MEADOWBANK GOLD PROJECT

DEWATERING DIKES

Operation, Maintenance and Surveillance Manual

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 8
March 2019

DEWATERING DIKES

OPERATION, MAINTENANCE AND

SURVEILLANCE MANUAL

MEADOWBANK GOLD PROJECT

AGNICO EAGLE MINES LIMITED

DISTRIBUTION LIST

AEM - General Mine Manager

AEM – General Superintendent

AEM- Environment Superintendent

AEM- Mine Operations Superintendent

AEM- Engineering Superintendent

AEM- Energy & Infrastructure Superintendent

AEM- Maintenance Superintendent

AEM- Nunavut Division Engineer of Record

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
(first revision)	February 2012	All	All	
V2	August 27, 2013	All	All	
V3	September 15, 2013	All	All	Updated items mentioned by MDRB and the Mine Inspector in the Annual Geotechnical Inspection in September 2013
V4	January 2015	All	All	
V5	January 2016	All	All	
V6	February 2017	All	All	
V7	February 2018	All	All	
V8	February 2019	All	All	

Approved by :

Luc Chouinard
Mine Manager

Pierre McMullen
Engineering Superintendent

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SECTION 1 • INTRODUCTION

1.1 OBJECTIVE OF THE OMS MANUAL

The objective of this manual is to define the technical aspects related to the operation, maintenance and surveillance (OMS) of the Dewatering Dikes at the Meadowbank Gold Project operated by Agnico Eagle Mines Limited (AEM), Meadowbank Division.

This manual is intended as a practical document used by the personnel involved in with the Dewatering Dikes at the Meadowbank Gold Project. It incorporates operating, maintenance and surveillance procedures recommended by the Canadian Dam Association (CDA) "Dam Safety Guidelines" (CDA 2013 & 2014) and the Mining Association of Canada (MAC) "Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities" (MAC, 2018). This manual was written by the Meadowbank Engineering team with the support of SNC-Lavalin and the Nunavut Engineer of Record.

The objectives of this OMS manual are to define and describe:

- Roles, responsibilities, and level of authority of personnel who perform activities related to the Dewatering Dikes at Meadowbank
- The Dewatering Dikes at Meadowbank covered in the scope of this OMS manual
- Plans, procedures and processes for :
  - The operation, maintenance and surveillance of the Dewatering Dikes at Meadowbank Gold Project to ensure that they function in accordance with their design, meet performance objectives and link to emergency response planning
  - Evaluating performance of the structures, and report performance results
  - Managing change

This manual contains protocols and information that will assist AEM to operate, maintain, and monitor the Dewatering Dikes in a safe manner and identify early signs of malfunction.

Elements related to design, construction and closure of the Dewatering Dikes, infrastructures related to management of underground water and to water treatment are out of scope of this manual.

1.2 CONTROL OF DOCUMENTED INFORMATION

This OMS manual is a controlled document. The latest version of this document is available in Intelex.

The person responsible for the preparation, update and distribution of this manual is the Engineering Superintendent. Any change to this OMS manual must be submitted to and approved by the Engineering Superintendent who will be responsible to update the OMS manual in Intelex.

It is each user's responsibility to ensure that they are using the latest version of this document. In case of issue with retrieving the electronic version of this document, the most up to date paper version of this document will always be kept in the Engineering Superintendent Office.

The Engineering Superintendent is responsible to communicate any change to this manual by e-mail to the distribution list in Table 1-1. The Engineering Superintendent is responsible for maintaining an up-to-date distribution list of this manual.

Table 1-1 :OMS Manual Distribution List

Position	Name
General Mine Manager	Luc Chouinard
General Superintendant	Eric Côté / Jacques Proulx
Environment Superintendent	Nancy Duquet-Harvey
Mine Operations Superintendent	Yan Côté, Nicolas P. Deschamps (asst.)
Engineering Superintendent	Pierre McMullen, Miles Legault (asst.)
Maintenance Superintendant	Christian Quirion
Energy & Infrastructures Superintendent	Guillaume Gemme
Engineer of Record, Meadowbank Division	Thomas Lepine

1.3 MANAGEMENT OF CHANGE

This manual will be reviewed on an annual basis at the beginning of Q3 and revised as necessary to accommodate changes in the condition and operation of the facilities. The Engineering Superintendent will be responsible to coordinate this review process.

In conducting the review and update of the OMS manual the following must be taken into account:

- Performance of the structure
- Current life cycle of the structure
- Change since the last review (site condition, critical control, risk profile, personnel, methodology and technology for OMS activities)

In addition to the annually scheduled review, a review may be triggered by a significant event or may need to be updated in response to:

- Planned changes, such as change in surveillance instrumentation or methodologies, or introduction of new instrumentation methodology
- Changes in personnel or roles referred to in the OMS manual
- Other changes that may occur that need to be addressed prior to the next scheduled review of the OMS manual

The update needs to be completed in a timely manner following the document control criteria specified in Section 1.2.

As a good practice, the Engineering Superintendent should organise on a yearly basis a session to present the changes in the OMS manual to the persons in its distribution list.

1.4 REQUIRED LEVELS OF KNOWLEDGE

To preserve the integrity of the operation of these structures, the personnel must have a good comprehension of the factors that can impact the performance of the Dewatering Dikes. It must also be known that any deviation can signify the emergence of a problem and change the role that each person must have in the operation, maintenance and surveillance of these infrastructures.

It is the responsibility of each person in the distribution list of this manual to be familiar with it and understand its whole content. They also need to ensure that everyone under their supervision who's duty involves tasks related to the operation, maintenance or surveillance of any component of the Dewatering Dikes have the appropriate level of knowledge and the resources to comply with the protocol presented in this document.

1.5 LINKAGE WITH EMERGENCY RESPONSE PLAN

An emergency is a situation that poses an impending or immediate risk to health, life, property, or the environment and which requires urgent intervention to prevent or limit the expected outcome.

This OMS manual addresses conditions related to operation under normal or upset conditions, as opposed to emergency situation. An Emergency Response Plan (ERP) describes measures the Owner and, in some cases, external parties will take to prepare for an emergency, and to respond if an emergency occurs.

An OMS and ERP manual must be aligned. As a result, this OMS manual contains the following information (refer to Section 4 and 5):

- Performance, occurrences, or observations that would result in an emergency being declared
- Roles and responsibilities of key personnel in transition from normal or upset conditions to an emergency
- Actions to be taken to transition from normal or upset conditions to an emergency situation

Once an emergency has been declared, reference must be made to the Emergency Response Plan (Reference included in Table 1-2). The most recent version of the ERP can be found on Intelex and in the Engineering Superintendent Office

Table 1-2: Emergency Response Reference Documents

Document	Current Revision
Emergency Response Plan	Updated by AEM. Version 12, January 2018. (Intelex)

SECTION 2 • ROLES AND RESPONSIBILITIES

A functional chart for the Dewatering Dikes at the Meadowbank Project is shown in Figure 2-1.

The roles and responsibilities of the key personnel involved in the Dewatering Dikes of the Meadowbank Project are shown in Table 2-1. Contact information for each position is indicated in Table 2-2.

Personnel who have tasks directly related to the Dewatering Dikes need to receive a training when they start in the position, to ensure they understand their roles and responsibilities related to this OMS manual.

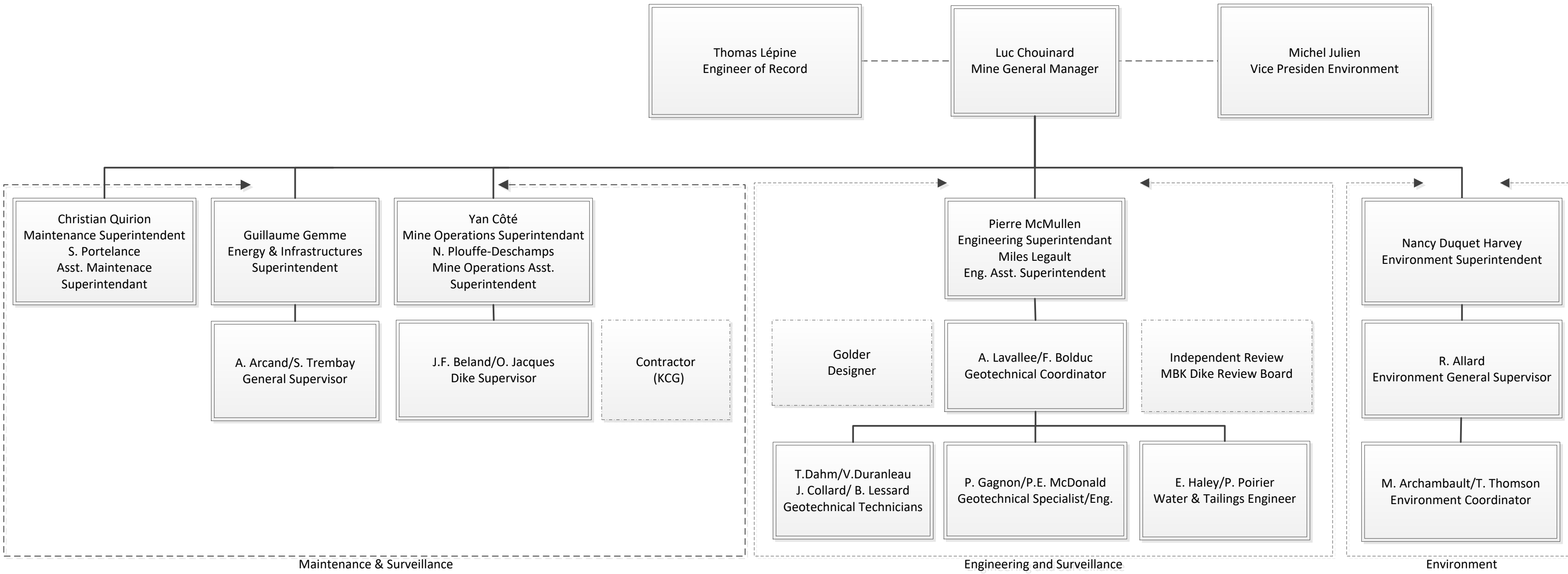

Figure 2-1 :Organizational structure

Table 2-1 : Responsibilities related to Meadowbank Water Management

Role	Responsibilities
Vice-President Environment	• Be aware of key outcomes of water management risk assessment and of how these risks are being managed • Has accountability and responsibility for putting in place appropriate management structure • Assign responsibility and appropriate budgetary authority for water management and define the personnel duties, responsibility and reporting relationships, supported by job description and organisational charts to implement the water management system through all stages in the facility life cycles • Provide assurance to AEM and its Community of Interest that the Dewatering Dikesare are managed responsibly
General Mine Manager	• Identify the scope of work and budget requirement for all aspect of water management • Approve budget for OMS related activity • Establish an organisational structure with Roles and Responsibilities that meets the operational needs • Delegate specific tasks and responsibilities for water management to qualified personnel • Liaise with independent reviewer (MDRB) as required
Engineer of Record (EoR)	• Input into the OMS activities in accordance with the design • Receive and review the OMS manual on a regular basis • Either confirm operation is compliant or identify deviations from performance objectives and advise the Owner with recommendations • Advise on contemplated changes on the structure operation • Maintain records related to design construction and operation • Participate in inspections and independent reviews
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	• Provide independent, objective, expert commentaries, advices and recommendations, to assist in identifying, understanding, and managing risks associated with the Dewatering Dikes
Engineering Superintendent	• Revise and update the OMS Manual to reflect as-built conditions and any other changes • Review and update the OMS manual into Intelex • Maintain up to date distribution list of the OMS Manual • Establish a formal relationship with the EOR to ensure operation is compliant with design intent • Identify when/where contemplated operational changes are a potential deviation from the design intent and engage the EoR and Designer as part of process to manage changes • Coordinate work force as required for monitoring and maintenance.

Role	Responsibilities
Mine Operations Superintendent / Dike Supervisor	• Maintain access to the structure and seepage collection systems, including making road repairs, controlling dust and removing snow. • Carry out field maintenance related to earthwork as required, • Supervise Mine Contractor for aspect related to earthwork construction and maintenance
Geotechnical Coordinator	• Supervise the work of the geotechnical engineer/specialist, geotechnical technician and water and tailings engineer
Geotechnical Engineer	• Carry out inspections of the structures as required in the OMS Manual. • Carry out instrument monitoring as required in the OMS Manual. • Review and analyse surveillance data to evaluate dike performance with respect to design parameters • Review and distribute surveillance reporting as required in the OMS Manual • Analyse geotechnical instrumentation monitoring data to evaluate dike performance with respect to design parameters
Geotechnical Technician	• Carry out inspections of the structures as required in the OMS Manual • Monitor instrumentation as required in the OMS Manual • Maintain instrumentation, readout units, data acquisition system and cabins • Responsible for data acquisition as required in the OMS manual • Prepare reports on instrumentation readings, dike performance, visual observations, etc., as required in the OMS Manual.
Water & Tailings Engineer	• Carry out inspections of the structures as required in the OMS Manual • Carry out instrument monitoring as required in the OMS Manual • Coordinate equipment, labour, materials and maintenance activities required for pumps and pipelines associated with dewatering, seepage collection systems and any runoff diversions. • Prepare reports on instrumentation readings, dike performance, visual observations, etc., as required in the OMS Manual
Environment Department Superintendent / General Supervisor / Coordinator / Technician	• Ensure monitoring of water quality and total suspended solids as required in the water management plan • Review environmental monitoring data for compliance with Water License and regulations and to determine dike performance with respect to design parameters • Liaise with external stakeholders including NIRB, Nunavut Water Board, NGO's, government agencies

Role	Responsibilities
Energy & Infrastructures Superintendent / General Supervisor / Pump crew supervisor / electrical supervisor	• Installation and operation of pumps and pipeline (electrical, mechanical) • Maintain and service pumps and pipelines • Coordinate equipment, labour and materials for maintenance of electrical and mechanical equipment • Carry out field operations, including pumping • Carry out field maintenance on pumps and pipeline, including electrical and mechanical repairs
Mine Contractor	• Rent equipment and manpower for construction and maintenance of the Dewatering Dikes
Design Engineer	• Advise on contemplated changes to the structure design • Advisor on structure performance as required • Participate in inspection and independent review as required
Maintenance Superintendent/ Pump mechanics	• Ensure preventive maintenance is carried out regularly on each pumping equipment • Repair pumping equipment as required • Update and maintain a list of operational pumping equipment • Keep records of maintenance on pumping equipment

Table 2-2 : OMS Manual Contact for each position

Role	Name	Work Contact Info
Vice-President Environment	Michel Julien	michel.julien@agnicoeagle.com 416-947-1212 x3738 514-244-5876
General Mine Manager	Luc Chouinard	819-759-3555 x4606896
Engineer of Record (EoR)	Thomas Lepine	thomas.lepine@agnicoeagle.com 416-947-1212 x3722 418-473-8077
Engineering Superintendent / Assistant	Pierre McMullen Miles Legault	819-759-3555 x4606721
Mine Operations Superintendent / Assistant	Yan Côté Nicolas Plouffe-Deschamps	819-759-3555 x4606832
Dike Supervisor	Jean-François Béland Olivier jacques	819-759-3555 x4606807
Geotechnical Coordinator	Frédérick L.Bolduc Alexandre Lavallée	819-759-3555 x4606837

Role	Name	Work Contact Info
Geotechnical Engineer	Patrice Gagnon Pier-Eric McDonald	819-759-3555 x4606726
Geotechnical Technician	Vincent Duranleau Thomas Dahm Bruno Lessard Jerome Collard	819-759-3555 x4606818 819-759-3555 x4606851
Water & Tailings Engineer	Eric Haley Pascal Poirier	819-759-3555 x4606752
Environment Superintendent	Nancy Duquette	819-759-3555 x4606980 x3175
Environment General Supervisor	Robin Allard	819-759-3555 x4606838
Environment Coordinator	Martin Archambault Tom Thomson	819-759-3555 x4606744
Energy & Infrastructures Superintendent	Guillaume Gemme	819-759-3555 x4606632
Maintenance Superintendent	Pierre Laberge Sylvain Portelance	819-759-3555 x4606722
Energy & Infrastructure General Supervisor	Alexandre Arcand Steven Tremblay	819-759-3555 x4606822
Pump crew supervisor	Shawn Valiquette Gaetan Martel	819-759-3555 x4606616
Electrical Supervisor	Alain Villeneuve	819-759-3555 x4606762
Mine Contractor	KCG	819-759-3555 x4606963 418-615-0559
Designer – Golder	Yves Boulianne	514 383 6196 x7434 514 207-0264
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	• Anthony Rattue • Don Hayley	anthony.rattue@bell.net don.hayley@icloud.com

SECTION 3 • DEWATERING DIKES DESCRIPTION

The Meadowbank Gold Project site is located approximately 80 km north of Baker Lake, Nunavut. The Meadowbank property is located on Inuit Owned Land, in the Kivalliq region of Nunavut. A description of the physical conditions of the site, as well as a geological and geotechnical conditions can be found in the design document of each structure referred to in this section.

