes and Standards are defined in Section 2.3 of Specification 1000-01 Administration Specifications.

3.0 SITE INSPECTION AND TESTING

The Contractor shall provide QC during Central Dike construction. Appropriate QC shall include:

- Experienced and qualified QC personnel;
- Suitable testing equipment, maintained in good repair at all times; and
- A proper facility / location for performing the required testing.

The Contractor shall prepare a QC Plan which includes the following:

- The minimum quality testing listed below;
- Location of samples;
- Sampling methods;
- Sampling frequency;
- Site investigations frequency;
- Checklists for each of the work specified; and
- Non-conforming materials and corrective action procedures;

3.1 Minimum Field Testing

The quality control testing requirements and frequency are listed in Table 1. The Contractor shall, at a minimum, perform all the required testing to document the construction quality.

TABLE 1: Construction QC Testing, by Contractor

Item	QC Testing	
	Type of Testing	**Frequency**
Cutoff Trench Excavation	Geotechnical mapping of side walls and bedrock base.	Continuously
Lean Concrete Platform Construction	Visual inspection that formwork and concrete placement meet minimum dimensions	Continuously
Drilling and Grouting	Grout Hole Orientation Survey	1 per grout hole (at 3m intervals upon completion of drilling)
	Calibration Checks (pressure transducer and gauges)	1 per week against a reference pressure gauge
	Calibration Checks (flowmeters)	1 per week against a known volume container.
	Marsh Funnel	1 at the initiation of injection of every stage, and thereafter, at every change of mix.
	Lombardi Cohesion	1 at the initiation of injection of every stage, and thereafter, at every change of mix.
	Mud Balance	1 at the initiation of injection of every stage, and thereafter, at every change of mix.
	Bleed	1 at the initiation of injection of every stage, and thereafter, at every change of mix.
	Mix Water and Grout Mix Temperature	1 at the initiation of injection of every stage, and thereafter, at every change of mix.
	Strength Testing	2 sets of 6 cylinders per grout mix used per week.
Liner Installation	Visual inspection	Entire length of all seams
	Non-Destructive and Destructive test	As specified in Coletanche ES3 Bituminous Liner Specification 1000-04

TABLE 1: (continued)
Construction QC Testing, by Contractor

Compaction QC Testing				
Item	**Compaction**		**Testing**	
	Maximum Loose Lift Thickness	**Compaction Method**	**Type of Testing**	**Frequency**
Glacial Till for Central Dike	1 m	No compaction	Visual inspection	Continuously
Coarse Filter	0.5 m	10-ton smooth drum vibratory roller, 4 passes	Gradation	1 every 4,000 m^3
			Visual inspection	Continuously
Fine Filter	0.3 m	95% Standard Proctor	Gradation	1 every 1,000 m^3
			Moisture Content	1 every 1,000 m^3
			Density	1 every 1,000 m^3
			Standard Proctor	1 every 10,000 m^3
			Visual Gradation	Continuously
Rockfill	1.0 m downstream wedge and 2.0 m upstream wedge	10-ton smooth drum vibratory roller, 6 passes	Visual Gradation[1]	Continuously

Notes: 1. Maximum particle size to be visually controlled during fill placement. Samples will not be taken.

4.0 SAMPLE SITE CHECKLISTS

QA/QC checklist forms to be used for documenting the construction activities are attached and include:

- Central Dike Construction Checklist – Foundation Preparation.
- Central Dike Construction Checklist – Cutoff Trench Excavation.
- Central Dike Construction Checklist – Lean Concrete Mat Construction.
- Central Dike Construction Checklist – Drilling and Grouting.
- Central Dike Construction Checklist – Liner Installation.

- Central Dike Construction Checklist – Fill Placement.

- Central Dike Construction Checklist – Instrumentation.

5.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of works, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

CENTRAL DIKE CONSTRUCTION CHECKLIST - FOUNDATION PREPARATION

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA Manager
1.	Survey lines and layout checked to ensure the locations conform with the drawings		
2.	Storage areas planned for disposal of removed materials		
3.	Occurrence of snow and removal method in place		
4.	Occurrence of boulders and removal method in place		
5.	Occurrence of hummocks and scalping method in place		
6.	Occurrence of surface and ground water and its impact mitigation in place		
7.	Presence of other unsuitable materials and removal method in place		
8.	Soil frozen or thawed and measures taken		
9.	Blasting requirement to remove unsuitable material and safety measure checked		
10.	Adjustment made to suit design in field		
11.	Final walkover inspection before re-sloping or fill placement		
12.	"As-excavated" survey conducted		

REMARKS :
DEVIATIONS : (Attach list if necessary)
DATE OF RECTIFICATION :

ACCEPTED BY QA Manager:	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

CENTRAL DIKE CONSTRUCTION CHECKLIST – CUTOFF TRENCH EXCAVATION

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC. :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA Manager
1.	Survey lines and layout conform with the drawings		
2.	Surficial conditions and boring information reviewed		
3.	Fill materials stockpiled and meet the specification requirements		
4.	Storage areas for excavated materials planned and conform to requirement		
5.	Blasting requirement planned and reviewed		
6.	Compaction equipment and methods acceptable		
7.	Dewatering measures provided for surface and groundwater		
8.	Required soil tests performed		
9.	Required visual inspection of the cutoff trench soil conditions, including talik, performed		
10.	Snow, water and loose materials removed from the trenches		
11.	Side slope conditions meet the ice poor criteria and are smooth		
12.	Side slope gravel sand seams if present covered by filter prior to liner placement		
13.	Bedrock cleaned, mapped and open fractures in bedrock filled with dental mortar		
14.	Final trench base inspection performed before lean concrete constructed		
15.	Final trench inspection performed before liner placement		
16.	Floor and upstream wall surfaces of cutoff trench are smooth.		
17.	As-built survey conducted		
18.	Acceptance and sign-off for bedding material and cut-off trench as suitable for placement of ES3 liner.		
19.	Acceptance and sign-off for cutoff trench base suitable for lean concrete placement.		

REMARKS :
DEVIATIONS : (Attach list if necessary)
DATE OF RECTIFICATION :

ACCEPTED BY QA Manager :	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

CENTRAL DIKE CONSTRUCTION CHECKLIST – LEAN CONCRETE MAT CONSTRUCTION

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC. :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA Manager
1.	Survey lines and layout conform with the drawings		
2.	Dewatering measures provided for surface and groundwater		
3.	Required concrete tests performed		
4.	Required visual inspection of the cutoff trench base prior to concrete placement		
5.	Snow, water and loose materials removed from the trench base		
6.	Bedrock conditions mapped		
7.	Bottom open fractures in bedrock filled with dental mortar		
8.	Final trench base inspection performed before lean concrete constructed		
9.	Weather condition meets the requirements during lean concrete placement		
10.	No snow trapped during construction		
11.	Lift thickness and dimensions according to specification		
12.	As-built survey conducted		
13.	Acceptance and sign-off for lean concrete pad for drilling and grouting.		

REMARKS :

DEVIATIONS : (Attach list if necessary)

DATE OF RECTIFICATION :

ACCEPTED BY QA Manager :	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

CENTRAL DIKE CONSTRUCTION CHECKLIST – DRILLING AND GROUTING

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC. :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA Manager
1.	Survey lines and layout conform with the drawings		
2.	Dewatering measures provided for surface and groundwater		
3.	Required grouting tests performed		
4.	As-built survey conducted		

REMARKS :
DEVIATIONS : (Attach list if necessary)
DATE OF RECTIFICATION :

ACCEPTED BY QA Manager :	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

CENTRAL DIKE CONSTRUCTION CHECKLIST – LINER INSTALLATION

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC. :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA MANAGER
1.	Liner material received meets the specification and with certification		
2.	Visual inspection performed to determine physical damages during handling		
3.	Deficiencies reported before installation		
4.	Bedding surface meets specification		
5.	Compaction equipment and methods acceptable		
6.	Placement and compaction of the bedding materials meet the specification		
7.	Visual inspection during installation performed		
8.	Required bedding material tests performed		
9.	Weather conditions meet the requirement during installation		
10.	Welding carried out in accordance with the manufacture's specification		
11.	Liner (routine destructive and non-destructive) testing and sampling performed		
12.	Entire processes of anchor trench, liner installation, bedding and cover material placement inspected		
13.	Floor and upstream wall surfaces of cut-off trench are smooth.		
14.	No snow trapped in the bedding and cover materials		
15.	Liner anchoring conforms to the drawings		
16.	Damages during installation repaired in accordance with specification		
17.	Site cleaned up		
18.	Final inspection and sample archive performed		
19.	As-built survey conducted		

REMARKS :

DEVIATIONS : (Attach list if necessary)

DATE OF RECTIFICATION :

ACCEPTED BY QA Manager:	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

CENTRAL DIKE CONSTRUCTION CHECKLIST – FILL PLACEMENT

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC. :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA MANAGER
1.	Survey lines and layout conform with the drawings		
2.	Fill materials stockpiled meet the specification requirements		
3.	Compaction equipment and methods acceptable		
4.	Dewatering measure provided		
5.	Required soil tests performed		
6.	Required visual inspection of stockpiled materials performed		
7.	Required visual inspection of placed materials performed		
8.	Snow and loose materials removed from the surface		
9.	Each fill lift inspected and acceptable		
10.	Weather condition meets the requirements during fill placement and compaction		
11.	Fill materials contain no frozen chunks		
12.	Adequate control of segregation of fill materials		
13.	No snow trapped during placement		
14.	Final trench inspection performed before backfill		
15.	Lift thickness and compaction according to specifications		
16.	As-built survey conducted		

REMARKS :

DEVIATIONS : (Attach list if necessary)

DATE OF RECTIFICATION :

ACCEPTED BY QA Manager:	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

CENTRAL DIKE CONSTRUCTION CHECKLIST - INSTRUMENTATION

CONTRACTOR :	PKG No. :	DATE :	SHEET OF
DESCRIPTION :	SPEC. :	DWG. :	
EQUIPMENT No./DESCRIPTION :	SYSTEM No./DESCRIPTION :		
LOCATION:			

NO.	ITEMS TO BE INSPECTED	INSPECTED BY CONTRACTOR	INSPECTED BY QA MANAGER
1.	Survey lines and layout conform with the drawings		
2.	Instrumentation equipment and methods acceptable		
3.	Instrumentation details provided in asbuilt		
4.	As-built survey conducted		

REMARKS :

DEVIATIONS : (Attach list if necessary)

DATE OF RECTIFICATION :

ACCEPTED BY QA Manager:	ACCEPTED BY CONTRACTOR :	ACCEPTED BY MMC (If Required) :
NAME:	NAME:	NAME:
SIGNATURE :	SIGNATURE :	SIGNATURE :
DATE	DATE	DATE

PREPARED FOR:

PREPARED BY:

REV.	DATE	REASON FOR REVISION	BY	APP
D	16/MAR/07	ISSUED FOR TENDER	AS	TLE
C	21/FEB/07	ISSUED FOR CLIENT REVIEW	AS	HH
A	18/FEB/07	ISSUED FOR REVIEW	AS	HH

TABLE OF CONTENTS

1.0 SCOPE

This specification describes Care of Water during the Central Dike construction, which consists of all work required to control water from any sources, including groundwater, surface water and precipitation, in order to complete the Work in accordance with the Drawings and Specifications, and in accordance with all environmental and safety controls established by MMC.

Care of water shall include the following:

- Managing water before, during and after excavating; preparing, and constructing foundation and abutments; placing dam fills; designated waste areas, access roads, and stockpiles; constructing seepage collection works; and undertaking any other part of the Work.

- Dewatering foundations and associated working areas. The contractor shall provide, operate and maintain any channels, flumes, drains, sumps, pumps and other drainage facilities and equipment necessary to divert water away form, to remove water from areas required to be used for construction of the Work and/or as required to meet environmental or safety requirements.

- Constructing and maintaining any embankments and other protective works required to divert water away from areas required for the Work, and where applicable, removing such structures upon completion of the Work.

- Diverting and controlling surface runoff occurring along the abutments at the edge of the rockfill.

2.0 GENERAL

The Contractor shall temporarily divert and manage surface water during construction of the Work. The contractor shall construct any channel, ditch, dike or other facility required to divert surface water from any area required to complete the Work, and shall also furnish, install, maintain and operate all pumps, hoses, culverts and any other equipment required to dewater an maintain all parts of the construction site free from water.

The Contractor shall adequately operate and maintain temporary diversion and protective works and pumping stations. These shall also be readily accessible at all times.

The Contractor shall remove dikes and other temporary works promptly, when they are no longer required. Materials from such removal shall be hauled to disposal areas designated by the Construction Manager.

Environmental requirements shall be established by the Construction Manager.

3.0 EXECUTION

The Contractor shall not commence any part of the Work until appropriate Care of Water measures have been designed, submitted to the Construction Manager for review, approved in the writing by the Construction Manager, and implemented.

Care of Water systems shall include, but no necessarily limited to, embankments, trenches, ditches, and lined channels to divert or collect surface water runoff; pipes, drains and sumps to manager groundwater; and pumping systems.

3.1 Dewatering Foundations

Excavations shall be dewatered in advance, to ensure that the Work is carried out in safe and dry conditions. Proposed methods for preventing and controlling seepage shall be submitted to the Construction Manager for review.

4.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of works, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

5.0 QUALITY CONTROL (QC)

The Contractor shall be responsible for his own quality control testing to ensure that the Work is constructed in accordance with the Drawing and Specifications.

6.0 QUALITY ASSURANCE (QA)

QA monitoring and testing will be carried out by the Engineer through his QA Representative, to satisfy himself and MMC that the Work is being carried out in accordance with the Drawings and Specifications. Results of QA testing will not be withheld from the Contractor.

PREPARED FOR:

PREPARED BY:

D	16/MAR/07	ISSUED FOR TENDER	AS	TLE
C	21/FEB/07	ISSUED FOR CLIENT REVIEW	AS	HH
A	18/FEB/07	ISSUED FOR REVIEW	AS	HH
REV.	DATE	REASON FOR REVISION	BY	APP

TABLE OF CONTENTS

1.0 SCOPE

This specification describes the requirements for supply and installation of anchor bars for the Central Dike.

2.0 GENERAL

Anchors shall include steel bars firmly bonded within the drill holes by means of appropriate grout or adhesive.

Details regarding installation patterns are shown on the Drawings or will be provided by the CM when required.

3.0 SPECIFICATIONS

3.1 Types of Anchor Bars

Anchor Bars shall consist of deformed steel bars, with diameter and embedded length as shown on the Drawings. The free end of the anchor protruding from the rock surface shall be of the shape and dimensions shown on the Drawings.

3.2 Materials

Steel rods for anchors shall comply with CSA-G-30.18 standard for typical rebar.

Grout to be used shall be 1117 Grout (Silica Fume Anchor Bolt Grout) by Target Products or approved equivalent. Specified 28-day strength shall be 70 MPa and unconfined expansion shall be 1% to 3% (ASTM C-109). Flow shall be 20 to 40 seconds (ASTM 942).

3.3 Installation

The Contractor shall install anchor bars as shown on the Drawings or required by the CM.

The maximum diameter for anchor bar holes shall be 50 mm plus anchor bar diameter unless otherwise directed by the grout manufacturer.

Immediately prior to installation of the anchor bar, the anchor bar holes shall be flushed with water or air to remove drill cuttings.

Prior to installation, anchor bars shall be pressure-washed to remove all mill scale, loose rust, dirt, grease and any other foreign substances.

Centralizers shall be attached along the anchored length at 1 m intervals prior to installation.

3.4 Grouting

After installation of the anchor bar into the anchor bar hole, cement grout shall be pumped through a tremie line to the base of the hole until the hole is completely full of grout. Pumping of the grout shall continue as the tremmie line is removed.

Substrate shall be kept at 5^{o}C to 35^{o}C for 72 hours after grouting.

4.0 SAFETY PROGRAM

The Contractor shall provide to MMC a detailed Safety plan for each activity specified in this Specification.

The Contractor shall be responsible for the protection and safety of works, plant and materials in each working area. The Contractor shall implement any necessary installation or measure to ensure this.

5.0 QUALITY CONTROL (QC)

The Contractor shall be responsible for his own quality control testing to ensure that the Work is constructed in accordance with the Drawing and Specifications.

6.0 QUALITY ASSURANCE (QA)

QA monitoring and testing will be carried out by the Engineer through his QA Representative, to satisfy himself and MMC that the Work is being carried out in accordance with the Drawings and Specifications. Results of QA testing will not be withheld from the Contractor.

