



MEMO

Date:

August 18, 2021

To:

Randall Doneen, Minnesota Department of Natural Resources

Michele Walker, Minnesota Department of Natural Resources

From:

Bobby Hahn, Enbridge Energy, Limited Partnership

Subject:

Line 3 Replacement Project Uncontrolled Flow MP 910.0 Remedial Action Plan

This memorandum provides additional information requested by the Minnesota Department of Natural Resources ("MDNR") on June 16, 2021, July 14, 2021, August 16, 2021, and August 18, 2021 concerning the uncontrolled flow near milepost ("MP") 910.0 west of the Clearbrook Terminal on Enbridge Energy, Limited Partnership's ("Enbridge's") Line 3 Replacement Project ("L3R" or "Project").

The attached revised Remedial Action Plan prepared by Barr Engineering ("Barr") on behalf of Enbridge describes the plan for installing the second line at this location and the corrective actions to stop the uncontrolled flow. Revisions are noted in red font. This plan has been revised to address the MDNR comments received on August 16, 2021 and August 18, 2021. Enbridge will also prepare and submit a monitoring plan following the implementation of the corrective action to include:

- how the site will be monitored
- frequency of monitoring
- frequency of the submittal of the vibe wire monitoring data to MDNR
- plan for monitoring of the Leon 33 calcareous fen (Steenerson and Deep Lake Fens)

Please do not hesitate to reach out should the MDNR require additional information.

Technical Work Plan – Rev 1

To: Bobby Hahn, Enbridge, Kristin Lenz, Merjent
From: Ray W. Wuolo, PE, PG; Peter M. Demshar, PE. Travis A. Davidsavor, PE, Kevin Eisen, PE
Subject: Clearbrook Uncontrolled Flow Remediation Plan – Revision 1
Date: August 17, 2021

Introduction

This Work Plan provides the proposed steps for sealing artesian flow that developed during excavation for the Line 3 Replacement project at the Enbridge Clearbrook Terminal near Clearbrook, Minnesota. This Work Plan was prepared at the request of Enbridge and is based on currently available data and information on groundwater pressures, stratigraphy, prior construction sequences and procedures, available sealing technology, and uncontrolled flow location and rates.

It is our understanding that uncontrolled surface flows of groundwater under artesian pressures are associated with a pit excavation to install a new pipeline beneath an existing pipeline at the Clearbrook Terminal. Sheet piling was driven to a depth of approximately 28 feet below grade around the proposed excavation to stabilize soils during construction. During excavation, water was pumped from the excavation base from two gravel sumps. The new pipe was installed, the excavation was backfilled with the previously excavated soil, and the sheet piling was removed. Figure 2 depicts the construction information. Groundwater began to flow to the surface in the backfilled area after completion of construction. The flows appear to have caused quick conditions within portions of the backfilled area, resulting in soil piping and enlargement of a hole, which is presently filled with flowing water.

The flowing groundwater is approximately 4,800 feet west-northwest of a calcareous fen wetland complex, as shown on Figure 1. The calcareous fen is likely fed by upwelling groundwater conditions, through confining clays and peat at the fen. The same hydrogeologic conditions that support the fen are likely responsible for the flowing conditions at the excavated area.

Monitoring Data and Hydrogeologic Conditions

Vibrating wire piezometers (VWP) were installed at locations shown on Figure 1. The installation details are presented in Attachment 1. The purpose of these piezometers is to collect groundwater pressure data under current conditions (i.e., uncontrolled artesian flow) and to monitor pressures during and after sealing efforts of the flowing conditions. Boring logs and groundwater level data from the piezometers are summarized in Attachment 1. **The depths and elevations of the piezometers are tabulated in Table 2 of Attachment 1.**

Geologic cross sections are presented in Attachment 1, using data collected from installation of the VWPs and from existing wells and borings installed during previous investigations. These data are interpreted to

show a lower permeability layer of clay and silty clay down to depths of 30 to 50 feet across the Terminal and surrounding area. It is important to note that the confining layer does not appear to be homogeneously comprised of low permeability materials – it is likely variable in thickness and both grain size and hydraulic conductivity characteristics because of the glacial and glacio-fluvial environments in which the materials were deposited. Thin layers of permeable sand may be present within the confining layer and may be connected with other sand or layers of higher hydraulic conductivity to varying degrees.

Below the confining unit is a more permeable sand and gravel aquifer that is generally under artesian pressure (i.e., the hydraulic head is above the ground surface). In the vicinity the fen, it appears that the depth to the confined aquifer is shallower than elsewhere, which may explain why the fen formed in that area (i.e., upwelling groundwater flow has less resistance where the confining layer is thinner).

Artesian flow at the excavation is presently estimated to be approximately 90 gallons per minute. Flow measurements are currently being measured by pumping the water from the uncontrolled flow pool with a submersible pump through a flowmeter. The pump discharge rate is being controlled by a valve and a recirculation loop. To maintain accurate flowrate rates, the pump discharge rate is adjusted to maintain a steady pool elevation.

Preliminary Assessment of Artesian Conditions

In the immediate vicinity of the backfilled excavation, the subsurface conditions are estimated by recent and past geotechnical investigation data to include the following:

- Approximate depth to top of confining layer: 18 feet
- General soil type above the confining layer: variable glacial deposits – clay, silty sand, silt.
- Approximate depth to the bottom of the confining layer: 30 feet
- General soil type of the confining layer: lean clay
- General soil type of the confined aquifer: poorly graded gravel with cobbles
- Ground surface elevation: 1338.8 feet
- Elevation of shallow groundwater: not encountered prior to mud rotary drilling methods
- Elevation of pressurized groundwater (i.e., the confined aquifer): 1347.7 feet
- Head above ground surface of the confined aquifer: 8.9 feet
- Estimated depth of the excavation during construction: 19.5 feet
- Estimated depth of temporary construction sheet piling (now removed): 28 feet

It is understood that the excavation was backfilled with native material that was removed during the initial excavation of the pit.

The working hypothesis of how uncontrolled artesian flow developed is that the excavation reduced the overall thickness of the confining layer within the footprint of the excavation and the backfilled material was not able to compensate for the excess pressure at the base of the confining layer. The confining layer became more permeable in the excavated and thinned condition than in its native (unexcavated) thicker condition. Upward hydraulic pressure from the confined aquifer likely resulted in upward flow through the confining layer and into the initial excavation. Once backfilled, the flow concentrated on a path to the surface. Once flow began, soil piping may have enlarged the preferential flow paths, resulting in loss of effective stress in the backfilled materials. This may have taken place in more than one spot within the backfill.

It is also possible that the sheet piling may have also entirely penetrated into the confined aquifer at one or more spots and when removed, created an upward preferential flow path to the surface.

The excavation depth within the sheet pile perimeter for this pipe was approximately 19 feet, rather than the more typical 8 feet for pipe of this size, because it needed to go underneath an existing shallower pipe at this location. This unusually deep excavation is likely the reason similar flowing conditions may not have been encountered in previous pipe installation in the vicinity of the Clearbrook Terminal.

Proposed Method for Controlling Artesian Flow

Prior to initiation of work activities designed to control the artesian flow, it is recommended that the remaining section of the pipeline be installed, which does not have to be installed underneath other existing pipelines and will have a more routine depth of excavation of 8 feet. This recommendation is based on the following:

- Installation of the remaining shallower section of pipe will allow the work activities associated with controlling the artesian flow to be unincumbered with the additional construction activities associated with mainline construction.
- In the unlikely event that the remaining construction encounters artesian flow, the required specialty contractors will already be on site and able to respond in near real time.

It is unlikely that pressure grouting using low mobility grout, alone, will be effective at controlling the artesian flows at the ground surface because the flow rates and pressures in the confining layer where flow is taking place cannot likely be overcome even by injecting quick-set grout. This has been the experience in somewhat similar settings, such as at Toad River, near Detroit Lakes. However, grouting is a reliable remedy if the upward pressures in the confining unit and the underlying confined aquifer can be substantially reduced. Therefore, installing a multi-cased, temporary high-capacity dewatering well to temporarily reduce confined aquifer pressures is required. The wells would be constructed to pump from the underlying confined aquifer adjacent to the excavation area with pumping of these wells at a rate

sufficient to (1) temporarily stop flow at the ground surface and (2) reduce upward pressures in the confined aquifer to a level that will allow for grout to be injected and set, allowing sealing of existing flow paths.

The temporary high-capacity wells are proposed to be drilled near the recently installed pipeline and as close to the main groundwater surface flow zone as practical, while maintaining sufficient distance to not pull placed grout into the well screen. Approximate locations are shown in Attachment 2. The temporary high-capacity dewatering wells are proposed to have the following general characteristics:

- Installed through two casings. The outer casing will be drilled to approximately 10 feet above the top of the confined aquifer and grouted in place. An inner casing will then be advanced into the confined aquifer. The borehole will be advanced approximately 20 feet into the confined aquifer and a 10-foot screen will be installed. The screen and inner casing will have a diameter of 8-12 inches to accommodate a temporary high-capacity submersible pump.
- The temporary submersible pump will be capable of pumping at a sustained rate sufficient to lower the piezometric head in the confined aquifer to the bottom of the confining unit in the immediate vicinity of the wells. This may require pumping rates in excess of 1,000 gpm over short periods of time.
- The screened portion of the wells will be sufficiently deep to prevent placed grout from being pumped into the wells.
- The wells and pump system will be designed to prevent flow up the casing to the ground surface when not pumped.
- Pumped water will be discharged via a temporary discharge line to dewatering structure(s) sited and designed in accordance with Enbridge's Environmental Protection Plan and applicable permits and certifications. This water should be essentially free of sediment due to the artesian aquifer source. Potential dewatering locations are shown on Figure 1.
- Final well construction details will be determined in consultation with the experience and licensed well drilling contractor, who will be selected on the basis of their experience in undertaking similar projects within the region. The drilling contractor may opt for different casing diameters, depths, etc., but with the overall intent of installing wells that will not, itself, become a conduit for groundwater flow and will accomplish the task of depressurizing the confined aquifer at the excavation while not becoming unusable during grout placement.

Surface flows should cease soon after depressurization pumping begins. Pressure and/or permeation grouting through injection points will commence while pumping continues using a quick-set grout. Grouting will focus on the bottom of the confining layer and the gravel unit underlying the confining layer, below the excavation in the area identified in Attachment 2 with the intent of augmenting the existing undisturbed confining layer to reduce and finally stop flow.

Actual site conditions encountered during the grouting process will dictate final grouting methods and locations of the injection points. However, based on site visits and follow-up discussions with the specialty grouting contractor (Keller Group – Hayward Baker) a permeation grouting method will be implemented and is expected to require approximately 400, 2-inch diameter, sleeve-port grout pipes, installed in a 3 ft equilateral triangle spacing. The anticipated effective radius of treatment of each injection point is 18-24 inches. Additional intermediary injection points may be required as the grouting process is underway.

If the permeation grouting is not completely effective and pressure grouting is pursued, Keller anticipates that 8 ft diameter "columns" may be required. Installation details, including the injection point spacing and location(s) will be dependents on the effectiveness of the permeation grouting.

Grouting will take place in the lower portion of the confining layer and the upper portion of the confined unit in order to fill aquifer void volume and connected sand seams (if present). The grouting will be performed over the identified area using a series of drilled injection points and staged injection elevations. When the grout has had sufficient time to set, the pumping rate of the well will be reduced, and areas of remaining flowing conditions will be identified and marked. The well pumping rates will be increased, and these identified areas will be grouted with additional phases of grout placement. This process will be repeated until all flow at the surface is stopped. Once the surface flows have been stopped, the pumping of the dewatering wells will cease. A 48-hour period will begin and conditions at the surface will be observed. If surface seepage is identified, pumping of the dewatering wells will recommence and those areas with surface flows will be grouted with additional phases.

After a 48-hour period has elapsed without any visible surface flows, the temporary pumps will be removed, and the wells will be shut-in. The temporary dewatering wells will not be abandoned for a period of at least one year if seepage at the surface is observed at a later date or that maintenance work to the pipeline is required.

Monitoring and Reporting

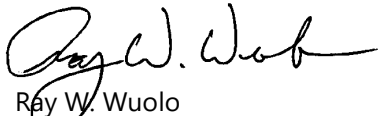
Flow rates of the high-capacity pumps in the wells will be recorded using **one or more** totalizing flow meters. Water levels and water pressures will be monitored in the existing monitoring wells and VWP's during pumping and sealing of the surface seeps. Surface returns of grout, if any, will be noted during grouting and will be contained. Quantities of grout pumped will be recorded.

A memo on the sealing process will be prepared and submitted to the Minnesota DNR upon completion of the grouting program and will include monitoring data.

To: Bobby Hahn, Enbridge, Kristin Lenz, Merjent
From: Ray W. Wuolo, PE, PG; Peter M. Demshar, PE, Travis A. Davidsavor, PE, Kevin Eisen, PE
Subject: Clearbrook Uncontrolled Flow Remediation Plan – Revision 1
Date: August 17, 2021
Page: 6

A monitoring plan will be developed and submitted following the corrective action(s) taken at the site. The monitoring plan will include information on how, where, and how often the area will be visually monitored for breakthrough groundwater discharges. Additionally, the monitoring plan will identify how frequently the vibrating wire data from the piezometers will be processed, analyzed, and reported to the Minnesota DNR. The monitoring plan will also include the methodology to assess the health of the nearby calcareous fen near Steenerson and Deep Lakes.