The Meadowbank Project required the construction of a series of Dewatering Dikes as shown in Figure 3-1.

Table 3-1 : Description of the Dewatering Dikes of the Meadowbank Project

Infrastructure	Function
East Dike	Non-contact water retention and dewatering structure. ED isolates the Portage pit mining activities from Second Portage Lake and provides an area for the storage of tailings
Bay-Goose Dike	Non-contact water retention and dewatering structure. Isolates the Portage and Goose pit mining activities from Third Portage Lake
South Camp Dike	Non-contact water retention structure. Isolates the Portage and Goose pit mining activities from Third Portage Lake
Vault Dike	Non-contact water retention and dewatering structure. Isolates the Vault pit mining activities from Wally Lake
West Channel Dikes (dismantled)	Used to isolate the Portage pit mining from Second Portage Lake. Dismantled in 2012 as part of the Portage Pit mining operation.

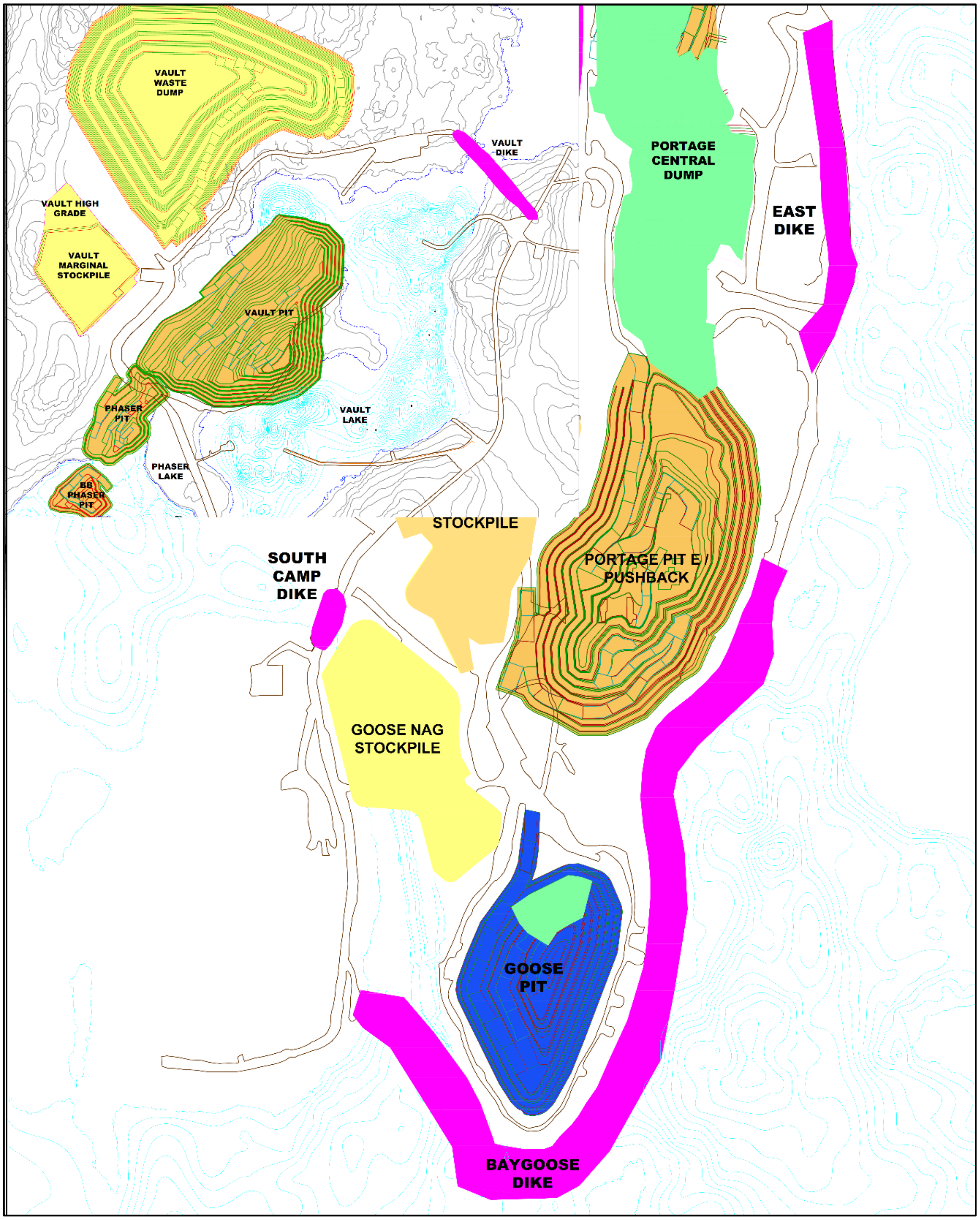

Figure 3-1: Dewatering Dike Plan View

3.1 EAST DIKE

The East Dike together isolate the northwest arm of Second Portage Lake. It isolates the Portage Pit and the tailings storage area from Second Portage Lake. In closure, East Dike will separate Third Portage Lake from Second Portage Lake. There are no spillways or water diversion works associated with the East Dike. The East Dike was also used to serve as a haul road to connect the North Portage Pit to the ore stockpiles and to the crushing facility within the plant site. The West Channel Dike is used to cover a narrow channel and prevent flow from Third Portage Lake to Second Portage Lake.

3.1.1 East Dike - Design and Construction

References to key document for the design and construction of East Dike are presented in Table 3-2. Table 3-3 summarises the main design criteria of ED.

Table 3-2 : Reference documents for East Dike Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
East Dike	Design Report	East Dike Design Report (Golder, 2008) 07-1413-0074/2500/1000 Doc. No. 572 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\East Dike\Doc 572 1031_08 RPT-East Dike Design Report-Meadowbank Ver 0.pdf
	Drawings	Appendix VIII of East Dike Design Report (Golder, 2008) 07-1413-0074/2500/1000 Doc. No. 572 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\East Dike\Doc 572 1031_08 RPT-East Dike Design Report-Meadowbank Ver 0.pdf
	Technical Specifications	Appendix VII East Dike Design Report (Golder, 2008) 07-1413-0074/2500/1000 Doc. No. 572 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\East Dike\Doc 572 1031_08 RPT-East Dike Design Report-Meadowbank Ver 0.pdf
	As-built	East Dike Construction As-Built Report (Golder, 2009) 07-1413-0074; 09-1428-5007 Doc. No. 900 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\East Dike\Doc 900 1202_09 Rpt-East Dike Construction As-Built Report - Meadowbank Ver 0.pdf

Table 3-3 : Design criteria for East Dike

Use	Water type	Classification (CDA, 2007)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Water Retention / Dewatering	Non-contact	High	1/3 between 1000-year and PMF[1]	133.1	135.1	137.1
Note 1: PMF means Probable Maximum Flood						

The East Dike was constructed in the summer of 2008 and grouting of the foundation and bedrock occurred in 2008 and during the first quarter of 2009. It is approximately 800 m in length, and was constructed within Second Portage Lake prior to dewatering. The dike consists of a wide rockfill shell, with downstream filters and a soil-bentonite cutoff wall that extends to bedrock. The cutoff wall extends up to 8 m below lake level.

Dike construction occurred in the following general manner:

Rockfill Embankment:

- A rockfill platform approximately 50 m wide was advanced from the south abutment to the north. The rockfill platform provided construction access and support for the core materials.
- The width of the rockfill platform (embankment) was subsequently increased by placement of additional rockfill on the downstream side, to provide an adequate road width to accommodate two-way haul traffic.

Initial Trench Excavation:

- Rockfill and lakebed soils were excavated from the crest of the rockfill platform to expose bedrock along the cutoff centreline. Loose blocks or slabs from the bedrock surface were removed, as practical.

Backfilling of the Initial Trench:

- A coarse granular filter (150 mm minus) was placed using the bucket of the excavator on the downstream slope of excavation.
- Then the remaining portion of the excavation was backfilled with Core Backfill (19 mm minus) material in the central portion along the cutoff wall centreline and Coarse Filter (150 mm minus) material on the upstream and downstream sides of the Core Backfill. Backfilling of the trench with the Core Backfill and Coarse Filter materials was a simultaneous activity and occurred progressively as the initial trench was the excavation front advanced.
- At the bedrock surface, a minimum of 5 m of Core Backfill material was to be placed.

Compaction of Core Backfill:

- Core Backfill and Coarse Filter were placed to an elevation of 2 m above the water level to form a platform from which densification could occur.

- The Core Backfill was densified using multiple passes of dynamic compaction. Craters produced by the dropped weight were backfilled to level the working platform between passes.

Cutoff:

- A 1 m wide trench was excavated through the Core Backfill material and extended to the bedrock surface along the cutoff wall centreline. Bentonite slurry was used to support the trench.
- The trench was backfilled with soil-bentonite.

Grouting:

- Grouting of the bedrock foundation and "contact area" identified as the zone between the base of the cutoff wall and bedrock surface was performed through the centerline of the cutoff wall.

In July 2009, during dewatering, a sinkhole cavity (18 m^3) was identified in the general vicinity of a leak identified at Sta.60+472. This was caused by erosion of the soil bentonite material in the cut-off wall. Additional grouting was performed to mitigate this occurrence. The dike has been performing adequately since then.

3.2 BAY-GOOSE DIKE

The Bay-Goose Dike together with the South Camp Dike isolates the Bay-Goose Basin from Third Portage Lake, which permits mining of the Goose Pit and the southern portion of Portage Pit. No spillways or water diversion works are associated with the Bay-Goose Dike.

3.2.1 Bay-Goose Dike – Design and Construction

Reference to key document for the design and construction of Bay-Goose Dike are presented in Table 3-4. Table 3-5 summarises the main design criteria of Bay-Goose Dike.

Table 3-4 : Reference documents for Bay-Goose Dike Design and Construction

Dike	Type of Information	Document Reference	Link to Retrieve Document
Bay-Goose Dike	Design Report	Bay-Goose Dike and South Camp Dike Designs (Golder, 2009) 08-1428-0028 Doc. No. 802 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\Bay-Goose Dike\Doc 802 0202_09-Let-Bay Goose Dike South Camp Dike Designs-Ver 0.pdf
	Drawings	Appendix A of Bay-Goose Dike and South Camp Dike Designs (Golder, 2009) 08-1428-0028 Doc. No. 802 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\Bay-Goose Dike\Doc 802 0202_09-Let-Bay Goose Dike South Camp Dike Designs-Ver 0.pdf
	Technical Specifications	Appendix B of Bay-Goose Dike and South Camp Dike Designs (Golder, 2009) 08-1428-0028 Doc. No. 802 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\Bay-Goose Dike\Doc 802 0202_09-Let-Bay Goose Dike South Camp Dike Designs-Ver 0.pdf
	As-built	Bay-Goose Dike Construction As-Built Report (Golder, 2013) 09-1428-5007 1328 Ver. 0	..\..\..\..\04-DewateringDikes\Bay-Goose Dike\As Built\From Golder\Bay Goose Final As-Built Report\Doc 1328-0914285007 0419_13 Text & Figures - Ver. 0.pdf

Table 3-5 : Design Criteria for the Bay-Goose Dike

Use	Water Type	Classification (CDA, 2007)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Water Retention/Dewatering	Non-contact	High		134.1		137.1

The Bay-Goose Dike is approximately 2,200 m in length and was constructed "in the wet", prior to dewatering. The earthworks component of the Bay-Goose Dike construction occurred over two summer construction seasons. The north portion of the Bay-Goose Dike was constructed in 2009 and the south portion in 2010. Grouting and jet grouting works commenced in 2010 and were completed by mid-July 2011.

Dike construction occurred in the following general manner:

Rockfill Platform / Embankment:

- A rockfill platform of varying width (approximately 60 to 90 m) was advanced from the north abutment to Goose Island, between July and September 2009 to an elevation of about 134 m.

- A rockfill causeway about 25 m wide was advanced from Goose Island to the south abutment between February and June 2010 while ice cover existed on Third Portage Lake. Ice was broken and removed, as practical, in front of the advancing rockfill platform.
- Following ice breakup from the lake in July 2010, additional rockfill was placed to widen the causeway to the full design width of the rockfill platform (approximately 55 to 100 m).
- The rockfill platforms surface elevation was about 134 m and was used to provide a working surface for the subsequent construction activities. The rockfill also provides lateral support for the granular core materials.

Initial Trench Excavation:

- Rockfill and lakebed soils were excavated from the rockfill platform surface to bedrock or competent lakebed soils along the cutoff centreline. As much as practical, loose blocks or slabs from the bedrock surface were removed.
- Ice rich soils beneath the cutoff wall were removed with the exception of at the south abutment where beyond Sta. 32+112 some ice-rich soils remain beneath the base of the initial trench excavation and cutoff wall.
- The required bottom width of the excavation varied based on its depth and varied between 8 and 11 m.

Backfilling of the Initial Trench:

North Portion of Dike

- A layer of Core Backfill (19 mm minus) material was placed along the downstream slope of the excavation such that Core Backfill material would be in contact with the lakebed soils.
- Then the remaining portion of the excavation was backfilled with Core Backfill (19 mm minus) material in the central portion along the cutoff wall centerline, with Coarse Filter (150 mm minus) material simultaneously placed on either side of the Core Backfill. Backfilling of the excavated trench occurred progressively as the excavation front advanced.

South Portion of Dike

- In very limited areas along the alignment, a layer of Core Backfill (19 mm minus) material was placed along the downstream slope of the excavation prior to the primary backfilling of the trench.
- The excavation was backfilled with Core Backfill (19 mm minus) material in the central portion along the cutoff wall centerline, with Coarse Filter (150 mm minus) material simultaneously placed on the downstream side of the Core Backfill and a “Fine Rockfill” material placed on the upstream side. Backfilling of the excavated trench occurred progressively as the excavation front advanced.
- In areas to be compacted using the vibratory-densification method, the width of Core Backfill material was required to be 8 m. Therefore, once the initial backfilling had been completed relatively small V-shaped excavations were made at the surface on either side of the initially placed Core Backfill. These excavations were then refilled with Core Backfill material to provide the required 8 m width of Core Backfill.

Compaction of Core Backfill:

- For all of the North Portion of the dike and a majority of the South Portion of the dike, a 2 m layer of Core Backfill, Coarse Filter, and Rockfill was placed to increase the elevation of the platform to provide a working surface for the dynamic compaction.
- The Core Backfill was densified using multiple passes of dynamic compaction. Craters produced by the dropped weight were backfilled to the level of the working platform between passes.
- For the South Portion of the dike, in zones where the initial excavation was not extended to bedrock, termed "partial cutoff" zones, compaction of the Core Backfill material was done using two methods: vibratory-densification and dynamic-compaction. Vibratory-densification of the Core Backfill material was conducted from the initial rockfill platform working surface (134 m). Vibro-densification was utilized to treat the Core Backfill material at the base of the excavation up to an elevation of about.128 m (i.e. 6 m below the water level). Then the 2 m of additional Core Backfill, Coarse Filter, and Rockfill materials were placed to increase the elevation of the platform to about 136 m creating the working surface for the dynamic compaction. The upper portion of the Core Backfill material was then treated using multiple passes of dynamic compaction. Craters produced by the dropped weight were backfilled to the level of the working platform between passes.

<u>Cutoff:</u>

- A 1 m wide trench was excavated through the Core Backfill material and extended to bedrock or competent till surface along the cutoff wall centreline. Bentonite slurry was used to support the trench.
- The trench was backfilled with:
    - Soil-bentonite (SB);
    - Cement Soil-bentonite (CSB); or
    - A combination of SB and CSB.
- Then a capping layer about 0.5 m thick of SB was placed above the trench to an approximate elevation of 136.5 m.

<u>Jet Grouted Wall</u>

- Jet grouting has been used to extend the low permeability element (cutoff wall) of the dike to the bedrock surface. A double jet system was used with a cement water ratio of 1:1 to construct the jet grouted columns. Jet grouting was completed from a working platform elevation of approximately 137 m.
- Jet grouting beneath the cutoff wall to the bedrock surface was conducted in the "partial cutoff" areas where the cutoff wall was not excavated to bedrock. This occurred in Channel 1 (Sta. 32+007 to 32+110), Channel 2 (Sta. 31+820 to 31+928), and Channel 3 (Sta. 31+575 to 31+611). Jet grouted columns were constructed with a centre to centre spacing of 1.2 m with an overlap with the cutoff wall and extended into the bedrock surface. Columns were constructed in two passes, primary columns at a spacing of 2.4 m with secondary columns subsequently constructed between the primary columns.
- Jet grouting was also conducted in two additional areas of the dike where significant silt accumulated at the base of the initial excavation and prevented the cutoff wall from being successfully constructed to bedrock. These two areas the North Channel (Sta. 30+361 to

30+435) and between Channel 1 and Channel 2 (Sta. 31+928 to 32+007). Jet grouted columns were constructed with a centre to centre spacing generally of 1.5 m, with the exception of the portion between Sta. 31+928 and Sta. 31+966.4 where a spacing of 1.2 m was utilized, following a primary and secondary sequence for installation.

