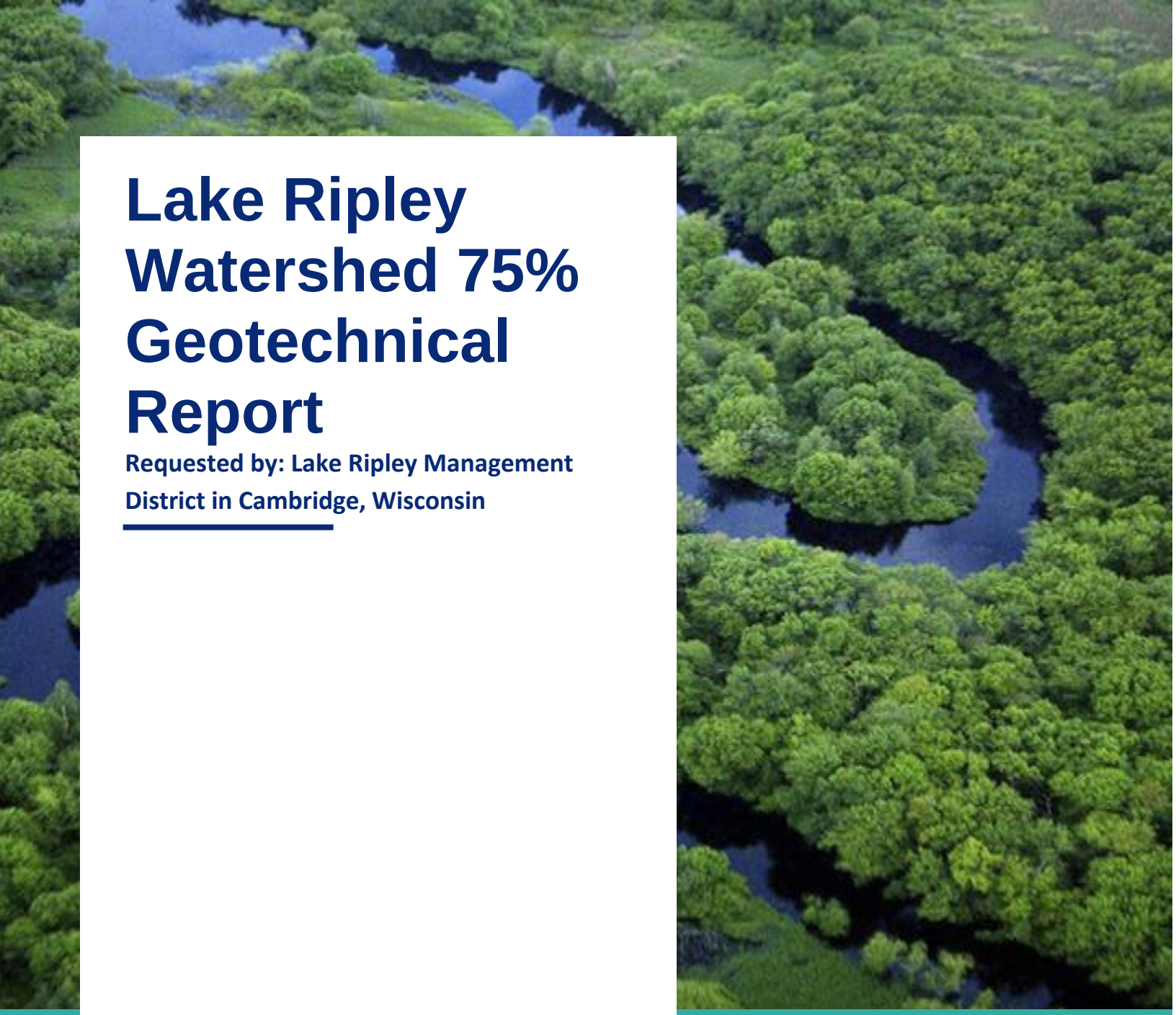

Lake Ripley Watershed 75% Geotechnical Report

Requested by: Lake Ripley Management District in Cambridge, Wisconsin

OCTOBER 21ST, 2021

BEAVER PROFESSIONAL SERVICES
Authored by: Faith Gillen, Will Mockert, Luke Senta, & Caroline Skotarzak

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BEAVER PROFESSIONAL SERVICES
NATURE BASED SOLUTIONS

Ms. Lianna Spencer
Lake Manager
N4450 County Road A
Cambridge, WI 53523

October 21st, 2021

RE: Subsurface Soil Investigation Report
Lake Ripley Management District Preserve
Village of Cambridge
Cambridge, WI

Dear Lianna Spencer,

Per your request, Beaver Professional Services has performed a Geotechnical Engineering Subsurface Investigation and Report for the Engineering Services for Watershed Improvements project. Enclosed you will find our "75% Geotechnical Report – Lake Ripley Management District Preserve," which showcases our conclusions and recommendations.

If there are any questions, comments, or concerns that arise as you review this report or if our firm can be of further service during the construction phase of the project, please feel free to reach out to me or any member of our team. Our goal is to make this project as seamless and successful as possible for the Lake Ripley Management District.

Thank you for your time,

Caroline R Skotarzak

Caroline R. Skotarzak
Project Manager
Beaver Professional Services

Enclosed:
Report (pg. 1)
Location Map (pg. 8)
Boring Logs (pg. 20)

DISCLAIMER: Student Project Documents

The concepts, drawings and written materials provided here were prepared by students in the Department of Civil & Environmental Engineering at the University of Wisconsin-Madison as an activity in the course Civ Engr 578 – Senior Capstone Design/GLE 479 – Geological Engineering Design. These do not represent the work products of licensed Professional Engineers. These are not for construction purposes.

Introduction

Beaver Professional Services has completed geotechnical investigation for the area of proposed watershed improvements surrounding Lake Ripley in Cambridge, WI. This investigation focuses on subsurface exploration adjacent to the Lake Ripley influent stream which will be the location of design. It also factors in locations on the Lake District Preserve just north of the influent stream that may be impacted by proposed designs.

This document contains analysis of soil and geological conditions of the project site. Recommendations will be made based on this investigation to limit the impact that site conditions could have on construction of engineering design alternatives.

Project Description

The Lake Ripley Management District seeks to improve water quality in Lake Ripley by making improvements to the lake's influent stream. This stream travels through the Lake District Preserve in addition to neighboring properties. Three proposed alternatives aim to redirect the stream to meander through the Lake District Preserve where native prairie species will strip the surface water of pollutants such as phosphorus as well as settling out suspended solids in the water before it reaches the lake.

The project area lies in a generally flat prairie wetland at an approximate elevation of 842 ft. There are no existing structures on the preserve, and there is a hill to the east of the proposed stream redirection that peaks at an approximate elevation of 884 ft.

Scope of Subsurface Exploration

Hollow stem augers were used to perform standard penetration test borings of the project area. Five soil borings (Borings 1-5) were collected for testing. All collected soil boring samples are included in Figure 9-13. Three were taken directly adjacent to the influent stream, and two were taken in the flat wetland north of the stream where redirected surface water will flow towards Lake Ripley. Boring 1 was taken at a location on the west side of the Lake District Preserve where a weir is proposed for Alternative 3. A detailed map of the boring locations can be found in Figure 3-4. Soil borings were drilled to a depth of 30 ft. This depth was sufficient to explore the existing soil conditions, but drilling did not need to extend to further depths due to the absence of any significant infrastructure being constructed on the site location.

