SUMMIT
GEOENGINEERING SERVICES

# GEOTECHNICAL REPORT

## East Bayside Lofts
## 89 Anderson Street
## Portland, Maine

Prepared for:

Redfern Properties
P.O. Box 8816
Portland, Maine 04101

Prepared by:

Summit Geoengineering Services
145 Lisbon St.
Lewiston, Maine

Project #14221
February 2015

SUMMIT
GEOENGINEERING SERVICES

February 26, 2015
SGS #14221

Jonathan Culley
Redfern Properties
P.O. Box 8816
Portland, Maine 04104

Reference: Geotechnical Report, East Bayside Lofts
89 Anderson Street, Portland, Maine

Dear Jonathan;

Summit Geoengineering Services, Inc. (SGS) has completed a geotechnical investigation for the proposed East Bayside Loft at the site reference above. Our scope of services included the drilling of 4 borings, conducting one cone penetration test (CPT), performing laboratory testing on collected samples, and preparing this geotechnical report summarizing our findings and providing geotechnical recommendations.

Our scope of services for this project did not include an environmental site assessment or further investigation for the presence or absence of hazardous or toxic material on, below, or around the site. Any statements in this report, or on the soil boring logs, regarding odors or unusual and suspicious conditions observed are for informational purposes and are not intended to constitute an environmental assessment.

## 1.0 Project Description

The project consists of the construction of a mixed used commercial building and parking spaces at 89 Anderson Street in Portland, Maine. The site is located at northeasterly corner of Fox Street and Anderson Street. There is an existing single story masonry block building serving as an auto repair shop at the northern corner of the lot and a small storage building at the southern corner. Both existing structures are planned to be removed. The western portion of the site is a paved lot and the eastern portion contains a gravel surface. Grades at the site slope up gently from approximately 13 feet to approximately 17 feet in a northerly direction. The northern border of the site abuts the parking lot for a multi housing unit complex.

The proposed building will be located along the southwestern and southeastern portion of the site adjacent to Anderson Street and Everett Street. We understand that the proposed building is anticipated to be four stories tall; the first story will comprise of a restaurant and commercial retail space, and the second through fourth stories will contain a total of 12 studio

apartments, 29 one-bedroom apartments, and 12 two-bedroom apartments for a total of 53 rental units within the building. A surface level parking lot (partially below the building) will also be included in construction. The ground floor level will be at or near the existing ground surface.

Anticipated structural loads provided by Structural Integrity, Inc. for the newly constructed building are as follows:

Interior Columns = 125 to 250 kips
Exterior Columns = 100 to 190 kips
Strip Footings = 5 to 7 kip/lf

A retaining wall is proposed to be constructed along the eastern border of the site between the proposed parking lot and existing gravel parking for the apartment complex adjacent to the site.

## 2.0 Exploration and Testing

### 2.1 Exploration

Summit Geoengineering Services (SGS) observed the subsurface conditions at the site with the drilling of 4 borings and one cone penetration test (CPT) on November 25, 2014. The borings were drilled to depths ranging from 12 to 22 feet using 2-1/2" hollow stem augers. Continuous split spoon sampling was conducted in general accordance with ASTM D1586 from the ground surface to the top of the soft silty clay layer to collect blow counts and soil samples for subsequent laboratory testing. Once the soft clay layer was encountered, split spoon sampling was conducted at 5 foot intervals to a depth of 22 feet in borings B-1, B-3, and B-4. Boring B-2 was terminated at depth of 12 feet.

A Cone Pentration Test (CPT) was conducted along the proposed building alignment to determine engineering properties of the soft clay, thicknesses of subsurface layers, groundwater depth, and depth to refusal. CPT-1 was advanced to a depth of 52 feet below ground surface where refusal was encountered. The CPT was performed using a rubber track mounted PowerProbe 9500 VTR with a single point hollow stem anchor set to a depth of 5 feet. The CPT was performed using a Vertek 5 ton digital cone pushed at a constant rate (2 cm/s). Parameters obtained include cone resistance ($q_c$), sleeve friction ($f_s$), and piezocone pore pressure (u), and shear wave velocity ($V_s$).

Locations of the borings and CPT were marked by SGS prior to drilling by measuring from the existing building. These locations can be seen in the SGS Exploration Plan in Appendix A. A copy of the boring logs and CPT log can be seen in Exploration Logs in Appendix B.

## 2.2 Laboratory Testing Results

Moisture content testing (*ASTM D2216/4643*) was performed on 6 collected clay samples and Atterberg Limit testing (*ASTM D4318*) was conducted on 2 collected clay samples. Results from these tests are summarized in the table below. Detailed test results are included in Appendix C.

| LABORATORY TEST RESULTS | | | | | | |
|---|---|---|---|---|---|---|
| **Sample** | **Depth (ft)** | **Moisture** | **LL** | **PL** | **PI** | **USCS** |
| B1-S5 | 8 to 10 | 47.2 % | - | - | - | CL |
| B1-S6 | 10 to 12 | 39.7 % | - | - | - | CL |
| B1-S7 | 15 to 17 | 46.2 % | 39 | 19 | 20 | CL |
| B1-S8 | 20 to 22 | 46.2 % | - | - | - | CL |
| B4-S6 | 9 to 10 | 29.8 % | - | - | - | CL |
| B4-S7 | 15 to 17 | 34.7 % | 26 | 14 | 12 | CL |

LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, USCS = Unified Soil Classification System, CL = "Lean Clay"

## 3.0 Subsurface Conditions

### 3.1 Soil

The soil at the site generally consists of ***fill*** overlying ***stiff clay*** over ***soft clay*** overlying ***silty sand*** overlying ***glacial till*** or ***bedrock***.

The ***fill***, encountered in all borings and the CPT, is described as dark brown sandy silt to clayey silt, to gravelly sand to fine sand to gray ash. It ranges from 4 feet to 9 feet in thickness, in general increasing in thickness towards the western end of the site. The fill ranges from dry to wet and loose to compact. Occasional fragments of wood chips and brick are present in the layer. It classifies as ML, SP, or SM in accordance with the Unified Soil Classification System.

The ***stiff*** clay was encountered in borings B-2 and B-3 and is described as a stiff olive brown silty clay. It ranges from 4 feet to 4.5 feet in thickness. Pocket penetrometer measurements (an estimate of unconfined compressive strength) ranged from 600 psf to greater than 9000 psf. This layer becomes softer with depth as it transitions into the soft gray silty clay. It classifies as CL in accordance with the Unified Soil Classification System.

A 2.5' layer of silty sand is present between the stiff clay and soft clay layers at boring B-3. This confined layer is described as mottled gray silty fine sand with trace to little clay. It is wet and very loose. It classifies as SM in accordance with the Unified Soil Classification System.

