

PUBLIC SERVICES AND PROCUREMENT CANADA

KINGSTON MILLS LOCKS 46 TO 49 REHABILITATION INVESTIGATIVE GEOTECHNICAL REPORT

JUNE 27, 2018



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1 INTRODUCTION

1.1 CONTEXT

WSP Canada Inc. (WSP) was retained by Public Services and Procurement Canada (PSPC) to complete an assessment of the Kingston Mills Lockstation, part of the Rideau Canal waterway system, and provide recommendations and design requirements to complete proposed rehabilitation work. As part of the assessment and design process, a review of the available geotechnical information was undertaken and supplementary geotechnical field investigations were completed. Results of a detailed review of all available historical information, a supplemental field investigation and design analysis are presented in the ensuing paragraphs

This report was prepared in accordance with professional services agreement No. EQ754-171828/A with PSPC as the intended recipient. A disclosure of this report to third parties can only be made by the intended recipient who will assume responsibility for such a disclosure. The information, data, and opinions expressed in this report reflect WSP's best judgement in light of the information available at the time of preparation of the report. Any use of the report by third parties reliance upon, or decisions made based upon information provided in this report, are the responsibility of such third parties and specifically WSP accepts no responsibility for damages, if any, suffered by any third parties as a result of decisions made or actions taken based on information contained in this report. This limitations statement is considered part of this report.

1.2 PROJECT AND SITE DESCRIPTION

1.2.1 PROJECT DESCRIPTION

The project site is located approximately in the county of Frontenac, 7.8 km northeast of The City of Kingston near Kingston Mills, Ontario. Access to project site is north of Highway 401, west of Highway 15, westerly on Kingston Mills Road (County Road 21) to the project site.

WSP's overall scope includes design of rehabilitation works for the locks and associated structures which have been identified as being in relatively poor condition.

WSP's geotechnical scope of work included the following:

- Review of existing historical geotechnical information;
- Drilling of six exploratory boreholes within the study area;
- Drilling four exploratory boreholes and two hand augers holes within the project area;
- Excavating three exploratory test pits near selected retaining and chamber walls;
- Coring the exterior walls of selected retaining walls;
- In-situ soil sampling and testing, including Standard Penetration Testing (SPT);
- Obtaining soil samples and rock core samples for additional review and laboratory testing;
- Laboratory testing;
- Geotechnical analysis; and
- Compiling all results into a single, concise report.

1.2.2 SITE DESCRIPTION

The existing lock station consists of a set of four locks, divided into two areas separated by a turning basin. The northern most lock (Lock 46), acts as a turning basin from Cranberry Lake while the south set of locks (Lock 47 through 49), provide access to the St. Lawrence River.

The topography of the land consists of steep hills with flat areas cut into or filled on top of the existing hillsides. The ground slopes downward to the south from approximately elevation 90.5 m to elevation 87.0 m at the top of the first set of locks. The ground continues to slope downwards to the south at the second set of locks to approximately elevation 86.1 m downwards past the railroad bridge to approximately elevation 78.8 m.

1.2.3 SUMMARY OF ORIGINAL LOCK CONSTRUCTION

Upon review of historical documents and site observations from supplemental work completed by WSP staff, the lock components are generally constructed on bedrock with some sections partially constructed on oak sills. Additional discussion on lock construction is presented in the ensuing paragraphs.

Lock 46 are built partially on bedrock and partially on oak sills. The oak sills support components of the structure upstream of the breast wall, where bedrock is not present. Site observations note that timbers are visible in the stream adjacent to the shore at the west upstream embankment, possibly from original construction of the Lockstation. The section of chamber floor in front of the breast wall towards the downstream gate was noted to be constructed on bedrock. Bedrock is also present behind the chamber walls. A centre bearing swing bridge is present and installed over this lock, with the centre pier and east abutment on bedrock immediately behind the west and east walls of the chamber lock, respectively. The east rest abutment that is utilized when the bridge is open to traffic is partially constructed on top of the east chamber wall.

Locks 47 and 48 are constructed within a blasted/excavated bedrock outcrop area. The west side walls of Locks 47 and 48 are built directly against the bedrock while the east side walls of Locks 47 and 48 were built elevated on bedrock and have the back of the walls exposed. The original bedrock floors in Locks 47 and 48 were overlaid in the past with concrete directly over bedrock in an apparent attempt to seal the bedrock and prevent water infiltration towards the breast walls.

At Lock 49, available information indicates that more than 70% of the lock is constructed on timber rafts placed on top of the fill with the north section of the lock supported by bedrock. The downstream end of Lock 49 was modified and repaired very shortly after original construction with some very significant structural interventions required in the years following construction. The past repairs appear to focus on the concern of global stability and resilience to settlement. The most recent major intervention was in 1972 when lower wingwalls and monoliths were dismantled, backfill replaced and masonry grouted.

2 INVESTIGATIVE METHODOLOGY

2.1 DESKTOP STUDY

2.1.1 PUBLISHED SURFICIAL AND BEDROCK GEOLOGY MAPS

A review of available geological mapping (GSC Map M2227) noted that native soil in the general study area consists of shallow till and rock ridges. Precambrian bedrock in the area is of the Grenville Formation consisting of granite-gneiss.

2.1.2 PREVIOUS GEOTECHNICAL INVESTIGATIONS

To develop a thorough understanding of the existing site conditions in addition to determining where additional boreholes were to be placed, the following reports information was provided to WSP by PSPC for review:

Site Investigation Services Limited, 1977 – Swing Bridge at Kingston Mills

A geotechnical investigation was carried out to assess the soil and rock conditions behind the east abutment of the swing bridge at the Kingston Mills Lock station. A total 10 boreholes were advanced at selected locations in near the east abutment. Borehole locations from the investigation are presented on a borehole plan in Appendix A and also included on a site plan appended to the full report included in Appendix D.

Based on the results of the investigation, the following observations were reported:

South of the Swing Bridge:

- Overburden near the lock wall consisted of topsoil over clayey silt fill to a depth of 910 mm
- Bedrock was encountered within 910 mm of the top of the lock wall.
- Bedrock is exposed 4.57 to 6.1m from the wall line

North of the Swing Bridge

- At boreholes E and J, overburden consisted of topsoil over a native stony sandy clayey silt till.
- Bedrock was encountered at elevation 87.93 (2.9 m below the top of the concrete wall at boreholes E and J)
- At boreholes G, H, and I rockfill was encountered at approximately 1.5 m below grade.
- At borehole J, bedrock was observed at elevation 87.5.

Golder Associates, 1979 – Borehole Results - Kingston Mills Lock Station Rideau Canal, Kingston Ontario

The purpose of the geotechnical investigation was to provide supplemental information to Public Services and Procurement Canada on the condition of the soils underlying Lock 49.

Two boreholes were advanced within Lock 49:

- One at the upstream Sill.
- One at the downstream Sill.

Trow Ontario Ltd., 1990 – Geotechnical Investigation – Grouting Test Program, Locks 47 and 48, Kingston Mills Locks, Kingston, Ontario

A geotechnical investigation was carried out to assess the construction of lock 47 and 48. A total of 20 horizontal and 6 vertical boreholes were advanced through the structures as part of the investigation. A grouting program was also completed to assess the condition of the grouting techniques used in the rehabilitation of the locks. A detailed discussion on the extent of the grouting program can be found in Appendix D.

Quontacon Associates, 1999 – Kingston Mills Swing Bridge, Rideau Canal, Geotechnical Investigation

A geotechnical investigation was commissioned by Public Services and Procurement Canada to obtain an assessment of the foundations of the existing swing bridge (Lock 46) at the Kingston Mills Lockstation. A total of 14 vertical boreholes and cores were advanced within the study limits. The boreholes were placed at select locations as indicated below:

- 6 boreholes to obtain core samples within the abutments and pivot pier foundations
- 1 borehole through the bridge deck and concrete counter weight
- 4 boreholes near the bridge abutments (1 per quadrant of the bridge)
- 2 boreholes near the concrete pivot pier adjacent to the circular track
- 1 borehole through the concrete counterweight at the west end of the bridge.

Further details on the investigation and recommendations can be found in Appendix D.

Jacques Whitford, 2005 – Geotechnical Investigation for the Kingston Mills Lock No. 46, Kingston, Ontario

A geotechnical investigation was completed at Lock 46. A total of 11 cores were extracted at select locations to assess the material properties of the structure.

Golder Associates, 2015 – Geotechnical Investigation, Proposed Structural Rehabilitation – Kingston Mills Swing Bridge, Kingston, Ontario

Additional investigative work was completed to provide recommendations for the proposed rehabilitation of the swing bridge. A desktop study was completed which included a review of additional historical reports (not documented above):

- J.D. Lee Engineering Limited, 1976 – The foundation condition of the swing bridge at Kingston Mills, Ontario
- J.D. Lee Engineering Limited, 1977 – Swing Bridge at Kingston Mills

The field program consisted of

- Three horizontal boreholes
- One vertical borehole
- Four test pits
- In situ testing and a laboratory testing program

In general, soil conditions encountered consisted of 2.5 m to 3 m of fill over bedrock. A more detailed explanation of site conditions within the limits of the lock station is presented in Section 3.

Please refer to the full report presented in Appendix D.

2.2 SUPPLEMENTAL INVESTIGATION

A geotechnical investigation was completed by WSP in April and October 2017. The investigation included selective coring of the existing stone, borehole drilling, test pitting, installation of monitoring wells, laboratory testing of selected soil samples, geotechnical analysis and preparation of this report.

2.2.1 CORING INVESTIGATION

A total of 33 core holes (CH 1 through CH 33) were placed at selected locations within the study area as shown in Appendix A. Cores were advanced with diamond tipped coring equipment supplied by CCC Geotechnical and Environmental Drilling Ltd. Of Ottawa, Ontario.

During the field investigation, all drilling operations were supervised on a full-time basis by a member of WSP's geotechnical staff who logged the depths at which different soil strata were encountered and processed and transported samples to our accredited laboratory facilities in Ottawa.

2.2.2 BOREHOLE AND TEST PIT INVESTIGATION

A total of 4 boreholes (BH 17-1 through 3 and BH 17-6), 2 hand auger holes (HA 17-4 and 17-5) and 3 test pits (TP 17-1 through 17-3) were placed at key locations within the study areas in consultation with the structural team as shown in Appendix A.

Prior to the start of drilling and excavating activities, utility clearances were obtained for all borehole and test pitting locations. Boreholes were advanced with CME hydraulic drilling equipment. Test pits were excavated using a rubber tire backhoe. All equipment and operating staff was supplied by Canadian Environmental Drilling and Contracting Inc. of Ivernary, Ontario. Soil samples were obtained at selected intervals using split spoon sampling techniques in conjunction with Standard Penetration Testing (SPT). Field shear vane testing was completed in areas where cohesive soil was encountered.

Standpipe piezometers were installed at all borehole locations to permit the ongoing measurement of stabilized groundwater levels within the study area. Records of each piezometer installation completed are presented as drawings in the attached borehole logs presented in Appendix C.

During the field investigation, all drilling operations were supervised on a full-time basis by a member of WSP's geotechnical staff who logged the depths at which different soil strata were encountered as well as processed and transported samples to our accredited laboratory facilities in Ottawa.

2.2.3 LABORATORY TESTING PROGRAM

All recovered samples were visually reviewed and a laboratory testing program was carried out on selected soil samples which included natural moisture content, particle size analysis and Atterberg limits (plasticity) testing. Laboratory index testing results are presented on the individual borehole logs and are included in Appendix C.

Samples of the stone masonry and rock from the current WSP coring investigation was also tested for the following parameters:

- Percent Absorption
- Bulk Specific Gravity.
- Compressive Strength
- Uniaxial Compression

3 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

A summary of subsurface conditions encountered within the study limits is presented in the ensuing sections. A detailed description of the soil stratigraphy encountered at each borehole location is shown on the borehole log sheets shown in Appendix C and D. Please note that the factual descriptions shown in each borehole logs takes precedence over the generalized (and simplified) descriptions presented below.

3.1.1 TOPSOIL AND ORGANICS

Topsoil was encountered at the ground surface at the majority of all the boreholes and test pit locations. The topsoil thickness varied from 30 mm to 330 mm.

The measured topsoil thicknesses where encountered are summarized below.

Table 3.1 Measured Topsoil Thickness

LOCATION	TOPSOIL THICKNESS
Lock 46	30 mm to 330 mm
Lock 47	80 mm to 270 mm
Lock 48	160 mm to 240 mm
Lock 49	170 mm

3.1.2 PAVEMENT STRUCTURE – KINGSTON MILLS ROAD

Historical boreholes were advanced through the pavement structure of Kingston Mills Road during the 1977 investigation completed by Site Investigation Service, the 2000 investigation completed by Quontacon Associates and the 2015 investigation completed by Golder Associates.

East of Lock 46, four boreholes (77 G through I and 15-101) were advanced through the existing pavement platform. Field observations noted a flexible pavement structure (asphalt over granular fill). The asphalt thickness was observed to be a consistent 100 mm and generally supported by sand fill over clayey sandy silt to silty clay some sand fill that extended to depths ranging from 1.2 to 1.5m from surface within the westbound lane and extended to 2.7 m within the eastbound lane.

West of Lock 46, two boreholes were advanced through the existing pavement structure (00 C3 and C4). Conditions observed during the field investigation noted the presence of a composite pavement structure (asphalt over concrete). Asphalt thickness was observed to vary from 38 mm to 50 mm. The concrete base extended to depths ranging from 300 to 400 mm below the surface.

3.1.3 FILL

Fill material was also encountered beyond Kingston Mills Road throughout the project limits in all the current boreholes and in most of the previous boreholes. The depth of fill encountered in the various boreholes (both current and previous) ranged from surface to 4.6 m from surface.

The fill material includes a range of soil and rock materials, but is most typically described as ranging from silt with clay and varying amounts of gravel and sand to silty sand. Fill is often, by nature, a heterogeneous material and has

likely been placed as part of multiple previous projects in the area. It should, therefore, be anticipated that variability will exist in the fill material (i.e. materials other than those described in the borehole logs could be encountered during construction).

SPT ‘N’ values within the fill material typically ranged from 3 blows to 29 blows per 305 mm of penetration through most of the project, indicating a loose to compact consistency soil.

Grain size curves for selected samples of fill material from the 2017 WSP Investigation is presented in Appendix B. A summary of these grain size distributions is also presented in the table below.

Table 3.2 Results of Grain Size Analyses for Fill

BOREHOLE NO.	SAMPLE NO.	GRAIN SIZE DISTRIBUTION			
		% Gravel	% Sand	% Silt	% Clay
15-1A*	2	0	8	92	
	3	2	6	92	
	4	0	7	93	
17-1	SS4	9	14	56	21
17-2	SS3	9	47	37	7
17-3	SS3	6	24	60	9
17-6	SS4	9	44	41	6
	SS6	2	22	58	18
TP17-2	GRAB 2	2	89	9	
	GRAB 3	3	33	53	12
TP17-3	GRAB 3	48	34	18	

Note*: Approximate grain size distribution values interpreted from review of graphical chart available.

3.1.4 TILL

Glacial till was reported to have been encountered during the 1977 Site Investigation Services. The glacial till consists of a heterogeneous mixture of gravel, sandy clayey silt till.

Table 3.3 Glacial Till

Investigation	Borehole	Depth Encountered (m)	Thickness (m)
Site Investigation Service - 1977	77-E	250 mm - 2.7 m	2.45
	77-F	230 mm - 2.3 m	2.07
	77-J	1.8 m - 2.7 m	0.90

3.1.5 AUGER REFUSAL AND BEDROCK

Auger refusal was encountered at 14 boreholes (12 at Lock 46, 1 at Lock 48 and 1 at Lock 49) drilled as part of previous investigations at depths ranging from of 100 mm to 2.7 m from surface. Bedrock was cored at boreholes 17- 1, 17-2, and 17-3 during the WSP investigation using ‘NQ’ sized diamond coring equipment. A summary of the elevation as which bedrock was encountered in the WSP investigations as well as within historical investigations is presented in Appendix F.

The rock encountered in the cored holes consisted of fresh granite. Rock Quality Designation (RQD) ranged from 0 to 100% (indicating a rock quality of “very poor” to “excellent”). Generally, the RQD values increase with depth (i.e. is typically “very poor” to “poor” quality near surface, and becomes “fair” to “excellent” quality with depth. When analyzing the rock quality results within the Kingston Mills Lock station, the RQD values were general observed to be good to excellent once encountered (one exception was at BH 17-2 where the RQD was observed to be 27%) and decreased in RQD value with depth.

Results of the testing are presented in Appendix C and D respectively.

3.1.6 SUMMARY

A summary of the sub-surface conditions noted in the historical information review encountered at the various boreholes is presented in Appendix E.

3.2 GROUNDWATER CONDITIONS

Groundwater measurements were obtained (by others) in various boreholes in 1979 and 2015. In addition, monitoring wells and data loggers were installed in the boreholes drilled as part of this investigation, and stabilized groundwater levels were obtained from during drilling and from site visits completed between the months of October and November 2017. All data logging devices have been left in the drilled boreholes as part of an ongoing groundwater monitoring program to assess fluctuations in the stabilized groundwater levels over the winter months. To date, groundwater data has been collected and processed from October to November 2017 and from November 2017 to May 2018. A final round of data collection will be completed in August 2018. A graphical representation of the groundwater information collected to date is presented in Appendix B.

A summary of the groundwater levels measured at the various boreholes and monitoring wells (in the current investigation as well as reported in previous investigations) is presented in the table below.

Table 3.4 Groundwater Level Data By Investigation

BH	Lock	Ground Surface Elevation (m)	Installation Depth (m)	Soil Type at Response Zone	Measured Groundwater Elevation/Depth (m)					
					1979	2015	2017			2018
					14 - May	14 - May	4-Oct	12-Oct	30-Nov	17-May
15-101	46	91.9	N/A	Bedrock		88.65/ 3.25				
17-1	46	90.5	1.93 – 3.45	Silt to Silty Sand Fill			86.92/ 3.58	88.33/ 2.17	88.49/ 2.01	88.67/ 1.83
17-2	46	90.5	1.21 – 2.43	Silty Sand Fill			87.73/ 2.77	88.33/ 2.17	88.19/ 2.31	
17-3	47	86.1	1.01 – 2.28	Silt Fill			83.02/ 3.08	84.12/ 1.98	84.12/ 1.98	85.19/ 0.91
17-6	49	78.8	5.2 – 6.7	Silt Fill/Sand Till			72.22/ 6.58	74.96/ 3.84	75.06/ 3.74	75.61/ 3.19
79-1	49	75.18	N/A	Silty Sand/Gravel/Boulder	76.20/ 1.02					

A summary of depth and dates where a notable change in static water levels were recorded is shown in the table below:

Table 3.5 Data Logger Information – Changes In Water Level

Borehole Location	Lock	Stabilized Static Water Level (m)	Date	Depth of Fluctuation (Elevation)	Change Water Level (m)
17-1	46	87.87	Oct 19/17 to Oct 20/17	88.29 - 87.90	0.39
		88.43	Oct 29/17 to Oct 30/17	87.90 – 88.87	0.97
		87.46	Nov 8/17 to Nov 14/17	88.87 – 87.82	1.05
		87.14	Dec 10/17 to Dec 11/17	87.25 – 87.72	0.47
			Jan 11/18 to Jan 12/18	87.07 - 88.07	1.00
		87.08	Feb 21/18 to Feb 26/18	87.14 - 87.77	0.63
87.89	Mar 29/18 to Apr 5/18	87.10 – 87.81	0.71		
17-2	46	88.34	Oct 29/17 to Oct 31/17	88.34 – 88.08	0.26
17-3	47	84.00	Oct 29/17 to Oct 31/17	83.99 - 84.95	0.96
			Nov 2/17 to Nov 3/17	83.99 – 84.61	0.62
			Nov 6/17 to Nov 7/17	83.99 – 84.68	0.69
			Dec 5/18	84.03 – 84.28	0.25
			Jan 11/18 to Jan 12/18	84.00 - 85.10	1.10
			Jan 24/18	84.00 - 84.47	0.47
			Jan 27/18	84.00 - 84.67	0.67
			Feb 14/18	84.00 - 84.66	0.66
			Feb 19/18 to Feb 28/18	84.01 – 84.86	0.85
			Mar 30/18 to Mar 31/18	84.02 – 84.31	0.29
			Apr 3/18 to Apr 5/18	83.99 – 84.71	0.72
			Apr 12/18 to Apr 19/18	84.02 – 84.78	0.76
			Apr 28/18	84.03 – 84.28	0.25
			May 17/18	83.99 – 85.66	1.67
17-6	49	74.48	Oct 29/17 to Oct 30/17	74.48 – 74.85	0.37
		74.55	Nov 9/17 to Nov 12/17	74.85 – 74.55	0.30
		74.94	Jan 10/18 to Jan 25/18	74.81 – 75.12	0.31
		75.12	Feb 18/18 to Mar 14/18	74.96 – 75.18	0.22
		74.87	Apr 4/18	74.92 – 75.37	0.45
		75.27	Apr 8/18 to Apr 17/18	75.00 – 75.27	0.27
		75.24	May 4/18	75.34 – 75.73	0.39
			May 17/18	75.28 – 75.55	0.27

Note: Maximum change in water level shown within date range indicated.

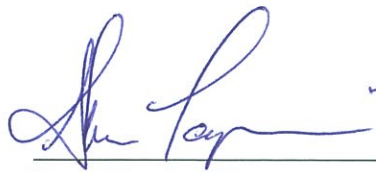
Gap in data from November 15 to November 30 due to removal and installation of data logger

4 CLOSURE

Fieldwork for this assignment was completed by trained WSP technicians, under the direct supervision of C.Hendry P.Eng. and S.Lapain P.Eng. Review of information and preparation of this Investigative Geotechnical Report was carried out by S.Lapain P.Eng. The report was reviewed by C.Hendry, P.Eng.

We trust this information satisfies the requirements of the Public Services and Procurement Canada at this time. Should you have any questions on the contents of this report, please do not hesitate to contact the undersigned.

Sincerely,



Shawn Lapain, P.Eng.
Geotechnical Engineer



Chris Hendry, P.Eng.
Senior Geotechnical Engineer

APPENDIX

A LOCATION OF BOREHOLES



⊗ VERTICAL HISTORIC TEST HOLE
 1977 SITE INVESTIGATION SERVICES VERTICAL BOREHOLE
 2000 QUONTACON ASSOCIATES VERTICAL BOREHOLES
 2005 JACQUES WHITFORD VERTICAL BOREHOLES
 2015 GOLDBER ASSOCIATES VERTICAL BOREHOLES AND TEST PITS

⊗ VERTICAL 2017 WSP INVESTIGATION
 2017 VERTICAL BOREHOLE
 2017 TEST PIT
 2017 VERTICAL CORE

XX XX - XX
 TEST HOLE ID
 YEAR OF STUDY
 TYPE OF TEST HOLE:
 BH BOREHOLE
 TP TEST PIT
 HA HAND AUGER
 - CORE HOLE

▲ HORIZONTAL HISTORIC TEST HOLE
 2005 JACQUES WHITFORD HORIZONTAL BOREHOLES
 2015 GOLDBER ASSOCIATES HORIZONTAL BOREHOLES

△ HORIZONTAL 2017 WSP CORES

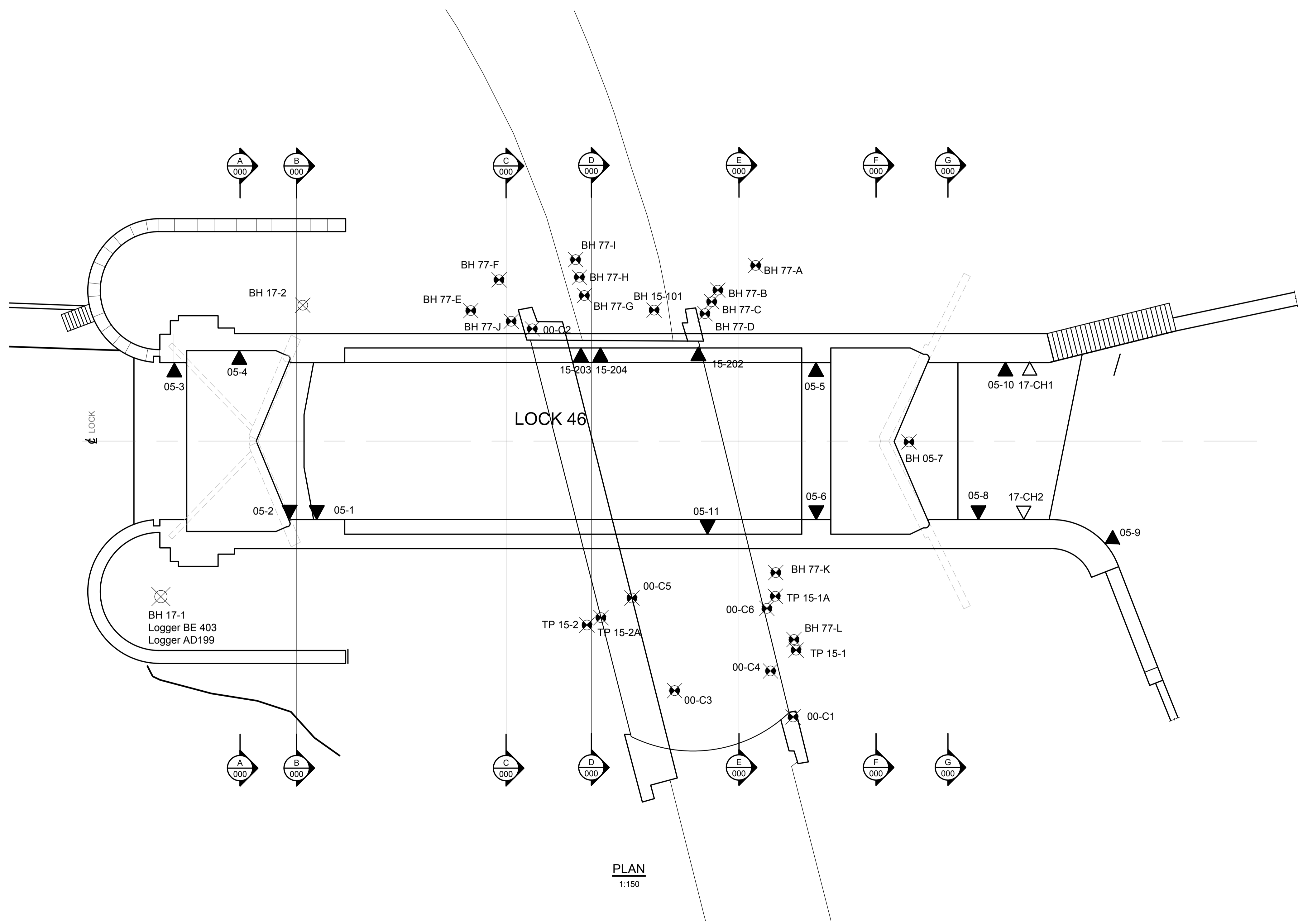
NOTE:
 ALL LOCATIONS ARE APPROXIMATE.



