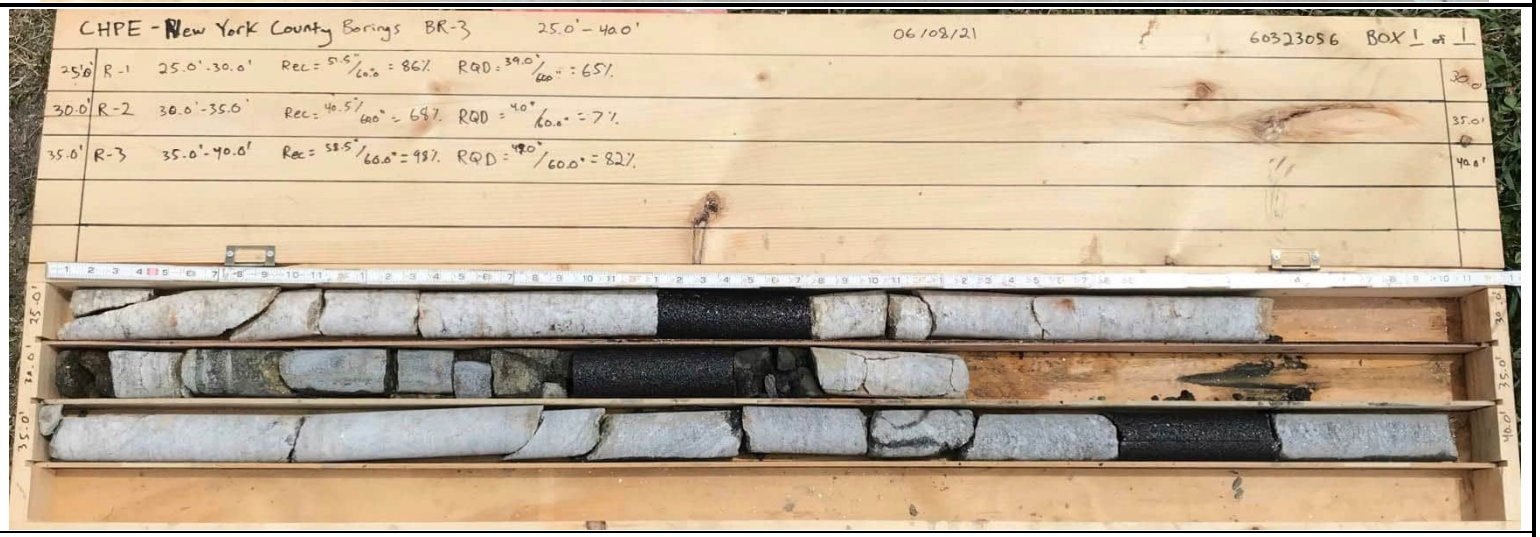
# ROCK CORE PHOTOGRAPHIC LOG

AECOM Project No: **60323056**
Project Name: **CHPE Geotechnical Investigation**
Location: **Bronx, Randall's Island to AGC Receiving Pit Segment, Bronx and Queens Co's, NY**

AECOM

| Boring No. | Depth (ft.) |
|---|---|
| BR-1 | 60.0-70.0 |

| Boring No. | Depth (ft.) |
|---|---|
| BR-3 | 25.0 to 40.0 |




Note: Black foam inserts represent core pieces that were removed for geotechnical and/or thermal resistivity laboratory testing

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AECOM

| Boring No. | Depth (ft.) |
|---|---|
| RA-1 | 32.0-50.0 |

| Boring No. | Depth (ft.) |
|---|---|
| RA-1 | 50.0-65.0 |

Note: Black foam inserts represent core pieces that were removed for geotechnical and/or thermal resistivity laboratory testing

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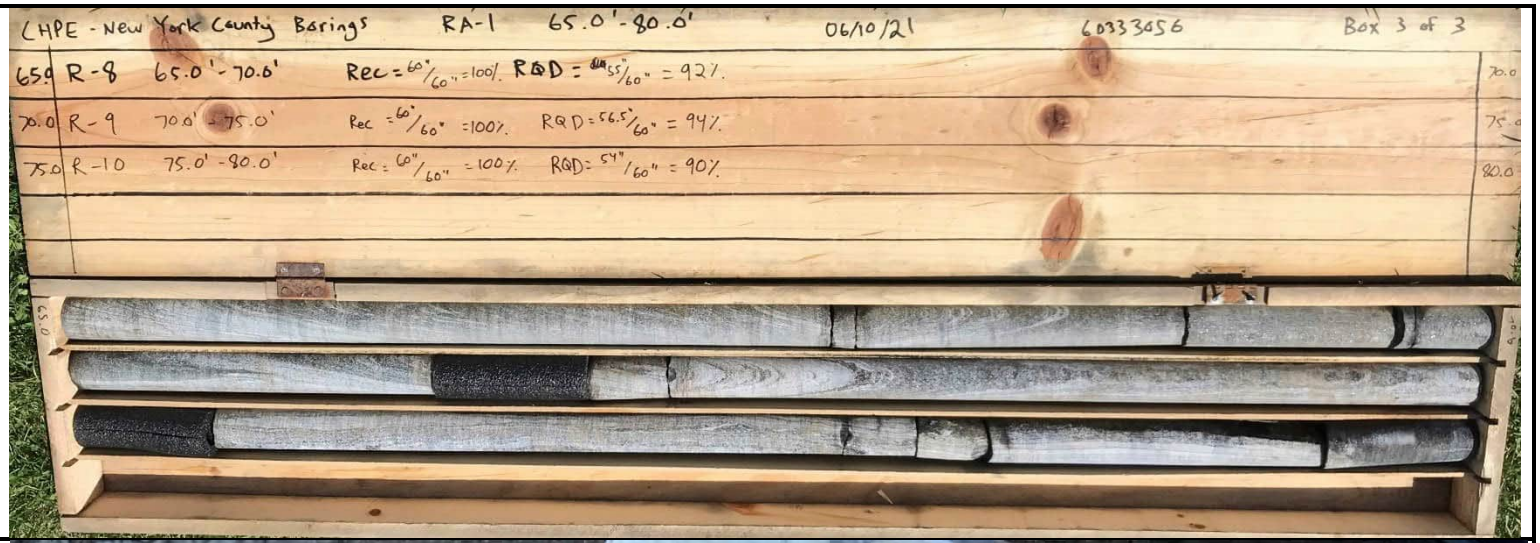
Location: **Bronx, Randall's Island to AGC Receiving Pit Segment, Bronx and Queens Co's, NY**

AECOM

| Boring No. | Depth (ft.) |
|---|---|
| RA-1 | 65.0-80.0 |




| Boring No. | Depth (ft.) |
|---|---|
| RA-2 | 50.0 – 70.0 |

Note: Black foam inserts represent core pieces that were removed for geotechnical and/or thermal resistivity laboratory testing

## ROCK CORE PHOTOGRAPHIC LOG

AECOM Project No: **60323056**
Project Name: **CHPE Geotechnical Investigation**
Location: **Bronx, Randall's Island to AGC Receiving Pit Segment, Bronx and Queens Co's, NY**

AECOM

| Boring No. | Depth (ft.) |
|---|---|
| RA-2 | 70.0-78.5 |

| Boring No. | Depth (ft.) |
|---|---|
| RA-3 | 31.8 to 39.0 |

Note: Black foam inserts represent core pieces that were removed for geotechnical and/or thermal resistivity laboratory testing

# Appendix D – Thermal Resistivity Laboratory Testing Results

## Appendix D Note:

***Test borings completed in the CHPE Randall's Island project segment are identified as BR-1, BR-2, BR-3, BR-4, RA-1, RA-2, RA-3, and RA-4. The Geotherm USA reports in this appendix include sample thermal resistivity test results from these borings.***

***In addition to sample results from the Randall's Island segment borings, the Geotherm USA report dated July 30, 2021 in this appendix includes sample test results from four borings (AR-2, AR-6, AR-7 and AR-8) that were completed in the CHPE Astoria-Rainey project segment. Those sample test results are irrelevant to the Randall's Island project segment and have been redacted in this appendix accordingly.***

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**July 30, 2021**

**AECOM**
40 British American Blvd.
Latham, NY 12110
**Attn: Carsten H. Floess, P.E., D.GE.**

**Re: Thermal Analysis of Native Soil & Rock Core Samples (PO: 60323056)**
**CHPE Upland Cable Project – Bronx-Randall's Island/Queens-Astoria Rainey**

The following is the report of thermal dryout characterization tests conducted on thirty-one (31) samples of native soil and rock cores from the referenced project received at our laboratory.

**Thermal Resistivity Tests:**

The tube and rock samples were tested "as is". The bulk samples were tested at 'as received' moisture content and 95% of the single point modified Proctor density ***conducted by Geotherm.*** The core samples of granite, schist and gneiss has only surface moisture and thus it was not practical to develop dryout curves. The thermal resistivity tests were conducted in accordance with the **IEEE Standard 442-2017.** Based on the soil descriptions given in the AECOM borehole logs, a total of five (5) soil types were identified. The results are tabulated below, and the thermal dryout curves are presented in **Figures 1 to 7.**

1. Sand
2. Gravelly Sand / Sandy Gravel
3. Silty Clayey Sand with or without organics
4. Till
5. Rock (Granite, Schist, Gneiss)

Geotherm USA

## Sample ID, Description, Thermal Resistivity, Moisture Content and Density

| Sample ID | Depth (ft) | Description (AECOM) | Thermal Resistivity (°C-cm/W) | | Moisture Content (%) | Dry Density (lb/ft³) | Soil Type |
|---|---|---|---|---|---|---|---|
| | | | Wet | Dry | | | |
| BR-2 TR1 | 11.0-11.5 | Sand with little gravel | 91 | 464 | 33 | 77 | 1 |
| BR-2 TR2 | 21.5-22.0 | top: sandy gravel bottom: clayey silt | 47 | 102 | 9 | 133 | 2 |
| BR-2 TR3 | 44.5-45.0 | Till | 48 | 107 | 10 | 129 | 4 |
| BR-2 TR4 | 51.0-51.5 | Till | 69 | 244 | 11 | 128 | 4 |
| BR-3 TR1 | 3.0-6.0 | Gray f to c sand, some angular gravel | 93 | 312 | 15 | 89 | 1 |
| BR-3 TR2 | 13.0-13.5 | Gray silty clay, trace organics | 112 | 504 | 75 | 67 | 3 |
| BR-3 TR3 | 27.80-28.35 | Granite | 62 | 62 | 0 | 168 | 5 |
| BR-3 TR4 | 33.55-34.10 | Schist | 48 | 48 | 0 | 173 | 5 |
| BR-3 TR5 | 38.7-39.25 | Schist | 45 | 45 | 0 | 172 | 5 |
| RA-1 TR1 | 3.0-5.0 | Gravelly sand with cobbler | 96 | 164 | 4 | 125 | 2 |
| RA-1 TR2 | 12.5-13.0 | Gravelly sand Gneiss | 70 | 183 | 9 | 128 | 2 |
| RA-1 TR3 | 15.0-15.5 | Gravelly sand Gneiss | 84 | 386 | 18 | 99 | 2 |
| RA-1 TR4 | 32.0-32.6 | Gneiss | 59 | 59 | 0 | 177 | 5 |
| RA-1 TR5 | 42.05-42.7 | Gneiss | 61 | 61 | 0 | 175 | 5 |
| RA-1 TR6 | 50.75-51.3 | Gneiss | 63 | 63 | 0 | 177 | 5 |
| RA-1 TR7 | 61.9-62.7 | Gneiss | 65 | 65 | 0 | 176 | 5 |
| RA-1 TR8 | 71.35-71.9 | Gneiss | 65 | 65 | 0 | 174 | 5 |
| RA-1 TR9 | 75.0-75.5 | Gneiss | 67 | 67 | 0 | 172 | 5 |
| ~~AR-2 TR1~~ | ~~3.0'-5.0'~~ | ~~Gravelly sand~~ | ~~68~~ | ~~181~~ | ~~5~~ | ~~118~~ | ~~2~~ |
| ~~AR-2 TR2~~ | ~~6.0'-6.5'~~ | ~~Gravelly sand (Till)~~ | ~~52~~ | ~~100~~ | ~~7~~ | ~~132~~ | ~~4~~ |
| ~~AR-2 TR3~~ | ~~10.5'-11.0'~~ | ~~Gravelly sand (Till)~~ | ~~97~~ | ~~261~~ | ~~3~~ | ~~107~~ | ~~4~~ |
| ~~AR-2 TR4~~ | ~~15.5'-16.0'~~ | ~~Sand~~ | ~~61~~ | ~~205~~ | ~~13~~ | ~~115~~ | ~~1~~ |
| ~~AR-6 TR1~~ | ~~3.0'-5.0'~~ | ~~Sand~~ | ~~54~~ | ~~117~~ | ~~10~~ | ~~126~~ | ~~1~~ |
| ~~AR-6 TR2~~ | ~~8.0'-8.5'~~ | ~~Sand~~ | ~~58~~ | ~~142~~ | ~~18~~ | ~~110~~ | ~~1~~ |
| ~~AR-7 TR1~~ | ~~3.0-5.0~~ | ~~Gravelly sand~~ | ~~59~~ | ~~143~~ | ~~16~~ | ~~110~~ | ~~2~~ |
| ~~AR-7 TR2~~ | ~~8.5-9.0~~ | ~~Silty sand~~ | ~~67~~ | ~~192~~ | ~~24~~ | ~~109~~ | ~~3~~ |

Geotherm USA

## Sample ID, Description, Thermal Resistivity, Moisture Content and Density

| Sample ID | Depth (ft) | Description (AECOM) | Thermal Resistivity (°C-cm/W) | | Moisture Content (%) | Dry Density (lb/ft³) | Soil Type |
|---|---|---|---|---|---|---|---|
| | | | Wet | Dry | | | |
| ~~AR-7-TR3~~ | ~~12.0-12.5~~ | ~~Silty sand~~ | ~~68~~ | ~~202~~ | ~~13~~ | ~~119~~ | ~~3~~ |
| ~~AR-7-TR4~~ | ~~14.5-15.0~~ | ~~Silt and clay~~ | ~~88~~ | ~~309~~ | ~~27~~ | ~~82~~ | ~~3~~ |
| ~~AR-8-TR1~~ | ~~3.0-5.0~~ | ~~Gravelly sand~~ | ~~55~~ | ~~156~~ | ~~14~~ | ~~112~~ | ~~2~~ |
| ~~AR-8-TR2~~ | ~~12.5-13.2~~ | ~~Gneiss~~ | ~~66~~ | ~~66~~ | ~~0~~ | ~~171~~ | ~~5~~ |
| ~~AR-8-TR3~~ | ~~15.3-16.0~~ | ~~Gneiss~~ | ~~68~~ | ~~68~~ | ~~0~~ | ~~169~~ | ~~5~~ |

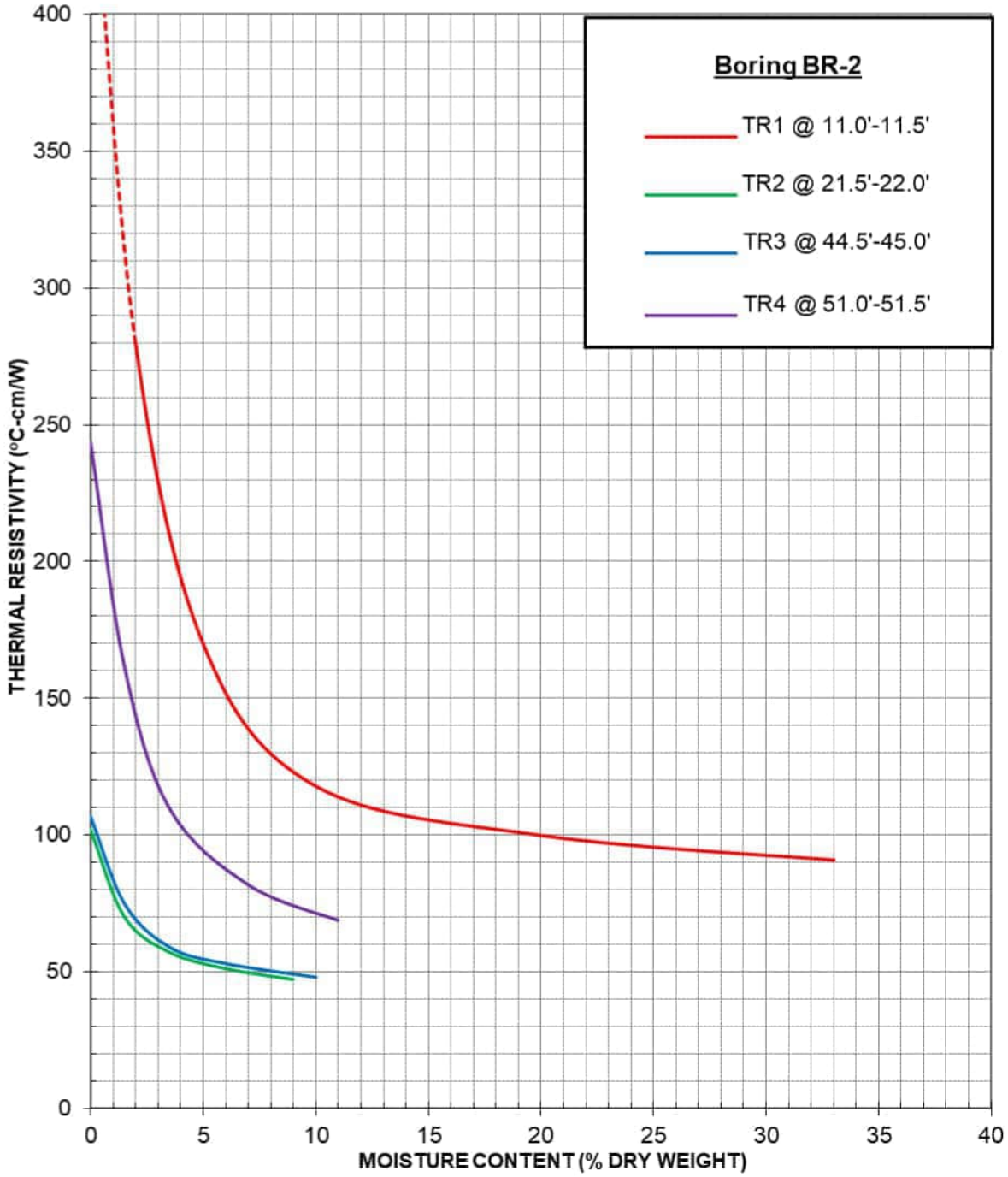
| Boring ID | Milepost | Boring Depth (ft) | Cable Depth (ft) | Suggested TR (°C-cm/W) |
|---|---|---|---|---|
| BR-1 | 0.46 | | 5' 10" | No Samples |
| BR-2 | 0.6 | 52 | 46' 6" | 75 |
| BR-3 | 0.84 | 40 | 10' 5" | 120 |
| RA-1 | 1.41 | 80 | 38' 8" | 70 |
| RA-2 | 2.11 | | 5' 10" | No Samples |
| ~~AR-1~~ | ~~0.03~~ | | ~~3' 10" - 6' 6.5"~~ | ~~No Samples~~ |
| ~~AR-2~~ | ~~0.52~~ | ~~16~~ | ~~14' - 17' 6.5"~~ | ~~100~~ |
| ~~AR-3~~ | ~~1.01~~ | | ~~12' 6" - 16' 0"~~ | ~~No Samples~~ |
| ~~AR-4~~ | ~~1.51~~ | | ~~10' - 13' 6.5"~~ | ~~No Samples~~ |
| ~~AR-5~~ | ~~1.91~~ | | ~~10' - 13' 6.5"~~ | ~~No Samples~~ |
| ~~AR-6~~ | ~~2.5~~ | ~~16~~ | ~~8' 2.5" - 11' 6.5"~~ | ~~90~~ |
| ~~AR-7~~ | ~~2.91~~ | ~~16~~ | ~~11' 6" - 15' 0"~~ | ~~@ 12 ft - 100~~<br>~~@ 15 ft - 130~~ |
| ~~AR-8~~ | ~~3.3~~ | ~~16~~ | ~~4' 6" - 8' 3"~~ | ~~90~~ |

Please contact us if you have any questions or if we can be of further assistance.