Selection of boring location was determined based on proximity to where construction will take place in the three proposed alternatives. A boring was taken at the location where a weir would be implemented. The installation of a weir would require the presence of machinery and equipment that would affect soil conditions, so it is important to consider whether the presence of this equipment

would cause erosion of the streambanks. Another two borings were taken near the stream on the northside of where a berm and diversion would be implemented or the beginning of new stream excavation to gauge how the water table changes moving away from the influent stream. The final two borings were taken in the wetland to gain an understanding of the prairie's soil condition. Should a new channel be excavated through the prairie, machinery would need to enter this area. No matter what alternative is selected, the goal is to redirect water from the influent stream towards the wetland to then flow towards Lake Ripley. The team will need a comprehensive analysis of how increased surface water flow will affect soil conditions in this area.

To collect soil boring samples, a standard penetration test was performed at each location using hollow stem augers. This process was completed in accordance with ASTM D1586. This testing procedure obtains samples at discreet depths and provides a standardized blow count that can be used to analyze a soil sample. Collection and testing were performed by Beaver Professional Services geotechnical engineering team on October 1, 2021.

Site Description

Area Geology

Lake Ripley is located in Cambridge, WI in Jefferson County. An estimation of existing area geology was collected from the Natural Resources Conservation Service (NRCS). A map of the NRCS data for the Lake Ripley project location is illustrated in Figure 5. Approximately 50 percent of the intended site location consists of Houghton muck. A detailed description of Houghton muck is located in the "NRCS Soil Survey Information" in the Appendix. This section of the project site is the low-lying prairie in the Lake District Preserve. Houghton muck is abundant in herbaceous organic material, and in the site location of this project, it is very poorly drained. Houghton muck is accompanied in the project area by small sections of Wacousta silty clay loam and Casco-Rodman complex soil. These sections are located on the eastern hill and on areas of higher elevation on the project site. Detailed descriptions of both soil types are also located in the "NRCS Soil Survey Information" in the Appendix.

Subsurface Conditions

Collected soil borings show a distribution of a sand and clay layer to approximate depths of 5 ft where it then transitions to lean clay layers up to an approximate 15 ft depth. Moving deeper in the boring, a sandy layer with gravel is located from approximate depths of 15 ft to 27 ft. Finally in the deepest section of the soil boring, a very dense layer is found that shows characteristics of weathered sandstone bedrock. A schematic of the general soil cross-section for the Lake Ripley project site is laid out in Figure 1, further details of each individual boring can be found in Figures 9-13 in the Appendix.

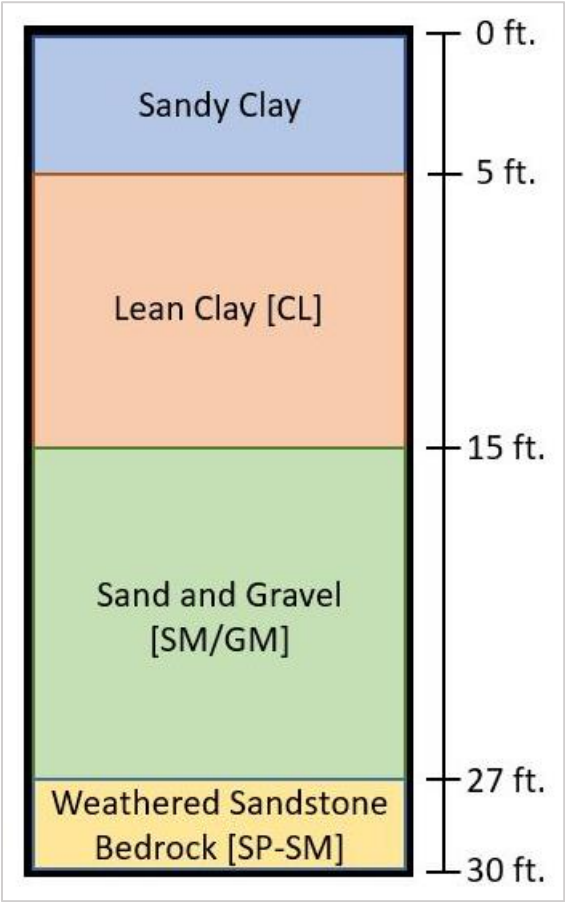


Figure 1: General Soil Cross-Section on Lake Ripley Preserve

Groundwater Conditions

Water table elevation plays an important role in borings collected from the Lake Ripley project site. Groundwater was encountered at 2-3 ft. in the soil borings adjacent to the influent stream and at 5 ft. depth for the borings in the central area of the Lake District Preserve. Groundwater levels found closer to the surface is a result of the proximity of the Lake Ripley influent stream to the boring location. Groundwater conditions will continue to be a factor in engineering design of this project because it will affect the construction conditions of a proposed alternative. Settlement caused by excavators on the site will need to be determined to avoid unnecessary delays caused by wet conditions in the surrounding area.

Environmental Concerns

While the collected soil borings do not show signs of contamination, it is recommended that a more detailed environmental investigation and report be conducted prior to the beginning construction services for this project.

Discussion and Recommendations

Site Selection

When investigating the differences between the location of where a weir would be installed versus the location where a berm would be implemented of a new channel excavated, there are minimal differences because both sites are directly adjacent to the influent stream. There is a general uniformity among the characteristics of all soil borings that shows there is no need to limit site selection based on geotechnical advantage.

Bearing Capacity

The footprint of the 30,000 lb excavator to be used in construction is 100 sq. ft. This corresponds to a 300 psf loading from the excavator that must be resisted by soil during construction. Allowable bearing capacity calculations found in the Calculations section of this report indicate that the project site has a bearing capacity of 3310 psf with a factor of safety of 3.0. For this reason, excavation does not pose a reason for concern over geological site conditions.

Geotechnical-Related Construction Issues

Season of Construction Considerations

The bulk of work will take place in the upper layer of sandy clay topsoil, creating a potentially unstable environment for larger equipment. Due to these unstable surface conditions, BPS is recommending all construction activities requiring heavy equipment to be executed during the Winter months, when the ground is frozen, so that soil conditions are at their most stable. If using heavy machinery when the soil is thawed, BPS recommends using a swamp mat or another wetland construction method to ensure safe use of equipment.

Soil Reuse

Soil excavated In each of the three alternatives will be used to grade the streambank on the north side where overflow is expected in each alternative. In Alternative 1, there will be less need for soil reuse and more need to dispose of excavated soil. Any excess soil that cannot be reused on the project site will be transported by dump truck to a landfill for a cost of $0.025 per pound of soil.