Canada



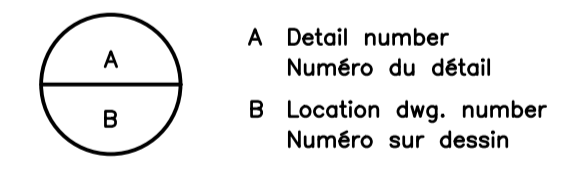
300-2611 QUEENSWAY DRIVE
 OTTAWA (ONTARIO)
 CANADA K2B 8K2
 TELEPHONE: 613-829-2800 FAX: 613-829-8299
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PLAN
 1:150

No.	Description	Dwn.By Des.Par	Date
Revision / Révision			

Do not scale drawings.
 Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.



Project title / Titre du projet
**RIDEAU CANAL
 NATIONAL HISTORIC SITE
 KINGSTON MILLS LOCKSTATION
 LOCKS 46 - 49
 REHABILITATION**
 ELGIN ONTARIO

Drawing title / Titre du dessin
**LOCK 46
 BOREHOLE AND TEST
 PIT LOCATIONS**

Drawn by / Dessiné par BN/AM/JH	Designed by / Conçu par JENNIFER HUNTLEY
Approved by / Approuvé par JULIA MARSON	Drawing Date / Date du dessin MARCH 2018
Project manager / Administrateur de projet SHAWN FILION	Drawing Number / Numéro du Dessin GR-02
Project Number / Numéro du projet R.079796.009	Sheet / Feuille 2 of 3

- ⊗ VERTICAL HISTORIC TEST HOLE
1979 GOLDER ASSOCIATES BOREHOLE
1990 TROW ASSOCIATES VERTICAL BOREHOLE
- ▲ HORIZONTAL HISTORIC TEST HOLE
1990 TROW ASSOCIATES HORIZONTAL BOREHOLE

- ⊗ VERTICAL 2017 WSP INVESTIGATION
2017 VERTICAL BOREHOLE AND VERTICAL CORE
2017 HAND AUGER
2017 TEST PIT
- △ HORIZONTAL 2017 WSP CORES

- XX XX - XX
- TEST HOLE ID
 - YEAR OF STUDY
 - TYPE OF TEST HOLE:
BH BOREHOLE
TP TEST PIT
HA HAND AUGER
- CORE HOLE

NOTE:
ALL LOCATIONS ARE APPROXIMATE.

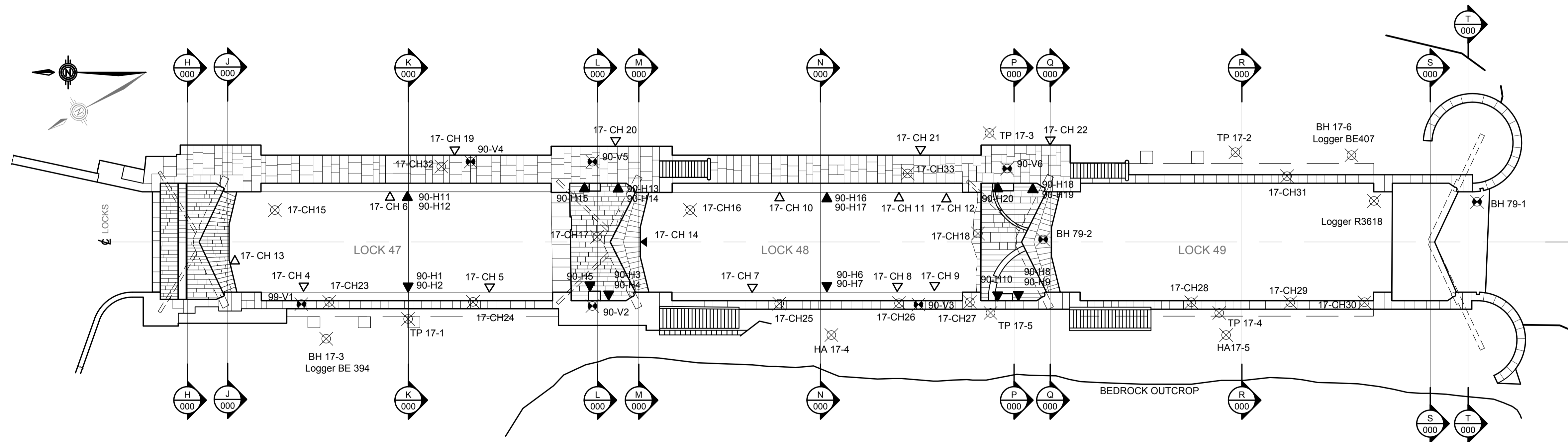
Public Services and Procurement Canada
Services publics et Approvisionnement Canada

Heritage Canada and Engineering Works Group
Parcs Canada Infrastructure Directorate
Groupe Canaux historiques et travaux d'ingénierie
Direction de l'Infrastructure de Parcs Canada

Parcs Canada
Parcs Canada



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PLAN
1:250

No.	Description	Dwn.By Des.Par	Date
Revision / Révision			

Do not scale drawings.
Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.

A	A Detail number Numéro du détail
B	B Location dwg. number Numéro sur dessin

Project title / Titre du projet
**RIDEAU CANAL
NATIONAL HISTORIC SITE
KINGSTON MILLS LOCKSTATION
LOCKS 46 – 49
REHABILITATION**

ELGIN ONTARIO

Drawing title / Titre du dessin
**LOCK 47, 48, & 49
BOREHOLE AND TEST PIT
LOCATIONS**

Drawn by / Dessiné par BN/AM/JH	Designed by / Conçu par JENNIFER HUNTLEY
Approved by / Approuvé par JULIA MARSON	Drawing Date / Date du dessin MARCH 2018
Project manager / Administrateur de projet SHAWN FILION	Drawing Number / Numéro du Dessin GR-02
Project Number / Numéro du projet R.079796.009	Sheet Feuille 3 of 3

APPENDIX

B PHOTOS



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 46
East Side of Lock Station – Lower Gate/Monolith



Lock 46
West Side of Lock Station – Lower Gate/Monolith/Buttress



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 46
Chamber – East Wall



Lock 46
Chamber – West Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 46
East Side – Sluice Tunnel



Lock 46
West Side – Sluice Tunnel



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 46
Breast Wall



Lock 46
Floor



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 46
East Side of Lock – Southeast Wing wall



Lock 46
West Side of Lock – Southwest Wing wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Turning Basin
East Wall



Turning Basin
West Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Turning Basin
Floor



Turning Basin
Basin Sluice



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 47
East Upstream Walls



Lock 47
West Upstream Walls



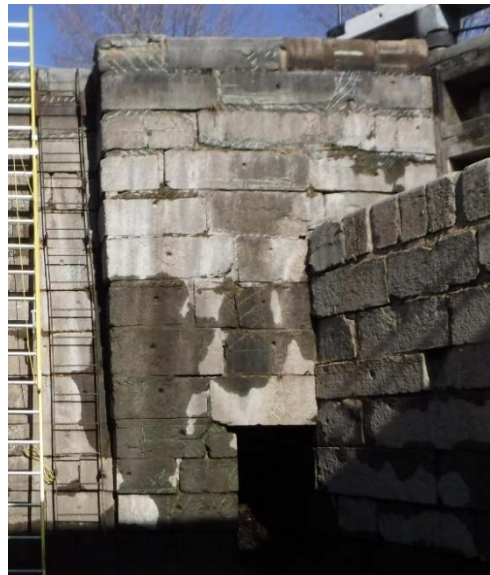
**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 47
East Side – Monolith



Lock 47
West Side – Monolith



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 47
East Side – Chamber Wall



Lock 47
West Side – Chamber Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 47
East Side – Sluice Tunnel



Lock 47
West Side – Sluice Tunnel



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 47
Breast Wall



Lock 47
Floor



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 47
East Side – Buttress/Vertical Wall



Lock 47
West Side – Buttress/Vertical Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 48
East Side – Monolith



Lock 48
West Side – Lower Gate/Monolith



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 48
East Side – Chamber Wall



Lock 48
West Side – Chamber Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 48
East Side – Sluice Tunnel



Lock 48
West Side – Sluice Tunnel



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 48
Breast Wall



Lock 48
Floor



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 48
East Side – Buttress and Vertical Wall



Lock 48
West Side – Buttress and Vertical Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 49
East Side – Chamber Wall



Lock 49
West Side – Chamber Wall



**Kingston Mills Lock Station Rehabilitation
Locks 46 to 49
Kingston Mills, Ontario**

**171-02359-00
General Site Conditions**

Lock 49
Wingwall



Lock 49
Breast Wall



APPENDIX

C WSP INVESTIGATION



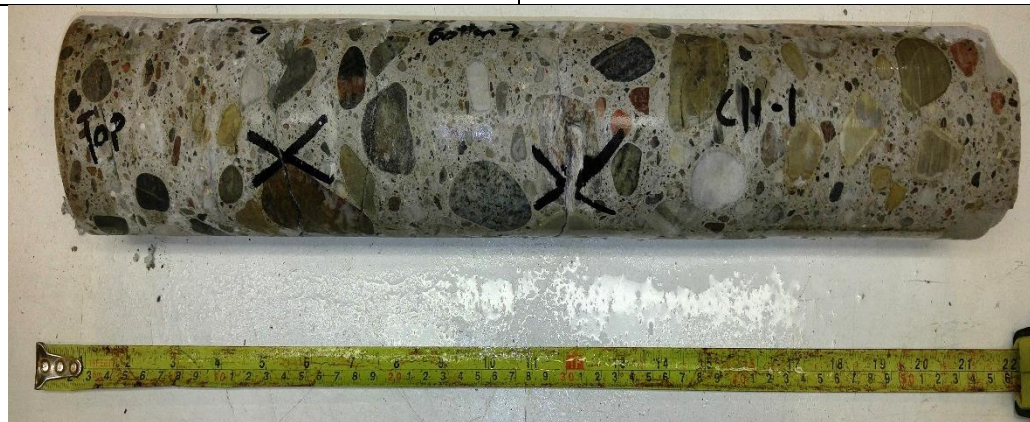
APPENDIX

C-1 *CORING INVESTIGATION*



Core Location at East Pier

ID	CH 1
Date Cored	April 21, 2017
Lock	46
Location	Pier
Section	46E-PIE10
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	490 mm
General Notes: Concrete 0 – 490 mm	





Core Location at West Pier

ID	CH 2
Date Cored	April 21, 2017
Lock	46
Location	Pier
Section	46W-PIE9
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	470 mm
General Notes: 0 – 470 mm	





Core Location at North Basin Wall

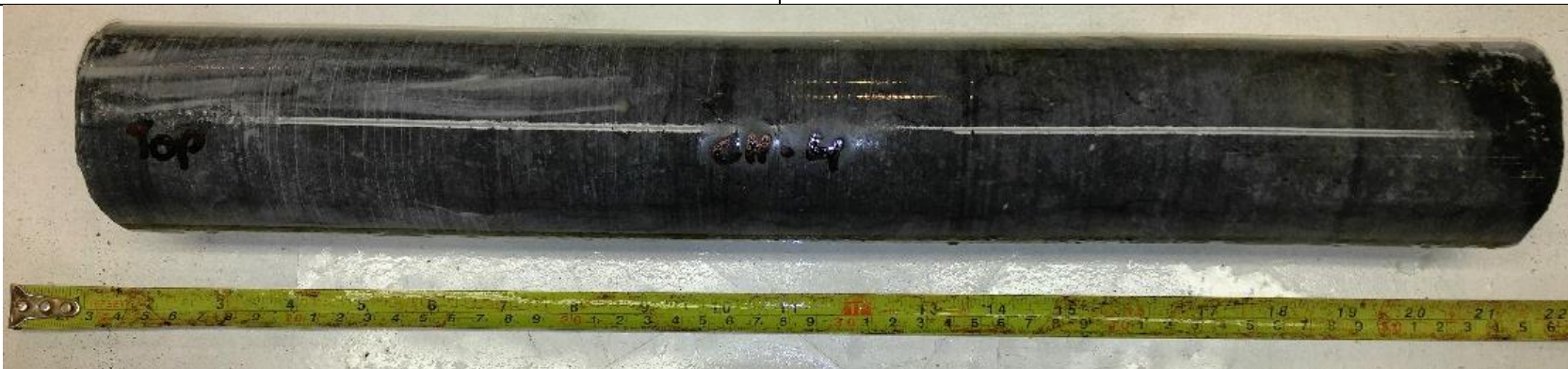
ID	CH 3
Date Cored	April 21, 2017
Lock	Turning Basin
Location	Basin Wall
Section	BAS-NBW1
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	410 mm
General Notes: Concrete 0 -410 mm	





Core Location at West Chamber Wall

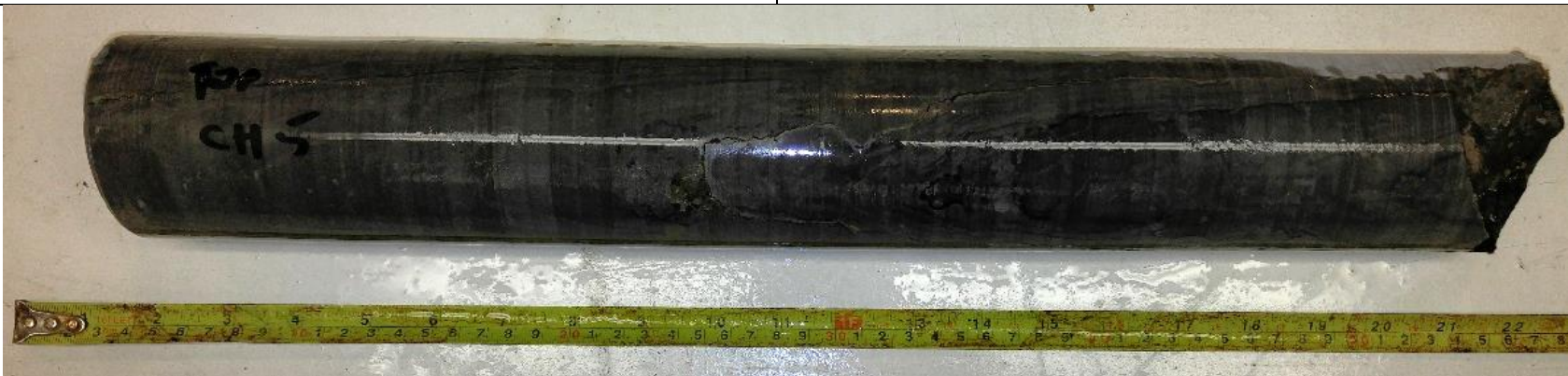
ID	CH 4
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47W-CHW2
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	470 mm
General Notes: Limestone 0 – 470 mm	





Core Location at West Chamber Wall

ID	CH 5
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47W-CHW1
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at East Chamber Wall

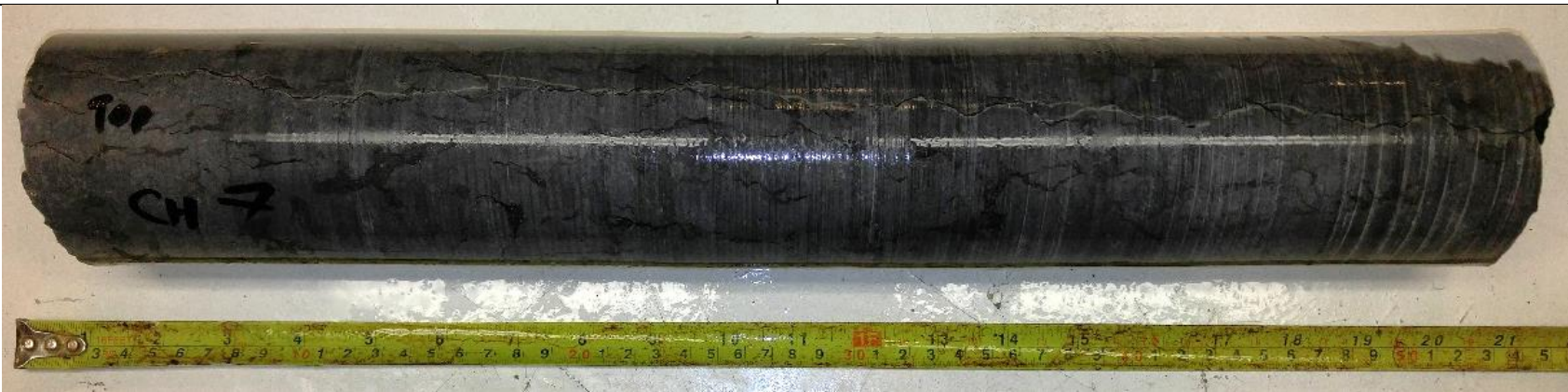
ID	CH 6
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47E-CHW1
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	500 mm
General Notes: Limestone 0 – 500 mm	





Core Location at West Chamber Wall

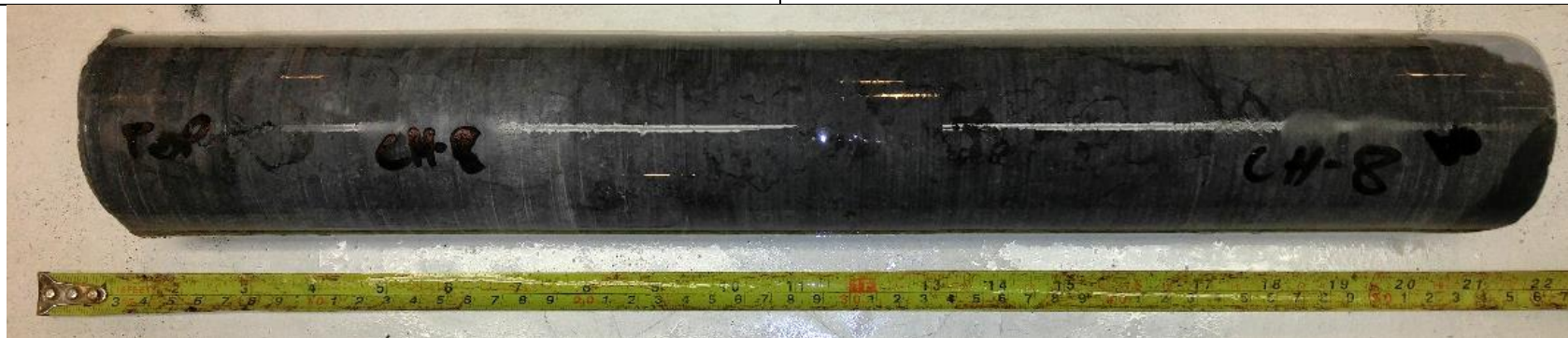
ID	CH 7
Date Cored	April 21, 2017
Lock	Chamber Wall
Location	48
Section	Chamber Wall
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at West Chamber Wall

ID	CH 8
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48W-CHW1
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at West Chamber Wall

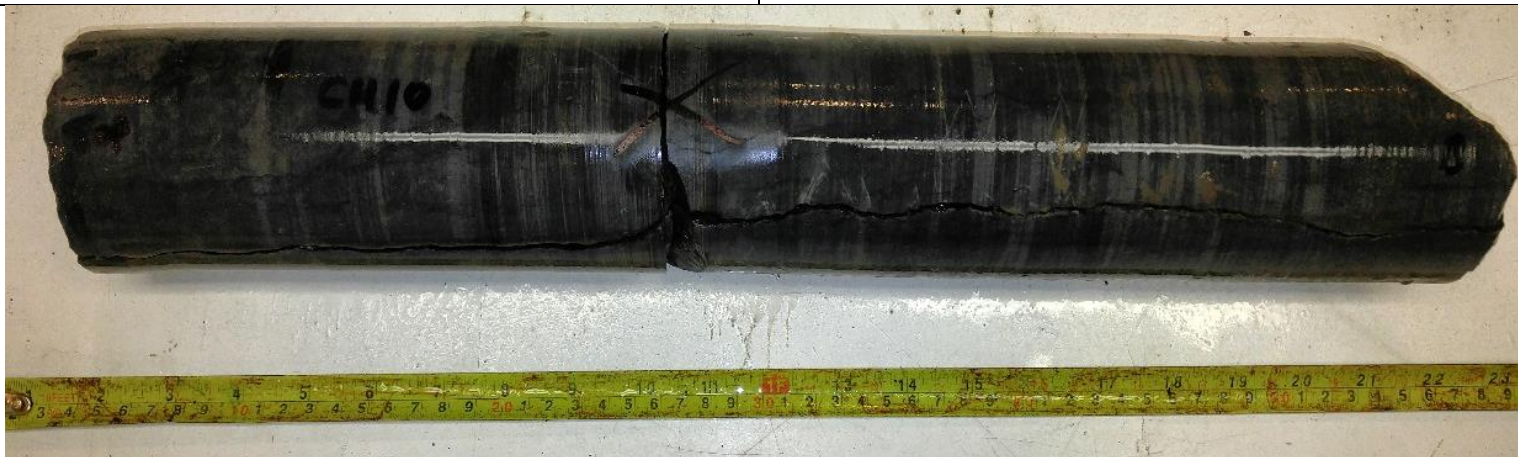
ID	CH 9
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48W-CHW1
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at East Chamber Wall

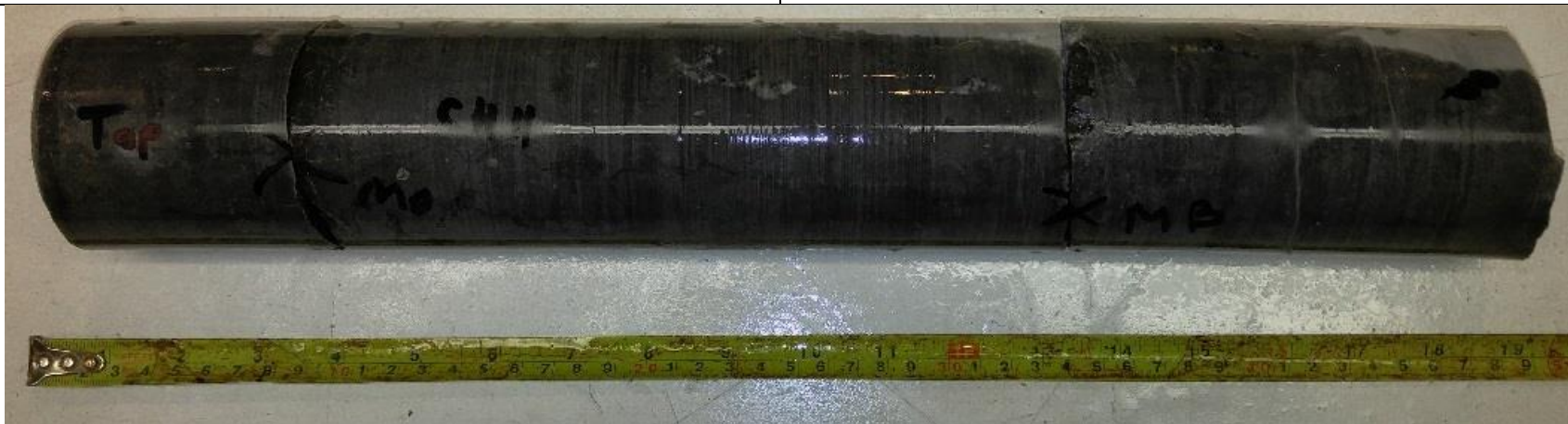
ID	CH 10
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48E-CHW1
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at East Chamber Wall

ID	CH 11
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48E-CHW2
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	440 mm
General Notes: Limestone 0 – 440 mm	





Core Location at East Chamber Wall

ID	CH 12
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48E-CHW2
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at Breast Wall