***Geotherm USA***

Nimesh Patel

# THERMAL DRYOUT CURVES



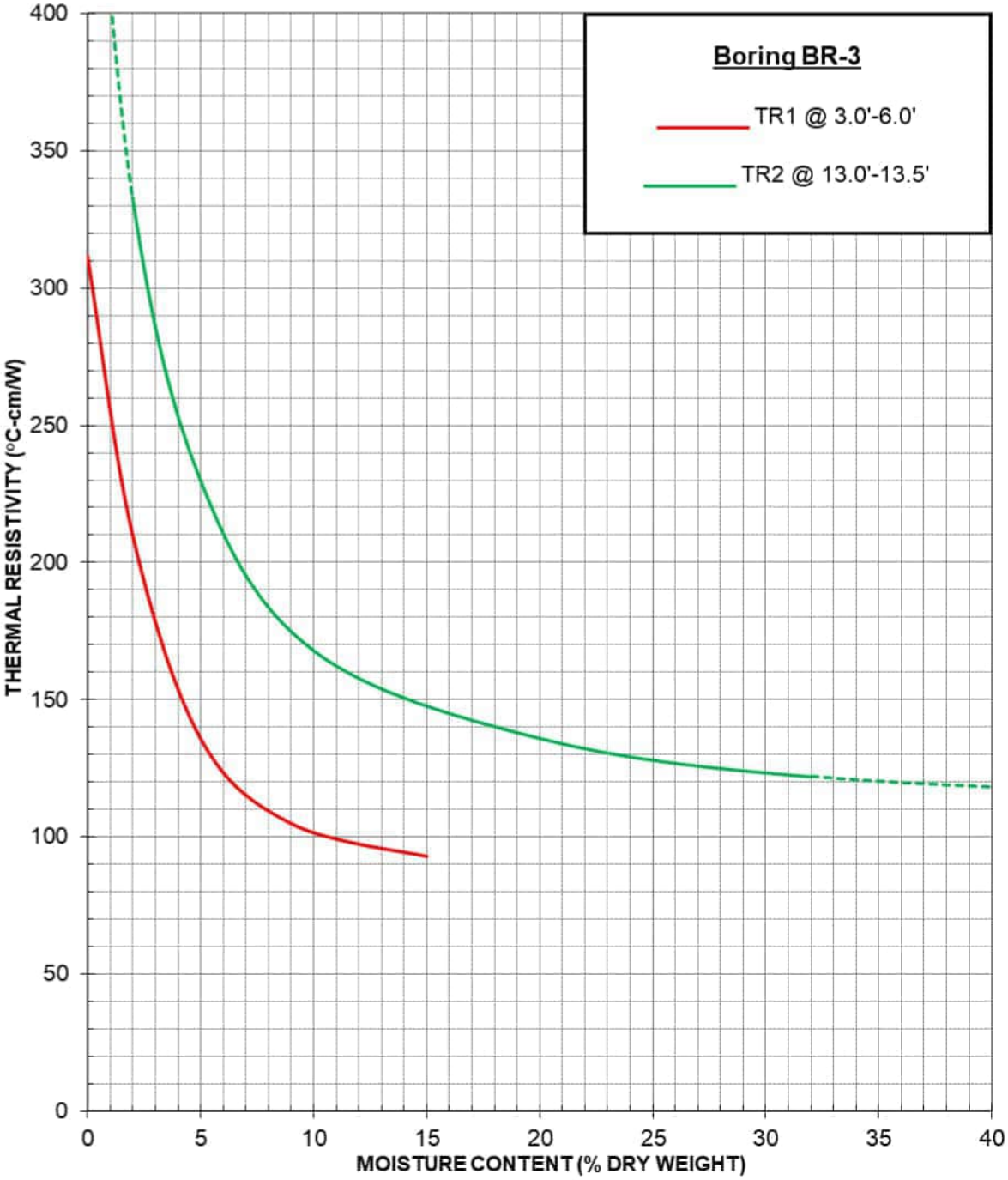

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 1**

# THERMAL DRYOUT CURVES



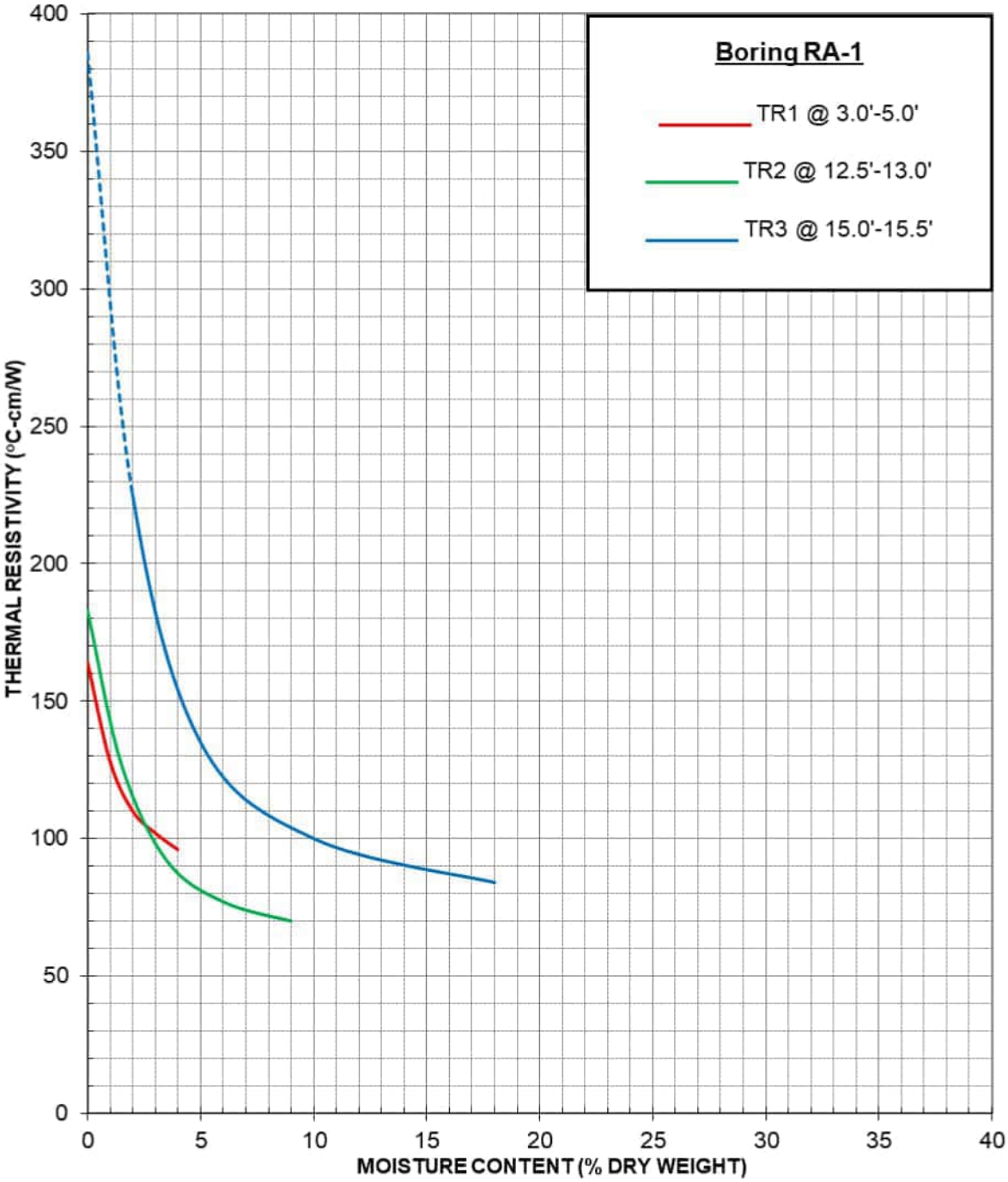

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 2**

# THERMAL DRYOUT CURVES



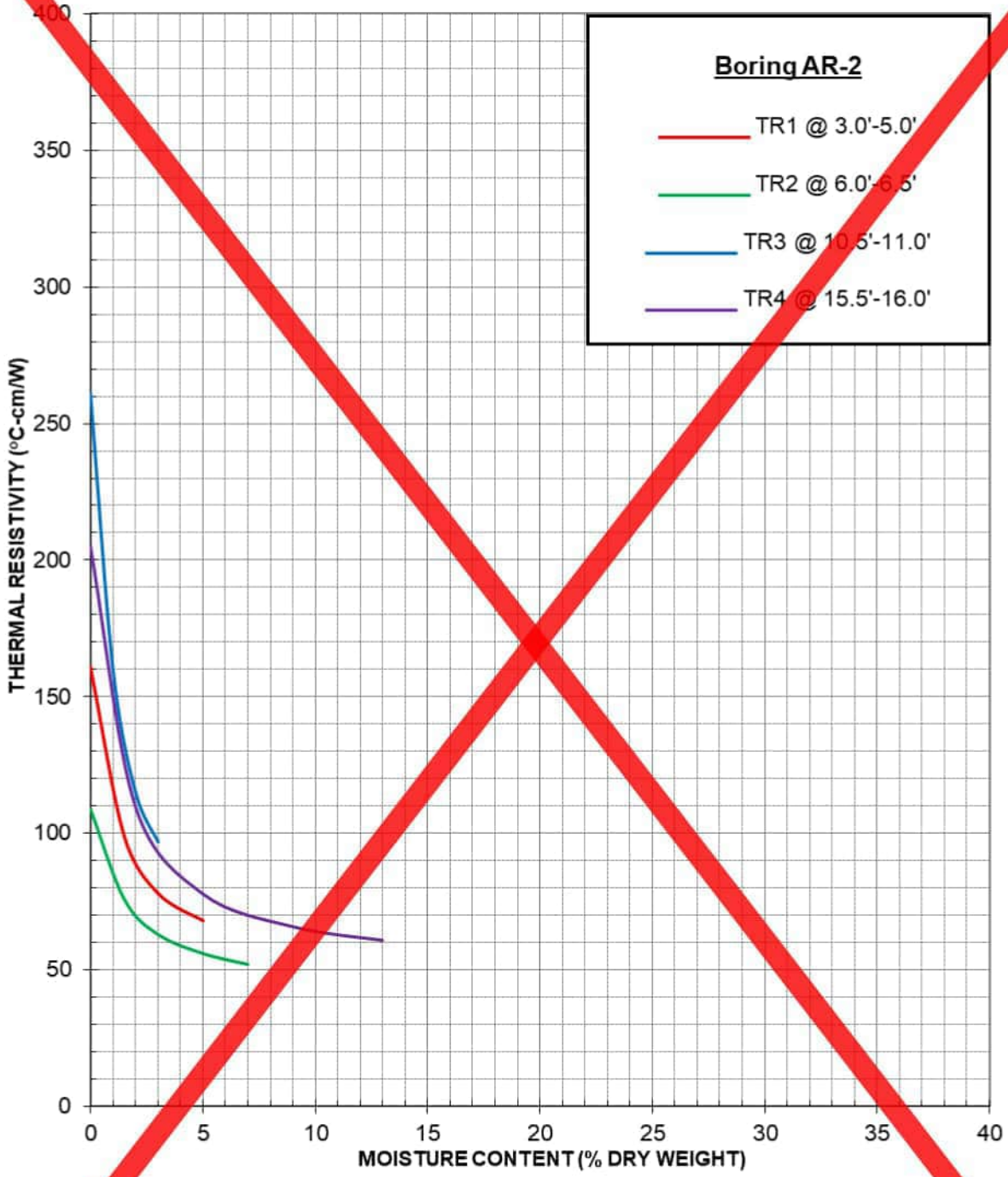

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 3**

# THERMAL DRYOUT CURVES



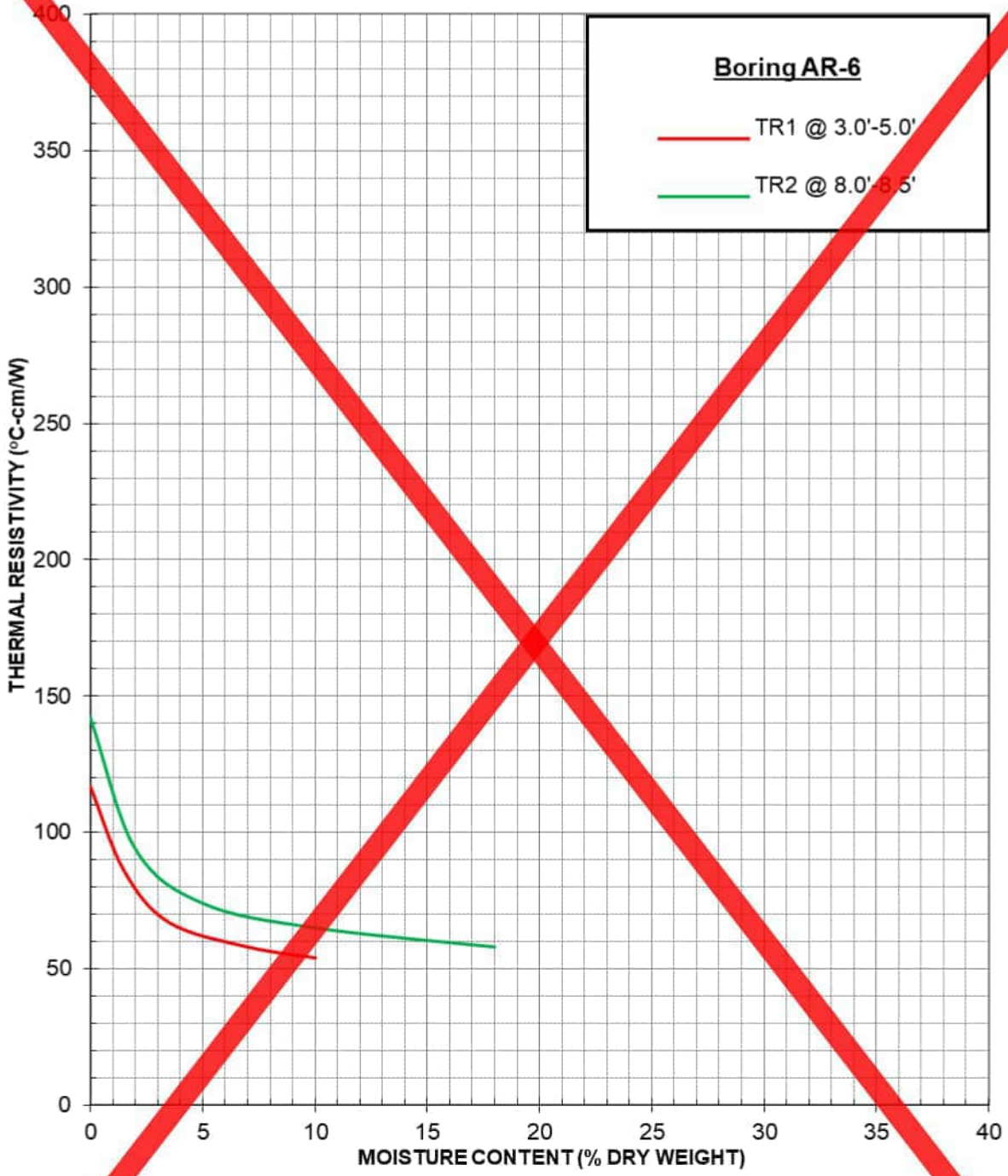

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 4**

# THERMAL DRYOUT CURVES



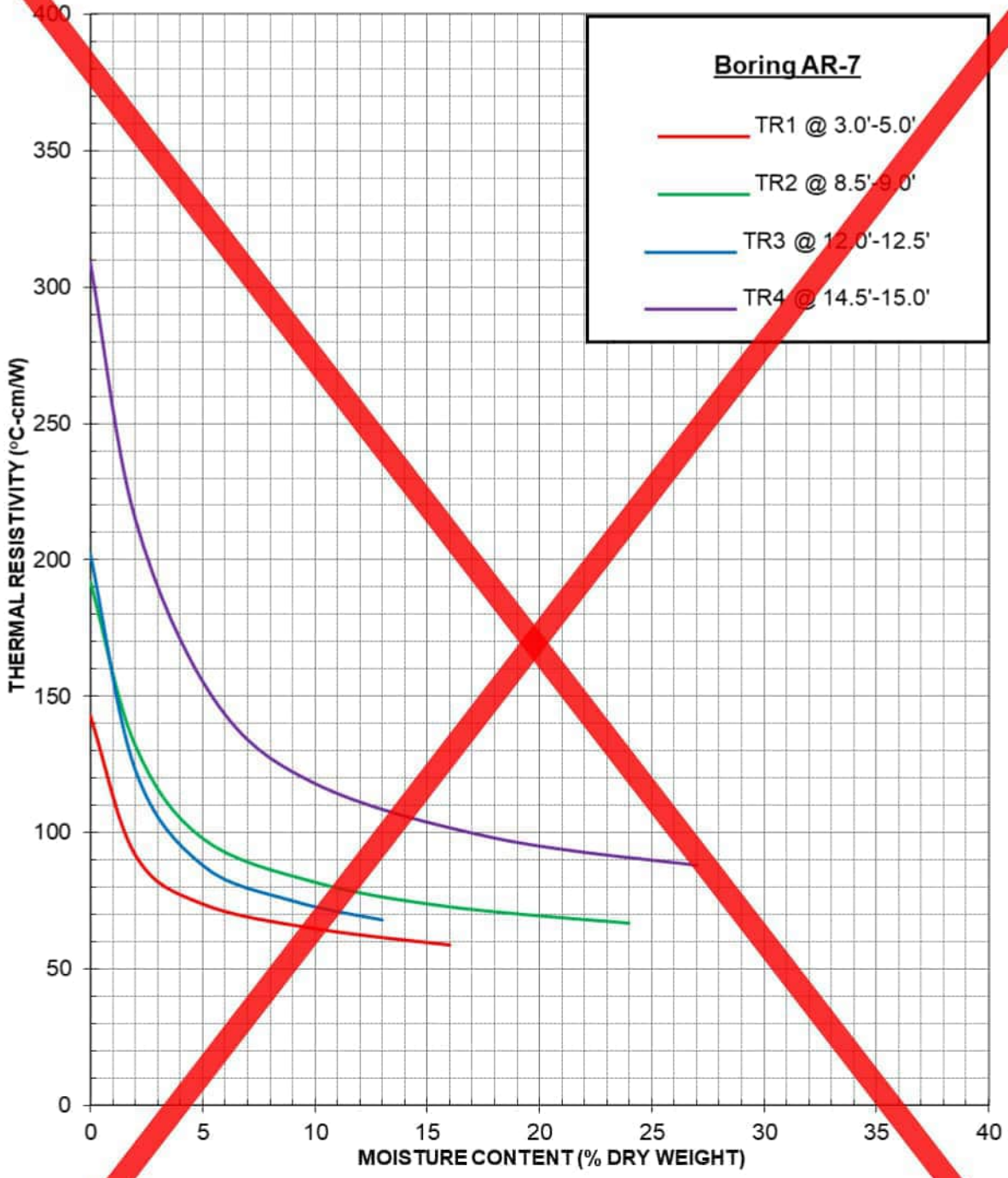

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 5**

# THERMAL DRYOUT CURVES



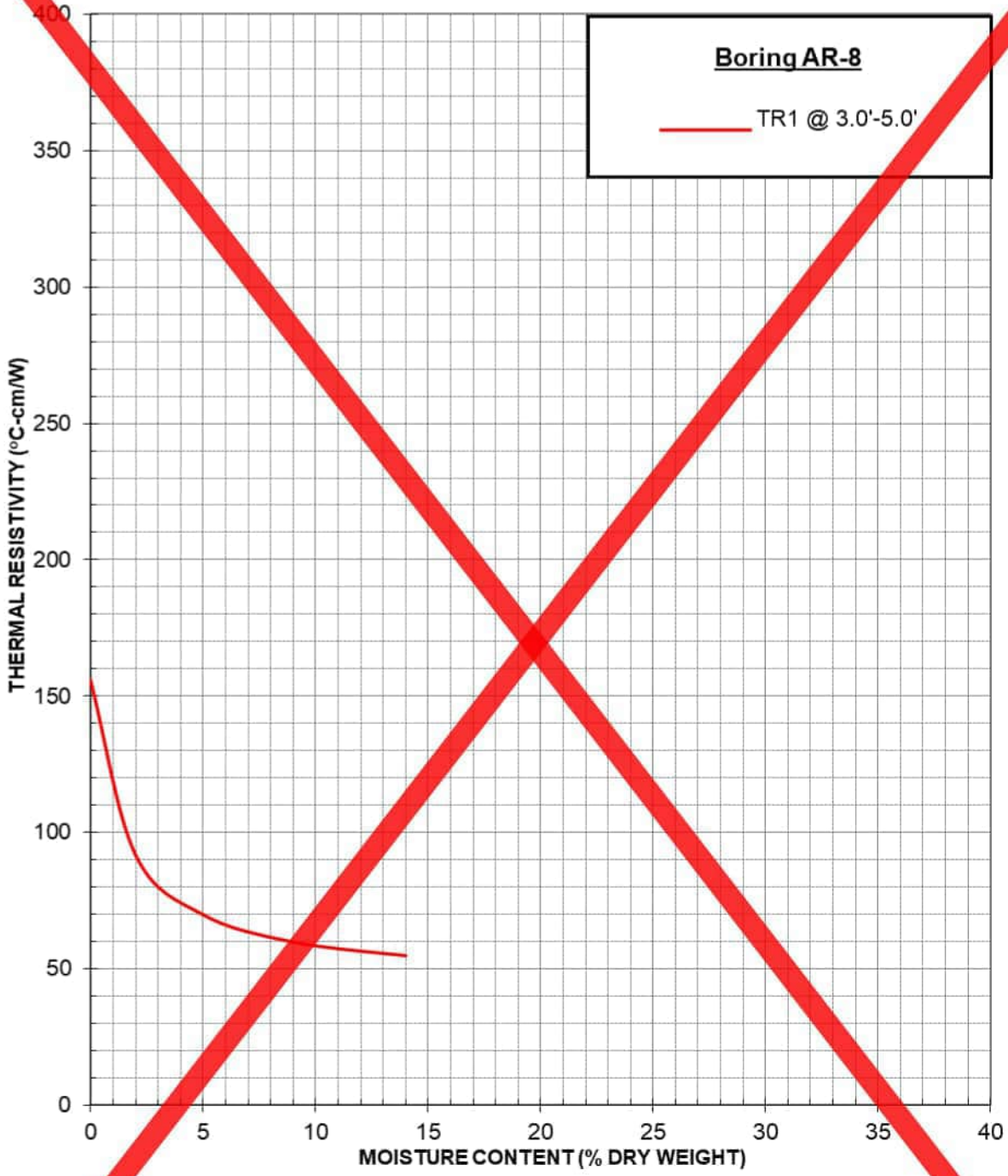

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 6**

# THERMAL DRYOUT CURVES




**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**July 2021** **Figure 7**

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**April 25, 2022**

**AECOM**
40 British American Blvd.
Latham, NY 12110
**Attn: Carsten H. Floess, P.E., D.GE.**

**Re: Thermal Analysis of Native Soil & Rock Core Samples (PO: 60323056)**
**CHPE Upland Cable Project – Bronx-Randall's Island/Queens-Astoria Rainey**

The following is the report of thermal dryout characterization tests conducted on thirty-one (31) samples of native soil and rock cores from the referenced project received at our laboratory.