The ***soft clay*** starts from 8 to 11 feet below ground surface and is described as wet and very soft gray silty clay with occasional fine sand seams. Moisture content ranges from 29.8% to 47.2% and the Liquid Limit ranges from 26 to 39. Soil behavior classification from CPT-1 indicates the

clay layer to extend to 45' below ground surface. Frequent seams are present in the bottom 10 feet of the layer. It classifies as CL in accordance with the Unified Soil Classification System.

The ***silty sand*** encountered at CPT-1 extends from 45 feet to 52 feet below ground surface and consists of stratified layers of silt-sand mixtures and silty clay based on soil behavior type (SBT) classification from the cone penetration test. Corrected tip resistance ($q_t$) values in this layer range from 8 tsf to 176 tsf with an average value of 56 tsf. Sleeve friction ($f_s$) measured in the layer range from -4 tsf to 11 tsf with an average of 2 tsf. Negative sleeve friction values can occur in thin layers of soft soils due to abrupt changes in lateral pressures. Negative sleeve friction values do not have significance in geotechnical design.

The ***glacial till*** or ***bedrock*** starts at 52 feet below ground surface at location CPT-1. This layer caused refusal to advancement of the cone, and from experience on similar geotechnical investigations in the area, is likely either dense glacial till or bedrock.

### 3.2 Groundwater

Groundwater was observed to be at or near the elevation of the top of the soft clay layer ranging from depth 6.5 feet below ground surface to 9 feet below ground surface (ranging from elevation 5 feet to 7 feet).

### 3.3 Bedrock

Refusal of CPT-1 was encountered at 52 feet below ground surface and was likely either dense glacial till or bedrock. According to the Maine Geological Survey, bedrock at the site is of the Precambrian Z Spring Point Formation consisting of green schist and amphibolites facies ranging from and mafic to felsic volcanic rock.

## 4.0 Geotechnical Recommendations

Based on the proposed building loads and presence of the shallow soft marine clay at the site, we do not believe that the newly constructed building will be adequately supported on shallow spread footings. Predicted settlements of column footings and spread footings supported by a shallow foundation are estimated to be anywhere from 2 inches to 4 inches. We believe these magnitudes of settlement are unacceptable for this construction.

Alternative foundations considered for the new building included a structural mat, helical piles (intermediate foundation), preload, and piles (deep foundation). Due to cost, feasibility, and time constraints, the structural mat, helical piles, and preload options are not recommended for this site.

We recommend that the columns and load bearing elements of the new building be supported by a deep foundation system. This should consist of HP12x53 Grade 50 steel piles connected with pile caps. H-piles should be vibrated or driven to a dense stratum to provide sufficient end bearing capacity. We believe that if this deep foundation system is used, and the recommendations from this report are followed, that the total settlement will be negligible.

Non-load bearing walls and concrete slabs-on-grade can be constructed on the existing fill or native stiff silty clay soil.

### *4.1 Pile Foundation Recommendations*

Based on anticipated design loads of the new structure, we recommend that driven or vibrated HP12x53 Grade 50 steel piles be used as the foundation system for the newly constructed building. We recommend that all piles be vibrated or driven to a dense stratum, either glacial till or bedrock, which is anticipated to range from 50 feet to 70 feet below the current ground surface (elevation -37 to -57 feet). Recommended pile design values are summarized in the table below.

**TABLE 1- Pile Design Values**

| Parameter: | HP 12 x 53 | Factor of Safety |
|---|---|---|
| Allowable Compressive Capacity | 75 ton/pile | 2.5 |
| Allowable Uplift Capacity | 8 ton/pile | 5.0 |
| Allowable Lateral Capacity | 2 ton/pile | 2.0 |

Allowable pile design values from Table 1 are based on the following:

- A MKT DE 42/35 or similar diesel pile driver
- Rated energy of 35,000 lbs-ft to 42,000 lbs-ft
- A 2-inch thick MC-904(P) Blue Nylon pile cushion or similar is used
- Steel HP12x53 consist of Grade 50 steel
- Piles are driven to a dense stratum, anticipated at an elevation of -37 to -57 feet
- Pile spacing in accordance with recommendations described below
- Dynamic pile testing is conducted on a minimum of 1 installed pile (see Section 5.0)

These recommendations are based on evaluating static analysis for the site soil conditions and wave analysis using GRLWEAP 2005 with assumed pile driver information typical of local pile driving contractors based on our experience. Design of all pile caps and pile splices should be in accordance with the International Building Code 2009 (IBC 2009)

We do not anticipate that vibration during pile installation will be significant enough to have adverse effects on surrounding structures.

The recommended allowable lateral capacity of the installed HP12x53 steel piles is 2 tons per pile. This assumes the horizontal loading to be oriented perpendicular to the flanges of the HP12x53 so that bending occurs about the strong axis of the pile. Furthermore, all areas of exposed native soil within a 3 foot width beyond the edge of the pile in all directions should be proofrolled with a minimum of 2 passes in each of two perpendicular directions with a 5-ton (operating weight) vibratory roller.

We recommend that piles within a pile group be spaced at a minimum of 4 feet center to center. We further recommend that piles within a pile group which are spaced parallel to the direction of horizontal loading should be spaced at a minimum of 6 feet center to center. Piles spaced closer than this will result in overlapping stress distributions in the soil and cause lateral capacity to be reduced. Pile spaced 4 feet center to center oriented parallel to the direction of horizontal loading will reduce the factor of safety from 2.0 to 1.25.

Lateral capacity can also be developed by the soil resistance against the pile caps and grade beams. If the lateral deflection of the pile cap or grade beam is greater than 0.005 feet per foot of grade beam/pile cap depth, the passive resistance of the soil will be mobilized. We recommend that the allowable lateral capacity of the soil against pile caps and grade beams be taken as 400 psf per foot of depth perpendicular to the lateral force applied (passive equivalent fluid pressure) for this condition. If lateral deflections are less than 0.005 feet per foot of depth, we recommend an allowable lateral capacity of 70 psf per foot of depth (at-rest equivalent fluid pressure) for this condition. These soil resistances assume that Foundation Backfill (FB, Section 4.4) is compacted to 95 percent of its maximum dry density, determined in accordance with ASTM D1557, and that the design moist unit weight of the soil is a minimum of 130 pounds per cubic foot (pcf).

| **TABLE 2- Pile Cap and Grade Beam Lateral Resistance** | |
|---|---|
| **Lateral Deflection** | **Lateral Soil Resistance** |
| < 0.005 ft/ft of depth | 70 psf/ft of depth |
| > 0.005 ft/ft of depth | 400 psf/ft of depth |

### *4.2 Slabs-on-grade*

All foundation elements of existing structures in the area of the proposed building footprint should be removed in their entirety. Voids created by the removal of existing foundation elements should be filled with compacted SF or ¾" crushed stone. All areas of exposed native soil should be proofrolled with a minimum of 2 passes in each of two perpendicular directions with a 5-ton (operating weight) vibratory roller.