Sincerely,



Ray W. Wuolo
Vice President/Senior Hydrogeologist

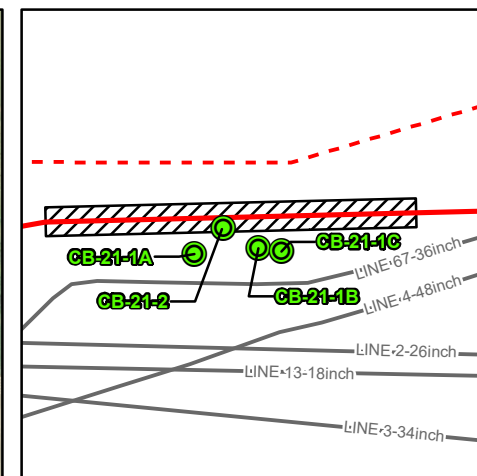
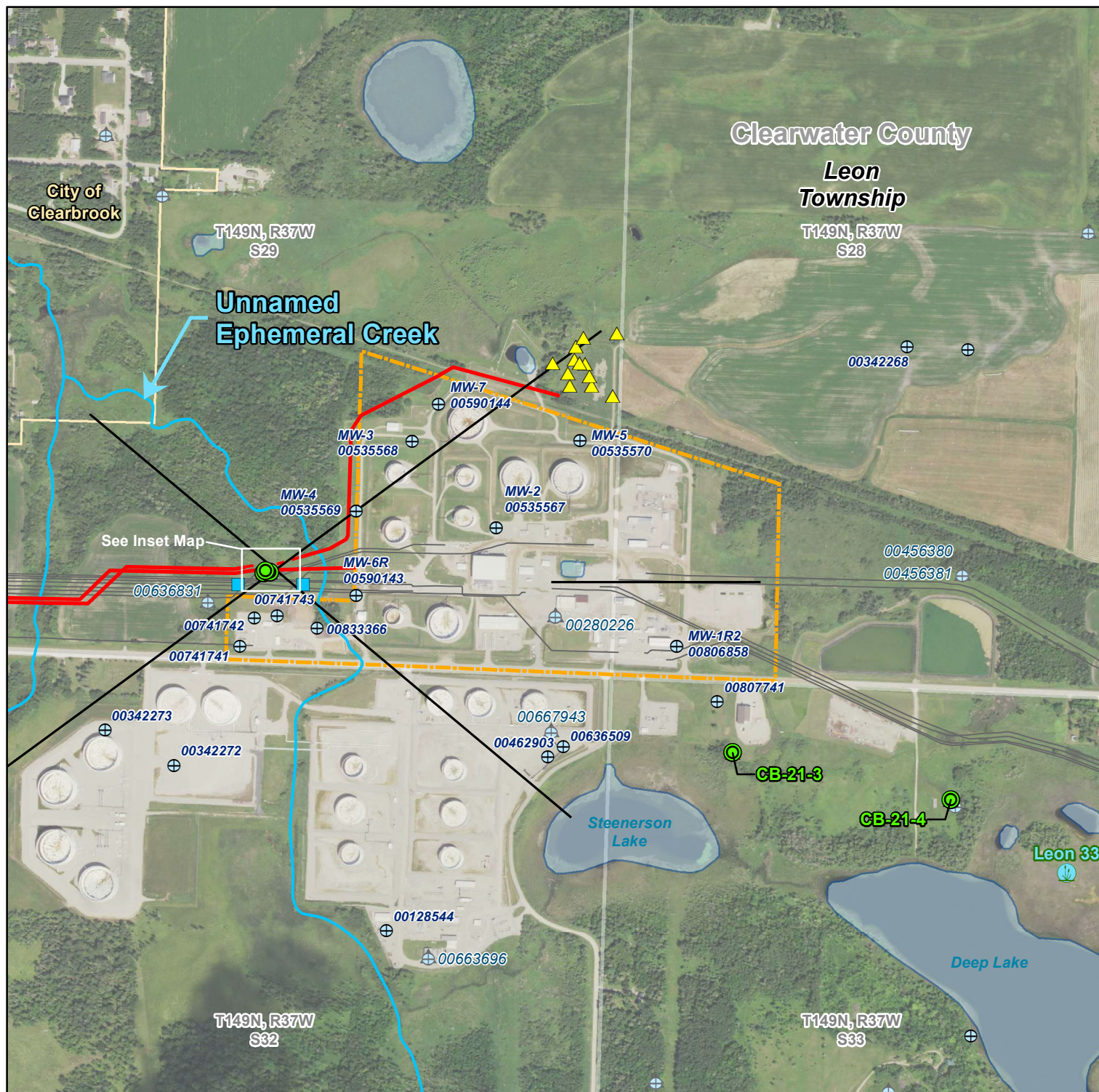
Figures

- Figure 1 Completed Boring Locations
Figure 2 Clearbrook MP910 Excavation Detail

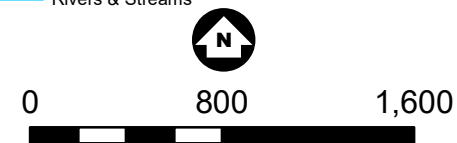
Attachments

- Attachment 1 Clearbrook Groundwater Investigation Data Submittal
Attachment 2 Preliminary Grouting Plan

Figures



- Completed Boring Locations
- Excavation/Trench Box
- ▲ Previous Geotechnical Exploration Locations (Completed by Barr)
- Potential Dewatering Location
- ⊕ Wells - Minnesota Well Index
- ⊕ Unverified Well - Minnesota Well Index
- Constructed Line 3 Replacement
- - - Line 3 Replacement (Not Constructed)
- Enbridge Pipelines
- Cross Sections
- - - Terminal Property Boundary
- Calcareous Fen Location
- Rivers & Streams



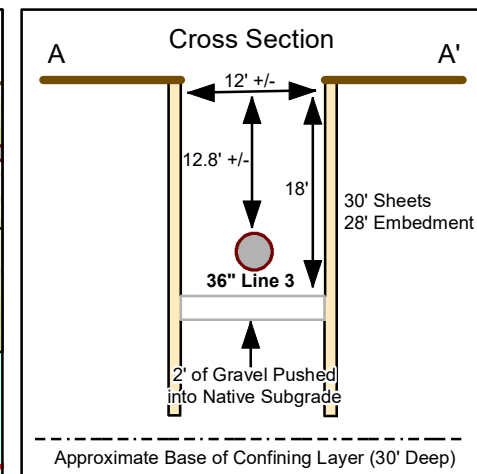
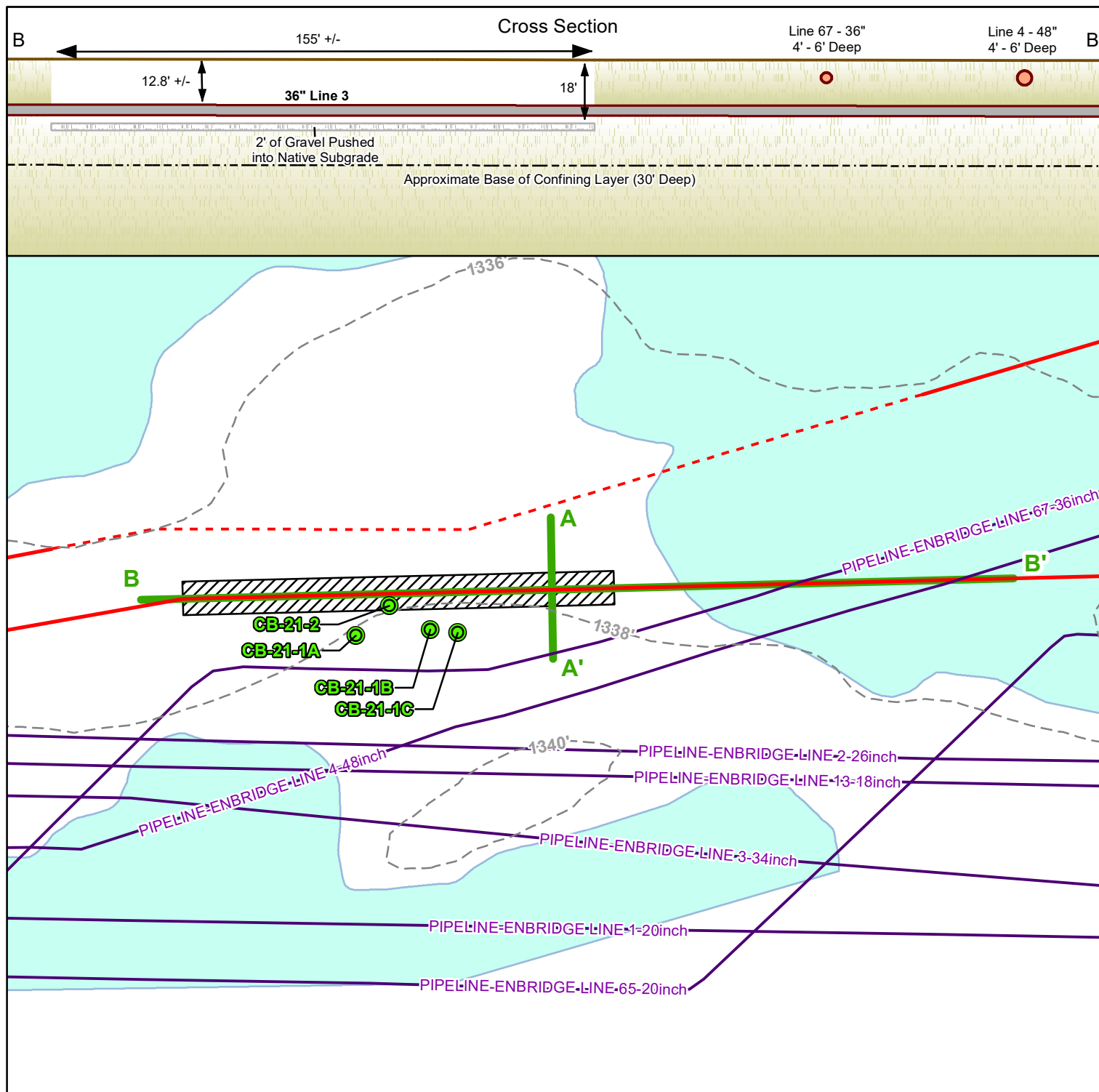
Feet

1 Inch = 800 Feet

Figure 1

**CLEARBROOK
COMPLETED BORING LOCATIONS**
Clearbrook Terminal
Enbridge Energy, L.P.
Clearbrook, Minnesota





- Completed Boring Locations
- ▨ Excavation/Trench Box
- Excavation Cross Section
- Constructed Line 3 Replacement
- - - Line 3 Replacement (Not Constructed)
- Enbridge Pipelines
- - - Lidar Contours (2-Foot)
- Surveyed Wetlands

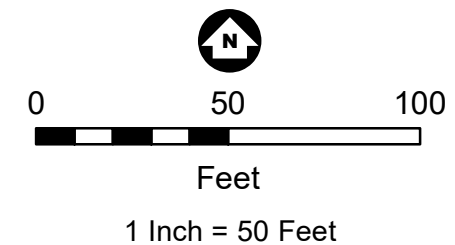


Figure 2

CLEARBROOK
MP910.0 EXCAVATION DETAIL
 Clearbrook Terminal
 Enbridge Energy, L.P.
 Clearbrook, Minnesota



Attachments

Attachment 1

Clearbrook Groundwater Investigation Data Submittal

Memorandum

To: Minnesota Department of Natural Resources
From: Peter Demshar (PE) and Ray Wuolo, PE, PG (Barr)
Subject: Clearbrook Groundwater Investigation Data Submittal - Revision 1
Date: August 17, 2021
Project: Line 3 Replacement Project

Barr Engineering Co. (Barr), under contract with Enbridge Energy, Limited Partnership (Enbridge), completed a geotechnical investigation in support of the proposed Line 3 Replacement (L3R) pipeline near the Clearbrook Terminal in Clearbrook, Minnesota. The purpose of this memorandum is to provide the results of the recently completed investigation and out interpretation of the subsurface soil and groundwater conditions.

Six rotosonic borings were performed to investigate the subsurface soil and ground water conditions. The boring locations were submitted to the MDNR on July 10, 2021 and the MDNR approved these locations on July 12, 2021 and July 29, 2021 (for wells CB-21-3 and CB-21-4), indicated on Figure 1. The coordinates and elevations for the boring locations, provided by the project surveyor Northwestern Surveying & Engineering, Inc. of Bemidji, Minnesota, are shown in Table 1 below:

Table 1 Boring Summary

Borehole ID	Northing (ft)	Easting (ft)	Elevation (ft)
CB-21-1A	770502.8	2054029.1	1338.9
CB-21-1B	770505.0	2054055.8	1338.8
CB-21-1C	770503.8	2054065.5	1338.9
CB-21-2	770513.5	2054041.1	1338.9
CB-21-3	769474.1	2056718.5	1353.3
CB-21-4	769204.4	2057970.3	1359.7

Coordinate system FIPS 2201
Minnesota State Plane North, Datum NAD83

The rotosonic borings were completed with equipment owned and operated by Traut Companies (Traut) of Waite Park, Minnesota using a track mounted drill rig. The borings were advanced using a variety of drilling techniques including rotosonic drilling where 8-inch diameter surface casing was installed and a 6-inch outer casing with a 4-inch diameter sampler was used to advance the boring beyond the depth of the surface casing. Additionally, 4 7/8-inch and 3 7/8-inch tricone mud rotary techniques with standard split spoon (SPT) sampling was completed for borings CB-21-1A, CB-21-1B, and CB-21-2 for depths below the surface casing. Because of the potential for pressurized groundwater conditions, the borings were completed using heavy (weighted) drilling mud. To evaluate the presence of confining layers, rotosonic

and SPT sampling was completed continuously to semi-continuously throughout the depths of all borings.

Subsurface Conditions

The results of the geotechnical soil borings were compiled to obtain an understanding of the lithology and groundwater hydrogeology of the study area. Boring logs can be found in Attachment 1. The existing soil conditions generally consist of fill to depths of 2.5 to 13 feet (elevation 1336.3 to 1325.8 feet) for borings CB-21-1 (A,B,C) and CB-21-2. The fill is underlain by lean (CL) to fat (CH) clay with varying amounts of sand to an approximate depth of 29.7 feet (elevation 1309.1) where gravel was encountered. For borings CB-21-3 and CB-21-4 the soil conditions generally consist of lean clay (CL) underlain by poorly graded sand (SP) and well graded gravel (GW) throughout the depths of the soil borings. However, a poorly graded sand layer was encountered much shallower in CB-21-4 than CB-21-3 at elevation 1344.2 and 1313.1 feet, respectively. A geologic cross section representing the stratigraphy in the region is shown in Figure 2.

Groundwater was not observed in any of the geotechnical borings due to the drilling technique which utilizes a drilling fluid to advance the casing and sampling tools.

Instrumentation

Vibrating wire piezometers were installed in all borings at various depths as indicated in Table 2.

Table 2 Vibrating Wire Piezometer Summary

Piezometer ID	Serial Number	Installation Depth (ft)	Installation Elevation (ft)	Data Location
CB-21-1A-B ¹	1930856	32.7	1306.2	Attachment 3-A
CB-21-1A-T ²	2003965	30.7	1308.2	NA ³
CB-21-1B ¹	1912958	23.3	1315.5	Attachment 3-A
CB-21-1C ¹	1912959	19.4	1319.5	Attachment 3-A
CB-21-2-B ²	2134224	18.4	1320.5	Attachment 3-B
CB-21-2-T ²	2134696	13.4	1325.5	Attachment 3-B
CB-21-3 ²	2003966	42.4	1309.2	Attachment 3-C
CB-21-4-B ²	2134222	44.9	1314.8	Attachment 3-D
CB-21-4-T ²	2129043	17.9	1341.8	Attachment 3-D

1. Vibrating wire piezometer connected to automated logger

2. Vibrating wire piezometer connected to Geokon LC2x4 logger for manual data collection

3. Vibrating wire piezometer installed as backup. Not reported at this time.

Nested vibrating wire piezometers were installed in CB-21-1A, CB-21-2, and CB-21-4 prior to abandonment while single vibrating wire piezometers were installed in CB-21-1B, CB-21-1C, and CB-21-3. All boreholes were backfilled with neat cement grout and bentonite slurry upon completion of drilling, in accordance with Minnesota Department of Health (MDH) requirements. Piezometer locations and

associated depths/elevations are also shown on the attached Instrumentation Logs provided in Attachment 2.