**Thermal Resistivity Tests:**

The tube and rock samples were tested "as is". The bulk samples were tested at 'as received' moisture content and 95% of the single point modified Proctor density ***conducted by Geotherm.*** The core samples of granite, schist and gneiss has only surface moisture and thus it was not practical to develop dryout curves. The thermal resistivity tests were conducted in accordance with the **IEEE Standard 442-2017.** Based on the soil descriptions given in the AECOM borehole logs, a total of eight **(8)** soil types were identified. The results are tabulated below, and the thermal dryout curves are presented in **Figures 1 to 6.**

1. Sand
2. Gravel and Sand / Sand and Gravel
3. Silt and Sand / Sand and Silt
4. Till
5. Sand and Gravel Till
6. Silty clay
7. Gray Clayey Silt
8. Rock (Gneiss, Quartz Vein)

Geotherm USA

## Sample ID, Description, Thermal Resistivity, Moisture Content and Density

| Sample ID | Depth (ft) | Description (AECOM) | Thermal Resistivity (°C-cm/W) | | Moisture Content (%) | Dry Density (lb/ft³) | Soil Type |
|---|---|---|---|---|---|---|---|
| | | | Wet | Dry | | | |
| ~~AR-1 TR1~~ | ~~3.0 – 6.0~~ | ~~Gravel & Sand~~ | ~~84~~ | ~~185~~ | ~~36~~ | ~~88~~ | ~~2~~ |
| ~~AR-1 TR2~~ | ~~6.5 – 7~~ | ~~Silt and Sand~~ | ~~79~~ | ~~271~~ | ~~32~~ | ~~83~~ | ~~3~~ |
| ~~AR-1 TR3~~ | ~~10 – 10.5~~ | ~~Silt and Sand~~ | ~~58~~ | ~~195~~ | ~~22~~ | ~~101~~ | ~~3~~ |
| ~~AR-1 TR4~~ | ~~14.5 – 15~~ | ~~Sand~~ | ~~55~~ | ~~207~~ | ~~20~~ | ~~113~~ | ~~1~~ |
| RA-2 TR1 | 5.5 – 6 | Sand & Gravel | 57 | 268 | 22 | 79 | 2 |
| RA-2 TR2 | 36.5 - 37 | Silty Clay | 89 | 309 | 22 | 88 | 6 |
| RA-2 TR3 | 41 – 41.5 | Silty Clay | 76 | 281 | 33 | 86 | 6 |
| RA-2 TR4 | 41.5 – 42 | Sand & Gravel Till | 62 | 196 | 15 | 121 | 5 |
| RA-2 TR5 | 60.65 – 61.10 | Gneiss | 54 | 69 | 1 | 174 | 8 |
| RA-2 TR6 | 68.6 – 69.6 | Quartz Vein | 49 | 61 | 1 | 165 | 8 |
| RA-3 TR1 | 3 – 5 | Sand & Gravel | 49 | 155 | 15 | 105 | 2 |
| RA-3 TR2 | 6 – 6.5 | Gravel & Sand | 64 | 226 | 18 | 89 | 2 |
| RA-3 TR3 | 14.5 - 15 | Gray Clayey Silt | 92 | 256 | 38 | 81 | 7 |
| RA-3 TR4 | 26 – 26.5 | Till | 79 | 233 | 10 | 109 | 4 |
| RA-3 TR5 | 35.35 – 35.85 | Gneiss | 53 | 71 | 1 | 159 | 8 |
| RA-4 TR1 | 3 - 5 | Sand & Gravel | 56 | 125 | 9 | 116 | 2 |
| RA-4 TR2 | 10 – 10.5 | Sand & Silt | 69 | 174 | 17 | 113 | 3 |
| RA-4 TR3 | 31 – 31.5 | Sand | 70 | 216 | 11 | 112 | 1 |
| RA-4 TR4 | 36 – 36.5 | Sand | 67 | 204 | 15 | 119 | 1 |
| RA-4 TR5 | 46 – 46.5 | Sand | 69 | 263 | 18 | 112 | 1 |
| BR-1 TR-1 | 6 – 6.5 | Sand | 75 | 247 | 23 | 92 | 1 |
| BR-1 TR-2 | 14.5 – 15 | Sand | 69 | 194 | 18 | 107 | 1 |
| BR-1 TR-3 | 16.5 – 17 | Sand | 67 | 220 | 19 | 109 | 1 |
| BR-1 TR-4 | 27.10 – 27.75 | High quartz/calcite Gneiss | 45 | 54 | 1 | 166 | 8 |
| BR-1 TR-5 | 38.1 – 38.85 | Pink Gneiss | 53 | 61 | 1 | 163 | 8 |
| BR-1 TR-6 | 42 – 42.55 | Gray Gneiss | 49 | 58 | 1 | 170 | 8 |

| Sample ID | Depth (ft) | Description (AECOM) | Thermal Resistivity (°C-cm/W) | | Moisture Content (%) | Dry Density (lb/ft³) | Soil Type |
|---|---|---|---|---|---|---|---|
| | | | Wet | Dry | | | |
| BR-4 TR-1 | 6 – 6.5 | Sand and gravel (fill) | 66 | 105 | 10 | 130 | 2 |
| BR-4 TR-2 | 14 – 14.5 | Weathered rock | 88 | 224 | 19 | 108 | 8 |
| BR-4 TR-3 | 26 – 26.5 | Silty clay | 77 | 288 | 60 | 62 | 6 |
| BR-4 TR-4 | 31 – 31.5 | Sand | 69 | 185 | 21 | 98 | 1 |
| BR-4 TR-5 | 76.5 - 77 | Sand and gravel (till) | 66 | 159 | 6 | 112 | 2 |

## Suggested Thermal Resistivity Values

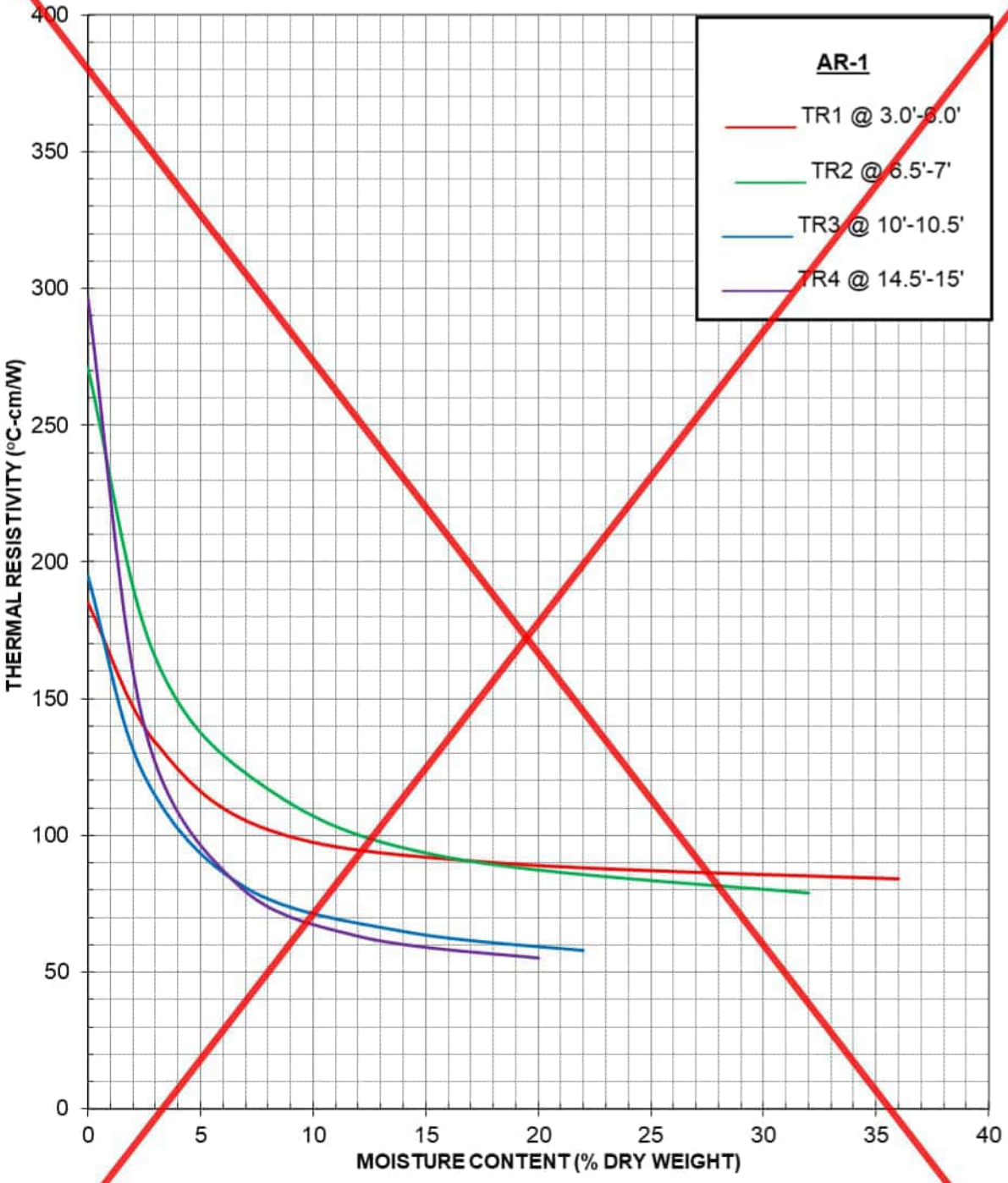
| Boring ID | Milepost | Boring Depth (ft) | Cable Depth (ft) | Suggested TR (°C-cm/W) |
|---|---|---|---|---|
| ~~AR-1~~ | ~~0.03~~ | ~~17~~ | ~~3' 10" - 6' 6.5"~~ | ~~110~~ |
| RA-2 | 2.11 | 78 | 5' 10'' | 80 |
| RA-3 | 2.21 | 39 | 5- 0" - 10' 0" | 90 |
| RA-4 | 2.3 | 47 | 5- 0" - 10' 0" | 90 |
| BR-1 | 0.46 | 70 | 5' 10'' | 100 |
| BR-4 | 0.19 | 82 | 6' 3" | 80 |
| | | | 14' 3" | 110 |
| | | | 26' 3" | 95 |
| | | | 31' 3" | 85 |
| | | | 76' 3" | 80 |

Please contact us if you have any questions or if we can be of further assistance.

***Geotherm USA***

Nimesh Patel

# THERMAL DRYOUT CURVES



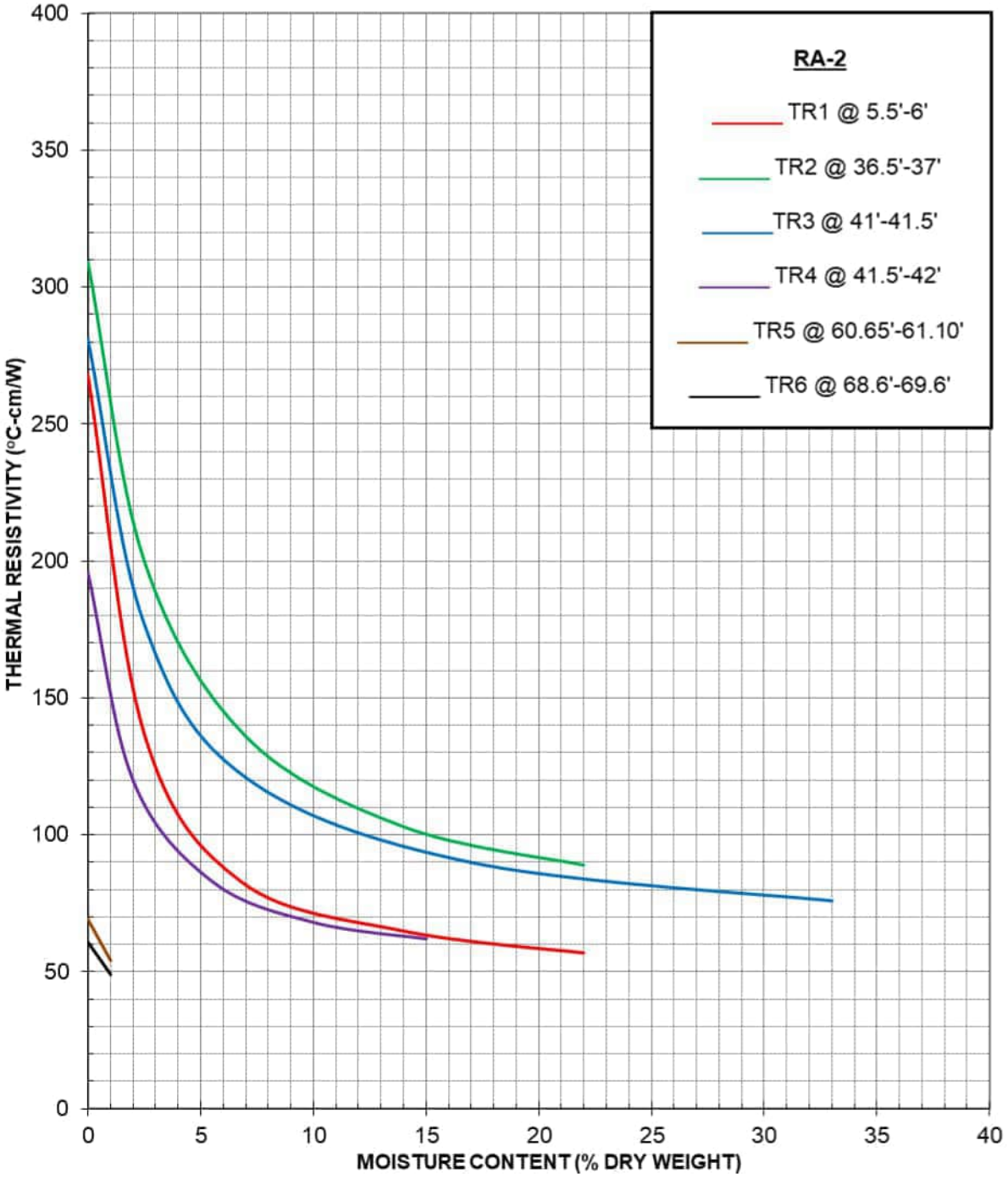

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**April 2022** **Figure 1**

# THERMAL DRYOUT CURVES




**AECOM (PO: 60323056)**

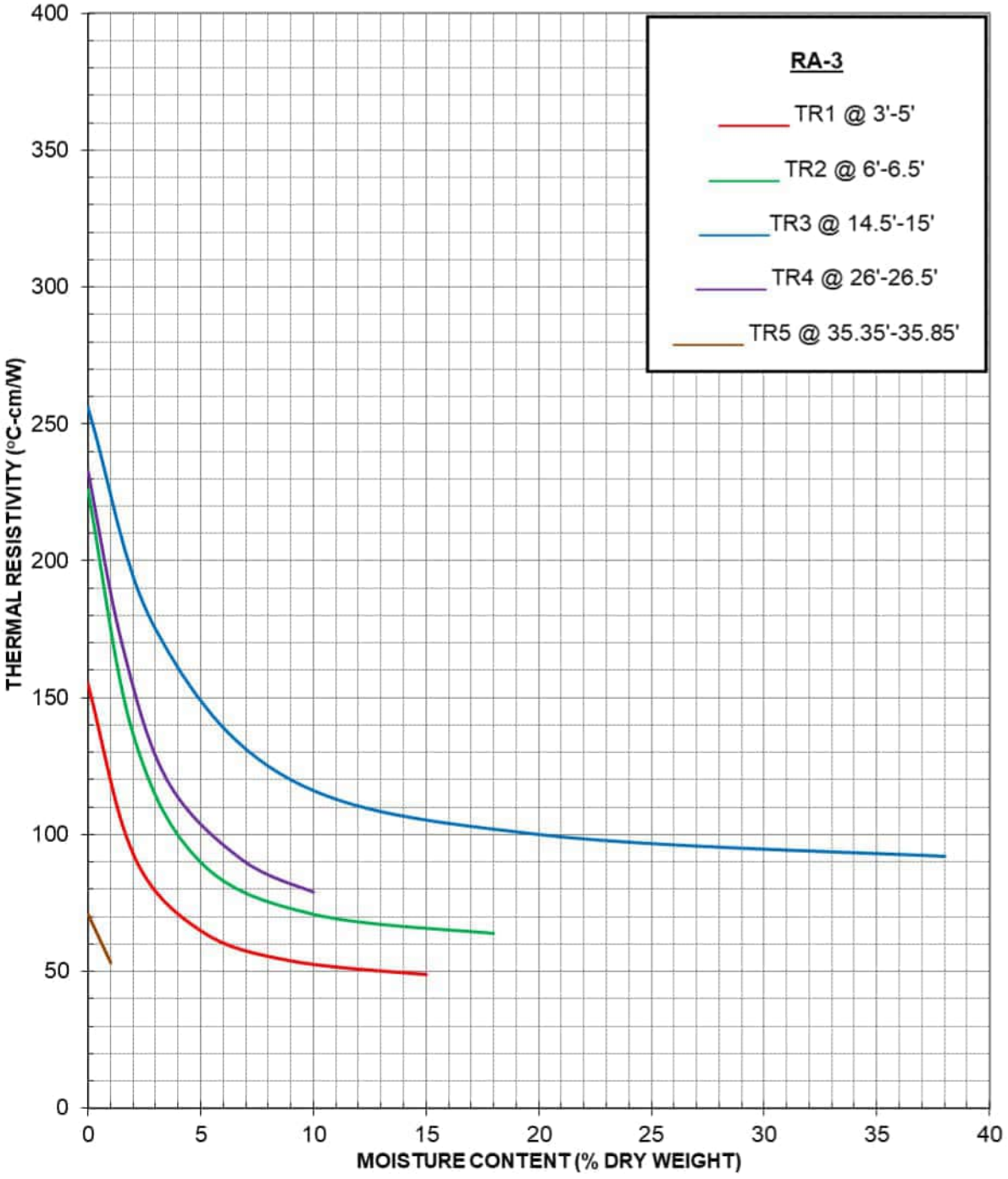
**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**April 2022**

**Figure 2**

# THERMAL DRYOUT CURVES



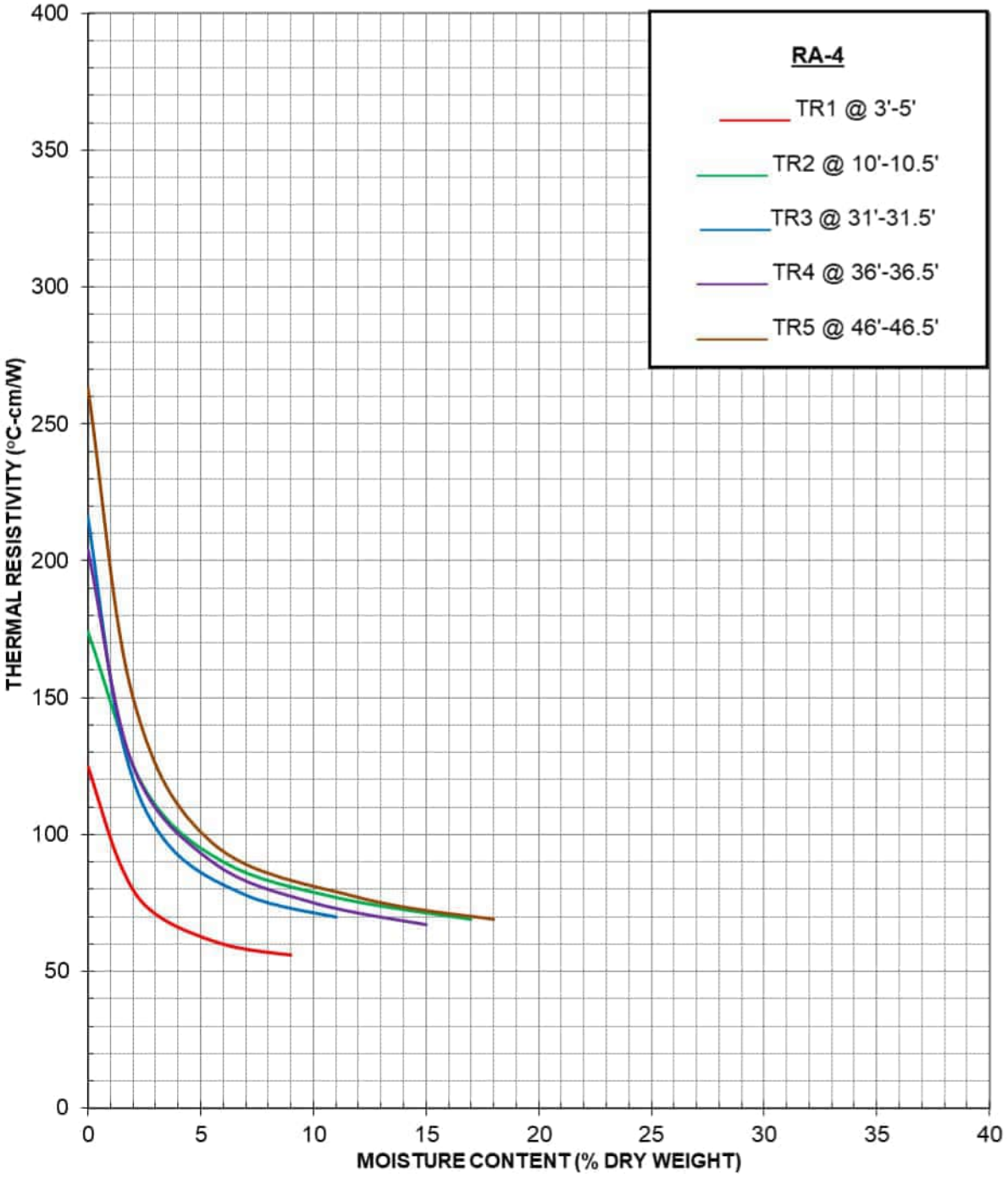

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**April 2022** **Figure 3**

# THERMAL DRYOUT CURVES




**AECOM (PO: 60323056)**

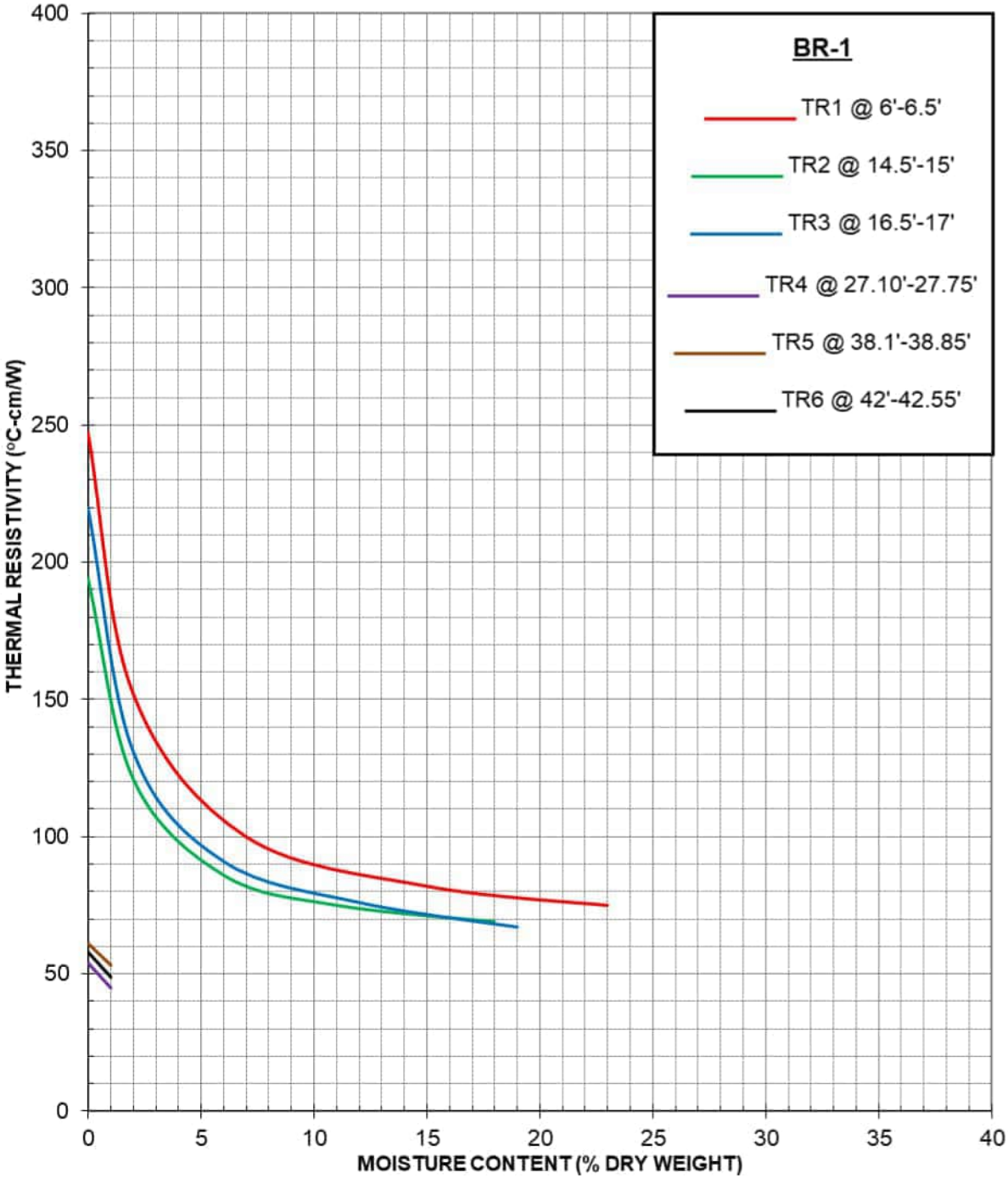
**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**April 2022**