We recommend that all fill within the building footprint consist of Structural Fill. The building slab should be constructed on a minimum 12 inch thick layer of Structural Fill (SF). The portion of SF passing the 3" sieve shall meet the following gradation requirements.

| **STRUCTURAL FILL (SF)** | |
|---|---|
| **Sieve Size** | **Percent finer** |
| 3 inch | 100 |
| ½ inch | 38 to 80 |
| ¼ inch | 25 to 65 |
| No. 40 | 0 to 30 |
| No. 200 | 0 to 7 |

**Reference**: MDOT Specification 703.06, Type D

The maximum particle size should be limited to 6 inches. Structural Fill should be placed in 6 to 12 inch lifts and should be compacted to a minimum of 95 percent of its maximum dry density, determined in accordance with ASTM D1557.

For the conditions described above, the slab can be designed using a subgrade modulus of 100 pci.

### *4.3 Frost Protection and Foundation Backfill*

Based on a 10-year design air freezing index of 1,200 degree F days for the Portland, Maine region, all pile caps, grade beams, and foundation walls exposed to freezing temperatures should be constructed at a minimum depth of 4 feet below finish exterior grade. We recommend that these elements be backfilled with Foundation Backfill (FB). The portion of FB passing the 3" sieve size should meet the following gradation requirements:

| **FOUNDATION BACKFILL (FB)** | |
|---|---|
| **Sieve Size** | **Percent finer** |
| 3 inch | 100 |
| ¼ inch | 25 to 100 |
| No. 40 | 0 to 50 |
| No. 200 | 0 to 7 |

**Reference**: MDOT Specification 703.06, Type E

Maximum particle size should be limited to 6 inches. Foundation backfill should be placed in 6 to 12 inch lifts and compacted to 95% of its optimum dry density determined in accordance with ASTM D1557.

### *4.4 Non-Bearing Foundation Walls*

We recommend that all load bearing foundation walls and columns for the new building be supported by the deep foundation. However, non-bearing foundation walls can be constructed directly on the native fill or native stiff silty clay. If the subgrade preparation recommendations outlined below are followed, non-bearing foundation walls can be proportioned using an allowable bearing capacity of 1,500 psf.

Exterior walls exposed to freezing temperatures should be constructed at a minimum depth of 4 feet below finish grade. We recommend that all exposed native soils beneath constructed walls be proofrolled with a minimum of 3 passes with a walk behind plate compactor. Soft, wet, or unsuitable soils should be removed and replaced with compacted SF or ¾" crushed stone. Walls should be backfilled using FB placed in accordance with the methods outlined in Section 4.3.

### *4.5 Seismic Site Class and Design Criteria*

Based on shear wave velocity measurements collected during CPT-1 and laboratory testing on collected samples, the East Bayside Loft site classifies as Site Class D "stiff soil profile" in accordance with the 2009 International Building Code. The following seismic site coefficients should be used:

| SEISMIC DESIGN COEFFICIENTS | |
|---|---|
| **Seismic Coefficient** | **Site Class D** |
| Short period spectral response ($S_S$) | 0.314 |
| 1 second spectral response ($S_1$) | 0.077 |
| Maximum factored spectral response ($S_{MS}$) | 0.486 |
| 1 second factored spectral response ($S_{M1}$) | 0.185 |
| Design short period spectral response ($S_{DS}$) | 0.324 |
| Design 1 second spectral response ($S_{D1}$) | 0.123 |

### *4.6 Pavement Section Recommendations*

Based on a mean annual air freezing index of 900 degree F days for the Portland, Maine region, we recommend a minimum total pavement section thickness of 18 inches, equal to 50% of the approximate mean annual frost penetration of 36 inches. We further recommend that the pavement section consist of the following materials.

| PAVEMENT SECTION RECOMMENDATION | | |
|---|---|---|
| **Material** | **Thickness (in)** | **Specification** |
| Asphalt Surface Course | 1 | MDOT Superpave |
| Asphalt Binder Course | 2 | MDOT Superpave |
| Base Soil | 3 | MDOT 703.06 Type A |
| Subbase Soil | 15 | Structural Fill (MDOT 703.06 Type D) |

All foundation elements of existing structures in the area of the proposed parking lot should be removed in their entirety. If it is desirable to leave portions of the existing foundation in place within proposed parking areas, we recommend that a 12 inch thick minimum cushion be provided between the top of the remaining foundation element and the pavement surface. This cushion should consist of compacted SF. All areas of exposed native soil should be proofrolled by making a minimum of 2 passes in each of two perpendicular directions using a minimum 5 ton (operating weight) vibratory roller.

The maximum particle size of the Structural Fill should be limited to 6 inches and the maximum particle size of the MDOT 703.06 Type A should be limited to 4 inches. All placed fill should be placed in a maximum of 12-inch lifts, and be compacted to 95 percent, in accordance with ASTM D1557.

## 5.0 Testing and Field Monitoring Recommendations

All piles should be installed to an ultimate capacity equal to the allowable axial capacity (75 tons per pile) multiplied by a factor of safety of 2.5 to equal 187 tons per pile. To ensure that this capacity is developed, and to avoid over-stressing of the installed piles, we recommend dynamic pile testing (PDA) be performed on select piles in accordance with ASTM D4945. We further recommend that a specialty consultant be used to perform these tests.

In addition to the PDA testing, we also recommend that a detailed pile-driving log for each pile be performed and reviewed to evaluate pile installation and consistency. The contractor or a qualified technician can record the pile-driving logs. If the contractor is selected to record the pile driving logs, we recommend that SGS review the logs and verify that the piles are being installed within the design recommendations.

We recommend that the skin friction values generated by the compressive load test (ASTM D4945) be evaluated to verify the field uplift capacity.

Field testing for lateral capacity is not required.

## 6.0 Cast-in-Place Retaining Walls

We recommend that cast in place retaining walls be designed for the lateral earth pressures taken from the following table.

| CAST-IN-PLACE RETAINING WALL LATERAL LOADS | | | |
|---|---|---|---|
| **Condition** | **Drained at Base** | **Equivalent Fluid Pressure** | **Live Load Surcharge** |
| Free at Top | Yes | 42 psf/ft | 250 |
| | No | 84 psf/ft | |
| Fixed at Top | Yes | 64 psf/ft | 250 |
| | No | 95 psf/ft | |

Passive resisting pressure in front of cast-in-place walls can be taken as 375 psf per foot of embedment depth. A value of 0.5 or 0.45 should be used for the friction coefficient at the base of the wall for walls constructed on the existing proofrolled fill or proofrolled native stiff silty clay, respectively.

Cast in place retaining wall footings should be constructed at a minimum depth of 4 feet below the exterior finished grade for frost protection. The maximum retaining wall footing contact pressure should be limited to 1,500 psf. This assumes the subgrade is prepared in accordance with the recommendations presented in Section 4.4.

We recommend that retaining walls be backfilled with FB meeting the gradation requirements presented in Section 4.3. FB should be compacted to 95% of its maximum dry density in accordance with ASTM D1557.