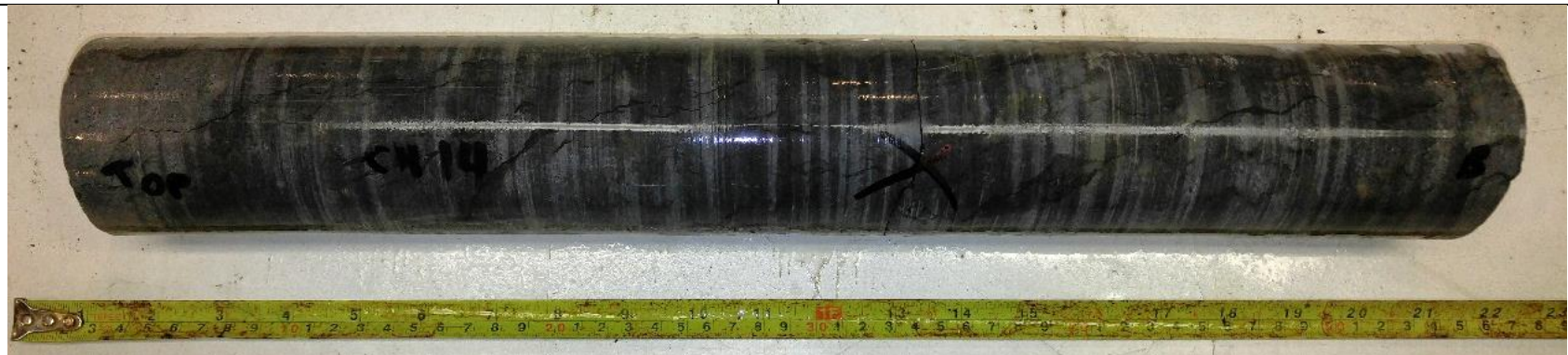
ID	CH 13
Date Cored	April 21, 2017
Lock	47
Location	Breast Wall
Section	47-BRE4
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at Breast Wall

ID	CH 14
Date Cored	April 21, 2017
Lock	48
Location	Breast Wall
Section	48-BRE3
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at Lock Floor

ID	CH 15
Date Cored	April 21, 2017
Lock	47
Location	Floor
Section	47 FLR
Direction Core Extracted	Vertical
Tested	NO
Total Hole Depth	480 mm
General Notes: Concrete 0 – 270 mm Granite 0 – 480 mm	





Core Location at Lock Floor

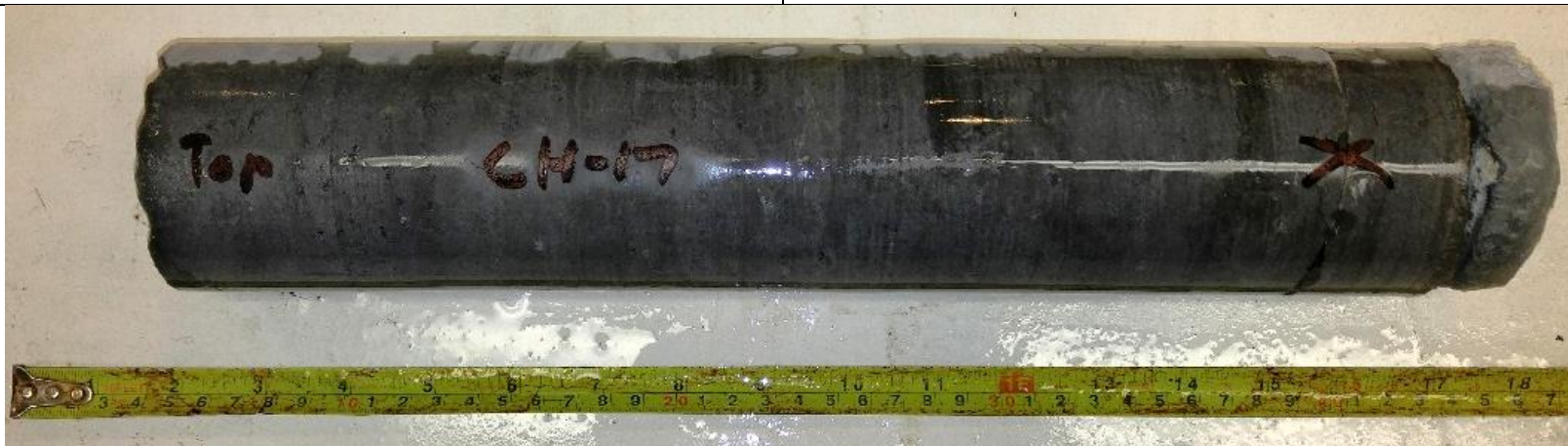
ID	CH 16
Date Cored	April 21, 2017
Lock	48
Location	Floor
Section	48 FLR
Direction Core Extracted	Vertical
Tested	No
Total Hole Depth	590 mm
General Notes:	
Concrete 0 -240 mm	
Granite 240 – 590 mm	

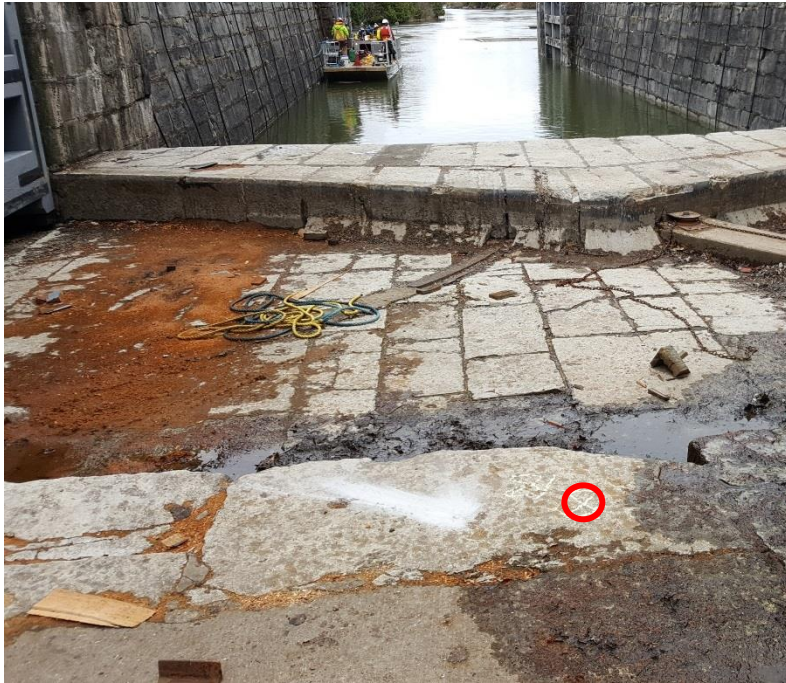




Core Location at Gate Recess Floor

ID	CH 17
Date Cored	April 21, 2017
Lock	47
Location	Gate Recess Floor
Section	47-GRF3
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	370
General Notes: Limestone 0 – 370 mm	





Core Location at Gate Recess Floor

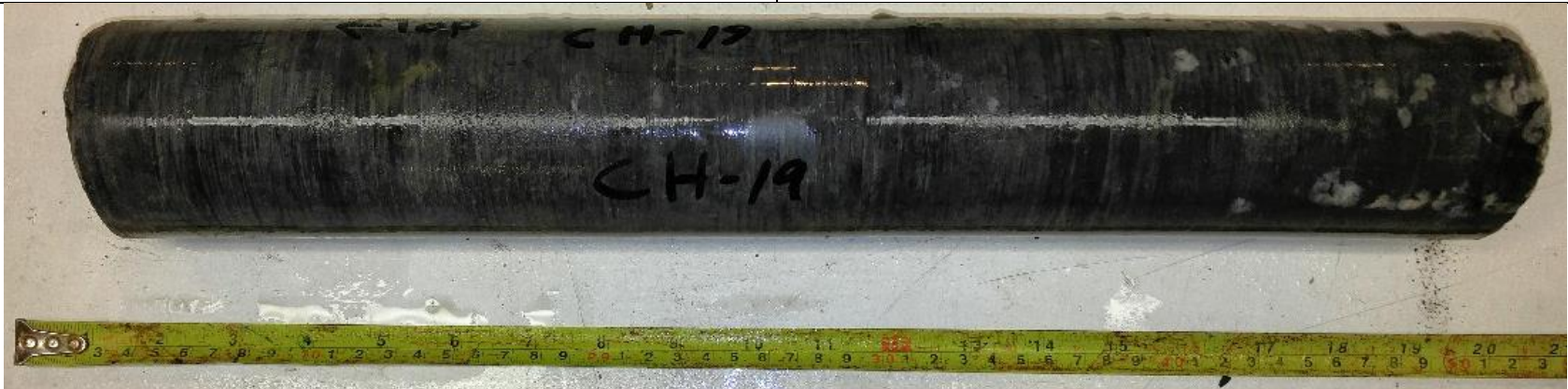
ID	CH 18
Date Cored	April 21, 2017
Lock	48
Location	Gate Recess Floor
Section	48-GRF2
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	540 mm
General Notes: Limestone 0 – 540 mm	





Core Location at East Chamber Wall

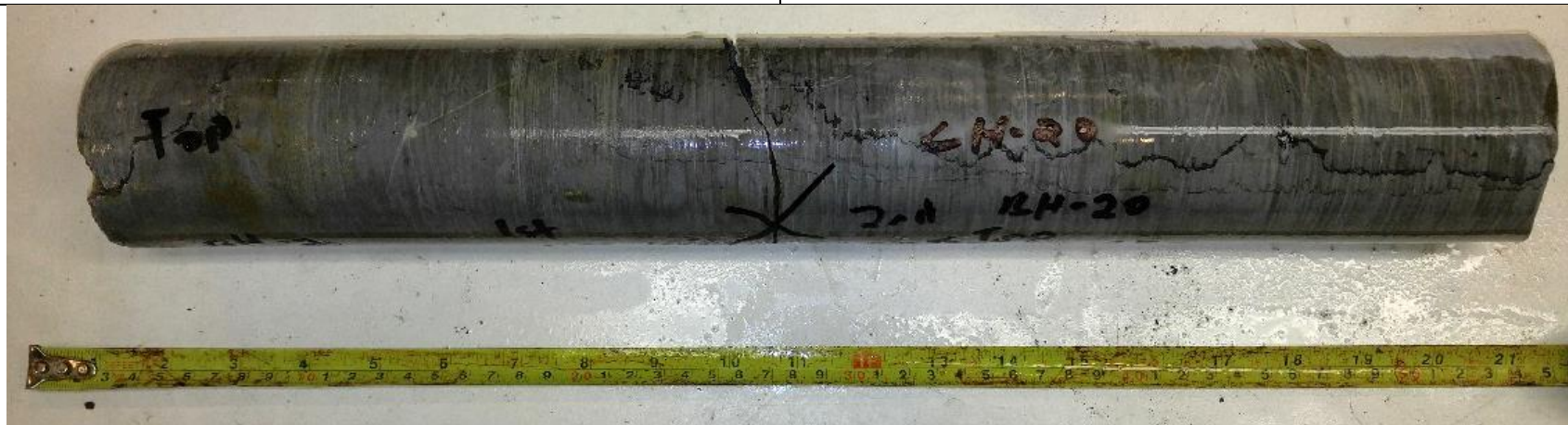
ID	CH 19
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47E-CHW1
Direction Core Extracted	Horizontal
Tested	No
Total Hole Depth	440 mm
General Notes: Limestone 0 – 440 mm	





Core Location at East Pier

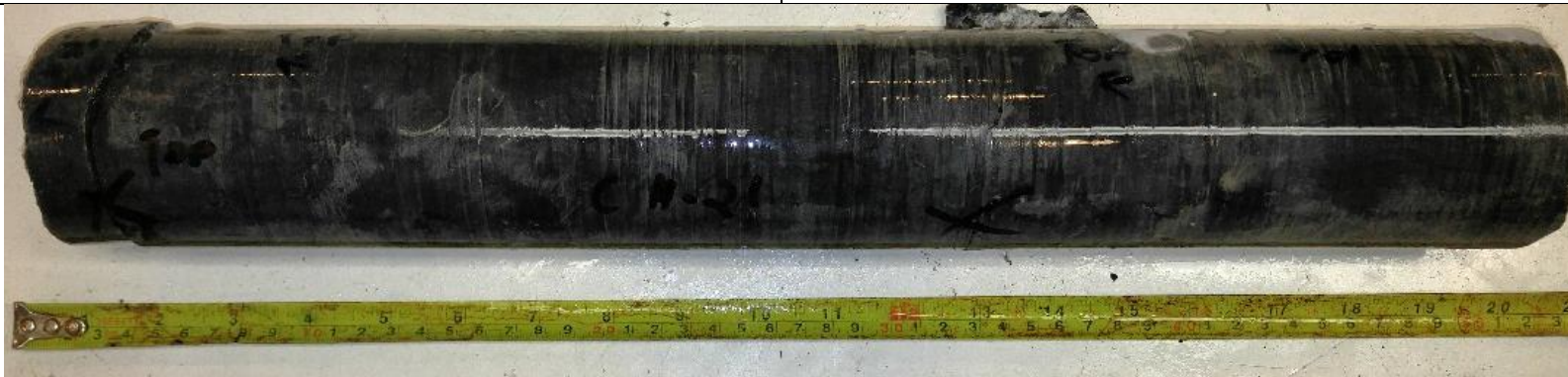
ID	CH 20
Date Cored	April 21, 2017
Lock	47
Location	Pier
Section	47E-PIE6
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at East Chamber Wall

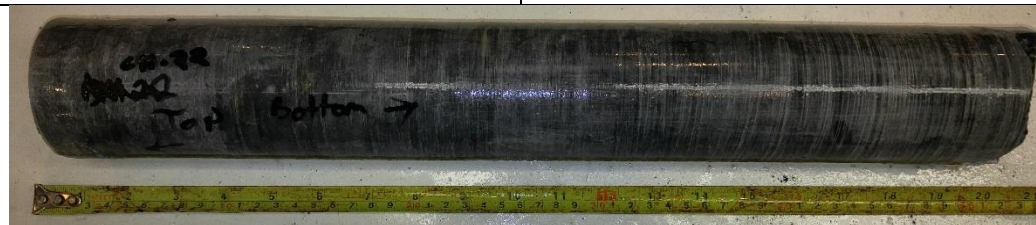
ID	CH 21
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48E-CHW2
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	470 mm
General Notes: Limestone 0 – 470 mm	





Core Location at West Gate Recess Wall

ID	CH 22
Date Cored	April 21, 2017
Lock	48
Location	Gate Recess Wall
Section	48E-GRW4
Direction Core Extracted	Horizontal
Tested	Yes
Total Hole Depth	480 mm
General Notes: Limestone 0 – 480 mm	





Core Location at West Chamber Wall

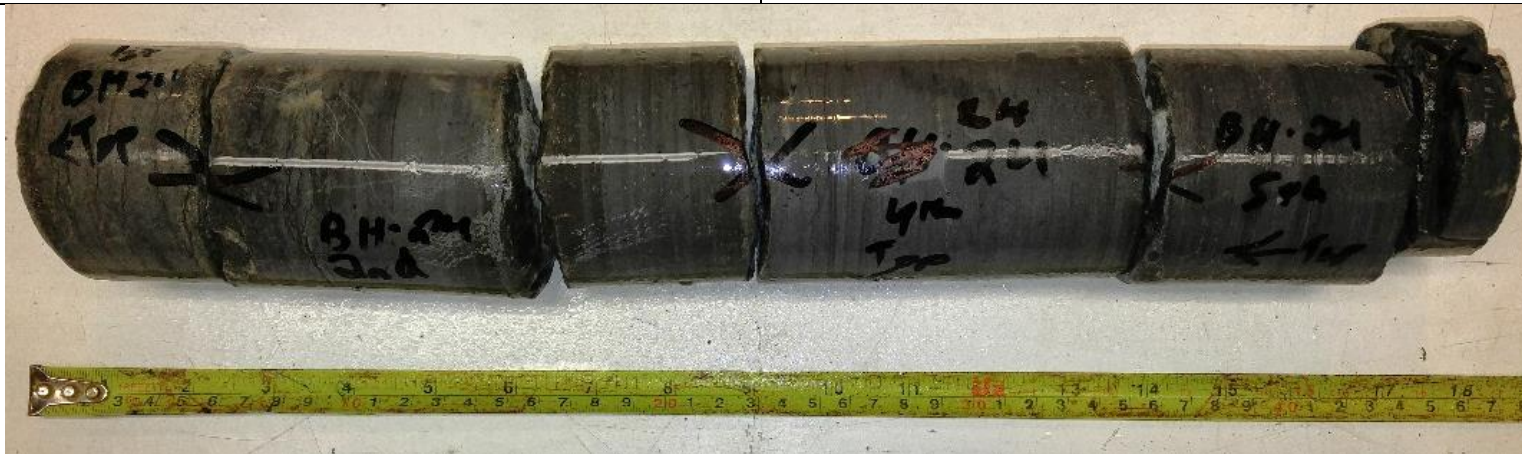
ID	CH 23
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47W-CHW2
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	460 mm
General Notes:	
Limestone 0 – 420 mm	
Mortar 420 – 460 mm	

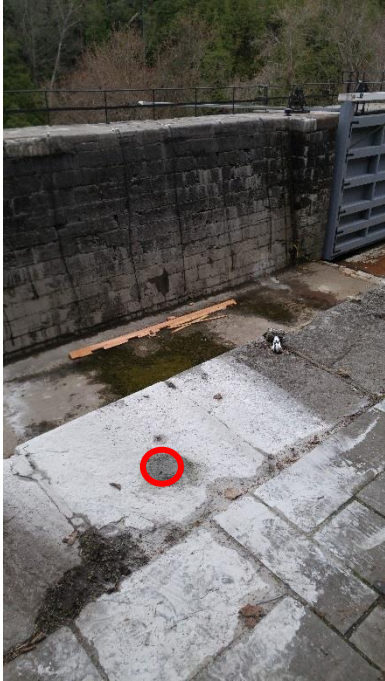




Core Location at West Chamber Wall

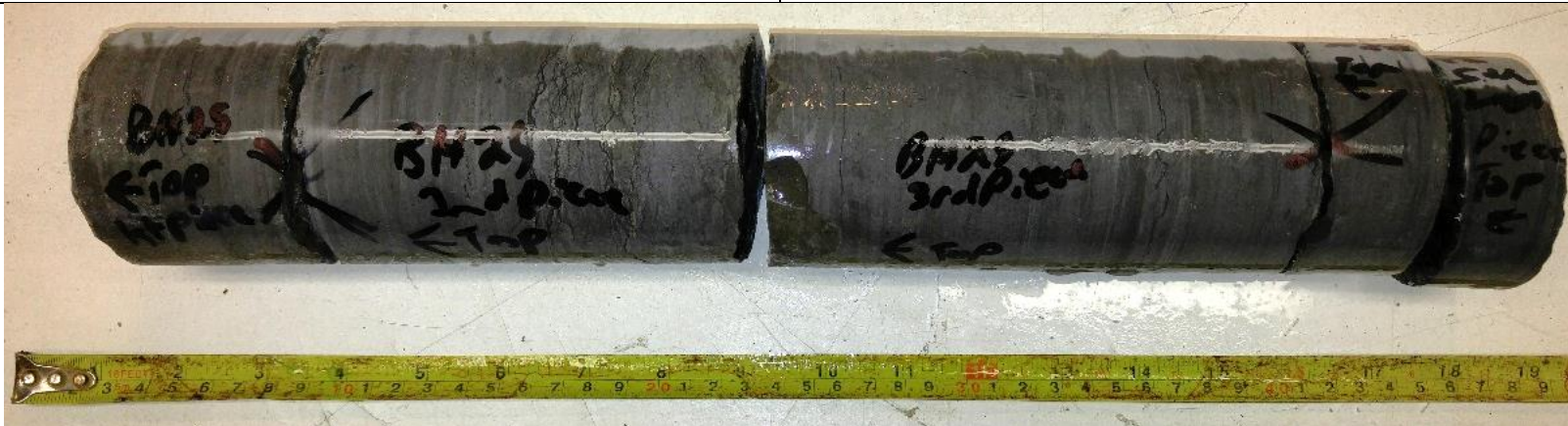
ID	CH 24
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47W-CHW1
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	410 mm
General Notes: Limestone 0 – 410 mm	





Core Location at West Chamber Wall

ID	CH 25
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48W-CHW1
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	400 mm
General Notes: Limestone 0 – 400 mm	





Core Location at West Chamber Wall

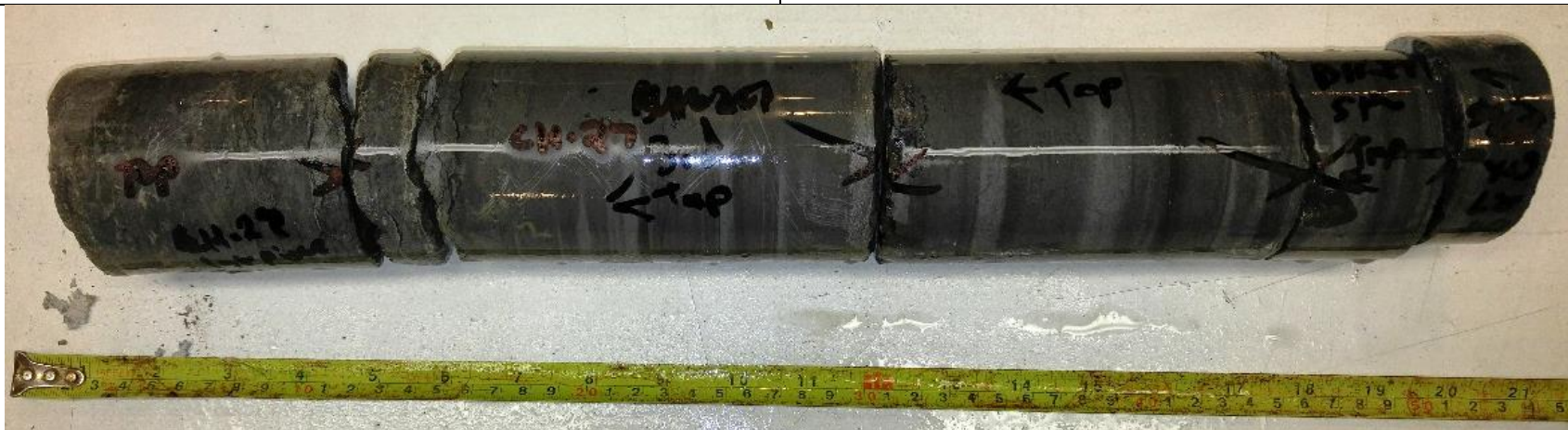
ID	CH 26
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48W-CHW1
Direction Core Extracted	Vertical
Tested	No
Total Hole Depth	430 mm
General Notes:	
Limestone 0 – 410 mm	
Mortar/concrete 410 – 430 mm	





Core Location at West Chamber Wall

ID	CH 27
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48W-CHW1
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	500 mm
General Notes: Limestone 0 – 500 mm	





Core Location at West Chamber Wall

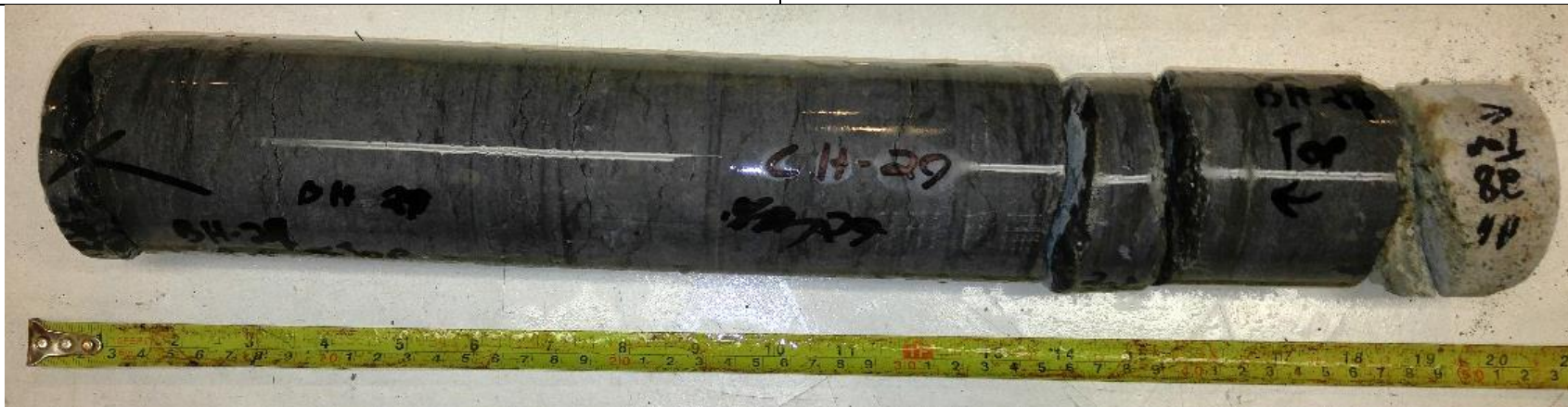
ID	CH 28
Date Cored	April 21, 2017
Lock	49
Location	Chamber Wall
Section	49W-CHW2
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	460mm
General Notes: Limestone 0 – 400 mm Mortar/concrete 400 – 460 mm	





Core Location at West Chamber Wall

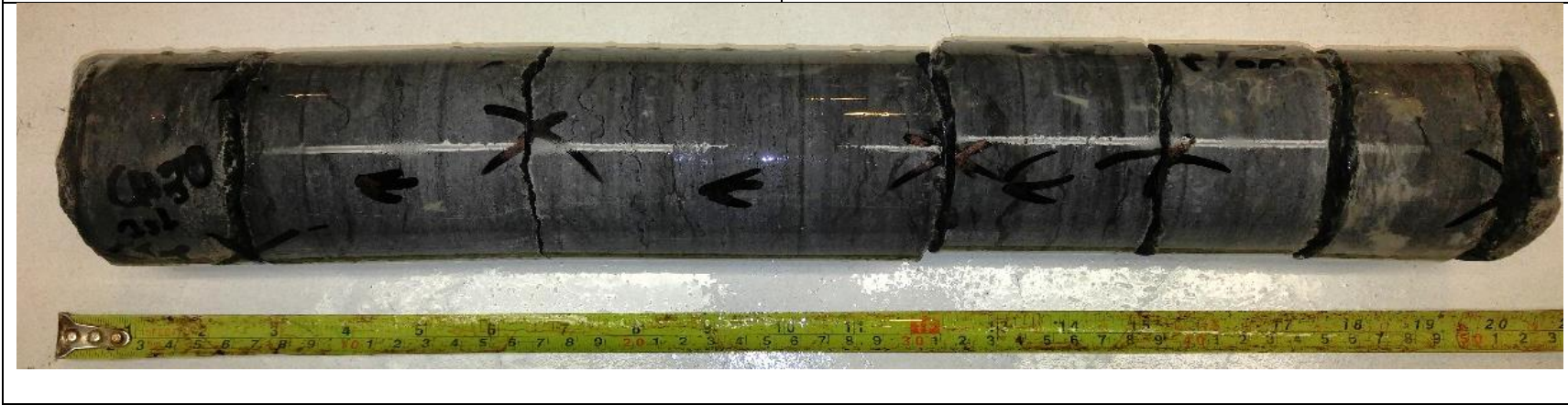
ID	CH 29
Date Cored	April 21, 2017
Lock	49
Location	Chamber Wall
Section	49W-CHW1
Direction Core Extracted	Vertical
Tested	No
Total Hole Depth	460 mm
General Notes:	
Limestone 0 – 400 mm	
Mortar 400 – 460 mm	