**Figure 4**

# THERMAL DRYOUT CURVES



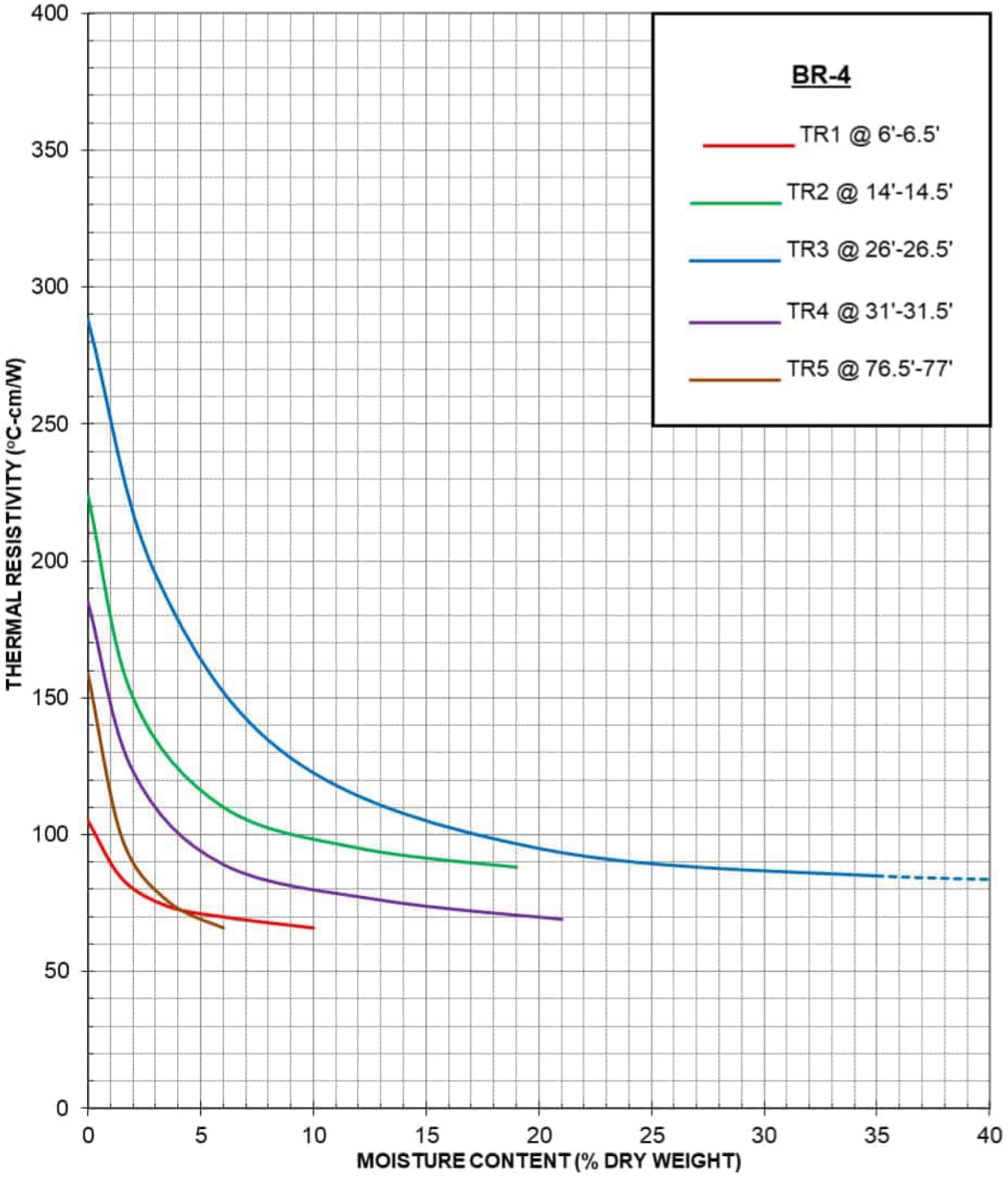

**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**September 2021** **Figure 5**

# THERMAL DRYOUT CURVES




**AECOM (PO: 60323056)**

**CHPE Upland Cable Route - Bronx-Randall's Island/Queens-Astproa Rainey**

**Thermal Analysis of Native Soil and Rock Core Samples**

**September 2021** **Figure 6**

# Appendix E – Geotechnical Laboratory Testing Results

## Appendix E Note:

***Test borings completed in the CHPE Randall's Island project segment are identified as BR-1, BR-2, BR-3, BR-4, RA-1, RA-2, RA-3, and RA-4. The geotechnical laboratory report in this appendix include sample test results from these borings.***

***In addition to sample results from the Randall's Island segment borings, the geotechnical report dated July 28, 2021 in this appendix includes sample test results from four borings (AR-2, AR-6, AR-7 and AR-8) that were completed in the CHPE Astoria-Rainey project segment. Those sample test results are irrelevant to the Randall's Island project segment and have been redacted in this appendix accordingly.***

TerraSense

45H Commerce Way, Totowa, NJ 07512
973.812.1818
terrasenselab.com

07/28/21
TerraSense Project Number: 21004385A

Chris Stratton
Project Manager
Aquifer Drilling & Testing
75 East 2nd Street
Mineola, NY 11501

Dear Mr. Stratton:

**Re: Laboratory Test Results for CHPE – Randall's Island/Astoria-Rainey Borings**

The purpose of this letter is to present the results of the laboratory tests performed on the samples delivered to the TerraSense laboratory on 07/01/21. Testing was performed based on the assignment dated 07/01/21 by AECOM.

**Test Results**
Test results are reported on the accompanying test pages.

**Test Comments**
Testing was performed in general accordance to the ASTM or other methods as listed on the test pages. Deviations from the test standards are noted on these pages.

**Limitations**
Our professional services for this project have been performed in accordance with generally accepted engineering practices; no other warranty, expressed or implied, is made.

**Sample Disposition**
If we do not receive other instructions from you within thirty days, this material will be disposed of.
If you have any questions concerning the test results reported in this letter, please call us.
Sincerely,

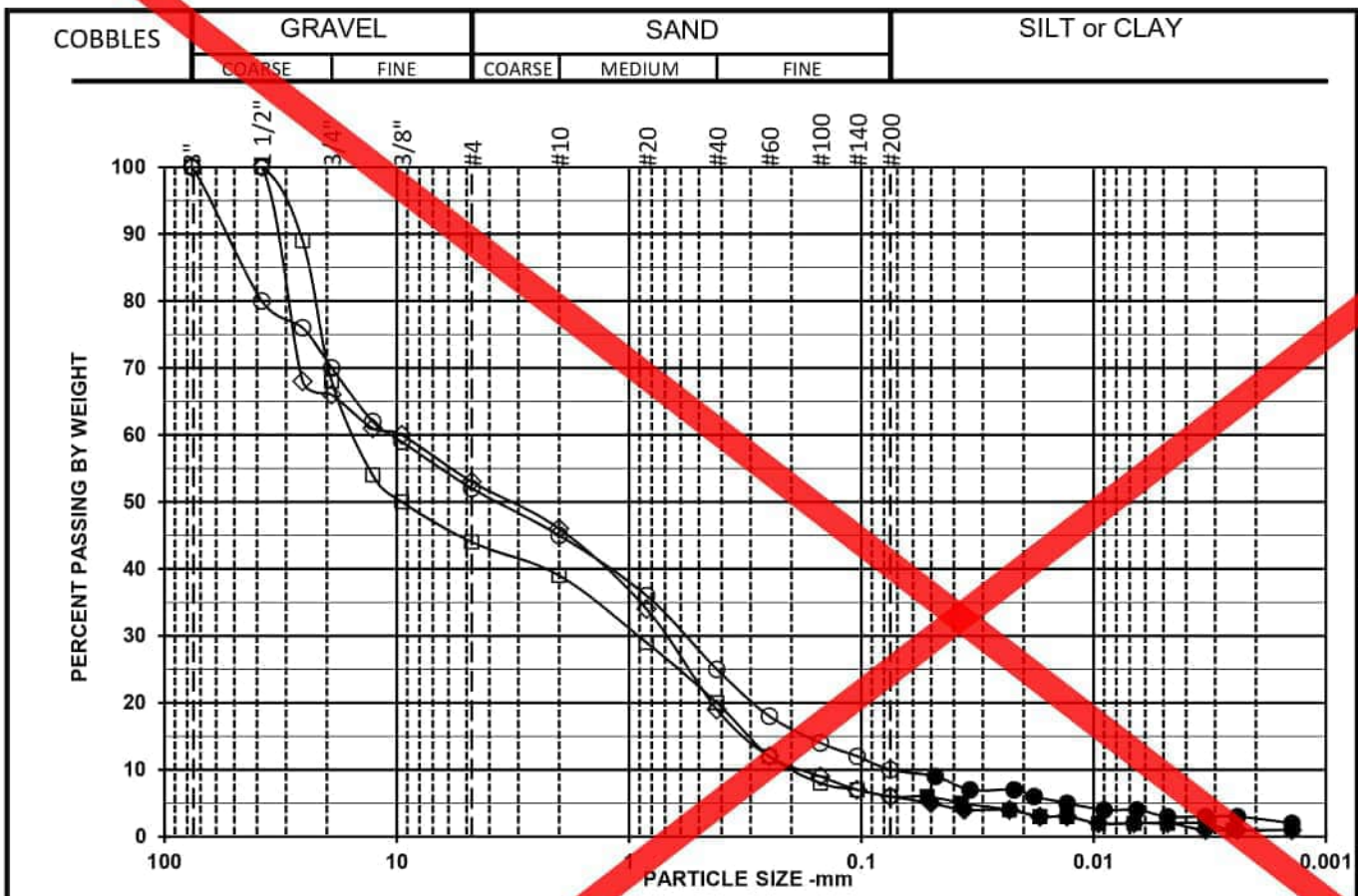
Gregory Thomas
*Laboratory Manager*

Enclosure:

**Aquifer #602211013**
**CHPE - Randall's Island/Astoria-Rainey Borings**
**LABORATORY SOIL TESTING DATA SUMMARY**

| BORING NO. | SAMPLE NO. | DEPTH (ft) | IDENTIFICATION TESTS | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WATER CONTENT (%) | LIQUID LIMIT (-) | PLASTIC LIMIT (-) | PLAS. INDEX (-) | USCS SYMB. (1) | SIEVE MINUS NO. 200 (%) | HYDROMETER % MINUS 2 μm (%) | ORGANIC CONTENT (burnoff) (%) | |
| ~~AR-2~~ | ~~S-2~~ | ~~5-7~~ | ~~4.4~~ | | | | ~~GP-GM~~ | ~~6~~ | ~~1~~ | | |
| ~~AR-2~~ | ~~S-4~~ | ~~9-11~~ | ~~3.4~~ | | | | ~~SP-SM~~ | ~~6~~ | ~~1~~ | | |
| ~~AR-2~~ | ~~S-6~~ | ~~13-15~~ | ~~5.2~~ | | | | ~~GP-GM~~ | ~~10~~ | ~~3~~ | | |
| ~~AR-6~~ | ~~S-2~~ | ~~5-7~~ | ~~12.8~~ | | | | ~~SP-SM~~ | ~~10~~ | ~~3~~ | | |
| ~~AR-6~~ | ~~S-3~~ | ~~7-9~~ | ~~19.1~~ | ~~22~~ | ~~18~~ | ~~4~~ | ~~CL-ML~~ | ~~57.8~~ | ~~11~~ | | |
| ~~AR-6~~ | ~~S-4~~ | ~~9-11~~ | ~~21.3~~ | | | | ~~SM~~ | ~~27.2~~ | ~~5~~ | | |
| ~~AR-7~~ | ~~S-2~~ | ~~5-7~~ | ~~17.1~~ | | | | ~~SM~~ | ~~19~~ | ~~6~~ | | |
| ~~AR-7~~ | ~~S-4~~ | ~~9-11~~ | ~~19.4~~ | | | | ~~SM~~ | ~~16~~ | ~~4~~ | | |
| ~~AR-7~~ | ~~S-6~~ | ~~13-15~~ | ~~10.5~~ | ~~64~~ | ~~25~~ | ~~39~~ | ~~SC~~ | ~~43~~ | ~~14~~ | ~~5.2~~ | |
| BR-2 | S-5 | 20-22 | 10.7 | | | | SW-SM | 12 | 3 | | |
| BR-2 | S-7 | 44.5-46.5 | 8.9 | 26 | 15 | 11 | SC | 24 | 7 | | |
| BR-3 | S-4 | 10-12 | 22.8 | | | | SW | 1 | 0 | | |
| BR-3 | S-5 | 12-14 | 73.1 | 99 | 35 | 64 | OH | 94 | 33 | 4.2 | |
| BR-3 | S-7 | 20-22 | 8.4 | | | | SP-SM | 7 | 1 | | |
| | | | | | | | | | | | |

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 4.4 | | | | GP-GM | | Brown, Poorly graded gravel with silt and sand shale noted, Insufficient sample size | 07/12/21 |
| ◇ | 3.4 | | | | SP-SM | | Brown, Poorly graded sand with silt and gravel, Insufficient sample size | 07/12/21 |
| ○ | 5.2 | | | | GP-GM | | Brown, Poorly graded gravel with silt and sand, Insufficient sample size | 07/12/21 |

**Aquifer** #602211013

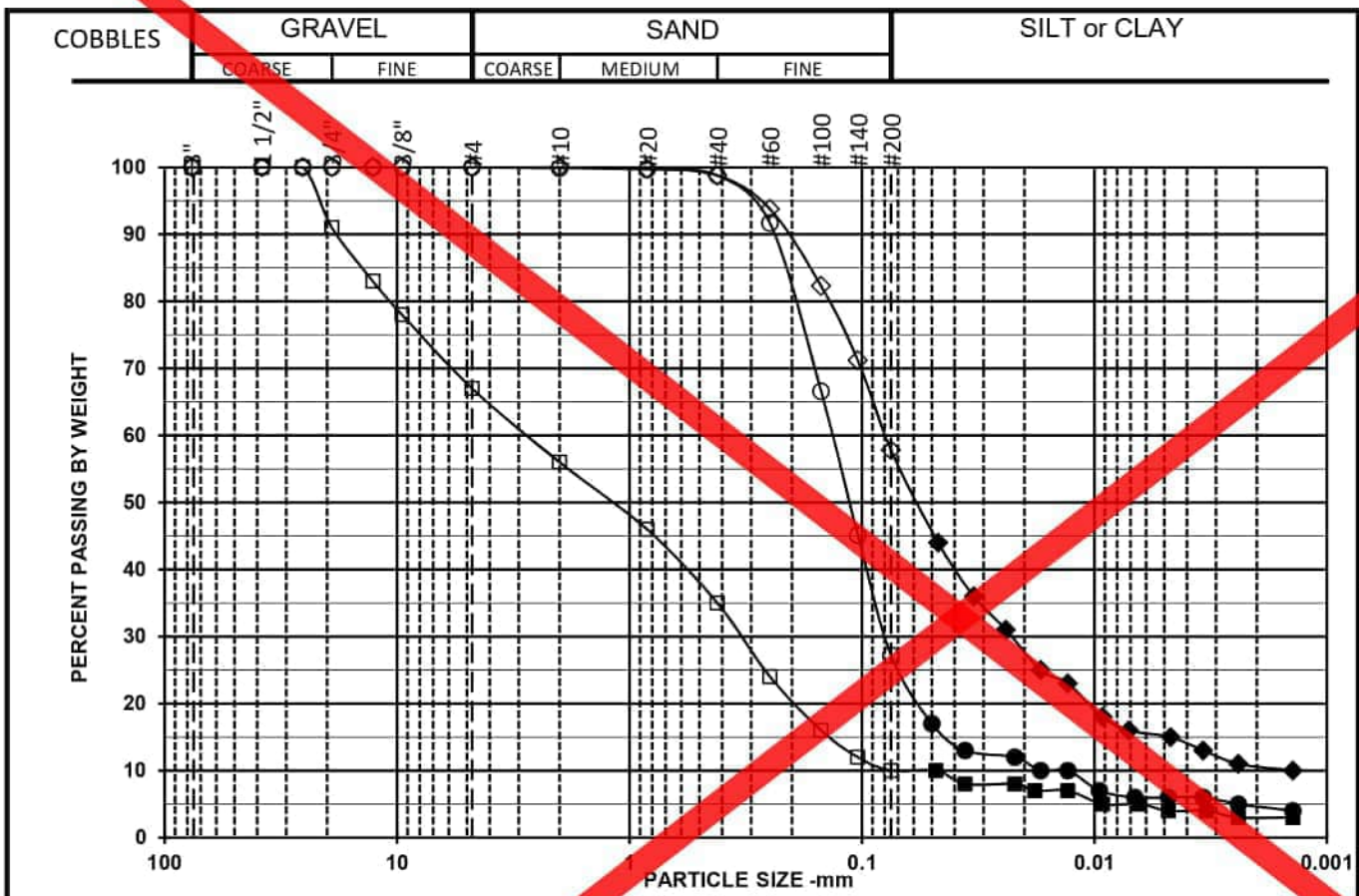
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | AR-2 | AR-2 | AR-2 |
| Sample | S-2 | S-4 | S-6 |
| Depth | 5-7 | 9-11 | 13-15 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 56 | 47 | 48 |
| % SAND | 38 | 47 | 42 |
| %C SAND | 5 | 7 | 7 |
| %M SAND | 19 | 27 | 20 |
| %F SAND | 14 | 13 | 15 |
| % FINES | 6 | 6 | 10 |
| $D_{100}$ (mm) | 38.1 | 38.1 | 76.2 |
| $D_{60}$ (mm) | 15.1 | 9.53 | 10.5 |
| $D_{30}$ (mm) | 0.92 | 0.7 | 0.58 |
| $D_{10}$ (mm) | 0.19 | 0.18 | 0.075 |
| Cc | 0.3 | 0.3 | 0.4 |
| Cu | 79.5 | 52.9 | 140 |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | 100 |
| 4" | 100 | 100 | 100 |
| 3" | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 80 |
| 1" | 89 | 68 | 76 |
| 3/4" | 68 | 66 | 70 |
| 1/2" | 54 | 61 | 62 |
| 3/8" | 50 | 60 | 59 |
| #4 | 44 | 53 | 52 |
| #10 | 39 | 46 | 45 |
| #20 | 29 | 34 | 36 |
| #40 | 20 | 19 | 25 |
| #60 | 12 | 12 | 18 |
| #100 | 8 | 9 | 14 |
| #140 | 7 | 7 | 12 |
| #200 | 6 | 6 | 10 |
| 5μ m | 2 | 2 | 3 |
| 2μ m | 1 | 1 | 3 |
| 1μ m | 1 | 1 | 1 |

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 12.8 | | | | SP-SM | | Brown, Poorly graded sand with silt and gravel, Insufficient sample size | 07/12/21 |
| ◇ | 19.1 | 22 | 18 | 4 | CL-ML | | Brown, Sandy silty clay | 07/09/21 |
| ○ | 21.3 | | | | SM | | Brown, Silty sand | 07/12/21 |

**Aquifer** #602211013

**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

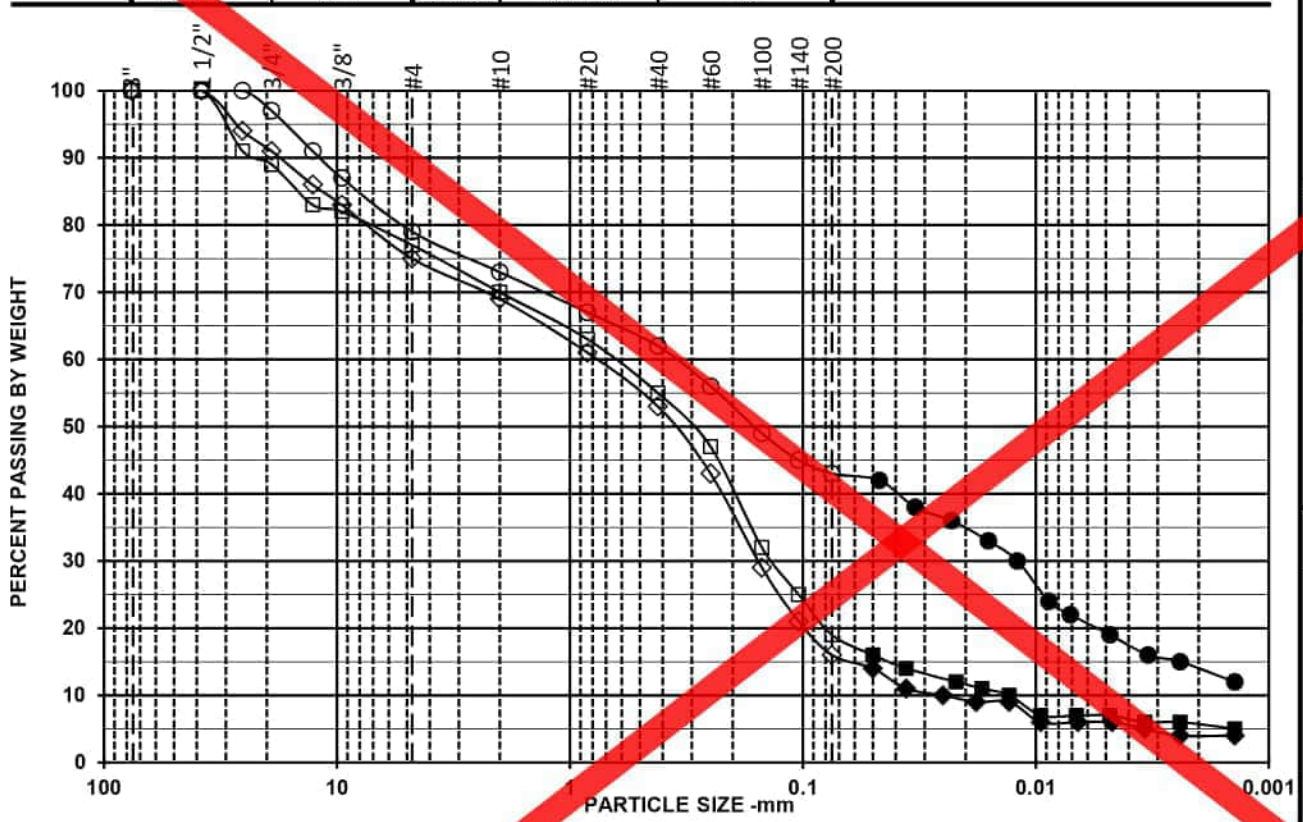
| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | AR-6 | AR-6 | AR-6 |
| Sample | S-2 | S-3 | S-4 |
| Depth | 5-7 | 7-9 | 9-11 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 33 | 0 | 0 |
| % SAND | 57 | 42.2 | 72.8 |
| %C SAND | 11 | 0 | 0.1 |
| %M SAND | 21 | 1.2 | 1.1 |
| %F SAND | 25 | 41 | 71.6 |
| % FINES | 10 | 57.8 | 27.2 |
| $D_{100}$ (mm) | 25.4 | 4.75 | 4.75 |
| $D_{60}$ (mm) | 2.74 | 0.079 | 0.134 |
| $D_{30}$ (mm) | 0.33 | 0.023 | 0.079 |
| $D_{10}$ (mm) | 0.075 | 0.001 | 0.017 |
| Cc | 0.5 | 4.8 | 2.7 |
| Cu | 36.5 | 56.6 | 7.9 |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100.0 | 100.0 |
| 4" | 100 | 100.0 | 100.0 |
| 3" | 100 | 100.0 | 100.0 |
| 1 1/2" | 100 | 100.0 | 100.0 |
| 1" | 100 | 100.0 | 100.0 |
| 3/4" | 91 | 100.0 | 100.0 |
| 1/2" | 83 | 100.0 | 100.0 |
| 3/8" | 78 | 100.0 | 100.0 |
| #4 | 67 | 100.0 | 100.0 |
| #10 | 56 | 100.0 | 99.9 |
| #20 | 46 | 99.8 | 99.7 |
| #40 | 35 | 98.8 | 98.8 |
| #60 | 24 | 93.8 | 91.7 |
| #100 | 16 | 82.3 | 66.6 |
| #140 | 12 | 71.2 | 45.1 |
| #200 | 10 | 57.8 | 27.2 |
| 5μ m | 4 | 15 | 6 |
| 2μ m | 3 | 11 | 5 |
| 1μ m | 3 | 9 | 3 |

