CASE STUDY

131 STELCOR DDMS INSTALLED FOR A PAPER MILL IN DULUTH, MN

DESIGN LOADS:

PILE TYPE #1:
80 Tons Compression Load

PILE TYPE #2:
30 Tons Compression Load
25 Tons Tension Load

TEST LOADS:

PILE TYPE #1:
200 Tons Compression Load

PILE TYPE #2:
75 Tons Tension Load

PILE DETAIL:

STELCOR 1200
BarrelForm Displacement
(2) 12” Stinger Plates
14” Corrugated Grout Column
11” Solid Grout Column
8” Reverse Grout Auger
5.50” O.D. X 0.361” W.T. – 80 ksi
Central Shaft

PILE LENGTH:
TYPE #1: 100’-106’
TYPE #2: 29’-36’

BOND LENGTH:
TYPE #1: 90’-96’
TYPE #2: 19’-26’

NUMBER OF PILES: 131

OVERVIEW:

ST Paper & Tissue acquired its Duluth, MN location in early 2021 and began a $54 million overhaul of the facilities shortly after. Scheduled to open in the fall of 2022, the upgraded paper and tissue mill will allow for increased automation and further diversification of their paper product offerings. The installation of a new tissue paper machine will be one of the most notable upgrades to the facility. Adding a new mill will allow the plant to double its production capacity and provide more local jobs. The new paper mill will be installed inside the existing factory, and a new foundation will be necessary to support it.

ALL THE NECESSARY EQUIPMENT AND MATERIALS HAD TO BE LIFTED OVER THE EXISTING MACHINERY USING A CRANE AND LOWERED INTO THE INSTALLATION AREA

GEOLOGY:

At this site, subsurface conditions generally consisted of concrete, fill, weathered rock, and fat clays. A 9-12 inch concrete layer from the current building foundation existed across the entire surface. Beyond the concrete, a layer of fill, made up of silty sands, was present up to 15 feet below the surface. Poorly graded brown sands that were generally fine and water-bearing extend around 38 feet in all borings. Fat clays were found below the layer of sand and went beyond 100 feet where the borings were terminated. 38 feet in all borings. Fat clays were found below the layer of sand and went beyond 100 feet below the surface in areas.

CASE STUDY

131 STELCOR DDMS INSTALLED FOR A PAPER MILL IN DULUTH, MN

CHALLENGES:

It was determined that the new paper-making machine would need a deep foundation due to the poor soils at this location. The installation of a deep foundation presented multiple challenges. The most significant challenge was that a clear path to the install area did not exist. Therefore, all the necessary equipment and materials had to be lifted over the existing machinery using a crane and lowered into the installation area. Furthermore, a 9-12 inch concrete slab existed across the entire site, and an opening had to be cored through the slab at every pile location. Another complication of working inside of an existing factory is spoils and mess. Due to limited access and open space within the building, there was no room to manage spoils, and removing them would be difficult. Wherever possible, mess needed to be eliminated or reduced. Containing installation mess and performing excessive site cleanup would increase costs and complications.

In the early stages of this project, driven piles and traditional micropiles were the recommended piling methods. Traditional micropiles were considered for this project as they could perform well in the challenging soil conditions. However, the excess water and mess in the enclosed space would have added complications and costs to the installation. Driven piles then seemed to be the most economical solution as the material costs were relatively low. However, given the logistics of the project, the disadvantages soon became apparent. The soils encountered during installation would have proven difficult or nearly impossible to advance a driven pile without predrilling through the top 30’ of material. The installation equipment required would also be more challenging to mobilize within the site’s confines, and there were concerns about how the vibrations would affect the existing structure. The complications associated with each pile type increased the total cost of the foundation package to a point where they were no longer competitive.

STELCOR DDMS WERE SUCCESSFULLY LOAD TESTED TO 200 TONS COMPRESSION AND 75 TONS IN TENSION.

SOLUTION:

Tri-State Drilling, the installer on this project, brought this to the IDEAL Design Team as they felt STELCOR DDMs would work well with the site restrictions. The IDEAL Design Team ran a preliminary design analysis for the project and found STELCOR to be an excellent fit for the soils at the site. The IDEAL Design Team then developed a soil displacement head specific to this project’s soil profile. The design team specified a displacement head configuration, ensuring the pile would be well suited to challenging soils. The custom configuration included a stinger tip and the patented BarrelForm displacement structure.

STELCOR was presented as an alternate and was successfully load tested to 200 tons compression and 75 tons in tension. STELCOR DDMs were accepted, and Tri-State Drilling successfully installed 131 STELCOR DDMs within the limited install area with no vibrations. The compression piles were installed to 100,’ and the tension piles resisted the required load at 29’. The STELCOR system requires minimal installation equipment and utilizes an excavator for installation. Therefore, a dedicated piling rig would not have to be mobilized. STELCOR was also installed with no spoils and minimal mess as it displaces soils during installation and relies on mechanical grouting rather than pressure grouting. As a result, the resources required for site cleanup were reduced, and installation rates were increased, leading to significant cost and time savings.

Twin Ports Testing Inc.
1301 N 3rd St. • Superior WI 54880 • 715-392-7114 • 1-800-373-2562 • F 715-392-7163 • www.twinportstesting.com

Geotechnical Evaluation Report

New Tissue Machine Installation
100 N Central Avenue
Duluth, Minnesota

Prepared for:

CR Meyer and Sons Company

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Brett Carlson, PE
October 6, 2021

TPT Project Number: 21G1426

BRETT MICHAEL CARLSON
55983

October 6, 2021
TPT Project No. 21G1426

Mr. Sean Richardt
CR Meyer and Sons Company
895 W 20th Avenue – PO Box 2157
Oshkosh, Wisconsin

Re: Geotechnical Evaluation Report
New Tissue Machine
100 N Central Avenue
Duluth, Minnesota

Dear Mr. Richardt:

Enclosed is our geotechnical evaluation report for the above referenced project. We have prepared this report and based our conclusions upon current applicable professional standards.

