CONSTRUCTION SUMMARY (AS-BUILT) REPORT FOR DIKE D-CP5, MELIADINE GOLD PROJECT, NUNAVUT



PRESENTED TO

AGNICO EAGLE MINES LTD.

MELIADINE GOLD PROJECT

OCTOBER 19, 2017
ISSUED FOR USE
FILE: 704-ENG.EARC03076-01.WM14

AGNICO EAGLE DOCUMENT NUMBER: 6515-E-132-007-132-REP-013

REVISION 0

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EXECUTIVE SUMMARY

Dike D-CP5 was constructed across the south portion of Lake A54. D-CP5 is a water retention dike approximately 300 m long with a maximum dike height of approximately 3.3 m. The primary water retention element in Dike D-CP5 is a geomembrane liner. The intent of D-CP5 is to create a contact water collection pond in the north portion of Lake A54; named CP5. The construction of Dike D-CP5 started in October 2016 and was completed in July 2017.

Tetra Tech Canada Inc. designed the dike, provided construction monitoring, earth-work quality control and quality assurance testing services during the construction of Dike D-CP5. Construction management was overseen by Agnico Eagle Mines Ltd. MTKSL Contracting Joint Venture produced construction materials and constructed the dike. Liner installation was performed by Texel Geosol Inc. (Texel) working as a sub-contractor for MTKSL. Liner QC testing and monitoring was performed by Texel.

Dike D-CP5 was generally completed according to its design intent and overall specifications with the available construction materials under the field site and construction conditions. Some variations were made during construction to accommodate the field material availability, constructability, construction method and schedule, and design changes. Variations are documented in this report, Request for Information (RFI), and Engineering Change Notices (ECN). The Tetra Tech design team was responsible for approval of all implemented RFIs. Agnico Eagle Mines Ltd. was responsible for approval of all ECNs. The variations are not expected to materially impact the performance of the dike structure. Key variations are as follows:

- Unsuccessful attempts at mixing and placing Type K (nearly-saturated 20 mm minus granular fill) at Dike D-CP1 resulted in the suspension of its use at D-CP1 and D-CP5. The bottom liner elevation was modified to accommodate not using Tyke K material.
- The key trench geometry was altered and its volume increased in areas due to ground conditions and to accommodate the deeper liner. Difficulties controlling ripping and excavation activities also contributed in the key trench over-excavation and increased volumes. The consequence of this increase volume was the use of more construction materials than originally estimated.
- Comparison of the as-built drawings with the design indicates that some sections of the dike have as-built dimensions slightly less than designed. The deficiencies are not critical and will not affect the dikes overall stability.

The QA/QC material testing results and construction records drawings are presented in this report.

Two (2) horizontal and three (3) vertical ground temperature cables and three (3) steel rod settlement monitoring hubs were installed to monitor the performance of Dike D-CP5.

Performance monitoring is an integral part of the operation of any water retention structure. The performance of Dike D-CP5 must be monitored throughout its operating life. Long-term monitoring of D-CP5 should include thermal monitoring, settlement monitoring, routine visual inspections, and annual inspections according to the regulatory requirements.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
AEM	Agnico Eagle Mines Ltd.
AEP	Annual Exceedance Probability
CAT	Caterpillar
CP	Collection Pond
DRE	Dike Resident Engineer
ECN	Engineering Change Notice
GTC	Ground Temperature Cable
HGTC	Horizontal Ground Temperature Cable
IDF	Inflow Design Flood
km	Kilometers
m	Meters
QA	Quality Assurance
QC	Quality Control
RFI	Request For Information
ROM	Run-Of-Mine
VGTC	Vertical Ground Temperature Cable

LIMITATIONS OF REPORT

1.0 INTRODUCTION

1.1 General

Agnico Eagle Mines Ltd. (Agnico Eagle) is currently developing the Meliadine Gold Project (the project). Dike D-CP5 was constructed at the project site as part of its development plan. Tetra Tech Canada Inc. (Tetra Tech) was retained by Agnico Eagle to prepare a construction summary (as-built) report for Dike D-CP5. The project is located approximately 25 km north from Rankin Inlet, Nunavut. The project site is located on the peninsula between the east, south, and west basins of Meliadine Lake (63°01'23.8"N, 92°13'6.42"W). A general location plan for the project is shown in Figure 1.

Dike D-CP5 was designed by Tetra Tech. It was constructed between October 2016 and July 2017. Tetra Tech provided construction monitoring, quality assurance, and earthworks quality control testing services during its construction. Construction management was overseen by Agnico Eagle's Meliadine Division's Construction Department. MTKSL Contracting Joint Venture (MTKSL) produced construction materials and constructed the dike. MTKSL was also responsible for survey control during construction and compilation of as-built information. Liner installation was performed by Texel Geosol Inc. (Texel) working as a sub-contractor for MTKSL. Liner QC testing and monitoring was performed by Texel.

A technical advisory committee reporting to Agnico Eagle oversaw the dike construction. The committee included Mr. Thomas Lepine from Agnico Eagle, Mr. Luciano Piciacchia from BBA, and Mrs. Fiona Esford from Golder Associates. During the dike construction the team received the daily and weekly dike construction QA/QC reports, was involved in several key technical discussions, and had several field visits to the project site.

Dike D-CP5 is located across the south portion of Lake A54 South. A general site plan showing the location is presented in Figure 2. A description of the dike construction activities and the quality assurance and quality control test results are presented in this report. Construction record drawings are attached in Appendix B. The survey data used for producing Dike D-CP5 construction record drawings was provided by MTKSL.

Dike D-CP5 was generally completed according to its design intent and overall specifications with the available construction materials under the field site and construction conditions. Some variations were made during construction to accommodate the field material availability, constructability, construction method and schedule, and design changes made during the construction. These variations are described in Section 7.0. Variations are documented in this report, Request for Information (RFI), and Engineering Change Notices (ECN). The Tetra Tech design team was responsible for approval of all implemented RFIs. Agnico Eagle Mines Ltd. was responsible for approval of all ECNs.

This report, which is to be submitted to the Nunavut Water Board, is prepared to meet the requirements in the Type "A" Water Licence No. 2AM-MEL 1631 – Agnico Eagle Mines Limited for the Meliadine Gold Project (Part D, Item 3).

1.2 Dike Design Concept

The detailed design of Dike D-CP5 was presented in Design Report for D-CP5 Meliadine Gold Project, NU (Tetra Tech EBA 2016a). This dike is one of several water retention dikes required to manage the site contact water during pre-production, operation, and interim mine closure.

Located across the south portion of the existing shallow Lake A54, D-CP5 is a water retention dike approximately 300 m long with a maximum dike height of approximately 3.3 m above the original ground. The intent of D-CP5 is to create a contact water collection pond in the north portion of Lake A54; named CP5. The CP5 pond is created for the following main reasons:

- CP5 will serve as a seasonal water transfer and management pond with a limited water storage capacity. A water pumping system will be installed in CP5 to manage the water impounded by the D-CP5 dike;
- The water collected in CP5 will be actively pumped to CP1 (the main site water collection pond) during the open water season each year so that the CP5 pond will be nearly empty most of the time, except for several early days (up to 3 days) during the annual spring freshet for start-up of the pump system or during an extreme rainfall event; and
- CP5 will also serve as a water transfer pond to receive the contact water that is pumped from two proposed open pits (Tiri_1000_01 and Tiri_1000_02). The water from the two open pits will only be pumped to CP5 when the CP5 pumping station (pumping water from CP5 to CP1) is fully operable.

Dike D-CP5 was designed as a lined dike with the liner keyed in a key trench. The liner system consists of a geomembrane liner (Coletanche ES2). The liner is keyed into the ground at the base of a key trench with a layer of bentonite-augmented 20 mm minus material (Type F). The superstructure is constructed of run-of-mine rock (Types A and A1), transition rockfill (Types B and B1), and granular fill material (Type C). A general section of Dike D-CP5 design concept is presented in Figure 3.

1.3 Related Documents

The supporting and related documents for Dike D-CP5 construction are as follows:

- Design Report For Dike D-CP5, AEM Document Number: 6515-132-007-132-REP-004, Version 0 (Tetra Tech EBA 2016a);
- Geotechnical Specifications for the Construction of Dike D-CP5, AEM Document Number: 6515-E-132-007-132-SPT-003 R1, Revision 1 (Tetra Tech EBA 2016b);
- Construction Quality Plan for Dikes D-CP1 and D-CP5, AEM Document Number: 6515-132-007-132-QQP-000, Version 0 (Tetra Tech EBA 2016c); and
- Liner Installation QC Plan prepared by Texel.

Table 1-1 below presents the list of issued for construction drawings used for the construction of D-CP5.

Table 1-1: List of Issued for Construction Drawings used for the Construction of Dike D-CP5

AEM Design Drawing Number	Revision Number	Tittle
65-685-230-214	0	D-CP5 General Location Plan
65-685-230-215	0	D-CP5 Key Trench and Dike Layout
65-685-230-216	0	D-CP5 Profiles
65-685-230-217	0	D-CP5 Thermal Cover Layout Plan and Profiles
65-685-230-218	0	D-CP5 Typical Sections and Quantities
65-685-230-219-001	0	D-CP5 Sections Station 1+030 to 1+170
65-685-230-219-002	0	D-CP5 Sections Station 1+180 to 1+310
65-685-230-220	0	D-CP5 Instrumentation Plan and Details for Ground Temperature Cables
65-685-230-221	0	D-CP5 Instrumentation Plan and Details for Ground Temperature Cables and Settlement Survey Monuments
65-685-230-222	0	D-CP5 Typical Details

1.4 Request for Information (RFI)

An RFI register for Agnico Eagle's Meliadine Project (Project Number 6515) under Contract Number C-007 which included Dikes D-CP1 and D-CP5 was established during the dike's construction. Table 1-2 below summarizes the request for information (RFIs) related to Dike D-CP5 that were received from MTKSL or Agnico Eagle. Details of these RFIs and corresponding responses are attached in Appendix D1.