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeV6Rev1a14

Siev1b 7/28/2021




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 17.1 | | | | SM | | Brown, Silty sand with gravel shale & mica noted, Insufficient sample size | 07/12/21 |
| ◇ | 19.4 | | | | SM | | Brown, Silty sand with gravel, Insufficient sample size | 07/12/21 |
| ○ | 40.5 | 64 | 25 | 39 | SC | | Gray, Clayey sand with gravel, Insufficient sample size | 07/09/21 |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | AR-7 | AR-7 | AR-7 |
| Sample | S-2 | S-4 | S-6 |
| Depth | 5-7 | 9-11 | 13-15 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 23 | 25 | 21 |
| % SAND | 58 | 59 | 36 |
| %C SAND | 7 | 6 | 6 |
| %M SAND | 15 | 16 | 11 |
| %F SAND | 36 | 37 | 19 |
| % FINES | 19 | 16 | 43 |
| $D_{100}$ (mm) | 38.1 | 38.1 | 25.4 |
| $D_{60}$ (mm) | 0.648 | 0.771 | 0.352 |
| $D_{30}$ (mm) | 0.14 | 0.16 | 0.012 |
| $D_{10}$ (mm) | 0.013 | 0.025 | |
| Cc | 2.3 | 1.3 | |
| Cu | 49.8 | 30.8 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | 100 |
| 4" | 100 | 100 | 100 |
| 3" | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 |
| 1" | 91 | 94 | 100 |
| 3/4" | 89 | 91 | 97 |
| 1/2" | 83 | 86 | 91 |
| 3/8" | 82 | 83 | 87 |
| #4 | 77 | 75 | 79 |
| #10 | 70 | 69 | 73 |
| #20 | 63 | 61 | 67 |
| #40 | 55 | 53 | 62 |
| #60 | 47 | 43 | 56 |
| #100 | 32 | 29 | 49 |
| #140 | 25 | 21 | 45 |
| #200 | 19 | 16 | 43 |
| 5μ m | 7 | 6 | 19 |
| 2μ m | 6 | 4 | 14 |
| 1μ m | 4 | 4 | 10 |

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

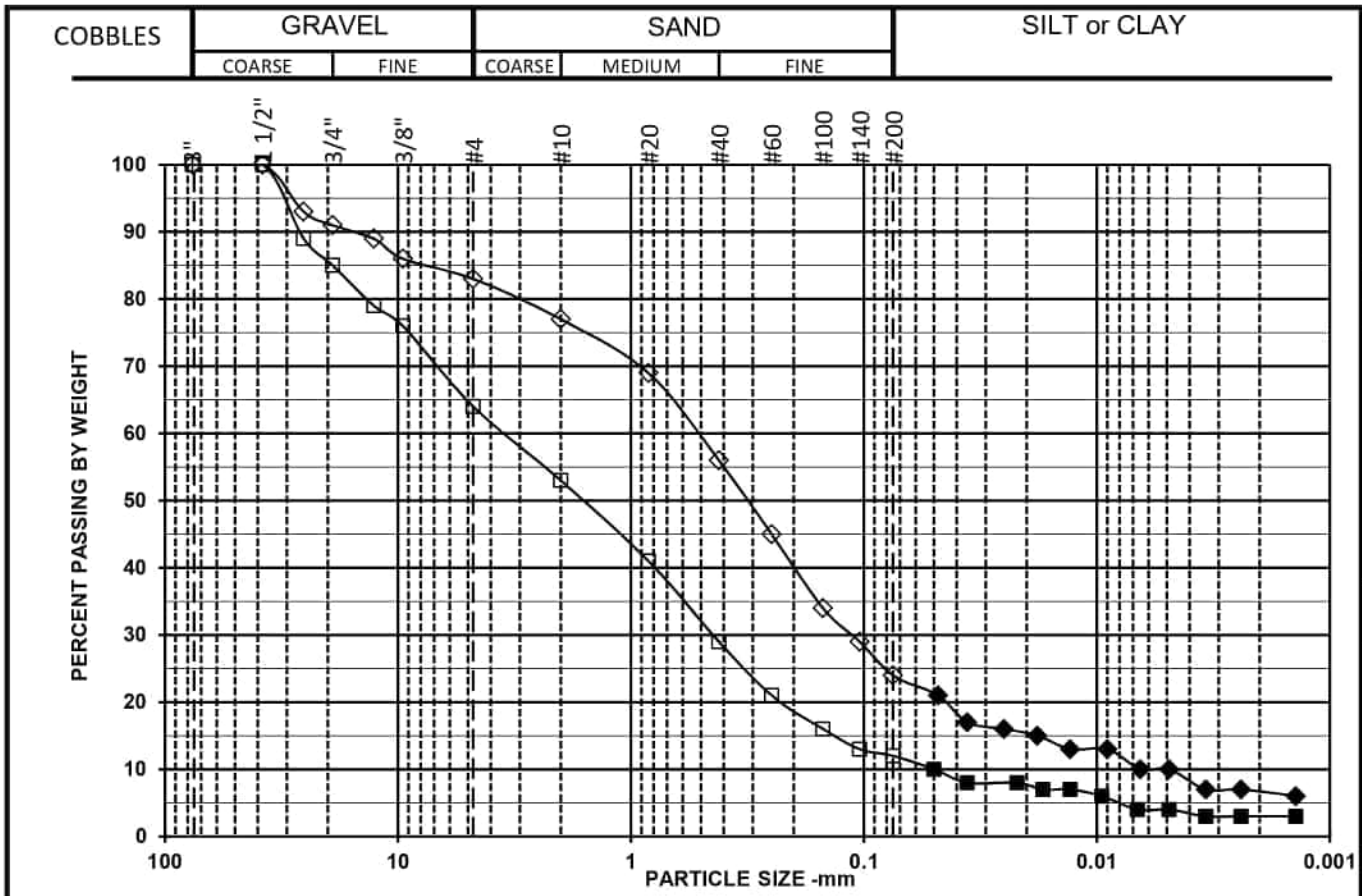
**Aquifer** #602211013

**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

TerraSense Analysis File: GrainSizeV6Rev1a14

Siev1c 7/28/2021




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 10.7 | | | | SW-SM | | Grayish brown, Well-graded sand with silt and gravel, Insufficient sample size | 07/09/21 |
| ◇ | 8.9 | 26 | 15 | 11 | SC | | Brown, Clayey sand with gravel, Insufficient sample size | 07/09/21 |
| ○ | | | | | | | | |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | BR-2 | BR-2 | |
| Sample | S-5 | S-7 | |
| Depth | 20-22 | 44.5-46.5 | |
| % +3" | 0 | 0 | |
| % Gravel | 36 | 17 | |
| % SAND | 52 | 59 | |
| %C SAND | 11 | 6 | |
| %M SAND | 24 | 21 | |
| %F SAND | 17 | 32 | |
| % FINES | 12 | 24 | |
| $D_{100}$ (mm) | 38.1 | 38.1 | |
| $D_{60}$ (mm) | 3.47 | 0.519 | |
| $D_{30}$ (mm) | 0.44 | 0.11 | |
| $D_{10}$ (mm) | 0.05 | 0.007 | |
| Cc | 1.1 | 3.6 | |
| Cu | 69.4 | 79.8 | |

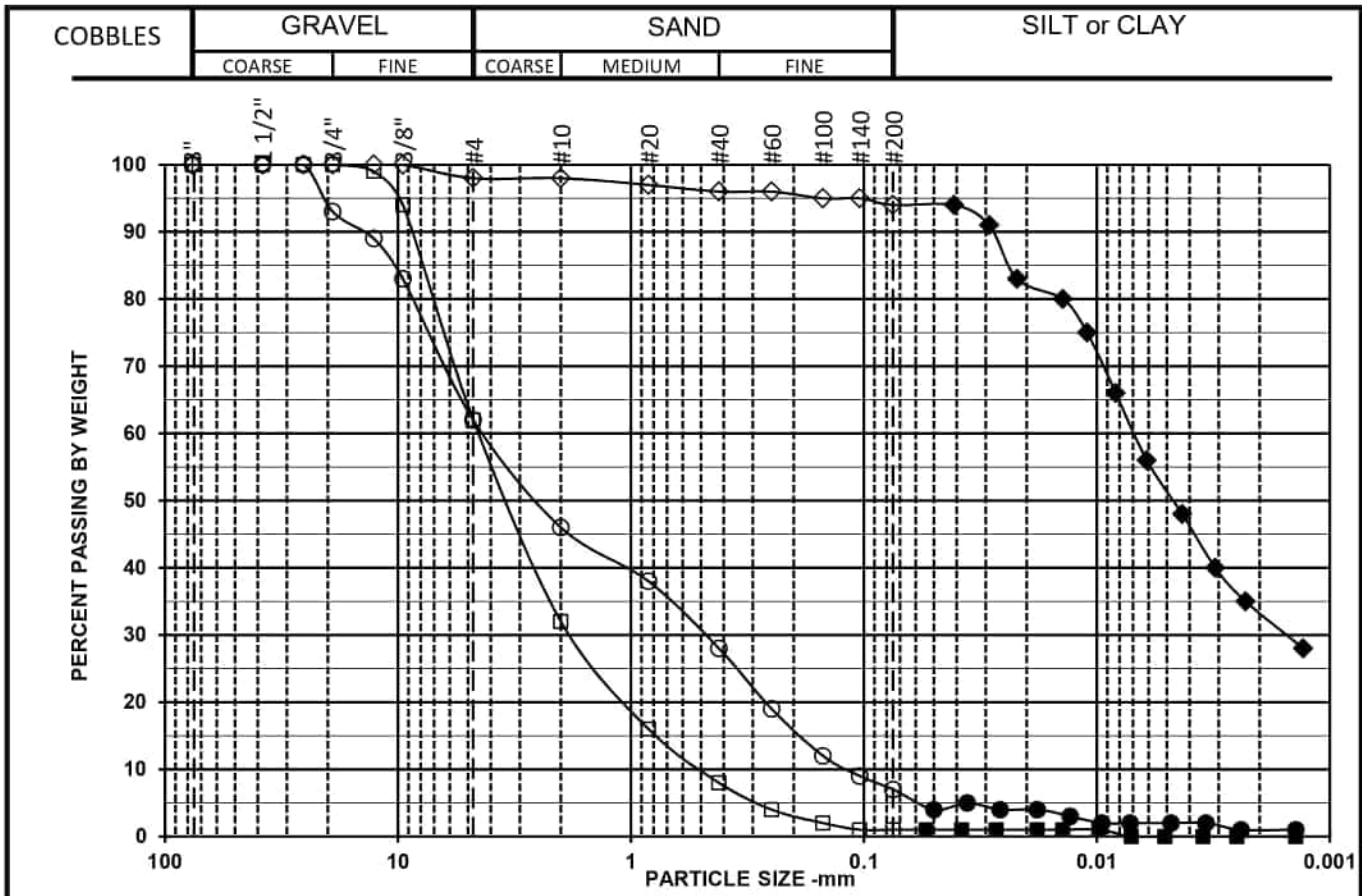
| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | |
| 4" | 100 | 100 | |
| 3" | 100 | 100 | |
| 1 1/2" | 100 | 100 | |
| 1" | 89 | 93 | |
| 3/4" | 85 | 91 | |
| 1/2" | 79 | 89 | |
| 3/8" | 76 | 86 | |
| #4 | 64 | 83 | |
| #10 | 53 | 77 | |
| #20 | 41 | 69 | |
| #40 | 29 | 56 | |
| #60 | 21 | 45 | |
| #100 | 16 | 34 | |
| #140 | 13 | 29 | |
| #200 | 12 | 24 | |
| 5μ m | 4 | 10 | |
| 2μ m | 3 | 7 | |
| 1μ m | 3 | 5 | |

**Aquifer** #602211013

**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 22.8 | | | | SW | | Dark gray, Well-graded sand with gravel, Insufficient sample size | 07/09/21 |
| ◇ | 73.1 | 99 | 35 | 64 | OH | | Gray, Organic clay organic mat'l noted, Insufficient sample size | 07/09/21 |
| ○ | 8.4 | | | | SP-SM | | Grayish brown, Poorly graded sand with silt and gravel mica noted, Insufficient sample size | 07/09/21 |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | BR-3 | BR-3 | BR-3 |
| Sample | S-4 | S-5 | S-7 |
| Depth | 10-12 | 12-14 | 20-22 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 38 | 2 | 38 |
| % SAND | 61 | 4 | 55 |
| %C SAND | 30 | 0 | 16 |
| %M SAND | 24 | 2 | 18 |
| %F SAND | 7 | 2 | 21 |
| % FINES | 1 | 94 | 7 |
| $D_{100}$ (mm) | 19.1 | 9.53 | 25.4 |
| $D_{60}$ (mm) | 4.48 | 0.007 | 4.26 |
| $D_{30}$ (mm) | 1.8 | 0.002 | 0.48 |
| $D_{10}$ (mm) | 0.5 | | 0.12 |
| Cc | 1.4 | | 0.5 |
| Cu | 9 | | 35.5 |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | 100 |
| 4" | 100 | 100 | 100 |
| 3" | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 |
| 3/4" | 100 | 100 | 93 |
| 1/2" | 99 | 100 | 89 |
| 3/8" | 94 | 100 | 83 |
| #4 | 62 | 98 | 62 |
| #10 | 32 | 98 | 46 |
| #20 | 16 | 97 | 38 |
| #40 | 8 | 96 | 28 |
| #60 | 4 | 96 | 19 |
| #100 | 2 | 95 | 12 |
| #140 | 1 | 95 | 9 |
| #200 | 1 | 94 | 7 |
| 5μ m | 0 | 51 | 2 |
| 2μ m | 0 | 33 | 1 |
| 1μ m | 0 | 25 | 1 |

**Aquifer** #602211013

**TerraSense** #21004385A

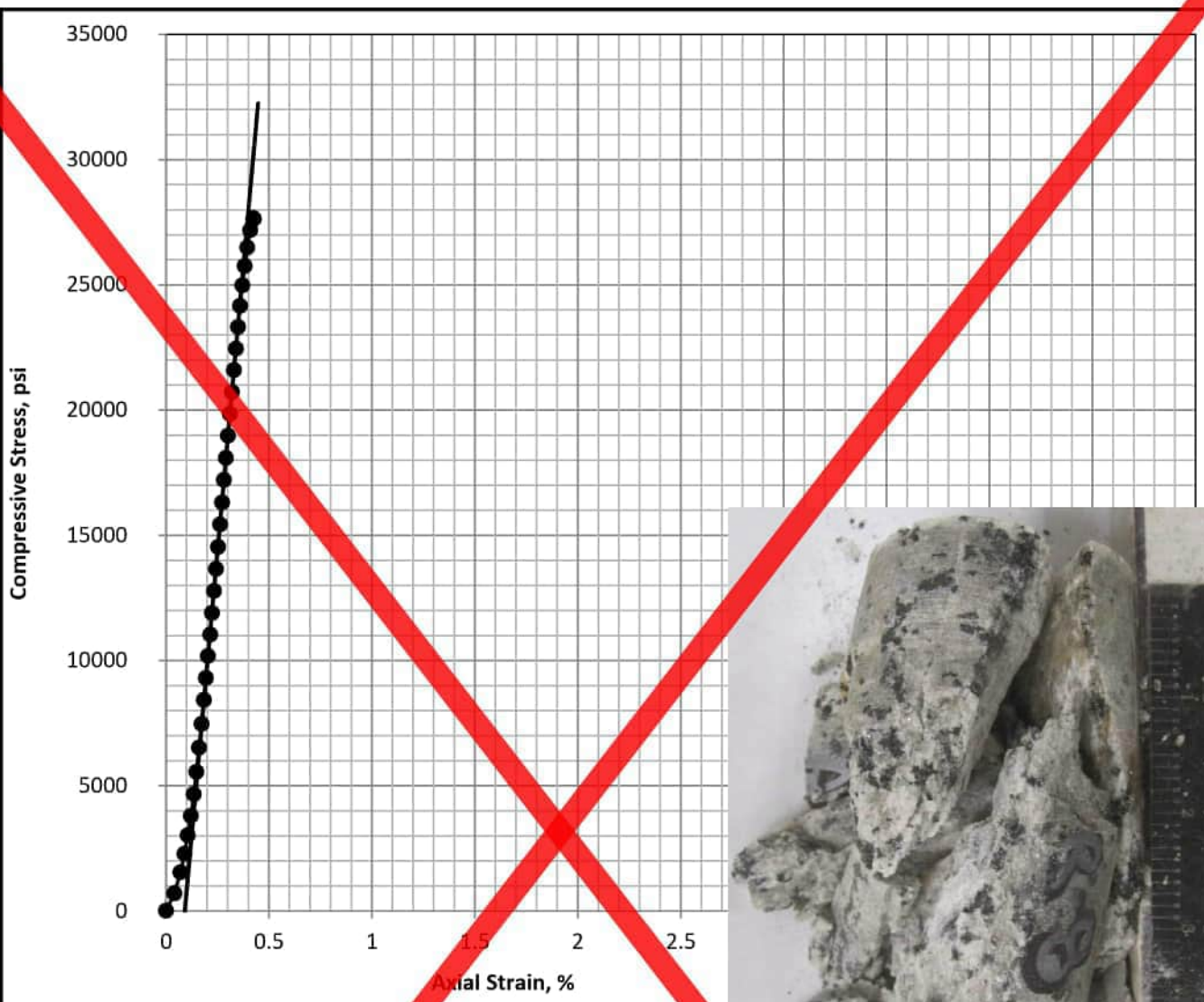
CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

## Aquifer
## CHPE - Randall's Island/Astoria-Rainey Borings
## SUMMARY OF ROCK TESTING

| SAMPLE IDENTIFICATION | | | STATE PROPERTIES | | | ENGINEERING PROPERTY TESTS | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Run | Depth | WATER CONTENT (1) (%) | TOTAL UNIT WGT. (pcf) | DRY UNIT WGT. (pcf) | TEST TYPE (2) | HARDNESS TESTS Mohs HARDNESS (-) | UNCONFINED COMPRESSION TESTS (ASTM D7012) COMPRESSIVE STRENGTH (psi) | AXIAL STRAIN @ FAILURE (%) | ESTIMATED (5) ELASTIC MODULUS (psi) | |
| ~~AR-8~~ | ~~R-1~~ | ~~13.4-14.1~~ | | | | ~~M~~ | ~~9~~ | | | | |
| ~~AR-8~~ | ~~R-1~~ | ~~13.5-13.9~~ | ~~0.2~~ | ~~169~~ | ~~169~~ | ~~UC~~ | | ~~27660~~ | ~~0.33~~ | ~~9E+06~~ | |
| | | | | | | | | | | | |
| BR-3 | R-1 | 26.2-27 | | | | M | 9 | | | | |
| BR-3 | R-1 | 26.5-26.9 | 0.3 | 165 | 164 | UC | | 8040 | 0.26 | 4E+06 | |
| | | | | | | | | | | | |
| BR-3 | R-3 | 35.9-36.8 | | | | M | 8 | | | | |
| BR-3 | R-3 | 36-36.4 | 0.2 | 167 | 167 | UC | | 12030 | 0.21 | 7E+06 | |
| | | | | | | | | | | | |
| RA-1 | R-1 | 32.6-33.5 | | | | M | 8 | | | | |
| RA-1 | R-1 | 32.7-33.1 | 0.2 | 177 | 177 | UC | | 20100 | 0.24 | 9E+06 | |
| | | | | | | | | | | | |
| RA-1 | R-3 | 42.6-43.5 | | | | M | 9 | | | | |
| RA-1 | R-3 | 42.7-43.1 | 0.2 | 178 | 178 | UC | | 17510 | 0.21 | 9E+06 | |
| | | | | | | | | | | | |
| RA-1 | R-5 | 50-50.9 | | | | M | 8 | | | | |
| RA-1 | R-5 | 50.1-50.5 | 0.1 | 186 | 186 | UC | | 21120 | 0.20 | 1E+07 | |
| | | | | | | | | | | | |
| RA-1 | R-8 | 68.9-69.7 | | | | M | 9 | | | | |
| RA-1 | R-8 | 69-69.4 | 0.1 | 177 | 177 | UC | | 14130 | 0.21 | 8E+06 | |

Notes: (1) Water contents determined after trimming and shearing.
(2) Test Type Abbreviations: M: Mohs Hardness, UC: Unconfined Compression test with estimated elastic moduli determination
(5) Modulus estimated based on corrected gross deformations.