APPENDIX VI

DRAWINGS

MEADOWBANK

MINING CORPORATION

MEADOWBANK GOLD PROJECT

CENTRAL DIKE DESIGN

DRAWINGS INDEX		
DWG NO.	TITLE	REVISION
4000-00	LOCATION MAP AND DRAWINGS INDEX	B
4000-01	OVERALL SITE PLAN	B
4000-02	BOREHOLE LOCATIONS PLAN	B
4000-03	GEOLOGIC SECTION ALONG DIKE ALIGNMENT	B
4000-04	PROPOSED DIKE FOOTPRINT SHOWING BATHYMETRY CONTOURS	B
4000-05	PROPOSED DIKE LAYOUT SHOWING SOIL THICKNESS	B
4000-07	CONSTRUCTION STAGING OVERVIEW	B
4000-08	EXCAVATION PLAN STAGE 1	B
4000-09	EXCAVATION PLAN STAGE 2 AND 3	B
4000-10	GROUTING PLAN AND LINER DETAILS	B
4000-12	STAGE 1 PLAN	B
4000-13	STAGE 1 SECTIONS	B
4000-14	STAGE 2 PLAN	B
4000-15	STAGE 2 SECTIONS	B
4000-16	STAGE 3 PLAN	B
4000-17	STAGE 3 SECTIONS	B
4000-18	STORMWATER DIKE AND SADDLE DAM LAYOUT	A
4000-19	CONSTRUCTION STAGING OVERVIEW - STORMWATER DIKE	A
4000-20	CONSTRUCTION STAGING OVERVIEW - SADDLE DAM	A
4000-21	ROCKFILL PLACEMENT - PLAN	A
4000-22	ROCKFILL REGRADING - PLAN	A
4000-23	EXCAVATION PLAN	A
4000-24	CENTRAL DIKE INSTRUMENTATION - PLAN LOCATIONS	A
4000-25	CENTRAL DIKE INSTRUMENTATION - TYPICAL SECTION	A

NOTE:

UNUSED DWG NOS:

4000-06, 4000-11

KEY PLAN

LIST OF SPECIFICATIONS		
SPECIFICATION No.	TITLE	REVISION
1000-01	ADMINISTRATION	D
1000-02	EARTHWORKS	D
1000-03	LEAN CONCRETE MAT	D
1000-04	BITUMINOUS LINER	D
1000-05	DRILLING AND GROUTING	D
1000-06	INSTRUMENTATION INSTALLATION	D
1000-07	QC REQUIREMENTS	D
1000-08	CARE OF WATER	D
1000-09	ANCHOR BARS	D

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	RWJ	RVW
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP

T. L. ELDRIDGE LICENSEE Mar 16/07 N.W.T.

PROJECT: MEADOWBANK MINING CORPORATION

TITLE: MEADOWBANK GOLD PROJECT LOCATION MAP AND DRAWINGS INDEX

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-00	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-00		
CHECK	-	-			
REVIEW	-	-			

REVISION DATE: 07/03/16 11:31AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-00.dwg

NOTES

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
4. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
5. LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2ND PORTAGE LAKE = 133.1M, THIRD PORTAGE LAKE = 134.1M

7220000 N
7217500 N
7216250 N
7215000 N
7212750 N
640750 E
640000 E
638750 E
637500 E

VAULT LAKE
VAULT PIT
VAULT ROCK STORAGE FACILITY
PHASER LAKE
DRILL TRAIL LAKE
TURN LAKE
SECOND PORTAGE LAKE
EAST DIKE
THIRD PORTAGE LAKE
BAY ZONE DIKE
GOOSE ISLAND DIKE
PORTAGE PIT
PORTAGE ROCK STORAGE FACILITY
CENTRAL DIKE
NORTH SADDLE DAM
STORMWATER DIKE
SOUTH SADDLE DAM
BATCH PLANT
GOOSE ISLAND PIT
SOUTH CAMP DIKE
FUEL STORAGE
PLANT SITE
THIRD PORTAGE LAKE

0 25 50 75 100 125
Scale in Meters

NOT FOR CONSTRUCTION

REVISION DATE: 07/03/16 10:19AM By: ASchnobr
CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-01.dwg

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP: NORTHWEST TERRITORIES PROFESSIONAL ENGINEER LICENSEE Mar16/07 N.W.T.

PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT CENTRAL DIKE OVERALL SITE PLAN**

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-01	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-01		
CHECK	-	-			
REVIEW	-	-			

639000 E
638500 E
638000 E
637500 E
637000 E
7215000 N
7215500 N
7216000 N
7216500 N
7217000 N
7217500 N

PORTAGE ROCK STORAGE FACILITY

PORTAGE PIT

CENTRAL DIKE

NORTH SADDLE DAM

SOUTH SADDLE DAM

STORMWATER DIKE

TILL/LAKEBED SEDIMENT DISPOSAL AREA

SOUTH CAMP DIKE

BATCH PLANT

FUEL STORAGE

PLANT SITE

WATER INTAKE

03GT-TD-1
03GT-TD-2
03GT-TD-3
03GT-TD-4
03GT-TD-5A
03GT-TD-6
06GT-TD1
06GT-TD2A
06GT-TD3
02GT-05
02GT-06
02GT-07
02GT-08
02GT-09
02GT-10
02GT-11

LEGEND:

- BH (BOREHOLE)
- BH WITH THERMISTOR INSTALLATION

NOTES

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
4. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
5. LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2ND PORTAGE LAKE = 133.1M 3RD PORTAGE 134.1M

BH#	NORTHING (UTM)	EASTING (UTM)	ELEVATION (masl)	INCLINATION (DEGREES)	AZIMUTH (DEGREES)	LENGTH (m)
02GT-05	7214823	638598	132.50	-90	-	17.0
02GT-06	7214640	638462				42.7
02GT-07	7215396	638149	132.62	-90	-	15.5
02GT-08	7215344	638003	132.60	-90	-	17.0
02GT-09	7215349	637859	136.77	-48.4	79	30.5
02GT-10	7215480	638275	136.29	-48.7	238	30.0
02GT-11	7214557	638394	132.78	-90	-	27.0
03GT-TD-1	7214847	638842	134.34	-56.7	223	49.5
03GT-TD-2	7214712	638772	133.00	-90	-	29.4
03GT-TD-3			133.00	-90	-	39.0
03GT-TD-4	7214353	638775	133.00	-90	-	29.3
03GT-TD-5A	7214123	638775				
03GT-TD-6	7214516	638752	132.58	-90	-	52.3
06GT-TD1	7214678	638718	135.10	-89.4	-	204.0
06GT-TD2A	7214487	638804	135.10	-89.3	-	201.0
06GT-TD3	7214396	638738	135.10	-89.6	-	117.0

0 50 100 150 200 250
Scale In Meters

NOT FOR CONSTRUCTION

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
BOREHOLE LOCATIONS PLAN

STAMP
PROFESSIONAL ENGINEER LICENSEE Mar16/07 N.W.T.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	BW	RB
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. 4000-02
REFERENCES

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-02	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07			
CHECK	-	-			
REVIEW	-	-			

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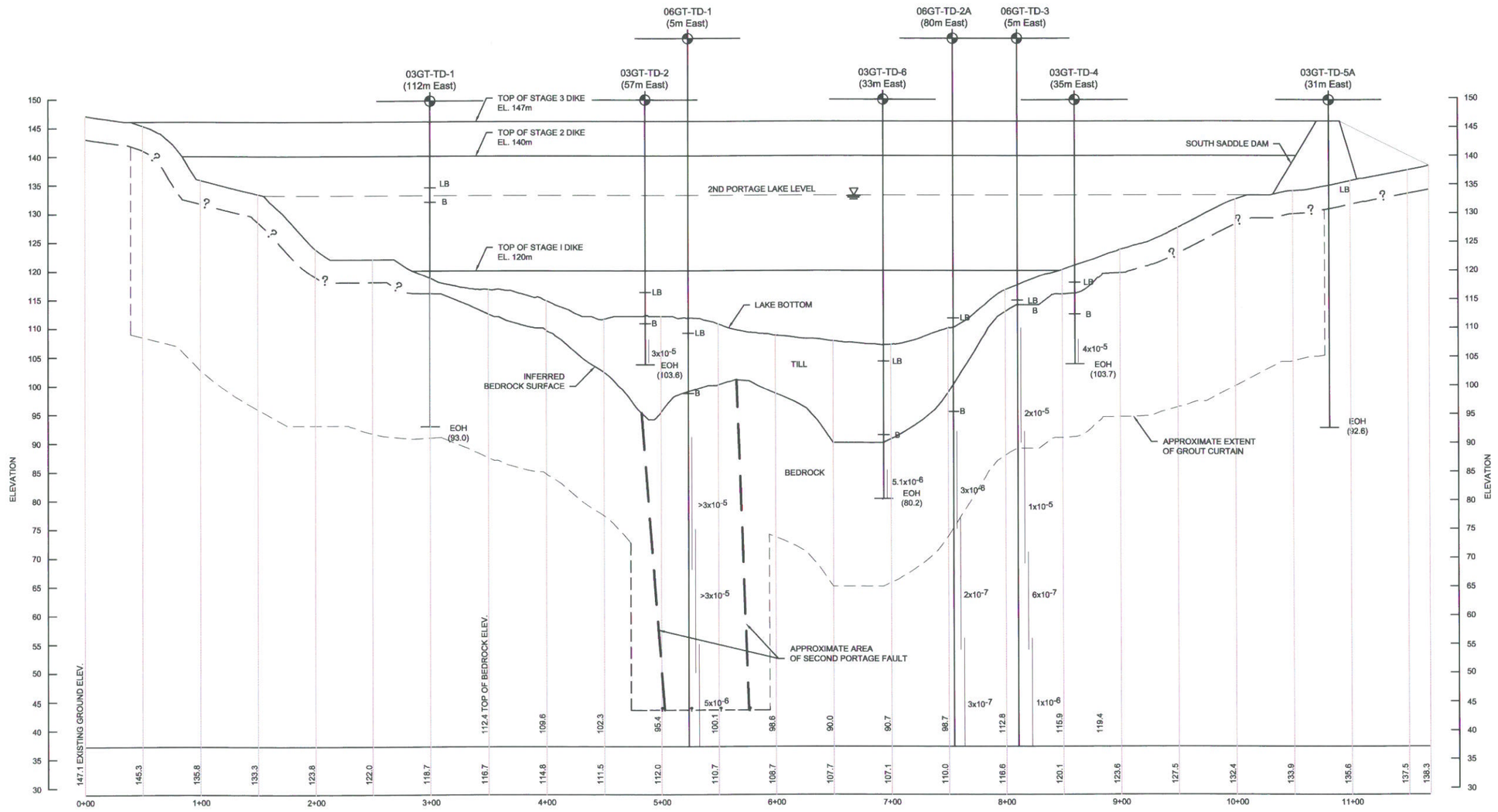

A 02 **LONGITUDINAL SECTION**

0 20 40 60 80 100
Scale in Meters

VERTICAL EXAGGERATION = 5x

LEGEND:

$2x10^{-5}$ HYDRAULIC CONDUCTIVITY TEST INTERVAL WITH RESULTS IN m/s

03GT-SE-2 (150m East) -BOREHOLE NAME -(OFFSET FROM DIKE CENTERLINE)

ALL BOREHOLES FROM ICE SURFACE -ELEVATIONS ADJUSTED FOR CLARITY.

LB LAKEBED

EOH END OF HOLE

B BEDROCK

NOTES

1. OVERBURDEN BASED ON SEISMIC SURVEY. ACTUAL THICKNESS SHOULD BE CONFIRMED.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (masl) UNLESS OTHERWISE NOTED.
4. SECOND PORTAGE FAULT IS APPROXIMATELY 5m WIDE. 70°/235° DIRECTION FROM NORTH, THROUGH BH 06GT-TD-1

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP: PROFESSIONAL ENGINEER PROVINCE OF NWT LICENSEE Mar 16/07

PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT**
CENTRAL DIKE
GEOLOGIC SECTION ALONG DIKE ALIGNMENT

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-03	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-03		
CHECK	-	-			
REVIEW	-	-			

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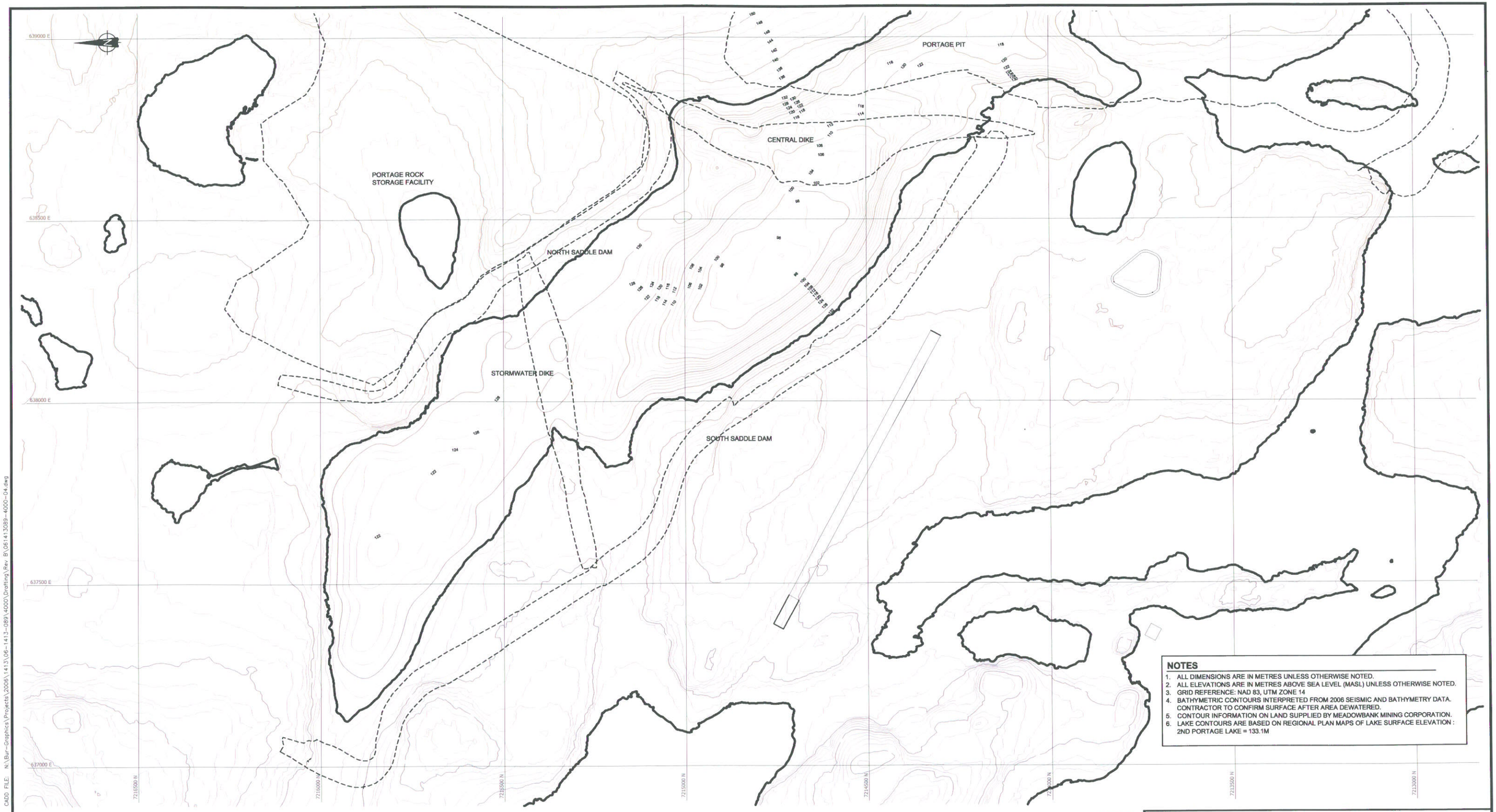


NOTES

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. BATHYMETRIC CONTOURS INTERPRETED FROM 2006 SEISMIC AND BATHYMETRY DATA. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
5. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
6. LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2ND PORTAGE LAKE = 133.1M

NOT FOR CONSTRUCTION

REVISION DATE: 07/03/16 11:37AM By: ASalvador
CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-04.dwg

DRAWING NO.	REFERENCES

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

STAMP

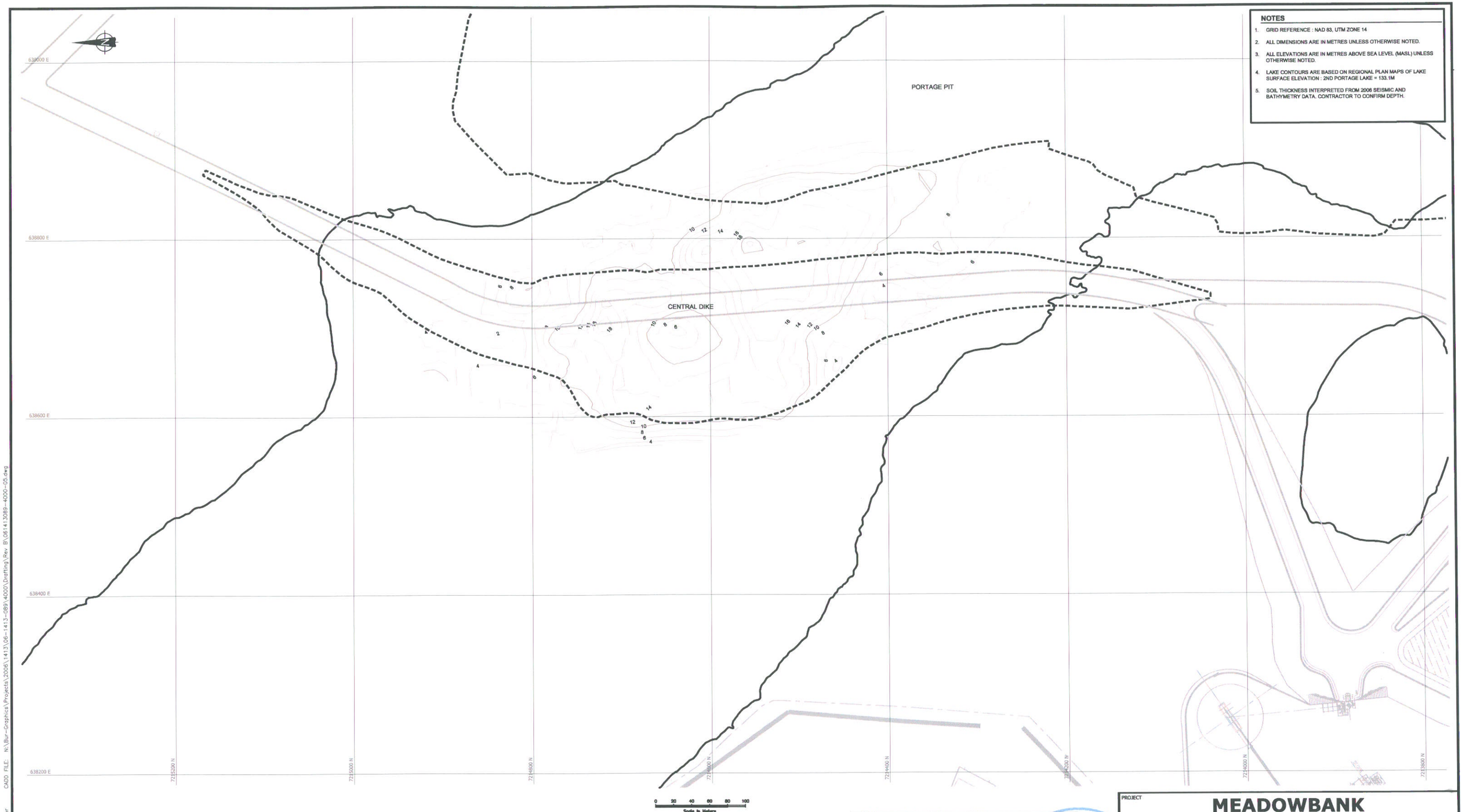
PROFESSIONAL ENGINEER — R.D. RUDGE — LICENSEE — March 07 — N.W.T.

