



a division of Englobe

TOWN OF OKOTOKS URBAN SYSTEMS LTD. FORW - RESERVOIR GEOTECHNICAL DESIGN REPORT – REVISION 1

Prepared By:

Chang Liu, P.Eng.

Geotechnical Engineer

Date: April 15, 2025

Project #: 29121-005-11

Reviewed By:

Trevor Curtis, P.Eng.

Geotechnical Manager

MPE a division of Englobe

6715 8 St NE #320,

Calgary, AB T2E 7H7

P: (403) 250-1362

Proud of Our Past... Building the Future

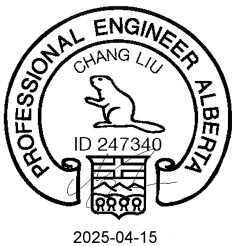
www.mpe.ca

CORPORATE AUTHORIZATION

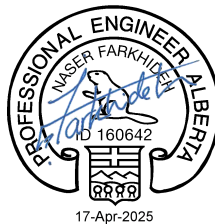
This report has been prepared by MPE a division of Englobe (MPE), for the sole use of the Town of Okotoks, Foothills County, and Urban Systems Ltd. Any use that a third party makes of this report, or reliance on or decisions made based upon it is the responsibility of the third party. MPE accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based upon this report. This report represents MPE's best judgement, based on the information available at the time of report preparation. Use of this report is subject to the appended Terms of Reference.

Respectfully submitted,

MPE a division of Englobe



Prepared by:
Chang Liu, P.Eng.
Geotechnical Engineer
Tel: 403-250-1362
Email: cliu@mpe.ca



Reviewed by:
Naser Farkhideh, M.Sc., P.Eng.
Geotechnical Engineer
Tel: 825-747-2676
Email: nfarkhideh@mpe.ca



Reviewed by:
Trevor Curtis, P.Eng.
Geotechnical Manager
Tel: 403-329-3442
Email: tcurtis@mpe.ca

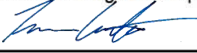
PERMIT TO PRACTICE	
MPE, a division of Englobe Corp.	
Signature	
APEGA ID	111070
Date	April 15, 2025
PERMIT NUMBER: P 7841	
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)	

TABLE OF CONTENTS

1.0 INTRODUCTION	1
2.0 BACKGROUND	1
2.1 DAM SAFETY REQUIREMENTS	1
2.2 DESIGN STANDARD	2
2.3 PREVIOUS REPORTS	2
2.4 LAND USE	3
2.5 TOPOGRAPHY	3
2.6 GEOLOGY	3
2.7 HYDROGEOLOGY	4
3.0 SCOPE OF WORK	4
4.0 SOIL STRATIGRAPHY	5
4.1 PROPOSED PUMP STATION SITE	6
4.2 RESERVOIR 1	6
4.3 RESERVOIR 2	8
4.4 PIEZOMETRIC CONDITIONS	9
5.0 ANALYSIS	11
5.1 STABILITY ANALYSIS	11
6.0 GEOTECHNICAL DESIGN	15
6.1 EARLY CONCEPTUAL DESIGN	15
6.2 GEOMETRY	15
6.3 RESERVOIR LINER OPTIONS	15
6.4 UNDERDRAIN SYSTEM	18
6.5 EMBANKMENT ZONING	19
6.6 EMBANKMENT CONSTRUCTION	20
6.7 GRAVEL PAVEMENT RECOMMENDATIONS	21
7.0 DAM SAFETY REQUIREMENTS	22
REFERENCES	23

APPENDIX A: TERMS OF REFERENCE

APPENDIX B: FIGURES

APPENDIX C: STABILITY ANALYSIS RESULTS

APPENDIX D: BOREHOLE LOGS

APPENDIX E: LAB RESULTS

APPENDIX F: WATERLINE REPORT

LIST OF TABLES

TABLE A – FACTORS OF SAFETY FOR SLOPE STABILITY2

TABLE B – BOREHOLE LOCATIONS.....5

TABLE C – GROUNDWATER LEVELS10

TABLE D – SUMMARY OF IN-SITU HYDRAULIC CONDUCTIVITY TESTING11

TABLE E – SOIL STRENGTH AND SEEPAGE PROPERTIES12

TABLE F – STABILITY RESULTS SUMMARY14

TABLE G – GRAVEL PAVEMENT STRUCTURES21

1.0 INTRODUCTION

MPE a division of Englobe (MPE) was retained by Urban Systems Ltd. (USL) on behalf of Foothills County and the Town of Okotoks (the Owner) to assist in the design of a raw water reservoir near the Town of Okotoks, AB. Overall, the Owner would like two raw water storage reservoirs, also known as Reservoir 1 (R1) and Reservoir 2 (R2), and a pumping station at the southwest corner of R1. The primary water source for the reservoirs would be from the Highwood River, about 350 m south of the confluence with the Bow River and are proposed to have storage volumes of at least 290,000 m³ for R1 and R2, separately.

The project site is located approximately 10 km northeast of Okotoks, Alberta, as shown in **Figure 1** in **Appendix B**. Authorization to proceed with the work outlined in the proposal by MPE was received in Change Order 08 signed by Ms. Elaine Vincent, Chief Administrative Officer of the Town of Okotoks on December 7, 2022.

2.0 BACKGROUND

2.1 DAM SAFETY REQUIREMENTS

The Canadian Dam Association (CDA) defines a dam as a barrier used for water retention capable of holding at least 30,000 m³ of liquid that is at least 2.5 m high. Both the storage capacity and embankment height of both reservoirs exceed these limits and must be designed to CDA standards (CDA, 2013). In Alberta, dams and canals are defined and regulated by the Water Act (Government of Alberta, 2018a), and are subject to the Alberta Dam and Canal Safety Directive (Government of Alberta 2018). The prevailing Dam Safety Guidelines are those by the CDA (CDA, 2013). This geotechnical design report has been prepared with consideration of the applicable regulations, directives, CDA Guidelines (2013) and related technical bulletins.

The consequence classification report completed by MPE, *Phase 1 Reservoir Dam Consequence Classification Rev. 1* dated January 25, 2025 was reviewed. The report summarizes dam consequence classification of R1 resulting in a “Significant” classification based on the potential damage to the environment, surrounding properties and infrastructure, and potential loss of life.

2.2 DESIGN STANDARD

The accepted Factors of Safety (FS) as per the Alberta Dam and Canal Safety Directive (Government of Alberta, 2018) and CDA (2013) consider the reliability of inputs to the stability analysis, the probability of the loading condition, and the consequences of potential failure. These accepted FS values are provided in **Table A**.

Table A – Factors of Safety for Slope Stability

Loading Condition	Minimum Factor of Safety (FS)	Slope
End of construction before reservoir filling	1.3	Upstream and Downstream
Long term (steady-state seepage, normal reservoir level)	1.5	Downstream
Full or partial rapid drawdown	1.2 – 1.3	Upstream
Pseudo-static	1.0	Upstream and Downstream
Post-earthquake	1.2 – 1.3	Upstream and Downstream

2.3 PREVIOUS REPORTS

MPE reviewed the following documents as part of the current assignment:

- Preliminary Geotechnical Investigation for the Proposed Reservoir Site – Rev 2. MPE a division of Englobe (2021)
- FORWP – Reservoir, Geotechnical Investigation Report. MPE a division of Englobe (2023).
- Geotechnical Memorandum 01 – Rev. 1, FORW Reservoir Liner Optimization Memo. MPE a division of Englobe (2024).
- Geotechnical Memorandum 02 – Rev. 1, FORW Reservoir Geotechnical Memo. MPE a division of Englobe (2024).
- Phase 1 Reservoir Dam Consequence Classification Rev. 1. MPE a division of Englobe (2025).
- Proposed Okotoks Reservoir (NW-21-021-28 W4M) – Geotechnical Drilling and Hydraulic Response Testing Program Summary. Waterline Resources Inc. (2022).
- Stormwater Management & Design Manual. Calgary: The City of Calgary – Water Resources. The City of Calgary. (2011).
- Surficial Geology of Alberta Map 601. Edmonton: Alberta Energy Regulator. Alberta Geological Survey. (2003).
- Bedrock Geology of Alberta Map 600. Edmonton: Alberta Energy Regulator. Alberta Geological Survey. (2013).
- Regional Geological and Hydrogeological Characterization of the Calgary-Lethbridge Corridor in

the South Saskatchewan Regional Planning Area Report 91. Edmonton: Alberta Energy Regulator. Alberta Geological Survey. (2017).

- Distribution of Hydraulic Head in the Scollard/Willow Creek Hydrostratigraphic Unit Map 629. Edmonton: Alberta Energy Regulator. Alberta Geological Survey. (2022).
- Alberta Regulation 205/98 Water Act Water (Ministerial) Regulation. Edmonton: Queen's Printer. Government of Alberta. (2018).
- Alberta Water Wells. Alberta Environment and Parks. Government of Alberta. (2022).

2.4 LAND USE

The site is located in Foothills County within NW-21-21-28-W4M and is bounded by Highway 552 to the north and east, 112 Street E to the west, and agricultural land to the south. The land use in the area is agricultural to the east and south, and residential to the west and north. The site is roughly the shape of a circle quadrant with a radius of 750 m and has a total approximate area of 30 ha. The site is currently used for agriculture and has been used for agriculture for at least the past 30 years, based on historical satellite imagery. Several wetlands and marshes are located within or near the proposed reservoirs as shown in **Figure 1** in **Appendix B**.

2.5 TOPOGRAPHY

The ground surface elevation at the study site ranges between approximately 1014 m and 1023 m. The topographic highs are located east of the proposed pump station site near 22BH021 and 22BH014 while the lows are located on the northeast boundary of the site along the wetlands.

2.6 GEOLOGY

2.6.1 Surficial Geology

MPE reviewed mapping published by the Alberta Geological Survey (AGS). According to the surficial geology map (Alberta Geological Survey, 2013), the site surficial geology is classified as glaciolacustrine deposits. The AGS defines glaciolacustrine deposits as follows:

Glaciolacustrine Deposits: *Sediments deposited in or along the margins of glacial lakes; includes a) offshore sediment; rhythmically laminated to massive fine sand, silt, and clay, locally containing debris released by the melting of floating ice; and b) littoral (nearshore) sediments; massive to stratified, well-sorted silty sand, pebbly sand, and minor gravel; occurs in beaches, bars, and deltas.*

2.6.2 Bedrock Geology

MPE reviewed the bedrock geology map (Alberta Geological Survey, 2013), and the site bedrock geology was classified as belonging to the Scollard formation of the Edmonton Group. The AGS defines the Scollard formation as follows:

Scollard Formation: Generally fine-grained, commonly cross-stratified, light grey to buff sandstone and pale to dark grey, sandy to silty mudstone; thick coal seams and carbonaceous mudstone intervals in upper part; nonmarine

2.6.3 Glacial Landforms

MPE reviewed AGS Map 47-1960 titled *Buried Valleys in Central and Southern Alberta*, in conjunction with the more up to date Map 603 titled *Sediment Thickness of Alberta*. Neither map indicated the existence of buried valleys. Map 47-1960 indicates that the buried Preglacial Bow Valley is located some 2 km to the north, and another Preglacial Sheep Valley is located some 6 km to the south. Map 603 indicates a range of sediment thickness (depth to bedrock) of 0 m to 20 m for the site.

2.7 HYDROGEOLOGY

Based on the findings of Atkinson et al. (2017), the bedrock hydrogeology of this area is comprised of the Willow Creek hydrostratigraphic unit which consists of thick sandstone and siltstone units interbedded with thin mudstone beds and coal. The estimated hydraulic head for this area was 901 m to 1050 m, which is, at some locations, well above the ground surface elevation.

3.0 SCOPE OF WORK

Based on requirements from USL and previous discussions, the site geotechnical design will include:

- Geotechnical site characterizations to verify and quantify the material properties of the site soils.
- Stability analysis of elected sections of the reservoir embankments in various scenarios.
- Stability analysis of the reservoir embankments during various drawdown scenarios.
- Recommendations regarding the selection and construction of a synthetic liner.
- Recommendations regarding the design and construction of an underdrain system for R1.
- Pavement design for the access roads along the perimeter of R1 and near the pump station.

Two subsurface investigation programs were carried out in February 2021 and August 2022. The site is depicted on **Figure 1** in **Appendix B**, with approximate borehole locations shown. The subsurface investigations were divided into two phases as listed below:

Phase	Date
Phase I: Preliminary Reservoir Design (21BH001 – 21BH006)	February 19, 2021
Phase II: Geotechnical Analysis and Reporting (22CH001 and 22BH001 – 22BH022)	August 22 - 25, 2022

The borehole logs and the one corehole log are provided in **Appendix D** along with a description of the symbols and terms used on the logs. The coordinates and elevations of the various testholes were surveyed by MPE and are presented on the logs and on **Figure 1**. where appropriate, laboratory test results are summarized on the logs.

Phase I was carried out on February 19, 2021, using a drill rig equipped with solid stem continuous flight augers contracted from Chilako Drilling Services Ltd., of Coaldale, AB. Phase II was carried out on August 22 to 25, 2022 using a drill rig equipped with solid stem continuous flight augers and rotary coring contracted from Val's Drilling Ltd., of Rocky View County, AB. Disturbed soil samples were retrieved at intervals of approximately 0.6 m. The soil was classified and logged by MPE field representative Mr. Stuart Smith and Mr. Curtis Tams. Standard Penetration Testing (SPT) was generally performed at approximately 1.5 m intervals in the boreholes. Standpipe piezometers were installed in all boreholes. The water levels were measured in the Phase I piezometers on February 26, 2021, seven days after completion of drilling and in the Phase II piezometers on September 20, 2022, by representatives from Waterline Resources Inc. (Waterline), about four weeks after completion of drilling. The water levels for Phase II boreholes were also measured on April 22, 2024. Borehole 22BH010 was not completed during the Phase II field investigation as the proposed borehole location was within a wetland and had an unsuitable accessway. The borehole locations were based on a previous site plan of the reservoirs provided by USL. After the conclusion of Phase II drilling program, the reservoirs were relocated after discussions with the Owner and USL based on the groundwater conditions revealed from the program.

Laboratory testing was completed on selected soil samples to aid in the determination of properties and engineering characteristics of the site soils. Testing included natural moisture content, Atterberg Limits, particle size analysis, sieve analysis and dispersivity testing of clay by the pinhole test. Additionally, Waterline was retained by USL to provide hydraulic conductivity testing on selected locations and soil layers across the site. The moisture content and Atterberg Limit test results are provided on the borehole logs in **Appendix E**.

4.0 SOIL STRATIGRAPHY

The soil conditions encountered across the site are separated into three sections, one for the proposed pump station proposed footprint and one section for each of the reservoirs. **Table B** below outlines where the boreholes are located in regard to the revised site plan.

Table B – Borehole Locations

Borehole Location	Boreholes
Pump Station	22BH018
Reservoir 1	22BH001 to 22BH006, 22BH008, 22BH009, 22BH011 to 22BH013, 22BH019, 22BH020
Reservoir 2	22BH007, 22BH014 to 22BH017, 22BH021, 22BH022

As noted in **Section 2.1**, both R1 and R2 meet the CDA definition of a dam and must be designed to meet CDA guidelines. The information collected from the boreholes was used in order to determine the risk of failure of the east reservoir embankments and to verify the design would meet the operational requirements. For a more detailed view of the soil conditions, refer to the borehole logs attached in

Appendix D along with a description of the terms and symbols used on the borehole logs. In the following, the soil descriptions for each layer are based on the drilling program of year 2022 (i.e., Boreholes 22BH001 to 22BH022).

4.1 PROPOSED PUMP STATION SITE

The soils at the proposed pump station consisted of a surficial layer of topsoil underlain by sand over gravel. A layer of silt was encountered within the sand. A summary of the soil layers encountered at the pump station is provided below.

4.1.1 Topsoil

Topsoil was encountered at the surface of Borehole 22BH018. The topsoil was about 100 mm thick. Based on prior experience with similar soils, the topsoil is considered to be unsuitable for engineered fill and should be stripped prior to construction of the reservoirs.

4.1.2 Sand

Sand was encountered beneath the surficial topsoil of 22BH018 and extended to a depth of 6.5 m. The sand was described as some silt, trace to some gravel, poorly graded, fine grained, sub-rounded, dry to damp, compact and light brown.

Moisture contents ranged between 2.5% and 4.8%. SPT N values within the sand ranged between 24 and 28, indicating a compact consistency.

4.1.3 Silt

A 0.7 m layer of silt was encountered within the sand at a depth of 2.8 m. The silt was described as some sand, trace clay, moist, stiff, low plastic and brown. One SPT performed in the silt resulted in an N value of 15, indicating a stiff consistency.

4.1.4 Gravel

Gravel was found beneath the sand and extended to the maximum drilled depth of 9.1 m. The gravel was described as silty, sandy, well graded, fine grained, sub-rounded, moist, compact and brown. Two moisture contents taken from the gravel were both measured at 8.0%.

SPTs were unable to be performed in this layer due to sloughing from the sand and gravel layers.

4.2 RESERVOIR 1

4.2.1 Topsoil

Topsoil was encountered at the surface of all boreholes within the R1 footprint. The topsoil was about 100 mm thick. Based on prior experience with similar soils, the topsoil is considered to be unsuitable for engineered fill and should be stripped prior to construction of the reservoirs.

4.2.2 Silt

Silt was found beneath the surficial topsoil in 22BH001, 22BH003 and 22BH012 and at a depth of 2.0 m in 22BH020, 9.4 m in 22BH005 and 13.0 m in 22BH006. The upper silt was described as trace clay, trace to some sand inclusions and light brown. The lower silt was described as clayey, some sand, moist, stiff to hard and medium plastic.

Moisture contents taken from silt samples ranged between 4.1% and 25.9%. Seepage was noted during drilling within the silt layers of 22BH003, 22BH005 and 22BH020, which likely resulted in the high moisture contents. Atterberg Limit testing of an upper silt sample in 22BH003, indicated a Liquid Limit of 25.0% and a Plastic Limit of 18.2%, indicative of low plasticity. One grain size distribution test in the upper silt resulted in 0.6% sand, 85.9% silt and 13.5% clay. SPT N values within the silt ranged between 5 and 32, indicating a very firm to hard consistency.

A sand layer was noted at the bottom of the silt in 22BH020. One grain size distribution test of the silt resulted in 55.5% sand, 30.9% silt and 13.6% clay.

4.2.3 Sand

Sand was observed beneath the surficial topsoil in 22BH004, 22BH005 and 22BH020. Sand was also encountered at a depth of 1.0 m in 22BH011, 1.8 m in 22BH019 and 3.0 m in 22BH012. Additionally, sand was encountered below the clay till in 22BH001 and 22BH002 at a depth of 4.0 m and 3.5 m, respectively. The sand extended beyond the maximum drilled depths in 22BH011 and 22BH012. The thickness of the sand layers ranged from 0.2 m to at least 6.6 m. The surficial sand was described as poorly graded, fine grained, sub-rounded to rounded, dry to damp and light brown to brown. The buried sand layers were described as some silt to silty, trace clay, dry to moist, fine- to medium-grained, sub-rounded and brown.

Moisture contents taken from the surficial sand ranged between 2.1% and 4.3% while moisture contents taken from the buried sand ranged between 1.6% and 27.3%. SPT N values within the sand ranged between 12 and 45, indicating a compact to dense consistency.

4.2.4 Clay Till

Clay till was encountered beneath the silt in 22BH003, 22BH006, 22BH012 and 22BH020, below the sand in 22BH002, 22BH004, 22BH005, 22BH019 and 22BH020 and overlain by the topsoil in 22BH006, 22BH008, 22BH009, 22BH011, 22BH013 and 22BH019. It was also observed in 22BH001 below the clay and silt layer at a depth of 2.0 m. The clay till was generally described as some silt to silty, trace to some sand, trace gravel, dry to moist, medium to high plastic and brown to dark grey.

Moisture contents taken from the till ranged between 6.4% and 23.4%. Atterberg Limit testing of clay till samples indicated a Liquid Limit ranging between 20.3% and 33.0%, and a Plastic Limit ranging between 10.5% and 11.8%, indicative of low plasticity. Grain size distribution testing in the clay till ranged from 0 to 14.4% gravel, 0.8% to 34.5% sand, 35.4% to 77.0% silt and 21.9% to 25.1% clay. SPT N values within the clay ranged between 1 and 41, indicating a very soft to hard consistency.

4.2.5 Siltstone

Siltstone was noted in 22CH001 at 7.3 m, 22BH009 at 9.6 m and in 22BH013 at 8.0 m. The siltstone was highly to completely weathered, dry, and brown to light grey. The weathered siltstone was noted to have the consistency of a hard soil. SPTs in the siltstone resulted in N value of 38 to 50 blows per 300 mm of penetration, indicative of a hard consistency (for soils). In 22BH009, a blow count of 50 was recorded at a penetration of 150 mm, indicative of the siltstone layer (bedrock) at that depth.

4.2.6 Claystone

Claystone was found beneath the siltstone in 22CH001 at a depth of 15.5 m. The claystone was described as silty, weathered, grey, damp, medium plastic and extremely weak. The claystone also contained interbedded siltstone layers.

4.3 RESERVOIR 2

4.3.1 Topsoil

Topsoil was encountered at the surface of all boreholes within the R2 footprint. The topsoil was about 100 mm thick. Based on prior experience with similar soils, the topsoil is considered to be unsuitable for engineered fill and should be stripped prior to construction of the reservoirs.

4.3.2 Silt

Silt was encountered beneath the surficial topsoil in 22BH014, 22BH015, 22BH016 and 22BH022 and at a depth of 4.0 m in 22BH021. The silt was described as trace to some clay, dry to moist and light brown to brown.

Moisture contents taken from the silt ranged between 3.1% and 21.3%. Seepage was encountered in the silt layers in 22BH015, 22BH021 and 22BH022, resulting in higher moisture contents. Atterberg Limit testing of silt samples indicated a Liquid Limit ranging between 25.6% and 28.9% and a Plastic Limit ranging between 14.2% and 15.1%, indicative of low plasticity. Grain size distribution testing in the silt ranged from 0.0% to 2.1% gravel, 12.8% to 16.1% sand, 51.6% to 70.0% silt and 17.2% to 30.2% clay. SPT N values within the silt ranged between 4 and 20, indicating a firm to very stiff consistency.

4.3.3 Sand

Sand was encountered beneath the surficial topsoil in 22BH007 and 22BH017 and beneath the silt in 22BH014, 22BH016, 22BH021 and 22BH022. In 22BH022, sand was also encountered below clay till at a depth of 9.0 m. The thickness of the sand layers ranged from 0.9 m to at least 7.5 m. The sand was described as some silt to silty, trace to some clay, trace gravel to gravelly, poorly graded, fine to medium grained, sub-rounded to rounded, dry to moist, compact to dense and light brown to brown.

Moisture contents taken from the sand ranged between 1.6% and 24.8%. SPT N values within the sand ranged between 5 and 60, indicating a loose to very dense consistency.

4.3.4 Gravel

Gravel was encountered beneath the sand in 22BH016. The gravel was described as sandy, some silt, trace cobbles, well graded, coarse grained, sub-rounded, loose to compact, moist and brown.

Moisture contents taken from the gravel ranged between 1.6% and 25.3%. SPT N values within the gravel ranged between 8 and 25, indicating a loose to compact consistency.

4.3.5 Clay Till

Clay till was encountered beneath the silt in 22BH015, below the sand in 22BH017, 22BH021 and 22BH022, the gravel in 22BH016 and the topsoil in 22BH021. The clay till was generally described as some silt to silty, trace to some sand, trace gravel, dry to moist, medium to high plastic, stiff to hard and light brown.

Moisture contents taken from the till ranged between 9.3% and 19.6%. Atterberg Limit testing of clay till samples indicated a Liquid Limit ranging between 27.5% and 33.3%, and a Plastic Limit ranging between 11.7% and 12.5%, indicative of low to medium plasticity. Grain size distribution testing in the clay till ranged from 0.1% to 0.4% gravel, 29.3% to 38.5% sand, 36.9% to 40.3% silt and 22.2% to 30.1% clay. SPT N values within the clay till ranged between 10 and 26, indicating a stiff to hard consistency.

4.4 PIEZOMETRIC CONDITIONS

At the time of drilling, seepage was observed in all boreholes with the exception of 22BH004, 22BH008, 22BH009, 22BH013 and 22BH014. Piezometers were installed in all boreholes in selected soil layers. The groundwater readings were taken on September 20, 2022, by Waterline and again on April 22, 2024. The results are summarized in **Table C** below. The piezometers completed in 2021 (21BH001 – 21BH006) were destroyed at the time of the April 2024 readings, therefore no readings were available.

Table C – Groundwater Levels

Borehole Location	Seepage Depth (m)	Screened Material	Borehole Elevation (m)	Groundwater Depth (m) Sept. 20, 2022	Groundwater Elevation (m) Sept. 20, 2022	Groundwater Depth (m) April 22, 2024	Groundwater Elevation (m) April 22, 2024
22BH001	4.2	Siltstone	1019.6	3.65	1015.95	1.39	1018.21
22BH002	2.2	Clay Till / Siltstone	1019.8	4.04	1015.76	N/A*	N/A*
22BH003	1.6	Silt	1018.0	Dry	Dry	3.51	1014.49
22BH004	-	Clay Till	1018.4	10.3	1008.10	5.48	1012.92
22BH005	9.6	Clay Till / Silt	1018.2	2.43	1015.77	N/A*	N/A*
22BH006	3.5	Clay Till / Silt	1019.6	3.78	1015.82	3.94	1015.66
22BH007	6.5	Sand	1021.5	4.21	1017.29	Dry	Dry
22BH008	-	Clay Till	1021.1	5.22	1015.88	N/A*	N/A*
22BH009	-	Clay Till	1019.8	Dry	Dry	5.22	1014.58
22BH011	1.9	Sand	1019.7	3.21	1016.49	N/A*	N/A*
22BH012	4.5	Sand	1020.0	4.41	1015.59	4.20	1015.80
22BH013	-	Clay Till / Siltstone	1020.0	4.57	1015.43	4.47	1015.53
22BH014	-	Sand	1022.3	Dry	Dry	Dry	Dry
22BH015	2.5	Clay Till	1019.9	4.24	1015.66	N/A*	N/A*
22BH016	6.1	Sand / Gravel	1021.0	4.81	1016.19	4.92	1016.08
22BH017	6.0	Clay Till	1022.0	6.10	1015.90	6.21	1015.79
22BH018	6.3	Sand / Silt	1022.0	Dry	Dry	Dry	Dry
22BH019	5.9	Sand / Clay Till	1022.0	5.98	1016.02	6.11	1015.89
22BH020	3.0	Clay Till	1021.0	5.19	1015.81	4.84	1016.16
22BH021	4.2	Sand / Clay Till	1022.3	6.01	1016.29	N/A*	N/A*
22BH022	2.5	Clay Till / Sand	1020.6	4.71	1015.89	4.74	1015.86

*Piezometers destroyed for April 22, 2024 readings.

Based on historic groundwater readings by the City of Calgary (2011), groundwater readings above may rise up to 1.5 m during rainfall events. Additionally, records from nearby water wells located about 400 m west of the proposed reservoirs indicated water bearing gravel and sand layers at elevations between 1013.5 m to 1019.6 m with static water levels at elevations of 1019.2 m to 1024.1 m. Pumping tests were conducted with rates between 45.5 L/min and 80.0 L/min (65 and 115 m³/day) and decreased the groundwater table by 0.12 m to 0.76 m over a 2-hour period.

Hydraulic conductivity testing was performed in selected boreholes by Waterline in six piezometers. The results of the testing is summarized in **Table D** and the full report is included in **Appendix F**.

Table D – Summary of In-Situ Hydraulic Conductivity Testing

Borehole Location	Screened Material	Test Type	Estimated Hydraulic Conductivity (m/s)
22BH003	Silt	Falling Head	1.3×10^{-7}
22BH004	Clay Till	Falling Head	2.2×10^{-10}
22BH006	Clay Till / Silt	Rising Head	1.6×10^{-8}
22BH009	Clay Till	Falling Head	3.0×10^{-8}
22BH014	Sand	Falling Head	7.0×10^{-5}
22BH018	Sand / Silt	Falling Head	2.8×10^{-6}

The results of the hydraulic conductivity testing were used in the stability and seepage analyses of selected sections of the reservoirs. The stability and seepage analyses are further explored in **Section 5.0**.

5.0 ANALYSIS

5.1 STABILITY ANALYSIS

The intended goal of the stability analysis for this project was to confirm that the proposed reservoir embankments meet the minimum Factors of Safety (FS) described previously. The FS is the ratio of soil shear strength to shear stress along a failure plane within the slope, perpendicular to the axis (long dimension) of the dam. A FS of 1.0 is defined as reaching limit equilibrium and therefore the slope being analyzed is in a state of failure or deformation. An FS larger than 1.0 is theoretically indicative of a stable slope.

5.1.1 Critical Sections

A topographic site plan of the project area associated with the conceptual design was provided by USL and used to create the critical cross sections used in the stability and seepage analyses. Two slope sections meeting the CDA definition of dam with the greatest embankment heights were chosen in order to assess the suitability of the FORW Phase 1 design. The section locations are shown on the **Site Plan** in **Figure 1**, **Appendix B**. Details for the cross sections are shown in **Figure 2** and **Figure 3**. Cross section B was changed from the LiDAR surface to include future conditions when both reservoirs are constructed.

5.1.2 Soil Strength and Seepage Parameters

Soil strength parameters were based on field and laboratory testing conducted on samples collected from the site. In addition, previous laboratory test results on soil types similar to the site soils were referenced to confirm that soil strength parameters deduced from the laboratory and field testing were within

acceptable ranges. The effective friction angles of the fine-grained materials were estimated using various data including clay fraction, liquid limit, vertical effective stress, in-situ testing, and experience with similar materials. Soil strength parameters selected for the analyses contained within this report are shown in **Table E** below.

Table E – Soil Strength and Seepage Properties

Soil Unit	Bulk Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Angle of Friction (°)	Hydraulic Conductivity (m/s)
Waste Fill	15	0	20	1.0e-07
Clay Fill	19	0	27 [20-30]	1.0e-07
Clay Till	21	0	27 [20-30]	1.0e-08*
Silt	19	0	23	1.0e-07
Gravel	20	0	35	1.0e-02
Sand	20	0	32 [25-33]	7.0e-05*
Synthetic Liner	20	1	32	3.0e-8
Topsoil	15	0	18	1.0e-04

*Values based on Waterline (2022)

Values selected were intended to be representative of site conditions and reasonably conservative. The cohesion used in the model is lower than measured directly in the laboratory; this is typical in slopes where cohesion may degrade due to environmental effects over time. For the effective internal friction angle, representative values for each material were selected from within the bounds shown.

In order to simulate conditions when the synthetic liner eventually leaks and the berms become saturated by water seepage, a very conservative hydraulic conductivity of 3.0e-8 was chosen for the synthetic liner in the models to simulate a slow seepage for the liner.

The provided design geometry satisfies current guidelines (CDA, 2013). The stability model is sensitive to soil strength parameters, so the design strength parameters represent values on the low end of the range which are considered suitable based on laboratory testing and experience with similar soils on similar projects.

5.1.3 Seepage Model

The geotechnical modelling computer program SLIDE, by RocScience, version 9.031, was used to complete the steady state and transient seepage analyses for this project to determine the phreatic surface in the embankment for stability modelling. Soil profiles were constructed along Cross Sections A and B from the boreholes as shown in **Figure 1**. The phreatic surface was modeled with a pressure head of 1016.0 m based on the findings in the Waterline (2022) report and confirmed with the April 2024 groundwater

readings. The reservoir was modeled at a conservative operating level of 1022.0 m, which is the proposed Full Supply Level (FSL) by Urban Systems.

Steady-state seepage was conducted at the FSL to assess the long-term stability upstream and downstream, and a transient seepage analysis was conducted to assess the upstream stability during rapid drawdown. Based on the conceptual design from USL, the pumped volume of the reservoirs ranges from 1 to 20 megaliters per day or 1,000 to 20,000 m³/day. The proposed reservoirs have a storage volume of 295,600 m³ and 296,600 m³, resulting in a drawdown of about 14 to 297 days. Rapid drawdown was assessed using an assumed draw down period of 14 days for a reservoir water surface elevation drop from the FSL of 1022.0 m to a completely empty elevation of 1017.5 m. The minimum drawdown period was modeled as it would provide the most conservative FS for the sections.

Multiple scenarios were considered for Section B, including steady-state seepage conditions when both reservoir cells are filled, when Cell #1 is filled and Cell #2 is not filled, and vice versa. Multiple transient seepage scenarios were also considered for Section B, including when Cell #1 experiences rapid drawdown while Cell #2 is filled, when Cell #1 experiences rapid drawdown while Cell #2 is empty, and when both cells experience rapid drawdown at the same time. The material properties for the seepage model were based on information discussed in the previous sections and the seepage models are shown in **Figures C.1 to C.25** in **Appendix C**.

5.1.4 Seismic Loading Condition

Seismic stability was modelled by performing a pseudo-static analysis for the design earthquake, as required by the CDA guidelines. The analysis for pseudo-static seismic conditions applies a horizontal force (seismic coefficient, K_H) to the stability model to simulate earthquake loading. The seismic coefficient is taken as a fraction of the Peak Ground Acceleration (PGA) for the site, for a given design earthquake. The design earthquake for Significant Consequence dams has an Annual Exceedance Probability of 1:1000.

The National Building Code of Canada Seismic Hazard Calculator was used to obtain a site-specific PGA value of 0.09 g for the 1:1000-year event. The site PGA is for a “Soft Soil” condition (NBCC 2020 Site Classification E).

For the determination of the seismic coefficient, K_H , Hynes-Griffin and Franklin (1984) pseudo static parameter modifications were used by reducing the PGA by half. A **PGA of 0.045 g** was used to complete the pseudo-static limit equilibrium analysis. It should be noted that this method allows for up to 1 m of allowable movement during the design earthquake and undrained shear strengths are generally reduced to 80% for seismic analysis.

5.1.5 Stability Models and Results

The geotechnical modelling computer program SLIDE, by RocScience, version 9.031, was used to complete the limit equilibrium analysis for this project. The geometry, material properties, and piezometric conditions for the stability model were based on information in the previous sections. The Morgenstern-

Price method was used to complete the analysis due to its ability to accommodate differing slip surface shapes, varied side force orientations, and because it satisfies force and moment equilibrium. It should be noted that 2D equilibrium modelling was used for this project, as such the findings of the modelling are potentially conservative at some sections. The results of the loading conditions are summarized in **Table F** below and are shown in **Figures C.1 to C.25** in **Appendix C**.

Table F – Stability Results Summary

Loading Condition	Minimum FS Required by CDA	Section A, FS	Section A With Topsoil, FS	Section B, FS	Section B Prior to Cell #2 Filling, FS
Long Term (Steady State) Downstream	1.5	1.6	1.6	3.0	2.4
Post-Construction (Before Reservoir Filling) Upstream	1.3	2.5	2.5	2.5	2.5
Post-Construction (Before Reservoir Filling) Downstream	1.3	1.9	1.4	2.5	2.5
Rapid Drawdown Upstream	1.2	2.5	2.5	1.4	1.5
Rapid Drawdown Upstream – Both Sides (Section B)	1.2	-	-	1.5	-
Pseudo-Static Seismic Upstream	1.0	2.5	2.5	2.5	2.5
Pseudo-Static Seismic Downstream	1.0	1.3	1.2	2.4	1.9

The governing failure mode was an upstream failure induced by rapid drawdown while the R2 reservoir is full in Section B (**Figure C.16** in **Appendix C**). When the reservoir level is lowered, the stabilization effects of the water pressure on the upstream slope is lost. In addition, the pore pressures in the slope may not have time to reach equilibrium with the new reservoir water level, causing reduced stability. As noted in **Section 5.1.3**, an assumed drawdown period of 14 days was used for analysis. Due to the side slopes of the reservoir, the drawdown occurs more rapidly at lower levels and drawdown of pore pressures within the embankment take longer as drawdown increases, hence the effects of drawdown experienced were more severe at the lower end of the drawdown.

It is also understood that extra topsoil may be stockpiled along the eastern downstream embankments of R1. Stability analyses were conducted to simulate the effect to the R1 embankments and the FS were within CDA requirements. The results of the stability analyses are shown in **Figures C.7 to C.12** in **Appendix C**.

6.0 GEOTECHNICAL DESIGN

6.1 EARLY CONCEPTUAL DESIGN

Based on early conversations with USL, the initial reservoir inverts were at an elevation of 1012 m to 1014 m, about 2 m to 4 m below the water table encountered in the Phase 2 investigation. High groundwater flow rates were also noted in water well records in the area which would require a costly dewatering system. Additional issues such as variability of soil conditions, the presence of a high-permeability soil layer throughout the site and potential instability of the reservoir embankments due to the groundwater and varying soils would have impacted the proposed development.

The early conceptual design did not meet the requirements as outlined by the CDA. Modeling results had shown that the reservoir fails in the rapid drawdown condition and flotation occurs as the reservoir is drawn down past half-full. Groundwater measurements and water well data show that excavating into the water bearing sand layers may not be feasible as the flow rates encountered within the sand may be too high for a typical dewatering system. In order to minimize issues with the groundwater table, the final reservoir invert was set to 1017 m as the deepest limit.

6.2 GEOMETRY

The proposed embankments meet CDA (CDA, 2013) factors of safety under differing facility operations. The upstream slope consists of a 5H:1V slope up to the FSL elevation of 1022.0 m and then steepens to a 3H:1V slope up to the crest of the embankment at 1023.0 m. The crest width is 10.0 m wide berm and includes a 5.0 m wide vehicle access road. The reservoir bottom ranges from 1017 m to 1018 m to allow for drainage. As discussed in **Section 6.5**, the general configuration of the embankment consists of a centralized clay core with waste fill on the downstream side. Typical embankment cross sections are provided on **Figure 2 and 3 of Appendix B**.

6.3 RESERVOIR LINER OPTIONS

As provided in the MPE Geotechnical Investigation report for the FORW Reservoir, the use of a synthetic liner system is required for this site due to the variable nature of the site soils. MPE considered a number of potential liner materials for this project, settling on two recommended options: HDPE and coated LLDPE.

6.3.1 HDPE Liner

High Density Polyethylene (HDPE) with a minimum thickness of 60 Mil (1.52 mm) is considered a suitable option for the FORW reservoir. HDPE has been utilized in many different applications across Canada in the last 30+ years. HDPE liners are known for overall durability and long design life that have been recorded in many water storage and landfill applications. Advanced weathering tests have shown exposed HDPE to be highly resistant to oxidization forces. When exposed to UV, the design life typically exceeds 30 years. When buried, HDPE liners could last 50 to 75 years or more. Hydraulic conductivity values for HDPE can range as low as 1.0×10^{-12} , creating negligible water losses. However, large sheets of HDPE cannot be prefabricated (due to low ductile properties) which means more field seams are required (over 15 times more than flexible membranes such as LLDPE or RPE). Quality of field seams can

be compromised by temperature and moisture conditions meaning the liner is potentially more susceptible to leaks and seepage.

While this material has a high chemical and abrasion resistance it is prone to stress cracking. Points of constant stress include stone protrusions and stresses across seams which can lead to liner failure (Ian D. Peggs 2003). Figure 1 was taken from one of the largest manufacturers of liners in the U.S. (I-Corp International) and highlights the different failure types observed in HDPE liners. Stone punctures are responsible for over 50% of failures within the liner, highlighting the importance of good subgrade preparation and gentle placement of cover materials. Proper subgrade preparation should produce a smooth, uniform, clean surface free of any deformations and stones.

Figure 1: Typical Failure Methods of HDPE Liner (Ian D. Peggs 2003)

WHEN/WHERE	AMOUNT	DETAILS	AMOUNT
Liner installation	24%	Extrusion	61%
		Melting	18%
		Stone Puncture	17%
		Cuts	4%
Covering	73%	Stone Punctures	68%
		Heavy Equipment	16%
		Grade Stakes	16%
Post-Construction	2%	Heavy Equipment	67%
		Construction	31%
		Weather, etc.	2%

What is not included in Figure 1 is failure due to stress cracking and yield stresses. Single-axis elongation of HDPE is generally good, but under dual-axis strain the material becomes brittle and can rupture. Typical failures of HDPE are observed between 15-20% elongation making the liner more susceptible to cracking when subjected to tensile stress.

If HDPE is selected for the FORW reservoir, careful subgrade preparation including the use of bedding sand, is highly recommended.

6.3.2 Stabilized LLDPE Liner

UV and Oxidation resistant Low Linear Density Polyethylene (LLDPE) liner with a minimum thickness of 60 Mil can also be considered as a suitable option for the FORW reservoir. Specifically, the Layfield Enviro-Liner 6060 is recommended. This product extends the benefits of LLDPE with the addition of UV and Oxidation resistance. Note that uncoated LLDPE is not recommended due to its poor UV resistance.

Enviro-Liner 6000 is a plastic liner that is more able to stretch and deform around uneven subgrades. It is used in a wide variety of critical containment applications where long-term, fully impermeable barriers are required. Enviro-Liner 6000 is also chemically stable, designed to contain harmful leachates and contaminants. Hydraulic conductivity values can range as low as 1.0×10^{-13} cm/s, indicating negligible seepage loss. Enviro Liner 6000 is NSF 61 certified allowing it to be used in drinking water applications.

Greater ductility and flexibility can make installation easier, with the option to manufacture large panels before shipping to site thus fewer field seams are required (might not be applicable for 60 mil thickness; contractor to confirm). This can also contribute to reduced susceptibility to leaks and seepage caused by field seam procedures. The ductility properties far exceed any other liner allowing for stretching and deformation during installation.

Design lifetime of Enviro Liner 6000 when exposed to ultraviolet light should be similar to HDPE (30+ years). In a buried state the European polymer journal claims possible lifetimes for LLDPE of over 100 years with proper installation and full protection from the elements (Hyun J.J 2014).

6.3.3 Liner Construction Considerations

With both liner options, a 300 mm subgrade preparation is required across the reservoir bottom with general procedures as follows:

- Scarification and moisture conditioning to within $\pm 2\%$ of Optimum Moisture Content (OMC)
- Removal of oversize particles and/or large bedrock fragments, as required.
- Compaction to 95% of Standard Proctor Density.
- Fill any voids caused by rock removal with sand, and smooth roll the finished surface.
- Conduct a proof roll in the presence of a qualified geotechnical engineer to identify any soft areas requiring additional work (such as subcut and replacement with more competent material).

For the reservoir sideslopes, the embankments should be slightly overbuilt during initial construction (by perhaps 0.3 m), then trimmed back to their final grade and smooth rolled. This ensures the final surface is uniformly compacted and smooth. If the embankments are properly built, it will not be necessary to do additional subgrade prep on the sideslopes unless directed by the Engineer.

The finished subgrade should be protected from equipment damage or rutting in order to maintain a smooth surface. Only low ground pressure equipment should be allowed on the finished subgrade. Drainpipes should also be installed along the inside perimeters of each cell as specified in the Geotechnical Report.

For HDPE Liner:

Upon completion of subgrade preparation and proof roll, a 100 mm thick layer of free draining bedding sand should be placed under the liner across the reservoir bottom. Bedding sand will also be required on the embankment sideslopes, depending on the quality of embankment materials (specifically the rock content). Bedding sand on the sideslopes may be reduced at the discretion of the Engineer. To maximize the effectiveness of the liner, the surface of the sand should be smooth drum rolled while moist to create a smooth and dimple free surface. Where the liner is to be buried, a light weight (8 ounce) non-woven geotextile should be placed directly on top of the liner.

For Enviro Liner 6000:

Upon completion of subgrade preparation, the finished surface should be inspected for sharp rocks, voids, or otherwise uneven areas. All uneven or rocky areas should be levelled with a thin layer of sand, just enough to fill voids. For budgeting purposes, a 25 mm thick layer of levelling sand across the reservoir

bottom may be assumed. The levelled surface should then receive a heavy nonwoven geotextile (8 ounce minimum). The liner may be placed directly on the nonwoven geotextile.

For either liner option, cover material (if required) should be free from sharp or oversize (larger than 25 mm) particles within the top 200 mm of cover. If cover is to be provided on the reservoir sideslopes, the use of textured liner is recommended, and the fill should be placed from the bottom up to avoid sliding. At this time, the use of cover material is not deemed necessary from a geotechnical perspective.

6.3.4 Liner Maintenance

Given the importance of the liner in the context of the facility's classification as a Dam, proper maintenance of the liner is important. Routine inspection of the embankments and liner should be conducted, including visual inspection of the liner and monitoring of the underdrain flow volumes. If the flow volume increases by a significant margin, it may be assumed that a leak has developed, and further investigation is warranted. Any identified leaks should be repaired immediately.

Given the quality of the raw water inflows, sediment buildup and dredging are unlikely to be required. Dredging over synthetic liners is not recommended unless a substantial soil cover is placed (minimum 600 mm with coarse granular layer on top to signal equipment operators to halt excavation). Vehicles and equipment should stay off the exposed liner at all times. Liner cleaning may be conducted with pressure washers, however, care should be taken not to use extreme pressures which might damage the liner.

6.3.5 Cost Considerations

The relative cost between 60 mil HDPE and EnviroLiner 6000 in terms of material supply and installation is expected to be less than \$1.00 per m² (EnviroLiner 6000 being slightly more expensive). The difference in required sand bedding is expected to be a significant cost savings in favour of the EnviroLiner, which requires very little sand (only a very thin course to level rocky areas).

6.4 UNDERDRAIN SYSTEM

Venting is required to reduce the risk of liner floatation. Liner floatation occurs when gasses buildup beneath it due to organics or sometimes groundwater flow. The risk of liner floatation is considered low to moderate, however, the consequences should floatation occur include loss of storage and the need to empty the cell to allow workers to release the gasses and repair the liner.

In order to reduce the risk of liner floatation, an underdrain system should be installed within the toe of the reservoir embankments to provide an escape for water that eventually leaks through the liner, which is important during reservoir drawdown. A minimum slope of 0.20% is proposed for the underdrain system, following the sloping of the proposed reservoir bottom as shown on **Figure 4** in **Appendix B**. Layfield Biplanar Hydranet Geocomposite (8 oz) at 20 m intervals are placed on the prepared subgrade across the reservoir bottom in conjunction with the toe drain along the reservoir embankments as shown on **Figure 4**.

The proposed underdrain pipes consist of at minimum a 150 mm perforated drain pipe with a drainage sleeve along the outside of the pipe. The proposed underdrain system will drain towards an underdrain collection manhole at the southwest corner of R1, as shown on **Figure 4**. As the underdrain system's main

purpose is to collect minor groundwater seepage and leaks through the synthetic liner, the amount of waterflow through the underdrain system is expected to be low with a maximum flow rate of approximately 20 GPM. The sump should be monitored during the construction phase, and a potential future pump should be considered for the underdrain sump depending on how much water the sump collects. The sump should also be monitored periodically during operations for excessive water seepage as that may indicate a leak in the synthetic liner. Four additional manholes are also proposed along the perimeter of R1 as a way to maintain the underdrain system and provide a way to inspect or flush the system if a leak or blockage is suspected.

The underdrain should be covered with minimum 0.5 m of drain rock to mitigate fines from eventually clogging the drain pipe. The drain rock should be washed, graded, crushed durable rock conforming to City of Calgary Waterworks Construction Standards – Class 1B. The Layfield Biplanar Hydranet Geocomposites will connect to the central drain trench by overlying the trench, allowing drainage through the geocomposites. The proposed underdrain was modeled in the stability analysis as shown in **Figures C.1 to C.25 in Appendix C**. Based on the analysis results, the underdrain location along the embankment toe is considered acceptable for dam stability. The details and sections of the proposed underdrain system are shown on **Figure 5 in Appendix B**.

6.5 EMBANKMENT ZONING

The on-site clay till is considered suitable for embankment construction. A zoned embankment has been designed to maximize the use of materials on site while meeting the stability requirements. The proposed embankment will consist of Zone 1, Clay, Zone 2, Random Fill and Zone 3, Topsoil. The zones are shown on **Figures 2 and 3 in Appendix B** and are described below in greater detail including construction requirements and specifications. Import material will need to be assessed to verify that it meets the design intent of the various zones.

Zone 1: Clay

Zone 1 should consist of a cohesive, low to medium plasticity clay till. The recommended compaction moisture content is from optimum to 3% above optimum moisture content in accordance with ASTM Designation D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (SPMDD).

The soil should be moisture conditioned prior to placement. The material should be placed in 200 mm thick, uncompacted (loose) layers and compacted to a dry density greater or equal to 95% of SPMDD. The clay till anticipated in the proposed cut areas of the reservoirs should make up the bulk of the embankment materials. As the site soils are varied, careful material selection and separation will be required.

Materials that are not suitable for Zone 1 include silt, sand, gravel, bedrock or topsoil. These materials should either be wasted, or selected for use in Zone 2 or Zone 3, as described below. Full-time construction monitoring and compaction testing is required.

Zone 2: Random Fill

Zone 2 will be comprised of fill material unsuitable for use in Zone 1, except for topsoil. This includes the silt, sand, and gravel encountered within the footprint of the proposed reservoirs. Zone 2 material should be compacted to 95% SPMDD, with moisture content $\pm 2\%$ of Optimum.

Zone 3: Topsoil

Zone 3 will be comprised of topsoil excavated from earthwork operations. It is understood that extra topsoil will be stockpiled along the eastern downstream embankments of R1, as investigated in **Section 5.0** and shown in **Figures C.7 to C.12** in **Appendix C**.

Providing relative compaction as a percentage to SPMDD is not suitable for soils with relatively high organic contents such as topsoil. Organic components of the topsoil layer are prone to decomposition over time. When placing topsoil, the material should be compacted in layers with loose thicknesses not greater than 300 mm. Topsoil is considered highly compressible under loading and should not be mixed with structural fill in Zones 1 and 2. The embankments with topsoil placed on top should be inspected regularly to ensure no ponding along the top of the embankments and proper drainage along the slopes.

6.6 EMBANKMENT CONSTRUCTION

Following stripping of topsoil, the exposed subgrade should be proof rolled in the presence of an engineer to determine the required subgrade treatment. It may be necessary to subcut unsuitable subgrade materials if thick organics or very loose/soft soils are encountered. Any required subcut should be replaced with Zone 1 clay.

After completion of the above, the subgrade beneath embankments should be prepared by scarifying the surface using appropriate equipment in such a way as to achieve through mixing of surface materials. After scarification is completed, the mixed material should be moisture conditioned to within $\pm 2\%$ of OMC and compacted to 98% of SPMDD. As a minimum, the required depth of subgrade preparation for embankments is 600 mm.

Embankment materials should be placed in uniform lifts no thicker than 200 mm (loose). Embankments should be brought up evenly. Construction should be carried out by a qualified contractor with experience in large earthworks projects.

6.7 GRAVEL PAVEMENT RECOMMENDATIONS

It is understood that gravel pavement is proposed along the berms of the R1. After excavation, the subgrade should be inspected by a proof roll prior to construction of the pavement. Any soft spots must be over-excavated and backfilled with approved material. Traffic for the gravel pavement is expected to consist of cars and trucks less than one ton around the reservoir perimeter, with heavier heavy vehicles such as water trucks, hydrovacs expected around the proposed pump station at the southwest corner. Fire access is also required up to and around the pump station access roads. The light duty structure thicknesses are considered suitable for minimal light vehicle traffic. Heavy duty structure thicknesses are considered suitable for fire access and other heavy-duty trucks. A 300 mm thick subgrade preparation for the pump station access roads comprising of compaction to 98% of SPMDD at $\pm 2\%$ of OMC is recommended.

Granular sub-base and granular base coarse aggregates should conform to Town of Okotoks standards. In order to prevent weed growth along the reservoir berms, the granular base coarse aggregates should be limited to less than 3% fines. The granular aggregates should be moisture conditioned to within $\pm 2\%$ of OMC and 100% of SPMDD. Occasional regrading of the gravel surface may be required over the life of the pavement structure.

Table G – Gravel Pavement Structures

Granular Material	Light Duty Structure "Reservoir Perimeter Access"	Heavy Duty Structure "Pump Station Perimeter Access"
Base Coarse Aggregate (mm)	100	100
Sub-base Aggregate (mm)	150	300

The gravel roads should be graded to avoid any ponding of water along the crest of the embankments. Gravel access road around the perimeter of reservoir should have a minimum 3% crossfall away from the crest of the reservoir. Where the access are located on the berm separating the future cell, the pavements should have a minimum 3% slope away from the centre of the road crests. The gravel access near the pump station should also be graded to avoid any ponding of water next to the building and grade supported structures such as sidewalks or pavements. Samples of the granular base or surfacing aggregates should be checked for conformance to Town of Okotoks or other applicable specifications, prior and during construction. In-situ density testing must be carried out to verify that satisfactory levels of compaction are achieved.

7.0 DAM SAFETY REQUIREMENTS

As per the 2018 Alberta Dam & Canal Safety Directive (the Directive), a number of requirements will need to be met for design, construction, first filling, and throughout the operational life. For a comprehensive list of requirements, refer to the Directive. A brief summary of next steps is presented:

- Submission of the complete design package, including geotechnical design report, dam consequence classification report, and relevant civil design documents through the Water Act. This will trigger review by Alberta Dam Safety.
- Final Design should address any outstanding dam safety items, such as:
 - Geotechnical Instrumentation Plan
 - Construction QA/QC Plan
 - First Filling Plan
 - Development of the Operations, Maintenance, and Surveillance (OMS) manual

A proposed Geotechnical Instrumentation Plan is shown on **Figure 6** in **Appendix B**. The proposed plan is considered preliminary and should be adjusted according to site conditions encountered during construction.

REFERENCES

- Alberta Geological Survey. (2003). *Surficial Geology of Alberta Map 601*. Edmonton: Alberta Energy Regulator.
- Alberta Geological Survey. (2013). *Bedrock geology of Alberta Map 600*. Edmonton: Alberta Energy Regulator.
- Alberta Geological Survey. (2015). *Sediment Thickness of Alberta Map 603*. Edmonton: Alberta Energy Regulator.
- Alberta Geological Survey. (2017). *Regional Geological and Hydrogeological Characterization of the Calgary-Lethbridge Corridor in the South Saskatchewan Regional Planning Area Report 91*. Edmonton: Alberta Energy Regulator.
- Alberta Geological Survey. (2022). *Distribution of Hydraulic Head in the Scollard / Willow Creek Hydrostratigraphic Unit Map 629*. Edmonton: Alberta Energy Regulator.
- Carter, D. W. (2003). Goodbye, Hazen; Hello Kozeny-Carman. *Geotechnical and Geoenvironmental Engineering*, Vol. 129, Issue 11.
- City of Calgary. (2011). *Stormwater Management & Design Manual*. Calgary: The City of Calgary - Water Resources
- CDA. (2013). *Dam Safety Guidelines*. Toronto: Canadian Dam Association.
- Government of Alberta. (2018). *Alberta Dam and Canal Safety Directive*, Edmonton: Queen's Printer..
- Government of Alberta. (2018a). *Alberta Regulation 205/98 Water Act Water (Ministerial) Regulation*. Edmonton: Queen's Printer.
- Hanes-Griffen, M. E., & Franklin, A. G. (1984). Rationalizing the Seismic Coefficient Method. *US Army Corps of Engineers Geotechnical Laboratory*, GL-84-13.
- National Research Council Canada. (2020). *National Building Code of Canada: 2020*.
- Stark, T. D., & Hussain, M. (2003). Empirical Correlations: Drained Shear Strength for Slope Stability Analyses. *Geotechnical and Geoenvironmental Engineering*, Vol. 139, Issue 6.
- Waterline. (2022). *Proposed Okotoks Reservoir (NW-21-021-28 W4M) – Geotechnical Drilling and Hydraulic Response Testing Program Summary*, Waterline Resources Inc.

APPENDIX A:

TERMS OF REFERENCE

TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY MPE A DIVISION OF ENGLOBE.

MPE has prepared the following Terms of Reference to assist in the interpretation and use of MPE's Geotechnical Reports. Note that the information contained herein is considered supplemental to the body of the report. In case of any discrepancy between this appendix and the body of the report, the report will take precedence.

1.1 USE OF THE REPORT

This geotechnical report has been prepared for and tailored to the needs of a specific client, project, site, and purpose. Any party relying on this report other than the client for which it was prepared does so at their own risk.

In order to properly understand the suggestions, recommendations, and opinions expressed in the Report, reference must be made to the whole of the report. MPE cannot be responsible for improper use of portions of the report without reference to the whole report.

1.2 CHANGING PROJECT DETAILS

Important changes to project details which are made after this report has been prepared could render this report obsolete, or reduce its relevancy. MPE's geotechnical engineer should be retained to review project changes. Examples of important changes may include but are not limited to the following:

- Site layout.
- Function of a proposed structure.
- Type of structure or materials used.
- Elevations, design grades, or drainage.
- Project ownership or design team.

1.3 NATURE AND EXACTNESS OF DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods used in professional geotechnical practice. Classification and identification of geological units are judgemental in nature as to their type, condition, or characteristics. MPE does not warrant conditions represented in the Report as being exact.

Changes from one geological zone to another may be indicated on the logs as a distinct line, but may in fact be transitional. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.4 CHANGES IN SUBSURFACE CONDITIONS

This report has been prepared based on conditions that existed at the time the work scope was undertaken. Do not rely on this report if it is judged that the reliability of the report has been affected by:

- The passage of time;
- Man made events such as construction on or adjacent to the site;
- Natural events such as flood, drought, seismic activity, erosion, groundwater fluctuations, slope instability, etc;

Please contact MPE to confirm that this report is still reliable following any changes to the site or if the passage of time raises any question whether changes may have occurred.

1.5 FINDINGS AND RECOMMENDATIONS ARE PROFESSIONAL OPINION

Site exploration and testing are performed only at specific locations. The exploration provides a valuable yet incomplete picture of the site. In many cases, MPE will review regional geology alongside borehole and laboratory data. Engineering judgement has been applied in the interpretation of the data in order to render an opinion about the rest of the site. Actual subsurface conditions may differ significantly from those identified in the report. MPE should be retained to provide geotechnical design review and construction monitoring in order to manage the risks associated with unanticipated conditions.

1.6 RECOMMENDATIONS ARE NOT FINAL

Many of the recommendations presented in this report are considered confirmation-dependent, as they are developed on engineering judgement and opinion based on an incomplete investigation of site conditions. As such, they should not be considered final.

MPE's recommendations can be finalized only after the actual site conditions are revealed during construction. MPE cannot assume responsibility or liability for this report's recommendations if MPE has not been retained to perform the necessary construction monitoring.

1.7 DO NOT REDRAW BOREHOLE LOGS

MPE has prepared the final borehole logs based on interpretation of field logs and lab data. To prevent errors and omissions, the logs included in this report should not be redrawn for inclusion in other design drawings. Only photographic or complete electronic reproduction of the original is acceptable. Note that separating logs from the report can elevate risk.

1.8 DESIGN PARAMETERS

Where MPE's Report includes design parameters which have been derived from a site investigation, those recommended parameters are based on engineering judgement and may take into account multiple factors. Third party designers who apply their own interpretation to MPE's borehole logs do so at their own risk. MPE cannot be liable for third party interpretations.

1.9 PROTECTION OF EXPOSED GROUND

Weathering and disturbance can substantially alter the physical properties of soil or rock. In circumstances where the strength of soil or rock is to be relied upon (such as for foundation support, floor slabs, roads, excavation or embankment sideslopes, etc.), it must be protected against weathering and disturbance at all times. Weathering includes freezing, wetting, or drying conditions.

1.10 GROUNDWATER FLUCTUATION

MPE's site investigation should not be considered an exhaustive study of groundwater conditions. Groundwater levels will fluctuate, and MPE's boreholes may not have penetrated all natural flow paths. Groundwater conditions encountered during construction may differ dramatically from this report. Local experience and sound judgement will be required in the development of care-of-water procedures.

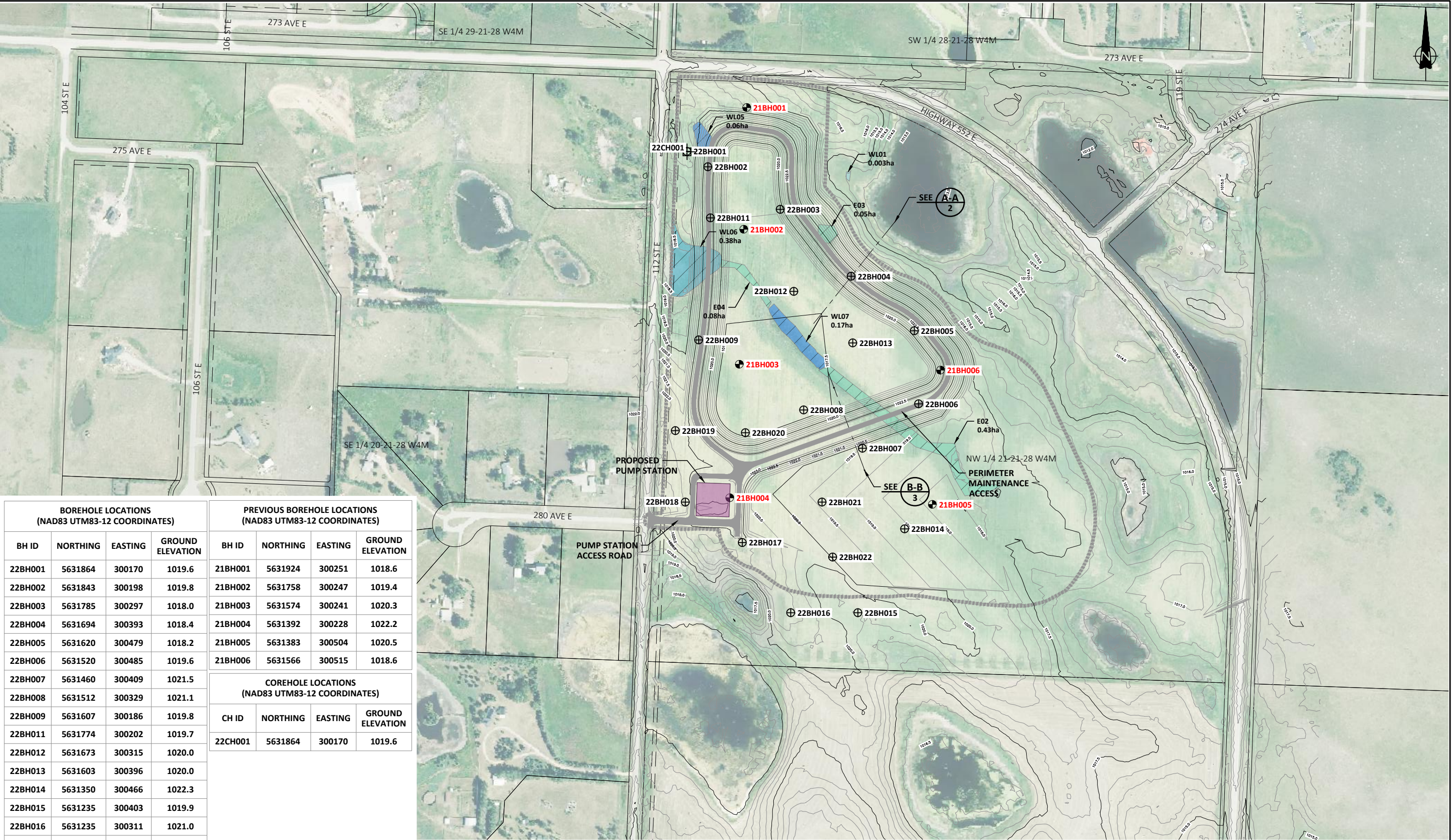
1.11 SUPPORT OF ADJACENT STRUCTURES

The influence that construction activity can have on adjacent structures or facilities should be considered by the owner, architect, prime engineer, contractor, or developer. MPE's geotechnical engineers should be consulted if adverse conditions are suspected.

Support of ground and structures adjacent to the proposed construction, which may be impacted by construction, is required.

APPENDIX B:

FIGURES



BOREHOLE LOCATIONS (NAD83 UTM83-12 COORDINATES)			
BH ID	NORTHING	EASTING	GROUND ELEVATION
22BH001	5631864	300170	1019.6
22BH002	5631843	300198	1019.8
22BH003	5631785	300297	1018.0
22BH004	5631694	300393	1018.4
22BH005	5631620	300479	1018.2
22BH006	5631520	300485	1019.6
22BH007	5631460	300409	1021.5
22BH008	5631512	300329	1021.1
22BH009	5631607	300186	1019.8
22BH011	5631774	300202	1019.7
22BH012	5631673	300315	1020.0
22BH013	5631603	300396	1020.0
22BH014	5631350	300466	1022.3
22BH015	5631235	300403	1019.9
22BH016	5631235	300311	1021.0
22BH017	5631331	300245	1022.0
22BH018	5631386	300168	1022.0
22BH019	5631484	300154	1022.0
22BH020	5631481	300249	1021.0
22BH021	5631386	300354	1022.3
22BH022	5631311	300368	1020.6

PREVIOUS BOREHOLE LOCATIONS (NAD83 UTM83-12 COORDINATES)			
BH ID	NORTHING	EASTING	GROUND ELEVATION
21BH001	5631924	300251	1018.6
21BH002	5631758	300247	1019.4
21BH003	5631574	300241	1020.3
21BH004	5631392	300228	1022.2
21BH005	5631383	300504	1020.5
21BH006	5631566	300515	1018.6

COREHOLE LOCATIONS (NAD83 UTM83-12 COORDINATES)			
CH ID	NORTHING	EASTING	GROUND ELEVATION
22CH001	5631864	300170	1019.6

LEGEND

⊕

22BH000 - BOREHOLES

⊕

22CH000 - COREHOLES

●

21BH000 - PREVIOUS BOREHOLES

—

ALIGNMENTS

■

PROPOSED PUMP STATION

■

POTENTIAL FUTURE EXPANSION AREA

▨

WETLANDS

■

WETLAND/WATERBODY AREA TO BE REMOVED

■

EPHERMERAL WATERBODY/WETLANDS

■

SHALLOW OPEN WATER - PERMANENT

■

MARSH - GRAMINOID - SEASONAL

■

MARSH - GRAMINOID - TEMPORARY

MPE

a division of Englobe

SCALE: 1:5000

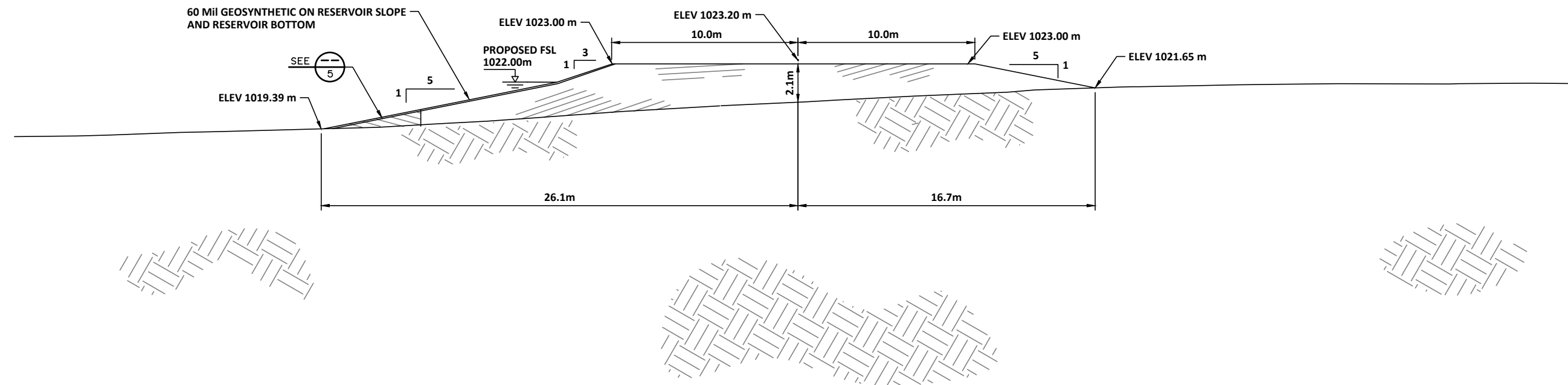
DATE: FEBRUARY 2025

URBAN SYSTEMS LTD.

RESERVOIR - GEOTECHNICAL DESIGN
SITE PLAN - BOREHOLE AND COREHOLE
LOCATIONS

JOB: 29121-005-11

FIGURE: 1



LEGEND	
	ZONE 1 - CLAY
	EXISTING GROUND

NOTES:
1. LINER AND UNDERDRAIN DETAILS SHOWN IN FIGURE 5



a division of Englobe

URBAN SYSTEMS LTD.

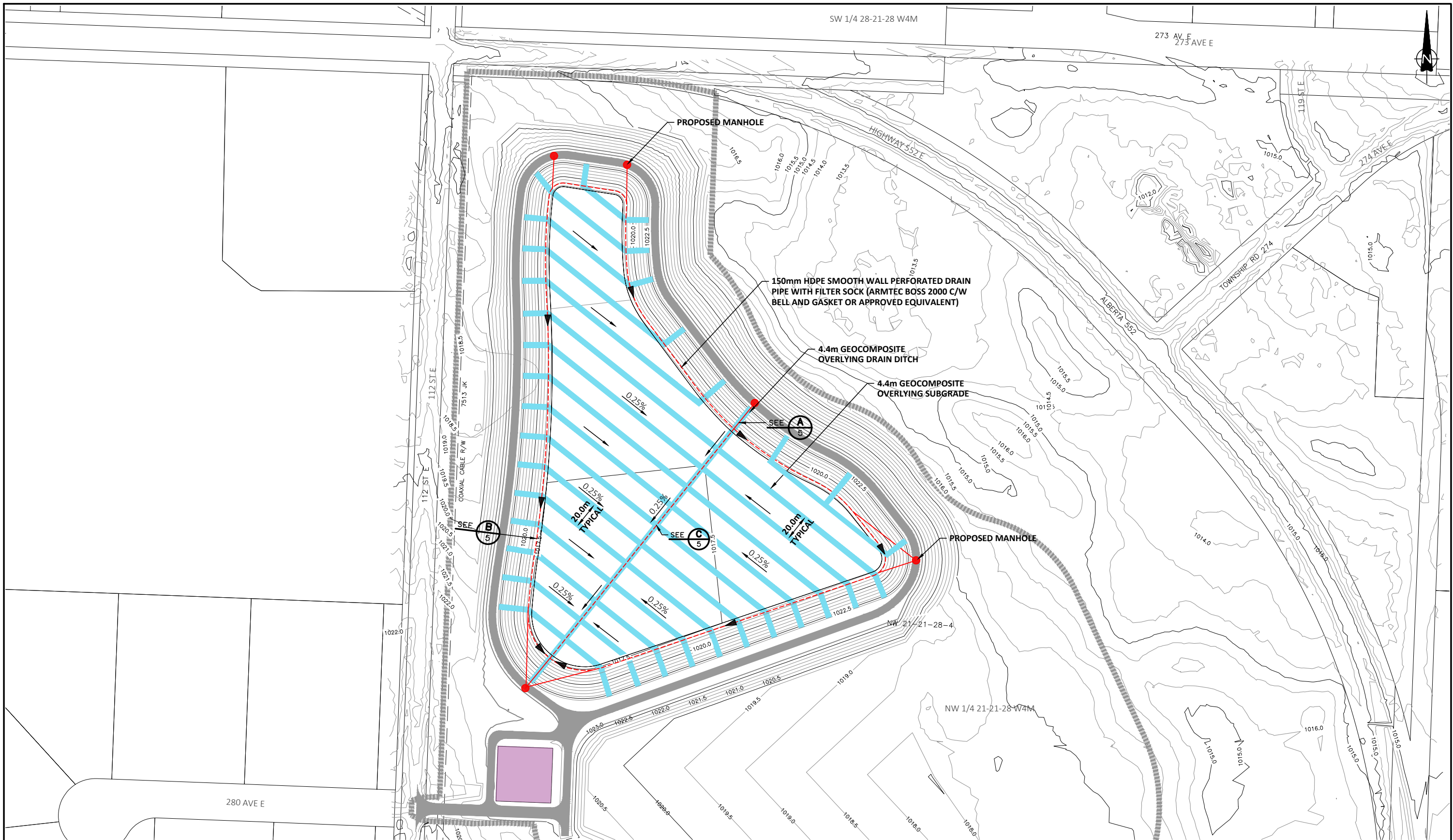
RESERVOIR - GEOTECHNICAL DESIGN
STABILITY ANALYSIS - SECTION B

SCALE: 1:250

DATE: FEBRUARY 2025

JOB: 29121-005-11

FIGURE: 3



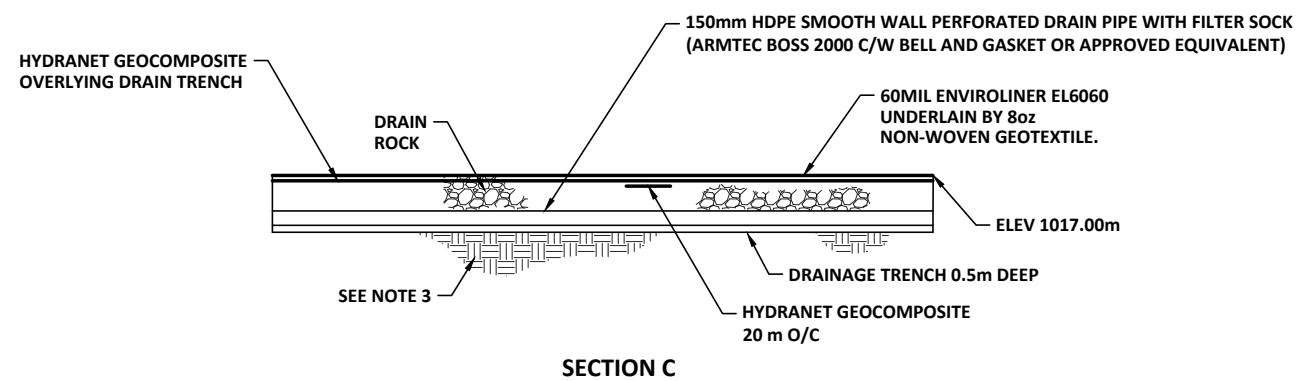
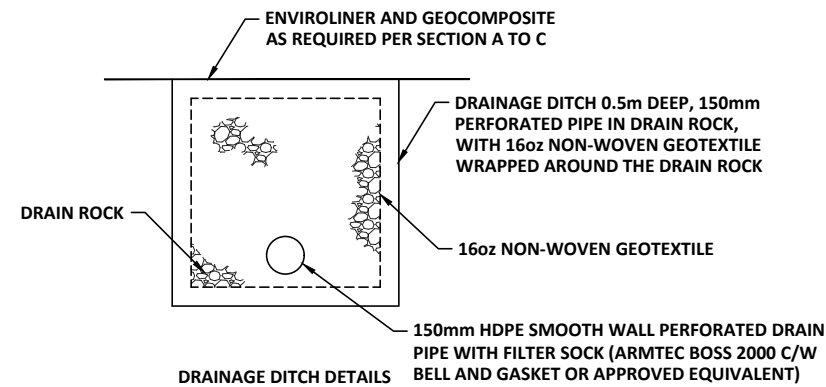
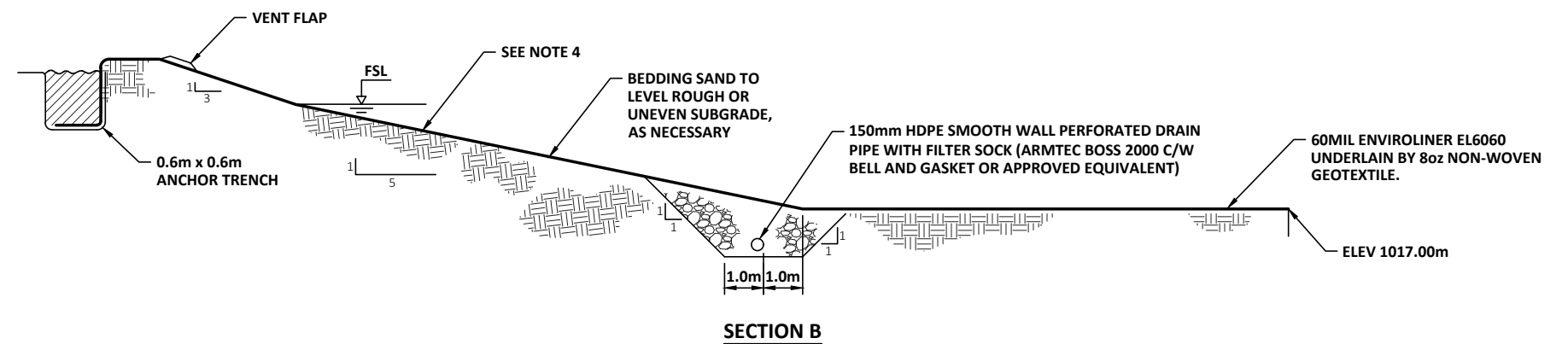
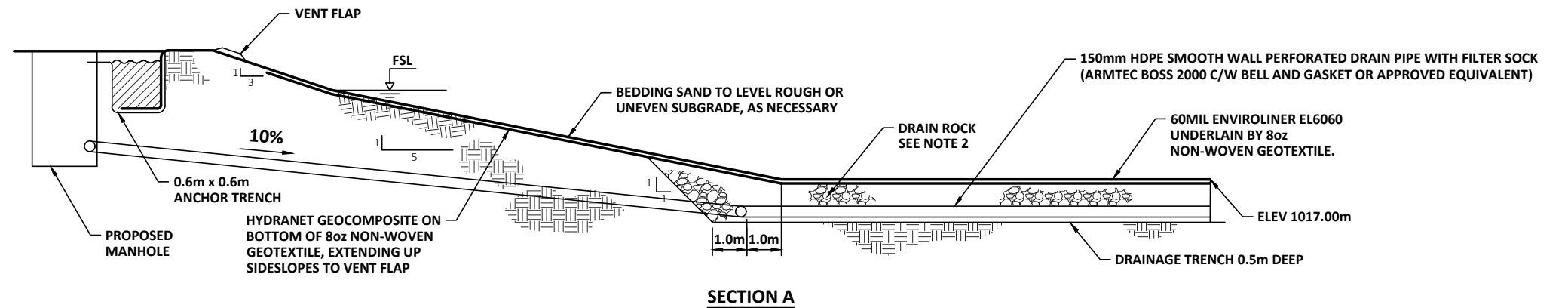
- 150mm HDPE PERFORATED DRAIN PIPE
- 150mm HDPE NON-PERFORATED DRAIN PIPE



a division of Englobe

URBAN SYSTEMS LTD.
RESERVOIR - GEOTECHNICAL DESIGN
PROPOSED UNDERDRAIN SYSTEM

SCALE: 1:3000	DATE: FEBRUARY 2025	JOB: 29121-005-11	FIGURE: 4
---------------	---------------------	-------------------	-----------



NOTES:

- HEIGHTS, LENGTHS AND SLOPE VARIES.
- THE DRAIN ROCK SHOULD BE WASHED, GRADED, CRUSHED DURABLE ROCK CONFORMING TO CITY OF CALGARY SEWER CONSTRUCTION STANDARDS - CLASS 1B.
- 300mm SUBGRADE PREPARATION REQUIRED ACROSS THE RESERVOIR BOTTOM WITH SCARIFICATION AND MOISTURE CONDITIONING TO WITHIN 2% OF OMC, AND COMPACTION TO 95% SPMDD. ANY OVERSIZED GRAVEL TO BE REMOVED AND THE VOIDS FILLED WITH BEDDING SAND. THE FINISHED SUBGRADE SHOULD BE SMOOTH ROLLED AND PROOF ROLLED TO IDENTIFY ANY SOFT AREAS REQUIRING ADDITIONAL WORK.
- THE HYDRANET GEOCOMPOSITE TO BE COMPROMISED OF LAYFIELD HYDRANET BIPLANER GEOCOMPOSITE, AND REQUIRED TO BE PINNED ALONG THE SLOPE EVERY 5m.
- NO PERFORATION THROUGH EMBANKMENT AND INCLUDE CLAY PLUG
- DRAIN PIPE EXTENDING THROUGH EMBANKMENTS SHALL BE NON-PERFORATED, DRAINAGE TRENCH SHALL BE BACKFILLED WITH IMPERMEABLE CLAY FILL.