A fully automated monitoring system was installed following piezometer installation to provide near-real-time monitoring of instrumentation at 15-minute intervals for the piezometers indicated in Table 2. Geokon LC2x4 dataloggers were installed at locations identified in Table 2 to provide data collection on 15-minute intervals with data collected manually from the logger at regular intervals. A weather station was also installed in order to evaluate vibrating wire piezometer data with associated rain events and barometric pressure changes.

Results of the vibrating wire piezometer data indicate that pressurized groundwater conditions are present at the site. The vibrating piezometers installed CB-21-1A-B, CB-21-3, and CB-21-4-T all show piezometric heads above the ground surface at the boring locations. CB-21-1B, CB-21-2-T, and CB-21-2B indicate piezometric heads very near the ground surface. CB-21-1C and CB-21-4-B both indicate that the piezometers are dry and are not showing any piezometric head acting on the sensor. Data from all installed piezometers are shown in Attachment 3.

Figures

Figure 1 Clearbrook Completed Boring Locations

Figure 2 Clearbrook Geologic Cross Section

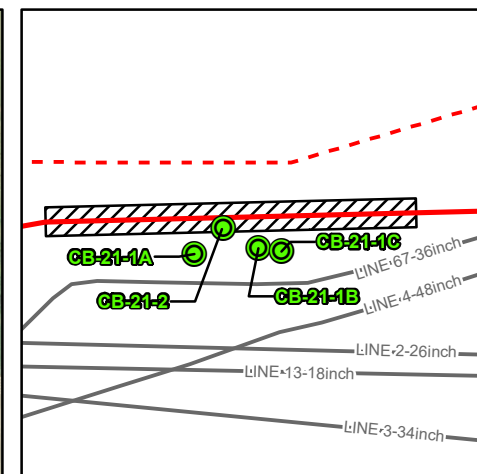
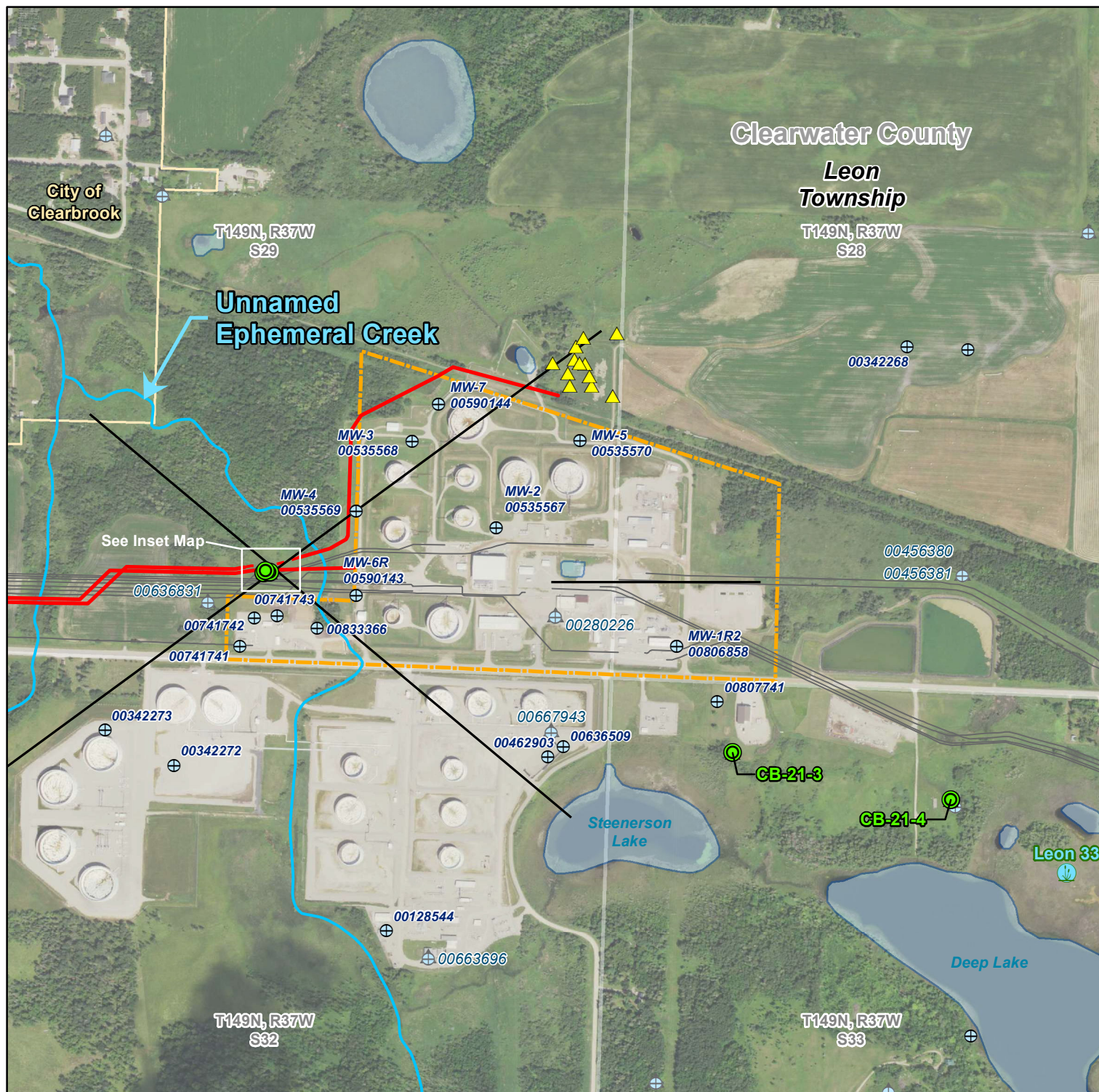
Attachments

Attachment 1 Soil Boring Logs

Attachment 2 Instrumentation Logs

Attachment 3 Vibrating Wire Piezometer Data

Figures



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- Excavation/Trench Box
- ▲ Previous Geotechnical Exploration Locations (Completed by Barr)
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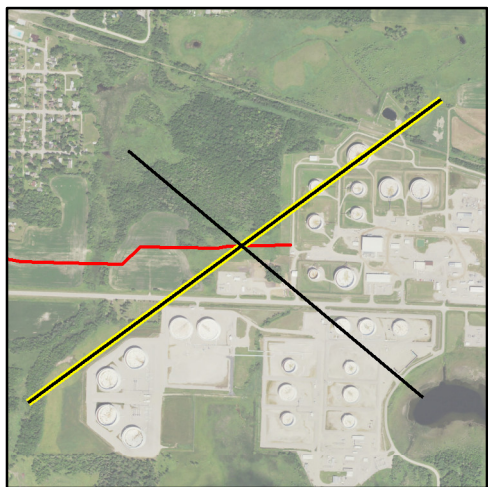
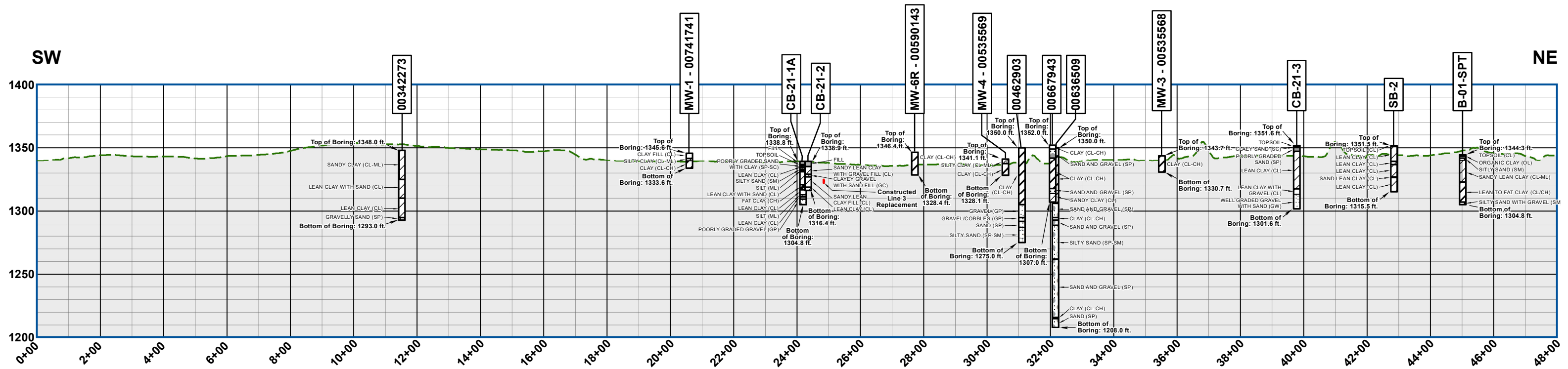
Feet

1 Inch = 800 Feet

Figure 1

**CLEARBROOK
COMPLETED BORING LOCATIONS**
Clearbrook Terminal
Enbridge Energy, L.P.
Clearbrook, Minnesota





NOTE:
Topographic information depicted based on MnTOPO LiDAR elevation data.

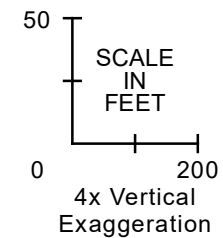
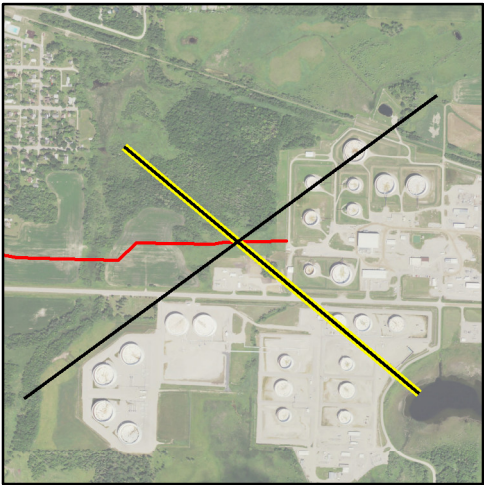
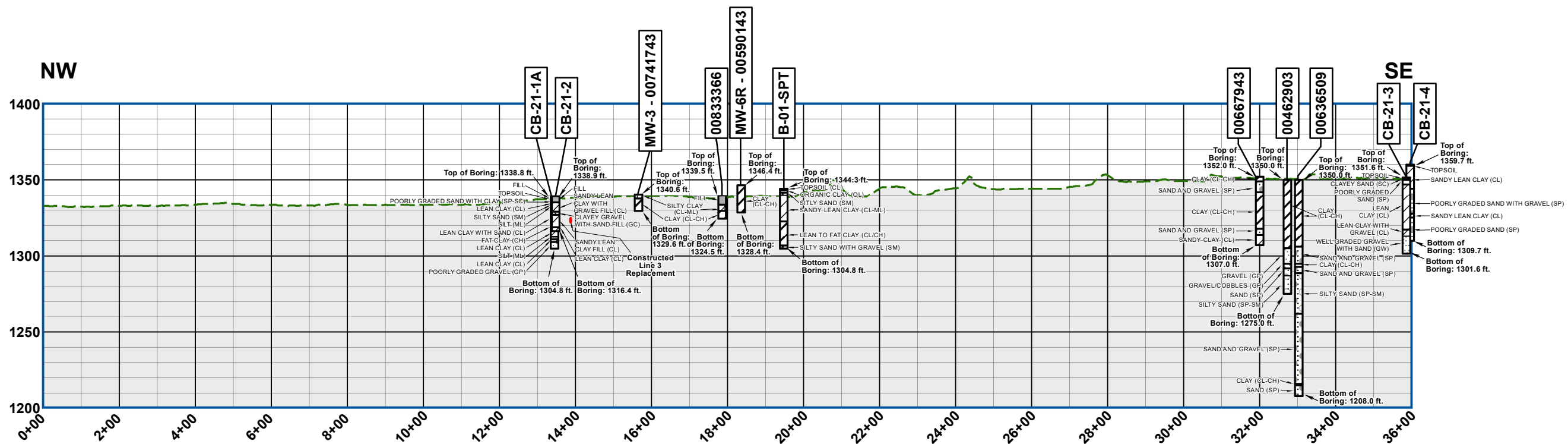


Figure 2-1
**CLEARBROOK TERMINAL
STRATIGRAPHY
RUNNING SW- NE**
Enbridge Energy, L.P.
Clearbrook, Minnesota





NOTE:
Topographic information depicted based on MnTOPO LiDAR elevation data.