Core Location at West Chamber Wall

ID	CH 30
Date Cored	April 21, 2017
Lock	49
Location	Chamber Wall
Section	49W-CHW1
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	460 mm
General Notes: Limestone 0 – 460 mm	





Core Location at East Chamber Wall

ID	CH 31
Date Cored	April 21, 2017
Lock	49
Location	Chamber Wall
Section	49E-CHW2
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	460 mm
General Notes: Limestone 0 – 460 mm	





Core Location at East Chamber Wall

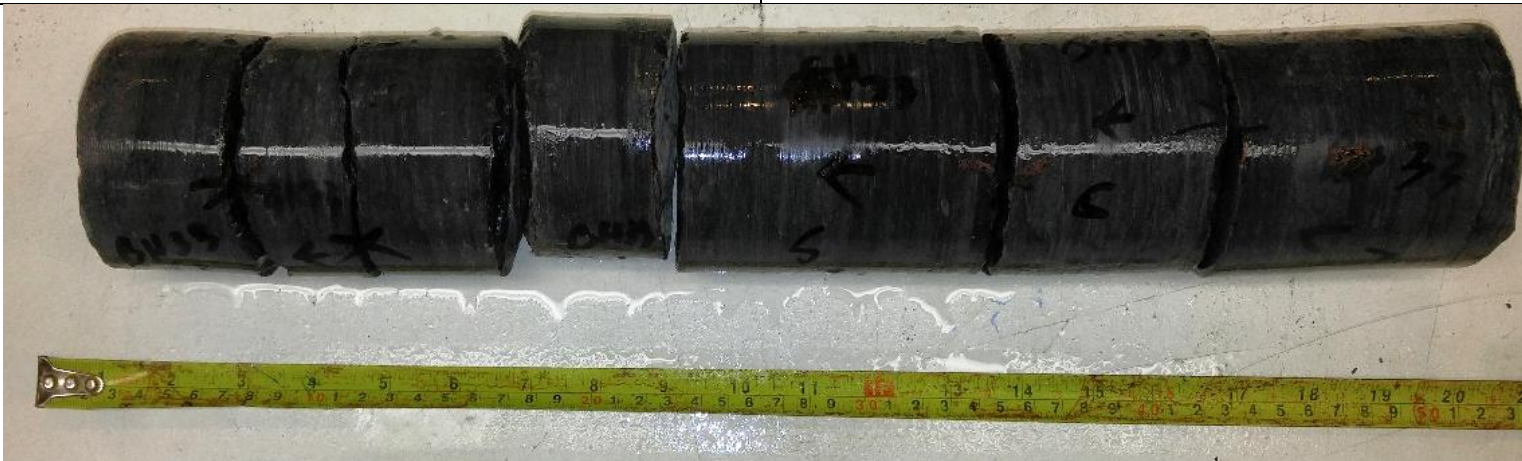
ID	CH 32
Date Cored	April 21, 2017
Lock	47
Location	Chamber Wall
Section	47E-CHW2
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	430 mm
General Notes: Limestone 0 – 430 mm	





Core Location at East Chamber Wall

ID	CH 33
Date Cored	April 21, 2017
Lock	48
Location	Chamber Wall
Section	48E-CHW2
Direction Core Extracted	Vertical
Tested	Yes
Total Hole Depth	460 mm
General Notes: Limestone 0 – 460 mm	



**Kingston Mills Lockstation
Rehabilitation of Locks 46 to 49
Results of Laboratory Testing**

ID	Core Orientation	Percent Water Absorption (%)																				Classification	Comments		
		C	Block 1	C	Block 2	C	Block 3	C	Block 4	C	Block 5	C	Block 6	C	Block 7	C	Block 8	C	Block 9	Min	Max			Avg	Std Dev
CH 8	Horizontal	W	0.09	W	0.11	W	0.09	W	0.10	W	0.10	W	0.12	-	-	-	-	-	-	0.09	0.12	0.10	0.01	Type III	
CH 9	Horizontal	W	0.03	W	0.05	W	0.06	W	0.06	W	0.06	W	0.07	W	0.07	-	-	-	-	0.03	0.07	0.06	0.01	Type III	
CH 11	Horizontal	W	0.08	W	0.11	W	0.08	W	0.08	W	0.07	-	-	-	-	-	-	-	0.07	0.11	0.08	0.01	Type III		
CH 12	Horizontal	D	0.09	D	0.10		0.09	D	0.07	-	0.08	D	0.12	W	0.12	-	-	-	-	0.07	0.12	0.10	0.02	Type III	
CH 14	Horizontal	-	-	-	-	W	0.13	W	0.12	W	0.07	W	0.06	W	0.07	-	-	-	-	0.06	0.13	0.09	0.03	Type III	
CH 17	Vertical	D	0.09	D	0.08	D	0.06	D	0.06	D	0.08		0.12	-	-	-	-	-	0.06	0.12	0.08	0.02	Type III		
CH 18	Vertical	W	0.09	W	0.10	W	0.11	W	0.11	W	0.09	-	-	-	-	-	-	-	0.09	0.11	0.10	0.01	Type III		
CH 21	Horizontal	D	0.08	D	0.07	D	0.06	D	0.08	D	0.08	-	-	-	-	-	-	-	0.06	0.08	0.07	0.01	Type III		
CH 22	Horizontal	W	0.16	W	0.15	W	0.15	W	0.15	W	0.13	-	0.15	-	-	-	-	-	0.13	0.16	0.15	0.01	Type III		
CH 27	Vertical	W	0.14	W	0.11	W	0.11	W	0.04	W	0.09	-	-	-	-	-	-	-	0.04	0.14	0.10	0.03	Type III		
CH 31	Vertical	D	0.22	D	0.09	D	0.13	D	0.08	D	0.13	-	-	-	-	-	-	-	0.08	0.22	0.13	0.05	Type III		
All Samples																		Min	0.0	0.1	0.1		Type III		
																		Max	0.1	0.2	0.1				
																		Avg	0.1	0.1	0.1				
ID	Core Orientation	Bulk Specific Gravity (kg/m³)																				Classification	Comments		
		C	Block 1	C	Block 2	C	Block 3	C	Block 4	C	Block 5	C	Block 6	C	Block 7	C	Block 8	C	Block 9	Min	Max			Avg	Std Dev
CH 8	Horizontal	W	2730	W	2750	W	2740	W	2730	W	2730	W	2740	-	-	-	-	-	2730	2750	2737	7	Type III		
CH 9	Horizontal	W	2370	W	2370	W	2730	W	2710	W	2720	-	2730	-	2720	-	-	-	2370	2730	2621	159	Type III		
CH 11	Horizontal	W	2740	W	2710	W	2740	W	2730	W	2720	-	-	-	-	-	-	2710	2740	2728	12	Type III			
CH 12	Horizontal	D	2720	D	2720	-	2710	D	2730	-	2710	D	2720	W	2720	-	-	-	2710	2730	2719	6	Type III		
CH 14	Horizontal	-	-	-	-	W	2720	W	2720	W	2730	W	2860	W	2720	-	-	-	2720	2860	2750	55	Type III		
CH 17	Vertical	D	2740	D	2720	D	2710	D	2720	D	2710		2710	-	-	-	-	2710	2740	2718	11	Type III			
CH 18	Vertical	W	2720	W	2720	W	2720	W	2730	W	2740	-	-	-	-	-	-	2720	2740	2726	8	Type III			
CH 21	Horizontal	D	2720	D	2720	D	2720	D	2720	D	2720	-	-	-	-	-	-	2720	2720	2720	0	Type III			
CH 22	Horizontal	W	2730	W	2730	W	2720	W	2730	W	2720	-	2740	-	-	-	-	2720	2740	2728	7	Type III			
CH 27	Vertical	W	2730	W	2750	W	2770	W	2730	W	2720	-	-	-	-	-	-	2720	2770	2740	18	Type III			
CH 31	Vertical	D	2710	D	2730	D	2720	D	2720	D	2740	-	-	-	-	-	-	2710	2740	2724	10	Type III			
All Samples																		Min	2370	2720	2621		Type III		
																		Max	2730	2860	2750				
																		Avg	2685	2751	2719				
Note: C Test Condition (W=Wet, D = Dry)																									

**Kingston Mills Lockstation
Rehabilitation of Locks 46 to 49
Results of Laboratory Testing**

ID	Core Orientation	Compressive Strength (MPa)																								Classification	Comments							
		C	T	Block 1	C	T	Block 2	C	T	Block 3	C	T	Block 4	C	T	Block 5	C	T	Block 6	C	T	Block 7	C	T	Block 8			C	T	Block 9	Min	Max	Avg	Std Dev
CH 8	Horizontal	W	**	146	W	**	123	W	**	112	W	**	121	W	**	99	-	-	-	-	-	-	-	-	-	-	-	-	99	146	120	15	Type III	
CH 9	Horizontal	W	**	118	W	**	157	W	**	136	W	**	180	W	**	137	-	-	-	-	-	-	-	-	-	-	-	-	118	180	146	21	Type III	
CH 11	Horizontal	W	**	97	W	**	19	W	*	42	W	**	88	W	**	66	-	-	-	-	-	-	-	-	-	-	-	19	97	62	29	Type III		
CH 12	Horizontal	D	**	113	D	**	192	-	-	-	D	**	167	-	-	-	D	**	114	W	**	189	-	-	-	-	-	113	192	155	35	Type III		
CH 14	Horizontal	-	-	-	-	-	-	W	**	7	W	**	135	W	**	228	W	**	213	W	*	216	-	-	-	-	-	7	228	160	83	Type III		
CH 17	Vertical	D	*	38	D	**	149	D	**	140	D	**	75	D	*	149	-	-	-	-	-	-	-	-	-	-	-	38	149	110	45	Type III		
CH 18	Vertical	W	**	144	W	**	166	W	*	135	W	*	115	W	*	45	-	-	-	-	-	-	-	-	-	-	-	45	166	121	41	Type III		
CH 21	Horizontal	D	**	154	D	**	136	D	**	121	D	**	103	D	*	18	-	-	-	-	-	-	-	-	-	-	-	18	154	106	47	Type III		
CH 22	Horizontal	W	**	155	W	**	135	W	**	128	W	**	92	W	**	110	-	-	-	-	-	-	-	-	-	-	-	92	155	124	22	Type III		
CH 27	Vertical	W	**	98	W	*	31	W	*	47	W	*	35	W	**	90	-	-	-	-	-	-	-	-	-	-	-	31	98	60	28	Type III		
CH 31	Vertical	D	**	133	D	**	95	D	*	9	D	*	51	D	*	42	-	-	-	-	-	-	-	-	-	-	-	9	133	66	43	Type III		
All Samples																Min	7	97	60	Type III														
																Max	118	228	160															
																Avg	54	154	112															
Note:	C	Test Condition (W=Wet, D = Dry)																																
	T	Test Orientation																																
	*	Sample Tested Parallel to Core Axis																																
	**	Sample Tested Perpendicular to Core Axis																																
		ASTM C170 / C170M-17 includes testing parallel and perpendicular to the rift of the stone. The rift could not be identified in the sandstone samples. Testing was therefore completed both parallel and perpendicular to the core axis.																																

APPENDIX

C-2 *BOREHOLE AND TEST PIT INVESTIGATION*



LOG OF BOREHOLE 17-1

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905453 E 384954

DRILLING DATA
 Rig Type: Portable
 Method: Solid Stem Auger
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/4/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)							PLASTIC LIMIT
90.5							20	40	60	80	100	W _p	w	W _L	GR SA SI CL
90.4	TOPSOIL (70 mm)		1	SS	10										
	SILT with clay, some sand, trace gravel, brown, moist, compact to dense (FILL)		2	SS	10										
			3	SS	5										
			4	SS	6										9 14 56 21
87.5			5	SS	100 over 25										
3.1	SILTY SAND trace gravel and clay, some organics, grey, wet, dense (FILL)		1	CORE	mm/										
87.0															
86.9	BEDROCK fresh, close jointing thin bedding														
3.6	Notes: 1) Borehole terminated at 3.6 m below the existing surface elevation 2) 50 mm monitoring well installed at 3.45 m below the existing ground surface. 3) Date Groundwater Depth 10/4/2017 3.58 m 10/12/2017 2.17 m 11/30/2017 2.01 m														

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ●=3% Strain at Failure



LOG OF BOREHOLE 17-2

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905454 E 384975

DRILLING DATA
 Rig Type: CME 55
 Method: Solid Stem Auger
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/6/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40	60	80	100				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L
90.5	TOPSOIL (90 mm)																	
90.1	SILTY SAND trace gravel and clay, brown, moist, soft to stiff (FILL)		1	SS	9						○							
			2	SS	3						○							
			3	SS	4						○							9 47 37 7
88.1	GRANITE slightly weathered to fresh, thin to medium bedding, close jointing		4	SS	100 over 25 mm						○							
2.4	TCR - 100% SCR - 42% RQD - 27% Concrete/Masonry observed		1	CORE														
86.5	END OF BOREHOLE																	
4.0	Notes: 1) Borehole terminated at 3.96 m below the existing surface elevation 2) 50 mm monitoring well installed at 2.43 m below the existing ground surface. 3) Date Groundwater Depth 10/6/2017 2.77 m 10/12/2017 2.17 m 11/30/2017 2.31 m																	

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

Shallow/Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure



LOG OF BOREHOLE 17-3

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905334 E 384932

DRILLING DATA
 Rig Type: CME 55
 Method: Solid Stem Auger
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/4/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40	60	80						
86.1	TOPSOIL (80 mm)																
86.0	SILT with sand, trace clay and gravel, brown, moist, loose to compact (FILL)		1	SS	5							o					
	occasional cobbles		2	SS	4							o					
			3	SS	100 over 50 mm							o				6	24 60 9
83.8																	
2.3	GRANITE Fresh, Moderately close jointing, Medium to thin bedding		4	SS	100 over 0 mm												
	TCR - 100%																
	SCR - 89%																
	RQD - 94%																
	GRANITE Fresh, Moderately close jointing, Medium to thin bedding		1	CORE													
82.2																	
3.9	TCR - 100%																
	SCR - 92%																
	RQD - 75%																
	END OF BOREHOLE																
	Notes:																
	1) Borehole terminated at 3.88 m below the existing surface elevation																
	2) 50 mm monitoring well installed at 1.77 m below the existing ground surface.																
	3) Date Groundwater Depth																
	10/5/2017 3.08 m																
	10/12/2017 1.98 m																
	11/30/2017 1.98 m																

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ●=3% Strain at Failure



LOG OF BOREHOLE HA17-4

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905285 E 384907

DRILLING DATA
 Rig Type: Hand Dug
 Method: Solid Stem Auger
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/6/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	20	40	60	80							100
82.6																		
- 82.6	SILTY SAND AND GRAVEL some organics, brown, moist, loose (160 mm) (FILL) END OF TEST PIT	☒	1	GRAB							o							
0.2	Notes: 1) Hand dug test pit terminated at 160 mm below the existing surface elevation on inferred boulder																	

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ e=3% Strain at Failure

Shallow/Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽



LOG OF BOREHOLE HA17-5

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905251 E 384887

DRILLING DATA
 Rig Type: Hand Dug
 Method: Solid Stem Auger
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/6/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)		
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)										WATER CONTENT (%)	
78.8							20	40	60	80	100								
78.0	SILTY SAND AND GRAVEL some organics, brown, moist, loose (100 mm) (FILL) END OF TEST PIT	XX		1	GRAB														
0.1	Notes: 1) Hand dug test pit terminated at 100 mm below the existing surface elevation on inferred boulder																		

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

GRAPH NOTES

+³, ×³: Numbers refer to Sensitivity

○ = 3% Strain at Failure

Shallow/Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽



LOG OF BOREHOLE 17-6

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905251 E 384897

DRILLING DATA
 Rig Type: CME 55
 Method: Solid Stem Auger
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/5/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40	60	80	100				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L
78.8	TOPSOIL (100mm)																	
78.0	SAND AND SILT trace gravel and clay, grey brown, moist to wet, loose (wood fragment at 5.79m) (FILL)		1	SS	13						○							
78.0			2	SS	9						○							
77.0			3	SS	7						○							
76.0			4	SS	9						○							9 44 41 6
75.0			5	SS	5						○							
75.0	SILT with sand, some clay, trace gravel, brown, wet, loose to very dense (FILL)		6	SS	3						○							2 22 58 18
74.0			7	SS	12						○							
73.0			8	SS	21						○							
72.7																		
72.7	SILTY SAND trace gravel and clay, grey wet, loose to dense		9	SS	10						○							
72.0																		
71.0			10	SS	4						○							
70.6	END OF BOREHOLE																	
Notes: 1) Borehole terminated at 8.22 m below the existing surface elevation 2) 50 mm monitoring well installed at 6.7 m below the existing ground surface. 3) Date Groundwater Depth 10/5/2017 6.58 m 10/12/2017 3.84 m 11/30/2017 3.74 m																		

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ●=3% Strain at Failure



LOG OF BOREHOLE TP17-1

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905328 E 384930

DRILLING DATA
 Rig Type: Backhoe
 Method: Rubber Tire Backhoe
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/18/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40	60	80	100			
86.1	TOPSOIL (70mm)		2	GRAB											
86.0	SILT with clay some sand trace gravel, brown, moist		1	GRAB											
			5	GRAB											
			3	GRAB											
84.4			4	GRAB											
1.7	END OF TESTPIT														
	Notes: 1) Borehole terminated at 1.74 m below the existing surface elevation 2) Bedrock encountered at 1.74 m below surface														

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

Shallow/Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ ● =3% Strain at Failure



LOG OF BOREHOLE TP17-2

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905266 E 384916

DRILLING DATA
 Rig Type: Backhoe
 Method: Rubber Tire Backhoe
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/18/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40	60	80	100				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L
78.7																		
78.9	TOPSOIL (170 mm)																	
0.2	SILTY SAND some clay, some cobble, brown, moist		1	GRAB							o							
78.2																		
78.4	SAND trace silt and gravel, brown, moist		2	GRAB							o							2 89 (9)
0.6	SANDY SILT some clay, trace gravel, some sand, frequent cobbles and boulders, brown, moist		3	GRAB							o							3 33 53 12
77.6																		
1.1	END OF TESTPIT																	
	Notes: 1) Testpit terminated at 1.1 m below the existing surface elevation 2) bedrock encountered at 1.1 m below surface																	

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ = 3% Strain at Failure

Sheet No. 1 of 1

Shallow/Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽



LOG OF BOREHOLE TP17-3

Project: Kingston Mills Lockstation Rehabilitation
 Client: Parks Canada
 Project Location: Kingston Mills, Ontario
 Datum: Geodetic
 BH Location: N 4905249 E 384901

DRILLING DATA
 Rig Type: Backhoe
 Method: Rubber Tire Backhoe
 Borehole Diameter: 150 mm
 Core Diameter:

Project No.: 171-012359-00
 Date Started: 10/18/2017
 Supervisor: D.R
 Reviewer: C.H.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40	60	80	100						
78.8																		
78.0	TOPSOIL (160 mm)		1	GRAB														
0.2	SANDY GRAVEL some silt, brown, moist		2	GRAB														
			3	GRAB													48 34 (18)	
77.2																		
1.6	END OF TEST PIT																	
	Notes: 1) Borehole terminated at 1.6 m below the existing surface elevation on bedrock																	

WSP SOIL LOG - OTTAWA KINGSTON MILLS.GPJ SPL.GDT 4/26/18

GROUNDWATER ELEVATIONS

Shallow/Single Installation ▽ ▽ Deep/Dual Installation ▽ ▽

GRAPH NOTES

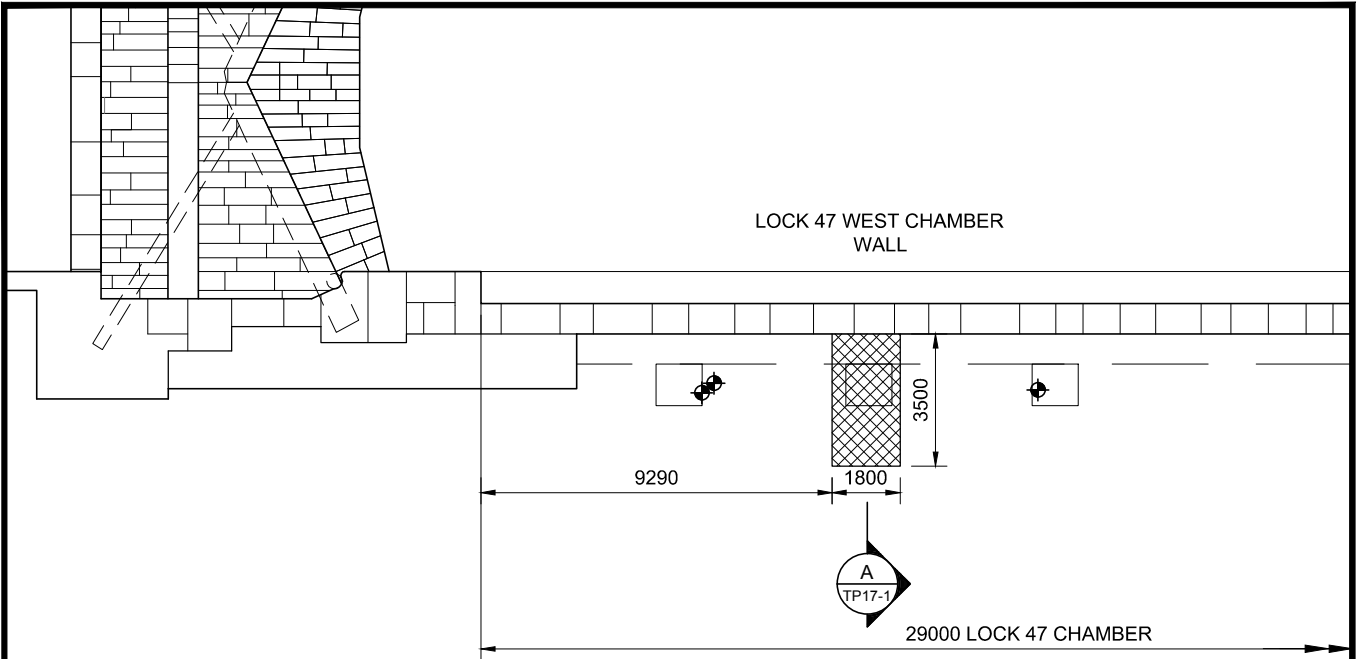
+³, ×³: Numbers refer to Sensitivity

○ ●=3% Strain at Failure

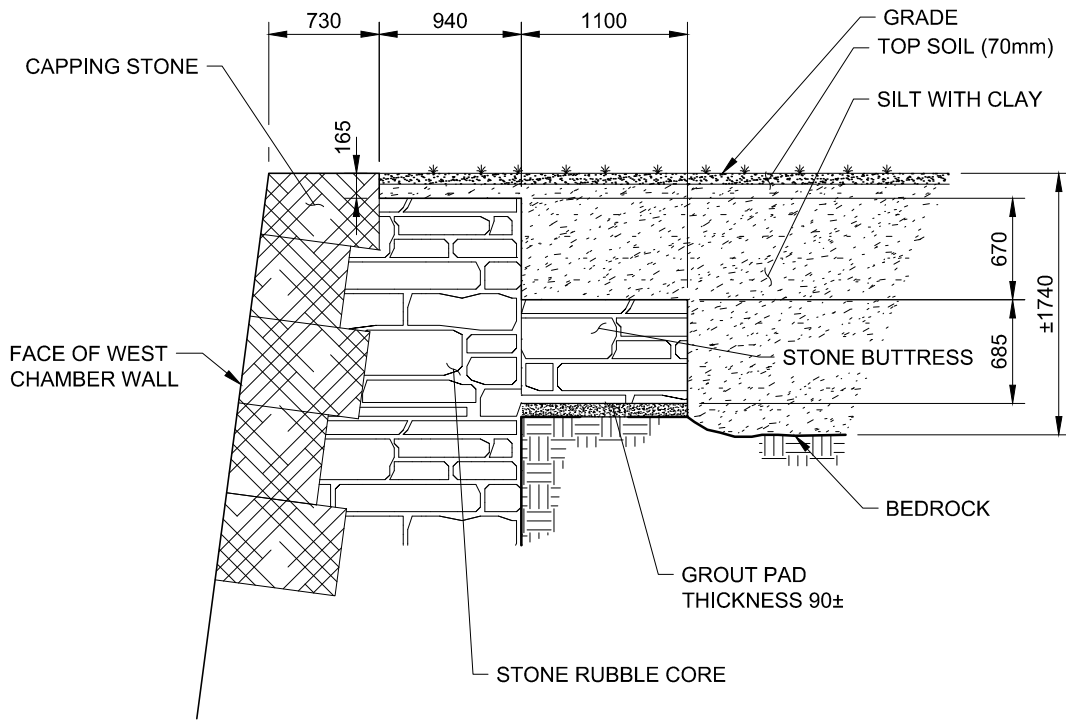
APPENDIX

C-3 *TEST PIT SKETCHES AND PHOTOS*

WSP-A4Vrt PLOTTED BY: ADRIAN.MEUNIER DATE PLOTTED: Feb 12, 2018 FILE NAME: 500 Test Pits 01.dwg