LEGEND	
	FILL
	BEDDING SAND
	CLAY
	GRANULAR FILL



a division of Englobe

URBAN SYSTEMS LTD.

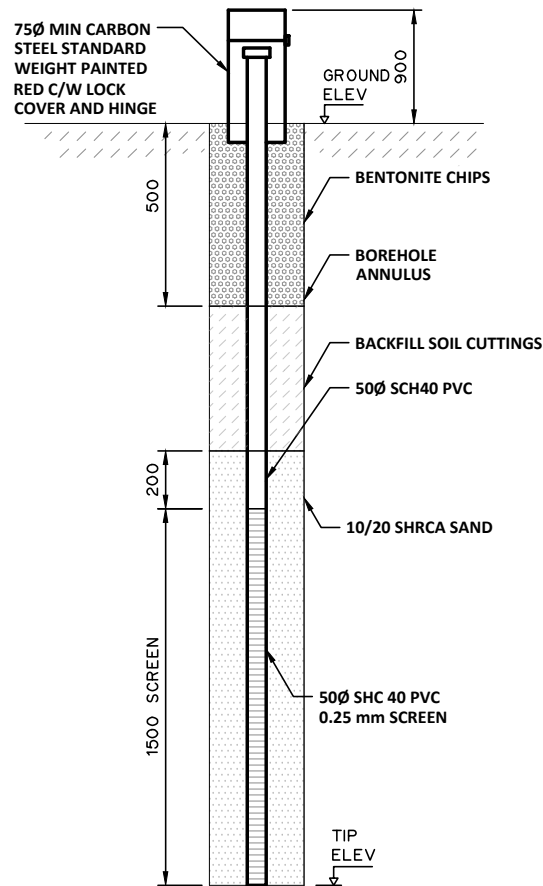
RESERVOIR - GEOTECHNICAL DESIGN
TYPICAL UNDERDRAIN DETAILS

SCALE: NTS

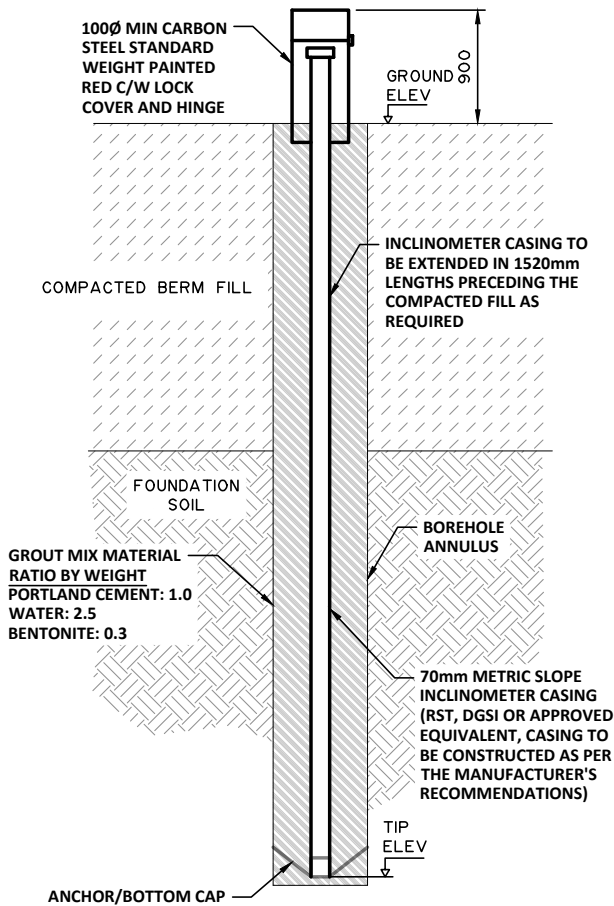
DATE: FEBRUARY 2025

JOB: 29121-005-11

FIGURE: 5



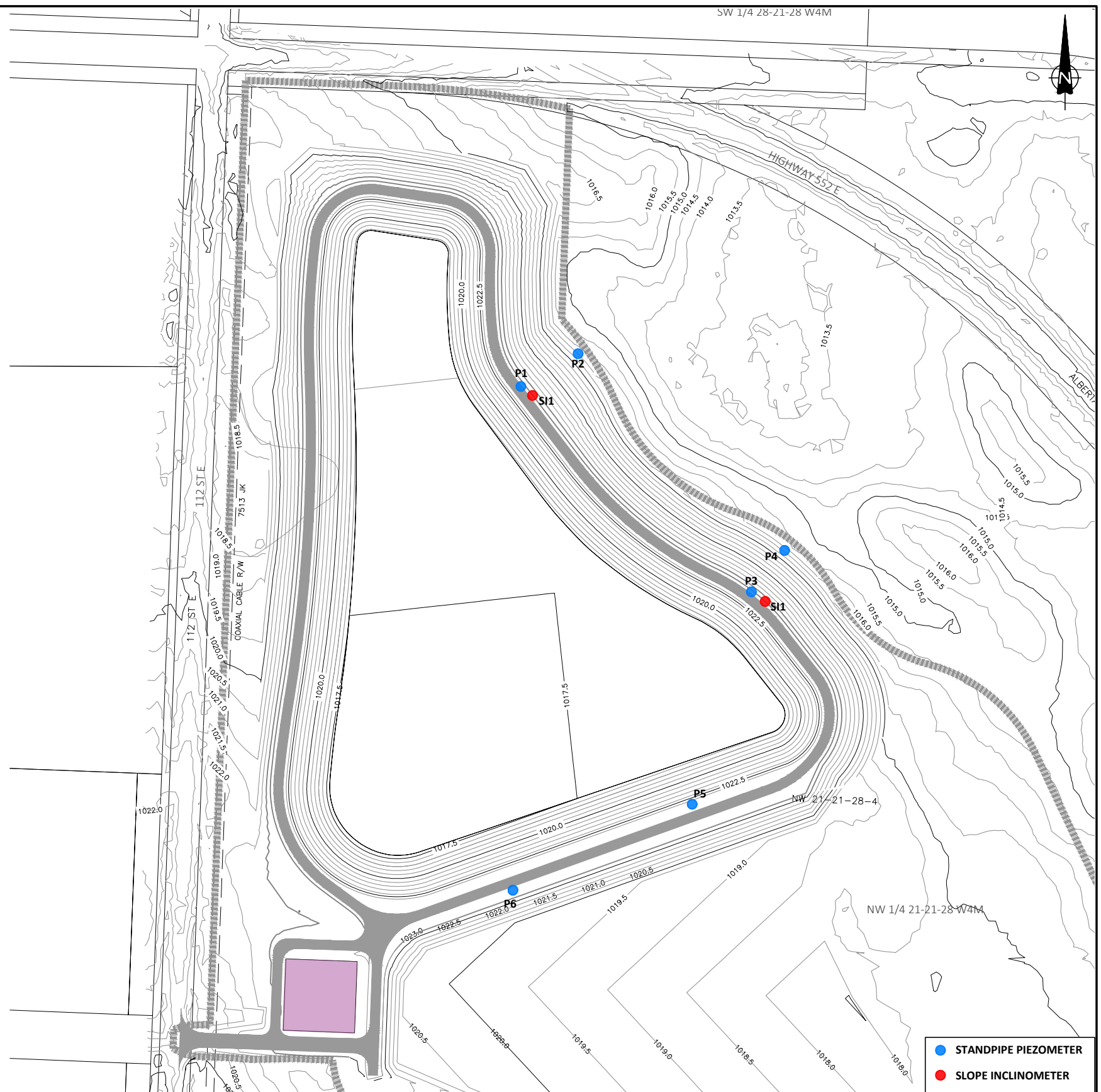
TYPICAL STANDPIPE PIEZOMETER DETAIL
NTS



TYPICAL SLOPE INCLINOMETER DETAIL
NTS

INSTRUMENTS	PRELIMINARY DEPTHS
P1	5.0m
P2	12.0m
P3	5.0m
P4	12.0m
P5	5.0m
P6	5.0m
SI1	2m INTO COMPETENT BEDROCK
SI2	2m INTO COMPETENT BEDROCK

- NOTES:
1. PROPOSED PIEZOMETER DEPTHS SUBJECT TO CHANGE BASED ON FINDINGS DURING CONSTRUCTION AND GROUNDWATER CONDITIONS.
 2. SLOPE INCLINOMETER TO BE INSTALLED AT MINIMUM 2m INTO COMPETENT BEDROCK TO ENSURE PROPER ANCHORAGE.



a division of Englobe

URBAN SYSTEMS LTD.

RESERVOIR - GEOTECHNICAL DESIGN
PROPOSED GEOTECHNICAL
INSTRUMENTATION PLAN

SCALE: 1:3000

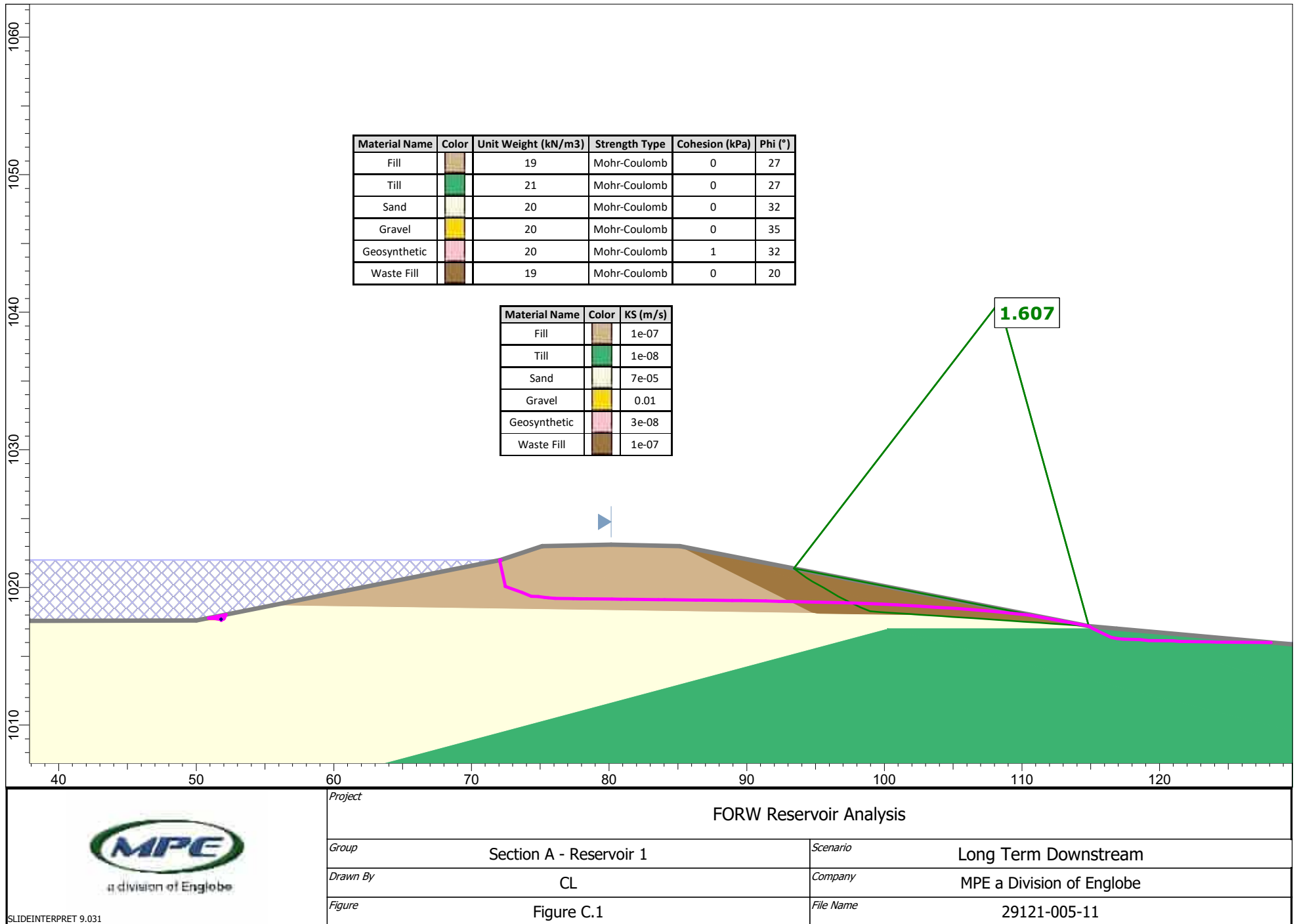
DATE: FEBRUARY 2025

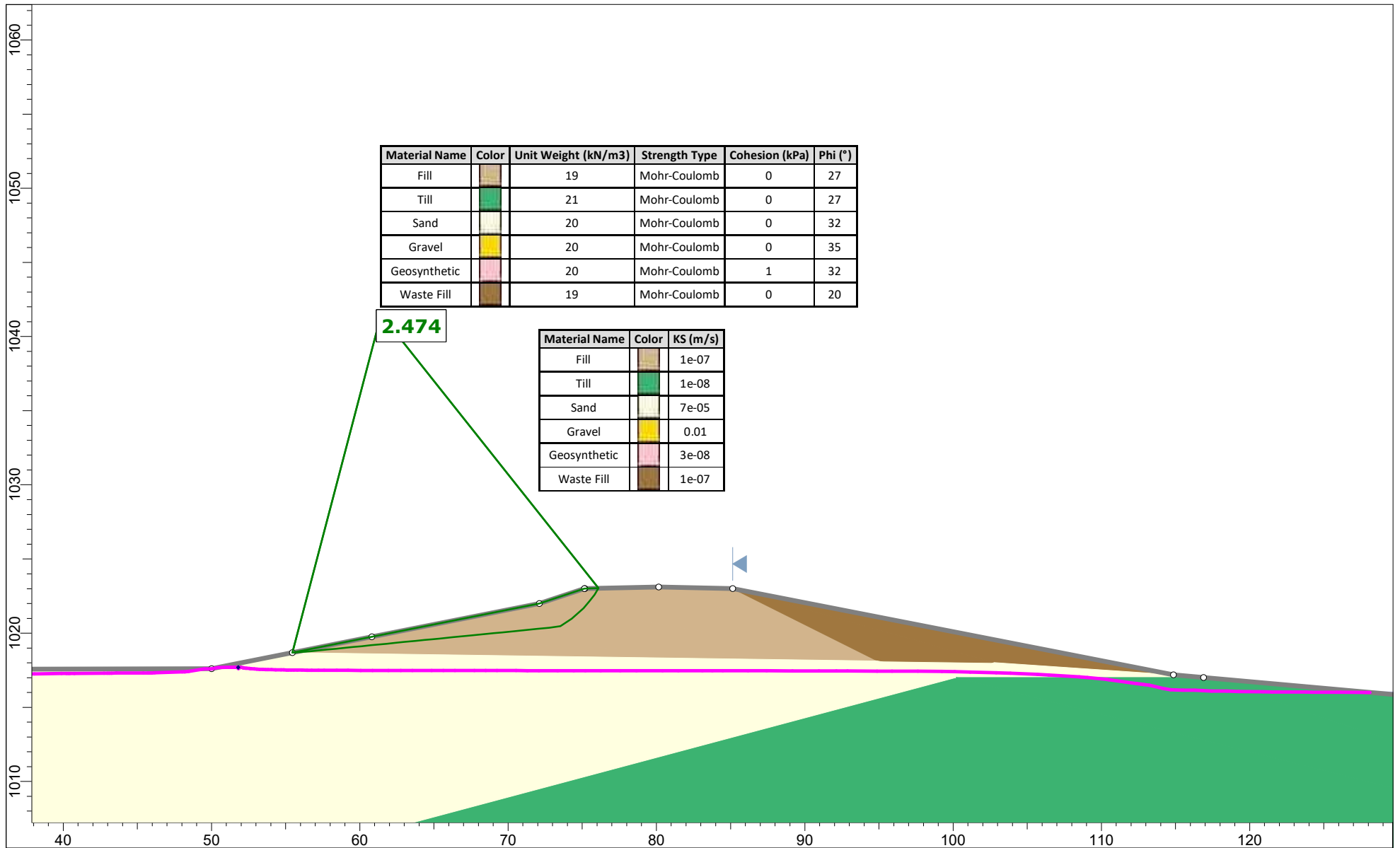
JOB: 29121-005-11

FIGURE: 6

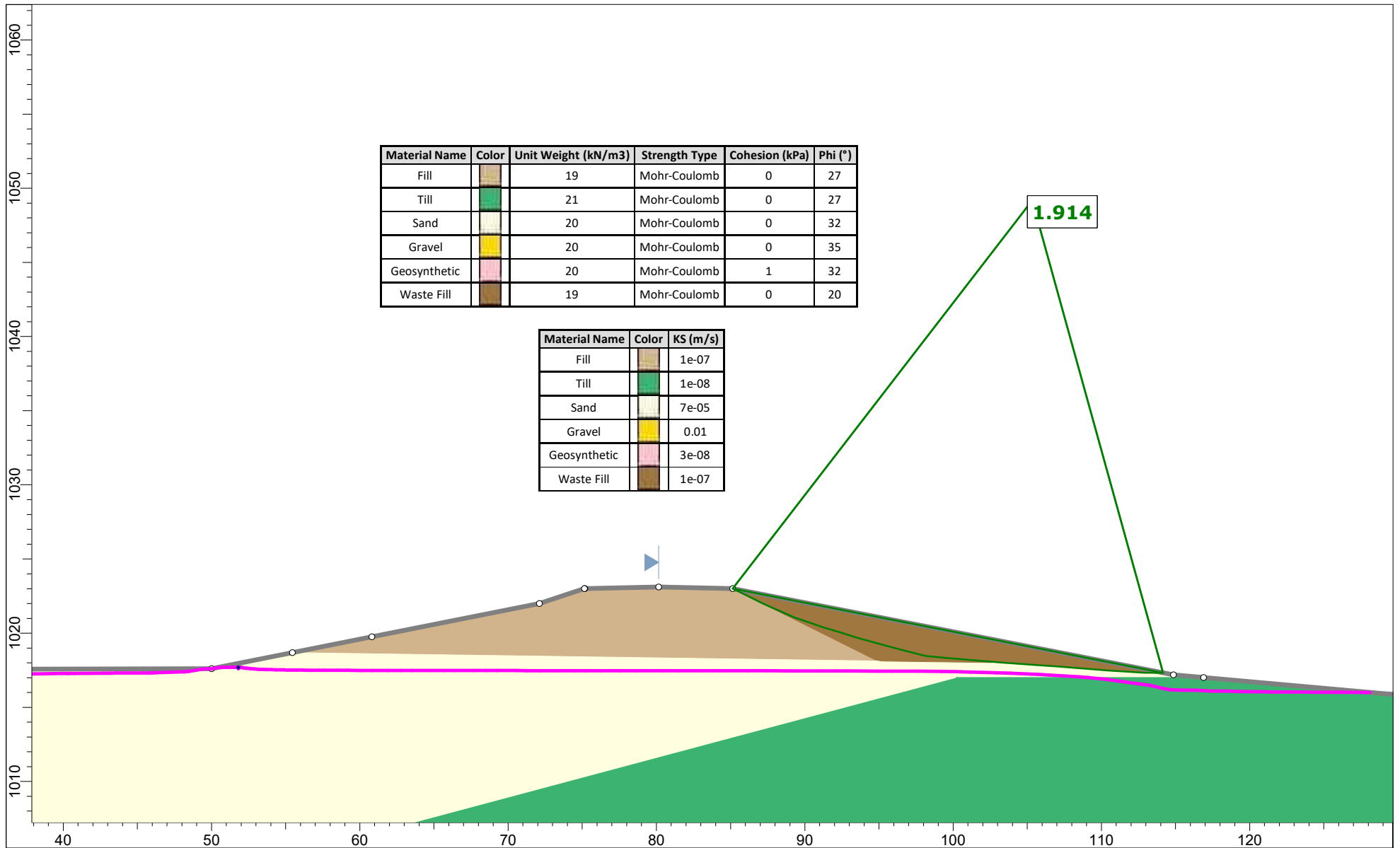
APPENDIX C:

STABILITY ANALYSIS RESULTS





Project			
FORW Reservoir Analysis			
Group	Section A - Reservoir 1		Scenario
			End of Construction Upstream
Drawn By	CL		Company
			MPE a Division of Englobe
Figure	Figure C.2		File Name
			29121-005-11



Project

FORW Reservoir Analysis

Group

Section A - Reservoir 1

Scenario

End of Construction Downstream

Drawn By

CL

Company

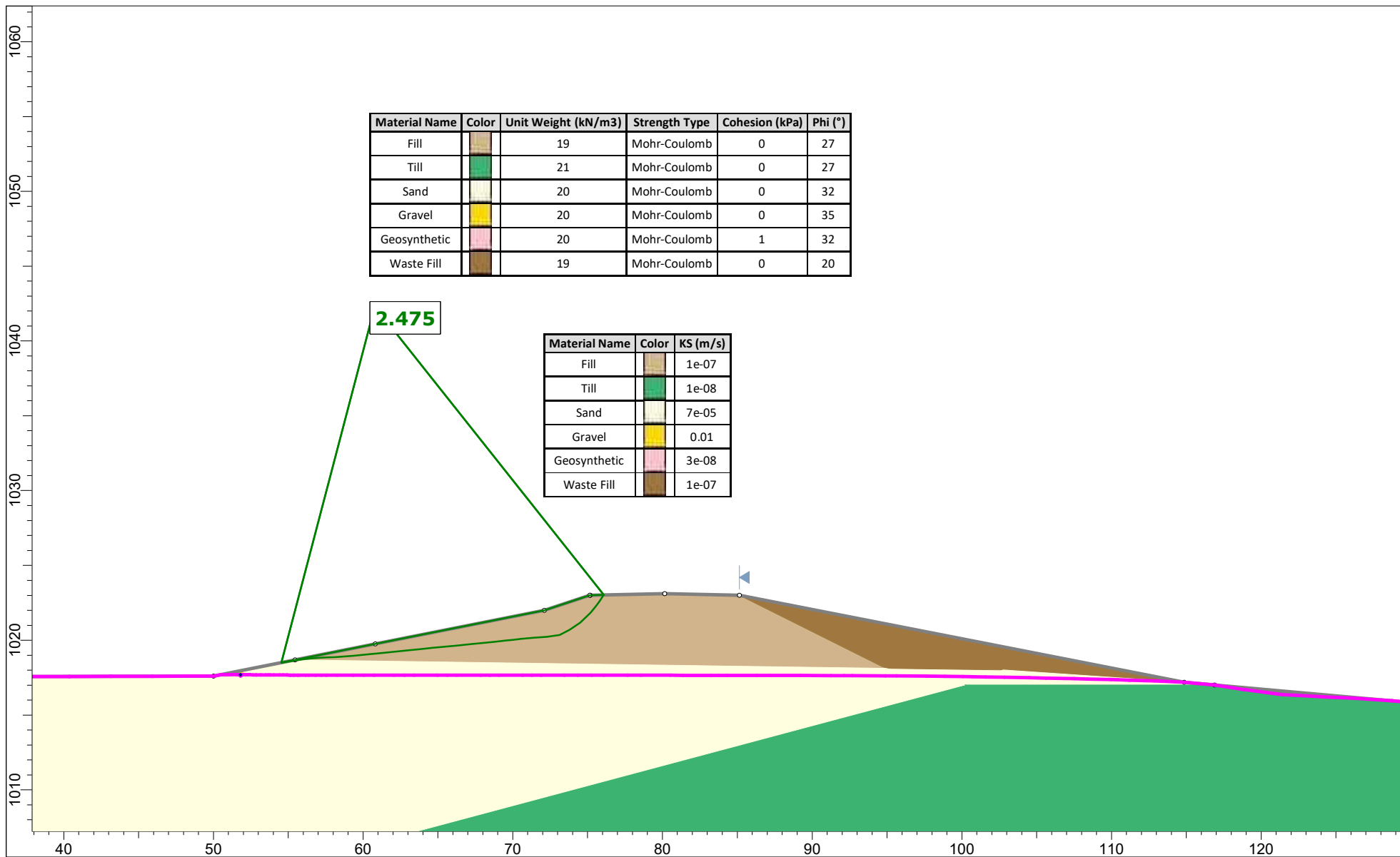
MPE a Division of Englobe

Figure

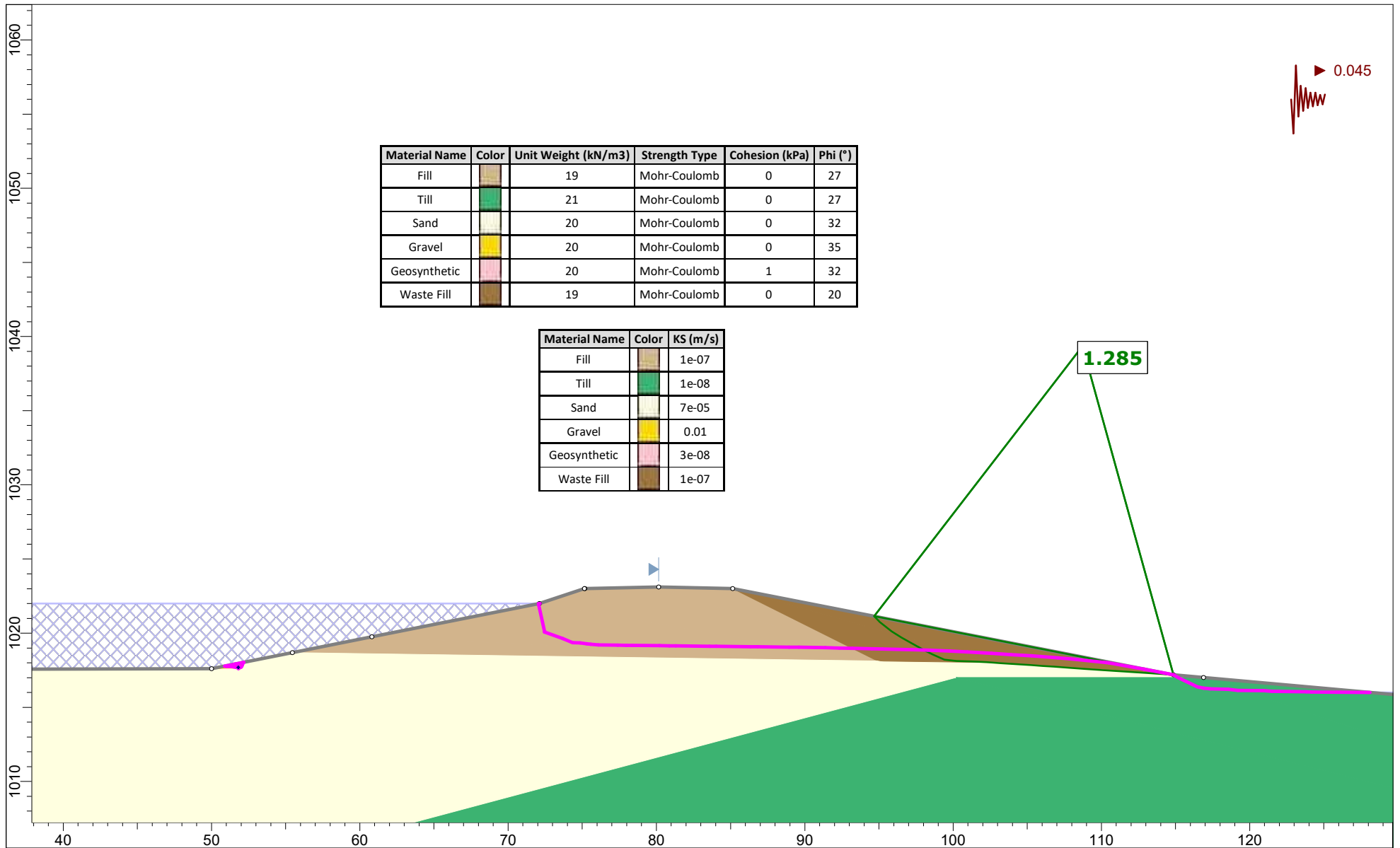
Figure C.3

File Name

29121-005-11



Project			
FORW Reservoir Analysis			
Group	Section A - Reservoir 1		Scenario
			Rapid Drawdown Upstream
Drawn By	CL		Company
			MPE a Division of Englobe
Figure	Figure C.4		File Name
			29121-005-11



Project

FORW Reservoir Analysis

Group

Section A - Reservoir 1

Scenario

Pseudo-static Downstream

Drawn By

CL

Company

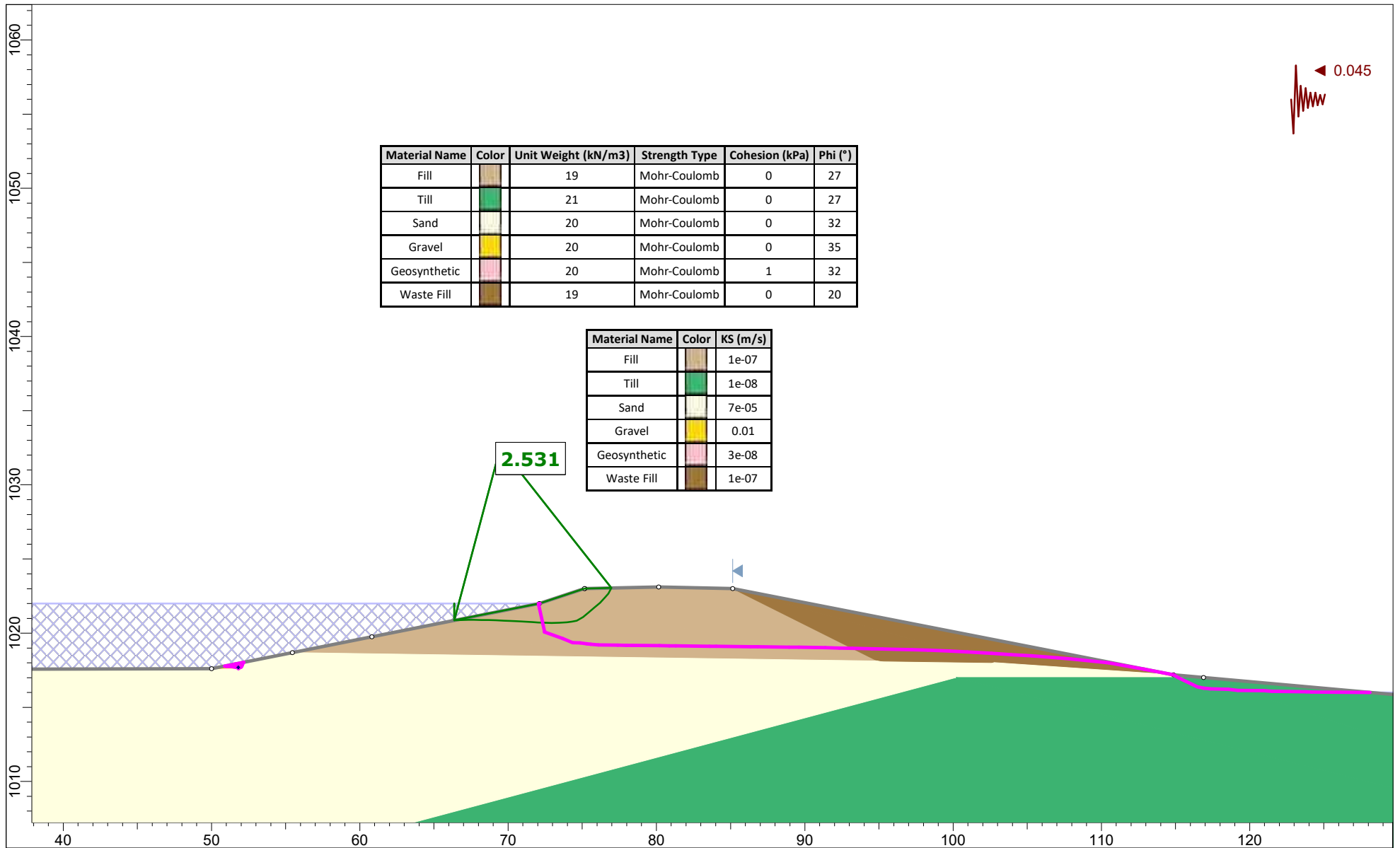
MPE a Division of Englobe

Figure

Figure C.5

File Name

29121-005-11



Project

FORW Reservoir Analysis

Group

Section A - Reservoir 1

Scenario

Pseudo-static Upstream

Drawn By

CL

Company

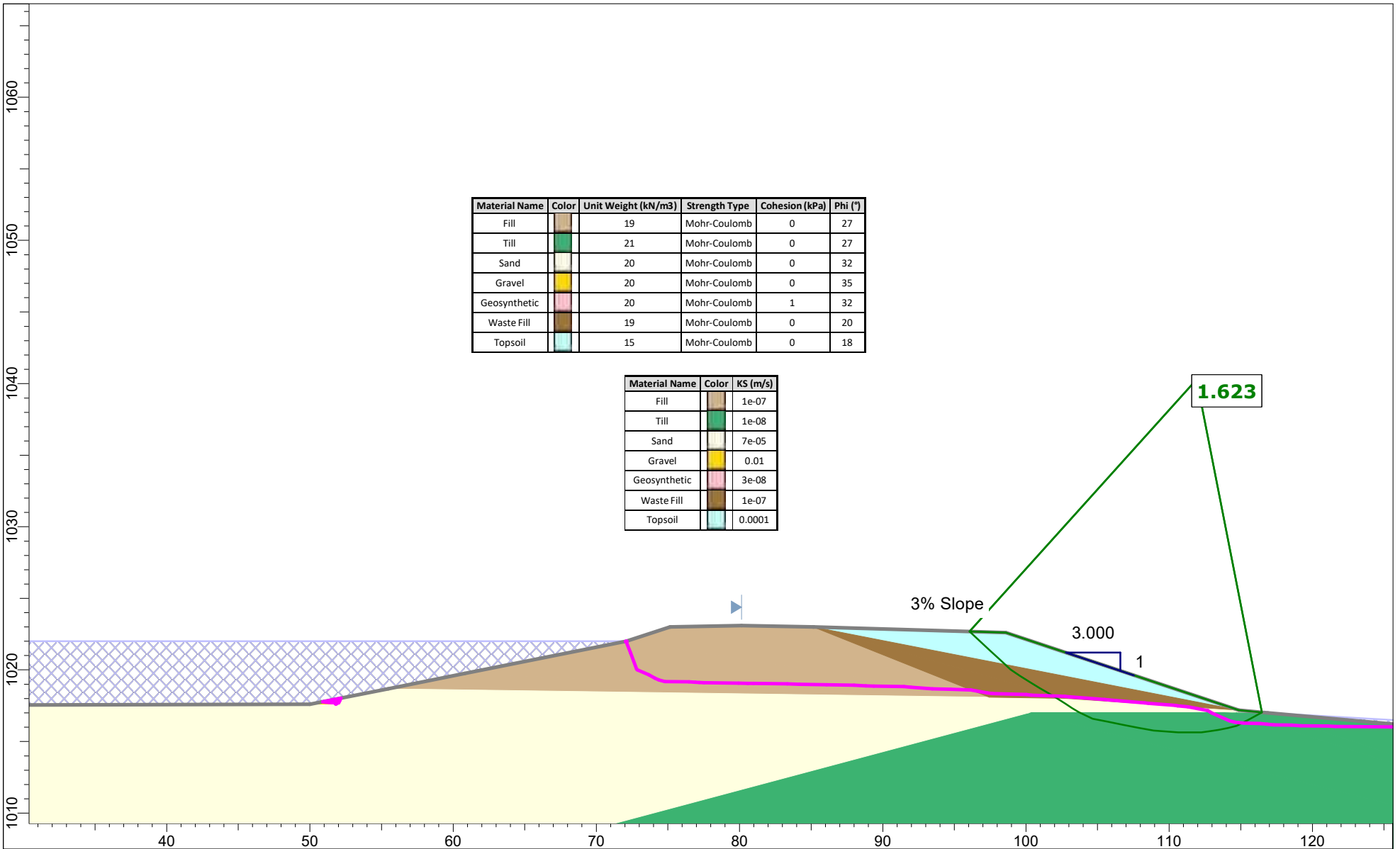
MPE a Division of Englobe

Figure

Figure C.6

File Name

29121-005-11



Project

FORW Reservoir Analysis

Group

Section A - Reservoir 1, Topsoil along Downstream Embankment

Scenario

Long Term Downstream

Drawn By

CL

Company

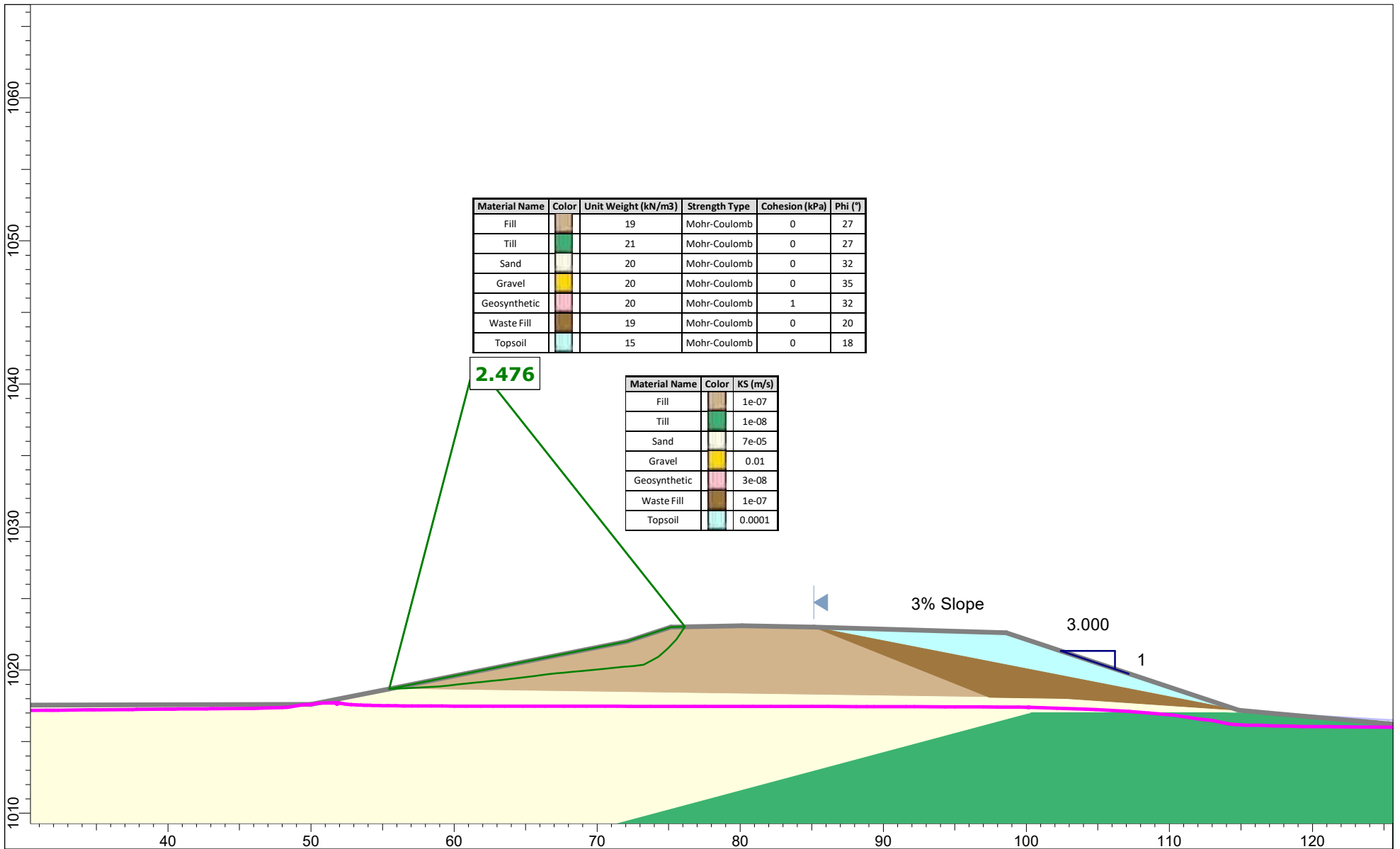
MPE a Division of Englobe

Figure

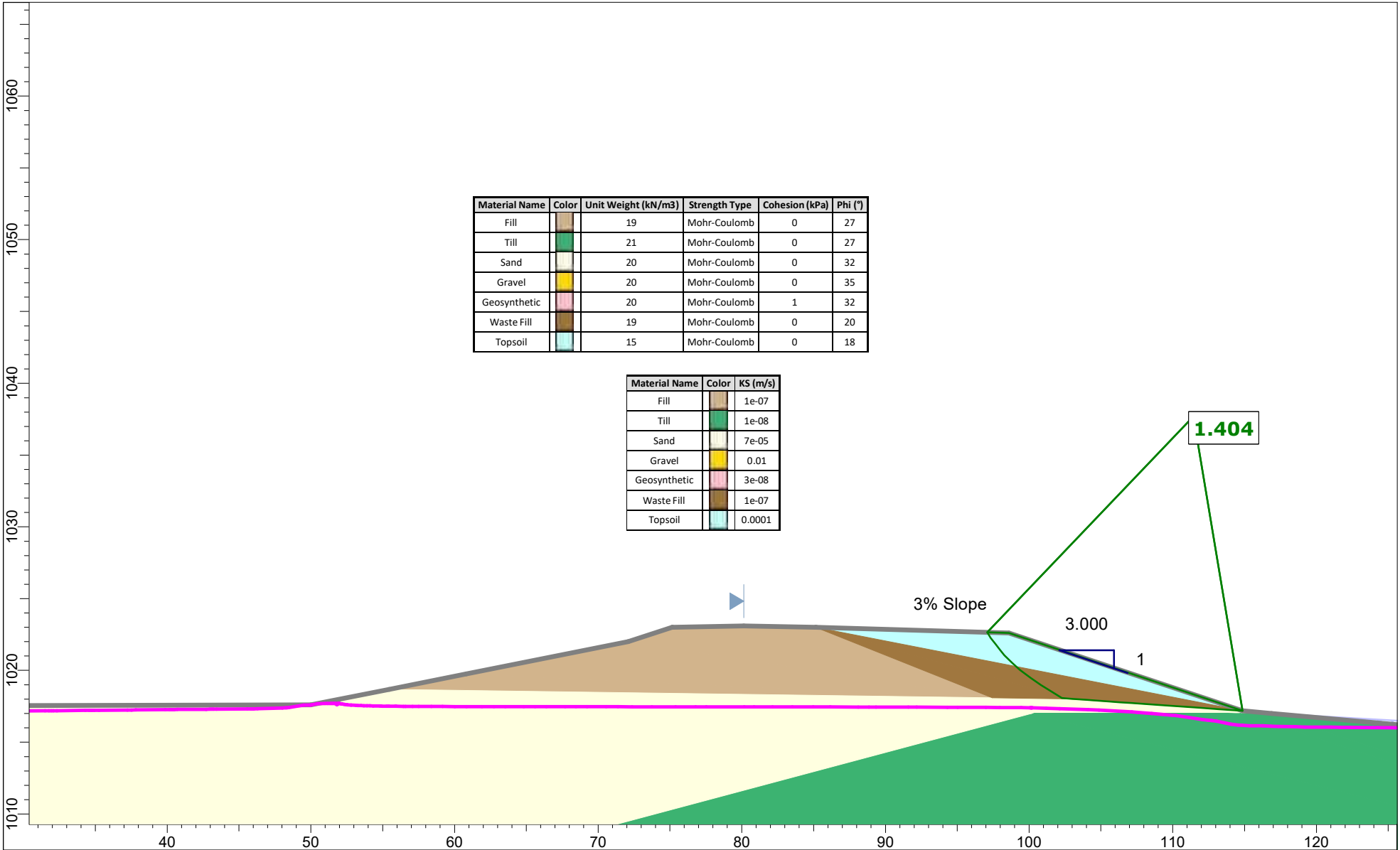
Figure C.7

File Name

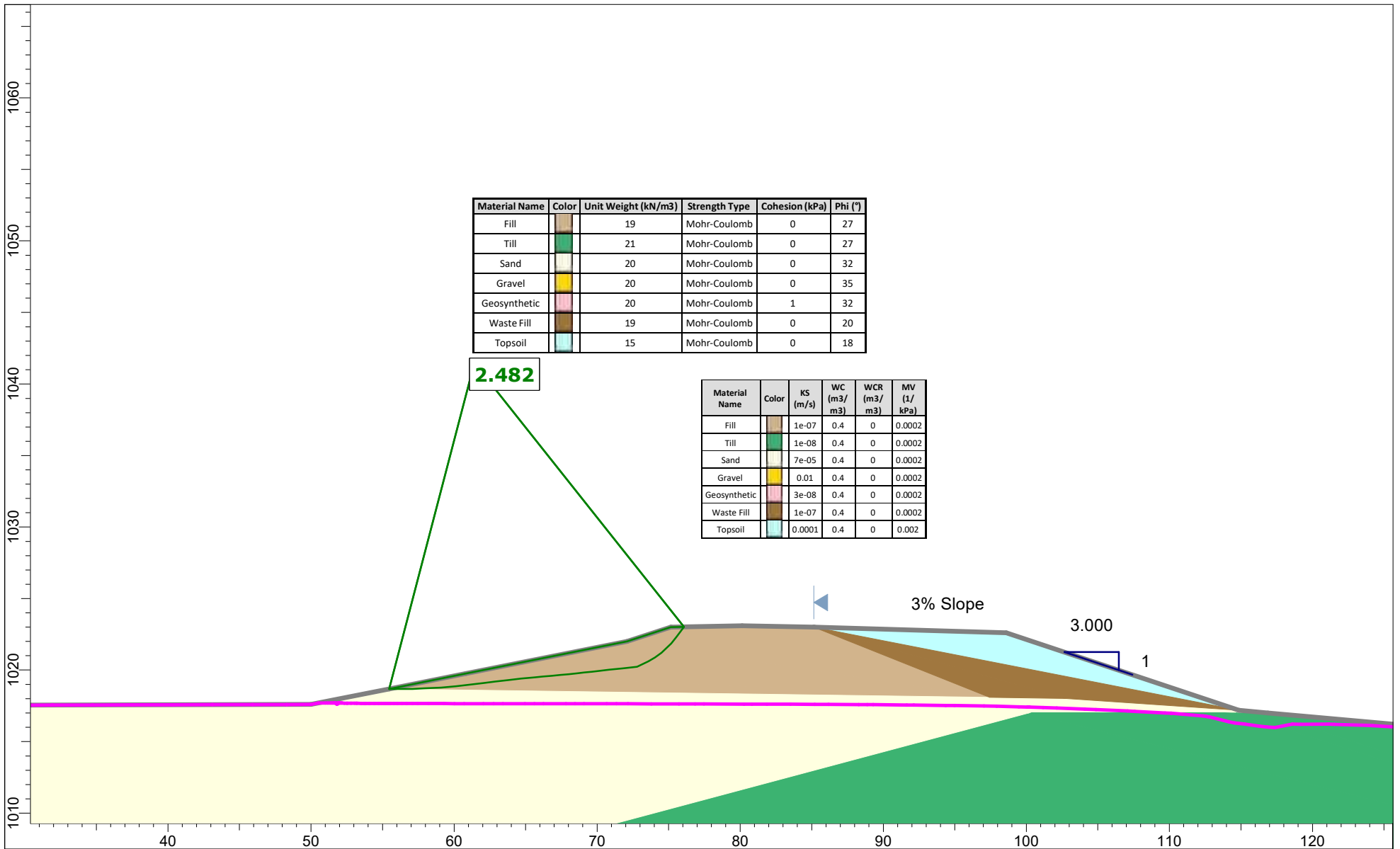
29121-005-11



 SLIDEINTERPRET 9.037	Project		FORW Reservoir Analysis	
	Group		Scenario	
	Section A - Reservoir 1, Topsoil along Downstream Embankment		End of Construction Upstream	
	Drawn By		Company	
	CL		MPE a Division of Englobe	
	Figure		File Name	
	Figure C.8		29121-005-11	



	Project		FORW Reservoir Analysis	
	Group	Section A - Reservoir 1, Topsoil along Downstream Embankment	Scenario	End of Construction Downstream
	Drawn By	CL	Company	MPE a Division of Englobe
	Figure	Figure C.9	File Name	29121-005-11



Project

FORW Reservoir Analysis

Group

Section A - Reservoir 1, Topsoil along Downstream Embankment

Scenario

Rapid Drawdown Upstream

Drawn By

CL

Company

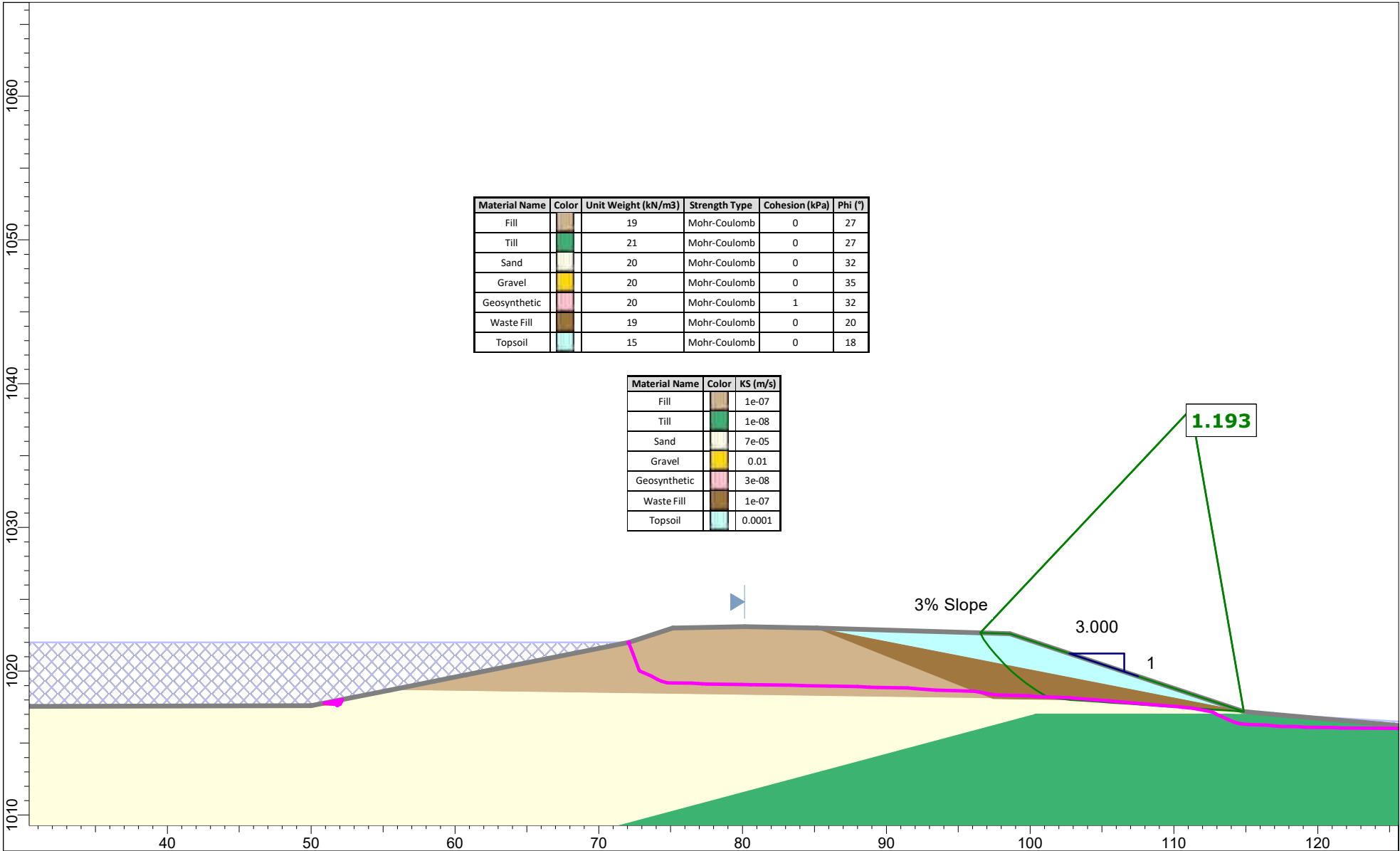
MPE a Division of Englobe

Figure

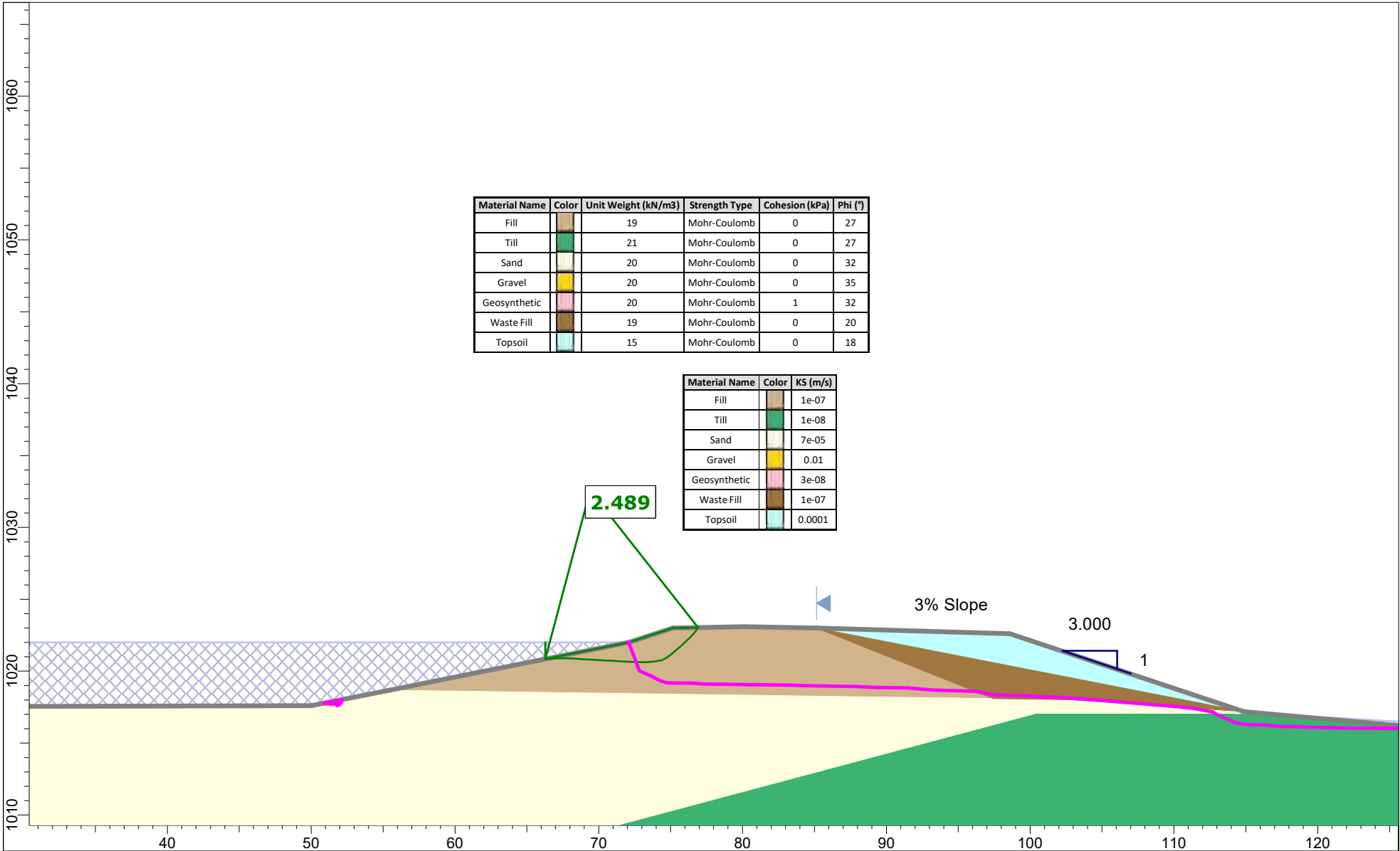
Figure C.10

File Name

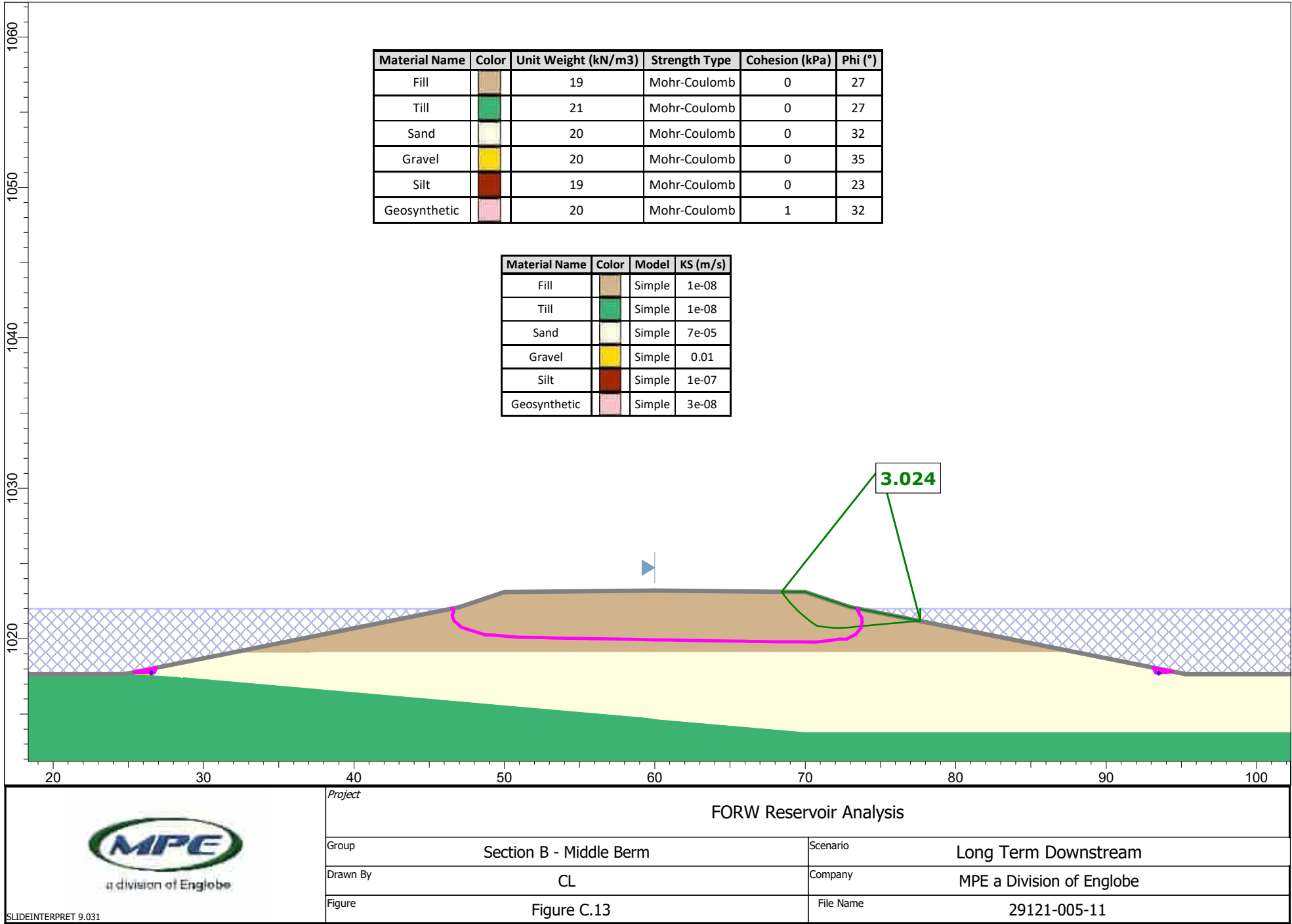
29121-005-11

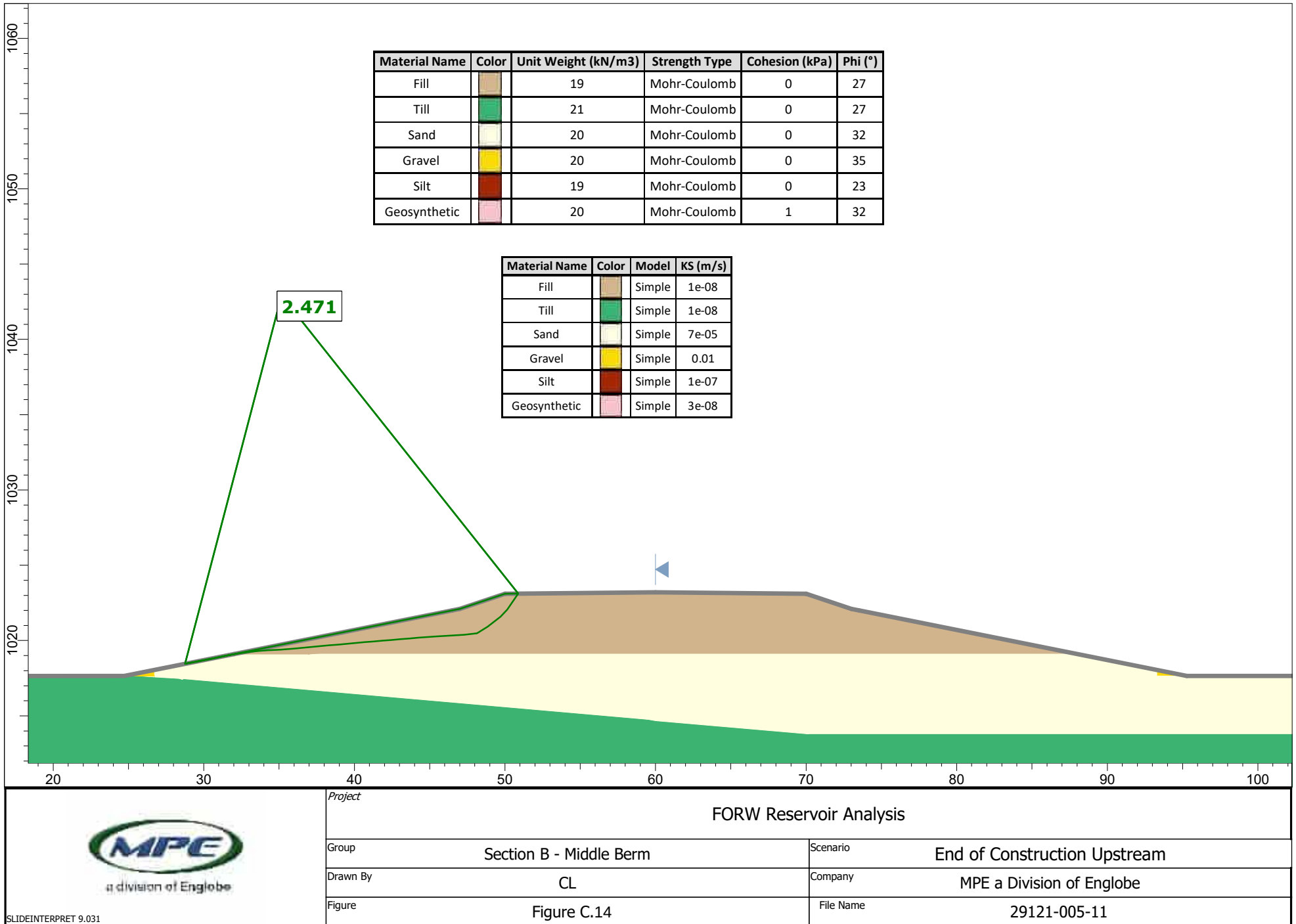


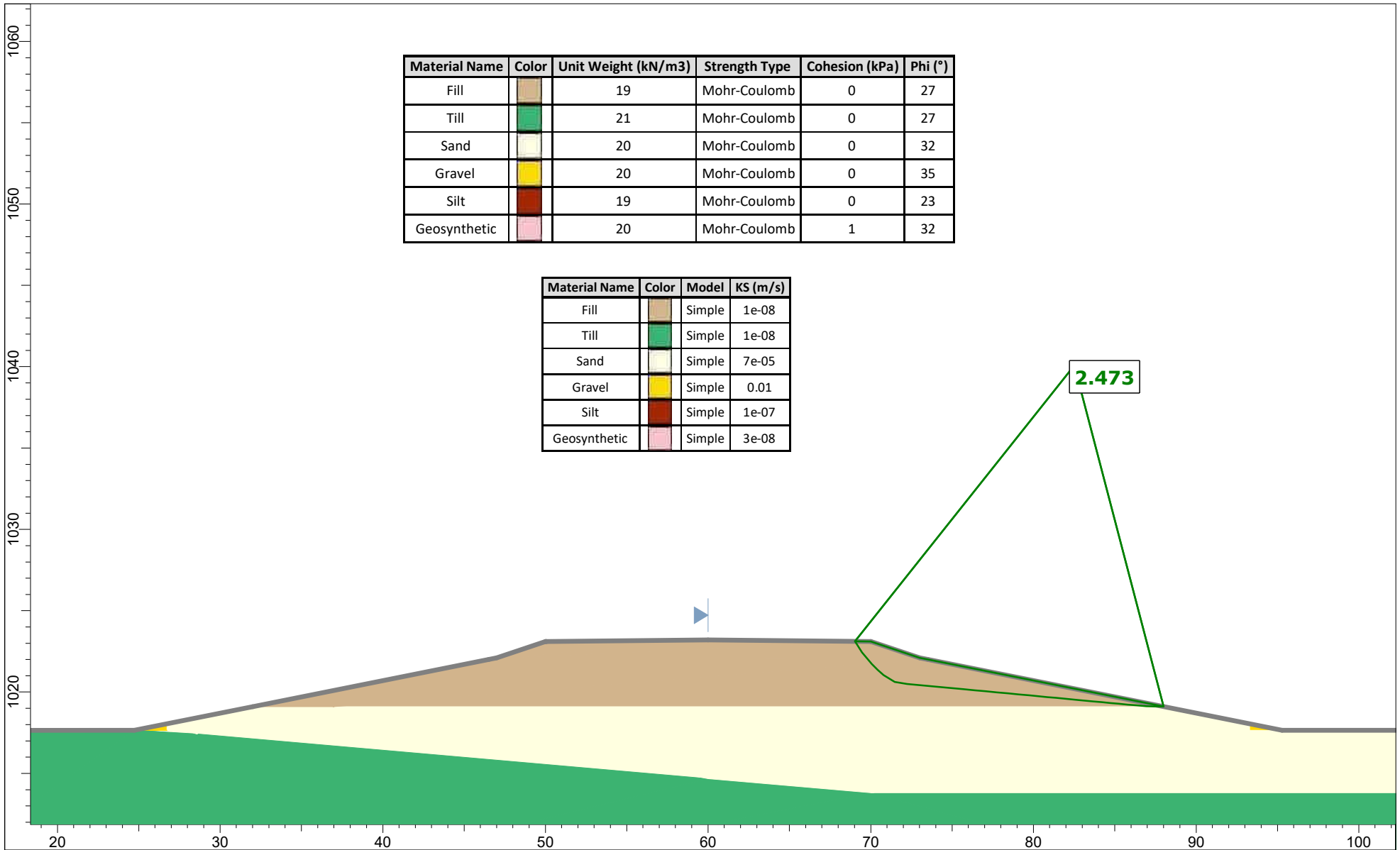
 SLIDEINTERPRET 9.037	Project FORW Reservoir Analysis		
	Group Section A - Reservoir 1, Topsoil along Downstream Embankment	Scenario Pseudo-Static Downstream	
	Drawn By CL	Company MPE a Division of Englobe	
	Figure Figure C.11	File Name 29121-005-11	



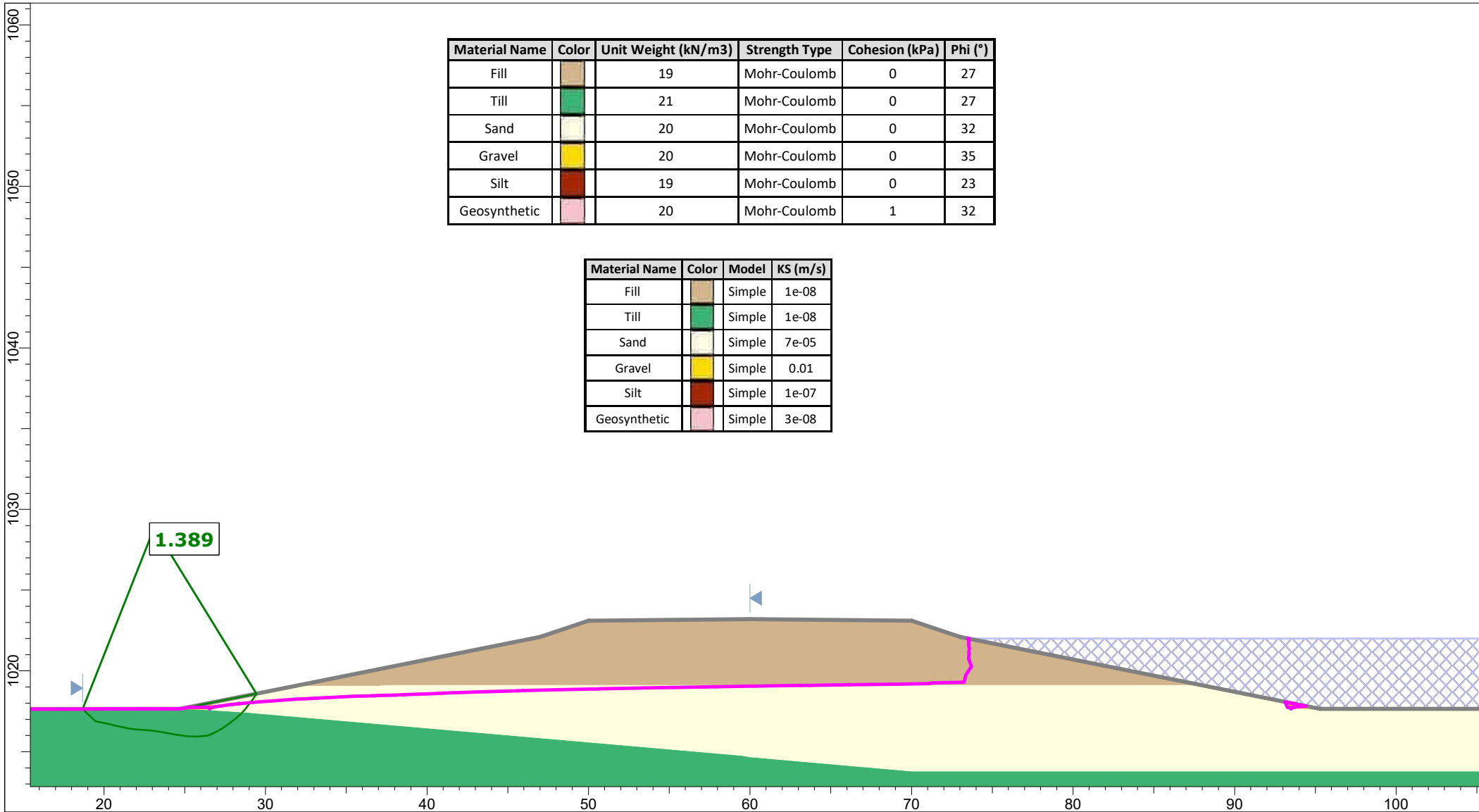
 SLIDEINTERPRET 9.037	Project FORW Reservoir Analysis		
	Group Section A - Reservoir 1, Topsoil along Downstream Embankment	Scenario Pseudo-Static Upstream	
	Drawn By CL	Company MPE a Division of Englobe	
	Figure Figure C.12	File Name 29121-005-11	