Calculations

Ultimate Bearing Capacity (Q_u):

For soil type found in NRCS data, attributes estimated include:

- Cohesion, c = 1.5 psi
- Friction angle, Φ'=30 degrees, therefore:
  - $N_q = 22.46$
  - $N_c = 37.16$
  - $N_\gamma = 19.70$
- Saturated unit weight of soil, 100 pcf

- Unit weight of water, 62.4 pcf
- D = depth of footing = 0.5 ft. for 6" weir installation
- B = footing width = 4 ft.

$$Q_u = cN_c + \gamma DN_q + 0.5\gamma BN_\gamma$$

$$Q_u = 1.5psi * \frac{144in^2}{ft^2} * 37.16 + (100pcf - 62.4pcf) * 0.5\,ft * 22.46 + 0.5 * (100pcf - 62.4pcf) * 4ft * 19.70 = 9930.25\,psf$$

Allowable Bearing Capacity (Q_{all}):

Factor of Safety (FS) = 3, therefore:

$$Q_{all} = \frac{Q_u}{FS} = (9930.25\,psf)/3.0 = 3310.08\,psf$$

Appendix

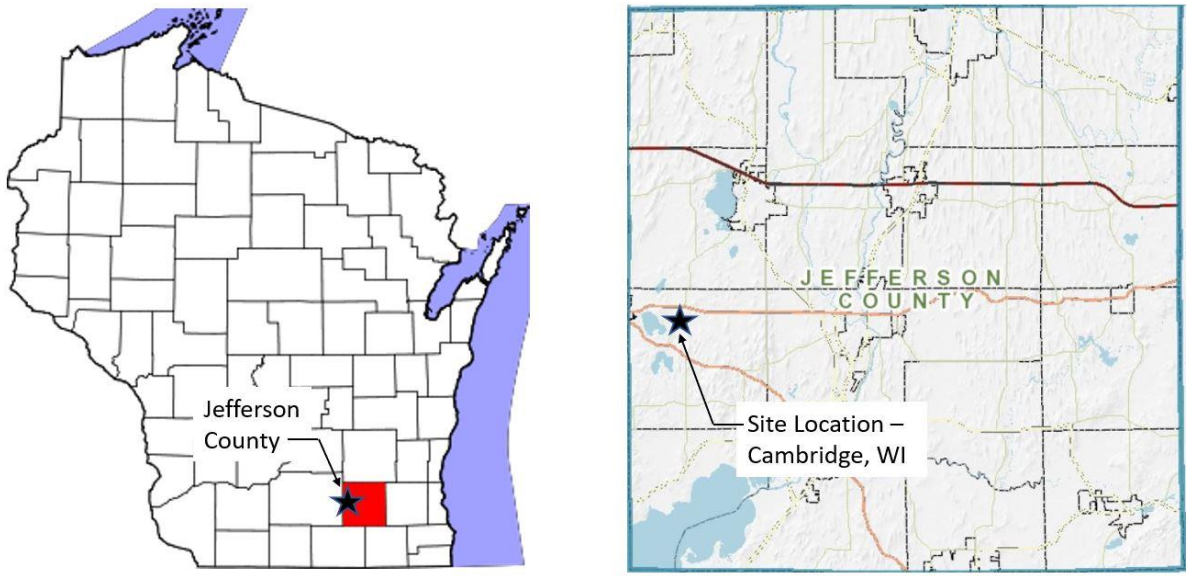


Figure 2: Project Site Location

Figure 3: Soil Boring 1 Location

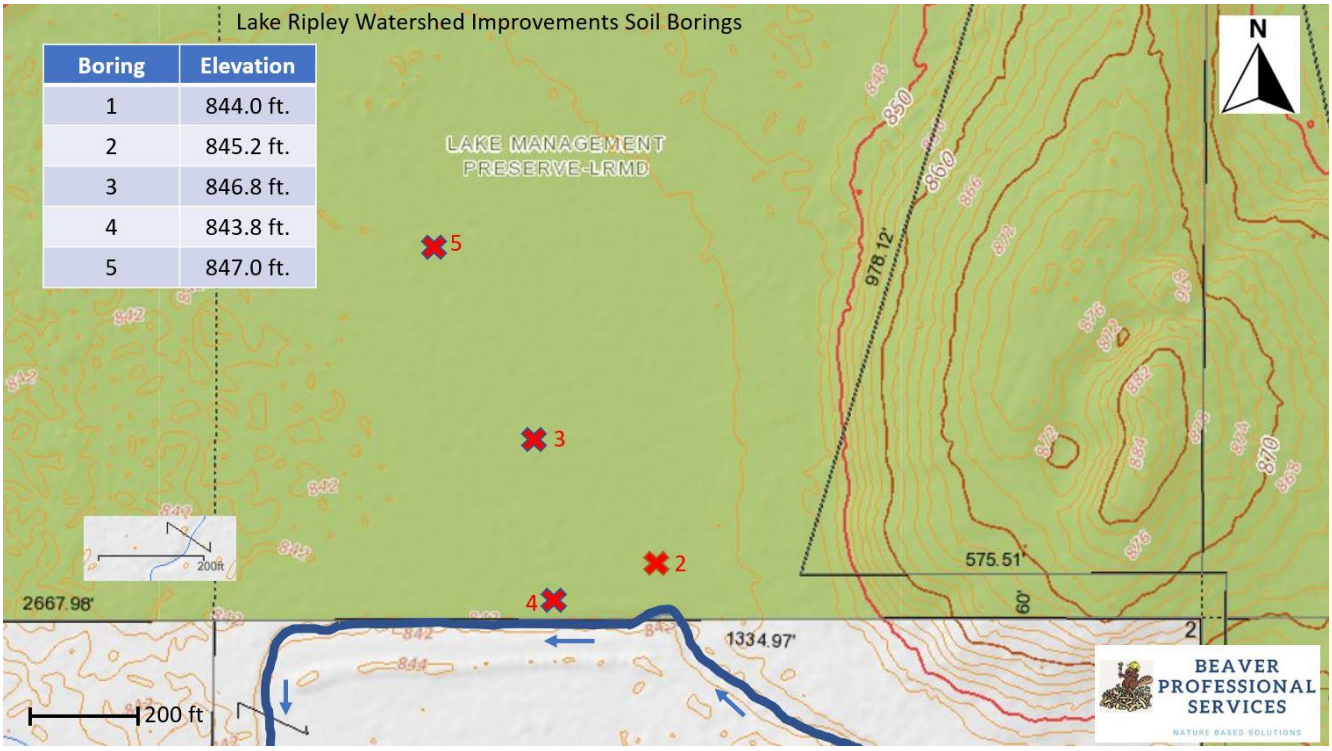


Figure 4: Soil Borings 2-4 Location

Figure 5: NRCS Map

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jefferson County, Wisconsin
Survey Area Data: Version 20, Sep 9, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 29, 2011—Mar 28, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CrD2	Casco-Rodman complex, 12 to 20 percent slopes, eroded	14.1	15.1%
FoC2	Fox loam, 6 to 12 percent slopes, eroded	6.9	7.4%
FsB	Fox silt loam, 2 to 6 percent slopes	6.0	6.4%
Ht	Houghton muck, 0 to 2 percent slopes	47.6	51.0%
RaA	Radford silt loam, 0 to 3 percent slopes	1.1	1.2%
VwA	Virgil silt loam, gravelly substratum, 0 to 3 percent slopes	4.4	4.7%
Wa	Wacousta silty clay loam, 0 to 2 percent slopes	13.2	14.1%
Totals for Area of Interest		**93.3**	**100.0%**

Figure 6: Houghton Muck Data

Jefferson County, Wisconsin

Ht—Houghton muck, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2szff
Elevation: 600 to 1,090 feet
Mean annual precipitation: 31 to 35 inches
Mean annual air temperature: 43 to 48 degrees F
Frost-free period: 124 to 192 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Houghton, muck, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Houghton, Muck

Setting

Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Herbaceous organic material

Typical profile

Oap - 0 to 6 inches: muck
Oa - 6 to 79 inches: muck

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 5.95 in/hr)
Depth to water table: About 0 to 4 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 23.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Hydric soil rating: Yes