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.15 | 169 | 169 | 4.383 | 1.979 |

Specimen meets ASTM D4543 shape tolerances

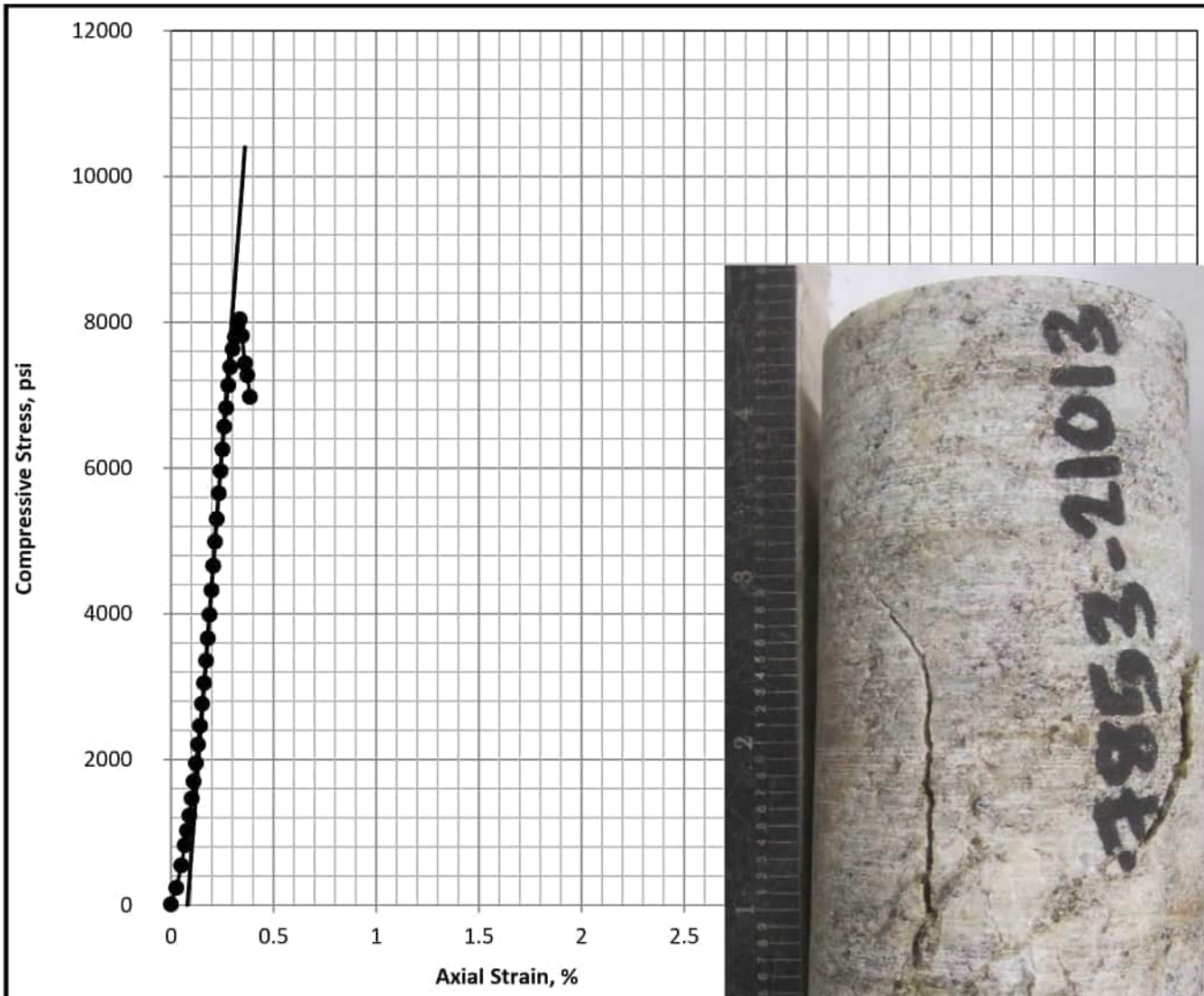
**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.08 | 0.33 | 27660 | 9E+06 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: AR-8 Run: R-1**<br>**Depth 13.5-13.9 ft.** |



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.26 | 165 | 164 | 4.412 | 1.979 |

Specimen meets ASTM D4543 shape tolerances

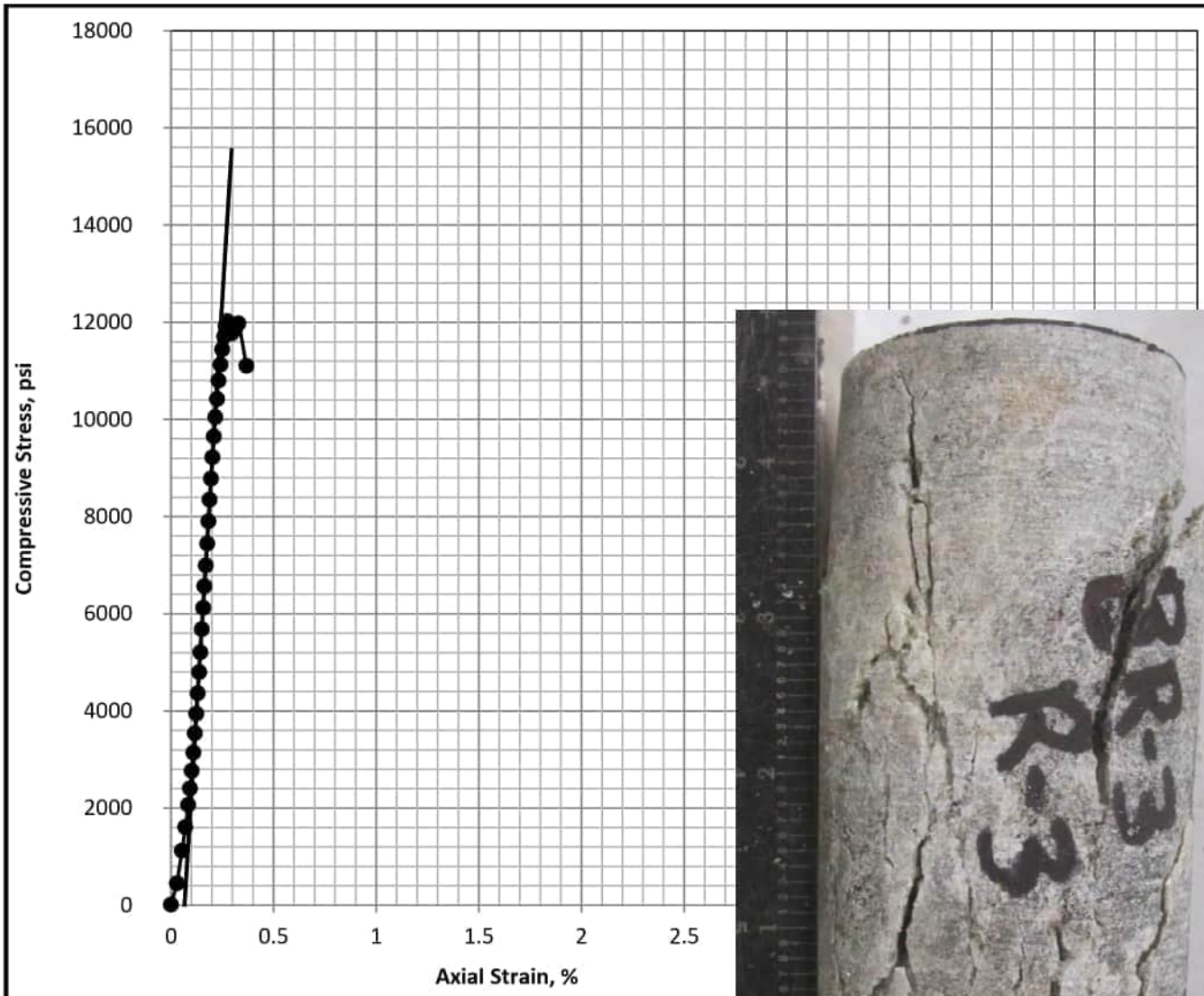
**FAILURE PHOTO**

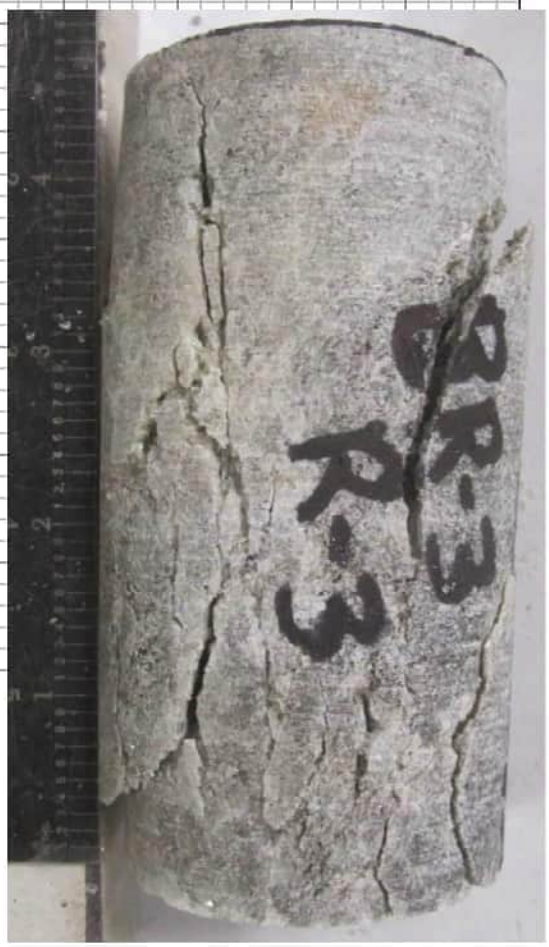
**Test Summary**

| Strain Rate (%/min) | Corrected Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.13 | 0.26 | 8040 | 4E+06 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: BR-3 Run: R-1**<br>**Depth 26.5-26.9 ft.** |



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.16 | 167 | 167 | 4.469 | 1.983 |

Specimen meets ASTM D4543 shape tolerances

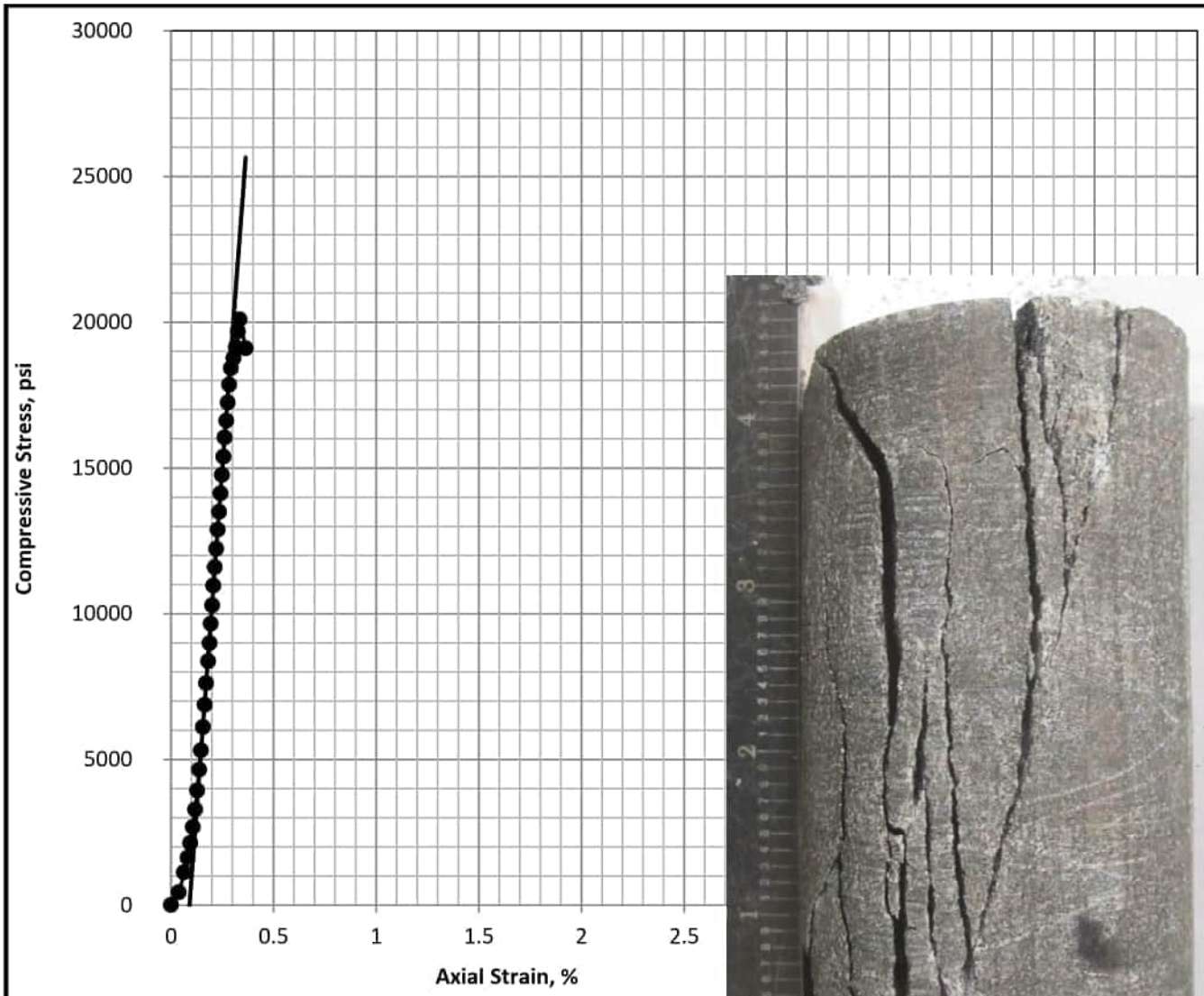
**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.10 | 0.21 | 12030 | 7E+06 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN**<br>**UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: BR-3 Run: R-3**<br>**Depth 36-36.4 ft.** |



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.16 | 177 | 177 | 4.315 | 1.981 |

Specimen meets ASTM D4543 shape tolerances

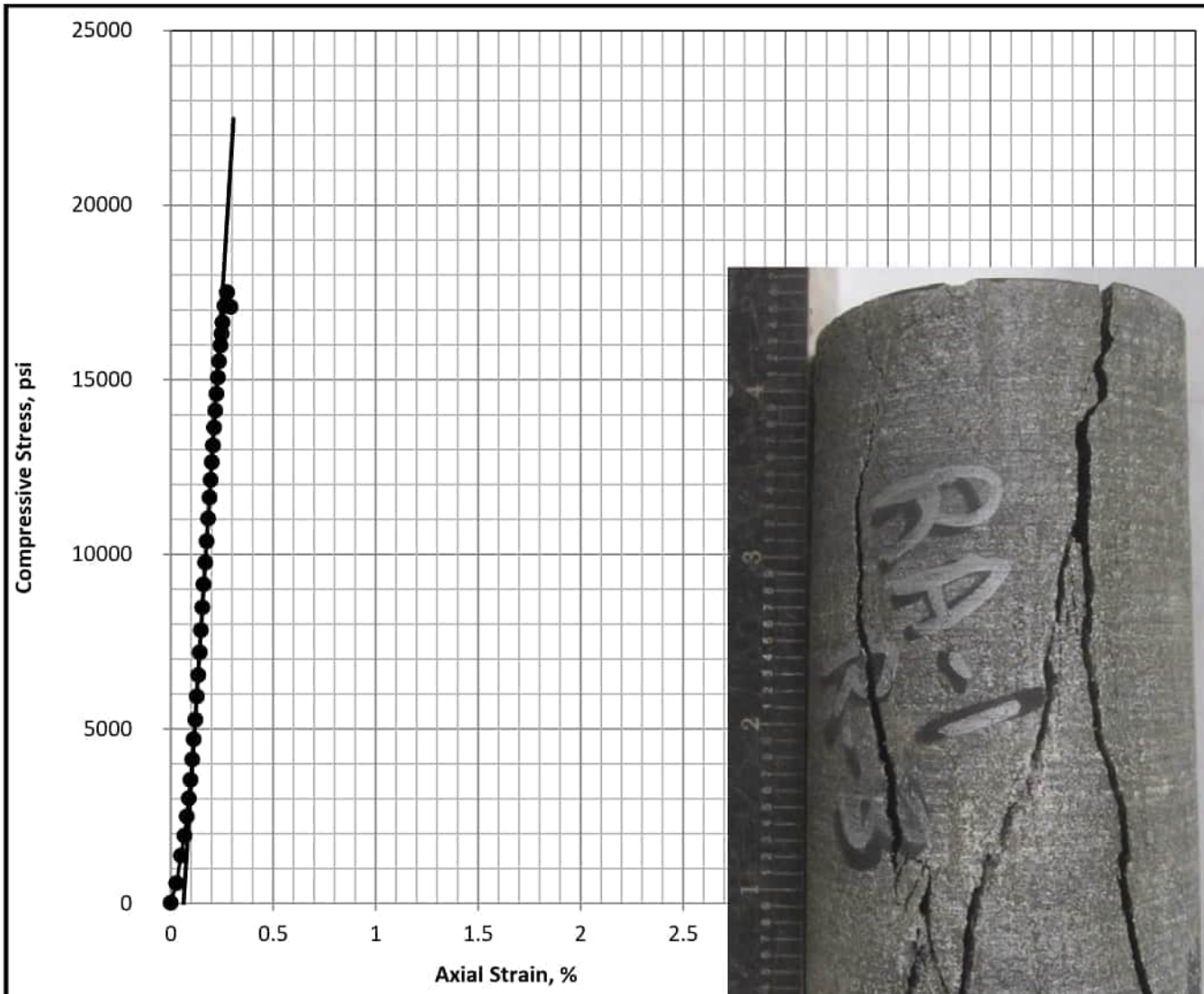
**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.08 | 0.24 | 20100 | 9E+06 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: RA-1 Run: R-1**<br>**Depth 32.7-33.1 ft.** |



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.16 | 178 | 178 | 4.332 | 1.980 |

Specimen meets ASTM D4543 shape tolerances

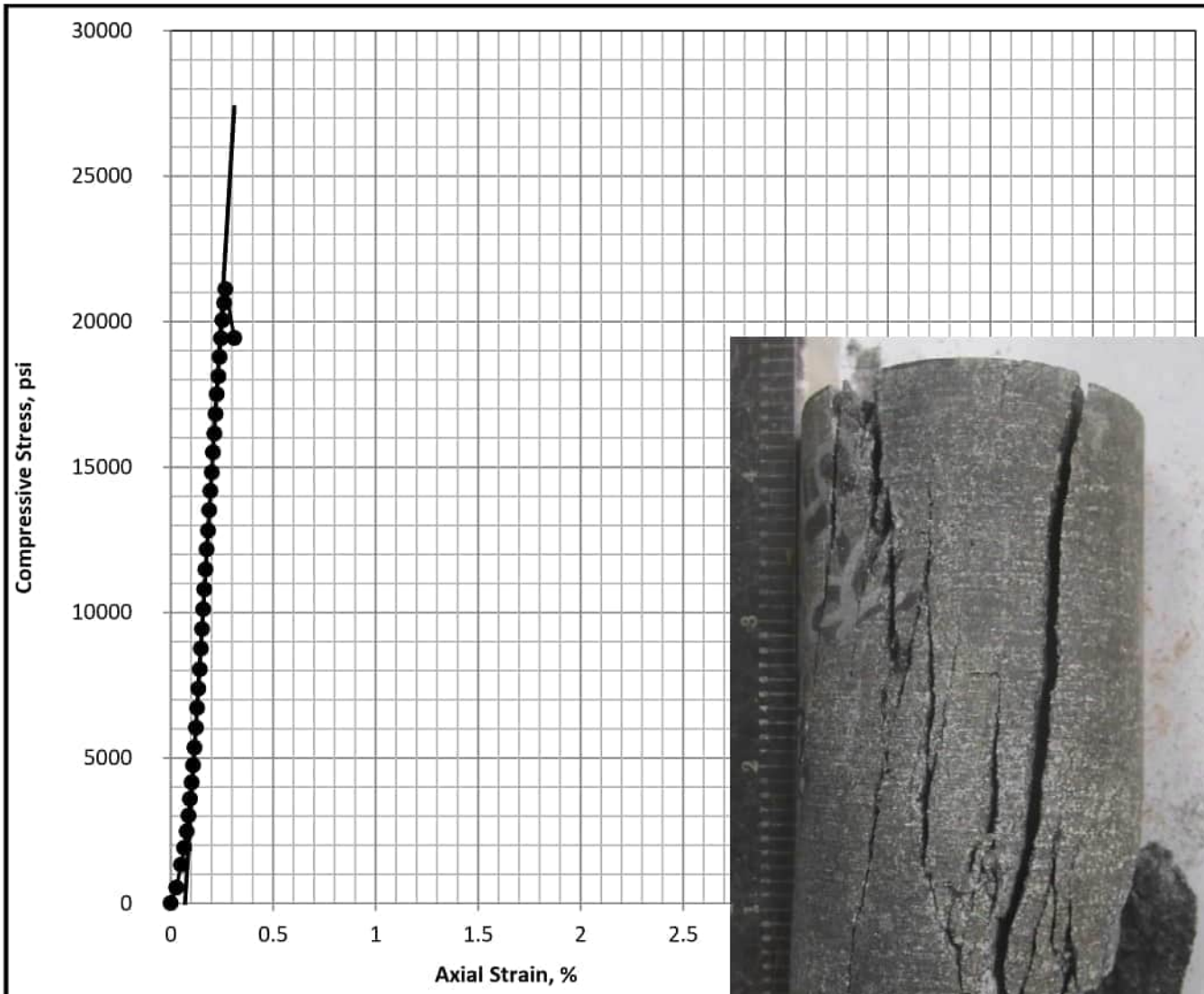
**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.08 | 0.21 | 17510 | 9E+06 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: RA-1 Run: R-3**<br>**Depth 42.7-43.1 ft.** |



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.12 | 186 | 186 | 4.403 | 1.978 |

Specimen meets ASTM D4543 shape tolerances

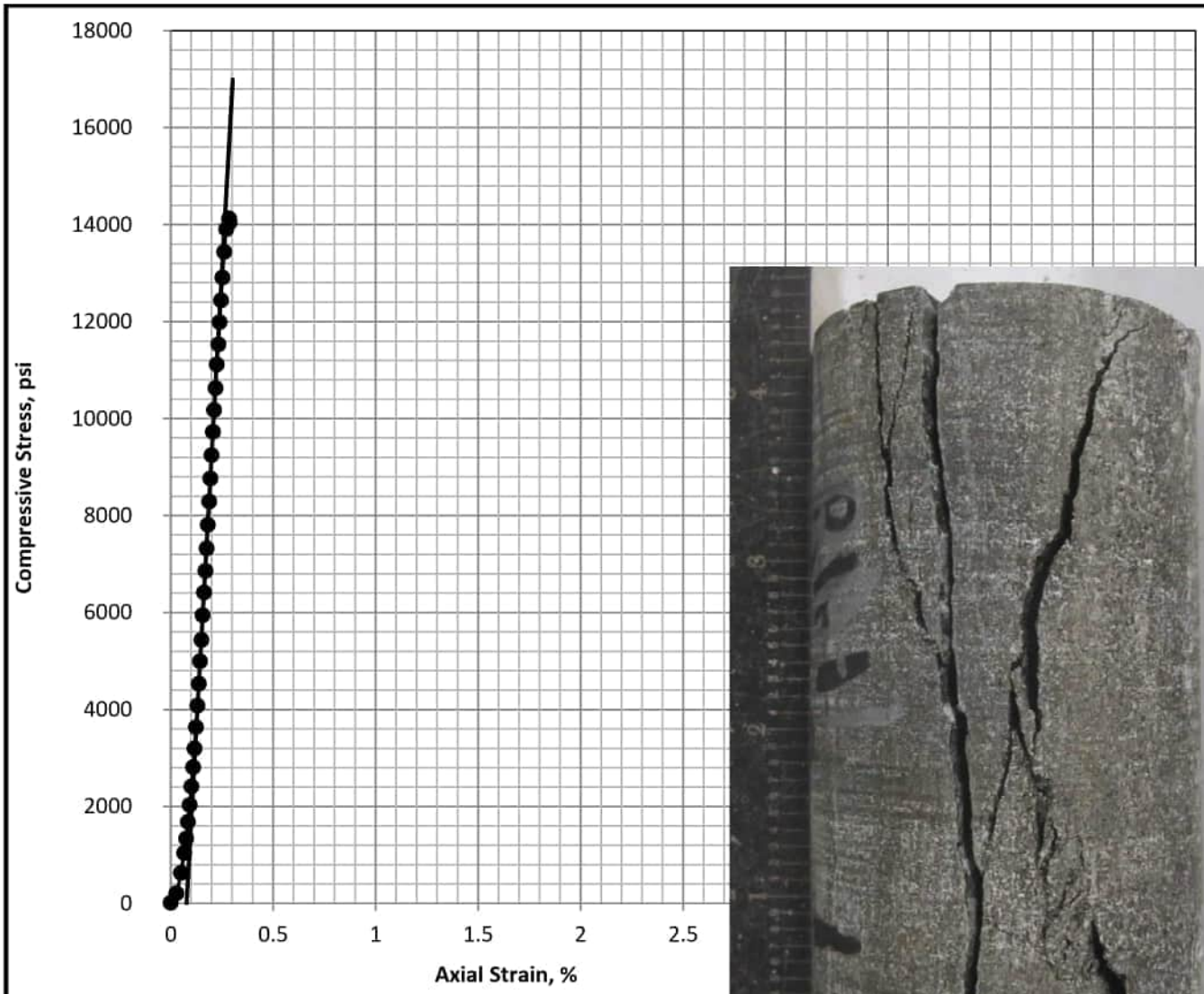
**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.07 | 0.20 | 21120 | 1E+07 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: RA-1 Run: R-5**<br>**Depth 50.1-50.5 ft.** |



**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.14 | 177 | 177 | 4.287 | 1.979 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.10 | 0.21 | 14130 | 8E+06 |

Test by: DM
Test Date: Jul-19-21
Reviewed by: GET

| | | |
|---|---|---|
| **Aquifer**<br>**Project # 602211013** | **CHPE - Randall's Island/Astoria-Rainey Borings** | **COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** |
| **TerraSense**<br>**Project # 21004385A** | | **Boring: RA-1 Run: R-8**<br>**Depth 69-69.4 ft.** |

TerraSense

45H Commerce Way, Totowa, NJ 07512
973.812.1818
terrasenselab.com

03/21/2022
TerraSense Project Number: 21004385A-3

Chris Stratton
Project Manager
Aquifer Drilling & Testing
75 East 2nd Street
Mineola, NY 11501

Dear Mr. Stratton:

**Re: Laboratory Test Results for 602.21.1013 – CHPE – Randall's Island/Astoria-Rainey Borings**

The purpose of this letter is to present the results of the laboratory tests performed on the samples delivered to the TerraSense laboratory on 03/03/22. Testing was performed based on the assignment dated 02/10/22 by Walter Howard.