Grouting:

- The working platform along the cutoff wall centerline was raised with Coarse Filter material to an elevation of 137 m, from which grouting work was conducted.
- Grouting of the bedrock foundation and "contact area" identified as the zone between the base of the cutoff wall or jet grout columns and bedrock surface was performed through the centerline of the cutoff wall.

3.3 SOUTH CAMP DIKE

The South Camp Dike covers a narrow channel within Third Portage Lake and in conjunction with the Bay-Goose Dike isolate the Bay-Goose Basin from Third Portage Lake. No spillways or water diversion works are associated with the South Camp Dike. It is located south of the plant site area and is used to connect the mainland to South Camp Island. It covers a narrow channel, approximately 60 m in width, where water depths were between 0.5 and 1 m.

3.3.1 South Camp Dike – Design and Construction

Reference to key document for the design and construction of South Camp Dike are presented in Table 3-6. Table 3-7 summarises the main design criteria of South Camp Dike.

Table 3-6 : Reference documents for South Camp Dike Design and Construction

Dike	Type of Information	Document Reference	Link to Retrieve Document
South Camp Dike	Design Report	Bay-Goose Dike and South Camp Dike Designs (Golder, 2009) 08-1428-0028 Doc. No. 802 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\Bay-Goose Dike\Doc 802 0202_09-Let-Bay Goose Dike South Camp Dike Designs-Ver 0.pdf
	Drawings	Appendix A of Bay-Goose Dike and South Camp Dike Designs (Golder, 2009) 08-1428-0028 Doc. No. 802 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\Bay-Goose Dike\Doc 802 0202_09-Let-Bay Goose Dike South Camp Dike Designs-Ver 0.pdf
	Technical Specifications	Appendix B of Bay-Goose Dike and South Camp Dike Designs (Golder, 2009) 08-1428-0028 Doc. No. 802 Ver. 0	..\..\..\..\99-Archive\References\Dike Designer Report GOLDER\Bay-Goose Dike\Doc 802 0202_09-Let-Bay Goose Dike South Camp Dike Designs-Ver 0.pdf
	As-built	South Camp Dike Construction Summary Report (AEM, 2012)	..\..\..\..\04-DewateringDikes\South Camp Dike\As-Built\As-Built report\South Camp Dike Construction Summary VER 0_stamp.pdf

Table 3-7 : Design Criteria for the South Camp Dike

Use	Water Type	Classification (CDA, 2007)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Water Retention	Non-contact	Significant		134.1		137.6

The South Camp Dike was primarily constructed between April and June of 2009, prior to ice breakup. During the winter of 2009-2010 additional thermal capping material and rockfill for the haul road was added to the dike. The South Camp Dike has a broad rockfill shell with a bituminous geomembrane liner installed on the upstream side of the shell. The liner was founded on native frozen (permafrost) till material, in a trench approximately 3 to 5 m below the lakebed surface. Compacted granular material mixed with bentonite was placed above the toe of the liner. The haul road is located on the downstream side of the dike.

The dike design includes the following components: a rockfill shell, a bituminous geomembrane liner and granular material mixed with bentonite.

3.4 VAULT DIKE

Vault Dike is located across a shallow creek which connects Wally Lake and Vault Lake, at the Vault Pit area approximately 8 km north of the main Meadowbank site. Vault Dike is essential to allow the dewatering of Vault Lake and to isolate Vault Pit during mining activities from Wally Lake.

3.4.1 Vault Dike– Design and Construction

References to key document for the design and construction of Vault Dike are presented in Table 3-8. Table 3-9 summarises the main design criteria of Vault Dike.

Table 3-8 : Summary of key reference documents for Vault dike

Dike	Type of Information	Document Reference	Link to Retrieve Document
Vault Dike	Design Report	610548-2020-4GER-0001_00	"\\CAMBFS01\Groups\Engineering\05-Geotechnic\04-DewateringDikes\Vault Dike\1 - Design Work\Documents from SNC\610548-2020-4GER-0001_00.pdf"
	Drawings	Appendix 1 of Construction of Vault Dike (SNC, 2013) 610548-2020-4GEF-0001	..\..\..\..\04-DewateringDikes\Vault Dike\1 - Design Work\Documents from SNC\610548-2020-4GEF-0001-00.pdf
	Technical Specifications	Construction of Vault Dike (SNC, 2013) 610548-2020-4GEF-0001	..\..\..\..\04-DewateringDikes\Vault Dike\1 - Design Work\Documents from SNC\610548-2020-4GEF-0001-00.pdf
	As-built	Construction Summary Report Vaut (AEM, 2013)	..\..\..\..\04-DewateringDikes\Vault Dike\18-As-Built Report and Drawings\Vault Dike Construction Report Final with Appendices.pdf

Table 3-9 : Design criteria for Vault Dike

Use	Water Type	Classification (CDA, 2007)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Water Retention/Dewatering	Non-contact	Low	1-100 year snow melt + 1-100 year rainfall	139.52	141	142.5

The construction of the Vault Dike at Meadowbank was conducted from February 2013 to March 2013. Vault Dike is designed and constructed as a zoned rockfill dam with filter zones, an impervious upstream liner consisting of a bituminous membrane, and an upstream key trench made of aggregate mixed with bentonite. The filter zones minimize seepage and internal erosion and facilitate seepage collection. Vault Dike includes a key trench at the base of the upstream side filled with a 0-25 mm fill amended with bentonite surrounding the liner. Coarse and fine filter material was placed on the upstream slope as geomembrane bedding. The bulk part of the dike consists of coarse rockfill material. The embankment crest is at El. 142.4 m and the upstream toe is at approximately El. 139.4 m. The downstream toe is at approximately El. 139.6 m and the bottom of the key trench ranges from El. 135.6m to El. 142.3m, with an average height of El. 137.0m. The upstream and downstream fill slopes of the dam are 1.5H:1V.

3.5 INSTRUMENTATION

The Dewatering Dikes are instrumented to continuously monitor performance. In-situ instrumentations are installed within the structure and their foundation (piezometers, thermistors, inclinometers).

Water levels in the ponds are monitored by means of a visible staff gauge installed at a strategic location, piezometers and periodic water survey.

Reference document for the instrumentation installed on the Dewatering Dikes is summarized in Table 3-12. The summary of the instrument installed is summarised in Table 3-13

Table 3-10 : Reference documents for instrumentation

Type of Information	Reference Document	Link to retrieve document
Instrumentation campaign as-built	As-built report for each dike	ED: Refer to table 3.2 BGD: Refer to table 3.4 SCD: Refer to table 3.6 VD: Refer to table 3.8
Instruments database	AEM	ED & BGD : ..\..\..\..\11-Instrumentation\Instruments\ALL Instruments Databases (GKM)\ED & BGD Instrument_database_rev2.xls
Manufacturer data sheet	GKM	..\..\..\..\11-Instrumentation\Instruments\Instruments SHEETS
Instrument map and cross-section	AEM	ED : ..\..\..\..\04-DewateringDikes\East Dike\Instrument Monitoring\Cross Sections\East Dike-sections.pdf BGD : ..\..\..\..\04-DewateringDikes\Bay-Goose Dike\Instrument Monitoring\Cross Sections\Bay Goose-Sections-30158-to-30645.5-NORTH.pdf & ..\..\..\..\04-DewateringDikes\Bay-Goose Dike\Instrument Monitoring\Cross Sections\Bay Goose-Sections-31165-to-32105-SOUTH.pdf

Table 3-11 : Instrumentation summary on the water management infrastructure

Structure	**Piezometer**	**Thermistors**	**Inclinometer**	**Survey Monument**	**Staff Gauge**
East Dike	44	5	3	-	-
Bay-Goose Dike	125	33	6	-	-
South Camp Dike	-	2	-	-	-
Vault Dike	-	5	-	-	-

SECTION 4 • DEWATERING

The Dewatering Dikes isolate the open pit mining activities from the Second Portage Lake, Third Portage Lake, and Wally Lake. The northwest arm of Second Portage Lake was dewatered upon completion of the East Dike and West Channel Dike in 2009. A total of 6.7 Mm^3 were pumped from the Second Portage Arm.

The Bay-Goose Dike together with the South Camp Dike isolates the Bay-Goose Basin from Third Portage Lake. Dewatering of the Bay-Goose Basin commenced on July 25, 2011 and was completed on November 14 2011. As the operational stage of Goose Pit has started, both dikes are no longer under dewatering conditions. The approximate pool volume dewatered is in the order of 3 Mm^3. This is referring to the amount of water removed to expose the majority of the downstream toe of the Bay-Goose Dike.

Vault Dike isolates Vault Pit from Wally Lake. Dewatering of Vault Lake started on June 27th, 2013 and was completed during the summer of 2014. The approximate pool volume to be dewatered was in the order of 2 Mm^3.

All of the dewatering dikes are now in the operation phase as dewatering is complete. The following outlines the key criteria and constraints that will need to be observed and followed in accordance with the design objectives, concepts, and assumptions for the Dewatering Dikes.

4.1 PERFORMED DEWATERING

4.1.1 East Dike - Dewatering

During dewatering of the northwest arm of Second Portage Lake, an apparent leak through the East Dike of up to 0.5 m^3/s occurred over several days near Sta. 60+490. The leak then appeared to self-heal following drilling works for the additional grouting carried out in this sector. A sinkhole cavity of about 18 m^3 in the general vicinity of the leak (Sta. 60+472) also appeared in July 2009. The sinkhole was located immediately upstream of the cutoff wall and extended at least partially through the cutoff wall. A Technical Memorandum entitled “Meadowbank East Dike Grouting Response Plan – Completed Works” (Golder 2009b) provides additional information regarding the remedial grouting work and Golder Doc. No. 961 (Golder, 2009d) “East Dike Sinkhole Summary Report” provides more details about the sinkhole.

Following the appearance of the sinkhole, a cone penetration test (CPT) investigation was conducted, and three diamond drill holes and a surface geophysical survey were advanced in the area to obtain additional information. Based on the CPT results, there appeared to be a zone of coarser grained material (area with lower fines content) in the apparent leak area. The drilling investigation indicated that there may be soil between the base of the cut-off wall and underlying bedrock that was not completely excavated and/or grouted. An additional investigation of the sinkhole and apparent leakage area consisting of the temporary installation of thermistor strings and monitoring of the thermal condition was initially conducted in 2010 and repeated in 2011. Based on the thermal results, it appeared that a pervious zone existed within the cut-off wall and shallow bedrock between approximately Sta. 60+440 and 60+504. In the past, AEM considered potential mitigation options to reduce seepage through the dike and to provide contingency protection for the Portage Pit. Based on the stability of the dike and the seepage rate, remediation or implementation of contingency control measures is not considered necessary. The condition of the dike will continually be monitored and if the condition of the dike is judged to be deteriorating then remediation would be reassessed. Details regarding these investigations are provided in East Dike CPT Investigation Report (Golder, 2010b) and East Dike Sinkhole Investigation Program October-November 2009 (Golder 2010a).

The seepage is currently controlled by a seepage collection system and is not impacting the mining operation. The seepage is regularly monitored and appears to have stabilized and does not have a negative effect on the dike stability.

4.1.2 Vault Dike – Dewatering

The dewatering of Vault Lake started on June 27th, 2013 and was completed in the summer of 2014. The approximate pool volume to be dewatered was 2 Mm^3. The downstream water levels and the upstream water levels needed to be closely monitored during dewatering to preserve the integrity of the dike. During dewatering, water from the Vault Basin was pumped and directly discharged to Wally Lake through a diffuser or processed through the Water Treatment Plant (WTP) to reduce Total Suspended Solids (TSS).

SECTION 5 • OPERATIONS

The following section outlines the key operational procedures that need to be observed and followed during operation of the Dewatering Dikes at Meadowbank in accordance with the performance objective.

5.1 REFERENCES

References to key documents for the operation of the Dewatering Dikes are presented in Table 5-1.

Table 5-1 : Key reference documents for Operation of the Dewatering Dikes at Meadowbank

Type of information	Reference	Link to Retrieve Document
Meadowbank Water Management Plan	V7 AEM 2018	..\..\..\..\..\12- Annual Report\2019\Water management plan
Meadowbank Annual Water Balance	2019	..\..\..\..\05-WaterManagement\2019\Water Balance

5.2 SUMMARY OF PERFORMANCE OBJECTIVE AND OPERATION CONTROL

The performance objective and the operational criteria for the Dewatering Dikes at Meadowbank during operation are summarized in Table 5-2.

Table 5-2 : Performance objectives and operational criteria of the Dewatering Dikes at Meadowbank

Water Management
• Operational freeboard of each water retention structure must be respected during operation (refer to section 5.2.1) • Water movement must respect the water balance for intake and discharge location (refer to water balance) • Water movement must be tracked and recorded on a monthly basis (volume, origin, destination) • The water management system (pump, pipes) must be operated and maintained as per the defined operating procedure • Any seepage must be captured by sump and pumped back to allowed location (or naturally report to an approved location)
Water Quality
• All water discharged in the environment must be through an approved diffuser • Water quality at discharge met the approved criteria (refer to water management plan) • Water quality forecast data is used to make informed water management strategy decision • Water quality and quantity of seepage water is monitored
Surveillance
• Proper surveillance (inspection and data review) of the Dewatering Dikes performance occur and is documented during dewatering (refer to section 7) • The performance of the Dewatering Dikes during dewatering is reviewed against the threshold for performance criteria and trigger pre-defined actions (refer to Table 5-4 to 5-8)

5.2.1 Freeboard

The design criteria for minimum freeboard for the Dewatering Dikes are presented in Table 5-3. The freeboard may change due to fluctuations in lake levels or due to settlement of the dikes. Maintenance may be required to restore loss of freeboard due to settlement.

Table 5-3 : Freeboard

Structure	Freeboard	
	To the Dike Crest (m)	To the Dike Cut-off Wall or Liner (m)
East Dike	3.0	1.0
Bay-Goose Dike	4.0	1.0
South Camp Dike	3.0	1.0
Vault Dike	3.0	1.5

5.3 SEEPAGE MANAGEMENT

If seepage is observed through a Dewatering Dike, a system of collection ditch and sump will be constructed at the downstream toe of the structure to capture the seepage into a contact water retention pond. The water quality will be monitored and it will be directed to an approved discharge point.

The quantity and quality of each seepage from a Dewatering Dike has to be monitored as per the requirement of section 7.

5.3.1 East Dike - Seepage Collection System

The purpose of the seepage collection system is to:

- Collect and convey seepage and runoff away from the downstream toe area; and
- Allow measurement of seepage through the dike.

The downstream toe of the East Dike was mostly exposed by July 2009 and then entirely by July 2010. Three seepage zones have been identified along the toe of the East Dike at approximately Sta. 60+480, Sta. 60+225 and Sta. 60+550. A temporary rectangular weir was installed in 2009 to monitor the seepage observed at approximately Sta. 60+480. Monitoring of the seepage from this location has occurred during the open water season (approximately mid-July through early October) in 2009 and 2010. During 2010, a temporary v-notch weir was installed to measure a second zone of seepage exposed near Sta. 60+225 following dewatering. This portion of the dike was not exposed for visual inspection in 2009 due to the downstream water elevation. No monitoring system has been installed in the area around Sta. 60+550. Seepage flows have been measured to be between 7 L/s and 11 L/s at Sta. 60+480 and around 4 L/s at Sta. 60+225 and estimated to be about 1 L/s at Sta. 60+550.

The installation of a seepage collection system downstream of East Dike to capture and pump the seepage water started in September 2011 and was completed in 2012. After the system installation, 3 zones of seepage were identified near the downstream toe. The zones at about Sta. 60+247 and Sta. 60+498 each had a collection sump with pump connected to a year round pumping and piping system.

In 2011, the downstream seepage at Sta. 60+498 had been stable at a rate of about 864 m^3/day (10 L/s) with no visual signs of turbidity, which was consistent with rates recorded during previous years. In 2011, the seepage downstream at Sta.60+247 appeared stable at around 345.6 m^3/day (4L/s) with no visual signs of turbidity noted, which was consistent with previous rates. Since the installation of the seepage collection system, all seepage is being captured within the sumps and no sign of additional seepage on the ground surface or downstream in the Portage Pit was observed. No active monitoring of the seepage rate at these locations occurred in 2012 but AEM has been visually inspecting the flow in the sumps and no turbidity was noted. AEM performed a pump test after the installation of the sumps, it was noted that the measured flow were consistent with 2010 and 2011 data. Flow meters have been installed in 2013 at the exit of each pump. Since then, the observed flow average 474 m^3/day in 2018 with a maximum flow of 615 m^3/day in May and minimum flow of 354 m^3/day in December 2018.