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
CENTRAL DIKE
PROPOSED DIKE FOOTPRINT SHOWING BATHYMETRY CONTOURS

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-04	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07			
CHECK	-	-	4000-04		
REVIEW	-	-			



NOTES

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
4. LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2ND PORTAGE LAKE = 133.1M
5. SOIL THICKNESS INTERPRETED FROM 2006 SEISMIC AND BATHYMETRY DATA. CONTRACTOR TO CONFIRM DEPTH.

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP

LICENSEE Mar/6/07

PROJECT

MEADOWBANK
MINING CORPORATION

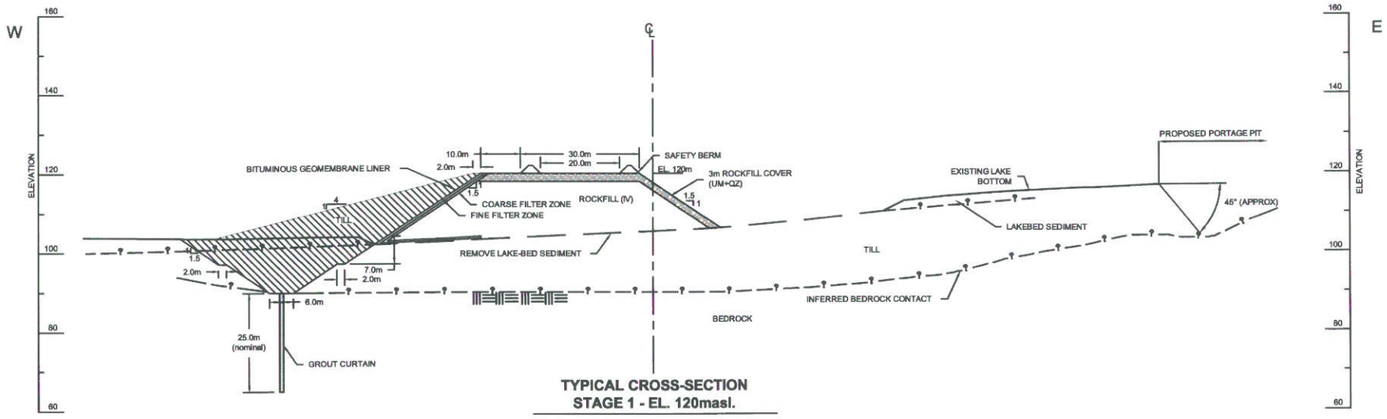
TITLE

MEADOWBANK GOLD PROJECT
CENTRAL DIKE
PROPOSED DIKE FOOTPRINT SHOWING SOIL THICKNESS

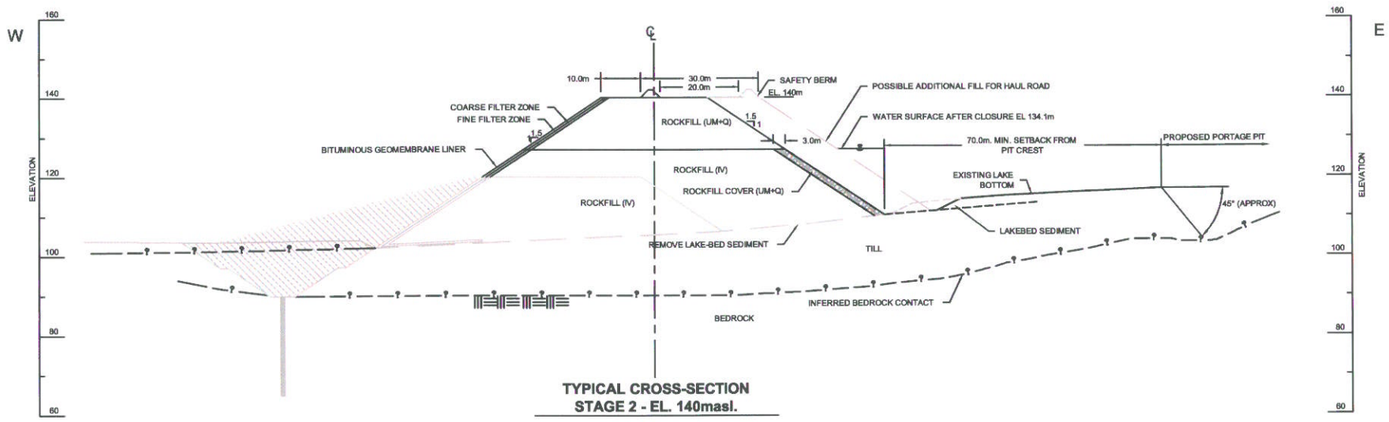
Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-05	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07			
CHECK	-	-	4000-05		
REVIEW	-	-			

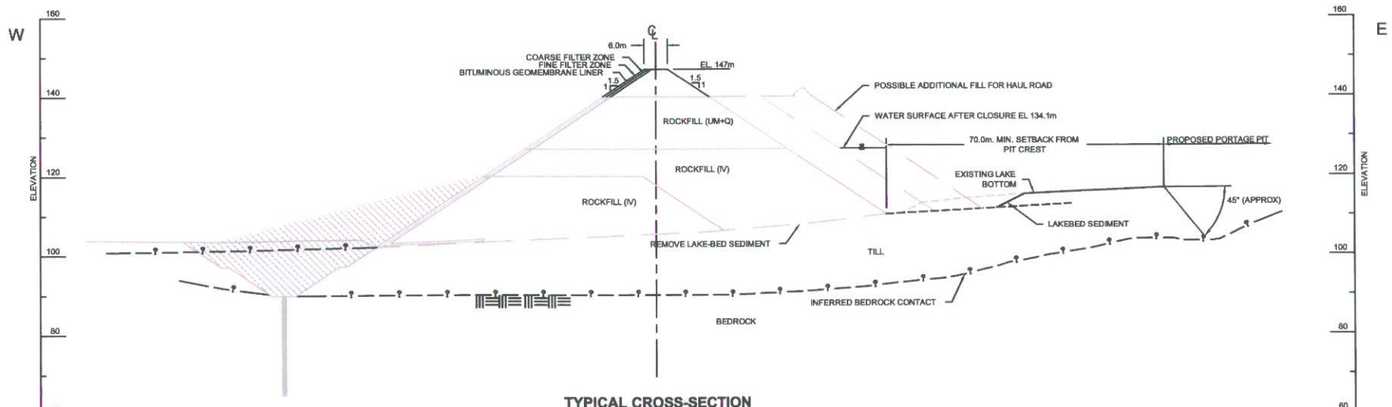
REVISION DATE: 07/03/16 10:18AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\14131(06-1413-089)4000\Drafting\Rev B\061413089-4000-05.dwg



TYPICAL CROSS-SECTION
STAGE 1 - EL. 120masl.



TYPICAL CROSS-SECTION
STAGE 2 - EL. 140masl.



TYPICAL CROSS-SECTION
STAGE 3 - EL. 147masl.

MATERIAL	TYPE	CONSTRUCTION ELEVATION			TOTAL QUANTITIES
		BASE - 120	120-140	140-147	
EXCAVATION		145,262	17,232	5,429	167,923 cu.m.
ROCKFILL	IV	189,041	747,349		936,390 cu.m.
ROCKFILL	UM+Q	51,364	233,801	318,417	603,582 cu.m.
OVERBURDEN FILL		201,532			201,532 cu.m.
FINE FILTER	IV	12,271	8,139	7,584	27,994 cu.m.
COARSE FILTER	IV	12,271	8,139	7,584	27,994 cu.m.
LINER		21,542	36,679	16,535	74,756 m².

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
3. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
4. LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2ND PORTAGE LAKE = 133.1M , 3RD PORTAGE = 134.1M
5. 1m ROCKFILL LIFT TO EL. 148m AT CLOSURE.
6. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.

NOT FOR CONSTRUCTION

0 5 10 15 20 25
Scale in Metres

VERT EXAGGERATION = 5x

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	BWJ	RVW
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

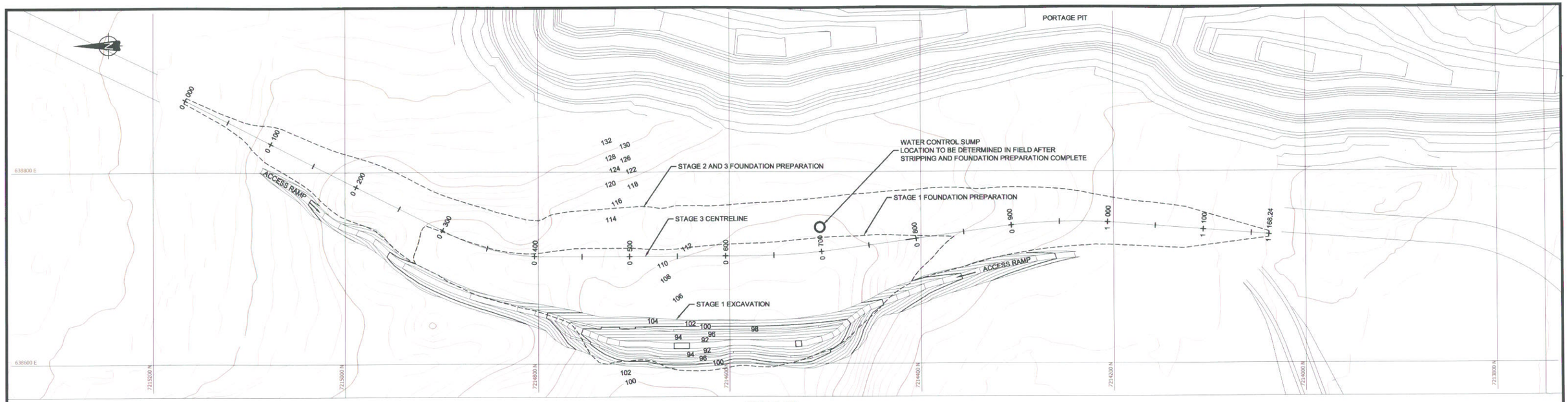
STAMP: REGISTERED PROFESSIONAL ENGINEER — LICENSEE — Mar 16/07 — N.W.T.

PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT**
CENTRAL DIKE
CONSTRUCTION STAGING OVERVIEW

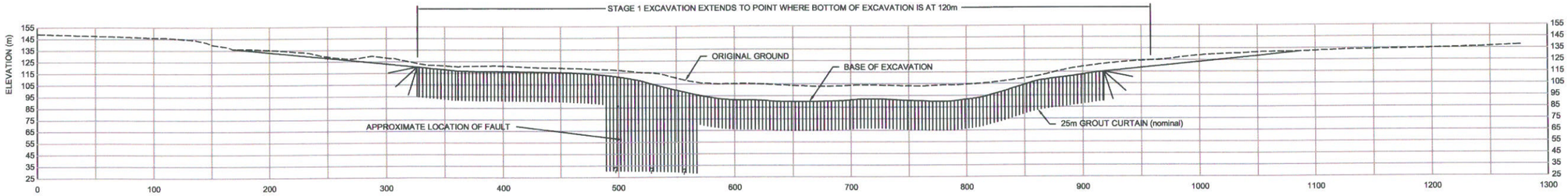
Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-07	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-07		
CHECK	-	-			
REVIEW	-	-			



SITE PLAN

0 20 40 60 80 100
Scale in Meters



SECTION THROUGH BASE OF EXCAVATION

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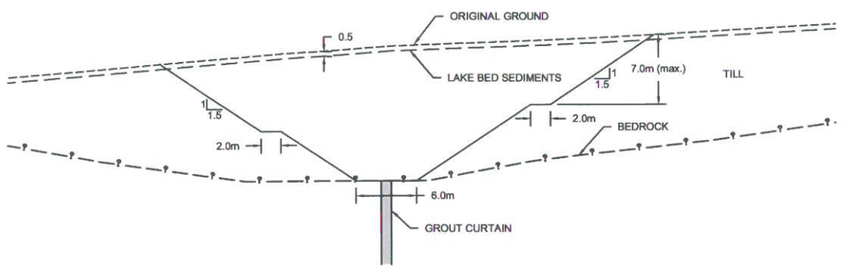
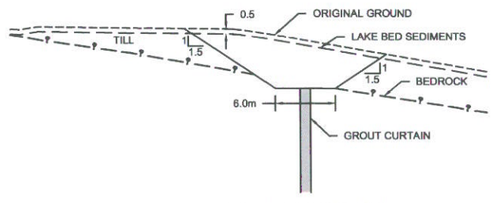
Scale in Meters



TYPICAL CROSS-SECTION DEEPER THAN 7m

0 3 6 9 12 15
Scale in Meters



TYPICAL CROSS-SECTION LESS THAN 7m

0 3 6 9 12 15
Scale in Meters

NOTES

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
4. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
5. LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2ND PORTAGE LAKE = 133.1M
6. GEOMETRY OF EXCAVATION TO BE CONFIRMED BY CONTRACTOR FOR STABILITY AFTER AREA DEWATERED AND INVESTIGATION COMPLETED.
7. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
8. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP: REGISTERED PROFESSIONAL ENGINEER — LICENSEE — Mar16/07 — N.W.T.

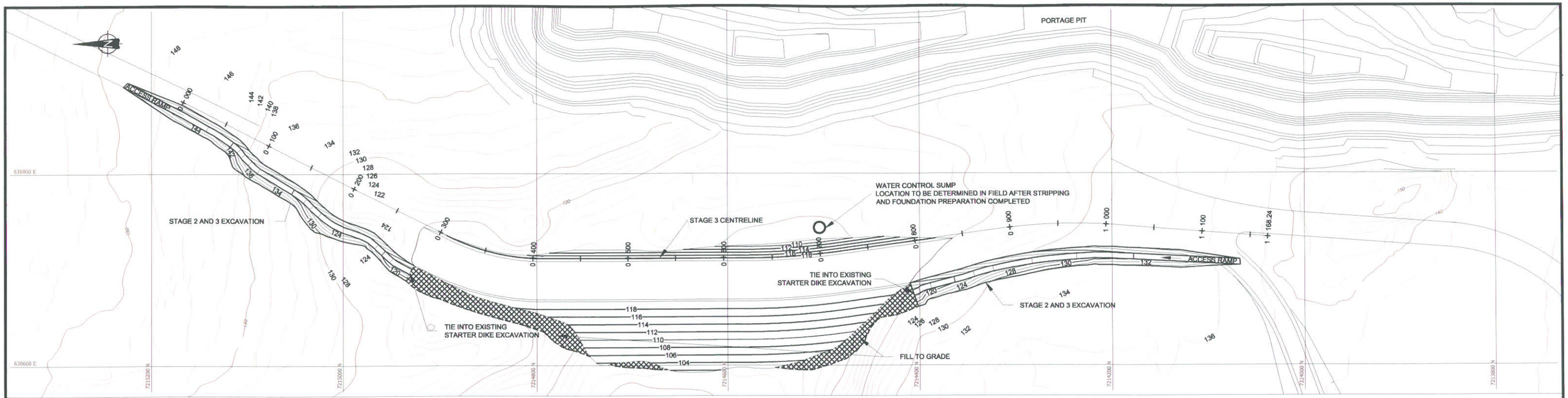
PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT EXCAVATION PLAN STAGE 1**

Golder Associates

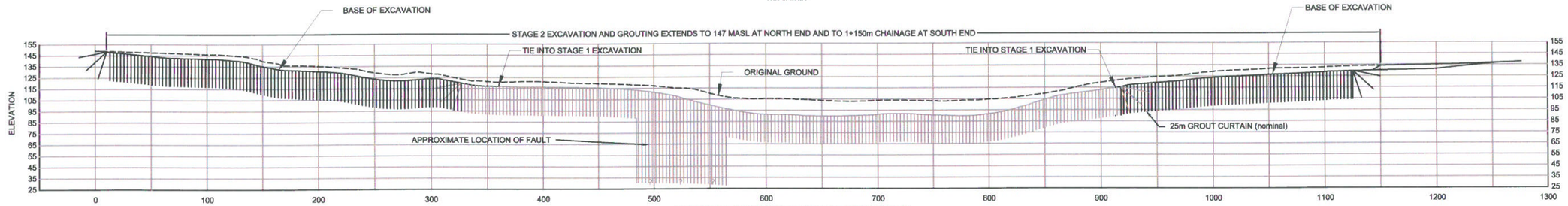
PROJECT No.	06-1413-089		FILE No.	061413089-4000-08	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RHL	10JAN07	4000-08		
CHECK	-	-			
REVIEW	-	-			

REVISION DATE: 07/03/16 10:43AM By: AGalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\06141308 9-4000-08.dwg



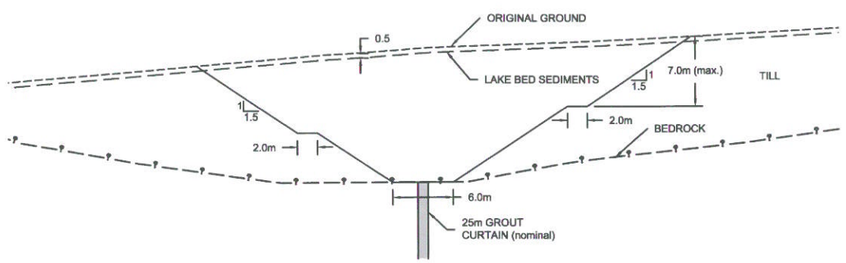
SITE PLAN

0 20 40 60 80 100
Scale in Meters



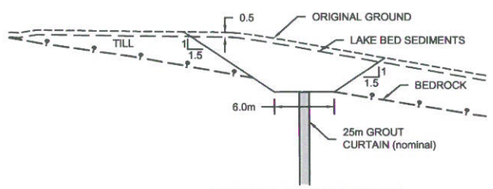
SECTION THROUGH BASE OF EXCAVATION

0 20 40 60 80 100
Scale in Meters



TYPICAL CROSS-SECTION DEEPER THAN 7m

0 3 6 9 12 15
Scale in Meters



TYPICAL CROSS-SECTION LESS THAN 7m

0 3 6 9 12 15
Scale in Meters

NOTES

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
4. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
5. EXTENT OF GROUTING TO BE DETERMINED IN THE FIELD BASED ON WATER PRESSURE TESTING.
6. CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD. ,2002, 2003, 2006. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
7. GEOMETRY OF EXCAVATION TO BE CONFIRMED FOR STABILITY BY CONTRACTOR AFTER AREA DEWATERED.
8. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
9. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.