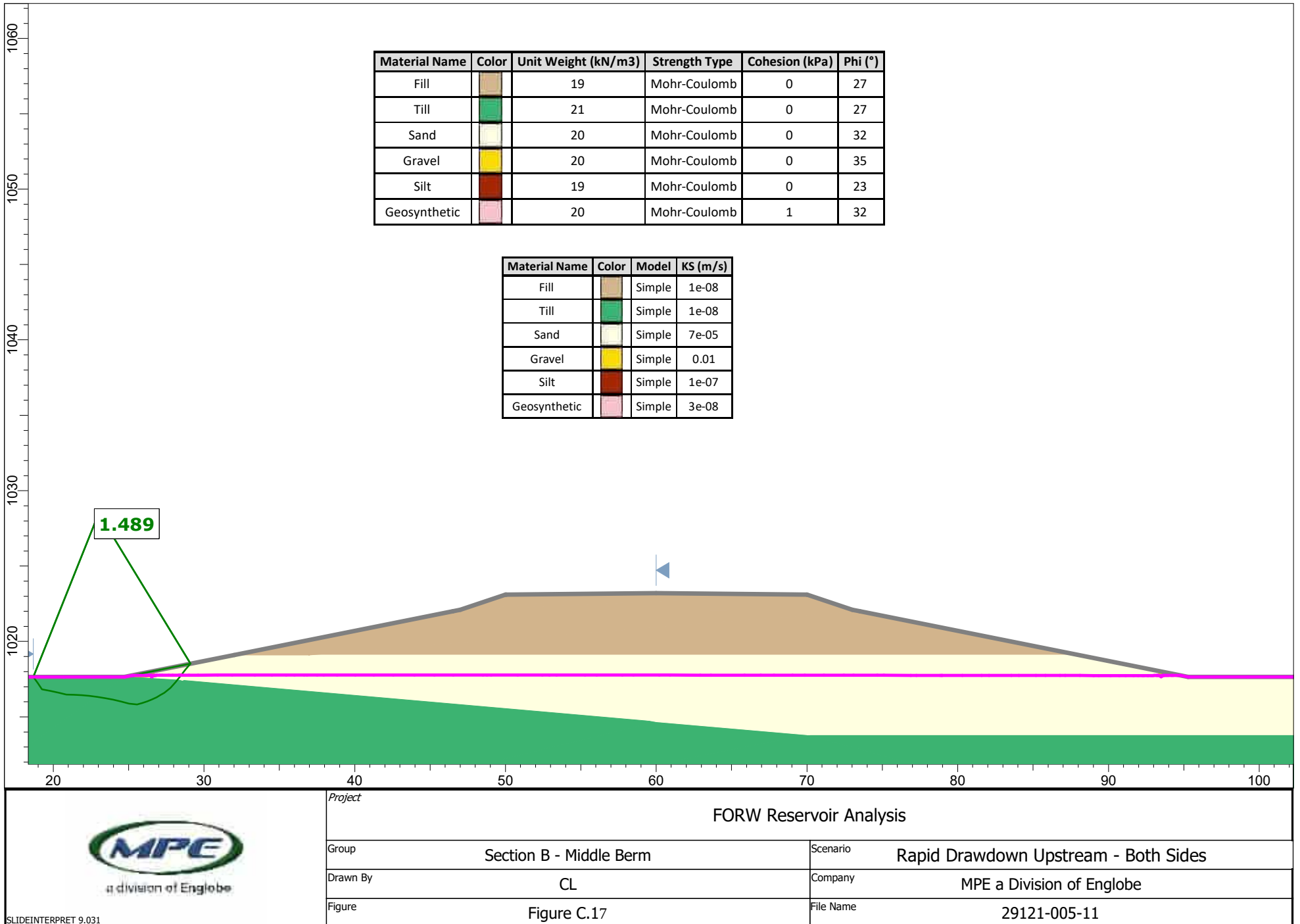


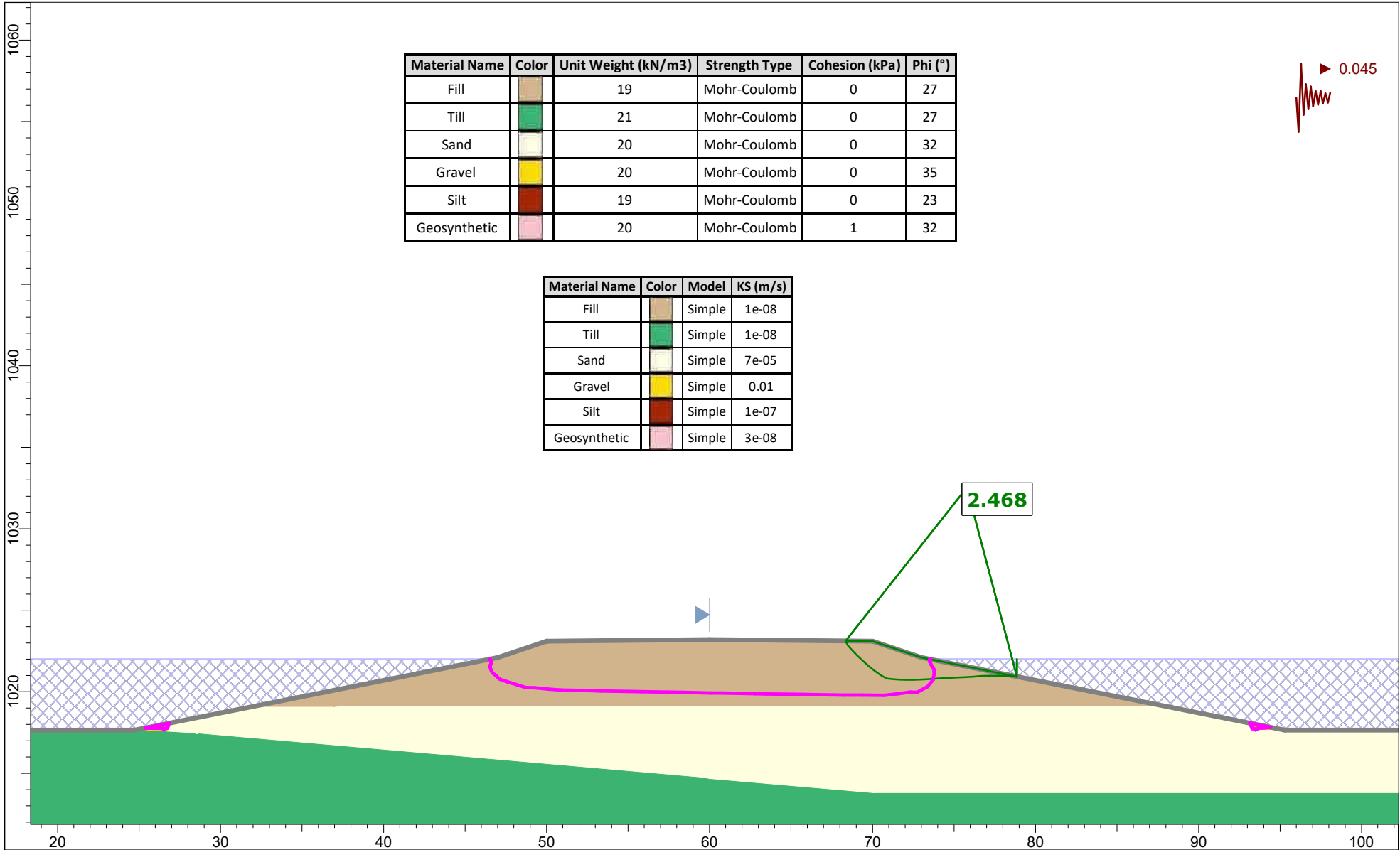


Project		FORW Reservoir Analysis	
Group	Section B - Middle Berm	Scenario	End of Construction Downstream
Drawn By	CL	Company	MPE a Division of Englobe
Figure	Figure C.15	File Name	29121-005-11



Project			
FORW Reservoir Analysis			
Group	Section B - Middle Berm		Scenario
Rapid Drawdown Upstream - One Side		Company	MPE a Division of Englobe
Drawn By	CL		File Name
Figure C.16		29121-005-11	



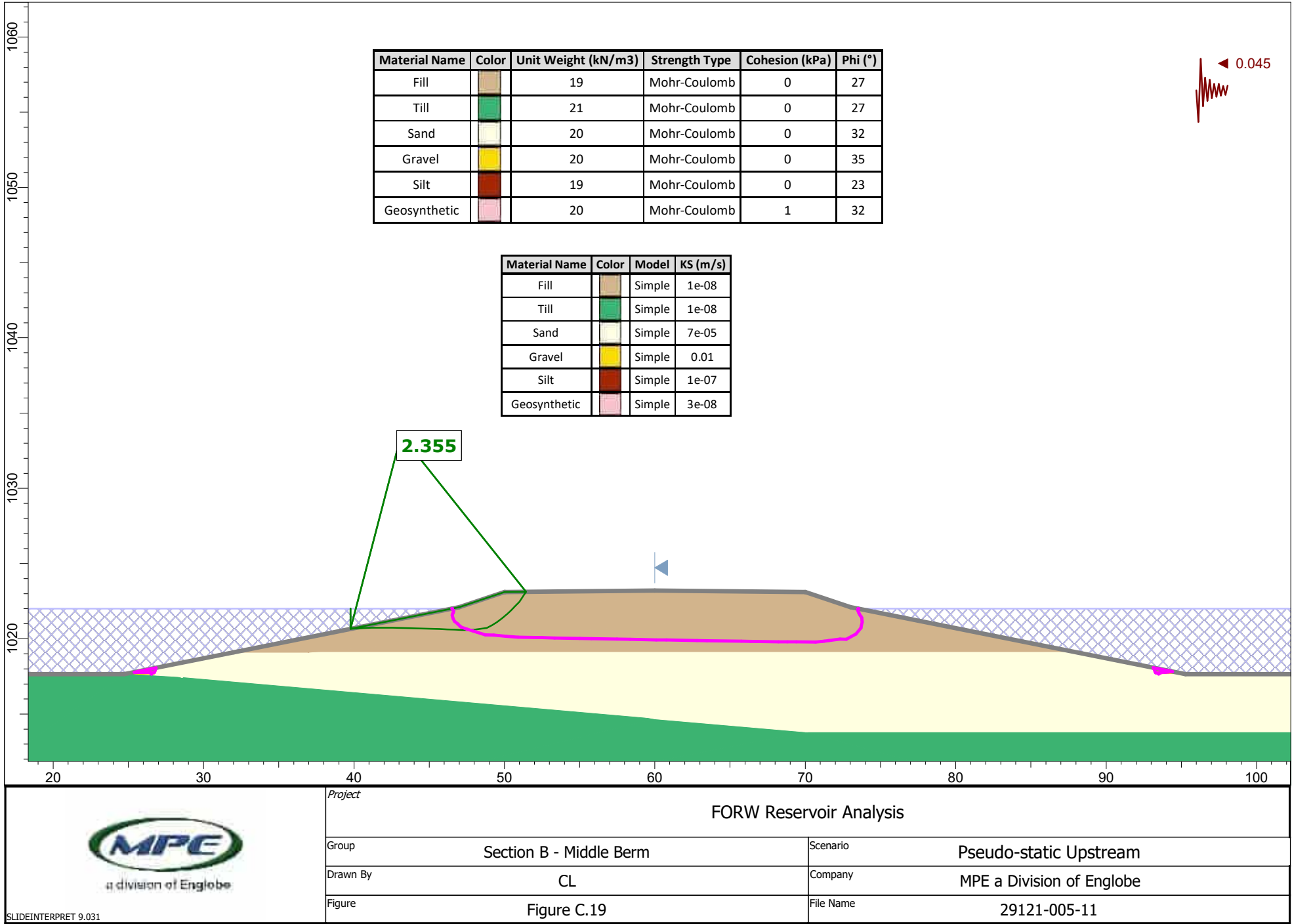


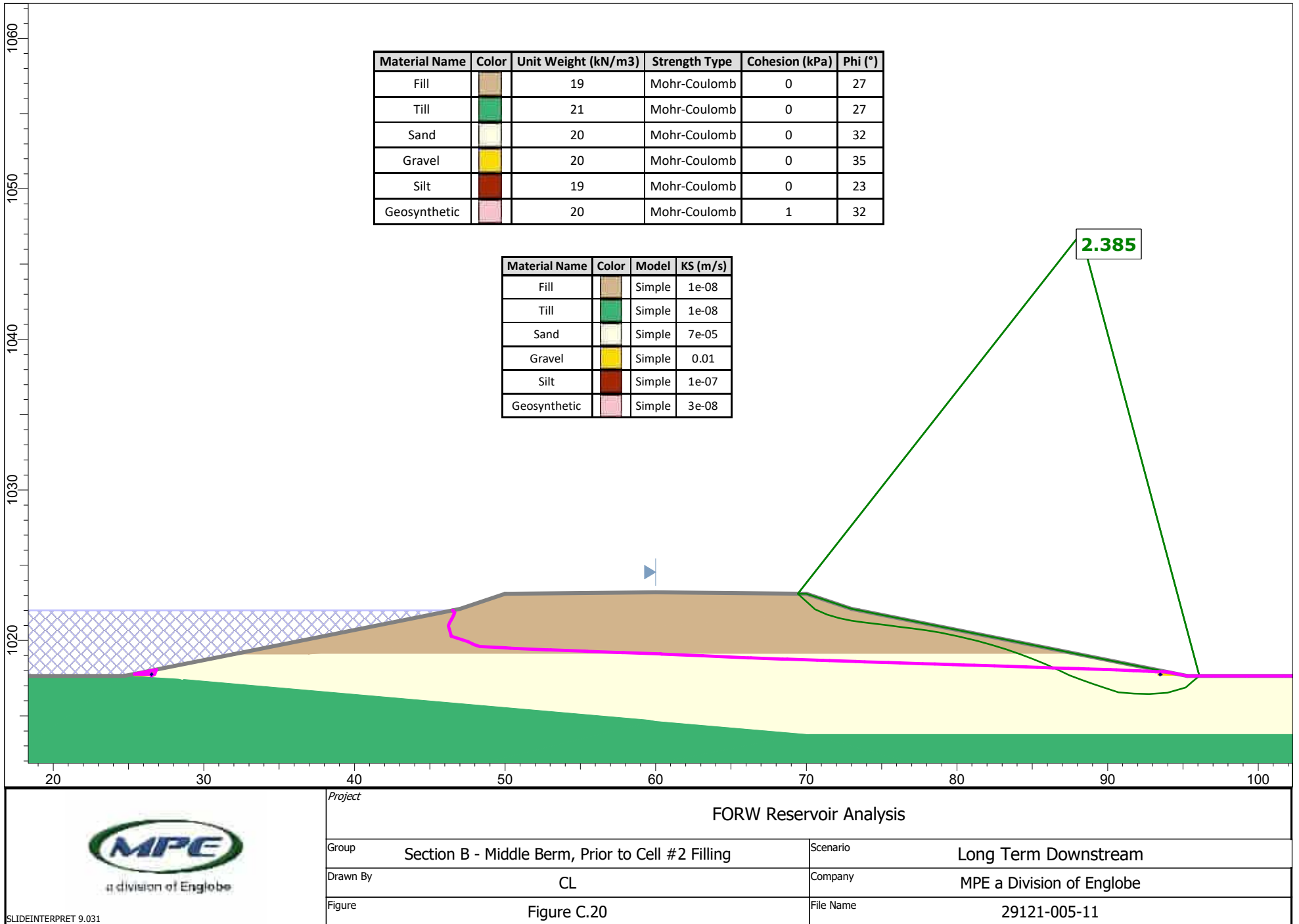
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
Fill		19	Mohr-Coulomb	0	27
Till		21	Mohr-Coulomb	0	27
Sand		20	Mohr-Coulomb	0	32
Gravel		20	Mohr-Coulomb	0	35
Silt		19	Mohr-Coulomb	0	23
Geosynthetic		20	Mohr-Coulomb	1	32

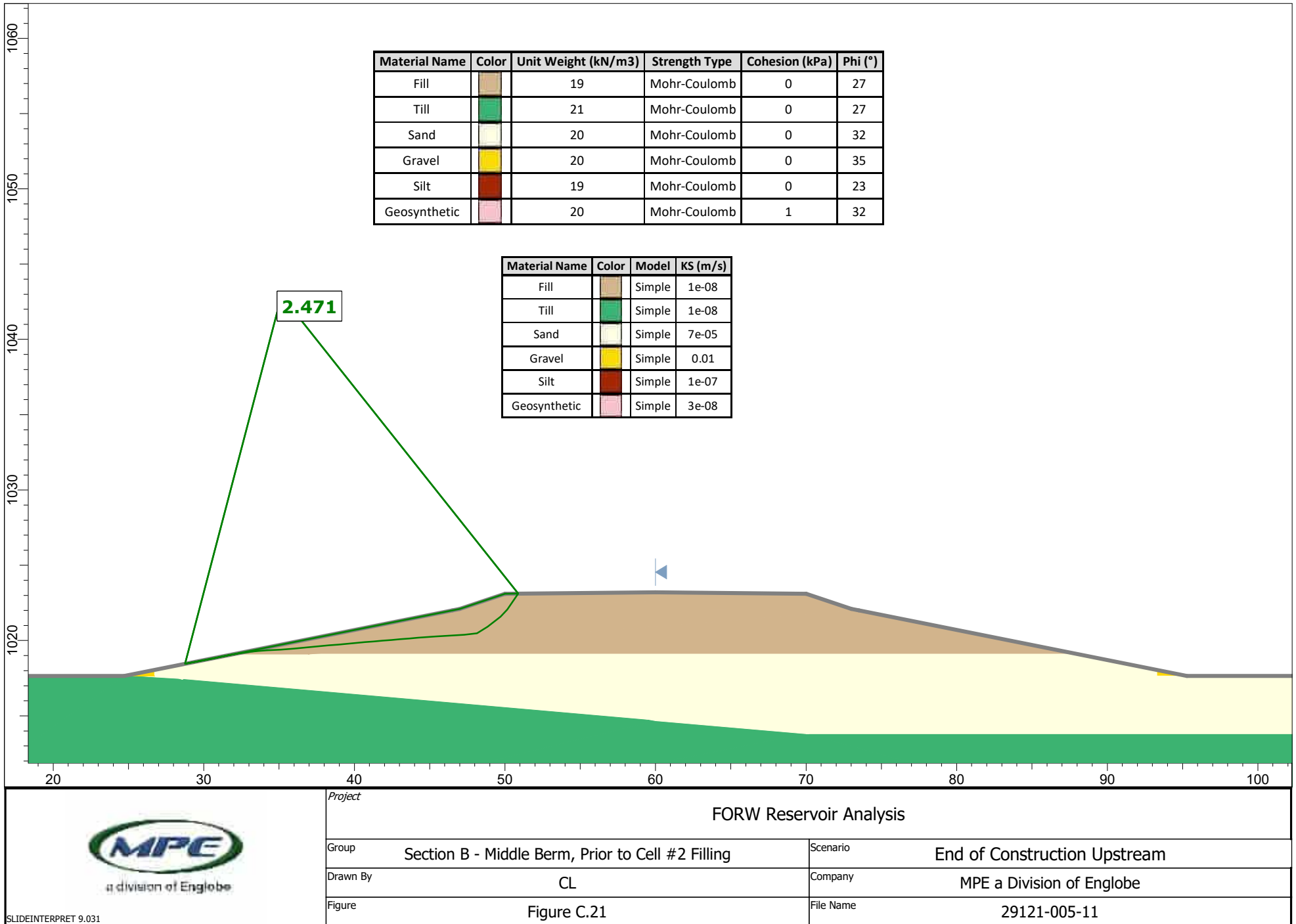
Material Name	Color	Model	KS (m/s)
Fill		Simple	1e-08
Till		Simple	1e-08
Sand		Simple	7e-05
Gravel		Simple	0.01
Silt		Simple	1e-07
Geosynthetic		Simple	3e-08

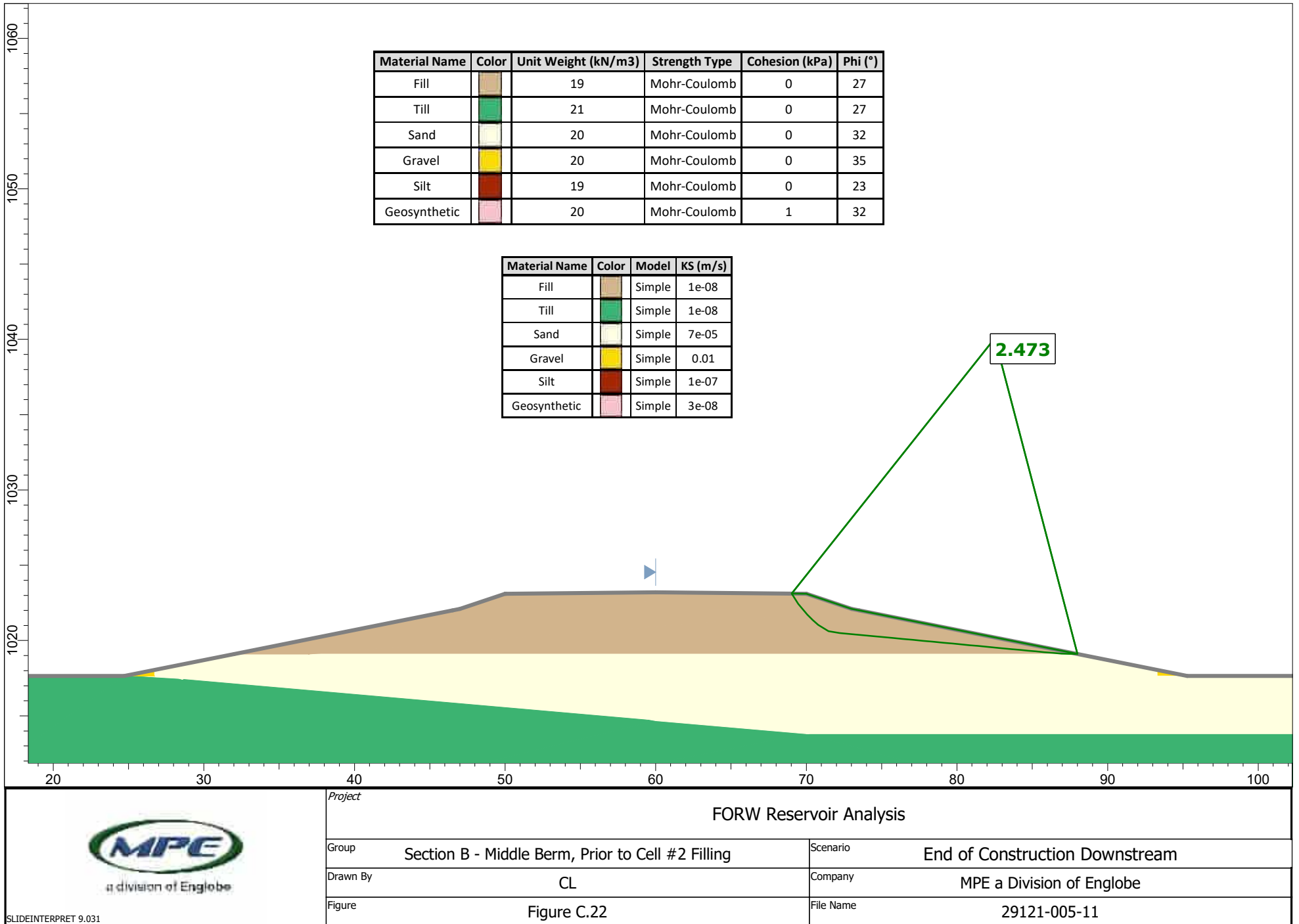


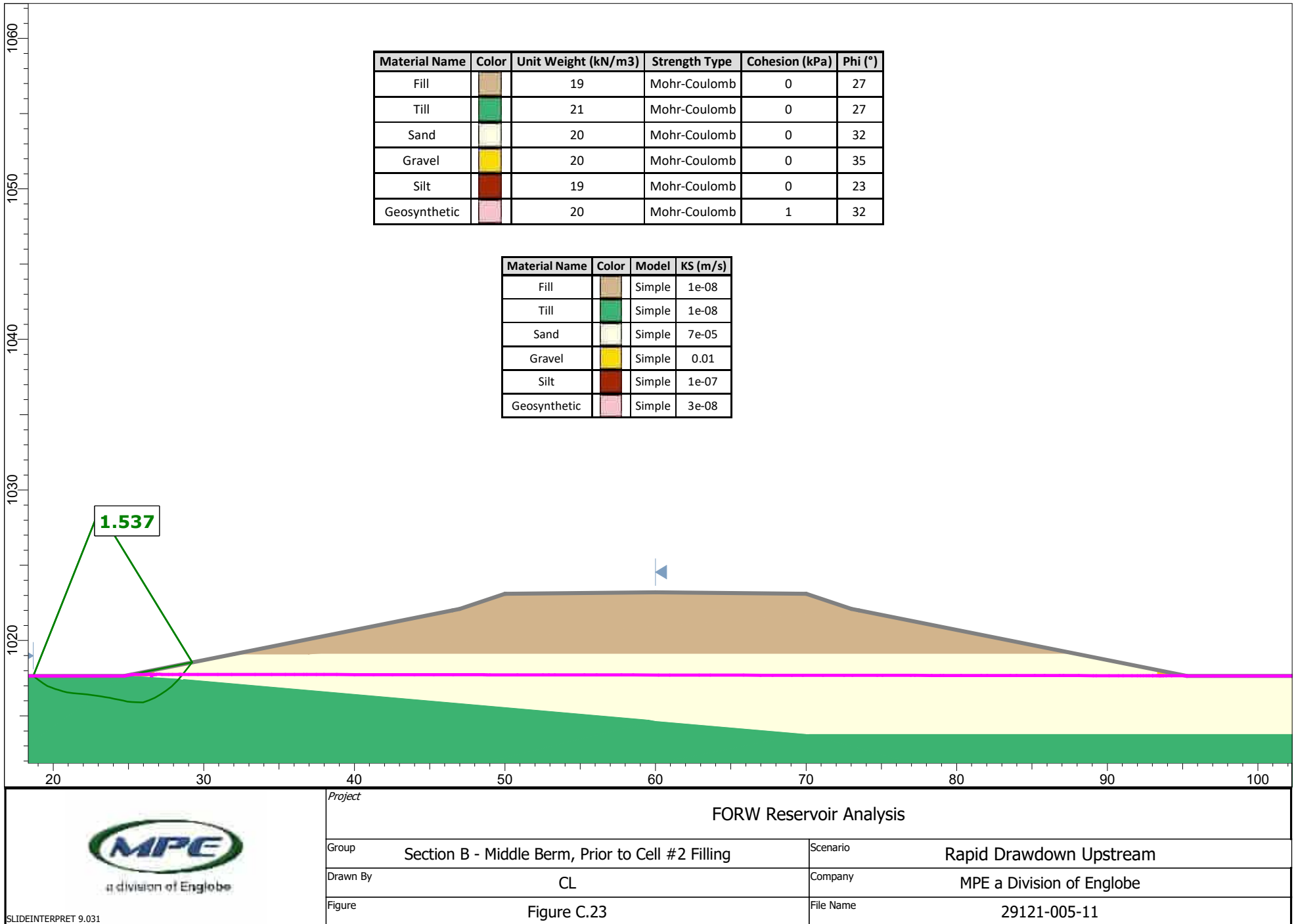
Project			
FORW Reservoir Analysis			
Group	Section B - Middle Berm		Scenario
Drawn By	CL		Company
Figure	Figure C.18		File Name
			29121-005-11

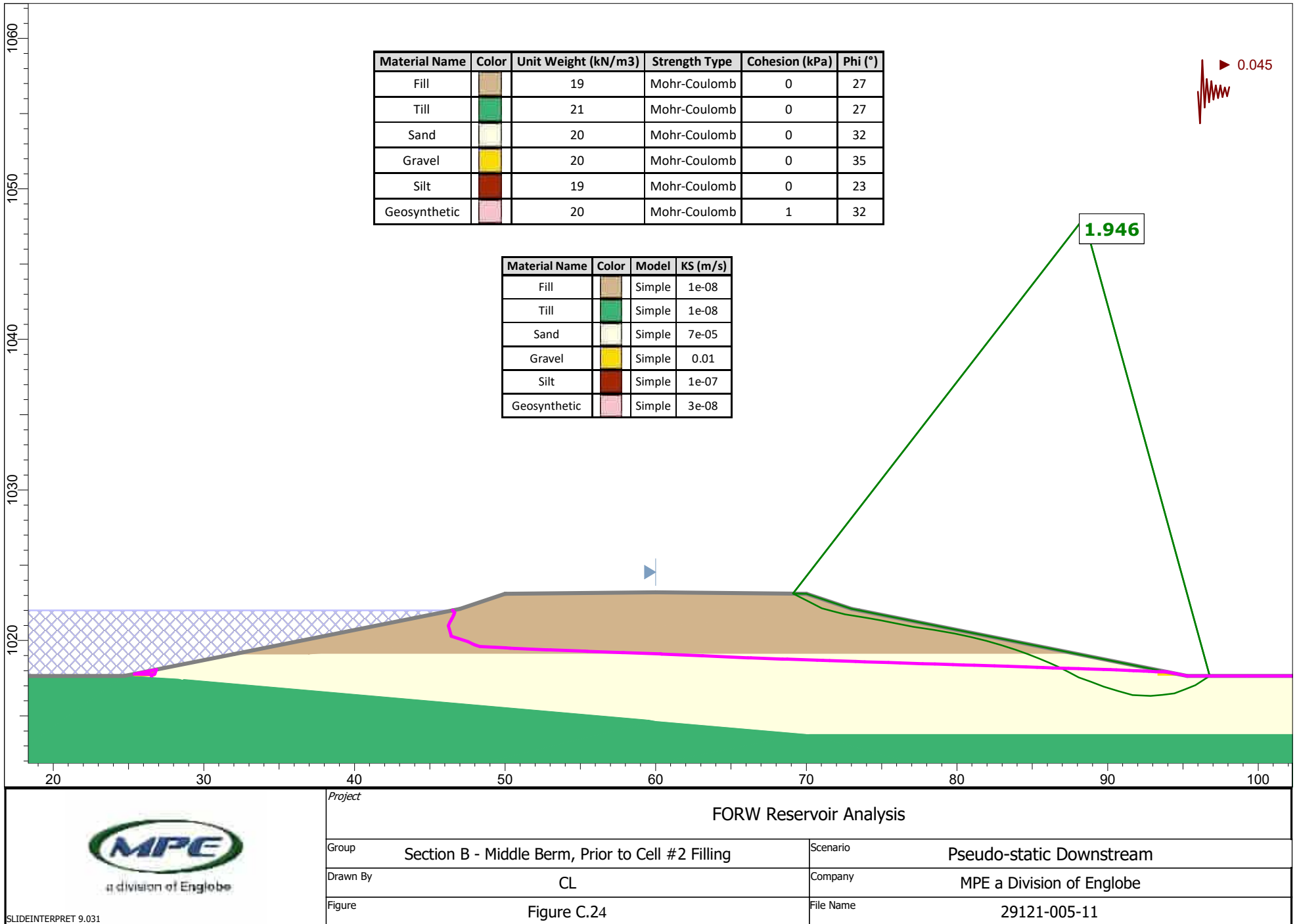


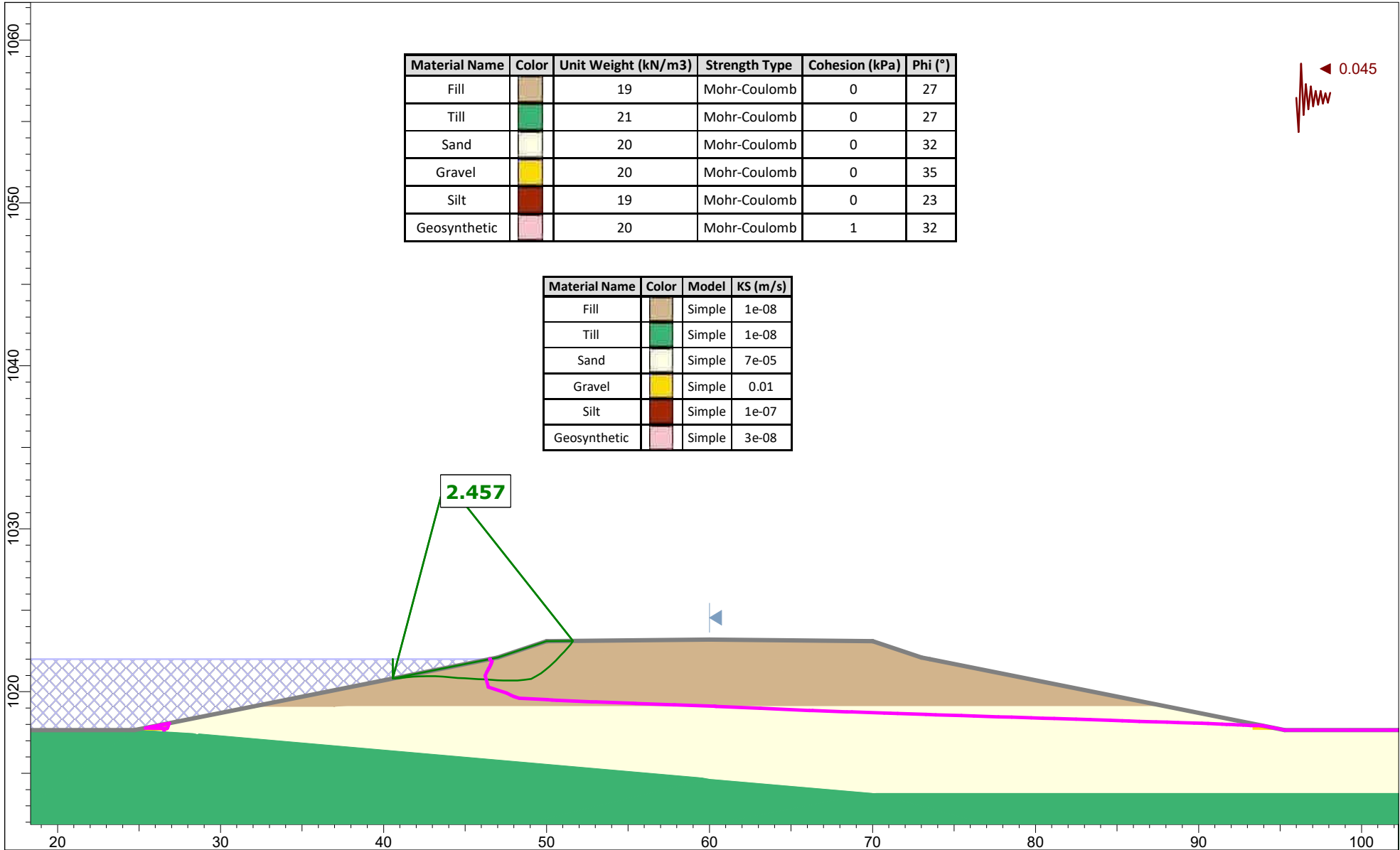












Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)
Fill		19	Mohr-Coulomb	0	27
Till		21	Mohr-Coulomb	0	27
Sand		20	Mohr-Coulomb	0	32
Gravel		20	Mohr-Coulomb	0	35
Silt		19	Mohr-Coulomb	0	23
Geosynthetic		20	Mohr-Coulomb	1	32

Material Name	Color	Model	KS (m/s)
Fill		Simple	1e-08
Till		Simple	1e-08
Sand		Simple	7e-05
Gravel		Simple	0.01
Silt		Simple	1e-07
Geosynthetic		Simple	3e-08

Project		FORW Reservoir Analysis	
Group	Section B - Middle Berm, Prior to Cell #2 Filling	Scenario	Pseudo-static Upstream
Drawn By	CL	Company	MPE a Division of Englobe
Figure	Figure C.25	File Name	29121-005-11

APPENDIX D:

BOREHOLE LOGS

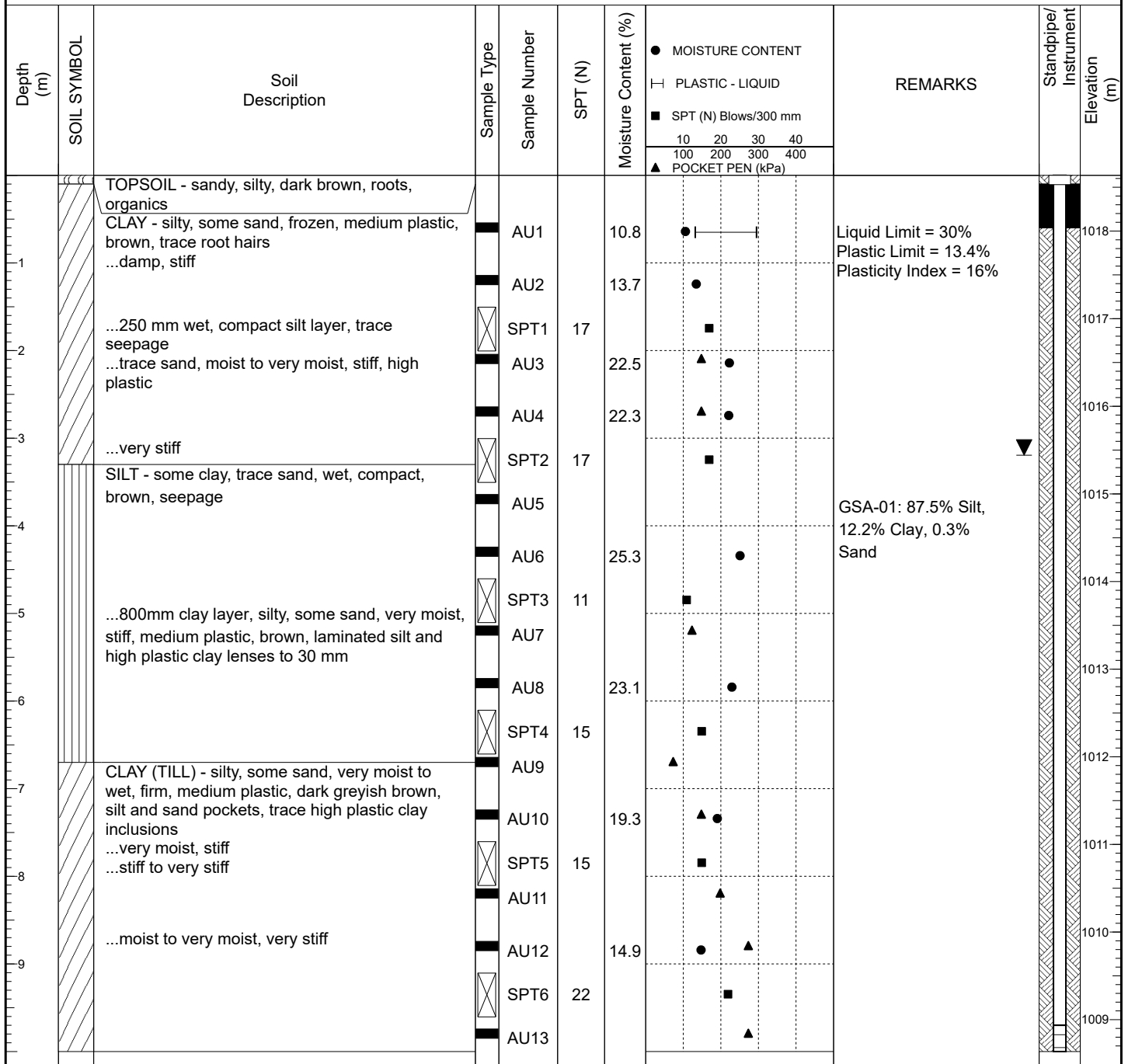


Engineering Ltd.

BOREHOLE No : 21BH001

PAGE 1 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1018.64m N 5631924.000 E 300251.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1015.53 m



Notes:

No Seepage, Sloughing to 8.5 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 12.7 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1018.64m N 5631924.000 E 300251.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1015.53 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
11		...moist, dark grey, sandstone and claystone fragments to 10 mm	■	AU14	13.3	●			1008
			⊗	SPT7	25	■			
			■	AU15		▲			1007
12		SILT - sandy, trace clay, wet, dense, dark grey	■	AU16	22.4	●			1006
			⊗	SPT8	36	■			
13		End of Borehole @12.7 m							
14									
15									
16									
17									
18									
19									

Notes:

No Seepage, Sloughing to 8.5 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 12.7 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

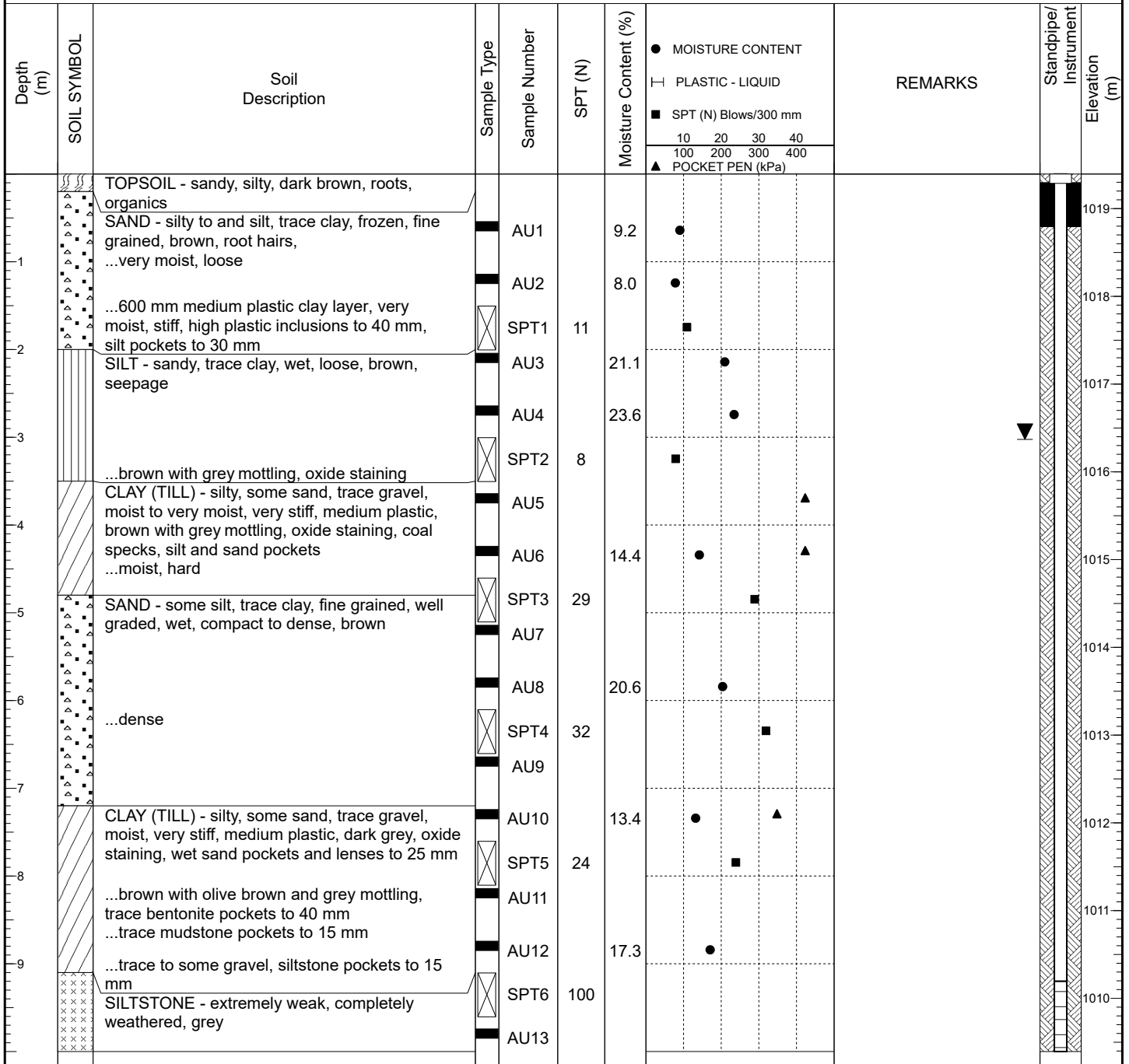


Engineering Ltd.

BOREHOLE No : 21BH002

PAGE 1 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1019.39m N 5631758.000 E 300247.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1016.45 m



Notes:

No Seepage, Sloughing to 11.5 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 12.2 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis



Engineering Ltd.

BOREHOLE No : 21BH002

PAGE 2 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1019.39m N 5631758.000 E 300247.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1016.45 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11	XXXXX	...interbedded brown sandstone and blackish dark brown mudstone layers to 200 mm	■	AU14	100	17.2			1009
	XXXXX		⊗	SPT7					1008
12	XXXXX		■	AU16		17.8			1007
		End of Borehole @12.2 m							1006
13									1005
14									1004
15									1003
16									1002
17									1001
18									1000
19									

Notes:

No Seepage, Sloughing to 11.5 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 12.2 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith
Reviewed By: Trevor Curtis

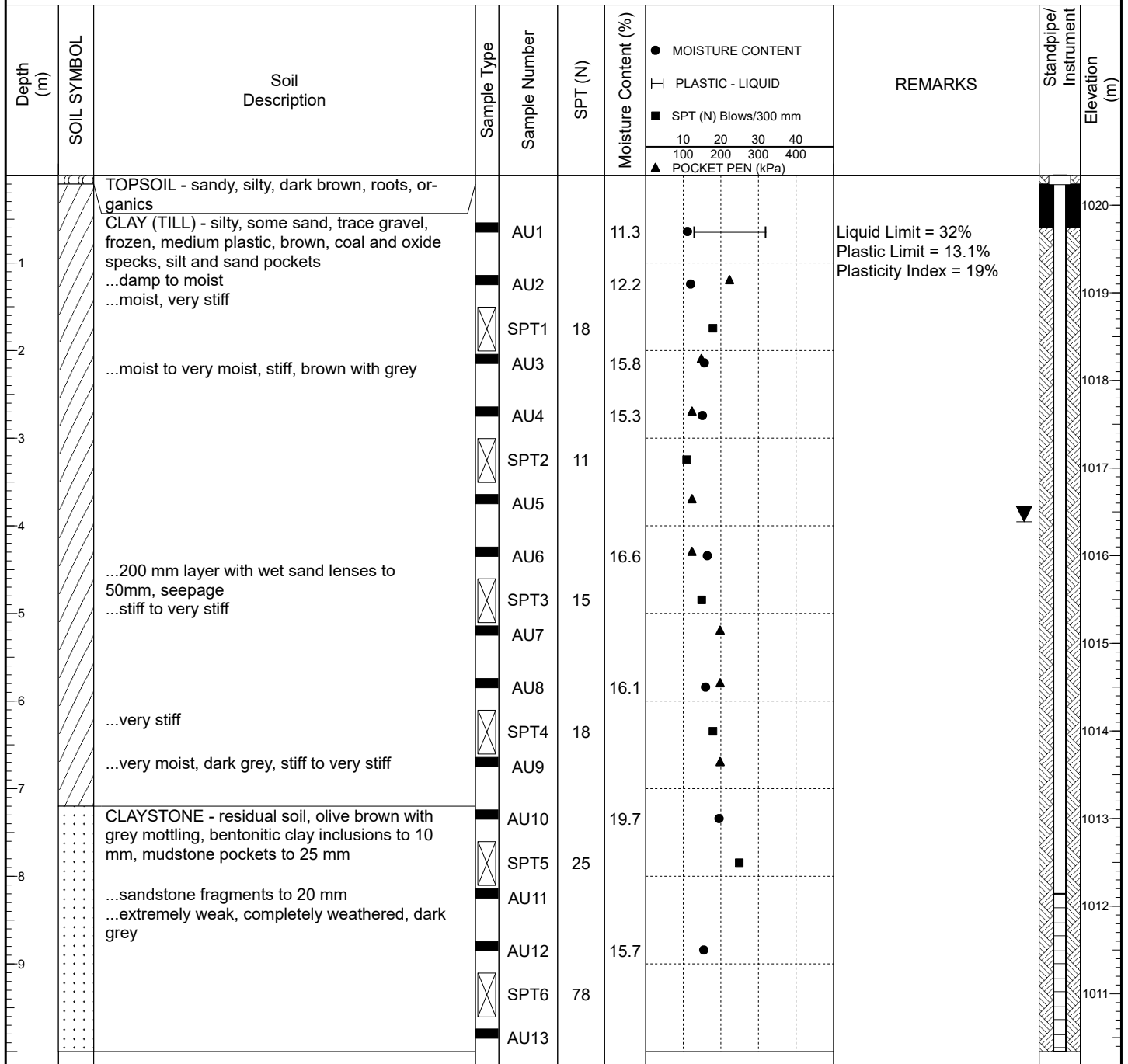


Engineering Ltd.

BOREHOLE No : 21BH003

PAGE 1 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1020.34m N 5631574.000 E 300241.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1016.47 m



Notes:

No Seepage or Sloughing Upon Completion. Slotted 25 mm PVC Standpipe Installed to 11.2 m.
Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1020.34m N 5631574.000 E 300241.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1016.47 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		...400 mm sandstone layer, extremely weak, completely weathered, dark grey	■	AU14	8.8	●			1010
		End of Borehole @11.2 m	⊗	SPT7	78				1009
12									1008
13									1007
14									1006
15									1005
16									1004
17									1003
18									1002
19									1001

Notes:

No Seepage or Sloughing Upon Completion. Slotted 25 mm PVC Standpipe Installed to 11.2 m.
Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

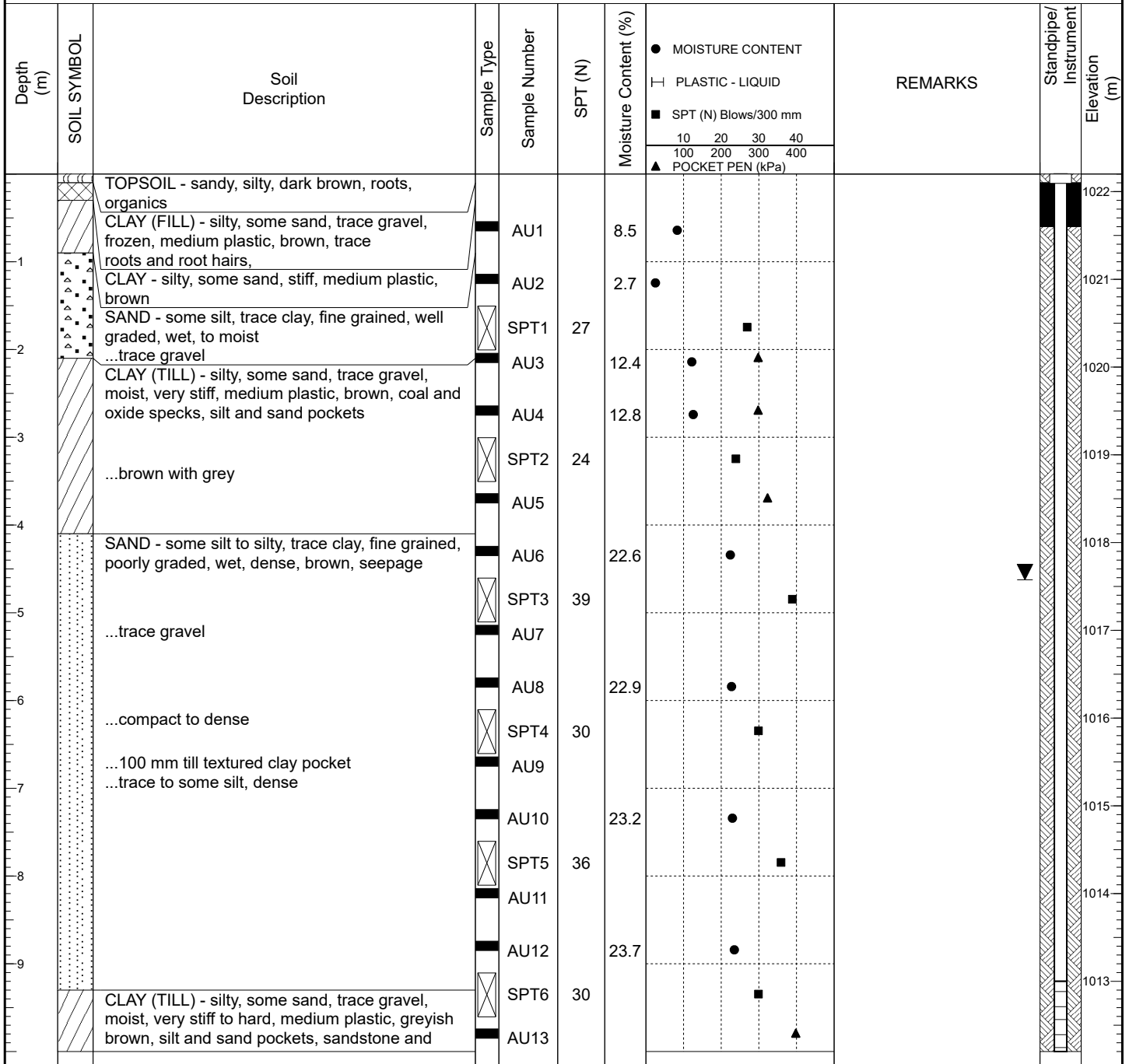


Engineering Ltd.

BOREHOLE No : 21BH004

PAGE 1 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1022.20m N 5631392.000 E 300228.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1017.66 m



Notes:

No Seepage, Sloughing to 7.9 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 8.5 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1022.20m N 5631392.000 E 300228.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1017.66 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
		mudstone fragments to 15 mm		AU14					1012
11		...trace to some sandstone fragments to 20 mm		SPT7	27				1011
		...very stiff, claystone pockets to 50 mm		AU15					1011
12				AU16					1010
		End of Borehole @12.2 m							
13									1009
14									1008
15									1007
16									1006
17									1005
18									1004
19									1003

Notes:

No Seepage, Sloughing to 7.9 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 8.5 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis



Engineering Ltd.

BOREHOLE No : 21BH005

PAGE 1 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1020.46m N 5631383.000 E 300504.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1015.86 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)		
1		TOPSOIL (100 mm) - sandy, silty, dark brown, roots, organics		AU1	8.7			1020
		CLAY - silty, sandy, frozen, low plastic, brown ...damp, stiff		AU2	11.5			1019
2		... 300 mm silt layer, very moist, compact	SPT1	17				
		SAND - trace silt, trace clay, fine grained, poorly graded, moist, compact, brown		AU3	4.2			1018
3				AU4	9.7			1017
			SPT2	27				
4		...500 mm till textured layer, moist to very moist, very stiff, coal and oxide specks, silt and sand pockets		AU5				1016
5		...100 mm wet sand pocket, seepage	SPT3	37				
		...some silt, fine grained, well graded, wet		AU6	15.8			1015
6				AU7				1014
			SPT4	23				
7		...trace silt, fine grained, poorly graded, grey		AU8	21.5			1013
				AU9				1012
8		...trace gravel, fine grained, well graded, very dense, trace coarse grained sand	SPT5	22				
				AU10	19.5			1011
9				AU11				
			SPT6	55				
				AU12	20.4			
				AU13				

Notes:

No Seepage, Sloughing to 6.1 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 7.9 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1020.46m N 5631383.000 E 300504.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1015.86 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11				AU14	27.8				1010
12		CLAY (TILL) - silty, some sand, trace gravel, very moist, very stiff, medium plastic, dark grey, silt and sand pockets, trace sandstone inclusions		AU15					1009
		End of Borehole @12.2 m		AU16	17.1				1008
13									1007
14									1006
15									1005
16									1004
17									1003
18									1002
19									1001

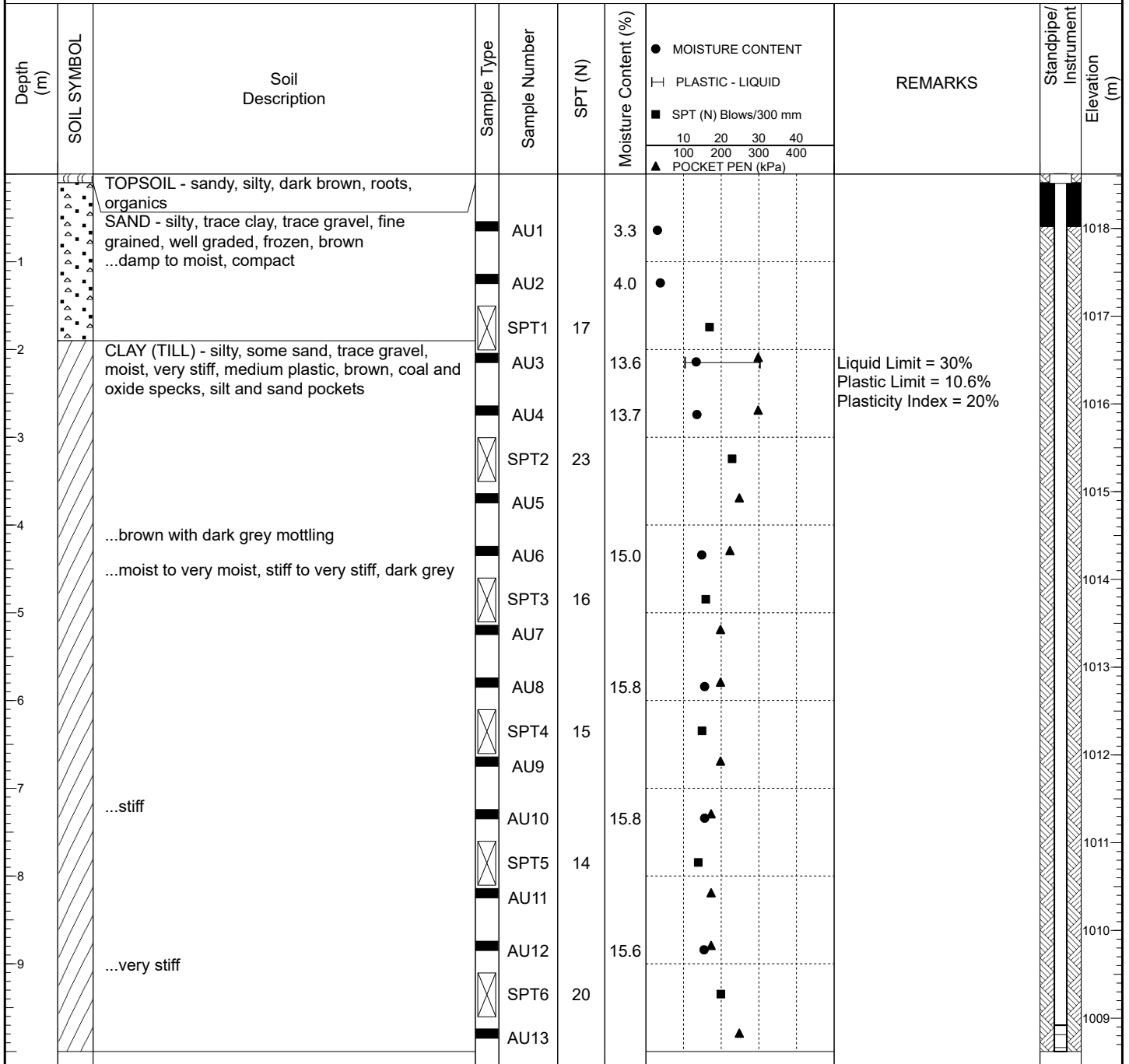
Notes:

No Seepage, Sloughing to 6.1 m Upon Completion. Slotted 25 mm PVC Standpipe Installed to 7.9 m. Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1018.62m N 5631566.000 E 300515.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1007.50 m



Notes:

No Seepage or Sloughing Upon Completion. Slotted 25 mm PVC Standpipe Installed to 12.7 m.
 Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis



Engineering Ltd.

BOREHOLE No : 21BH006

PAGE 2 OF 2

CLIENT	Urban Systems	PROJECT NAME	Foothills Sub Regional Water Design
PROJECT NUMBER	29121-005-04	PROJECT LOCATION	LSD 13-21-21-28 W4M
DATE STARTED	02/19/2021	COMPLETED	02/19/2020
DRILLING CONTRACTOR	Chilako Drilling	GROUND ELEVATION	1018.62m N 5631566.000 E 300515.000
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	1007.50 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
11		...dark greyish brown		AU14		14.9			1008
			☒	SPT7	21				
				AU15					1007
12				AU16		15.3			
			☒	SPT8	20				1006
13		End of Borehole @12.7 m							
14									1005
15									1004
16									1003
17									1002
18									1001
19									1000
									999

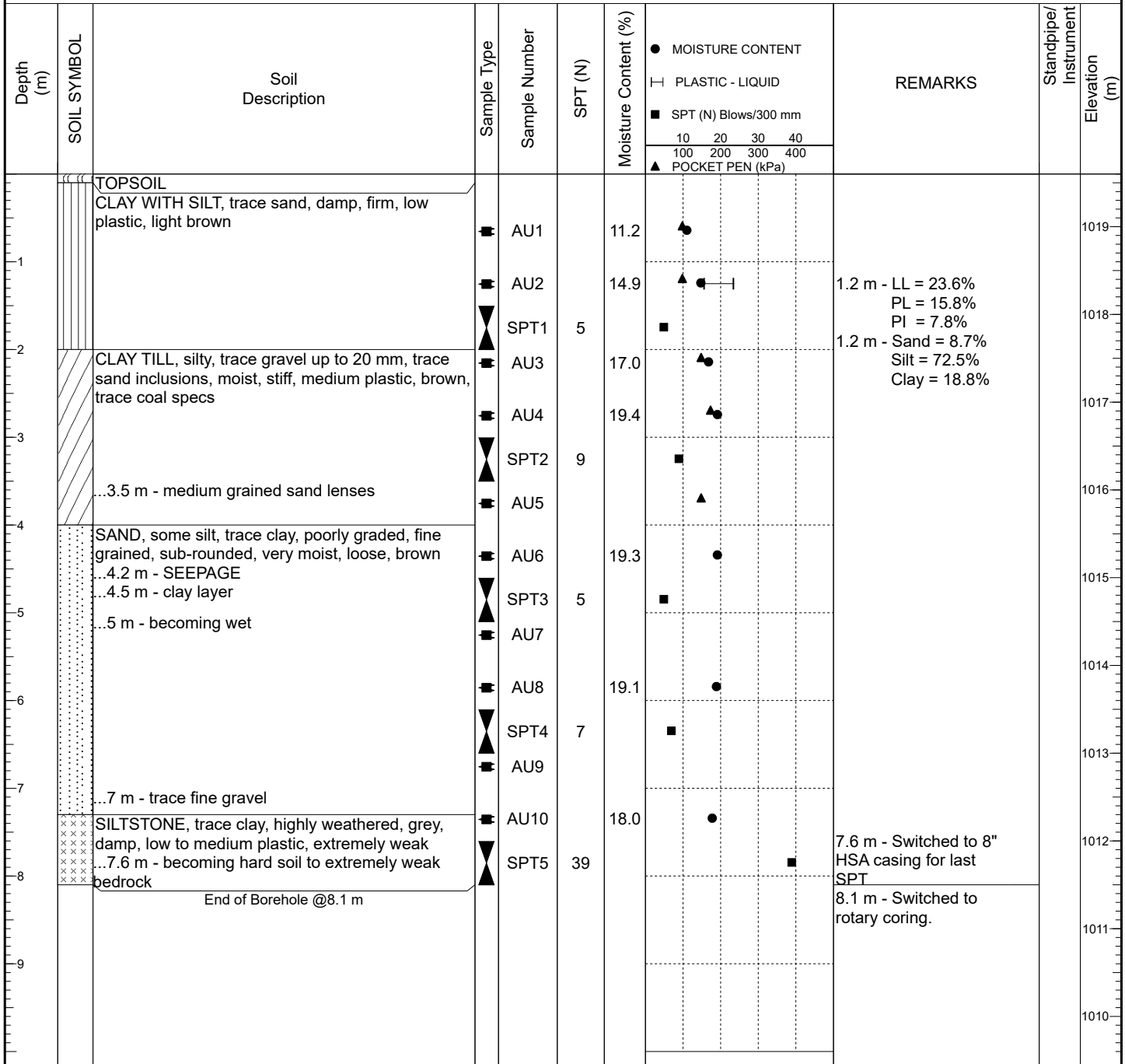
Notes:

No Seepage or Sloughing Upon Completion. Slotted 25 mm PVC Standpipe Installed to 12.7 m.
Indicated Water Level Measured on February 26, 2021.

Logged By: Stuart Smith

Reviewed By: Trevor Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/22/2022
GROUND ELEVATION	1019.60m	N	5631864.179 E 300169.579
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 4.2 m. Minor sloughing observed upon completion. Switched to rotary coring at 8.1 m. See 22CH001 log for backfill information.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/22/2022
GROUND ELEVATION	1019.60m	N	5631863.640
GROUND WATER ELEVATION / DEPTH	1015.95 m	E	300169.685
DRILLING CONTRACTOR	Val's Drilling	DATE GROUND WATER RECORDED	09/20/2022
CORING TYPE	HQ3	DIAMETER (mm)	61

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	Run Depth (m)	Run Number	RQD TCR SCR	Fracture Index (#/m)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
									● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 50 100 150 200 ▲ POCKET PEN (kPa)			
1		OVERBURDEN. Refer to 22BH001 for Log Report.										1019
2												1018
3												1017
4												1016
5												1015
6												1014
7												1013
8												1012
9												1011
8.08 - 9.60		SILTSTONE, some clay, highly weathered, light grey, damp, medium plastic, extremely weak, massive ...8.1 m - 100 mm of slough ...8.8 m - 30 mm clayey layer ...9.2 m - 250 mm very weak layer ...9.6 m - becoming interbedded sandstone and claystone layers ...9.8 m - vertical fracture, 100 mm of sandstone pieces	RC1			1	100	1				1010
9.60 - 11.12			RC2			2	54	1				
							59					
							42					

Notes:

Target depth of 19.5 m achieved. Corehole completed as a well. Water level read at a depth of 3.65 m on September 20, 2022.

Monitoring Installation Pipe Work

Depth Top	Depth Bottom	Pipe Type
0.00	10.98	PLAIN
10.98	14.02	SLOTTED

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/22/2022
GROUND ELEVATION	1019.60m	N	5631863.640
E	300169.685		
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.95 m 3.65 m
CORING TYPE	HQ3	DIAMETER (mm)	61
DATE GROUND WATER RECORDED	09/20/2022		

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	Run Depth (m)	Run Number	RQD TCR SCR	Fracture Index (#/m)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
									● MOISTURE CONTENT □ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
11	XXXX	SILTSTONE, some clay, highly weathered, light grey, damp, medium plastic, extremely weak, massive		RC3	11.12	3	39	2				1009
	XXXX	...10.3 m - vertical fracture					55					
	XXXX	...10.4 m - sandy slough					37					
	XXXX	...10.5 m - 0.62 m of core loss										
	XXXX	...11.2 m - becoming residual soil, clay till with some gravel up to 30 mm										
12	XXXX	...11.7 m - cored through boulder		RC4	12.64	4	0	20				1008
	XXXX	...12.0 m - .68 m of core loss					26					
13	XXXX	...12.9 m - gravel up to 40 mm					4					1007
	XXXX	...13.0 m - 1.12 m of core loss										
14	XXXX	...14.1 m - 100 mm well graded, fine gravel layer with clay infill		RC5	14.16	5	12	20				1006
	XXXX						105					
15	XXXX						12					1005
16	XXXX	CLAYSTONE, silty, medium weathered, grey, damp, medium plastic, extremely weak, thinly laminated, interbedded siltstone layers, massive		RC6	15.68	6	68	3				1004
	XXXX						100					
17	XXXX	...17.2 m - highly fractured run		RC7	17.20	7	8	20				1003
	XXXX						79					
18	XXXX	...18.1 m - 0.2 m strong calcified shale layer					13					1002
	XXXX	...18.4 m - 0.32 m of core loss										
19	XXXX			RC8	18.72	8	68	4				1001
	XXXX						100					
	XXXX						70					1000

Notes:

Target depth of 19.5 m achieved. Corehole completed as a well. Water level read at a depth of 3.65 m on September 20, 2022.

Monitoring Installation Pipe Work

Depth Top	Depth Bottom	Pipe Type
0.00	10.98	PLAIN
10.98	14.02	SLOTTED

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/22/2022
GROUND ELEVATION	1019.60m	N	5631863.640
E	300169.685		
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.95 m 3.65 m
CORING TYPE	HQ3	DIAMETER (mm)	61
DATE GROUND WATER RECORDED	09/20/2022		

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	Run Depth (m)	Run Number	RQD TCR SCR	Fracture Index (#/m)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
									● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
21		CLAYSTONE, silty, medium weathered, grey, damp, medium plastic, extremely weak, thinly laminated, interbedded siltstone layers, massive										999
22												998
23												997
24												996
25												995
26												994
27												993
28												992
29												991
												990

Notes:

Target depth of 19.5 m achieved. Corehole completed as a well. Water level read at a depth of 3.65 m on September 20, 2022.