5.3.2 Bay-Goose Dike - Seepage Collection System

In 2012, four small seepage areas were identified with a total of 9 seepage channels along the dike. The number of active seepage channels decreases each year, as some channels stop flowing. No turbidity has been observed in the seepage. The total flow coming from these seepages each year has been decreasing. The flow of the seepages is directed toward Goose Pit as part of natural reflooding. The overall seepage is less than anticipated and is not a concern for now. The area will continue to be monitored to follow the evolution of the seepage in these areas.

Refer to the 2018 Annual Geotechnical Inspection (Golder Associates) for detailed field observations made on the dike. No mitigation measure has been implemented on the dike other than additional geotechnical instrumentation installation and field investigation in certain areas. No seepage collection has been implemented so far as the seepage is not affecting the mine operation or the integrity of the dike. The condition of the dike will continually be monitored and if the condition of the dike is judged to be deteriorating then remediation would be reassessed.

5.3.3 Vault Dike - Seepage Collection System

As of summer 2018 no seepage through the Vault Dike has been observed. Seepage through the dike will be visually monitored if discovered. Seepage and runoff from the Vault Dike will be collected in ditches along the downstream toe and directed to topographic lows if required based on the visual monitoring.

5.4 OPERATING PROCEDURE DURING OPERATION OF THE DEWATERING DIKES AT MEADOWBANK

Table 5-4 to 5-8 below present performance indicators for each of the Dewatering Dike at Meadowbank and the Triger Action Response Plan (TARP) if the associated performance criteria deviate from defined range.

Table 5-4 : Threshold Criteria and pre-defined action during operation of East Dike

		Threshold Criteria During Operation			
		Green **Acceptable Situation**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Downstream toe displacement, sloughing or bulging	None visible	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height
	Tension crack along downstream rockfill embankment (more than 3 m from centreline)	Within 7 m of the downstream crest edge and < 0.1 m deep and < 3 m length along the dike	Within 10 m of the downstream crest edge and > 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Tension crack along upstream rockfill embankment (more than 3 m from centreline)	< 0.1 m deep and < 3 m length along the dike	> 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Tension crack within 3 m each side of the cutoff wall at crest (upstream or downstream)	None visible	< 0.1 m deep or < 0.1 m wide	> 0.1 m deep or > 0.1 m wide	> 0.1 m deep or > 0.1 m wide
	Sinkhole on crest	Not visible	> 5 m outside from centreline	Within 5 m from centreline	Within 5 m from centreline
	Cut-off wall lateral cumulative deformation (based on survey monument)	None	<0.05 m	> 0.05 and 0.10 m	> 0.10 m
	Cut-off wall lateral cumulative deformation (based on inclinometer)	None	< 0.05 m	> 0.05 m and < 0.10 m	> 0.10 m
	Lake elevation	< 134.1 masl	> 134.1 and < 134.8 masl	> 134.8 and < 135.6 masl	> 135.6 masl
	Pore water pressure (based on piezometers)	Pore water pressure measurements stable or decreasing.	Increasing trend in pore water pressure downstream of cut-off wall.	Anomalous trends (sharp increase) in pore water pressure downstream of cut-off wall.	Anomalous trends (sharp increase) in pore water pressure downstream of cut-off wall.
	Temperature variation along centreline (based on thermistors and piezometers)	Temperature measurement stable and similar variation at surface from previous years.	Increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer
	Seepage through dike (excluding Freshet water)	< 3,000 m^3/day	>3,000 m^3/day and <6,000 m^3/day and / or turbidity in the water	> 6,000 m^3/day and < 20,000 m^3/day and / or turbidity in the water	> 20,000 m^3/day *Condition where the seepage inflow is rapidly increasing and projected to soon exceed pumping capacity*
Action Required		• Instrumentation monitoring and visual inspection according to frequency set out in OMS manual. • Possibility of a mitigation plan to be evaluated by Engineering Department.	• Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Identify potential cause • Implement engineering review.	• Suspend activities on dike crest at area of concern • Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Plan and take appropriate mitigation measures with engineering review. (Use as reference contingency measures for different scenarios proposed by AEM (See Table 12-9)). • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Temporary evacuation of personnel and equipment from pit and suspension of activities. • Update planning and take appropriate mitigation with engineering review.
Personnel Notified		Geotechnical Engineer/Specialists, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor (if required), Environment Superintendent, Mine Manager, Discuss at MDRB Meeting.	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel).

Table 5-5 : Threshold Criteria and pre-defined action during operation of Bay-Goose Dike

		Threshold Criteria During Operation			
		Green **Acceptable Situation**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Downstream toe displacement, sloughing or bulging	None visible	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline and bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height
	Tension crack along downstream rockfill embankment (more than 3 m from centreline)	Within 7 m of the downstream crest edge and < 0.1 m deep and < 3 m length along the dike	Within 10 m of the downstream crest edge and > 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Tension crack along upstream rockfill embankment (more than 3 m from centreline)	< 0.1 m deep and < 3 m length along the dike	> 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Tension crack within 3 m of either side of the cutoff wall at crest	None visible	< 0.1 m deep or < 0.1 m wide	> 0.1 m deep or > 0.1 m wide	> 0.1 m deep or > 0.1 m wide
	Sinkhole on crest	Not visible	> 5 m outside from centreline	Within 5 m from centreline	Within 5 m from centreline
	Cut-off wall lateral cumulative deformation (based on survey monument)	None	<0.05 m	> 0.05 and 0.10 m	> 0.10 m
	Cut-off wall lateral cumulative deformation (based on inclinometer)	None	< 0.05 m	> 0.05 m and < 0.10 m	> 0.10 m
	Lake elevation	< 135.1 masl	> 135.1 and < 135.8 masl	> 135.8 and < 136.1 masl	> 136.1 masl
	Pore water pressure (based on piezometers)	Pore water pressure measurements stable or decreasing.	Increasing trend in pore water pressure downstream of cut-off wall.	Anomalous trends (sharp increase) in pore water pressure downstream of cut-off wall.	Anomalous trends (sharp increase) in pore water pressure downstream of cut-off wall.
	Temperature variation along centreline (based on thermistors and piezometers)	Temperature measurement stable and similar variation at surface from previous years.	Increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer
	Seepage through dike at toe (excluding Freshet water)	< 300 m^3/day	>300 m^3/day and <1,000 m^3/day and / or turbidity in the water	> 1,000 m^3/day and < 2,000 m^3/day and / or turbidity in the water	> 2,000 m^3/day *Seepage inflow is rapidly increasing and projected to soon exceed pumping capacity*
	Seepage through dike in North Channel area	< 150 m^3/day	>150 m^3/day and <500 m^3/day and / or turbidity in the water	> 500 m^3/day and < 1,000 m^3/day and / or turbidity in the water	> 1,000 m^3/day *Seepage inflow is rapidly increasing and projected to soon exceed pumping capacity*
	Seepage through dike in pit (excluding Freshet water, estimated visually)	Slow trickle of water along pit walls, easily handled by regular pit sumps	Steady stream of water along pit walls, easily handled by regular pit sumps	Large quantity of water flowing down the pit walls, cannot be easily handled by regular pit sumps, mining activities are impacted	Water flowing down the walls cannot be handled by regular pit sumps and has markedly increased in flow rate and quantity, mining activities are disrupted.
Action Required		• Instrumentation monitoring and visual inspection according to frequency set out in OMS manual. • Possibility of a mitigation plan to be evaluated by Engineering Department.	• Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Identify potential cause • Implement engineering review.	• Suspend activities on dike crest at area of concern • Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Plan and take appropriate mitigation measures with engineering review. (Use as reference contingency measures for different scenarios proposed by AEM (See Table 12-9)). • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Temporary evacuation of personnel and equipment from pit and suspension of activities. • Update planning and take appropriate mitigation with engineering review.
Personnel Notified		Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor (if required), Environment Superintendent, Mine Manager, Discuss at MDRB Meeting.	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel).

Table 5-6 : Threshold Criteria and pre-defined action during operation of South Camp Dike

		Threshold Criteria During Operation			
		Green **Acceptable Situation**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Downstream toe displacement, sloughing or bulging	None visible	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height
	Tension crack along downstream rockfill embankment (more than 3 m from centreline)	Within 7 m of the downstream crest edge and < 0.1 m deep and < 3 m length along the dike	Within 10 m of the downstream crest edge and > 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Tension crack along upstream rockfill embankment (more than 3 m from centreline)	< 0.1 m deep and < 3 m length along the dike	> 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Sinkhole on crest	Not visible	> 5 m outside from centreline	Within 5 m from centreline	Within 5 m from centreline
	Lake elevation	< 135.6 masl	> 135.6 and < 136.3 masl	> 136.3 and < 136.6 masl	> 136.6 masl
	Temperature variation within foundation (based on thermistors)	Temperature measurement stable and similar variation at surface from previous years.	Increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer
	Seepage through dike (excluding Freshet water)	< 300 m^3/day	>300 m^3/day and <1,000 m^3/day and / or turbidity in the water	> 1,000 m^3/day and < 2,000 m^3/day and / or turbidity in the water	> 2,000 m^3/day *Condition where the seepage inflow is rapidly increasing and projected to soon exceed pumping capacity*
Action Required		• Instrumentation monitoring and visual inspection according to frequency set out in OMS manual. • Possibility of a mitigation plan to be evaluated by Engineering Department.	• Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Identify potential cause • Implement engineering review.	• Suspend activities on dike crest at area of concern • Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Plan and take appropriate mitigation measures with engineering review. • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Temporary evacuation of personnel and equipment from pit and suspension of activities. • Update planning and take appropriate mitigation with engineering review.
Personnel Notified		Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor (if required), Environment Superintendent, Mine Manager, Discuss at MDRB Meeting.	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel).

Table 5-7 : Threshold Criteria and pre-defined action during operation of Vault Dike

		Threshold Criteria During Operation			
		Green **Acceptable Situation**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Downstream toe displacement, sloughing or bulging	None visible	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height
	Tension crack along downstream rockfill embankment (more than 3 m from centreline)	Within 7 m of the downstream crest edge and < 0.1 m deep and < 3 m length along the dike	Within 10 m of the downstream crest edge and > 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Tension crack along upstream rockfill embankment (more than 3 m from centreline)	< 0.1 m deep and < 3 m length along the dike	> 0.1 m and < 1.0 m deep	> 1.0 m deep	> 1.0 m deep
	Sinkhole on crest	Not visible	> 5 m outside from centreline	Within 5 m from centreline	Within 5 m from centreline
	Lake elevation	< 141.5 masl	> 141.5 and < 142.2 masl	> 142.2 and < 142.5 masl	> 142.5 masl
	Temperature variation within foundation (based on thermistors)	Temperature measurement stable and similar variation at surface from previous years.	Increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer	Continuous increasing trend in temperature below the active layer
	Seepage through dike (excluding Freshet water)	< 300 m^3/day	>300 m^3/day and <1,000 m^3/day and / or turbidity in the water	> 1,000 m^3/day and < 2,000 m^3/day and / or turbidity in the water	> 2,000 m^3/day *Condition where the seepage inflow is rapidly increasing and projected to soon exceed pumping capacity*
Action Required		• Instrumentation monitoring and visual inspection according to frequency set out in OMS manual. • Possibility of a mitigation plan to be evaluated by Engineering Department.	• Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Identify potential cause • Implement engineering review.	• Suspend activities on dike crest at area of concern • Increased instrumentation monitoring frequency, particularly in area of concern. • Document location, photograph, survey, and increase inspection and monitoring in area of concern. • Plan and take appropriate mitigation measures with engineering review. • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Temporary evacuation of personnel and equipment from pit and suspension of activities. • Update planning and take appropriate mitigation with engineering review.
Personnel Notified		Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor (if required), Environment Superintendent, Mine Manager, Discuss at MDRB Meeting.	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel, if required).	Geotechnical Engineer/Specialist, Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder or SNC), Specialized Contractor, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel).

5.5 COMMUNICATION AND DECISION MAKING

Figure 5-1 indicates the communication and decision processes when the threshold criteria are met and when pre-defined action need to be implemented.

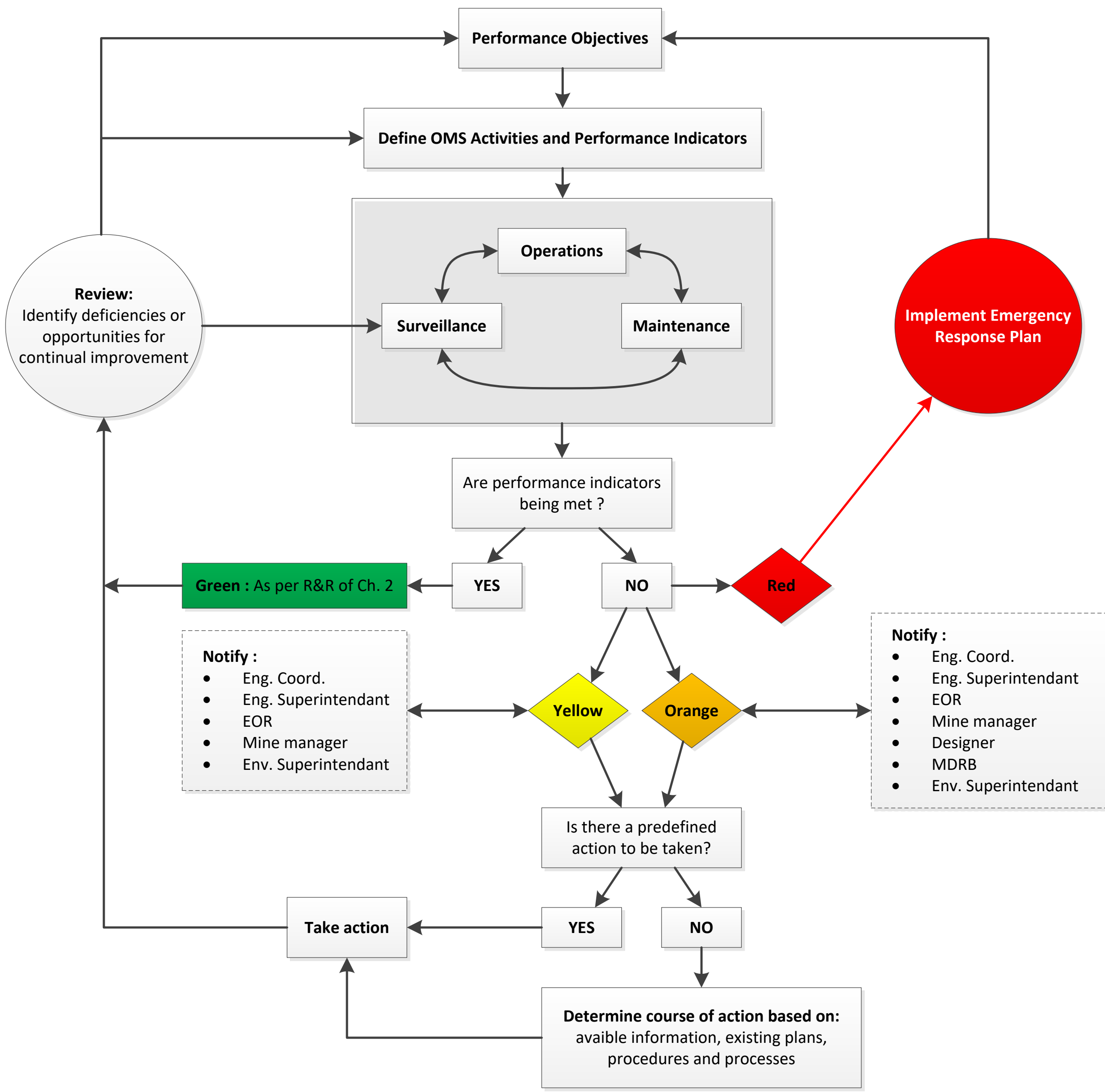

Figure 5-1 : Communication and Decision Process for Water Management Infrastructure TARP

SECTION 6 • MAINTENANCE

This section identifies all infrastructures within the scope of this manual that have maintenance requirements and identifies all preventative, predictive and corrective maintenance activities.

6.1 PREVENTATIVE, PREDICTIVE AND CORRECTIVE MAINTENANCE

Maintenance is divided into preventative (planned), predictive and corrective.

Preventative maintenances are planned, recurring maintenance activities conducted at a fixed or approximate frequency and not typically arising from results of surveillance activities. Example of such maintenance includes calibration and maintenance of surveillance equipment or regularly changing oil on a pump as per manufacturer's requirement.

Predictive maintenances are pre-defined maintenances conducted in response to results of surveillance activities that measure the condition of a specific component against performance criteria.