We recommend that underdrains be installed at the base of retaining walls to prevent the build-up of hydrostatic pressures. The underdrains should be located adjacent to the wall on the top of the footing. The underdrain should consist of 4" rigid perforated PVC surrounded by a minimum of 6 inches of crushed stone and filter fabric to prevent clogging from the migration of the fine soil particles in the foundation backfill soils. The underdrain pipes should outlet to a location where they will be free flowing.

## 6.0 Construction Consideration

Based on the groundwater levels observed from our explorations, we do not anticipate that groundwater will be encountered within the building excavations. Diversion and control of surface water should be performed to prevent water flow from adjacent wet areas or from rain or snowmelt from entering the excavations.

All exposed native soil which will be load bearing (under slabs, pile caps, and grade beams) should be proofrolled with a minimum of 2 passes in each of two perpendicular directions with a 5-ton (operating weight) vibratory roller.

All foundation elements of existing structures in the area of the proposed parking lot should be removed down to a minimum depth of 12" below proposed finish grade. If desired, the foundation elements can be removed in their entirety. All foundation elements of existing structures in the area of the proposed building footprint should be removed in their entirety.

General excavations within the silty clay soil, if encountered, will be susceptible to softening when wet. If subgrade softening does occur, we recommend over excavation and replacement with a minimum of 6 inches of ¾" crushed stone. The placed crushed stone should be compacted with a minimum of four passes with a walk-behind plate compactor.

Excavations deeper than 4 feet should be sloped no greater than 1.5H to 1V for fill or previously disturbed soils and 0.75H:1V for the stiff silty clay soil. Excavations below groundwater should be limited to 1.5H to 1V. These slopes are based on the current OSHA Excavation Guidelines.

## 7.0 Closure

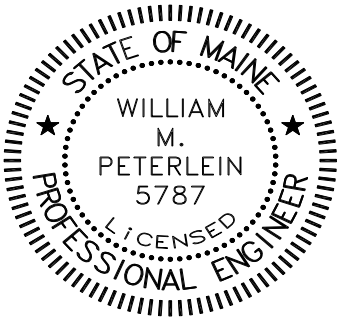
Our recommendations are based on professional judgment and generally accepted principles of geotechnical engineering. Some changes in subsurface conditions from those presented in this report may occur. Should these conditions differ materially from those described in this report, or should building loads and configurations change significantly, SGS should be notified so that we can re-evaluate our recommendations. Furthermore, SGS should be notified should pile

material change, expected fill height increase, or pile refusal be encountered outside of the expected range of -37 feet to -57 feet.

We appreciate the opportunity to serve you during this phase of your project. If there are any questions or additional information is required, please do not hesitate to call.

Sincerely,
**Summit Geoengineering Services, Inc.**

Mathew Hardison, EI
Geotechnical Engineer




William M. Peterlein, PE
Principal Geotechnical Engineer

# APPENDIX A

# EXPLORATION PLAN

## LEGEND

B-1 SUMMIT TEST BORING (NOVEMBER 25, 2014)

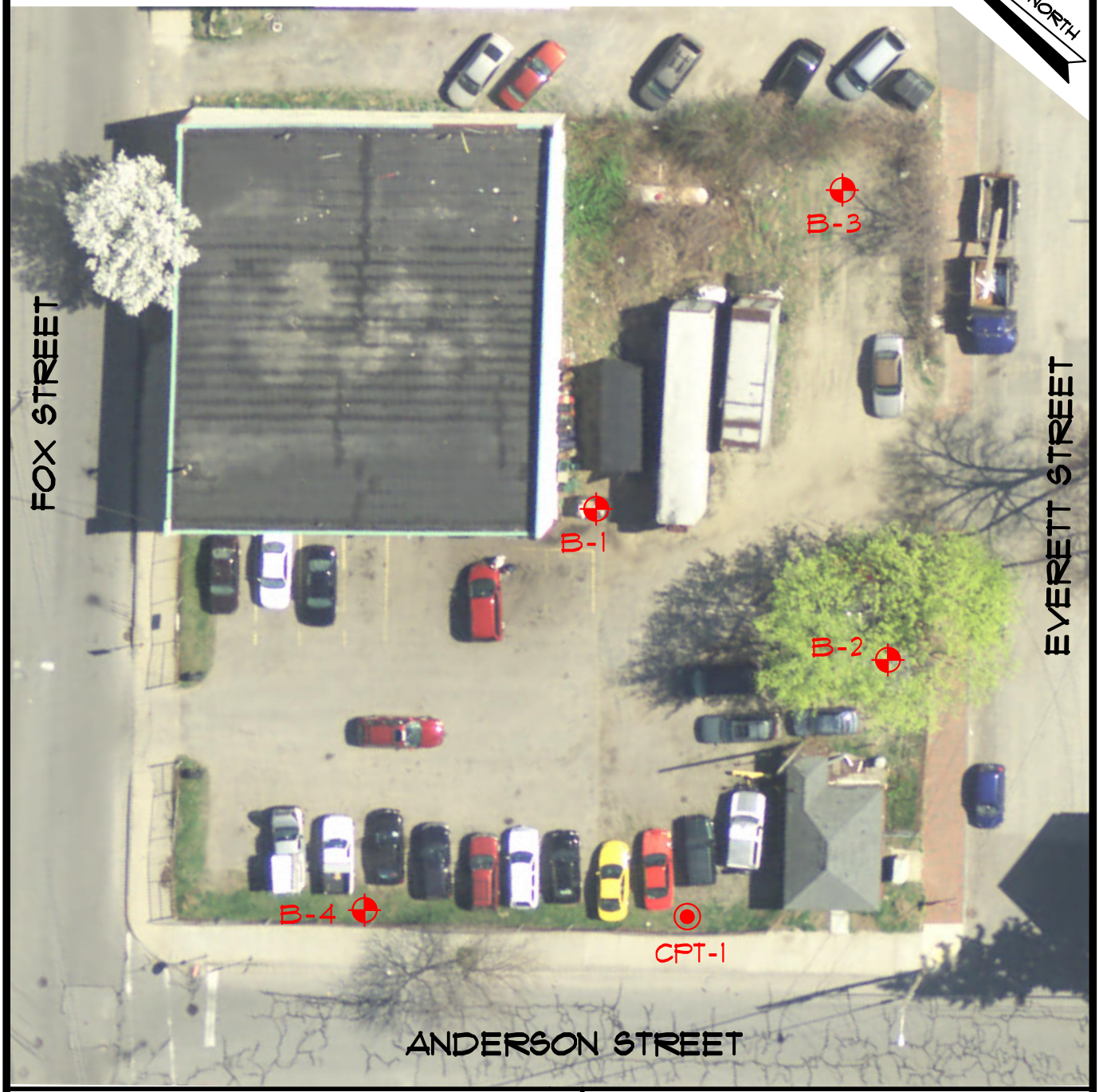
CPT-1 CONE PENETRATION TEST (NOVEMBER 25, 2014)

## PLAN REFERENCE

AERIAL IMAGE OBTAINED FROM MAINE OFFICE OF G.I.S.