NOT FOR CONSTRUCTION

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
CENTRAL DIKE
EXCAVATION PLAN STAGE 2 AND 3

STAMP
REGISTERED PROFESSIONAL ENGINEER
LICENSEE
16/07
N.W.T.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-09	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-09		
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REVIEW	-	-			

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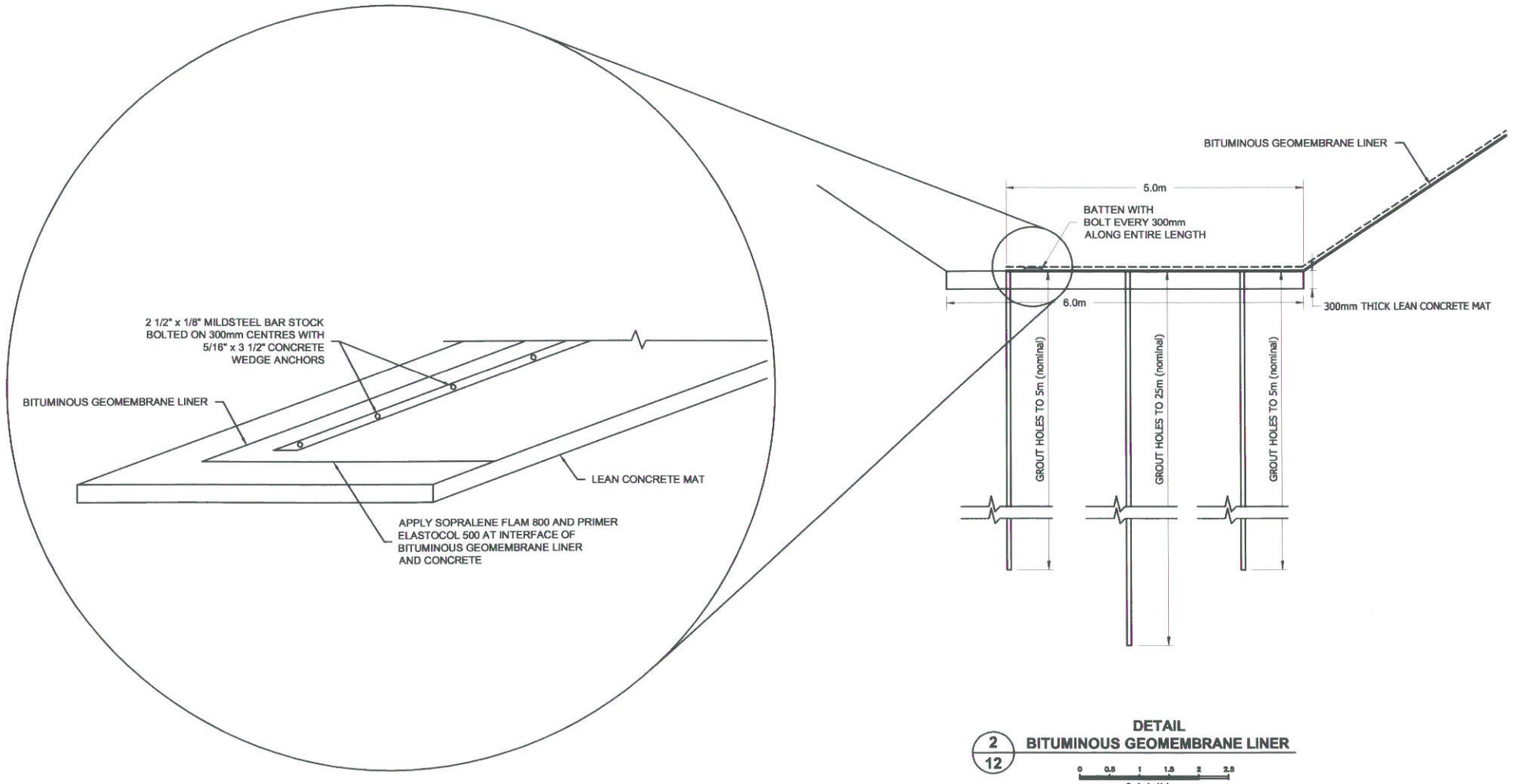
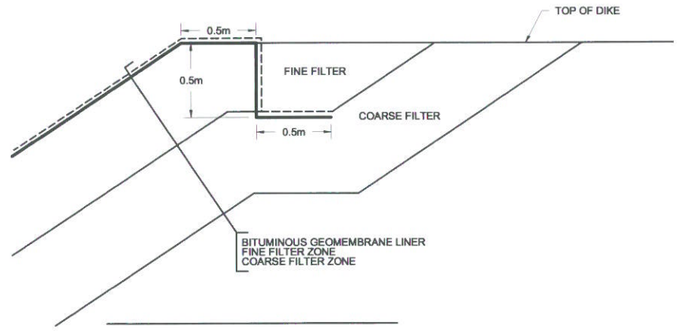


DETAIL
BITUMINOUS GEOMEMBRANE LINER
2/12
0 0.5 1 1.5 2 2.5
Scale in Meters



DETAIL - TOP OF
BITUMINOUS GEOMEMBRANE LINER
3/12 3/14 3/16
0 0.2 0.4 0.6 0.8 1
Scale in Meters

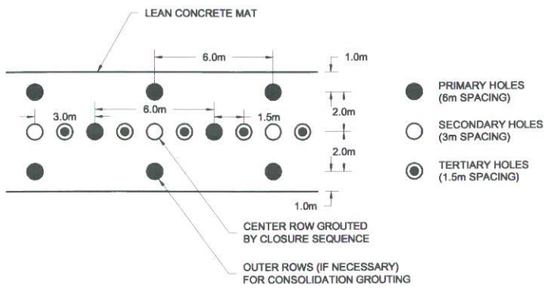
GROUTING WORK PLAN:

THE WORK PLAN OUTLINED BELOW IS TO BE CARRIED OUT FROM THE LEAN CONCRETE MAT.

1. DRILL VERTICAL PRIMARY GROUT HOLES AT 6.0 m CENTRES ALONG THE CENTRAL ROW UP TO 25 m INTO BEDROCK OR TO 100m IN PORTAGE FAULT ZONE.
2. FLUSH GROUT HOLES.
3. CARRY OUT WATER PRESSURE TESTS ON 5M STAGES IN SELECTED PRIMARIES AS DIRECTED BY THE ENGINEER.
4. GROUT PRIMARIES WITH CEMENT BASED GROUT.
5. DEPENDING ON RESULTS OBTAINED IN THE PRIMARY GROUT HOLES, CONSOLIDATION GROUT HOLES SHALL BE DRILLED UP TO 5M INTO BEDROCK, FLUSHED, WATER PRESSURE TESTED AND GROUTED, ALONG THE TWO OUTER ROWS, AT THE DIRECTION OF THE ENGINEER.
6. DRILL, FLUSH, WATER PRESSURE TEST AND GROUT SECONDARIES, TERTIARIES AND QUATERNARY GROUT HOLES ALONG THE CENTRAL ROW. AS DIRECTED BY THE ENGINEER.
7. AS DIRECTED BY THE ENGINEER, ADDITIONAL HOLES WILL BE DRILLED AND WATER PRESSURE TESTED, TO CONFIRM PERFORMANCE CRITERIA.

NOTES

1. BEFORE WATER PRESSURE TESTING OR GROUTING OF ANY HOLE IS STARTED, EACH HOLE SHALL BE THOROUGHLY FLUSHED WITH ALTERNATING JETS OF CLEAN WATER AND COMPRESSED AIR FOR AT LEAST 5 MINUTES TO REMOVE DRILL CUTTINGS OR ANY JOINT FILLING MATERIALS.
2. IMMEDIATELY BEFORE COMMENCING WATER PRESSURE TESTING, THE HOLE TO BE TESTED SHALL BE CAREFULLY WASHED AND FLUSHED UNTIL THE RETURN WATER IS CLEAR IN ORDER TO REMOVE ANY DRILL CUTTINGS OR LOOSE MATERIALS.
3. UNLESS OTHERWISE DIRECTED BY THE ENGINEER, ALL GROUTING SHOULD BEGIN WITH MIX A (AS DESCRIBED IN THE SPECIFICATIONS) AND INJECTED AT A GRADUALLY INCREASING RATE TO A MAXIMUM OF 2 LPM / M STAGE LENGTH.



DETAIL - GROUTING SEQUENCE
1/12
0 1 2 3 4 5
Scale in Meters

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP

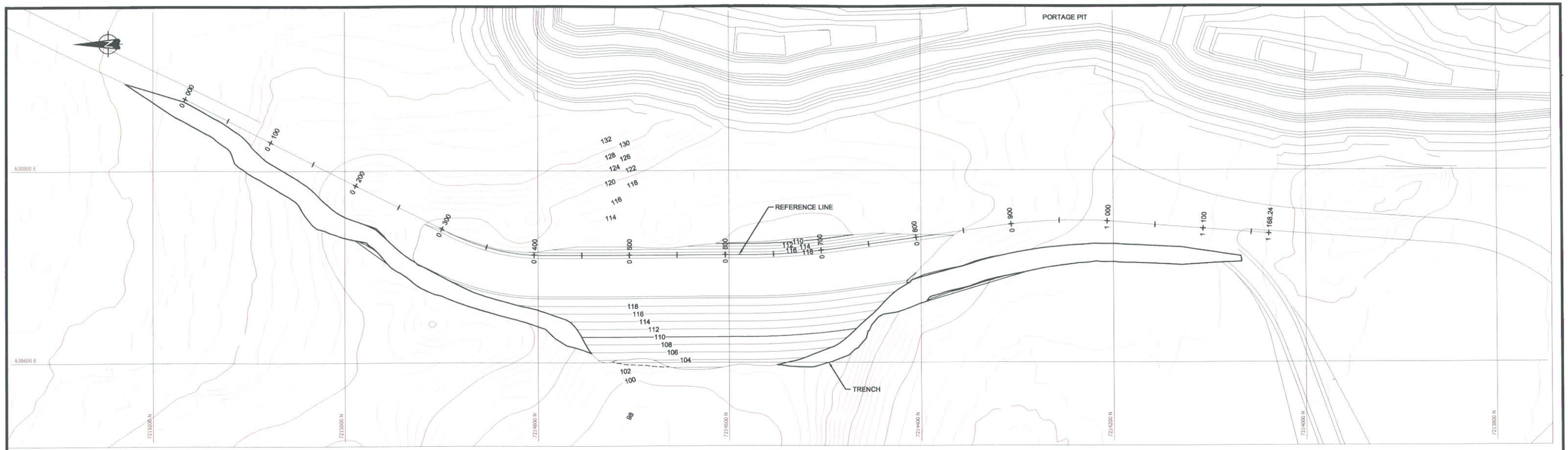
PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
CENTRAL DIKE
GROUTING PLAN AND LINER DETAILS

Golder Associates

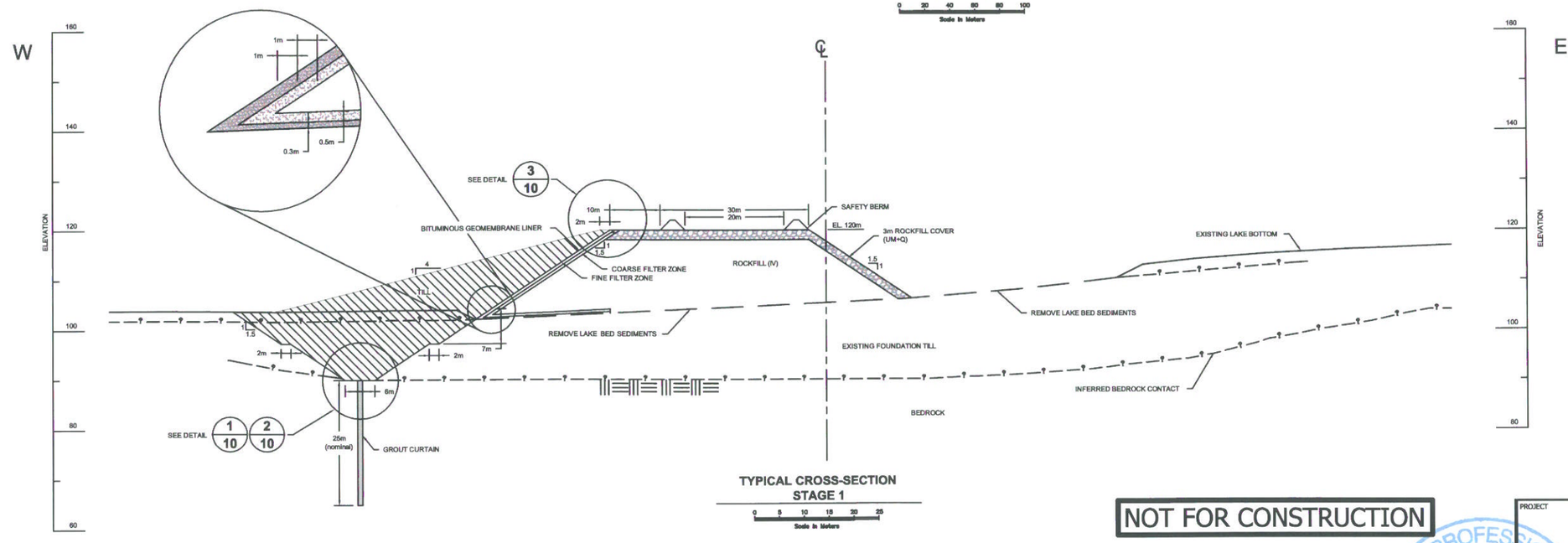
PROJECT No.	06-1413-089		FILE No.	061413089-4000-10	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-10		
CHECK	-	-			
REVIEW	-	-			

REVISION DATE: 07/03/16 10:43AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-10.dwg



SITE PLAN

0 20 40 60 80 100
Scale in Meters



TYPICAL CROSS-SECTION STAGE 1

0 5 10 15 20 25
Scale in Meters

NOTE

1. TILL PLACED UPSTREAM OF LINER AND IN CUTOFF TRENCH TO RECEIVE NOMINAL COMPACTION TO PROVIDE A STABLE FILL.
2. GRID REFERENCE : NAD 83, UTM ZONE 14
3. EXTENT OF GROUTING TO BE DETERMINED IN THE FIELD BASED ON WATER PRESSURE TESTING.
4. CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD. ,2002, 2003, 2006. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
5. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
6. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
7. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (masl) UNLESS OTHERWISE NOTED.
8. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
9. GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.
10. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.