Table 1-2: Summary of RFIs for Dike D-CP5

RFI Number	Description	Date Submitted	Date Closed
RFI_6515-C-230-007_001	Missing bid Items for D-CP1 downstream water collection channel sump and D-CP1/D-CP5 Instrumentation	09/01/2016	09/01/2016
RFI_6515-C-230-007_002	20 mm minus material classification / Liner type for D-CP5	09/06/2016	09/06/2016
RFI_6515-C-230-007_004	Horizontal tolerances that will be acceptable for lift placement	10/11/2016	10/12/2016
RFI_6515-C-230-007_005	Stake out point for each material	10/14/2016	10/17/2016
RFI_6515-C-230-007_006	Type K Material Mixing	10/24/2016	11/10/2016
RFI_6515-C-230-007_007	D-CP5 Initial Lift & Water Management	10/26/2016	11/04/2016
RFI_6515-C-230-007_009	Variation of fill placement specification	11/01/2016	11/04/2016
RFI_6515-C-230-007_010	Key Excavation From 1.8 m to 2.8 m	11/04/2016	11/10/2016
RFI_6515-C-230-007_011	Liner termination details	11/16/2016	11/17/2016
RFI_6515-C-230-007_012	Crushing and screening material acceptance	11/29/2016	12/09/2016
RFI_6515-C-230-007_014	Solutions to address potential Type A1 material shortage	12/10/2016	12/22/2016
RFI_6515-C-230-007_015	This RFI was not submitted		
RFI_6515-C-230-007_016	Type K material mixing	01/05/2017	01/09/2017
RFI_6515-C-230-007_017	This RFI was not submitted		
RFI_6515-C-230-007_018	Type K placement	01/19/2017	01/20/2017
RFI_6515-C-230-007_019	Downstream excavation proposal	01/22/2017	01/22/2017
RFI_6515-C-230-007_020	Does RFIs #18 and 19 apply to D-CP5?	01/23/2017	01/25/2017
RFI_6515-C-230-007_022	Slope when excavating past 2.8	01/27/2017	01/27/2017
RFI_6515-C-230-007_024	Type B Material Shortage	02/20/2017	02/21/2017

1.5 Engineering Change Notice (ECN)

Table 1-3 below summarizes the Engineering Change Notices (ECNs) related to Dike D-CP5. Details of these ECNs and corresponding responses are attached in Appendix D2.

Table 1-3: Summary of ECNs for Dike D-CP5

ECN Number	Description	Date Issued
6515-C-235-007-ECN-001_RA	Revision 1 for Construction Specifications of D-CP1 and D-CP5	11/10/2016
6515-C-235-007-ECN-002_RA	Design Change of Dike Liner Key-in Detail at Crest for D-CP1 and D-CP5	11/14/2016

2.0 CONSTRUCTION MATERIALS

2.1 General

The following materials were used for the construction of Dike D-CP5:

- Run-of-Mine Rockfill (600 mm minus) – Types A and A1;
- Transition Rockfill (150 mm minus) – Types B and B1;
- Granular Fill (20 mm minus) – Type C
- Bentonite-Augmented Material (20 mm minus) – Type F; and
- Geomembrane Liner (Coletanche ES2).

2.2 Run-of-Mine Rockfill (600 mm minus) – Types A and A1

Type A1 material consisted principally of greywacke ROM that was excavated from the saline water storage pond during its construction from September to October 2016. The material generally had a maximum particle size of about 600 mm. Type A material consisted principally of greywacke run-of-mine (ROM) from underground operations. The Type A material generally had a maximum particle size of about 600 mm. The principal difference between Types A and A1 material, is that the Type A material has a residual salinity as it was sourced from the underground operations.

Type A1 was specified to be used for the downstream shell of the dike. Because of a shortage of Type A1 material portions of the uppermost part of downstream shell was constructed with Type A material as per RFI_6515-C-230-007_014 from Station 1+110 to 1+315.

Type A was specified for the upstream shell of the dike and for thermal cover over the abutments.

Types A and A1 materials were placed in lifts with maximum thickness of about 900 mm. Care was taken during placement to avoid segregation and nesting of larger particles. Each lift was compacted with a 10 ton vibratory roller drum compactor (minimum of six complete passes) and haul truck traffic prior to placing the next.

2.3 Transition Rockfill (150 mm minus) Types B and B1

Transition rockfill (150 mm minus) was used to backfill most of the key trench and as a filter-graded material between the ROM and fine granular fill (Type C) materials.

The design called for the use of transition rockfill produced from Type A1 material. Due to the shortage of Type A1 material discussed in Sections 2.2 and 2.3 above, some of the transition rockfill used was produced using Type A material. Based on Tetra Tech QA/QC personnel field notes and daily reports, most of the transition material produced from Type A material was placed above the top liner (from approximately Elevation 66.8 m to 67.8 m). This information was not provided in MTKSL as-built survey data. To differentiate between these materials, transition material produced from Type A material is referred to in this report and the as-built drawings as Type B material while transition material produced from Type A1 material is referred to as Type B1 material.

The maximum particle size of the material was typically less than 150 mm. The 150 mm minus material was the product of the jaw crusher and did not require further processing. The specified gradation limits are presented in the design documents and shown on the particle size analyses in Appendix E1. Quality assurance particle size analysis testing conducted during the production of the material indicated that the average gradation was within the specified gradation limits.

The material was placed in lifts with maximum thickness of 300 mm. Despite the care taken during material handling and placement to avoid segregation and nesting of larger particles, minor segregation issues were observed in some instances. Following advice from QA/QC personnel, MTKSL generally mitigated this by ripping and mixing the stockpile and placing the material mostly with a dozer (as opposed to an excavator) when feasible.

In the months of February and March 2017, the Type B1 material stockpile was essentially frozen. MTKSL used a D8 or D9 CAT dozer to rip the stockpile. As a result, a few larger and frozen lumps were noticed in the material placed during those months. When observed by field QC staff, MTKSL was instructed to remove the frozen chunks prior to compaction.

Lifts of transition material were generally compacted, with a 10 ton vibratory roller drum compactor (minimum of six complete passes). The first lift of Type B1 material in the key trench over the Type C material and liner was lightly compacted to avoid damaging the liner.

2.4 Granular Fill (20 mm minus) – Type C

The granular fill material (20 mm minus) referred to as Type C was used to construct the key trench fillet zone and also serves as the bedding layers above and below the liner to protect it from damage.

The 20 mm minus material was produced by the crusher from natural esker material sourced from the Meliadine Esker. The specified gradation limits are presented in the design documents (Tetra Tech EBA 2016a and 2016b). Tetra Tech's QC site representatives performed quality assurance testing on the material produced for the dike's construction. The tests included particle size analysis (gradation test), moisture content, moisture-density relationship test (ASTM 698) and single point frozen soil dry density. Test results are attached in Appendix E2.

2.5 Bentonite-Augmented Material – Type F

Type F material was used to construct the key trench leveling course and to provide a low permeability seal between the liner and the underlying frozen till and bedrock foundation beneath the liner and a seal at the liner hinge point. Type F material was produced by blending Type C (20 mm minus) material with dry powdered bentonite to achieve an average bentonite content of not less than 10% (by weight) with a minimum of 8% (by weight) at any grab sample. Two different particle sizes of bentonite were supplied and used for dikes construction; bentonite in smaller-sized (2,500 pound) cylindrical bags which had a slightly finer grain size and bentonite in larger (3,000 pound) bags. Both materials were tested (swell tests and bulk density) by Tetra Tech QA/QC personnel and found suitable for dike construction.

Three 20 foot containers were used to construct a U-shaped area on the Industrial pad for the purpose of blending bentonite and Type C material. Materials were blended by dumping/spreading Type C material within the U-shaped area, followed by placing the appropriate volume of bentonite on top of it and mixing using either a CAT 980 or a CAT IT62 loader. The mix proportions developed by MTKSL are presented in Table 2-1 below. The material was loaded in CAT 740 haul trucks and hauled to the dike where it was dumped and placed along the key trench using a CAT Excavator which further assisted in the blending.

Table 2-1: Summary Mix Proportion of Bentonite Augmented (Type F) Material

Loader	Bag Type	Number of Loader Buckets of Type C Material	Number of Bentonite Bags
CAT IT62	Large Bag (3,000 Lbs.)	3 level	1
CAT IT62	Small Bag (2,500 Lbs.)	3 level	1
CAT 980	Large Bag (3,000 Lbs.)	1 level and 1 heaped	1
CAT 980	Small Bag (2,500 Lbs.)	2 level	1

Tetra Tech's QC representatives frequently observed the mixing station and mixing process and verified the number of bentonite bags and quantities of Type C material used were as indicated. The number of bentonite bags used for the blending were tracked by MTKSL on a daily basis and recorded by Tetra Tech's QC representatives.

Visual swell assessments on samples of placed Type F material were performed with satisfactory results. Density and moisture QA/QC test results on the Type F material are presented in Appendix E3.

2.6 Geomembrane Liner (Coletanche ES2)

The bituminous geomembrane liner system is the primary water retention element for Dike D-CP5. Coletanche bituminous geomembrane liner ES2 was used for D-CP5.

The liner was purchased from Coletanche and shipped to site by Agnico Eagle. Liner installation was performed by Texel working as a sub-contractor for MTKSL. MTKSL provided logistical and equipment support to the Texel team. Liner QC testing and monitoring was performed by Texel while QA was performed by the Dike Resident Engineer (DRE).

The Coletanche ES2 geomembrane was rolled and shipped to site in sea containers. It was un-rolled, placed in panels of varying lengths accordingly, and welded in place.

3.0 CONSTRUCTION EQUIPMENT

3.1 General

Most of the mobile equipment used for the construction of Dike D-CP5 was provided by MTKSL. Details of the principal equipment used for the dikes construction are presented in the following subsections.

3.2 Mobile Construction Equipment

Table 3-1 presents the major equipment used during Dike D-CP5 construction.

Table 3-1: Equipment Used During D-CP5 Construction

Haul Trucks	Bulldozers	Excavators	Loaders	Others
CAT 773	CAT D5K	CAT 330C	CAT 988G	Compactor CS563E
CAT 740	CAT D6M	CAT345B	CAT 980G	Compactor CS56
CAT D300	CAT D8T	CAT345C	CAT IT62	HAMM 3205
	CAT D9R	CAT336		Walk-behind Drum roller
		CAT320E		CAT Skid Steer
		Komatsu PC400		Hydra-Trac 400 RAB Drill

3.3 Crusher

MTKSL's aggregate crushing plant was used to produce the crushed granular materials (Types B, B1, and C). The crushing plant was operated by MTKSL employees. The crusher system consists of a primary jaw crusher, a vibratory screen deck, and a secondary cone crusher.

Quality control testing of the material produced was performed daily by Tetra Tech's QC site representatives. Test results for materials produced and used throughout the dike construction period are provided in Appendixes E1 to E3.

4.0 DIKE D-CP5 CONSTRUCTION ACTIVITIES

4.1 General

Construction of Dike D-CP5 occurred between October 2016 and July 2017. Dike D-CP5 was generally constructed according to the guidelines and requirements stated in the design documents. Variations from the design were documented in RFIs and ECNs and are discussed in Section 7.0.

Dike D-CP5 construction management was performed by Agnico Eagle's Meliadine Construction Division. The construction crew constituting a site superintendent, foremen, mobile equipment operators, truck drivers, laborers, drill/blast personnel, and surveyors was provided solely by MTKSL. The drill/blast of the downstream channel/sump was conducted by a sub-contractor (McCaw South). MTKSL sub-contracted Texel for liner installation and liner QC.