If you have any questions concerning the data, the recommendations presented, or if we may be of further service on this project, please contact us at (715) 392-7114. We appreciate the opportunity to be of service to you.

Sincerely,

Twin Ports Testing

Brett Carlson, PE
Geotechnical Engineer

Mich D Haapala

Michael A. Haapala, PE
Principal Engineer

Attachment:
Geotechnical Evaluation Report

Contents

Appendix:
Boring Location Sketch (1 Page)
Push Probe Logs DPT-2 through DPT-4 (3 Pages)
CPT Sounding Logs CPT-4 through CPT-4 (3 Pages)
Soil Classification Data/Boring Log Notes (2 Pages)

1 Introduction

This report presents the results of our geotechnical evaluation for the proposed New Tissue Machine Installation at ST Paper (former Verso Duluth Mill) located at 100 N Central Avenue in Duluth, Minnesota.

1.1 Scope of Services

The scope of our geotechnical evaluation as outlined in our Cost Estimate 21G1426, dated August 27, 2021, included:

- Performing a field exploration program consisting of five (5) Direct Push (DPT) Borings to depths up to 60 feet or refusal.
- Performing five (5) CPT_u Soundings adjacent the the DPT Borings to depths of 100 feet or refusal.
- Performing laboratory tests and observations of soil samples to evaluate pertinent engineering properties of materials encountered.
- Preparing a geotechnical evaluation report containing a description of the exploration program, a description of the geology and subsurface conditions encountered, groundwater conditions, push probe logs with a test location sketch, results of laboratory testing, and recommendations for design.

Due to the close proximity of boring/sounding locations and time constraints only three locations were performed.

Twin Ports Testing, Inc. (TPT) has prepared this report for design purposes only. It may not have sufficient subsurface information to prepare an accurate construction bid. We recommend that contractors preparing bids or proposals for this project be provided with a complete copy of this report as a supplement to the plans and specifications.

1.2 Proposed Project

We understand that CR Meyer is in the design process for a New Tissue Machine and associated foundations at the ST Paper facility located at 100 N Central Avenue in Duluth, Minnesota. It is our understanding that a row of multiple pile caps is needed for the New Tissue Machine; pile caps are anticipated to be supported with micropiles. Maximum axial and uplift loading on the pile caps is estimated to be around 460 kips.

Changes in the nature, design, and location of all or parts of this project may occur during the design process. The conclusions and recommendations contained in this report shall not be considered applicable to changes unless they are reviewed by the geotechnical engineer of record. We will then make necessary changes or modifications to this report in writing only.

1.2.1 Reference Information

We were provided the following relevant documents as part of this project:

- Soil Boring Location Plan with Structural Loads – prepared by CR Meyer – dated August 19, 2021

We referenced the following documents as part of this project:

- Micropile Design and Construction Guidelines – FHWA – Publication No. FHWA-SA-97-070, dated June 2000
- Minnesota Geological Survey titled, "Geologic Map of Minnesota, Quaternary Geology", dated 1982, prepared by Hobbes and Goebel.

2 Site Conditions

2.1 Geologic Setting

Through an understanding of the geologic history and processes of an area, we are better able to define and understand the range of geotechnical properties observed in the geological materials encountered at the site. Knowledge of the anticipated subsurface profile at the site is important for interpreting and correlating the tests from the field exploration program.

Based upon information from geological survey reports and previous soil explorations in the area, the surficial geology local to the site mostly consists of deposits of glacial lake sediment associated with historic Glacial Lake Duluth. Glacial lake sediment is described as clay and clayey silt.

2.2 Site Location and Existing Conditions

This site is located inside the existing building at the former Verso Duluth Mill, near the center of the building.

2.3 Topography and Elevations

The areas immediately adjacent to the proposed foundations are flat and consist of a finished concrete floor with negligible change in elevation throughout.

3 Field Procedures

The completed subsurface exploration program for this project consisted of three (3) CPT_u

Soundings and adjacent DPT borings. CPT_u soundings were performed to refusal depths ranging from 92 feet to 115 feet below the existing finished concrete floor surface. DPT borings were performed to depths ranging from 30 feet to 40 feet.

Soundings and borings were performed with a Geoprobe Systems 6625CPT track-mounted rig. Field procedures were performed between September 15, 2021 and September 17, 2021.

3.1 Boring Locations and Elevations

Boring locations are shown on the attached Boring Location Sketch in the Appendix. Boring locations were determined in the field by TPT and CR Meyer Personnel.

Surface elevations of test locations were not determined at the time of this report; boring location depths were referenced to the top surface level of the existing finished concrete floor with a negligible change in elevation between locations.

3.2 Sampling/Soundings

3.2.1 Direct Push (DPT) Borings

Continuous sampling of soil stratigraphy was performed in three to five foot increments at the boring locations. Direct push or percussion hammer techniques were used to advance the tooling. Collected samples were sealed in the field to preserve natural water content and returned to the laboratory for classification and testing.

3.2.2 Cone Penetration Test (CPT_u) Soundings

CPT_u soundings were performed at two locations in accordance with ASTM D5778 procedures. A 10 square centimeter cone with a maximum point capacity of 100 MPa was used to perform the soundings. Observed values of point resistance, side friction, pore pressure (U_2 position), and tilt angle were recorded continuously throughout the length of the soundings.

3.3 Boring/CPT Logs

Field boring logs were prepared for each DPT boring by our field supervisor. These logs contain interpretation of the soil conditions observed, as described in accordance with ASTM D420 and D2488.