NOT FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER LICENSEE 16/07 N.W.T.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

PROJECT: **MEADOWBANK**
MINING CORPORATION

TITLE: **MEADOWBANK GOLD PROJECT**
STAGE 1 PLAN

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-12	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-12		
CHECK	-	-			
REVIEW	-	-			

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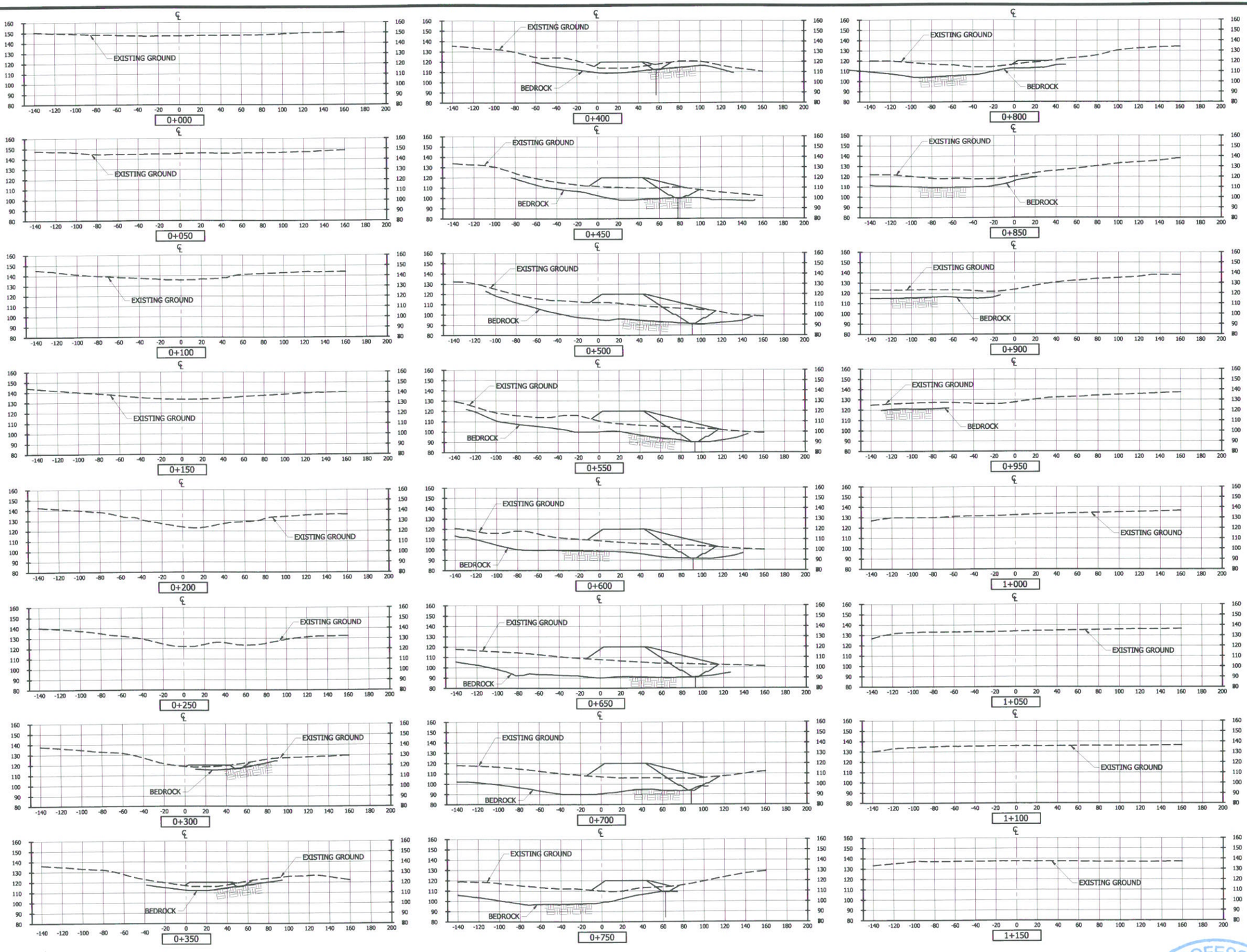
REVISION DATE: 07/03/16 11:43AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-12.dwg



NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
3. GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.
4. THICKNESS OF LAKEBED SEDIMENT TO BE CONFIRMED AFTER SITE DEWATERED.
5. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.
6. EXTENT OF GROUTING TO BE DETERMINED IN THE FIELD BASED ON WATER PRESSURE TESTING.
7. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.

NOT FOR CONSTRUCTION

0 20 40 60 80 100
Scale in Meters

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
STAGE 1 SECTIONS

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	BW	RVW
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP: REGISTERED PROFESSIONAL ENGINEER — LICENSEE — Mar 16/07 — N.W.T.

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-13	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	EA	10JAN07	4000-13		
CHECK	-	-			
REVIEW	-	-			

REVISION DATE: 07/03/16 10:43AM By: ASalvador
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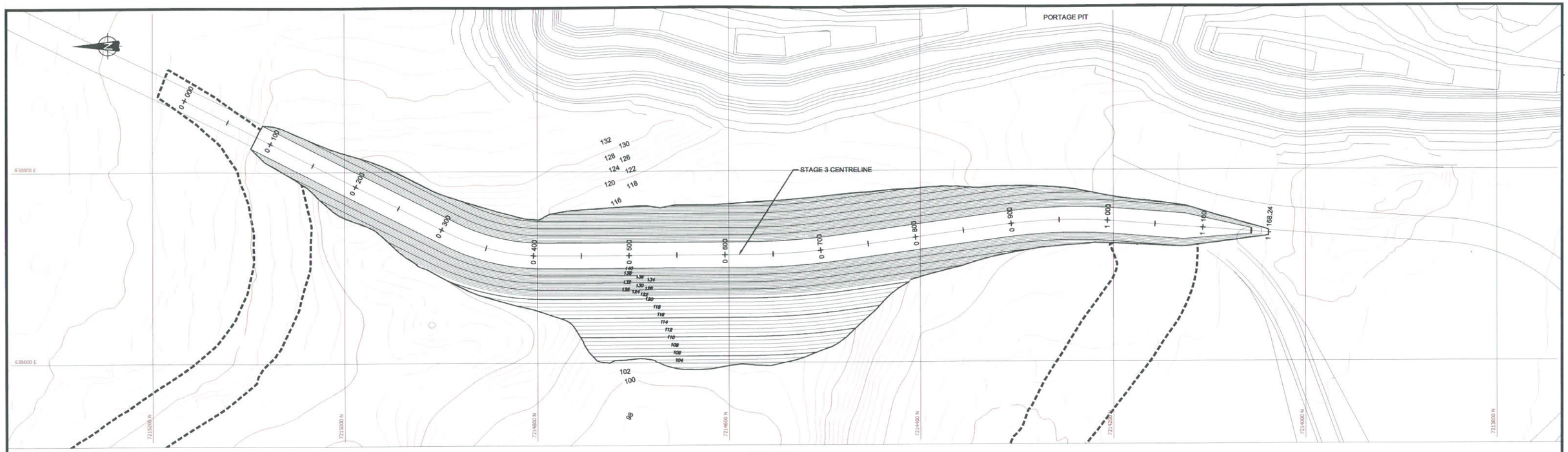
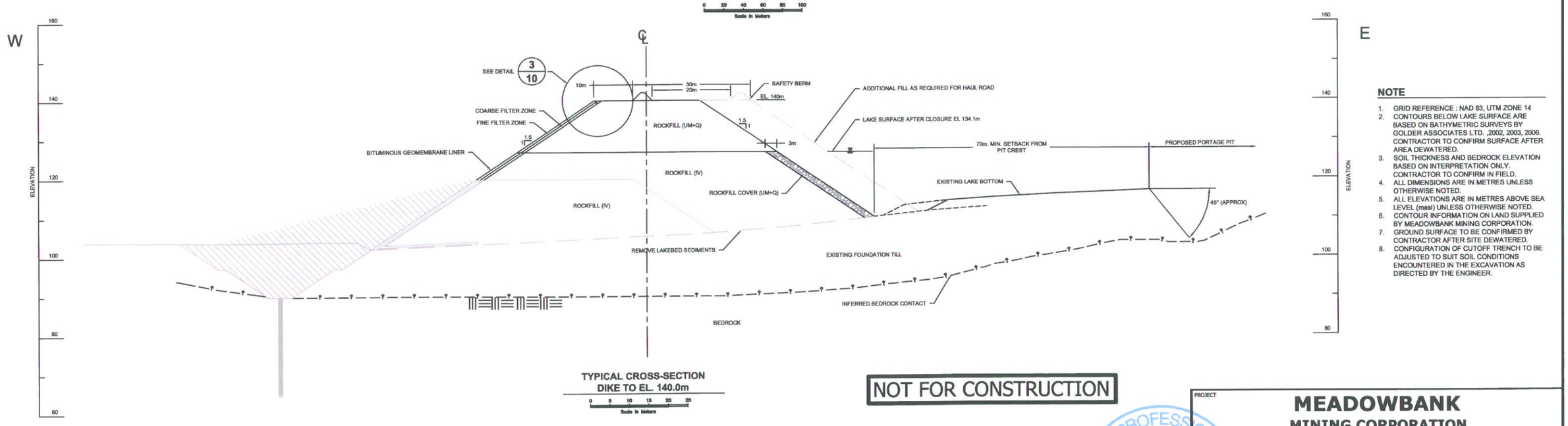


SITE PLAN

Scale in Meters: 0 20 40 60 80 100



TYPICAL CROSS-SECTION DIKE TO EL. 140.0m

Scale in Meters: 0 5 10 15 20 25

NOTE

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD. ,2002, 2003, 2006. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
3. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
4. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
5. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (masl) UNLESS OTHERWISE NOTED.
6. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
7. GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.
8. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.

NOT FOR CONSTRUCTION

REVISION	DATE	DES	DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	BW	MS
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

STAMP: PROFESSIONAL ENGINEER — LICENSEE — Mar 16/07 — N.W.T.

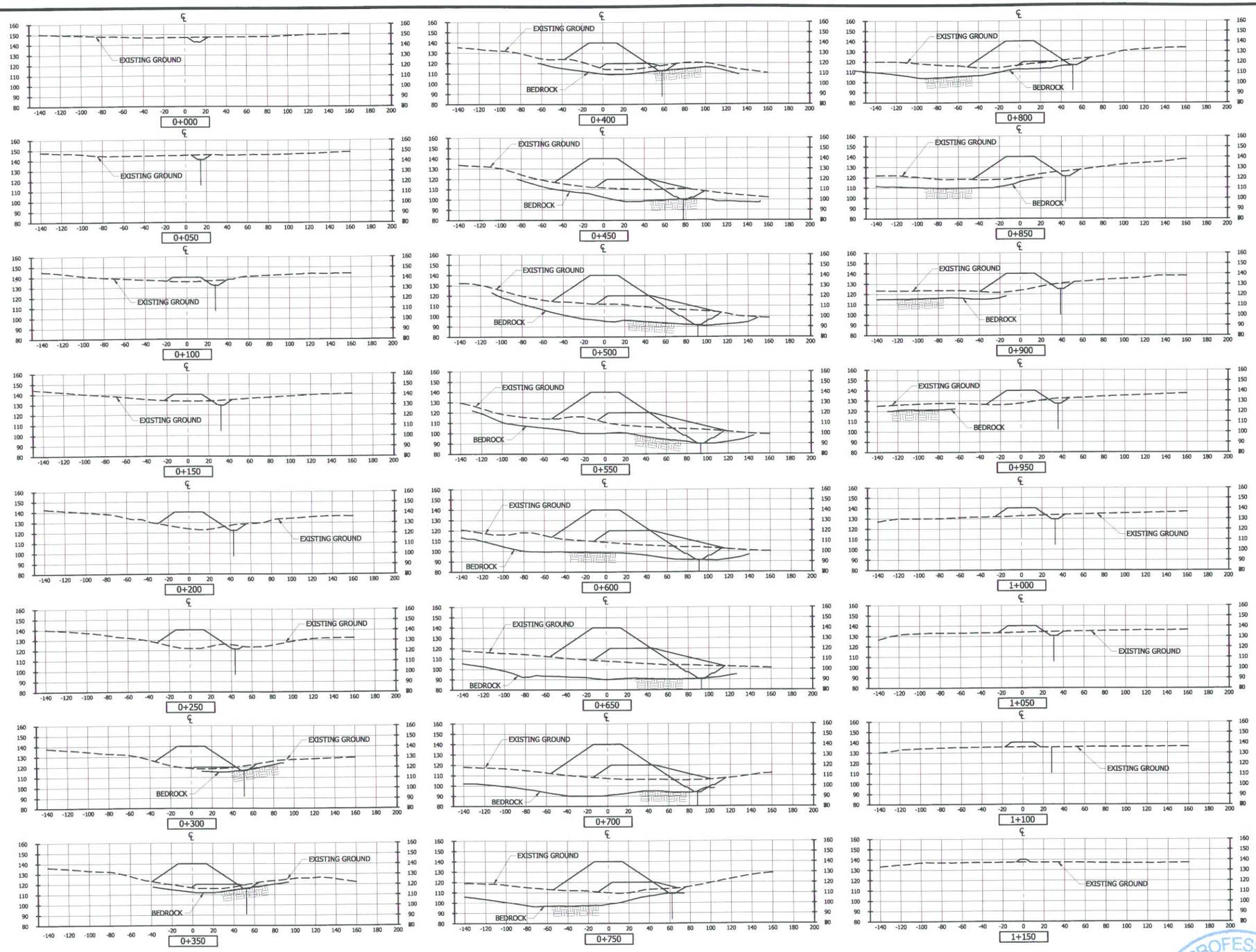
PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT STAGE 2 PLAN**

Golder Associates

PROJECT No.	06-1413-089		FILE No.	061413089-4000-14	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	RML	10JAN07	4000-14		
CHECK	-	-			
REVIEW	-	-			

CADD FILE N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-14.dwg
REVISION DATE 07/03/16 10:43AM By ASalvador



NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
3. GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.
4. THICKNESS OF LAKEBED SEDIMENT TO BE CONFIRMED AFTER SITE DEWATERED.
5. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.
6. EXTENT OF GROUTING TO BE DETERMINED IN THE FIELD BASED ON WATER PRESSURE TESTING.
7. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.

NOT FOR CONSTRUCTION

0 20 40 60 80 100
Scale in Metres

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
STAGE 2 SECTIONS

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA		
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

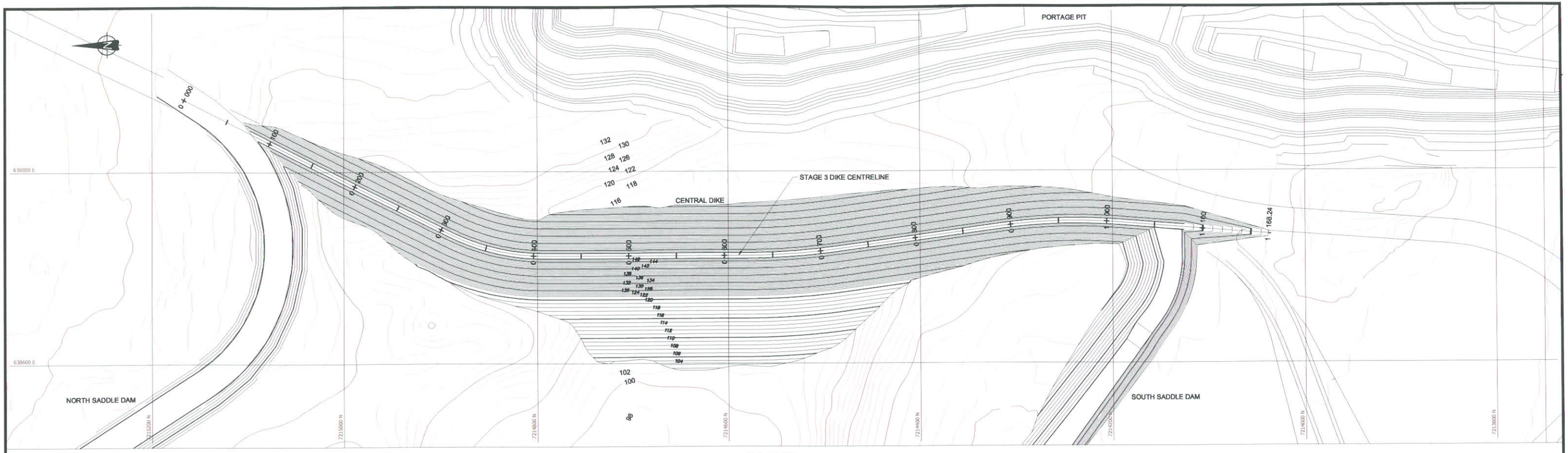
DRAWING NO. | REFERENCES

STAMP: REGISTERED PROFESSIONAL ENGINEER — LICENSEE — Mar 16/07 — N.W.T.

Golder Associates

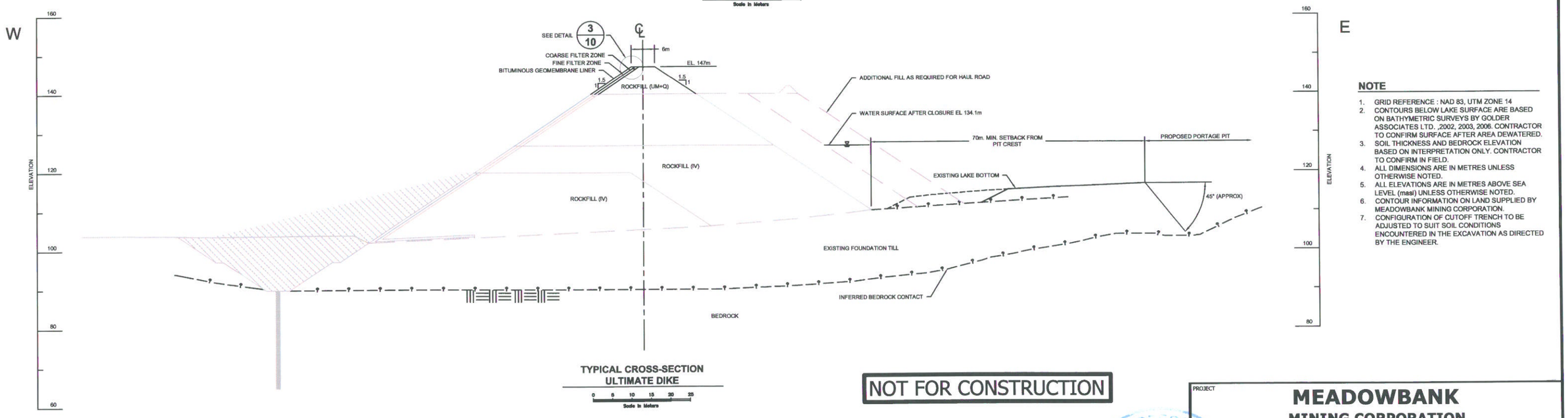
PROJECT No.	06-1413-089		FILE No.	061413089-4000-15	
DESIGN	SA	27NOV06	SCALE	AS SHOWN	REV. B
CADD	EA	27NOV06	4000-15		
CHECK	-	-			
REVIEW	-	-			

REVISION DATE: 07/03/16 10:43AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-15.dwg



SITE PLAN

0 20 40 60 80 100
Scale in Meters



TYPICAL CROSS-SECTION ULTIMATE DIKE

0 5 10 15 20 25
Scale in Meters

NOTE

1. GRID REFERENCE : NAD 83, UTM ZONE 14
2. CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD., 2002, 2003, 2006. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
3. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
4. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
5. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (masl) UNLESS OTHERWISE NOTED.
6. CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
7. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.