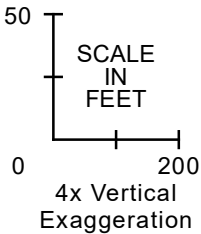


Figure 2-2
**CLEARBROOK TERMINAL
STRATIGRAPHY
RUNNING NW - SE**
Enbridge Energy, L.P.
Clearbrook, Minnesota



Attachments

Attachment 1

Soil Boring Logs

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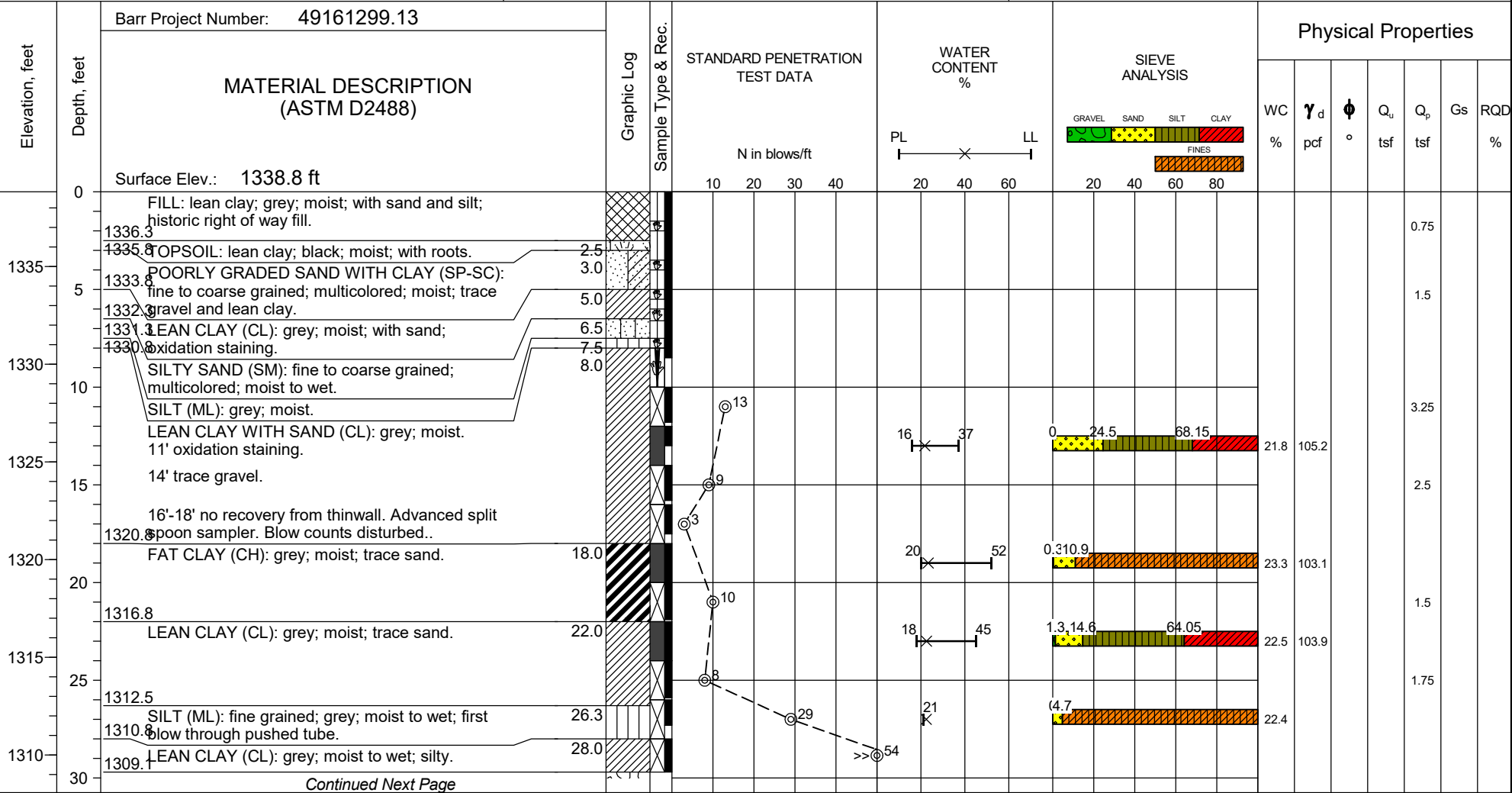


Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING CB-21-1A

Sheet 1 of 2

Project:	L3 Replacement - Clearbrook GIP	Location:	Clearbrook, MN	Client:	Enbridge
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Continued Next Page

Completion Depth:	34.0	Remarks: Boring was advanced from 0 to 10' with a 4" diameter rotasonic core barrel and 6" diameter override casing. The boring was then cased to 11' with 8" diameter steel casing. The boring was completed through the casing to 34' using mud rotary drilling methods and a 4-7/8" diameter tricone and NW drill rod. Drilling mud was approximately 15.2 PPG.		
Date Boring Started:	7/27/21			
Date Boring Completed:	7/30/21			
Logged By:	PMD/JEE			
Drilling Contractor:	Traut; Coleman Engineering			
Drilling Method:	Rotosonic; mud rotary			
Ground Surface Elevation:	1338.822			
Coordinates:	N 770,503.0 ft E 2,054,029.0 ft			
Datum:	MN State Plane N, NAD83, NAVD88			
		SAMPLE TYPES		WATER LEVELS (ft)
		ROTASONIC SOIL CORE		At Time of Drilling Not encountered prior to mud rotary
		GRAB SAMPLE		
		SPLIT SPOON		
		3-inch Shelby Tube		
				LEGEND
		MC Moisture Content		Q_u Unconfined Compression
		γ_d Dry Unit Weight		Q_p Hand Penetrometer UC
		ϕ Friction Angle		Gs Specific Gravity
				RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

O:\GINT\PROJECTS\49161299\LINE 3 REPLACEMENT GEOTECH SURVEY\49161299.13 L3 CLEARBROOK GIP.GPJ BARR\LIBRARY\GLB HORIZONTAL LOG REPORT - BARR GEOTECH TEMPLATE.GDT



Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING CB-21-1A

Sheet 2 of 2

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge																
Elevation, feet	Depth, feet	Barr Project Number: 49161299.13		Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA				WATER CONTENT %		SIEVE ANALYSIS				Physical Properties						
		MATERIAL DESCRIPTION (ASTM D2488)				N in blows/ft				PL LL		GRAVEL SAND SILT CLAY FINES				WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
1305	30	POORLY GRADED GRAVEL (GP): coarse grained; grey; moist; apparent cobble from 29.7'-32'. (Continued)		29.7'																		
	34.0	Bottom of Boring at 34.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers		34.0																		
	35																					
	40																					
	45																					
	50																					
	55																					
	60																					
Completion Depth:		34.0		Remarks: Boring was advanced from 0 to 10' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 11' with 8" diameter steel casing. The boring was completed through the casing to 34' using mud rotary drilling methods and a 4-7/8" diameter tricone and NW drill rod. Drilling mud was approximately 15.2 PPG.																		
Date Boring Started:		7/27/21																				
Date Boring Completed:		7/30/21		SAMPLE TYPES				WATER LEVELS (ft)				LEGEND										
Logged By:		PMD/JEE		<input type="checkbox"/> ROTASONIC SOIL CORE <input checked="" type="checkbox"/> GRAB SAMPLE <input checked="" type="checkbox"/> SPLIT SPOON				<input checked="" type="checkbox"/> At Time of Drilling <input type="checkbox"/> Not encountered prior to mud rotary				MC Moisture Content γ_d Dry Unit Weight ϕ Friction Angle Q_u Unconfined Compression Q_p Hand Penetrometer UC Gs Specific Gravity RQD Rock Quality Designation										
Drilling Contractor:		Traut; Coleman Engineering																				
Drilling Method:		Rotasonic; mud rotary																				
Ground Surface Elevation:		1338.822																				
Coordinates:		N 770,503.0 ft E 2,054,029.0 ft																				
Datum:		MN State Plane N, NAD83, NAVD88																				

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF BORING CB-21-1B

Sheet 1 of 1

Project: L3 Replacement - Clearbrook GIP				Location: Clearbrook, MN				Client: Enbridge										
Elevation, feet	Depth, feet	Barr Project Number: 49161299.13		Graphic Log Sample Type & Rec.	STANDARD PENETRATION TEST DATA N in blows/ft		WATER CONTENT %		SIEVE ANALYSIS		Physical Properties							
		MATERIAL DESCRIPTION (ASTM D2488)									WC	γ_d	ϕ	Q_u	Q_p	Gs	RQD	
		Surface Elev.: 1338.8 ft											%	pcf	°	tsf	tsf	
	0	FILL: lean clay; grey; moist to wet; trace wood debris; trace sand and gravel.																
1335	5	4.5' black fibrous organics; organic smell.																
		5'-7' increased sand.																
1330		5'-10' very soft.																
	10																	
1325	1325.8	LEAN CLAY (CL): grey; with redish-brown mottle; moist to wet; trace sand.																
	15	16.3' thinwall attempted with no recovery; then attempted split spoon with no recovery.																
1320	20	21.8' - 3" sand seam.																
1315	25	24.3' thinwall attempted with no recovery.																
	1312.5	Bottom of Boring at 26.3 feet Abandoned with neat cement grout; Installed vibrating wire piezometers																
	30																	
Completion Depth:		26.3		Remarks: Boring was advanced from 0 to 15' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 16" with 8" diameter steel casing. The boring was completed through the casing to 26.3' using mud rotary drilling methods with a 4-7/8" diameter tricone and NW drill rod. Drilling mud was approximately 15.2 PPG.														
Date Boring Started:		7/29/21		SAMPLE TYPES					WATER LEVELS (ft)					LEGEND				
Date Boring Completed:		8/1/21												Q_u Unconfined Compression				
Logged By:		PMD/JEE												γ Dry Unit Weight				
Drilling Contractor:		Traut; Coleman Engineering												ϕ Friction Angle				
Drilling Method:		Rotosonic; mud rotary												Q_p Hand Penetrometer UC				
Ground Surface Elevation:		1338.764												Gs Specific Gravity				
Coordinates:		N 770,505.0 ft E 2,054,056.0 ft												RQD Rock Quality Designation				
Datum:		MN State Plane N, NAD83, NAVD88																

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF BORING CB-21-1C

Sheet 1 of 1

Project: L3 Replacement - Clearbrook GIP				Location: Clearbrook, MN				Client: Enbridge														
Elevation, feet	Depth, feet	Barr Project Number: 49161299.13		Graphic Log Sample Type & Rec.	STANDARD PENETRATION TEST DATA		WATER CONTENT %		SIEVE ANALYSIS		Physical Properties											
		MATERIAL DESCRIPTION (ASTM D2488)			N in blows/ft	PL	LL	GRAVEL	SAND	SILT	CLAY	FINES	WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	G_s	RQD %			
		Surface Elev.: 1338.9 ft																				
	0	FILL: lean clay; grey to tan to redish-brown; moist; trace vegetation and grass; trace sand and gravel. 2' black organic seam.			10	20	30	40														
1335	5																					
1330	7.0	LEAN CLAY (CL): grey to tan to redish-brown; moist; stiff; trace rounded gravel; trace to with sand.								19	45		1	19		22.3	104			2		
	10																			2.5		
																				3		
1325	15																			3.5		
1320	20	1318.1								19	49		2.1	113.3		23.3	102.8					
		1317.4 CLAYEY SAND (SC): fine to medium grained; grey; moist.																				
		1317.1																				
		LEAN CLAY (CL): grey; moist; trace sand.																				
	21.8	Bottom of Boring at 21.8 feet Abandoned with neat cement grout; Installed vibrating wire piezometers																				
	25																					
	30																					
Completion Depth:		21.8		Remarks: Boring was advanced from 0 to 10' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 11' with 8" diameter steel casing. The boring was completed through the casing to 21.8' using mud rotary drilling methods and a 4-7/8" diameter tricone and NW drill rod. Drilling mud was approximately 15.2 PPG.																		
Date Boring Started:		7/30/21																				
Date Boring Completed:		8/2/21																				
Logged By:		PMD/JEE																				
Drilling Contractor:		Traut; Coleman Engineering																				
Drilling Method:		Rotosonic; mud rotary		SAMPLE TYPES				WATER LEVELS (ft)				LEGEND										
Ground Surface Elevation:		1338.923		<div>ROTOSONIC SOIL CORE</div> <div>GRAB SAMPLE</div> <div>SPLIT SPOON</div>				<div>At Time of Drilling</div>				<div>MC Moisture Content</div> <div>γ Dry Unit Weight</div> <div>ϕ Friction Angle</div> <div>Q_u Unconfined Compression</div> <div>Q_p Hand Penetrometer UC</div> <div>G_s Specific Gravity</div> <div>RQD Rock Quality Designation</div>										
Coordinates:		N 770,504.0 ft E 2,054,066.0 ft		<div>3-inch Shelby Tube</div>																		
Datum:		MN State Plane N, NAD83, NAVD88																				

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF BORING CB-21-2

Sheet 1 of 1

Project: L3 Replacement - Clearbrook GIP			Location: Clearbrook, MN			Client: Enbridge														
Elevation, feet	Depth, feet	Barr Project Number: 49161299.13		Graphic Log Sample Type & Rec.	STANDARD PENETRATION TEST DATA		WATER CONTENT %		SIEVE ANALYSIS		Physical Properties									
		MATERIAL DESCRIPTION (ASTM D2488)			N in blows/ft	PL	LL	GRAVEL	SAND	SILT	CLAY	WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %		
	0	Surface Elev.: 1338.9 ft			10	20	30	40												
		FILL: lean clay; grey; moist; with grass; historic trench fill.																		
1335		1334.9																		
	5	FILL: sandy lean clay with gravel; grey; wet.																		
		SS through 3T sample.																		
1330		1328.9																		
	10	8'-10' and 10'-12' thinwall samples attempted with little recovery; drove split spoon sampler; SPT N-values disturbed.																		
		1326.9																		
		FILL: clayey gravel with sand; grey; moist to wet. 10' lost return.																		
1325		1326.9																		
	15	FILL: sandy lean clay; grey; moist; trace gravel. 12' Mud return started again.																		
		17.5' thinwall attempted with no recovery; drove split spoon sampler; SPT N-values disturbed.																		
1320		1318.9																		
	20	LEAN CLAY (CL): grey; moist; trace sand.																		
		1316.4																		
	25	Bottom of Boring at 22.5 feet Abandoned with neat cement grout; Installed vibrating wire piezometers																		
Completion Depth:		22.5		Remarks: Boring was advanced from 0 to 22.5' using mud rotary drilling methods and a 4-7/8" diameter tricone with NW drill rod. Drilling mud was approximately 14.9 PPG.																
Date Boring Started:		8/2/21																		
Date Boring Completed:		8/3/21																		
Logged By:		PMD																		
Drilling Contractor:		Coleman Engineering																		
Drilling Method:		Mud Rotary																		
Ground Surface Elevation:		1338.933																		
Coordinates:		N 770,513.5 ft E 2,054,041.1 ft																		
Datum:		MN State Plane N, NAD83, NAVD88																		
SAMPLE TYPES				WATER LEVELS (ft)				LEGEND												
SPLIT SPOON				At Time of Drilling not encountered prior to mud rotary				MC Moisture Content γ Dry Unit Weight ϕ Friction Angle Q_u Unconfined Compression Q_p Hand Penetrometer UC Gs Specific Gravity RQD Rock Quality Designation												

The stratification lines represent approximate boundaries. The transition may be gradual.

