GEOTECHNCIAL REPORT

Coal Mine Brook
Observation Platforms
December 2021
0 Plantation Street Worcester, Massachusetts

Prepared for:

Beals & Thomas
Reservoir Corporate Center
144 Turnpike Road
Southborough, MA 01772-1204

City of Worcester
Department of Public Works
50 Skyline Drive
Worcester, MA 01605

Gill Engineering Associates, Inc.
63 Kendrick Street
Needham, MA 02494

GILL ENGINEERING

COMMONWEALTH OF MASSACHUSETTS
KEITH T. NELSON
CIVIL
No. 49490
REGISTERED
PROFESSIONAL ENGINEER

Keith Nelson
Digitally signed by Keith Nelson
Date: 2022.03.31 13:36:52-04'00'

Table of Contents

Appendix

1. INTRODUCTION

1.1. Scope of Report

The purpose of this report is to provide recommendations for the foundations for the proposed observation platforms to be constructed along Coal Mine Brook in the City of Worcester, Massachusetts. The observation platforms are part of park improvements being done by the City's Department of Public Works. All parameters provided will be in accordance with AASHTO LRFD 9th Edition Design Specifications and the 9th Edition of the Massachusetts State Building Code. The report will also provide recommendations for the construction of the proposed foundations with guidance on minimizing potential construction issues.

1.2. Site Description

The park is located along Lake Quinsigamond in the eastern part of the City Worcester as depicted on the site location map in Appendix 6.1. The observation platforms being proposed are to be located adjacent to Coal Mine Brook and the existing East Side Trail.

As part of the park improvements, two observation platforms are being proposed to overlook Coal Mine Brook. This will require clearing and grubbing of the vegetation that currently exist in the proposed observation platform locations. The photo below shows the dense vegetation along Coal Mine Brook and the East Side Trail, as well as Lake Quinsigamond in the background.

Photo 1-Showing dense vegetation nearby the proposed observation platform locations.

There are overhead transmission lines between the east and west observation platforms. These lines are not anticipated to interfere during construction.

2. SUBSURFACE CONDITIONS

2.1. Local Geology

According to the USGS Bedrock Geologic Map of the Worcester North Quadrangle, Worcester County, Massachusetts, the site is underlain by quartz-muscovite phyllite or schist, overtop metsandstone beds as much as 5cm thick. Some plagioclase-biotite-hornblende-quartz granofels can also be found in the area. See Appendix 6.2 for the map.

According to the Soil Conservation Survey Map, the site the upper layers consist of loamy sand and fine sandy loam. See Appendix 6.2 for the map.

2.2. Subsurface Exploration

The subsurface exploration consisted of two (2) soil borings located within 50' of the proposed observation platforms (designated as B-1 & B-2). The borings were drilled using a 3-inch hollow stem auger casing and a 1 3/8-inch split spoon sampler on April 22, 2021 by New England Boring Contractors, Inc. of Derry, New Hampshire and observed by Gill Engineering Associates, Inc. (GEA) which included a visual and hands-on examination of the soil samples. See Appendix 6.3 for an as-drilled boring site plan and Appendix 6.4 for boring logs.

2.3. Subsurface Profile

2.3.1. Boring B-1

The existing ground grade at B-1 is at ~400.0'. The top 12 feet consists of loose soil comprised of medium or silty sand with some coarse gravel and cobble. The layer from 12 feet down to the end of the boring at 27 feet consists of medium dense medium sand, coarse sand, or silty sand, and gravel with trace fine cobble. Ground water depth was measured to be at ~25' below grade.

2.3.2. Boring B-2

The existing ground grade at B-2 is at ~380'. The top 12 feet consists of very loose to loose medium sand with some cobble. The layer below 12 feet to the end of the boring at 27 feet consists of coarse and medium sand with coarse gravel and trace cobble. Ground water depth was measured to be at ~20' below grade.

2.3.3. Soil Parameters

See Table 1 for recommended soil parameters for design. See Appendix 6.6 for calculations.

Table 1: Recommended Soil Parameters

Layer	Unit Weight γ (lb/ft^3)	Friction Angle Φ
Upper (0' to 10')	120	30
Lower (>10')	120	38
Gravel Borrow	125	37

1. Friction angle based upon SPT $N1_{60}$ Correlation and AASHTO Table 10.4.6.2.4-1
2. Gravel borrow per MassDOT M1.03.0

2.4. Seismic Design Category Evaluation

Seismic design parameters were determined using the 9th Edition of the Massachusetts Building Code and ASCE 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Calculations are presented in Appendix 6.6 – Preliminary Design Calculations. The following are recommended seismic parameters for design:

Site Class: D (Medium dense soil with 15<N<50 blows/ft)

Mapped Ground and Spectral Response:

- Peak Horizontal Ground Acceleration (PGA): 0.12
- Horizontal Response Spectral Acceleration, 0.2 Sec (S_S): 0.21
- Horizontal Response Spectral Acceleration, 1.0 Sec (S_1): 0.05

Site Factors:

- Zero-Period (F_{pga}): 1.6
- Short Period (F_a): 1.6
- Long Period (F_v): 2.6

Design Spectral Response Parameters for Site Class D:

- A_S: 0.19 G
- S_{DS}: 0.22 G
- S_{D1}: 0.05 G

Seismic Design Category B

2.5. Liquefaction Potential

Based on the soil conditions found at the project site, seismically induced settlement should not be significant; therefore, there is a low potential for liquefaction in the event of seismic activity. The soils present are medium dense and well-graded. Additionally, the site has a low probability of having an event that would trigger liquefaction (M<6.0).

3. RECOMMENDED FOUNDATION SYSTEM

3.1. Shallow Foundation

It is not recommended to use a shallow foundation for the support for the boardwalk structure due the loose upper soil layers.

3.2. Deep Foundation

A deep foundation consisting of helical piles may be a viable alternative and will provide ease of construction due to the site constraints of the timber terrain.

An analysis was performed to determine the length, size and number of helical plates for the maximum load. See summary table below and Appendix 6.6 for detailed calculations.

Table 1-Summary of Helical Pile Analysis

Boring #	Plate Diameter				Min. Embedment	Max. Unsupported L	Allow. Pile Load
	Pile Size	1	2	3			
1 & 2	2.875 in	12.00 in	10.00 in	8.00 in	10 ft	6 ft	18.2 kips

4. CONSTRUCTION CONSIDERATIONS

4.1. Excavation

As required by OSHA regulations, lateral support is required for any excavation depth greater than four feet and where 1.5:1 slope cannot be maintained. Items for temporary earth support should be included in the contract documents. The design of any temporary support earth (SOE) is the responsibility of the Contractor and should be designed in accordance with Massachusetts Building Code requirements.

4.2. Obstructions

The proposed observation platforms will be located over area currently occupied with heavy vegetation including trees. Foundation placement should consider obstruction from tree roots that would remain in place after site preparations and the presence of cobbles. The presence of obstructions may require relocating helical piles in order to meet the minimum embedment length.

4.3. Protection of Adjacent Structures and Utilities

There are overhead transmission lines between the east and west observation platforms. These lines are not anticipated to interfere during construction, assuming there is a 20' clearance for construction equipment.

4.4. Sequence of Construction Activities

No special sequencing of construction will be anticipated to accommodate pedestrians within the park or adjacent traffic.

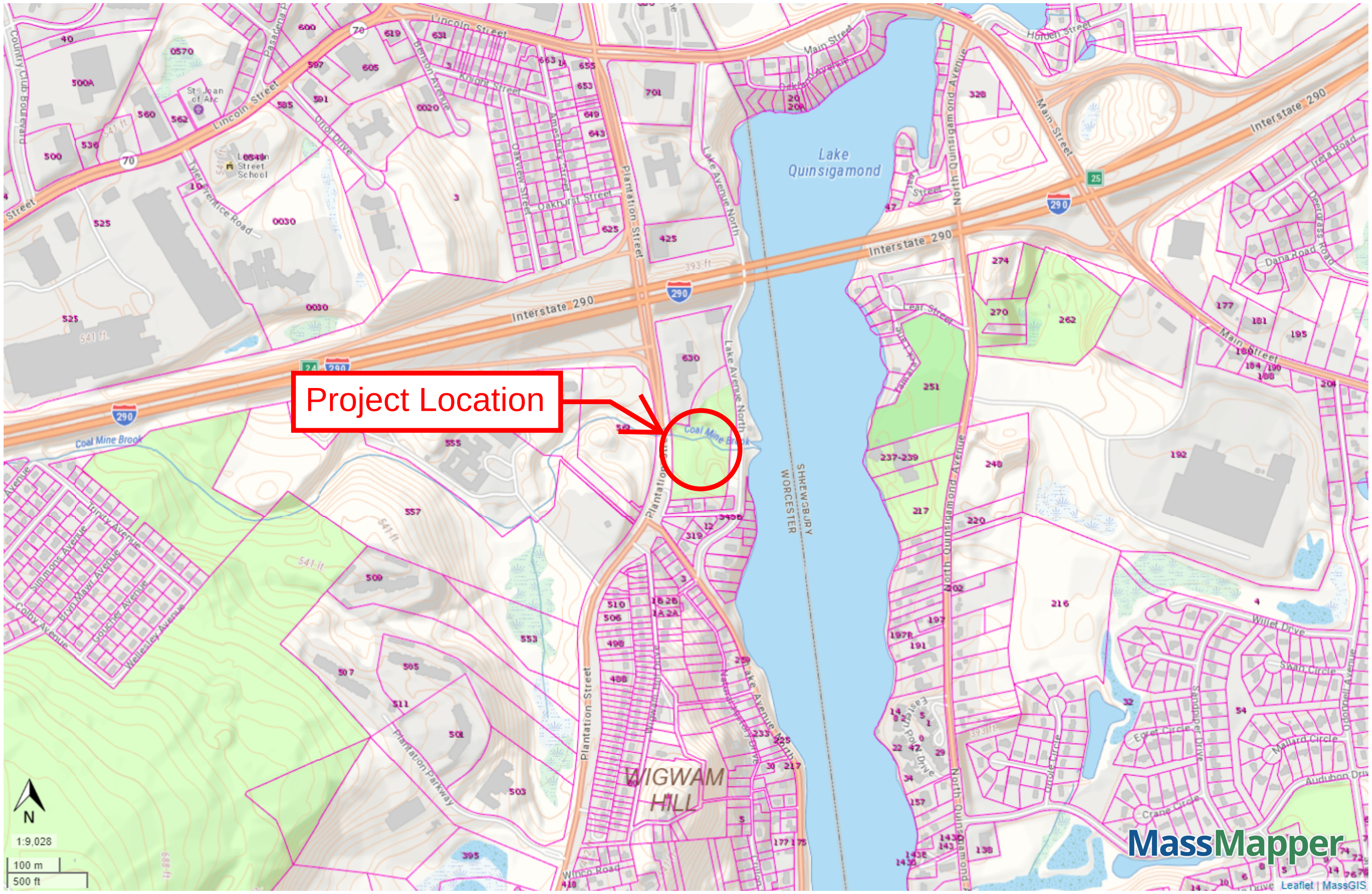
5. CONCLUSION

It is recommended to use helical piles to support the observation platform structures. It is recommended that the contractor evaluate soil conditions prior to ordering helical piles due to the presence of obstructions.

APPENDIX

6.1. Project Locus Map

Coal Mine Brook Observation Platforms



Property Tax Parcels

APPENDIX

6.2. Surficial Geologic Map

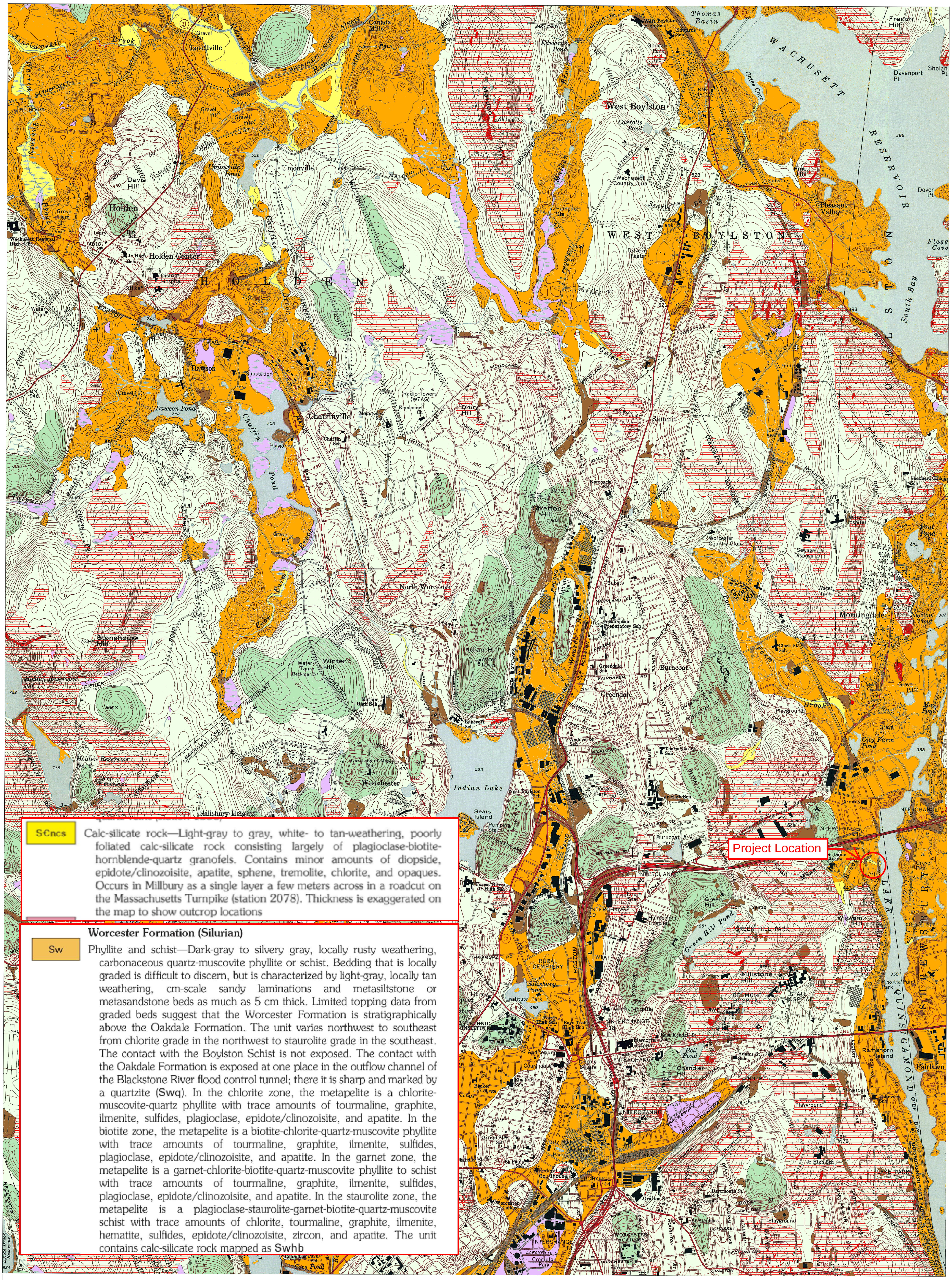
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
COMMONWEALTH OF MASSACHUSETTS
OFFICE OF THE STATE GEOLOGIST
AND EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS

OPEN-FILE REPORT 2006-1260-D
(SHEET 1 of 8)
WORCESTER NORTH QUADRANGLE

Stone, B.D., Stone, J.R., and DiGiacomo-Cohen, M.L., 2008, Surficial geologic map of the Worcester North-Oxford-Wrentham-Attleboro nine-quadrangle area in south-central Massachusetts: U.S. Geological Survey Open-File Report 2006-1260-D.
Available online at http://pubs.usgs.gov/of/2006/1260/D.

Explanatory pamphlet accompanies map



S€ncs — Calc-silicate rock—Light-gray to gray, white- to tan-weathering, poorly foliated calc-silicate rock consisting largely of plagioclase-biotite-hornblende-quartz granofels. Contains minor amounts of diopside, epidote/clinozoisite, apatite, sphene, tremolite, chlorite, and opaques. Occurs in Millbury as a single layer a few meters across in a roadcut on the Massachusetts Turnpike (station 2078). Thickness is exaggerated on the map to show outcrop locations

Worcester Formation (Silurian)

Sw — Phyllite and schist—Dark-gray to silvery gray, locally rusty weathering, carbonaceous quartz-muscovite phyllite or schist. Bedding that is locally graded is difficult to discern, but is characterized by light-gray, locally tan weathering, cm-scale sandy laminations and metasiltstone or metasandstone beds as much as 5 cm thick. Limited topping data from graded beds suggest that the Worcester Formation is stratigraphically above the Oakdale Formation. The unit varies northwest to southeast from chlorite grade in the northwest to staurolite grade in the southeast. The contact with the Boylston Schist is not exposed. The contact with the Oakdale Formation is exposed at one place in the outflow channel of the Blackstone River flood control tunnel; there it is sharp and marked by a quartzite (Swq). In the chlorite zone, the metapelite is a chlorite-muscovite-quartz phyllite with trace amounts of tourmaline, graphite, ilmenite, sulfides, plagioclase, epidote/clinozoisite, and apatite. In the biotite zone, the metapelite is a biotite-chlorite-quartz-muscovite phyllite with trace amounts of tourmaline, graphite, ilmenite, sulfides, plagioclase, epidote/clinozoisite, and apatite. In the garnet zone, the metapelite is a garnet-chlorite-biotite-quartz-muscovite phyllite to schist with trace amounts of tourmaline, graphite, ilmenite, sulfides, plagioclase, epidote/clinozoisite, and apatite. In the staurolite zone, the metapelite is a plagioclase-staurolite-garnet-biotite-quartz-muscovite schist with trace amounts of chlorite, tourmaline, graphite, ilmenite, hematite, sulfides, epidote/clinozoisite, zircon, and apatite. The unit contains calc-silicate rock mapped as Swhb

Base from U.S. Geological Survey, 1974.
Map was scanned, processed, georeferenced, rectified, and cropped by the Office of the Massachusetts State Geologist. Image available online at: http://www.geo.umass.edu/stategeologist/frame_maps.htm

SCALE 1:24,000
1 0.5 0 1 MILES
1 0.5 0 1 KILOMETERS
CONTOUR INTERVAL 10 FEET

Map units were reproduced from Stone, 1980.

Surficial Geologic Map of the Worcester North Quadrangle, Massachusetts

Compiled by
Byron D. Stone, Janet R. Stone, and Mary L. DiGiacomo-Cohen
2008

USGS
science for a changing world

Worcester County, Massachusetts, Northeastern Part (MA613)

Worcester County, Massachusetts, Northeastern Part (MA613)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
245B	Hinckley loamy sand, 3 to 8 percent slopes	0.6	43.3%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	0.7	56.7%
Totals for Area of Interest		**1.3**	**100.0%**

APPENDIX

6.3. Boring Location Plan

LOCUS

NOT TO SCALE

BORING PLAN

NOT TO SCALE

NOTES:

1. LOCATION OF DRIVE SAMPLE BORINGS ARE SHOWN THUS: ⯁
2. BORING DEPTHS SHALL BE APPROXIMATELY 25 FEET.
3. BORING LOGS SHALL BE PREPARED AND SUBMITTED TO GILL ENGINEERING ASSOCIATES.
4. BORING LOCATIONS MAY BE ADJUSTED TO AVOID CONFLICTS WITH EXISTING UTILITIES.
5. SOIL SAMPLES SHALL BE PROVIDED TO THE ENGINEER ON-SITE FOR STORAGE AT GILL ENGINEERING.

GILL ENGINEERING	BORING PLAN CITY OF WORCESTER	BORING PLAN FOR COAL MINE BROOK PLATFORMS	PLAN VIEW 4/28/2021
	Gill Engineering Associates, Inc. 63 Kendrick Street Needham, MA 02494 781-355-7100 www.gill-eng.com		SHEET 1 OF 1

Coal Mine Brook Boring Plan.dwg Plotted on 28-Apr-2021 1:58 PM

APPENDIX

6.4. Boring Logs

GILL ENGINEERING

Gill Engineering Associates, Inc.
63 Kendrick Street
Needham, MA 02494

Boring No. B-1

City/Town: Worcester, MA	Bridge Number: N/A	Project File Number: N/A	Contract Number:
Location: Coal Mine Brook – West Platform		Date & Time Started: 4/22/2021 at 10:55 AM	Total Hours: 1
Groundwater Depth (Feet): ~25'	Date & Time: 4/22/2021	Date & Time Completed: 4/22/2021 at 12:00 PM	
Coordinates: N: 42˚17'27" W: 71˚45'35"		Driller's Company & Name: NEBC – Anthony	
Ground Elevation (Feet): ~400'		Gill Representative: Nikki Nelson	

Depth (Feet)	Sample Number	Depth Range (Feet)	Blow Counts per 6 Inches / Coring Times Minutes per Foot	Recovery (inches)	Field Description	Strata Changes
-	S-1	0' – 2'	1 – 2 – 3 – 2	7"	Dry, very loose, brown, MEDIUM SAND and coarse gravel, trace of cobble	
- - -						
5	S-2	5' – 7'	4 – 2 – 2 – 2	6"	Moist, very loose, brown and red, SILTY SAND, some cobble and coarse gravel	5'
- - - -						
10	S-3	10' – 12'	3 – 2 – 4 – 3	15"	Moist, loose, light brown, MEDIUM SAND	
- - - -						
15	S-4	15' – 17'	16 – 22 – 16 – 18	9"	Moist, medium dense, brown/grey, MEDIUM SAND, trace of cobble and gravel	17'
- - - -						
20	S-5	20' – 22'	26 – 27 – 26 - 28	23"	Dry, medium dense, brown/grey, COARSE SAND and gravel, some cobble	
- - - -						
25	S-6	25' – 27'	23 – 18 – 15 – 13	13"	Moist, medium dense, brown, SILTY SAND, some coarse gravel, trace of cobble	27'
- - - -					End of Exploration	
30						
- - - -						
35						

Remarks:	Arrow-Board: x Signs: x Cones: x	Protective Device – Stand: x Box: x Well Depth: x Solid Pipe: x Stick Up Pipe: x Screen Pipe: x

Penetration Resistance (N) Guide

Cohesionless Soils (Sands, Gravels)		Cohesive Soils (Silts, Clays)	
Relative Density	Penetration Resistance	Consistency	Penetration Resistance
Very Loose	0 – 4	Very Soft	0 – 2
Loose	4 – 10	Soft	2 – 4
Medium Dense	10 – 30	Medium Stiff	4 – 8
Dense	30 – 50	Stiff	8 – 15
Very Dense	Over 50	Very Stiff	15 – 30
		Hard	Over 30

N = Sum of Second and Third 6" Blow counts

Terms Used for Second Entry of Descriptions: and = 40-50%, some = 10-40%, trace = 10% or less

Type of Drill Rig: Mobile Controlled

Casing Type: Hollow Stem Size: 3"
Hammer Weight: 300lbs
Fall: 30"
Depth: x

Sampler Type: S/S Size: 1-3/8"
Automatic Hammer Weight: x
Safety Hammer Weight: x
Donut Hammer Weight: 140 lbs
Fall: 30"

Core Barrel Type: x Size: x

Gill Engineering Associates, Inc.
63 Kendrick Street
Needham, MA 02494

Boring No. B-2

City/Town: Worcester, MA	Bridge Number: N/A	Project File Number: N/A	Contract Number:
Location: Coal Mine Brook – East Platform		Date & Time Started: 4/22/2021 at 8:46 AM	Total Hours: 1.75
Groundwater Depth (Feet): ~20’	Date & Time: 4/22/2021	Date & Time Completed: 4/22/2021 at 10:30 AM	
Coordinates: N: 42˚17’27” W: 71˚45’33”		Driller’s Company & Name: NEBC – Anthony	
Ground Elevation (Feet): ~380’		Gill Representative: Nikki Nelson	

Depth (Feet)	Sample Number	Depth Range (Feet)	Blow Counts per 6 Inches / Coring Times Minutes per Foot	Recovery (inches)	Field Description	Strata Changes
-	S-1	0’ – 2’	2 – 3 – 4 – 4	7"	Dry, very loose, brown, MEDIUM SAND, trace of cobble	
- - -						
5	S-2	5’ – 7’	4 – 5 – 7 – 6	4”	Dry, very loose, brown, MEDIUM SAND, with some cobble	5’
- - - -						
10	S-3	10’ – 12’	9 – 7 – 6 – 6	11”	Dry, loose, light brown, MEDIUM SAND, and coarse gravel, some cobble	
- - - -						
15	S-4	15’ – 17’	21 – 19 – 18 - 21	9”	Dry, medium dense, light brown, COARSE SAND and gravel and cobble	17’
- - - -						
20	S-5	20’ – 22’	11 – 13 – 12 – 10	13”	Wet, medium dense, brown, MEDIUM SAND and coarse gravel, trace of cobble	
- - - -						
25	S-6	25’ – 27’	12 – 15 – 18 – 21	11”	Wet, medium dense, brown, MEDIUM SAND and coarse gravel, trace of cobble	27’
- - - -					End of Exploration	
30						
- - - -						
35						

Remarks:	Arrow-Board: x Signs: x Cones: x	Protective Device – Stand: x Box: x Well Depth: x Solid Pipe: x Stick Up Pipe: x Screen Pipe: x

Penetration Resistance (N) Guide

Cohesionless Soils (Sands, Gravels)		Cohesive Soils (Silts, Clays)	
Relative Density	Penetration Resistance	Consistency	Penetration Resistance
Very Loose	0 – 4	Very Soft	0 – 2
Loose	4 – 10	Soft	2 – 4
Medium Dense	10 – 30	Medium Stiff	4 – 8
Dense	30 – 50	Stiff	8 – 15
Very Dense	Over 50	Very Stiff	15 – 30
		Hard	Over 30

N = Sum of Second and Third 6” Blow counts

Terms Used for Second Entry of Descriptions: and = 40-50%, some = 10-40%, trace = 10% or less

Type of Drill Rig: Mobile Controlled

Casing Type: Hollow Stem Size: 3”
Hammer Weight: 300lbs
Fall: 30”
Depth: x

Sampler Type: S/S Size: 1-3/8”
Automatic Hammer Weight: x
Safety Hammer Weight: x
Donut Hammer Weight: 140 lbs
Fall: 30”

Core Barrel Type: x Size: x

APPENDIX

6.5. Preliminary Design Calculations

EXISTING SOIL CONDITIONS

Soil Strength — Worcester, MA

References:
(1) AASHTO LRFD Bridge Design, 9th Edition, 2020
(2) 04/22/2021 Geologic Earth Exploration - Subsurface Investigation

Soil Strength (10.4.6.2.4)

γ_w = 0.062 kcf
γ_{sat} = 0.120 kcf

Water Table B-1 = 25.00 ft — 10 year flood
Water Table B-2 = 20.00 ft — 10 year flood

Boring B-1 Blow Count Correction for Overburden Pressure - West Platform

To Depth (ft)	h_1 (ft)	h_2 (ft)	σ'_v (ksf)	C_N	N blows/ft	$N1 = C_N N$ blows/ft	N_{60} = (ER/60%)N blows/ft	$N1_{60} = C_N N_{60}$ blows/ft
1	1	0	0.120	1.94	5	9.7	6.67	12.95
5	5	0	0.600	1.40	4	5.6	5.33	7.49
10	10	0	1.200	1.17	6	7.0	8.00	9.38
15	15	0	1.800	1.04	38	39.4	50.67	52.54

Boring B-2 Blow Count Correction for Overburden Pressure - East Platform

To Depth (ft)	h_1 (ft)	h_2 (ft)	σ'_v (ksf)	C_N	N blows/ft	$N1 = C_N N$ blows/ft	N_{60} = (ER/60%)N blows/ft	$N1_{60} = C_N N_{60}$ blows/ft
1	1	0	0.120	1.94	7	13.6	9.33	18.13
5	5	0	0.600	1.40	12	16.9	16.00	22.47
10	10	0	1.200	1.17	13	15.2	17.33	20.33
15	15	0	1.800	1.04	37	38.4	49.33	51.16

h_1 = depth above water table
h_2 = depth below water table
$\sigma'_v = \gamma h_1 + \gamma' h_2$
$\gamma' = \gamma_{sat} - \gamma_w$
$C_N = 0.77 \log_{10}(40 / \sigma'_v) < 2$ — (1) 10.4.6.2.4.-1

Hammer Efficiency Correction

$N_{60} =$ (ER/60%)N (1) 10.4.6.2.4-2

ER = 80% Automatic Trip Hammer used

$N_{60} =$ 1.333 N

$N1_{60} = C_N N_{60}$ (1) 10.4.6.2.4-3

Drained Friction Angle

Table 10.4.6.2.4-1—Correlation of *SPT N*1_{60} Values to Drained Friction Angle of Granular Soils (modified after Bowles, 1977)

$N1_{60}$	ϕ_f
<4	25–30
4	27–32
10	30–35
30	35–40
50	38–43

Conservatively use lower values of range:

N160	ϕ_f
<4	25
4	27
10	30
30	35
50	38

Depth (ft)	$N1_{60}$	$N1_{60\ low}$	$N1_{60\ high}$	$\phi_{f\ low}$	$\phi_{f\ high}$	ϕ_f
1	13	10	30	30	35	30
5	16	10	30	30	35	31
10	52	50	50	38	38	38
15	53	50	50	38	38	38

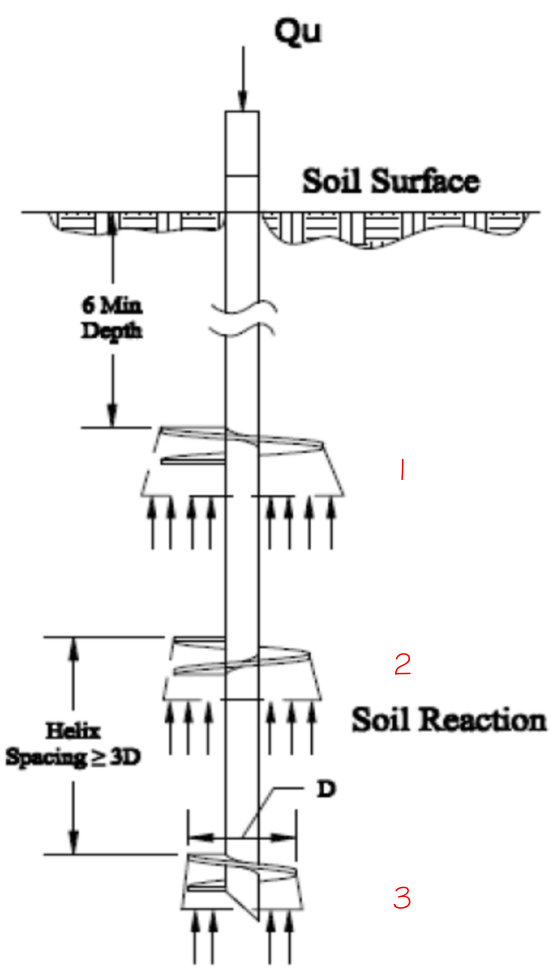
Recommended Friction Angles:

$\phi_f =$ 30

$\phi_f =$ 38

HELICAL PILE DESIGN — Worcester, MA

References:
(1) AASHTO LRFD Bridge Design, 9th Edition, 2020
(2) Helical Anchors, Inc. Engineering Design Manual, 2014



General Equation for computing bearing capacity per Helix Plate:

Equation 1

$$Q_u = A_h(cNc + q'Nq + 0.5\gamma' BN\gamma)$$

REF-2

Where:
- Q_u = Ultimate Capacity (lbs)
- A_h = Projected Helical Plate Area (ft^2)
- c = Soil Cohesion (lb/ft^2)
- N_c = Bearing capacity factor for cohesion (dimensionless)
- q' = Effective Overburden Pressure (lb/ft^2)
- N_q =Bearing capacity factor for overburden (dimensionless)
- γ' = Effective unit weight of the soil (lb/ft^3)
- B = Footing width (ft)
- N_γ = Bearing Capacity factor (dimensionless)

The base width B term can be neglecte which reduces the equation to:

Equation 2

$$Q_u = A_H(cN_c + q'N_q)$$

REF-2

Helical Pile Input:

Shaft Square or Round? Round
Width or Diameter? 2.88 in

Shaft Area= 6.49 in^2

Plate #	Dia	A_h (in^2)
1	12.00 in	106.61
2	10.00 in	72.048
3	8.00 in	43.774

Soil Properties:

γ_w = 0.062 kcf
γ_{sat} = 0.120 kcf

Water Table Depth = 20.00 ft

Plate #	Depth	h_1 (ft)	h_2 (ft)	q' (ksf)	c (ksf)	N_c	ϕ_f	N_q	Q_u (Kips)
1	6	6	0	0.720	0	0	34	29.4	15.67
2	8	8	0	0.960	0	0	34	29.4	14.12
3	10	10	0	1.200	0	0	34	29.4	10.72
								Total=	40.52

$Q_{all}=Q_u/FS$ Where FS= 2 Q_{all}= 20.3 Kips

Factored Nominal Bearing Resistance of piles, $R_R=\phi R_n$ where $Q_u= R_n$ REF 1-10.7.3.8.6a-1

Where ϕ= 0.45 R_R= 18.2 Kips

	Pile Diameter x Thickness (in) x (in)	Max Torque (Tube Connection Failure Point) (lb-ft)	Allowable Compression Capacity (SF of 2 applied) (lb)	Allowable Tension Capacity depth ≤ 14ft (SF of 2 applied) (lb)	Allowable Tension Capacity depth >14ft (SF of 2 applied) (lb)	Torque Correlation Factor Kt (ft^{-1})
1 7/8”	1.875”x 0.154”	1975	9875	4938	6913	10
2 3/8”	2.375”x 0.154”	3150	15750	7875	11025	10
2 7/8”	2 875”x 0.250”	7020	31590	15795	22113	9
3 ½”	3.500”x 0.250”	11500	40250	20125	28175	7
4 ½”	4.500”x 0.250”	18495	51786	25893	36250	5.6
5 9/16”	5.5625”x 0.250”	29120	65520	32760	45864	4.5
5 9/16”	5.5625”x 0.375”	40988	92223	46112	64556	4.5
6 5/8”	6.625”x 0.250”	42155	84310	42155	59017	4
6 5/8”	6.625”x 0.375”	59951	119902	59951	83931	4
8 5/8”	8.625”x 0.250”	73231	109847	54923	76893	3
8 5/8”	8. 625”x 0.375”	105451	158177	79088	110724	3
10 ¾”	10.75”x 0.250”	115832	144510	72225	101157	2.5
10 ¾”	10.75”x 0.375”	167832	209790	104895	146853	2.5
12 ¾”	12.75”x 0.375”	239756	239756	119878	167829	2

NORMATIVE INFORMATION

GoliathTech Inc. products are certified and approved by ICC-ES ESR-3726 and the Canadian Construction Materials Centre (CCMC 13675-R.) Their performance is equivalent or superior to prescribed NBC2015 standards. GoliathTech manufacturing facility is certified to the quality standard ISO 9001:2015 (Certificate number Q101242) as well as the environmental standard ISO 14001:2015. Its manufacturing welding facility is certified to CSA W47.1

NOTES

Helical piles shall be installed to appropriate depth in suitable bearing stratum as determined by the geotechnical engineer or local jurisdictional authority. Torque correlated capacities are based on installing the pile to its torque rating, using consistent rate of advance and RPM. A minimum factor of safety of 2 has already been applied to the above numbers. To calculate ultimate compression or tension multiply above allowable numbers by 2. Deflections of 0.25 to 0.50 inches are typical at allowable capacity.

1. The distance between the piles has to be a minimum of 3x the helix size (although we suggest 5x) from the center of the pile but no less than 3'.
2. Compression values are based on fully laterally supported piles (pile fully embedded in soil), if not, contact engineering department for calculations.
3. The compression and tension values take into account the steel corrosion for 50 years.
4. Steel shaft conform to CAN/CSA G40.21 and ASTM-A500 class C , hot dip galvanized conform to ASTM A123.
5. Steel yield strength for 3 1/2" piles and less Fy = 60 ksi, Tensile strength Fu = 70 ksi
6. Steel yield strength for 4 1/2" piles and more Fy = 55 ksi, Tensile strength Fu = 65 ksi (other strengths can be obtained for special orders, contact customer service.)
7. Different helix configurations and pile heads are available.
8. For custom heads or steel assembly (including mechanical design and shop drawing) contact customer service.

GoliathTech Inc *175B rue Péladeau, Magog, QC, Canada, J1X 5G9*	*Date* *August 1st 2019*	*Revised and Approved by* ***Hussien Abd El Baky***
TECHNICAL DATA SHEET	*Doc Number* *GTSPEC001*	***Massachusetts license number 55074***