NOT FOR CONSTRUCTION

REVISION DATE: 07/03/16 10:43AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev. B\061413089-4000-16.dwg

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	RVW	RVW
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

DRAWING NO. | REFERENCES

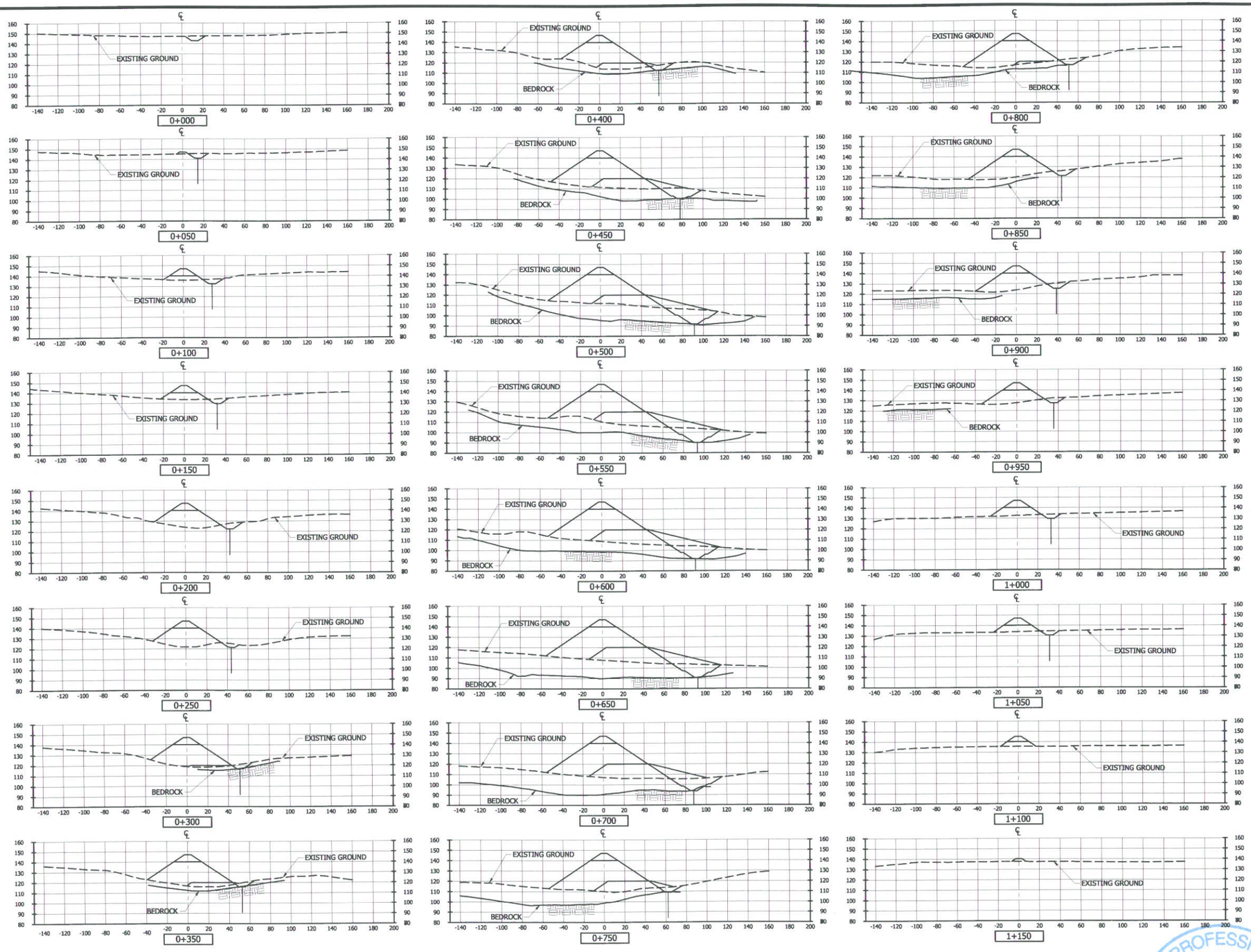
STAMP: REGISTERED PROFESSIONAL ENGINEER — LICENSEE — Mar 16/07 — N.W.T.

PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT STAGE 3 PLAN**

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-16	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	EA	10JAN07			
CHECK	-	-	4000-16		
REVIEW	-	-			



NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
3. GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.
4. THICKNESS OF LAKEBED SEDIMENT TO BE CONFIRMED AFTER SITE DEWATERED.
5. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.
6. EXTENT OF GROUTING TO BE DETERMINED IN THE FIELD BASED ON WATER PRESSURE TESTING.

NOT FOR CONSTRUCTION

0 20 40 60 80 100
Scale in Metres

CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\Rev B\061413089-4000-17.dwg
REVISION DATE: 07/03/16 10:42AM By: ASalvador

DRAWING NO.	REFERENCES

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
B	16MAR07	-	ISSUED FOR TENDER	EA	BW	KT
A	21FEB07	-	DRAFT FOR REVIEW	EA	-	-

STAMP

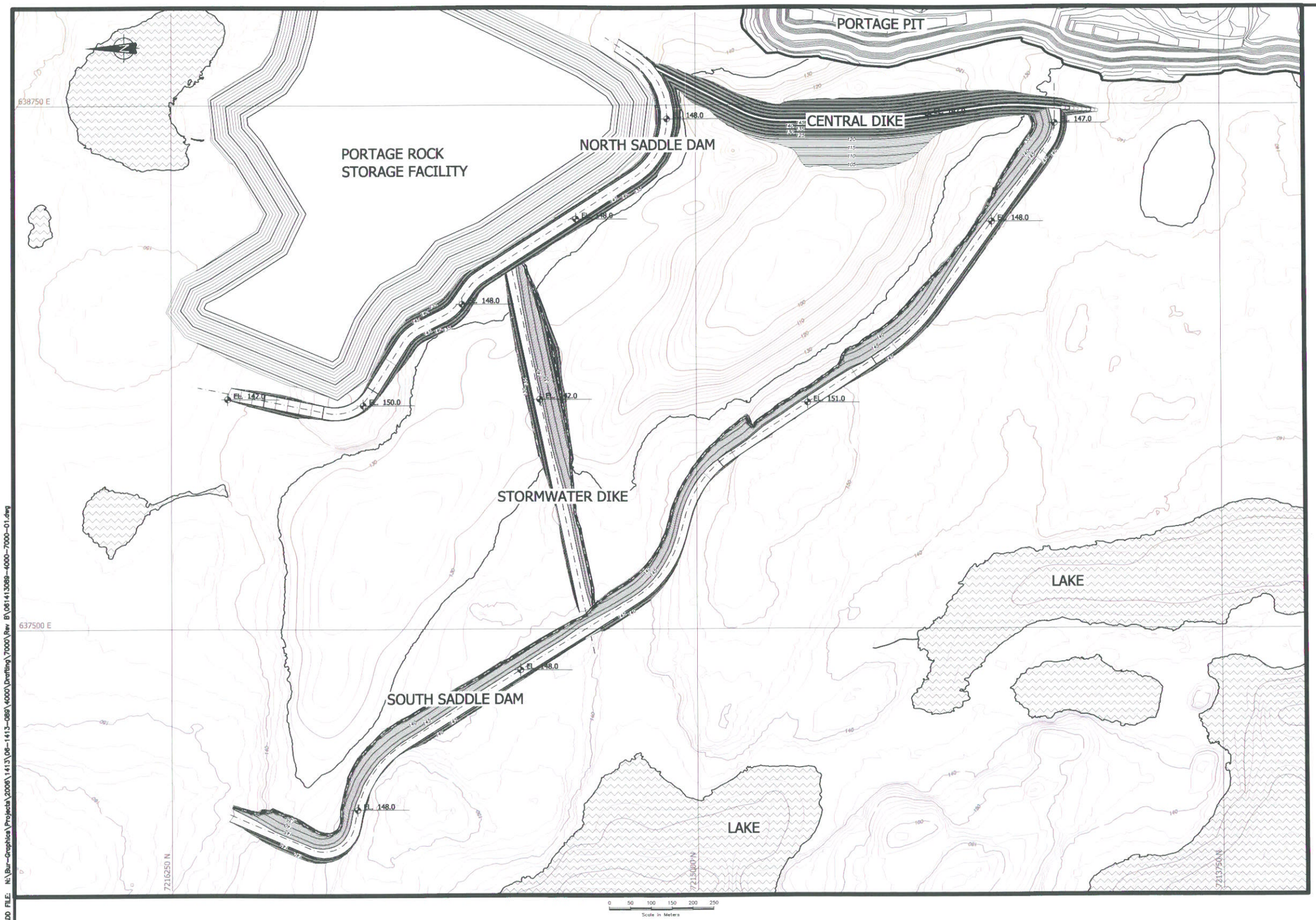
REGISTERED PROFESSIONAL ENGINEER
LICENSEE
Mar 16 07
N.W.T.

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
STAGE 3 SECTIONS

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-17	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. B
CADD	EA	10JAN07	4000-17		
CHECK	-	-			
REVIEW	-	-			



NOTES

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5. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.
6. EXTENT OF GROUTING TO BE DETERMINED IN THE FIELD BASED ON WATER PRESSURE TESTING.
7. RAMPS FROM NORTH AND SOUTH SADDLEDAMS TO STORMWATER DIKE NOT SHOWN.
8. GRID REFERENCE : NAD 83, UTM ZONE 14

NOT FOR CONSTRUCTION

REVISION DATE: 07/03/18 11:35AM By: ASalvador
CADD FILE: K:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\7000\Rev B\061413089-4000-7000-01.dwg

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	16MAR07	-	ISSUED FOR TENDER	-	-	

DRAWING NO. | REFERENCES

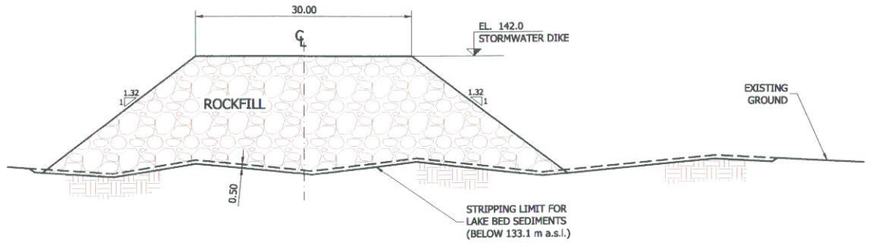
STAMP: REGISTERED PROFESSIONAL ENGINEER N.W.T. LICENSEE Mar 16/07

PROJECT: **MEADOWBANK**
MINING CORPORATION

TITLE: **MEADOWBANK GOLD PROJECT**
STORMWATER DIKE AND
SADDLE DAM LAYOUT

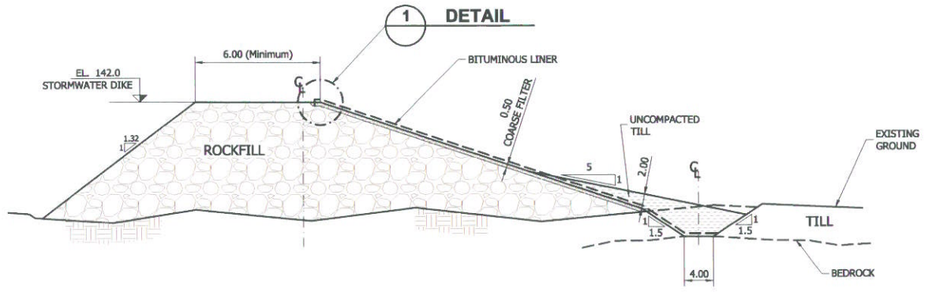
Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-7000-01	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. A
CADD	EA	10JAN07			
CHECK	-	-	4000-18		
REVIEW	-	-			



TYPICAL SECTION
STORMWATER DIKE

0 4 8 12 16 20
Scale in Meters

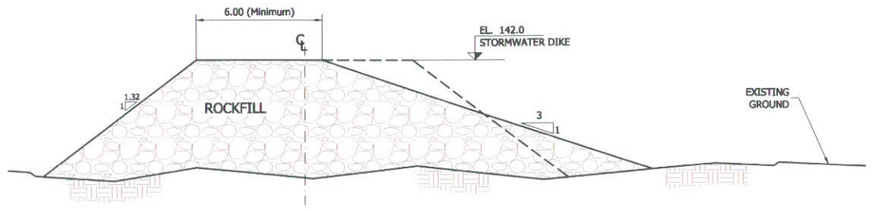


TYPICAL SECTION
STORMWATER DIKE OPTION 1
BITUMINOUS LINER

0 4 8 12 16 20
Scale in Meters

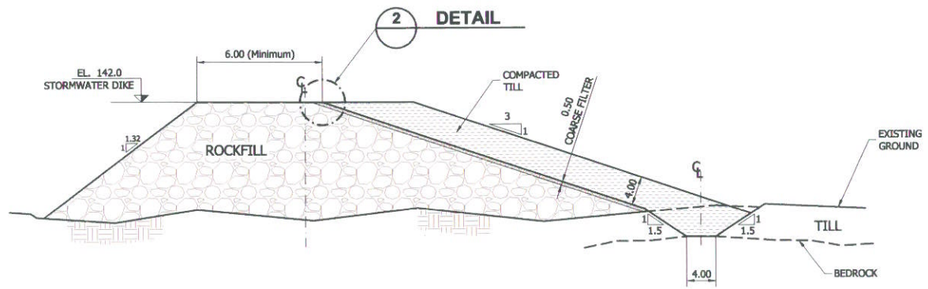
MATERIAL QUANTITY OPTION 1	
NAME	VOLUME (m3)
COARSE FILTER	11,670
UNCOMPACTED TILL	47,230
NAME	AREA (m2)
BITUMINOUS LINER	31,775

MATERIAL QUANTITY OPTION 2	
NAME	VOLUME (m3)
COARSE FILTER	11,110
COMPACTED TILL	115,700



TYPICAL SECTION
REGRADED
STORMWATER DIKE

0 4 8 12 16 20
Scale in Meters



TYPICAL SECTION
STORMWATER DIKE OPTION 2
COMPACTED TILL LAYER

0 4 8 12 16 20
Scale in Meters

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
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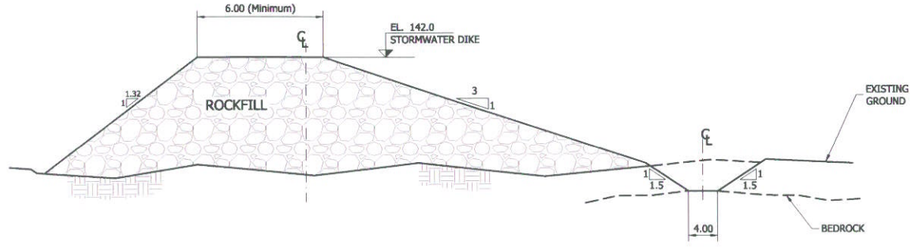
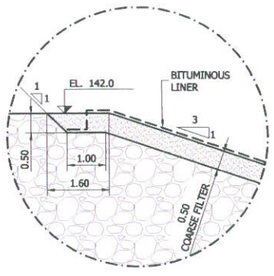
6. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.