N

NORTH




# TEST BORING LOCATION PLAN
# EAST BAYSIDE LOFTS

89 ANDERSON STREET - PORTLAND, ME

PREPARED FOR

## REDFERN PROPERTIES, LLC

| | | |
|---|---|---|
| DATE: 11-26-14 | DRAWN BY: KRF | CHECKED BY: WMP |
| JOB: 14221 | SCALE: 1" = 30' | FILE: 14221 BOR |


145 LISBON ST. - SUITE 601
LEWISTON, ME 04240
Tel.: (207) 576-3313

173 PLEASANT STREET
ROCKLAND, ME 04841
Tel.: (207) 318-7761

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# APPENDIX B

# EXPLORATION LOGS

**SUMMIT**
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# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | East Bayside | Boring #: | **B-1** |
| Location: | 89 Anderson Street | Project #: | 14221 |
| City, State: | Portland, Maine | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 14 ft. +/- |
| Driller: | C. Coolidge, P.E. | Reference: | Survey plan prepared by Nadeau Land Surveys dated 7/21/2014 |
| Summit Staff: | B. Peterlein, P.E. | Date started: 11/25/2014 | Date Completed: 11/25/2014 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: 24" SS |
| Model: AMS Power Probe | Diameter: 2"OD/1.5"ID |
| Method: 2-1/2" H.S.A. | Hammer: 140 lb |
| Hammer Style: Auto | Method: ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 11/25/2014 | 9 ft | 5 ft. +/- | In borehole at completion |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | S-1 | | 0 to 2 | 3 | | | | |
| 1 | | | | 2 | | Brown SAND, trace Silt, dry, loose, SM | | FILL |
| | | | | 3 | | | | |
| 2 | | | | 3 | | Olive-gray Sandy SILT, trace ash, dry | | |
| | S-2 | | 2 to 4 | 2 | | | | |
| 3 | | | | 1 | | Gray Clayey SILT, moist, soft, ML | | |
| | | | | 2 | | | | |
| 4 | | | | 2 | | | | |
| | S-3 | | 4 to 6 | 3 | | Olive-brown Clayey SILT, trace wood chips, moist, firm, | | |
| 5 | | | | 2 | | ML | | |
| | | | | 3 | | | | |
| 6 | | | | 2 | | | | |
| | S-4 | | 6 to 8 | 3 | | No recovery - gravel in tip of spoon | | |
| 7 | | | | 1 | | | | |
| | | | | 6 | | | | |
| 8 | | | | 2 | | | | |
| | S-5 | | 8 to 10 | WH | | | | |
| 9 | | | | WH | | Gray Silty CLAY, trace fine Sand in seams, damp, | MC = 47.2 | GLACIAL MARINE |
| | | | | WH | | very soft, CL | | |
| 10 | | | | WH | | | | |
| | S-6 | | | WH | | Same as above | | |
| 11 | | | | WH | | | | |
| | | | | WH | | | MC = 37.9 | |
| 12 | | | | WH | | | | |
| | | | | | | | | |
| 13 | | | | | | | | |
| | | | | | | | | |
| 14 | | | | | | | | |
| | | | | | | | | |
| 15 | | | | | | | | |
| | S-7 | | 15 to 17 | WH | | Same as above | LL = 39 | |
| 16 | | | | WH | | | PI = 20 | |
| | | | | WH | | | MC = 46.2 | |
| 17 | | | | WH | | | | |
| | | | | | | | | |
| 18 | | | | | | | | |
| | | | | | | | | |
| 19 | | | | | | | | |
| | | | | | | | | |
| 20 | | | | | | | | |
| | S-8 | | 20 to 22 | WH | | Same as above | | |
| 21 | | | | WH | | | MC = 46.2 | |
| | | | | WH | | | | |
| 22 | | | | WH | | | | |
| | | | | | | End of Boring at 22 ft | | |
| 23 | | | | | | | | |
| | | | | | | | | |
| 24 | | | | | | | | |
| | | | | | | | | |
| 25 | | | | | | | | |
| | | | | | | | | |
| 26 | | | | | | | | |
| | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | East Bayside | Boring #: | B-2 |
| Location: | 89 Anderson Street | Project #: | 14221 |
| City, State: | Portland, Maine | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 14 ft. +/- |
| Driller: | C. Coolidge, P.E. | Reference: | Survey plan prepared by Nadeau Land Surveys dated 7/21/2014 |
| Summit Staff: | B. Peterlein, P.E. | Date started: 11/25/2014 | Date Completed: 11/25/2014 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 11/25/2014 | 8 ft | 6 ft. +/- | In borehole at completion |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | S-1 | | 0 to 2 | 3 | | | | |
| 1 | | | | 5 | | Brown Gravelly SAND, trace Silt, dry, compact, SP | | FILL |
| | | | | 5 | | | | |
| 2 | | | | 3 | | | | |
| | S-2 | | 2 to 4 | 2 | | | | |
| 3 | | | | 2 | | Gray Ash mixed with bricks and silty sand | | |
| | | | | 3 | | | | |
| 4 | | | | 1 | | | | |
| | S-3 | | 4 to 6 | 4 | | | | |
| 5 | | | | 3 | | Olive-brown Silty CLAY, moist, firm, CL | PP >4.5 tsf | GLACIAL MARINE |
| | | | | 3 | | | | |
| 6 | | | | 5 | | | | |
| | S-4 | | 6 to 8 | 8 | | Same as above | | |
| 7 | | | | 5 | | | | |
| | | | | 5 | | | | |
| 8 | | | | 2 | | | | |
| | S-5 | | 8 to 10 | WH | | | | |
| 9 | | | | 1 | | Gray Silty CLAY, trace fine Sand in seams, wet, very | | |
| | | | | WH | | soft, CL | | |
| 10 | | | | 1 | | | | |
| | | | | WH | | | | |
| 11 | | | | 1 | | | | |
| | | | | WH | | | | |
| 12 | | | | 1 | | | | |
| | | | | | | End of Boring at 12 ft | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| 21 | | | | | | | | |
| 22 | | | | | | | | |
| 23 | | | | | | | | |
| 24 | | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
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# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | East Bayside | Boring #: | B-3 |
| Location: | 89 Anderson Street | Project #: | 14221 |
| City, State: | Portland, Maine | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 16 ft. +/- |
| Driller: | C. Coolidge, P.E. | Reference: | Survey plan prepared by Nadeau Land Surveys dated 7/21/2014 |
| Summit Staff: | B. Peterlein, P.E. | Date started: 11/25/2014 | Date Completed: 11/25/2014 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 11/25/2014 | 9 ft | 7 ft. +/- | in borehole at completion |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | S-1 | | 0 to 2 | 3 | | Dark brown Sandy SILT, trace organics, humid, | | |
| 1 | | | | 4 | | firm, ML | | FILL |
| | | | | 3 | | | | |
| 2 | | | | 4 | | | | |
| | S-2 | | 2 to 4 | 4 | | Same as above, trace ash, moist, firm, ML | | |
| 3 | | | | 3 | | | | |
| | | | | 3 | | | | |
| 4 | | | | 3 | | | | |
| | S-3 | | 4 to 6 | WH | | | | |
| 5 | | | | 1 | | Olive-gray Silty CLAY, moist, soft, CL | | GLACIAL MARINE |
| | | | | 2 | | | PP = 1.4 to 1.7 tsf | |
| 6 | | | | 1 | | | | |
| | S-4 | | 6 to 8 | WH | | Same as above, damp | | |
| 7 | | | | 3 | | | | |
| | | | | 1 | | | PP = 0.3 to 0.5 tsf | |
| 8 | | | | 1 | | | | |
| | S-5 | | 8 to 10 | WH | | | | |
| 9 | | | | WH | | | | |
| | | | | 1 | | Gray Silty fine SAND, trace to little Clay, mottled | | |
| 10 | | | | WH | | wet, SM | | |
| | | | | | | | | |
| 11 | | | | | | | | |
| | | | | | | | | |
| 12 | | | | | | | | |
| | | | | | | | | |
| 13 | | | | | | | | |
| | | | | | | | | |
| 14 | | | | | | | | |
| | | | | | | | | |
| 15 | | | | | | | | |
| | S-6 | | 15 to 17 | WH | | Gray Silty CLAY, trace fine Sand in seams, wet, very | | |
| 16 | | | | WH | | soft, CL | | |
| | | | | WH | | | | |
| 17 | | | | WH | | | | |
| | | | | | | | | |
| 18 | | | | | | | | |
| | | | | | | | | |
| 19 | | | | | | | | |
| | | | | | | | | |
| 20 | | | | | | | | |
| | S-7 | | 20 to 22 | WH | | Same as above | | |
| 21 | | | | WH | | | | |
| | | | | WH | | | | |
| 22 | | | | WH | | | | |
| | | | | | | End of Boring at 22 ft | | |
| 23 | | | | | | | | |
| | | | | | | | | |
| 24 | | | | | | | | |
| | | | | | | | | |
| 25 | | | | | | | | |
| | | | | | | | | |
| 26 | | | | | | | | |
| | | | | | | | | |
| 27 | | | | | | | | |
| | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | East Bayside | Boring #: | B-4 |
| Location: | 89 Anderson Street | Project #: | 14221 |
| City, State: | Portland, Maine | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 12 ft. +/- |
| Driller: | C. Coolidge, P.E. | Reference: | Survey plan prepared by Nadeau Land Surveys dated 7/21/2014 |
| Summit Staff: | B. Peterlein, P.E. | Date started: 11/25/2014 | Date Completed: 11/25/2014 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 11/25/2014 | 6.5 ft | 5.5 ft. +/- | On borehole at completion |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | S-1 | | 0 to 2 | 1 | | Dark brown Sandy SILT, trace rootlets and organics, | | |
| 1 | | | | 1 | | humid, very soft, ML | | FILL |
| | | | | 1 | | | | |
| 2 | | | | 3 | | Olive-brown Silty SAND, trace Clay, moist, loose, SM | | |
| | S-2 | | 2 to 4 | 1 | | | | |
| 3 | | | | 1 | | | | |
| | | | | 2 | | Brown medium to fine SAND, trace Silt, moist, loose, SP | | |
| 4 | | | | 3 | | | | |
| | S-3 | | 4 to 6 | 3 | | | | |
| 5 | | | | 5 | | Brown medium to fine SAND, little Gravel, trace Silt, wet, | | |
| | | | | 11 | | compact, SP | | |
| 6 | | | | 7 | | | | |
| | S-4 | | 6 to 8 | 3 | | Same as above | | |
| 7 | | | | 2 | | | | |
| | | | | 2 | | | | |
| 8 | | | | 2 | | | | |
| | S-5 | | 8 to 10 | 2 | | Same as above | | |
| 9 | | | | 4 | | | | |
| | | | | 2 | | | MC = 29.8 | |
| 10 | | | | 1 | | Olive-gray Silty CLAY, wet, very soft, CL | | GLACIAL MARINE |
| | S-6 | | 10 to 12 | WH | | | | |
| 11 | | | | WH | | | | |
| | | | | WH | | | | |
| 12 | | | | WH | | | | |
| | | | | | | | | |
| 13 | | | | | | | | |
| | | | | | | | | |
| 14 | | | | | | | | |
| | | | | | | | | |
| 15 | | | | | | | | |
| | S-7 | | 15 to 17 | WH | | Same as above | | |
| 16 | | | | WH | | | LL = 26 | |
| | | | | WH | | | PI = 12 | |
| 17 | | | | WH | | | MC = 34.7 | |
| | | | | | | | | |
| 18 | | | | | | | | |
| | | | | | | | | |
| 19 | | | | | | | | |
| | | | | | | | | |
| 20 | | | | | | | | |
| | S-7 | | 20 to 22 | WH | | Same as above | | |
| 21 | | | | WH | | | | |
| | | | | WH | | | | |
| 22 | | | | WH | | | | |
| | | | | | | End of Boring at 22 ft | | |
| 23 | | | | | | | | |
| | | | | | | | | |
| 24 | | | | | | | | |
| | | | | | | | | |
| 25 | | | | | | | | |
| | | | | | | | | |
| 26 | | | | | | | | |
| | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