PLAN
1:200



SECTION
1:50



300-2611 QUEENSVIEW DRIVE
OTTAWA (ONTARIO)
CANADA K2B 8K2
TELEPHONE: 613-829-2800 FAX: 613-829-8299
WWW.WSPGROUP.COM

TITLE:
KINGSTON MILLS
LOCK STATION
TEST PIT 17-1

SCALE:
AS SHOWN
DATE:
7-Feb-2018
PROJECT NO:
171-02359-00

REVISION:
DRAWING NO:
TP17-1

PHOTOS – TEST PIT #1



Test Pit #1 – Top of wall and buttress



Test Pit #1 – Top of wall and buttress

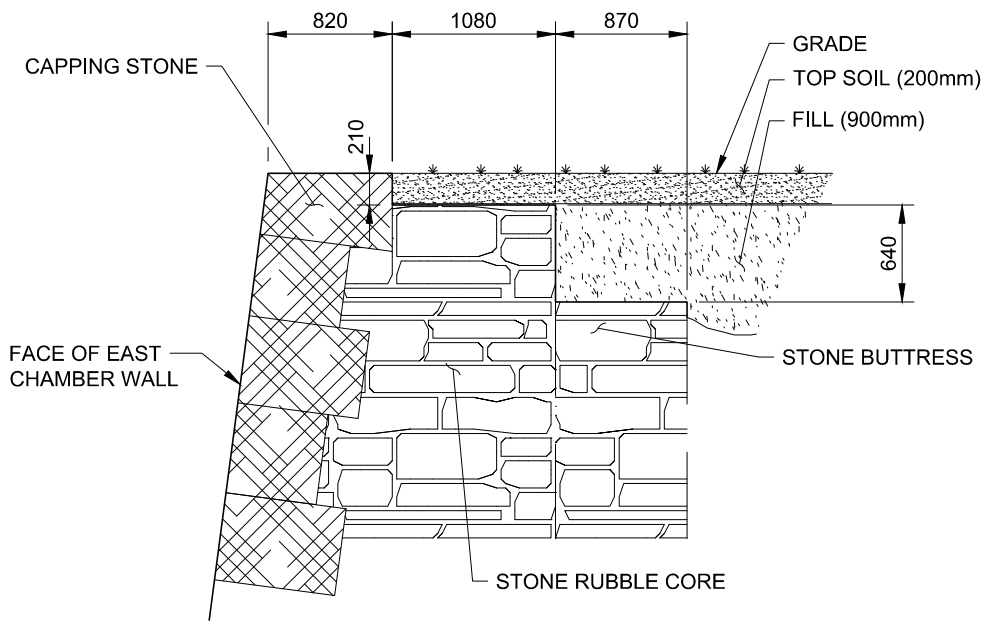
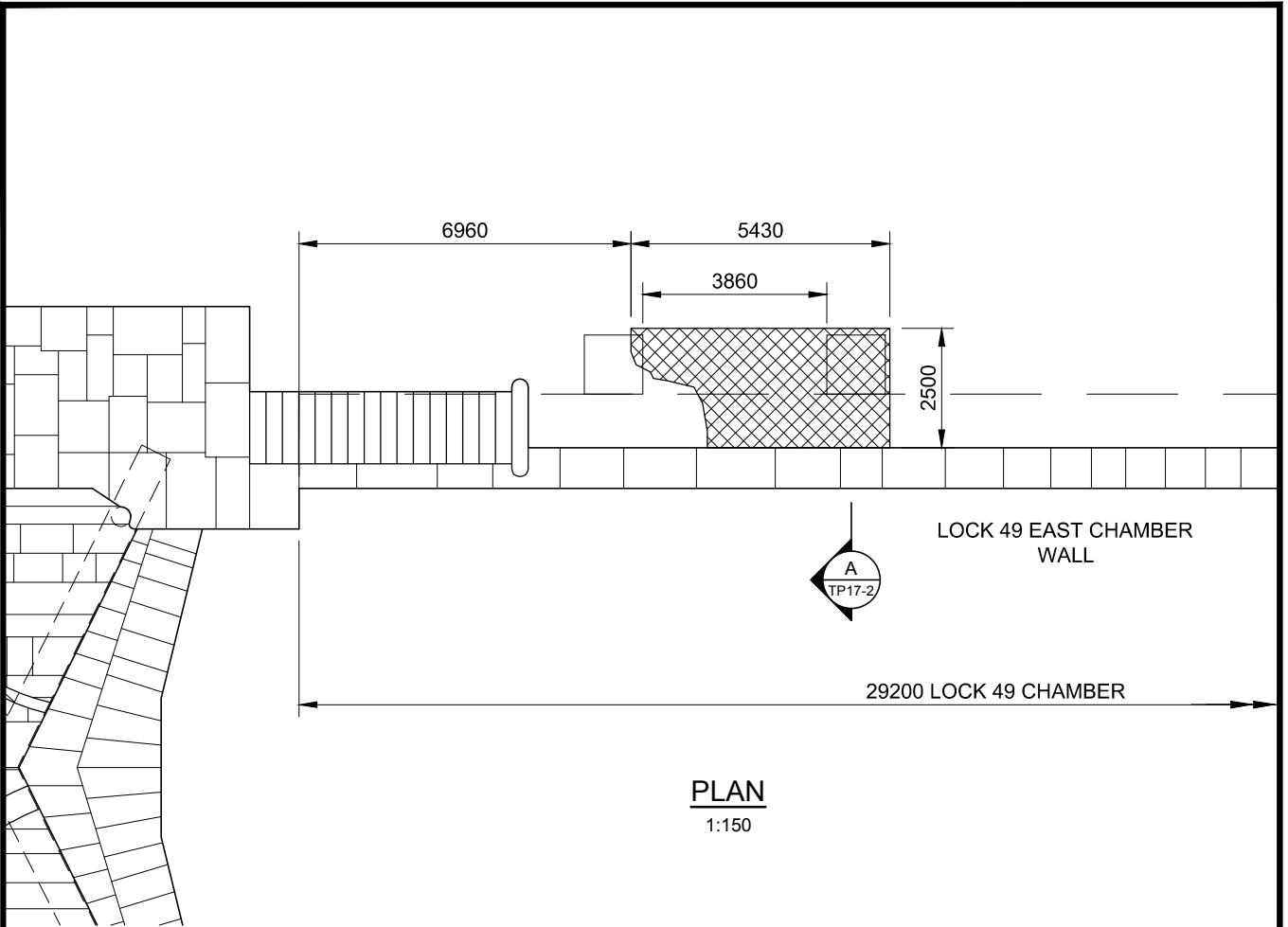


PHOTOS – TEST PIT #1



Test pit #1 – Layer of grout at bedrock

WSP-A4Vrt PLOTTED BY: ADRIAN.MEUNIER DATE PLOTTED: Feb 12, 2018 FILE NAME: 500 Test Pits 01.dwg



300-2611 QUEENSVIEW DRIVE
OTTAWA (ONTARIO)
CANADA K2B 8K2
TELEPHONE: 613-829-2800 FAX: 613-829-8299
WWW.WSPGROUP.COM

TITLE:
KINGSTON MILLS
LOCK STATION
TEST PIT 17-2

SCALE:
AS SHOWN
DATE:
7-Feb-2018
PROJECT NO:
171-02359-00

REVISION:
DRAWING NO:
TP17-2

PHOTOS – TEST PIT #2

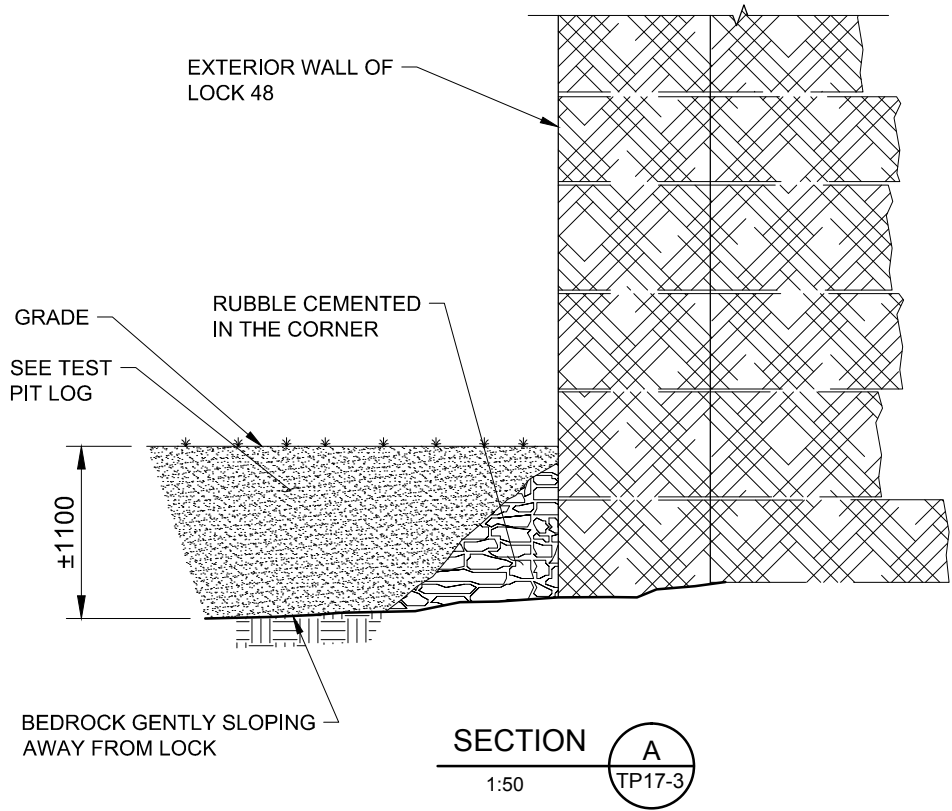
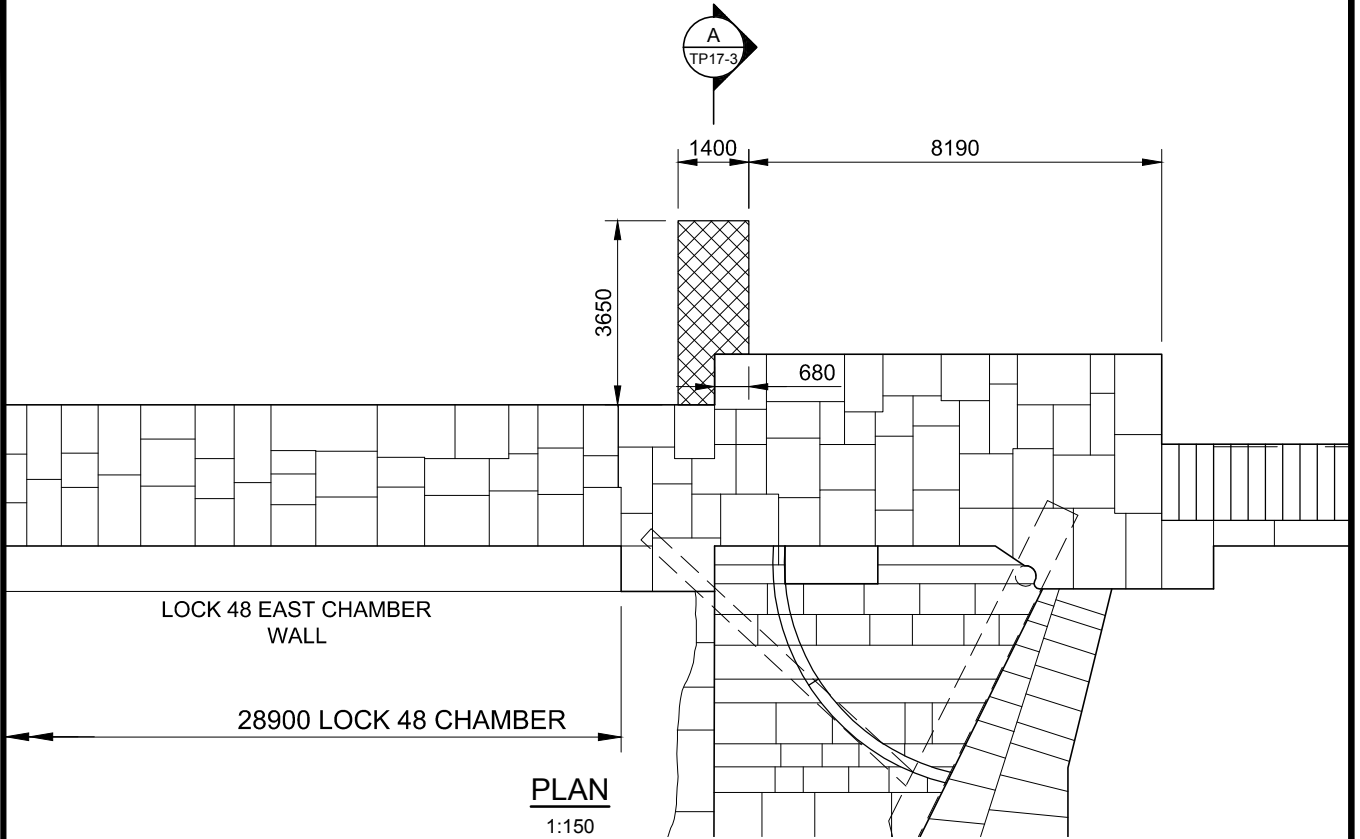


Test Pit #2 – Butters and back of chamber wall



Test Pit #2 – Butters and back of chamber wall

WSP-A4Vrt PLOTTED BY: ADRIAN.MEUNIER DATE PLOTTED: Feb 12, 2018 FILE NAME: 500 Test Pits 01.dwg



300-2611 QUEENSVIEW DRIVE
OTTAWA (ONTARIO)
CANADA K2B 8K2
TELEPHONE: 613-829-2800 FAX: 613-829-8299
WWW.WSPGROUP.COM

TITLE:
KINGSTON MILLS
LOCK STATION
TEST PIT 17-3

SCALE:
AS SHOWN
DATE:
7-Feb-2018
PROJECT NO:
171-02359-00

REVISION:
DRAWING NO:
TP17-3

PHOTOS – TEST PIT #3



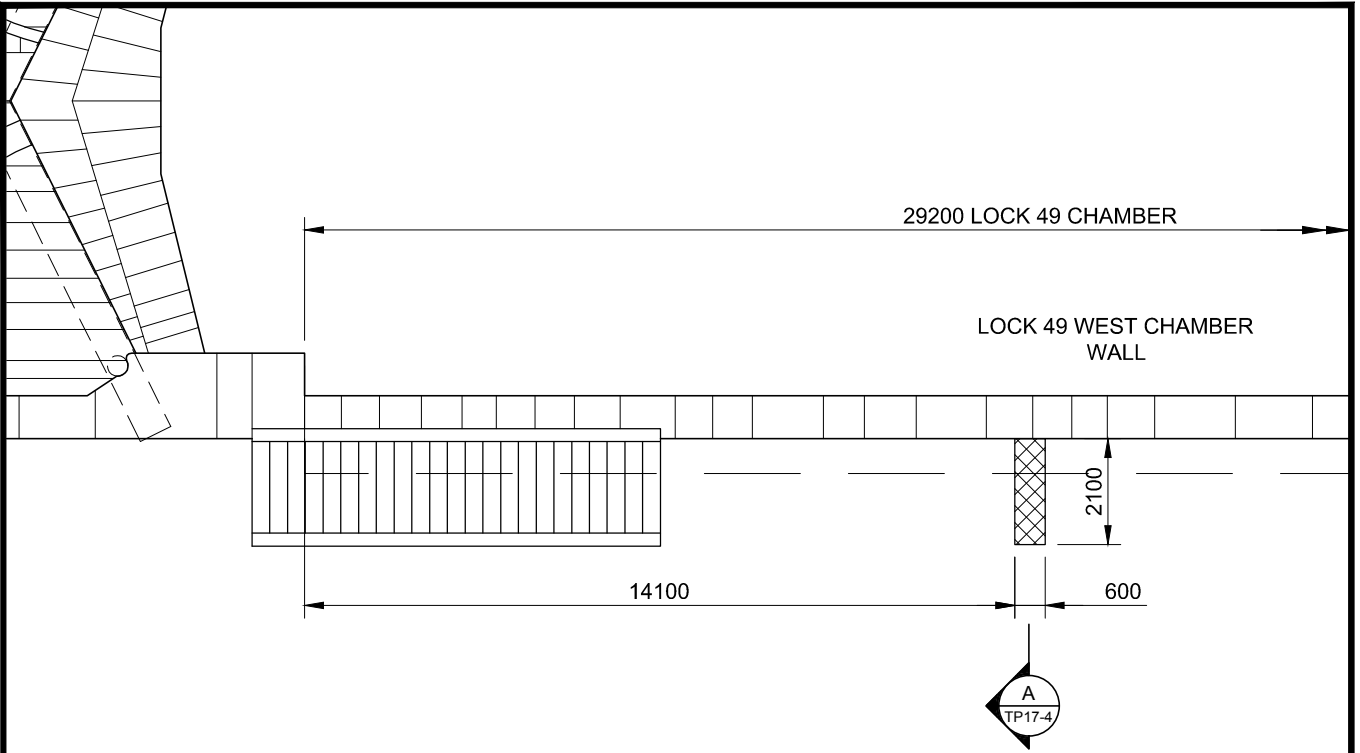
Test Pit #3 – Grouted rubble at base of chamber wall

PHOTOS – TEST PIT #3

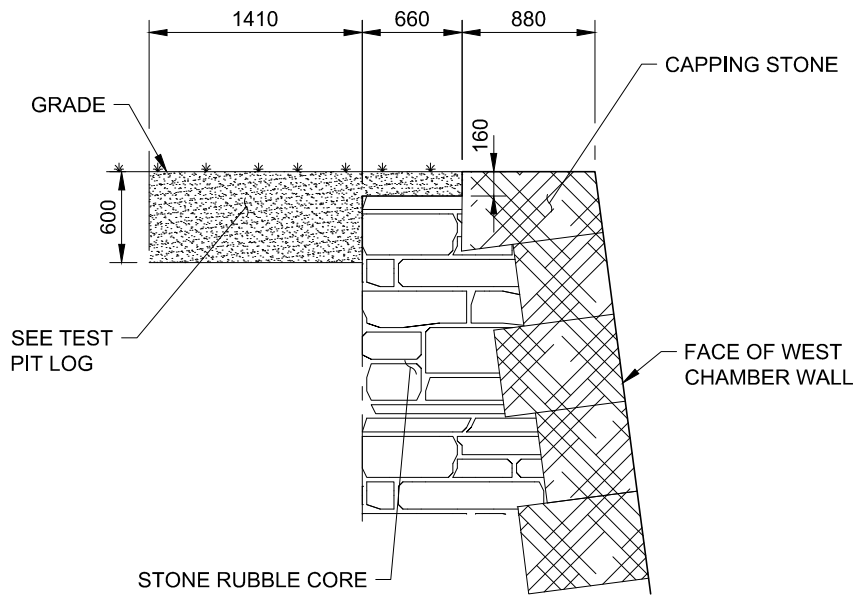


Test Pit #3 – Monolith #4 and back of lock chamber wall

WSP-A4Vrt PLOTTED BY: ADRIAN.MEUNIER DATE PLOTTED: Feb 12, 2018 FILE NAME: 500 Test Pits 01.dwg



PLAN
1:150



SECTION
1:50



300-2611 QUEENSVIEW DRIVE
OTTAWA (ONTARIO)
CANADA K2B 8K2
TELEPHONE: 613-829-2800 FAX: 613-829-8299
WWW.WSPGROUP.COM

TITLE:
KINGSTON MILLS
LOCK STATION
TEST PIT 17-4

SCALE:
AS SHOWN
DATE:
7-Feb-2018
PROJECT NO:
171-02359-00

REVISION:
DRAWING NO:
TP17-4

PHOTOS – TEST PIT #4

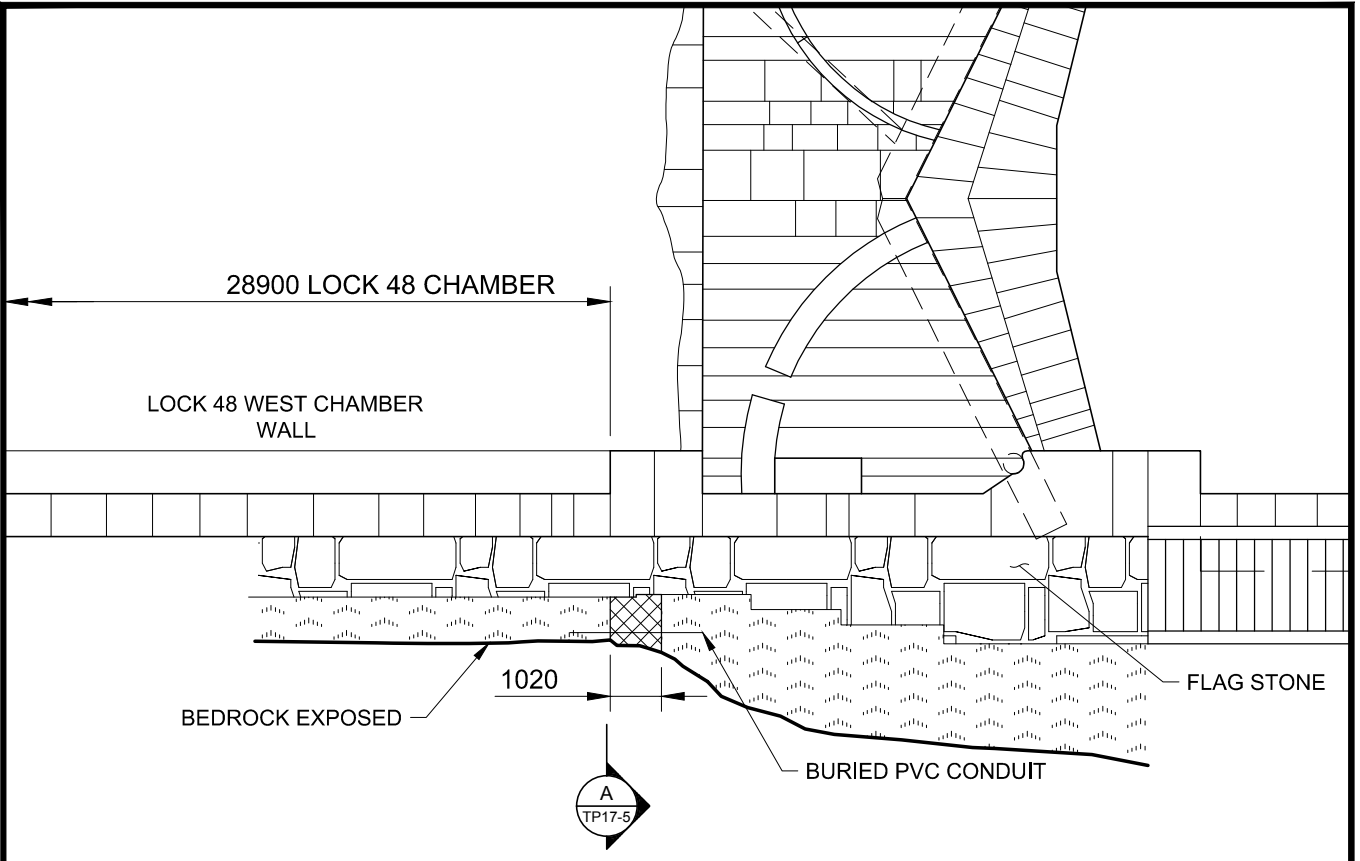


Test Pit #4 – Back of chamber wall

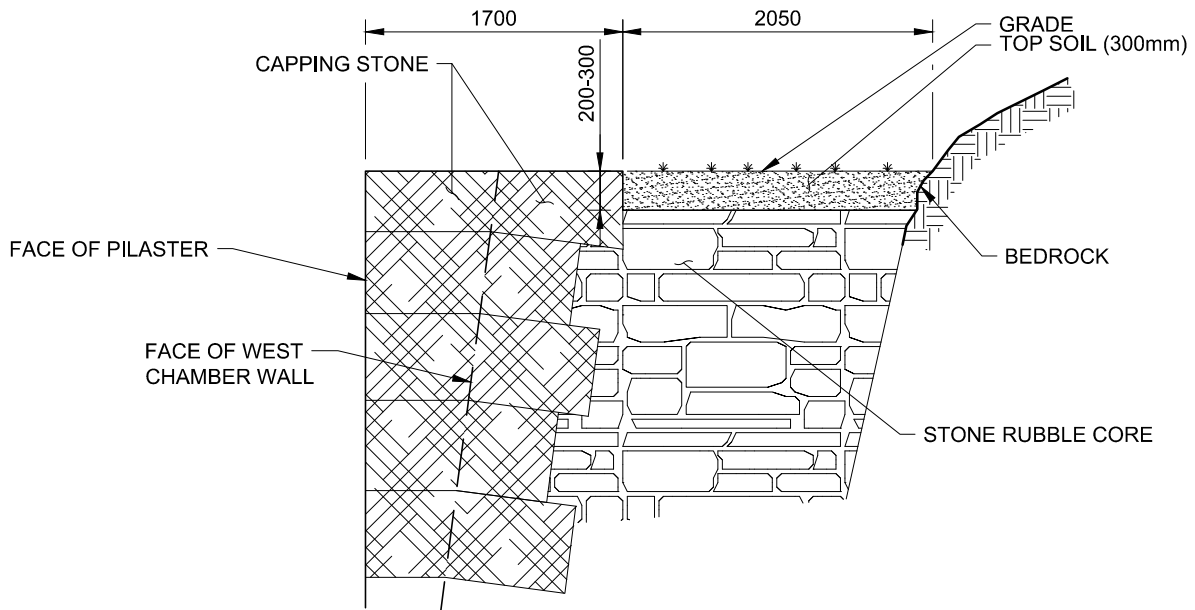


Test Pit #4 – Back of chamber wall

WSP-A4Vrt PLOTTED BY: ADRIAN.MEUNIER DATE PLOTTED: Feb 12, 2018 FILE NAME: 500 Test Pits 01.dwg