Final boring logs are included in the Appendix. The final logs represent our interpretation of the contents of the field logs after laboratory observations by our geotechnical engineer and laboratory tests of collected field samples were complete. Soils are described in this report according to the Unified Soil Classification System (USCS), as outlined in the Boring Log Notes and Soil Classification Data which can be found in the Appendix.

CPT logs were prepared for each sounding using collected field data. Soil properties and interpretations are shown using accepted methodology and calculations. Graphic CPT logs are included in the Appendix.

3.4 Water Level Readings

Water level readings were observed in the borings at the times and under the conditions stated on the boring logs. We have reviewed the data and have reported interpretations in the text of this report. However, it must be noted that fluctuations in the level of ground water may occur because of variations in rainfall, temperature, subsurface materials and other conditions or factors different from those observed at the time of our measurements. It should be noted that such conditions are subject to change.

4 Subsurface Conditions

4.1 Soil

The subsurface conditions encountered at this site generally consist of four stratigraphic units; (1) Concrete, (2) Fill, (3) Weathered Rock, and (4) Apparent Bedrock.

4.1.1 Concrete

Between 9 inches and 12 inches inches of concrete was encountered at the surface of all boring locations.

4.1.2 Fill

Fill soils were encountered beneath the concrete slab to depths up to 15 feet at each boring location. Fill soils generally consisted of poorly graded sand with silt, was fine to coarse grained, brown, and moist to waterbearing.

4.1.3 Poorly Graded Sand

Poorly graded sand soils were encountered beneath the fill soils to depths up to 38 feet in each boring location. Poorly graded sand soils were generally fine grained, brown, and waterbearing

4.1.4 Fat Clay

Fat clay soils were encountered beneath the poorly graded sand soils in each boring location to the boring termination depths. Fat clay soils were generally reddish brown and wet. Based upon Soil Behavior Types correlated from CPT sounding data the fat clay soils extend to depths of 100 feet or greater.

4.2 Groundwater

Groundwater was observed at all boring locations at depths around five feet below existing grade during field procedures at this site. A detailed evaluation of groundwater levels at the site would require long term monitoring of piezometers and was not included in the scope of this evaluation.

5 Laboratory Testing

Results of the field testing and observed subsurface conditions were evaluated to develop a laboratory testing program. Laboratory testing of collected samples included visual classification by a geotechnical engineer and water content testing. Results of laboratory tests are shown in the Appendix.

5.1 Water Content

Laboratory water content testing was performed in substantial compliance with ASTM Method D2216 on collected samples from the field exploration. Values of water content are shown on the boring logs in the Appendix.

6 Analyses and Design Recommendations

The proposed New Tissue Machine foundations are anticipated to consist of concrete pile caps supported by micropiles. Axial and uplift loads of up to 460 kips per pile cap have been estimated by CR Meyer. It is our understanding that the existing building is supported on driven steel piles.

6.1 Design Considerations

6.1.1 Fill and Organic soils: Fill soils were encountered to depths up to 15 feet in all boring locations at this site. Organic soils and peat have been encountered to depths greater than 15 feet in past geotechnical evaluations near this site. Fill and organic soils are not suitable for foundation support.

6.1.2 Shallow Groundwater: Groundwater levels observed at this site were as shallow as five feet below the existing grade. Excavations that extend below the hydrostatic groundwater surface will require an advanced dewatering system. An experienced dewatering contractor should be contacted prior to construction if excavations are anticipated to extend below the groundwater surface.

6.1.3 Low Overhead Clearance: It is our understanding that the existing building is supported on driven steel piles and has performed well in the past; however, driven piles are not a feasible option due to low overhead clearance less than 15 feet.

6.2 Micropiles

A micropile is a small diameter (usually 6 to 12 inches) drilled and grouted replacement pile that is reinforced with steel. To construct a micropile a borehole is drilled, the reinforcement placed and the grout is poured. The axial strength of a micropile is typically assumed to come from the skin friction resulting from the grout to soil adhesion. This adhesion is affected by the drilling method, grout pressure and other factors that can be controlled during pile construction. Permanent or temporary casing may be required to keep the borehole open for installation of micropile elements when cohesionless or caving soils are encountered.

Gravity grouted micropiles are likely the most feasible option for foundation support. We recommend that gravity grouted micropiles using permanent steel casing be extended through the fill and bear in native soils encountered below a depth of 15 feet or greater. We recommend retaining an experienced specialty geotechnical contractor for final micropile construction, type, size, and connection. The grout to ground bond strength for use in design of micropiles should be determined by the micropile designer based on the type of installation equipment and technique. In general, design loads of 50 to 200 kips per pile are typical in micropile design.

Rotary duplex or rotary percussive duplex are likely the most effective methods for the expected subsurface conditions. Permanent casing should be used.

7 Recommendations for Construction

We offer the following recommendations for use during construction of this project.

7.1 Grout

Proper storage of materials should be used to prevent premature hydration of cements. Water used for grout should be potable free from impurities that could cause corrosion of reinforcing or casing. Grout samples should be tested for compressive strength at seven and 28 days.

7.2 Observation

Installation of micropiles should be observed and documented full time by a qualified technician or engineer.

7.3 Pile Load Testing

We recommend that axial load testing of at least one micropile be performed using verification methods.

8 Limitations of Evaluation and Report

8.1 Site Variations

We have based the analyses and recommendations submitted in this report in part on the data obtained from three (3) CPT_u Soundings and adjacent DPT borings. The nature and extent of variations at the site will not become evident until construction. Where major variations appear it will be necessary for us to re-evaluate the recommendations of this report.