A technical advisory committee reporting to Agnico Eagle oversaw the dike construction. The committee received the daily and weekly dike construction QA/QC reports, was involved in several technical discussions, and had several field visits to the project site during the dike construction.

Tetra Tech's quality control team carried out quality control testing for the earthworks, prepared daily reports for their work on site, and maintained a photographic record of the work completed during construction. Liner quality control was performed by Texel technicians.

DREs from Tetra Tech carried out quality assurance and overall quality monitoring for the construction activities. They produced daily and weekly reports which covered construction activities on site. The daily and weekly reports are not attached to this report but can be provided upon request.

Figure 4 summarizes the relationship between various stake holders during the dike's construction.

Selected photographs showing various aspects and activities during the dike's construction are presented in the Photographs section of the report. The major components of the construction are listed below and summarized in detail in the following sections:

- Surveying (Section 4.2);
- Working Platforms Construction (Section 4.3);
- Key Trench Excavation and Cleaning (Section 4.4);
- Bentonite-Augmented Material Placement (Section 4.5);
- Fillet Zone Material Placement (Section 4.6);
- Key Trench Backfilling (Section 4.7);
- Run-of-Mine Placement (Section 4.8);
- Liner System Installation (Section 4.9); and
- Instrumentation Installation (Section 5.0).

4.2 Survey

MTKSL surveyors provided the following survey services throughout the construction of Dike D-CP5:

- Original ground surface surveying prior to construction;

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- Layout for key trench excavation;
- Construction grade control;
- Detailed survey of as-built dike fills, liner panel layout, and final graded slopes for material zones;
- Modeled surfaces of placed material zones; and
- Survey of instrumentation installations.

4.3 Working Platforms Construction

Prior to key trench excavation, working platforms were constructed on the upstream and downstream sides of the key trench to facilitate the movement of equipment and personnel. The working platforms were basically the first and second lifts of either Type A (upstream side) and a combination of Types A and A1 (downstream side) materials which constitute the upstream and downstream shells of the dike respectively. They were approximately 1 m thick and were placed and compacted following specifications for the material.

Foundation preparation was necessary such that there was good contact between the fill materials for the working platforms as this material constitutes the base of the dike's shell. Foundation preparation activities included removing loose boulders and cobbles, and snow and ice within the footprint of upstream and downstream shells.

Foundation preparation was executed principally with the CAT dozers and excavators (see Photos 1, 2, and 3). Lake A54 South was pumped to A54 North to reduce seepage into the dike footprint. Seepage was reduced to the extent that it didn't impact material placement and compaction. The loose boulders and cobbles, snow and ice was hauled to a dump location designated by Agnico Eagle.

4.4 Key Trench Excavation and Cleaning

Key trench excavation and ripping began in January 2017 and was completed in March 2017. The ground was frozen during this time. Excavating and ripping with the CAT D8T and D9R dozers was challenging because of the frozen ground and the narrow width of the key trench. Ripping with the excavators (PC400 and CAT 330C) with rock breakers attached was the main digging mechanism. Cleaning and removing excavated and ripped material was done with the CAT excavators. Various aspects of key trench excavation are presented in Photos 3 to 6.

The actual key trench geometry varied are as a result of variable ground conditions and adjustments made following RFI_6515-C-230-007_019 and RFI_6515-C-230-007_021 to achieve the design slope and dimensions of the bottom liner. The key trench excavation depths were governed by where competent bedrock or non-ice-rich, ice-saturated frozen till (with an ice saturation of no less than 90%) was encountered or a maximum depth of 2.8 m was achieved. The key trench was generally excavated to a maximum depth of 3.2 m. Table 4-1 below summarises final key trench excavation depths and material encountered at the base of the key trench. Details of the key trench excavation materials are provided in Appendix E4.

Table 4-1: Summary of of Final Key Trench Excavation Depths

Station	Final Depth Range (m)	Material at Final Key Trench Base
0+10 to 0+40	1.6 to 2.0	Ice-saturated soil
0+45 to 0+60	1.5 to 1.8	Bedrock
0+65 to 0+80	1.8 to 2.0	Ice-saturated soil
0+85 to 0+245	1.6 to 2.3	Bedrock
0+245 to 0+255	2.5 to 2.8	Ice rich soil at 2.3 m
0+255 to 0+265	2.5 to 2.8	Ice-saturated soil
0+265 to 0+285	3.0 to 3.2	Ice rich soil at 2.8 m

The till material and weathered rock from the excavation was hauled to the dump area designated by Agnico Eagle while some of the rock was hauled to the crusher and used for making Type B1 material.

Key trench base bulk cleaning was carried out with CAT excavators. Final and dental cleaning was carried out with hand tools which included, shovels, brooms, and compressed air. Loose, broken, or altered material from the base of the key trench was blown out with compressed air. Snow and ice was also hand shovelled and blown out with compressed air prior to fill placement. Local depressions, open joints, and voids on the rugged bedrock surface were filled with bentonite-augmented material. The quality of bedrock encountered was good such that no grout treatment was required. Key trench cleaning was inspected and approved by Tetra Tech's QC personnel and the DRE prior to fill placement.

4.5 Bentonite-Augmented Material (Type F) Placement

The bentonite-augmented material (Type F) material was produced by mixing Type C material with dry bentonite powder at the mixing station described in Section 2.6.

The Type F material was required to provide a seal with the foundation beneath the liner and at the hinge point. The material was placed in lifts approximately 200 mm thick. The number of lifts depended on the final key trench excavation depth and the liner depth which ranged from 1.45 m to 2.65 m below original ground level. Type F material was placed using either the CAT D5K dozer along the key trench bottom and the upstream fillet zone or CAT excavators for the downstream fillet zone and the liner hinge point. The compaction of the Type F material was performed with the CAT CS563E or CS56 compactors for the most part. The downstream fillet was compacted with a walk-behind drum roller.

The key trench bottom was cleaned and inspected to make sure it was free of deleterious material prior to placement of the Type F material. The placement and compaction of Type F material is shown in Photos 7 to 9.

Material placement and compaction was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer and/or the "modified" sand cone method. Test results are attached in Appendix E3.

4.6 Fillet Zone Materials Placement

The fillet zone is a wedge of Type C material underlined by a layer of Type F material. The upstream fillet was constructed prior to liner placement. Fillet construction is shown in Photos 10 to 12.

The Type C fillet was constructed in maximum 300 mm thick lifts using haul trucks, the CAT D5 dozer, CAT excavators, and a CAT skid steer. The compaction of the lifts of material for fillet was performed by the CAT CS563E or CS56 compactors or the HAMM 3205 towards the top of the upstream fillet. The final surface of the upstream lifts of material were shaped using an excavator to provide a flat surface to lay the liner on. Placement and compaction was monitored and tested by Tetra Tech's QC personnel as described in Section 4.5.

4.7 Key Trench Backfill

Following liner installation within the key trench, the key trench was backfilled with Types B1 and C materials. Type C material; approximately 500 mm thick was placed above the liner to serve as a bedding layer, followed by Type B1 material up to approximately original ground elevation.

The backfill materials were placed and compacted in 250 mm thick lifts in the case of Type C and 300 mm thick lifts in the case of Type B1. The first lift of Type C material over the liner was not compacted, while the second lift was compacted with a walk-behind drum roller. The first lift and second lifts of the Type B1 material were compacted with the HAMM 3205 packer while subsequent lifts were compacted with the CAT CS563E or CS56 compactors.

Material placement and compaction was monitored and tested by Tetra Tech's QC personnel.

Various aspects of key trench backfilling are shown in Photos 13 and 14.

4.7.1 Granular Fill Material (20 mm minus) – Type C

Two zones of Type C material were placed; one below and one above the liner system. The Type C material serves as the bedding layer for the liner system. The Type C material was placed over the base liner in approximately 200 mm to 300 mm thick lifts using the skid steer loader, CAT excavators above the key trench slope liner and below the dike slope liner, and CAT D5 dozer above the liner on the dike slope. The compaction of the 20 mm minus material was performed by the walk-behind drum roller, HAMM 3205 packer, and/or the excavator bucket. Various aspects of the 20 mm minus material placement are shown in Photos 13 to 15.

4.8 Transition Rockfill (150 mm minus)

Transition rockfill was used to backfill the key trench and on the dike crest from approximately Stations 1+160 to 1+250. It was placed below and above the liner system as transition above the key trench between the ROM and the Type C liner bedding material.

Transition rockfill was placed in lifts approximately 300 mm in thickness using CAT excavators or the CAT D5 dozer. The compaction of the transition rockfill material was performed by the CAT CS563E or CS56 packers or the HAMM 3205 packer. The placement of the transition rockfill material on the crest is shown in Photo 16.

4.9 Run-of-Mine (ROM) Placement

ROM material (Types A and A1) constitutes the upstream and downstream shells of the dike. The thermal cover above the dike is built with Type A material. As stated in Sections 2.2 and 2.3, parts of the downstream shell was constructed with Type A material instead of the specified Type A1 due to material shortage.

The material was placed in lifts with maximum thickness of about 900 mm to 1,000 mm using the CAT D5 dozer and excavators. Care was taken during placement to avoid segregation and nesting of larger particles. Each lift was compacted with the CAT CS563E or CS56 packer (minimum of six complete passes) and haul truck traffic prior to placing the next.

The material was visually inspected by Tetra Tech’s QC site representatives to verify that, in general, the particles adhered to the maximum particle size and that deleterious materials such as snow or till were not present. Additionally, Tetra Tech observed that the specified lift thickness was maintained and that the material was compacted sufficiently. ROM placement and compaction are shown in Photos 17 and 18.

4.10 Liner Installation

The geomembrane liner (Coletanche ES2) was installed by Texel. The liner was installed in two phases. The first phase consisted of placing the liner within the key trench and the second phase consisted of placing liner material on the upstream slope.

The first phase of the liner placement included placing the liner panels within the key trench. The liner extended out of the key trench to a hinge point as shown in Photos 19 and 20. The liner hinge point was covered with sheets of plywood and 20 mm material placed on the plywood to protect the liner while construction continued.

For the second phase of liner placement on the upstream slope, the liner hinge was uncovered and inspected for damage. The liner flap had an approximately 0.5 m horizontal tie-in length at the hinge.

The construction methods employed during the second phase of the liner installation were the same as those employed in the first phase of liner installation. Photos 21 to 22 show aspects of the second phase of liner installation.