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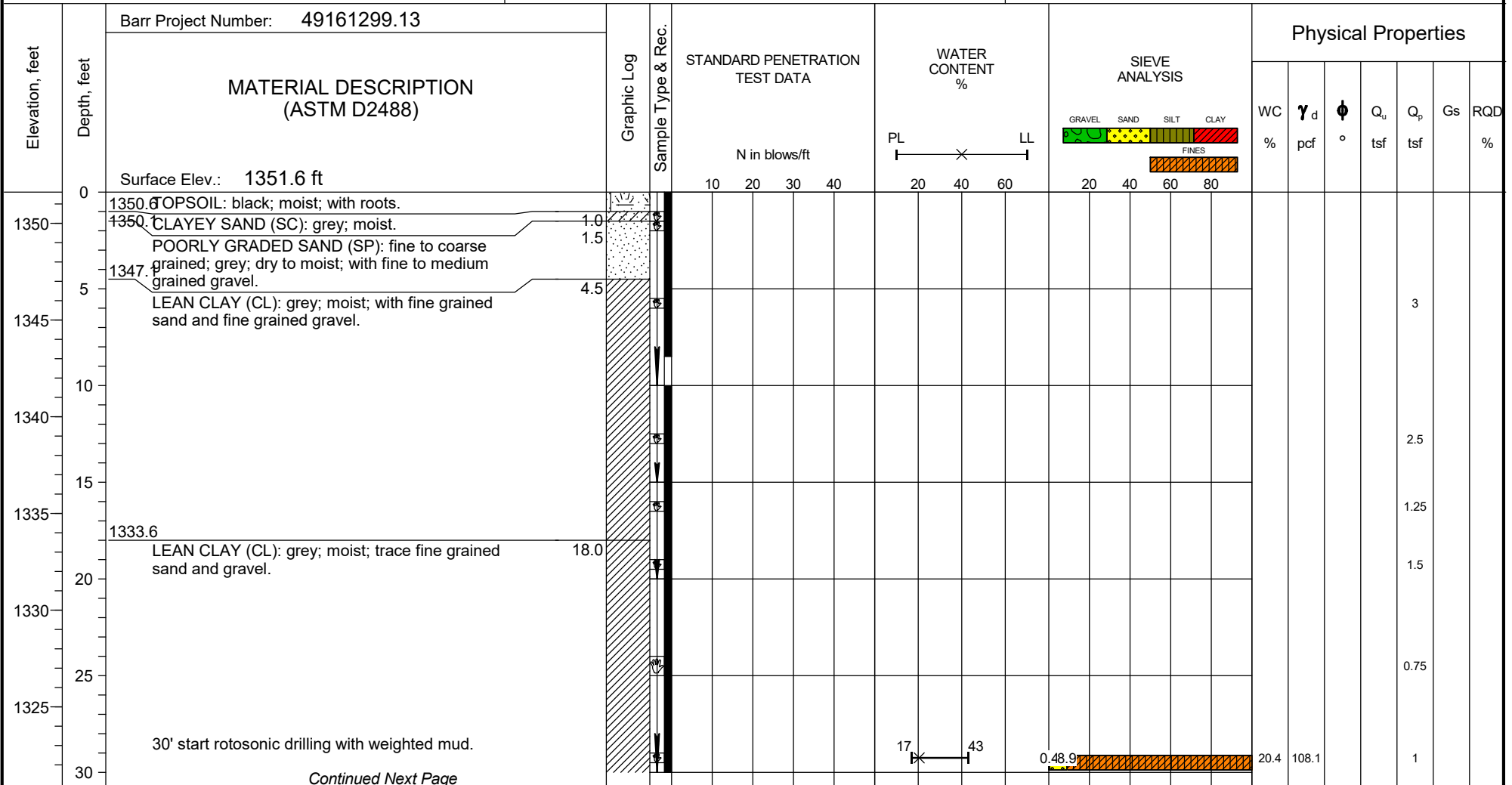
LOG OF BORING CB-21-3

Sheet 1 of 2

Project: L3 Replacement - Clearbrook GIP

Location: Clearbrook, MN

Client: Enbridge



Completion Depth: 50.0
Date Boring Started: 7/27/21
Date Boring Completed: 8/3/21
Logged By: PMD/JEE
Drilling Contractor: Traut
Drilling Method: Rotasonic
Ground Surface Elevation: 1351.614
Coordinates: N 769,474.0 ft E 2,056,719.0 ft
Datum: MN State Plane N, NAD83, NAVD88

Remarks: Boring was advanced from 0 to 15' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 16' with 8" diameter steel casing. The boring was then completed through the casing to 50' using roto sonic drilling methods. Drilling mud was approximately 13 PPG.

SAMPLE TYPES		WATER LEVELS (ft)		LEGEND	
ROTASONIC	GRAB SAMPLE	At Time of Drilling	not encountered prior to drilling with mud	MC Moisture Content	Q_u Unconfined Compression
SOIL CORE				γ Dry Unit Weight	Q_p Hand Penetrometer UC
				ϕ Friction Angle	Gs Specific Gravity
					RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF BORING CB-21-3

Sheet 2 of 2

Project: L3 Replacement - Clearbrook GIP				Location: Clearbrook, MN				Client: Enbridge																
Elevation, feet	Depth, feet	Barr Project Number: 49161299.13		Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA				WATER CONTENT %				SIEVE ANALYSIS				Physical Properties						
		MATERIAL DESCRIPTION (ASTM D2488)																WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	30	LEAN CLAY (CL): grey; moist; trace fine grained sand and gravel. (Continued)																						
1320		1317.6																						
	35	LEAN CLAY WITH GRAVEL (CL): grey; moist; trace sand.		34.0																				
1315		1313.1																						
	40	WELL GRADED GRAVEL WITH SAND (GW): fine to coarse grained; grey to tan; moist; trace 3-4" cobbles.		38.5																				
1310		Sieve on composite sample from 42' and 47'.																						
	45																							
1305																								
	50	1301.6	Bottom of Boring at 50.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers		50.0																			
	55																							
	60																							
Completion Depth:		50.0		Remarks: Boring was advanced from 0 to 15' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 16' with 8" diameter steel casing. The boring was then completed through the casing to 50' using roto sonic drilling methods. Drilling mud was approximately 13 PPG.																				
Date Boring Started:		7/27/21																						
Date Boring Completed:		8/3/21		SAMPLE TYPES				WATER LEVELS (ft)				LEGEND												
Logged By:		PMD/JEE		ROTOSONIC GRAB				At Time of Drilling not encountered prior to drilling with mud				<div>MC Moisture Content</div> <div>γ_d Dry Unit Weight</div> <div>ϕ Friction Angle</div> <div>Q_u Unconfined Compression</div> <div>Q_p Hand Penetrometer UC</div> <div>Gs Specific Gravity</div> <div>RQD Rock Quality Designation</div>												
Drilling Contractor:		Traut		SOIL CORE SAMPLE																				
Drilling Method:		Rotosonic																						
Ground Surface Elevation:		1351.614																						
Coordinates:		N 769,474.0 ft E 2,056,719.0 ft																						
Datum:		MN State Plane N, NAD83, NAVD88																						

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF BORING CB-21-4

Sheet 1 of 2

Project:	L3 Replacement - Clearbrook GIP	Location:	Clearbrook, MN	Client:	Enbridge
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Elevation, feet	Depth, feet	Barr Project Number: 49161299.13	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log Sample Type & Rec.	STANDARD PENETRATION TEST DATA N in blows/ft	WATER CONTENT % PL LL	SIEVE ANALYSIS GRAVEL SAND SILT CLAY FINES	Physical Properties						
								WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0	Surface Elev.: 1359.7 ft												
	1359		TOPSOIL: brown; moist; roots.											
			SANDY LEAN CLAY (CL): tan to grey; moist; trace subrounded gravel; some red-brown mottling; glacial till.									0.5		
1355	5					15 31	2.2 33.1	17.8	112.4			1.75		
1350	10											3.5		
												4.25		
1345	15	1344.2	POORLY GRADED SAND WITH GRAVEL (SP): fine to coarse grained; tan; moist; trace silt; gravel is subrounded and fine to coarse grained; glacial outwash.			×	46.9 99.05.3							
1340	20		Slight artesian flow of water noted after advancing 6" override casing to 20'.											
			20' start roto sonic drilling with weighted mud.											
1335	25		20-30' no recovery; possibly pushed a rock with core barrel.											
1330	30													

Continued Next Page

Completion Depth:	50.0	Remarks: Boring was advanced from 0 to 10' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 11' with 8" diameter steel casing. The boring was completed through the casing to 50' using roto sonic drilling methods. Drilling mud was approximately 14 PPG.												
Date Boring Started:	8/2/21													
Date Boring Completed:	8/4/21													
Logged By:	JEE													
Drilling Contractor:	Traut													
Drilling Method:	Roto sonic													
Ground Surface Elevation:	1359.67													
Coordinates:	N 769,204.0 ft E 2,057,970.0 ft													
Datum:	MN State Plane N, NAD83, NAVD88													
		SAMPLE TYPES			WATER LEVELS (ft)			LEGEND						
		ROTO SONIC CORE GRAB SAMPLE			At Time of Drilling not encountered prior to drilling with mud			MC Moisture Content Q_u Unconfined Compression γ Dry Unit Weight Q_p Hand Penetrometer UC ϕ Friction Angle Gs Specific Gravity RQD Rock Quality Designation						

The stratification lines represent approximate boundaries. The transition may be gradual.

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LOG OF BORING CB-21-4

Sheet 2 of 2

Project: L3 Replacement - Clearbrook GIP				Location: Clearbrook, MN				Client: Enbridge															
Elevation, feet	Depth, feet	Barr Project Number: 49161299.13		Graphic Log Sample Type & Rec.	STANDARD PENETRATION TEST DATA N in blows/ft <div><div>10</div><div>20</div><div>30</div><div>40</div></div>				WATER CONTENT % PL <div><div></div><div>X</div><div></div></div> LL				SIEVE ANALYSIS <div><div>GRAVEL</div><div>SAND</div><div>SILT</div><div>CLAY</div><div>FINES</div></div>				Physical Properties						
		WC %	γ_d pcf														ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %		
		30	1327.7		SANDY LEAN CLAY (CL): grey; moist.	32.0																	
1325	35	1325.2	POORLY GRADED SAND (SP): fine to medium grained; tan; moist; trace fine grained rounded gravel.	34.5																			
1320	40																						
1315	45																						
1310	50	1309.7	Bottom of Boring at 50.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers	50.0																			
	55																						
	60																						
Completion Depth:		50.0		Remarks: Boring was advanced from 0 to 10' with a 4" diameter roto sonic core barrel and 6" diameter override casing. The boring was then cased to 11' with 8" diameter steel casing. The boring was completed through the casing to 50' using roto sonic drilling methods. Drilling mud was approximately 14 PPG.																			
Date Boring Started:		8/2/21																					
Date Boring Completed:		8/4/21		SAMPLE TYPES				WATER LEVELS (ft)				LEGEND											
Logged By:		JEE		<div><div>ROTOSONIC</div><div>SOIL CORE</div></div> <div><div>GRAB</div><div>SAMPLE</div></div>				<div><div>At Time of Drilling</div><div>not encountered prior to drilling with mud</div></div>				<div><div>MC</div><div>Moisture Content</div><div>γ</div><div>Dry Unit Weight</div><div>ϕ</div><div>Friction Angle</div></div> <div><div>Q_u</div><div>Unconfined Compression</div><div>Q_p</div><div>Hand Penetrometer UC</div><div>Gs</div><div>Specific Gravity</div><div>RQD</div><div>Rock Quality Designation</div></div>											
Drilling Contractor:		Traut																					
Drilling Method:		Rotosonic																					
Ground Surface Elevation:		1359.67																					
Coordinates:		N 769,204.0 ft E 2,057,970.0 ft																					
Datum:		MN State Plane N, NAD83, NAVD88																					



















The stratification lines represent approximate boundaries. The transition may be gradual.

Attachment 2

Instrumentation Logs

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge	
Barr Project Number: 49161299.13		Surface Elevation: 1338.8 ft				Top of Casing Elevation:	
STRATA		SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft		ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
DESCRIPTION							
				0.0	GS	1338.8	PROTECTIVE CASING Diameter: 8" Type: Steel Interval: -0.75' to 11'
FILL: lean clay; grey; moist; with sand and silt; historic right of way fill. 1336.3 ft				11.0		1327.8	GROUT Type: neat cement grout Mix: see below Interval: 0' to 34'
TOPSOIL: lean clay; black; moist; with roots. 1335.8 ft							
POORLY GRADED SAND WITH CLAY (SP-SC): fine to coarse grained; multicolored; moist; trace gravel and lean clay. 1333.8 ft							
LEAN CLAY (CL): grey; moist; with sand; oxidation staining. 1332.3 ft							
SILTY SAND (SM): fine to coarse grained; multicolored; moist to wet. 1331.3 ft							
SILT (ML): grey; moist. 1330.8 ft							
LEAN CLAY WITH SAND (CL): grey; moist. 1320.8 ft							
FAT CLAY (CH): grey; moist; trace sand. 1316.8 ft							
LEAN CLAY (CL): grey; moist; trace sand. 1312.5 ft							
SILT (ML): fine grained; grey; moist to wet; first blow through pushed tube. 1310.8 ft							
LEAN CLAY (CL): grey; moist to wet; silty. 1309.1 ft				29.7	TVT	1309.2	VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: T: 2003965(700 kPa) B: 1930856 (700 kPa)
POORLY GRADED GRAVEL (GP): coarse grained; grey; moist; apparent cobble from 29.7'-32'. 1304.8 ft				30.7	BVT	1308.2	
				31.7	TVT	1307.2	
				32.7	BVT	1306.2	
				34.0		1304.8	Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement
Bottom of Boring at 34.0 feet							
Completion Depth: 34.0 ft Date Started: 7/27/21 Date Completed: 7/30/21 Logged By: PMD/JEE Drilling Contractor: Traut; Coleman Engineering Drilling Method: Rotasonic; mud rotary Datum: MN State Plane N, NAD83, NAVD88 Coordinates: N 770,503.0 ft E 2,054,029.0 ft		LEGEND FILTER PACK BENTONITE CEMENT GROUT CUTTINGS / BACKFILL TPC TOP OF PROTECTIVE CASING TRC TOP OF RISER CASING BPC BASE PROTECTIVE CASING GS GROUND SURFACE TVT TOP VIBRATING-WIRE TIP BVT BOTTOM VIBRATING-WIRE TIP TD TOTAL DEPTH				WATER LEVELS(ft) At Time of Drilling Not encountered prior to mud rotary	