TYPICAL SECTION
EXCAVATION CUTOFF TRENCH
STORMWATER DIKE

0 4 8 12 16 20
Scale in Meters



1 **DETAIL**

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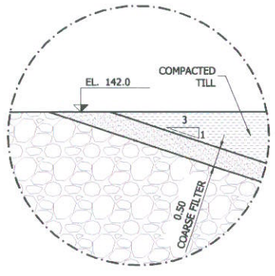
Scale in Meters



2 **DETAIL**

0 0,5 1 1,5 2 2,5
Scale in Meters

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	16MAR07	-	ISSUED FOR TENDER	BW	-	KS

DRAWING NO. | REFERENCES

PROJECT
MEADOWBANK
MINING CORPORATION

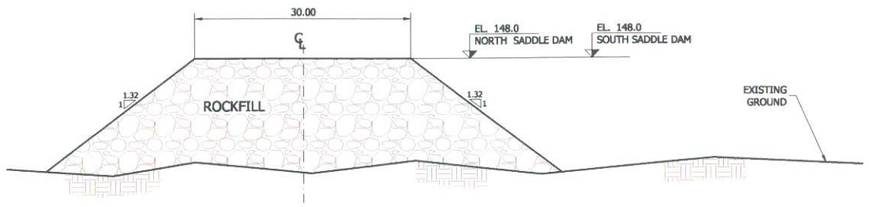
TITLE
MEADOWBANK GOLD PROJECT
CONSTRUCTION STAGING OVERVIEW - STORMWATER DIKE

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-7000-02	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. A
CADD	EA	10JAN07	4000-19		
CHECK	-	-			
REVIEW	-	-			

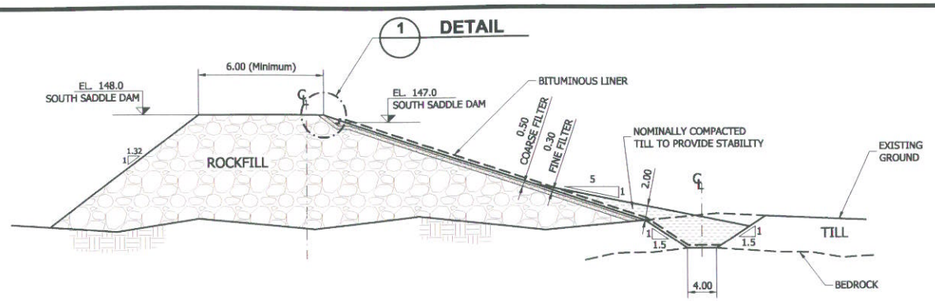
STAMP: REGISTERED PROFESSIONAL ENGINEER LICENSEE Mar 16/07 NWT

REVISION DATE: 07/03/16 11:35AM By: ASalvador CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\7000\Rev B\061413089-4000-7000-02.dwg



TYPICAL SECTION
NORTH AND SOUTH SADDLE DAM

0 4 8 12 16 20
Scale in Meters

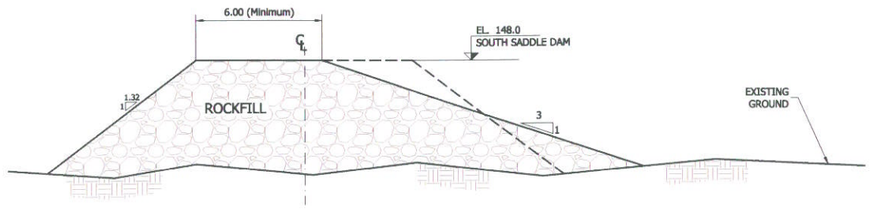


TYPICAL SECTION
SOUTH SADDLE DAM OPTION 1
BITUMINOUS LINER

0 4 8 12 16 20
Scale in Meters

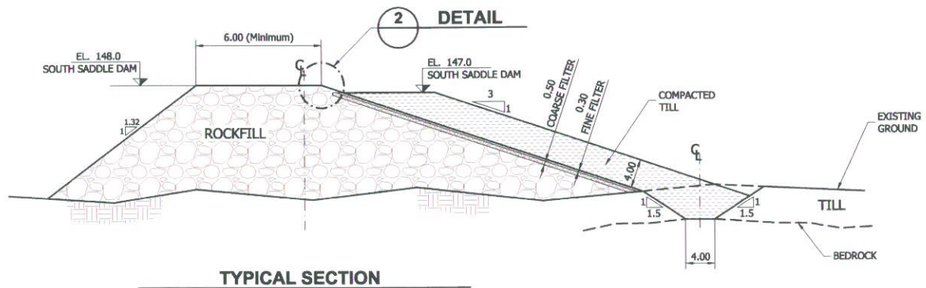
MATERIAL QUANTITY OPTION 1	
NAME	VOLUME (m3)
FINE FILTER	22,725
COARSE FILTER	36,185
UNCOMPACTED TILL	116,960
NAME	AREA (m2)
BITUMINOUS LINER	86,705

MATERIAL QUANTITY OPTION 2	
NAME	VOLUME (m3)
FINE FILTER	18,765
COARSE FILTER	32,395
COMPACTED TILL	299,715



TYPICAL SECTION
REGRADED
SOUTH SADDLE DAM

0 4 8 12 16 20
Scale in Meters

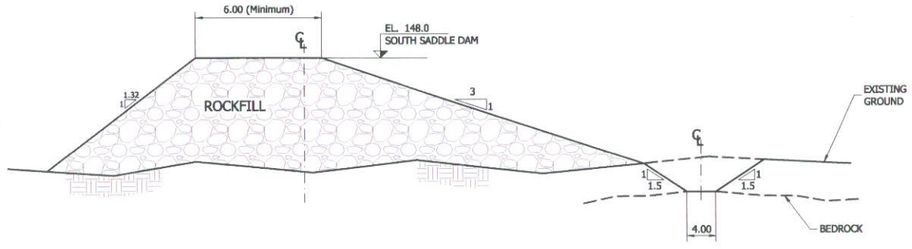


TYPICAL SECTION
SOUTH SADDLE DAM OPTION 2
COMPACTED TILL LAYER

0 4 8 12 16 20
Scale in Meters

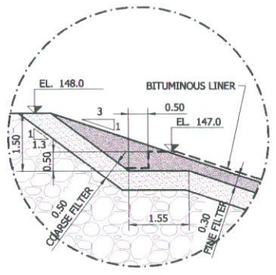
NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL) UNLESS OTHERWISE NOTED.
3. GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.
4. SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
5. THICKNESS OF LAKEBED SEDIMENT TO BE CONFIRMED AFTER SITE DEWATERED.
6. CONFIGURATION OF CUTOFF TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.



TYPICAL SECTION
EXCAVATION CUTOFF TRENCH
SOUTH SADDLE DAM

0 4 8 12 16 20
Scale in Meters



1 **DETAIL**

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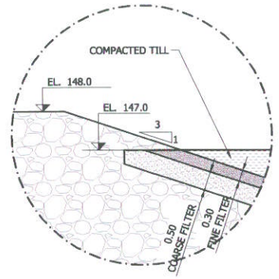
Scale in Meters



2 **DETAIL**

0 0,5 1 1,5 2 2,5
Scale in Meters

NOT FOR CONSTRUCTION

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
0	16MAR07	-	ISSUED FOR TENDER	-	BW	MB

REFERENCES

DRAWING NO.

STAMP

REGISTERED PROFESSIONAL ENGINEER
TYLER RIDGE
LICENSEE
Mar 16/07
N.W.T.

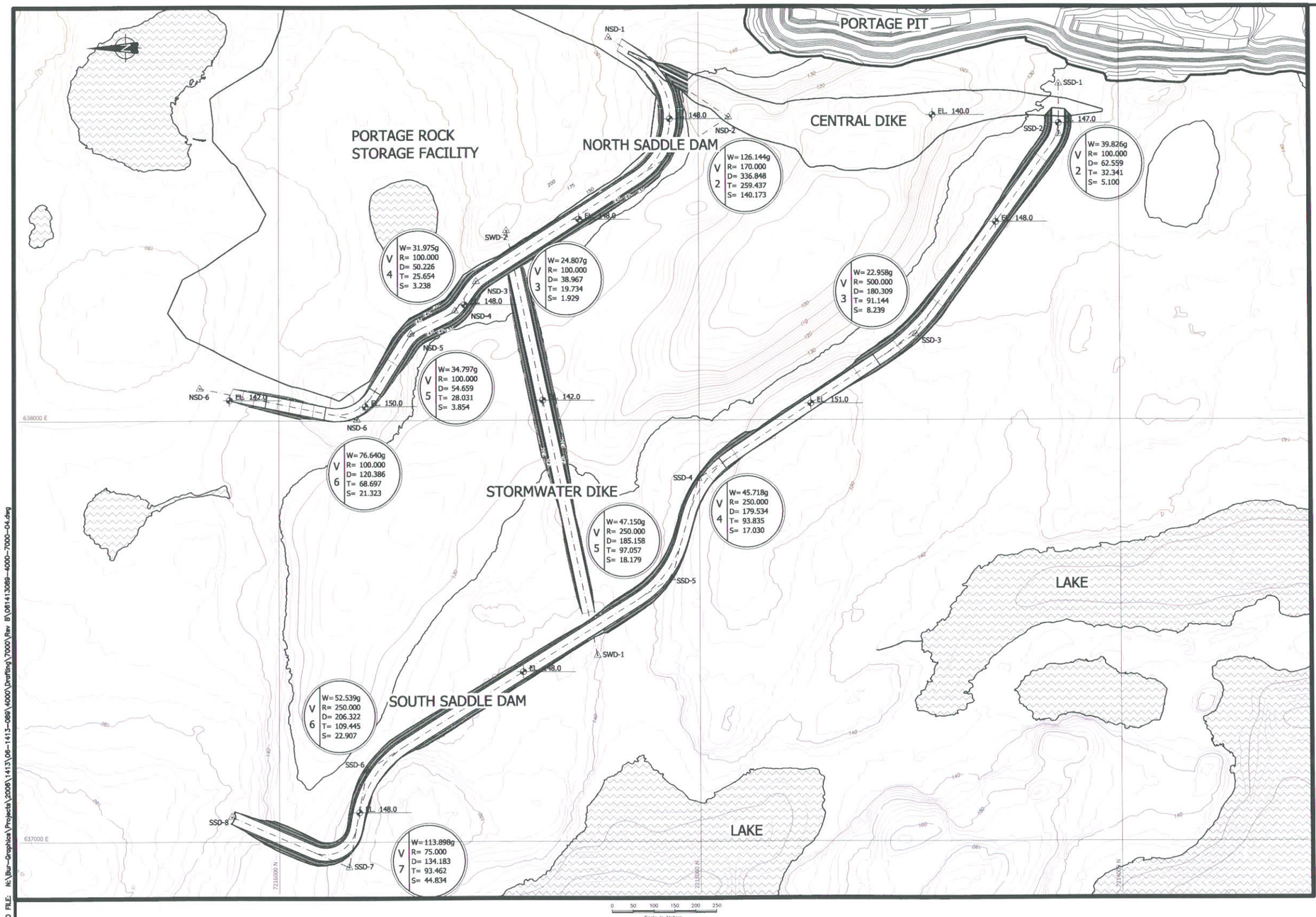
PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
CONSTRUCTION STAGING OVERVIEW - SADDLE DAM

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-7000-03	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. A
CADD	EA	10JAN07	4000-20		
CHECK	-	-			
REVIEW	-	-			

REVISION DATE: 07/03/16 11:35AM By: ASalvador
CADD FILE: N:\Bur-Graphics\Projects\2006\1413\06-1413-089\4000\Drafting\7000\Rev B\061413089-4000-7000-03.dwg



MATERIAL QUANTITY	
NAME	VOLUME (m3)
CENTRAL DIKE	SEE DWG 4000-07
NORTH SADDLE DAM	511,381
SOUTH SADDLE DAM	540,184
STORMWATER DIKE	277,250

COORDINATES OF ALIGNMENT SOUTH SADDLE DAM		
VERTEX	EAST	NORTH
SSD-1	638,798.44	7,214,142.40
SSD-2	638,678.90	7,214,142.40
SSD-3	638,203.99	7,214,485.47
SSD-4	637,861.90	7,215,002.42
SSD-5	637,626.15	7,215,067.18
SSD-6	637,170.49	7,215,790.60
SSD-7	636,940.37	7,215,833.29
SSD-8	637,059.20	7,216,113.00

COORDINATES OF ALIGNMENT NORTH SADDLE DAM		
VERTEX	EAST	NORTH
NSD-1	638,911.59	7,215,216.12
NSD-2	638,720.49	7,214,927.98
NSD-3	638,330.50	7,215,530.39
NSD-4	638,258.19	7,215,580.56
NSD-5	638,206.46	7,215,684.46
NSD-6	638,002.96	7,215,812.69
NSD-7	638,077.05	7,216,187.21

COORDINATES OF ALIGNMENT STORMWATER DIKE		
VERTEX	EAST	NORTH
SWD-1	637,441.87	7,215,245.92
SWD-2	638,450.98	7,215,459.20

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) CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD. ,2002, 2003, 2006. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
5) CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
6) LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2nd PORTAGE LAKE = 133.1m
7) CONNECTION OF DIKES BY FIELD FIT.

NOT FOR CONSTRUCTION

REVISION DATE: 07/03/16 11:35AM By: ASchnobr CADD FILE: N:\Bur--Graphics\Projects\2008\1413\06--1413--089\4000\Drafting\7000\Rev B\061413089--4000--7000--04.dwg

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	16MAR07	-	ISSUED FOR TENDER	-	BW	AS

DRAWING NO. | REFERENCES

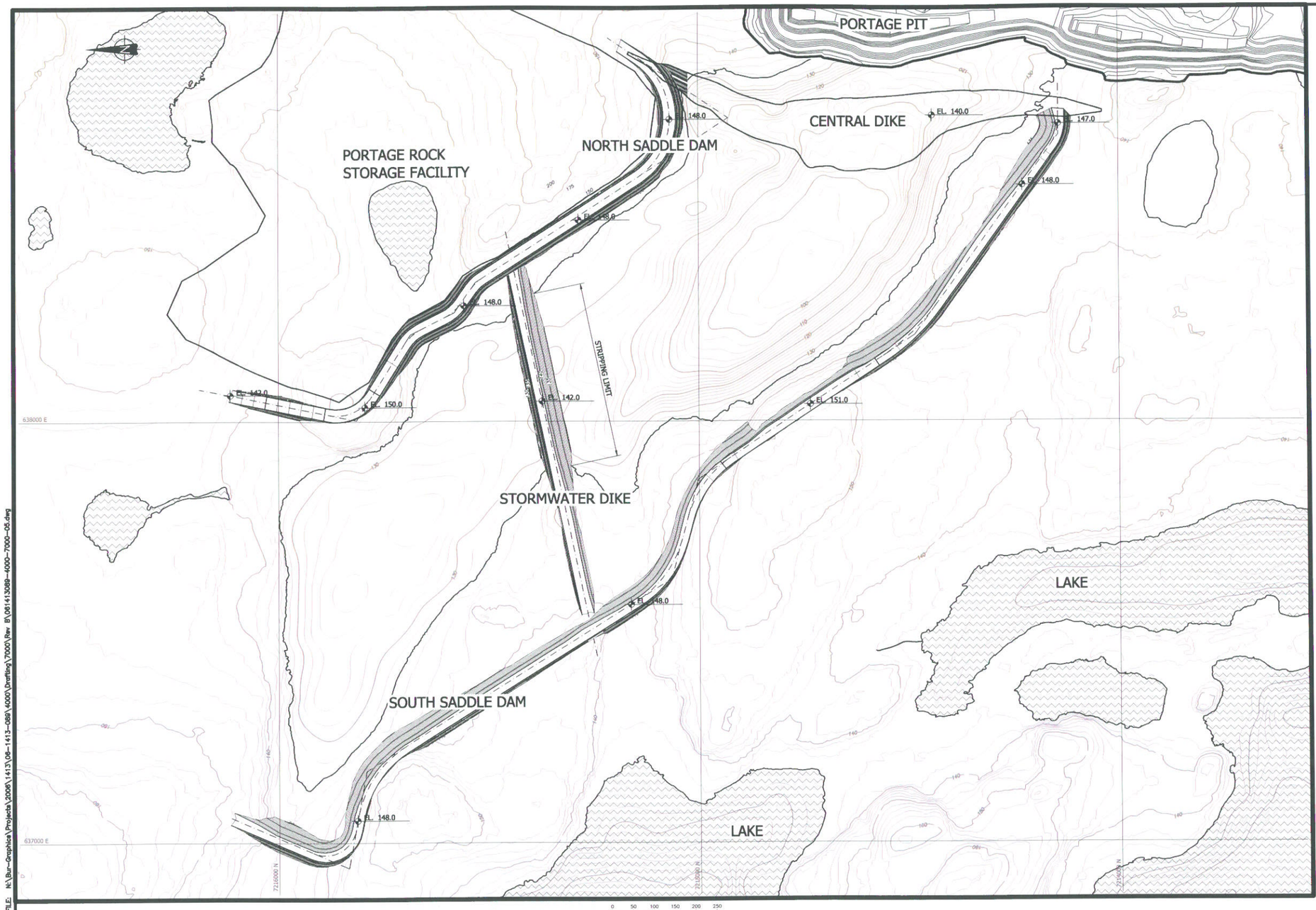
STAMP: NORTHWEST TERRITORIES ASSOCIATION OF PROFESSIONAL ENGINEERS AND GEOSCIENTISTS — LICENSEE — Mar 16/07 — N.W.T.

PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT ROCKFILL PLACEMENT PLAN**

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-7000-04	
DESIGN	BW	10JAN07	SCALE	AS SHOWN	REV. A
CADD	EA	10JAN07	4000-21		
CHECK	-	-			
REVIEW	-	-			



NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
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7) CONNECTION OF DIKES BY FIELD FIT.

NOT FOR CONSTRUCTION

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REVISION DATE: 07/03/16 11:35AM By: AScharoder

DRAWING NO.	REFERENCES

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	16MAR07	-	ISSUED FOR TENDER	-	BWJ	AS

STAMP: PROFESSIONAL ENGINEERS — LICENSEE — Mar 16/07 — N.W.T.