Liner installation quality assurance was carried out by the DRE and quality control testing by Texel. Quality control testing and monitoring was carried out following the QC plan developed by Texel. The QA/QC procedure that was executed each day when liner was installed was as follows;

- DRE reviewed as-built survey data for the sub-grade to confirm it was built to design;
- DRE reviewed subgrade fill material placement QC monitoring and testing results to make sure design specifications were achieved;
- A subgrade inspection was carried about 30 minutes before the planned installation time by the DRE, Texel's foreman, and Texel's QC technician to verify that the subgrade was free of deleterious substances, snow and ice, compaction specifications were met, and an adequate liner base was present;
- Test welding was performed by a Texel welder on a piece of liner besides or in the key trench about 30 minutes before planned installation time;
- An ultrasonic test was performed on the test strip by Texel's QC technician;
- Three (3) samples for tensile resistance were taken from the test strip and tested by the Texel QC technician; and
- If all three (3) test strips tested had results above the minimum required 74 lb/in (13 kN/m) for ES2, the DRE approved liner placement.

The DRE observed the process of liner installation and qualification welding tests, seam welding, and ultrasonic tests along seams. The DRE also witnessed liner repairs and testing. Elements of the liner system were installed according to the requirements in the design documents and test results met specifications. The liner installation quality control report is presented in Appendix F.

5.0 INSTRUMENTATION

5.1 General

Ground Temperature Cables (GTCs) and survey monitoring points were installed in Dike D-CP5 for performance monitoring purposes. Horizontal Ground temperature Cables (HGTCs) were installed in the key trench and Vertical Ground Temperature Cables (VGTCs) were installed on the upstream and downstream sides of the key trench. Survey monitoring points were installed above the liner system along the dike crest. The location of the instruments are shown on the construction record drawings in Appendix B. The ground temperature cables and the survey monitoring points are discussed in the following sections.

5.2 Ground Temperature Cables

Two (2) HGTCs (HGTC-1 and HGTC-2) were installed above the first lift of Type C material, approximately 250 mm above the bottom liner along most of the key trench length. The cables were placed in 25 mm I.D. flush coupled threaded PVC pipes. The detail locations of the HGTCs are presented in the as-built drawing 65-685-230-220.

Three (3) VGTCs (VGTC-1, VGTC-2, and VGTC-3) were installed vertically on the upstream and downstream sides of the key trench. VGTC-1 and VGTC-2 are installed through the dike, upstream of the liner system and key trench, to monitor temperatures in the upstream portion of the dike and its foundation. VGTC-3 is installed through the dike, downstream of the liner system and key trench, to monitor temperatures in the downstream portion of the dike and its foundation.

Cable locations were carefully selected to avoid any damage to the liner system while drilling the holes to install VGTCs. The detail locations of the VGTCs are presented in the as-build drawing 65-685-230-221.

VGTC holes were drilled with a Hydra-Trac 400 RAB drill rig or Canadrill's drilll rig operated by McCaw South and Canadrill respectively. The holes were cased with a thick walled PVC pipe for about 1 m through the fill material to prevent the holes from caving in. A 25 mm I.D. flush coupled threaded PVC pipe was lowered down the cased boreholes and the GTCs installed inside the pipe. After cable installation, the holes were backfilled with sand.

Photos 23 to 26 show GTC installations. The GTC connectors were placed inside protective thick-walled 100 mm I.D. PVC pipe with an end cap as shown in Photo 26.

Manual ground temperature readings were taken before and immediately after installation to confirm that all the thermistor beads were working and several times later to allow the ground to equilibrate after drilling/backfilling. Tetra Tech's site personnel continued taking readings at least once a week during the remaining construction stage. Readings taken by Tetra Tech site representatives during the construction period and those taken by Agnico Eagle and sent to Tetra Tech prior to writing this report have been used to plot the ground temperature profiles presented in Appendix C. Readings from the GTCs indicate frozen ground conditions within the critical zones of the dike key trench and below it, as designed. The detail thermistor bead locations for each GTC are summarized in Appendix C.

5.3 Survey Monuments

Three (3) settlement survey monuments (M-1, M-2, and M-3) were installed in the central area of the dike located immediately above the liner crest to monitor any settlements of the liner crest. The survey monuments consist of a 1.4 m long, 25 mm diameter metal rod welded to a 500 mm square steel plate. A thick-walled 50 mm I.D. PVC pipe was placed around the metal rod as a protective casing. Photos 27 to 28 show the installation of M-2 and Photo 29 shows M-1 installed and protective casing inserted around it. The survey points are to be used in determining if dike settlement is occurring. A 16" pile was installed directly west of the south abutment in a hole drilled 1 m into bedrock and grouted in place to serve as a control point for the survey monuments. The detail locations of the survey monuments are presented in the as-build drawing 65-685-230-221.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 Dike Resident Engineer (DRE)

Agnico Eagle selected Tetra Tech to be responsible for QA activities during the construction of the dikes. Tetra Tech provided a DRE who was on site on a full time basis (day shift only) during the construction of the dikes.

The DRE's role on site is summarized as follows:

- Performed QA activities and examined dike construction issues first hand and refer to Design Engineer if needed;
- Oversaw and monitored QC activities, including field and laboratory testing;
- Approved or rejected the materials and construction done at critical stage gates;
- Tracked, reported, and followed up with any non-conformance reports;
- Observed and approved any QC activities (including both earthworks and liner);
- Reviewed, approved, or rejected QC testing results;
- Ensured the QC teams met calibration requirements for the testing facilities, equipment, and devices;
- Visually inspected materials hauled to the dike for conformance with contract or construction specifications;
- Compiled and maintained QA/QC results;

- Oversaw the installation of instrumentation;
- Prepared and distributed daily and weekly activity QA reports, documenting dike construction and QA/QC activities;
- Received and reviewed as-built survey data/drawings provided by the surveyor and ensured the as-built survey data/drawings met specified requirements; and
- Conducted other QA tasks related to dike construction, as directed by Agnico Eagle.

6.2 Quality Control

6.2.1 Earthworks Quality Control

Agnico Eagle selected Tetra Tech to perform earthworks QC services for dike construction. Tetra Tech provided field engineers and technologists who performed laboratory and field testing on construction materials and verified the key trench foundation conditions. The earthworks QC field personnel were onsite on a full time basis (day and night shifts) for the majority of the dike's construction duration. Earthworks QC engineers and technologists activities during dike construction are summarized as follows:

- Tested and confirmed the acceptance of the construction materials;
- Observed key trench excavation;
- Confirmed if key trench foundation depth met design requirements;
- Observed various fill material placement (lift thicknesses, segregation etc.) and compaction efforts;
- Completed in situ density testing using a nuclear densometer or the "modified" sand cone method;
- Conducted soil laboratory testing (sieve, moisture content, moisture-density relationship, jar test (for determining ice content), bentonite swell test);
- Ensured proper calibrations and use of laboratory and field testing equipment; and
- Prepared and distributed daily activity and earthworks QC reports.

6.2.2 Liner Quality Control

Liner QC work was conducted by a technician from Texel. The liner QC technician's activities during liner installation are summarized as follows:

- Checked liner panels and made sure they were free of punctures and wrinkles prior to installation;
- Observed the liner installation works and ensured the liner was installed according to the construction specifications and manufacturer's recommendation;
- Performed QC testing on installed liner as per the specifications and Texel's QC plan; and
- Prepared and distributed daily activity and liner QC testing reports.

6.3 Earthworks Quality Assurance and Quality Control Testing

6.3.1 Run-of-Mine Rockfill (600 mm minus)

The material was visually inspected by Tetra Tech's QC site representatives to verify that, in general, the particles adhered to the maximum particle size and that deleterious materials such as snow or till were not present. Additionally, Tetra Tech observed that the specified lift thickness was maintained during placement and that the material was compacted sufficiently.

No QA/QC testing was conducted on ROM Type A or Type A1 materials.

6.3.2 Transition Rockfill (150 mm minus) Material

6.3.2.1 Particle Size Analysis

Samples of transition material were taken after and during crushing operations. Samples that were taken after crushing were from the stockpiles crushed in September and October 2016 prior to QC personnel's arrival on site. Samples obtained from the crusher were taken off the jaw crusher discharge belt. Particle size analyses conducted on eleven (11) samples of transition material produced from September 2016 to April 2017 indicated that average particle size distribution was generally within the limits presented in the design specifications. Results of particle size analysis for the produced transition material are presented in Appendix E1.

6.3.2.2 Moisture content

The moisture contents of the samples used for particle size analyses were also determined. Results are reported in the particle size analyses reports presented in Appendix E1 and summarized in Table E1.1.

6.3.2.3 Compaction Monitoring

Transition material placement and compaction was observed and monitored by Tetra Tech's QC site representatives. They verified transition material was placed in lifts approximately 300 mm in thickness. The material was generally handled properly to avoid segregation and each lift subjected to at least six (6) passes with the smooth drum vibratory CAT CS56 or CS563E compactors. When it wasn't possible to use the 10 ton CAT compactors because of safety concerns, lift thicknesses were reduced to 200 mm maximum and the HAMM 3205 packer was used with a minimum of ten (10) passes made.

6.3.3 Granular Fill (Type C) Material

6.3.3.1 Particle Size Analysis

Particle size analyses were conducted on Type C (20 mm minus) material produced at the crusher and used for the dike construction to verify compliance with the design specifications. A total of fifty seven (57) tests were conducted in the site laboratory from October 2016 to May 2017 when the dike was constructed. Two (2) QA samples were tested in Tetra Tech's Edmonton laboratory in October and November 2016. Particle size analyses for Type C material indicated that the average gradation was within the specified limits. A detailed summary of the analyses is presented in Appendix E2.

6.3.3.2 Moisture Content

The moisture contents of the samples used for particle size analyses were also determined. Moisture contents of stockpiled materials were determined prior to their use when visually the material appeared to contain snow in it or a high fines content. Results are reported in the particle size analyses reports presented in Appendix E2 and summarized in Table E2.1

6.3.3.3 Moisture Density Testing

Moisture-Density relationship testing (ASTM 698) was performed on seven (7) samples in the site laboratory and two (2) samples in Tetra Tech's Edmonton laboratory.

The field single point frozen soil density test (single point density test) was conducted outside the laboratory under the ambient air temperature by using a frozen soil sample taken from either the stockpile or construction site and by following the standard moisture-density test (ASTM 698) procedure without thawing the soil or adding water. This test was performed because the aggregate temperatures were generally well below freezing during construction making it unrealistic to compare field densities with results from standard moisture-density tests to assess compaction. Using this approach effectively evaluated if the material had been compacted to near the maximum achievable density in the frozen state.

Nine (9) single point density tests were performed on material from Type C stockpiles during dikes construction. Moisture-Density relationship test results are presented in Appendix E2. Single point density test results for Type C material are summarized in Table E2.2.

Results from the moisture-density relationship and frozen single point density tests were used to assess the level of compaction of Type C material.