8.2 Design Review

As the geotechnical engineer for this project, we recommend that we be provided an opportunity to perform a general review of final plans and specifications for this project to determine that recommendations provided have been properly interpreted and included. We assume no responsibility for misinterpretation or improper application of our recommendations and conclusions by others.

8.3 Continuity of Professional Responsibility

TPT recommends that we be retained to provide geotechnical engineering services during construction. This would allow us to observe compliance with the plans, specifications and our recommendations, provides continuity of professional responsibility, and allows design changes to be made in the event that subsurface conditions differ from those anticipated.

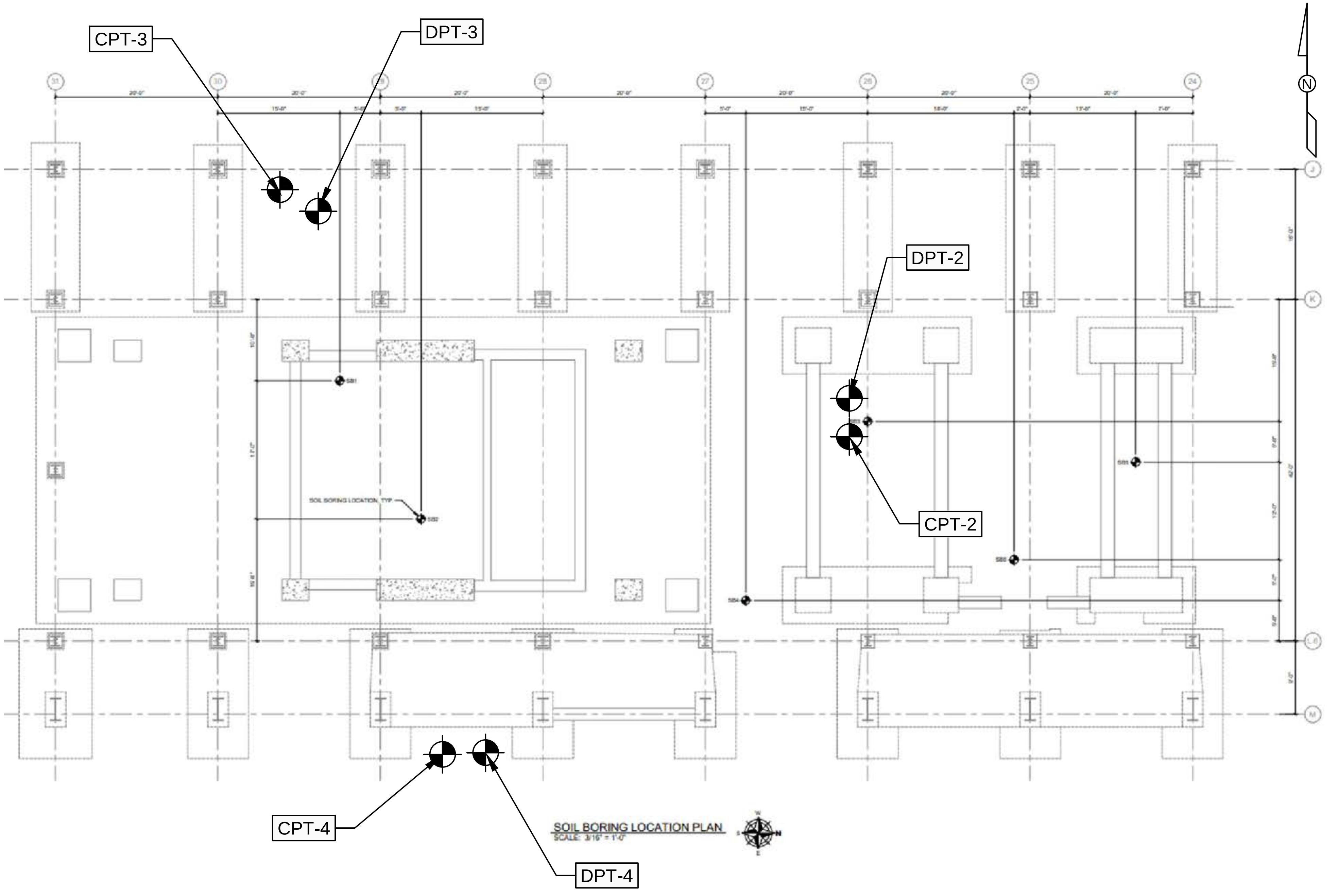
8.4 Exclusive Use

We have prepared this report for the exclusive use of CR Meyer and their design team, for specific application to the proposed New Tissue Machine foundations at ST Paper in Duluth, Minnesota. Professional services provided to this project were completed, findings obtained, and recommendations prepared using generally accepted engineering principles and practices. Conclusions and recommendations contained herein are based upon the applicable standards of our profession at the time this report was prepared. No warranty, express or implied, is made.

8.5 Safe Working Conditions

Responsibility to provide safe working conditions for earthwork and below grade aspects of this project is solely that of the contractors working on the project. It appears that the on site soils are generally OSHA Type B and C soils. However, our site exploration was limited to three test locations and therefore all excavations should be evaluated individually at the time of construction by the contractor. All local, state and federal requirements, statutes, ordinances, or building codes relating to slopes or temporary sheeting and bracing of trenches and excavations must be observed during construction.