PROJECT: **MEADOWBANK**
MINING CORPORATION

TITLE: **MEADOWBANK GOLD PROJECT**
ROCKFILL REGRADING
PLAN

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-7000-05	
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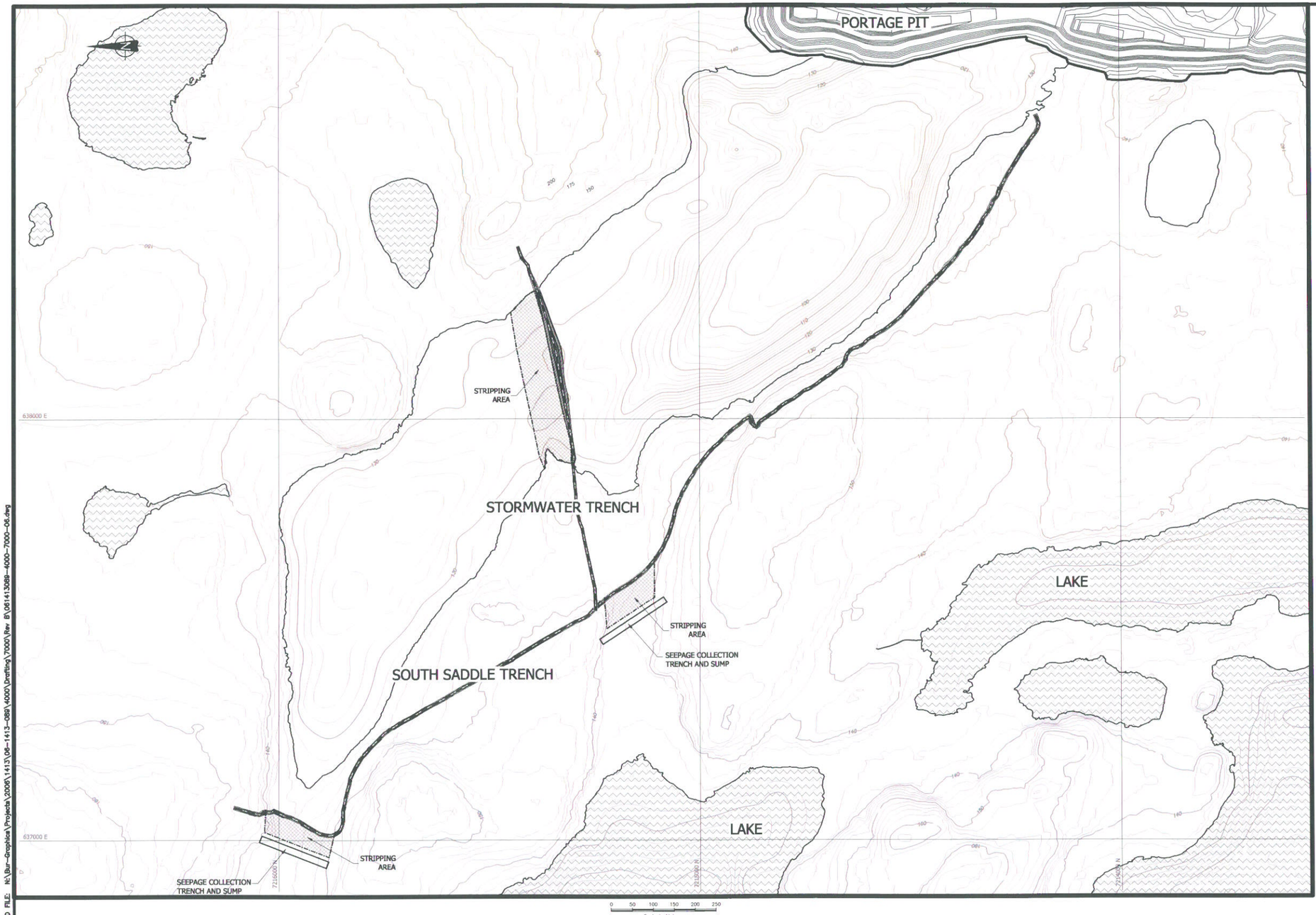

MATERIAL QUANTITY	
NAME	VOLUME (m3)
STRIPPING AREAS	22,200
SOUTH SADDLE TRENCH	33,490
STORMWATER TRENCH	26,930

*VOLUMES TO BE CONFIRMED BY THE CONTRACTOR.

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) CONTOURS BELOW LAKE SURFACE ARE BASED ON BATHYMETRIC SURVEYS BY GOLDER ASSOCIATES LTD. ,2002, 2003, 2006. CONTRACTOR TO CONFIRM SURFACE AFTER AREA DEWATERED.
5) CONTOUR INFORMATION ON LAND SUPPLIED BY MEADOWBANK MINING CORPORATION.
6) LAKE CONTOURS ARE BASED ON REGIONAL PLAN MAPS OF LAKE SURFACE ELEVATION : 2nd PORTAGE LAKE = 133.1m
7) CONNECTION OF DIKES BY FIELD FIT.
8) STRIPPING AREAS CALCULATED ASSUMING REMOVAL OF 0.5 M THICK LAYER
9) CONFIGURATION OF CUTOFF TRENCH AND SEEPAGE COLLECTION TRENCH TO BE ADJUSTED TO SUIT SOIL CONDITIONS ENCOUNTERED IN THE EXCAVATION AS DIRECTED BY THE ENGINEER.
10) GROUND SURFACE TO BE CONFIRMED BY CONTRACTOR AFTER SITE DEWATERED.

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		1	16MAR07	-	ISSUED FOR TENDER	-	BW	AB

STAMP

PROFESSIONAL ENGINEER — REGISTERED — LICENSEE — Mar 16/07 — N.W.T.

PROJECT
MEADOWBANK
MINING CORPORATION

TITLE
MEADOWBANK GOLD PROJECT
EXCAVATION PLAN

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-7000-06	
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CADD	EA	10JAN07	4000-23		
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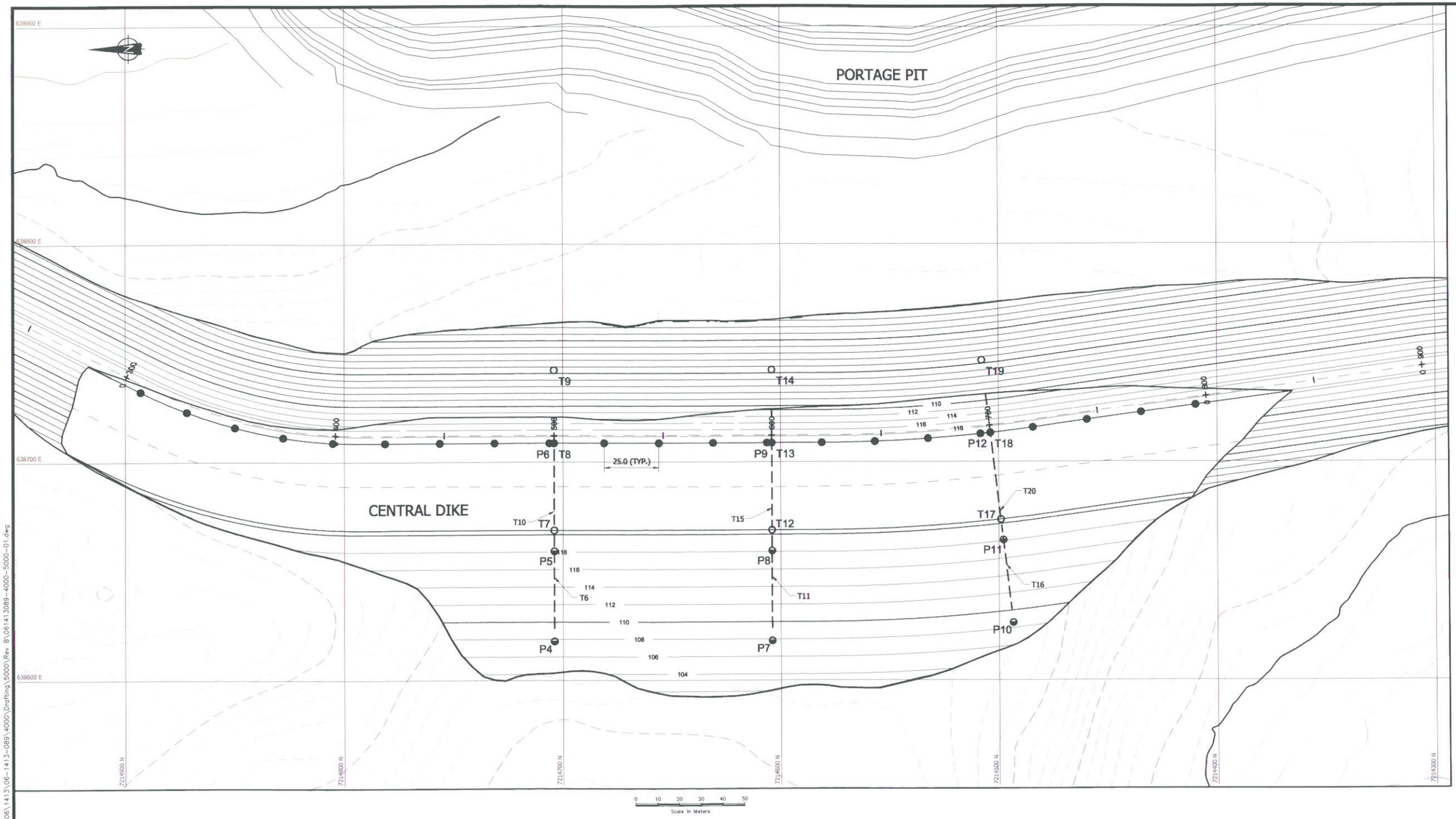

LEGEND:

- P1 - PIEZOMETER
- T1 - THERMISTOR
- - STAGE 1 SURVEY MONUMENTS

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., 2006.
6) LAKE CONTOURS ARE BASED ON SURVEYED LAKE SURFACE ELEVATIONS: 2ND PORTAGE LAKE = 133.1M, 3RD PORTAGE LAKE = 134.1M
7) SURVEY MONUMENTS ARE SPACED EVERY 25m ALONG DIKE CREST FOR EACH STAGE.
8) THERMISTOR STRINGS T1, T6, T11, T16, T21 ARE INCLINED ALONG THE TRENCH WALL INTO FILTER ZONE AT UPSTREAM FACE OF ROCKFILL.
9) THERMISTER STRING T5, T10, T15, T20, T25 ARE HORIZONTALLY INSTALLED.
10) INSTRUMENTATION AT STA. 0+300, 0+600 AND 0+700 SHALL BE INSTALLED DURING STAGE 1 CONSTRUCTION EXCEPT FOR DOWNSTREAM THERMISTORS T9, T14 AND T19. INSTRUMENTS AT 0+300 AND 0+900 SHALL BE INSTALLED DURING STAGE 2 CONSTRUCTION IN ADDITION TO DOWNSTREAM THERMISTORS.
11) SURVEY CONTROL MONUMENTS SHALL BE INSTALLED AT ABUTMENTS 25m FROM CHAINAGE START AND END.
12) INSTRUMENTATION FOR STAGE 1: 0+300M (NOT SHOWN), 0+500M, 0+600M, 0+700M, 0+900M (NOT SHOWN).
13) SEE TYPICAL SECTION VIEW ON DRAWING 4000-25.

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DRAWING NO.	REFERENCES

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	16MAR07	-	ISSUED FOR TENDER	EA		

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PROJECT: **MEADOWBANK MINING CORPORATION**

TITLE: **MEADOWBANK GOLD PROJECT CENTRAL DIKE INSTRUMENTATION PLAN LOCATIONS**

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-5000-01	
DESIGN	SA	10JAN07	SCALE	AS SHOWN	REV. A
CADD	EA	10JAN07	4000-24		
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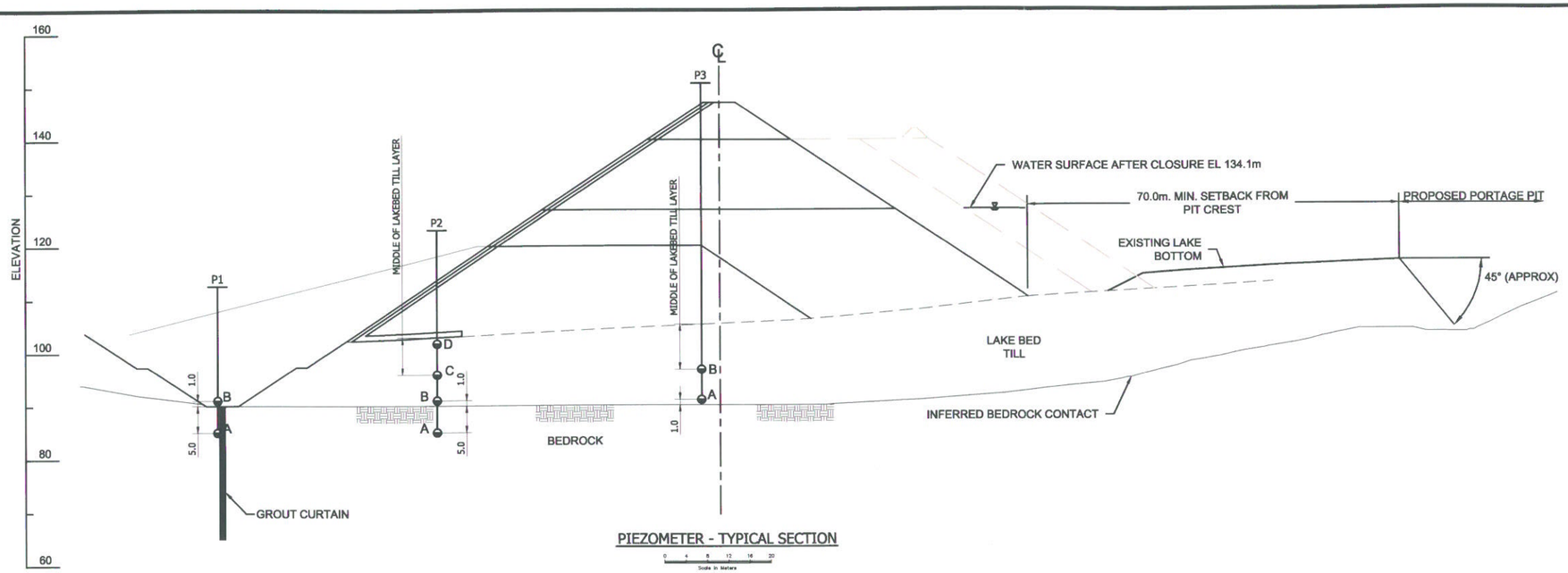
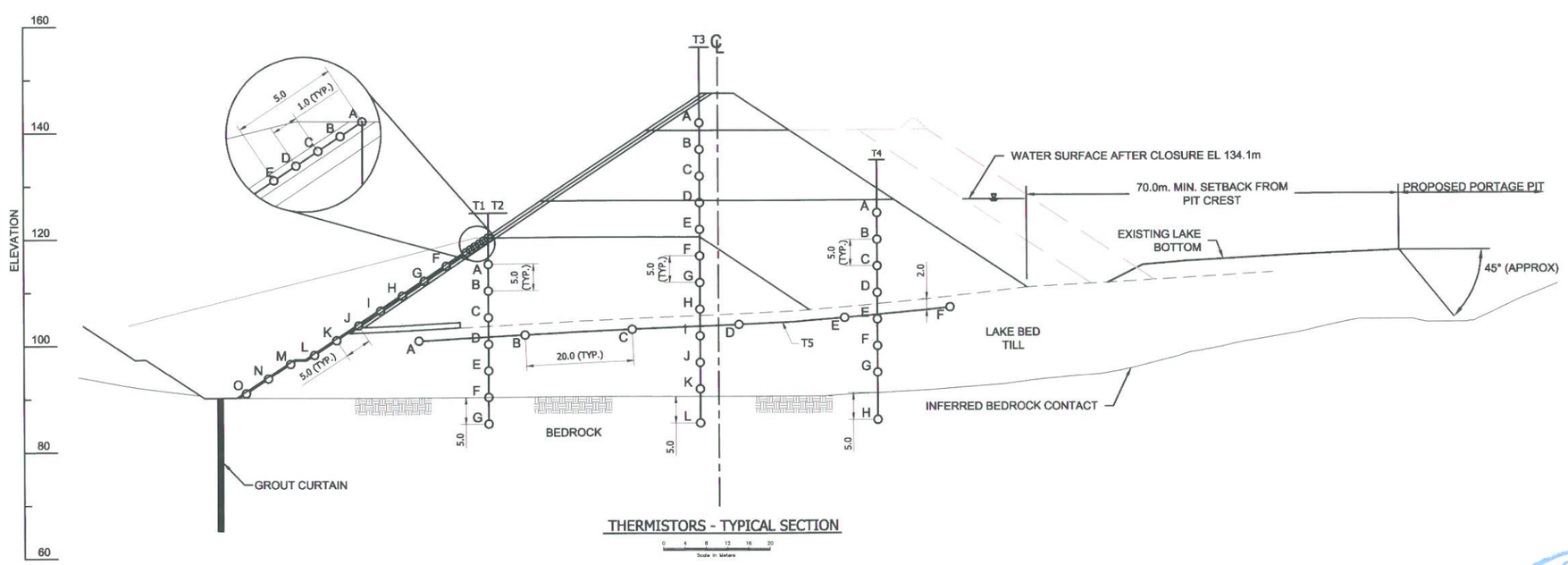


PIEZOMETER - TYPICAL SECTION

Scale in Metres 0 4 8 12 16 20



THERMISTORS - TYPICAL SECTION

Scale in Metres 0 4 8 12 16 20

LEGEND:

- P1 : PIEZOMETER.
- T1 : THERMISTOR.

NOTES:

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2) ALL ELEVATIONS ARE IN METRES ABOVE SEA LEVEL (MASL), UNLESS OTHERWISE NOTED.
3) THERMISTOR STRINGS T1, T6, T11, T16, T21 ARE INCLINED ALONG THE TRENCH WALL INTO FILTER ZONE AT UPSTREAM FACE OF ROCKFILL.
4) SOIL THICKNESS AND BEDROCK ELEVATION BASED ON INTERPRETATION ONLY. CONTRACTOR TO CONFIRM IN FIELD.
5) THERMISTER STRING T5, T10, T15, T20, T25 ARE HORIZONTALLY INSTALLED.
6) INSTRUMENTATION AT STA. 0+300, 0+600 AND 0+700 SHALL BE INSTALLED DURING STAGE 1 CONSTRUCTION EXCEPT FOR DOWNSTREAM THERMISTORS T9, T14 AND T19. INSTRUMENTS AT 0+300 AND 0+900 SHALL BE INSTALLED DURING STAGE 2 CONSTRUCTION IN ADDITION TO DOWNSTREAM THERMISTORS.

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REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	16MAR07	-	ISSUED FOR TENDER	EA		

DRAWING NO. | REFERENCES

STAMP: REGISTERED PROFESSIONAL ENGINEER — LICENSEE — PROVINCE OF ONTARIO

PROJECT: **MEADOWBANK**
MINING CORPORATION

TITLE: **MEADOWBANK GOLD PROJECT**
CENTRAL DIKE - INSTRUMENTATION
TYPICAL SECTION

Golder Associates

PROJECT No.		06-1413-089	FILE No.	061413089-4000-5000-025	
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CADD	EA	10JAN07	4000-25		
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