6.3.3.4 Field Density Testing

Type C material placement and compaction was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer and/or using a "modified" sand cone method. As aggregate temperatures were generally well below freezing and ambient temperatures at times as low as -35°C during construction from December 2016 to March 2017, the accuracy of field density values from the nuclear densometer were suspect. The "modified" sand cone method which involved the use of bentonite with a predetermined bulk density instead of sand was used to measure the in situ density during cold conditions. Results obtained from density tests were compared with the frozen single point density test results to estimate the compaction. From the test results and field observations, the best possible compaction under the field conditions for the available materials was generally achieved. Photo 30 shows density testing on a lift of Type C material. Test results are attached in Appendix E2.

Some of the field density tests indicated that some lifts of Type C placed in the key trench had relatively low density due to relatively high native ice content (moisture content) in the frozen material that was compacted in cold winter conditions.

6.3.4 Bentonite-Augmented Material (Type F)

6.3.4.1 Moisture Content

Moisture contents of six (6) samples of Type F material taken from the dike or the mixing station were determined. Results are summarized in Table E3.1.

6.3.4.2 Swell Test

Type F material production was monitored by Tetra Tech's QC site representatives (Photo 31). Regular visual swell assessment on samples of placed Type F material was performed (Photos 32) and the results proved the presence of bentonite in the material.

6.3.4.3 Moisture Density Testing

The presence of bentonite in this material made it not possible to do a normal standard moisture-density test on it. Seven (7) single frozen density tests were performed on the material during dikes construction. The single frozen density tests on Type F material under field conditions were performed without adding water. Test results were used in assessing field compaction. Test results for Type F material are summarized in Table E3.2.

6.3.4.4 Field Density Testing

Type F material placement and in situ density was monitored by Tetra Tech's QC site representatives. Density testing was carried out using a nuclear densometer and/or using a "modified" sand cone method. Results obtained from density tests were compared with frozen single point density test results to estimate the compaction. From the test results and field observations, the best possible compaction under field conditions for the available materials was generally achieved. Photo 33 shows density testing on a lift of Type F material. Test results are attached in Appendix E3.

6.3.5 Native Till at Bottom of Key Trench

Native till material from the base of the key trench was taken for jar tests (as described below) and moisture content to verify the ice content of the foundation. The criteria for base of key trench excavation was stipulated in Appendix A of the specifications and summarized as follows:

- Minimum excavation depth 1.4 m below existing ground; and
- Key trench is to be extended to greater than 1.4 m depth below existing ground surface, until a point where material at the base consists of "ice-saturated", but not "ice-rich" soil or approved bedrock. If the key trench was excavated to a depth of 2.8 m from the original ground surface and no icy soils were found at the bottom of the key trench, the key trench excavation was terminated at 2.8 m. The key trench was excavated to a maximum depth of 3.2 m.

Tetra Tech QC site representatives took samples for jar and moisture tests from the base of the key trench once a 1.4 m depth was attained and every approximately 0.5 m downwards. Samples were obtained using a concrete coring machine (Photo 34) or by ripping with an excavator.

The jar tests is a simple test performed on ice-rich frozen soil to estimate its volumetric ice content. The test was generally performed using an approximately 10 cm long frozen soil core placed in a graduated glass beaker and allowed to thaw. When it wasn't possible to take cores, disturbed samples were used. The thawed saturated soil was then thoroughly mixed and allowed to settle (Photos 35 and 36). Volumes of sediment and supernatant water are recorded to estimate excess ice content in percent of the sample. Following the criteria set in Appendix A of the specifications, key trench base material was classified as either:

- Ice-saturated – Having a minimum of 90% ice saturation (or a minimum of 82% of water saturation) and less than 10% free water by volume of thawed soil sample in the jar and acceptable as key trench base;
- Ice-rich – More than 10% but less than 30% free water by volume of thawed soil sample in jar and not acceptable as key trench base; and
- Icy–soil – More than 30% free water by volume of thawed soil sample in jar and not acceptable as key trench base.

Jar and moisture content tests results from the key trench base are attached in Appendix E4; as a summarized Table E4 and displayed on the chart in Figure E4.

6.4 Liner Quality Control Testing

Texel conducted QC testing during liner installation. The results of this program are presented in their Construction Report, which is presented in Appendix F. The DRE conducted visual inspections throughout liner construction and observed the qualification welding tests, seam welding, ultra-sonic tests on patches and on seams. Photographs were taken during some of the testing (Photos 37 and 38). Liner QC activities involved the following:

- An ultrasonic test for each roll (79 m of Coletanche ES2) of liner installed or one test per shift per welder when the liner is installed;

- An ultrasonic test on each patch;
- Trowel test and visual observations along the seams and repairs; and
- Final visual tests to check for punctures or wrinkles on the placed liner.

6.5 Liner Quality Assurance

Liner quality assurance was performed by the DRE. The DRE conducted visual inspections throughout liner construction and observed seam welding and non-destructive tests. The non-destructive tests included qualification welding tests, ultra-sonic tests on patches/repairs and on seams. Punctures were identified during some inspections. Texel was informed and repairs carried out following specifications.

Two samples (one from the top liner and one from the bottom liner) were taken for destructive testing along completed liner seams. Samples were taken by Texel from locations designated by the DRE. The samples were approximately 700 mm x 300 mm each. Destructive test sample locations were repaired and tested by Texel following specifications. Photo 39 shows a destructive sample location along seam between Liner Panels 35 and 36. The samples are currently stored on site and may be sent to an external laboratory for tensile shear strength and ultrasonic tests in the future.

7.0 VARIATIONS FROM DESIGN DOCUMENTS

7.1 Nearly Saturated Backfill (Type K)

Type K material which is basically saturated Type C material was designed to be used to backfill excavated zones of the key trench below 1.8 m from the existing ground surface. Excavations below 1.8 m from ground surface were required to remove ice-rich or icy soils following the criteria descried in Appendix A of the specifications.

In December 2016 and January 2017, MTKSL had several unsuccessful attempts at mixing water and Type C material to produce Type K material for dike D-CP1 construction. RFI No. 6515-C-230-007_018 was issued in January which resulted in the suspension of this material's use for the dike's construction. The alternative was to place a 0.15 m to 0.30 m thick layer of Type F material on the base of the key trench. The key trench excavation geometry had to be adjusted as described in Section 7.2 below. This change does not negatively affect the design intent, quality of the key trench, and the expected dike overall performance as a whole.

7.2 Key Trench Excavation Geometry and Volume Increase

The key trench excavation geometry had to be adjusted to meet design requirements based on the elimination of Type K material discussed in Section 7.1. Following the elimination of Type K material and consequently the lowering of the liner to depths in excess of 1.8 m below the existing ground surface, additional excavation in the key trench downstream side was required to comply with the design liner slope and width in the key trench base.

The depth of foundation preparation was greater than anticipated (>2.8 m) in the design in some sections of the key trench. This was because it was difficult to control ripping with the excavator rock hammer.

The as-built configuration meets the design intent of the dike. The consequences of these variations were an increase in excavation volume, additional liner required, and additional quantities of backfill material (Type B1, Type F (including bentonite), and Type C).

7.3 Shortage of Non-Saline Run-of-Mine Rockfill (Type A1)

Type A1 rockfill (clean ROM from the saline pond excavation) was intended to be used for the dike's downstream zone over the key trench. The design intent was to reduce the risk of potential salts that may be introduced in the dikes critical zones if the Type A rockfill from underground operations was used. In December 2016, Agnico Eagle's Construction team and MTKSL noted that the volume of Type A1 material left in the stockpile would not be sufficient to complete the construction of Dikes D-CP1 and D-CP5 as designed. The shortfall was due to 15% to 40% of oversized boulders in the Type A1 stockpile that could not be used for the dike construction. As a result, Type A material was used to construct the uppermost section (~1.5 m to 2 m) of the downstream shell between approximately Stations 1+110 and 1+270 as per RFI No: 6515-C-230-007_014.

The consequence of using Type A material to construct a portion of the dike's downstream zone over the key trench is the potential for salts to be leached from the Type A material being introduced into the key trench and dike foundations. The salts would lower the freezing point depressions of the affected soils and impact their thermal performance. Since the Type A material was used in the less critical zones that were a distance away from the key trench, its potential effect on the dike overall performance is judged to be relatively low and tolerable.

7.4 Shortage of Non-Saline Transition Material (Type B1)

Dike D-CP5's design assumed that the non-saline ROM from the saline pond (Type A1) would be crushed to produce transition rockfill material (which was referred to in the design drawings and report as Type B1). Following the material increases resulting from the key trench changes discussed in Section 7.2 and the shortage of Type A1 as discussed in Section 7.3, a portion of the dike's crest material was crushed from Type A material (Type B). Based on Tetra Tech QA/QC personnel field notes and daily reports, the transition material produced from Type A material was placed above the top liner (from approximately Elevation 66.8 m to 67.8 m). This information was not provided in MTKSL as-built survey data. The change was authorized in RFI No: 6515-C-230-007_024.

As noted in the RFI, the option of using Type B material produced from Type A is not ideal. Type A material contains salts that would increase the pore water salinity of the dike fills. Since most of the Type B material was used in the less critical zones above the top liner, its potential effect on the dike overall performance is judged to be relatively low and tolerable.

7.5 Bottom Liner Depth from Original Ground Surface

Based on design specifications, the liner was designed to be installed at a maximum depth of ~1.8 m below original ground surface. To accommodate changes introduced by RFI_6515-C-230-007_018, the bottom liner had to be lowered below 1.8 m from the original ground surface in parts of the key trench where excavation was greater than 1.8 m from original ground surface. As indicated in the as-built drawings, the liner was installed deeper than 2 m in the sections between Stations 0+250 and 0+310.

The as-built liner depths meet or exceed the design intent and requirements of the dike. The consequence of this variation was an increase in the liner quantity required to complete the dike.

7.6 Top Liner Key-In at Crest

During a meeting attended by the members of the Dike Review Committee, the Dike Designer, and Agnico Eagle on October 28, 2016, it was suggested that changes be made to the designed top liner key-in at the crest to avoid sharp corners when anchoring the liner over the dike crest. These modifications were made by the Dike Designer and documented in ECN # 6515-C-235-007-ECN-002_RA.

As per the ECN, these changes were made during Construction and shown in the as-built drawings. This change is not expected to affect the dike's performance.

7.7 Seepage into Key Trench

7.7.1 Observations

Seepage problems started with water coming in from the upstream into the hinge point just prior to top liner installation. This necessitated the removal of portions of the saturated Type F under liner at the hinge point and replacement with unsaturated Type F, as shown on Photo 41.

Water ponding against the downstream dike toe between Stations 1+130 and 1+280 caused a bulge in the bottom of the top liner from Stations 1+150 to 1+210 on May 14, 2017. Pumps were set up to pump the downstream water to the upstream side of the dike into the CP5 basin. Ground temperature readings from within the key trench were taken and indicated near zero temperatures in some areas which meant the water was seeping into the key trench. Photos 40 to 45 taken from May 13, 2017 to May 18, 2017 show various observations made during the water ponding. Mitigation measures are discussed in Section 7.7.2.