Minor Components

Houghton, ponded
Percent of map unit: 4 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Palms
Percent of map unit: 2 percent
Landform: Lakebeds (relict)
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Adrian
Percent of map unit: 2 percent
Landform: Lakebeds (relict)
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Willette, muck
Percent of map unit: 1 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Edwards
Percent of map unit: 1 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Jefferson County, Wisconsin
Survey Area Data: Version 20, Sep 9, 2021

Figure 7: Casco-Rodman Complex Data

Jefferson County, Wisconsin

CrD2—Casco-Rodman complex, 12 to 20 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2tjwm
Elevation: 640 to 1,200 feet
Mean annual precipitation: 29 to 35 inches
Mean annual air temperature: 43 to 48 degrees F
Frost-free period: 124 to 192 days
Farmland classification: Not prime farmland

Map Unit Composition

Casco, eroded, and similar soils: 53 percent
Rodman, eroded, and similar soils: 37 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Casco, Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy alluvium over calcareous, stratified sandy and gravelly outwash

Typical profile

Ap - 0 to 5 inches: loam
Bt - 5 to 17 inches: clay loam
2C - 17 to 79 inches: stratified sand to gravel

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 11 to 20 inches to strongly contrasting textural stratification
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Forage suitability group: Low AWC, adequately drained with limitations (G095BY003WI)
Other vegetative classification: Low AWC, adequately drained with limitations (G095BY003WI)
Hydric soil rating: No

Description of Rodman, Eroded

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy and gravelly outwash

Typical profile

Ap - 0 to 4 inches: gravelly sandy loam
Bw - 4 to 10 inches: gravelly sandy loam
C - 10 to 79 inches: stratified sand to gravel

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 45 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: R108AY012IL - Outwash Prairie, R110XY018IL - Steep Gravel Prairie
Forage suitability group: Low AWC, adequately drained with limitations (G095BY003WI)
Other vegetative classification: Low AWC, adequately drained with limitations (G095BY003WI)
Hydric soil rating: No

Minor Components

Fox

Percent of map unit: 10 percent
Landform: Moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Jefferson County, Wisconsin
Survey Area Data: Version 20, Sep 9, 2021

Figure 8: Wacousta Silty Clay Loam Data

Jefferson County, Wisconsin

Wa—Wacousta silty clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2tjx1
Elevation: 690 to 1,020 feet
Mean annual precipitation: 32 to 35 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 110 to 172 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Wacousta and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wacousta

Setting

Landform: Interdrumlins
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Stratified silty lacustrine deposits

Typical profile

Ap - 0 to 13 inches: silty clay loam
Bg - 13 to 19 inches: silty clay loam
Cg - 19 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 12.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w

Hydrologic Soil Group: B/D
Forage suitability group: Frequently flooded, organics (G095BY010WI)
Other vegetative classification: Frequently flooded, organics (G095BY010WI)
Hydric soil rating: Yes

Minor Components

Sable

Percent of map unit: 8 percent
Landform: Interdrumlins
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

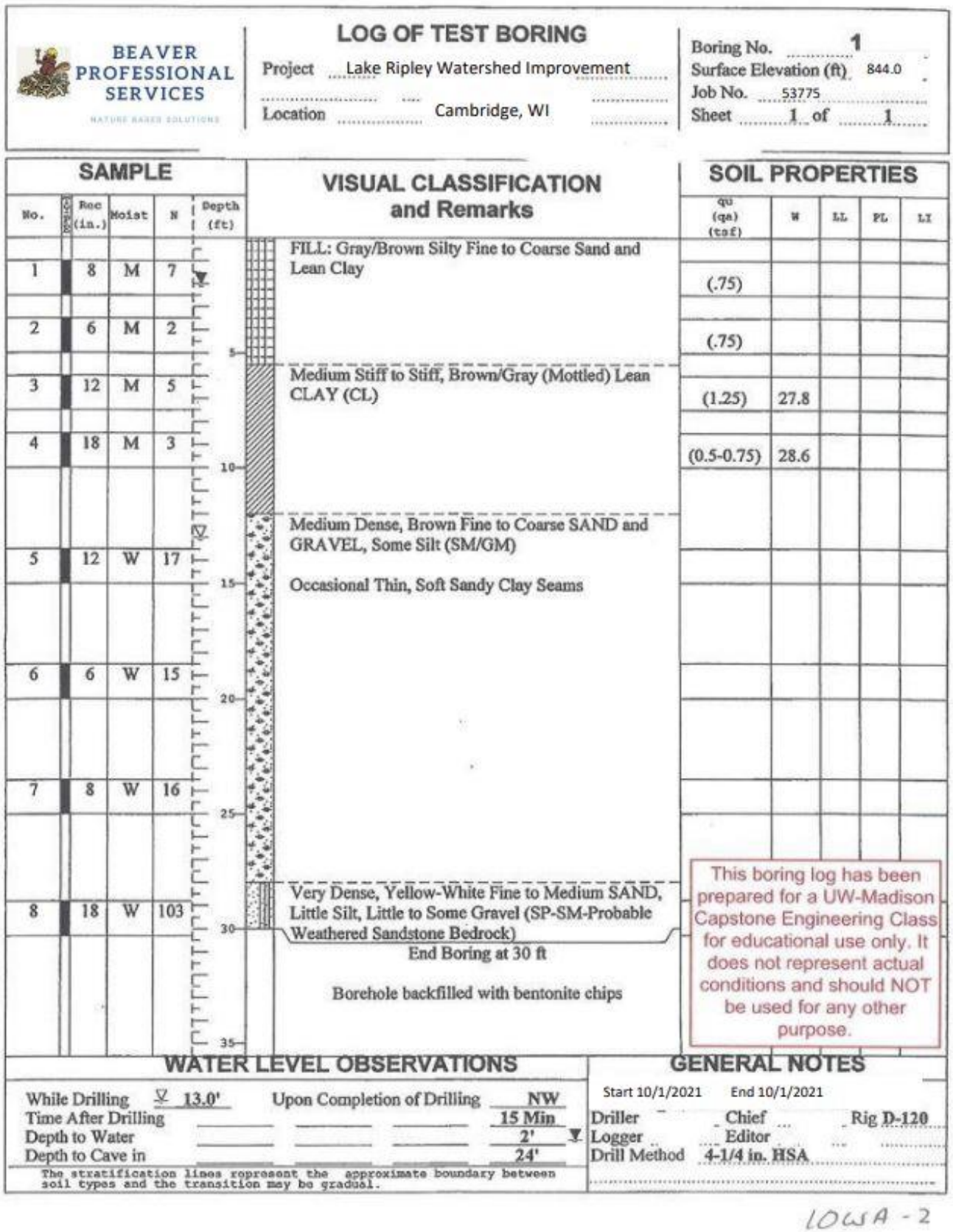
Sebewa

Percent of map unit: 7 percent
Landform: Interdrumlins
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Jefferson County, Wisconsin
Survey Area Data: Version 20, Sep 9, 2021