PLAN
1:150



SECTION A
1:50
TP17-5



300-2611 QUEENSVIEW DRIVE
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CANADA K2B 8K2
TELEPHONE: 613-829-2800 FAX: 613-829-8299
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TITLE:
KINGSTON MILLS
LOCK STATION
TEST PIT 17-5

SCALE:
AS SHOWN
DATE:
7-Feb-2018
PROJECT NO:
171-02359-00

REVISION:
DRAWING NO:
TP17-5

PHOTOS – TEST PIT #5



Test Pit #5 – Rubble behind wall to face of bedrock outcrop



Test Pit #5 – Rubble behind wall to face of bedrock outcrop

APPENDIX

C-4 *LABORATORY TESTING RESULTS*



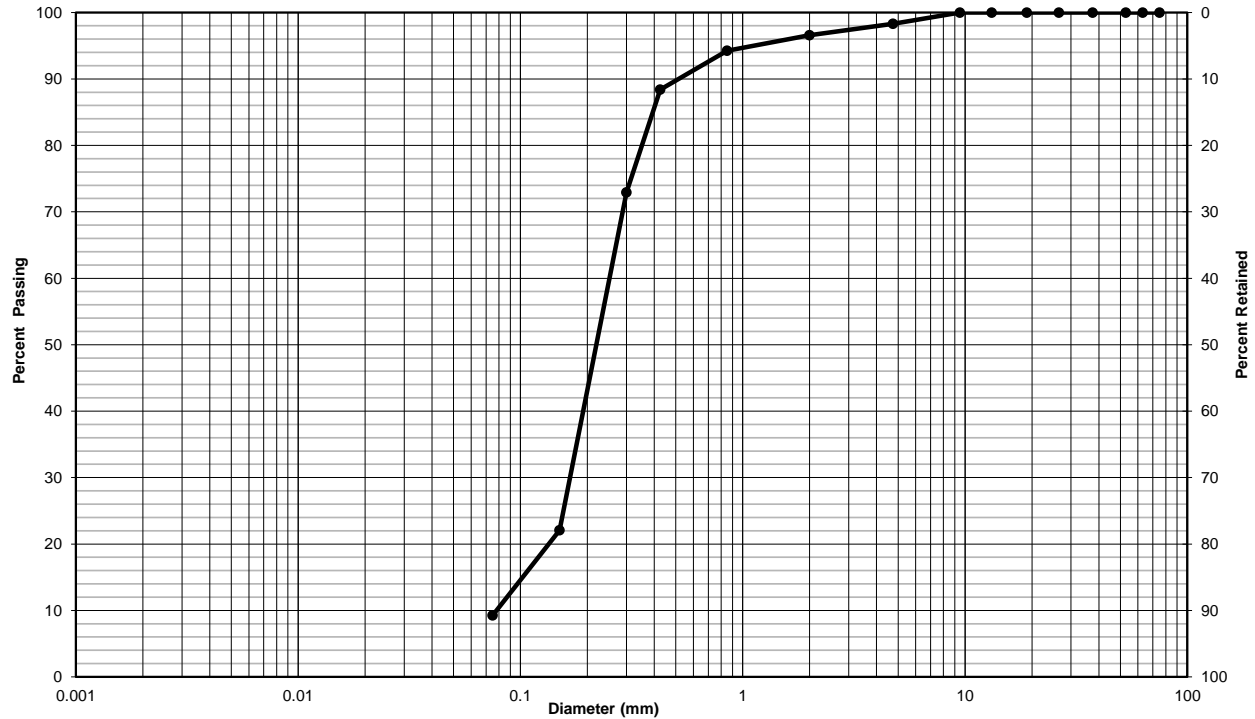
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada **Lab no.:** OL 229-6

Project/Site: Kingston Mills Rehabilitation **Project no.:** 171-02359-00

Borehole no.: TP 2 **Sample no.:** GS 2

Depth: 0.47-0.57m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	1.7	89.1	9.3	-	-

Remarks: _____

Performed by: N.Krebs **Date:** October 31, 2017

Verified by: N.Krebs **Date:** October 31, 2017



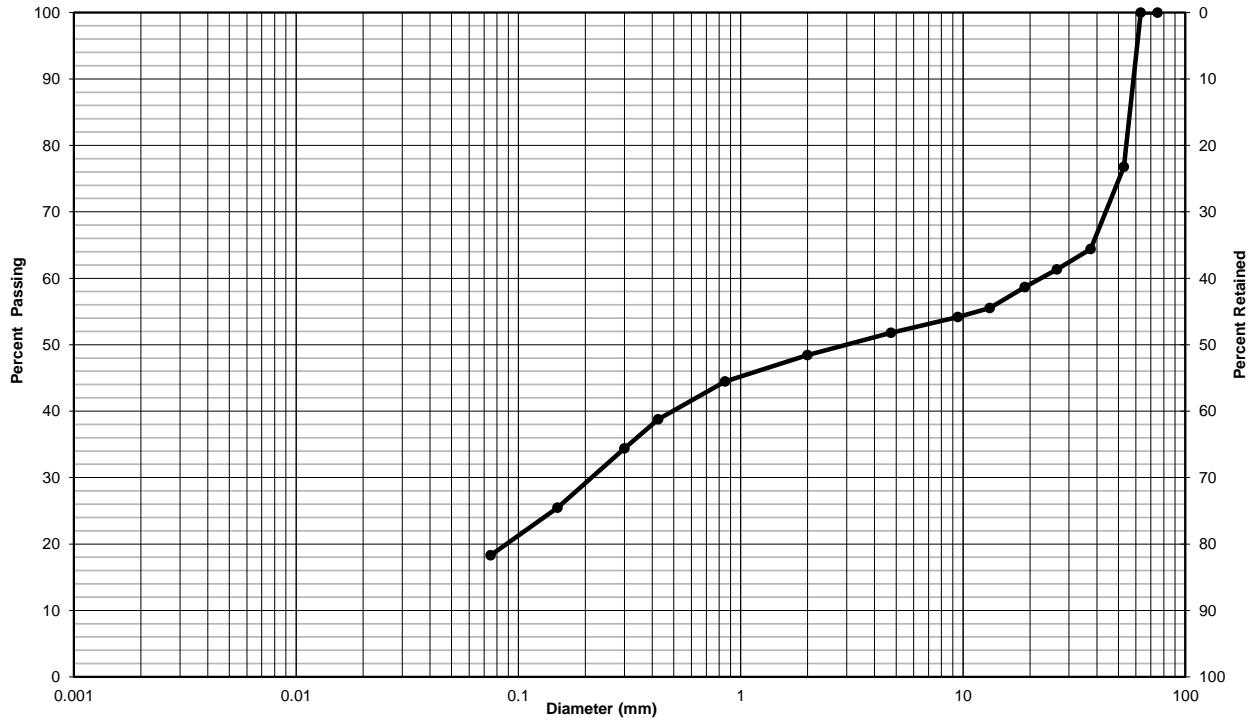
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada **Lab no.:** OL 229-8

Project/Site: Kingston Mills Rehabilitation **Project no.:** 171-02359-00

Borehole no.: TP 3 **Sample no.:** GS 3

Depth: 1-2m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	48.2	33.5	18.3	-	-

Remarks: 1 large, un-representative 3" stone omitted from sample

Performed by: N.Krebs **Date:** October 31, 2017

Verified by: N.Krebs **Date:** October 31, 2017



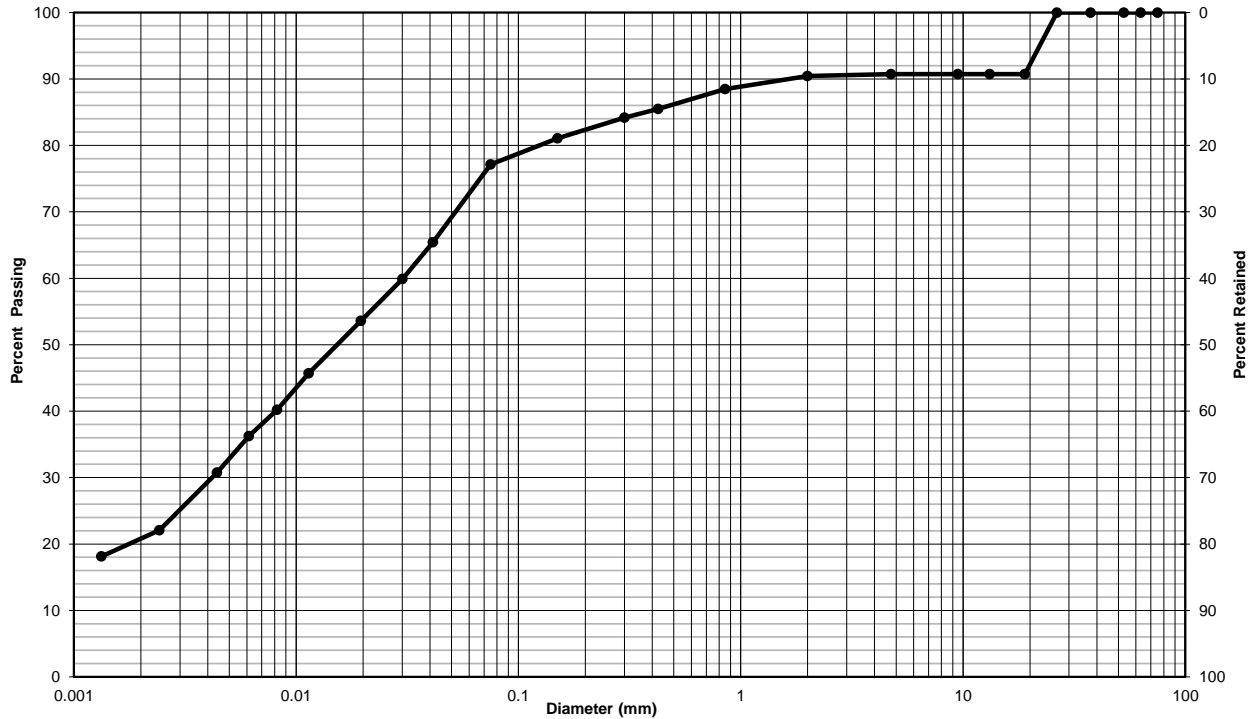
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada Lab no.: OL 229-1

Project/Site: Kingston Mills Rehabilitation Project no.: 171-02359-00

Borehole no.: 17-1 Sample no.: SS4

Depth: 2.25-2.85m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	9.3	13.6	77.1	56.1	21.0

Remarks: _____

Performed by: N.Krebs Date: November 7, 2017

Verified by: N.Krebs Date: November 7, 2017



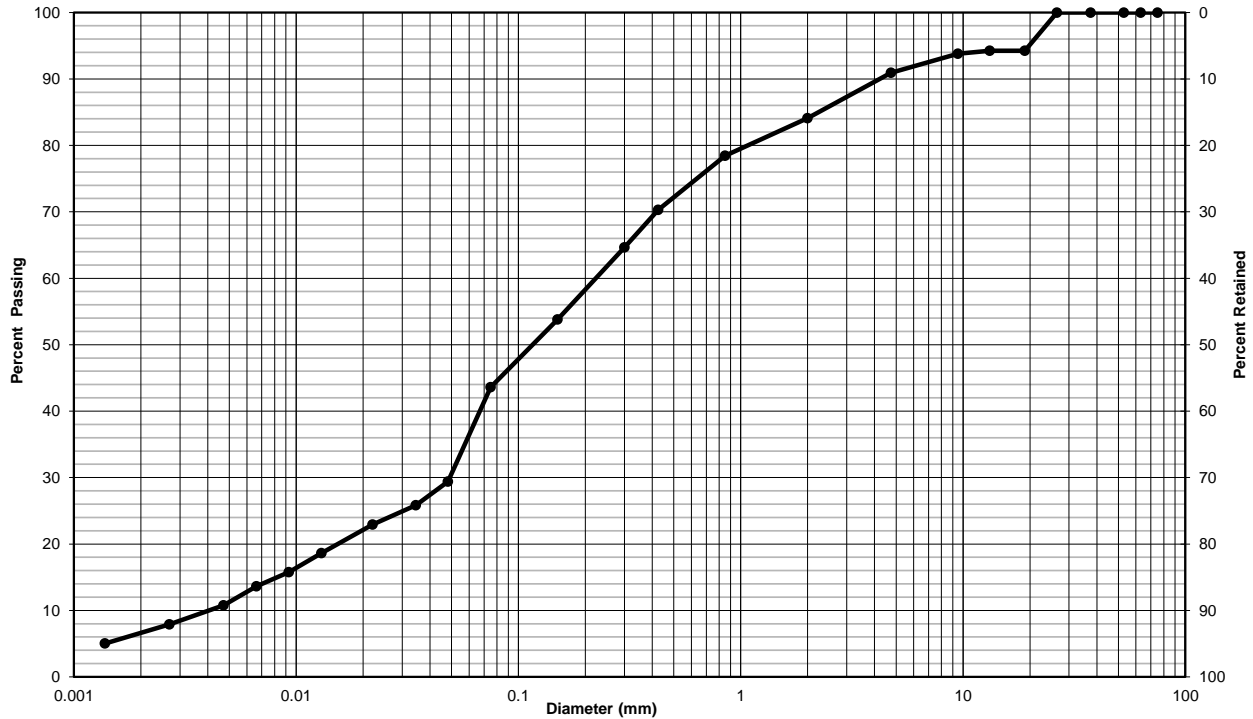
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada Lab no.: OL 229-2

Project/Site: Kingston Mills Rehabilitation Project no.: 171-02359-00

Borehole no.: 17-2 Sample no.: SS3

Depth: 1.5-2.1m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	9.1	47.3	43.6	36.6	7.0

Remarks: _____

Performed by: N.Krebs Date: November 7, 2017

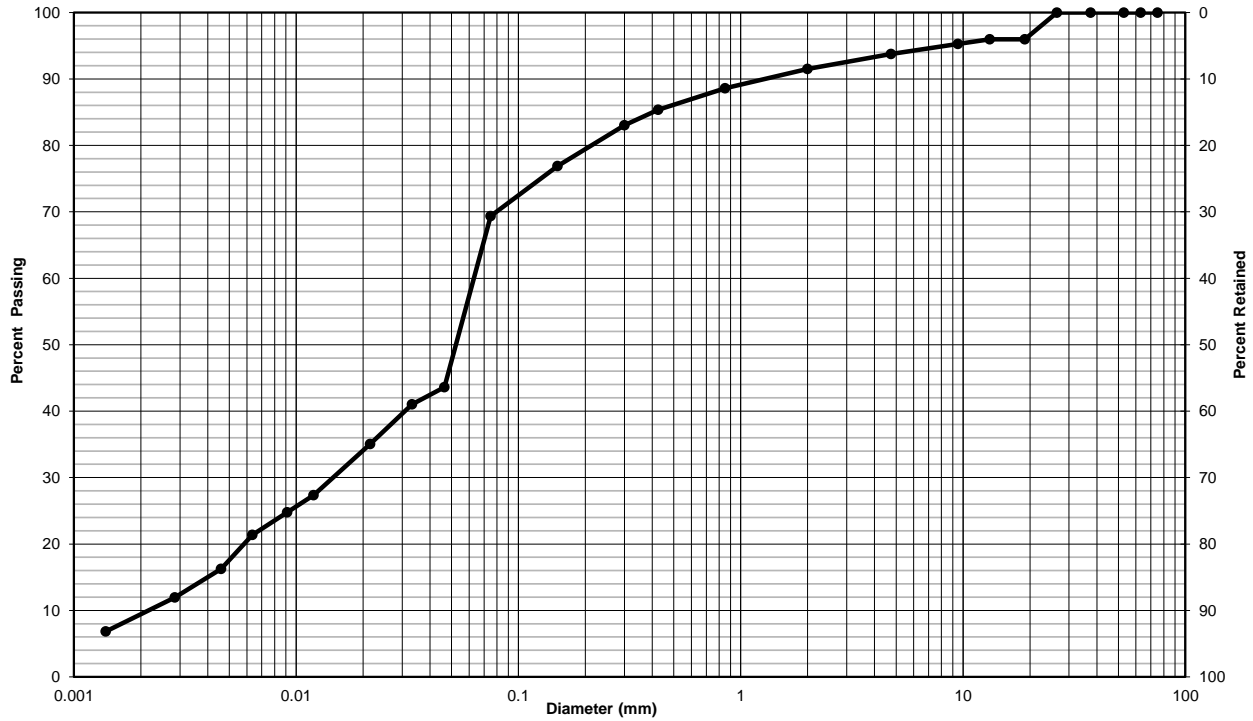
Verified by: N.Krebs Date: November 7, 2017



**Particle-Size Analysis of Soils
(ASTM D422)**

Client:	Parks Canada	Lab no.:	OL 229-3
Project/Site:	Kingston Mills Rehabilitation	Project no.:	171-02359-00

Borehole no.: 17-3	Sample no.: SS3
Depth: 1.5-2.1m	



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	6.3	24.4	69.3	60.3	9.0

Remarks:

Performed by: _____ N.Krebs **Date:** _____ November 8, 2017

Verified by: _____ N.Krebs **Date:** _____ November 8, 2017



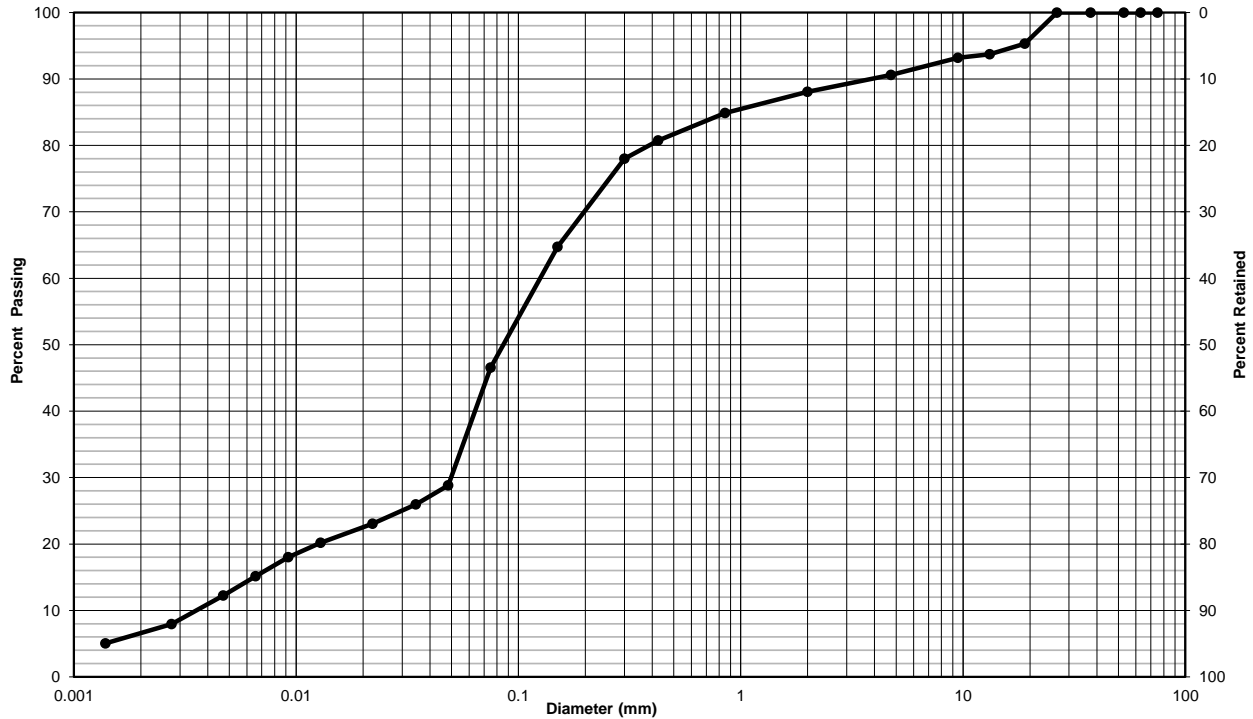
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada **Lab no.:** OL 229-4

Project/Site: Kingston Mills Rehabilitation **Project no.:** 171-02359-00

Borehole no.: 17-6 **Sample no.:** SS4

Depth: 2.25-2.85m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	9.4	44.0	46.5	40.5	6.0

Remarks: _____

Performed by: N.Krebs **Date:** November 8, 2017

Verified by: N.Krebs **Date:** November 8, 2017



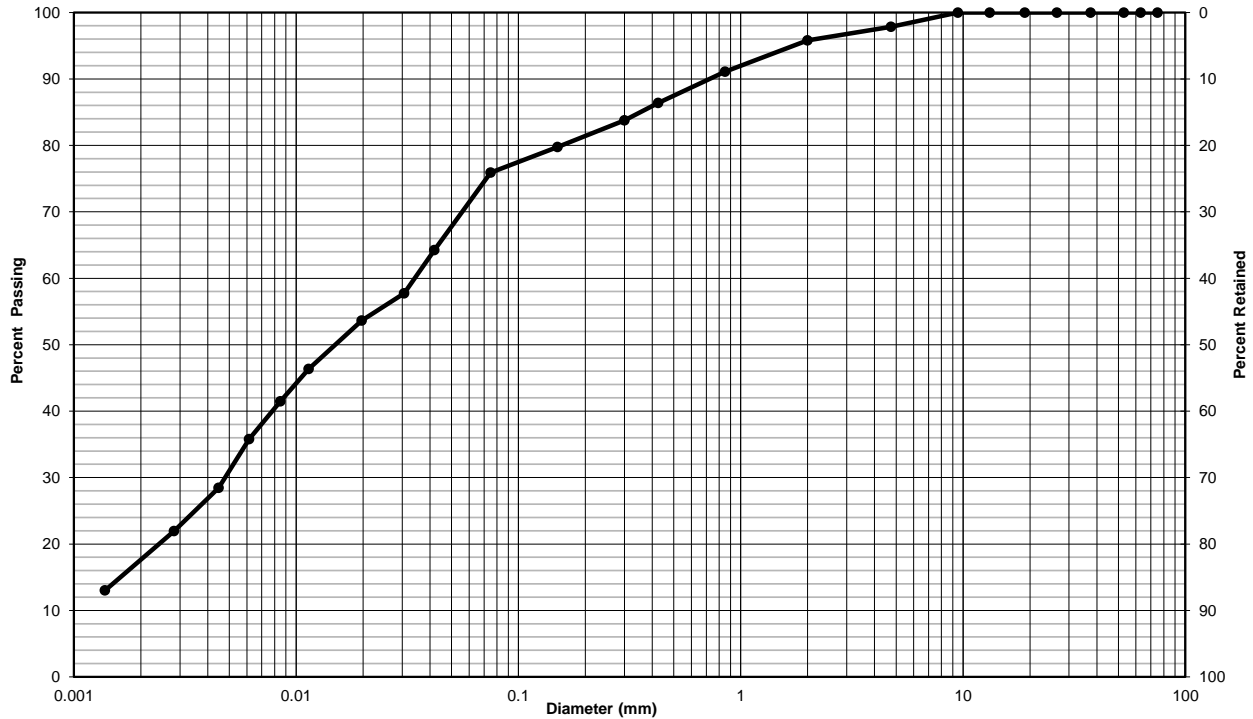
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada Lab no.: OL 229-5

Project/Site: Kingston Mills Rehabilitation Project no.: 171-02359-00

Borehole no.: 17-6 Sample no.: SS9

Depth: 6.1-6.7m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	2.1	22.0	75.9	57.9	18.0

Remarks: _____

Performed by: N.Krebs Date: November 8, 2017

Verified by: N.Krebs Date: November 8, 2017



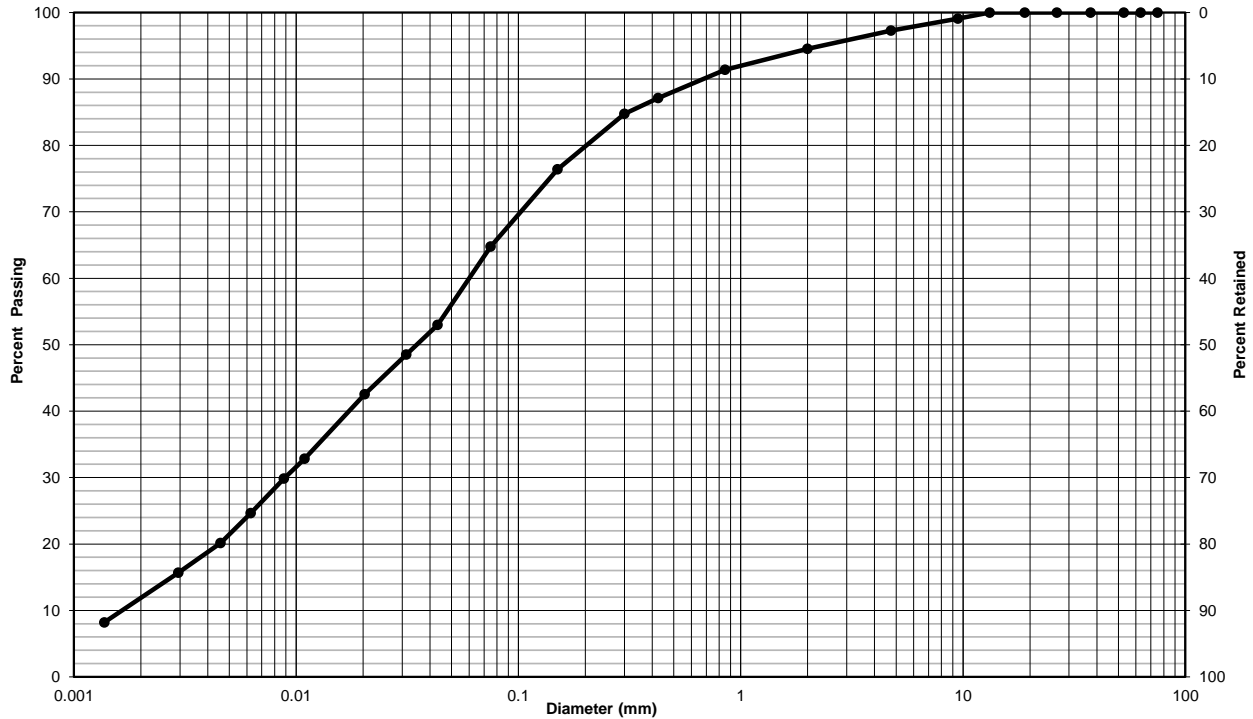
**Particle-Size Analysis of Soils
(ASTM D422)**