Corrective maintenance of a component of the water management system is to prevent further deterioration and ensure their performance in conformance with performance objectives. The need for corrective maintenances is based on surveillance activities, with surveillance results identifying the need and urgency of maintenance.

6.2 REFERENCES

References to key documents for the maintenance of the Dewatering Dikes at Meadowbank are presented in Table 6-1.

Table 6-1 : Reference documents for Maintenance of Dewatering Dikes at Meadowbank

Type of information	Link to Retrieve Information
Maintenance log of water management infrastructure	In progress
Maintenance log of pumping equipment	I:\MAINTENANCE\G dore\PWA-COM-LGT hrs reading.xlsx
Maintenance log of geotechnical instrumentation	In progress
Pump allocation tool	In progress
Geotechnical instrument & Datalogger inventory	In progress

6.3 COMPONENT OF THE DEWATERING DIKES REQUIRING MAINTENANCE

Table 6-2 indicates all the component of the Meadowbank water management infrastructure that requires maintenance.

Table 6-2 : Component of the Dewatering Dikes requiring maintenance

Water Management Infrastructure
• Dike embankment (i.e repair erosion) • Dike crest (i.e fill inactive tension cracks) • Seepage collection sump (i.e, reprofile slope, increase sump volume) • Ditches and diversions (i.e snow removal, repair erosion)
Surveillance
• Geotechnical instruments (thermistors, piezometers, inclinometers, survey monument) • Data acquisition system • Flowmeter
Other
• Dike crest access road • Access to sump

6.3.1 Maintenance components that are outside the scope of this OMS manual

The following component maintenance activities are outside of the scope of this OMS manual. For more information, the superintendent of the department responsible for these maintenance can be contacted

- Electrical systems and supply – E&I
- Maintenance of heavy equipment and light vehicles – Maintenance
- Communication infrastructures - IT
- Road used to access the infrastructures – Mine

6.4 DESCRIPTION OF MAINTENANCE ACTIVITIES

Table 6-3 summarizes the description of maintenance activities for each component of the Meadowbank water management infrastructure. Each component has activities as well as a trigger for that maintenance and a person responsible for this activity. It is the duty of the person responsible for the maintenance activity to ensure that the person doing the maintenance has the qualifications and competencies required to conduct the maintenance and is following the proper safety procedure. The responsible person must also ensure that the proper documentation and reporting requirement are followed.

Table 6-3 : **Description of maintenance activities for components of water management infrastructure**

Component	Type of maintenance	Nature of the activity	Frequency of maintenance (preventative) OR Trigger of maintenance (predictive and corrective)	Responsible for the activity	Documentation Required	Reporting Requirement
Water Management Infrastructure						
Dike embankment - repair erosion	Corrective	Gullies and depression to be filled with rockfill and re-sloped	Following a demand from engineering superintendant following a visual inspection showing erosion	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work	Engineering to update the maintenance log of the structure
Dike crest – fill inactive tension cracks	Corrective	Inactive tension cracks to be filled with bentonite to prevent widening due to water infiltration	Following a demand from engineering superintendant following a visual inspection showing inactive tension cracks	Geotechnical technician	Photo of remediation work	Engineering to update the maintenance log of the structure
Dike crest - compensate settlement	Corrective	Add rockfill to increase the height of the dike following observation of settlement	Following a demand from engineering superintendant following a visual inspection showing settlement that need to be compensated (i.e loss of freeboard)	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work Surveying of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Seepage collection sump– increase volume	Predictive	Excavate an additional sump or increase the capacity of an existing sump	Following a demand from engineering superintendant following a re-assessment of the sump capacity	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work Surveying of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Seepage collection sump – reprofile sump	Corrective	Excavate flatter slope for the sump or add material against the slope to reprofile them	Following a demand from engineering superintendant following a visual inspection showing instable sump slope	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Ditches – snow removal	Predictive	Use an excavator to remove snow in the ditch	Every year prior to freshet to ensure that ditch is clear of snow obstruction. Demand will be formulated by the Engineering Superintendent	Energy & Infrastructure Superintendant	Photo of remediation work	Engineering to update the maintenance log of the structure
Ditches – clean debris and sediment accumulation	Corrective	Remove any debris and accumulation of sediment that can hinder flow	Following a demand from engineering superintendant following a visual inspection showing accumulation of debris and sediment	Energy & Infrastructure Superintendant	Photo of remediation work	Engineering to update the maintenance log of the structure
Ditches – repair erosion of granular layer	Corrective	Add granular material to repair erosion of the ditches	Following a demand from engineering superintendant following a visual inspection showing erosion of the ditches	Energy & Infrastructure Superintendant	Photo of remediation work	Engineering to update the maintenance log of the structure
Ditches – release of TSS from the ditches	Corrective	Corrective action to mitigate release of TSS from ditches. Can include placement of sill curtain or temporary by-passing the ditches using pump	Following a demand from the environment superintendant following sampling of a high turbidity event from the diches	Environment Superintendant	Water sample results Photo of remediation work	Engineering to update the maintenance log of the structure
Surveillance						
Geotechnical Instrument – loss of reading	Corrective	Investigate the status of an instrument who no longer gave data	When an instrument no longer gave data for an unknown reason	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument – unusual reading	Corrective	Investigate the status of an instrument who gave unusual data	When an instrument gave an unusual data	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument – replacement	Corrective	Replace an instrument that no longer work	When the engineering superintendant as for a geotechnical instrument to be replaced	Geotechnical technician	Instrument installation as-built report Update spare inventory Calibration sheet Initial instrument rading	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument –calibration of total station	Preventative	Send the total station to be calibrated	yearly	Geotechnical technician	Calibration sheet	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument –calibration of inclinometer probe	Preventative	Send the inclinometer probe to be calibrated	yearly	Geotechnical technician	Calibration sheet	Update of the geotechnical instrument database by the geotechnical technician
Datalogger – maintenance	Preventative	Do maintenance of datalogger as per manufacturer specification	yearly	Geotechnical technician	Maintenance report	Update of the geotechnical instrument maintenance log by the geotechnical technician

Component	Type of maintenance	Nature of the activity	Frequency of maintenance (preventative) OR Trigger of maintenance (predictive and corrective)	Responsible for the activity	Documentation Required	Reporting Requirement
Datalogger – battery change	Predictive	Change battery when the battery level alarm get triggered	When the battery alarm is trigered in VDV	Geotechnical technician	Maintenance report	Update of the geotechnical instrument maintenance log by the geotechnical technician
Datalogger – troubleshooting	Corrective	Repair of a dataloger deficiency	When a dataloger is suspected of being deficient	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – calibration	Preventative	Send the flowmeter to be calibrated	yearly	Energy & Infrastructure Superintendant	Calibration sheet	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – deficient reading	Corrective	Repair of a flowmeter deficiency	When the Engineering Superintendant ask that a flowmeter be troubleshoot based on irregular data	Energy & Infrastructure Superintendant	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Other						
Dike crest access	Predictive	Snow clearing, maintaining roadway, grading access	As required to maintain access	Mine Superintendent	-	-
Access to sump	Predictive	Snow clearing, maintaining roadway, grading access	As required to maintain access	Mine Superintendent	-	-

SECTION 7 • SURVEILLANCE

Surveillance involves the inspection and monitoring (i.e collection of qualitative and quantitative observation and data) of the Dewatering Dikes. Surveillance also includes the timely documentation, analysis and communication of surveillance results, to inform decision making and verify whether performance objectives including critical controls are being met.

There are two type of surveillances activities which are further discussed in this chapter:

- Site observation and inspection
- Instrument monitoring

7.1 REFERENCE

References to key documents for site observation & inspection of the Dewatering Dikes at Meadowbank are presented in Table 7-1. References to key documents for instrument monitoring are presented in Table 7-2.

Table 7-1 : Key reference documents for Inspection of the Dewatering Dikes at Meadowbank

Type of information	Document #	Document Title and link
Simplified inspection form Template	-	OMS manual - Appendix A
Detailled visual inspection form template	-	OMS manual – Appendix A
East Dike Dewatering inspection report	ED-VIR	..\..\..\..\04-DewateringDikes\East Dike\Inspection
Bay-Goose Dike inspection report	BG-VIR	..\..\..\..\04-DewateringDikes\Bay-Goose Dike\Inspection
South Camp Dike inspection report	SCD-VIR	..\..\..\..\04-DewateringDikes\South Camp Dike\Inspection ....
Vault Dike inspection report	VD-VIR	..\..\..\..\04-DewateringDikes\Vault Dike\19 - Inspection...
Annual dike safety inspection (annual geotechnical inspection)	-	..\..\..\10- Audit & External Inspection\2- Annual Geotech Inspection..\..\..\04- Water Management\6- Inspection

Table 7-2 : Reference documents for Instrument monitoring of the Dewatering Dikes at Meadowbank

Type of information	Link to Retrieve Information
Geotechnical Instruments map	..\..\..\..\11-Instrumentation\Instruments\MAP & DWG
Access to instrument data	VDV
Instrumentation Report	..\..\7 - Instrumentation Report
Blast vibration log	**"\\CAMBFS01\Groups\Engineering\05-Geotechnic\99-Archive\Blast Monitoring\Events\k_factor(to update).xls"**

7.2 SITE OBSERVATIONS AND INSPECTIONS

The purpose of site observations and inspections is to identify warning signs of the development of potentially adverse conditions that could lead to a failure or some other form of loss of control. Site observations and inspections include the direct observations by personnel on or adjacent to the Dewatering Dikes and may also include observations from helicopter or photos taken from unmanned airborne vehicle (UAV, satellites).

Site observations and inspections are used to identify and track visible changes in the condition of the Dewatering Dikes. Changes that may be observed throughout site observations and inspections are included in Table 7-3

Table 7-3 : Changes that may be observed through site observation and inspection of the Dewatering Dikes at Meadowbank

Changes related to physical risk of dike, road, ramp
• Change in freeboard • Deformation or change in condition at the crest, slopes and toes (i.e bulge, cracks, sinkhole, sloughing, settlement) • Newly form or expanding areas of erosion • Evidence of piping or unexpected water movement through water containment structures • Changes in the seepage quantity (pumping rate) and quality (turbidity)
Changes related to physical risk of ditch
• Newly form or expanding areas of erosion • Newly form of obstruction to flow (i.e boulder, sediments, snow) • Newly form of slope instability
Changes related to water storage and transport
• Change in sump level • Verify using the staff gauge that the pond is operated within its normal operating condition • Changes in the seepage quantity (pumping rate) and quality (turbidity) • Condition of pipe for water transport • Sign of leaks from water line • Condition of pumps
Change related to surveillance instrumentation
• Condition of surveillance instruments and associate protection around instruments (i.e cover, barriers to prevent vehicle damage) • Condition of power supplies for instruments (i.e solar panel) • Condition of communication infrastructures associated with instruments (i.e antenna, datalogger)

7.2.1 Site observation

Site observation is conducted by personnel working on or adjacent to the Dewatering Dikes as part of their daily activities, maintaining awareness of the facility in the course of carrying their duties. Trained personnel such as geotechnical technician should be on the lookout for sign of changing condition as indicated in Table 7-3 as adverse condition can develop rapidly between inspections. A simplified visual observation form can be used to document such observations but they do not need to be documented unless a new condition has been observed. Any new observation should be documented by photograph and reported to the geotechnical personnel or Engineering Superintendent.

7.2.2 Inspection program

Inspections are conducted by the engineering department or other personnel with appropriate training and competency and are more rigorous than site observations.

The inspection program consists of several types of inspections such as routine and special visual inspection, dike safety inspection and dam safety review. The following sub-section describe in more details the scope, frequency and responsible for each type of inspection.

7.2.3 Routine Visual Inspection

Routine visual inspections are conducted on a pre-defined schedule and may target specific activities. Their objective is to identify any conditions that might indicate change in the Dewatering Dikes performance and therefore require follow-up. The inspections need to cover the aspect described in Table 7-2. Of particular significance are new occurrences or noted changed in seepage, erosion, sinkholes, boils, slope slumping, settlement, displacement, or cracking of structure components. These inspections are held during dewatering and operation.

There are two approved inspection form for inspection; a simplified one and a detailed one. The detailed form should be used for monthly inspection while the simplified one can be used when inspection are required at an increased frequency. All areas of the form must be filled.

The person responsible for the inspection must:

- Do the inspection as per the required frequency
- Fill all information on the proper inspection form
- Take pictures to supplement the inspection. As much as possible, these are to be taken from the same vantage points during each inspection so that changes in conditions can be readily identified. Photos should be annotated or captioned and should include a date stamp.
- Store electronically all photo and inspection form
- Update the surveillance log
- Ensure that the reviewer is aware that the document is ready to be reviewed

During the review process, the reviewer must:

- Ensure that all required information is present
- Ensure that the observation does not trigger a change in alert level
- Sign the inspection form as a reviewer
- Update the surveillance log
- Distribute the inspection results

The frequency for inspection of a structure will vary based on its TARP level and need to be updated in the surveillance log.

Table 7-4 summarises the Routine & Special visual inspection R&R, suggested frequency and scope in function of the alert level of the structure

Table 7-4 : Summary of routine inspection requirements

Structure	TARP Level	Inspection Responsible	Scope of inspection	Inspection Frequency	Reporting	Inspection Reviewer	Distribution List
East Dike, Bay-Goose Dike, South Camp Dike, Vault Dike - Operation	Green	Geotechnical Technician	Physical risk and surveillance	Monthly	Detailled inspection form	Geotechnical Engineer	Engineering Geotechnical Team, EOR
				Weekly during period of flow (from May to October)	Simplified inspection form	-	
	Yellow	Geotechnical Technician	Physical risk and surveillance	Monthly	Detailled inspection form + presentation and analysis of instrumentation data	Geotechnical Engineer	Engineering Geotechnical Team, EOR
				Weekly	Simplified inspection form		
	Orange	Geotechnical Technician	All of Table 7-2	Weekly	Report on summary of surveillance activity + status of mitigation action	Geotechnical Engineer	Engineering Geotechnical Team, EOR, designer, Management
				Monthly	Detailled inspection form + presentation and analysis of instrumentation data	Geotechnical Engineer	Engineering Geotechnical Team, EOR
		Geotechnical Engineer		Daily	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, EOR

7.2.3.1 Special Visual Inspection

Special inspections are conducted during and after unusual or extreme events that may impact the facility. Special inspections are conducted by the Geotechnical Engineer/Specialist or Engineer of Record using the detailed inspection form and using the same procedure for review and documentation. Special visual inspections must be done on each structure after each of these events:

- At the end of dewatering once downstream toe is exposed
- Following a blast that exceeds the vibration limits of the structure
- After an earthquake
- After a high intensity rainfall event (higher than a 1:2 years recurrence)
- Immediately after a site observation notices a change in condition
- Prior or immediately after increasing or decreasing the TARP level of a structure

7.2.3.2 Dike Safety Inspection (annual geotechnical inspection)

A dike safety review is a more comprehensive technical inspection, integrating inspections and results of monitoring instrument. This type of inspection is conducted by an external geotechnical engineer and supported by the Engineer of Record to have a more complete understanding of the facility performance and identify deficiencies in performance or opportunity for improvement. This will provide information to be used to revise the OMS manual.

For the Dewatering Dikes at Meadowbank, such inspection needs to occur on an annual basis between the month of July and September. The following components need to be inspected during this review:

- East Dike, Bay-Goose Dike, South Camp Dike and Vault Dike
- Ditches and channel

In addition to field inspection done as part of the safety review the following point should be addressed during the review:

- Review of all inspections report performed since the last review
- Review of monitoring instruments data;
- Identify deficiencies in performance or opportunity for improvement
- Review OMS performance and operational criteria and confirm that these meet the performance objective of the design
- Review and provide recommendations regarding OMS for the following year.

After each safety inspection, a report must be submitted to the Engineering Superintendent which includes the results of the inspection done and addressing all points above. These reports will be stored electronically.

7.2.3.3 Independent Dam Safety Review

Independent dam safety reviews are carried out by an independent third party to review all aspects of the design, construction, operation, maintenance, processes and other systems affecting the dam's safety, including the dam safety management system. The review defines and encompasses all components of the "dam system" under evaluation including the dams, foundations, abutments, instrumentation and seepage collection works. The independent third party for the Dewatering Dikes is the Meadowbank Dike Review Board (MDRB).

Modification to the MDRB composition can only be made by the Engineer of Record.

The Meadowbank Dike Review Board (MDRB) is comprised of the following member.

- Anthony Rattue
- Don Haley

An annual MDRB meeting will be held every year at the Meadowbank site. Other events that could trigger a MDRB meeting are:

- Major modifications to the design or design criteria;
- Discovery of unusual conditions that can compromise the integrity of the Dewatering Dikes;
- After extreme hydrological or seismic events; and
- Decommissioning.

During the annual MDRB meeting, a dam safety review will be carried out according to the recommendations laid out in the Dam Safety Guidelines (CDA, 2013).