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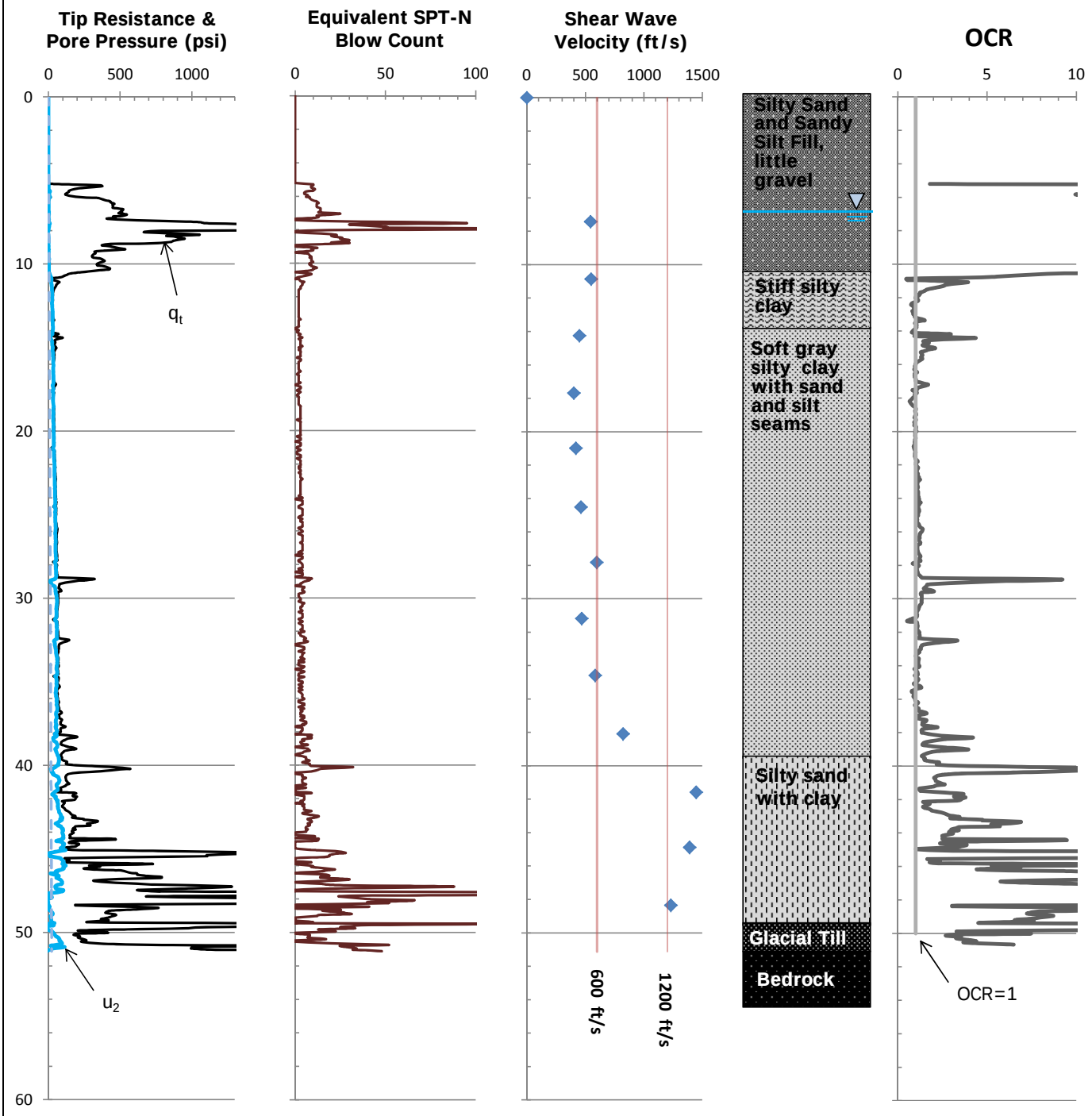
# PIEZOCONE PENETRATION LOG