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge		
Barr Project Number: 49161299.13		Surface Elevation: 1338.8 ft				Top of Casing Elevation:		
STRATA		SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft		ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR	
DESCRIPTION								
0		   		0.0	GS	1338.8	PROTECTIVE CASING Diameter: 8" Type: Steel Interval: 0' to 16' GROUT Type: neat cement grout Mix: see below Interval: 0' to 26.3' VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: 1912958 (350 kPa)	
FILL: lean clay; grey; moist to wet; trace wood debris; trace sand and gravel.								
5								
10								
15								
20								
1325.8 ft		   		16.0		1322.8		
LEAN CLAY (CL): grey; with redish-brown mottle; moist to wet; trace sand.								
25								
22.3								
23.3								
26.3								
1312.5 ft		   		26.3		1312.5	Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement	
Bottom of Boring at 26.3 feet								
Completion Depth: 26.3 ft		LEGEND  FILTER PACK  BENTONITE  CEMENT GROUT  CUTTINGS / BACKFILL TPC TOP OF PROTECTIVE CASING TRC TOP OF RISER CASING BPC BASE PROTECTIVE CASING GS GROUND SURFACE TVT TOP VIBRATING-WIRE TIP BVT BOTTOM VIBRATING-WIRE TIP TD TOTAL DEPTH					WATER LEVELS(ft) At Time of Drilling not encountered prior to mud rotary drilling	
Date Started: 7/29/21								
Date Completed: 8/1/21								
Logged By: PMD/JEE								
Drilling Contractor: Traut; Coleman Engineering								
Drilling Method: Rotasonic; mud rotary								
Datum: MN State Plane N, NAD83, NAVD88								
Coordinates: N 770,505.0 ft E 2,054,056.0 ft								



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LOG OF BORING CB-21-1C

Associated Boring #: CB-21-1C

Sheet 1 of 1

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge		
Barr Project Number: 49161299.13		Surface Elevation: 1338.9 ft				Top of Casing Elevation:		
STRATA		DEPTH, ft	SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft		ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
DESCRIPTION								
		0			0.0	GS	1338.9	PROTECTIVE CASING Diameter: 8" Type: Steel Interval: 0' to 11'
FILL: lean clay; grey to tan to redish-brown; moist; trace vegetation and grass; trace sand and gravel.								GROUT Type: neat cement grout Mix: see below Interval: 0' to 21.8'
1331.9 ft		5						VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: 1912959 (350 kPa)
LEAN CLAY (CL): grey to tan to redish-brown; moist; stiff; trace rounded gravel; trace to with sand.		10			11.0		1327.9	
		15						
		18.5			18.5	TVT	1320.5	
		19.5			19.5	BVT	1319.5	
1318.1 ft		20						
CLAYEY SAND (SC): fine to medium grained; grey; moist. 1317.4 ft					21.8		1317.1	
LEAN CLAY (CL): grey; moist; trace sand. 1317.1 ft								
Bottom of Boring at 21.8 feet								Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement
Completion Depth: 21.8 ft		LEGEND						WATER LEVELS(ft) ▼ At Time of Drilling
Date Started: 7/30/21		TPC TOP OF PROTECTIVE CASING						
Date Completed: 8/2/21		TRC TOP OF RISER CASING						
Logged By: PMD/JEE		BPC BASE PROTECTIVE CASING						
Drilling Contractor: Traut; Coleman Engineering		GS GROUND SURFACE						
Drilling Method: Rotosonic; mud rotary		TVT TOP VIBRATING-WIRE TIP						
Datum: MN State Plane N, NAD83, NAVD88		BVT BOTTOM VIBRATING-WIRE TIP						
Coordinates: N 770,504.0 ft E 2,054,066.0 ft		TD TOTAL DEPTH						
		FILTER PACK						
		BENTONITE						
		CEMENT GROUT						
		CUTTINGS / BACKFILL						

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge	
Barr Project Number: 49161299.13		Surface Elevation: 1338.9 ft				Top of Casing Elevation:	
STRATA		SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft		ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
DESCRIPTION							
				0.0	GS	1338.9	PROTECTIVE CASING Diameter: N/A Type: N/A Interval: N/A GROUT Type: neat cement grout Mix: see below Interval: 0' to 22.5' VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: T: 2134696 (350 kPa) B: 2134224(350 kPa)
FILL: lean clay; grey; moist; with grass; historic trench fill.							
1334.9 ft							
FILL: sandy lean clay with gravel; grey; wet.							
1328.9 ft							
FILL: clayey gravel with sand; grey; moist to wet.							
1326.9 ft							
FILL: sandy lean clay; grey; moist; trace gravel.				12.4	TVT	1326.5	
				13.4	BVT	1325.5	
				17.4	TVT	1321.5	
				18.4	BVT	1320.5	
1318.9 ft							
LEAN CLAY (CL): grey; moist; trace sand.							
1316.4 ft							
Bottom of Boring at 22.5 feet				22.5		1316.4	
Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement							

Completion Depth: 22.5 ft		LEGEND FILTER PACK BENTONITE CEMENT GROUT CUTTINGS / BACKFILL	TPC TOP OF PROTECTIVE CASING TRC TOP OF RISER CASING BPC BASE PROTECTIVE CASING GS GROUND SURFACE TVT TOP VIBRATING-WIRE TIP BVT BOTTOM VIBRATING-WIRE TIP TD TOTAL DEPTH		WATER LEVELS(ft) At Time of Drilling not encountered prior to mud rotary
Date Started: 8/2/21					
Date Completed: 8/3/21					
Logged By: PMD					
Drilling Contractor: Coleman Engineering					
Drilling Method: Mud Rotary					
Datum: MN State Plane N, NAD83, NAVD88					
Coordinates: N 770,513.5 ft E 2,054,041.1 ft					

The stratification lines represent approximate boundaries. The transition may be gradual.



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LOG OF BORING CB-21-3

Associated Boring #: CB-21-3

Sheet 1 of 2

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN			Client: Enbridge	
Barr Project Number: 49161299.13		Surface Elevation: 1351.6 ft			Top of Casing Elevation:	
STRATA	DEPTH, ft	SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft	ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
	0			0.0	GS 1351.6	PROTECTIVE CASING Diameter: 8" Type: Steel Interval: -1.66' to 16'
TOPSOIL: black; moist; with roots. 1350.6 ft						GROUT Type: neat cement grout Mix: see below Interval: 0' to 50'
CLAYEY SAND (SC): grey; moist. 1350.1 ft						VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: 2003966 (700 kPa)
POORLY GRADED SAND (SP): fine to coarse grained; grey; dry to moist; with fine to medium grained gravel. 1347.1 ft	5					
LEAN CLAY (CL): grey; moist; with fine grained sand and fine grained gravel.						
	10					
	15			16.0	1335.6	
1333.6 ft						
LEAN CLAY (CL): grey; moist; trace fine grained sand and gravel.	20					
	25					
						Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement
Completion Depth: 50.0 ft		LEGEND				WATER LEVELS(ft) ▼ At Time of Drilling not encountered prior to drilling with mud
Date Started: 7/27/21		FILTER PACK	TPC TOP OF PROTECTIVE CASING			
Date Completed: 8/3/21		BENTONITE	TRC TOP OF RISER CASING			
Logged By: PMD/JEE		CEMENT GROUT	BPC BASE PROTECTIVE CASING			
Drilling Contractor: Traut		CUTTINGS / BACKFILL	GS GROUND SURFACE			
Drilling Method: Rotasonic			TVT TOP VIBRATING-WIRE TIP			
Datum: MN State Plane N, NAD83, NAVD88			BVT BOTTOM VIBRATING-WIRE TIP			
Coordinates: N 769,474.0 ft E 2,056,719.0 ft			TD TOTAL DEPTH			

The stratification lines represent approximate boundaries. The transition may be gradual.



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LOG OF BORING CB-21-3

Associated Boring #: CB-21-3

Sheet 2 of 2

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge		
Barr Project Number: 49161299.13		Surface Elevation: 1351.6 ft				Top of Casing Elevation:		
STRATA		DEPTH, ft	SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft		ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
DESCRIPTION								
LEAN CLAY (CL): grey; moist; trace fine grained sand and gravel. (Continued)		30						PROTECTIVE CASING Diameter: 8" Type: Steel Interval: -1.66' to 16' GROUT Type: neat cement grout Mix: see below Interval: 0' to 50' VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: 2003966 (700 kPa)
1317.6 ft								
LEAN CLAY WITH GRAVEL (CL): grey; moist; trace sand.		35						
1313.1 ft								
WELL GRADED GRAVEL WITH SAND (GW): fine to coarse grained; grey to tan; moist; trace 3-4" cobbles.		40						
					41.4	TVT	1310.2	
					42.4	BVT	1309.2	
		45						
1301.6 ft		50			50.0		1301.6	
Bottom of Boring at 50.0 feet								

The stratification lines represent approximate boundaries. The transition may be gradual.



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LOG OF BORING CB-21-4

Associated Boring #: CB-21-4

Sheet 1 of 2

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN				Client: Enbridge	
Barr Project Number: 49161299.13		Surface Elevation: 1359.7 ft				Top of Casing Elevation:	
STRATA		SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft		ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
DESCRIPTION	DEPTH, ft						
				0.0	GS	1359.7	PROTECTIVE CASING Diameter: 8" Type: Steel Interval: 0' to 11' GROUT Type: neat cement grout Mix: see below Interval: 0' to 50' VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: T: 2134222 (350 kPa) B: 2129043 (700 kPa)
TOPSOIL: brown; moist; roots. 1359.0 ft	0						
SANDY LEAN CLAY (CL): tan to grey; moist; trace subrounded gravel; some red-brown mottling; glacial till.	5						
	10					11.0	1348.7
	15						
POORLY GRADED SAND WITH GRAVEL (SP): fine to coarse grained; tan; moist; trace silt; gravel is subrounded and fine to coarse grained; glacial outwash.	16.9				TVT	1342.8	
	17.9				BVT	1341.8	
	20						
	25						
							Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement
Completion Depth: 50.0 ft		LEGEND					WATER LEVELS(ft) At Time of Drilling not encountered prior to drilling with mud
Date Started: 8/2/21			FILTER PACK	TPC	TOP OF PROTECTIVE CASING		
Date Completed: 8/4/21			BENTONITE	TRC	TOP OF RISER CASING		
Logged By: JEE			CEMENT GROUT	BPC	BASE PROTECTIVE CASING		
Drilling Contractor: Traut			CUTTINGS / BACKFILL	GS	GROUND SURFACE		
Drilling Method: Rotasonic				TVT	TOP VIBRATING-WIRE TIP		
Datum: MN State Plane N, NAD83, NAVD88				BVT	BOTTOM VIBRATING-WIRE TIP		
Coordinates: N 769,204.0 ft E 2,057,970.0 ft				TD	TOTAL DEPTH		

The stratification lines represent approximate boundaries. The transition may be gradual.


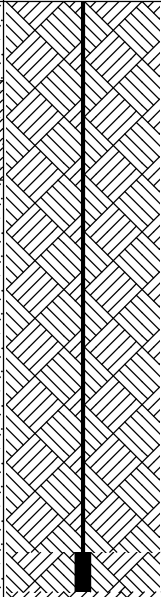

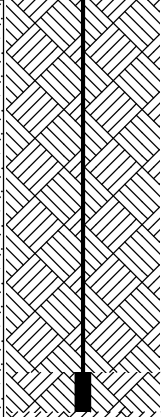

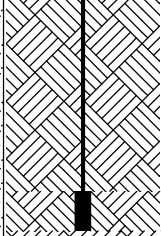



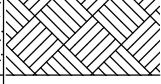




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LOG OF BORING CB-21-4

Associated Boring #: CB-21-4

Sheet 2 of 2

Project: L3 Replacement - Clearbrook GIP		Location: Clearbrook, MN			Client: Enbridge		
Barr Project Number: 49161299.13		Surface Elevation: 1359.7 ft			Top of Casing Elevation:		
STRATA		DEPTH, ft	SYMBOL	WELL OR PIEZOMETER CONSTRUCTION DETAILS	DEPTH, ft	ELEVATION, ft	PIEZOMETER CONSTRUCTION DETAILS FOR FULLY GROUTED VIBRATING-WIRE SENSOR
DESCRIPTION							
1327.7 ft		30					PROTECTIVE CASING Diameter: 8" Type: Steel Interval: 0' to 11'
SANDY LEAN CLAY (CL): grey; moist.							
1325.2 ft		35					GROUT Type: neat cement grout Mix: see below Interval: 0' to 50'
POORLY GRADED SAND (SP): fine to medium grained; tan; moist; trace fine grained rounded gravel.							
		40					VIBRATING-WIRE TIP Diameter: 0.75" Type: Geokon 4500S Serial No.: T: 2134222 (350 kPa) B: 2129043 (700 kPa)
		45			43.9	TVT	1315.8
		50			44.9	BVT	1314.8
1309.7 ft		50			50.0		1309.7
Bottom of Boring at 50.0 feet							
Remarks: Grout Mix: 94 lbs portland cement, 6 gals. water, 5% bentonite by weight of cement							
Completion Depth: 50.0 ft		LEGEND					WATER LEVELS(ft)
Date Started: 8/2/21							
Date Completed: 8/4/21							▼ At Time of Drilling not encountered prior to drilling with mud
Logged By: JEE							
Drilling Contractor: Traut							
Drilling Method: Rotasonic							
Datum: MN State Plane N, NAD83, NAVD88							
Coordinates: N 769,204.0 ft E 2,057,970.0 ft							

The stratification lines represent approximate boundaries. The transition may be gradual.