This review will include, but is not limited to:

- Review of the dikes classification;
- Site inspection;
- Review of design and construction records;
- Review of monitoring practices and the instrumentation records
- Assessment of the operation of the facilities;
- Provide recommendation on operation, maintenance and surveillance based on the results of the instrumentation readings, construction records and site observations;

7.3 INSTRUMENT MONITORING PROGRAM – DATA ACQUISTION

Instrument monitoring provides information on parameters or characteristics that cannot be detected through site observation or inspections, cannot be observed with sufficient precision and accuracy or need to be monitored at high frequency or continuously.

The objective of instrument monitoring is to collect data to be used to assess the performance of the infrastructures against the performance objectives and indicators and the critical controls (refer to table 4-2 and 5-2). Instrument monitoring and inspections work together as a comprehensive data set to enable assessment of the Dewatering Dikes performance and provide a basis for informed decision. All are essential, and none of these forms of surveillance can be neglected if performance objectives are to be met and risks are to be managed.

More information on the type of in-situ instruments installed on each structure, how they were installed and their location can be found in Section 3-6 of this OMS manual.

Table 7-5 indicates the type of information collected through instruments monitoring and how it is collected. Table 7-6 summarizes the data acquisition program related to instrument monitoring.

Table 7-5 : Information collected using instrument monitoring

Direct collection of information
• In-situ thermistors to measure temperature profile within the structure and its foundation • In-situ piezometer to measure pore-water pressure providing information about flow of water through the structure and foundation stability • In-situ shape array inclinometer (SAA) to provide information on deformation within the cut-off wall • Survey monument to provide information on settlement and deformation • Staff gauge to inform about water level of a pond versus its operating level • Blast monitor to inform on potential impact of blasting vibration on the structure • Flow meters and seepage monitoring station to inform on volume of water movement • Surveys conducted to measure ice cover, water level, update height and slope of containment structure
Collection of information from remote sensing
• Data acquired from airborne survey to generate detailed topographic map
Collection of information based on laboratory analyses
• Water quality analysis of seepage and surface runoff • Water quality analysis of water discharged through diffuser to inform on Environmental compliance • Water quality analysis of water stored in the various pond on site to inform on water movement decision
Collection of information related to the conduct of OMS activities
• Automatic data collection and transmission system for in-situ instruments (datalogger, solar panel, antenna, battery)

Table 7-6 : Summaries of data acquisition program related to instrument monitoring of the Dewatering Dikes at Meadowbank

Instrument monitoring	Location of monitoring (3)	Parameter measured	Acquisition Methodology	Standard Acquistion frequency	Acquisition Responsible	Documentation methodology	Documentation Responsible
Thermistors	East Dike, Bay-Goose Dike, South Camp Dike, Vault Dike	Temperature (C^0) point for each bead on the chain	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Geotechnical Technician	Data are exported from VDV into instrumentation report emited at a predetermined frequency (1)(2)	Geotechnical Engineer
Piezometer	East Dike, Bay-Goose Dike	Pressure (kpa) point for each instrument	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Geotechnical Technician	Data are exported from VDV into instrumentation report emited at a predetermined frequency (1)(2)	Geotechnical Engineer
Shape array accelerometer (SAA)	-	Displacement in mm	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Geotechnical Technician	Data are exported from VDV into instrumentation report emited at a predetermined frequency (1)(2)	Geotechnical Engineer
Survey monument	-	Elevation of monument which is then converted into mm of displacement (minimum precision of 3 mm required)	Data are acquired using a total station	Monthly in winter and bi-weekly from May to September	Geotechnical Technician	Data are exported into geoexplorer. Instrumentation report are emited at predetermined frequency (1)(2)	Geotechnical Technician
Staff Gauge	-	Water level in pond	Take picture of the gauge	During each inspection	Inspection officer	Within inspection report	Inspection officer
Blast Monitor	Bay-Goose Dike	Peak particle velocity (PPV) measured by the blast monitor (mm/s)	Placement of blast monitor at a predetermined area on the dike	Before each blast in the vicinity of the dike	Geotechnical Technician	Update the blast vibration log. Discussion on recorded vibration in instrumentation report	Geotechnical Technician
Flow meter	-	Volume of water pump (m^3)	Pumpman operator will inscribe flowmeter value ona pumping sheet	Daily when pump is operating	E&I Pump crew supervisor	Data will be integrated in the water balance	Water & Tailings engineer
Seepage monitoring station (manual reading with a V notch)	East Dike, Bay-Goose Dike	Seepage flow (m^3/s)	Using a bucket and a stopwatch	Weekly during period of flow	Geotechnical Technician	Documented within instrumentation	Geotechnical Engineer
Survey shot	East Dike, Bay-Goose Dike	Elevation of the water level (minimum precision of 3 mm required)	Surveyor will take a water/ice level at a predetermined area	Once per week	Surveyor Leader	Integrated in the water movement log	Water & Tailings engineer
Airborne survey	All water management infrastructure	Topographic aerial survey made using drone	Surveyor will take a drone survey	Once per year after freshet	Surveyor Leader	Within survey database	Surveyor Leader
Water quality(4)	East Dike	Parameter indicated within water management plan	Water quality sample taken and sent for laboratory analyses	Acquisition frequency within water management plan	Environment General Supervisor	Within Env water quality database	Environment General Supervisor

(1)Refer to section 7-5 for more information on reporting methodology and the frequency of reporting
(2) Refer to section 7-6 on how to present instrumentation data from VDV in a report
(3) Exact location of each instrument can be found in the instrumentation database
(4) Location of water quality sampling point can be found in water management plan

7.4 ADDING INSTRUMENT TO THE MONITORING PROGRAM

Any addition to the monitoring program must be validated by the Engineering Superintendent or by the Environment Superintendent for aspect relating to water quality. In-situ instrument installation must be recorded in an as-built report and added to the instrumentation database and map. After each installation of instrumentation the following must be done:

- Document the calibration sheet and initial data reading
- Document instrument specification (manufacturer sheet)
- Document Information to which datalogger the instrument is connected
- Survey instrument coordinates (x,y,z)
- If the instrument is drilled, a schematic view of the depth of the instrument versus the stratigraphy must be produced
- Photo of installation must be documented

7.5 ANALYSIS OF SURVEILLANCE RESULTS

For the effective use of surveillance results and decision making, results must be collated, examined, analysed and reported in a timely and effective manner.

For visual inspections, the process of analyzing the data and communicating the results is described in section 7-4 and happens while the inspection is done and the report is sent. The information gained from the analysis of these results is then compared during the inspection and review to the TARP criteria which will then indicate the action to take if performance indicators are not met.

For the instrumentation monitoring to be effective, the data must be reviewed, analysed and reported at the proper frequency. Table 7-6 summarises the requirements for review, analyses and reporting of instrumentation data.

The person responsible for instrumentation data review needs to update the surveillance log each time an instrument result has been reviewed and analysed. The person responsible for review of reporting and distribution needs to update the surveillance log once the report has been reviewed and distributed.

Table 7-7 : **Requirements for review, analyses and reporting of instrument data**

	TARP Level	Expected range of observation	Responsible for review & analyse	Frequency of review	Responsible for reporting	Reporting frequency	Responsible for review and distribution	Distribution List
Piezometer, thermistor, inclinomter, survey monument (**Operation**)	Green	Define in TARP of each structure	Geotechnical Engineer	Bi-Weekly	Geotechnical Technician	Quaterly instrumentation report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
			Geotechnical technician	Weekly				
	Yellow	Define in TARP of each structure	Geotechnical Engineer	Weekly	Geotechnical Technician	Instrumentation reporting included within monthly inspection report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
			Geotechnical technician	Every 3 days				
	Orange	Define in TARP of each structure	Geotechnical Engineer	Daily	Geotechnical Engineer	Instrumentation reporting included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
			Geotechnical technician	Daily				
Staff Gauge / Survey shot (freeboard)	Green	Define in TARP of each structure	Water & Tailings Engineer	Weekly	Water & Tailings Engineer	Within the monthly attenuation pond and pumping infrastructure inspection report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP of each structure	Water & Tailings Engineer	Daily	Water & Tailings Engineer	Within the monthly attenuation pond and pumping infrastructure inspection report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP of each structure	Water & Tailings Engineer	Twice a day	Water & Tailings Engineer	Included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Blast Monitor	-	PPV> 50 mm/s	Geotechnical Technician	After retrieving a blast monitor on a water management structure	Geotechnical Technician	In Quaterly instrumentation report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
Flow meter / Seepage monitoring	Green	Define in TARP of each structure	Water & Tailings Engineer	Weekly	Water & Tailings Engineer	During the monthly update of the water balance	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP of each structure	Water & Tailings Engineer	Daily	Water & Tailings Engineer	During the monthly update of the water balance	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP of each structure	Water & Tailings Engineer	Twice a day	Water & Tailings Engineer	Included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Water quality	Green	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendant	Engineering geotechnical team
	Yellow	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendant	Engineering geotechnical team
	Orange	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendant	Engineering geotechnical team

7.5.1 Procedure in case of data exceeding expected range of observation

If data exceeding the expected range of observation or anomalous data readings are observed, the following actions need to be taken:

- Re-read to check the reading (if the reading is from VDV, take a manual reading in the field);
- Check readout equipment to verify that it is functioning correctly;
- Verify calibration;
- If instrument has stopped functioning, notify the Engineering Superintendent immediately. If considered critical, a replacement instrument should be installed;
- If an anomalous reading is confirmed, a detailed review of the effects of the reading should be carried out and design or remedial actions should be implemented if determined necessary by the Engineering Superintendent. Any malfunctioning instrument or frozen piezometer must be documented;
- In the case of valid data that would exceed the TARP level do a special inspection if possible

Before modifying the TARP level due to in-situ instrumentation or reading that cannot be confirmed by other visual observation, the EOR must be consulted for further guidance.

7.5.1.1 Blast Monitor

If a reading exceeding the PPV limit for a water management structure (50 mm/s) is observed, this event must be communicated to the drill and blast engineer who will need to ensure that the blasting pattern is modified to avoid re-occurrence of this event. Afterward a special inspection will need to be done on the structure to look for changing condition.

If more than one occurrence of blast vibration exceeding the limit is observed within a 2 weeks period, the Engineering Superintendent needs to be notified of the situation.

7.5.2 Anomalous Instrumentation Data

Anomalous instrumentation data are presented in Table 7-8. These anomalies could happen without triggering a TARP level change and need to be investigated and recorded:

Table 7-8 : Example of anomalous data and some common causes

Thermistors
• Increase or decrease in measurements (over two or more readings) that cannot be explained by seasonal temperature variations; • Progressive loss of data (starting from the bottom and progressing). This is usually a sign of water infiltration • Observation of a spike in temperature in one bead. This is usually due to a capacitive effect • Loss of data (could be a transmission error, faulty hardware or a sheared cable)
Piezometer
• Increase or decrease in pore water pressure measurements that cannot be explained by seasonal lake level variations (verify that the instrument has not been installed in a casing); • Sharp increase in reading (verify that the instrument is not frozen) • Loss of data (could be a transmission error, faulty hardware or a sheared cable)
Inclinometer
• Cumulative increases in displacement (greater than 3 cm); • Erratic movement. This is usually a sign of water infiltration
Survey Monument
• Accelerating displacement rate of the survey monuments (x, y, z directions) (over two or more readings) (could be due to a prism shooting error or problem with the total station)
Blast Monitor
• Vibrations during a blast are not observed (the blast was cancelled, the blast monitor was not properly installed or vibrations were too weak to be recorded)
Flowmeter, survey shot and staff gauge
• Sudden change in staff gauge reading. Or reading that seems not to reflect the probable water elevation. This could be due to a settlement or displacement of the staff gauge. • Increase or decrease of a flowmeter reading that are inconsistent with pumping rate or rainfall or observed water level. • Survey elevation that has a sharp fluctuation from last reading. This can be caused by the reading not being taken at the good location, wave actions or daily variances in GPS signal

7.6 SURVEILLANCE DOCUMENTATION & REPORTING

One visual inspection report per structure needs to be completed, reviewed and distributed per the frequency shown in Table 7-4.

An instrumentation report needs to be prepared at predetermined frequency to present all instrumentation monitoring data as described in Table 7-7.
Table 7-9 describes how instrumentation data should be reported.

Instrumentation report needs to include the following informations:

- Table presenting all the instruments installed on each structure, their status and pertinent installation information
- Graph of all instruments for all structure covered by the report. The graph needs to present data for a minimum period of 1 year. Higher recurrence should be presented if clarity of the presented information allows it. The graph needs to be presented in a way that allows for data interpretation without referring to other document
- Analyses of all instruments data presented highlighting specific trend
- Discussion on anomalous trend

For the structure that have a yellow Tarp level, the instrumentation data relevant to the cause of the alert needs to be included with each visual inspection report.

For the structure that have an orange Tarp level, the instrumentation data relevant to the alert level needs to be included with each inspection report. In addition the weekly update report needs to be written with the following information:

- Context on why the structure is at the orange level
- Change in condition since the last weekly report
- What is the mitigation plan and what action have been taken since the last update report
- Discussion on the results of the instrumentation data

Table 7-9 : How data should be presented in report for instrumentation monitoring

Thermistor
• Temperature vs. depth plots over time. • The plot should indicate the thermistor string reference number and date of each measurements presented • The plot need to indicate relevant stratigraphy and their depth • Plot need to be presented with a cross-section of the installation (if on a structure) as well as a plan view showing the instrument location
Piezometer
• Plots of total head as elevation versus time; and • Plot need to be presented with a cross-section of the installation showing lithology with depth as well as a plan view showing the instrument location • The plot need to indicate the instrument number, the dates of each measurement and a mention if the temperature read by the instrument is less than 0 degree
Inclinometer
• Cumulative displacement plots (to view total displacement); • Incremental displacement plots (to present increasing or accelerating movements between readings); • Cumulative displacement at crest versus time; and • Time plots at zones of identified displacement. • The plot need to indicate the SAA number, what is considered positive and negative displacement and the dates of each measurement • Both elevations and depths should be presented together with the lithology. • A plan view needs to be included showing the instruments locations
Survey Monument
• Total net movement plots (to present total displacement); • Vertical displacement plots; and • Lateral displacement plots parallel and perpendicular to the dike axis • The plot need to indicate the survey monument number, what is considered positive and negative displacement and the dates of each measurement • A plan view needs to be included showing the instruments locations

7.7 DATA MANAGEMENT

An electronic library or database, which is easily accessible, shall be set up to catalogue and store inspection documents, maintenance reports and instrumentation measurements. The following will be stored in the hard copy and/or electronic format. Section 7.1 indicates where each of these items can be found electronically:

- Instrumentation report
- Visual inspection report
- Weekly report for structure in orange Tarp level

- Dike safety inspection (annual geotechnical inspection)
- Dam Safety Review report;
- Surveillance log
- Instruments database and map
- Maintenance log of geotechnical instrument
- Maintenance log of water management infrastructure
- Pump maintenance record

Appendix A

Simplified Inspection Form

Detailed Inspection Form Template

Simplified Inspection Form

Simplified Surveillance Form

Structure :	Date

Surveillance done by :

	Item	Changing condition ? Yes	No	NA	Comments
1	Freeboard and pond level				
2	Tension Cracks				
3	Sinkhole				
4	Settlement				
5	Sloughing				
6	Erosion				
7	Debris & Obstruction (ditches, sump)				
8	Seepage				
9	Turbidity				
10	Instrumentation Condition				
11	Piezometric reading				
12	Thermistor reading				
13	SAA reading				
14	Flowmeter				
15	Condition of pipe and pump				

Recommendation

This simplified form is to be used as per the OMS manual instruction. The surveillance log must be updated after this surveillance report is filed. All condition deviating from normal operating threshold must be described in the comments section. Picture of changing condition should be attached to this document. Any changing condition must be reported to the geotechnical engineer. Any chaning condition trigering a change in threshold level must be communicated to the Engineering Coordinator or Superintendant

Detailed Inspection Form Template

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

The instrumentation data is treated separately in the instrumentation quarterly report.

Inspecting Officer	Choose an item.
Report No.	Dike-VIR-
Inspection Date	

Dike name	

Last Inspection Date						
Weather during the current inspection		Sunny ☐	Overcast ☐	Rain ☐	Snow ☐	Wind ☐
	Comments:					
Main changes since the last inspection						

Tarp level (Based on OMS manual revision from March 2018)	

General Condition Summary

-

Inspecting Officer: ____________ Review Officer: ____________ Date Reviewed: ____________
(YY/MM/DD)

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Field observations

Location	Observations	Recommendations
Downstream slope and berm	▪	▪
Upstream slope and berm	▪	▪
Crest	▪	▪

Seepage Report

Location	Observations	Recommendations
	▪	▪

Methodology: For the visual inspection, any anomaly or change since the last inspection must be reported. These anomalies include cracks, erosion, settlements, sink holes, bulging, sloughing, seepage signs, snow/ice, rutting, mud, ponds/puddles, signs of saturated soil and any damage on the liner or objects/water over the liner.