Client: Parks Canada Lab no.: OL 229-7

Project/Site: Kingston Mills Rehabilitation Project no.: 171-02359-00

Borehole no.: TP 2 Sample no.: GS 3

Depth: 0.7-1m



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Percent %	Gravel	Sand	Clay & Silt	Silt	Clay
	2.7	32.5	64.8	52.8	12.0

Remarks: _____

Performed by: N.Krebs Date: November 8, 2017

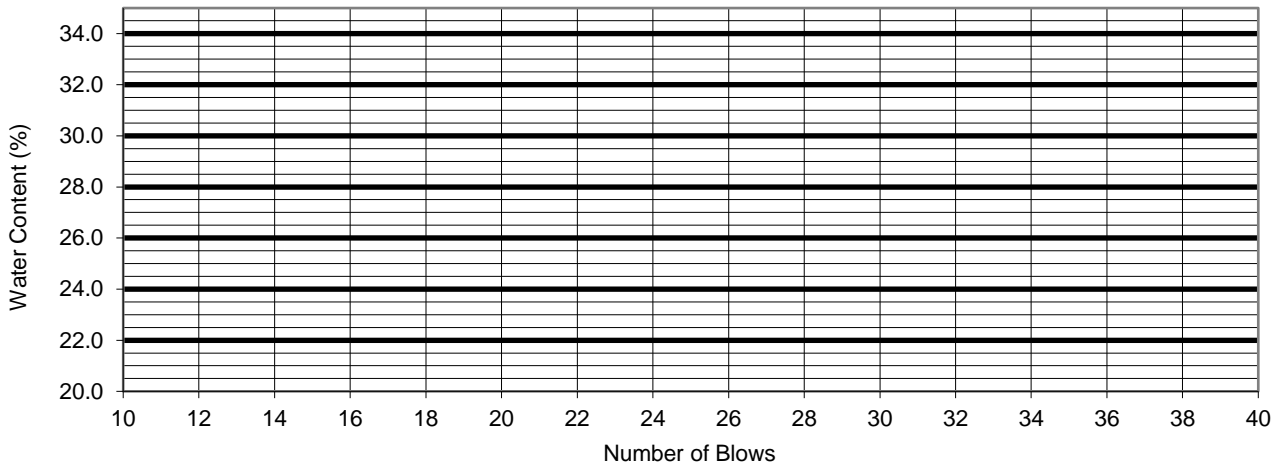
Verified by: N.Krebs Date: November 8, 2017



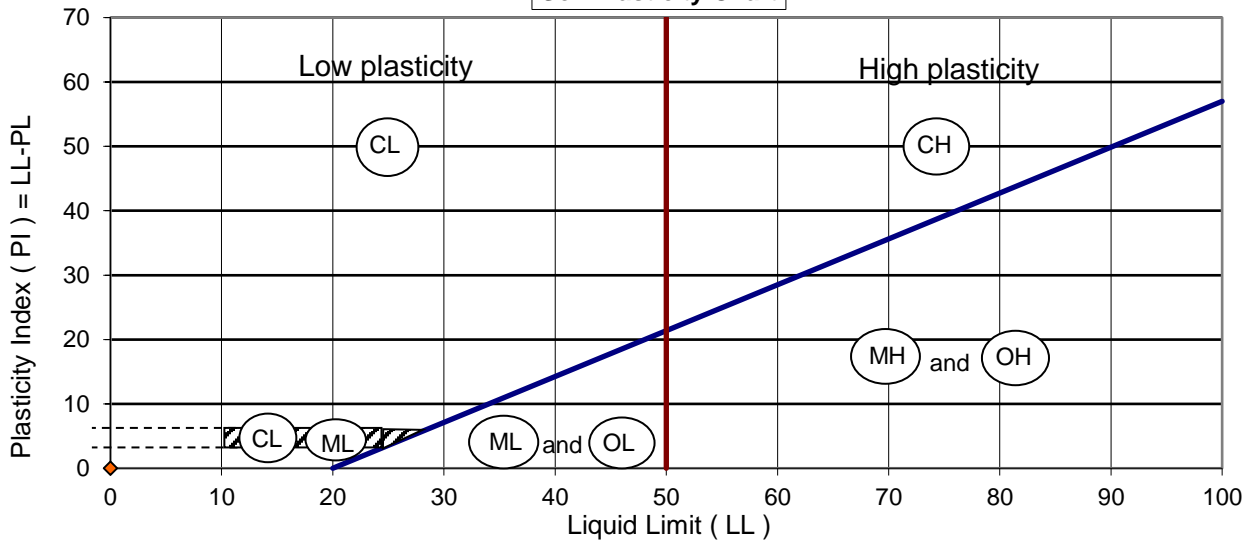
Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

Client:	Parks Canada	Lab No.:	OL 229-2
Project/Site:	Kingston Mills Lockstation Rehabilitation	Project No.:	171-02359-00
Borehole No.:	17-2	Sample No.:	SS 3
Sample Depth:	1.5-2.1m		

Liquid Limit Results



Soil Plasticity Chart



Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Natural Water Content %
0	0	0	18.0

Sample Description: Non-Plastic

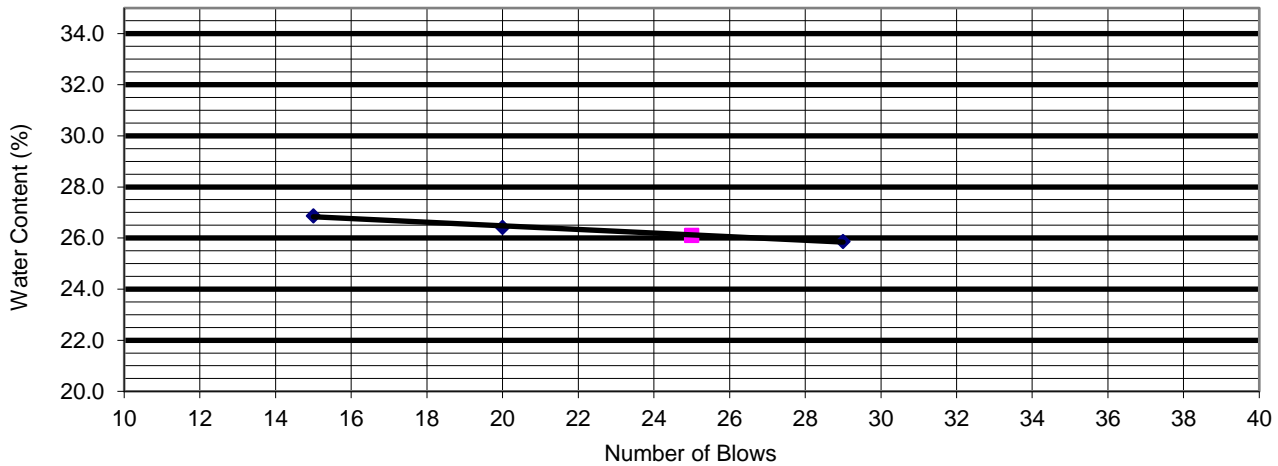
Performed By:	J.Meehan	Date:	November 8, 2017
Verified By:	N.Krebs	Date:	November 9, 2017



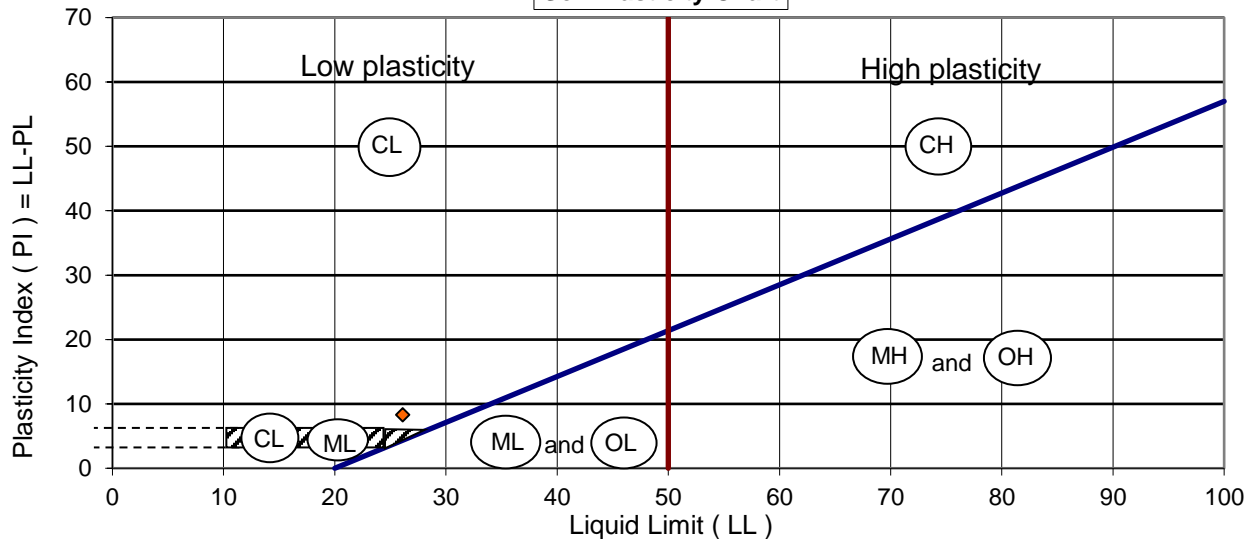
Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

Client:	Parks Canada	Lab No.:	OL 229-3
Project/Site:	Kingston Mills Lockstation Rehabilitation	Project No.:	171-02359-00
Borehole No.:	17-3	Sample No.:	SS 3
Sample Depth:	1.5-2.1m		

Liquid Limit Results



Soil Plasticity Chart



Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Natural Water Content %
26	18	8	29.0

Sample Description: CL - Low plasticity, inorganic clay

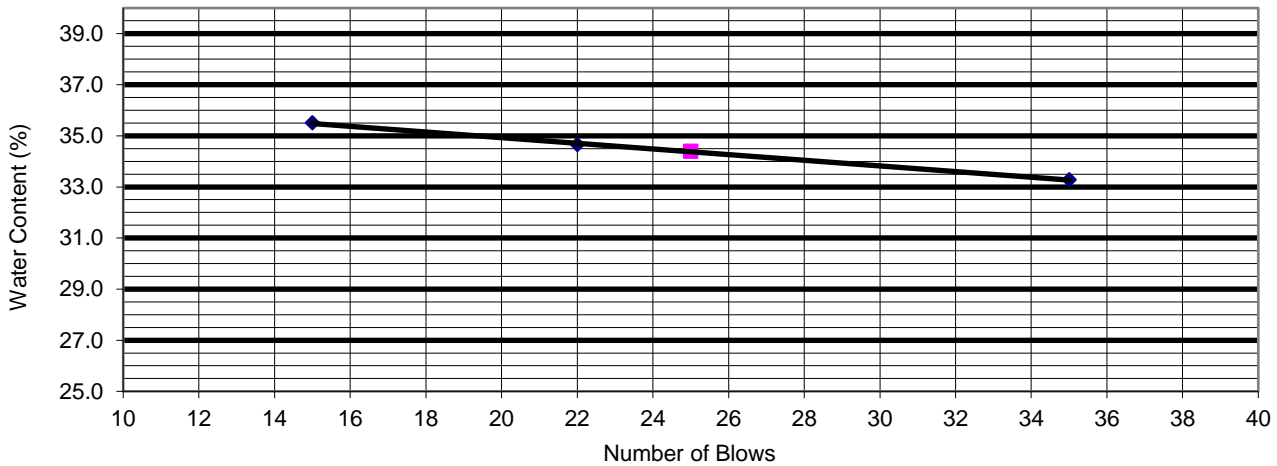
Performed By:	J.Meehan	Date:	November 8, 2017
Verified By:	N.Krebs	Date:	November 9, 2017



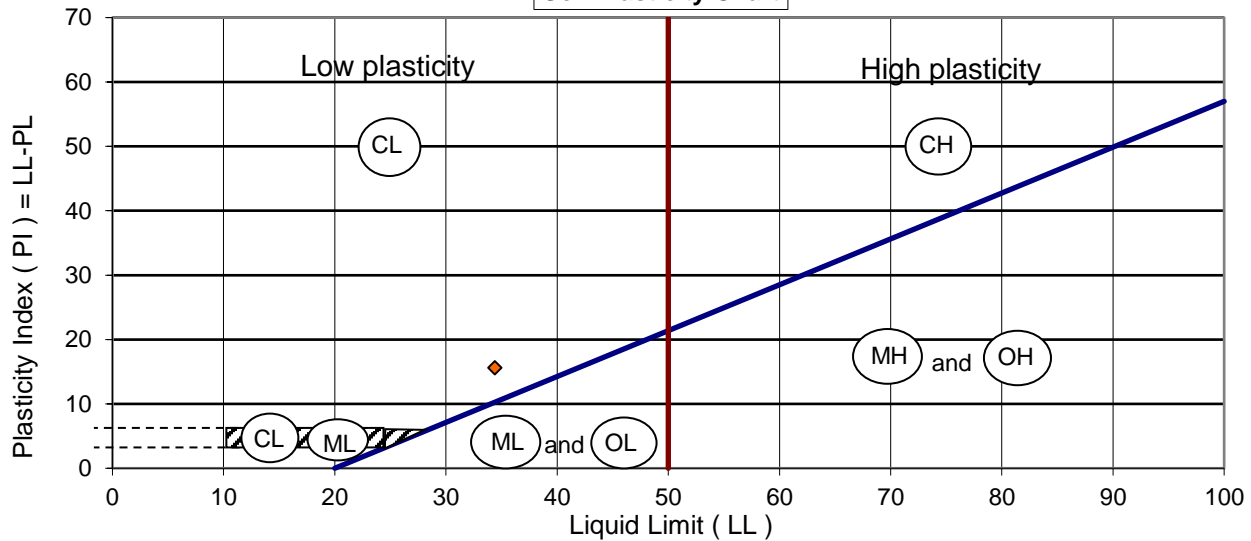
Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

Client:	Parks Canada	Lab No.:	OL 229-5
Project/Site:	Kingston Mills Lockstation Rehabilitation	Project No.:	171-02359-00
Borehole No.:	17-6	Sample No.:	SS 9
Sample Depth:	6.1-6.7m		

Liquid Limit Results



Soil Plasticity Chart



Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Natural Water Content %
34	19	16	39.3

Sample Description: CL - Low plasticity, inorganic clay

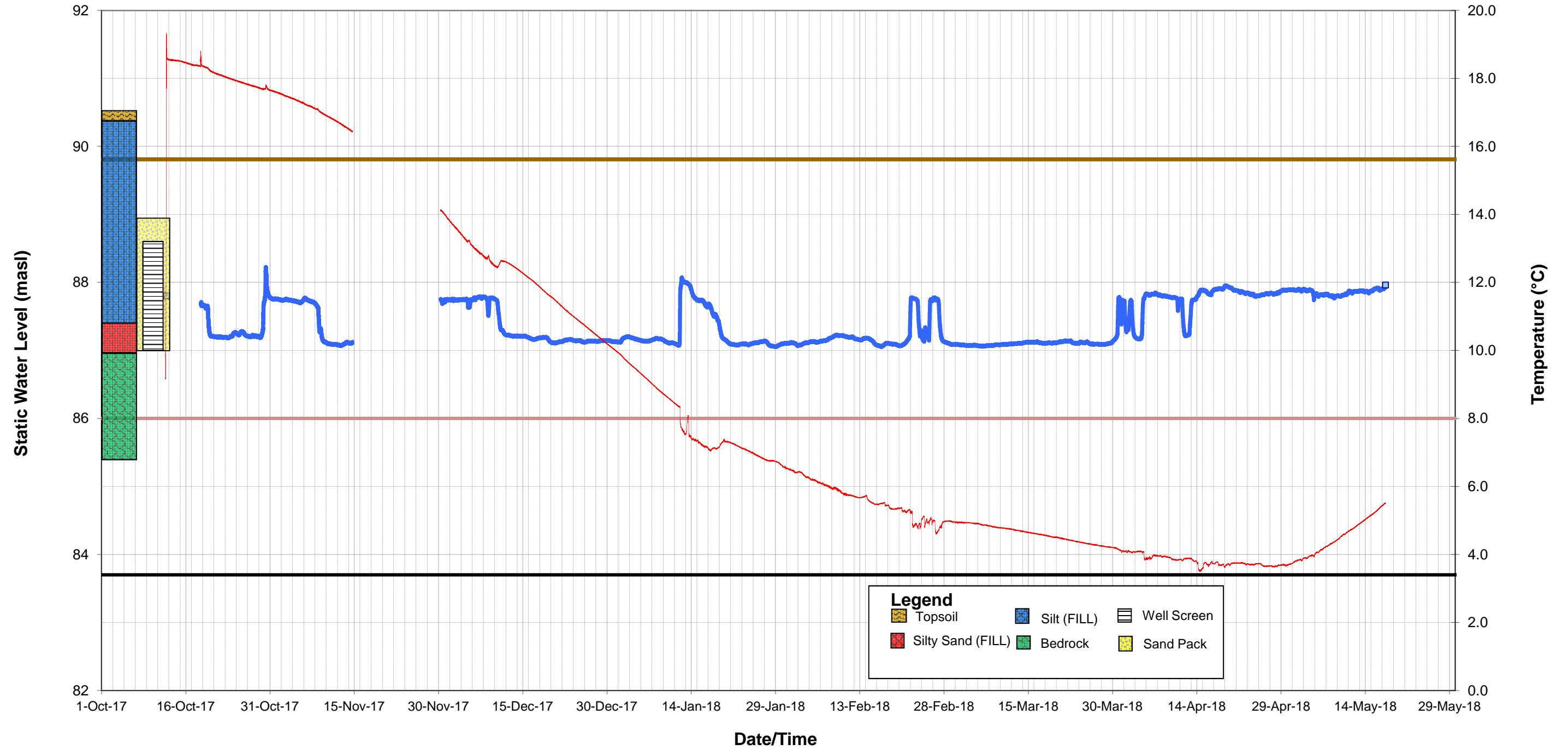
Performed By:	J.Meehan	Date:	November 2, 2017
Verified By:	N.Krebs	Date:	November 2, 2017

APPENDIX

C-5 *GROUNDWATER DATA*



Figure SWL-1: Static Water Levels and Groundwater Temperature
BH17-1 (2017/2018)



— Groundwater Elevation □ Manual Water Level — Ground Elevation — Lock 46 Floor — Lock 46 Bottom of Lock — Temperature



Figure SWL-1: Static Water Levels and Groundwater Temperature
BH17-2 (2017/2018)

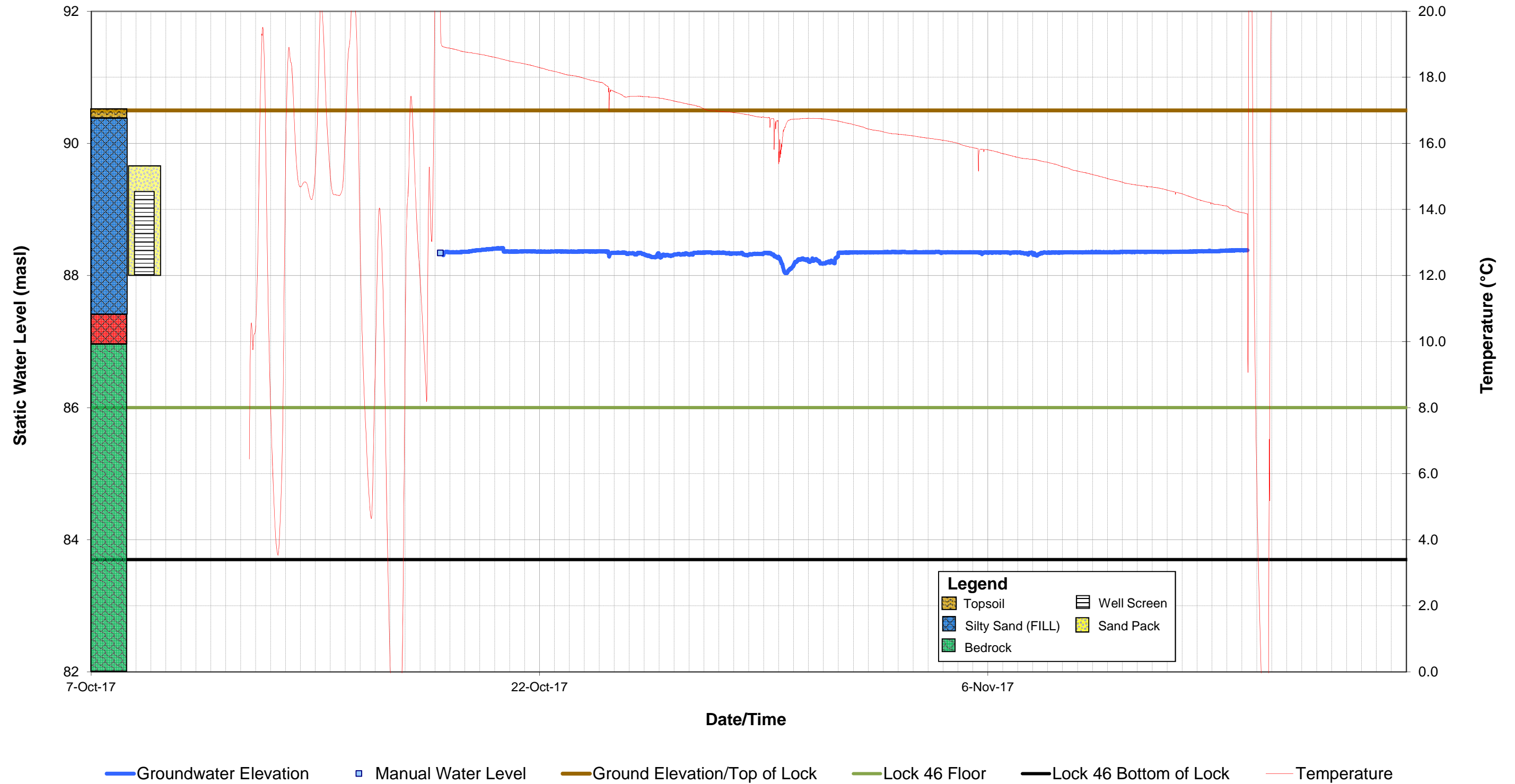
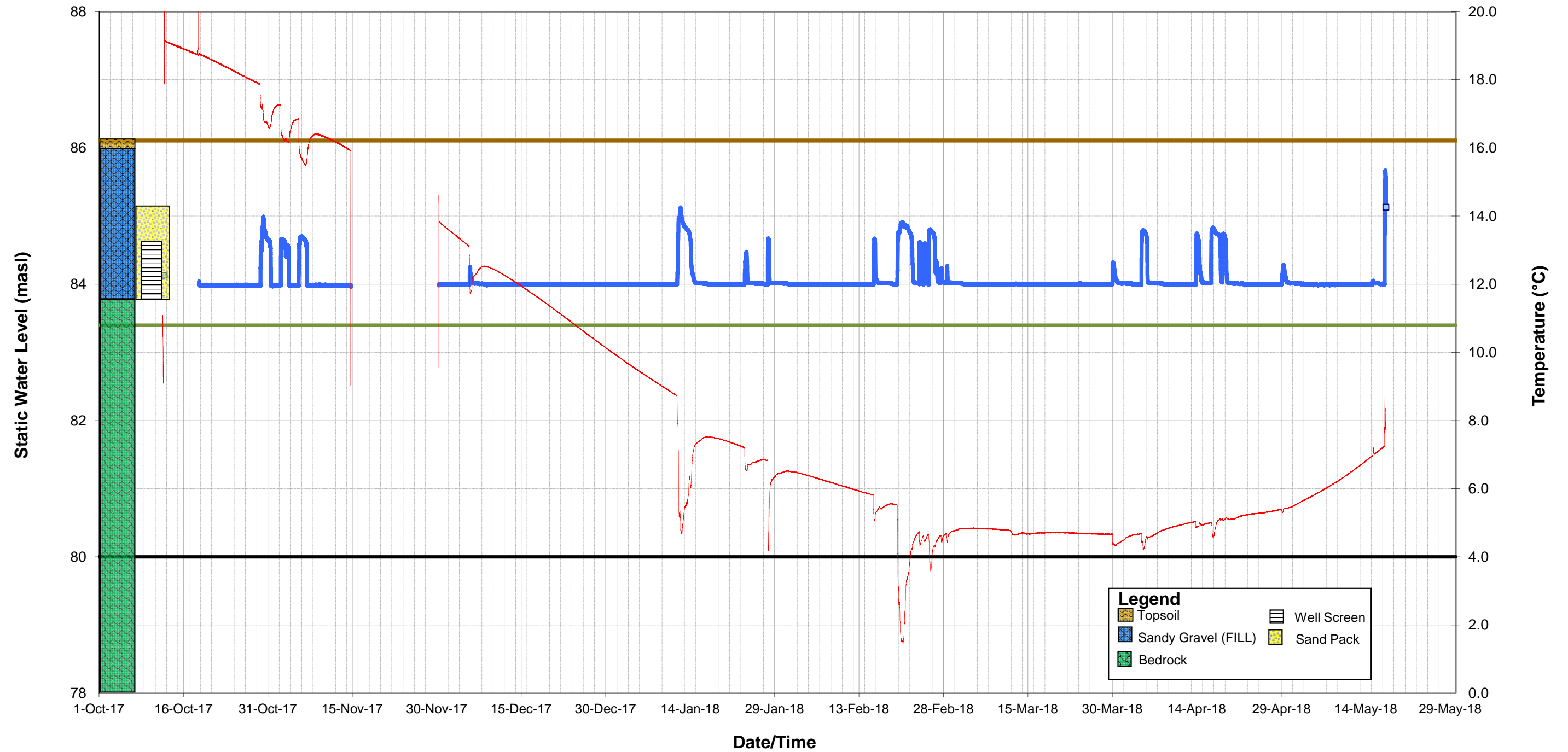