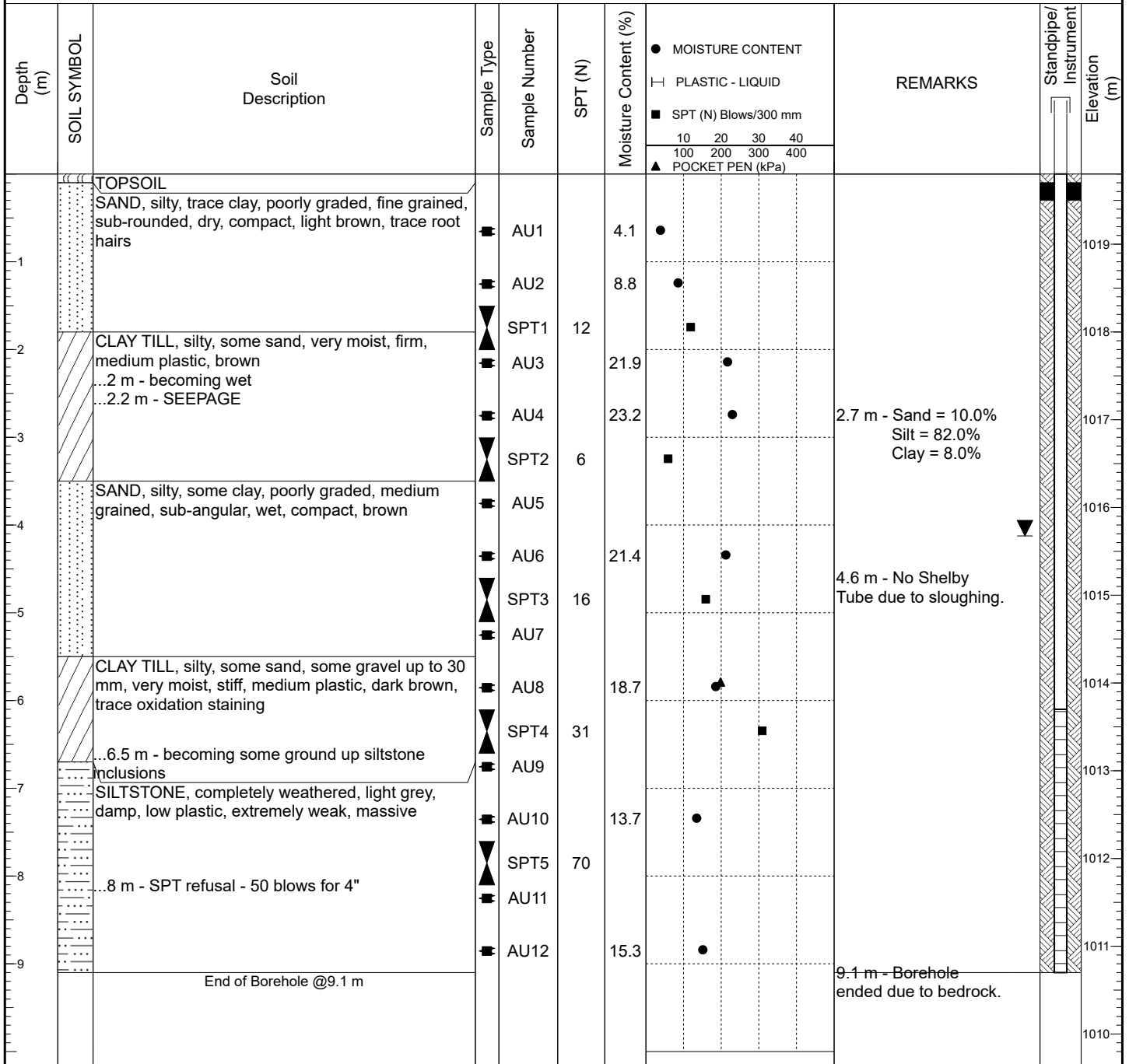
Monitoring Installation Pipe Work

Depth Top	Depth Bottom	Pipe Type
0.00	10.98	PLAIN
10.98	14.02	SLOTTED

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/23/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1019.80m N 5631843.144 E 300198.071
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	1015.76 m 4.04 m
		DATE GROUND WATER RECORDED	09/20/2022



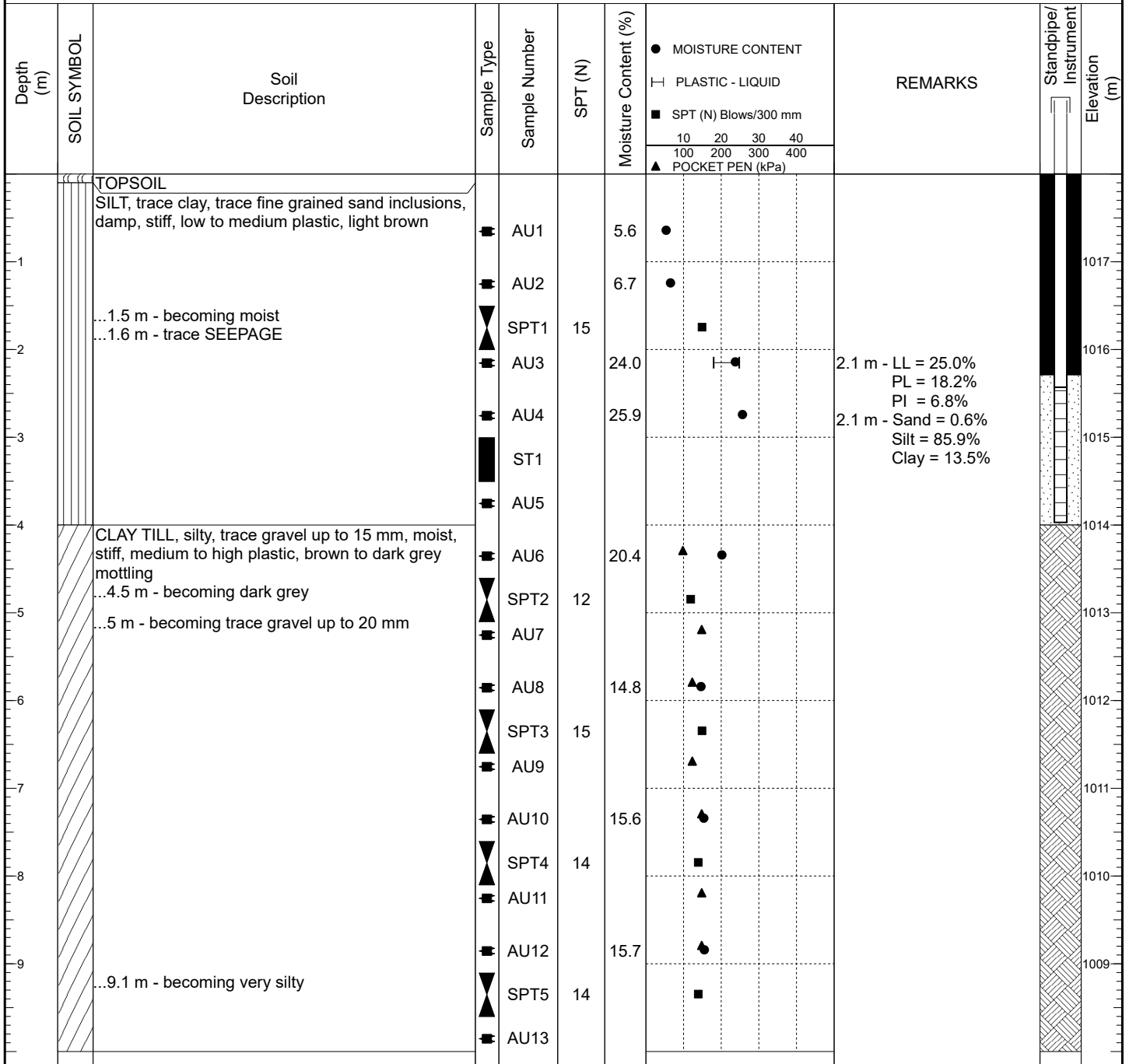
Notes:

Seepage observed at a depth of 2.2 m. Minor sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 9.1 m. Water level read at a depth of 4.04 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1018.00m N 5631785.148 E 300296.749
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	09/20/2022



Notes:

Seepage observed at a depth of 1.6 m. Minor sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 3.97 m.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH003**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/24/2022 COMPLETED 08/24/2022 GROUND ELEVATION 1018.00m N 5631785.148 E 300296.749
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace gravel up to 15 mm, moist, stiff, medium to high plastic, brown to dark grey mottling	■	AU14	15.9	●			1007
		End of Borehole @10.7 m							1006
12									1005
13									1004
14									1003
15									1002
16									1001
17									1000
18									999
19									

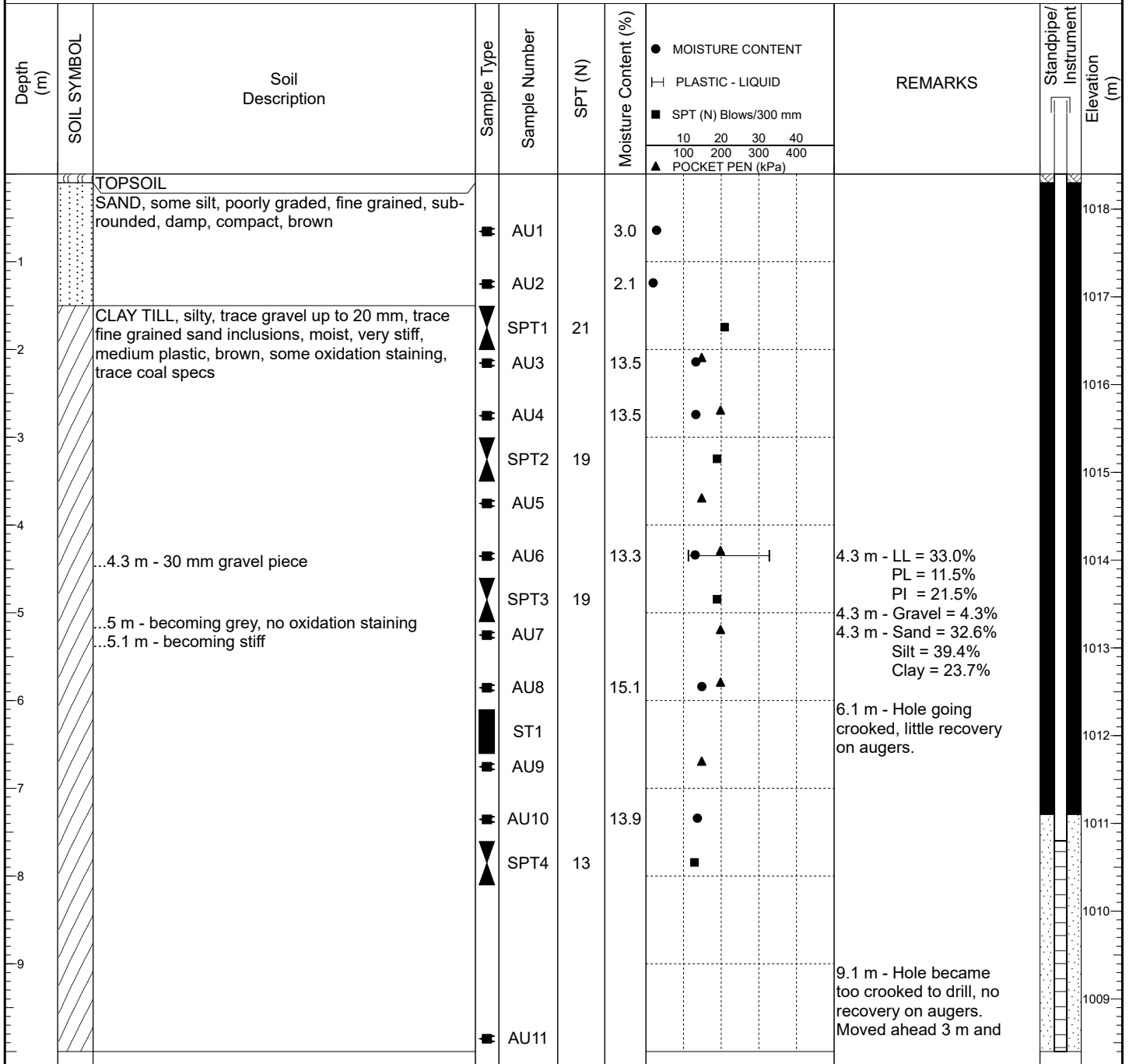
Notes:

Seepage observed at a depth of 1.6 m. Minor sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 3.97 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/24/2022	COMPLETED	08/24/2022	GROUND ELEVATION	1018.40m N 5631693.899 E 300393.328
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1008.10 m	10.30 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

No seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 10.3 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH004**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/24/2022 COMPLETED 08/24/2022 GROUND ELEVATION 1018.40m N 5631693.899 E 300393.328
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH 1008.10 m 10.30 m
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace gravel up to 20 mm, trace fine grained sand inclusions, moist, very stiff, medium plastic, brown, some oxidation staining, trace coal specs End of Borehole @10.7 m					drilled down to 10.7 m to install well. AU11 taken from second hole.	▼	1008
12									1007
13									1006
14									1005
15									1004
16									1003
17									1002
18									1001
19									1000
									999

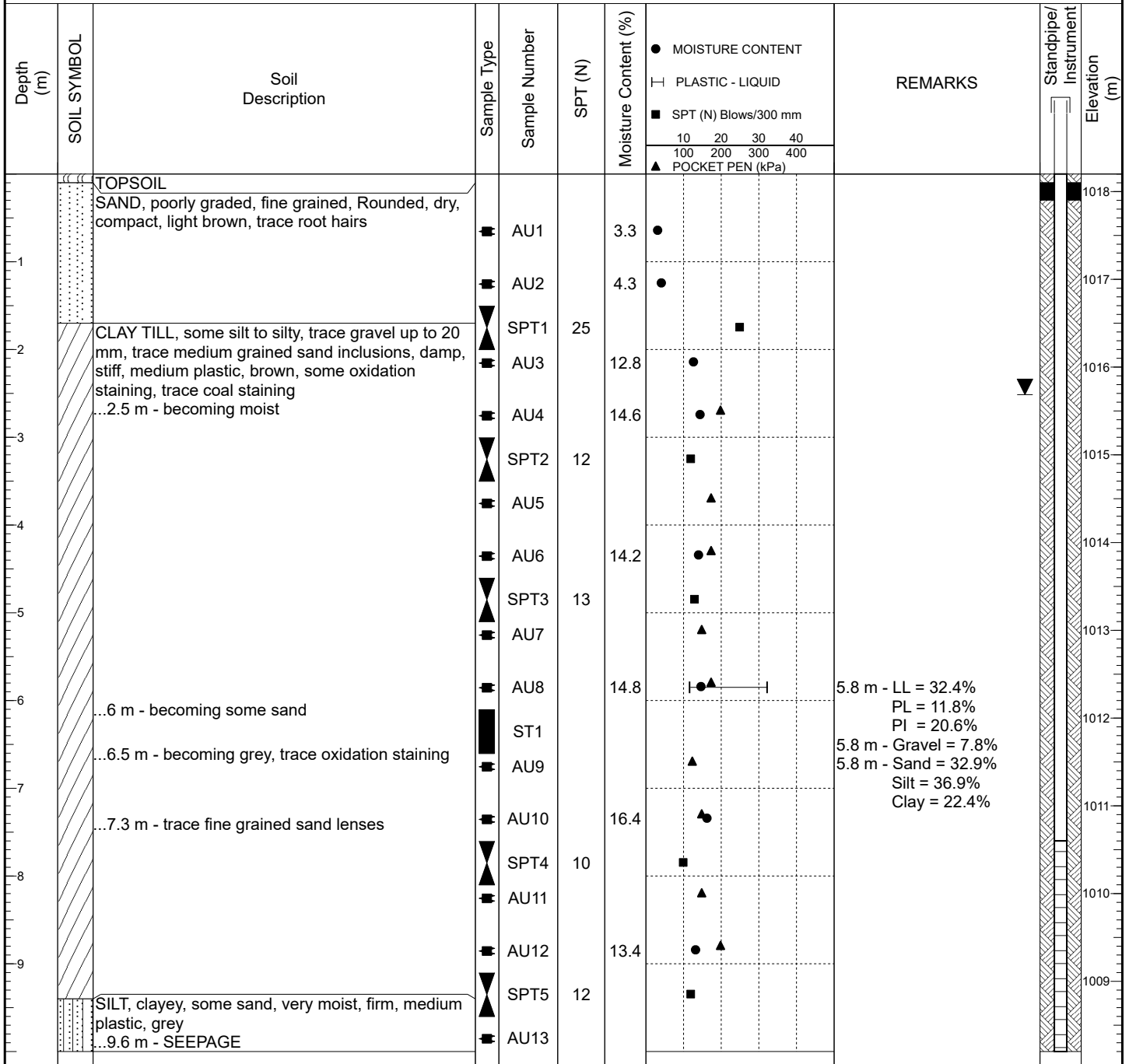
Notes:

No seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 10.3 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/23/2022	COMPLETED	08/23/2022	GROUND ELEVATION	1018.20m N 5631619.735 E 300479.382
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.77 m	2.43 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

Seepage observed at a depth of 9.6 m. No sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 2.43 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH005**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/23/2022 COMPLETED 08/23/2022 GROUND ELEVATION 1018.20m N 5631619.735 E 300479.382
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH 1015.77 m 2.43 m
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
		SILT, clayey, some sand, very moist, firm, medium plastic, grey	■	AU14	24.3	●			1008
11		End of Borehole @10.7 m							1007
12									1006
13									1005
14									1004
15									1003
16									1002
17									1001
18									1000
19									999

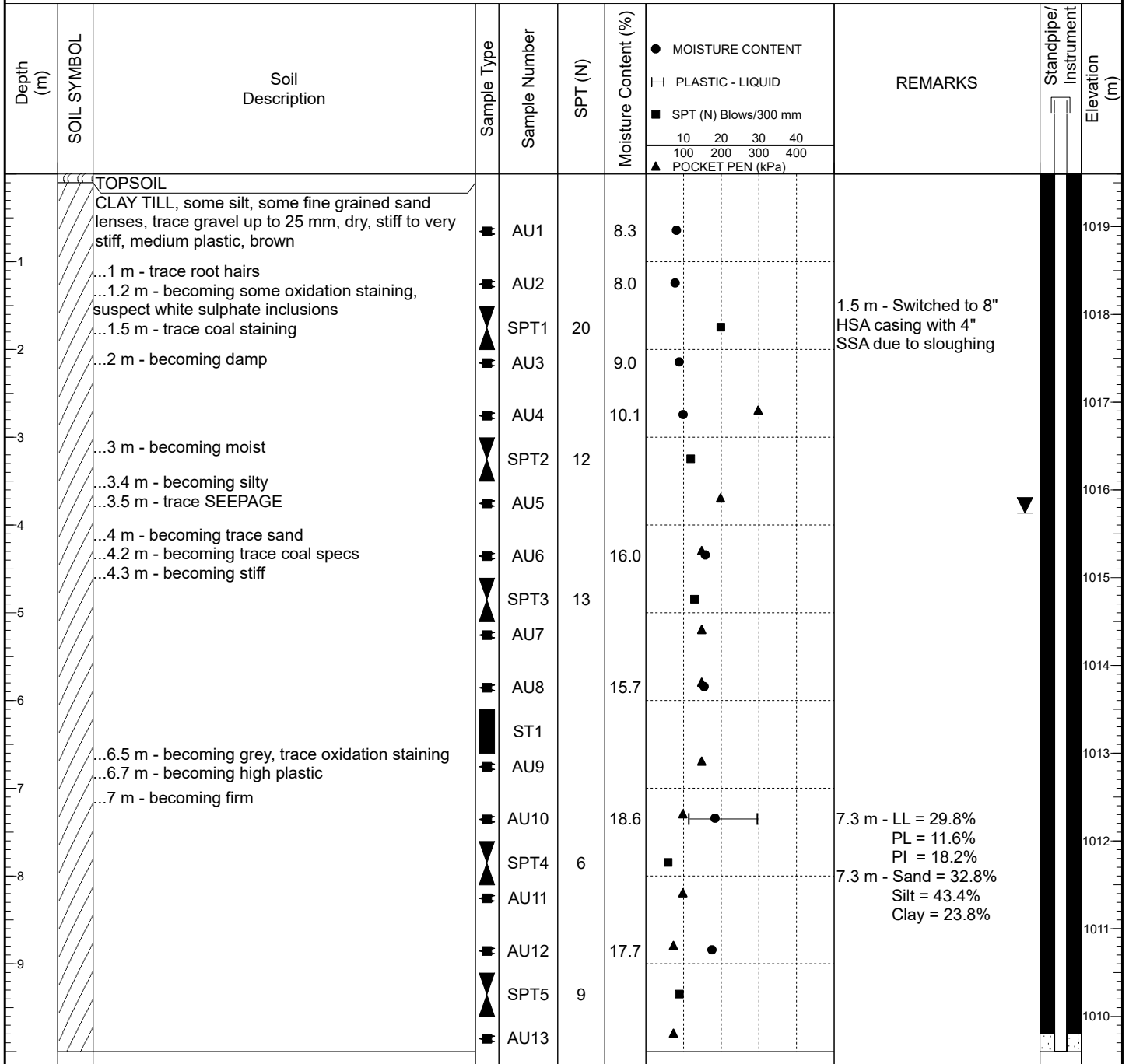
Notes:

Seepage observed at a depth of 9.6 m. No sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 2.43 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/23/2022	COMPLETED	08/23/2022	GROUND ELEVATION	1019.60m N 5631519.974 E 300485.281
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.82 m	3.78 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



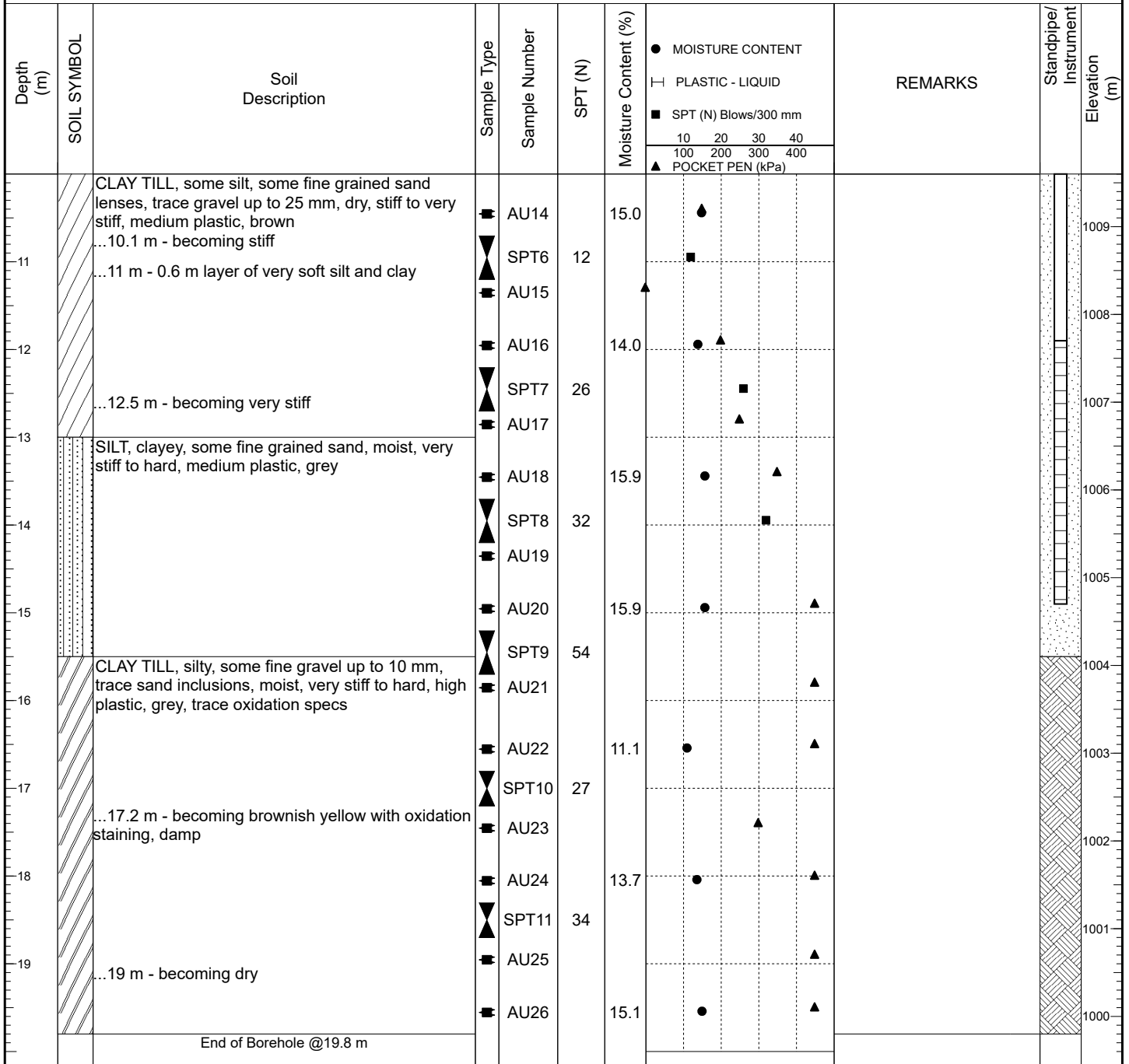
Notes:

Seepage observed at a depth of 3.5 m. Borehole sloughed in to 15.5 m. Slotted 50 mm PVC standpipe installed to a depth of 14.9 m. Water level read at a depth of 3.78 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/23/2022	COMPLETED	08/23/2022	GROUND ELEVATION	1019.60m N 5631519.974 E 300485.281
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.82 m	3.78 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



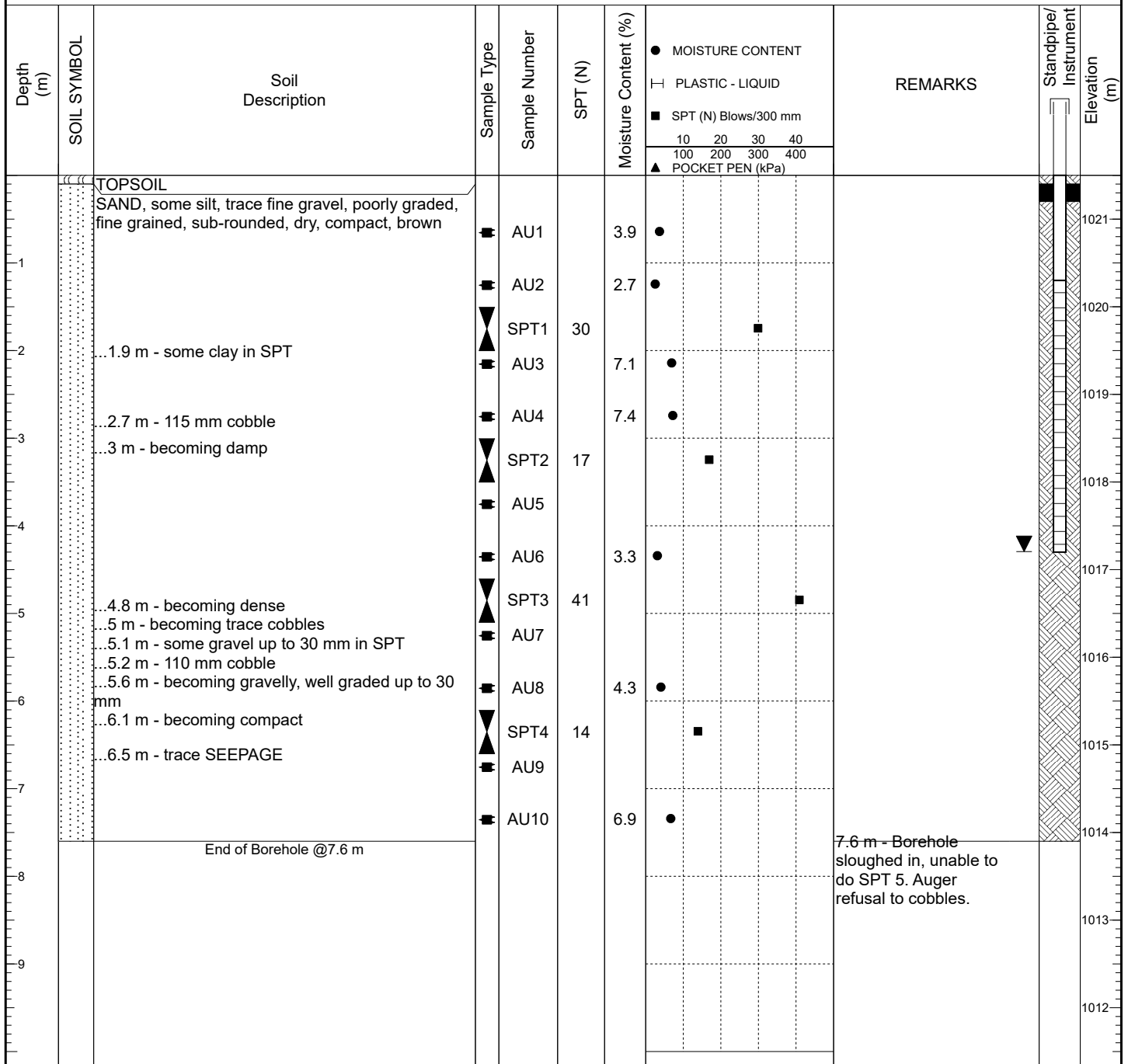
Notes:

Seepage observed at a depth of 3.5 m. Borehole sloughed in to 15.5 m. Slotted 50 mm PVC standpipe installed to a depth of 14.9 m. Water level read at a depth of 3.78 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/25/2022	COMPLETED	08/25/2022	GROUND ELEVATION	1021.50m N 5631459.521 E 300408.844
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1017.29 m	4.21 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



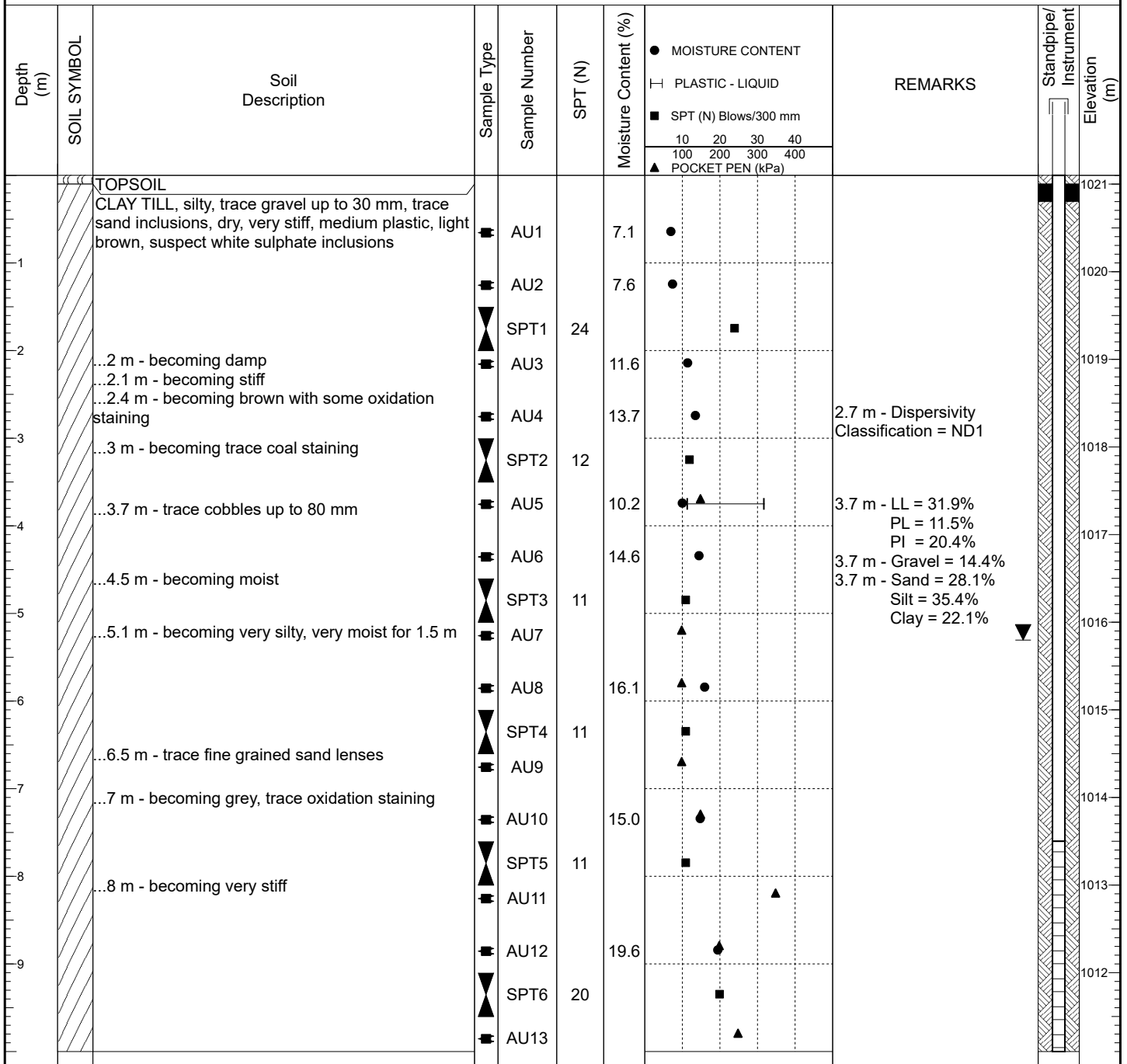
Notes:

Trace seepage observed at a depth of 6.5 m. Borehole sloughed in to 4.3 m. Slotted 25 mm PVC standpipe installed to a depth of 4.3 m. Water level read at a depth of 4.21 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/25/2022	COMPLETED	08/25/2022	GROUND ELEVATION	1021.10m N 5631511.821 E 300328.560
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.88 m	5.22 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

No seepage or sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 5.22 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/25/2022	COMPLETED	08/25/2022	GROUND ELEVATION	1021.10m N 5631511.821 E 300328.560
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.88 m	5.22 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace gravel up to 30 mm, trace sand inclusions, dry, very stiff, medium plastic, light brown, suspect white sulphate inclusions ..10.1 m - becoming damp, very silty, ground up; possible completely weathered siltstone End of Borehole @10.7 m	■	AU14	9.5	●			1011
12									1010
13									1009
14									1008
15									1007
16									1006
17									1005
18									1004
19									1003
									1002

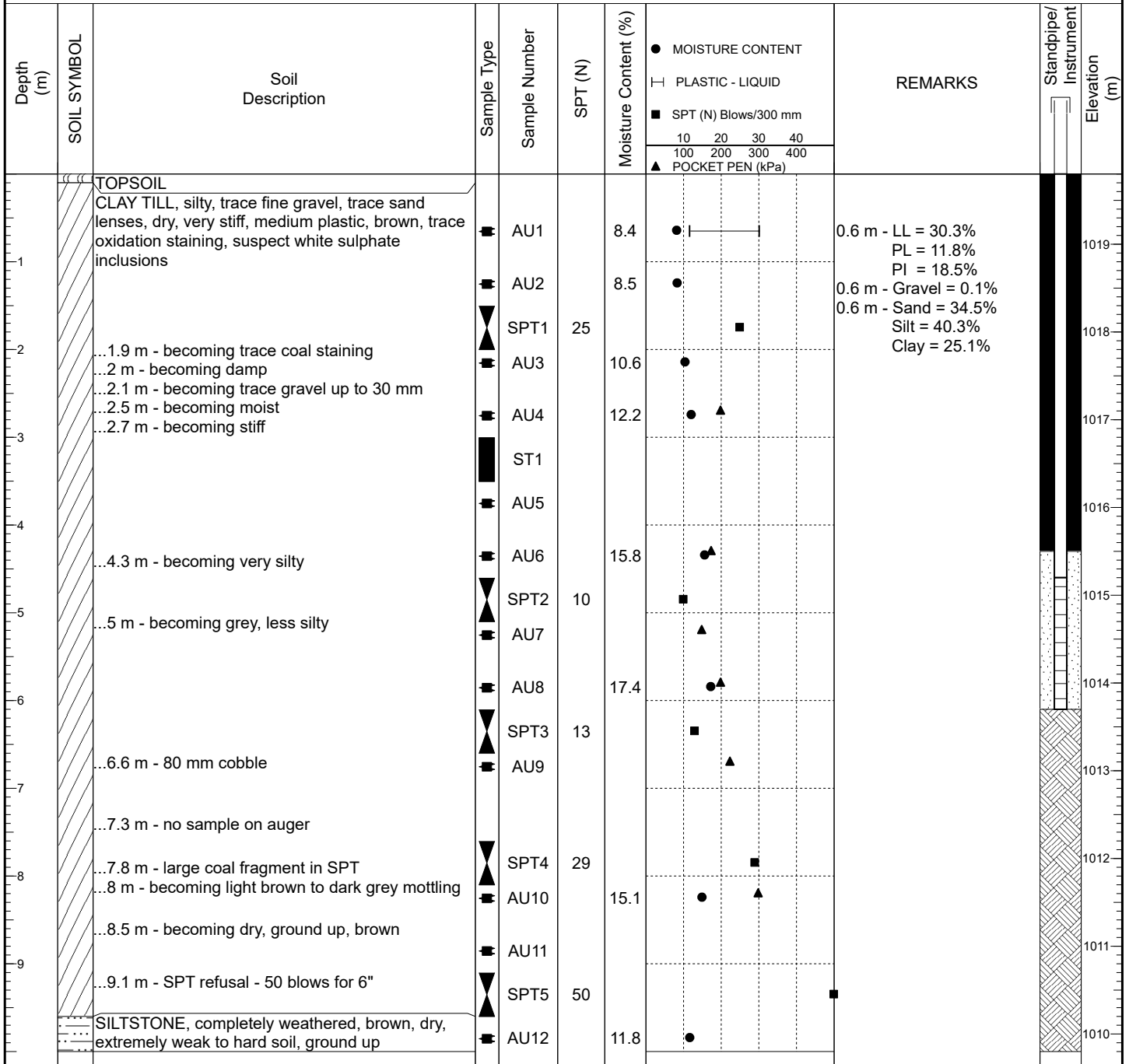
Notes:

No seepage or sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 5.22 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1019.80m N 5631607.234 E 300185.593
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	09/20/2022



Notes:

No seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 6.1 m.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH009**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/24/2022 COMPLETED 08/24/2022 GROUND ELEVATION 1019.80m N 5631607.234 E 300185.593
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		SILTSTONE, completely weathered, brown, dry, extremely weak to hard soil, ground up							1009
		End of Borehole @10.7 m							1008
12									1007
13									1006
14									1005
15									1004
16									1003
17									1002
18									1001
19									1000

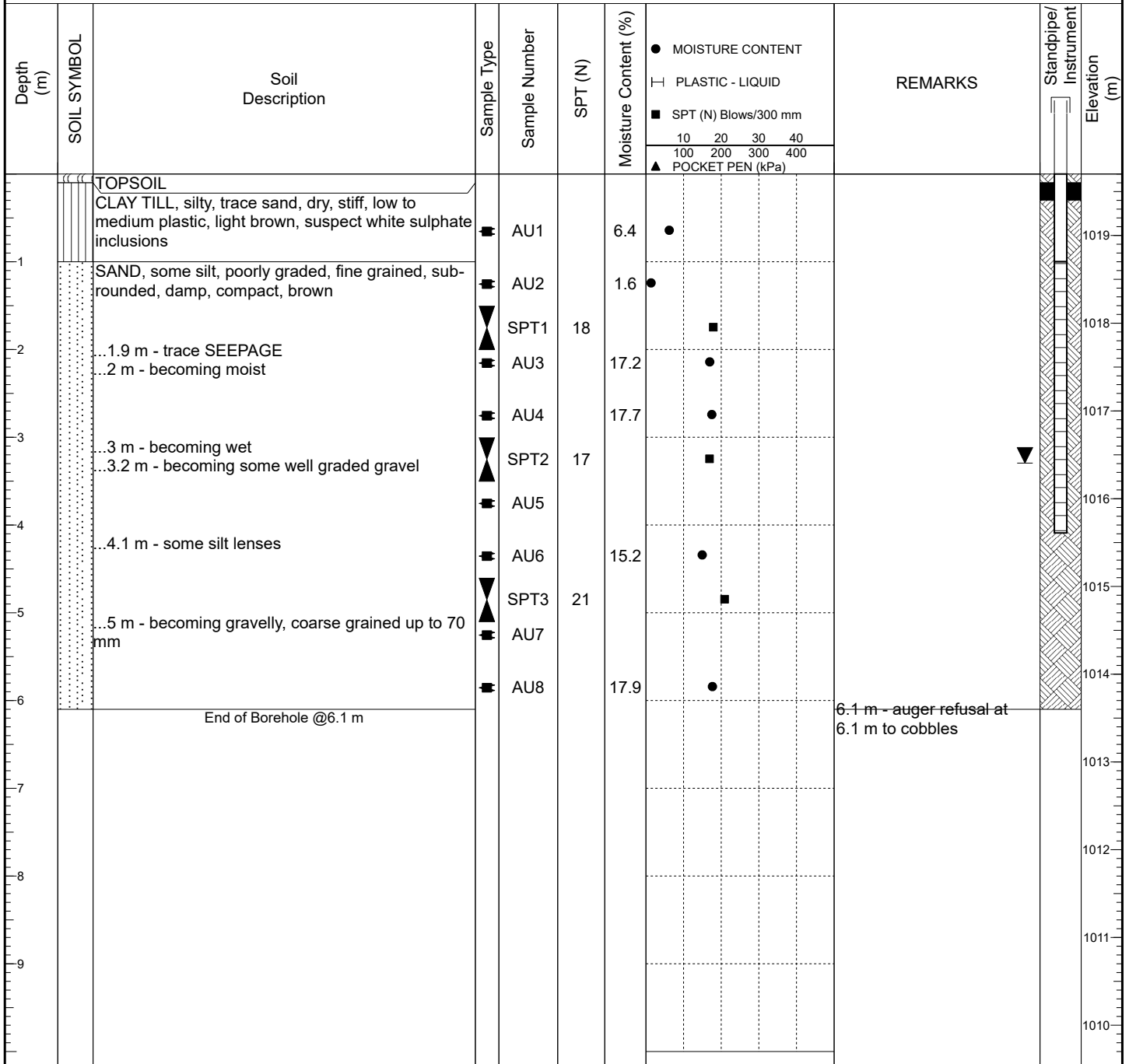
Notes:

No seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 6.1 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/24/2022	COMPLETED	08/24/2022	GROUND ELEVATION	1019.70m N 5631773.458 E 300201.569
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1016.49 m	3.21 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



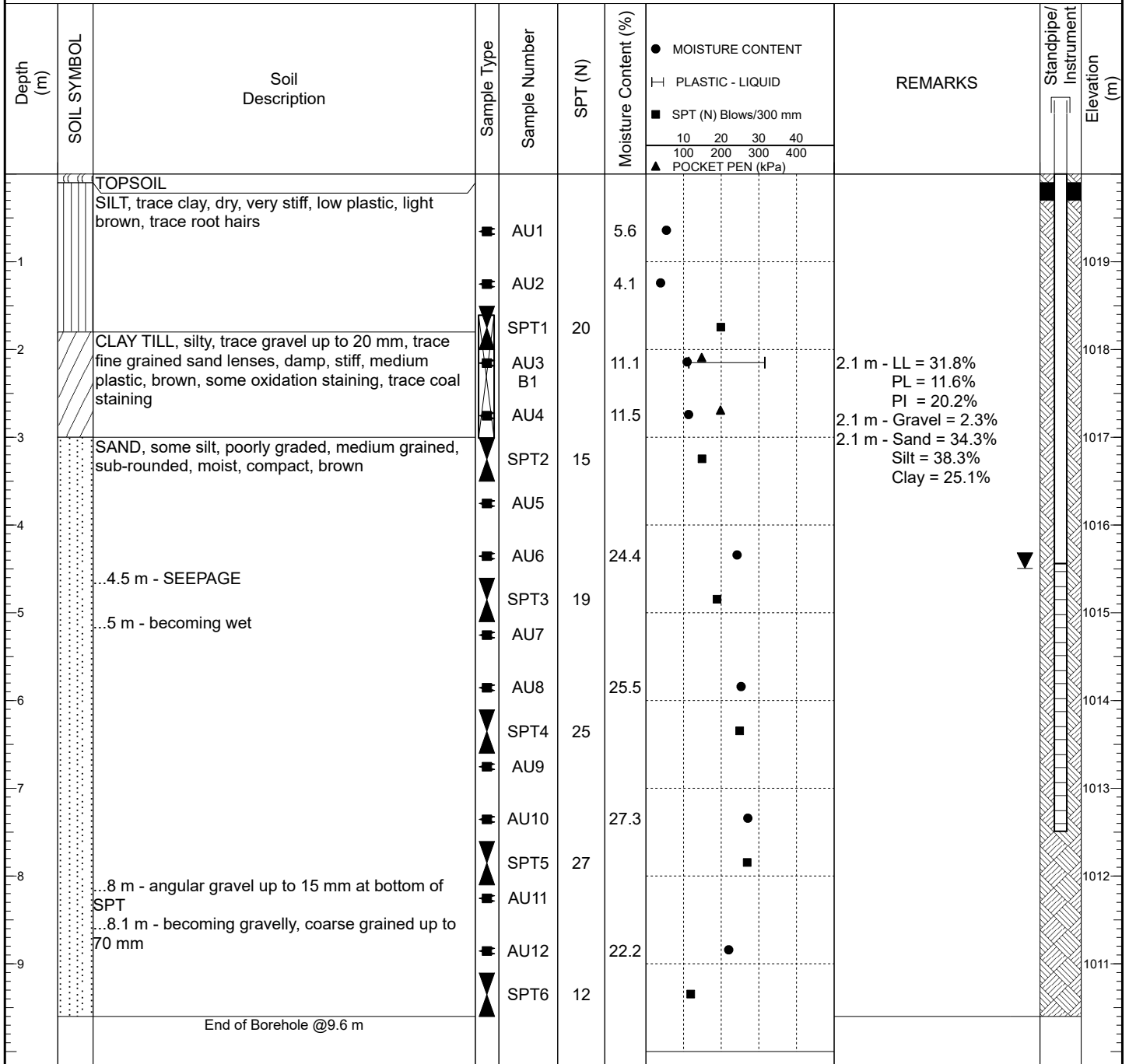
Notes:

Seepage observed at a depth of 1.9 m. Borehole sloughed in to 4 m. Slotted 25 mm PVC standpipe installed to a depth of 4.09 m. Water level read at a depth of 3.21 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/24/2022	COMPLETED	08/24/2022	GROUND ELEVATION	1020.00m N 5631673.256 E 300315.287
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.59 m	4.41 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



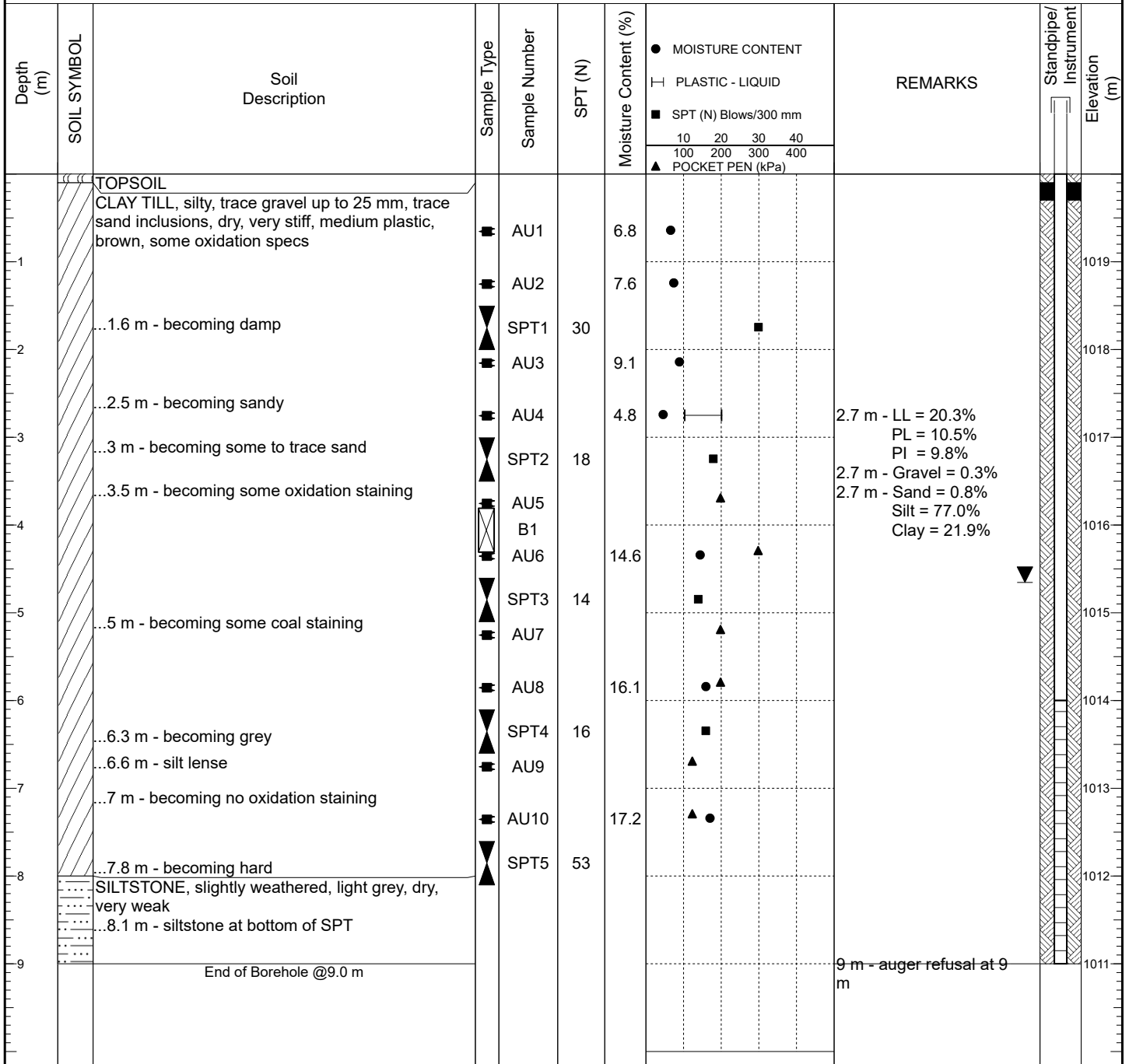
Notes:

Seepage observed at a depth of 4.5 m. Borehole sloughed in to 4.6 m. Slotted 25 mm PVC standpipe installed to a depth of 7.49 m. Water level read at a depth of 4.41 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/24/2022	COMPLETED	08/24/2022	GROUND ELEVATION	1020.00m N 5631603.079 E 300395.454
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.43 m	4.57 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



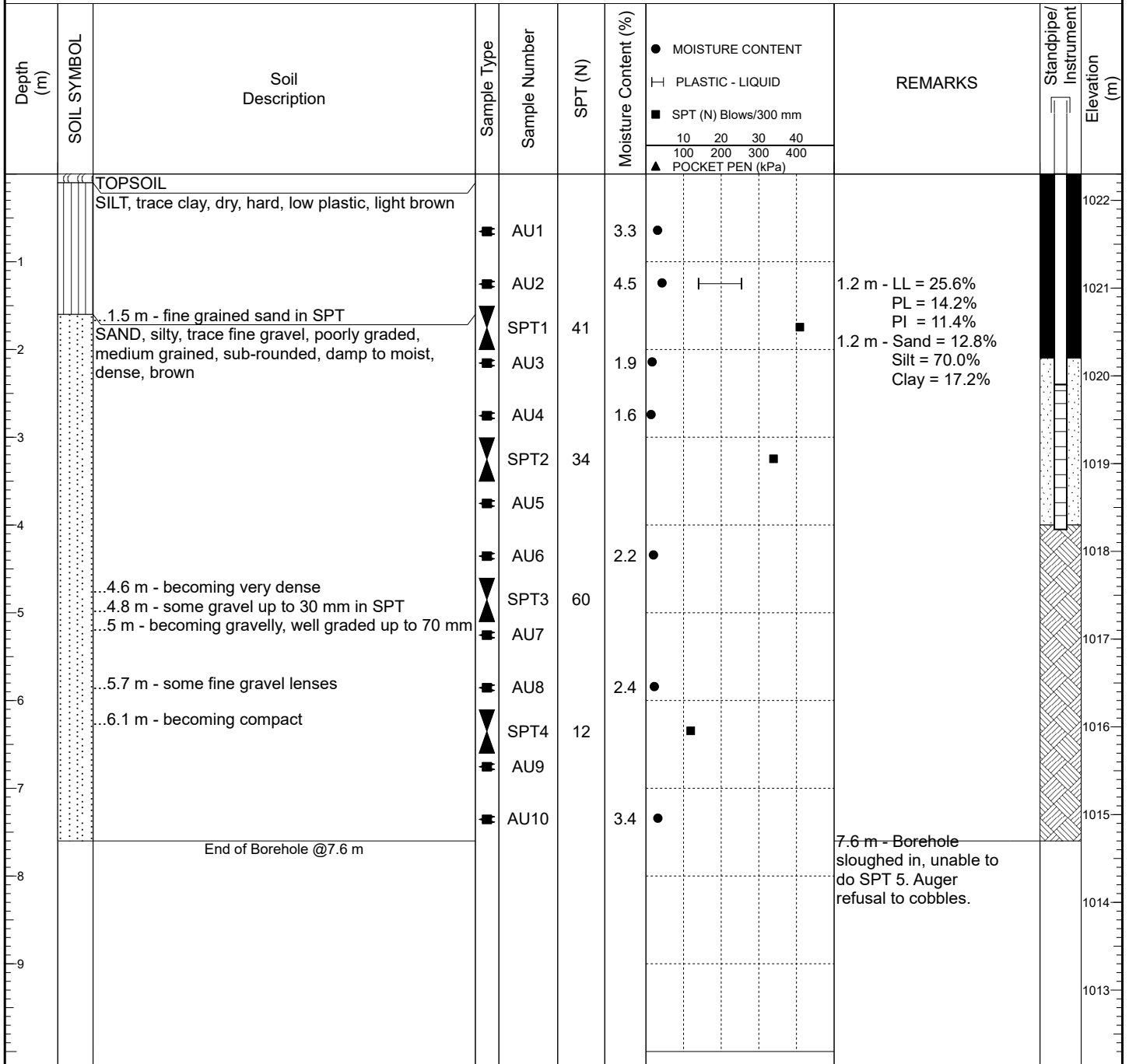
Notes:

No seepage or sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 9.0 m. Water level read at a depth of 4.57 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.30m N 5631349.616 E 300466.192
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	09/20/2022



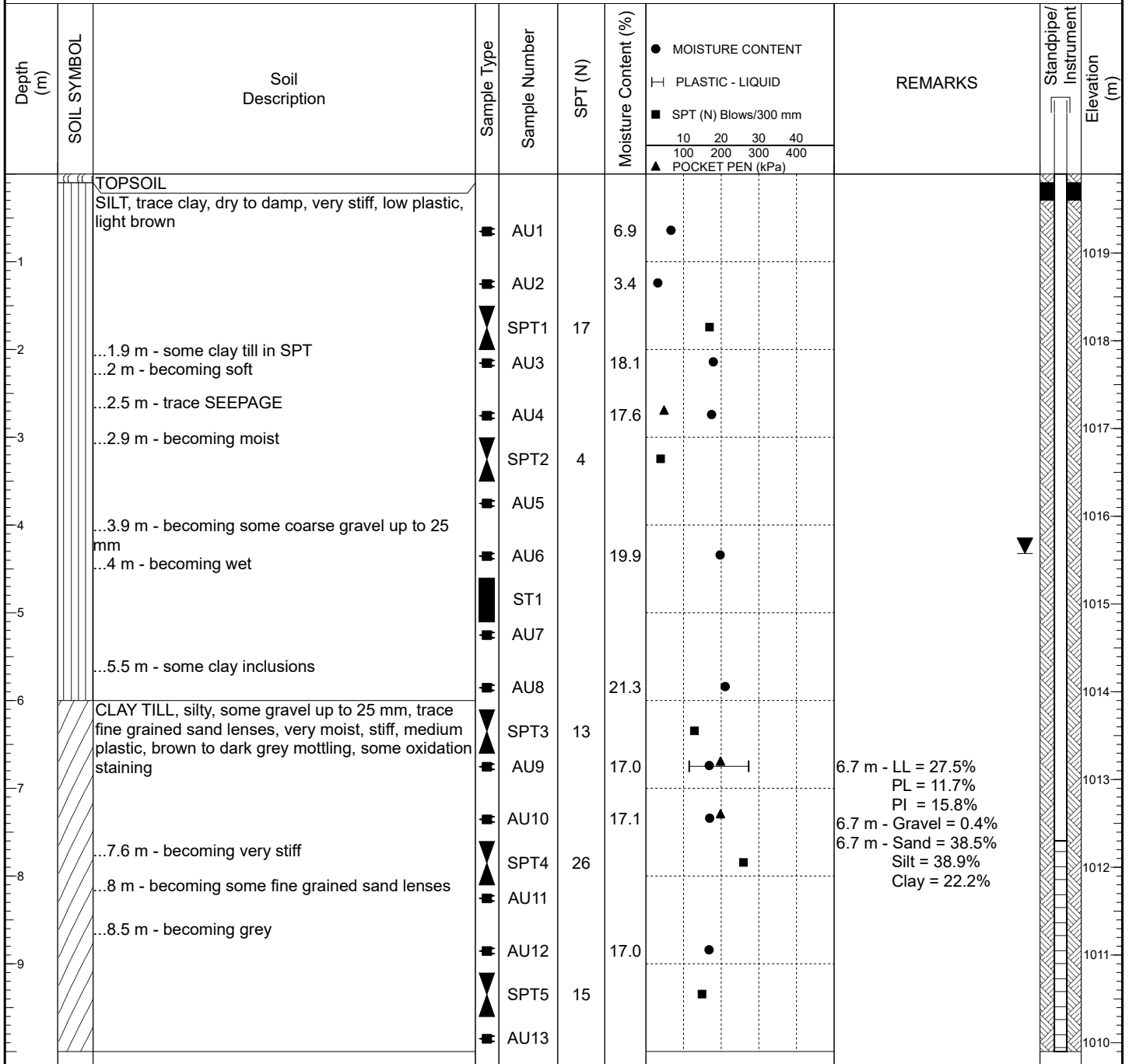
Notes:

No seepage observed upon completion. Borehole sloughed in to 4.0 m. Slotted 50 mm PVC standpipe installed to a depth of 4.05 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/25/2022	COMPLETED	08/25/2022	GROUND ELEVATION	1019.90m N 5631235.261 E 300402.623
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.66 m	4.24 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

Seepage observed at a depth of 2.5 m. Minor sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 4.24 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH015**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1019.90m N 5631235.261 E 300402.623
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH 1015.66 m 4.24 m
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, some gravel up to 25 mm, trace fine grained sand lenses, very moist, stiff, medium plastic, brown to dark grey mottling, some oxidation staining							1009
		End of Borehole @10.7 m							1008
12									1007
13									1006
14									1005
15									1004
16									1003
17									1002
18									1001
19									1000

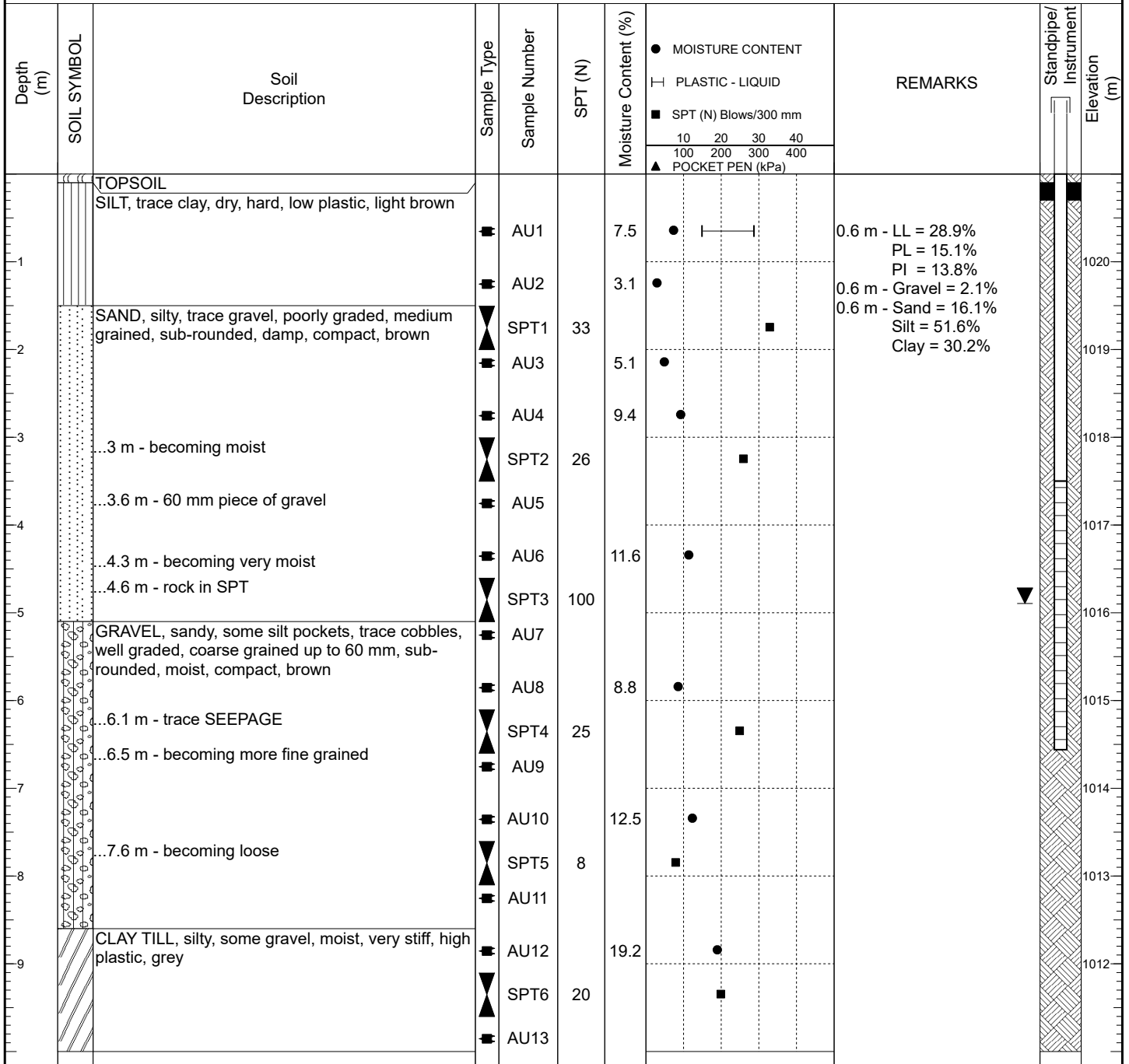
Notes:

Seepage observed at a depth of 2.5 m. Minor sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m. Water level read at a depth of 4.24 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
GROUND ELEVATION	1021.00m	N	5631235.367 E 300311.027
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1016.19 m 4.81 m
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022



Notes:

Seepage observed at a depth of 6.1 m. Borehole sloughed in to 6.56 m. Slotted 25 mm PVC standpipe installed to a depth of 6.56 m. Water level read at a depth of 4.81 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH016**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1021.00m N 5631235.367 E 300311.027
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH 1016.19 m 4.81 m
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
		CLAY TILL, silty, some gravel, moist, very stiff, high plastic, grey	■	AU14	19.6	●			
11		End of Borehole @10.7 m							1010
12									1009
13									1008
14									1007
15									1006
16									1005
17									1004
18									1003
19									1002

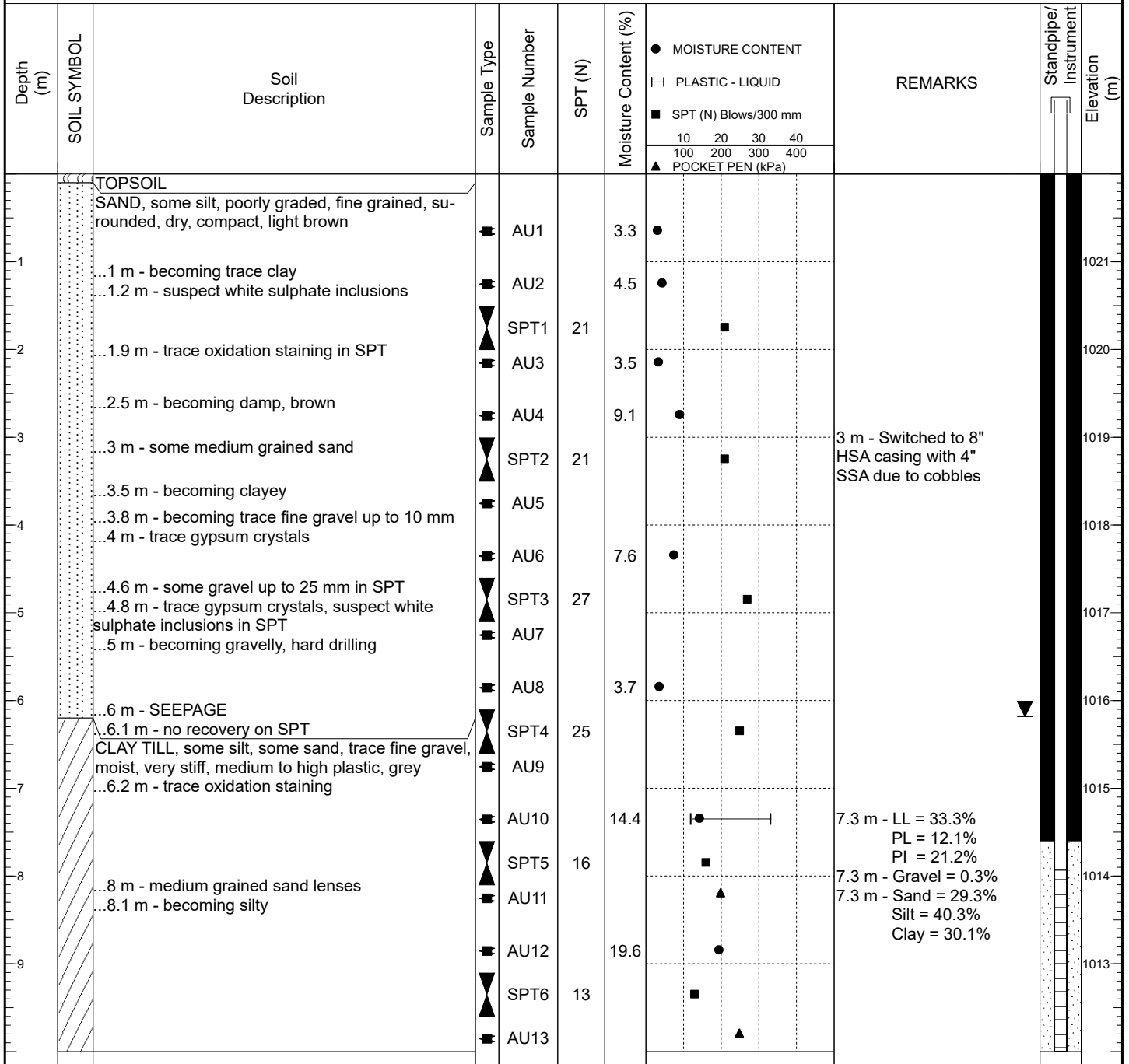
Notes:

Seepage observed at a depth of 6.1 m. Borehole sloughed in to 6.56 m. Slotted 25 mm PVC standpipe installed to a depth of 6.56 m. Water level read at a depth of 4.81 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.00m N 5631331.000 E 300245.000
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	1015.90 m 6.10 m
		DATE GROUND WATER RECORDED	09/20/2022



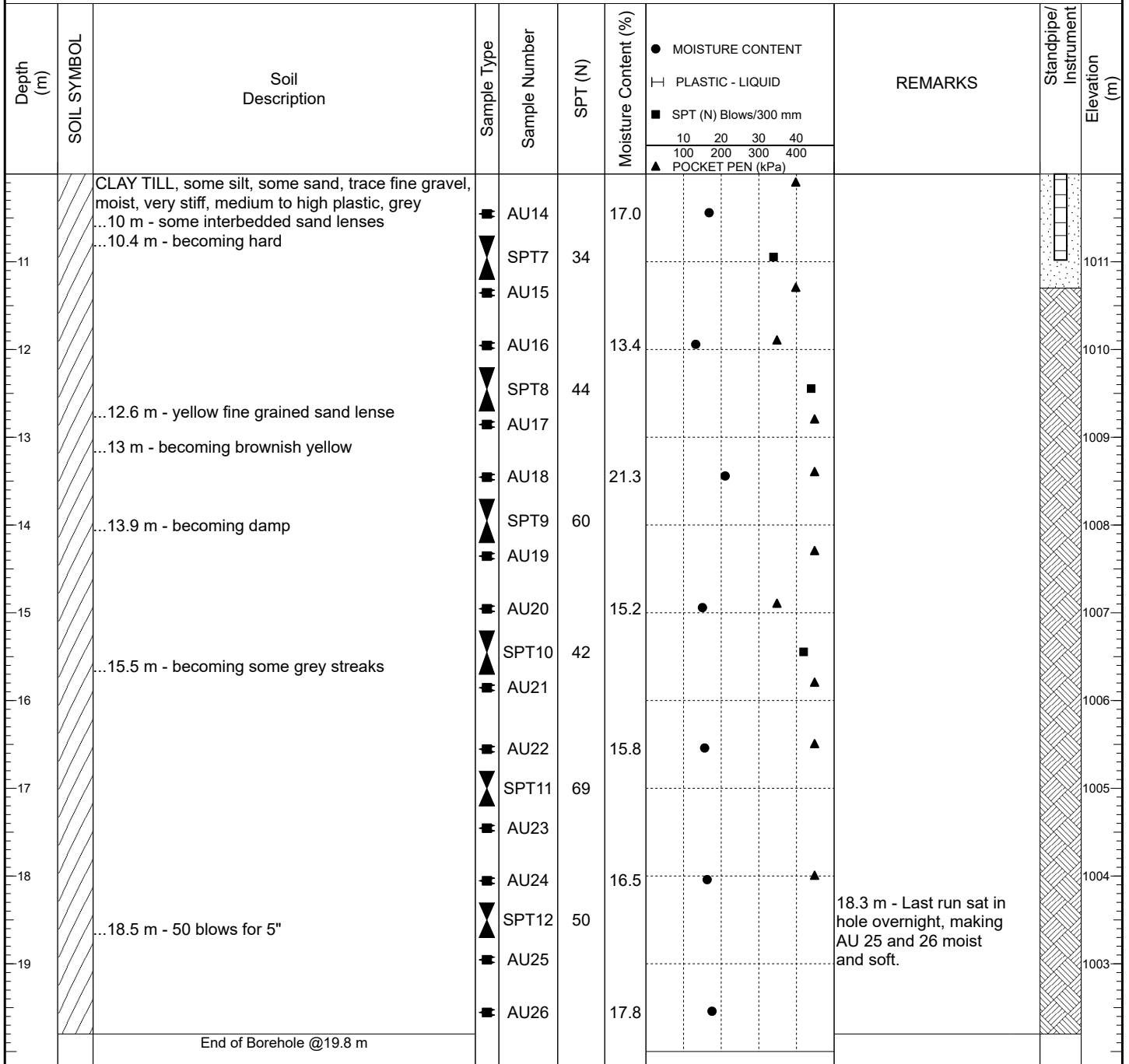
Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 11.3 m. Slotted 25 mm PVC standpipe installed to a depth of 10.98 m. Water level read at a depth of 6.10 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.00m N 5631331.000 E 300245.000
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	1015.90 m 6.10 m
		DATE GROUND WATER RECORDED	09/20/2022



Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 11.3 m. Slotted 25 mm PVC standpipe installed to a depth of 10.98 m. Water level read at a depth of 6.10 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/26/2022	COMPLETED	08/26/2022
GROUND ELEVATION	1022.00m	N	5631386.111 E 300167.545
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)		
0	TOPSOIL	SAND, some silt, trace gravel, poorly graded, fine grained, sub-rounded, dry, compact, light brown, trace root hairs	■	AU1	2.7	●		1021
1			■	AU2	2.5	●		
2		...2 m - becoming damp	▲	SPT1	24	■		1020
3		...2.6 m - becoming very silty, moist	■	AU3	4.8	●		
4		SILT, some sand, trace clay, moist, stiff, low plastic, brown	▲	SPT2	15	■		1019
5		SAND, some silt, some gravel up to 30 mm, poorly graded, fine grained, sub-rounded, damp, compact, brown	■	AU4	15.7	●		1018
6		...5 m - becoming gravelly, well graded up to 70 mm	■	AU5	4.7	●		
7		...5.1 m - becoming trace cobbles up to 110 mm	▲	SPT3	28	■		1017
8		...6.3 m - trace SEEPAGE	■	AU6	3.9	●	6.1 m - No SPT due to sloughing.	1016
9		...6.4 m - becoming some moist fine gravel pockets	■	AU7	8.0	●	7.6 m - No SPT due to sloughing.	1015
10		GRAVEL, silty, sandy, well graded, fine grained, sub-rounded, moist, compact, brown	■	AU8	8.0	●		1014
11			■	AU9				
12			■	AU10				
13			■	AU11				
14			■	AU12				
15		End of Borehole @9.1 m					9.1 m - Auger refusal at 9.1 m to gravel and cobbles.	1013

Notes:

Seepage observed at a depth of 6.3 m. Borehole sloughed in to 3.35 m. Slotted 50 mm PVC standpipe installed to a depth 3.35 m.