APPENDIX



TwinPortsTesting

BORING LOCATION SKETCH
ST Paper New Tissue Machine Installation
Verso Facility
Duluth, Minnesota

DRAWN BY: JJB
CHECKED BY: BMC
DATE: 9/17/21
SCALE: N/A
DRAWING NO: 21G1426-01
TPT PROJECT NO: 21G1426
DRAWING NO: 1/1
REV: A

⊕ Approximate Test Location

TwinPortsTesting

DPT-2

BORING LOG

Page 1 of 1

PROJECT: **ST Paper New Tissue Machine Installation**

CLIENT: **CR Meyer**

TPT Project No.: **21G1426**

ARCHITECT - ENGINEER: **CR Meyer**

SITE LOCATION: **Duluth, MN**

BORING LOCATION: **See Boring Location Sketch**

REPORT DATE: **9/17/21**

SURFACE ELEVATION:

○ UNCONFINED COMPRESSIVE STRENGTH (TONS/FT^2) 1 2 3 4 5

☆ PERCENT PASSING #200 SIEVE 10 20 30 40 50

× PLASTIC LIMIT % ● WATER CONTENT % △ LIQUID LIMIT % 10 20 30 40 50

⊗ STANDARD PENETRATION TEST N-VALUE 10 20 30 40 50

DEPTH (ft) ELEVATION (ft)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	WATER LEVEL	GRAPHIC LOG	STRATA CHANGE DEPTH	DESCRIPTION OF MATERIAL
0.0								9 inches of concrete pavement
	1	CS			▼		0.8	(FILL) Poorly graded Sand with silt, fine to coarse grained, brown, moist to wet
	2	CS						
10.0	3	CS						
	4	CS					15.0	(SP) POORLY GRADED SAND, fine grained, brown, waterbearing
20.0	5	CS						
	6	CS					27.0	(CH) FAT CLAY, reddish brown, wet
30.0							30.0	Boring then Backfilled with Bentonite
40.0								End of Boring

WATER LEVEL **5 ft WD**

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL

BORING STARTED **09/17/21**

BORING COMPLETED **09/17/21**

ABBREVIATIONS: ACR-After Casing Removal, BCR-Before Casing Removal, AB-After Boring, WD-While Drilling, WS-While Sampling, NE-None Encountered, DB-Diamond Bit, HSA-Hollow Stem Auger, RB-Rock Bit, SS-Split Spoon, ST-Shelby Tube, PA-Power Auger, MR-Mud Rotary, CS-Continuous, RP-Rock Probe, PH-Percussion Hammer, WL-Water Level, WOH-Weight of Hammer, EIL-Exceeds Instrument Level, TS-Topsoil, PP-Pocket Penetrometer

WATER LEVEL

CAVE IN LEVEL

SPT HAMMER

RIG **6625CPT**

CREW CHIEF **JJB**

TwinPortsTesting

BORING LOG

DPT-3

Page 1 of 1

PROJECT: **ST Paper New Tissue Machine Installation**	CLIENT: **CR Meyer**	TPT Project No.: **21G1426**
ARCHITECT - ENGINEER: **CR Meyer**	SITE LOCATION: **Duluth, MN**	
BORING LOCATION: **See Boring Location Sketch**	REPORT DATE: **9/17/21**	

○ UNCONFINED COMPRESSIVE STRENGTH (TONS/FT^2) 1 2 3 4 5

☆ PERCENT PASSING #200 SIEVE 10 20 30 40 50

× PLASTIC LIMIT % ● WATER CONTENT % △ LIQUID LIMIT % 10 20 30 40 50

⊗ STANDARD PENETRATION TEST N-VALUE 10 20 30 40 50

SURFACE ELEVATION:

DEPTH (ft) / ELEVATION (ft)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	WATER LEVEL	GRAPHIC LOG	STRATA CHANGE DEPTH	DESCRIPTION OF MATERIAL
0.0								1 foot of concrete pavement
	1 2 3	CS CS CS			▼		1.0	(FILL) Poorly graded Sand with silt, fine to coarse grained, brown, moist to wet
10.0								
	4 5 6 7	CS CS CS PH CS					15.0	(SP) POORLY GRADED SAND, fine grained, brown, waterbearing
20.0								
30.0								
							38.0	(CH) FAT CLAY, reddish brown, wet
40.0							40.0	Boring then Backfilled with Bentonite End of Boring

WATER LEVEL **5 ft WD**	*THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU, THE TRANSITION MAY BE GRADUAL.*		
WATER LEVEL	BORING STARTED **09/17/21**	BORING COMPLETED **09/17/21**	ABBREVIATIONS: ACR-After Casing Removal, BCR-Before Casing Removal, AB-After Boring, WD-While Drilling, WS-While Sampling, NE-None Encountered, DB-Diamond Bit, HSA-Hollow Stem Auger, RB-Rock Bit, SS-Split Spoon, ST-Shelby Tube, PA-Power Auger, MR-Mud Rotary, CS-Continuous, RP-Rock Probe, PH-Percussion Hammer, WL-Water Level, WOH-Weight of Hammer, EIL-Exceeds Instrument Level, TS-Topsoil, PP-Pocket Penetrometer
WATER LEVEL	CAVE IN LEVEL		
SPT HAMMER	RIG **6625CPT**	CREW CHIEF **JJB**	

TwinPortsTesting

DPT-4

BORING LOG

Page 1 of 1

PROJECT: **ST Paper New Tissue Machine Installation**
CLIENT: **CR Meyer**
TPT Project No.: **21G1426**
ARCHITECT - ENGINEER: **CR Meyer**
SITE LOCATION: **Duluth, MN**
BORING LOCATION: **See Boring Location Sketch**
REPORT DATE: **9/17/21**

○ UNCONFINED COMPRESSIVE STRENGTH (TONS/FT^2) 1 2 3 4 5
☆ PERCENT PASSING #200 SIEVE 10 20 30 40 50
✕ PLASTIC LIMIT % ● WATER CONTENT % △ LIQUID LIMIT % 10 20 30 40 50
⊗ STANDARD PENETRATION TEST N-VALUE 10 20 30 40 50