Figure 9: Boring 1



BEAVER PROFESSIONAL SERVICES
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LOG OF TEST BORING

Project: Lake Ripley Watershed Improvement
Location: Cambridge, WI

Boring No. 1
Surface Elevation (ft) 844.0
Job No. 53775
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES qu (qa) (tsf)	W	LL	PL	LI
1	8	M	7		FILL: Gray/Brown Silty Fine to Coarse Sand and Lean Clay	(.75)				
2	6	M	2	5		(.75)				
3	12	M	5		Medium Stiff to Stiff, Brown/Gray (Mottled) Lean CLAY (CL)	(1.25)	27.8			
4	18	M	3	10		(0.5-0.75)	28.6			
5	12	W	17		Medium Dense, Brown Fine to Coarse SAND and GRAVEL, Some Silt (SM/GM) Occasional Thin, Soft Sandy Clay Seams					
6	6	W	15	20						
7	8	W	16	25						
8	18	W	103	30	Very Dense, Yellow-White Fine to Medium SAND, Little Silt, Little to Some Gravel (SP-SM-Probable Weathered Sandstone Bedrock) End Boring at 30 ft Borehole backfilled with bentonite chips					
				35						

This boring log has been prepared for a UW-Madison Capstone Engineering Class for educational use only. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling	▽ 13.0'	Upon Completion of Drilling	NW	
Time After Drilling			15 Min	
Depth to Water			2'	▽
Depth to Cave in			24'	

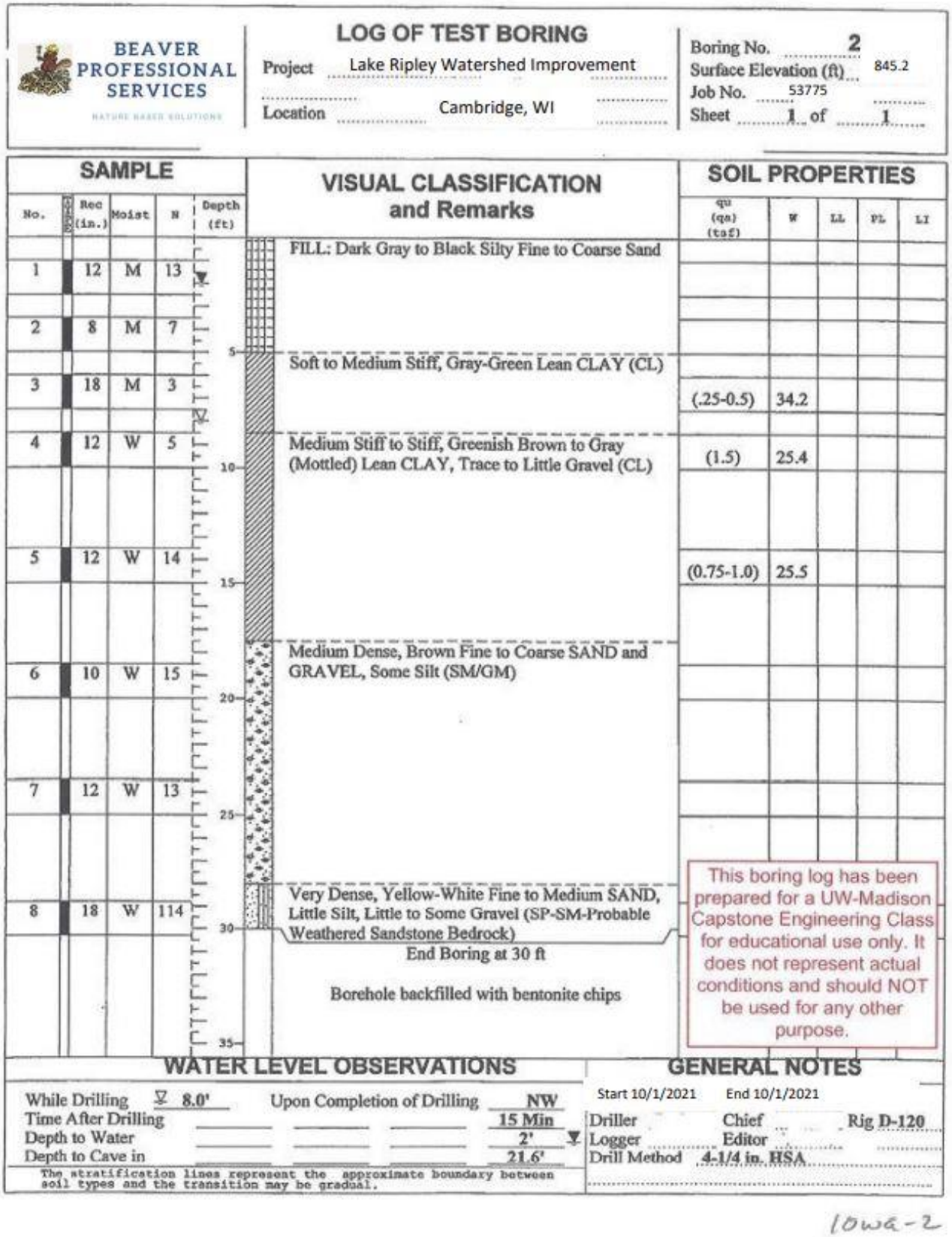
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 10/1/2021 End 10/1/2021
Driller Chief Rig D-120
Logger Editor
Drill Method 4-1/4 in. HSA

IOWA-2

Figure 10: Boring 2



BEAVER PROFESSIONAL SERVICES
NATURE BASED SOLUTIONS

LOG OF TEST BORING

Project: Lake Ripley Watershed Improvement
Location: Cambridge, WI

Boring No. 2
Surface Elevation (ft) 845.2
Job No. 53775
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (taf)	W	LL	PL	LI
					FILL: Dark Gray to Black Silty Fine to Coarse Sand					
1	12	M	13							
2	8	M	7	5						
					Soft to Medium Stiff, Gray-Green Lean CLAY (CL)					
3	18	M	3			(.25-0.5)	34.2			
4	12	W	5		Medium Stiff to Stiff, Greenish Brown to Gray (Mottled) Lean CLAY, Trace to Little Gravel (CL)	(1.5)	25.4			
				10						
5	12	W	14			(0.75-1.0)	25.5			
				15						
					Medium Dense, Brown Fine to Coarse SAND and GRAVEL, Some Silt (SM/GM)					
6	10	W	15	20						
7	12	W	13							
				25						
					Very Dense, Yellow-White Fine to Medium SAND, Little Silt, Little to Some Gravel (SP-SM-Probable Weathered Sandstone Bedrock)					
8	18	W	114	30	End Boring at 30 ft					
					Borehole backfilled with bentonite chips					
				35						

This boring log has been prepared for a UW-Madison Capstone Engineering Class for educational use only. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling ▽ 8.0'
Upon Completion of Drilling NW
Time After Drilling 15 Min
Depth to Water 2' ▽
Depth to Cave in 21.6'

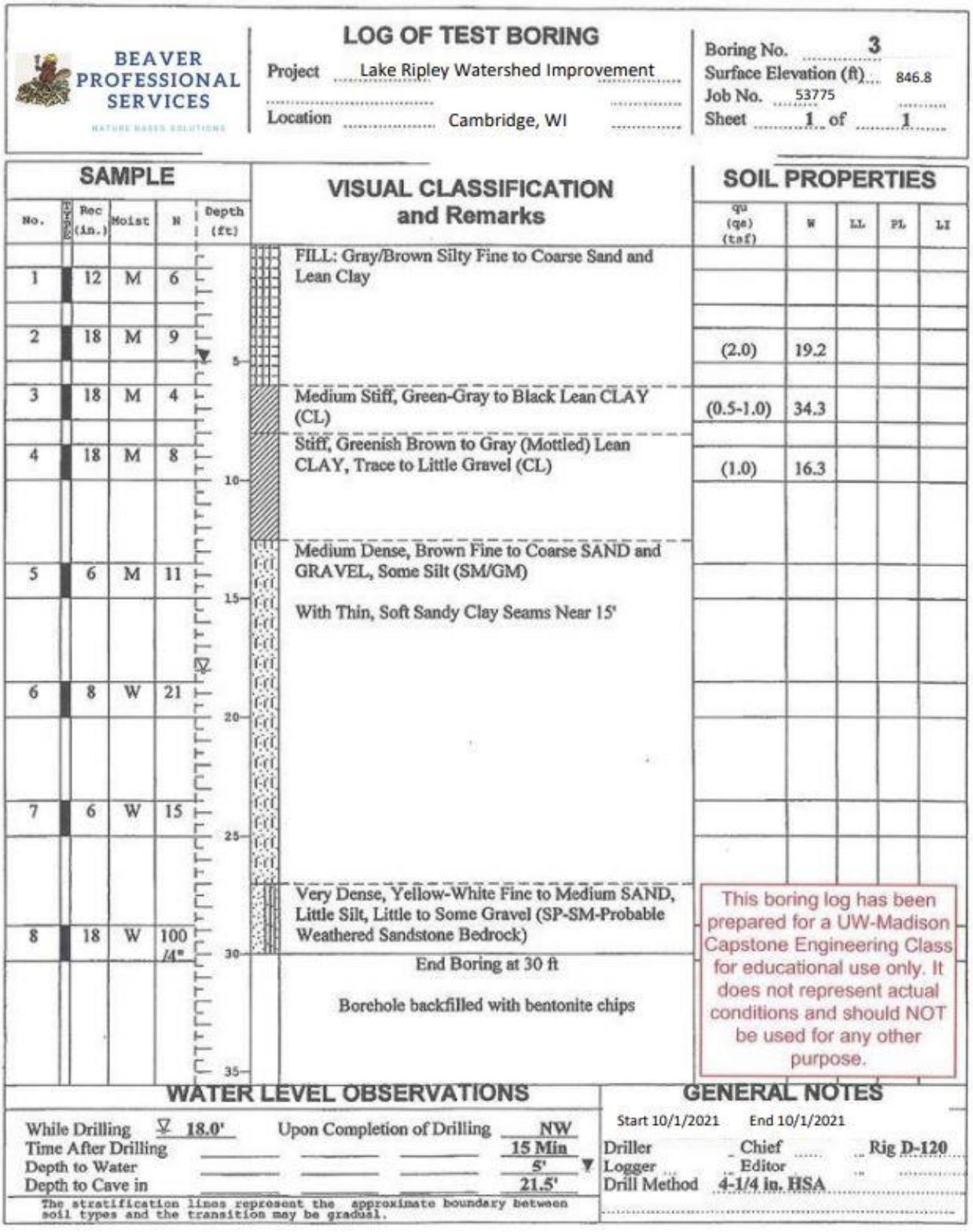
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 10/1/2021 End 10/1/2021
Driller Chief Rig D-120
Logger Editor
Drill Method 4-1/4 in. HSA

Iowa-2

Figure 11: Boring 3



BEAVER PROFESSIONAL SERVICES
NATURE BASED SOLUTIONS

LOG OF TEST BORING

Project: Lake Ripley Watershed Improvement
Location: Cambridge, WI

Boring No. 3
Surface Elevation (ft) 846.8
Job No. 53775
Sheet 1 of 1

SAMPLE No.	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qe) (tsf)	W	LL	PL	LI
1	12	M	6		FILL: Gray/Brown Silty Fine to Coarse Sand and Lean Clay					
2	18	M	9	5		(2.0)	19.2			
3	18	M	4		Medium Stiff, Green-Gray to Black Lean CLAY (CL)	(0.5-1.0)	34.3			
4	18	M	8	10	Stiff, Greenish Brown to Gray (Mottled) Lean CLAY, Trace to Little Gravel (CL)	(1.0)	16.3			
5	6	M	11	15	Medium Dense, Brown Fine to Coarse SAND and GRAVEL, Some Silt (SM/GM) With Thin, Soft Sandy Clay Seams Near 15'					
6	8	W	21	20						
7	6	W	15	25						
8	18	W	100/4"	30	Very Dense, Yellow-White Fine to Medium SAND, Little Silt, Little to Some Gravel (SP-SM-Probable Weathered Sandstone Bedrock)					
				35	End Boring at 30 ft Borehole backfilled with bentonite chips					

This boring log has been prepared for a UW-Madison Capstone Engineering Class for educational use only. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling	▽ 18.0'	Upon Completion of Drilling	NW
Time After Drilling			15 Min
Depth to Water			5' ▼
Depth to Cave in			21.5'

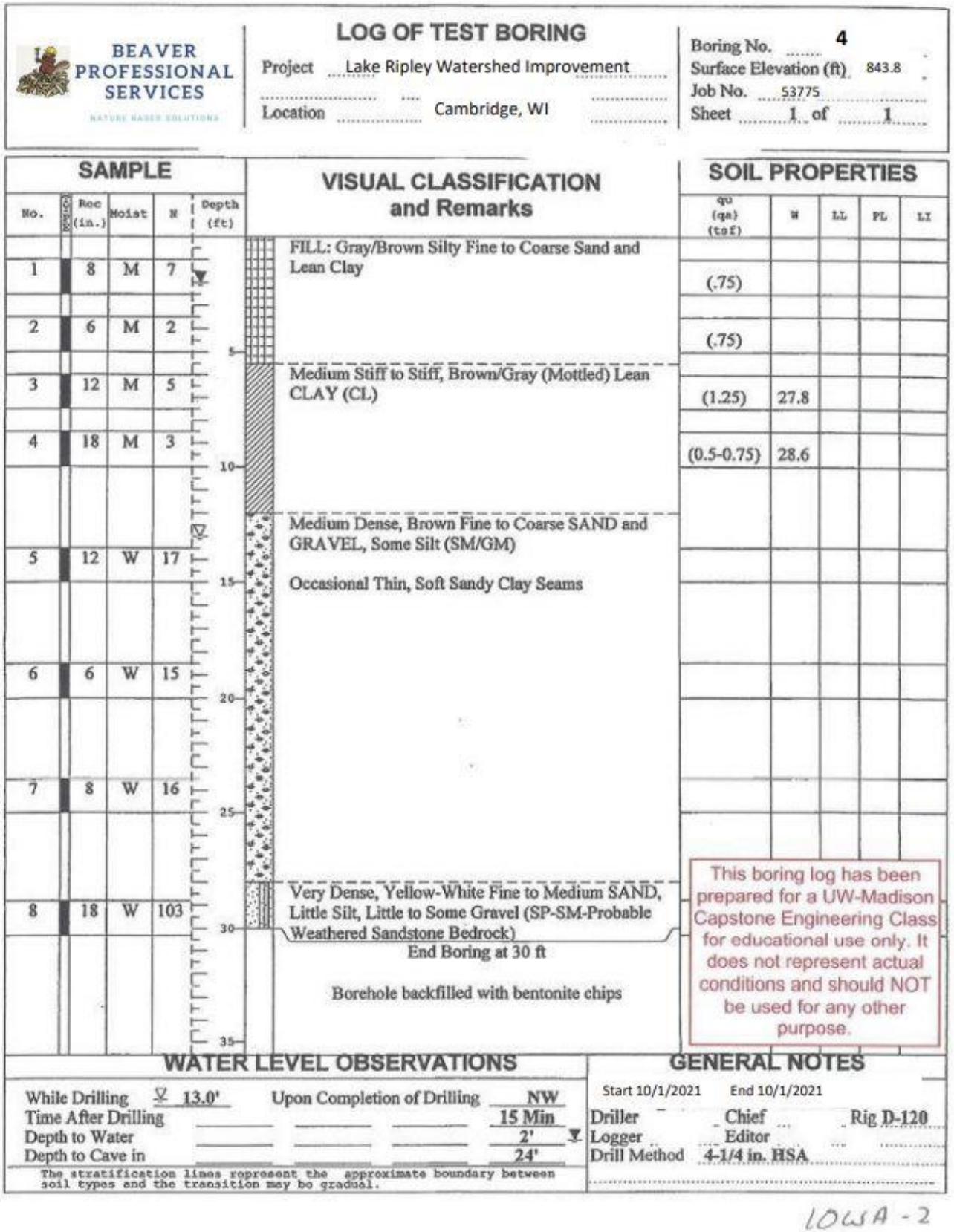
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 10/1/2021 End 10/1/2021
Driller Chief Rig D-120
Logger Editor
Drill Method 4-1/4 in. HSA

Iowa-2

Figure 12: Boring 4



BEAVER PROFESSIONAL SERVICES
NATURE BASED SOLUTIONS

LOG OF TEST BORING

Project: Lake Ripley Watershed Improvement
Location: Cambridge, WI

Boring No. 4
Surface Elevation (ft) 843.8
Job No. 53775
Sheet 1 of 1

SAMPLE No.	Core	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES qu (qa) (tsf)	W	LL	PL	LI
1		8	M	7		FILL: Gray/Brown Silty Fine to Coarse Sand and Lean Clay	(.75)				
2		6	M	2	5		(.75)				
3		12	M	5		Medium Stiff to Stiff, Brown/Gray (Mottled) Lean CLAY (CL)	(1.25)	27.8			
4		18	M	3	10		(0.5-0.75)	28.6			
5		12	W	17	15	Medium Dense, Brown Fine to Coarse SAND and GRAVEL, Some Silt (SM/GM) Occasional Thin, Soft Sandy Clay Seams					
6		6	W	15	20						
7		8	W	16	25						
8		18	W	103	30	Very Dense, Yellow-White Fine to Medium SAND, Little Silt, Little to Some Gravel (SP-SM-Probable Weathered Sandstone Bedrock) End Boring at 30 ft Borehole backfilled with bentonite chips					
					35						

This boring log has been prepared for a UW-Madison Capstone Engineering Class for educational use only. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling ▽ 13.0'	Upon Completion of Drilling		NW
Time After Drilling			15 Min
Depth to Water			2' ▽
Depth to Cave in			24'

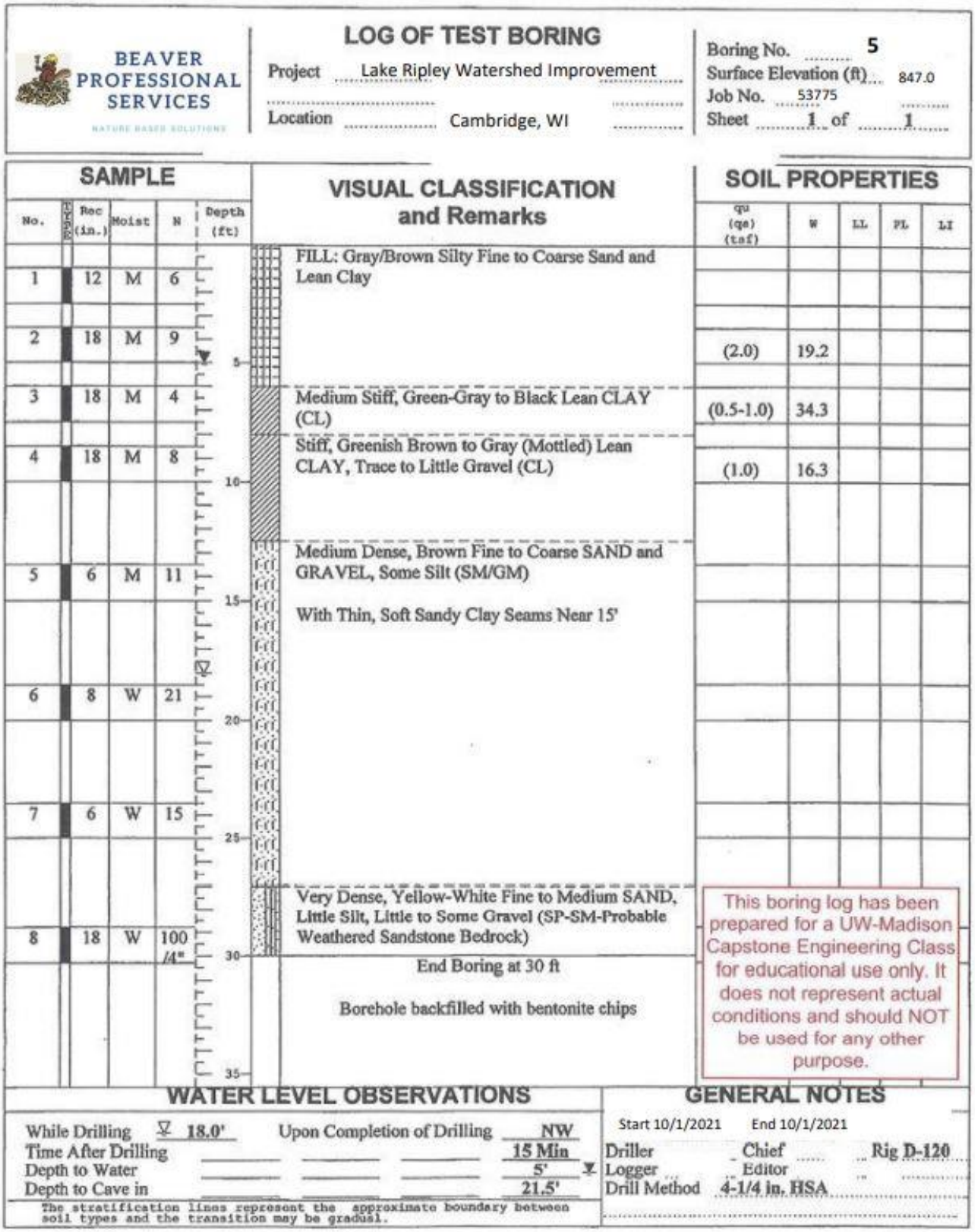
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 10/1/2021 End 10/1/2021
Driller Chief Rig D-120
Logger Editor
Drill Method 4-1/4 in. HSA

IOWA-2

Figure 13: Boring 5



BEAVER PROFESSIONAL SERVICES
NATURE BASED SOLUTIONS

LOG OF TEST BORING

Project: Lake Ripley Watershed Improvement
Location: Cambridge, WI

Boring No. 5
Surface Elevation (ft) 847.0
Job No. 53775
Sheet 1 of 1

SAMPLE No.	Type	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LI
1		12	M	6		FILL: Gray/Brown Silty Fine to Coarse Sand and Lean Clay					
2		18	M	9	5		(2.0)	19.2			
3		18	M	4		Medium Stiff, Green-Gray to Black Lean CLAY (CL)	(0.5-1.0)	34.3			
4		18	M	8	10	Stiff, Greenish Brown to Gray (Mottled) Lean CLAY, Trace to Little Gravel (CL)	(1.0)	16.3			
5		6	M	11	15	Medium Dense, Brown Fine to Coarse SAND and GRAVEL, Some Silt (SM/GM) With Thin, Soft Sandy Clay Seams Near 15'					
6		8	W	21	20						
7		6	W	15	25						
8		18	W	100/4"	30	Very Dense, Yellow-White Fine to Medium SAND, Little Silt, Little to Some Gravel (SP-SM-Probable Weathered Sandstone Bedrock) End Boring at 30 ft Borehole backfilled with bentonite chips					
					35						

This boring log has been prepared for a UW-Madison Capstone Engineering Class for educational use only. It does not represent actual conditions and should NOT be used for any other purpose.

WATER LEVEL OBSERVATIONS

While Drilling	▽ 18.0'	Upon Completion of Drilling	NW
Time After Drilling			15 Min
Depth to Water			5' ▼
Depth to Cave in			21.5'

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 10/1/2021 End 10/1/2021
Driller Chief Rig D-120
Logger Editor
Drill Method 4-1/4 in. HSA

Iowa-2

LOG OF TEST BORING
General Notes

Descriptive Soil Classification

GRAIN SIZE TERMINOLOGY

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders	Larger than 12"	Larger than 12"
Cobbles	3" to 12"	3" to 12"
Gravel: Coarse	3/4" to 3"	3/4" to 3"
Fine	4.76 mm to 3/4"	#4 to 3/4"
Sand: Coarse	2.00 mm to 4.76 mm	#10 to #4
Medium	0.42 to mm to 2.00 mm	#40 to #10
Fine	0.074 mm to 0.42 mm	#200 to #40
Silt	0.005 mm to 0.074 mm	Smaller than #200
Clay	Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

GENERAL TERMINOLOGY

Physical Characteristics
Color, moisture, grain shape, fineness, etc.
Major Constituents
Clay, silt, sand, gravel
Structure
Laminated, varved, fibrous, stratified, cemented, fissured, etc.
Geologic Origin
Glacial, alluvial, eolian, residual, etc.

RELATIVE DENSITY

Term	"N" Value
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

RELATIVE PROPORTIONS OF OF COHESIONLESS SOILS

Proportional Term	Defining Range by Percentage of Weight
Trace	0%-5%
Little	5%-12%
Some	12%-35%
And	35%-50%

CONSISTENCY

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.50
Medium	0.50 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	Loss on Ignition
Non Organic	Less than 4%
Organic Silt/Clay	4-12%
Sedimentary Peat	12-50%
Fibrous and Woody Peat	More than 50%

PLASTICITY

Term	Plastic Index
None to Slight	0-4
Slight	5-7
Medium	8-22
High to Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

SYMBOLS

DRILLING AND SAMPLING

CS--Continuous Sampling
RC--Rock Coring: Size AW, BW, NW, 2"W
RQD--Rock Quality Designator
RB--Rock Bit
FT--Fish Tail
DC--Drove Casing
C--Casing: Size 2 1/2", NW, 4", HW
CW--Clear Water
DM--Drilling Mud
HSA--Hollow Stem Auger
FA--Flight Auger
HA--Hand Auger
COA--Clean-Out Auger
SS--2" Diameter Split-Barrel Sample
2ST--2" Diameter Thin-Walled Tube Sample
3ST--3" Diameter Thin-Walled Tube Sample
PT--3" Diameter Piston Tube Sample
AS--Auger Sample
WS--Wash Sample
PTS--Peat Sample
PS--Pitcher Sample
NR--No Recovery
S--Sounding
PMT--Borehole Pressuremeter Test
VS--Vane Shear Test
WPT--Water Pressure Test

LABORATORY TESTS

q_p--Penetrometer Reading, tons/sq. ft.
q_u--Unconfined Strength, tons/sq. ft.
W--Moisture Content, %
LL--Liquid Limit, %
PL--Plastic Limit, %
SL--Shrinkage Limit, %
LI--Loss on Ignition, %
D--Dry Unit Weight, lbs/cu. ft.
pH--Measure of Soil Alkalinity or Acidity
FS--Free Swell, %

WATER LEVEL MEASUREMENT

▽ --Water Level at time shown
NW--No Water Encountered
WD--While Drilling
BCR--Before Casing Removal
ACR--After Casing Removal
CW--Caved and Wet
CM--Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

UNIFIED SOIL CLASSIFICATION SYSTEM

COARSE-GRAINED SOILS

(More than half of material is larger than No. 200 seive size.)

GRAVELS More than half of coarse fraction larger than No. 4 sieve size	**Clean Gravels** (Little or no 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 (Appreciable amount of fines)	
	GM^{d}_{u}	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS More than half of coarse fraction smaller than No. 4 sieve size	**Clean Sands** (Little or no fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with Fines (Appreciable amount of fines)	
	SM^{d}_{u}	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures

FINE-GRAINED SOILS

(More than half of material is smaller than No. 200 sieve.)

SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty or 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 greater than 50%	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

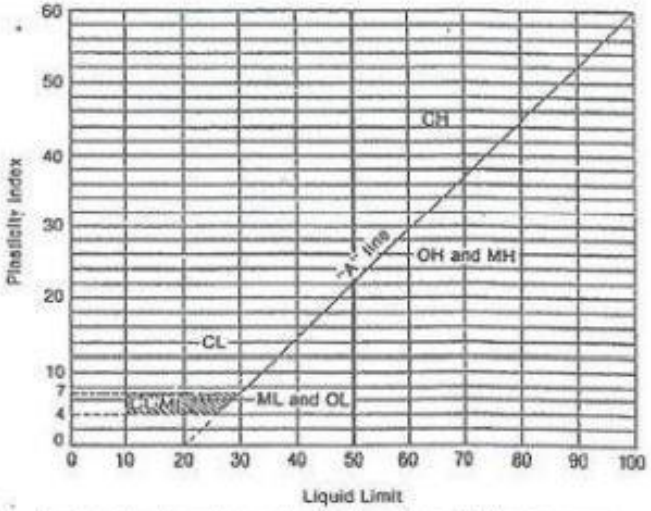
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ 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 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched 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 per cent ..... GW, GP, SW, SP
More than 12 per cent ..... GM, GC, SM, SC
5 to 12 per cent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



For classification of fine-grained soils and fine fraction of coarse-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols.

Equation of A-line: PI = 0.73 (LL - 20)

Document Qualifications and Limitations

- This report is based on a unique set of project-specific factors. Even seemingly minor changes in the function, location, loading conditions or other factors assumed or provided to us for this report could affect the validity of the recommendations in this report. The geotechnical engineer should be notified of such changes and asked to review their impact on the recommendations.

- This report is based on the findings of the soil borings and test results performed for this project at the locations shown on the accompanying boring location plan. Variations in subsurface soil and groundwater conditions should be expected between boring locations. These variations or differences may not be apparent until construction. For this reason, your geotechnical engineer should be engaged to provide construction observation services so that appropriate modifications can be made, where necessary, in the recommendations in this report.

- Subsurface conditions including groundwater and soil conditions can change with time due to construction activities on this site or nearby properties, water table fluctuations, weather conditions and other factors. Construction observation services provided by your geotechnical engineer will help you address the impact of these changes on your project.

- Environmental concerns are NOT addressed in this report, as they were not included within the scope of our work. Professional consultation and exploration by a qualified environmental consulting firm is recommended where such concerns may exist.