Logged By: C. Tams

Reviewed By: T. Curtis

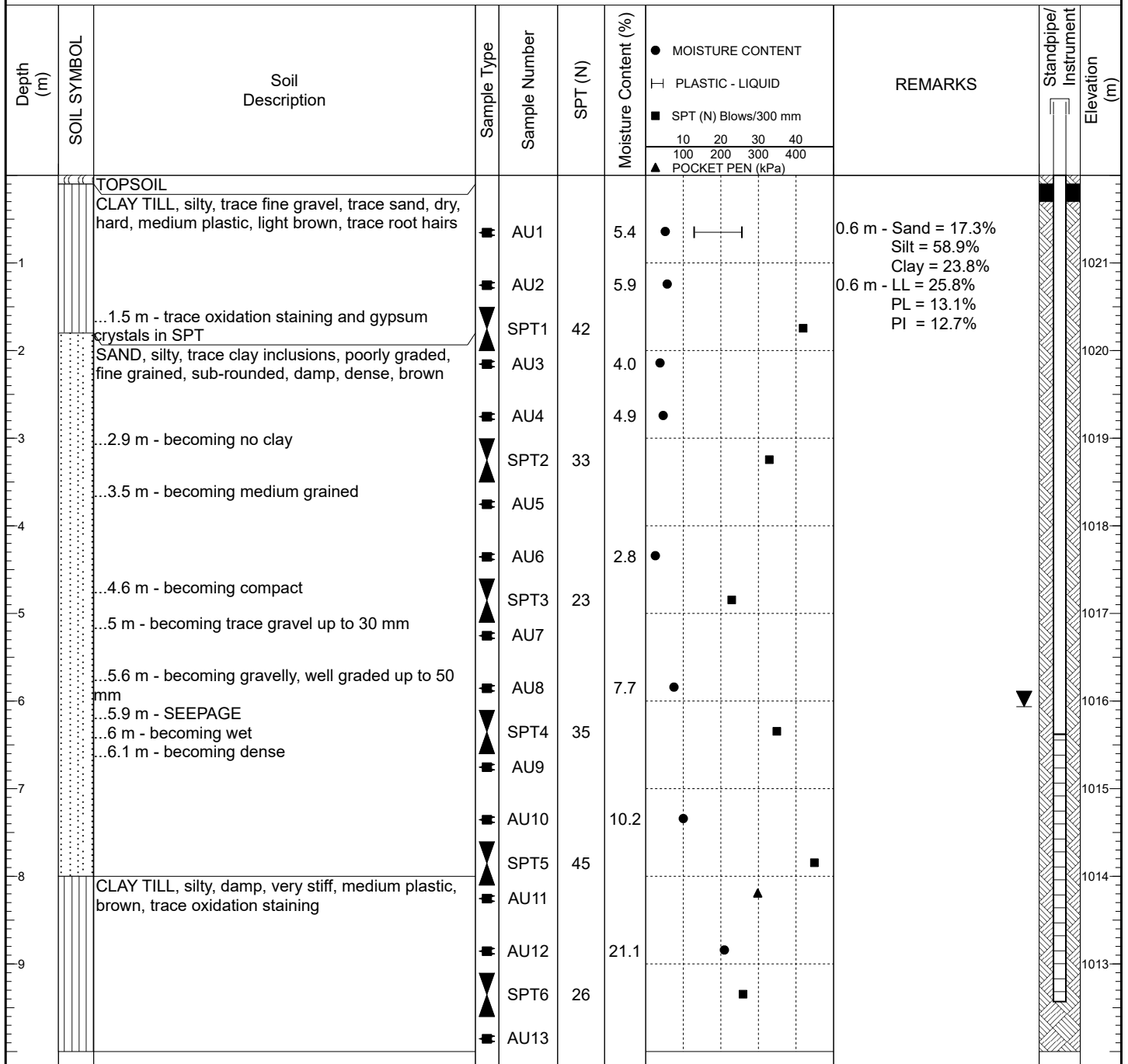


an Englobe company

BOREHOLE No : **22BH019**

PAGE 1 OF 2

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	Northeast of Okotoks, AB		
DATE STARTED	08/26/2022	COMPLETED	08/26/2022	GROUND ELEVATION	1022.00m N 5631483.474 E 300153.939
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1016.02 m	5.98 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 6.0 m. Slotted 25 mm PVC standpipe installed to a depth of 9.43 m. Water level read at a depth of 5.98 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



an Englobe company

BOREHOLE No : **22BH019**

PAGE 2 OF 2

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	Northeast of Okotoks, AB		
DATE STARTED	08/26/2022	COMPLETED	08/26/2022	GROUND ELEVATION	1022.00m N 5631483.474 E 300153.939
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1016.02 m	5.98 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, damp, very stiff, medium plastic, brown, trace oxidation staining ...10 m - becoming some fine gravel End of Borehole @10.7 m	■	AU14	23.4	●			1011
12									1010
13									1009
14									1008
15									1007
16									1006
17									1005
18									1004
19									1003

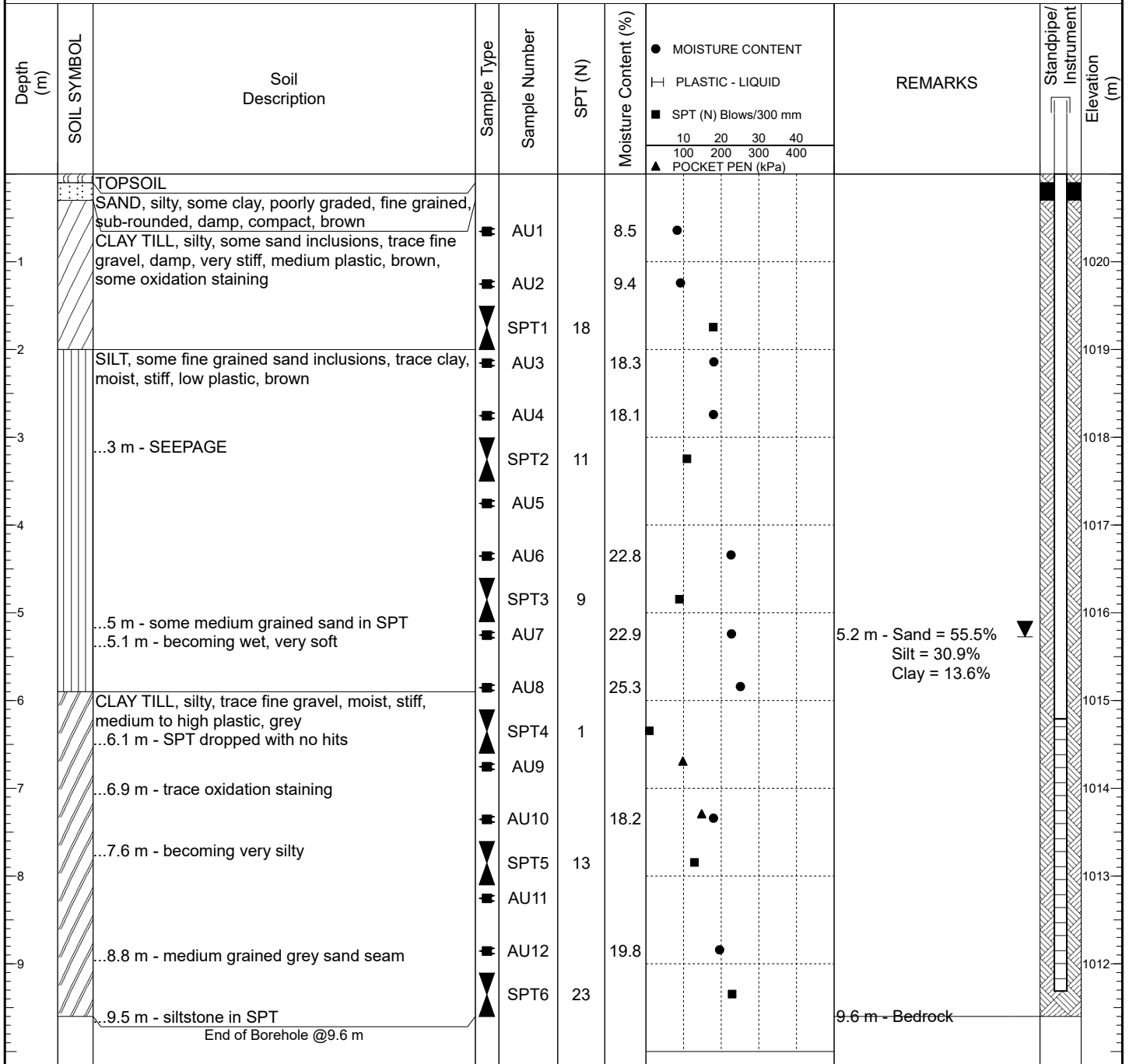
Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 6.0 m. Slotted 25 mm PVC standpipe installed to a depth of 9.43 m. Water level read at a depth of 5.98 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/26/2022	COMPLETED	08/26/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631480.669 E 300249.337
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	1015.81 m 5.19 m
		DATE GROUND WATER RECORDED	09/20/2022



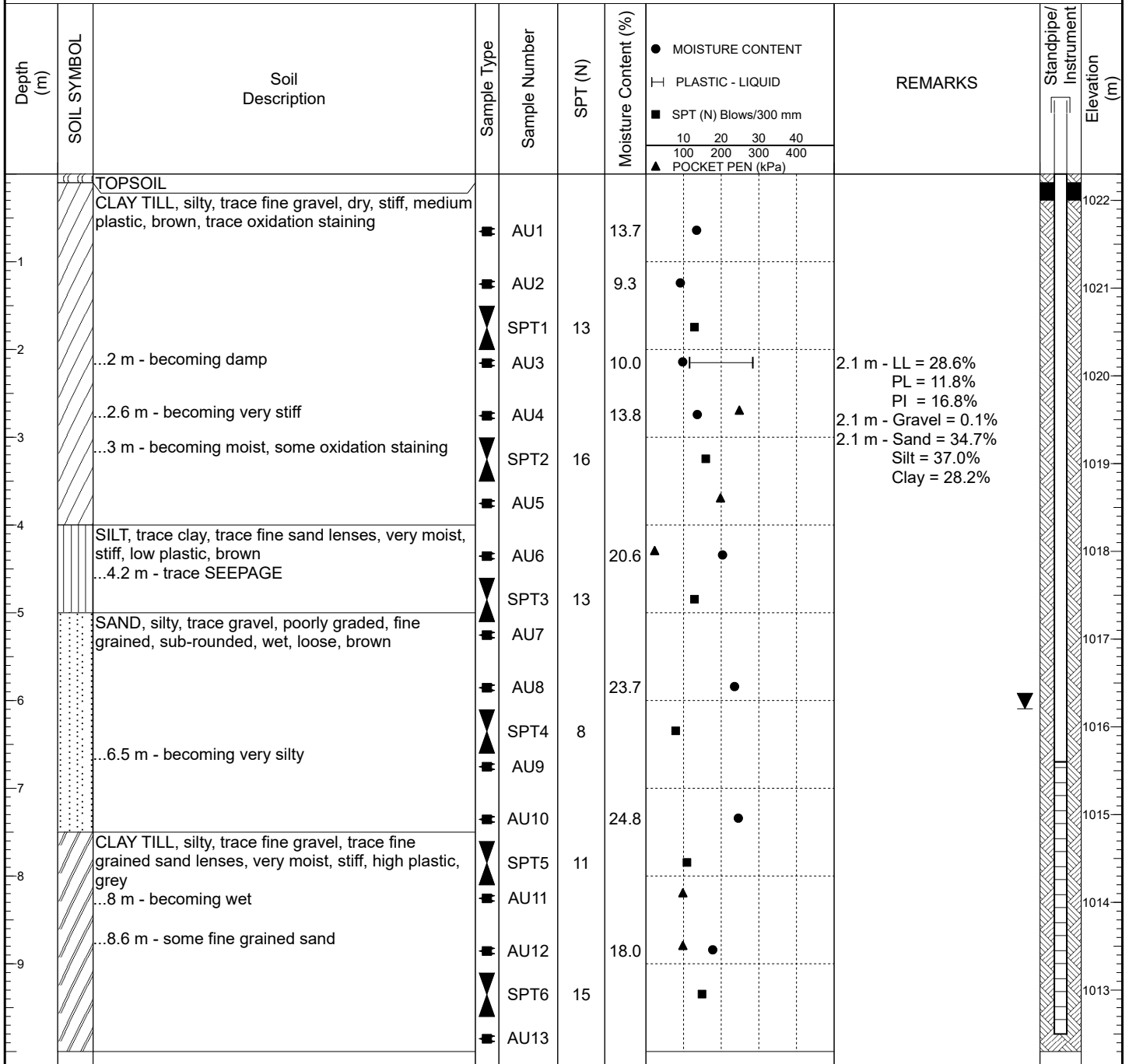
Notes:

Seepage observed at a depth of 3.0 m. Borehole sloughed in to 1.2 m. Slotted 25 mm PVC standpipe installed to a depth of 9.31 m. Water level read at a depth of 5.19 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/25/2022	COMPLETED	08/25/2022	GROUND ELEVATION	1022.30m N 5631386.105 E 300353.690
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1016.29 m	6.01 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

Seepage observed at a depth of 4.2 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m. Water level read at a depth of 6.01 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH021**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1022.30m N 5631386.105 E 300353.690
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH 1016.29 m 6.01 m
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace fine gravel, trace fine grained sand lenses, very moist, stiff, high plastic, grey	■	AU14	19.0	●			1012
		End of Borehole @10.7 m							
12									1011
13									1010
14									1009
15									1008
16									1007
17									1006
18									1005
19									1004
									1003

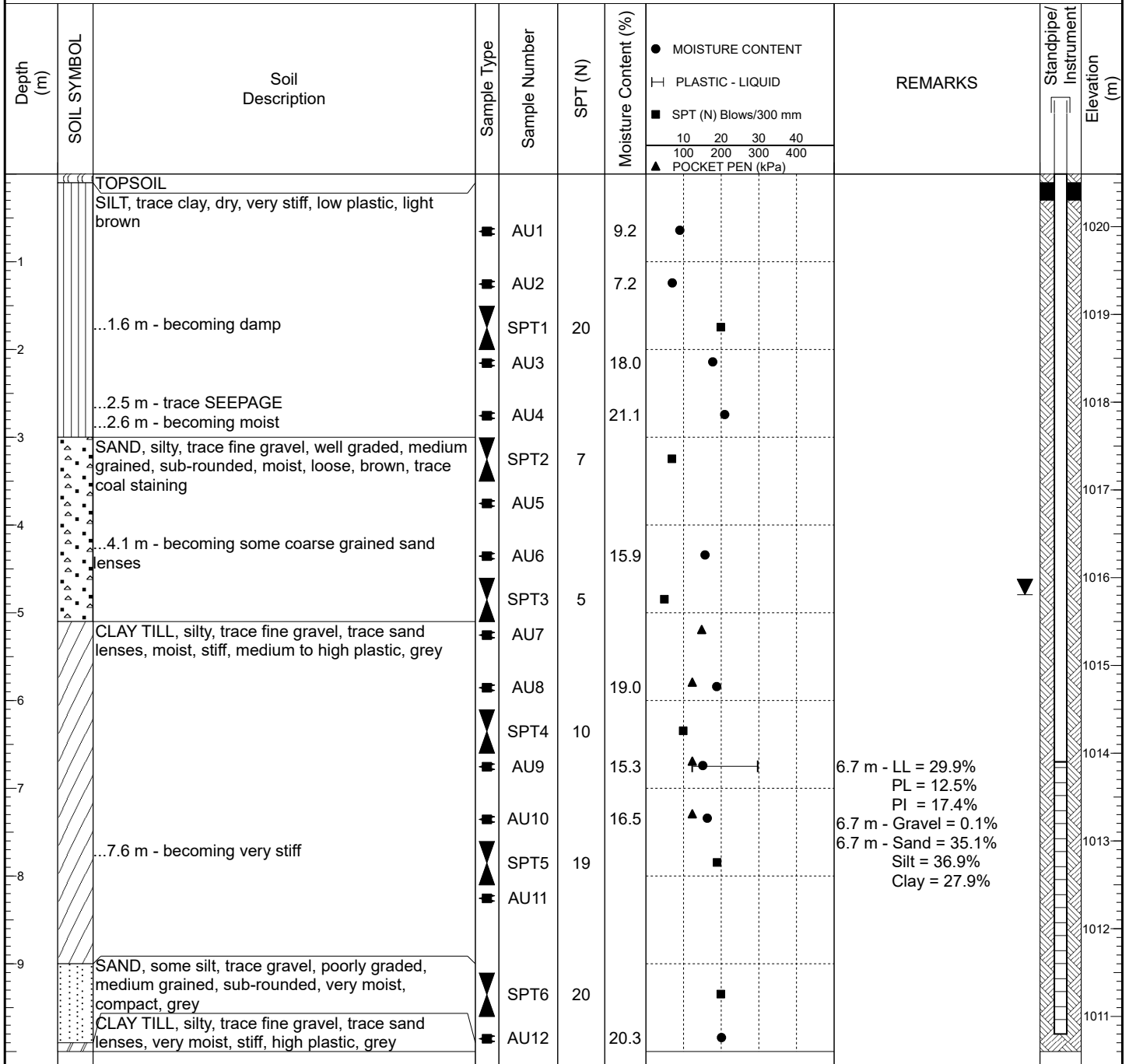
Notes:

Seepage observed at a depth of 4.2 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m. Water level read at a depth of 6.01 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir		
PROJECT NUMBER	29121-005-05	PROJECT LOCATION			
DATE STARTED	08/25/2022	COMPLETED	08/25/2022	GROUND ELEVATION	1020.60m N 5631311.202 E 300368.111
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	1015.89 m	4.71 m	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	09/20/2022		



Notes:

Seepage observed at a depth of 2.5 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m. Water level read at a depth of 4.71 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH022**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1020.60m N 5631311.202 E 300368.111
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH 1015.89 m 4.71 m
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED 09/20/2022

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
		CLAY TILL, silty, trace fine gravel, trace sand lenses, very moist, stiff, high plastic, grey	■	AU13					1010
11		End of Borehole @10.7 m							
12									1009
13									1008
14									1007
15									1006
16									1005
17									1004
18									1003
19									1002
									1001

Notes:

Seepage observed at a depth of 2.5 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m. Water level read at a depth of 4.71 m on September 20, 2022.

Logged By: C. Tams

Reviewed By: T. Curtis

TEST HOLE LOGS

EXPLANATION OF SYMBOLS AND TERMS

The symbols and terms used on the test hole logs to summarize the results of the field investigation and the laboratory testing are described on the following sheets.

Soils are classified and described according to their engineering properties and behaviour. The descriptions applied to the various soil units as shown on the logs follow the Unified Soil Classification system with slight modification to recognize inorganic clays to medium plasticity (CI). Such descriptions are judgmental in nature and may differ in detail from that actually encountered in the field. The descriptions noted in the logs from test holes are based solely on inspections of soil and rock samples recovered or cuttings observed. The actual nature of the materials between samples may vary.

Laboratory tests have been performed on the various samples noted, following standard testing procedures or protocol unless otherwise noted. The test results are intended to provide a general indication of some of the engineering properties of the material.

ABBREVIATIONS

w or MC	Moisture content (ASTM D2216)	PP	Pocket Penetrometer
W _p or PL	Plastic limit (ASTM D4318)	γ	Unit weight
W _L or LL	Liquid limit (ASTM D4318)	γ_d	Dry unit weight
I _p or PI	Plasticity Index	ρ	Density
NP	Non-plastic soil	ρ_d	Dry density
SH	Shelby tube sample	q _u	Unconfined compressive strength
AU	Auger sample	C _u	Undrained shear strength
B	Bulk Sample	SO ₄	Concentration of water-soluble sulphates
UD	Undisturbed Sample	TCR	Total Core Recovery
RC	Rock Core Sample	RQD	Rock Quality Index
SPT	Standard Penetration Test	SCR	Solid Core Recovery
VST	Vane Shear Test	FI	Fracture Index

SIZE RANGES OF SOIL COMPONENTS	
Component	Size Range mm (US Sieve)
Boulders	Over 300 (12 inch)
Cobbles	75 (3 inch) to 300 (12 inch)
Gravel:	
Coarse	19 (3/4 inch) to 75 (3 inch)
Fine	5 (#4) to 19 (3/4 inch)
Sand:	
Coarse	2 (#10) to 5 (#4)
Medium	0.4 (#40) to 2 (#10)
Fine	0.08 (#200) to 0.4 (#40)
Clay and Silt	Less than 0.08 (#200)

SECONDARY CONSTITUENTS	
Term	Percentage
and	35% - 50%
y/ey	20% - 35%
some	10% - 20%
trace	0 - 10%

CONSISTENCY OF FINE GRAINED SOILS			
Term	Undrained Shear Strength (kPa)	SPT N	Description
Very soft	< 12	< 2	Easily penetrated with fist
Soft	12 - 25	2 - 4	Easily penetrated with thumb
Firm	25 - 50	4 - 8	Moderate effort to penetrate with thumb
Stiff	50 - 100	8 - 15	Great effort to indent with thumb
Very Stiff	100 - 200	15 - 30	Easily indented with thumbnail
Hard	> 200	> 30	Effort required to indent with thumbnail

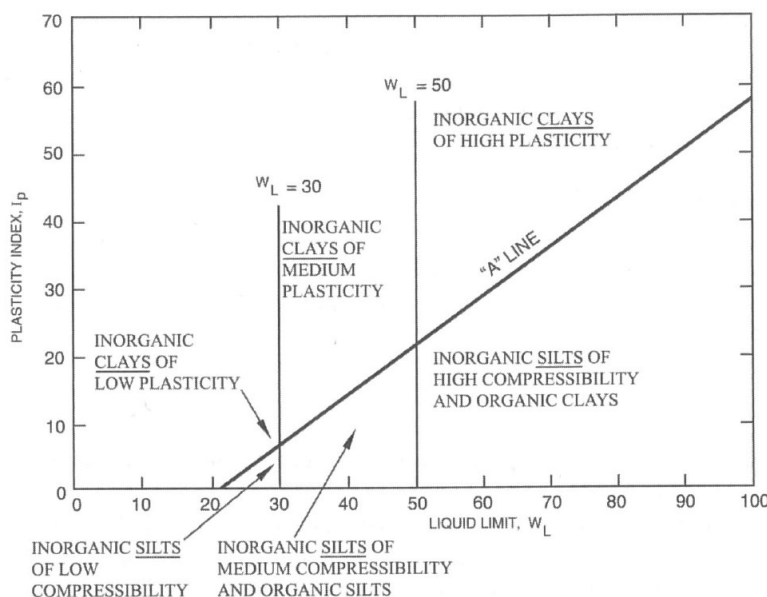
DENSITY OF COARSE GRAINED SOILS		
Term	SPT N	Approx. Relative Density (%)
Very loose	0 - 4	0 - 15
Loose	4 - 10	15 - 35
Compact	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very Dense	> 50	85 - 100

TEST HOLE LOGS

EXPLANATION OF SYMBOLS AND TERMS

UNIFIED SOIL CLASSIFICATION SYSTEM (MODIFIED)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils	Strong colour or odor and fibrous texture	
COARSE-GRAINED SOILS MORE THAN HALF BY WEIGHT LARGER THAN 75 µm	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well-graded gravels, gravel-sand mixtures	$C_u = D_{60}/D_{10} > 4$	$C_c = (D_{30})^2 / D_{10} \times D_{60}$ 1 to 3
			GP	Poorly graded gravels, gravel-sand mixtures	Not meeting all above requirements	
		GRAVELS WITH FINES (MORE THAN 12% FINES)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or $PI < 4$	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line or $PI > 7$	
	SANDS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well-graded sands, gravelly sands	$C_u = D_{60}/D_{10} > 6$	$C_c = (D_{30})^2 / D_{10} \times D_{60}$ 1 to 3
			SP	Poorly graded sands or gravelly sands	Not meeting all above requirements	
		SANDS WITH FINES (MORE THAN 12% FINES)	SM	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or $PI < 4$	
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line or $PI > 7$	
FINE-GRAINED SOILS MORE THAN HALF BY WEIGHT SMALLER THAN 75 µm	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML	Inorganic silts and very fine sands, rock flour, silty sands of slight plasticity	$LL < 50$	SEE PLASTICITY CHART BELOW
			MH	Inorganic silts, micaceous or diatomaceous, fine sandy or silty soils	$LL > 50$	
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL	Inorganic clays of low plasticity, gravelly, sandy, or silty clays	$LL < 30$	
			CI	Inorganic clays of medium plasticity, silty clays	$30 < LL < 50$	
			CH	Inorganic clays of high plasticity	$LL > 50$	
	ORGANIC SILTS AND CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL	Organic silts and organic silty clays of low plasticity	$LL < 50$	
			OH	Organic clays of high plasticity	$LL > 50$	



APPENDIX E:

LAB TESTING

ATTERBERG LIMITS

Project: Foothills Sub Regional Water Design
Project No.: 29121-005-04
Owner: Urban Systems Ltd
File No.: AL - 01

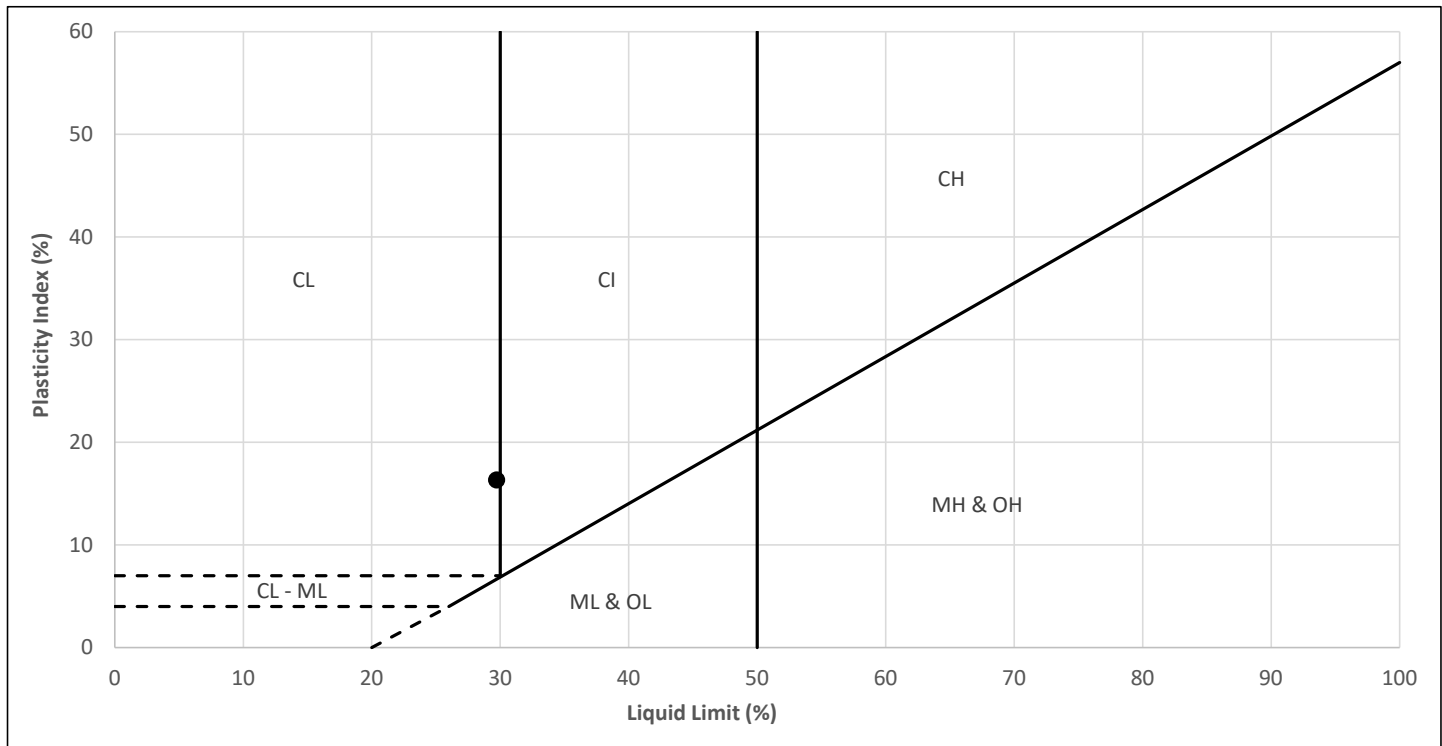
Sample #: 1AU1
Source: 21BH001
Sample By: Stuart Smith
Date: 04-Mar-21

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils)

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	29.7
Plastic Limit (PL)	13.4
Plasticity Index (PI)	16.3

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Foothills Sub Regional Water Design
Project No.: 29121-005-04
Owner: Urban Systems Ltd
File No.: AL - 02

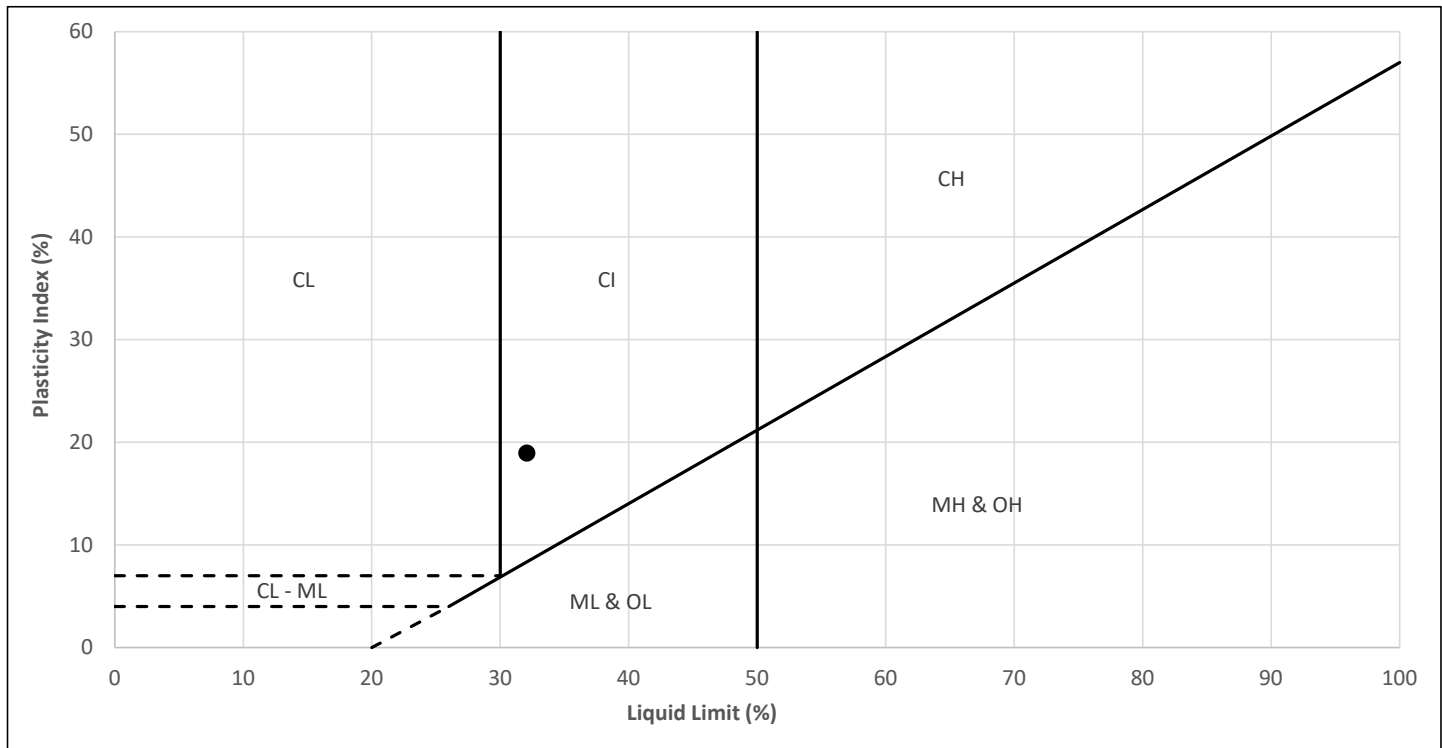
Sample #: 3AU1
Source: 21BH003
Sample By: Stuart Smith
Date: 04-Mar-21

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils)

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	32.1
Plastic Limit (PL)	13.1
Plasticity Index (PI)	18.9

Soil Plasticity	Medium
Soil Classification	CI



Comments:



Reviewed By: 
Kasz Leavitt, P.Tech. (Eng.)

ATTERBERG LIMITS

Project: Foothills Sub Regional Water Design
Project No.: 29121-005-04
Owner: Urban Systems Ltd
File No.: AL - 03

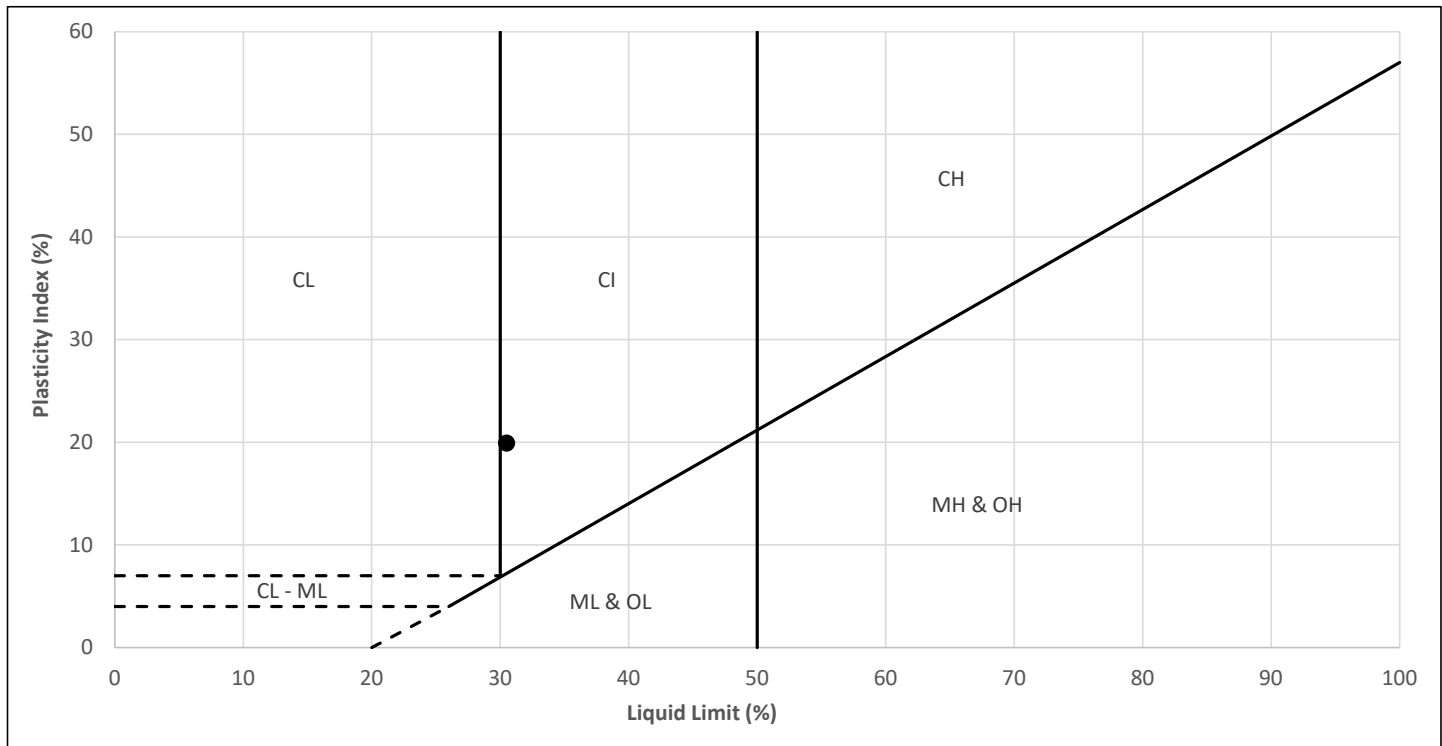
Sample #: 6AU3
Source: 21BH003
Sample By: Stuart Smith
Date: 04-Mar-21

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils)

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	30.5
Plastic Limit (PL)	10.6
Plasticity Index (PI)	19.9

Soil Plasticity	Medium
Soil Classification	CI



Comments:

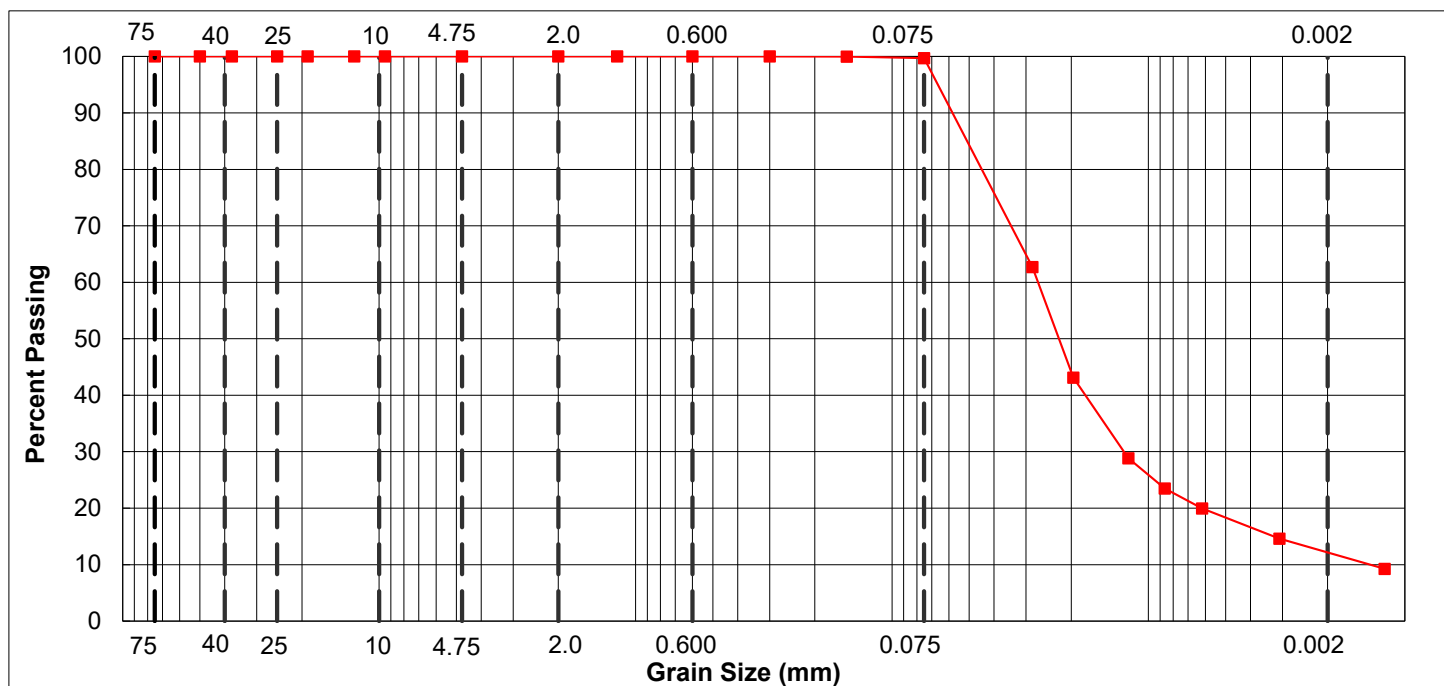
GRAIN SIZE ANALYSIS REPORT

Project: Foothills Sub Regional Water Design
Project No.: 29121-005-04
Owner: Urban Systems Ltd
File No.: GSA - 01

Sample No.: 1AU5
Source: 21BH001
Sample By: Stuart Smith
Date: 05-Mar-21

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	100.0	Type	%	Particle Size Range
75.0	100.0	0.300	100.0	Boulders	0	>300 mm
50.0	100.0	0.150	100.0	Cobbles	0	300 mm to 75 mm
37.5	100.0	0.075	99.7	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0283	62.7	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0196	43.1	Coarse Sand	0.0	4.75 mm to 2.00 mm
12.5	100.0	0.0120	28.9	Medium Sand	0.0	2.00 mm to 425 µm
9.5	100.0	0.0086	23.5	Fine Sand	0.3	425 µm to 75 µm
4.75	100.0	0.0062	19.9	Silt	87.5	75 µm to 2 µm
2.00	100.0	0.0031	14.6	Clay	12.2	<2 µm
1.180	100.0	0.0012	9.3			



SIEVE ANALYSIS REPORT

Project: Foothills Sub Regional Water Design
Project No.: 29121-005-04
Owner: Urban Systems Ltd.
File No.: SA - 01

Sample No.: 5AU3
Source: 21BH005
Sample By: Stuart Smith
Date: 05-Mar-21

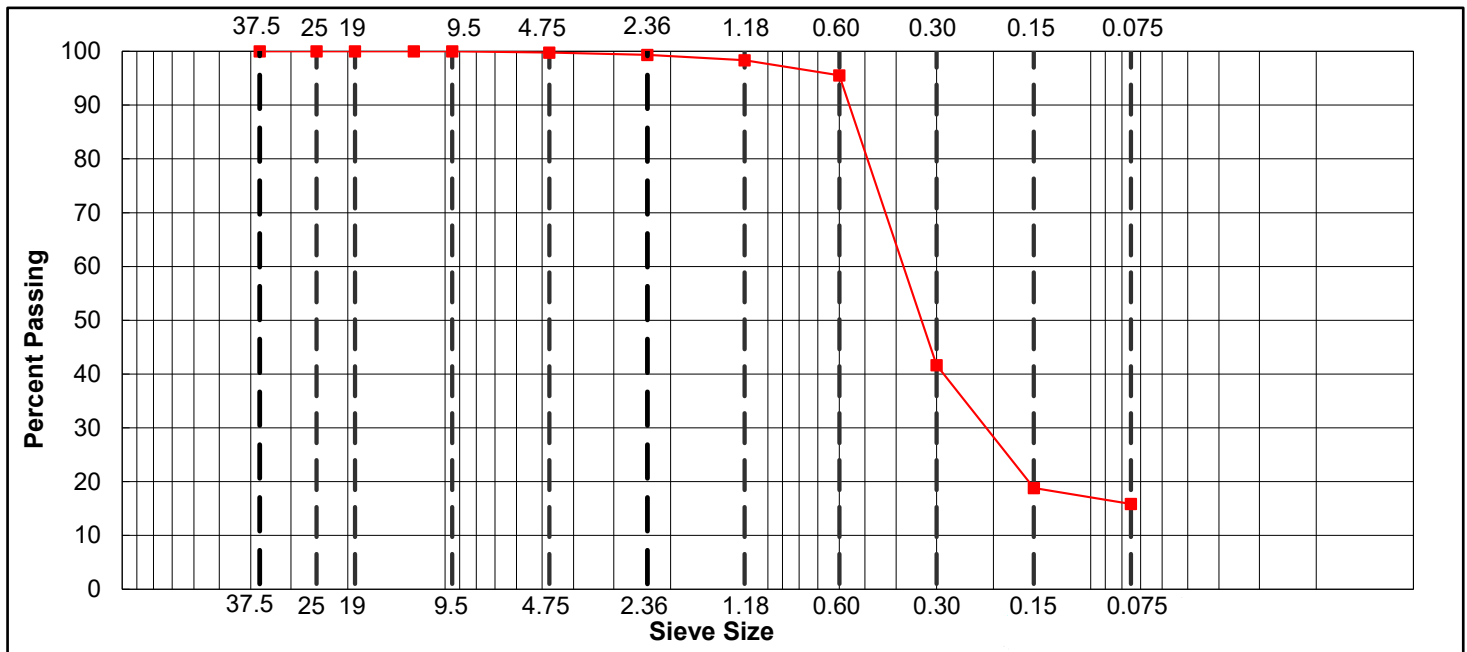
Tested in accordance with ASTM C117, C136, C702, D5821 (Size Analysis of Aggregates)

Aggregate Specification: Pit Run

SIEVE SIZE (mm)	PERCENT PASSING	Gradation Limits	
37.5	100		
25	100		
19	100		
12.5	100		
9.5	100		
4.75	100		
2.36	99		
1.18	98		
0.6	96		
0.3	42		
0.150	18.8		
0.075	15.9		

Additional Tests:

Comments:



ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 1AU2

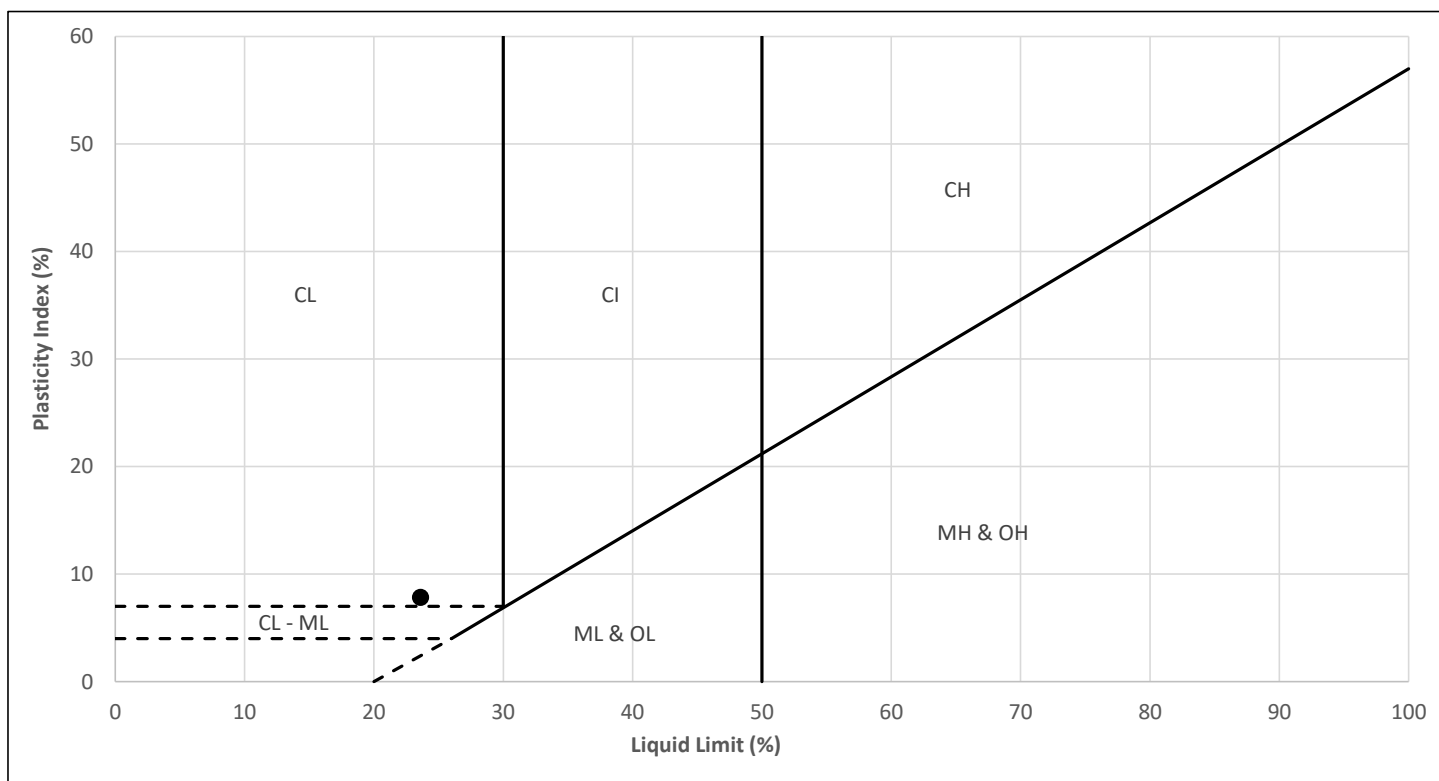
Sample #: 1AU2
Source: 22BH001
Sample Depth: 1.2m
Test Date: 8-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	23.6
Plastic Limit (PL)	15.8
Plasticity Index (PI)	7.8

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 3AU3

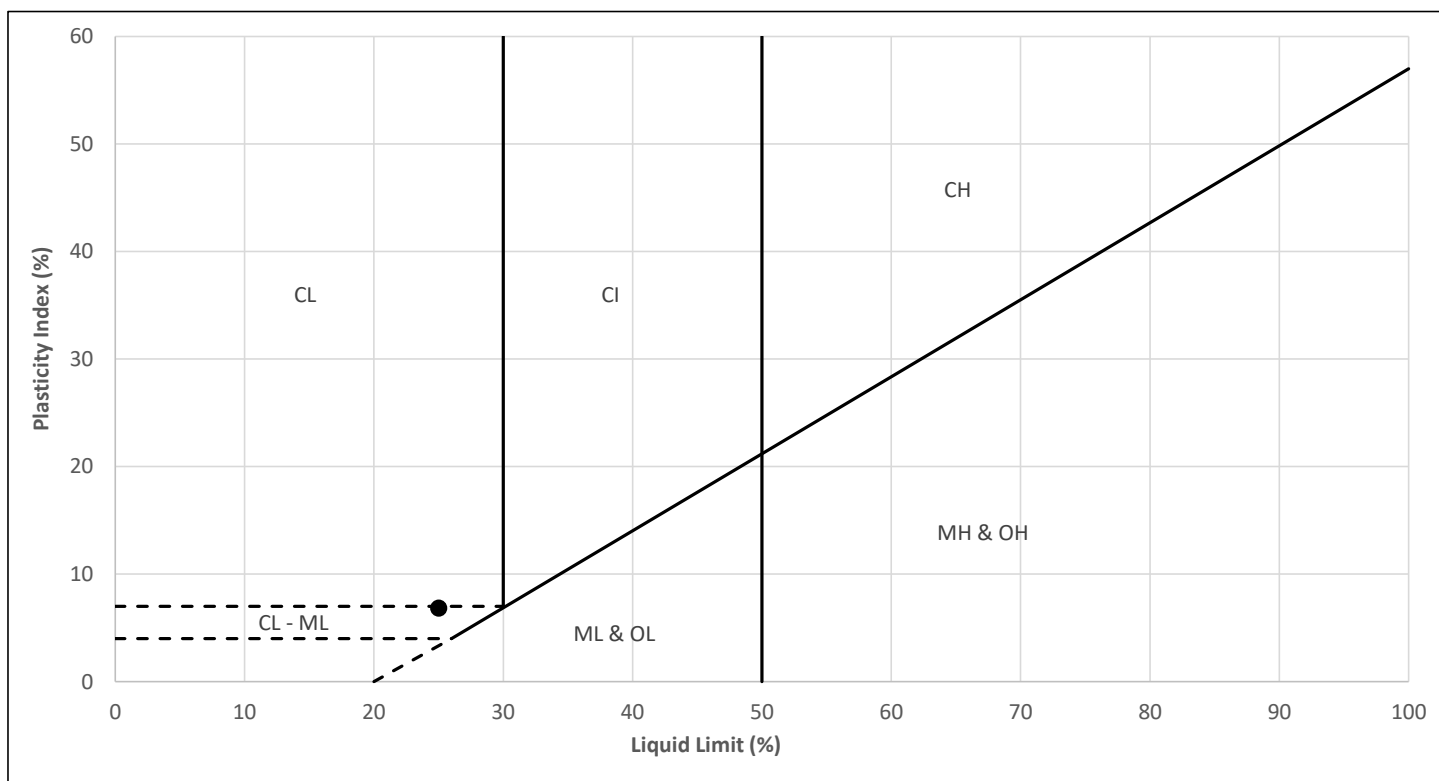
Sample #: 3AU3
Source: 22BH003
Sample Depth: 2.1m
Test Date: 8-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity

Liquid Limit (LL)	25.0
Plastic Limit (PL)	18.2
Plasticity Index (PI)	6.8

Soil Plasticity	Low
Soil Classification	ML



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 4AU6

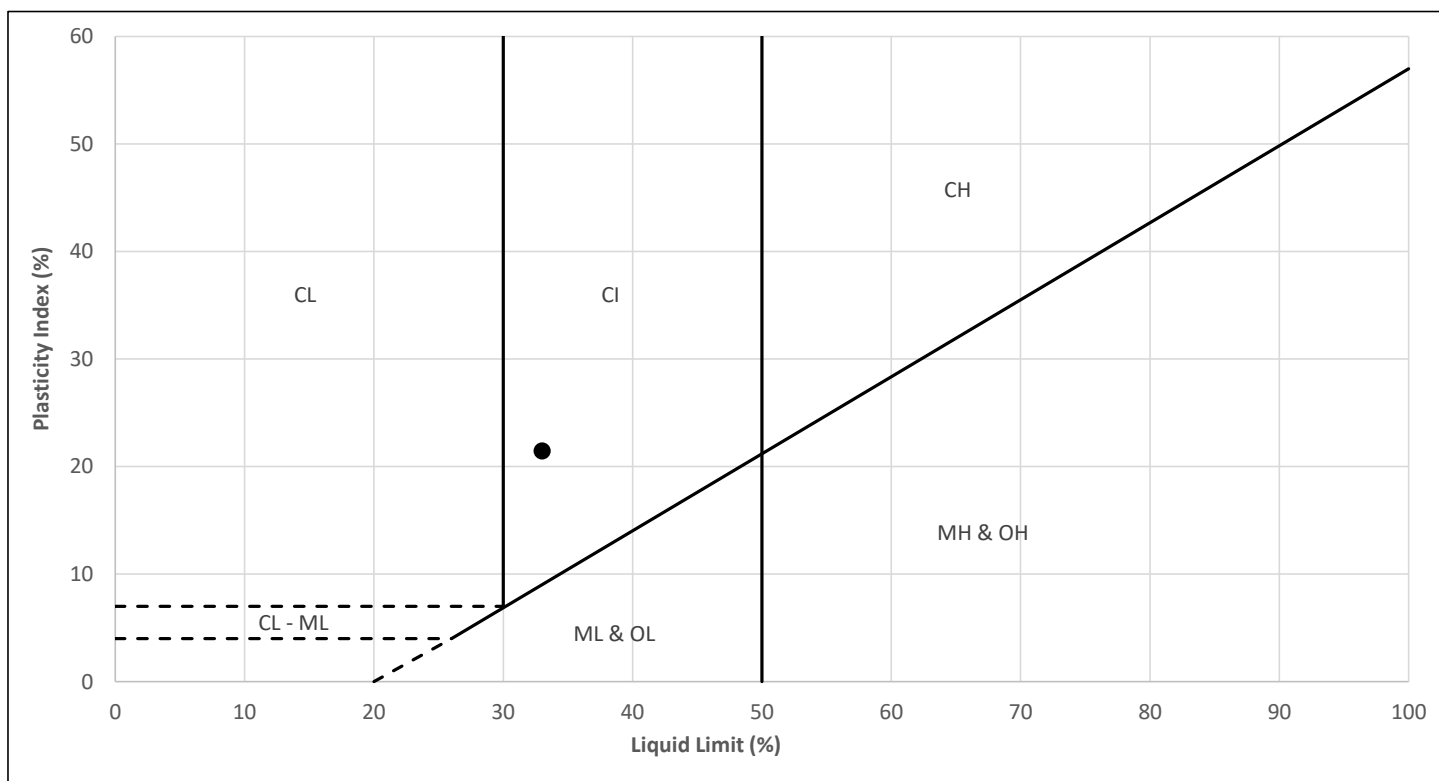
Sample #: 4AU6
Source: 22BH004
Sample Depth: 4.3m
Test Date: 8-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	33.0
Plastic Limit (PL)	11.5
Plasticity Index (PI)	21.5

Soil Plasticity	Medium
Soil Classification	CI



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 5AU8

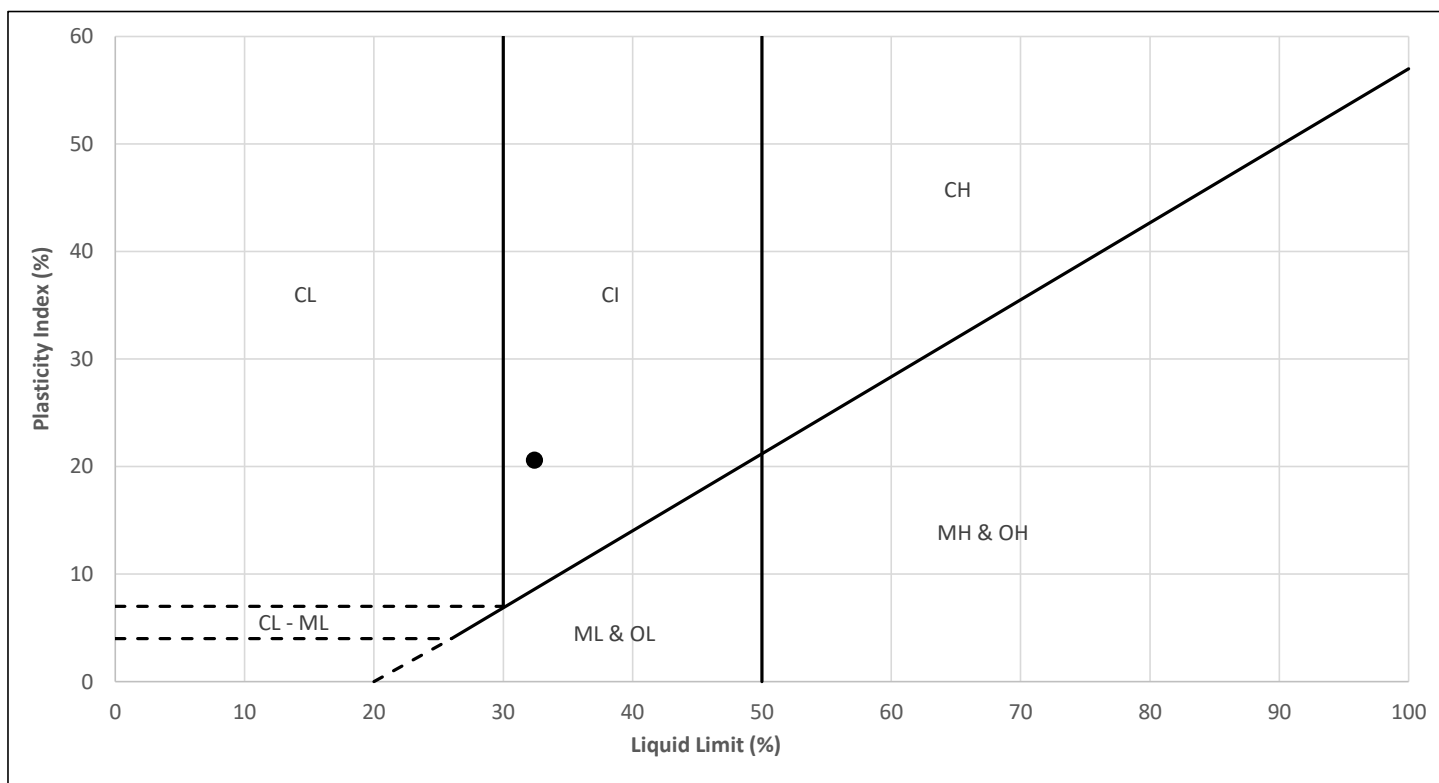
Sample #: 5AU8
Source: 22BH005
Sample Depth: 5.8m
Test Date: 8-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	32.4
Plastic Limit (PL)	11.8
Plasticity Index (PI)	20.6

Soil Plasticity	Medium
Soil Classification	CI



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 6AU10

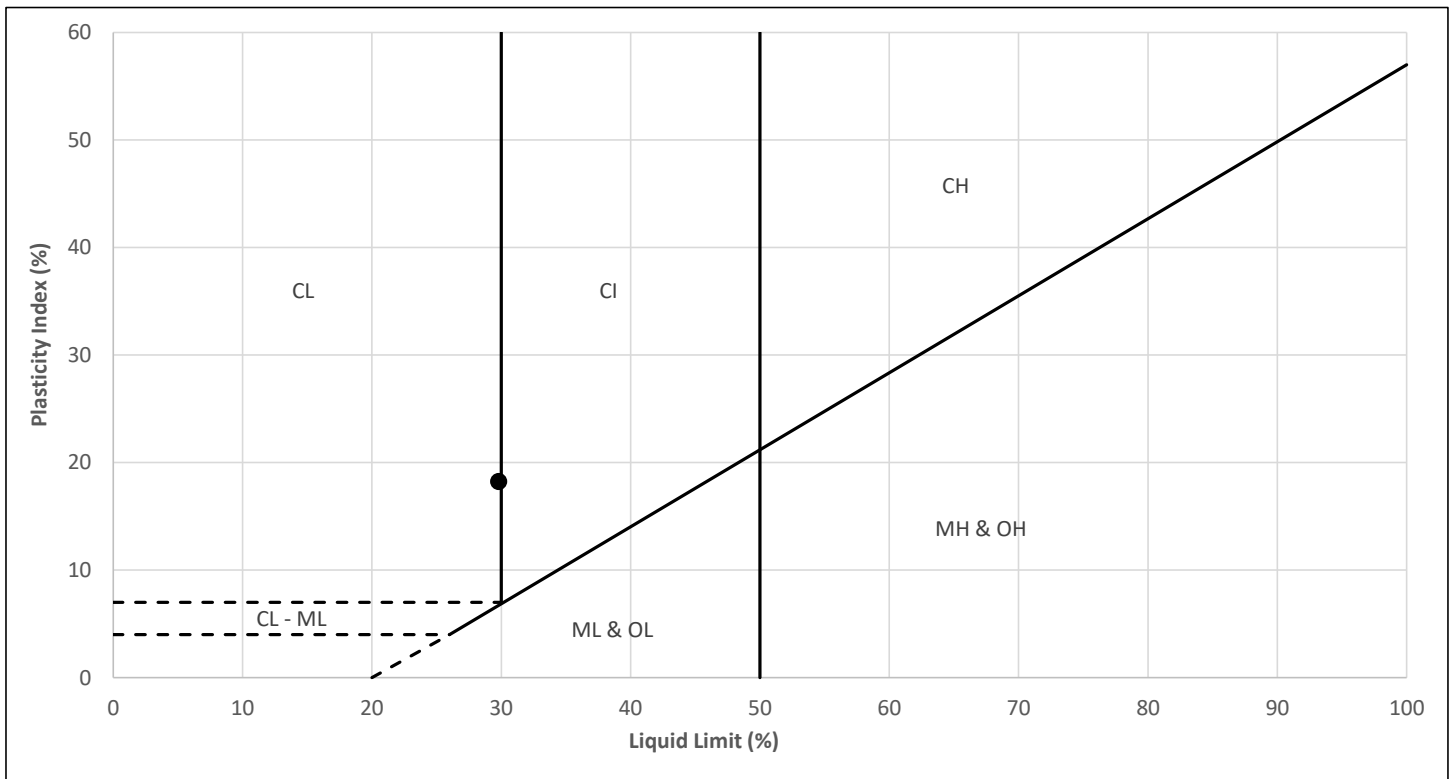
Sample #: 6AU10
Source: 22BH006
Sample Depth: 7.3m
Test Date: 7-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	29.8
Plastic Limit (PL)	11.6
Plasticity Index (PI)	18.2

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 8AU5

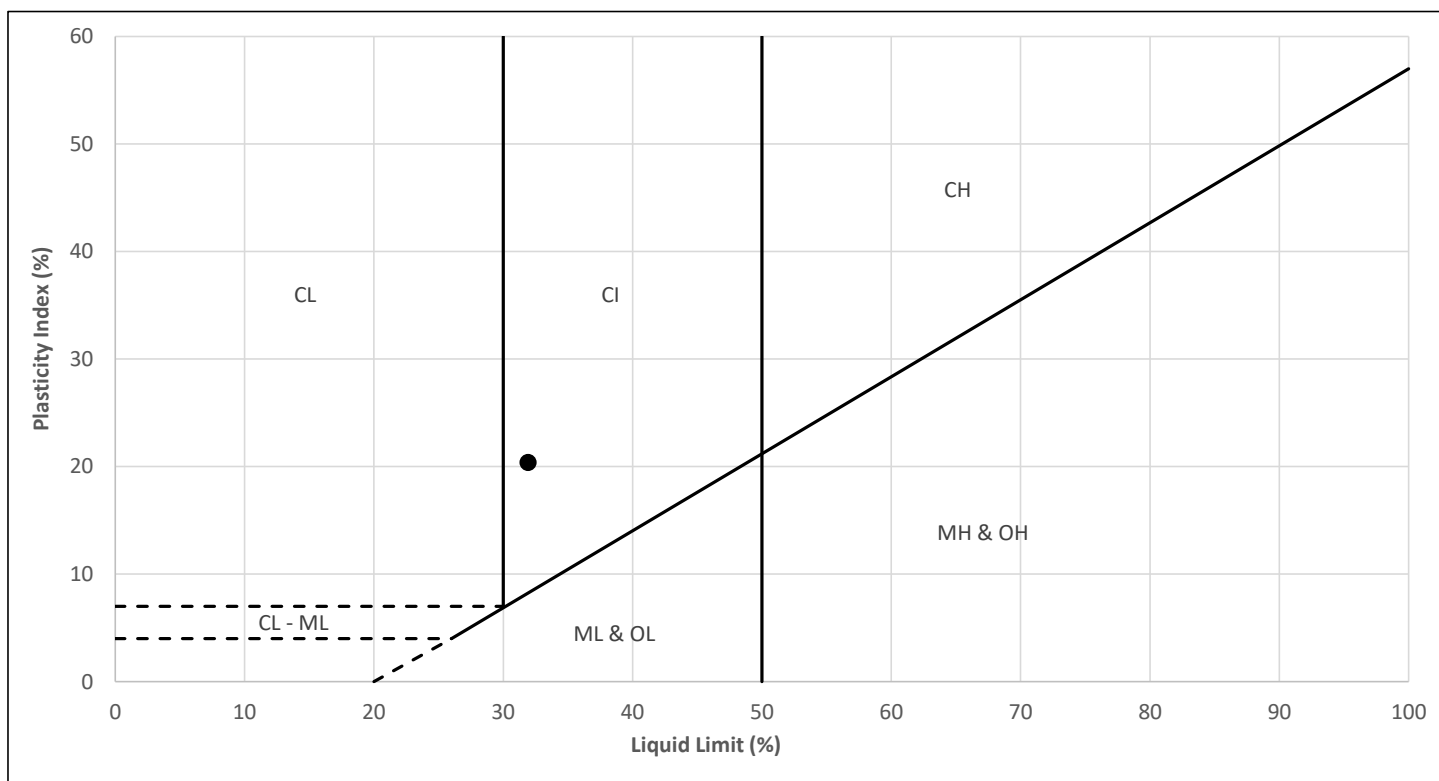
Sample #: 8AU5
Source: 22BH008
Sample Depth: 3.7m
Test Date: 7-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	31.9
Plastic Limit (PL)	11.5
Plasticity Index (PI)	20.4

Soil Plasticity	Medium
Soil Classification	CI



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 9AU1

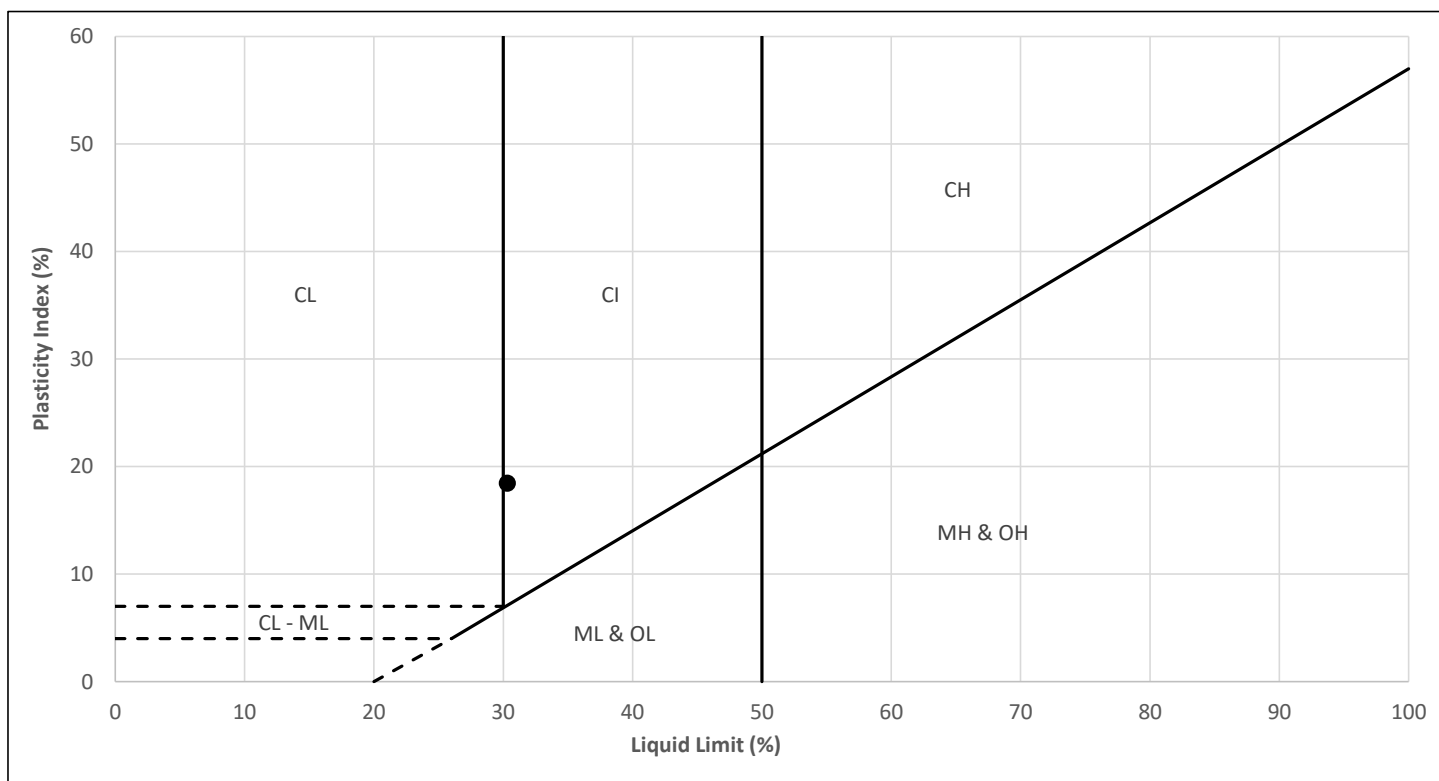
Sample #: 9AU1
Source: 22BH009
Sample Depth: 0.6m
Test Date: 7-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	30.3
Plastic Limit (PL)	11.8
Plasticity Index (PI)	18.5

Soil Plasticity	Medium
Soil Classification	CI



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 12AU3

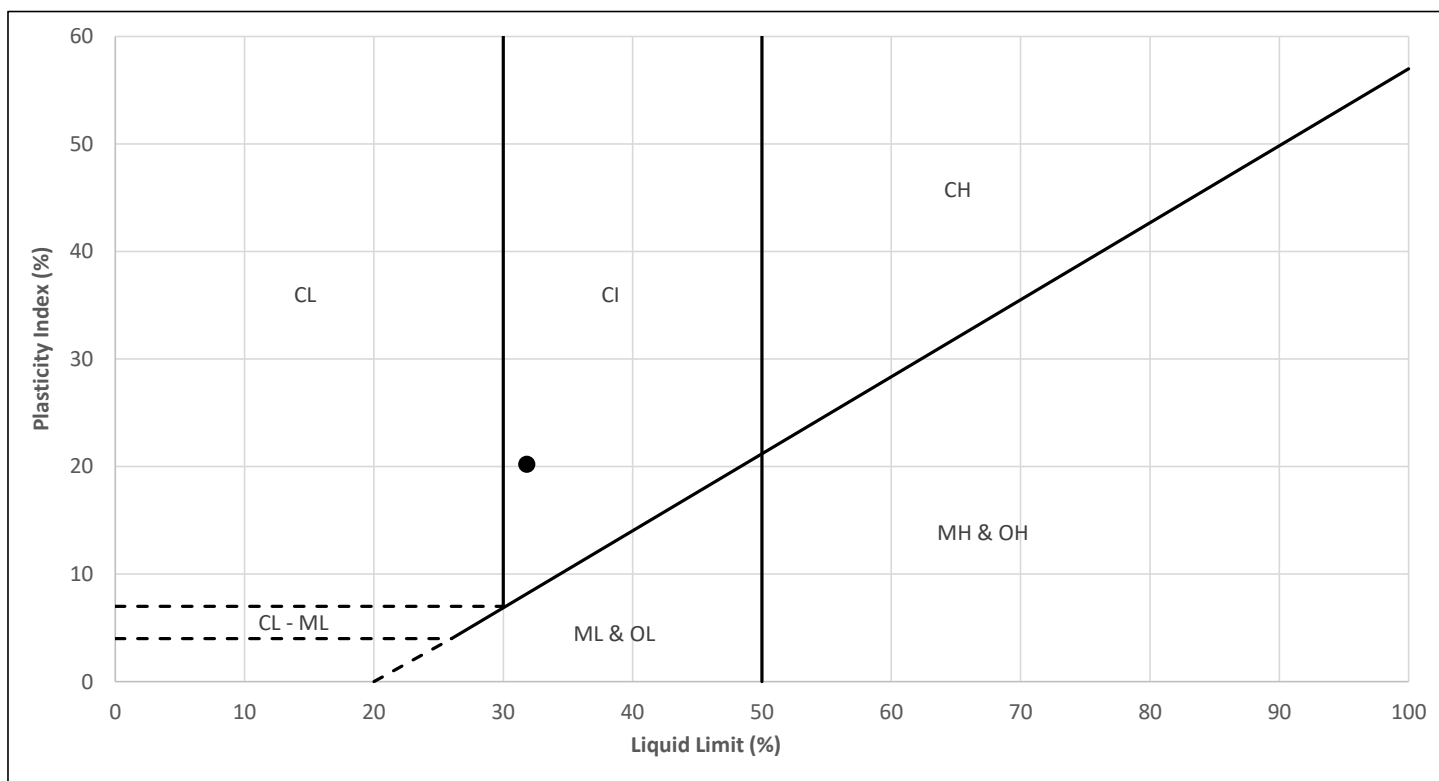
Sample #: 12AU3
Source: 22BH012
Sample Depth: 2.1m
Test Date: 7-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	31.8
Plastic Limit (PL)	11.6
Plasticity Index (PI)	20.2

Soil Plasticity	Medium
Soil Classification	CI



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 13AU4

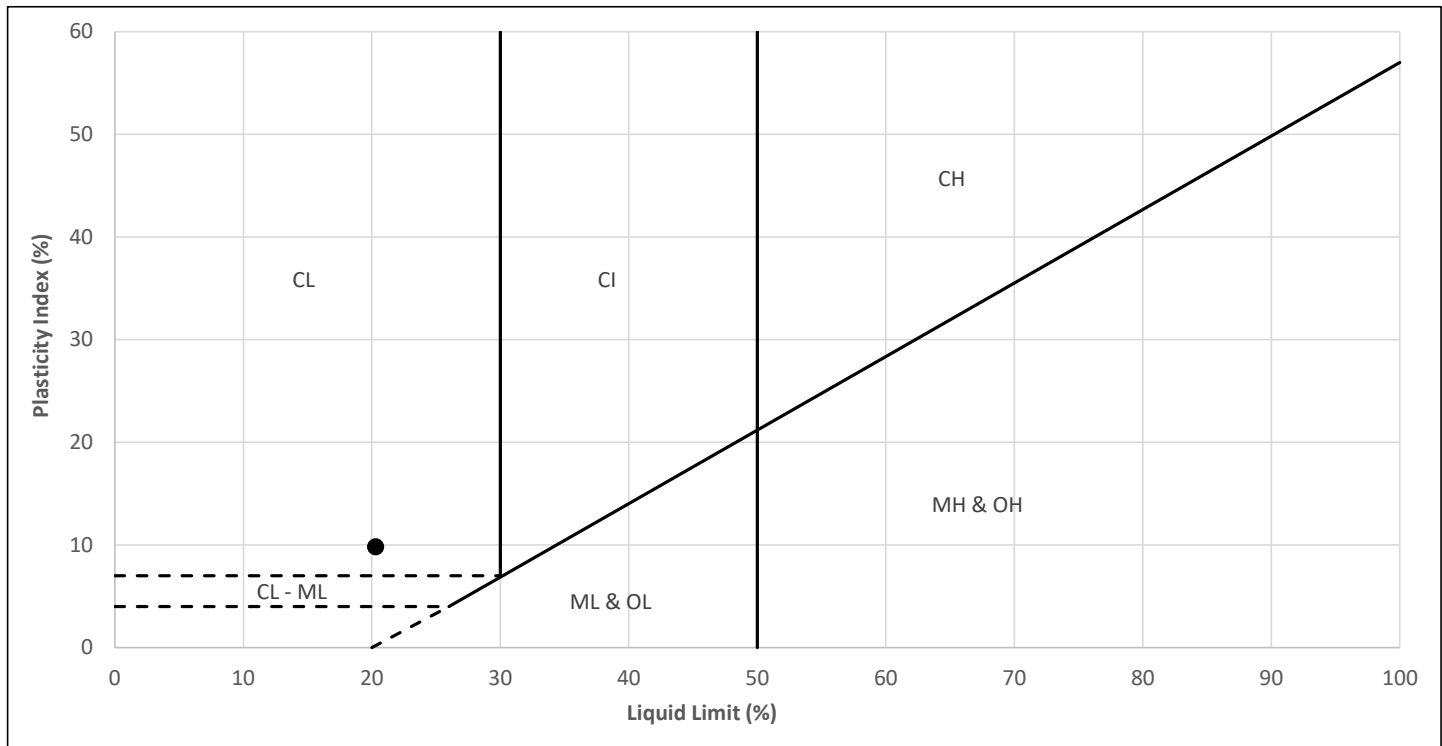
Sample #: 13AU4
Source: 22BH013
Sample Depth: 2.7m
Test Date: 14-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	20.3
Plastic Limit (PL)	10.5
Plasticity Index (PI)	9.8

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 14AU2

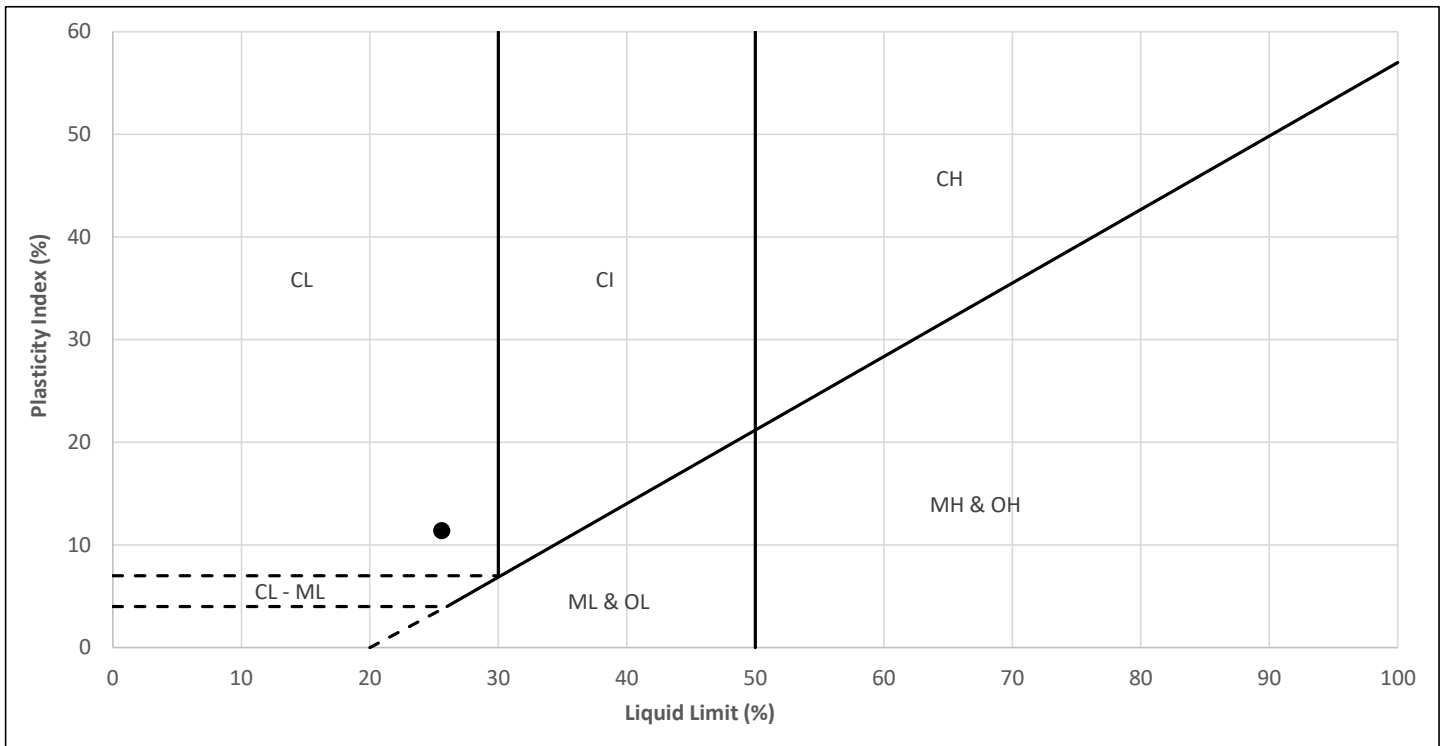
Sample #: 14AU2
Source: 22BH014
Sample Depth: 1.2m
Test Date: 15-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	25.6
Plastic Limit (PL)	14.2
Plasticity Index (PI)	11.4

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 15AU9

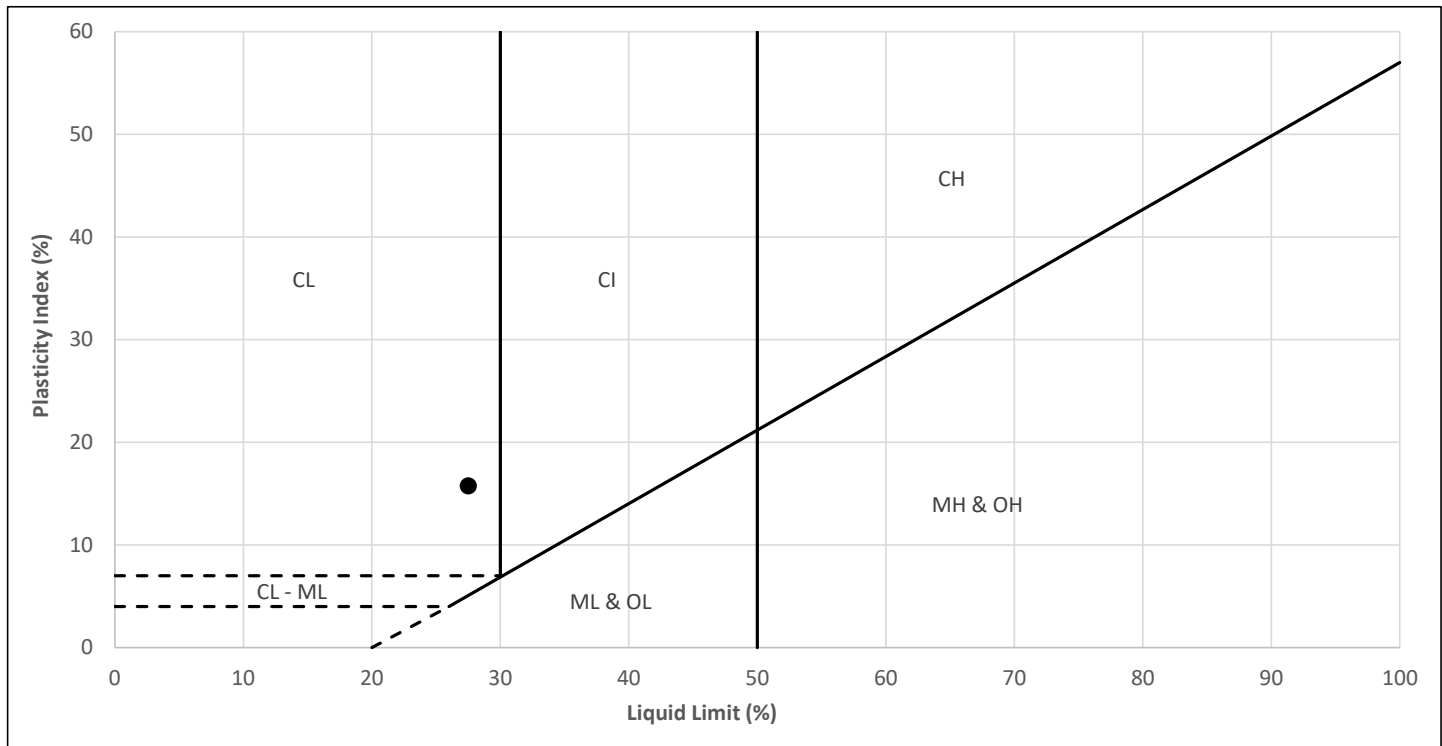
Sample #: 15AU9
Source: 22BH015
Sample Depth: 6.7m
Test Date: 15-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	27.5
Plastic Limit (PL)	11.7
Plasticity Index (PI)	15.8