DEPTH (ft) / ELEVATION (ft)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	WATER LEVEL	GRAPHIC LOG	STRATA CHANGE DEPTH	DESCRIPTION OF MATERIAL SURFACE ELEVATION:
0.0								10 inches of concrete pavement
	1	CS			▼	▨	0.8	(FILL) Poorly graded Sand with silt, fine to coarse grained, brown, moist to wet
	2	CS				▨		
10.0						▨		
	3	CS				▨		
	4	CS				⁚	15.0	(SP) POORLY GRADED SAND, fine grained, brown, waterbearing
20.0						⁚		
	5	CS				⁚		
	6	CS				⁚		
30.0						⁚		
		PH	■			⁚		
	7	CS				▨	35.0	(CH) FAT CLAY, reddish brown, wet
40.0							40.0	Boring then Backfilled with Bentonite End of Boring

WATER LEVEL **5 ft WD**

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL
BORING STARTED **09/16/21**
BORING COMPLETED **09/16/21**
WATER LEVEL
CAVE IN LEVEL
SPT HAMMER
RIG **6625CPT**
CREW CHIEF **JJB**

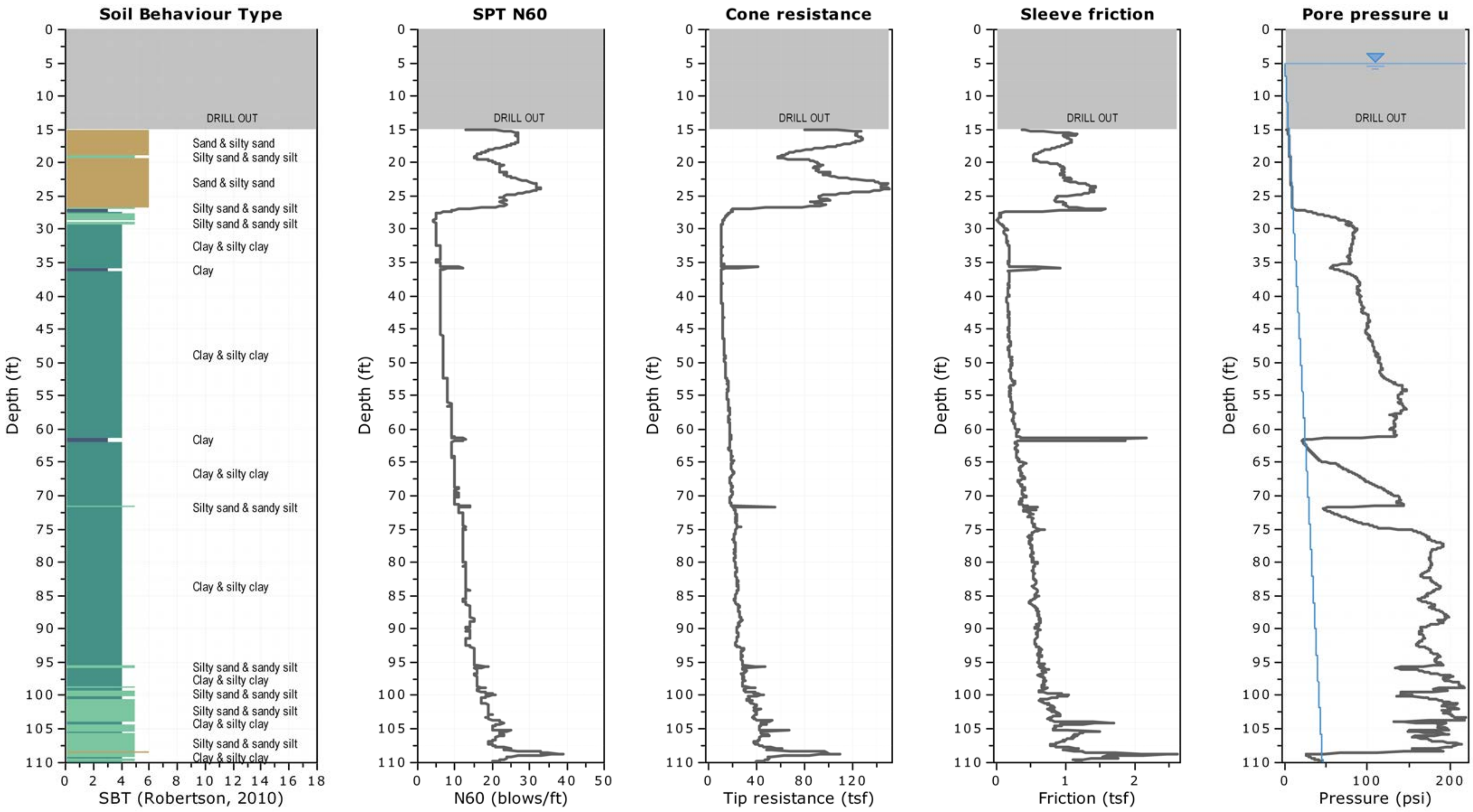
ABBREVIATIONS: ACR-After Casing Removal, BCR-Before Casing Removal, AB-After Boring, WD-While Drilling, WS-While Sampling, NE-None Encountered, DB-Diamond Bit, HSA-Hollow Stem Auger, RB-Rock Bit, SS-Split Spoon, ST-Shelby Tube, PA-Power Auger, MR-Mud Rotary, CS-Continuous, RP-Rock Probe, PH-Percussion Hammer, WL-Water Level, WOH-Weight of Hammer, EIL-Exceeds Instrument Level, TS-Topsoil, PP-Pocket Penetrometer

Twin Ports Testing
1301 North 3rd Street
Superior, WI 54880
www.twinportstesting.com

Project: **21G1426 ST Paper New Tissue Machine Installation**
Location: **100 N Central Avenue, Duluth, MN**