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Aerial view of the Dike

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Map of the Dike

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Downstream slope and berm

DS1: Downstream slope and berm.	Location and orientation of DS1.

DS2: Downstream slope and berm.	Location and orientation of DS2.

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Upstream slope and berm

US1: Upstream slope. Lake is frozen.	Location and orientation of US1.

US2: Upstream slope.	Location and orientation of US2.

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Crest surface

CR1: Rolling surface.	Location and orientation of **CR1**

Appendix B

Potential Mitigation for Upset Condition

Potential Mitigation Plan for Upset Condition on Water Management Infrastructures

Upset Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Overtopping and Subsidence	1a	Water level rise / storm event	Lake levels and crest elevations is monitored as part the water management infrastructure surveillance program Outflow channels are inspected during thaw, open water season and during ice break-up.	Add additional pumping unit If rise is caused by a channel obstruction, remove the obstruction
	1b	Dam crest settlement	This scenario requires extensive loss of support in the foundation since the rockfill of the dikes is essentially not settlement prone itself after construction and dewatering. For foundation settlement of this magnitude to occur, a piping event must develop or there is unexpected layer of compressible soil in the foundation. The situation would develop slowly with crest settlement evident at least several weeks before a run-away event develops. Easily observed cracks should be evident. Monitoring of the crest settlement is conducted routinely.	The crest is wide and comprises of coarse rockfill. Significant damage to the dike is not credible, based on performance of other rockfill structures subjected to overtopping or flow through events Rockfill from the mining operations can be placed to raise the dike crest and compensate settlement. Mining operations may need to be suspended, but there will be considerable warning time given the slow development of the scenario.
	1c	Wave action	Large freeboard and wide crest zone makes this a low concern	rip-rap can be added and/or dam crest can be raised.
Internal Erosion	2a	Dike section: Cut-off wall/geomembrane is defective, allowing high water flow. This defect occurs at a location where the core allows high flows and where the fills/geomembrane are defective; the combination allows erosion of the cut-off and/or the Core Backfill.	The cut-off wall/geomembrane and/or core backfill will develop a progressively increasing void ratio, thereby increasing the rate of water flow through the dike. This is not a catastrophic failure mode but could lead to an inability to manage water on site	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance
	2b	Dike section: geomembrane is defective.	Results in increasing the rate of water flow through the dike. This is not a catastrophic failure mode as the rockfill will be stable and at its worst would lead to temporary suspension of mining.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance
	2c	Foundation till is possibly non-uniform with more transmissive zones and not self-filtering. It is possible that one of these zones may align with defective construction of the cut-off wall allowing high flows. Seepage would lead to erosion of the cut-off into the downstream rockfill. Seepage could also erode the foundation tills at the downstream toe or into the downstream rockfill because of the lack of filtering.	Limited seepage at the toe or into the rockfill would accelerate in to a large inflow, and could lead to the undermining of the dike if no action was taken. This is a credible catastrophic mode if increased seepage is not detected in time. No particular instrumentation is needed as this failure mode will show itself as localized and increasing seepage. It could be detected by walk-over inspection by an experienced engineer or technician.	Remedial action could comprise a reverse filter and rockfill buttress depending on location of the flow and configuration of the foundation, freezing or grouting, if identified in time. In the worst case, the pit may be deliberately flooded in a controlled manner, the cut-off repaired and the pit dewatered. Build additional dike downstream increasing pumping.

Upset Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Seepage	3a	Within the Embankment	Seepage on its own is not a credible failure scenario. The downstream rockfill shell has extremely high flow through capacity. The rockfill zone is both large and pervious, so that seepage will not daylight and lead to instability.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance
	3b	Within the Foundation	Defective construction of cut-off leading to transfer of unexpectedly high fraction of the reservoir head into the downstream part of the dike foundation, or leading to a piping event as described in internal erosion (2c). If this mechanism arises it should show itself during initial dewatering or very shortly thereafter.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity Re-evaluate the impact of this water inflow on the site wide water balance Re-assess stability (numerical modelling) and construct a stabilising berm
Structural - Slope Instability	4a	Normal Operation: Slope Failure	The rockfill shoulders of the dike are wide and have high shear strength Slope failure requires failure in the foundation and which would extend into the overlying dike. Sliding failure is considered unlikely given the low horizontal forces generated by the water and ice relative to the normal frictional force due to the weight of the dikes and the frictional angles of foundational materials. This mechanism should develop during construction or dewatering, due to the increase in load and associated pore water pressure development. Initial stages of failure should be observable as tension cracks in the dike crest. Walk-over inspection of the dike by trained inspector is an appropriate monitoring strategy in addition the instrumentation. Survey of crest face and toe is conducted.	Re-assess stability (numerical modelling) and construct a stabilising berm if required Fill inactive tension cracks with bentonite
	4b	Earthquake Induced: Slope Failure	Site is located in a low seismic zone. Dam consisting of massive rock zone has a low sensitivity to seismic motion.	Do an inspection and repair damage
	4c	Erosion; washout, ice scour	Crest – minimum 50 m section, Downstream – large quarry rock face.	Repair erosion by placing additional rockfill and material
Structural – Lateral Movement	5a	Failure of Cut-off Wall	Differential horizontal movement of the dike due to dewatering, water or ice loading or pit wall failure may create a breach in the cut-off wall. Ice and water forces are not credible due to the ratio of frictional forces generated by the self weight of the dike versus ice loads and water pressure. Large inflows through the breach may occur as a consequence if the cut-off wall breached. Pit would flood requiring suspension of mining activities. Potential for loss of life of workers inside dikes. Inclinometer, settlement prism and monument monitoring is done routinely.	Repair the cutoff wall
Subsidence	6	Foundation Soils	Unexpected foundation soils consolidated during dike construction or dewatering. A significant quantity of clay would be required to generate settlement resulting in a water release event. Prism and monument monitoring is done routinely.	A 1 m core settlement would be required to allow water to flow through the rockfill and over the settled cut-off. This flow would not cause failure of the rockfill shells. It would also be readily repaired by excavating rockfill above the cut-off wall and placing more till. Soil conditions will be observed during dewatering to accommodate actual conditions.
Premature Closure	7	Corporate Bankruptcy or Early Resource Depletion	Bond is provided for this eventuality. Design of rehabilitation is the same as rehabilitation at closure of project.	This would trigger the closure plan
Pump and Pipeline Failure	8	Pumping infrastructures	Freezing protection is provided by heat tracing and insulation. Pipelines monitored pump pressures at plant and frequent site inspection.	Replace defect in pipeline Repair the pump and use another pump in the meantime

Appendix C

Instrumentation List

Table 1: Bay Goose Instruments List (TH+PZ)

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in m (top/bottom)
30+134	T1	TH	✓	Automatic (DL1)	-	-	16	135/115
30+158	Pz01P1A	PZ	×(F)	-	-	-	-	-
30+158	Pz01P1B	PZ	×(F)	-	-	-	-	-
30+158	Pz01P1C	PZ	×(F)	-	-	-	-	-
30+158	Pz01P2A	PZ	✓	Automatic (DL1)	117.05	10m below bedrock	-	-
30+158	Pz01P2B	PZ	✓	Automatic (DL1)	122.05	5m below bedrock	-	-
30+158	Pz01P2C	PZ	×(F)	Automatic (DL1)	128.05	1m above bedrock	-	-
30+158	Pz01P3A	PZ	×	Automatic (DL1)	117.13	10m below bedrock	-	-
30+158	Pz01P3B	PZ	×	Automatic (DL1)	122.13	5m below bedrock	-	-
30+167	Pz06P2	PZ	×	Automatic (DL1)	127.57	1m above bedrock	-	-
30+185	T2	TH	✓	Automatic (DL1)	-	-	16	135/115
30+249.5	Pz07P2	PZ	×(F)	Automatic (DL1)	129.85	1m above bedrock	-	-
30+260	T3	TH	✓	Automatic (DL1)	-	-	16	130/125.5
30+272	T4	TH	✓	Automatic (DL1)	-	-	16	130/125.5
30+276.5	Pz02P1A	PZ	×(F)	Automatic (DL1)	119.25	10m below bedrock	-	-
30+276.5	Pz02P1B	PZ	×(F)	Automatic (DL1)	124.25	5m below bedrock	-	-
30+276.5	Pz02P1C	PZ	×	Automatic (DL1)	130.25	1m above bedrock	-	-
30+276.5	Pz02P2A	PZ	✓	Automatic (DL1)	119.1	10m below bedrock	-	-
30+276.5	Pz02P2-B	PZ	✓	Automatic (DL1)	124.1	5m below bedrock	-	-
30+276.5	Pz02P2-C	PZ	×	Automatic (DL1)	130.1	1m above bedrock	-	-
30+276.5	Pz02P3-A	PZ	✓	Automatic (DL1)	119.7	10m below bedrock	-	-

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/ Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
30+276.5	Pz02P3-B	PZ	✓	Automatic (DL1)	124.7	5m below bedrock	-	-
30+288.5	T5	TH	✓	Automatic (DL1)	-	-	16	130/125.5
30+306.5	*Pz08P2*	*PZ*	×(F)	*Automatic (DL1)*	*129.65*	*1m above bedrock*	-	-
30+330.5	*T6*	*TH*	✓	*Automatic (DL1)*	-	-	*16*	*135/115*
30+378.5	*Pz03P1A*	*PZ*	✓	*Automatic (DL2)*	*113.12*	*10m below bedrock*	-	-
30+378.5	*Pz03P1B*	*PZ*	✓	*Automatic (DL2)*	*118.12*	*5m below bedrock*	-	-
30+378.5	*Pz03P1C*	*PZ*	✓	*Automatic (DL2)*	*124.12*	*1m above bedrock*	-	-
30+378.5	*Pz03P2A*	*PZ*	✓	*Automatic (DL2)*	*113.1*	*10m below bedrock*	-	-
30+378.5	*Pz03P2B*	*PZ*	✓	*Automatic (DL2)*	*118.1*	*5m below bedrock*	-	-
30+378.5	*Pz03P2C*	*PZ*	✓	*Automatic (DL2)*	*124.1*	*1m above bedrock*	-	-
30+378.5	*Pz03P3A*	*PZ*	✓	*Automatic (DL2)*	*113.58*	*10m below bedrock*	-	-
30+378.5	*Pz03P3B*	*PZ*	✓	*Automatic (DL2)*	*118.58*	*5m below bedrock*	-	-
30+386	*T7*	*TH*	✓	*Automatic (DL2)*	-	-	*16*	*135/115*
30+417.5	*T8*	*TH*	✓	*Automatic (DL2)*	-	-	*16*	*135/115*
30+440	*Pz09P2*	*PZ*	✓	*Automatic (DL2)*	*126.73*	*1m above bedrock*	-	-
30+453.5	*Pz04P1A*	*PZ*	✓	*Automatic (DL2)*	*116.61*	*10m below bedrock*	-	-
30+453.5	*Pz04P1B*	*PZ*	✓	*Automatic (DL2)*	*118.61*	*5m below bedrock*	-	-
30+453.5	*Pz04P1C*	*PZ*	×(F)	*Automatic (DL2)*	*124.61*	*1m above bedrock*	-	-
30+453.5	*Pz04P2A*	*PZ*	✓	*Automatic (DL2)*	*115.13*	*10m below bedrock*	-	-
30+453.5	*Pz04P2B*	*PZ*	✓	*Automatic (DL2)*	*120.13*	*5m below bedrock*	-	-
30+453.5	*Pz04P2C*	*PZ*	✓	*Automatic (DL2)*	*126.13*	*1m above bedrock*	-	-
30+453.5	*Pz04P3A*	*PZ*	✓	*Automatic (DL2)*	*115.25*	*10m below bedrock*	-	-
30+453.5	*Pz04P3B*	*PZ*	✓	*Automatic (DL2)*	*120.25*	*5m below bedrock*	-	-

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/ Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
30+489.5	T9	TH	✓	Automatic (DL2)	-	-	16	135/115
30+516.5	Pz010P2	PZ	×(F)	Automatic (DL2)	130.26	1m above bedrock	-	-
30+553.25	T10	TH	✓	Automatic (DL2)	-	-	16	135/115
30+621.5	T11	TH	✓	Automatic (DL3)	-	-	16	135/115
30+645.5	Pz05P1A	PZ	×(F)	Automatic (DL3)	118	10m below bedrock	-	-
30+645.5	Pz05P1B	PZ	×(F)	Automatic (DL3)	123	5m below bedrock	-	-
30+645.5	Pz05P1C	PZ	×(F)	Automatic (DL3)	129	1m above bedrock	-	-
30+645.5	Pz05P2A	PZ	✓	Automatic (DL3)	117.85	10m below bedrock	-	-
30+645.5	Pz05P2B	PZ	✓	Automatic (DL3)	122.85	5m below bedrock	-	-
30+645.5	Pz05P2C	PZ	×(F)	Automatic (DL3)	128.85	1m above bedrock	-	-
30+645.5	Pz05P3A	PZ	✓	Automatic (DL3)	115.15	10m below bedrock	-	-
30+645.5	Pz05P3B	PZ	✓	Automatic (DL3)	122.6	5m below bedrock	-	-
30+650	TH12	TH	✓	Automatic (DL3)	-	-	16	135/115
30+684.5	Pz11P2	PZ	×(F)	Automatic (DL3)	130.65	1m above bedrock	-	-
30+713	TH13	TH	✓	Automatic (DL3)	-	-	16	135/115
30+770	Pz12P2	PZ	×(F)	Automatic (DL3)	132.16	1m above bedrock	-	-
30+804.5	Pz13P2	PZ	×(F)	Automatic (DL3)	132.05	1m above bedrock	-	-
30+827	TH14	TH	✓	Automatic (DL3)	-	-	16	135/115
31+052	Pz14P2	PZ	×(F)	Automatic (DL4)	131.06	1m above bedrock	-	-
31+080	TH15	TH	✓	Automatic (DL4)	-	-	16	135/115
31+134.5	TH16	TH	✓	Automatic (DL4)	-	-	16	135.08/115.08

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	**ID**	**PZ/TH**	**Operational (✓)/Not operational (×)/ Frozen (F)**	**Manual/ Automatic**	**Elevation (m)**	**Stratigraphic unit**	**Number of operational beads**	**Elevation interval in meters (top/bottom)**
31+165	Pz23P1A	PZ	×(F)	Automatic (DL4)	118.49	10m below bedrock	-	-
31+165	Pz23P1B	PZ	×(F)	Automatic (DL4)	123.49	5m below bedrock	-	-
31+165	Pz23P1C	PZ	×(F)	Automatic (DL4)	127.49	1m above bedrock	-	-
31+165	Pz23P2A	PZ	✓	Automatic (DL4)	116.91	10m below bedrock	-	-
31+165	Pz23P2B	PZ	✓	Automatic (DL4)	121.91	5m below bedrock	-	-
31+165	Pz23P2C	PZ	×(F)	Automatic (DL4)	127.91	1m above bedrock	-	-
31+165	Pz23P3A	PZ	✓	Automatic (DL4)	116.96	10m below bedrock	-	-
31+165	Pz23P3B	PZ	✓	Automatic (DL4)	121.96	5m below bedrock	-	-
31+170	TH17	TH	✓	Automatic (DL4)	-	-	16	135/115
31+220	Pz15P2	PZ	×(F)	Automatic (DL4)	130.73	1m above bedrock	-	-
31+352	TH18	TH	✓	Automatic (DL4)	-	-	16	135/115
31+565	Pz16P2	PZ	×(F)	Automatic (DL5)	131.28	1m above bedrock	-	-
31+595	TH19	TH	✓	Automatic (DL5)	-	-	16	135/108
31+600	Pz24P1A1	PZ	✓	Automatic (DL5)	111.3	11m below bedrock	-	-
31+600	Pz24P1A2	PZ	×(F)	Automatic (DL5)	116.3	4m below bedrock	-	-
31+600	Pz24P1B1	PZ	×(F)	Automatic (DL5)	121.8	1m above bedrock	-	-
31+600	Pz24P1B2	PZ	×(F)	Automatic (DL5)	124.3	4m above bedrock	-	-
31+600	Pz24P2A1	PZ	✓	Automatic (DL5)	110.15	10m below bedrock	-	-
31+600	Pz24P2A2	PZ	✓	Automatic (DL5)	116.15	4m below bedrock	-	-
31+600	Pz24P2B1	PZ	✓	Automatic (DL5)	120.65	10m above bedrock	-	-
31+600	Pz24P2B2	PZ	✓	Automatic (DL5)	123.15	3m above bedrock	-	-