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 16AU1

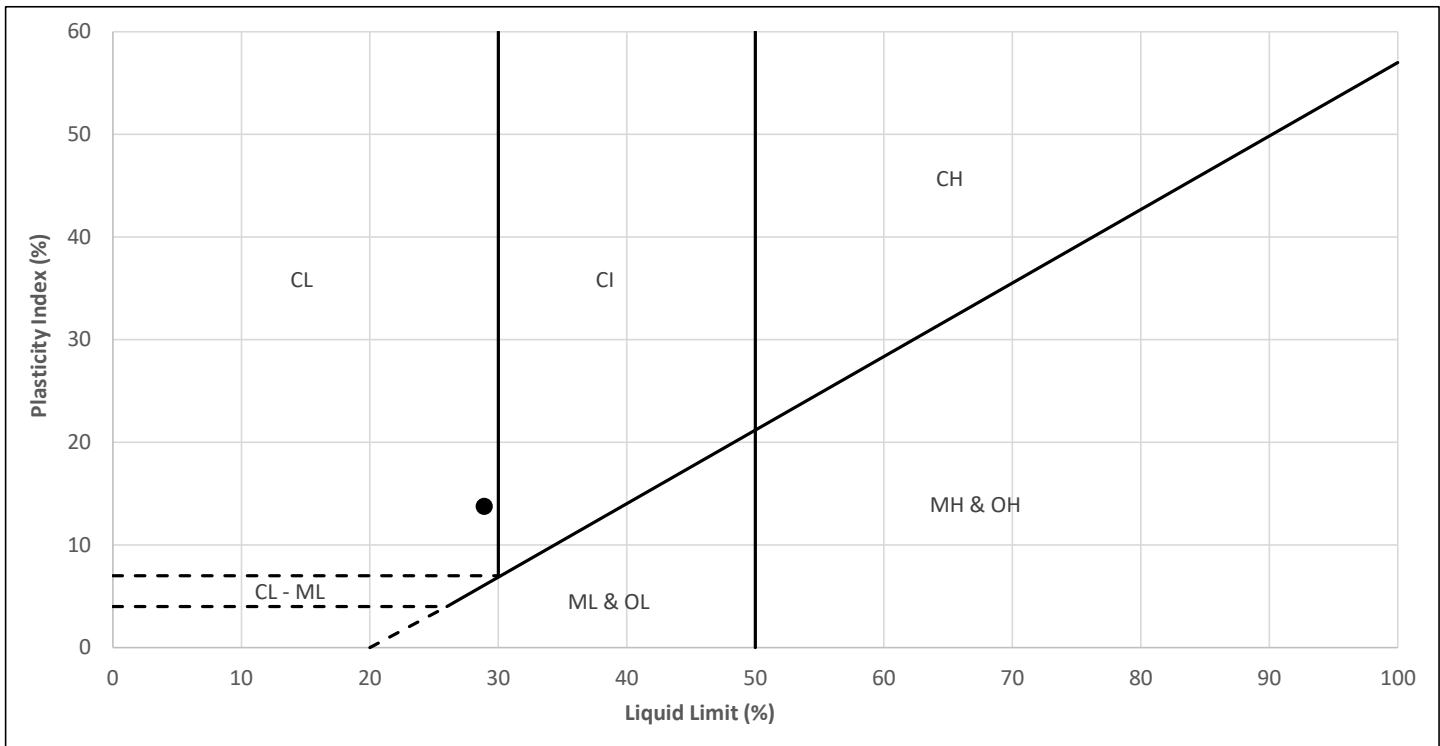
Sample #: 16AU1
Source: 22BH016
Sample Depth: 0.6m
Test Date: 15-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	28.9
Plastic Limit (PL)	15.1
Plasticity Index (PI)	13.8

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 17AU10

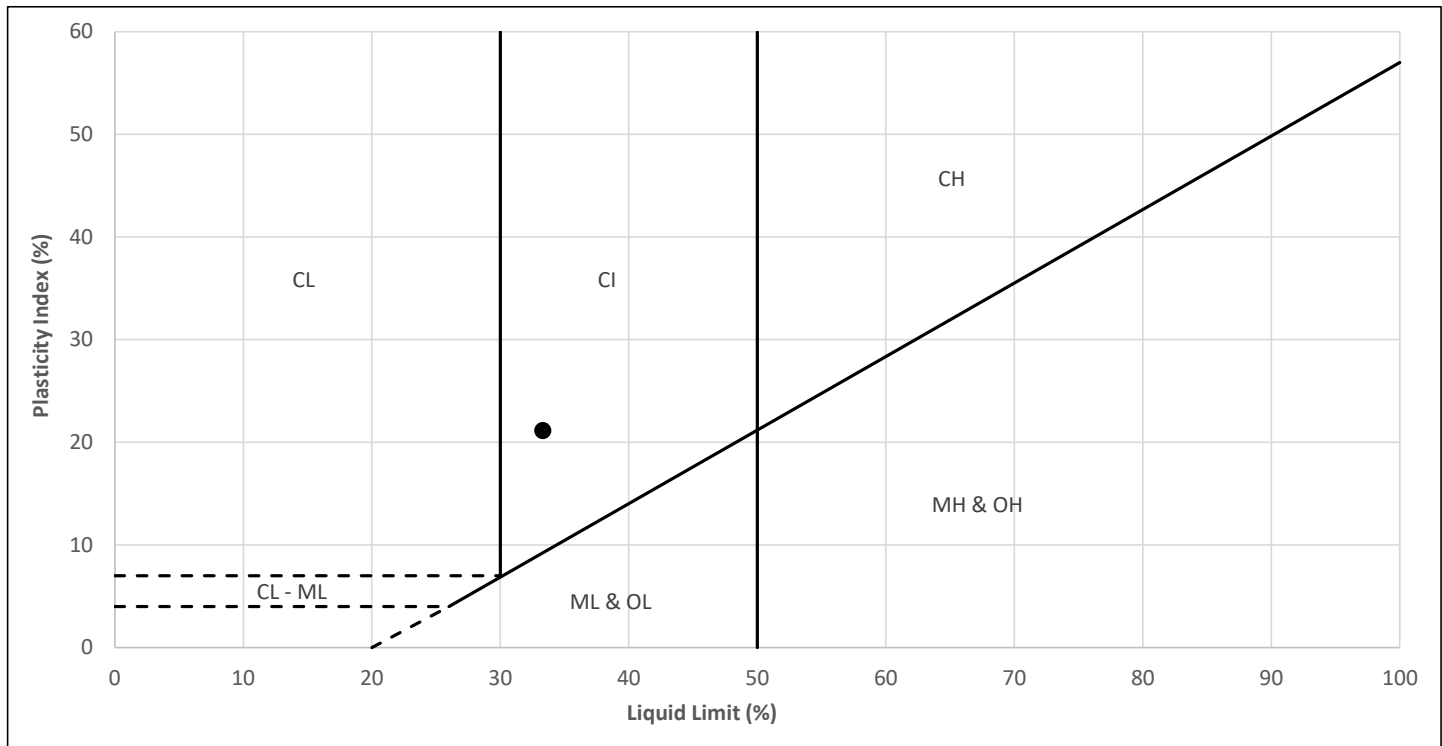
Sample #: 17AU10
Source: 22BH017
Sample Depth: 7.3m
Test Date: 14-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of medium plasticity, silty clays

Liquid Limit (LL)	33.3
Plastic Limit (PL)	12.1
Plasticity Index (PI)	21.2

Soil Plasticity	Medium
Soil Classification	CI



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 19AU1

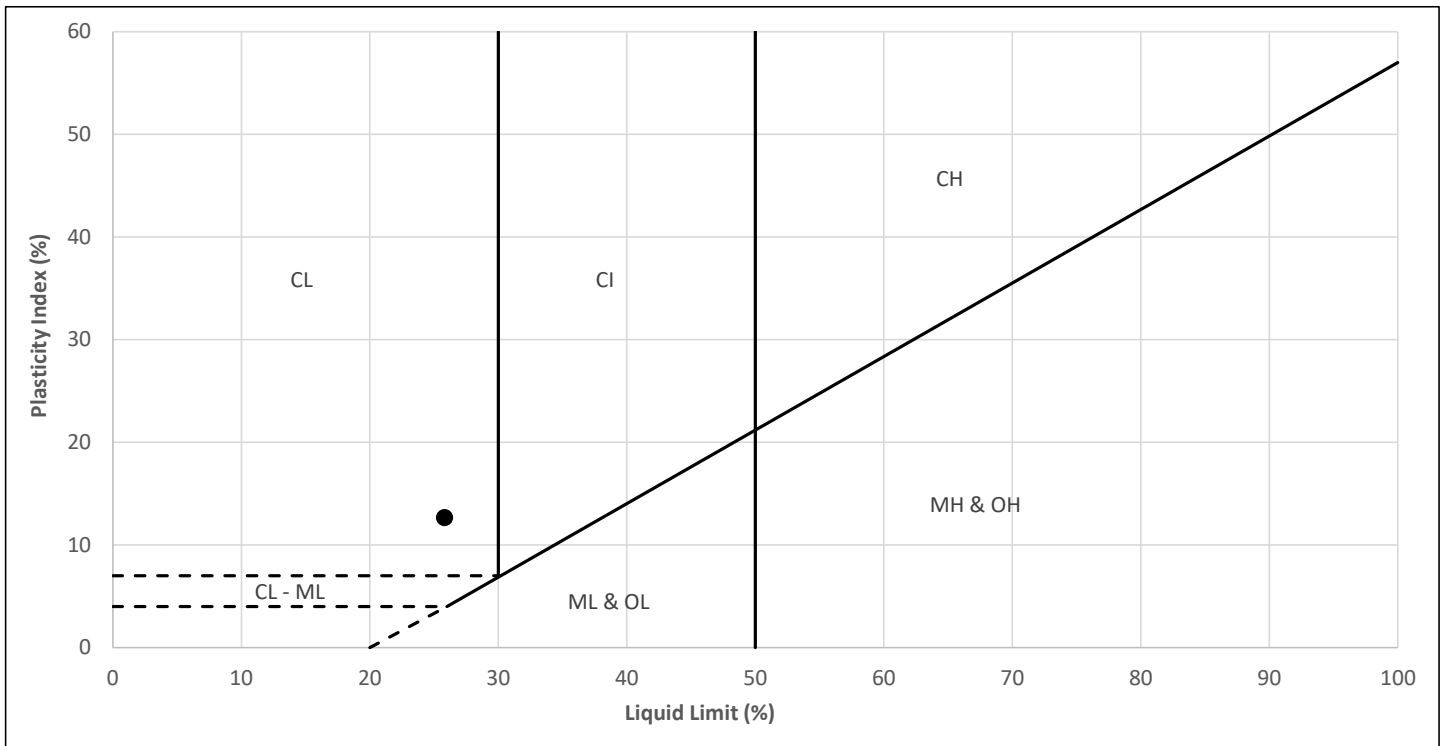
Sample #: 19AU1
Source: 22BH019
Sample Depth: 0.6m
Test Date: 14-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	25.8
Plastic Limit (PL)	13.1
Plasticity Index (PI)	12.7

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 21AU3

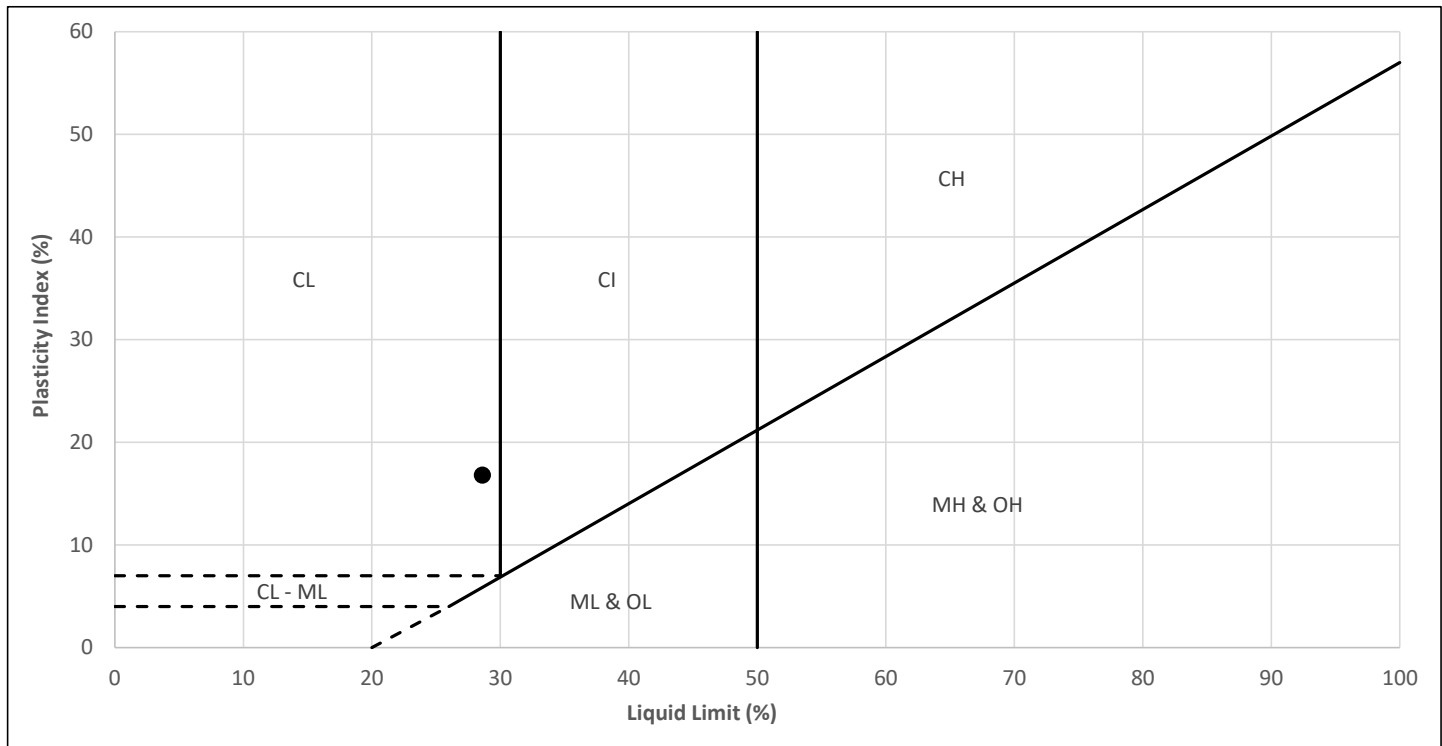
Sample #: 21AU3
Source: 22BH021
Sample Depth: 2.1m
Test Date: 15-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	28.6
Plastic Limit (PL)	11.8
Plasticity Index (PI)	16.8

Soil Plasticity	Low
Soil Classification	CL



Comments:

ATTERBERG LIMITS

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: AL - 22AU9

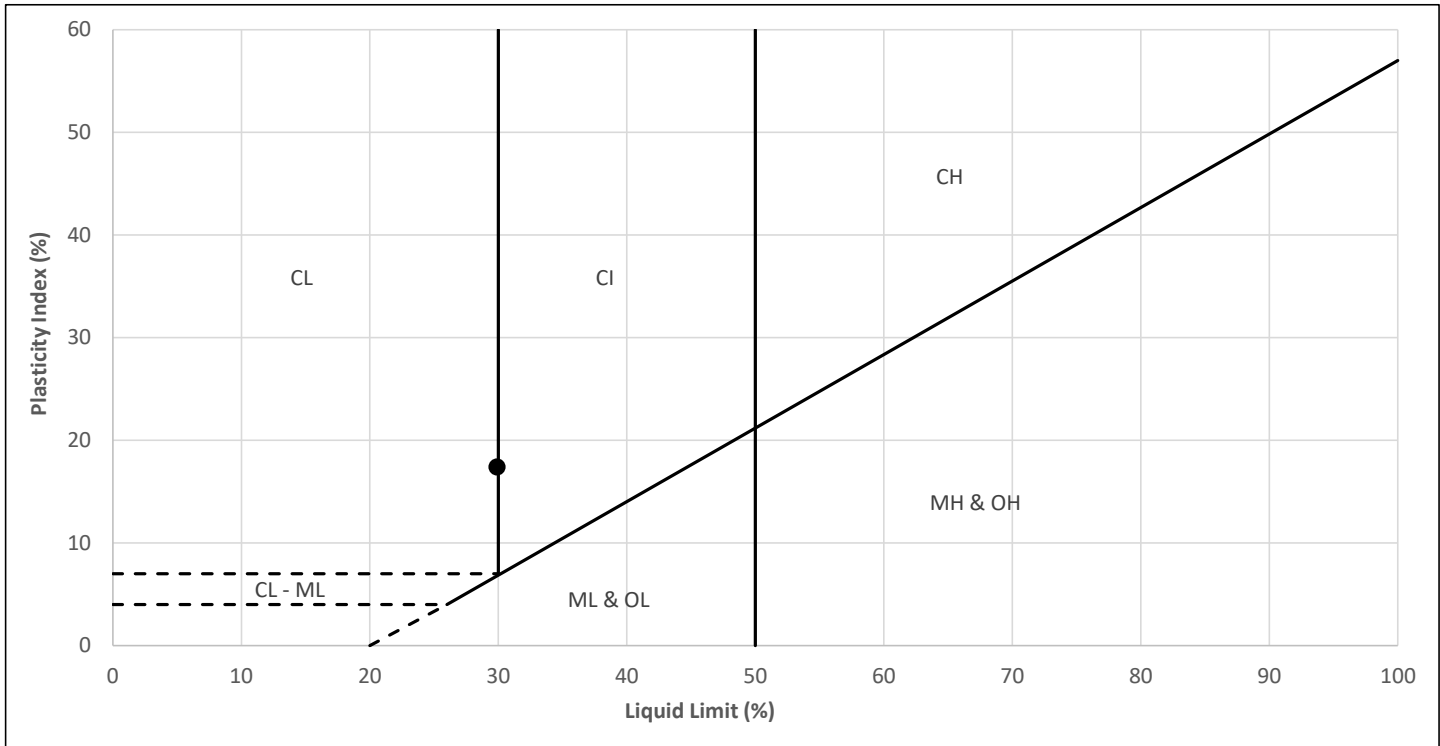
Sample #: 22AU9
Source: 22BH022
Sample Depth: 6.7m
Test Date: 15-Oct-22

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils). Additional test information available upon request.

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	29.9
Plastic Limit (PL)	12.5
Plasticity Index (PI)	17.4

Soil Plasticity	Low
Soil Classification	CL



Comments:

Dispersivity of Clay Soil by the Pinhole Test

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: DT - 8AU4

Sample #: 8AU4
Source: 22BH008
Sample Depth: 2.7m
Date: 8-Oct-22

Tested in accordance with ASTM D4647 (Identification and Classification of Dispersive Clay Soils by the Pinhole Test)

Sample Description:

CI

 Inorganic clays of medium plasticity, silty clays
Sample Type:

Remolded

Course Material >2mm:

1.0

 %
Specimen Density:

2005.6

 kg/m³
Moisture Content (before):

12.4

 %
Moisture Content (After):

13.4

 %
Length of Sample:

38.3

 mm

Test Method:

Method A

Classification:

ND1

Hydraulic Head:

1020

 mm
Flow Rate:

2.13

 ml/s

Dispersive Classification	Head (mm)	Test time (min)	Final flow rate through specimen (ml/s)	Cloudiness of flow at end of test From Side	Cloudiness of flow at end of test From Top	Hole size after test (mm)
D1	50	5	1.0 - 1.4	Dark	Very Dark	>=2.0
D2	50	10	1.0 - 1.4	Moderately Dark	Dark	>1.5
ND4	50	10	0.8 - 1.0	Slightly Dark	Moderately Dark	<=1.5
ND3	180	5	1.4 - 2.7	Barely Visible	Slightly Dark	>=1.5
ND3	380	5	1.8 - 3.2	Barely Visible	Slightly Dark	>=1.5
ND2	1020	5	>3.0	Clear	Barely	<1.5
ND1	1020	5	<=3.0	Perfectly Clear	Perfectly Clear	1.0
-	-	-	-	-	-	-

Comments:

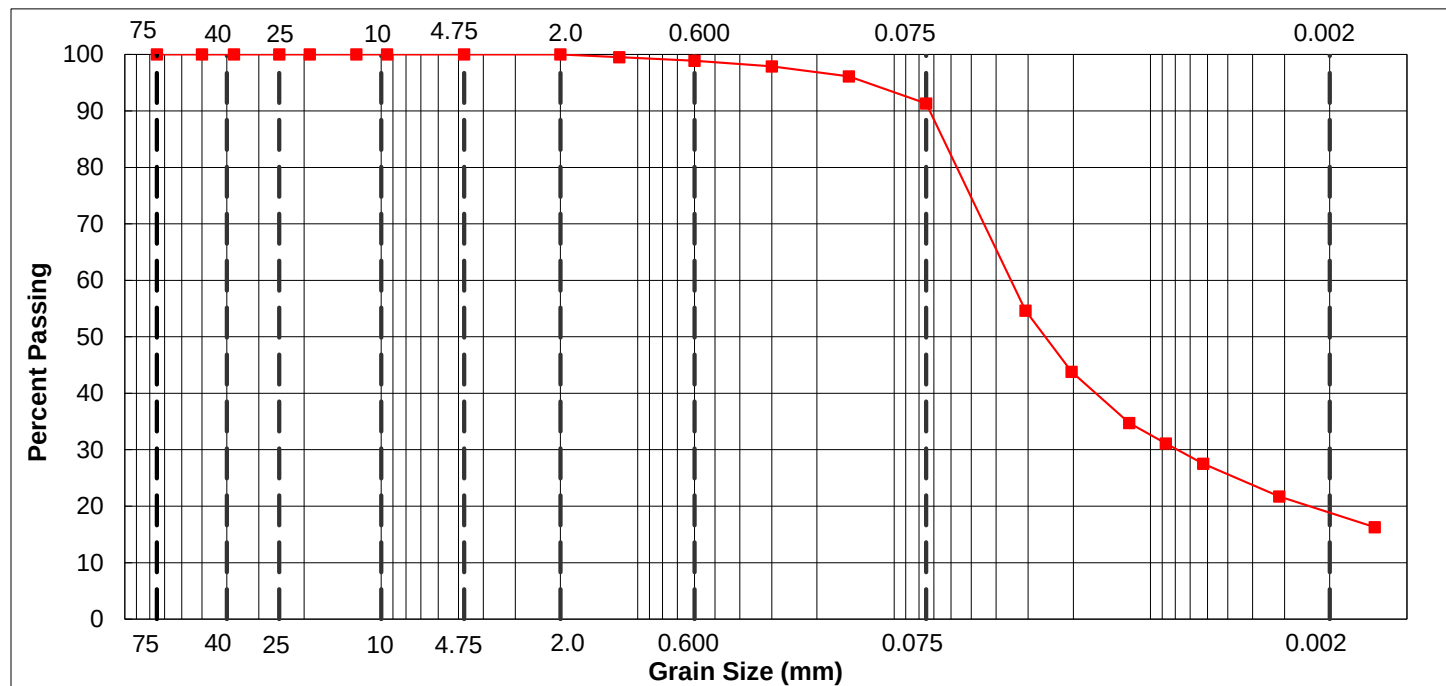
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 1AU2

Sample No.: 1AU2
Source: 22BH001
Sample Depth: 1.2m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	98.9	Type	%	Particle Size Range
75.0	100.0	0.300	97.9	Boulders	0.0	>300 mm
50.0	100.0	0.150	96.1	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	91.3	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0307	54.7	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0203	43.8	Coarse Sand	0.0	4.75 mm to 2.00 mm
12.5	100.0	0.0121	34.7	Medium Sand	1.1	2.00 mm to 425 µm
9.5	100.0	0.0087	31.1	Fine Sand	7.6	425 µm to 75 µm
4.75	100.0	0.0062	27.5	Silt	72.5	75 µm to 2 µm
2.00	100.0	0.0031	21.7	Clay	18.8	<2 µm
1.180	99.5	0.0013	16.3			



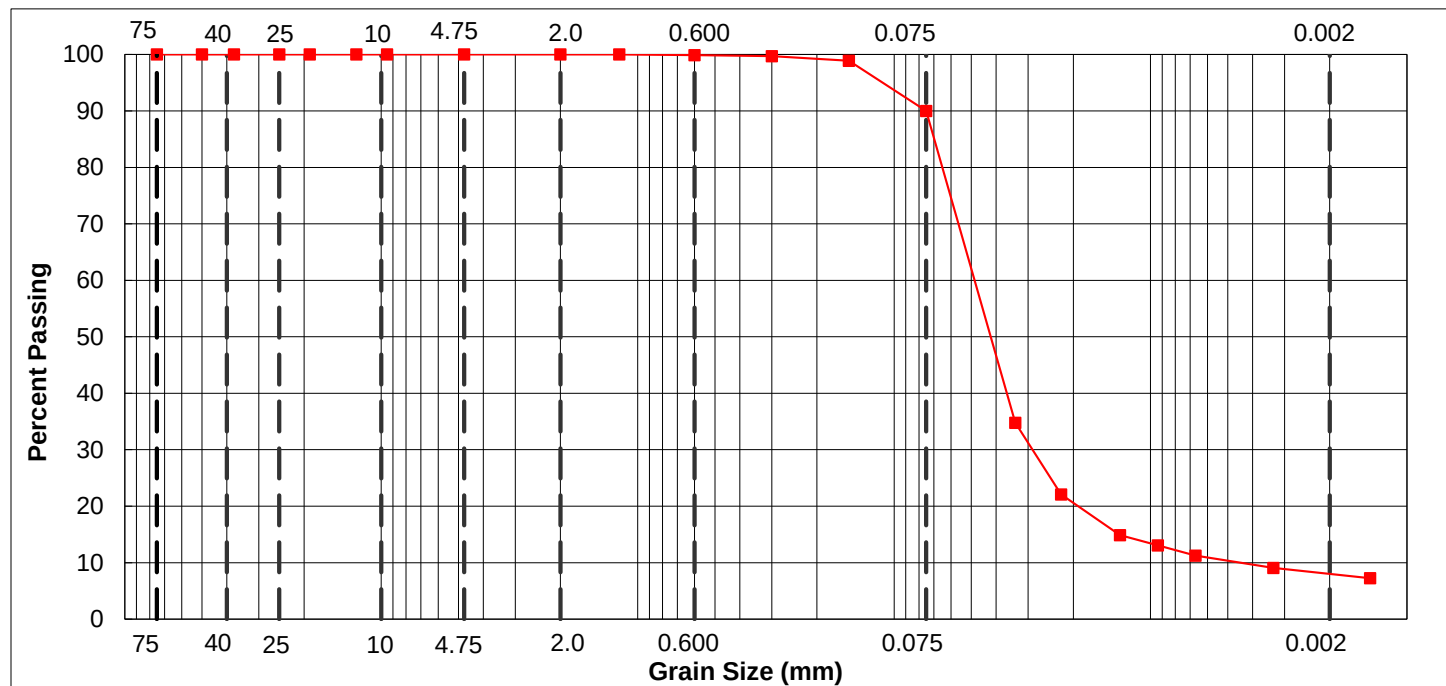
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 2AU4

Sample No.: 2AU4
Source: 22BH002
Sample Depth: 2.7m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	99.9	Type	%	Particle Size Range
75.0	100.0	0.300	99.7	Boulders	0.0	>300 mm
50.0	100.0	0.150	98.9	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	90.0	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0337	34.8	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0223	22.1	Coarse Sand	0.0	4.75 mm to 2.00 mm
12.5	100.0	0.0132	14.9	Medium Sand	0.1	2.00 mm to 425 µm
9.5	100.0	0.0094	13.0	Fine Sand	9.9	425 µm to 75 µm
4.75	100.0	0.0067	11.2	Silt	82.0	75 µm to 2 µm
2.00	100.0	0.0033	9.1	Clay	8.0	<2 µm
1.180	100.0	0.0014	7.2			



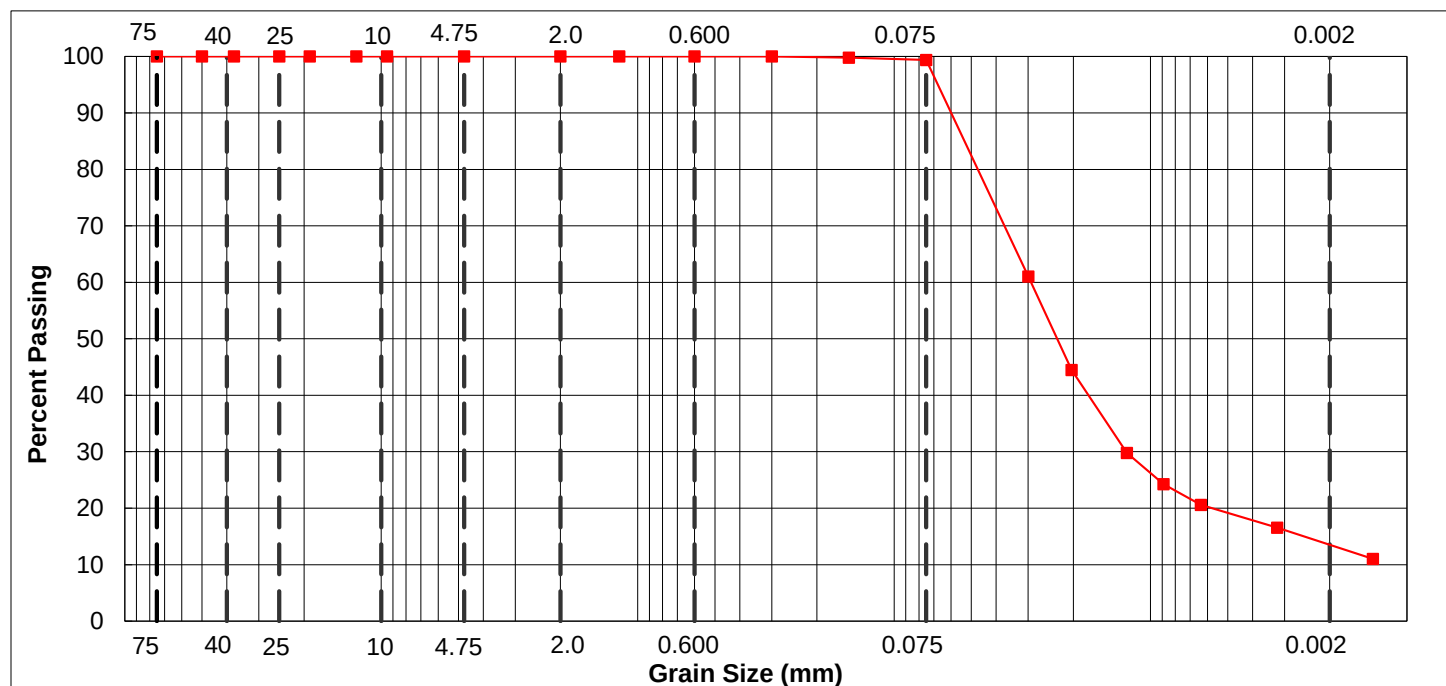
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 3AU3

Sample No.: 3AU3
Source: 22BH003
Sample Depth: 2.1m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	100.0	Type	%	Particle Size Range
75.0	100.0	0.300	100.0	Boulders	0.0	>300 mm
50.0	100.0	0.150	99.8	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	99.4	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0300	61.0	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0203	44.5	Coarse Sand	0.0	4.75 mm to 2.00 mm
12.5	100.0	0.0124	29.8	Medium Sand	0.0	2.00 mm to 425 µm
9.5	100.0	0.0089	24.3	Fine Sand	0.6	425 µm to 75 µm
4.75	100.0	0.0064	20.6	Silt	85.9	75 µm to 2 µm
2.00	100.0	0.0032	16.5	Clay	13.5	<2 µm
1.180	100.0	0.0014	11.0			



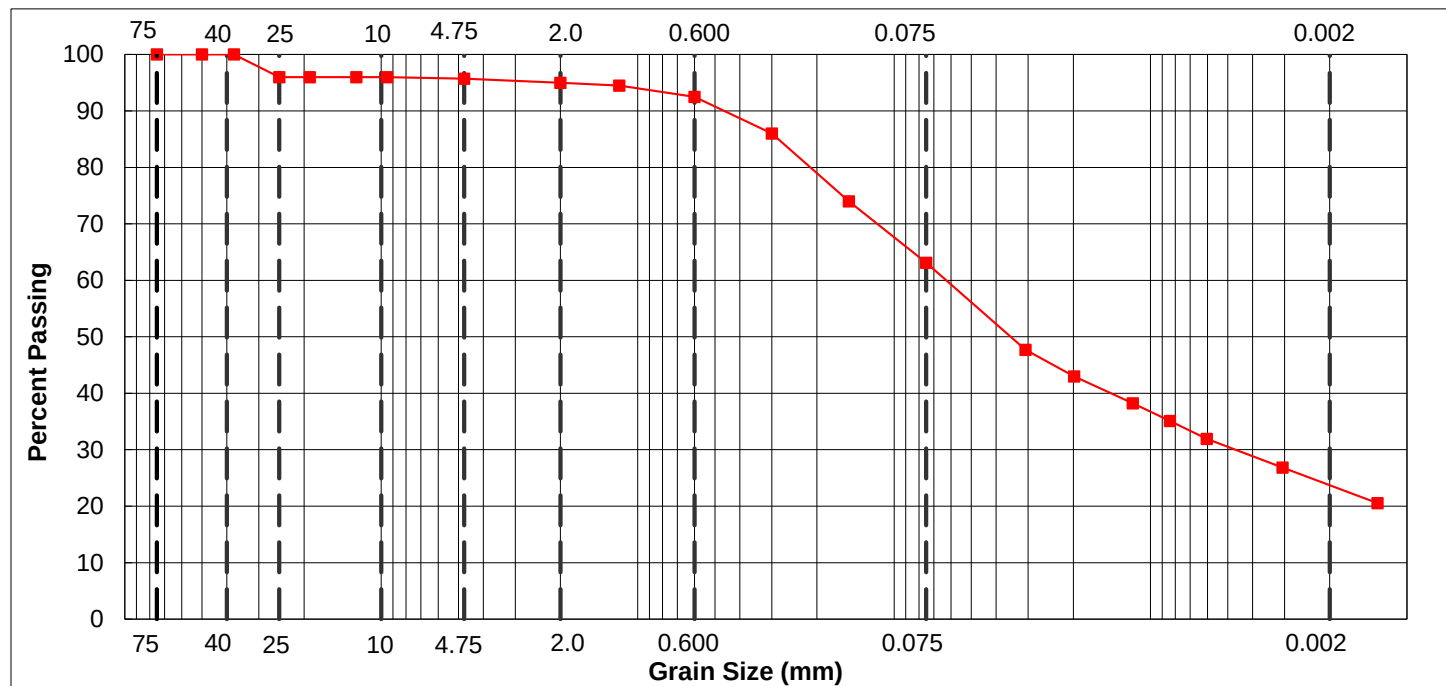
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 4AU6

Sample No.: 4AU6
Source: 22BH004
Sample Depth: 4.3m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	92.5	Type	%	Particle Size Range
75.0	100.0	0.300	86.0	Boulders	0.0	>300 mm
50.0	100.0	0.150	74.0	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	63.1	Coarse Gravel	4.0	80 mm to 20 mm
25.0	96.0	0.0307	47.7	Fine Gravel	0.3	20 mm to 4.75 mm
19.0	96.0	0.0199	43.0	Coarse Sand	0.7	4.75 mm to 2.00 mm
12.5	96.0	0.0117	38.2	Medium Sand	2.5	2.00 mm to 425 µm
9.5	96.0	0.0084	35.1	Fine Sand	29.4	425 µm to 75 µm
4.75	95.7	0.0060	31.9	Silt	39.4	75 µm to 2 µm
2.00	95.0	0.0031	26.9	Clay	23.7	<2 µm
1.180	94.5	0.0013	20.5			



Reviewed By: 
Kasz Leavitt, P.Tech. (Eng.)

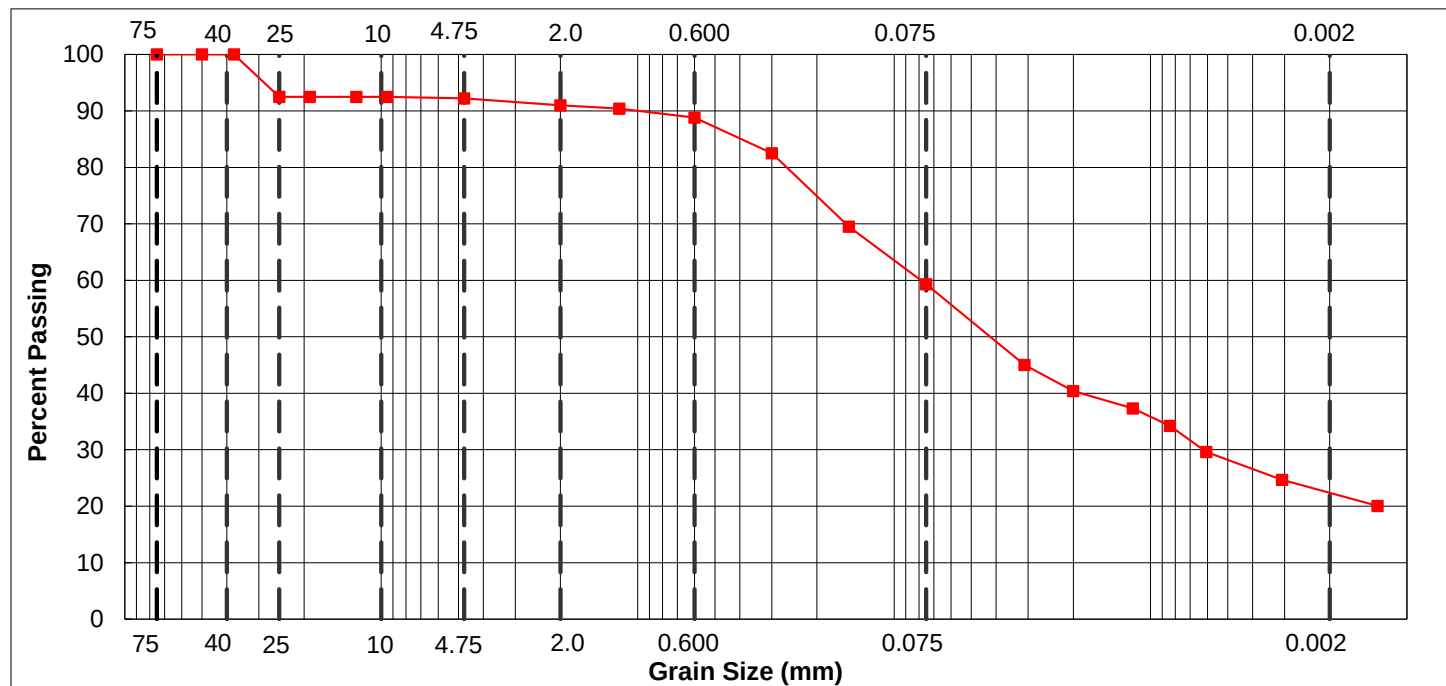
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 5AU8

Sample No.: 5AU8
Source: 22BH005
Sample Depth: 5.8m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	88.8	Type	%	Particle Size Range
75.0	100.0	0.300	82.5	Boulders	0.0	>300 mm
50.0	100.0	0.150	69.5	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	59.3	Coarse Gravel	7.5	80 mm to 20 mm
25.0	92.5	0.0310	45.0	Fine Gravel	0.3	20 mm to 4.75 mm
19.0	92.5	0.0201	40.4	Coarse Sand	1.2	4.75 mm to 2.00 mm
12.5	92.5	0.0117	37.3	Medium Sand	2.2	2.00 mm to 425 µm
9.5	92.5	0.0084	34.2	Fine Sand	29.5	425 µm to 75 µm
4.75	92.2	0.0061	29.6	Silt	36.9	75 µm to 2 µm
2.00	91.0	0.0031	24.7	Clay	22.4	<2 µm
1.180	90.4	0.0013	20.1			



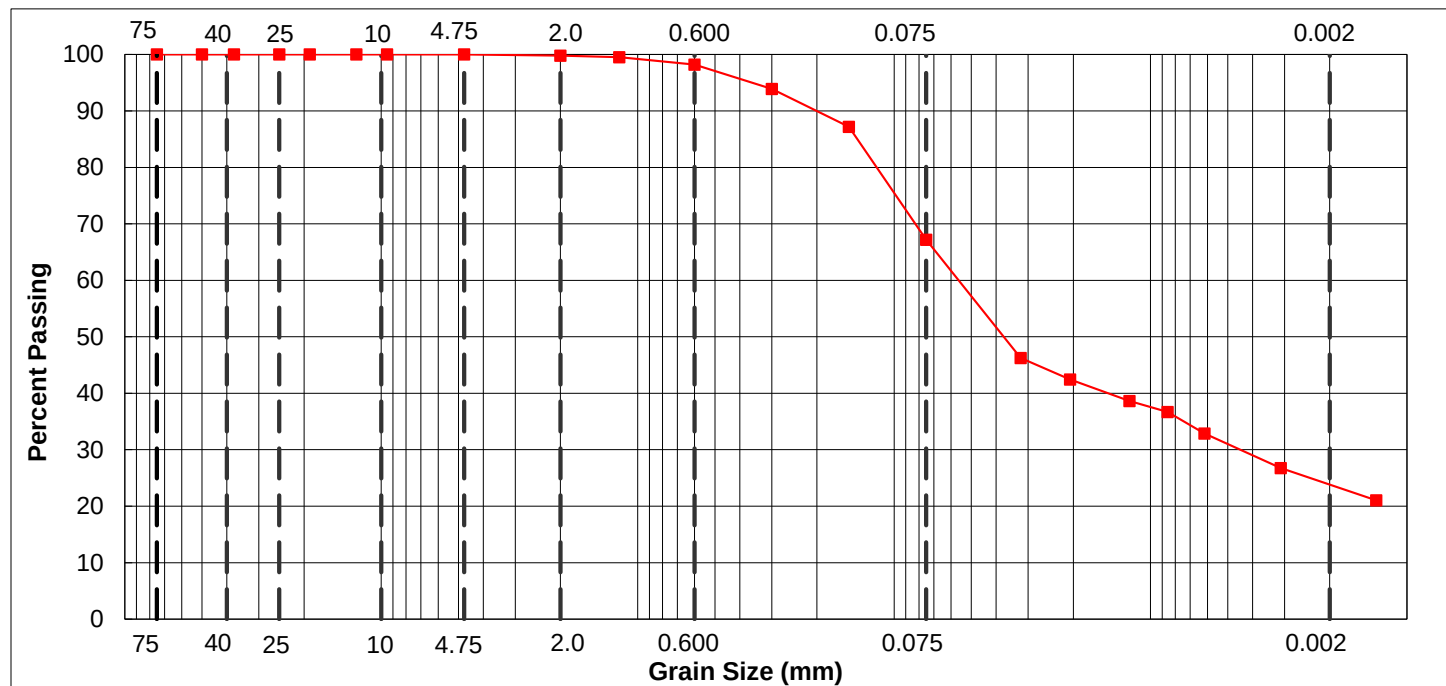
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 6AU10

Sample No.: 6AU10
Source: 22BH006
Sample Depth: 7.3m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	98.2	Type	%	Particle Size Range
75.0	100.0	0.300	93.9	Boulders	0.0	>300 mm
50.0	100.0	0.150	87.2	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	67.2	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0321	46.3	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0206	42.4	Coarse Sand	0.2	4.75 mm to 2.00 mm
12.5	100.0	0.0121	38.6	Medium Sand	1.6	2.00 mm to 425 µm
9.5	100.0	0.0086	36.7	Fine Sand	31.0	425 µm to 75 µm
4.75	100.0	0.0062	32.9	Silt	43.4	75 µm to 2 µm
2.00	99.8	0.0031	26.8	Clay	23.8	<2 µm
1.180	99.5	0.0013	21.0			



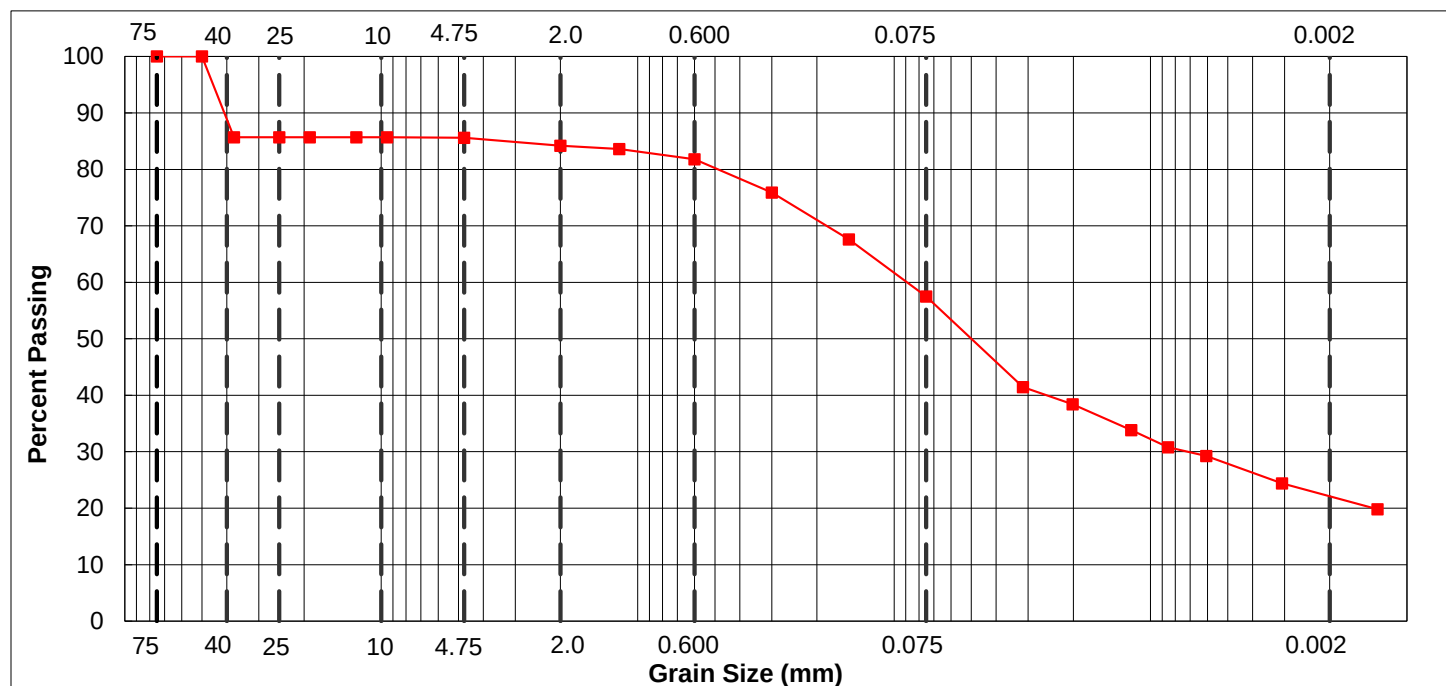
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 8AU5

Sample No.: 8AU5
Source: 22BH008
Sample Depth: 3.7m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	81.8	Type	%	Particle Size Range
75.0	100.0	0.300	75.9	Boulders	0.0	>300 mm
50.0	100.0	0.150	67.6	Cobbles	0.0	300 mm to 75 mm
37.5	85.7	0.075	57.5	Coarse Gravel	14.3	80 mm to 20 mm
25.0	85.7	0.0314	41.5	Fine Gravel	0.1	20 mm to 4.75 mm
19.0	85.7	0.0201	38.4	Coarse Sand	1.4	4.75 mm to 2.00 mm
12.5	85.7	0.0119	33.8	Medium Sand	2.4	2.00 mm to 425 µm
9.5	85.7	0.0085	30.8	Fine Sand	24.3	425 µm to 75 µm
4.75	85.6	0.0061	29.3	Silt	35.4	75 µm to 2 µm
2.00	84.2	0.0031	24.4	Clay	22.1	<2 µm
1.180	83.6	0.0013	19.8			



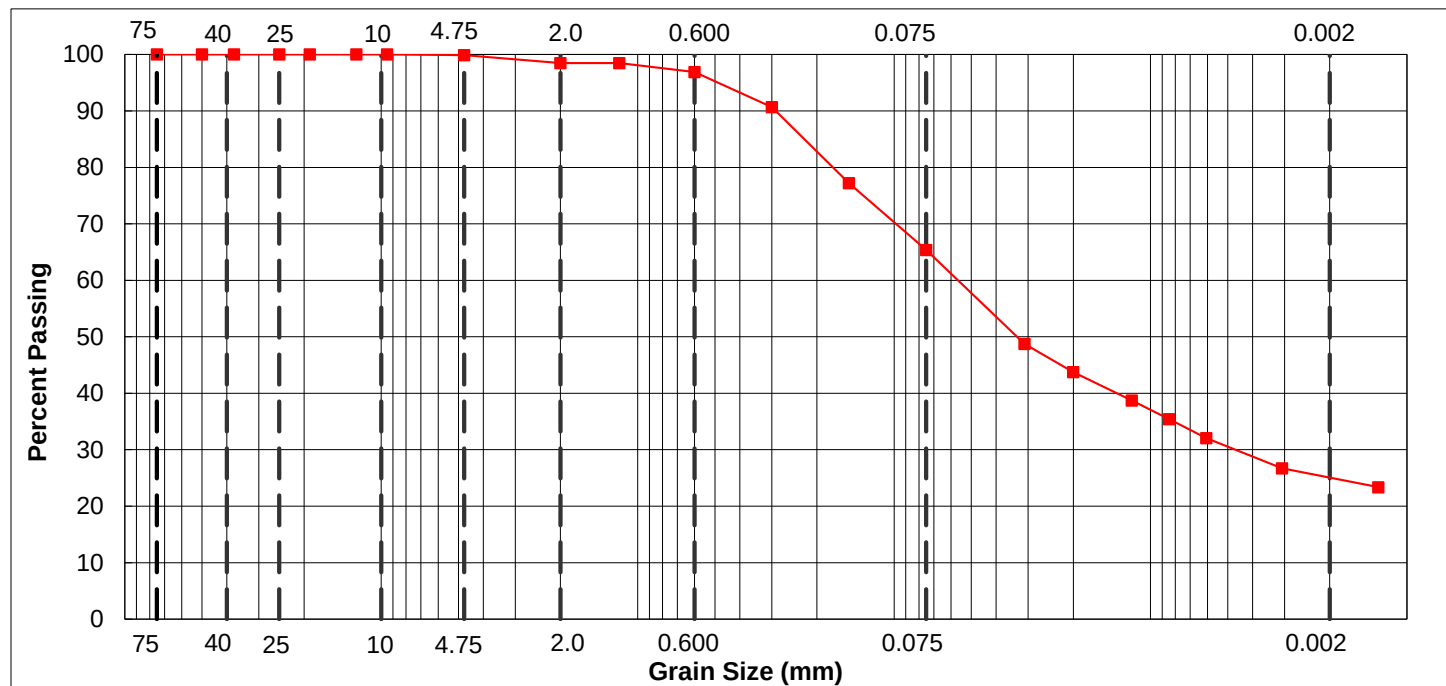
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 9AU1

Sample No.: 9AU1
Source: 22BH009
Sample Depth: 0.6m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	96.9	Type	%	Particle Size Range
75.0	100.0	0.300	90.7	Boulders	0.0	>300 mm
50.0	100.0	0.150	77.2	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	65.4	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0310	48.8	Fine Gravel	0.1	20 mm to 4.75 mm
19.0	100.0	0.0201	43.8	Coarse Sand	1.4	4.75 mm to 2.00 mm
12.5	100.0	0.0118	38.7	Medium Sand	1.6	2.00 mm to 425 µm
9.5	100.0	0.0085	35.4	Fine Sand	31.5	425 µm to 75 µm
4.75	99.9	0.0061	32.1	Silt	40.3	75 µm to 2 µm
2.00	98.5	0.0031	26.7	Clay	25.1	<2 µm
1.180	98.5	0.0013	23.4			



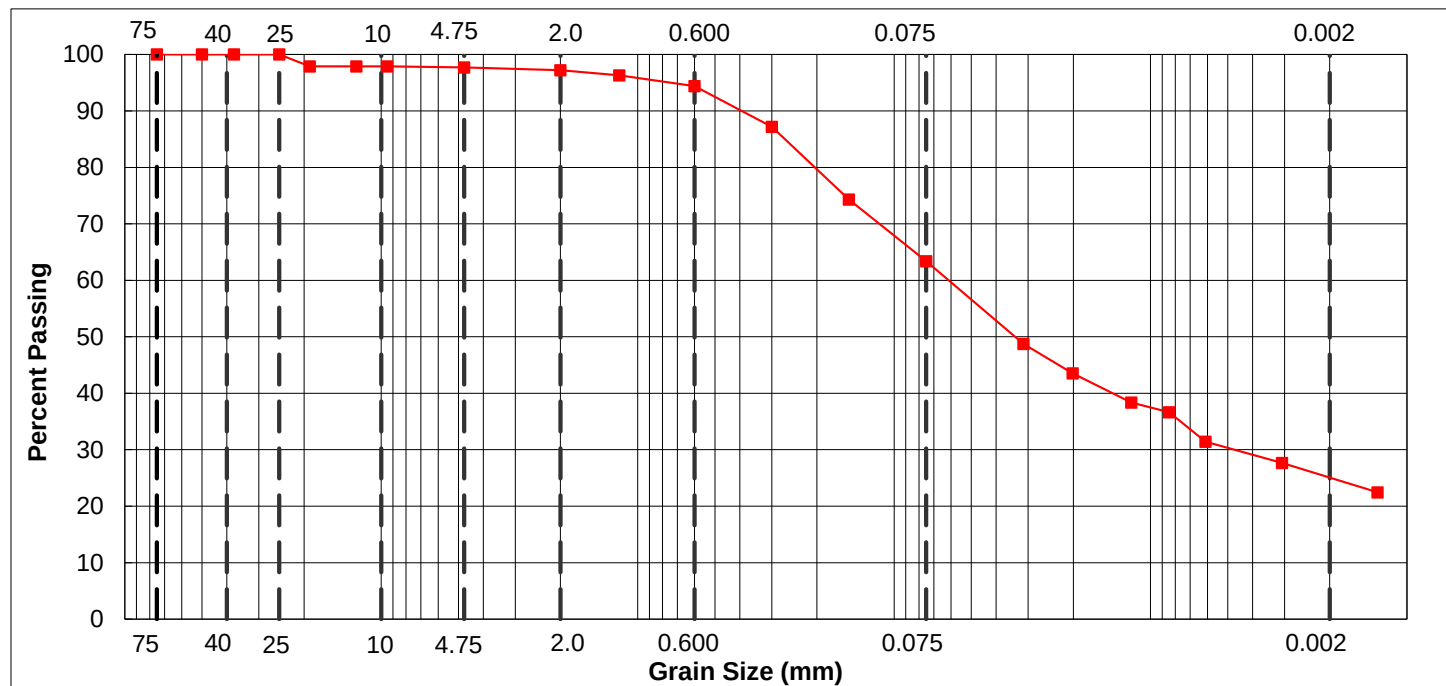
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 12AU3

Sample No.: 12AU3
Source: 22BH012
Sample Depth: 2.1m
Test Date: 7-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	94.4	Type	%	Particle Size Range
75.0	100.0	0.300	87.2	Boulders	0.0	>300 mm
50.0	100.0	0.150	74.3	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	63.4	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0313	48.7	Fine Gravel	2.3	20 mm to 4.75 mm
19.0	97.9	0.0201	43.5	Coarse Sand	0.5	4.75 mm to 2.00 mm
12.5	97.9	0.0119	38.4	Medium Sand	2.8	2.00 mm to 425 µm
9.5	97.9	0.0085	36.6	Fine Sand	31.0	425 µm to 75 µm
4.75	97.7	0.0061	31.4	Silt	38.3	75 µm to 2 µm
2.00	97.2	0.0031	27.6	Clay	25.1	<2 µm
1.180	96.3	0.0013	22.5			



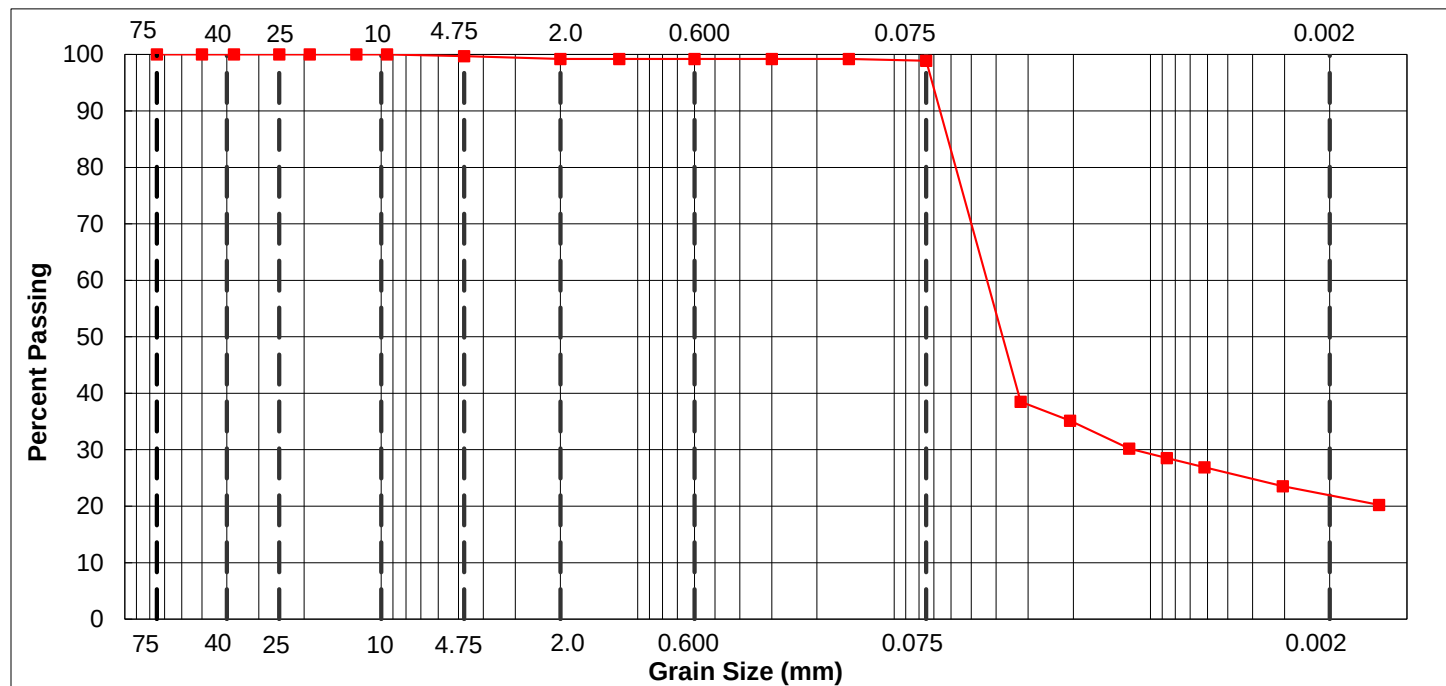
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 13AU4

Sample No.: 13AU4
Source: 22BH013
Sample Depth: 2.7m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	99.2	Type	%	Particle Size Range
75.0	100.0	0.300	99.2	Boulders	0.0	>300 mm
50.0	100.0	0.150	99.2	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	98.9	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0321	38.5	Fine Gravel	0.3	20 mm to 4.75 mm
19.0	100.0	0.0206	35.2	Coarse Sand	0.5	4.75 mm to 2.00 mm
12.5	100.0	0.0121	30.2	Medium Sand	0.0	2.00 mm to 425 µm
9.5	100.0	0.0086	28.5	Fine Sand	0.3	425 µm to 75 µm
4.75	99.7	0.0062	26.9	Silt	77.0	75 µm to 2 µm
2.00	99.2	0.0031	23.6	Clay	21.9	<2 µm
1.180	99.2	0.0013	20.2			



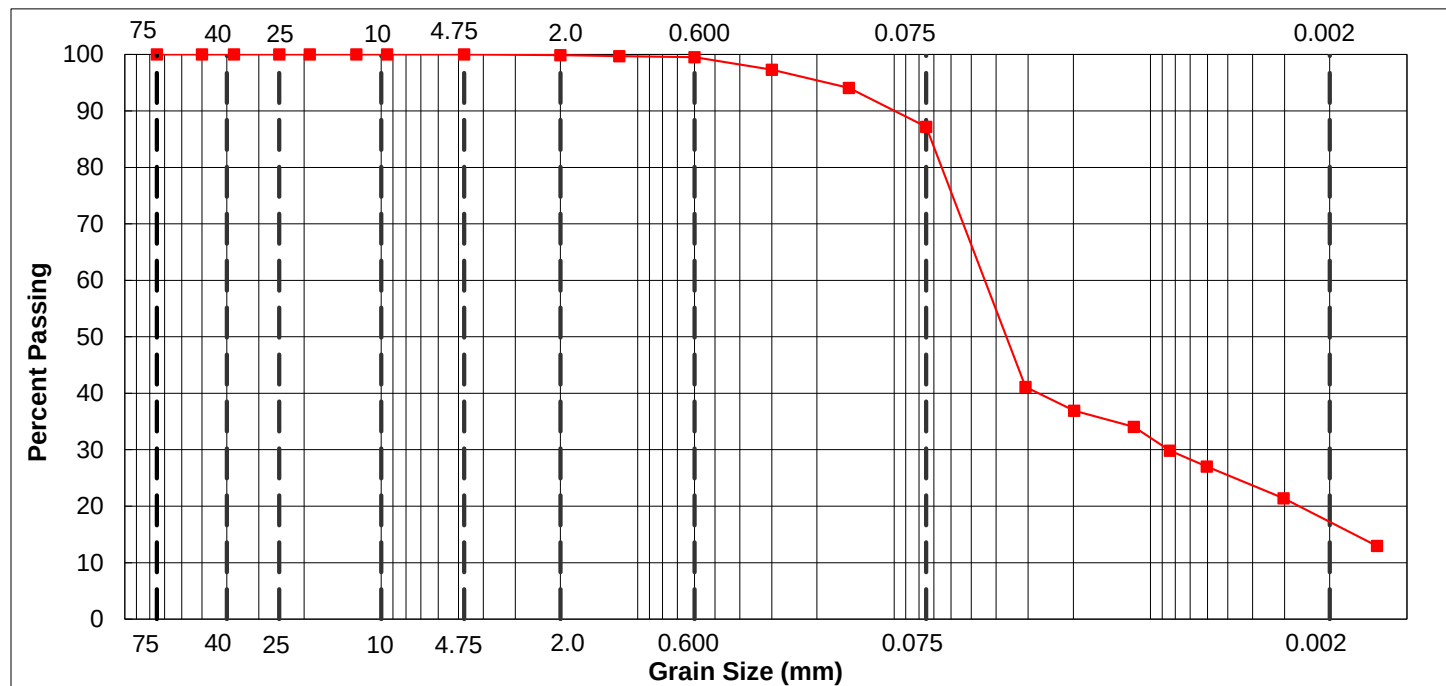
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 14AU2

Sample No.: 14AU2
Source: 22BH014
Sample Depth: 1.2m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	99.5	Type	%	Particle Size Range
75.0	100.0	0.300	97.3	Boulders	0.0	>300 mm
50.0	100.0	0.150	94.1	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	87.2	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0307	41.1	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0199	36.9	Coarse Sand	0.1	4.75 mm to 2.00 mm
12.5	100.0	0.0116	34.1	Medium Sand	0.4	2.00 mm to 425 µm
9.5	100.0	0.0084	29.9	Fine Sand	12.3	425 µm to 75 µm
4.75	100.0	0.0060	27.0	Silt	70.0	75 µm to 2 µm
2.00	99.9	0.0030	21.4	Clay	17.2	<2 µm
1.180	99.7	0.0013	13.0			



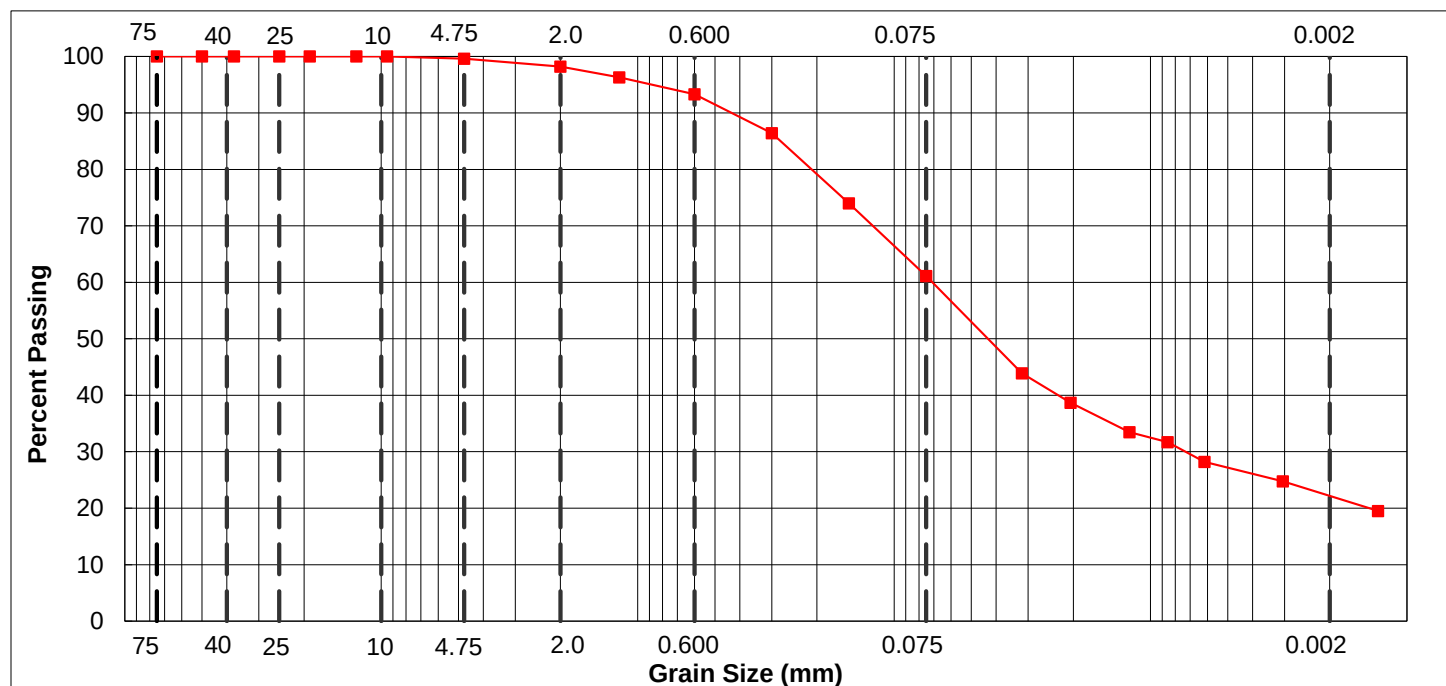
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 15AU9

Sample No.: 15AU9
Source: 22BH015
Sample Depth: 6.7m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	93.3	Type	%	Particle Size Range
75.0	100.0	0.300	86.4	Boulders	0.0	>300 mm
50.0	100.0	0.150	74.0	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	61.1	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0317	43.9	Fine Gravel	0.4	20 mm to 4.75 mm
19.0	100.0	0.0205	38.7	Coarse Sand	1.4	4.75 mm to 2.00 mm
12.5	100.0	0.0121	33.5	Medium Sand	4.9	2.00 mm to 425 µm
9.5	100.0	0.0086	31.7	Fine Sand	32.2	425 µm to 75 µm
4.75	99.6	0.0062	28.2	Silt	38.9	75 µm to 2 µm
2.00	98.2	0.0031	24.7	Clay	22.2	<2 µm
1.180	96.3	0.0013	19.5			



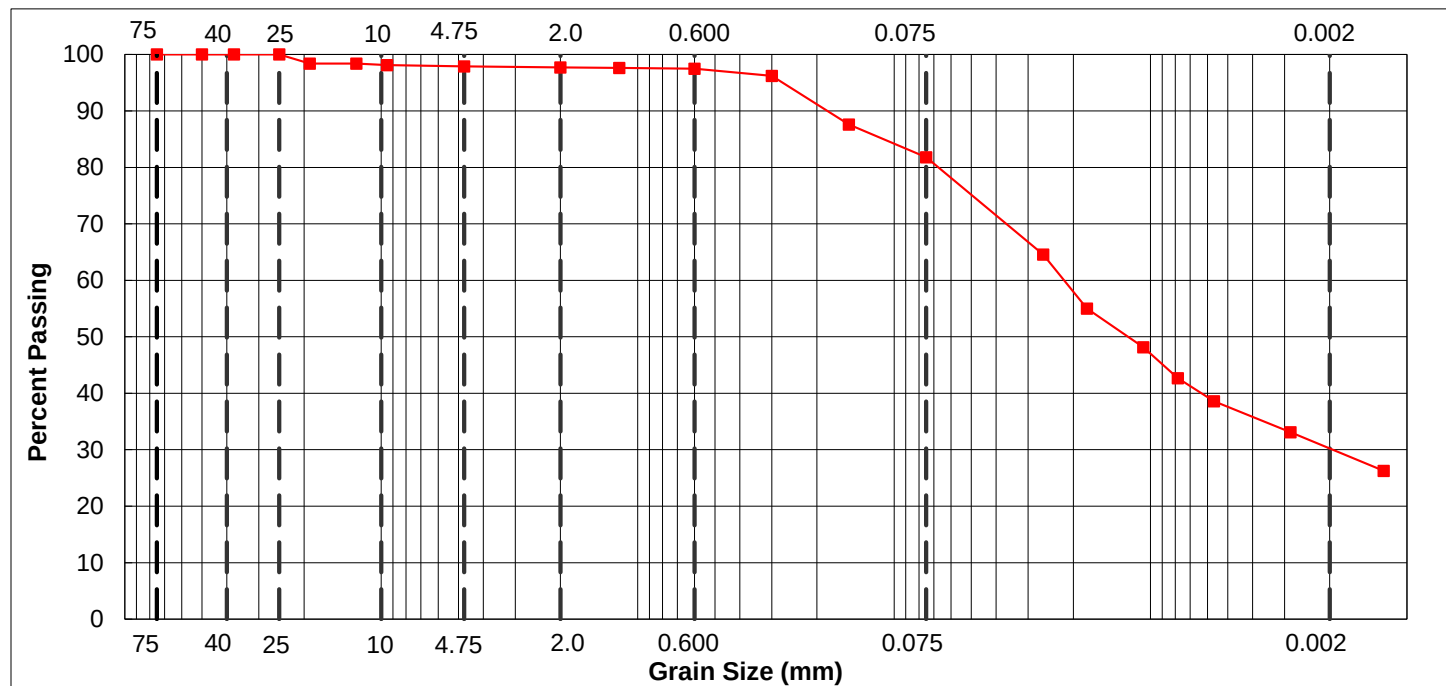
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 16AU1

Sample No.: 16AU1
Source: 22BH016
Sample Depth: 0.6m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	97.5	Type	%	Particle Size Range
75.0	100.0	0.300	96.2	Boulders	0.0	>300 mm
50.0	100.0	0.150	87.6	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	81.8	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0262	64.6	Fine Gravel	2.1	20 mm to 4.75 mm
19.0	98.4	0.0177	55.0	Coarse Sand	0.2	4.75 mm to 2.00 mm
12.5	98.4	0.0107	48.2	Medium Sand	0.2	2.00 mm to 425 µm
9.5	98.1	0.0078	42.7	Fine Sand	15.7	425 µm to 75 µm
4.75	97.9	0.0057	38.6	Silt	51.6	75 µm to 2 µm
2.00	97.7	0.0028	33.1	Clay	30.2	<2 µm
1.180	97.6	0.0012	26.3			



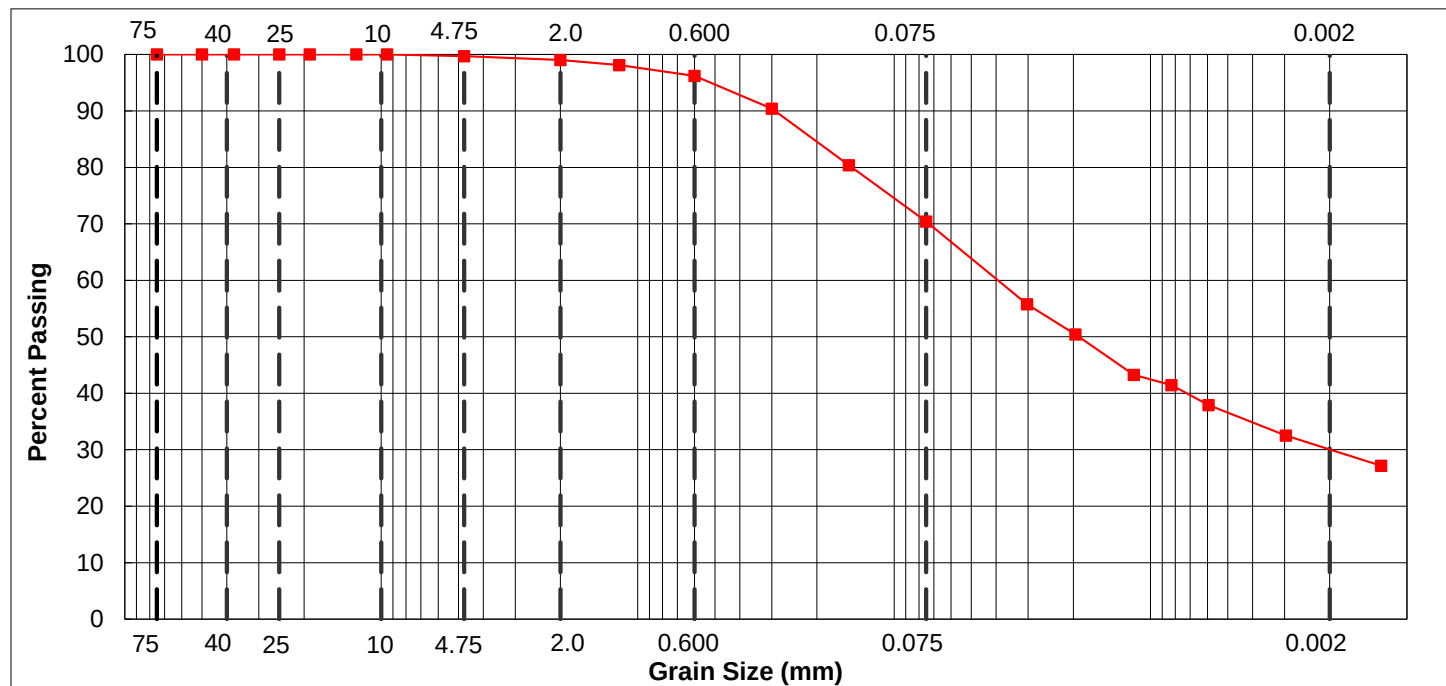
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 17AU10