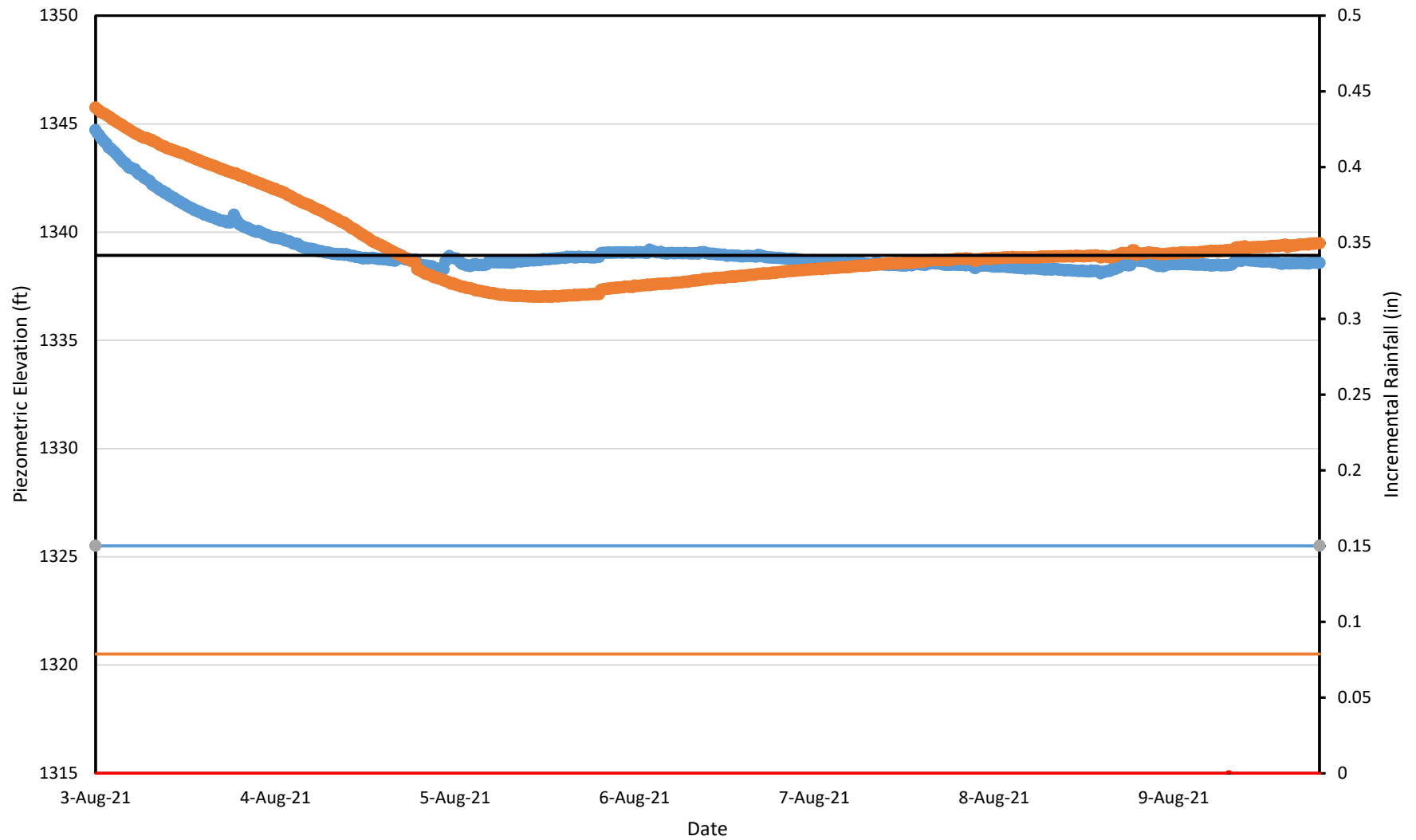
Attachment 3

Vibrating Wire Piezometer Data



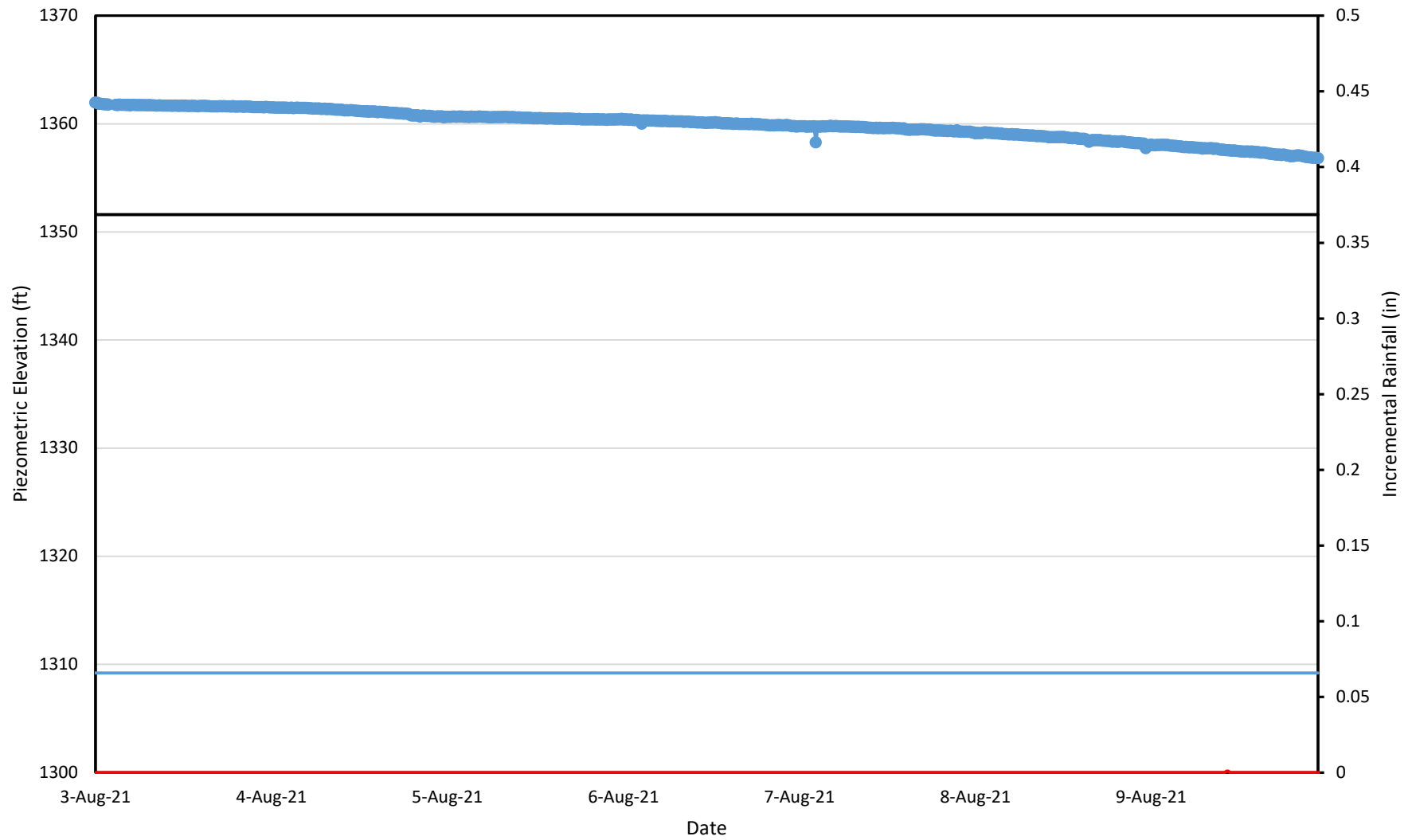
Attachment 3-A

Line 3 Replacement
Clearbrook GIP CB-21-2
Piezometric Elevation vs Time



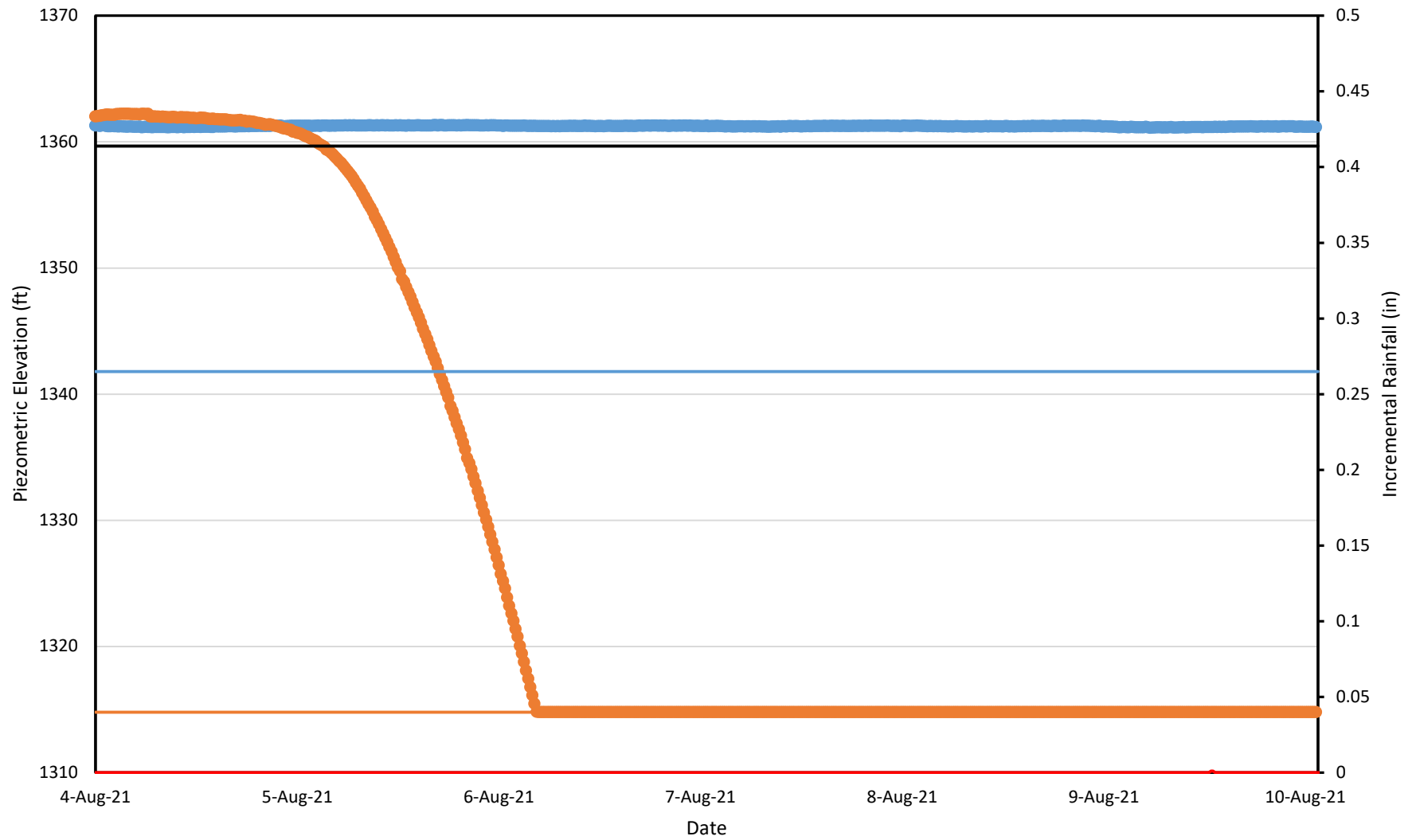
CB-21-2-T Total Head CB-21-2-B Total Head CB-21-2-T Tip Elev CB-21-2-B Tip Elev CB_21_2 Ground Elev Rainfall

Line 3 Replacement
Clearbrook GIP CB-21-3
Piezometric Elevation vs Time



● CB-21-3 Total Head — CB-21-3 Tip Elev — CB_21_3 Ground Elev — Rainfall

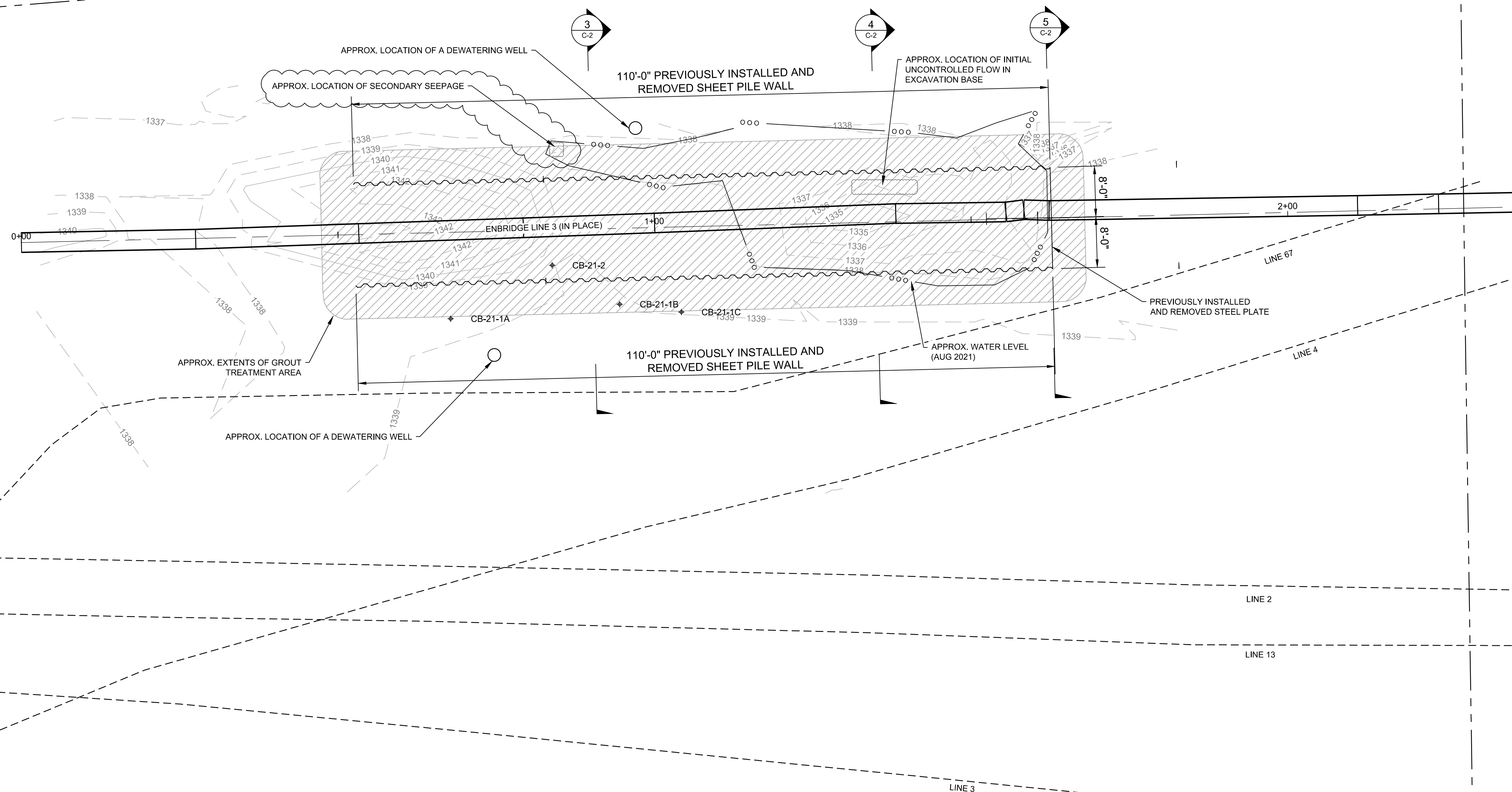
Line 3 Replacement
Clearbrook GIP CB-21-4
Piezometric Elevation vs Time



CB-21-4-T Total Head CB-21-4-B Total Head CB-21-4-T Tip Elev CB-21-4-B Tip Elev CB_21_4- Ground Elev Rainfall