SOUNDING: CPT-2

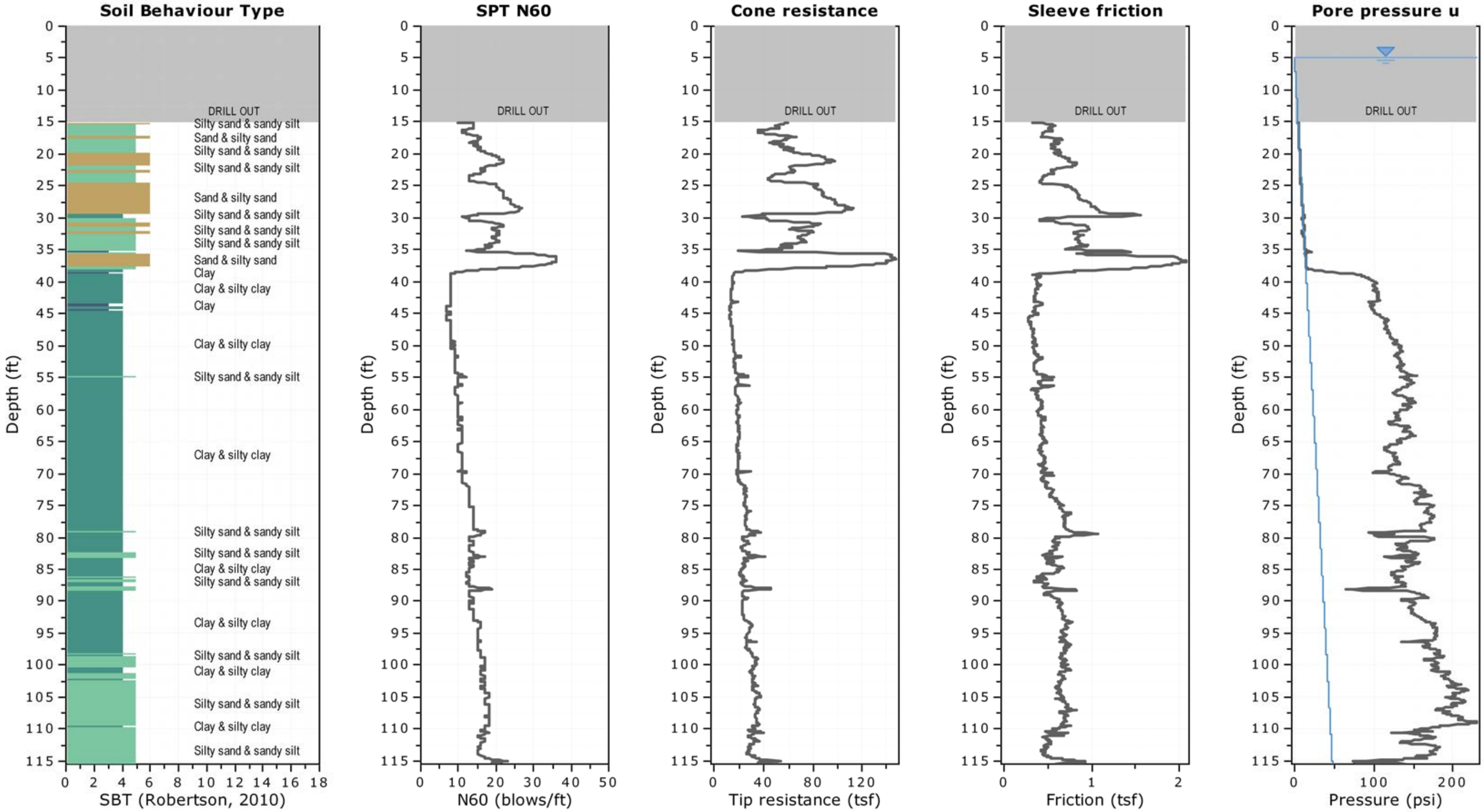
Total depth: 110.10 ft, Date: 9/16/2021
Cone Type: 10 sq. cm. NOVA
Cone Operator: Jim Johnson, PE



Twin Ports Testing
1301 North 3rd Street
Superior, WI 54880
www.twinportstesting.com

Project: **21G1426 ST Paper New Tissue Machine Installation**
Location: **100 N Central Avenue, Duluth, MN**