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/ Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
31+600	Pz24P2C	PZ	✓	Automatic (DL5)	124.65	4m above bedrock	-	-
31+600	Pz24P3A1	PZ	✓	Automatic (DL5)	110.64	10m below bedrock	-	-
31+600	Pz24P3A2	PZ	✓	Automatic (DL5)	115.64	5m below bedrock	-	-
31+600	Pz24P3B1	PZ	✓	Automatic (DL5)	121.16	11m above bedrock	-	-
31+600	Pz24P3B2	PZ	×(F)	Automatic (DL5)	123.00	13m above bedrock	-	-
31+605	TH20	TH	✓	Automatic (DL5)	-	-	16	135/115
31+615	Pz17P2	PZ	×(F)	Automatic (DL5)	129.4	1m above bedrock	-	-
31+700	Pz18P2	PZ	×(F)	Automatic (DL5)	130.53	1m above bedrock	-	-
31+752.5	TH21	TH	✓	Automatic (DL6)	-	-	16	135/115
31+815	Pz25P1A1	PZ	✓	Automatic (DL6)	117.02	7m below bedrock	-	-
31+815	Pz25P1A2	PZ	✓	Automatic (DL6)	122.02	2m below bedrock	-	-
31+815	Pz25P1B1	PZ	×(F)	Automatic (DL6)	127.52	3m above bedrock	-	-
31+815	Pz25P1B2	PZ	×(F)	Automatic (DL6)	129.52	5m above bedrock	-	-
31+815	Pz25P2A1	PZ	✓	Automatic (DL6)	113.82	11m below bedrock	-	-
31+815	Pz25P2A2	PZ	✓	Automatic (DL6)	118.82	6m below bedrock	-	-
31+815	Pz25P2B1	PZ	✓	Automatic (DL6)	124.32	bedrock	-	-
31+815	Pz25P2B2	PZ	✓	Automatic (DL6)	126.32	2m above bedrock	-	-
31+815	Pz25P2C	PZ	✓	Automatic (DL6)	127.32	3m above bedrock	-	-
31+815	Pz25P3A1	PZ	✓	Automatic (DL6)	115.1	9m below bedrock	-	-
31+815	Pz25P3A2	PZ	✓	Automatic (DL6)	120.1	4m below bedrock	-	-
31+815	Pz25P3B1	PZ	✓	Automatic (DL6)	123.1	12m below bedrock	-	-
31+815	Pz25P3B2	PZ	✓	Automatic (DL6)	125.1	1m above bedrock	-	-

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/ Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
31+820	TH22	TH	✓	Automatic (DL6)	-	-	16	135/115
31+842	Pz22P2	PZ	✓	Automatic (DL6)	116.8	2m above bedrock	-	-
31+850	TH23	TH	✓	Automatic (DL6)	-	-	16	135/108
31+880	TH24	TH	✓	Automatic (DL6)	-	-	16	135/108
31+885	Pz26P1A1	PZ	✓	Automatic (DL6)	104.44	10m below bedrock	-	-
31+885	Pz26P1A2	PZ	✓	Automatic (DL6)	109.44	5m below bedrock	-	-
31+885	Pz26P1B1	PZ	✓	Automatic (DL6)	114.94	bedrock	-	-
31+885	Pz26P1B2	PZ	✓	Automatic (DL6)	117.94	3m above bedrock	-	-
31+885	Pz26P2A1	PZ	✓	Automatic (DL6)	106.77	8m below bedrock	-	-
31+885	Pz26P2A2	PZ	✓	Automatic (DL6)	111.77	3m below bedrock	-	-
31+885	Pz26P2B1	PZ	✓	Automatic (DL6)	117.27	2m above bedrock	-	-
31+885	Pz26P2B2	PZ	✓	Automatic (DL6)	120.27	5m above bedrock	-	-
31+885	Pz26P2C	PZ	✓	Automatic (DL6)	123.27	8m above bedrock	-	-
31+885	Pz26P3A1	PZ	✓	Automatic (DL6)	104.74	10m below bedrock	-	-
31+885	Pz26P3A2	PZ	✓	Automatic (DL6)	109.69	5m below bedrock	-	-
31+885	Pz26P3B1	PZ	✓	Automatic (DL6)	117.46	2m above bedrock	-	-
31+885	Pz26P3B2	PZ	×(F)	Automatic (DL6)	120.46	5m above bedrock	-	-
31+928	Pz19P2	PZ	✓	Automatic (DL7)	123.22	1m above bedrock	-	-
31+960	TH25	TH	✓	Automatic (DL7)	-	-	16	135/115
31+990	Pz20P2	PZ	✓	Automatic (DL7)	122.44	1m above bedrock	-	-
31+995	TH26	TH	✓	Automatic (DL7)	-	-	16	135/115

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/ Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
32+000	Pz27P1A1	PZ	✓	Automatic (DL7)	113.25	8m below bedrock	-	-
32+000	Pz27P1A2	PZ	✓	Automatic (DL7)	118.25	3m below bedrock	-	-
32+000	Pz27P1B1	PZ	✓	Automatic (DL7)	123.75	2m above bedrock	-	-
32+000	Pz27P1B2	PZ	✓	Automatic (DL7)	125.75	4m above bedrock	-	-
32+000	Pz27P2A1	PZ	✓	Automatic (DL7)	112.61	9m below bedrock	-	-
32+002	Pz27P2A2	PZ	✓	Automatic (DL7)	117.61	4m below bedrock	-	-
32+000	Pz27P2B1	PZ	×(F)	Automatic (DL7)	123.11	2m above bedrock	-	-
32+000	Pz27P2B2	PZ	×(F)	Automatic (DL7)	125.11	4m above bedrock	-	-
32+000	Pz27P2C	PZ	✓	Automatic (DL7)	126.61	5m above bedrock	-	-
32+000	Pz27P3A1	PZ	✓	Automatic (DL7)	111.72	10m below bedrock	-	-
32+000	Pz27P3A2	PZ	✓	Automatic (DL7)	116.72	5m below bedrock	-	-
32+000	Pz27P3B1	PZ	✓	Automatic (DL7)	122.22	1m above bedrock	-	-
32+000	Pz27P3B2	PZ	×(F)	Automatic (DL7)	123.22	2m above bedrock	-	-
32+020	Pz21P2	PZ	✓	Automatic (DL7)	121.13	1m above bedrock	-	-
32+030	TH27	TH	✓	Automatic (DL7)	-	-	16	135/108
32+060	TH28	TH	✓	Automatic (DL7)	-	-	16	135/108
32+065	Pz28P1A1	PZ	✓	Automatic (DL7)	102.99	12m below bedrock	-	-
32+065	Pz28P1B1	PZ	✓	Automatic (DL7)	107.99	7m below bedrock	-	-
32+065	Pz28P1B2	PZ	✓	Automatic (DL7)	112.99	2m below bedrock	-	-
32+065	Pz28P1B3	PZ	✓	Automatic (DL7)	115.99	1m above bedrock	-	-
32+065	Pz28P2A1	PZ	✓	Automatic (DL7)	105.02	10m below bedrock	-	-

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)/ Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
32+065	Pz28P2B1	PZ	✓	Automatic (DL7)	110.02	5m below bedrock	-	-
32+065	Pz28P2B2	PZ	✓	Automatic (DL7)	115.02	bedrock	-	-
32+065	Pz28P2B3	PZ	✓	Automatic (DL7)	118.02	3m above bedrock	-	-
32+065	Pz28P2C	PZ	✓	Automatic (DL7)	124.02	9m above bedrock	-	-
32+065	Pz28P3A1	PZ	✓	Automatic (DL7)	105.91	10m below bedrock	-	-
32+065	Pz28P3B1	PZ	✓	Automatic (DL7)	110.91	5m below bedrock	-	-
32+065	Pz28P3B2	PZ	✓	Automatic (DL7)	115.91	1m above bedrock	-	-
32+065	Pz28P3B3	PZ	×(F)	Automatic (DL7)	118.91	4m above bedrock	-	-
32+100	TH29	TH	✓	Automatic (DL7)	-	-	16	135/115
32+105	Pz29P1A1	PZ	✓	Automatic (DL7)	115.32	10m below bedrock	-	-
32+105	Pz29P1B1	PZ	✓	Automatic (DL7)	120.32	5m below bedrock	-	-
32+105	Pz29P1B2	PZ	×(F)	Automatic (DL7)	125.32	bedrock	-	-
32+105	Pz29P1B3	PZ	×(F)	Automatic (DL7)	127.32	2m above bedrock	-	-
32+105	Pz29P2A1	PZ	✓	Automatic (DL7)	114.99	10m below bedrock	-	-
32+105	Pz29P2B1	PZ	✓	Automatic (DL7)	119.99	5m below bedrock	-	-
32+105	Pz29P2B2	PZ	✓	Automatic (DL7)	124.99	bedrock	-	-
32+105	Pz29P2B3	PZ	×(F)	Automatic (DL7)	126.99	2m above bedrock	-	-
32+105	Pz29P2C	PZ	×(F)	Automatic (DL7)	129.99	5m above bedrock	-	-
32+105	Pz29P3A1	PZ	✓	Automatic (DL7)	115.91	9m below bedrock	-	-
32+105	Pz29P3B1	PZ	✓	Automatic (DL7)	120.91	4m below bedrock	-	-
32+105	Pz29P3B2	PZ	✓	Automatic (DL7)	125.91	1m above bedrock	-	-
32+105	Pz29P3B3	PZ	×(F)	Automatic (DL7)	127.91	3m above bedrock	-	-
32+140	TH30	TH	✓	Automatic (DL7)	-	-	16	135/115

Table 2: Bay Goose (TDR)

Location of hole	DL #	Instrument ID	Inclination (°)	Length (m)	Casing elevation (m)	Crimps
31+255	9	TDR-11	60	70	134.4	Every 25 m
31+153	9	TDR-12	60	180	133.5	Every 25 m
31+105	9	TDR-14	60	200	133.6	Every 25 m
31+058	9	TDR-15	60	180	134.3	Every 25 m
31+035	9	TDR-17	60	206.35	134.9	Every 25 m
30+937	9	TDR-18	60	180	135.6	Every 25 m
30+960	9	TDR-20	60	200	136.5	Every 25 m

Table 3: Bay Goose (Inclinometers)

Location	Instrument ID	Operational (✓)/Not operational (×)	Manual/Automatic	Elevation interval in meters (top/bottom)
30+282	BG-IN-30+282	✓	Manual	139.3/124.8
30+390	BG-IN-30+390	✓	Manual	140.0/119.0
30+640	BG-IN-30+640	✓	Manual	138.8/124.3
31+180	BG-IN-31+180	✓	Manual	139.0/124.5
31+590	BG-IN-31+590	✓	Manual	139.5/115.0
31+815	BG-IN-31+815	✓	Manual	139.2/119.7
31+885	BG-IN-31+885	✓	Manual	138.8/113.3
32+065	BG-IN-32+065	✓	Manual	139.1/116.6

Table 4: East Dike (Inclinometers)

Location	Instrument ID	Operational (✓)/Not operational (×)	Manual/Automatic	Elevation interval in meters (top/bottom)
60+195	ED-IN-195	×(Damaged)	-	-
60+495	ED-IN-495	✓	Manual	136.6/124.1
60+705	ED-IN-705	✓	Manual	137.1/126.1

Table 5: East Dike Instruments List (TH+PZ)

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×) /Frozen (F)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
60+092	TH92	TH	✓	Automatic (DL8-SH1)	-	-	16	136/119
60+150	Pz150C	PZ	×(F)	Automatic (DL8-SH1)	127.35	Interface	-	-
60+185	TH185	TH	✓	Automatic (DL8-SH1)	-	-	16	136/119
60+190	Pz190P1A	PZ	✓	Automatic (DL8-SH1)	116.7	Bedrock	-	-
60+190	Pz190P1B	PZ	✓	Automatic (DL8-SH1)	121.7	Bedrock	-	-
60+190	Pz190P1C	PZ	✓	Automatic (DL8-SH1)	126.7	Interface	-	-
60+190	Pz190P2A	PZ	✓	Automatic (DL8-SH1)	116.34	Bedrock	-	-
60+190	Pz190P2B	PZ	✓	Automatic (DL8-SH1)	121.34	Bedrock	-	-
60+190	Pz190P2C	PZ	**×(F)**	Automatic (DL8-SH1)	126.34	Bedrock		
60+190	Pz190P3A	PZ	✓	Automatic (DL8-SH1)	116.63	Bedrock	-	-
60+190	Pz190P3B	PZ	✓	Automatic (DL8-SH1)	121.63	Bedrock	-	-
60+200	Pz200C	PZ	✓	Automatic (DL8-SH1)	127.71	Interface	-	-
60+240	Pz240C	PZ	✓	Automatic (DL8-SH1)	128.71	Interface	-	-
60+400	Pz400C	PZ	✓	Automatic (DL8-SH2)	126.76	Interface	-	-
60+420	Pz420C	PZ	✓	Automatic (DL8-SH2)	125.32	Interface	-	-
60+440	Pz440C	PZ	✓	Automatic (DL8-SH2)	124.66	Interface	-	-
60+450	Pz450C	PZ	✓	Automatic (DL8-SH2)	127	Interface	-	-
60+460	Pz460C	PZ	✓	Automatic (DL8-SH2)	125.15	Interface	-	-
60+470	Pz470C	PZ	×(F)	Automatic (DL8-SH2)	124.76	Interface	-	-

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
60+472	Pz472C	PZ	✓	Automatic (DL8-SH2)	126.87	Interface+1M	-	-
60+480	Pz480C	PZ	✓	Automatic (DL8-SH2)	125.44	Interface	-	-
60+485	TH485	TH	✓	Automatic (DL8-SH2)	-	-	16	136/119
60+490	Pz490P1A	PZ	✓	Automatic (DL8-SH2)	114.12	Bedrock	-	-
60+490	Pz490P1B	PZ	✓	Automatic (DL8-SH2)	119.12	Bedrock	-	-
60+490	Pz490P1C	PZ	✓	Automatic (DL8-SH2)	125.81	Interface	-	-
60+490	Pz490P2A	PZ	✓	Automatic (DL8-SH2)	115.07	Bedrock	-	-
60+490	Pz490P2B	PZ	✓	Automatic (DL8-SH2)	120.07	Bedrock	-	-
60+490	Pz490P2C	PZ	✓	Automatic (DL8-SH2)	126.76	Interface	-	-
60+490	Pz490P3A	PZ	✓	Automatic (DL8-SH2)	114.62	Bedrock	-	-
60+490	Pz490P3B	PZ	✓	Automatic (DL8-SH2)	119.62	Bedrock	-	-
60+500	Pz500C	PZ	✓	Automatic (DL8-SH2)	125.78	Interface	-	-
60+510	Pz 510C	PZ	✓	Automatic (DL8-SH2)	126.06	Interface	-	-
60+550	Pz 550C	PZ	**×(F)**	Automatic (DL8-SH2)	129.85	Interface	-	-
60+600	Pz 600C	PZ	✓	Automatic (DL8-SH3)	128.6	Interface	-	-
60+650	Pz 650C	PZ	×	Automatic (DL8-SH3)	128.48	Interface	-	-
60+695	TH695	TH	✓	Automatic (DL8-SH3)	-	-	16	136/119

Station	Instrument ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
60+700	Pz700P2A	PZ	✓	Automatic (DL8-SH3)	118.08	Bedrock	-	-
60+700	Pz700P2B	PZ	✓	Automatic (DL8-SH3)	123.08	Bedrock	-	-
60+700	Pz700P2C	PZ	✓	Automatic (DL8-SH3)	129.77	Interface	-	-
60+700	Pz700P3A	PZ	✓	Automatic (DL8-SH3)	117.93	Bedrock	-	-
60+700	Pz700P3B	PZ	✓	Automatic (DL8-SH3)	122.93	Bedrock	-	-
60+750	Pz750C	PZ	**×(F)**	Automatic (DL8-SH3)	128.16	Interface	-	-
60+842	TH842	TH	✓	Automatic (DL8-SH3)	-	-	16	136/119

Table 6: South Camp Dike (TH)

Hole	ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
38-3	SC-09-A	TH	✓	Manual	-	-	16	133.03/110.03
38-5	SC-10	TH	✓	Manual	-	-	16	132.40/109.40

Table 7: Vault Dike (TH)

Hole	ID	Type	Status	Readings	For PZ		For TH	
#	ID	PZ/TH	Operational (✓)/Not operational (×)	Manual/ Automatic	Elevation (m)	Stratigraphic unit	Number of operational beads	Elevation interval in meters (top/bottom)
71-2	VD-TH5	TH	✓	Manual	-	-	16	142.50/136.10
94-2	VD-TH6	TH	✓	Manual	-	-	16	140.50/121.50
96-1	VD-TH8	TH	✓	Manual	-	-	16	140.50/119.50
96-2	VD-TH7	TH	✓	Manual	-	-	16	140.50/119.50

Note that some of the marked Not Operational, still work and give temperature readings but cannot be used for collecting any good data and could also be frozen.