Sample No.: 17AU10
Source: 22BH017
Sample Depth: 7.3m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	96.2	Type	%	Particle Size Range
75.0	100.0	0.300	90.4	Boulders	0.0	>300 mm
50.0	100.0	0.150	80.4	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	70.4	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0303	55.8	Fine Gravel	0.3	20 mm to 4.75 mm
19.0	100.0	0.0196	50.4	Coarse Sand	0.7	4.75 mm to 2.00 mm
12.5	100.0	0.0116	43.3	Medium Sand	2.8	2.00 mm to 425 µm
9.5	100.0	0.0083	41.5	Fine Sand	25.8	425 µm to 75 µm
4.75	99.7	0.0059	37.9	Silt	40.3	75 µm to 2 µm
2.00	99.0	0.0030	32.5	Clay	30.1	<2 µm
1.180	98.1	0.0013	27.2			



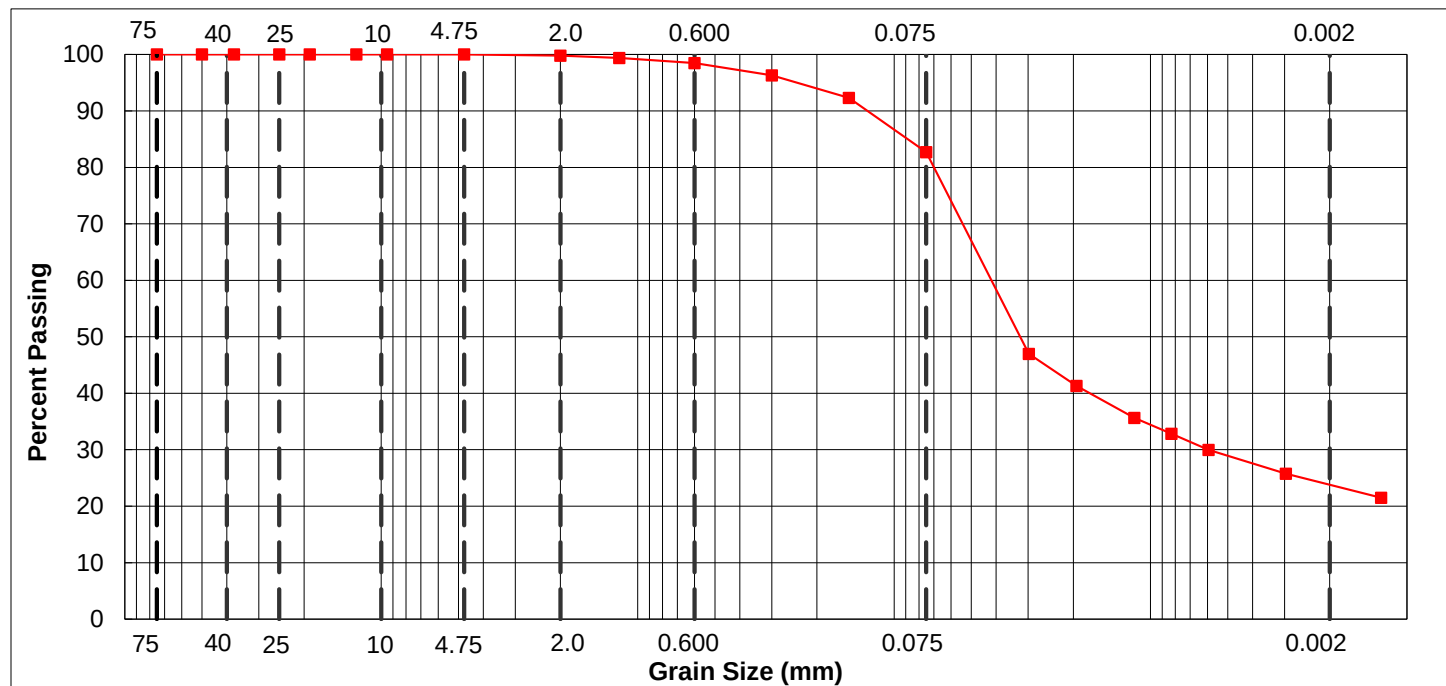
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 19AU1

Sample No.: 19AU1
Source: 22BH019
Sample Depth: 0.6m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	98.5	Type	%	Particle Size Range
75.0	100.0	0.300	96.3	Boulders	0.0	>300 mm
50.0	100.0	0.150	92.3	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	82.7	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0298	47.0	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0194	41.3	Coarse Sand	0.2	4.75 mm to 2.00 mm
12.5	100.0	0.0116	35.6	Medium Sand	1.3	2.00 mm to 425 µm
9.5	100.0	0.0083	32.8	Fine Sand	15.8	425 µm to 75 µm
4.75	100.0	0.0059	30.0	Silt	58.9	75 µm to 2 µm
2.00	99.8	0.0030	25.7	Clay	23.8	<2 µm
1.180	99.4	0.0013	21.5			



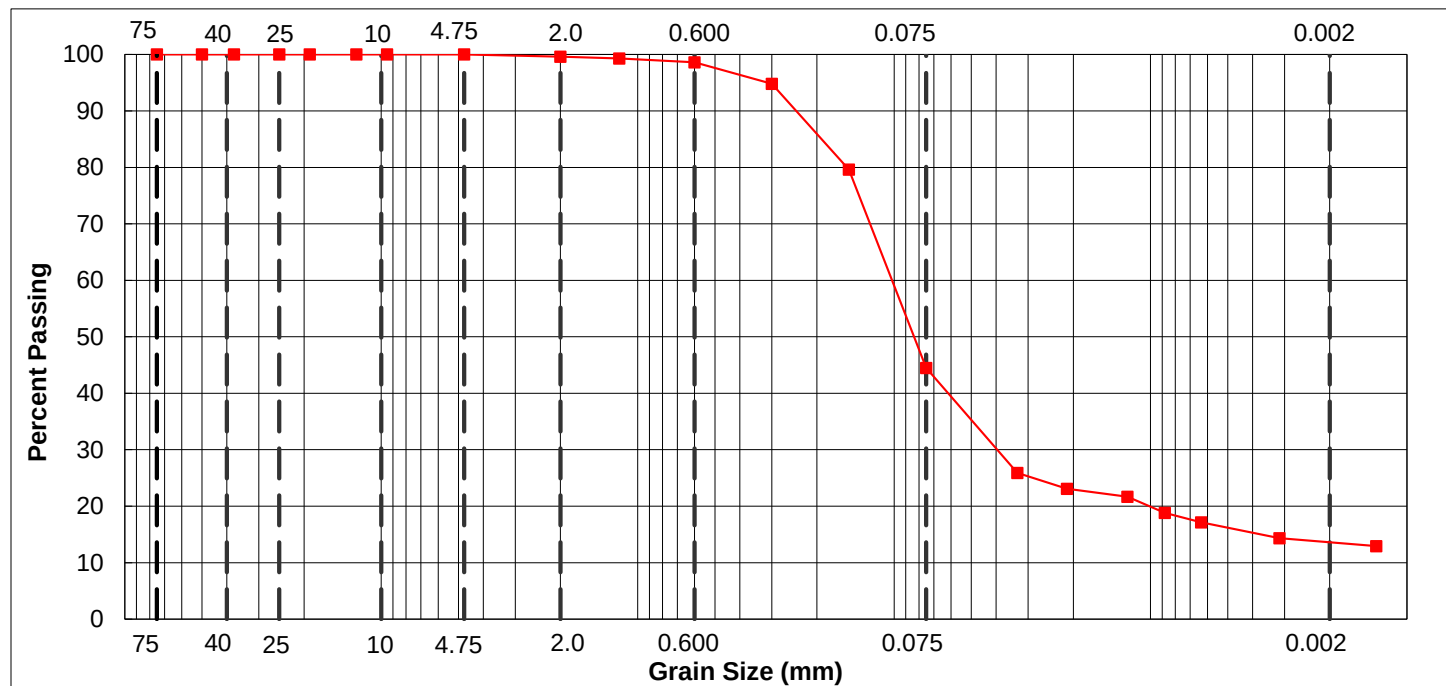
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 20AU7

Sample No.: 20AU7
Source: 22BH020
Sample Depth: 5.2m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	98.6	Type	%	Particle Size Range
75.0	100.0	0.300	94.8	Boulders	0.0	>300 mm
50.0	100.0	0.150	79.6	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	44.5	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0331	25.9	Fine Gravel	0.0	20 mm to 4.75 mm
19.0	100.0	0.0212	23.1	Coarse Sand	0.4	4.75 mm to 2.00 mm
12.5	100.0	0.0123	21.7	Medium Sand	1.0	2.00 mm to 425 µm
9.5	100.0	0.0088	18.8	Fine Sand	54.1	425 µm to 75 µm
4.75	100.0	0.0063	17.2	Silt	30.9	75 µm to 2 µm
2.00	99.6	0.0031	14.3	Clay	13.6	<2 µm
1.180	99.3	0.0013	12.9			



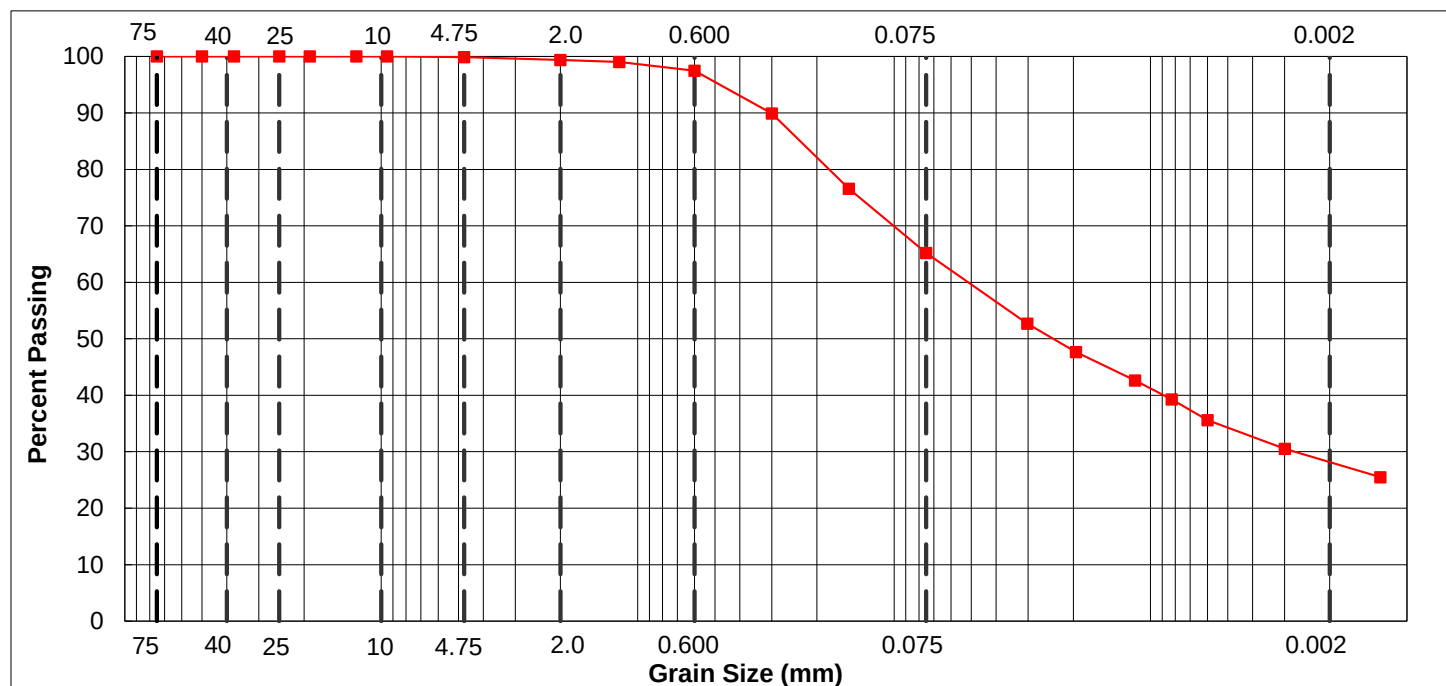
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 21AU3

Sample No.: 21AU3
Source: 22BH021
Sample Depth: 2.1m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	97.5	Type	%	Particle Size Range
75.0	100.0	0.300	89.9	Boulders	0.0	>300 mm
50.0	100.0	0.150	76.6	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	65.2	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0302	52.7	Fine Gravel	0.1	20 mm to 4.75 mm
19.0	100.0	0.0195	47.7	Coarse Sand	0.5	4.75 mm to 2.00 mm
12.5	100.0	0.0115	42.6	Medium Sand	1.9	2.00 mm to 425 µm
9.5	100.0	0.0083	39.3	Fine Sand	32.3	425 µm to 75 µm
4.75	99.9	0.0060	35.6	Silt	37.0	75 µm to 2 µm
2.00	99.4	0.0030	30.5	Clay	28.2	<2 µm
1.180	99.0	0.0013	25.5			



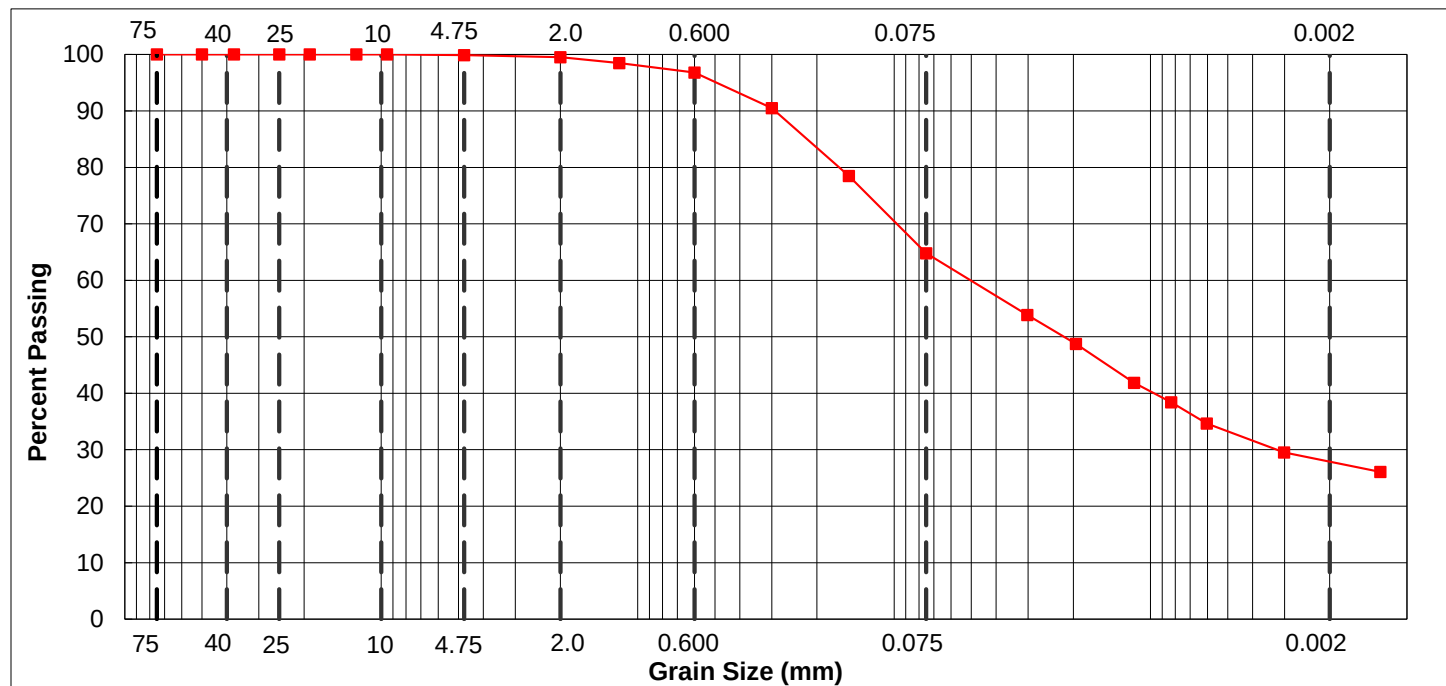
GRAIN SIZE ANALYSIS REPORT

Project: Okotoks Reservoir
Project No.: 29121-005-05
Owner: Urban Systems
File No.: GSA - 22AU9

Sample No.: 22AU9
Source: 22BH022
Sample Depth: 6.7m
Test Date: 13-Oct-22

Tested in accordance with AASHTO T 88 (Particle Size Analysis of Soils)

Grain Size (mm)	Percent Finer	Grain Size (mm)	Percent Finer	Material Description Proportion		
		0.600	96.8	Type	%	Particle Size Range
75.0	100.0	0.300	90.5	Boulders	0.0	>300 mm
50.0	100.0	0.150	78.5	Cobbles	0.0	300 mm to 75 mm
37.5	100.0	0.075	64.8	Coarse Gravel	0.0	80 mm to 20 mm
25.0	100.0	0.0302	53.9	Fine Gravel	0.1	20 mm to 4.75 mm
19.0	100.0	0.0195	48.7	Coarse Sand	0.4	4.75 mm to 2.00 mm
12.5	100.0	0.0116	41.9	Medium Sand	2.7	2.00 mm to 425 µm
9.5	100.0	0.0083	38.4	Fine Sand	32.0	425 µm to 75 µm
4.75	99.9	0.0060	34.7	Silt	36.9	75 µm to 2 µm
2.00	99.5	0.0030	29.5	Clay	27.9	<2 µm
1.180	98.5	0.0013	26.1			



APPENDIX F:

WATERLINE REPORT

Technical Memorandum

Prepared For:	Leigh Chmilar, Urban Systems Ltd.	Date:	October 17, 2022
Prepared By:	Shermin Negari, Hydrogeological Engineer. M.Eng. P.Eng.	File No.:	3319-22-001
Subject:	Proposed Okotoks Reservoir (NW-21-021-28 W4M) – Geotechnical Drilling and Hydraulic Response Testing Program Summary		

INTRODUCTION

The Town of Okotoks and Foothills County are working with Urban Systems Ltd. (Urban Systems), MPE Engineering Inc. (MPE), and Waterline Resources Inc. (Waterline) to develop a sub-regional water supply system to bring raw water sourced from the confluence of the Bow and Highwood rivers to water treatment plants in Okotoks and Foothills Country (the Project). In February 2021, MPE conducted a preliminary geotechnical investigation of a proposed reservoir site (the Site) located in NW-21-021-28 W4M in support of the Project. The preliminary geotechnical investigation was followed by a preliminary hydrogeological investigation completed by Waterline in December 2021.

Urban System is currently developing a comprehensive design for the proposed reservoir and as such, MPE and Waterline conducted a geotechnical and hydrogeological investigation (the investigation) at the Site.

The investigation included the installation of 15 shallow standpipes and six groundwater monitoring wells at the Site. Val's Drilling Ltd. completed the drilling and installation of the standpipes and wells from August 22 to 24, 2022. On September 20, 2022, Waterline completed hydraulic response test on the six groundwater monitoring wells and measured groundwater levels at all standpipes and monitoring wells.

RESULTS

The results of the investigation with respect to the hydrogeological conditions at the Site are discussed below. A site plan showing the geotechnical borehole locations is presented as Attachment 1 and copies of MPE's geotechnical borehole logs are provided as Attachment 2. Table 1 presents a summary of the standpipe and monitoring well completions, depth to water, and the logged material within the screened intervals. Table 1 also provides the estimated hydraulic conductivity of the screened material determined from the hydraulic response tests completed on the six groundwater monitoring wells.

Table 1: Summary of Standpipes and Monitoring Wells

Location	Date (mm/dd/yy)	Well Type		Stick up (m)	Well Depth (mbtoc)	Depth to Water (mbgl)	Screened Material	Estimated Hydraulic Conductivity (m/s)	Comments
		25 mm PVC Standpipe	50 mm PVC Monitoring Well						
22BH001	20/09/2022	X		0.82	14.55	3.65	Siltstone		Field labeled as 22CH001
22BH002	20/09/2022	X		0.8	9.78	4.04	Siltstone		
22BH003	20/09/2022		X	0.64	4.50	>3.86	Silt	1.3×10^{-7}	Dry. Falling head test completed.
22BH004	20/09/2022		X	0.93	11.48	10.30	Till	2.2×10^{-10}	Falling head test completed.
22BH005	20/09/2022	X		0.86	11.23	2.43	Silt, Till		
22BH006	20/09/2022		X	0.82	15.49	3.78	Till, Clayey Silt	1.6×10^{-8}	Rising head test completed.
22BH007	20/09/2022	X		0.75	4.98	4.21	silty Sand		
22BH008	20/09/2022	X		0.94	11.42	5.22	Till		
22BH009	20/09/2022		X	0.97	6.89	>5.92	Till	3.0×10^{-8}	Dry. Falling head test completed.
22BH010	20/09/2022								Not Drilled
22BH011	20/09/2022	X		0.87	4.96	3.21	Silty Sand		
22BH012	20/09/2022	X		0.91	8.40	4.41	Silty Sand		
22BH013	20/09/2022	X		0.3	9.10	4.57	Siltstone, Till		
22BH014	20/09/2022		X	0.88	4.88	>4.0	Silty Sand	7.0×10^{-5}	Dry. Falling head test completed.
22BH015	20/09/2022	X		0.91	11.46	4.24	Till		
22BH016	20/09/2022	X		0.84	7.40	4.81	Silty Sand, Gravel		
22BH017	20/09/2022	X		0.86	11.56	6.10	Till		
22BH018	20/09/2022		X	0.82	4.28	>3.46	Silt, Sand	2.8×10^{-6}	Dry. Falling head test completed.
22BH019	20/09/2022	X		0.79	10.22	5.98	Till, silty Sand		
22BH020	20/09/2022	X		0.57	9.88	5.19	Till		
22BH021	20/09/2022	X		0.79	10.58	6.01	Till		
22BH022	20/09/2022	X		0.76	9.85	4.71	Till, Sand		

Based on MPE's borehole log data, the unconsolidated deposits at the Site are comprised a mix of stratified layers of clay, silt, sand, and clay till. The thickness of the unconsolidated deposits was variable, ranging from 6.7 m at borehole 22BH002 to greater than 19.8 m at 22BH006 and 22BH017. Where encountered, the underlying bedrock consisted of highly weathered siltstone and claystone.

The depth to groundwater ranged from of 2.43 metres below ground level (mbgl) at 22BH005 to 6.10 mbgl at 22BH017. The exception was 22BH004 which had a groundwater level at 10.30 mbgl and may not have fully recovered since the time of installation due to low permeability clay at the screened interval. In addition, four shallow monitoring wells were dry and the groundwater level at these locations may have been below the well completion depth.

Hydraulic conductivity tests, consisting of a falling and rising head tests were conducted on six groundwater monitoring wells on September 20, 2022. All test data was analysed in AQTESOLV (HydroSOLV, 2007) using the Bouwer-Rive solution (Bouwer and Rice, 1976). Copies of the AQTESOLV plots are also provided in Attachment 3. The results indicate that the hydraulic conductivity for the unconsolidated deposits beneath the Site range from 7×10^{-5} m/s to 2×10^{-10} m/s which is generally consistent with the expected range of values of hydraulic conductivity (Freeze and Cherry, 1979), of the identified materials at the screened interval of the monitoring wells (Table 1). It is expected that the dominant shallow groundwater flow path will be in the unconfined sand layers (where they exists and are saturated) which have notably higher hydraulic conductivity (in range of 7×10^{-5} m/s) compared to lower hydraulic conductivity units, such as Till.

DISCUSSION

The unconsolidated sediments in the project area are characterized by glaciolacustrine and fluvial materials (Fenton et al, 2013; Moran, 1986) that are generally underlain by low permeability clay till deposits. As summarized in Table 2, based on unit top and bottom elevations indicated on the borehole logs (Attachment 2), the occurrence of a partially to fully saturated sand layer within the unconsolidated sediments is apparent in some of the borehole logs. It should be noted that the borehole elevations were not surveyed at the time of this report and the groundwater / lithological reference elevation should be treated as an approximation. This sand layer may not be spatially extensive and continuous as is evident by its absence in some of the boreholes (Attachment 1). While the saturated thickness of this shallow unconfined sand aquifer is variable beneath the Site, it can provide a potentially conducive path for shallow groundwater flow if seasonally saturated. The recorded groundwater levels suggest a general groundwater elevation in range of 1016 to 1018 masl (Table 2) which is also supported by long-term historical groundwater measurements at the Site (Waterline, 2021). As such the sand layer is most likely partially (to fully) saturated where it exists within (or below) the range of expected groundwater elevation.

Table 2: Summary of Sand Layer Verification in Geotechnical Boreholes

Location	Approximate Ground Elevation (masl)	Depth to Water (mbgl)	Groundwater Elevation (masl) ⁽¹⁾	Approximate Sand Layer Interval Elevation (masl)	Comments
22BH001	1021.0	3.65	1017.4	1013.5 - 1017.0	Potentially partial saturated sand layer as seepage noted during drilling.
22BH002	1022.0	4.04	1018.0	1020.0 – 1022.0 (dry) 1016.5 - 1018.5 (saturated)	First top layer sand close to surface noted as dry. The second sand layer noted as a partial (to fully) saturated.
22BH003 ⁽²⁾	1019.0	>3.86	<1015.1	-	A well-defined sand layer was not noted, but silt layer between 1015 to 1019 masl with seepage noted during drilling around 1017 masl.
22BH004	1019.0	10.30	1008.7	1017.5 - 1019.0	The sand layer is not saturated based on the water level elevation at the time of measurement.
22BH005	1019.0	2.43	1016.6	1017.5 - 1019.1	The sand layer is not saturated based on the water level elevation at the time of measurement.
22BH006	1021.0	3.78	1017.2	-	A well-defined sand layer was not noted. But trace sand around 1017 masl.
22BH007	1022.0	4.21	1017.8	1014.5 - 1022.0	Partially saturated sand layer.
22BH008	1022.0	5.22	1016.8	-	A well-defined sand layer was not noted, but silty/sandy material noted between 1015.5 to 1017.0 masl.
22BH009 ⁽²⁾	1021.0	>5.92	<1015.1	-	No apparent sand layer noted. However, silty material noted between 1016 to 1017 masl.
22BH010	-	-	-	-	Not Drilled.
22BH011	1021.0	3.21	1017.8	1015.0 - 1020.0	Partially saturated sand layer.
22BH012	1021.0	4.41	1016.6	1011.5 - 1018.0	Partially (to fully) saturated sand layer.
22BH013	1021.0	4.57	1016.4	-	No apparent sand layer noted. However, sandy material noted between 1018.0 to 1018.5 masl.
22BH014 ⁽²⁾	1024.0	>4.00	<1020	1016.5 - 1022.0	Groundwater level is below the depth of the borehole. The sand layer could potentially be partially saturated as the sand layer extended below the finished borehole depth and saturation could not be confirmed at the time of measurement.
22BH015	1021.0	4.24	1016.8	-	No apparent sand layer noted. However, wet gravel/sand seam noted around 1017 masl.
22BH016	1022.0	4.81	1017.2	1017.0 - 1020.5 (sand) 1013.5 - 1017.0 (gravel)	Saturated gravel layer overlain by partially saturated sand layer.
22BH017	1023.0	6.10	1016.9	1016.5 - 1023.0	Mostly dry sand layer with a groundwater level near the bottom of the layer at the time of measurement.

22BH018 ⁽²⁾	1023.0	>3.46	<1019.6	1016.5 - 1022.5 (sand) 1014.0 - 1016.5 (gravel)	Groundwater level is below the finished borehole depth of 1019.6 masl. However, the sand and gravel layers could potentially be partially saturated at lower elevations as these layers extended below the finished borehole depth (Some seepage noted at 1016.5 during drilling).
22BH019	1023.0	5.98	1017.0	1015.0 - 1021.0	Partially saturated sand layer.
22BH020	1022.0	5.19	1016.8	-	No apparent sand layer noted. However, wet sand seam noted around 1017 masl.
22BH021	1022.0	6.01	1016.0	1014.5 - 1017.0	Partially saturated sand layer.
22BH022	1022.0	4.71	1017.3	1017.0 - 1019.0	Partially saturated sand layer.

(1) The boreholes elevations are not accurately surveyed and as such the groundwater elevation and verified sand layer elevation are only approximate. (2) Boreholes were dry at the time of groundwater measurements. Groundwater elevation is potentially below the borehole depth. All measured groundwater levels were completed in September 2022.

CONCLUSIONS AND RECOMMENDATION

It is expected that any excavation or permanent structural design associated with the reservoir that intersect the groundwater elevation (i.e., 1016 to 1018 masl) may require dewatering to some level during construction and post-construction phases. The sustainability of the seepage inflow to the excavation, however, will vary spatially and seasonally and cannot be fully quantified as the continuity and the extent of the permeable sand layer is not understood beyond the site investigation area. Since the groundwater level within the sand layer occurs at approximately 1016 to 1018 masl, the reservoir geometry, such as reservoir base depth and water storage elevation during operation, could necessitate a permanent dewatering system. If the groundwater elevation in partial (or seasonally fully) saturated sand is notably higher than the reservoir's operational water elevation, an underdrain seepage collection system beneath the geosynthetic liner may be required to avoid liner floatation and limiting shear stress on the liner.

A long-term groundwater monitoring program is also recommended to establish baseline conditions and further quantify the effects of the reservoir construction and operation on the local water table aquifer. This monitoring data will directly support the active management and control of the reservoir operations, and local effects on the water table.

CERTIFICATION

This document was prepared under the direction of a professional geologist, geoscientist or engineer registered in the Province of Alberta.

Waterline Resources Inc. trusts that the information provided in this document is sufficient for your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Respectfully submitted,

Waterline Resources Inc.

Reviewed By:

Shermin Negari, M.Eng. P.Eng.
Hydrogeological Engineer

Jan Michaelian, B.Sc., P.Geo.
Principal Hydrogeologist

**PERMIT TO PRACTICE
WATERLINE RESOURCES INC.**

RM SIGNATURE: _____

RM APEGA ID #: _____

DATE: _____

PERMIT NUMBER: P007329
The Association of Professional Engineers and
Geoscientists of Alberta (APEGA)

REFERENCES

- Bouwer, H., Rice R.C., 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. *Water Resources Research*, Vol. 12, No. 3, Pages 423-428
- Fenton, M.M., Waters, E.J., Pawley, S.M., Atkinson, N., Utting, D.J., McKay, K., 2013. *Surficial Geology of Alberta*. Alberta Energy Regulator, AER/AGS Map 601.
- Freeze, R. A., & Cherry, J. A. (1979). *Groundwater*. Table 2.2 Range of Values of Hydraulic Conductivity and Permeability
- Moran, S. 1986. *Surficial Geology of the Calgary Urban Area*. Alberta Research Council, ARC/AGS Bulletin 53, 57 p.
- Waterline Resources Inc., 2021. Preliminary Hydrogeological Investigation for Proposed Reservoir Site. NW-21-021-28 W4M, Near Okotoks, Alberta, Submitted Urban Systems Ltd. Project No. 3319-21-001.

DRAFT

LIMITATIONS AND USE

The information presented in this document was compiled exclusively for Urban Systems Ltd. (the Client) by Waterline Resources Inc. (Waterline). This work was completed in accordance with the scope of work for this project that was agreed between Waterline and the Client. Waterline exercised reasonable skill, care and diligence to assess the information acquired during the preparation of this document, but makes no guarantees or warranties as to the accuracy or completeness of this information. The information contained in this document is based upon, and limited by, the circumstances and conditions acknowledged herein, and upon information available at the time of the preparation of this document. Any information provided by others is believed to be accurate but cannot be guaranteed. No other warranty, expressed or implied, is made as to the professional services provided to the Client.

Any use, reliance on, or decision made, by a third party based on this document is the sole responsibility of said third party. Waterline makes no representation or warranty to any third party with regard to this document and, or the work referred to in this document, and accepts no duty of care to any third party or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred as a result of the use of, reliance on, any decision made, or any action taken based on, this document or the work referred to in this document.

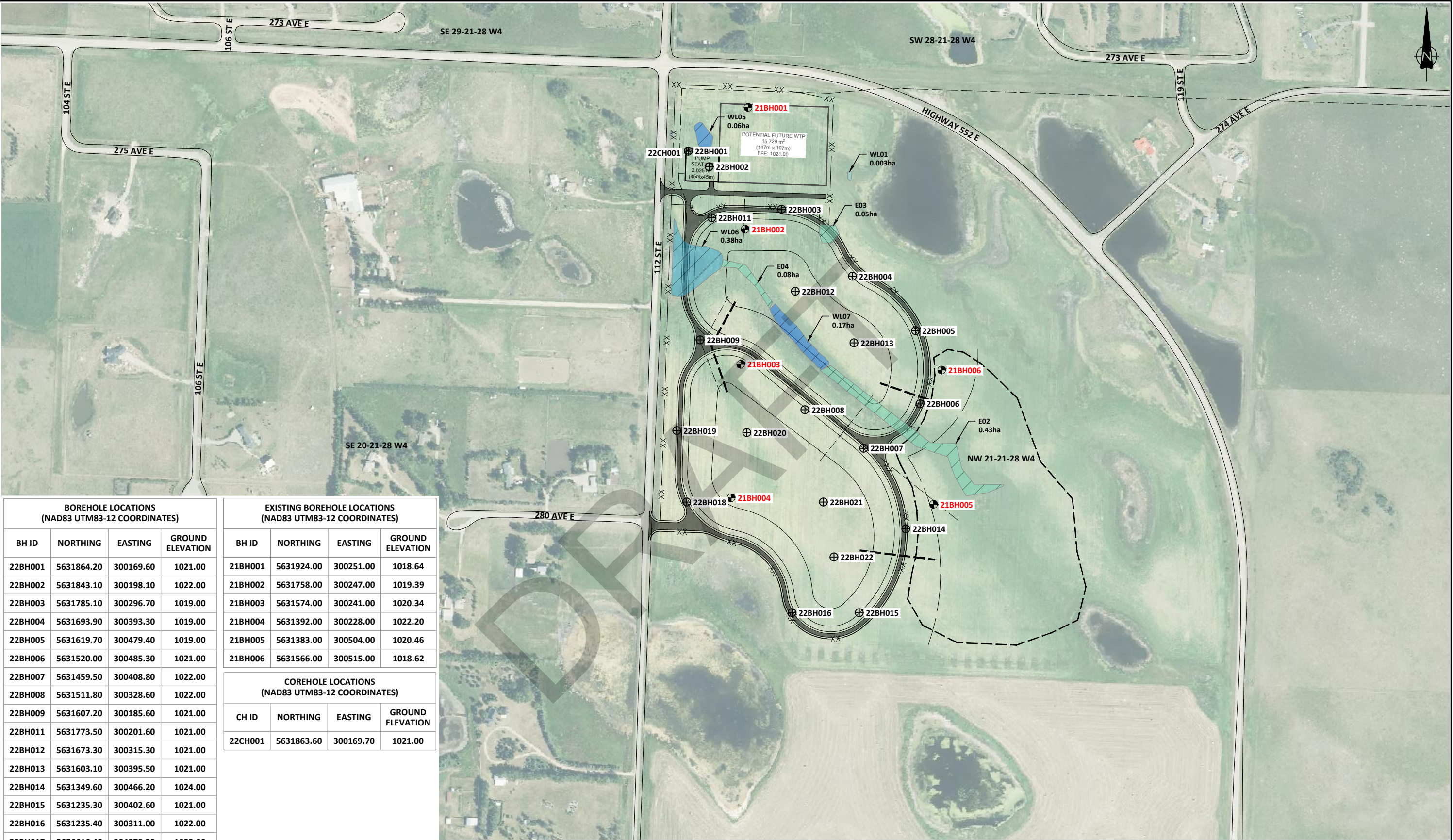
When Waterline submits instruments of professional service; including, reports, drawings and project-related deliverables, the Client agrees that only original signed and stamped paper versions shall be considered as original documents. The hard copy versions submitted by Waterline to the Client shall be considered as copies of the original documents, and in the event of a dispute or discrepancy, the signed and stamped original documents retained by Waterline shall govern over all copies, electronic or otherwise, provided to the Client.

This document is intended to be used in its entirety, and no individual part of the document may be taken as representative of the findings of the document. No part of this document may be reproduced, stored in a retrieval system, or transmitted in any form, by any third party, without the expressed written permission of the Client or Waterline.

ATTACHMENTS

- 1- Site Plan
- 2- Geotechnical Borehole Logs
- 3- AQTESOLV Results

Site Plan



BOREHOLE LOCATIONS (NAD83 UTM83-12 COORDINATES)			
BH ID	NORTHING	EASTING	GROUND ELEVATION
22BH001	5631864.20	300169.60	1021.00
22BH002	5631843.10	300198.10	1022.00
22BH003	5631785.10	300296.70	1019.00
22BH004	5631693.90	300393.30	1019.00
22BH005	5631619.70	300479.40	1019.00
22BH006	5631520.00	300485.30	1021.00
22BH007	5631459.50	300408.80	1022.00
22BH008	5631511.80	300328.60	1022.00
22BH009	5631607.20	300185.60	1021.00
22BH011	5631773.50	300201.60	1021.00
22BH012	5631673.30	300315.30	1021.00
22BH013	5631603.10	300395.50	1021.00
22BH014	5631349.60	300466.20	1024.00
22BH015	5631235.30	300402.60	1021.00
22BH016	5631235.40	300311.00	1022.00
22BH017	5656616.40	304879.20	1023.00
22BH018	5631386.10	300167.50	1023.00
22BH019	5631483.50	300153.90	1023.00
22BH020	5631480.70	300249.30	1022.00
22BH021	5631386.10	300353.70	1021.00
22BH022	5631311.20	300368.10	1022.00

EXISTING BOREHOLE LOCATIONS (NAD83 UTM83-12 COORDINATES)			
BH ID	NORTHING	EASTING	GROUND ELEVATION
21BH001	5631924.00	300251.00	1018.64
21BH002	5631758.00	300247.00	1019.39
21BH003	5631574.00	300241.00	1020.34
21BH004	5631392.00	300228.00	1022.20
21BH005	5631383.00	300504.00	1020.46
21BH006	5631566.00	300515.00	1018.62

COREHOLE LOCATIONS (NAD83 UTM83-12 COORDINATES)			
CH ID	NORTHING	EASTING	GROUND ELEVATION
22CH001	5631863.60	300169.70	1021.00

LEGEND

⊕ 22BH000 - COMPLETED BOREHOLES

△ 22CH000 - COMPLETED COREHOLES

● 21BH000 - EXISTING BOREHOLES

WETLANDS

▨ WETLAND/WATERBODY AREA TO BE REMOVED

■ EPHERMERAL WATERBODY

WETLANDS

■ SHALLOW OPEN WATER - PERMANENT

■ MARSH - GRAMINOID - SEASONAL

■ MARSH - GRAMINOID - TEMPORARY

Engineering Ltd.

SCALE: 1:5000

DATE: SEPTEMBER 2022

URBAN SYSTEMS LTD.

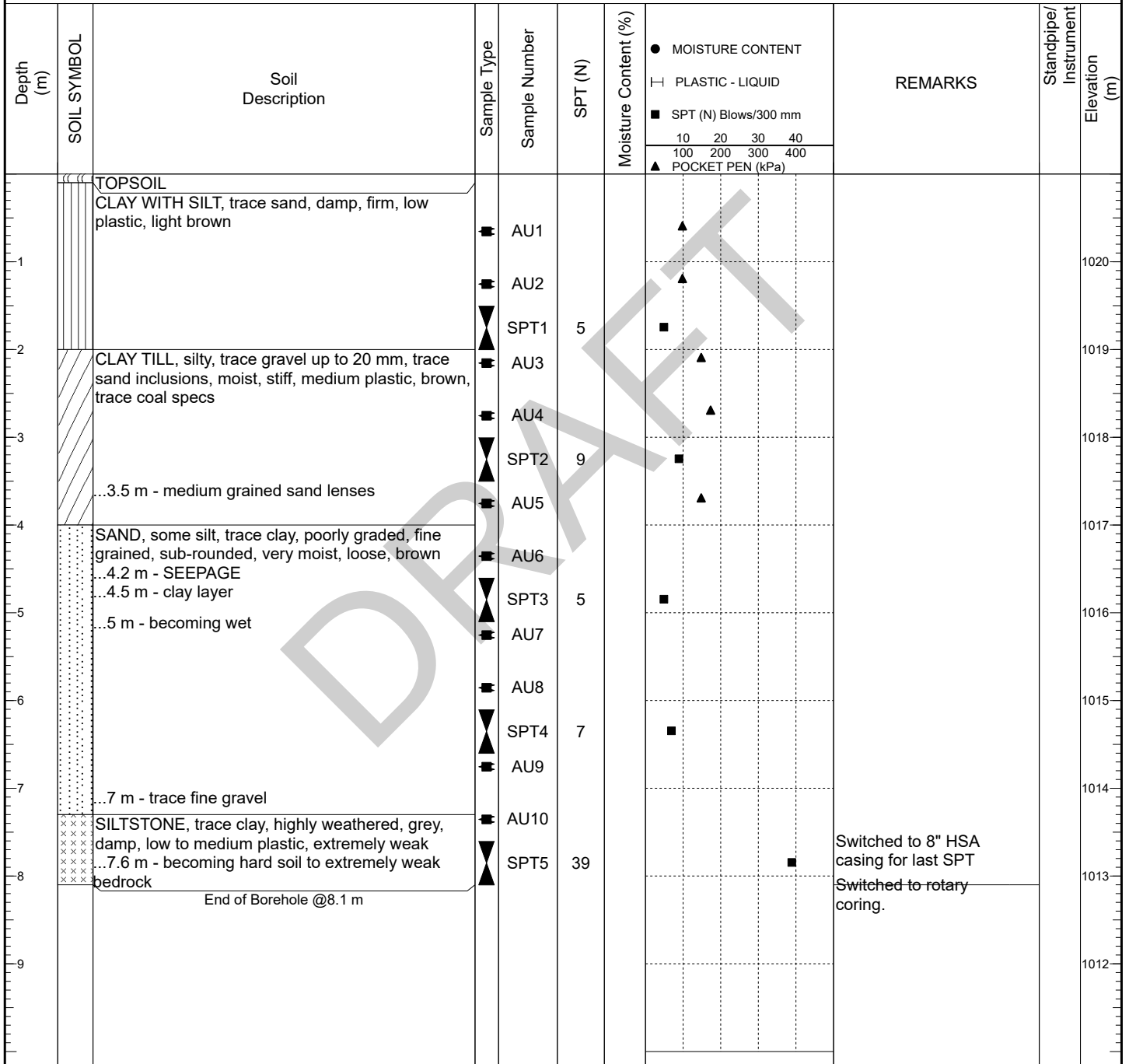
RESERVOIR - GEOTECHNICAL DESIGN
PROPOSED BOREHOLE LOCATION PLAN

JOB: 29121-005-05

FIGURE: 1

Geotechnical Borehole Logs

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/22/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631864.179 E 300169.579
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 4.2 m. Minor sloughing observed upon completion. Switched to rotary coring at 8.1 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/23/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.00m N 5631843.144 E 300198.071
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)		
0	TOPSOIL	SAND, silty, trace clay, poorly graded, fine grained, sub-rounded, dry, compact, light brown, trace root hairs	■	AU1				1021
1			■	AU2				
2		CLAY TILL, silty, some sand, very moist, firm, medium plastic, brown ...2 m - becoming wet ...2.2 m - SEEPAGE	▲	SPT1	12	■		1020
3			■	AU3				
4			▲	SPT2	6	■		1019
5		SAND, silty, some clay, poorly graded, medium grained, sub-angular, wet, compact, brown	■	AU4				
6			■	AU5				1018
7			■	AU6				
8			▲	SPT3	16	■	No Shelby Tube due to sloughing.	1017
9			■	AU7				
10		CLAY TILL, silty, some sand, some gravel up to 30 mm, very moist, stiff, medium plastic, dark brown, trace oxidation staining	■	AU8		▲		1016
11		...6.5 m - becoming some ground up siltstone inclusions	▲	SPT4	31	■		1015
12			■	AU9				
13		SILTSTONE, completely weathered, light grey, damp, low plastic, extremely weak, massive	■	AU10				1014
14			▲	SPT5	70			
15		...8 m - SPT refusal - 50 blows for 4"	■	AU11				1013
16			■	AU12				
17		End of Borehole @9.1 m					Borehole ended due to bedrock.	

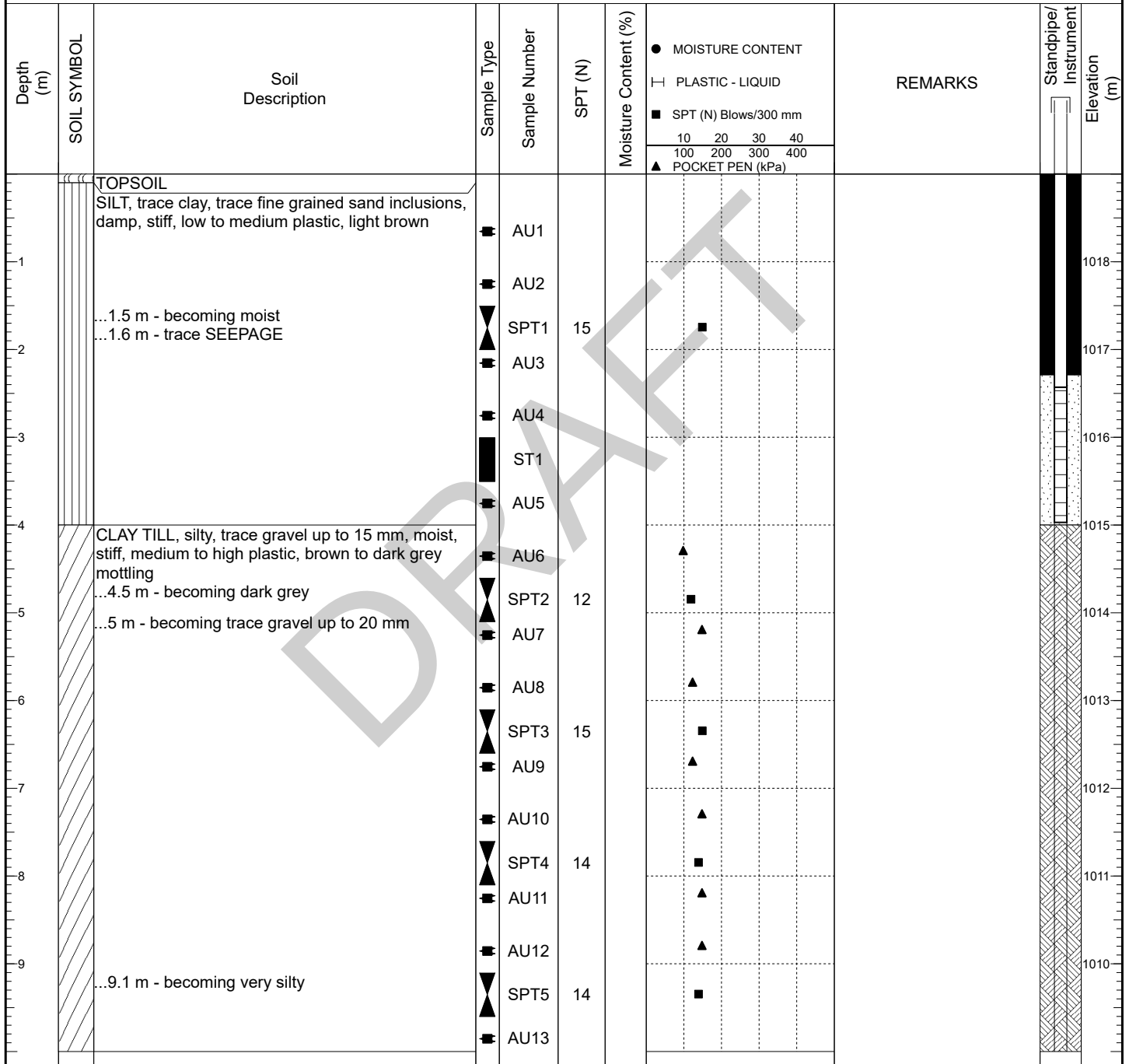
Notes:

Seepage observed at a depth of 2.2 m. Minor sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 9.1 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1019.00m N 5631785.148 E 300296.749
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 1.6 m. Minor sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 3.97 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/24/2022 COMPLETED 08/24/2022 GROUND ELEVATION 1019.00m N 5631785.148 E 300296.749
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace gravel up to 15 mm, moist, stiff, medium to high plastic, brown to dark grey mottling	■	AU14					1008
		End of Borehole @10.7 m							1007
12									1006
13									1005
14									1004
15									1003
16									1002
17									1001
18									1000
19									

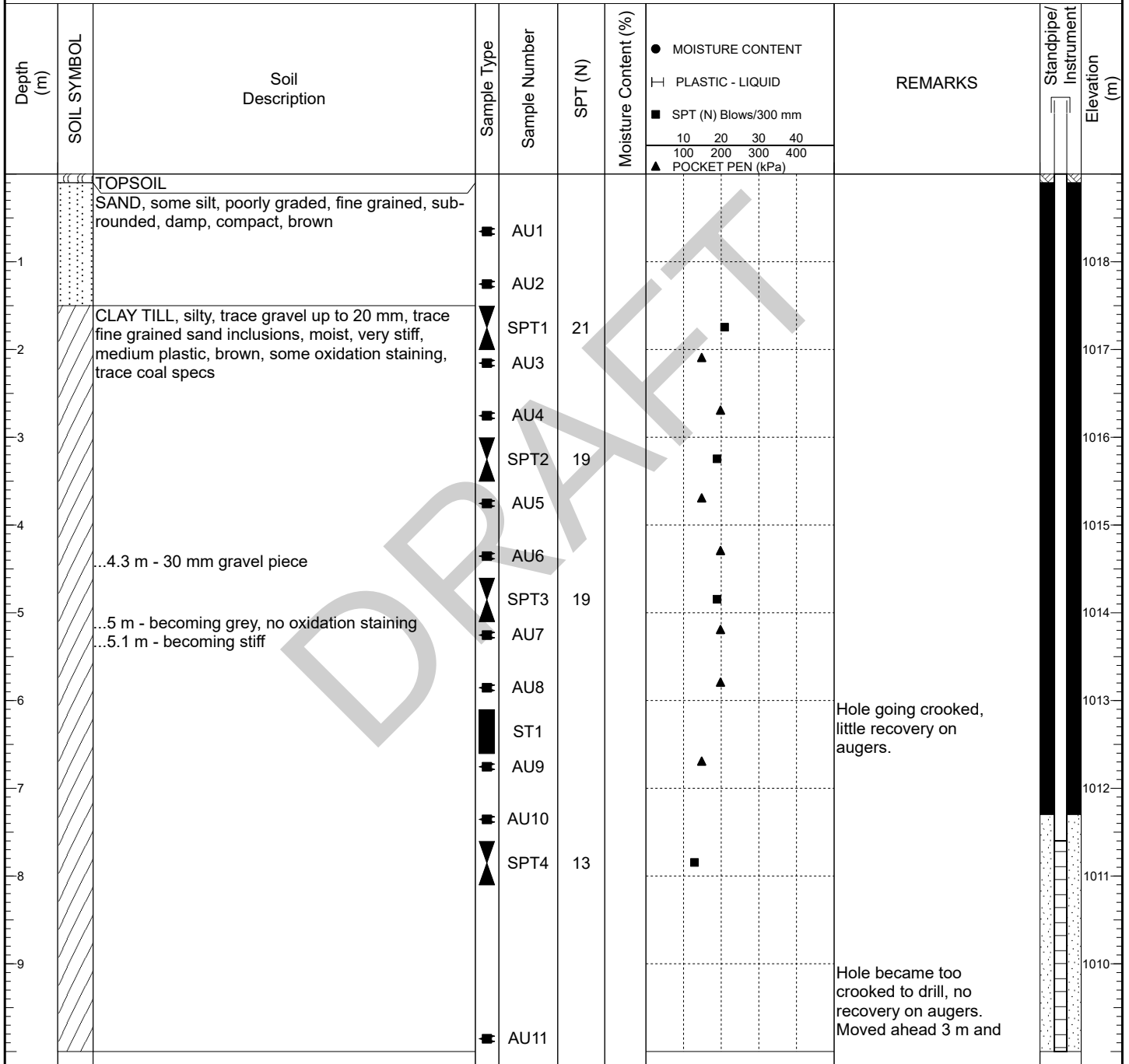
Notes:

Seepage observed at a depth of 1.6 m. Minor sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 3.97 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1019.00m N 5631693.899 E 300393.328
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
GROUND ELEVATION	1019.00m	N	5631693.899 E 300393.328
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace gravel up to 20 mm, trace fine grained sand inclusions, moist, very stiff, medium plastic, brown, some oxidation staining, trace coal specs					drilled down to 10.7 m to install well. AU11 taken from second hole.		1008
		End of Borehole @10.7 m							1007
									1006
									1005
									1004
									1003
									1002
									1001
									1000

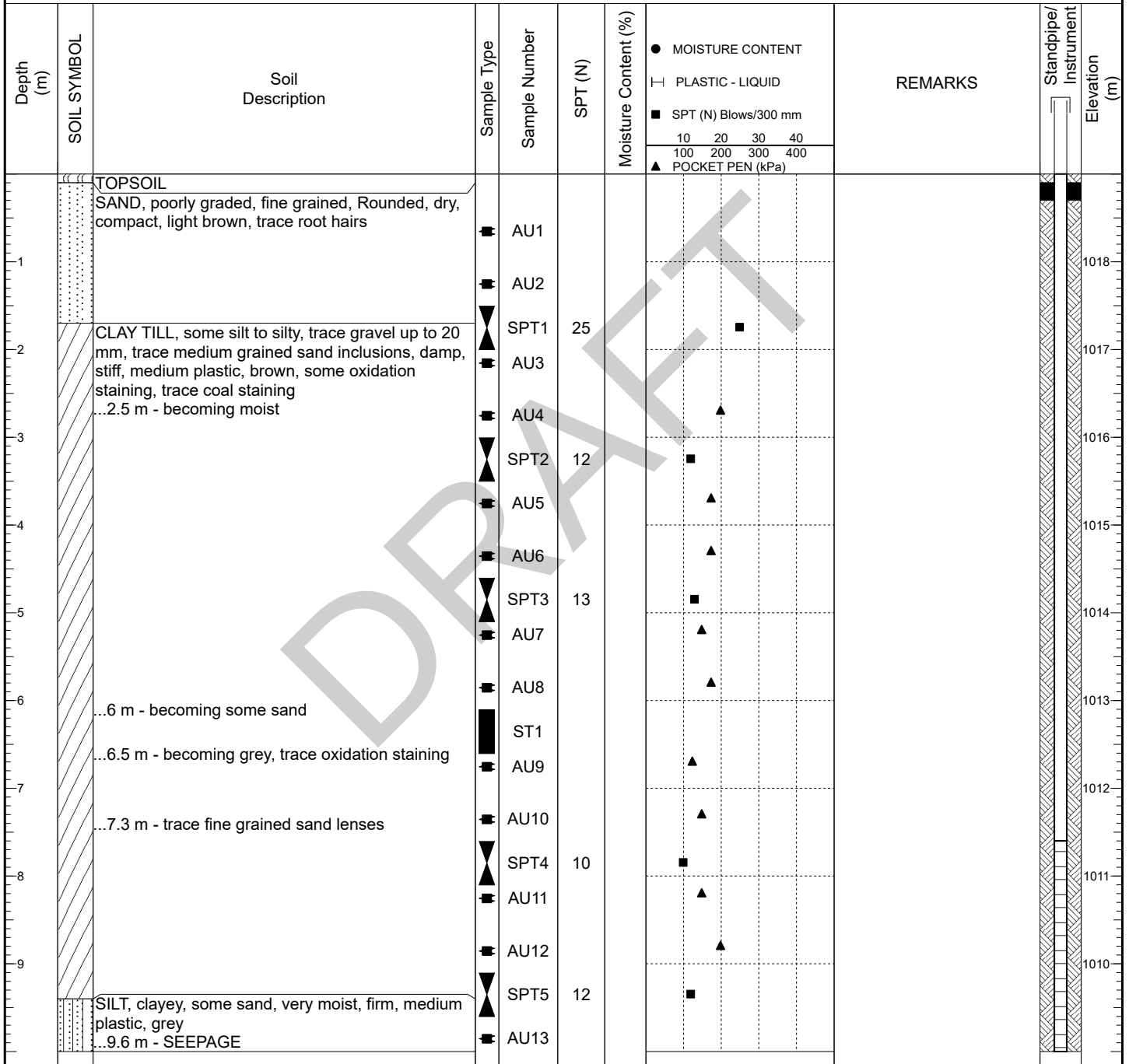
Notes:

no seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/23/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1019.00m N 5631619.735 E 300479.382
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 9.6 m. No sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/23/2022 COMPLETED 08/23/2022 GROUND ELEVATION 1019.00m N 5631619.735 E 300479.382
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
		SILT, clayey, some sand, very moist, firm, medium plastic, grey	■	AU14					
11		End of Borehole @10.7 m							1008
12									1007
13									1006
14									1005
15									1004
16									1003
17									1002
18									1001
19									1000

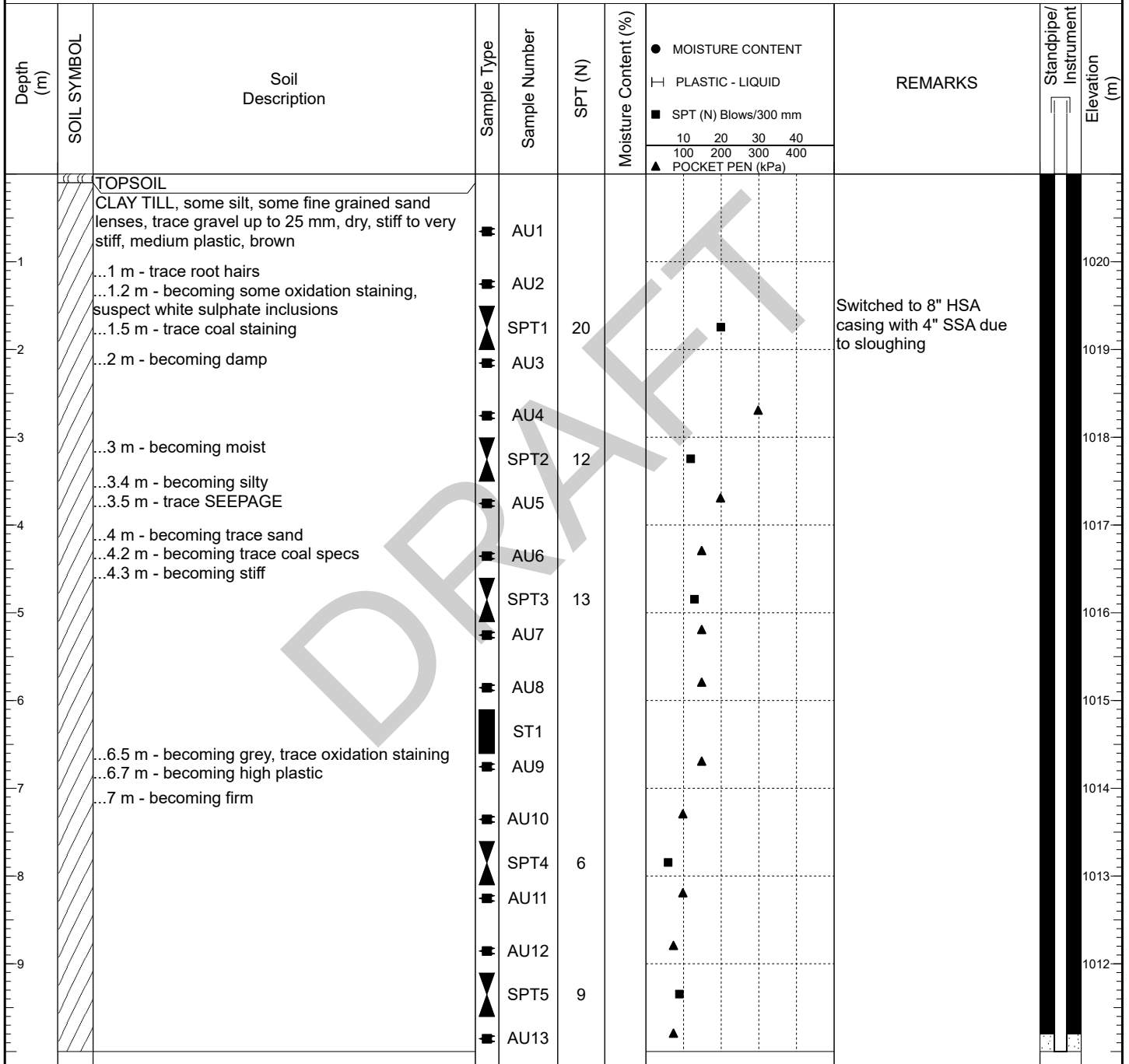
Notes:

Seepage observed at a depth of 9.6 m. No sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/23/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631519.974 E 300485.281
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



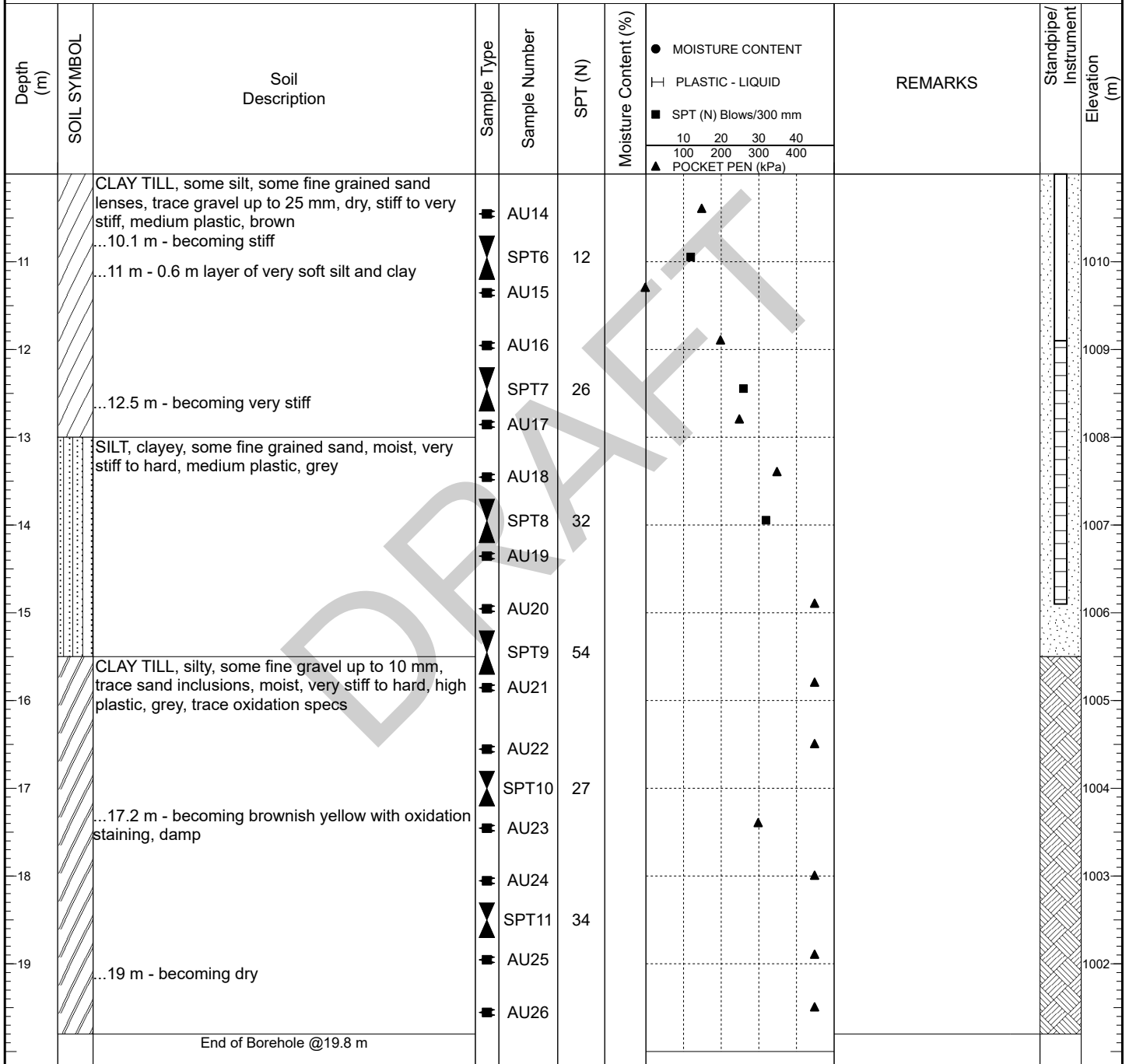
Notes:

Seepage observed at a depth of 3.5 m. Borehole sloughed in to 15.5 m. Slotted 50 mm PVC standpipe installed to a depth of 14.9 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/23/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631519.974 E 300485.281
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



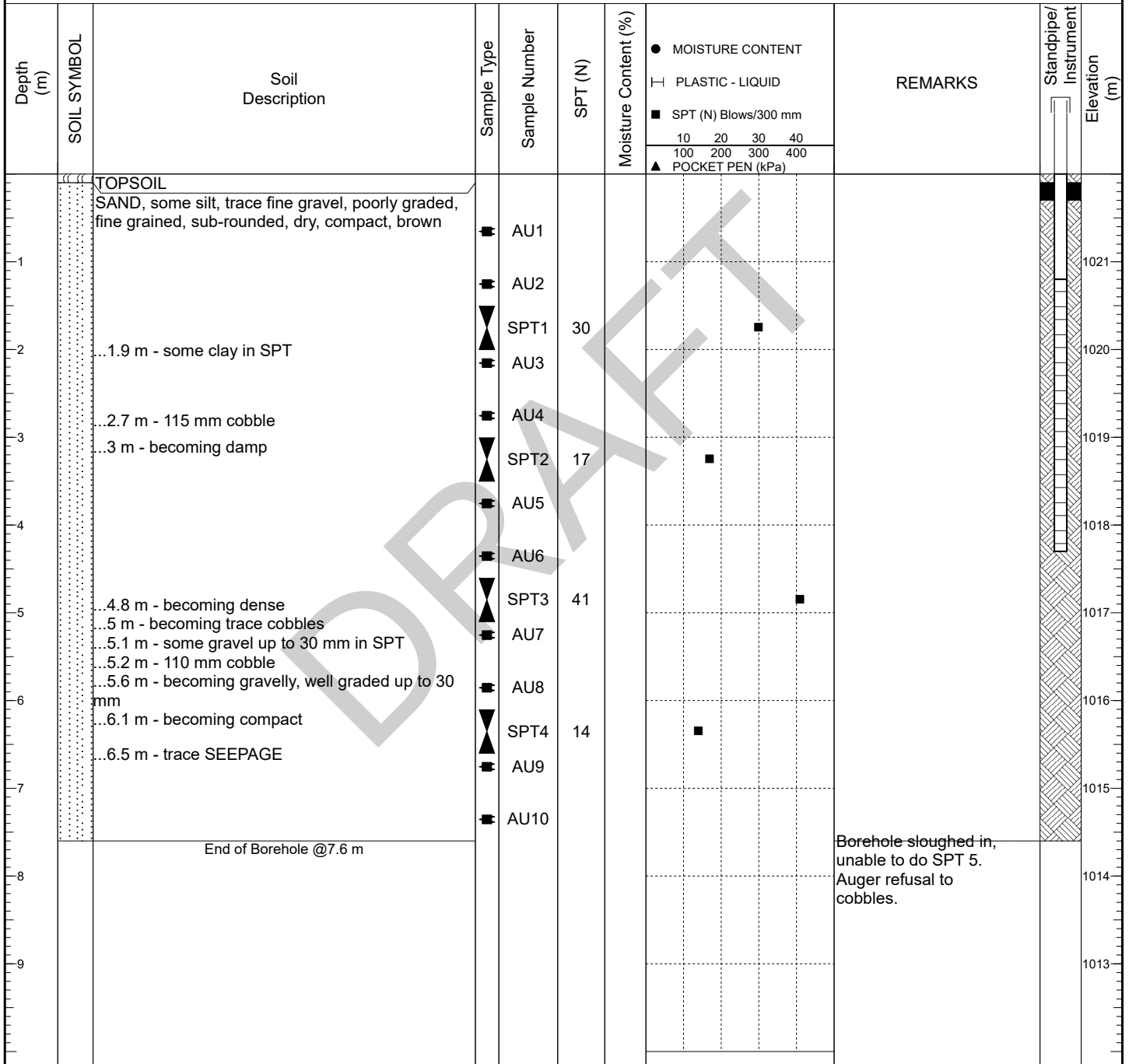
Notes:

Seepage observed at a depth of 3.5 m. Borehole sloughed in to 15.5 m. Slotted 50 mm PVC standpipe installed to a depth of 14.9 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.00m N 5631459.521 E 300408.844
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



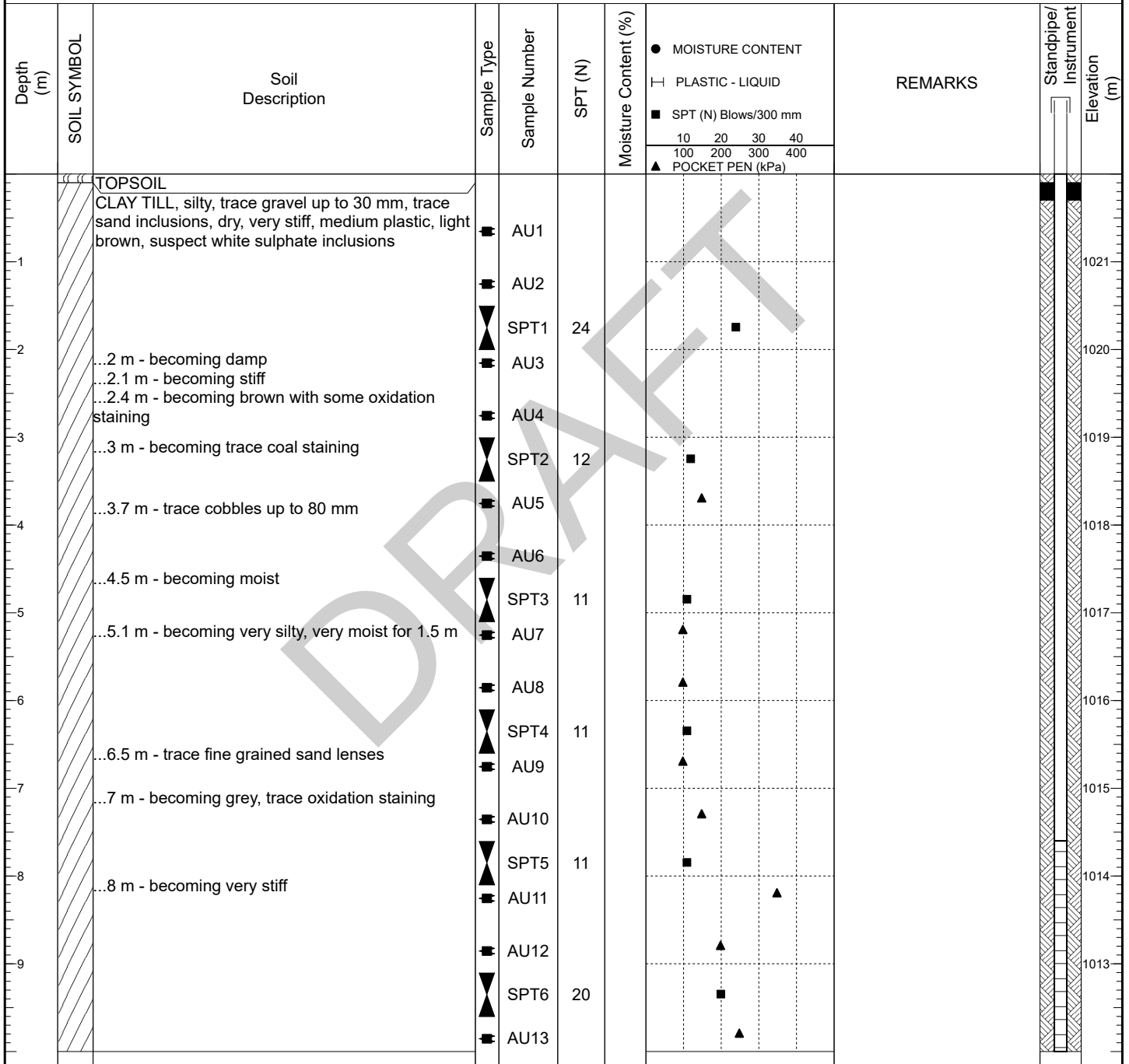
Notes:

Trace seepage observed at a depth of 6.5 m. Borehole sloughed in to 4.3 m. Slotted 25 mm PVC standpipe installed to a depth of 4.3 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.00m N 5631511.821 E 300328.560
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

No seepage or sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1022.00m N 5631511.821 E 300328.560
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace gravel up to 30 mm, trace sand inclusions, dry, very stiff, medium plastic, light brown, suspect white sulphate inclusions ..10.1 m - becoming damp, very silty, ground up; possible completely weathered siltstone End of Borehole @10.7 m	■	AU14					1011
12									1010
13									1009
14									1008
15									1007
16									1006
17									1005
18									1004
19									1003

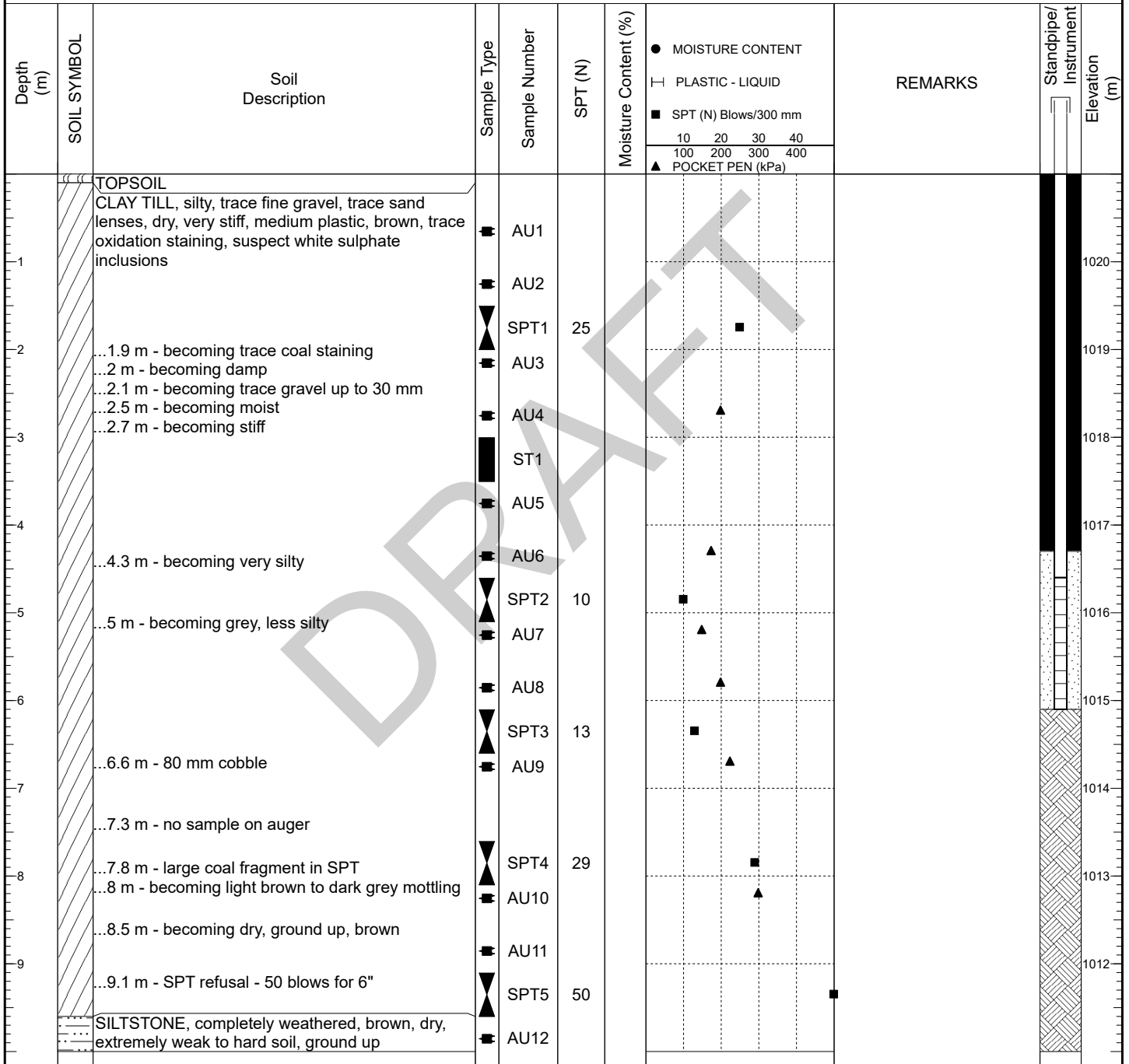
Notes:

No seepage or sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
GROUND ELEVATION	1021.00m	N	5631607.234 E 300185.593
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	



Notes:

No seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 6.1 m.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH009**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/24/2022 COMPLETED 08/24/2022 GROUND ELEVATION 1021.00m N 5631607.234 E 300185.593
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		SILTSTONE, completely weathered, brown, dry, extremely weak to hard soil, ground up							1010
		End of Borehole @10.7 m							
12									1009
13									1008
14									1007
15									1006
16									1005
17									1004
18									1003
19									1002

Notes:

No seepage or sloughing observed upon completion. Slotted 50 mm PVC standpipe installed to a depth of 6.1 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
GROUND ELEVATION	1021.00m	N	5631773.458 E 300201.569
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)		
0	TOPSOIL	CLAY TILL, silty, trace sand, dry, stiff, low to medium plastic, light brown, suspect white sulphate inclusions	■	AU1				1020
1		SAND, some silt, poorly graded, fine grained, sub-rounded, damp, compact, brown	■	AU2				1019
2		...1.9 m - trace SEEPAGE ...2 m - becoming moist	▲	SPT1	18			1018
3		...3 m - becoming wet ...3.2 m - becoming some well graded gravel	■	AU3				1017
4		...4.1 m - some silt lenses	▲	SPT2	17			1016
5		...5 m - becoming gravelly, coarse grained up to 70 mm	■	AU4				1015
6		End of Borehole @6.1 m	■	AU5				1014
7			■	AU6				1013
8			■	AU7				1012
9			■	AU8				
							auger refusal at 6.1 m to cobbles	

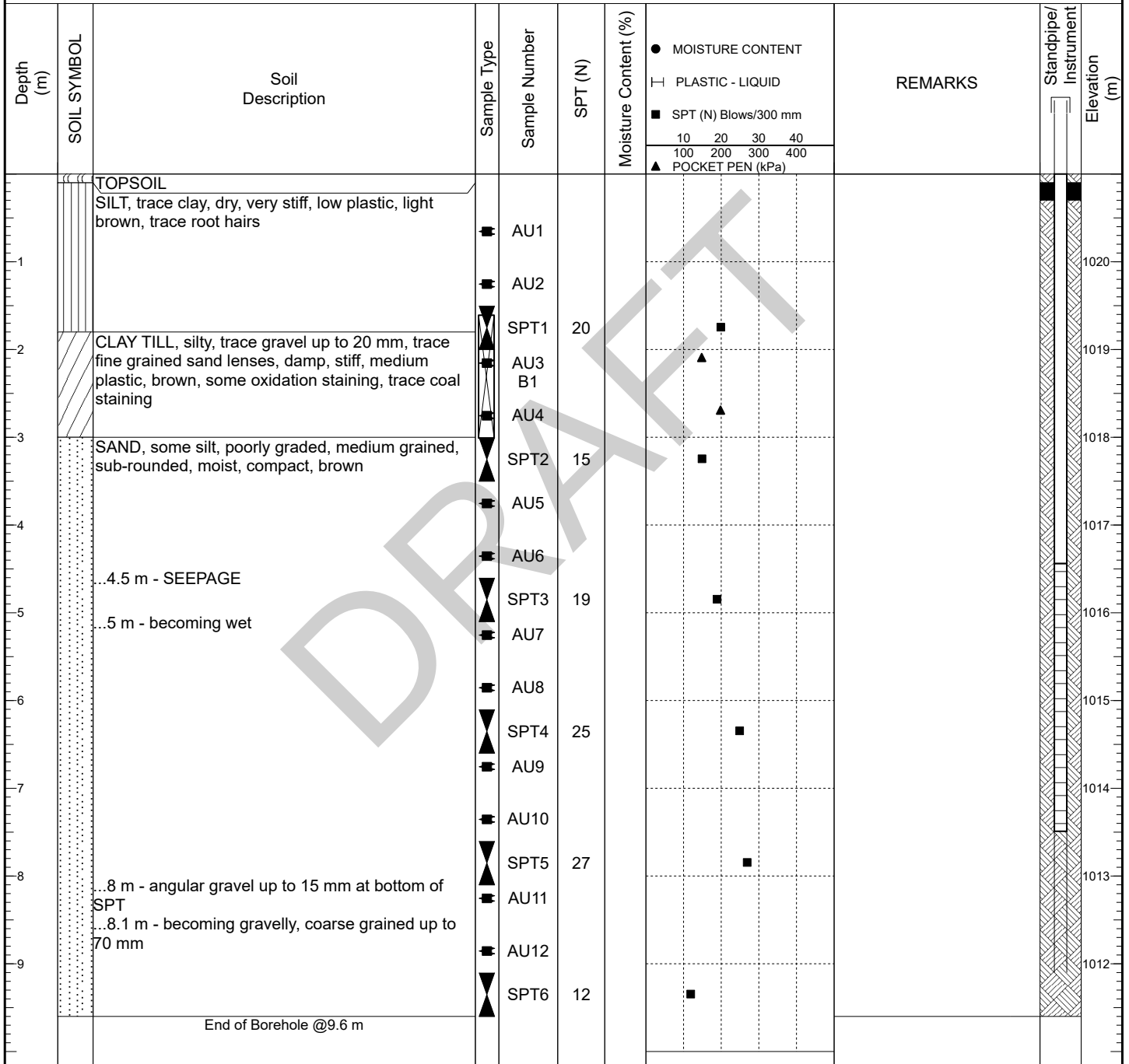
Notes:

Seepage observed at a depth of 1.9 m. Borehole sloughed in to 4 m. Slotted 25 mm PVC standpipe installed to a depth of 4.09 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631673.256 E 300315.287
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



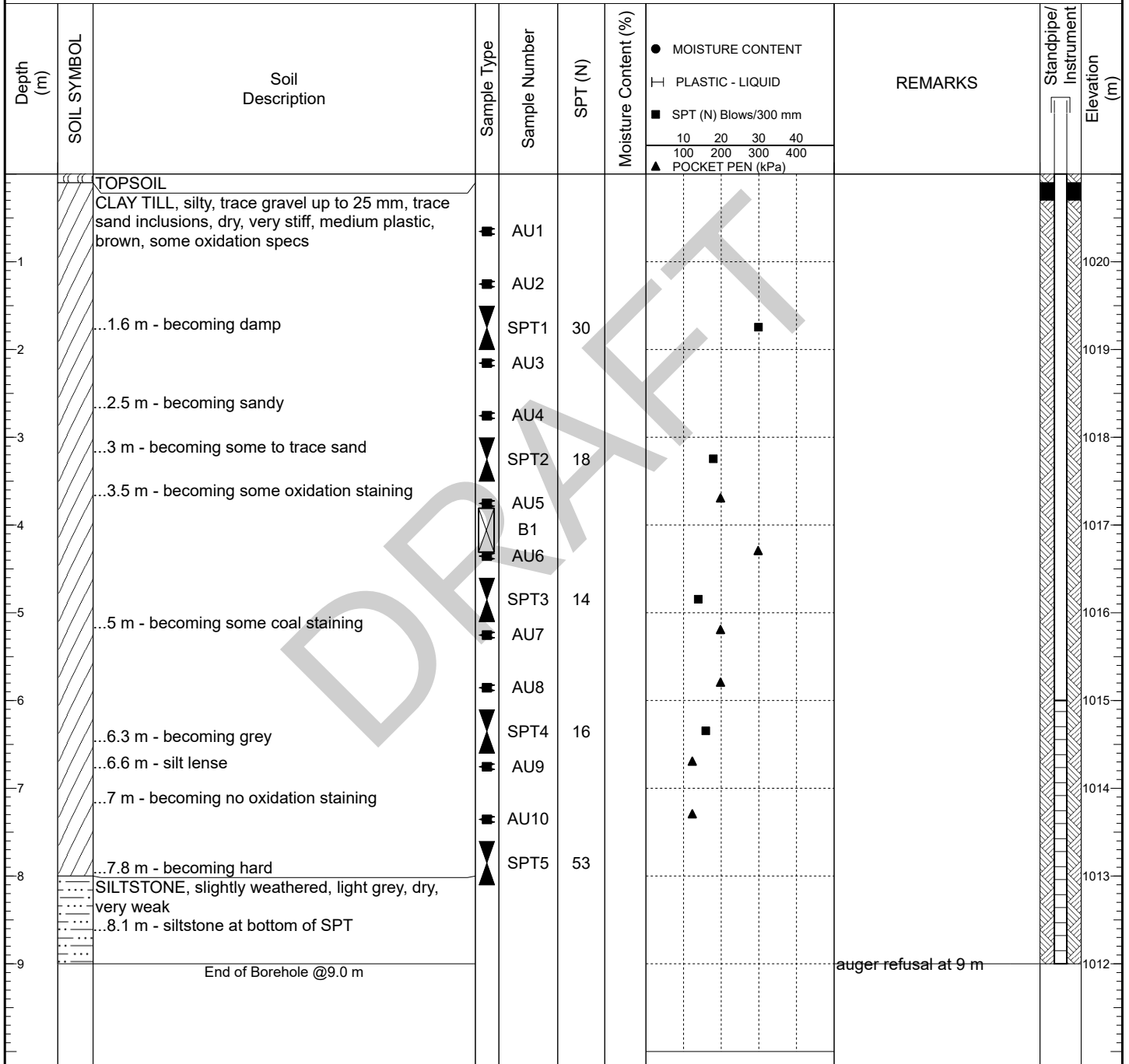
Notes:

Seepage observed at a depth of 4.5 m. Borehole sloughed in to 4.6 m. Slotted 25 mm PVC standpipe installed to a depth of 7.49 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/24/2022	COMPLETED	08/24/2022
GROUND ELEVATION	1021.00m	N	5631603.079 E 300395.454
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	



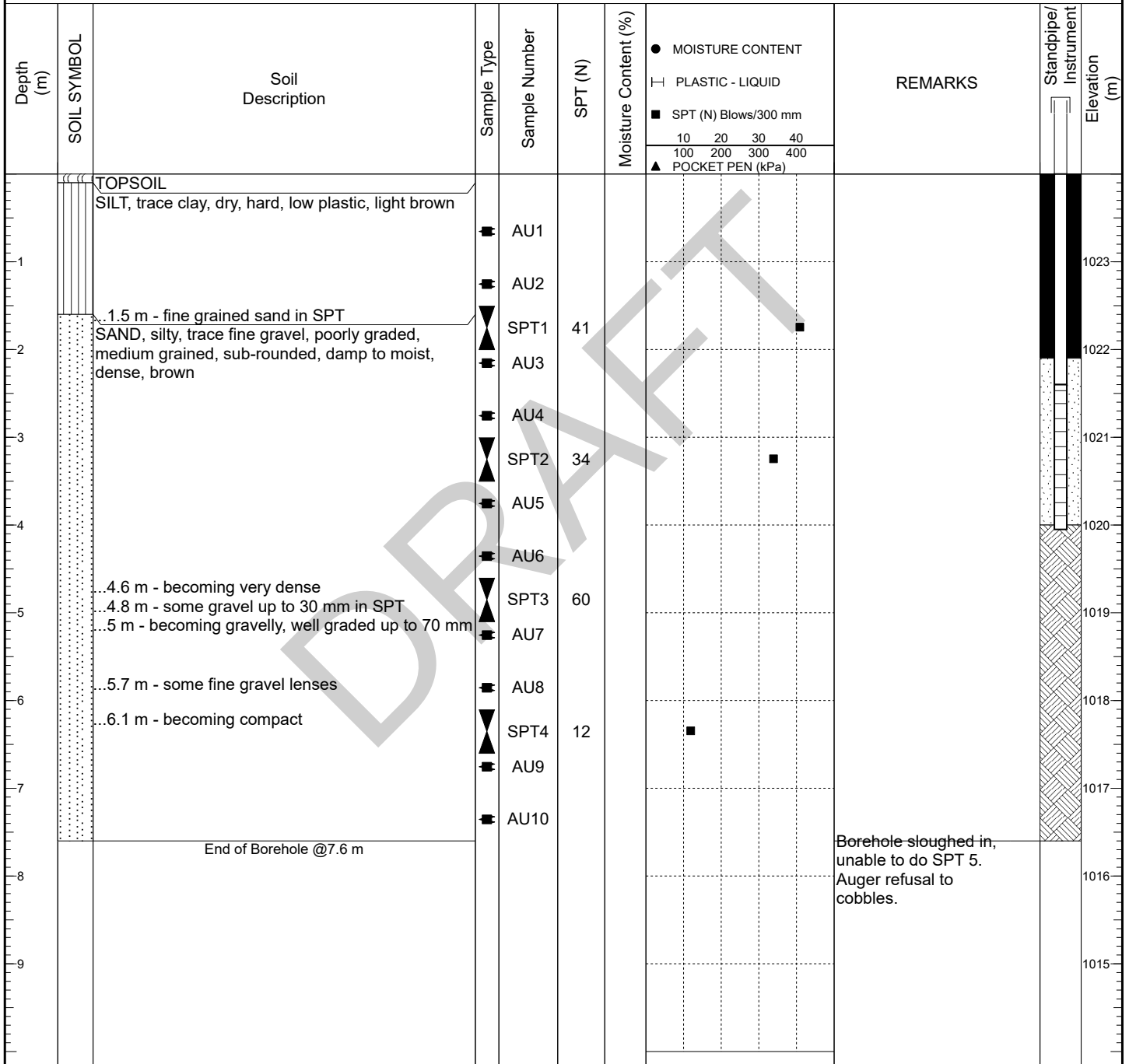
Notes:

No seepage or sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 9.0 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1024.00m N 5631349.616 E 300466.192
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



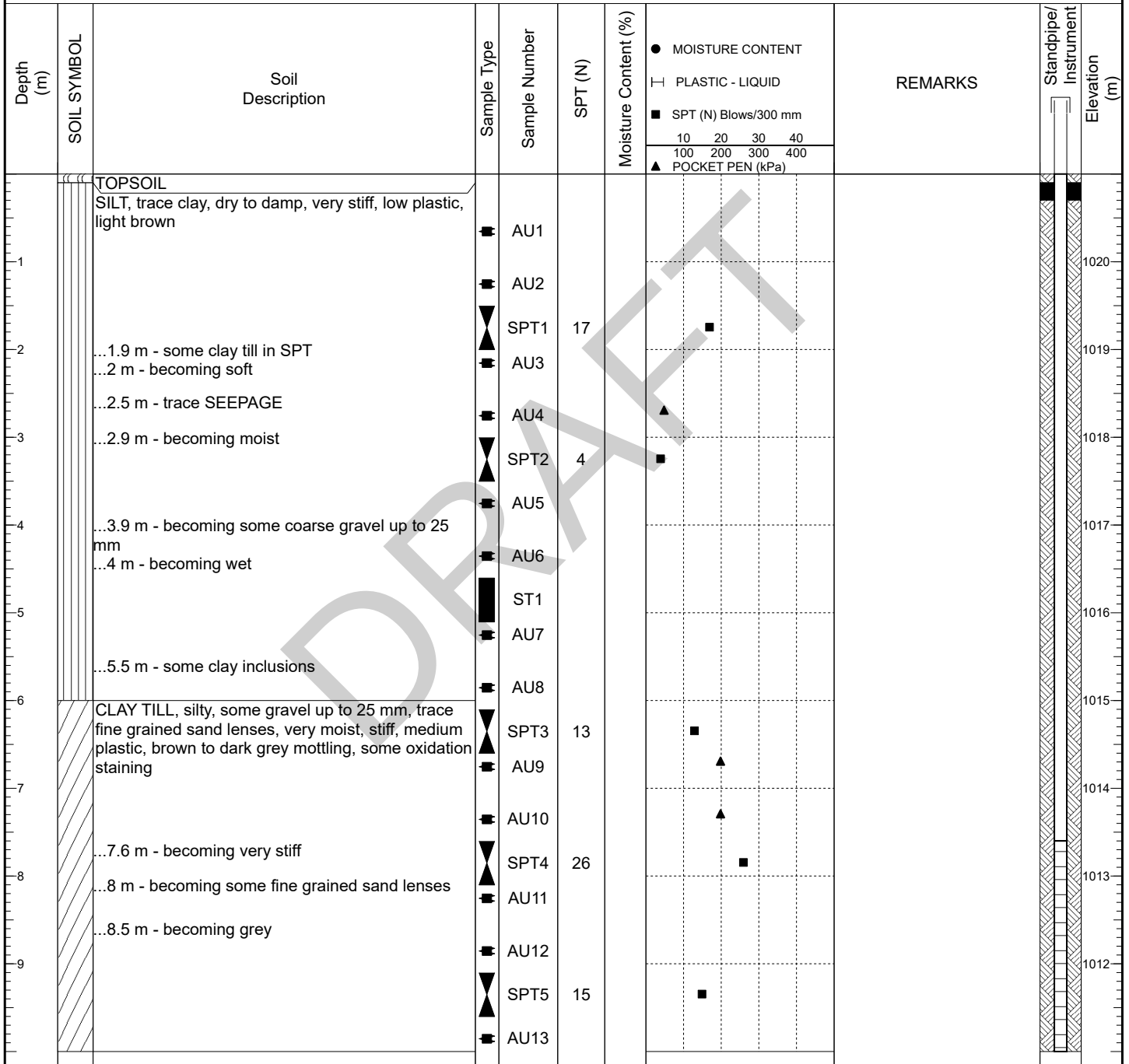
Notes:

No seepage observed upon completion. Borehole sloughed in to 4.0 m. Slotted 50 mm PVC standpipe installed to a depth of 4.05 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631235.261 E 300402.623
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 2.5 m. Minor sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis



BOREHOLE No : **22BH015**

PAGE 2 OF 2

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1021.00m N 5631235.261 E 300402.623
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, some gravel up to 25 mm, trace fine grained sand lenses, very moist, stiff, medium plastic, brown to dark grey mottling, some oxidation staining							1010
		End of Borehole @10.7 m							
12									1009
13									1008
14									1007
15									1006
16									1005
17									1004
18									1003
19									1002

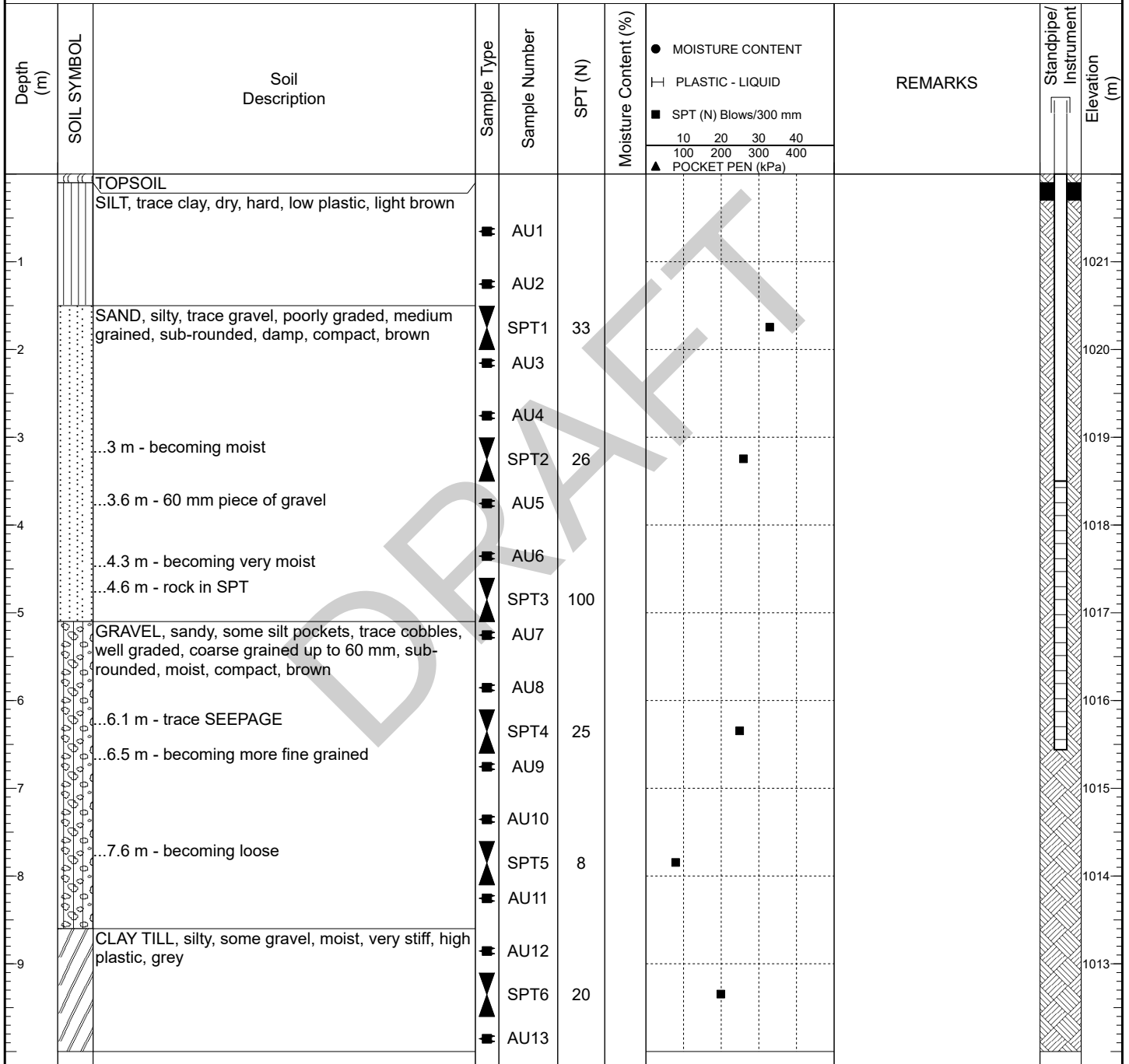
Notes:

Seepage observed at a depth of 2.5 m. Minor sloughing observed upon completion. Slotted 25 mm PVC standpipe installed to a depth of 10.7 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
GROUND ELEVATION	1022.00m	N	5631235.367 E 300311.027
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 6.1 m. Borehole sloughed in to 6.56 m. Slotted 25 mm PVC standpipe installed to a depth of 6.56 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1022.00m N 5631235.367 E 300311.027
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, some gravel, moist, very stiff, high plastic, grey	■	AU14					1011
		End of Borehole @10.7 m							1010
12									1009
13									1008
14									1007
15									1006
16									1005
17									1004
18									1003
19									

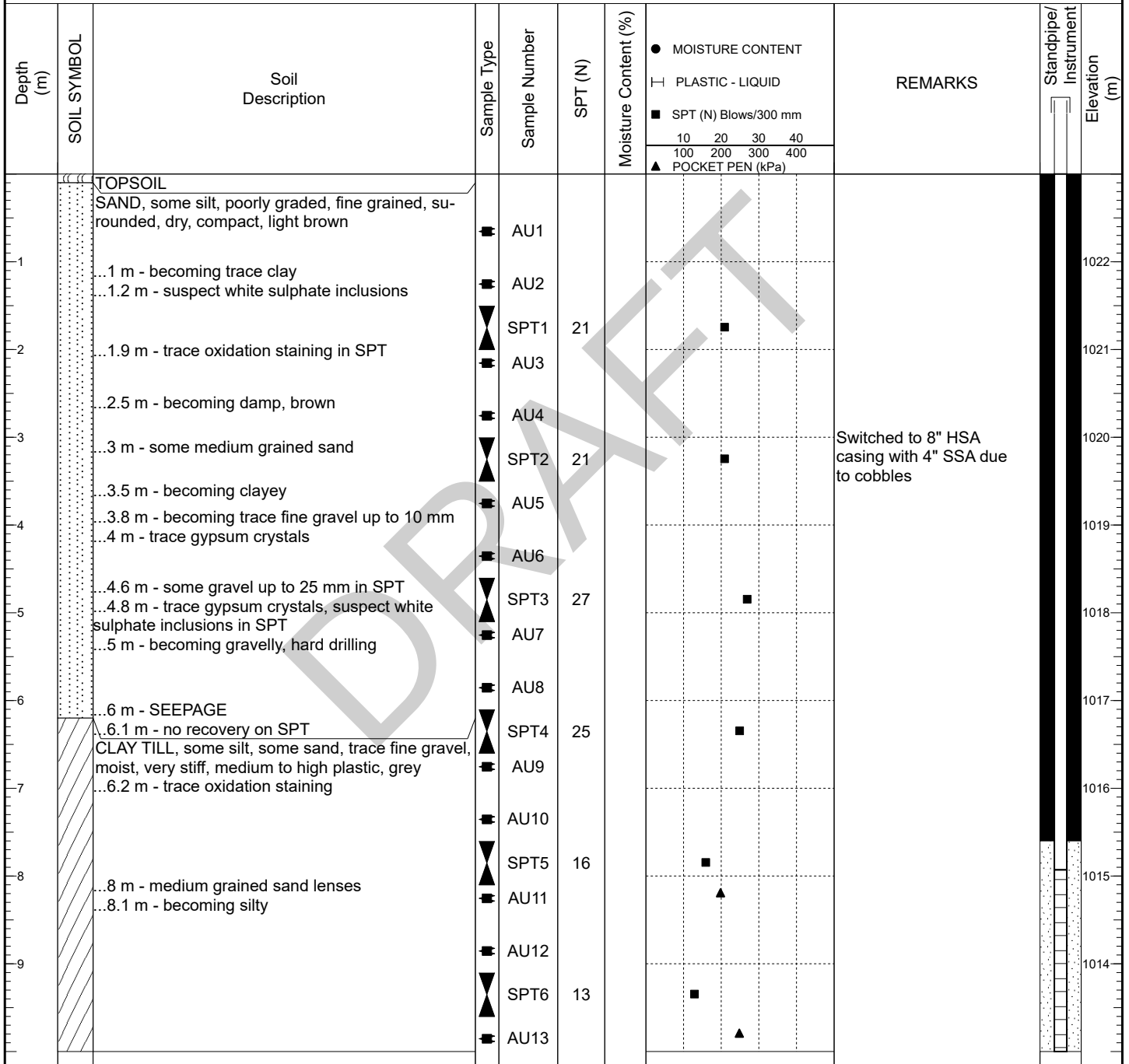
Notes:

Seepage observed at a depth of 6.1 m. Borehole sloughed in to 6.56 m. Slotted 25 mm PVC standpipe installed to a depth of 6.56 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1023.00m N 5656616.449 E 304879.229
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 11.3 m. Slotted 25 mm PVC standpipe installed to a depth of 10.98 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/22/2022	COMPLETED	08/23/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1023.00m N 5656616.449 E 304879.229
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)		
11		CLAY TILL, some silt, some sand, trace fine gravel, moist, very stiff, medium to high plastic, grey ...10 m - some interbedded sand lenses ...10.4 m - becoming hard	■	AU10	34			1012
			▲	SPT7				
			■	AU15				
12			■	AU16				1011
			▲	SPT8	44			
		...12.6 m - yellow fine grained sand lense	■	AU17				1010
13		...13 m - becoming brownish yellow	■	AU18				
			▲	SPT9	60			1009
14		...13.9 m - becoming damp	■	AU19				
			■	AU20				1008
15			▲	SPT10	42			
		...15.5 m - becoming some grey streaks	■	AU21				1007
16			■	AU22				
			▲	SPT11	69			1006
17			■	AU23				
18			■	AU24				1005
		...18.5 m - 50 blows for 5"	▲	SPT12	50			
19			■	AU25				1004
			■	AU26				
		End of Borehole @19.8 m						

Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 11.3 m. Slotted 25 mm PVC standpipe installed to a depth of 10.98 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/26/2022	COMPLETED	08/26/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1023.00m N 5631386.111 E 300167.545
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)		
0	TOPSOIL	SAND, some silt, trace gravel, poorly graded, fine grained, sub-rounded, dry, compact, light brown, trace root hairs	■	AU1				1022
1			■	AU2				
2		...2 m - becoming damp	▲	SPT1	24			1021
3		...2.6 m - becoming very silty, moist	■	AU3				
4		SILT, some sand, trace clay, moist, stiff, low plastic, brown	▲	AU4	15			1020
5		SAND, some silt, some gravel up to 30 mm, poorly graded, fine grained, sub-rounded, damp, compact, brown	■	AU5				1019
6			■	AU6				
7		...5 m - becoming gravelly, well graded up to 70 mm	▲	SPT3	28			1018
8		...5.1 m - becoming trace cobbles up to 110 mm	■	AU7				
9			■	AU8			No SPT due to sloughing.	1017
10		...6.3 m - trace SEEPAGE	■	AU9				1016
11		...6.4 m - becoming some moist fine gravel pockets	■	AU10			No SPT due to sloughing.	1015
12		GRAVEL, silty, sandy, well graded, fine grained, sub-rounded, moist, compact, brown	■	AU11				1014
13			■	AU12				
14		End of Borehole @9.1 m					Auger refusal at 9.1 m to gravel and cobbles.	

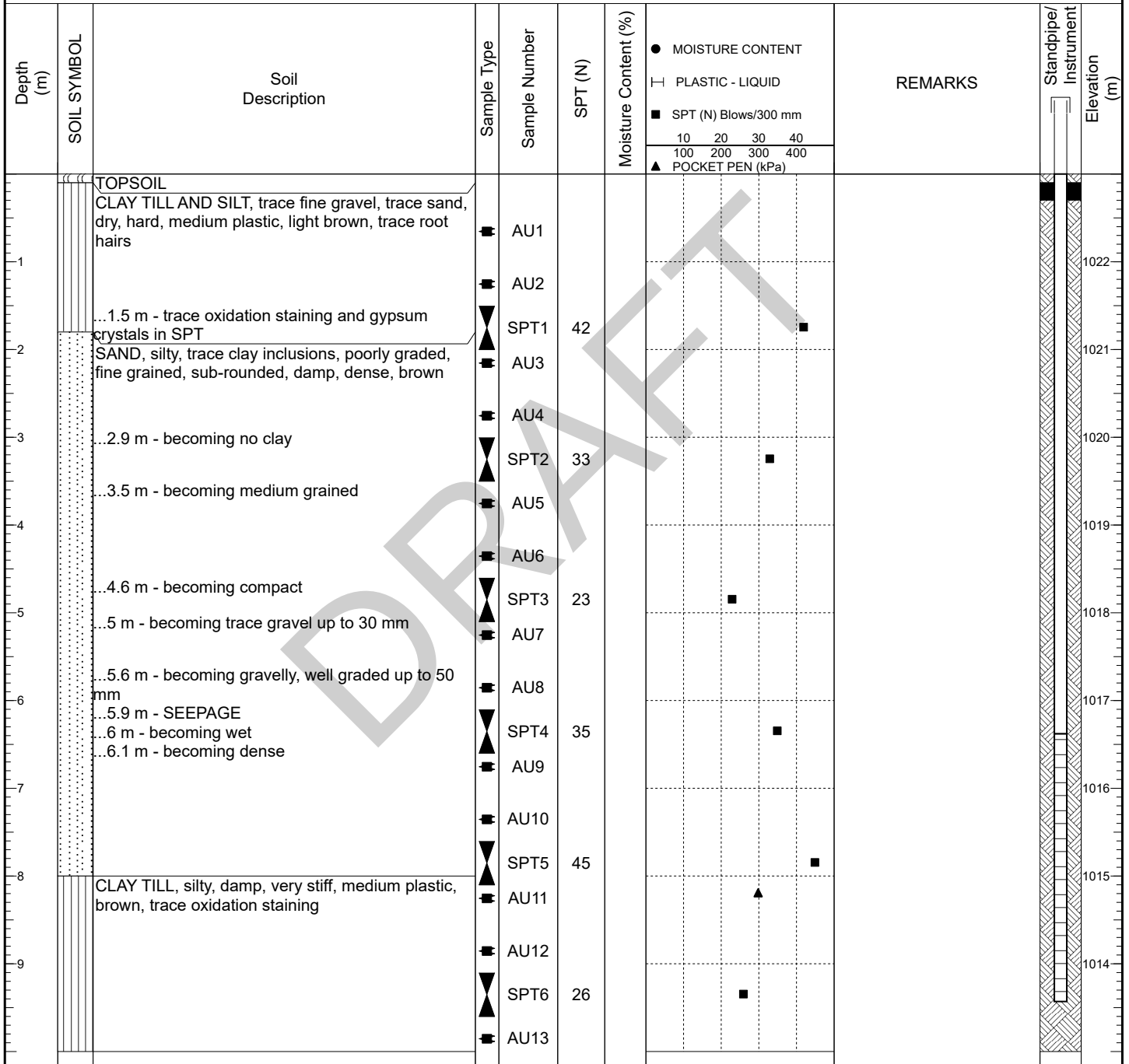
Notes:

Seepage observed at a depth of 6.3 m. Borehole sloughed in to 3.35 m. Slotted 50 mm PVC standpipe installed to a depth 3.35 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/26/2022	COMPLETED	08/26/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1023.00m N 5631483.474 E 300153.939
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 6.0 m. Slotted 25 mm PVC standpipe installed to a depth of 9.43 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/26/2022 COMPLETED 08/26/2022 GROUND ELEVATION 1023.00m N 5631483.474 E 300153.939
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, damp, very stiff, medium plastic, brown, trace oxidation staining ...10 m - becoming some fine gravel End of Borehole @10.7 m	■	AU14					1012
12									1011
13									1010
14									1009
15									1008
16									1007
17									1006
18									1005
19									1004

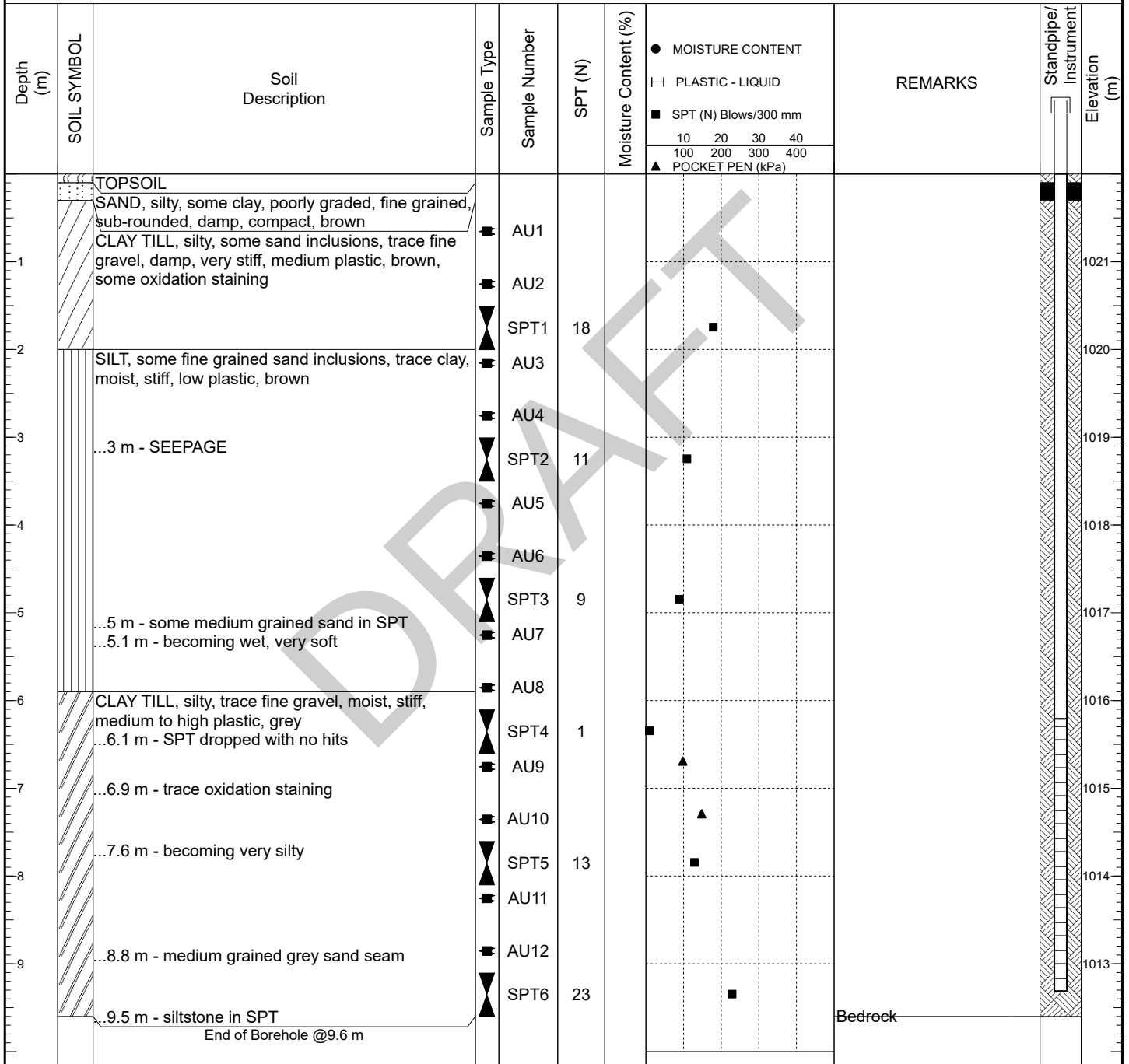
Notes:

Seepage observed at a depth of 6.0 m. Borehole sloughed in to 6.0 m. Slotted 25 mm PVC standpipe installed to a depth of 9.43 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/26/2022	COMPLETED	08/26/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1022.00m N 5631480.669 E 300249.337
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



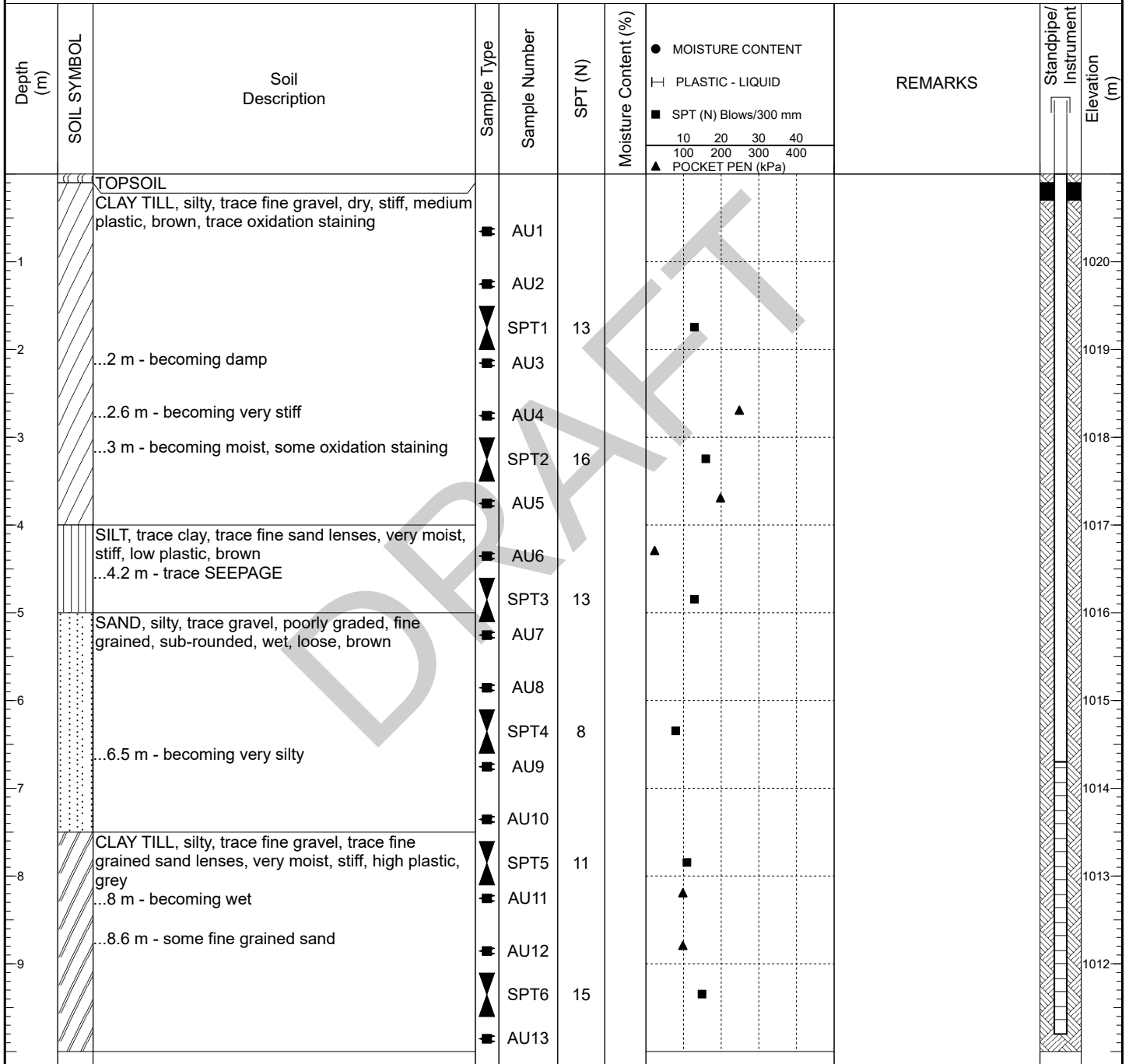
Notes:

Seepage observed at a depth of 3.0 m. Borehole sloughed in to 1.2 m. Slotted 25 mm PVC standpipe installed to a depth of 9.31 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
DRILLING CONTRACTOR	Val's Drilling	GROUND ELEVATION	1021.00m N 5631386.105 E 300353.690
DRILLING METHOD	6" SSA	GROUND WATER ELEVATION / DEPTH	
		DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 4.2 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1021.00m N 5631386.105 E 300353.690
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace fine gravel, trace fine grained sand lenses, very moist, stiff, high plastic, grey	■	AU14					1010
		End of Borehole @10.7 m							1009
12									1008
13									1007
14									1006
15									1005
16									1004
17									1003
18									1002
19									

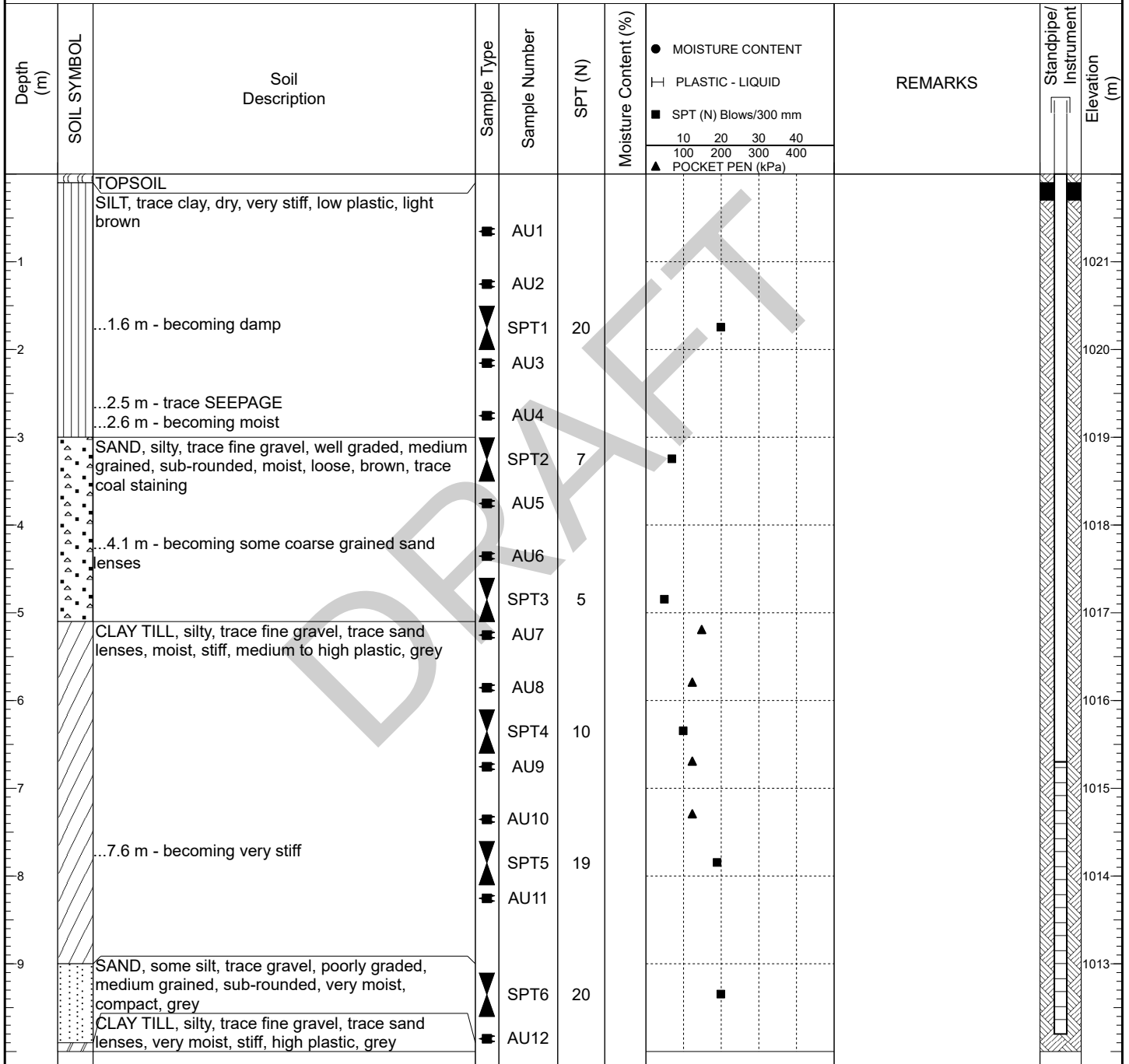
Notes:

Seepage observed at a depth of 4.2 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT	Town of Okotoks	PROJECT NAME	Foothills Okotoks Regional Raw Water Reservoir
PROJECT NUMBER	29121-005-05	PROJECT LOCATION	
DATE STARTED	08/25/2022	COMPLETED	08/25/2022
GROUND ELEVATION	1022.00m	N	5631311.202 E 300368.111
DRILLING CONTRACTOR	Val's Drilling	GROUND WATER ELEVATION / DEPTH	
DRILLING METHOD	6" SSA	DATE GROUND WATER RECORDED	



Notes:

Seepage observed at a depth of 2.5 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/25/2022 COMPLETED 08/25/2022 GROUND ELEVATION 1022.00m N 5631311.202 E 300368.111
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 DRILLING METHOD 6" SSA DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/ Instrument	Elevation (m)
						● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 ▲ POCKET PEN (kPa)			
11		CLAY TILL, silty, trace fine gravel, trace sand lenses, very moist, stiff, high plastic, grey	■	AU13					1011
		End of Borehole @10.7 m							1010
12									1009
13									1008
14									1007
15									1006
16									1005
17									1004
18									1003
19									

Notes:

Seepage observed at a depth of 2.5 m. Borehole sloughed in to 9.8 m. Slotted 25 mm PVC standpipe installed to a depth of 9.8 m.

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/22/2022 COMPLETED 08/22/2022 GROUND ELEVATION 1021.00m N 5631863.640 E 300169.685
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 CORING TYPE HQ3 DIAMETER (mm) 61 DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	Run Depth (m)	Run Number	RQD TCR SCR	Fracture Index (#/m)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
									● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
1		OVERBURDEN. Refer to 22BH001 for Log Report.										1020
2												1019
3												1018
4												1017
5												1016
6												1015
7												1014
8												1013
9												1012
8.08 - 9.60		SILTSTONE, some clay, highly weathered, light grey, damp, medium plastic, extremely weak, massive ...8.1 m - 100 mm of slough ...8.8 m - 30 mm clayey layer ...9.2 m - 250 mm very weak layer ...9.6 m - becoming interbedded sandstone and claystone layers ...9.8 m - vertical fracture, 100 mm of sandstone pieces		RC1		1	100 100 100	1				
9.60 - 11.12						2	54 59 42	1				

Notes:

Target depth of 19.5 m achieved. Borehole backfilled with bentonite chips.

Monitoring Installation Pipe Work

Depth Top	Depth Bottom	Pipe Type
0.00	10.98	PLAIN
10.98	14.02	SLOTTED

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/22/2022 COMPLETED 08/22/2022 GROUND ELEVATION 1021.00m N 5631863.640 E 300169.685
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 CORING TYPE HQ3 DIAMETER (mm) 61 DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	Run Depth (m)	Run Number	RQD TCR SCR	Fracture Index (#/m)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
									● MOISTURE CONTENT ▬ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
11	XXXX	SILTSTONE, some clay, highly weathered, light grey, damp, medium plastic, extremely weak, massive		RC2								
	XXXX	...10.3 m - vertical fracture			11.12	3	39	2				1010
	XXXX	...10.4 m - sandy slough			-		55					
	XXXX	...10.5 m - 0.62 m of core loss			12.64		37					
12	XXXX	...11.2 m - becoming residual soil, clay till with some gravel up to 30 mm		RC3								1009
	XXXX	...11.7 m - cored through boulder			12.64	4	0	20				
	XXXX	...12.0 m - .68 m of core loss			-		26					
13	XXXX	...12.9 m - gravel up to 40 mm		RC4	14.16		4					1008
	XXXX	...13.0 m - 1.12 m of core loss			-		105					
14	XXXX	...14.1 m - 100 mm well graded, fine gravel layer with clay infill			15.68	5	12	20				1007
	XXXX				-		105					
15	XXXX			RC5								1006
	XXXX				15.68	6	68	3				
16	XXXX	CLAYSTONE, silty, medium weathered, grey, damp, medium plastic, extremely weak, thinly laminated, interbedded siltstone layers, massive		RC6	17.20		53					1005
	XXXX				-							
17	XXXX	...17.2 m - highly fractured run			17.20	7	8	20				1004
	XXXX				-		79					
18	XXXX			RC7	18.72		13					1003
	XXXX	...18.1 m - 0.2 m strong calcified shale layer										
19	XXXX	...18.4 m - 0.32 m of core loss			18.72	8	68	4				1002
	XXXX				-		100					
	XXXX			RC8	20.24		70					

Notes:

Target depth of 19.5 m achieved. Borehole backfilled with bentonite chips.

Monitoring Installation Pipe Work

Depth Top	Depth Bottom	Pipe Type
0.00	10.98	PLAIN
10.98	14.02	SLOTTED

Logged By: C. Tams

Reviewed By: T. Curtis

CLIENT Town of Okotoks PROJECT NAME Foothills Okotoks Regional Raw Water Reservoir
 PROJECT NUMBER 29121-005-05 PROJECT LOCATION _____
 DATE STARTED 08/22/2022 COMPLETED 08/22/2022 GROUND ELEVATION 1021.00m N 5631863.640 E 300169.685
 DRILLING CONTRACTOR Val's Drilling GROUND WATER ELEVATION / DEPTH _____
 CORING TYPE HQ3 DIAMETER (mm) 61 DATE GROUND WATER RECORDED _____

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	Run Depth (m)	Run Number	RQD TCR SCR	Fracture Index (#/m)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
									● MOISTURE CONTENT └─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
21		CLAYSTONE, silty, medium weathered, grey, damp, medium plastic, extremely weak, thinly laminated, interbedded siltstone layers, massive										1000
22												999
23												998
24												997
25												996
26												995
27												994
28												993
29												992

Notes:

Target depth of 19.5 m achieved. Borehole backfilled with bentonite chips.

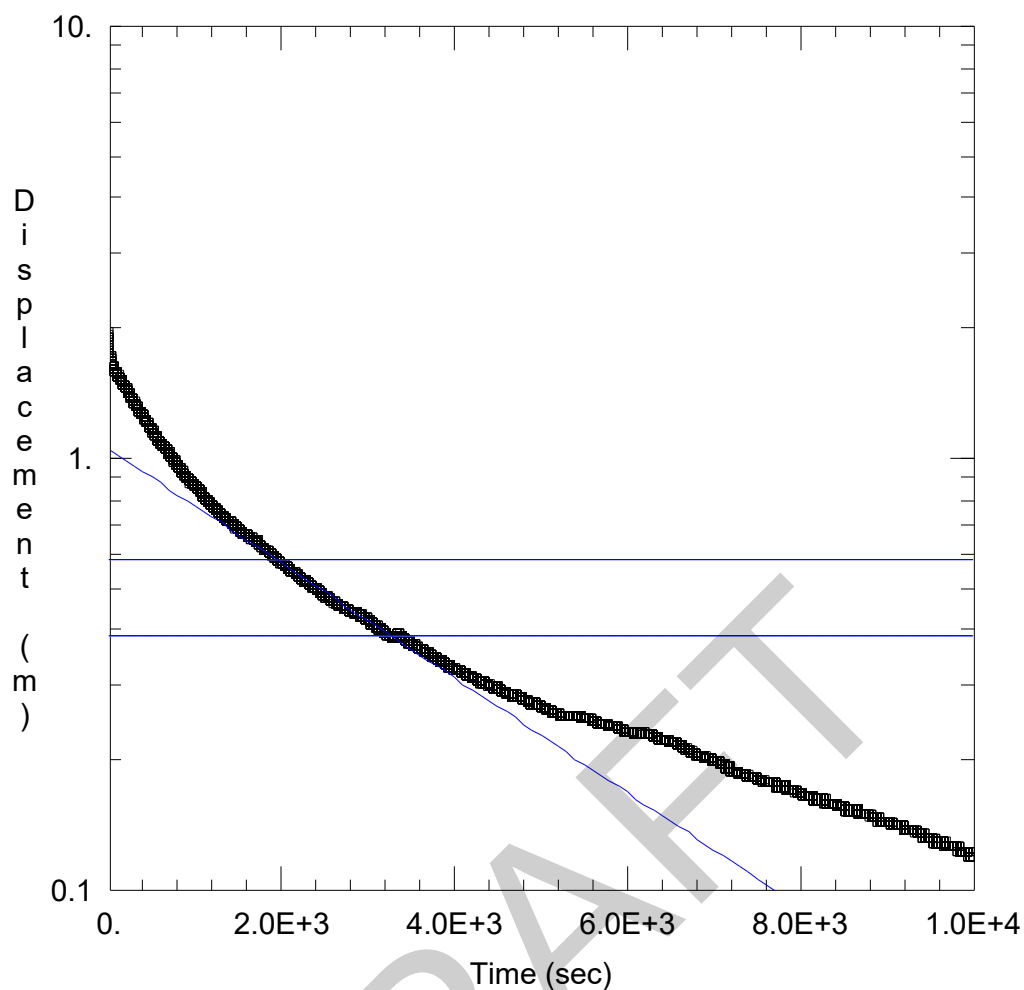
Monitoring Installation Pipe Work

Depth Top	Depth Bottom	Pipe Type
0.00	10.98	PLAIN
10.98	14.02	SLOTTED

Logged By: C. Tams

Reviewed By: T. Curtis

AQTESOLV Results



WELL TEST ANALYSIS

Data Set: P:\...\22BH003.aqt

Date: 10/14/22

Time: 09:40:39

PROJECT INFORMATION

Company: Waterline Resources Inc

Client: Urban System

Project: 3319-22-001

Location: NW-21-021-28 W4

Test Date: Sept 2022

AQUIFER DATA

Saturated Thickness: 1.7 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (22BH003)

Initial Displacement: 1.94 m

Static Water Column Height: 0. m

Total Well Penetration Depth: 1.7 m

Screen Length: 1.7 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

Gravel Pack Porosity: 0.3

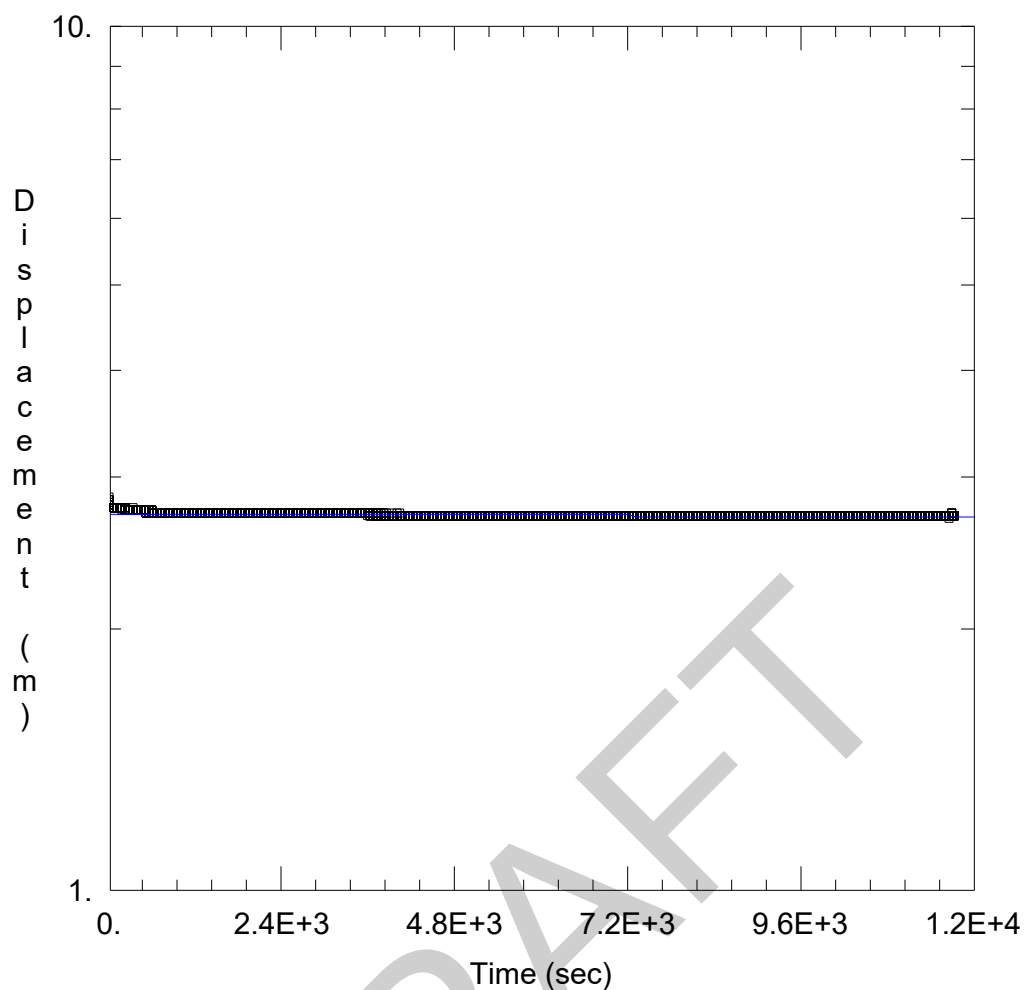
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 1.3E-7$ m/sec

$y_0 = 1.049$ m



WELL TEST ANALYSIS

Data Set: P:\...\22BH004.aqt

Date: 10/14/22

Time: 09:43:27

PROJECT INFORMATION

Company: Waterline Resources Inc

Client: Urban System

Project: 3319-22-001

Location: NW-21-021-28 W4

Test Date: Sept 2022

AQUIFER DATA

Saturated Thickness: 2.6 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (22BH004)

Initial Displacement: 2.84 m

Static Water Column Height: 0.22 m

Total Well Penetration Depth: 2.6 m

Screen Length: 2.6 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

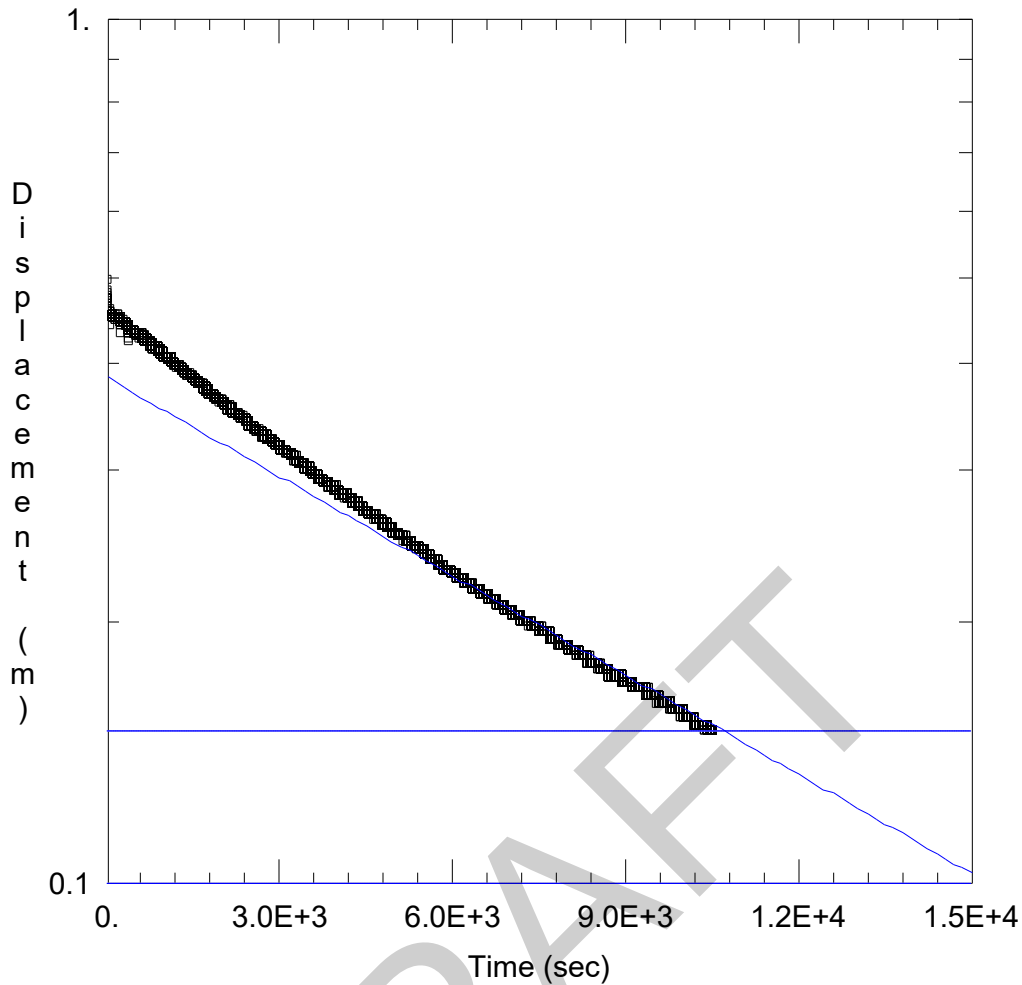
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 2.2E-10 m/sec

y0 = 2.726 m



WELL TEST ANALYSIS

Data Set: P:\...\22BH006.aqt

Date: 10/14/22

Time: 09:47:44

PROJECT INFORMATION

Company: Waterline Resources Inc

Client: Urban System

Project: 3319-22-001

Location: NW-21-021-28 W4

Test Date: Sept 2022

AQUIFER DATA

Saturated Thickness: 5.7 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (22BH006)

Initial Displacement: 0.5 m

Static Water Column Height: 11.09 m

Total Well Penetration Depth: 5.7 m

Screen Length: 5.7 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

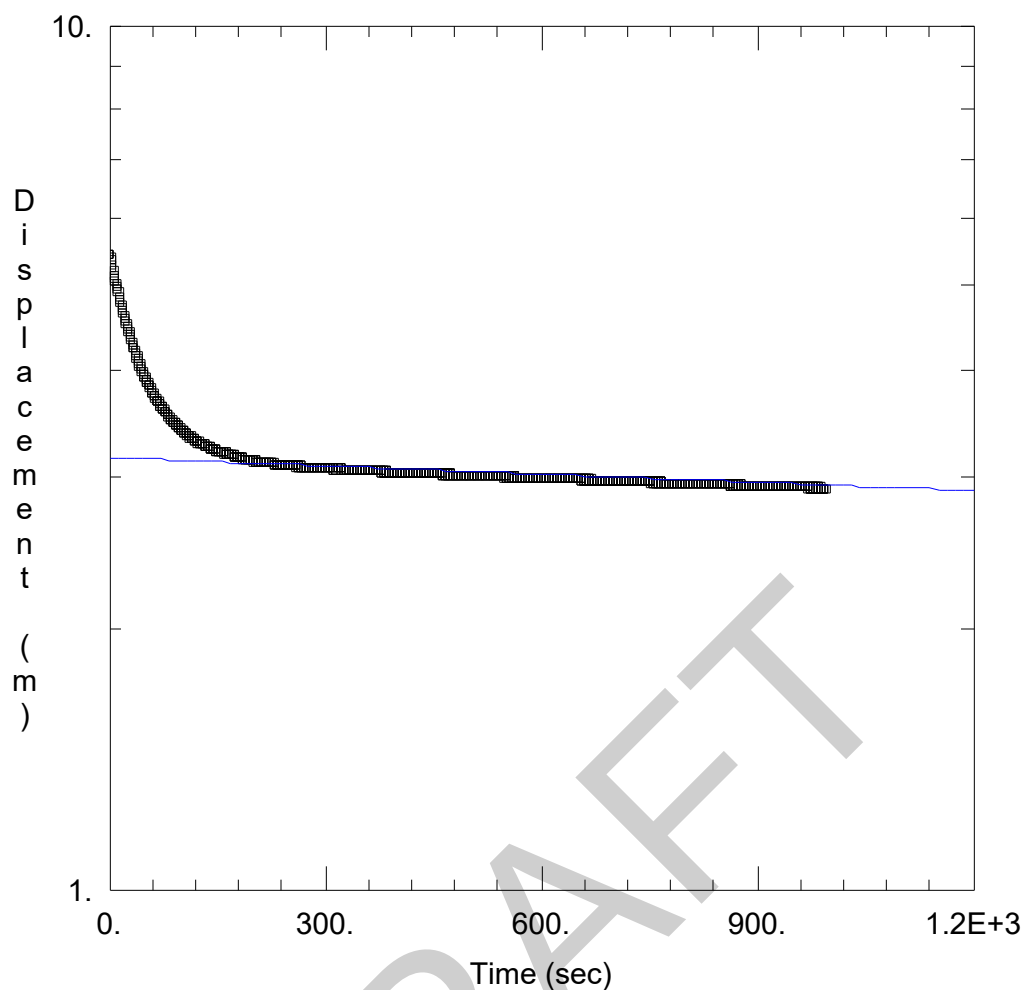
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 1.6E-8$ m/sec

$y_0 = 0.3844$ m



WELL TEST ANALYSIS

Data Set: P:\...\22BH009.aqt

Date: 10/14/22

Time: 09:51:00

PROJECT INFORMATION

Company: Waterline Resources Inc

Client: Urban System

Project: 3319-22-001

Location: NW-21-021-28 W4

Test Date: Sept 2022

AQUIFER DATA

Saturated Thickness: 1.8 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (22BH009)

Initial Displacement: 5.45 m

Static Water Column Height: 1.37 m

Total Well Penetration Depth: 1.8 m

Screen Length: 1.8 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

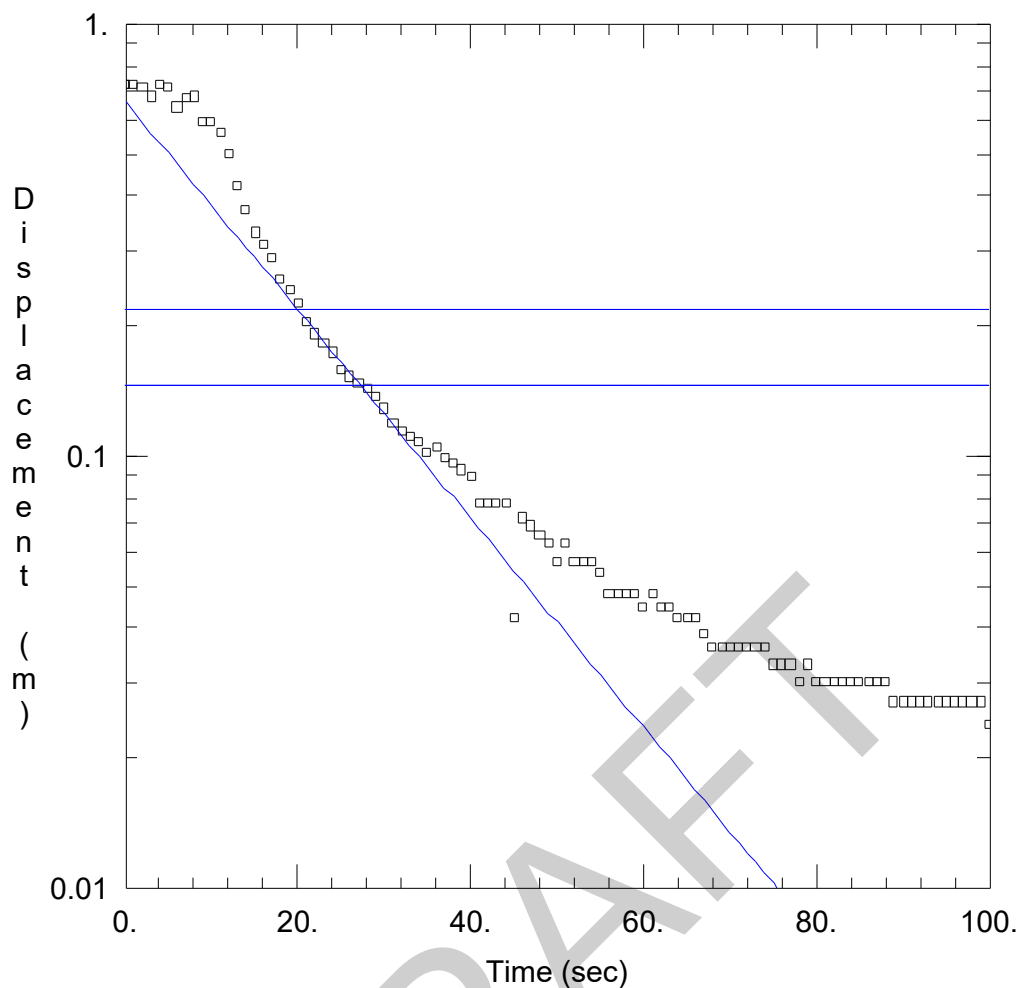
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 3.0E-8$ m/sec

$y_0 = 3.166$ m



WELL TEST ANALYSIS

Data Set: P:\...\22BH014.aqt

Date: 10/14/22

Time: 09:52:02

PROJECT INFORMATION

Company: Waterline Resources Inc

Client: Urban System

Project: 3319-22-001

Location: NW-21-021-28 W4

Test Date: Sept 2022

AQUIFER DATA

Saturated Thickness: 2.2 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (22BH014)

Initial Displacement: 0.729 m

Static Water Column Height: 0. m

Total Well Penetration Depth: 1.9 m

Screen Length: 1.9 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

Gravel Pack Porosity: 0.3

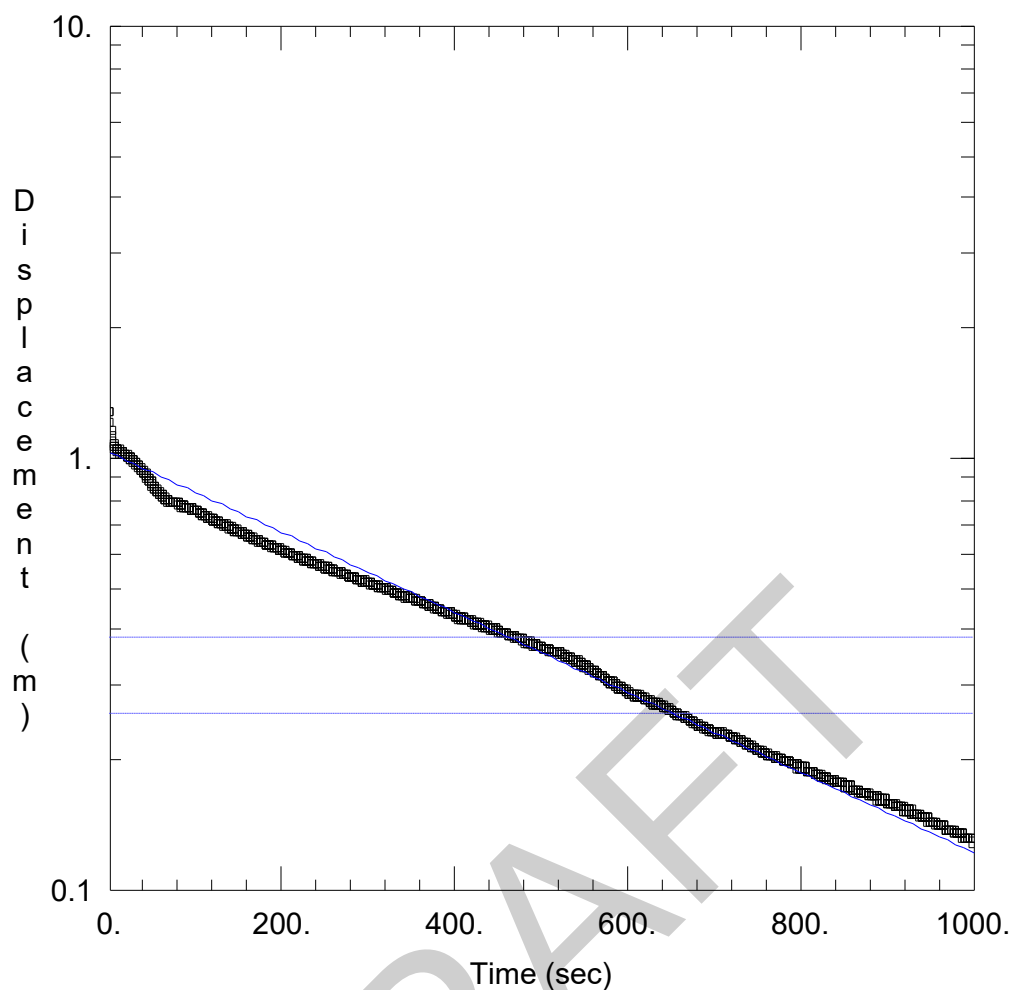
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 7.0E-5$ m/sec

$y_0 = 0.6631$ m



WELL TEST ANALYSIS

Data Set: P:\...\22BH018.aqt

Date: 10/14/22

Time: 09:58:36

PROJECT INFORMATION

Company: Waterline Resources Inc

Client: Urban System

Project: 3319-22-001

Location: NW-21-021-28 W4

Test Date: Sept 2022

AQUIFER DATA

Saturated Thickness: 3.5 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (22BH014)

Initial Displacement: 1.284 m

Static Water Column Height: 0. m

Total Well Penetration Depth: 1.6 m

Screen Length: 1.6 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 2.8E-6 m/sec

y0 = 1.034 m