**Test Results**
Test results are reported on the accompanying test pages.

**Test Comments**
Testing was performed in general accordance to the ASTM or other methods as listed on the test pages. Deviations from the test standards are noted on these pages.

**Limitations**
Our professional services for this project have been performed in accordance with generally accepted engineering practices; no other warranty, expressed or implied, is made.

**Sample Disposition**
If we do not receive other instructions from you within thirty days, this material will be disposed of.
If you have any questions concerning the test results reported in this letter, please call us.
Sincerely,

Gregory Thomas
*Laboratory Manager*

Enclosure:

21004385A-7853 (3)

# LABORATORY TEST ASSIGNMENT AND TRACKING SHEET

Project Number: 602211013 Task Number: **NA** Assigned by: ADT - Chris Stratton Date Assigned: 02.10.22

Project Name: CHPE - Randall's Island/Astoria-Rainey Borings Assigning Office: C/O AECOM Results requested by:

**Any known or suspected contamination of the material (yes or no)?** no If yes, HASP required for testing to proceed.

| SAMPLE IDENTIFICATION | | | | INDEX TESTS | | | | | | | | | | | | ENGINEERING PROPERTY TESTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exploration (1) Number | Sample Number | Sample (2) Depth (ft) | Sample Type (3) | Visual Classification | Water Content | Liquid & Plastic Limits | Sieve Analysis | Sieve and Hydrometer | % Fines (-#200) | Specific Gravity | Compaction (4) | Organic Content | Tube Unit Weight and Consistency | | | Lab Vane (4) | Permeability (4) | Consolidation (4) | Direct Shear (4) | Unconfined Compression | Unconsolidated (4) Undrained Triaxial | Consolidated (4) Undrained Triaxial | Consolidated (4) Drained Triaxial | Cyclic Triaxial (4) | Unconfined Strength | Mohs Hardness | Unit Weight | |
| | | | | D2488 VC | D2216 w | D4318 PI | D422 SA | D6913 & D792 MA | D422 WA | D854 Gs | D698 or D1557 CP | D2974 ORG | D2937 UW | | | D4648 LV | D5084 or D2434 K | D2435 CON | D3080 DS | D2166 UC | D2850 UU | D4767 CUTX | CDTX | D3999 or D5311 CyTX | D7012 | | | |
| BR-1 | S-3 | 7-9 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-1 | - - | 15-17 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-1 | R-2 | 25-30 | C | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-1 | R-7 | 45-50 | C | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-1 | R-11 | 65-70 | C | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-4 | S-7 | 25-27 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| ~~BR-4~~ | ~~S-4~~ | ~~11-13~~ | ~~J~~ | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-4 | S-6 | 20-22 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-4 | S-8 | 30-32 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-4 | S-10 | 40-42 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-4 | S-15 | 60-61.5 | J | | | | | | | | | | | | | | | | | | | | | | | | |
| BR-4 | S-16 | 61.5-62 | | | | | | | | | | | | | | | | | | | | | | | | | |

TEST SPECIFICATIONS AND OTHER INSTRUCTIONS

ASSUME THAT USCS SOIL CLASSIFICATION IS INCLUDED

If sample ID & depths do not correspond between jar and lab assignment, use the lab assignment ID & depths (above) for test results

Received 03/03/22 Potomac

NOTES: 1. Exploration Number = designation for boring, test pit, etc. 2. Give range or average depth. 3. See reverse for details 4. Additional instructions required, such as compactive effort, See reverse for details.

Key: Test Status Key (shown by symbol or letter key): Guide to Test Specifications and Instructions

TEST ASSIGNED | TEST IN PROGRESS | TEST COMPLETED | TEST FINALIZED

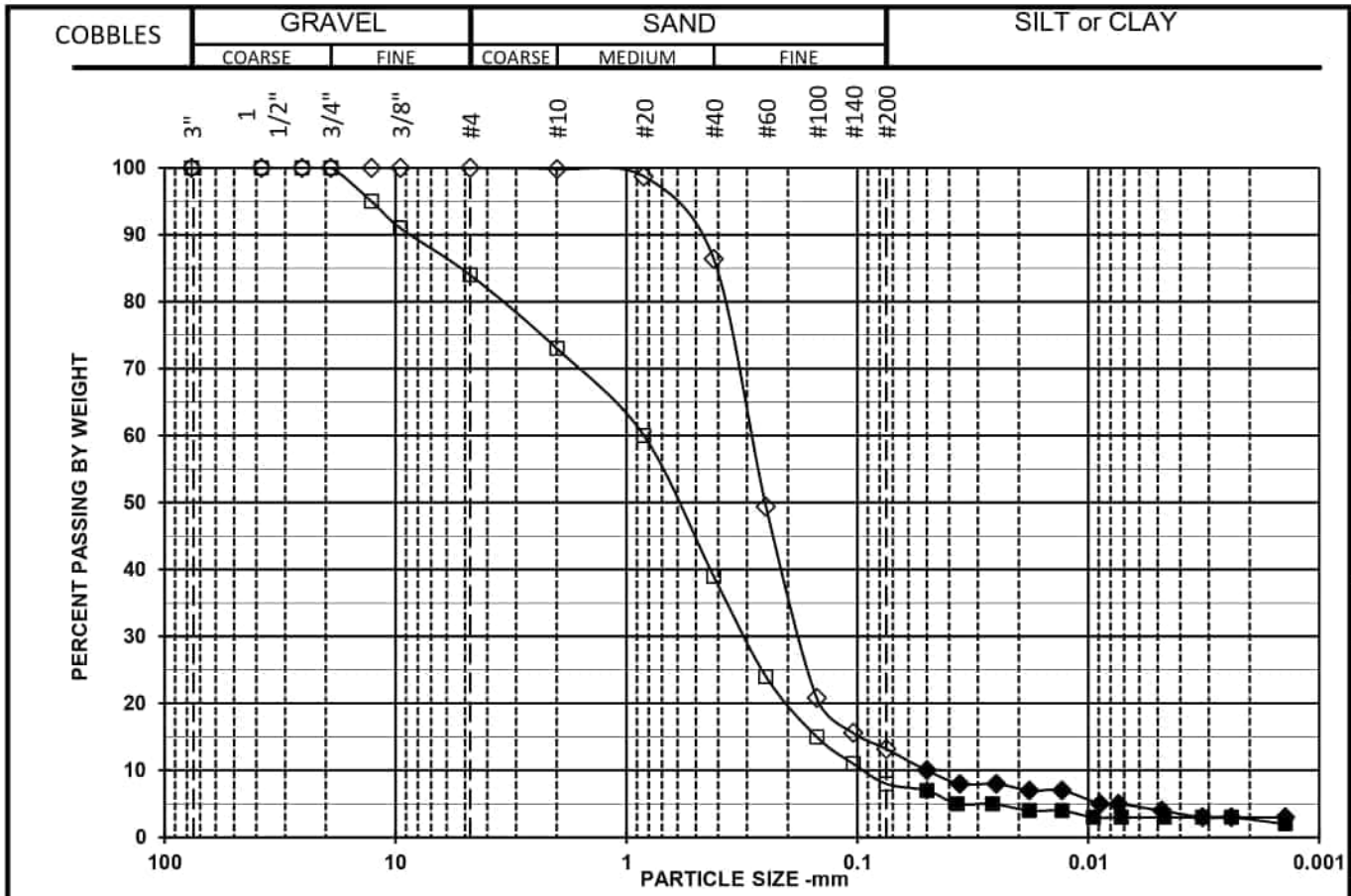


**TerraSense, LLC**
45 H Commerce Way Totowa, NJ 07512 (973) 812-1818

**ADT/Cascade #602.21.1013**
**CHPE - Randall's Island/Astoria-Rainey Borings**
**LABORATORY SOIL TESTING DATA SUMMARY**

| BORING NO. | SAMPLE NO. | DEPTH (ft) | IDENTIFICATION TESTS | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | WATER CONTENT (%) | LIQUID LIMIT (-) | PLASTIC LIMIT (-) | PLAS. INDEX (-) | USCS SYMB. (1) | SIEVE MINUS NO. 200 (%) | HYDROMETER % MINUS 2 μm (%) | |
| BR-1 | S-3 | 7-9 | 16.6 | | | | SW-SM | 8 | 3 | |
| BR-1 | | 15-17 | 21.7 | | | | SM | 13.2 | 3 | |
| BR-4 | S-6 | 20-22 | 7.2 | | | | GP | 2 | 1 | |
| BR-4 | S-7 | 25-27 | 56.1 | 77 | 30 | 47 | CH | 94.6 | | |
| BR-4 | S-8 | 30-32 | 26.3 | | | | SP-SM | 11.5 | 3 | |
| BR-4 | S-10 | 40-42 | 19.4 | | | | SP | 2 | 1 | |
| BR-4 | S-15 | 60-61.5 | 26.5 | | | | ML | 67.9 | | |
| BR-4 | S-16 | 61.5-62 | 32.6 | 36 | 18 | 18 | CL | 95.5 | | |
| | | | | | | | | | | |

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 16.6 | | | | SW-SM | | Gray, Well-graded sand with silt and gravel, Insufficient sample size | 03/07/22 |
| ◇ | 21.7 | | | | SM | | Brown, Silty sand | 03/07/22 |
| ○ | | | | | | | | |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | BR-1 | BR-1 | |
| Sample | S-3 | | |
| Depth | 7-9 | 15-17 | |
| % +3" | 0 | 0 | |
| % Gravel | 16 | 0 | |
| % SAND | 76 | 86.8 | |
| %C SAND | 11 | 0.2 | |
| %M SAND | 34 | 13.4 | |
| %F SAND | 31 | 73.2 | |
| % FINES | 8 | 13.2 | |
| $D_{100}$ (mm) | 19.1 | 4.75 | |
| $D_{60}$ (mm) | 0.841 | 0.289 | |
| $D_{30}$ (mm) | 0.31 | 0.18 | |
| $D_{10}$ (mm) | 0.093 | 0.05 | |
| Cc | 1.2 | 2.2 | |
| Cu | 9 | 5.8 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100.0 | |
| 4" | 100 | 100.0 | |
| 3" | 100 | 100.0 | |
| 1 1/2" | 100 | 100.0 | |
| 1" | 100 | 100.0 | |
| 3/4" | 100 | 100.0 | |
| 1/2" | 95 | 100.0 | |
| 3/8" | 91 | 100.0 | |
| #4 | 84 | 100.0 | |
| #10 | 73 | 99.8 | |
| #20 | 60 | 98.7 | |
| #40 | 39 | 86.4 | |
| #60 | 24 | 49.4 | |
| #100 | 15 | 20.8 | |
| #140 | 11 | 15.6 | |
| #200 | 8 | 13.2 | |
| 5μ m | 3 | 4 | |
| 2μ m | 3 | 3 | |
| 1μ m | 1 | 3 | |

**ADT/Cascade** #602.21.1013

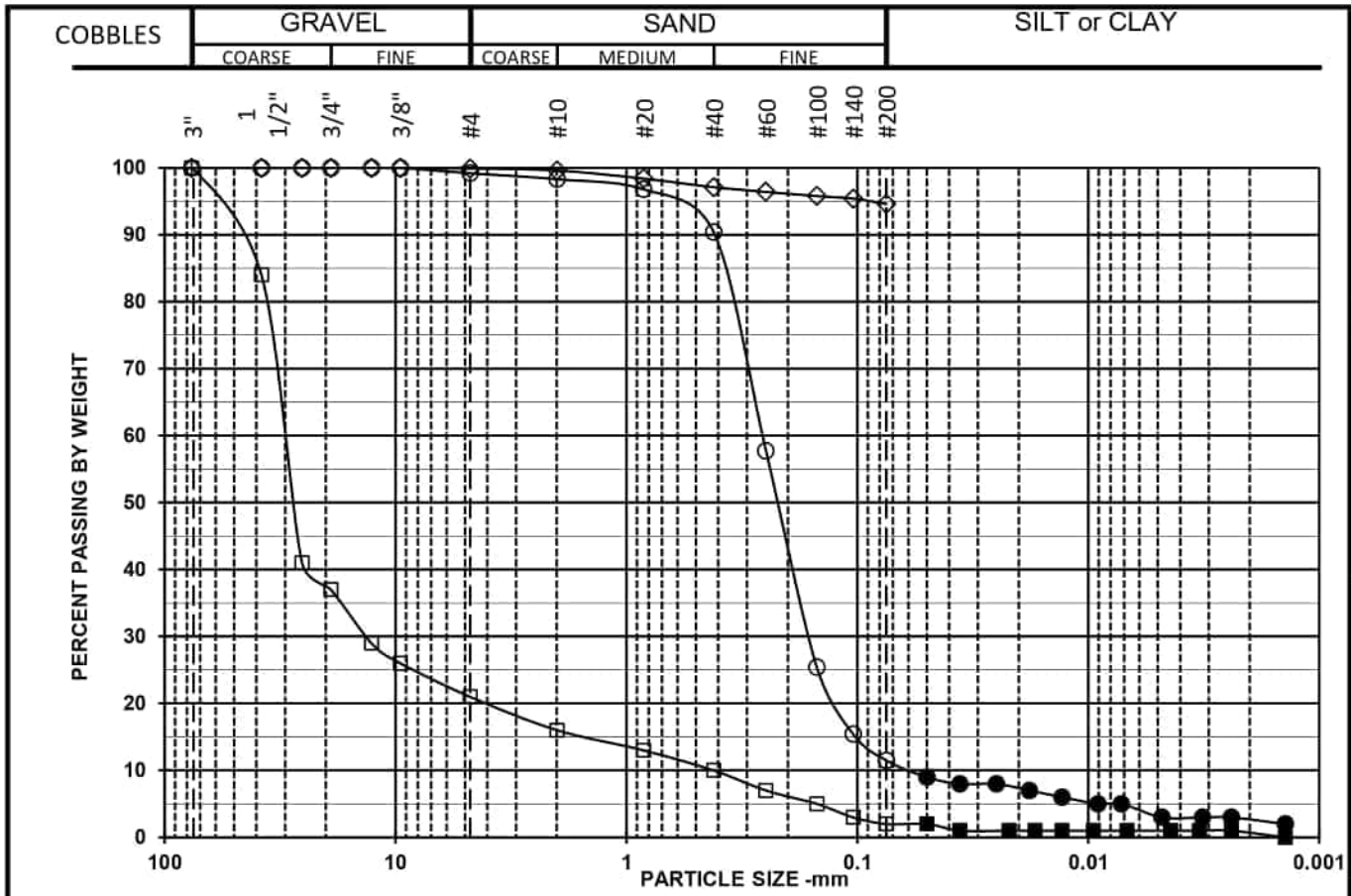
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev3a.xlsx 3/14/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 7.2 | | | | GP | | Gray, Poorly graded gravel with sand, Insufficient sample size | 03/07/22 |
| ◇ | 56.1 | 77 | 30 | 47 | CH | | Gray, Fat clay shell fragments noted | 03/07/22 |
| ○ | 26.3 | | | | SP-SM | | Brown, Poorly graded sand with silt | 03/07/22 |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | BR-4 | BR-4 | BR-4 |
| Sample | S-6 | S-7 | S-8 |
| Depth | 20-22 | 25-27 | 30-32 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 79 | 0.1 | 0.8 |
| % SAND | 19 | 5.3 | 87.7 |
| %C SAND | 5 | 0.3 | 0.9 |
| %M SAND | 6 | 2.5 | 7.9 |
| %F SAND | 8 | 2.5 | 78.9 |
| % FINES | 2 | 94.6 | 11.5 |
| $D_{100}$ (mm) | 76.2 | 9.53 | 9.53 |
| $D_{60}$ (mm) | 30.4 | | 0.258 |
| $D_{30}$ (mm) | 13 | | 0.16 |
| $D_{10}$ (mm) | 0.42 | | 0.059 |
| Cc | 13.2 | | 1.7 |
| Cu | 72.4 | | 4.4 |

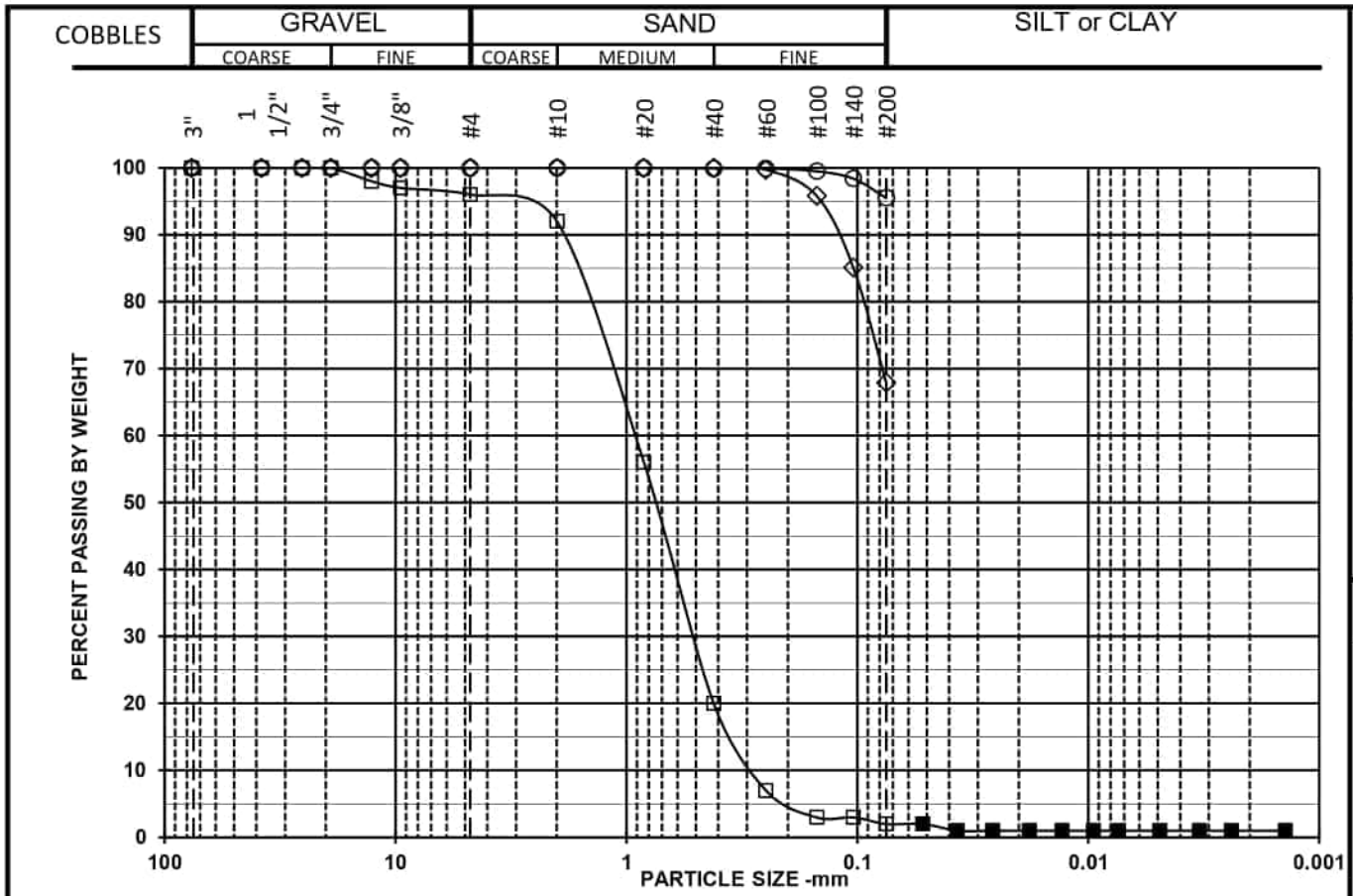
| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100.0 | 100.0 |
| 4" | 100 | 100.0 | 100.0 |
| 3" | 100 | 100.0 | 100.0 |
| 1 1/2" | 84 | 100.0 | 100.0 |
| 1" | 41 | 100.0 | 100.0 |
| 3/4" | 37 | 100.0 | 100.0 |
| 1/2" | 29 | 100.0 | 100.0 |
| 3/8" | 26 | 100.0 | 100.0 |
| #4 | 21 | 99.9 | 99.2 |
| #10 | 16 | 99.6 | 98.3 |
| #20 | 13 | 98.4 | 96.8 |
| #40 | 10 | 97.1 | 90.4 |
| #60 | 7 | 96.4 | 57.7 |
| #100 | 5 | 95.8 | 25.4 |
| #140 | 3 | 95.4 | 15.4 |
| #200 | 2 | 94.6 | 11.5 |
| 5μ m | 1 | | 3 |
| 2μ m | 1 | | 3 |
| 1μ m | | | 1 |