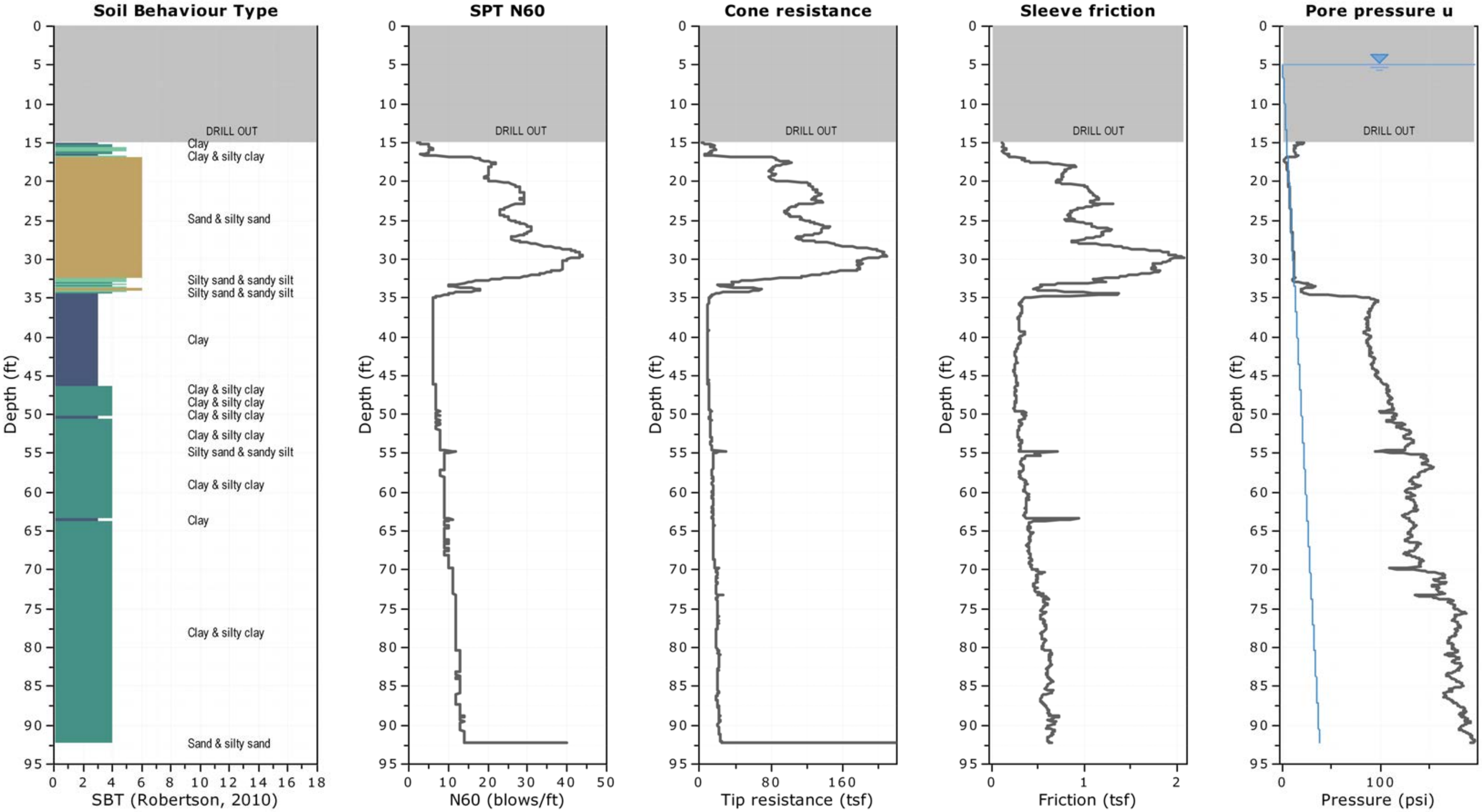
SOUNDING: CPT-3
Total depth: 115.49 ft, Date: 9/16/2021
Cone Type: 10 sq. cm. NOVA
Cone Operator: Jim Johnson, PE



Twin Ports Testing
1301 North 3rd Street
Superior, WI 54880
www.twinportstesting.com

Project: **21G1426 ST Paper New Tissue Machine Installation**
Location: **100 N Central Avenue, Duluth, MN**

SOUNDING: CPT-4
Total depth: 92.32 ft, Date: 9/16/2021
Cone Type: 10 sq. cm. NOVA
Cone Operator: Jim Johnson, PE



Twin Ports Testing Inc.

BORING LOG NOTES

Water Level

Water levels indicated on the boring logs are as measured at stated times. In clean sand soils, the elevations indicated are considered relatively reliable levels. However, in less permeable soils, even after several days of monitoring, accurate determinations may not be possible. Therefore, additional/alternative methods of groundwater elevation monitoring should be sought.

Commonly Used Moisture Conditions of Soils

Term	Meaning
Dry	Requires the addition of considerable moisture to attain optimum for compaction
Moist	Near optimum moisture for compaction
Wet	Requires drying to attain optimum moisture for compaction
Waterbearing	Saturated granular soils

Gradation Description and Terminology

Soil Type	Particle Name	Size Range
Coarse Grained Soils	Boulders	Over 12”
	Cobbles	3”-12”
	Gravels	#4-3”
	Gravels – Coarse	¾”-3”
	Gravels – Fine	#4-¾”
	Sands	#200-#4
	Sands – Coarse	#10-#4
	Sands – Medium	#40-#10
	Sands – Fine	#200-#40
Fine Grained Soils	Silt	0.005 mm-#200
	Clay	Less than 0.005 mm

Descriptive Terms of Components Present in Sample (other than ASTM D 2487)

Term	Percent of Dry Weight
Trace	1-5%
With	5-12%
Some	12-30%
And	30-50%

Relative Density of Granular Soils

N-Value (SPT)	Relative Density	Standard “N” Penetration
0-4	Very Loose	Blows per foot of a 140 pound hammer falling 30” on a 2” outside diameter split barrel sampler
5-10	Loose	
11-30	Medium Dense	
31-50	Dense	
Over 50	Very Dense	

Consistency of Cohesive Soils

N-Value (SPT)	Consistency	(Q, tsf or kg/cm^2)
0-2	Very Soft	Less than 0.25
3-4	Soft	0.25-0.50
5-8	Medium	0.50-1.00
9-15	Stiff	1.00-2.00
16-30	Very Stiff	2.00-4.00
Over 30	Hard	4.00-8.00

Twin Ports Testing Inc.

UNIFIED SOIL CLASSIFICATION SYSTEM – ASTM D 2487

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)			
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)		
	▨	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	▨	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)		
	▨	GM	Silty gravels, gravel-sand-silt mixtures
	▨	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)		
	▨	SW	Well-graded sands, gravelly sands, little or no fines
	▨	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)		
	▨	SM	Silty sands, sand-silt mixtures
	▨	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)			
SILTS AND CLAYS Liquid limit less than 50%	▨	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	▨	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	▨	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	▨	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	▨	CH	Inorganic clays of high plasticity, fat clays
	▨	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	▨	PT	Peat and other highly organic soils

LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART