Somat Engineering INCORPORATED

July 17, 2014
2013194A

Mr. John O'Meara, P.E.
Environmental Consulting & Technology, Inc. (ECT)
2200 Commonwealth Blvd., Suite 300
Ann Arbor, MI 48105

RE: Geotechnical Investigation Report
Stony and Celeron Islands, Habitat Restoration
Wayne County, Michigan

Dear Mr. O'Meara:

We have completed the geotechnical field investigation associated with the habitat restorations at Stony and Celeron Islands in Wayne County, Michigan. This report presents the results of our observations, geotechnical recommendations, and construction considerations.

The geotechnical soil samples collected during our field investigation will be retained in our laboratory for 90 days after the date of this report, at which time these samples will be discarded unless otherwise directed by you.

It was a pleasure working with you on this project. If you have any questions regarding this report, please do not hesitate to contact us.

Sincerely,
Somat Engineering, Inc.

Jonathan D. Zaremski, P.E.
Geotechnical Group Manager

Infrastructure Engineering Solutions

660 Woodward • Suite 2430 • Detroit • Michigan • 48224





GEOTECHNICAL INVESTIGATION REPORT

DETROIT RIVER AREA OF CONCERN (AOC)
STONY AND CELERON ISLANDS
HABITAT RESTORATION
WAYNE COUNTY, MICHIGAN

Owner:

Friends of the Detroit River

Prepared for:

Environmental Consulting & Technology, Inc.
2200 Commonwealth Blvd., suite 300
Ann Arbor, Michigan 48105

2013194A
July 17, 2014

Somat Engineering, INCORPORATED

REPORT SUMMARY

A general summary of the report conclusions and recommendations is provided below:

1. The proposed project consists of the habitat rehabilitation at Stony and Celeron Islands in Wayne County, Michigan. The islands are located within the Detroit River, near Grosse Ile. The proposed rehabilitation consists of the construction of shoals for the purpose to create protected habitat areas between the shoals and existing island shorelines. The shoal will be located around the southern part of Celeron Island, about 4,640 linear feet (LF) total. At Stony Island there will be a shoal in the upper bay, about 1,040 LF and a shoal at the lower bay at about 2,615 LF.

2. The field exploration program consisted of performing a total of thirteen (13) test pits. The depth of the test pits ranged from 0.2 to 6.5 feet below the existing river bottom grade. The test pits TP-C-1 to TP-C-6 were performed at Celeron Island and TP-S-1 to TP-S-7 were performed at Stony Island.

3. The bearing materials for the shoals are anticipated to consist of silty clay, sand/silty sand, and/or cobbles. Due to test pit sampling procedures, there was no laboratory testing for the strength of the clay soils or apparent density of the granular soils. The bearing capacity analyses were based on our experience in the area and observation of the field engineer and operator. We recommend an allowable bearing capacity of 3,000 psf. This incorporates a factor of safety of 3 on the ultimate capacity, for assumed shoal widths of 30 to 45 feet.

4. Due to the variation of the bearing material, we recommend utilizing a separator fabric material between the existing sediment/river bottom and the proposed shoal material.

5. Based on the material observed in the test pits, we recommend the dredging slopes for the proposed deep water habitats be graded to 1V:4H. This will provide a stable excavation for the observed various materials.

The summary presented above is general in nature and should not be considered apart from the entire text of the report with all the qualifications and considerations mentioned therein. Details of our findings and recommendations are discussed in the following sections and in the appendices of this report.

REPORT PREPARED BY:

Catherine J. Weirauch, E.I.T.
Senior Staff Engineer

REPORT REVIEWED BY:

Jonathan D. Zaremski, P.E.
Project Manager

Richard O. Anderson, P.E., Dist. M. ASCE
Principal Engineer

GEOTECHNICAL INVESTIGATION REPORT
DETROIT RIVER AREA OF CONCERN (AOC)
STONY AND CELERON ISLANDS
HABITAT RESTORATION
WAYNE COUNTY, MICHIGAN

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1.0 INTRODUCTION

1.1 GENERAL

Upon authorization from the Environmental Consulting & Technology, Inc. (ECT), Somat Engineering, Inc. (SOMAT) has performed a geotechnical investigation for the proposed habitat restoration in Wayne County, Michigan. These services were performed in accordance with SOMAT Proposal No. P130347 dated October 2, 2013.

The following sections of this report provide our understanding of the project, a description of our field investigation, the results of the field and laboratory tests, the logs of test pits and our interpretation of subsoil and groundwater conditions, and recommendations for the proposed design and construction.

1.2 PROJECT INFORMATION

The project consists of the habitat rehabilitation of the Detroit River at Stony and Celeron Islands. The islands are located near Grosse Ile. The rehabilitation will consist of the design of shoals with the objective to restore the habitat that was once present. The shoals themselves will provide habitat, and will also create and protect back water habitat areas. The proposed upgrades include a shoal around the southern part of Celeron Island, about 4,640 linear feet (LF) total. At Stony Island there will be a shoal in the upper bay, about 1,040 LF and a shoal at the lower bay at about 2,615 LF.

The geotechnical investigation is required to aid in design of the proposed shoal foundations, which will need to withstand the water current and ice flow. The geotechnical design will include bearing capacity and settlement analysis for the shoals.

1.3 PROPOSED DESIGN CONCEPT

The design concept of the shoal location was developed by ECT to create an area for the proposed aquatic habitats. This area would be located between the existing island shorelines and the proposed shoals. The shoals are proposed to include openings or gaps within the alignment to allow for water flow to the habitat areas. The preliminary design concepts are detailed below. Existing river bottom elevation data is derived from the bathometric survey performed by ECT.

Celeron Island

The lower bay design includes three discontinuous shoals, with gaps to allow for water flow into the habitat area. The existing river bottom varies from elevation 566 to 567 feet. The length of the shoals will be about 810 LF, 1,960 LF and 1,870 LF. The top of shoal is proposed to be a maximum of elevation of 578 feet, resulting in a maximum shoal height of 11 to 12 feet above the existing grade. Habitat enhancements include about two (2) deep water habitats, anticipated to be about a 6 foot deep depression with gravel habitat, along with various rock mounds and woody debris clusters.

Stony Island, Upper Bay

The upper bay design includes a discontinuous shoal for the northern portion (about 450 LF), with gaps or island shoals for the southern portion of the alignment (590 LF). We anticipate the island shoals will be about 100 to 200 feet in length. The existing river bottom varies from elevation 567 to 568 feet. The top of shoal is proposed to be a maximum of elevation of 582 feet, resulting in a maximum shoal height of 14 to 15 feet above the existing grade. There are minimal habitat improvements due to the existing wetland area.

Stony Island, Lower Bay

The lower bay design includes two discontinuous shoals, with a gap to allow for water flow into the habitat area. The shoal lengths will be about 1,375 LF and 1,240 LF. The existing river bottom varies from elevation 567 to 569 feet. The top of shoal is proposed to be a maximum of elevation of 578 feet, resulting in a maximum shoal height of 9 to 11 feet above the existing grade. Habitat enhancements include about four (4) deep water habitats, anticipated to be about a 6 foot deep depression with gravel habitat, along with various rock mounds and woody debris clusters. There is a proposed boulder and sand area to be placed in an existing cut where the river bottom is currently exposed.

The material composition and gradation for the shoals is not yet determined. We anticipate they will be constructed of large diameter rip rap stone, gravel, existing island and/or river material, or a combination of these materials. It is proposed to add spawning/habitat material at the front and back toe of the shoal slope, such as gravel, sand, existing soils, or wood debris. We anticipate the width of the shoals will vary from 30 to 45 feet.

2.0 SUBSURFACE INVESTIGATIONS

2.1 FIELD EXPLORATION

The field exploration program for the geotechnical investigation consisted of performing test pits from a barge in the Detroit River along the proposed shoal alignments. A total of thirteen (13) test pits were performed, with six (6) located at Celeron Island and seven (7) located at Stony Island, generally in the vicinity of the proposed shoals. The test pits were designated as TP-C-1 to TP-C-6 and TP-S-1 to TP-S-7, with the “C” or “S” prefix indicating Celeron or Stony Island. The anticipated depth of the test pits was 5 feet into soil through the river bottom. However some test pits terminated upon obstructions at shallow depths of about 0.2 to 3 feet below grade.

The number, depth, and location of the test pits were selected by SOMAT with input and approval from the project team. The field locations were determined by SOMAT, taking into consideration water depths and site access. The fieldwork was performed in general accordance with the USACE/MDEQ permit, obtained by ECT. River bottom elevations at test pit locations were estimated by SOMAT from the existing site bathometric information provided to us by the design team. All elevations are based on the NAVD88 datum, unless specified otherwise. A test pit location diagram is provided in Appendix A.

2.1.1 Test Pit Operations

The test pits were performed on April 8 and April 9, 2014 with a backhoe. The test pit operations were conducted from a barge. Prior to excavating the engineer noted the water depth at the test pit location, which is included in the remarks of each Test Pit Log. The material was excavated, and a sample was collected for each type of soil observed. Test pit soil samples were collected as bulk, grab samples, taken from the spoil piles of the excavated material.

The soil samples collected for this investigation will be retained in our laboratory for a period of 90 days after the date of this report, after which they will be discarded unless we are notified otherwise.

2.1.2 Environmental Sampling

Per the request of ECT, we collected additional samples for environmental testing, to be done by others and coordinated by ECT. The samples were numbered according to the test pit number, with one sample obtained per test pit. The samples were generally obtained from the upper 2 to 3 feet of depth during the test pits. The samples were documented by chain-of-custody from SOMAT to the testing laboratory. The environmental sample ID and description are detailed below. The locations that indicate "no sample" correspond with areas of minimal overburden observed; therefore no environmental samples were obtained.

Summary of Environmental Sampling		
Island Location	Test Pit Number & Environmental Sample ID	Depth of Sample (below river bottom)
Celeron	TP-C-1	0 to 3 ft
	TP-C-2	No sample
	TP-C-3	0 to 2 ft
	TP-C-4	0 to 2 ft
	TP-C-5	0 to 3 ft
	TP-C-6	0 to 2 ft
Stony	TP-S-1	No sample
	TP-S-2	No sample
	TP-S-3	No sample
	TP-S-4	0 to 2 ft
	TP-S-5	0 to 2 ft
	TP-S-6	0 to 2 ft
	TP-S-7	0 to 2 ft

2.2 LABORATORY TESTING

All samples were classified in general accordance with the Unified Soil Classification System. Due to the disturbed sampling method of the test pits, we were unable to perform any torvane or pocket penetrometer tests on the cohesive samples. No other lab testing was performed.

2.3 LIMITATIONS

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around this site, other than the previously mentioned collection of samples for testing and analysis by others.

3.0 EXISTING DATA

Prior to the field investigation, preliminary input on the soil and rock conditions was provided to the design team. According to information provided by the design team, we understand that these islands either have been built-up with limestone rubble or have shallow bedrock. The intent of the test pits was to either extend to refusal at bedrock or when substantial rubble pieces are encountered, or 1 to 2 feet into the natural clay soils, or to a maximum depth of 5 feet below the river bottom. Based on existing data from nearby surface investigations, the generalized top of bedrock is typically encountered at depths 10 to 20 feet below grade (elevation 560 to 550 ft). However, at locations near Stony Island, which is believed to have been built up with dredged rock material, the rock could be encountered at the surface.

- Mozolo 1967 ‘Topography of the Bedrock of Wayne County, Michigan
  - Indicates top of bedrock is about Elevation 550 ft based on mean sea level datum
- Somat soil borings from Elizabeth Park in Trenton, Michigan from 2013 indicate top of possible bedrock at depths 24.5 to 27 ft depth (elevation 548 to 552.5 feet NAVD88)
- Somat soil borings from the US Customs facility on Gibraltar Road indicate top of possible bedrock at depths 15 to 20 ft depth (elevation 565 to 560 feet)
- USGS “Construction of Shipping Channels in the Detroit River: History and Environmental Consequences”, dated 2011
  - Includes general information about dredging of Livingston and Trenton Channel
- History of Dredging and Compensation of St. Clair and Detroit Rivers, February 2009
  - Includes detailed information about dredging of Livingston and Trenton Channel including types of materials encountered and depths.
  - Includes information that Stony Island was built up with excavated material from the dredging of the adjacent shipping channels.
- Historic aerial photographs of the islands, provided by ECT.
  - Indicates proposed alignments of shoals will be constructed along previous natural shoals which have deteriorated over time. Due to possible boulders/cobbles, soil borings are not feasible to evaluate the existing soils.
- Existing site survey
  - Indicates existing grade at the islands is about elevation 570 feet.

Based on this information, for locations where bedrock was not encountered within the upper 5 feet of depth, we anticipate the bedrock will be encountered at depths of about 10 to 20 feet (elevation 560 to 550 ft) below the existing island grades. The overburden natural soils in the area are predominately clay soils. The purpose of the test pits was to confirm if there is suitable bearing soils at the surface of the river bottom, or if there is evidence that the existing shoal boulders are encountered.

4.0 SUBSURFACE CONDITIONS

4.1 SOIL STRATIFICATION

Soil conditions encountered at the test pit locations have been evaluated and are presented in the form of Logs of Test Pits. The Logs of Test Pits presented in Appendix B include approximate soil stratification with detailed soil descriptions and selected physical properties for each stratum encountered in the test borings. In addition to the observed subsoil stratigraphy, the logs present information relating to sample data, groundwater level conditions observed, personnel involved, and other pertinent data. For information, and to aid in understanding the data as presented on the boring logs, General Notes defining nomenclature used in soil descriptions are presented immediately following the logs in Appendix B. It should be noted that the Logs of Test Pits included with this report have been prepared on the basis of laboratory classifications and testing as well as field logs of the soils encountered.

A generalized description of the soils encountered during our field investigation is provided below beginning at river bottom elevation and proceeding downward.

Celeron Island TP-C-1 to TP-C-6

The water depth observed at the test pit locations was observed at depths of 3.5 to 6.2 feet. The river bottom ground surface elevation was estimated from the existing survey, and ranged from elevation 566 to 567 feet at the test pit locations.

Sand/Silty Sand. Sand or silty sand soils were observed in TP-C-1, 3, 4, 5, and 6. The material extended to depths of 3 to 6.5 feet below the bottom of the river (approximate elevation 560.5 to 563 ft). The material encountered trace gravel and cobbles, with occasional silty clay pockets. At TP-C-1 the silty sand with cobbles was mixed with silty clay soils. TP-C-3 terminated in this stratum at a depth of 5 feet below grade (elevation 562 ft).

Silty Clay. Natural silty clay was encountered in TP-C-5 at the surface and extended to a depth of about 3 feet below the river bottom (elevation 563 ft). This material was observed above the above sand material. Silty clay was also observed at TP-C-6 below the silty sand material, and was observed between depths of 3.5 to 5 feet below grade. A probe was performed below the test pit which indicated the silty clay extended to at least a depth of 8.5 feet. The test pit and probe terminated in the clay soil at a depth 8.5 feet (elevation 557.5 ft).

Cobbles. The engineer reported bedrock cobbles encountered at TP-C-2. The observed rock pieces had thicknesses ranging from 1 to 2 inches, with lengths greater than 12-inches. There was bucket refusal at a depth of 0.2 feet (elevation 566.8 ft), at possible top of bedrock.

Refusal. Some of the test pits terminated upon obstruction at bucket refusal at possible top of rock or cobble layer. TP-C-1 terminated at a depth of 3 feet at possible top of bedrock (elevation 563 ft). TP-C-4 and TP-C-5 terminated at a depth of 6.5 and 6.0 feet at possible cobbles (elevation 560.5 and 560.0 ft), respectively.

Stony Island TP-S-1 to TP-S-7

The water depth observed at the test pit locations was observed at depths of 3.5 to 5.4 feet. The river bottom ground surface elevation was estimated from the existing survey, and ranged from elevation 565 to 568 feet at the test pit locations.

Cobbles. The engineer reported bedrock cobbles encountered at TP-S-1 to TP-S-4. Three test pits terminated in this stratum with bucket refusal at TP-S-1 to TP-S-3 at a depth of 0.2 feet (elevation 564.8 to 566.8 ft), at possible top of bedrock. In TP-S-4 the cobbles extended to a depth of 3 feet below grade (elevation 562 ft) and had reported pockets of silty sandy clay.

Sediment. The engineer reported mucky sediment at the surface to TP-S-7, which extended to a depth of 4 feet below grade (elevation 563 ft).

Gravelly Sand/Silty Sand/Sand. Gravelly sand, sand or silty sand soils were observed in TP-S-5, 6 and 7. The material extended to depths of 2.5 to 6.0 feet below the bottom of the river (approximate elevation 561 to 565 ft).

Silty Clay. Natural silty clay was encountered in TP-S-4 below the cobbles and at TP-S-5 and 6 below the sand soils. At TP-S-7 a probe was performed which indicated silty clay soils below the sand soils. These test pits terminated within this stratum at depths of 4.5 to 7.5 feet (elevation 559.5 to 563 ft).

Please refer to the logs for the soil conditions at the specific test pit locations. It is emphasized that the stratification lines shown on the Logs of Test Pits are approximate indications of change from one soil type to another at the location of the pits. The actual transition from one stratum to the next may be gradual and may vary within the area represented by the test pit.

4.2 GROUNDWATER LEVEL OBSERVATIONS

The water depth of the Detroit River observed at the test pit locations during the fieldwork operations ranged from 3.5 to 6.2 feet. Water elevations for the days of the fieldwork as reported by the NOAA water level station #09044020 at Gibraltar, Michigan indicated an average water level of 571.5 IGLD, corresponding to elevation 571.77 feet NAVD88.

5.0 GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

The geotechnical analyses were preformed in consultation with ECT. The analyses are based on the preliminary design concept by ECT, which includes shoal heights ranging from 9 to 15 feet above the existing river bottom grade. We anticipate the width of the shoals will vary from 30 to 45 feet.

5.1 RECOMMENDATIONS FOR PROPOSED SHOALS

The existing river bottom/bottom of the proposed shoal varies for the project ranging from elevation 566 to 569 feet. Based on our geotechnical investigation, the existing material below the bottom of the proposed shoal will vary across the shoal footprint.

5.1.1 Bearing Capacity

The bearing material is anticipated to consist of silty clay, sand/silty sand, and/or cobbles. Due to the variation of the bearing material observed in the test pits, there is also a variation of the anticipated grain size of this material. For this reason we recommend utilizing a geotextile separator fabric material between the existing sediment/river bottom and the proposed shoal material. The fabric will minimize mitigation of existing bearing soil fine particles (silt and clay) into the voids in the proposed shoal material, gravel or rip-rap. Note the separator fabric may be omitted at locations where the test pits encountered auger refusal on cobbles or possible bedrock within the upper three feet of depth, as reported at test pits TP-C-1 to TP-C-2, and TP-S-1 to TP-S-4.

The existing sediment is not suitable for the direct support of the proposed shoals materials. We suspect the sediment will compact below the separator fabric during construction of the shoal due to the weight of the shoal materials during placement. The existing material below the surficial loose/soft bottom sediments is suitable for support of the proposed shoal.

Due to the varying materials across the site, we recommend the shoal rip-rap materials be vibrated into place during construction with a vibrating impact compactor, such as a Hoe-Pak type piece of equipment; or seated into place by mechanical push with an excavator bucket. The purpose of the placement method is to ensure the large rip-rap is bearing on suitable compact granular soils, silty clay, or cobbles to reduce the potential for settlement into looser material over time.

The existing material below the surficial loose/soft bottom sediments is suitable for the direct support of the proposed shoal, provided they are properly prepared. Although there was no laboratory testing for the strength of the clay soils, based on our experience in the area and observation of the field engineer and operator, we anticipate the consistency of the native clay will be stiff to very stiff. We have conservatively modeled this material as stiff clay with a cohesion of 2,000 psf in our bearing capacity analysis. For the granular soils, we did not have any apparent density data due to the test pit investigation methods. Utilizing the placement method above, we have assumed the material will consist of an internal friction angle of 28 to 30 degrees. Based on these assumptions we recommend an net allowable bearing capacity of 3,000 psf. This incorporates a factor of safety of 3 on the ultimate capacity, for assumed shoal widths of 30 to 45 feet. Due to possible erosion/scour of material, we did not include any embedment influence within our bearing capacity analyses.

We anticipate this bearing capacity will be sufficient for support of the proposed shoal structures. We estimated the maximum anticipated structure loading based on a 15 ft high shoal, comprised of stone rip-rap. The total unit weight of stone rip-rap typically varies from 150 to 175 pcf; and gravel material typically varies from 130 to 138 pcf. Considering the average total unit weight of rip-rap of 160 pcf we anticipate a maximum applied load of 2,400 psf for the preliminary design for a 15 foot high shoal. If the bouyancy of the rip-rap is considered for the lower 6 foot height of the shoal, then the net applied pressure on the bearing material is 2,000 psf.

5.1.2 Settlement

For locations where the shoal is bearing on cobbles, we anticipate the settlement observed will be negligible. For locations where the shoal is bearing on granular or cohesive soils, we anticipate the maximum settlement of the shoal structure will be approximately 4 inches. The actual settlement observed will depend on the height of the shoal and the bearing soils. The settlement will occur due to the settling of the new material through any remaining sediment and the consolidation of the existing soil subgrade. Most of this settlement will occur concurrently with the construction of the shoal, but there will be a long-term component of about 25% to 50% of the total settlement that will occur over about a 3 to 5 year period. This would be anticipated for the silty clay bearing soils. Because of the rough nature of the surface of the completed shoal, and the seasonally fluctuating river elevation, this settlement will probably not be noticeable.

5.1.3 Shoal Design Considerations

SOMAT's scope of work did not include any hydraulic analysis. We understand ECT will perform a hydraulic analysis as part of the design of the shoal for rock size determination and erosion/scour analysis. We have provided general recommendations below.

We recommend the size of the shoal rip-rap be sized based on the anticipated river current and ice conditions for the sites. If different type or size material is to be utilized for the construction of shoal, such as existing soils, smaller gravel, or rip-rap stone material, the layout and geometry should be designed to prevent loss of material through voids of the armor stone and core layers.

5.2 RECOMMENDATIONS FOR CONSTRUCTION SLOPES FOR DREDGING

We understand the rehabilitation of Celeron Island and the lower bay at Stony Island includes excavation of existing soils for creation of deep water habitat. Based on the preliminary design concept, select areas for deep water habitats will be dredged with excavated soils repurposed to create shallow water habitats. The deep habitats will be approximately 6 ft below the existing grades (elevation 560 to 563 ft). There are two (2) proposed deep water habitats at Celeron Island, and four (4) proposed at lower Stony Island.

At Celeron Island, the deep water areas are proposed at the east side of the island near TP-C-4 to TP-C-6. Based on these test pits we anticipate dredged material will consist of sand, silty sand or silty clay. Note that TP-C-4 and TP-C-5 terminated at 6.5 and 6 feet below existing grade (elevation 560.5 to 560 ft) due to bucket refusal on possible cobbles.

At Stony Island, the deep water areas are proposed along the lower bay shoals, near TP-S-2 to TP-S-7. Note that TP-S-2 and TP-S-3 terminated at refusal at 0.2 ft depth. However these test pits were performed east of the proposed shoal and deep water habitat in higher river current, therefore we anticipate larger overburden soils may be encountered toward the west near the lower current and existing wetland areas. Based on these test pits we anticipate dredged material will consist of gravelly sand, silty sand, silty clay and/or cobbles.

We anticipate the existing soils will have a high fines content due the silty sands and silty clay soils observed during the test pits. For the proposed deep water habitat areas, we recommend the dredging slopes for the observed material be graded to 1V:4H. This will provide a stable excavation for the observed granular materials; however it will also provide a feasible and conservative slope if natural silty clay is encountered.

It should be noted that the grain size analyses of the sediment samples indicates that this material may be very susceptible to erosion from the current of the Detroit River. The slope angles noted above represent a geometrically stable slope configuration without consideration of outside forces such as the current of the river. The current of the river will tend to flatten slopes if a new excavation is constructed. The movement of sediment from or to a new slope is a topic that should be evaluated in the design process.

6.0 GENERAL QUALIFICATIONS

All earthwork, dredging and construction activities should be monitored under the direction of a qualified engineering inspector.

This report and the attached Logs of Test Pits are instruments of service, which have been prepared in accordance with generally accepted soil and foundation engineering practices. We make no other warranties either expressed or implied as to the professional advice included in this report.

The contents of this report have been prepared in order to aid in the evaluation of expected subsoil properties to assist the engineer in the design of this project. In the event that any changes are made in the geotechnically related aspects of the project, however slight, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report are modified in writing by our office.

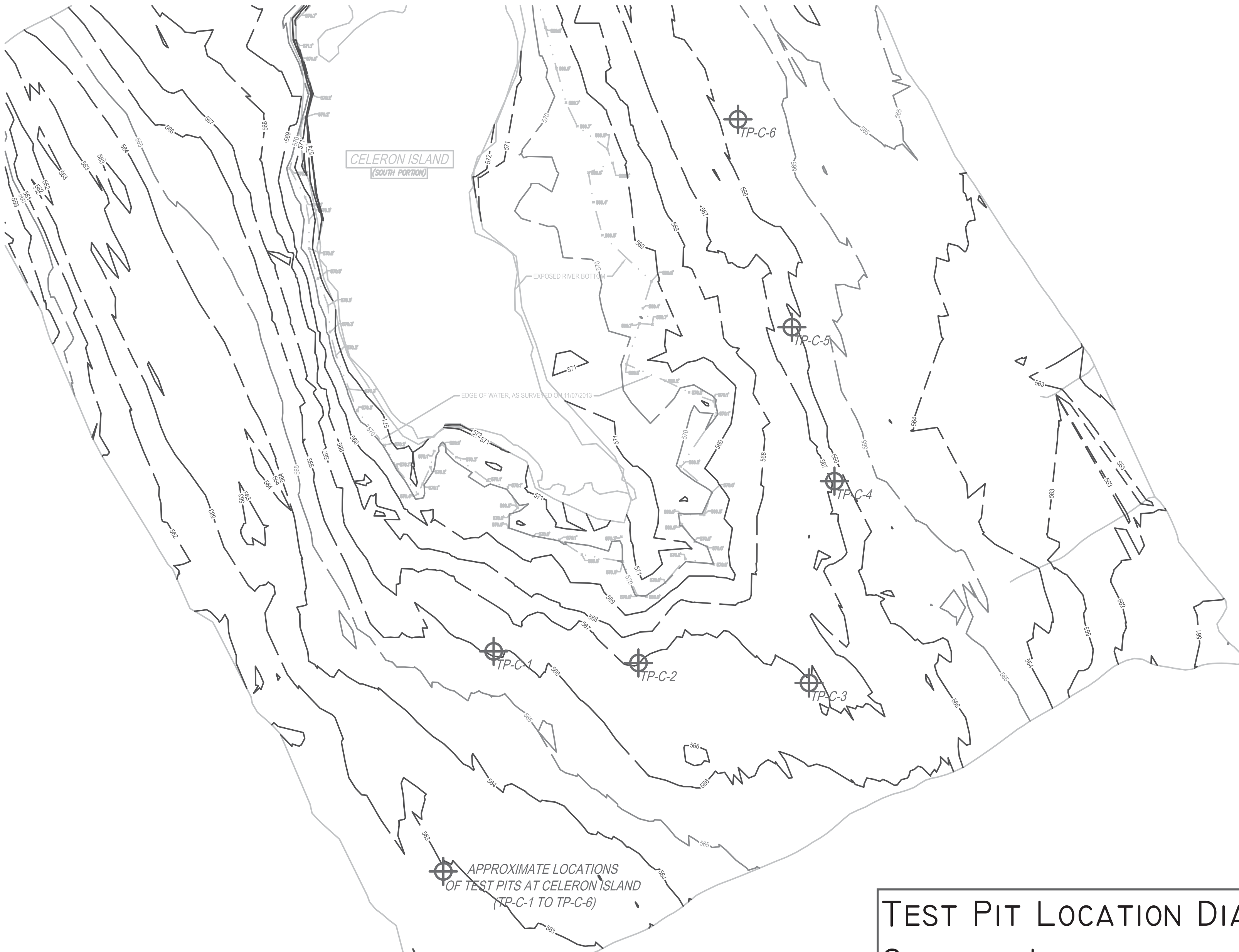
Since the information obtained from the test pits is specific to the exact test locations, soil and water depth information could be different from those occurring at other locations of the site. This report does not reflect variations that may occur between the test pit locations. The nature and extent of these variations may not become evident until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate the recommendations provided in this report.

This report should be made available to bidders prior to submitting their proposals and to the successful contractor and subcontractors for their information only, and to supply them with facts relative to the subsurface investigation, laboratory tests, etc.

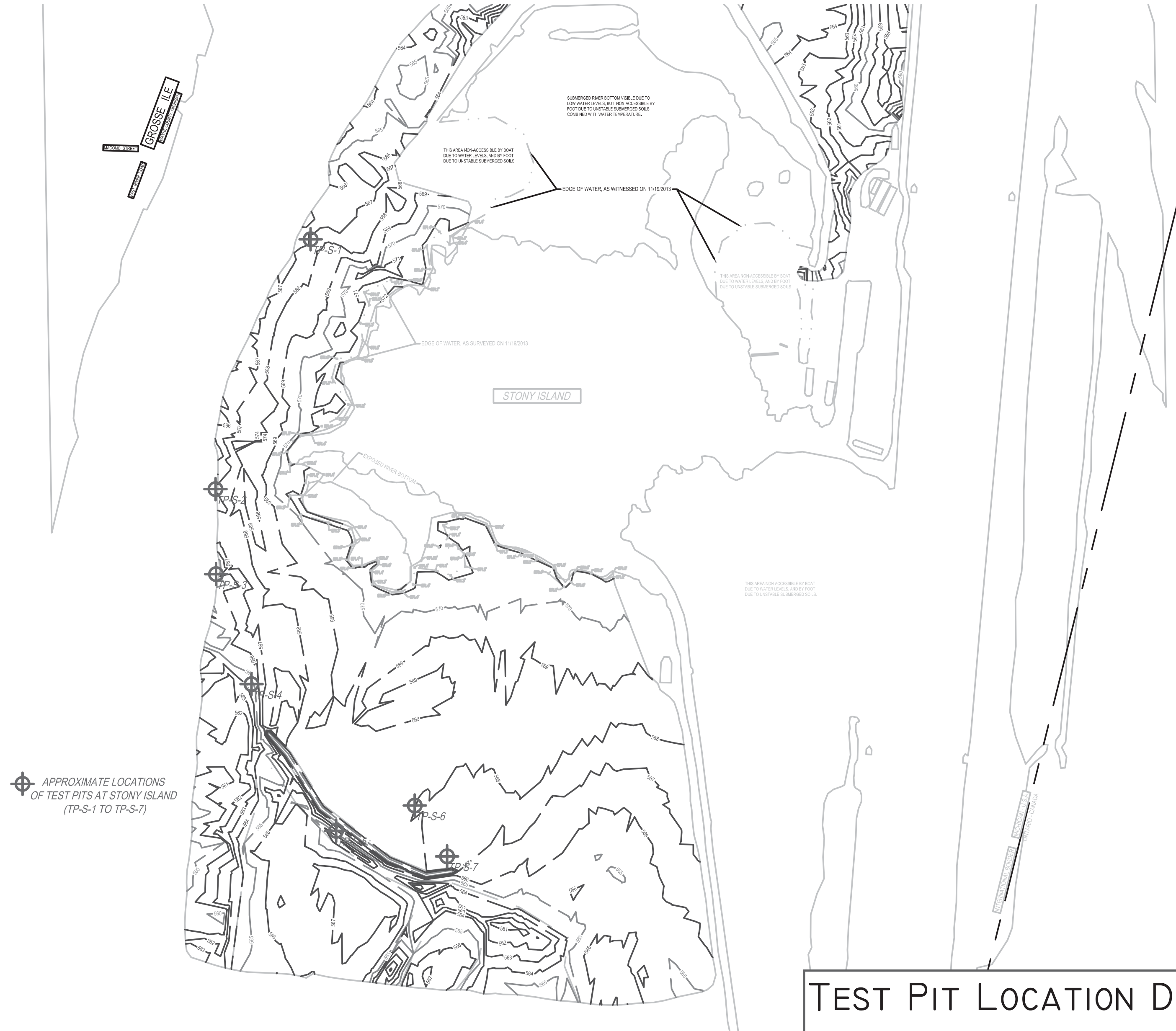
The discussions and recommendations submitted in this report are based on the soil information contained in the Logs of Test Pits and test results appended to this report. We expect that the Logs of Test Pits included in this report along with our discussions and conclusions will assist you in designing the proposed habitat restoration. If you have any questions regarding this report, please contact us.

APPENDIX A

TEST PIT LOCATION DIAGRAM



TEST PIT LOCATION DIAGRAM
CELERON ISLAND
2013194A JULY 16, 2014



Test Pit Location Diagram

Stony Island

2013194A JULY 16, 2014

APPENDIX B

LOGS OF TEST PITS

PROJECT NO. 2013194A **DATE** 4/9/2014 **LOG OF TEST PIT TP-C-1**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)
		Ground Surface Elevation 566 ft		0				
					GB1	1.0		
		SILTY MEDIUM TO COARSE SAND WITH COBBLES mixed with SILTY CLAY, trace to some sand, trace gravel, gray (SM/CL)			GB2	2.0		
563.00			3.0		GB3	3.0		
		Bottom of Test Pit at 3 ft. (Bucket refusal at 3 ft depth, possible top of bedrock)						

TEST PIT COORDINATES
E(x) Coordinate 13447988.0
N(y) Coordinate 210729.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-09-14
Date Completed: 04-09-14
Checked By: ALOG

\# Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 3.5 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/9/2014 **LOG OF TEST PIT TP-C-2**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 567 ft		0				
566.80		Engineer reported BEDROCK COBBLES. Observed pieces of rock had thickness of 1 to 2 inches, with length greater than 12 inches.	0.2					
		Bottom of Test Pit at 0.2 ft. (Bucket refusal at 0.2 ft depth, possible top of bedrock)						

TEST PIT COORDINATES
E(x) Coordinate 13448575.0
N(y) Coordinate 210682.0

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-09-14
Date Completed: 04-09-14
Checked By: ALOG

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 3.5 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/9/2014 **LOG OF TEST PIT TP-C-3**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 567 ft		0				
					GB1	2.0		
562.00		FINE TO MEDIUM SAND, trace silt and gravel, occasional silty clay pockets and cobbles, brown and gray (SP)	5.0		GB2	5.0		
		Bottom of Test Pit at 5 ft. (Terminate in sand soil)		5				

TEST PIT COORDINATES
E(x) Coordinate 13449266.0
N(y) Coordinate 210601.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-09-14
Date Completed: 04-09-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 3.6 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/9/2014 **LOG OF TEST PIT TP-C-4**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 567 ft		0				
					GB1	2.0		
		FINE TO MEDIUM SAND, trace silt, gravel and cobbles, brown and gray (SP) (Engineer reported upper 2 feet of material appeared to be loose)			GB2	4.0		
560.50			6.5	5	GB3	6.5		
		Bottom of Test Pit at 6.5 ft. (Bucket refusal at 6.5 ft depth, terminate on possible cobbles)						

TEST PIT COORDINATES
E(x) Coordinate 13449369.0
N(y) Coordinate 211419.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-09-14
Date Completed: 04-09-14
Checked By: ALOG

\# Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 4.4 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

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Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

ELEVATION ft	LOG OF SOIL PROFILE		Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)
		Ground Surface Elevation 566 ft		0				
563.00	(hatched)	SILTY CLAY, trace sand and gravel, gray (CL)	3.0		GB1	1.5		
					GB2	3.0		
560.00	(dotted)	FINE TO MEDIUM SAND, trace silt and gravel, brown and gray (SP)	6.0	5	GB3	6.0		
		Bottom of Test Pit at 6 ft. (Bucket refusal at 6.0 ft depth, terminate on possible cobbles)						

TEST PIT COORDINATES
E(x) Coordinate 13449189.0
N(y) Coordinate 212043.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-09-14
Date Completed: 04-09-14
Checked By: ALOG

\# Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 4.6 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/9/2014 **LOG OF TEST PIT TP-C-6**

ELEVATION ft	LOG OF SOIL PROFILE		Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 570 ft		0				
566.50		SILTY FINE SAND, trace gravel, brown and gray (SM)	3.5		GB1	3.5		
565.00		SILTY CLAY, trace sand and gravel, gray (CL) (samples disturbed so no hand penetrometer tests performed, excavator estimates medium to stiff consistency)	5.0		GB2 GB3	4.3 5.0		
561.50		Probe of material from 5 to 8.5 feet indicates silty clay soil	8.5	5				
		Bottom of Test Pit at 8.5 ft. (Bucket refusal at 8.50 ft depth, terminate in clay soil)						

TEST PIT COORDINATES
E(x) Coordinate 13448978.0
N(y) Coordinate 212886.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-09-14
Date Completed: 04-09-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 6.2 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT TP-S-1**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 567 ft		0				
566.80		Engineer reported BEDROCK COBBLES.	0.2					
		Bottom of Test Pit at 0.2 ft. (Bucket refusal at 0.2 ft depth, possible top of bedrock)						

TEST PIT COORDINATES
E(x) Coordinate 13457093.0
N(y) Coordinate 231576.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 4.2 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT** **TP-S-2**

	LOG OF SOIL PROFILE			FIELD DATA		LABORATORY DATA		
ELEVATION ft			Depth	DEPTH (ft)	SAMPLE NO.	SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)
		Ground Surface Elevation 567 ft		0				
566.80		Engineer reported BEDROCK COBBLES.	0.2		GB1	0.2		
		Bottom of Test Pit at 0.2 ft. (Bucket refusal at 0.2 ft depth, possible top of bedrock)						

TEST PIT COORDINATES
E(x) Coordinate 13456620.0
N(y) Coordinate 230333.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Remarks:
Engineer reported water depth of 4.0 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT TP-S-3**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 565 ft		0				
564.80		Engineer reported BEDROCK COBBLES.	0.2					
		Bottom of Test Pit at 0.2 ft. (Bucket refusal at 0.2 ft depth, possible top of bedrock)						

TEST PIT COORDINATES
E(x) Coordinate 13456623.0
N(y) Coordinate 229910.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Remarks:
Engineer reported water depth of 3.8 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT TP-S-4**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)
		Ground Surface Elevation 565 ft		0				
562.00		Engineer reported BEDROCK COBBLES, occasional pockets of silty sandy clay.	3.0		GB1	1.5		
					GB2	3.0		
560.00		SILTY SANDY CLAY, trace to some gravel and cobbles, brown (CL)	5.0	5	GB3	5.0		
		Bottom of Test Pit at 5 ft. (Terminate in clay soil)						

TEST PIT COORDINATES
E(x) Coordinate 13456799.0
N(y) Coordinate 229363.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

\# Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 4.1 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands Habitat Restoration Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT** **TP-S-5**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	UNCONFINED COMP STRENGTH (psf)	MOISTURE CONTENT (%)
		Ground Surface Elevation 566 ft		0				
563.50		GRAVELLY MEDIUM TO COARSE SAND, some cobbles, trace silt, brown (SP)	2.5		GB1	2.5		
561.50		SILTY CLAY, trace sand, gravel and cobbles, occasional sand pockets, gray (CL)	4.5		GB2	4.5		
		Bottom of Test Pit at 4.5 ft. (Terminate in clay soil)						

TEST PIT COORDINATES
E(x) Coordinate 13457220.0
N(y) Coordinate 228633.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 4.2 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT** **TP-S-6**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 568 ft		0				
565.00		SILTY FINE SAND, trace to some clay, trace gravel, gray (SM)	3.0		GB1	3.0		
563.00		SILTY CLAY, trace to some sand, trace gravel, mottled brown and gray to gray (CL)	5.0	5	GB2	4.0		
					GB3	5.0		
		Bottom of Test Pit at 5 ft. (Terminate in clay soil)						

TEST PIT COORDINATES
E(x) Coordinate 13457611.0
N(y) Coordinate 228759.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 3.5 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

PROJECT NO. 2013194A **DATE** 4/8/2014 **LOG OF TEST PIT TP-S-7**

ELEVATION ft		LOG OF SOIL PROFILE	Depth	FIELD DATA: DEPTH (ft)	FIELD DATA: SAMPLE NO.	LABORATORY DATA: SAMPLE TIP DEPTH (ft)	LABORATORY DATA: UNCONFINED COMP STRENGTH (psf)	LABORATORY DATA: MOISTURE CONTENT (%)
		Ground Surface Elevation 567 ft		0				
563.00		Sediment	4.0		GB1	4.0		
561.00		FINE SAND, trace silt and gravel, gray to dark gray (SP)	6.0	5	GB2	6.0		
559.50		Probe of material from 6 to 7.5 feet indicates silty clay soil	7.5		GB3	7.5		
		Bottom of Test Pit at 7.5 ft. (Terminate in sand soil)						

TEST PIT COORDINATES
E(x) Coordinate 13457772.0
N(y) Coordinate 228506.0

GROUNDWATER READINGS
First Encountered: N/A
Upon Completion: N/A

Contractor: Marine Services
Equipment: Test Pit
Engineer: J. Cunningham
Backfilled With: Cuttings
Date Started: 04-08-14
Date Completed: 04-08-14
Checked By: ALOG

Torvane
* Pocket Penetrometer
<> Disturbed Sample

Remarks:
Engineer reported water depth of 5.4 ft. Northing/Easting are estimates based on conversion of handheld GPS data. Ground surface estimated from existing survey.

Somat Engineering, Inc.

Stony & Celeron Islands
Habitat Restoration
Wayne County, Michigan

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon – 1 3/8" I.D., 2" O.D. (standard)
S :	Split Spoon – non-standard size, as noted
ST:	Thin-Walled Tube – 3" O.D., (unless otherwise noted)
LS:	Liner Sample
PA:	Power Auger
HA:	Hand Auger
AU:	Auger Sample
BS:	Bulk Sample
HS:	Hollow Stem Auger
DP:	Direct Push
PS:	Piston Sample
PT:	Pitcher Sample
WS:	Wash Sample
RC:	Rock Core with diamond bit, NX size, (unless otherwise noted)
RB:	Rock Bit/Roller Bit
WR:	Wash Rotary
NR:	No Recovery
VS:	Vane Shear Test

Standard Penetration Test Resistance, N-Value: Sum of 2nd and 3rd 6-inch increments, in blows per foot of a 140-pound hammer falling 30 inches and driving an 18-inch long, 2-inch OD split spoon.

WATER LEVEL MEASUREMENT:
Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. In pervious soils, the indicated levels may reflect the location of a groundwater table. In low permeability soils (clays and silts), the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION:
Soil classification is based on the Unified Soil Classification (USC) System and ASTM Standards D-2487 and D-2488. Coarse-grained soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: clays, if they are plastic, and silts, if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their apparent in-place density and fine-grained soils on the basis of their apparent in-place density (silty soils) or consistency (clayey soils).

SECONDARY SOIL CONSTITUENT

Percentage Range	Primary Constituent	
	Sand & Gravel	Clay & Silt
≤ 5%	Trace	Trace
>5% → ≤12%	Trace to Some	Trace to Some
>12% → ≤25%	Secondary Constituent	Some
>25% → <50%	Secondary Constituent	Secondary Constituent

COARSE-GRAINED SOILS

N-Value	Apparent Density
0 – 4	Very Loose
5 – 9	Loose
10 – 29	Medium Dense
30 – 49	Dense
50 – 80	Very Dense
>80	Extremely Dense

FINE-GRAINED SOILS

Unconfined Compressive Strength Qu, psf	Consistency
< 500	Very Soft
500 - <1000	Soft
1000 - <2000	Medium
2000 - <4000	Stiff
4000 - <8000	Very Stiff
≥ 8000	Hard

DEFINITIONS OF STRUCTURAL AND DEPOSITIONAL FEATURES

Term	Definition
Parting	≤ 1/16 inch (1.6 mm) thick
Seam	> 1/16 inch (1.6 mm) → ½ inch (12.7 mm) thick
Layer	> ½ inch (12.7 mm) to ≤ 12 inches (305 mm) thick
Pocket	Small, erratic deposits of limited lateral extent
Lens	Lenticular deposit
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Varved	Alternating partings or seams (1 mm – 12 mm) of silt and/or clay and sometimes fine sand
Stratified	Alternating layers of varying material or color with layers ≥ 6 mm thick
Laminated	Alternating layers of varying material or color with layers < 6 mm thick
Fissured	Contains shears or separations along planes of weakness
Slickensided	Shear planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Homogeneous	Same color and appearance throughout
Occasional	One or less per foot (305 mm) of thickness
Frequent	More than one per foot (305 mm) of thickness
Interbedded	Applied to strata of soil lying between or alternating with other strata of a different nature

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Size Range
Boulders	≥ 12" (300 mm)
Cobbles	< 12" - 3" (300 mm – 75 mm)
Gravel - Coarse	< 3" - ¾" (75 mm – 19 mm)
Gravel – Fine	< ¾" - #4 (19 mm – 4.75 mm)
Sand – Coarse	< #4 - #10 (4.75 mm – 2 mm)
Sand – Medium	< #10 - #40 (2 mm - 0.425 mm)
Sand – Fine	< #40 - #200 (0.425 mm -0 .074 mm)
Silt	< 0.074 mm - 0.005 mm
Clay	<0 .005 mm

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR REPORT

Important Information About Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

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