Attachment 2

Preliminary Grouting Plan



1 PLAN VIEW
1"=10'-0"

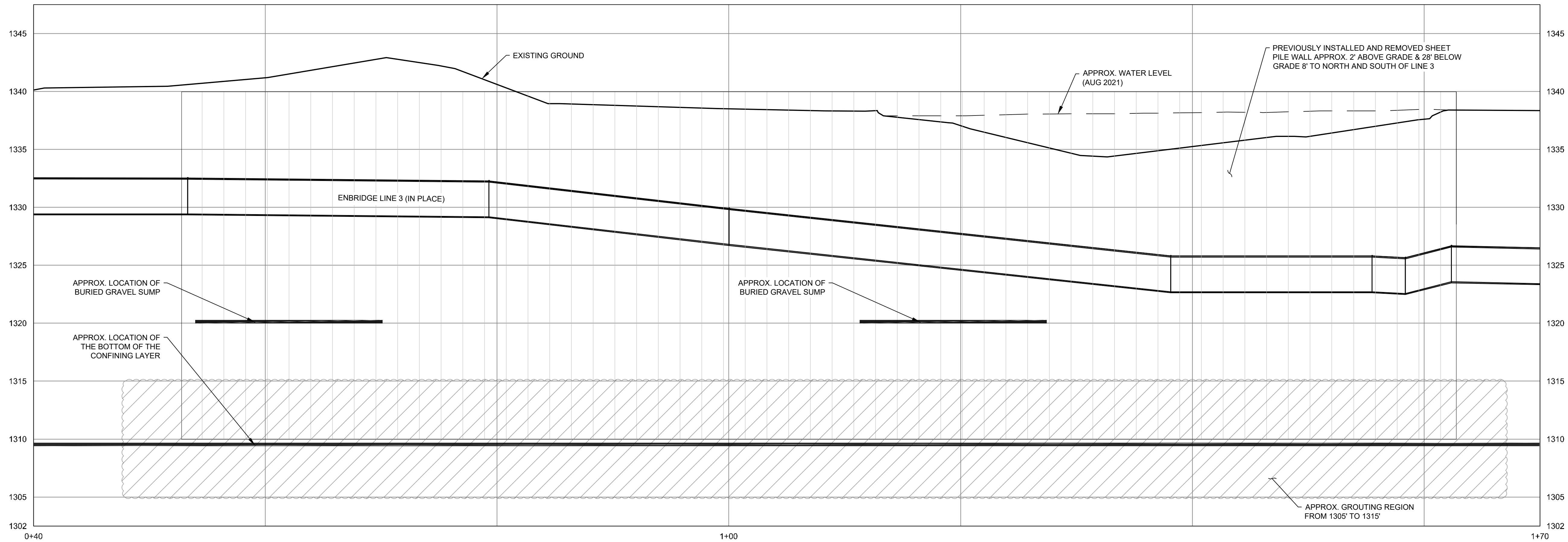
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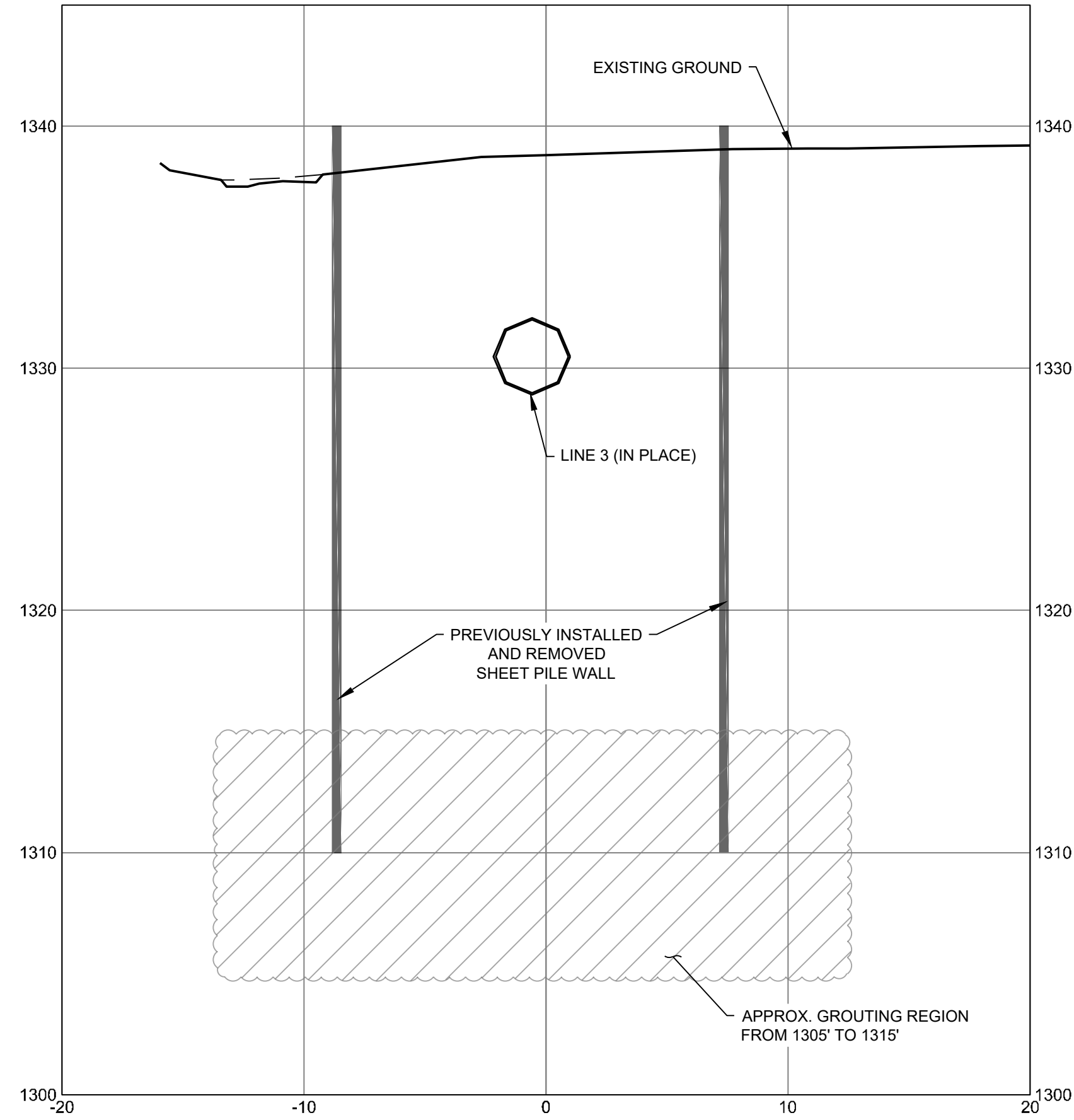


LINE 3
MP 910.0
CLEARBROOK SHEET PILE WALL
PLAN VIEW

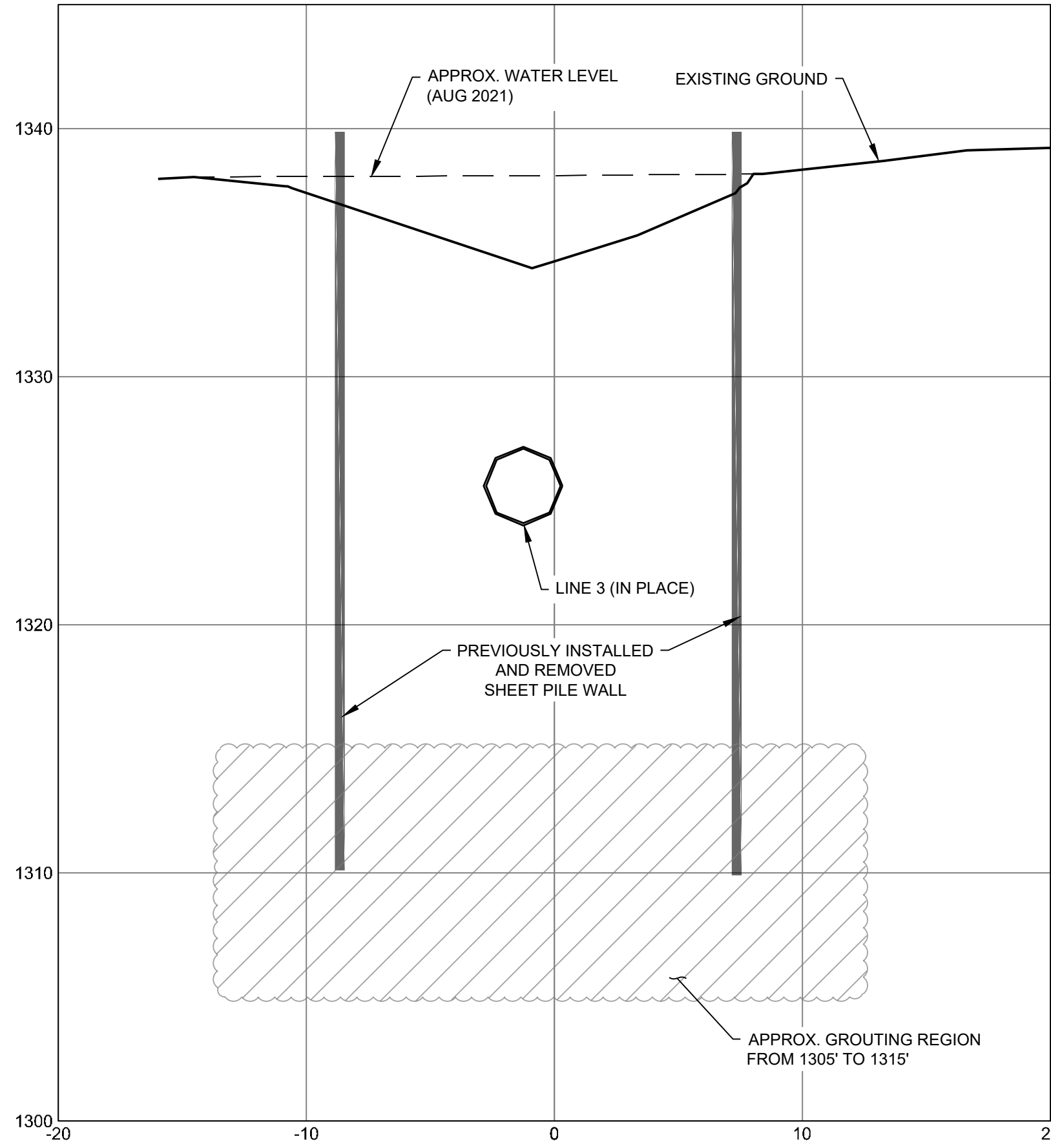
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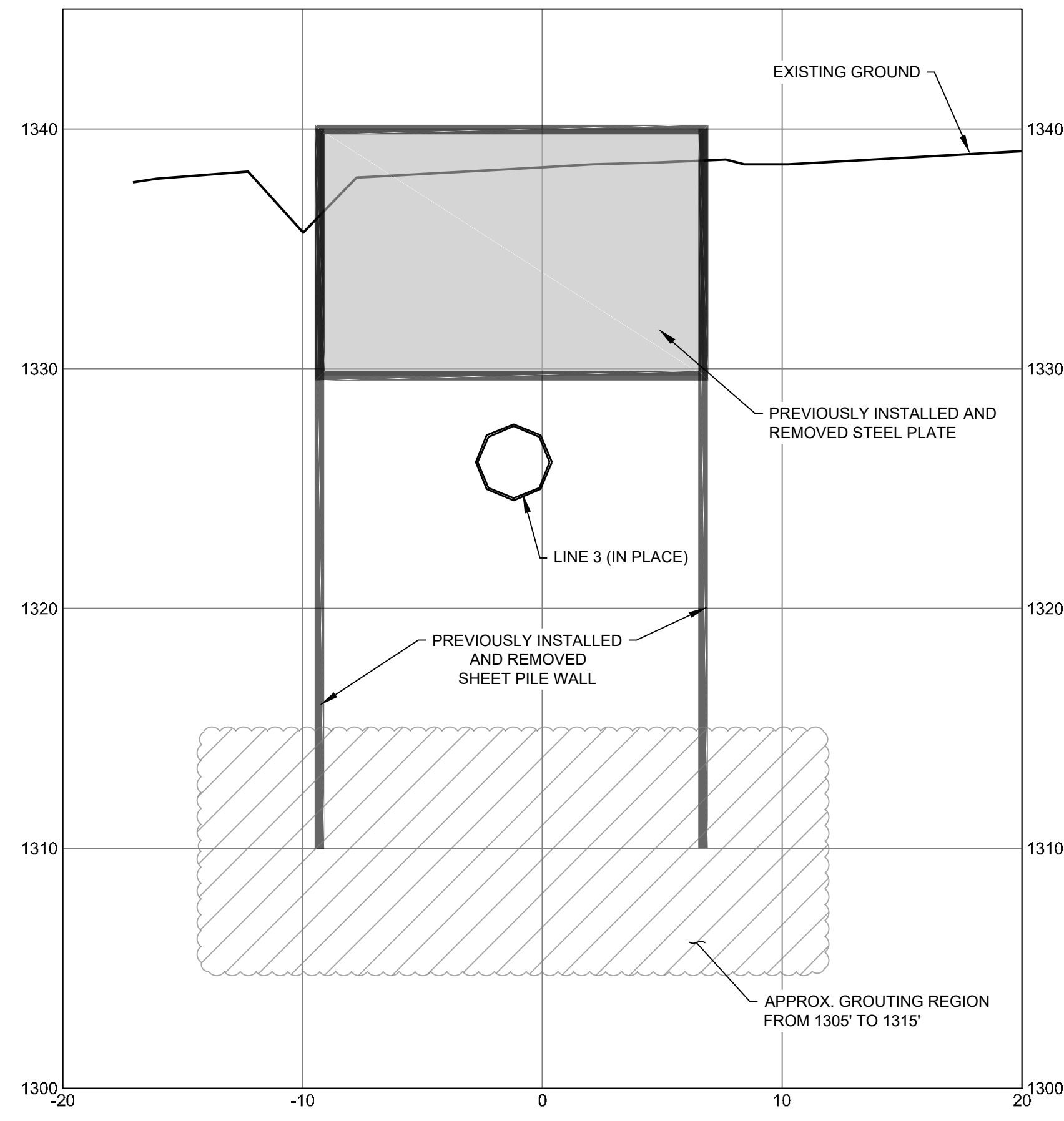
2 LINE 3 PROFILE VIEW
1"=5'-0"



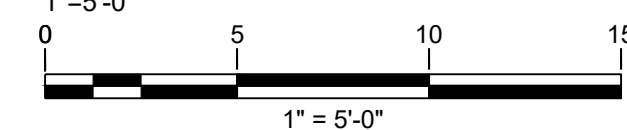
3 STA. 0+90 SECTION
1"=5'-0"




4 STA. 1+35 SECTION
1"=5'-0"



5 STA. 1+63 SECTION
1"=5'-0"



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LINE 3 MP 910.0 CLEARBROOK SHEET PILE WALL SECTIONS				
BY: JMD	CHK:	ENG. :	ENB APPR:	
DATE:	SCALE:	STATUS:		REV NO:
DWG NO.:				C-2
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