7.7.2 Mitigation Measures

Pumping from the downstream side of D-CP5 continued for about a month. After a week, the seepage seemed to be under control; the water that was ponding against the downstream toe from Station 1+130 to 1+280 at D-CP5 was completely pumped to the upstream side. One pump was continuously pumping out any inflow. Water elevations on the upstream and downstream sides of the dike were being measured and reviewed on a daily basis during the period.

By the end of May 2017, areas within the key trench of D-CP5 that had warmed, showed a gradual freezing trend; previously unaffected areas generally showed an overall warming trend. This was an indication that water was no longer seeping into the key trench. As of August 17, 2017, the measured temperatures at the HGTC locations within the key trench are generally below -2°C.

7.8 Dike Dimensions

7.8.1 Observations

Comparison of the as-built drawings with the design indicates that some sections of the dike have as-built dimensions slightly less than designed. Table 7-1 summarizes the stations where the upstream crest widths, as shown in the as-built drawings, are less than designed. Table 7-2 summarizes the stations where the as-built thermal cover crest widths are less than designed. The deficiencies are not critical and therefore will not affect the dike overall stability and safety of the dike. Further discussions are presented in Section 7.8.2.

Table 7-1: Stations with Shorter As-Built Upstream Crest Widths

Station Shown in As-Built Drawings	As-Built Width (m)	Designed Width (m)	Difference (m)
1+130	11.1	11.4	-0.3
1+140	11.5	12.0	-0.5
1+230	11.8	12.0	-0.2
1+250	11.8	12.0	-0.2
1+260	11.8	12.0	-0.2

Table 7-2: Stations with Shorter As-Built Thermal Cover Crest Widths

Station Shown in As-Built Drawing	As-Built Width (m)	Designed Width (m)	Difference (m)
1+060	7.2	8.0	-0.8
1+070	7.0	8.0	-1.0
1+080	7.4	8.0	-0.6
1+090	7.4	8.0	-0.6
1+180	7.7	8.0	-0.3
1+190	7.7	8.0	-0.3
1+200	7.8	8.0	-0.2
1+210	7.8	8.0	-0.2
1+250	7.6	8.0	-0.4
1+260	7.5	8.0	-0.5
1+270	7.4	8.0	-0.6
1+290	7.7	8.0	-0.3
1+300	7.7	8.0	-0.3

The majority of the as-built liner crest elevations are equal to or higher than the design elevation of 66.8 m, with exception that the as-built liner crest elevations in the zones from Stations 1+058 to 1+0065, 1+180 to 1+1+185, 1+202 to 1+207, and 1+225 to 1+275 are slightly lower than designed. The as-built minimum liner crest elevation is approximately 66.72 m at the location around Station 1+260. This elevation is 0.08 m lower than the design elevation of 66.8 m.

The as-built drawings indicate that the thickness of the Type F material placed immediately between the base of the bottom key trench and the bottom liner in the key trench was less than the specified minimum thickness of 0.15 m around Stations 1+110, 1+200, 1+210, 1+260, and 1+280. The minimum Type F thickness at these stations appear near zero. The Type F layer below the liner at the hinge point appears to be missing around Stations 1+220 to 1+310. It is suspected that the minimal thickness shown on the drawings is a result of the limitations of the survey. The field observations do not support the survey data.

7.8.2 Mitigation Measures

The variations in dike widths are small and therefore will not affect the dike overall stability. Dike performance must be regularly monitored during its service life. Further mitigation measures can be established should dike inspection and monitoring observations indicate any concerns of the dike performance.

The design maximum water elevation under the inflow design flood (IDF) for D-CP5 is 66.3 m, which is 0.42 m lower than the as-built minimum liner crest elevation of 66.72 m, providing freeboard for the IDF. The dike is designed based on the assumption that the CP5 will contain little water throughout the year. The water level in CP5 will rise during freshet and during localized IDF events to the design level.

Dike crest settlement survey monitoring will confirm the final liner crest elevation after the expected dike settlement is completed during the first several years of dike operation. The dike operator should ensure that the dike upstream water elevation will maintain, with a safe margin, below the final minimum liner crest elevation. If future survey data indicate that the safe margin is greatly reduced after settlement, it would be recommended to raise the dike liner crest elevations in the affected zones.

7.9 Fill Material Density

7.9.1 Observations

Some of the Type C and Type F materials placed in the key trench below the liner during the winter had lower densities than designed. This was due to the frozen conditions of the fill materials with relatively higher than desired moisture (ice) contents.

7.9.2 Mitigation Measures

After the observation of the relatively low density of the Type C and Type F during the QC tests, the QC team closely monitored the moisture content of the Types C and F materials. The materials with excess moisture content were rejected.

The deficiencies will not affect the dike overall stability and safety. Dike performance will be regularly monitored during its service life. Further mitigation measures can be established should dike inspection and monitoring observations indicate any concerns of the dike performance.

7.10 Construction Schedule and Material Production

It was assumed in the dike design that key trench excavation and backfill would be completed from October to November 2016. This was not achieved. As a result, challenges were encountered when completion of the key trench excavation and backfill occurred under very cold winter conditions. In addition, some of the Type C material was produced from drill-blast frozen natural esker sourced materials during the winter construction period, instead of unfrozen summer-stockpiled materials that did not have excess moisture content. This increased the variability of the materials.

8.0 MATERIAL QUANTITIES

8.1 General

The material quantities used for Dike D-CP5 construction is presented in Table 8.1. The material quantities have been calculated from the as-built survey data. The design volumes presented in the design documents are also presented in Table 8-1 for comparative purpose.

Table 8-1: Summary of Construction Material Quantities

Material Type	Dike D-CP5 Design Quantity	Dike D-CP5 As-Built Quantity
Total Key Trench Excavation (m^3)	4,515	5,788
Total Run-of-Mine Rockfill – Type A (m^3)	9,890	10,029
Total Run-of-Mine Rockfill – Type A1 (m^3)	3,080	3,137
Total Transition Rockfill – Type B1/B (m^3)	3,580	3,971
Total Granular Fill – Type C (m^3)	3,100	4,096
Total Bentonite Augmented Material – Type F (m^3)	890 to 1,252	979
Total Geomembrane Liner – Coletanche ES2 (m^2)	3,955	4,437

8.2 Discussions on Quantities

Referencing Table 8-1, reasonable variations occurred in the Types A, A1, B/B1, C, and F materials volumes. The majority of the difference can be attributed to the additional volume required for the key trench excavation and backfill as discussed in Section 7.2.

9.0 LONG-TERM MONITORING

9.1 Purpose

Performance monitoring is an integral part of the operation of any water retention structure. The performance of Dike D-CP5 will need to be monitored throughout its operating life.

Permafrost exists beneath the footprint of D-CP5. The design intent is to maintain the original permafrost foundation beneath the liner in the key trench in a frozen condition over the life of the dike. Long-term monitoring of D-CP5 will include the following:

- Monitor thermal regime to confirm thermal prediction;
- Monitor settlement movements of the dike;
- Conduct routine visual inspection of the dike; and
- Satisfying regulatory requirements for dike performance monitoring.

9.2 Thermal Monitoring

Ground temperature cables installed in D-CP5 need to be read on a regular basis. Tetra Tech recommends that the cables be read twice per month during each June and July and on a monthly basis during the remaining months for the service life of the dike. The reading frequency can be adjusted as required. The data will be used to confirm the thermal predictions used to design the dike and identify any potential concerns in dike performance during its operation. The monitoring data should be sent to the Engineer of Record for assessment.

9.3 Survey Monitoring

The survey monitoring points installed in D-CP5 need to be surveyed on a regular basis. Tetra Tech recommends that a survey be performed on a monthly basis for the first two years and reduced to quarterly thereafter during the service life of the dike. The survey frequency can be adjusted when required. Each survey should note northings, eastings, and elevations. Elevation measurements must be performed with a total station with a high accuracy. In addition, the dike upstream and downstream water elevations should be surveyed at the same frequency and when changes in the water elevation are observed or impacted by pumping activities. When required, a complete survey of the dike external surface can be conducted. Monitoring data should be sent to the Engineer on Record for assessment.

9.4 Routine Dike Visual Inspection

Routine dike inspection by Agnico Eagle's site field engineer or technician should be undertaken to regularly monitor the dike conditions and performance. The frequency of the dike inspection should be at least once every two weeks during the open water seasons and monthly during the winter season. The inspection should include visual inspections for any signs of slope instability, seepage, settlements, cracks, sink holes, and lateral deformations. This inspection can be taken together with the thermal and survey monitoring activities for the dike. Any unusual observations or concerns during the routine dike inspections should be documented and sent to the Engineer of Record for further assessment.

9.5 Formal Annual Inspection

An annual site inspection is required to fulfil the Type "A" Water Licence (No. 2AM-MEL1631) requirements. The annual site inspection should be carried out by the design team to formally evaluate the performance of Dike D-CP5. An annual inspection report shall be produced following each inspection.

The inspection will typically take place at the end of summer when the maximum annual thaw has developed. The annual inspection will include the following, but not be limited to:

- Inspection of the upstream and downstream slopes for any signs of distress or instability;
- Inspection of the dike crest for any sign of transverse cracking or excess deformations;
- Inspection of the abutments and downstream toe for any evidence of seepage;
- Review of documents generated from routine dike visual inspections by Agnico Eagle's on-site technical staff; and
- A review of GTCs and survey monument data collected.

10.0 CLOSURE.

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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PERMIT TO PRACTICE
TETRA TECH CANADA INC.

Signature ______

Date OCT. 19, 2017

PERMIT NUMBER: P 018

NT/NU Association of Professional Engineers and Geoscientists

REFERENCES

Tetra Tech EBA, 2016a. Design Report for Dike D-CP5, Meliadine Gold Project, NU. AEM Document Number: 6515-132-007-132-REP-004, Version 0, prepared by Tetra Tech EBA and submitted to Agnico Eagle Mines Ltd., August 15, 2016.

Tetra Tech EBA, 2016b. Geotechnical Specifications for Construction of Dike D-CP5, Meliadine Gold Project, NU. AEM Document Number: 6515-E-132-007-132-SPT-003 R1, Revision 1, prepared by Tetra Tech EBA and submitted to Agnico Eagle Mines Ltd., November 9, 2016.

Tetra Tech EBA, 2016c. Construction Quality Plan for Dikes D-CP1 and D-CP5, Meliadine Gold Project, NU. AEM Document Number: 6515-132-007-132-QQP-001, Version 0, prepared by Tetra Tech EBA and submitted to Agnico Eagle Mines Ltd., October 12, 2016.