| | | | |
|---|---|---|---|
| Project: | East Bayside Lofts | Test Number: | CPT-1 |
| Location: | 89 Anderson St., Portland, ME | Sheet: | 1 of 1 |
| Client: | Redfern Properties | Project Number: | 14221 |
| | | Method: | ASTM D5778 |
| | | Weather: | Clear |

| | | | |
|---|---|---|---|
| Cone ID: | Vertek #4644.101xx | Test Elevation: | |
| Cone Type: | VTK 5 Ton Digital Cone | Reference: | |
| Piezocone: | Silicone Single Filter | Date started: 11/25/2014 | Date Completed: 11/25/2014 |
| Push Rig: | AMS Power Probe 9500 VTR | ESTIMATED GROUND WATER DEPTH | |
| Anchor Style: | Single Point Hollow Stem Anchor | Date: 11/25/2014 | Depth: 7 ft |
| Performed By: | Craig Coolidge, P.E. | Elevation: | Reference: Cone pore pressure, nearby boring |




**NOTES:**

Soil Profile based on interpretation of CPT measurements and nearby borings
Shear Wave Velocity test ($V_s$) performed at 3.3 feet (1-meter) increments
Abrupt push refusal encountered at depth of 51.1 feet
OCR estimated using a *k-value* of 0.40

# APPENDIX C

# LABORATORY TEST RESULTS

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## Laboratory Determination of Water (Moisture) Content of Soil ASTM D2216 / D4643

| | | | |
|---|---|---|---|
| PROJECT NAME: | East Bayside Lofts | PROJECT #: | 14221 |
| CLIENT: | Redfern Properties | DRYING METHOD: | Oven Dried |
| SOURCE: | Borings B-1 & B-4 | DESCRIPTION: | Various Clay Samples |
| DATE: | 12/16/2014 | TECHNICIAN: | Erika Hawksley, E.I. |

| Location | Sample No. | Depth | Moisture Content | Remarks |
|---|---|---|---|---|
| B-1 | S-5 | 8' - 10' | 47.2% | (Contains black organic streaks & odor) |
| B-1 | S-6 | 10' -12' | 37.9% | |
| B-1 | S-7 | 15' - 17' | 46.2% | (Contains black organic streaks & odor) |
| B-1 | S-8 | 20' - 22' | 46.2% | (Contains black organic streaks & odor) |
| B-4 | S-5 | 9' - 10' | 29.8% | (Contains some fine sand seams) |
| B-4 | S-7 | 15' - 17' | 34.7% | (Contains some fine sand seams, organic streaks, & odor) |

REMARKS:

**145 Lisbon Street (PO Box 7216), Lewiston, Maine 04243, (207) 576-3313**
**173 Pleasant Street, Rockland, Maine 04841, (207) 318-7761**

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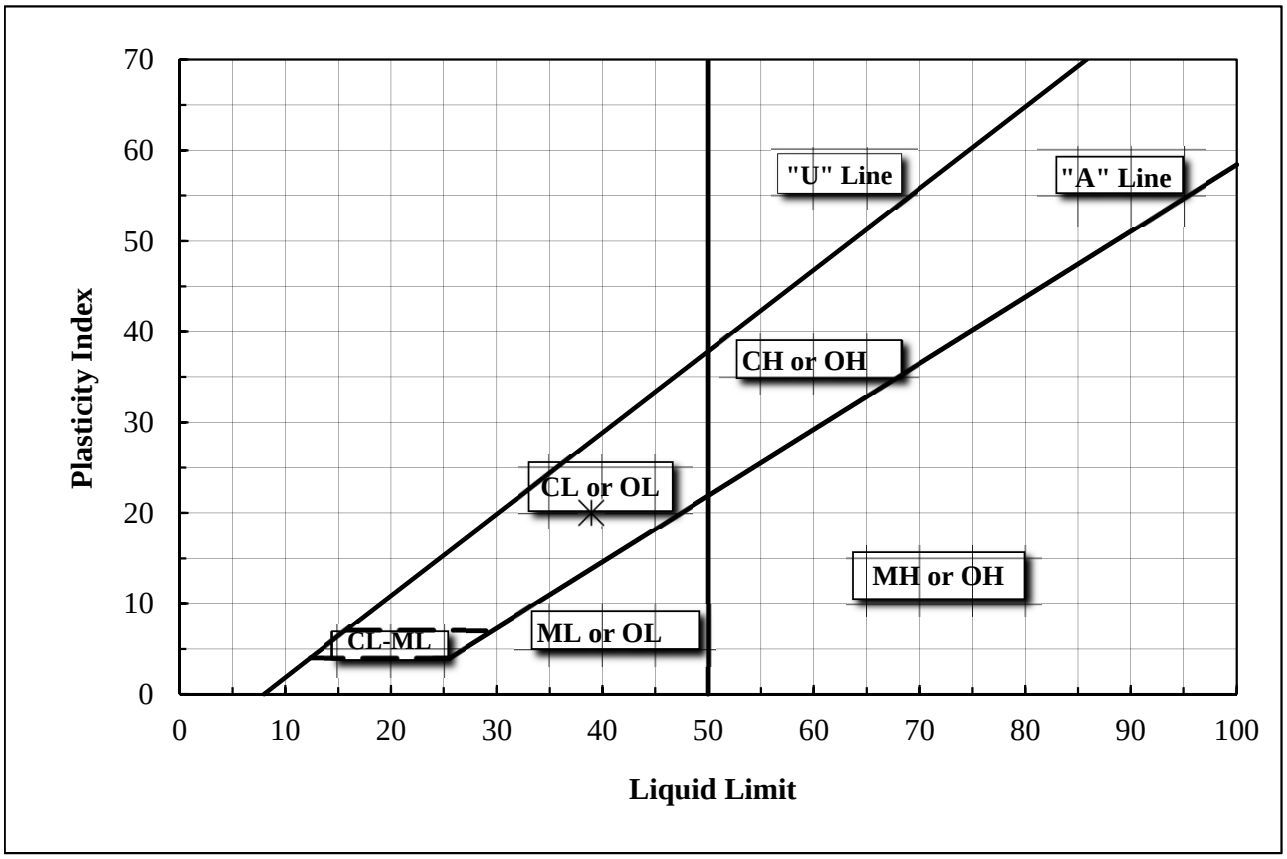
# ATTERBERG LIMIT TEST - ASTM D4318

Method "A" (Multi-point)

| | | | |
|---|---|---|---|
| PROJECT NAME: | East Bayside Lofts | PROJECT NUMBER: | 14221 |
| CLIENT: | Redfern Properties | SAMPLE NUMBER: | B-1, S-7 |
| SOURCE: | Boring B-1 | DEPTH: | 15'-17' |
| DATE: | 12/18/2014 | TECHNICIAN: | Erika Hawksley, E.I. |

## DATA

| Source | Depth | LL | PL | PI | Classification |
|---|---|---|---|---|---|
| B-1 | 15'-17' | 39 | 19 | 20 | Gray Silty CLAY, CL |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |




Notes: Sample contained black organic streaks, organic odor, and trace/occasional sea shells.

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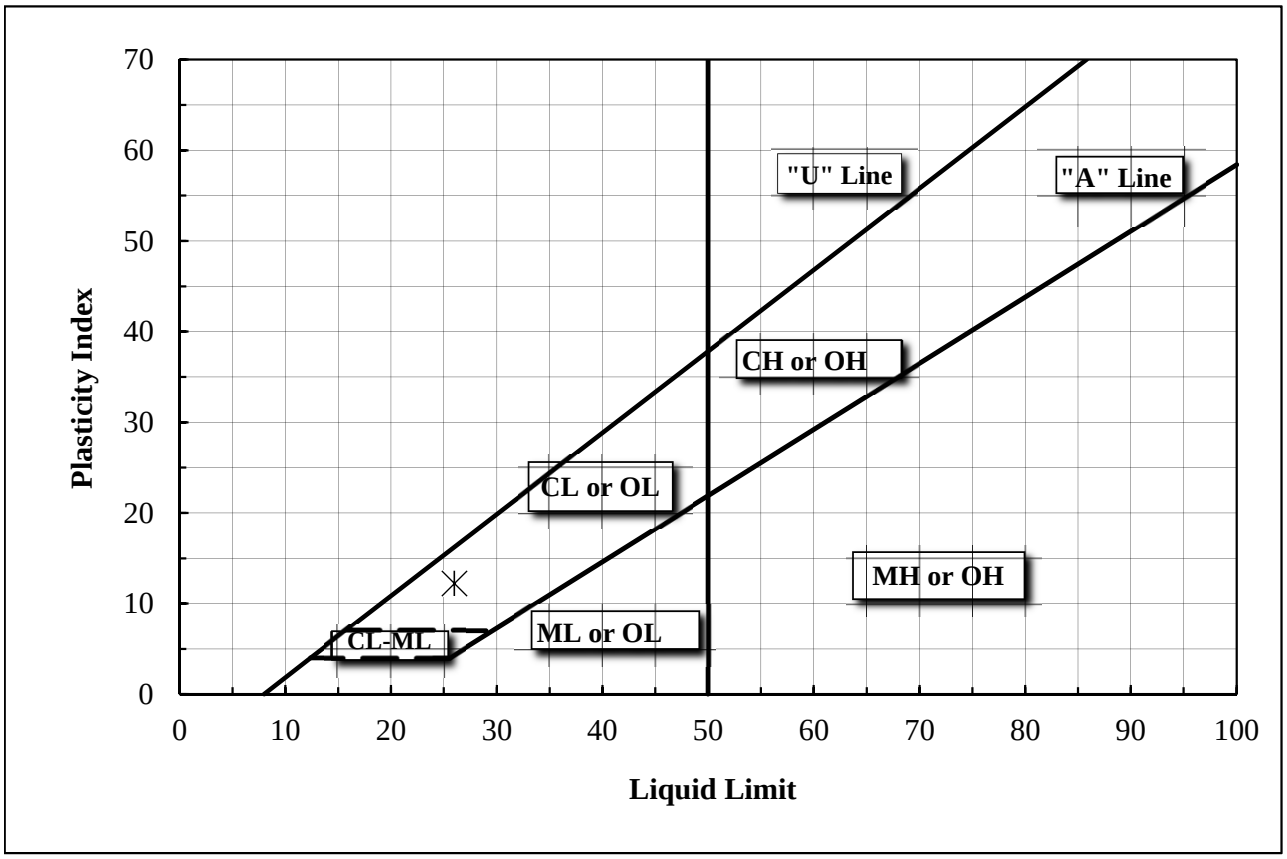
# ATTERBERG LIMIT TEST - ASTM D4318

Method "A" (Multi-point)

| | | | |
|---|---|---|---|
| PROJECT NAME: | East Bayside Lofts | PROJECT NUMBER: | 14221 |
| CLIENT: | Redfern Properties | SAMPLE NUMBER: | B-4, S-7 |
| SOURCE: | Boring B-4 | DEPTH: | 15'-17' |
| DATE: | 12/16/2014 | TECHNICIAN: | Erika Hawksley, E.I. |

## DATA

| Source | Depth | LL | PL | PI | Classification |
|---|---|---|---|---|---|
| B-4 | 15'-17' | 26 | 14 | 12 | Gray Silty CLAY, fine Sand seams, CL |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |




Notes: Sample contained black organic streaks, organic odor, and some fine sand seams.