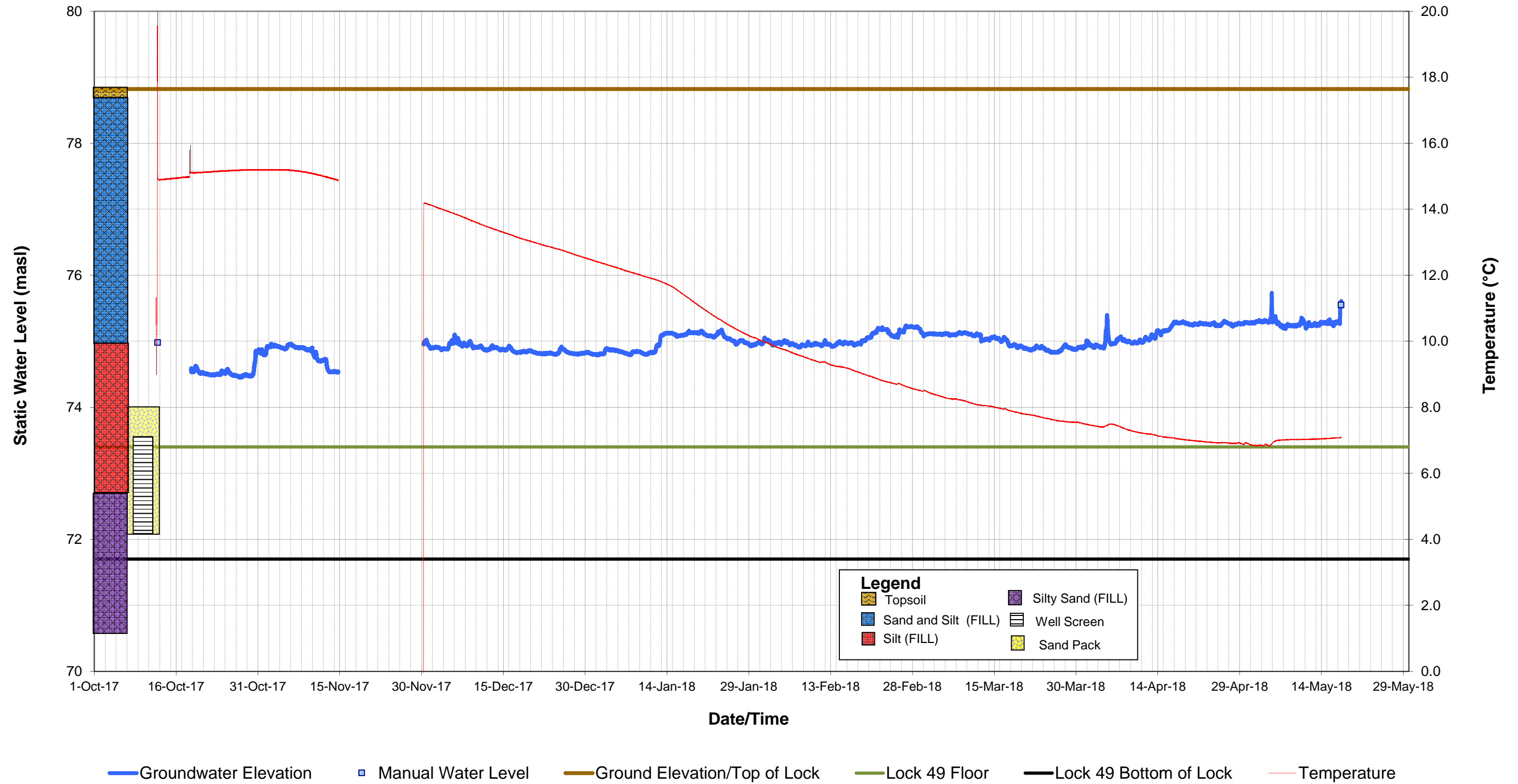
Figure SWL-1: Static Water Levels and Groundwater Temperature
BH17-3 (2017/2018)



— Groundwater Elevation □ Manual — Ground Elevation — Lock 47 Floor — Lock 47 Bottom of Lock — Temperature



Figure SWL-1: Static Water Levels and Groundwater Temperature
BH17-6 (2017/2018)



APPENDIX

D BEDROCK LOCATION



Historical Soils Information

- 1977 Site Investigation Services Vertical Borehole
- 2000 Quontacon Associates Boreholes
- 2005 Jacques Whitford Vertical Boreholes
- 2015 Golder Associates Vertical Boreholes and Test pits

2017 WSP Investigation

- 2017 WSP Vertical Borehole
- 2017 WSP Test Pit

ELEVATIONS LOCK 46:

UPSTREAM GATE RECESS	86.02
UPSTREAM SILL	86.56
CHAMBER INVERT	83.81
DOWNSTREAM GATE RECESS	83.45
DOWNSTREAM SILL	83.91
COPING ELEVATION EAST	90.50
COPING ELEVATION WEST	90.50

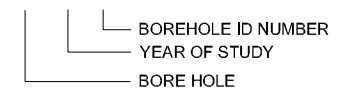
LEGEND:

- BH BOREHOLE
- GR GRADE
- BR BEDROCK

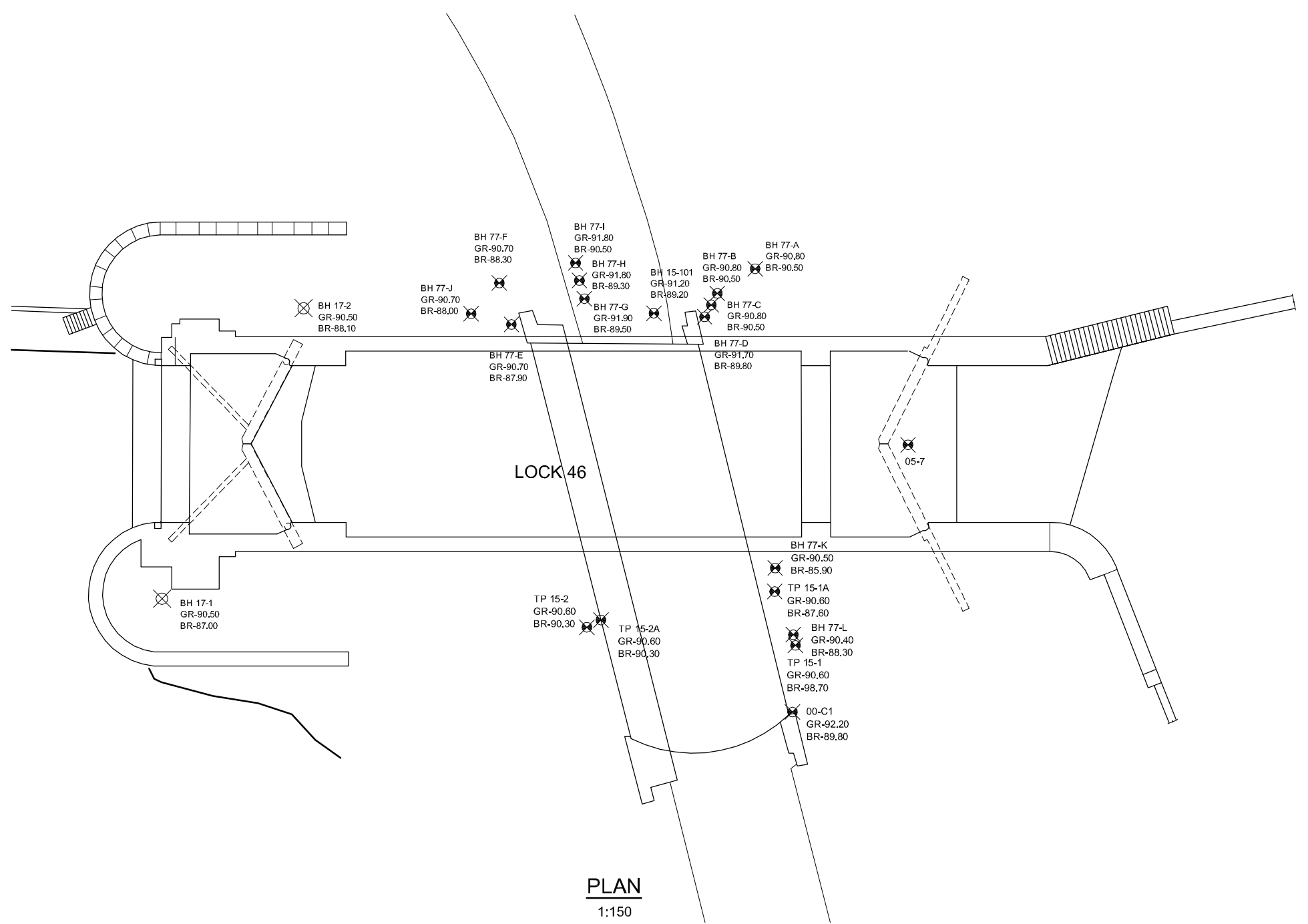
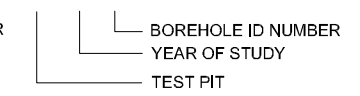
NOTE:

ALL LOCATIONS ARE APPROXIMATE.

BH XX-X



TP XX-X



PLAN
1:150

Public Services and Procurement Canada
Services publics et Approvisionnement Canada

Heritage Canals and Engineering Works Group
Parcs Canada Infrastructure Directorate
Groupe Canaux historiques et travaux d'ingénierie
Direction de l'infrastructure de Parcs Canada

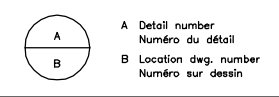
Parcs Canada
Parcs Canada



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No.	Description	Dwn.By Des.Pdr	Date
Revision / Révision			

Do not scale drawings.
Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.



Project title / Titre du projet
RIDEAU CANAL
NATIONAL HISTORIC SITE
KINGSTON MILLS LOCKSTATION
LOCKS 46 - 49
REHABILITATION
ELGIN ONTARIO

Drawing title / Titre du dessin
LOCK 46
BEDROCK ELEVATION
PLAN

Drawn by / Dessiné par BN/AM/JH	Designed by / Conçu par JENNIFER HUNTLEY
Approved by / Approuvé par JULIA MARSON	Drawing Date / Date du dessin DECEMBER 2017
Project manager / Administrateur de projet SOMEONE NEW	Drawing Number / Numéro du Dessin GR-02
Project Number / Numéro du projet R.079796.006	Sheet Feuille 2 of 3 du

Historical Soils Information
 1979 Golder Associates Borehole
 1990 Trow Associates Vertical Borehole

2017 WSP Investigation
 2017 WSP Borehole and Vertical Core

ELEVATIONS LOCK 47:

UPSTREAM GATE RECESS	83.44
UPSTREAM SILL	83.86
CHAMBER INVERT	80.38
DOWNSTREAM GATE RECESS	80.10
DOWNSTREAM SILL	80.35
COPING	86.00

ELEVATIONS LOCK 48:

CHAMBER INVERT	74.02
DOWNSTREAM GATE RECESS	76.23
DOWNSTREAM SILL	76.80
COPING	82.60

ELEVATIONS LOCK 49:

CHAMBER INVERT	72.35
DOWNSTREAM GATE RECESS	71.94
DOWNSTREAM SILL	72.40
COPING	78.80

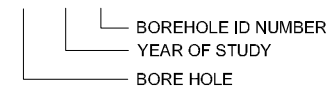
LEGEND:

BH BOREHOLE
 GR GRADE
 BR BEDROCK

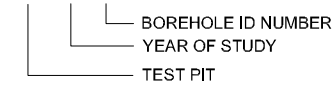
NOTE:

ALL LOCATIONS ARE APPROXIMATE.

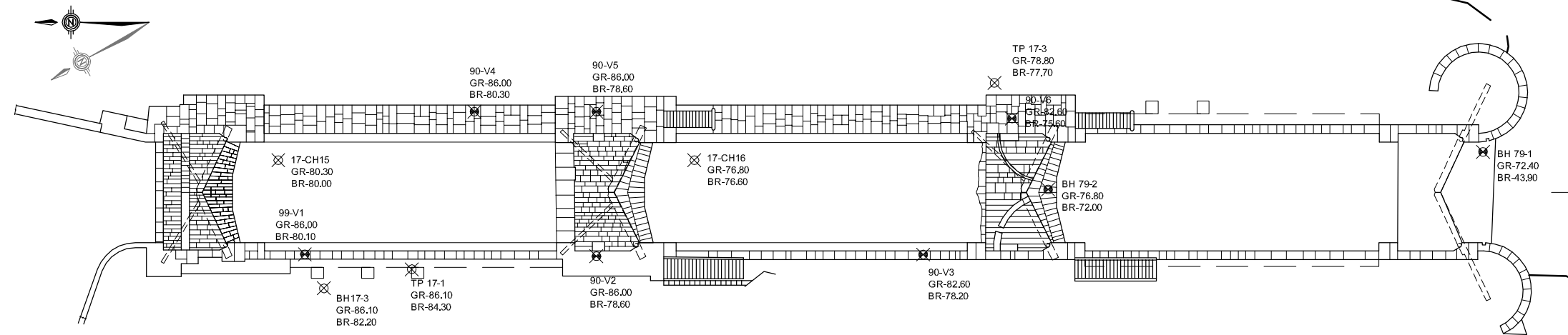
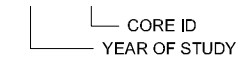
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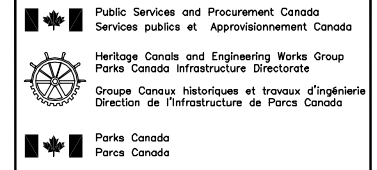
TP XX-X



XX - XXX



PLAN
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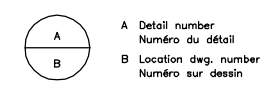
Canada



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No.	Description	Drawn By Des.Pdr	Date
Revision / Révision			

Do not scale drawings.
 Verify all dimensions and conditions on site and immediately notify the Departmental Representative of all discrepancies.



Project title / Titre du projet

RIDEAU CANAL
 NATIONAL HISTORIC SITE
 KINGSTON MILLS LOCKSTATION
 LOCKS 46 - 49
 REHABILITATION
 ELGIN ONTARIO

Drawing title / Titre du dessin

LOCK 47, 48, & 49
 BEDROCK ELEVATION
 PLAN

Drawn by / Dessiné par BN/AM/JH	Designed by / Conçu par JENNIFER HUNTLEY
Approved by / Approuvé par JULIA MARSON	Drawing Date / Date du dessin DECEMBER 2017
Project manager / Administrateur de projet SOMEONE NEW	Drawing Number / Numéro du Dessin GR-02
Project Number / Numéro du projet R.079796.006	Sheet 3 of 3 Feuille du

APPENDIX

E SUMMARY TABLE





**Kingston Mills Lock Station Rehabilitation
Locks 46
Kingston Mills, Ontario**

**171-02359-00
Simplified Soil Strata**

Borehole No. (Elevation)	Simplified Stratigraphy (Depth)										
	Asphalt	Conc	Topsoil	Structure	Fill (Rubble)	Fill (Soil)	Fill (Rock)	Till	Auger Refusal	Bedrock (Cored)	Inferred Bedrock
77-A (30.9)			0 - 250 mm						250 mm		250 mm
77-B (30.8)			0 - 330 mm						330 mm		330 mm
77-C (30.4)			0 - 300 mm			300 mm - 760 mm			760 mm		760 mm
77-D (30.1)			0 - 300 mm			300 mm - 910 mm			910 mm		910 mm
77-E (28.3)			0 - 250 mm					250 mm - 2.7 m	2.7 m		2.7 m
77-F (28.7)			0 - 230 mm					230 mm - 2.3 m	2.3 m		2.3 m
77-G (91.9)	0 - 100 mm					100 mm - 1.5 m	1.5 m - 2.4 m		2.4 m		
77-H (91.8)	0 - 100 mm					100 mm - 1.2 m	1.2 m - 1.4 m		1.4 m		
77-I (91.8)	0 - 100 mm					100 mm - 1.3 m					
77-J (90.7)			0 - 150 mm			150 mm - 1.8 m		1.8 m - 2.7 m		2.7 m - 4.3 m	
77-K (90.5)			0 - 100 mm			100 mm - 4.9 m			4.9 m		4.9 m
77-L (90.4)			0 - 100 mm			100 mm - 2.0 m			2.0 m		2.0 m
00-C1 (92.1)		0 - 1.5 m		1.5 m - 2.4 m						2.4 m - 3.0 m	
00-C2 (92.1)		0 - 3.8 m									
00-C3 (91.9)	0 - 50 mm	50 mm - 300 mm									
00-C4 (91.9)	0 - 38 mm	38 mm - 400 mm									
00-C5 (90.4)		0 - 1.7 m						1.7 m - 2.3 m			
00-C6 (90.4)		0 - 1.4 m						1.4 m - 1.9 m			
00-C7 (N/A)											
00-C8 (N/A)											
05-1 (85.9)		0 - 690 mm		690 mm - 1.7 m ¹							
05-2 (N/A)											
05-3 (86.8)		0 - 760 mm		760 mm - 1.7 m ¹							
05-4 (N/A)											
05-5 (N/A)											
05-6 (N/A)											
05-7 (N/A)											
05-8 (N/A)											
05-9 (N/A)											
05-10 (N/A)											
05-11 (N/A)											
05-9 (89.7)		0 - 790 mm		790 mm - 1.6 m ¹							



**Kingston Mills Lock Station Rehabilitation
Locks 46
Kingston Mills, Ontario**

**171-02359-00
Simplified Soil Strata**

Borehole No. (Elevation)	Simplified Stratigraphy (Depth)										
	Asphalt	Conc	Topsoil	Structure	Fill (Rubble)	Fill (Soil)	Fill (Rock)	Till	Auger Refusal	Bedrock (Cored)	Inferred Bedrock
05-11 (86.0)				0 - 410 mm	410 mm - 860 mm ¹						
15-TP1 (N/A)											
15-TP1A (90.6)			0 - 30 mm			30 mm - 3.0 m			3.0 m		
15-TP2 (N/A)											
15-TP2A (90.6)			0 - 30 mm			30 mm - 1.4 m			1.4 m		
15-101 (91.9)	0 - 100 mm					100 mm - 2.7 m				2.7 m - 5.1 m	
15-202 (86.6)				0 - 660 mm	660 mm - 2.1 m					2.1 m - 3.4 m	
15-203 (86.6)				0 - 310 mm	310 mm - 1.6 m					1.6 m - 2.6 m	
15-204 (86.6)				0 - 510 mm	510 mm - 2.8 m					2.8 m - 4.0 m	
17- CH1				0 - 490 mm ¹							
17- CH2				0 - 470 mm ¹							
17- CH3 (Turning Basin)				0 - 410 mm ¹							
BH 17-1 (89.8)			0 - 70 mm			70 mm - 3.5 m				3.5 m - 3.6 m	
BH 17-2 (89.8)			0 - 90 mm			90 mm - 2.4 m				2.4 m - 4.0 m	

1 - Did not penetrate wall



Kingston Mills Lock Station Rehabilitation
Locks 47
Kingston Mills, Ontario

171-02359-00
Simplified Soil Strata

Borehole No. (Elevation)	Simplified Stratigraphy (Depth)			
	Topsoil	Structure	Fill (Soil)	Bedrock (Cored)
90-H1 (84.9)		0 - 3.0 m	3.0 m - 3.2 m	
90-H2 (81.3)		0 - 1.9 m		1.9 m - 3.0 m
90-H3 (85.2)		0 - 3.6 m	3.6 m - 3.7 m	
90-H4 (82.8)		0 - 3.8 m	3.8 m - 3.9 m	
90-H5 (80.5)		0 - 2.2 m	2.2 m - 3.8 m	
90-H13 (85.3)		0 - 3.9 m		
90-H14 (82.9)		0 - 3.8 m		
90-H15 (79.9)		0 - 3.8 m	3.8 - 4.2 m	
90-V1 (86.0)		0 - 5.9 m		5.9 m - 7.5 m
90-V4 (86.0)		0 - 5.7 m		5.7 m - 7.1 m
90-V5 (86.0)		0 - 7.4 m		7.4 m - 8.9 m
17- CH4		0 - 470 mm ¹		
17- CH5		0 - 480 mm ¹		
17- CH6		0 - 500 mm ¹		
17- CH13		0 - 480 mm ¹		
17- CH15		0 - 370 mm ¹		
17- CH17		0 - 370 mm ¹		
17- CH19		0 - 440 mm ¹		
17- CH20		0 - 480 mm ¹		
17- CH23		0 - 460 mm ¹		
17- CH24		0 - 410 mm ¹		
17- CH32		0 - 430 mm ¹		
BH 17-3 (86.1)	0 - 80 mm		80 mm - 2.3 m	2.3 m - 3.3 m

1 - Did not penetrate wall



**Kingston Mills Lock Station Rehabilitation
Locks 48
Kingston Mills, Ontario**

**171-02359-00
Simplified Soil Strata**

Borehole No. (Elevation)	Simplified Stratigraphy (Depth)				
	Topsoil	Structure	Fill (Soil)	Auger Refusal	Bedrock (Cored)
90-H6 (81.7)		0 - 2.0 m			
90-H7 (77.6)		0 - 2.0 m			2.0 m - 3.0 m
90-H8 (82.01)		0 - 3.9 m			3.9 m - 4.2 m
90-H9 (79.6)		0 - 3.6 m			3.6 m - 4.2 m
90-H10 (76.3)		0 - 1.3 m			
90-H16 (81.7)		0 - 3.0 m			
90-H17 (72.6)		0 - 3.6 m			3.6 m - 3.8 m
90-H18 (82.0)		0 - 3.8 m			
90-H19 (79.4)		0 - 3.8 m			
90-H20 (77.0)		0 - 3.7 m			
90-V2 (N/A)					
90-V3 (82.6)		0 - 4.4 m			4.4 m - 6.7 m
90-V5 (N/A)					
90-V6 (82.6)		0 - 7.0 m			7.0 m - 8.6 m
17- CH7		0 - 480 mm ¹			
17- CH8		0 - 480 mm ¹			
17- CH9		0 - 480 mm ¹			
17- CH10		0 - 480 mm ¹			
17- CH11		0 - 440 mm ¹			
17- CH12		0 - 480 mm ¹			
17- CH14	0 - 240 mm	240 - 590 mm ¹			
17- CH16		0 - 540 mm ¹			
17- CH18		0 - 540 mm ¹			
17- CH21		0 - 470 mm ¹			
17- CH22		0 - 480 mm ¹			
17- CH25		0 - 400 mm ¹			
17- CH26		0 - 430 mm ¹			
17- CH27		0 - 500 mm ¹			
HA 17-4 (82.6)			0 - 160 mm	160 mm	
TP 17-3 (78.8)	0 - 160 mm		160 mm - 1.6 m		

1 - Did not penetrate wall



Kingston Mills Lock Station Rehabilitation
Locks 49
Kingston Mills, Ontario

171-02359-00
Simplified Soil Strata

Borehole No. (Elevation)	Simplified Stratigraphy (Depth)									
	Conc	Topsoil	Fill (Rubble)	Fill (Soil)	Clay	Silt	Sand	Till	Auger Refusal	Bedrock (Cored)
79-01 (72.4)	0 - 1.6 m		1.6 m - 1.9 m	1.9 m - 3.6 m	3.6 m - 6.4 m	6.4 m - 10.4 m	10.4 m - 28.8 m			28.8 m - 32.8 m
79-02 (76.8)				0 - 4.8 m	4.8 m - 8.5 m					
17- CH28 (N/A)				0 - 460 mm ¹						
17- CH29 (N/A)				0 - 460 mm ¹						
17- CH30 (N/A)				0 - 460 mm ¹						
17- CH31 (N/A)				0 - 460 mm ¹						
17- CH33 (N/A)				0 - 460 mm ¹						
HA 17-5 (78.8)				0 - 100 mm					100 mm	
BH 17-6 (78.8)			0 - 100 mm	100 mm - 6.1 m				6.1 - 8.2 m		
TP 17-2 (78.7)		0 - 170 mm		170 mm - 1.1 m						
TP 17-3 (78.8)			0 - 160 mm				160 mm - 1.6 m			
TP 17-4 (N/A) - Structural Hole										
TP 17-5 (N/A) - Structural Hole										

1 - Did not penetrate wall