FIGURES

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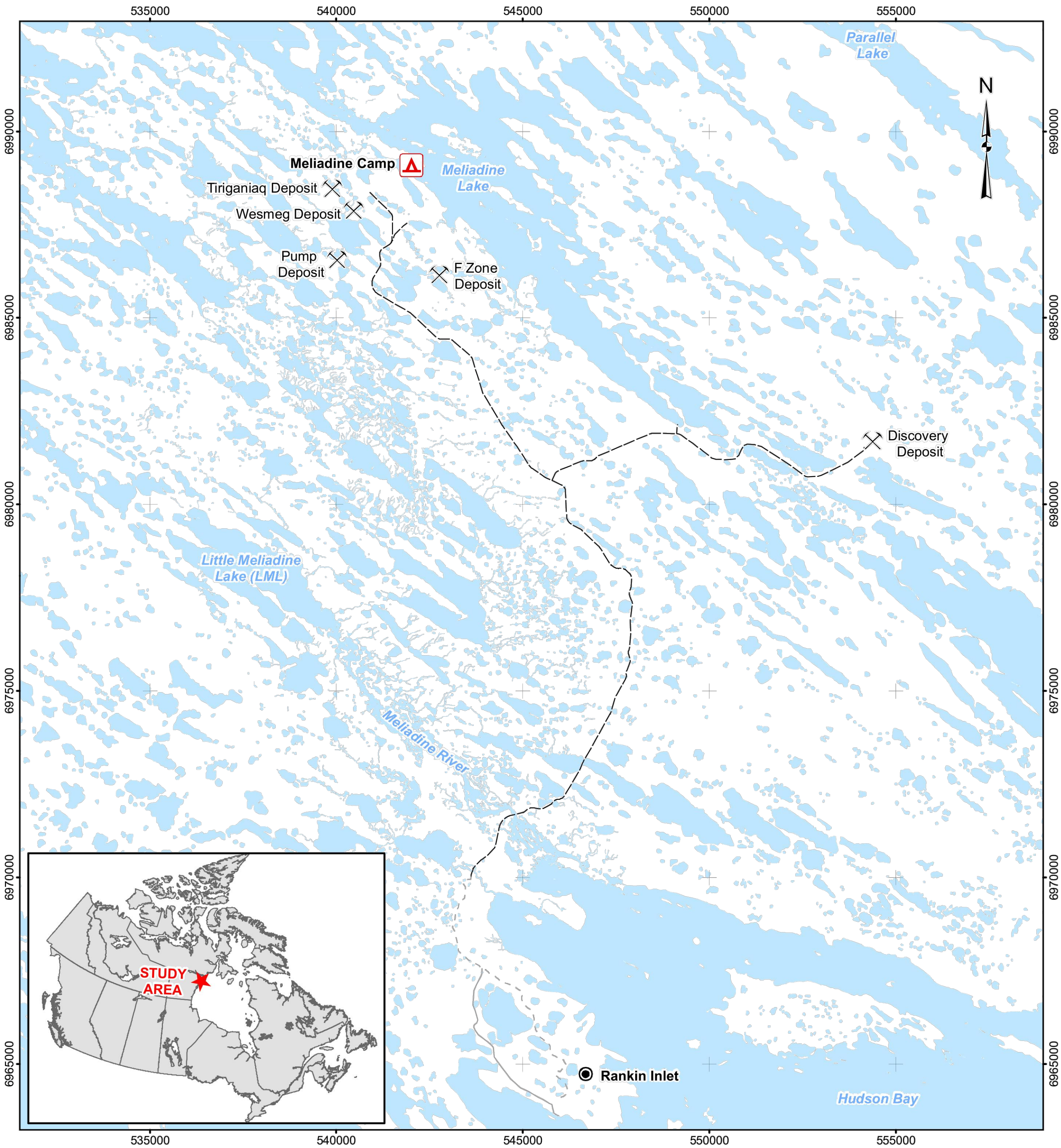

LEGEND

- Camp
- Proposed Mine Site
- All-weather Access Road (AWAR)
- Road - New
- Road - Existing
- Watercourse
- Waterbody

AGNICO EAGLE – MELIADINE DIVISION

AGNICO EAGLE

TETRA TECH

AGNICO EAGLE – MELIADINE DIVISION

FIGURE 1 GENERAL PROJECT LOCATION PLAN

No. PROJET / PROJECT No.		DATE	2017–10–06
DESSINÉ PAR / DRAWN BY	EL	FEUILLE/SHT	1 / 1
APPROUVÉ PAR / APPROVED BY	WTH		
NO. DESSIN / DRAWING NO.		REVISION	A

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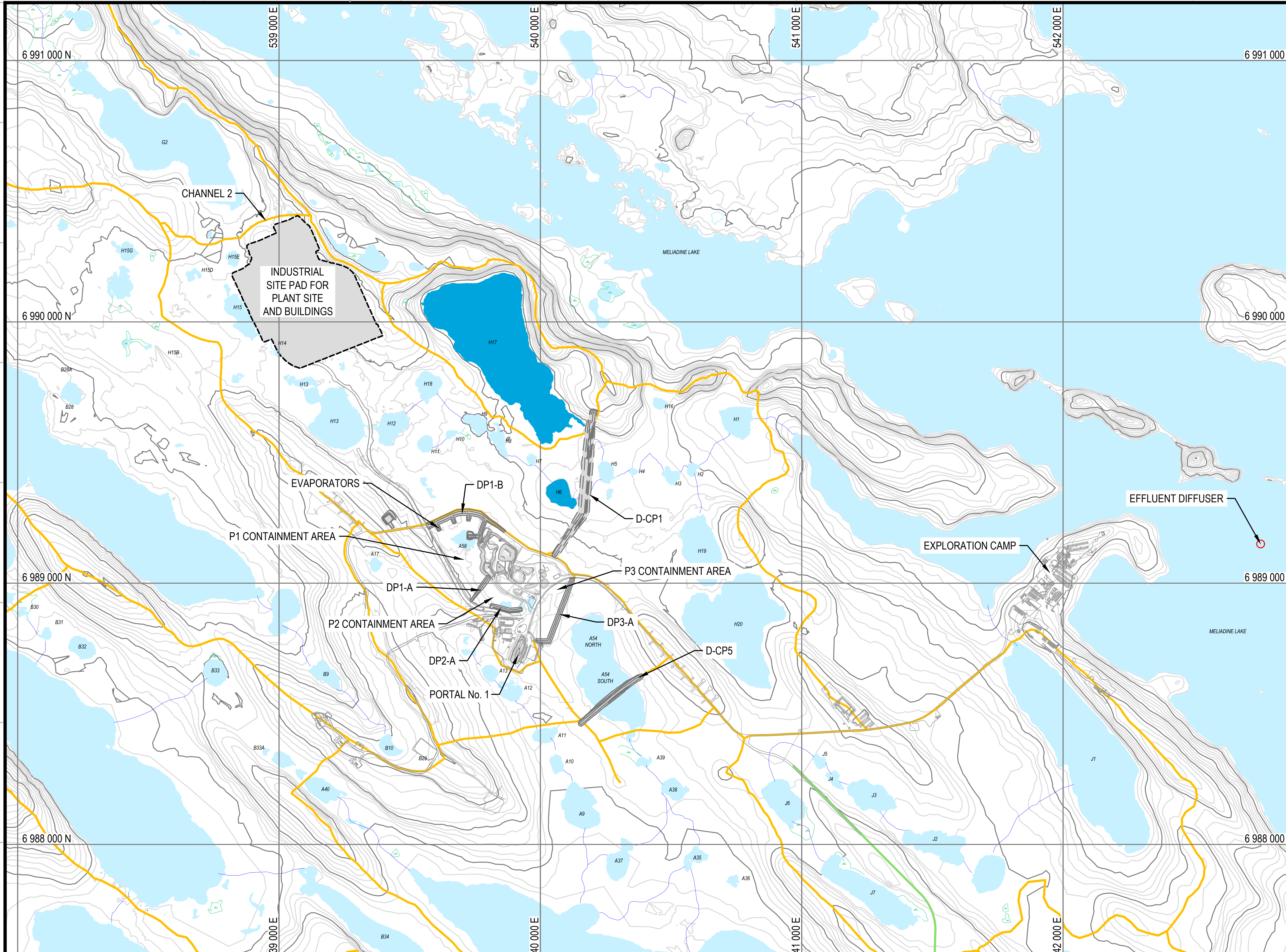
FILE NO. .DWG

NO. DESSIN
DRAWING NO.

FORMAT ANSI B-11x17



NOTES:

AGNICO EAGLE

TETRA TECH

TITRE / TITLE	# DWG
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DESSINS EN RÉFÉRENCE/REFERENCE DRAWINGS

REV	DESCRIPTION	DATE	PAR BY
A	ISSUED FOR REVIEW	2017-10-06	WTH

REVISIONS

DESSINÉ PAR DRAWN BY	EL	DATE	2017-10-06
VÉRIFIÉ PAR CHECKED BY	FN		2017-10-06
APPROUVÉ PAR APPROVED BY	WTH		2017-10-06
No. PROJET PROJECT NO.	6515		
DATE	2017-10-06		

TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT

FIGURE 2
GENERAL SITE PLAN SHOWING
DIKE D-CP5 LOCATION

ÉCHELLE/ SCALE | FICHIER FILE A

No. DESSIN/ DRAWING NO. | REVISION A | FEUILLE/SHT 1 / 1

AE-CART-ANSI B

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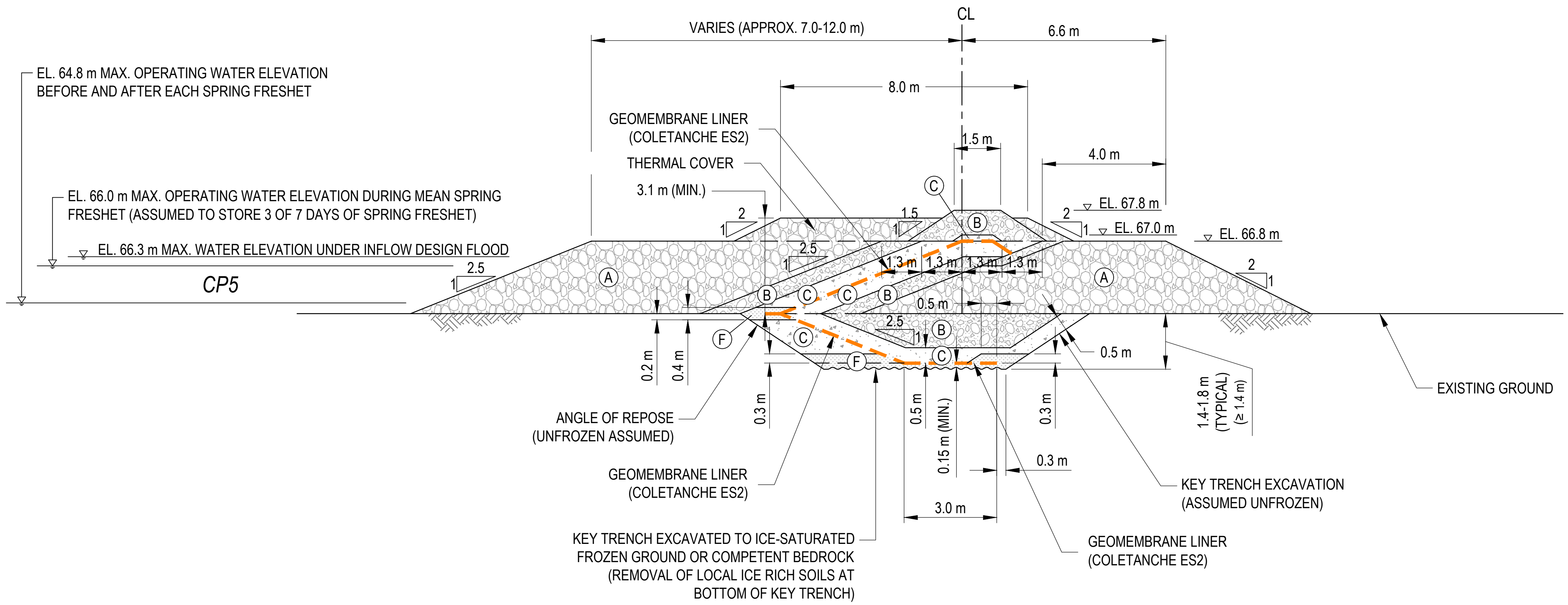
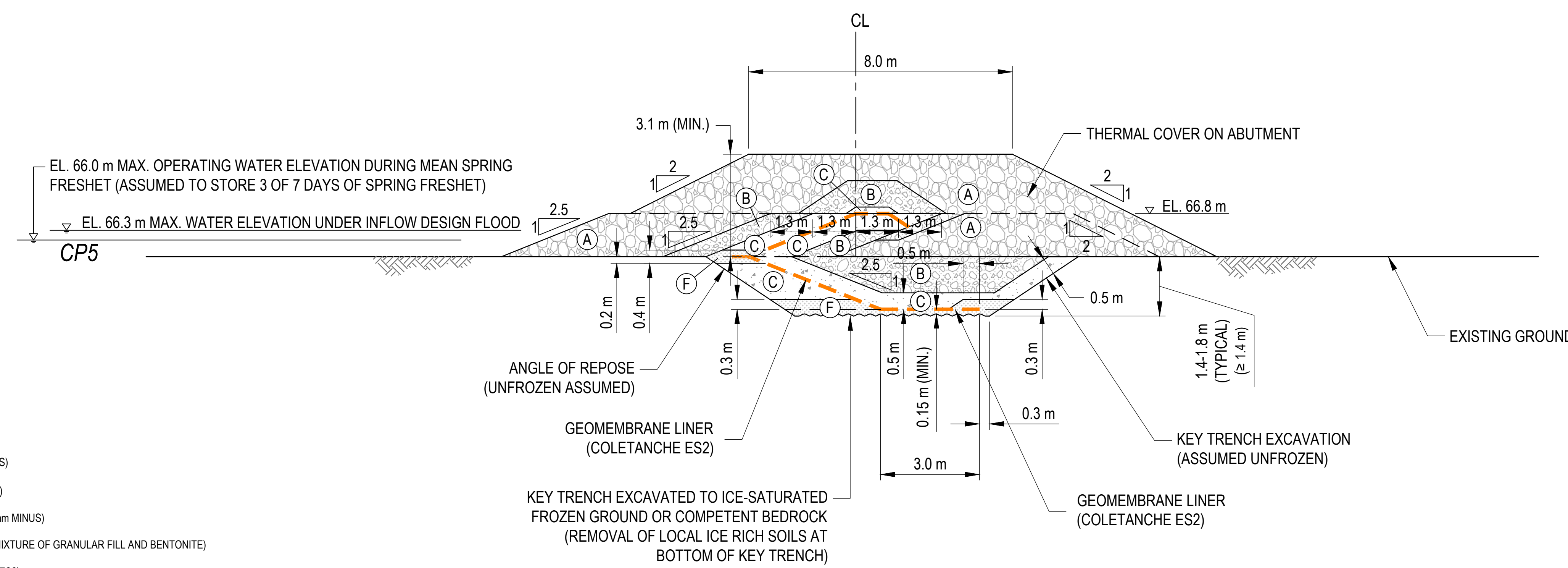


TYPICAL SECTION OF D-CP5



TYPICAL SECTION OF D-CP5 NEAR ABUTMENT

- (A) RUN-OF-MINE ROCKFILL (600 mm MINUS)
- (B) TRANSITION ROCKFILL (150 mm MINUS)
- (C) GRANULAR FILL OR ESKER SAND (20 mm MINUS)
- (F) BENTONITE-AUGMENTED MATERIAL (MIXTURE OF GRANULAR FILL AND BENTONITE)
- — — GEOMEMBRANE LINER (COLETANCHE ES2)

- ASSUMED KEY TRENCH EXCAVATION AND BACKFILL TO BE CONSTRUCTED FROM SEPTEMBER 2016 TO NOVEMBER 2016.
- THE SELECTION AND USE OF THE COLETANCHE LINER TYPE FOR D-CP1 AND D-CP5 WERE MADE BY AGNICO EAGLE MINES LIMITED.

AGNICO EAGLE

TETRA TECH

# DWG	TITRE / TITLE
-	-
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-	-
-	-

DESSINS EN RÉFÉRENCE/REFERENCE DRAWINGS

REV	DESCRIPTION	DATE	PAR BY
A	ISSUED FOR REVIEW	2017-10-06	WTH

REVISIONS

		DATE
DESSINÉ PAR DRAWN BY	EL	2017-10-06
VÉRIFIÉ PAR CHECKED BY	FN	2017-10-06
APPROUVÉ PAR APPROVED BY	WTH	2017-10-06
No. PROJET PROJECT NO.	6515	
DATE	2017-10-06	

TITRE / TITLE

AGNICO EAGLE MELIADINE GOLD PROJECT

GENERAL SECTION OF DIKE D-CP5 DESIGN CONCEPT

ÉCHELLE/ SCALE | FICHIER FILE

No. DESSIN/ DRAWING NO. - | REVISION A | FEUILLE/SHT 1 / 1

AE-CART-ANSI B

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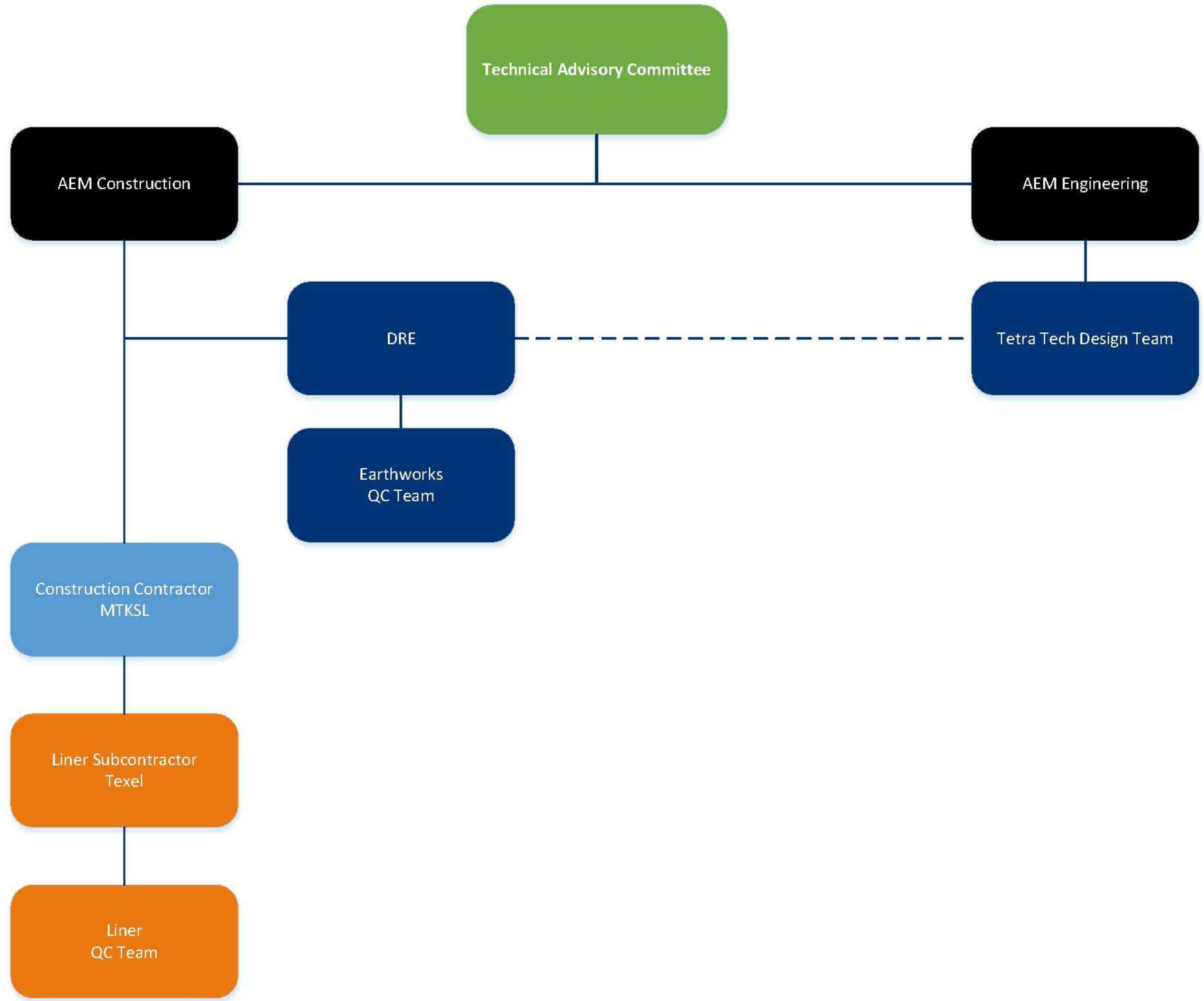

CLIENT

AGNICO EAGLE

TETRA TECH

OPERATIONAL PARAMETERS FOR D-CP1 AND D-CP5 DIKE CONSTRUCTION

ORGANIZATION CHART

PROJECT NO.	DWN	CKD	REV
ENG.EARC03076-01	EL	GZ	A
OFFICE	DATE		
EDMONTON	OCTOBER 12, 2017		

FIGURE 4