**ADT/Cascade** #602.21.1013

**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 19.4 | | | | SP | | Brown, Poorly graded sand, Insufficient sample size | 03/07/22 |
| ◇ | 26.5 | | | | ML | | Brown, Sandy silt | 03/07/22 |
| ○ | 32.6 | 36 | 18 | 18 | CL | | Brown, Lean clay | 03/07/22 |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | BR-4 | BR-4 | BR-4 |
| Sample | S-10 | S-15 | S-16 |
| Depth | 40-42 | 60-61.5 | 61.5-62 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 4 | 0 | 0 |
| % SAND | 94 | 32.1 | 4.5 |
| %C SAND | 4 | 0 | 0 |
| %M SAND | 72 | 0 | 0.1 |
| %F SAND | 18 | 32.1 | 4.4 |
| % FINES | 2 | 67.9 | 95.5 |
| $D_{100}$ (mm) | 19.1 | 2 | 2 |
| $D_{60}$ (mm) | 0.926 | | |
| $D_{30}$ (mm) | 0.51 | | |
| $D_{10}$ (mm) | 0.28 | | |
| Cc | 1 | | |
| Cu | 3.3 | | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100.0 | 100.0 |
| 4" | 100 | 100.0 | 100.0 |
| 3" | 100 | 100.0 | 100.0 |
| 1 1/2" | 100 | 100.0 | 100.0 |
| 1" | 100 | 100.0 | 100.0 |
| 3/4" | 100 | 100.0 | 100.0 |
| 1/2" | 98 | 100.0 | 100.0 |
| 3/8" | 97 | 100.0 | 100.0 |
| #4 | 96 | 100.0 | 100.0 |
| #10 | 92 | 100.0 | 100.0 |
| #20 | 56 | 100.0 | 100.0 |
| #40 | 20 | 100.0 | 99.9 |
| #60 | 7 | 99.7 | 99.9 |
| #100 | 3 | 95.8 | 99.5 |
| #140 | 3 | 85.1 | 98.4 |
| #200 | 2 | 67.9 | 95.5 |
| 5μ m | 1 | | |
| 2μ m | 1 | | |
| 1μ m | 1 | | |

**ADT/Cascade** #602.21.1013

**TerraSense** #21004385A

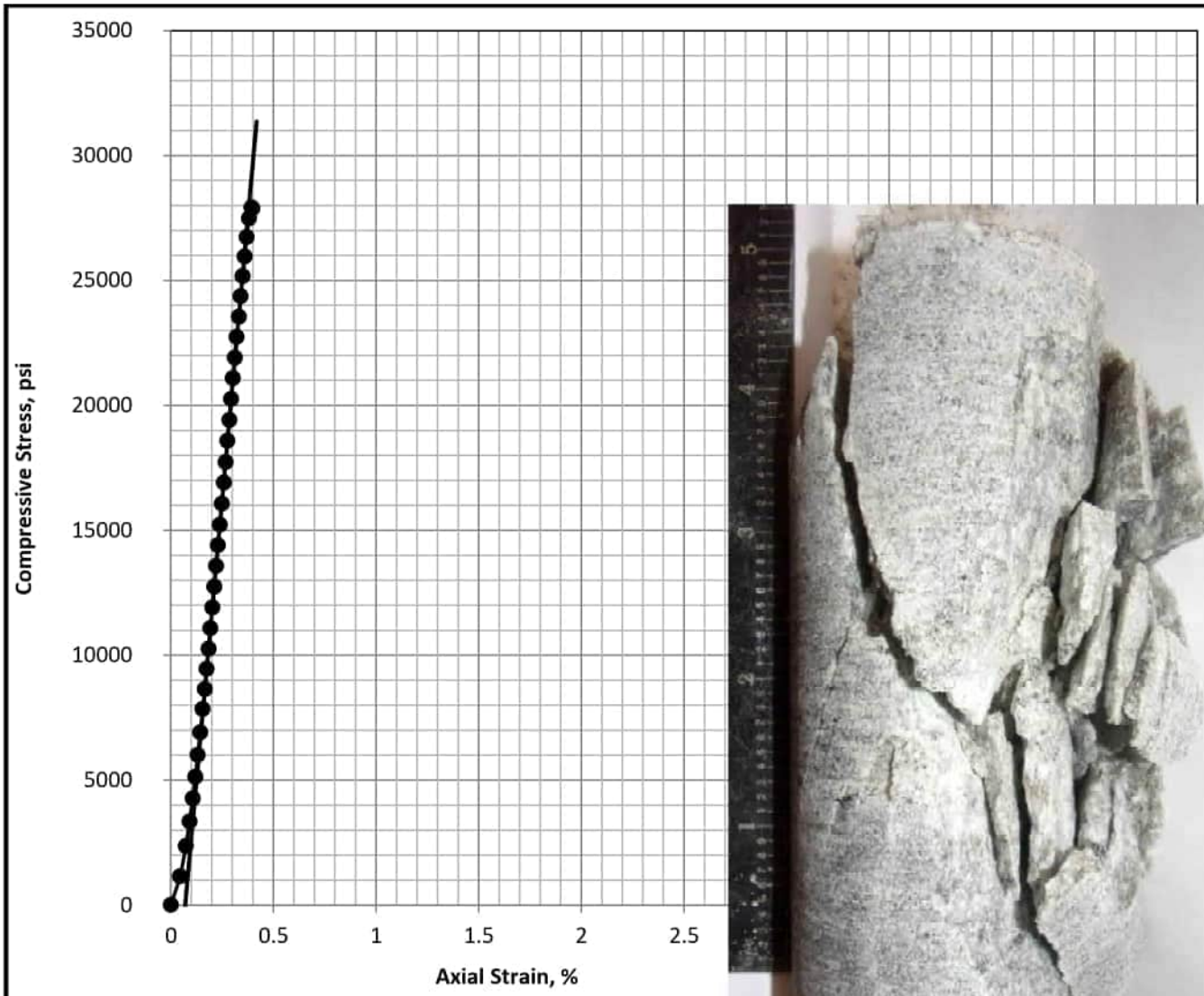
CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

## Aquifer #602.21.1013
## CHPE - Randall's Island/Astoria-Rainey Borings
## SUMMARY OF ROCK TESTING

| SAMPLE IDENTIFICATION | | | STATE PROPERTIES | | | ENGINEERING PROPERTY TESTS | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Run | Depth | WATER CONTENT (1) | TOTAL UNIT WGT. | DRY UNIT WGT. | TEST TYPE (2) | HARDNESS TESTS Mohs HARDNESS | UNCONFINED COMPRESSION TESTS (ASTM D7012) COMPRESSIVE STRENGTH | AXIAL STRAIN @ FAILURE | ESTIMATED (5) ELASTIC MODULUS | |
| | | (ft-ft) | (%) | (pcf) | (pcf) | | (-) | (psi) | (%) | (psi) | |
| BR-1 | R-2 | 25-30 | | | | M | 5 | | | | |
| BR-1 | R-2 | 26-26.4 | 0.1 | 166 | 166 | UC | | 27930 | 0.32 | 9E+06 | |
| | | | | | | | | | | | |
| BR-1 | R-7 | 45-50 | | | | M | 6 | | | | |
| BR-1 | R-7 | 46.1-46.5 | 0.2 | 165 | 164 | UC | | 30720 | 0.39 | 8E+06 | |
| | | | | | | | | | | | |
| BR-1 | R-11 | 65-70 | | | | M | 5 | | | | |
| BR-1 | R-11 | 66.1-66.5 | 0.2 | 162 | 162 | UC | | 31050 | 0.35 | 9E+06 | |

Notes: (1) Water contents determined after trimming and shearing.
(2) Test Type Abbreviations: M: Mohs hardness, UC: Unconfined Compression test with estimated elastic moduli determination
(5) Modulus estimated based on corrected gross deformations.




**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.09 | 166 | 166 | 4.415 | 1.971 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.09 | 0.32 | 27930 | 9E+06 |

Test by: DM
Test Date: Mar-06-22
Reviewed by: GET

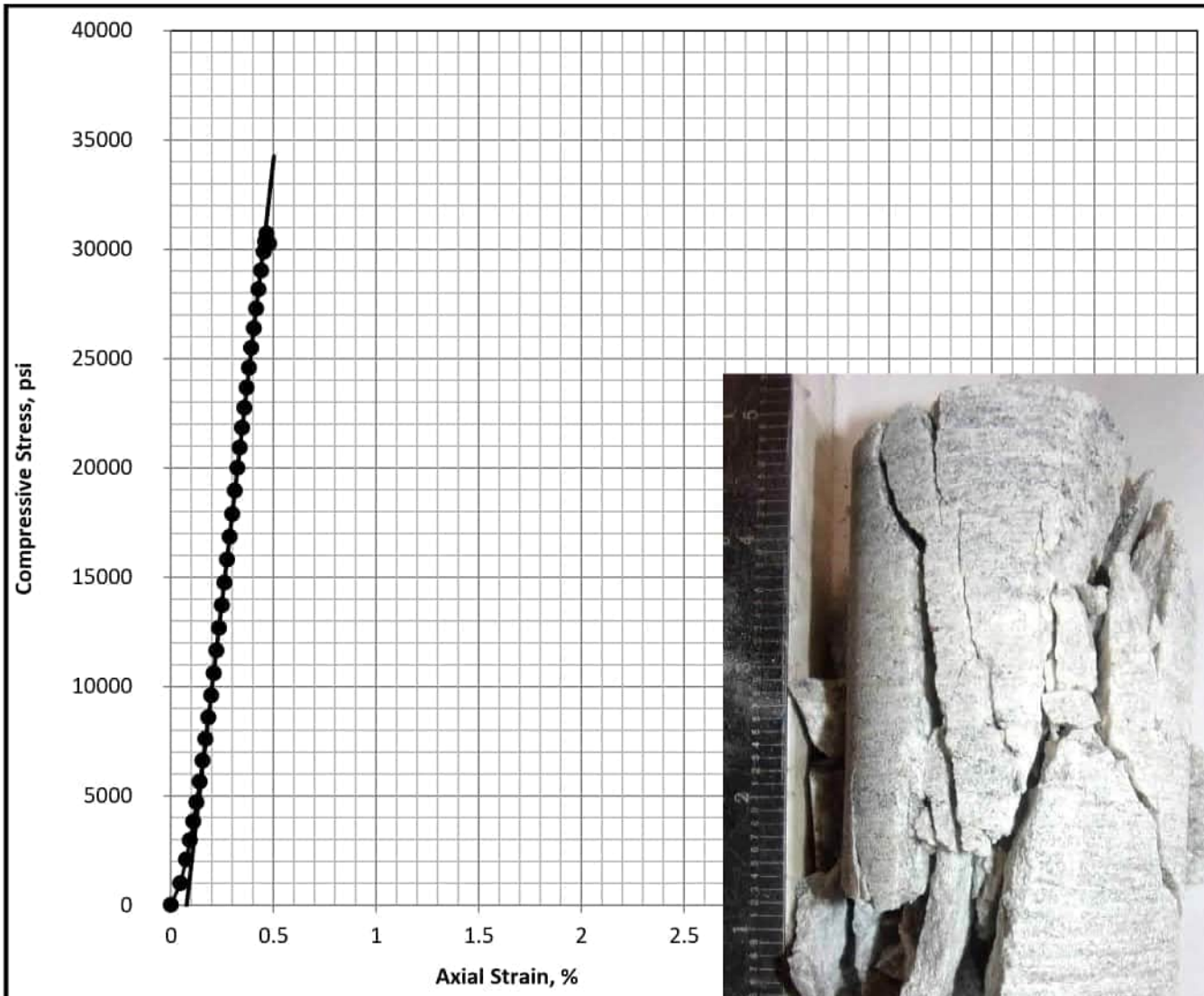
**Aquifer**
**Project # 602.21.1013**

**TerraSense**
**Project # 21004385A**

**CHPE - Randall's Island/Astoria-Rainey Borings**

**COMPRESSIVE STRESS VS STRAIN**
**UNCONFINED COMPRESSIVE STRENGTH TEST**

**Boring: BR-1 Run: R-2**
**Depth 26-26.4 ft.**




**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.16 | 165 | 164 | 4.596 | 1.973 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.10 | 0.39 | 30720 | 8E+06 |

Test by: DM
Test Date: Mar-06-22
Reviewed by: GET

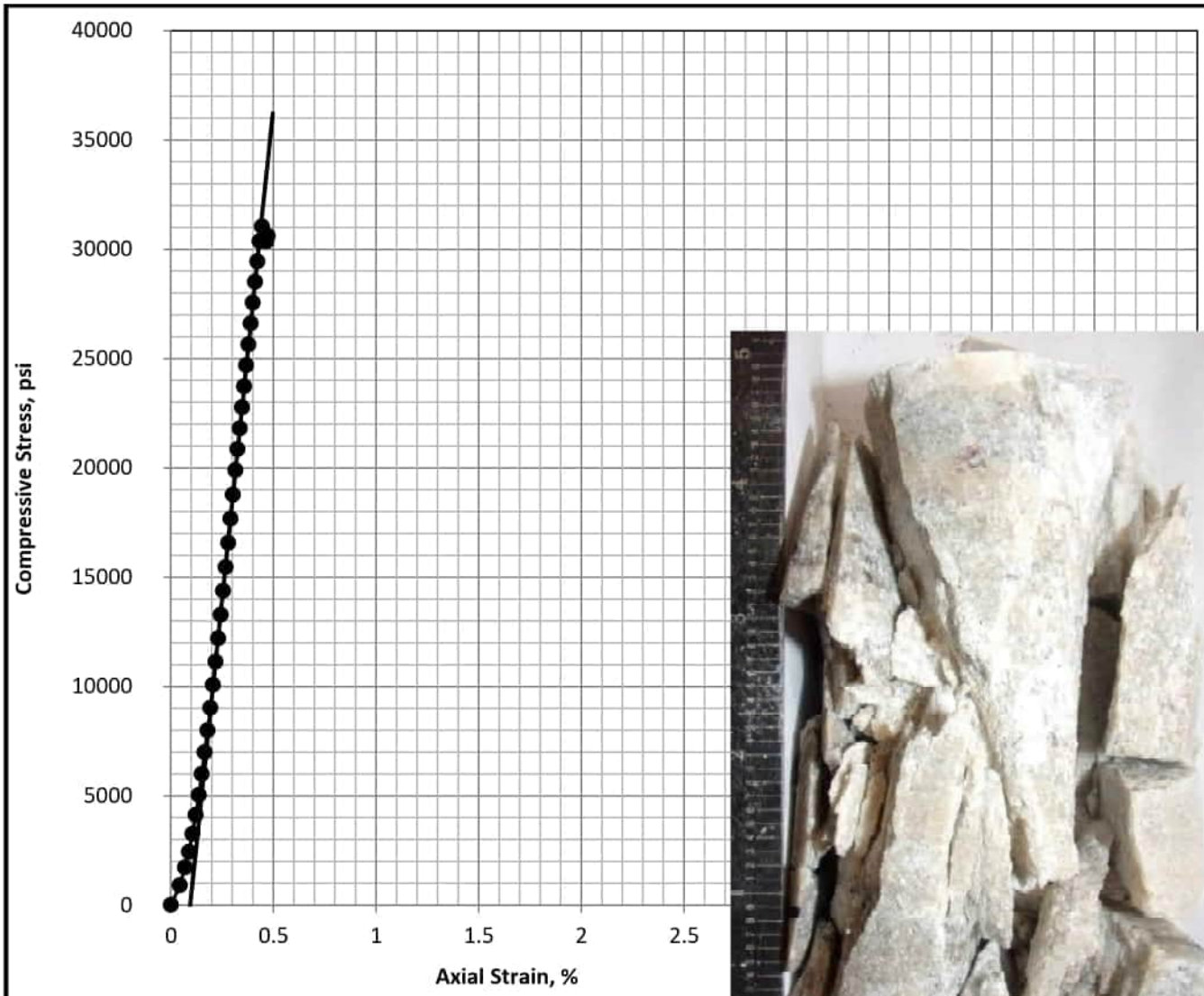
**Aquifer**
**Project # 602.21.1013**

**TerraSense**
**Project # 21004385A**

**CHPE - Randall's Island/Astoria-Rainey Borings**

**COMPRESSIVE STRESS VS STRAIN**
**UNCONFINED COMPRESSIVE STRENGTH TEST**

**Boring: BR-1 Run: R-7**
**Depth 46.1-46.5 ft.**




**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.16 | 162 | 162 | 4.542 | 1.972 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.09 | 0.35 | 31050 | 9E+06 |

Test by: DM
Test Date: Mar-06-22
Reviewed by: GET

**Aquifer**
**Project # 602.21.1013**

**TerraSense**
**Project # 21004385A**

**CHPE - Randall's Island/Astoria-Rainey Borings**

**COMPRESSIVE STRESS VS STRAIN**
**UNCONFINED COMPRESSIVE STRENGTH TEST**

**Boring: BR-1 Run: R-11**
**Depth 66.1-66.5 ft.**

TerraSense

45H Commerce Way, Totowa, NJ 07512
973.812.1818
terrasenselab.com

05/02/2022
TerraSense Project Number: 21004385A-4

Chris Stratton
Project Manager
Aquifer Drilling & Testing
75 East 2nd Street
Mineola, NY 11501

Dear Mr. Stratton:

**Re: Laboratory Test Results for 602.21.1013 – CHPE – Randall's Island/Astoria-Rainey Borings**

The purpose of this letter is to present the results of the laboratory tests performed on the samples delivered to the TerraSense laboratory on 04/06/22. Testing was performed based on the assignment dated 04/05/22 by Walter Howard.

**Test Results**
Test results are reported on the accompanying test pages.

**Test Comments**
Testing was performed in general accordance to the ASTM or other methods as listed on the test pages. Deviations from the test standards are noted on these pages.

**Limitations**
Our professional services for this project have been performed in accordance with generally accepted engineering practices; no other warranty, expressed or implied, is made.

**Sample Disposition**
If we do not receive other instructions from you within thirty days, this material will be disposed of.
If you have any questions concerning the test results reported in this letter, please call us.
Sincerely,

Gregory Thomas
*Laboratory Manager*

Enclosure:

# LABORATORY TEST ASSIGNMENT AND TRACKING SHEET 21004385A-7853-4

Project Number: 602.21.1013 Task Number: NA Assigned by: ADT - Chris Stratton Date Assigned: 4/5/2022

Project Name: CHPE - Randall's Island/Astoria-Rainey Borings Assigning Office: C/O AECOM Results requested by:

Any known or suspected contamination of the material (yes or no)? no If yes, HASP required for testing to proceed.

| SAMPLE IDENTIFICATION | | | | INDEX TESTS | | | | | | | | | | | | ENGINEERING PROPERTY TESTS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exploration (1) Number | Sample Number | Sample (2) Depth (ft) | Sample Type (3) | Visual Classification | Water Content | Liquid & Plastic Limits | Sieve Analysis | Sieve and Hydrometer | % Fines (-#200) | Specific Gravity | Compaction (4) | Organic Content | Tube Unit Weight and Consistency | | | Lab Vane (4) | Permeability (4) | Consolidation (4) | Direct Shear (4) | Unconfined Compression | Unconsolidated (4) Undrained Triaxial | Consolidated (4) Undrained Triaxial | Consolidated (4) Drained Triaxial | Cyclic Triaxial (4) | Unconfined Strength | Mohs Hardness | Unit Weight | |
| | | | | D2488 VC | D2216 w | D4318 PI | D422 SA | D6913 & D792 MA | D422 WA | D854 Gs | D698 or D1557 CP | D2974 ORG | D2937 UW | | | D4648 LV | D5084 or D2434 K | D2435 CON | D3080 DS | D2166 UC | D2850 UU | D4767 CUTX | CDTX | D3999 or D5311 CyTX | D7012 | | | |
| RA-2 | S-1 | 5-7 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-2 | S-7 | 20-22 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-2 | S-11A | 40-41.5 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-2 | S-12 | 45-47 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-2 | R-2 | 55-60 | C | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-2 | R-5 | 70-75 | C | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ~~AR-1~~ | ~~S-2~~ | ~~7-9~~ | ~~J~~ | | | | | | | | | | | | | | | | | | | | | | | | | |
| ~~AR-1~~ | ~~S-3~~ | ~~9-11~~ | ~~J~~ | | | | | | | | | | | | | | | | | | | | | | | | | |
| ~~AR-1~~ | ~~S-6~~ | ~~15-17~~ | ~~J~~ | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Box # Box # X

TEST SPECIFICATIONS AND OTHER INSTRUCTIONS

ASSUME THAT USCS SOIL CLASSIFICATION IS INCLUDED

If sample ID & depths do not correspond between jar and lab assignment, use the lab assignment ID & depths (above) for test results

Received 04/06/22 [illegible]

NOTES: 1. Exploration Number = designation for boring, test pit, etc. 2. Give range or average depth. 3. See reverse for details 4. Additional instructions required, such as compactive effort, See reverse for details.

Key: Test Status Key (shown by symbol or letter key): Guide to Test Specifications and Instructions

TEST ASSIGNED | TEST IN PROGRESS | TEST COMPLETED | TEST FINALIZED

# LABORATORY TEST ASSIGNMENT AND TRACKING SHEET 21004385A-7853-4

Project Number: 602.21.1013 Task Number: NA Assigned by: ADT - Chris Stratton Date Assigned: 4/5/2022

Project Name: CHPE - Randall's Island/Astoria-Rainey Borings Assigning Office: C/O AECOM Results requested by:

Any known or suspected contamination of the material (yes or no)? no If yes, HASP required for testing to proceed.

1 BOX 3

| SAMPLE IDENTIFICATION | | | | INDEX TESTS | | | | | | | | | | | | ENGINEERING PROPERTY TESTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exploration (1) Number | Sample Number | Sample (2) Depth (ft) | Sample Type (3) | Visual Classification | Water Content | Liquid & Plastic Limits | Sieve Analysis | Sieve and Hydrometer | % Fines (-#200) | Specific Gravity | Compaction (4) | Organic Content | Tube Unit Weight and Consistency | | | Lab Vane (4) | Permeability (4) | Consolidation (4) | Direct Shear (4) | Unconfined Compression | Unconsolidated (4) Undrained Triaxial | Consolidated (4) Undrained Triaxial | Consolidated (4) Drained Triaxial | Cyclic Triaxial (4) | Unconfined Strength | Mohs Hardness | Unit Weight | |
| | | | | D2488 | D2216 | D4318 | D422 | D6913 & D792 | D422 | D854 | D698 or D1557 | D2974 | D2937 | | | D4648 | D5084 or D2434 | D2435 | D3080 | D2166 | D2850 | D4767 | | D3999 or D5311 | D7012 | | | |
| | | | | VC | w | PI | SA | MA | WA | Gs | CP | ORG | UW | | | LV | K | CON | DS | UC | UU | CUTX | CDTX | CyTX | | | | |
| RA-3 | S-2 | 5-7 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-3 | S-3 | 7-9 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-3 | S-6 | 13-15 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-3 | S-9 | 26-26.5 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-3 | R-2 | 34-39 | C | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-4 | S-4 | 9-11 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-4 | S-6 | 15-17 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-4 | S-9 | 30-32 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-4 | S-11 | 36-37 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| RA-4 | S-12 | 45-46 | J | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

TEST SPECIFICATIONS AND OTHER INSTRUCTIONS

ASSUME THAT USCS SOIL CLASSIFICATION IS INCLUDED

If sample ID & depths do not correspond between jar and lab assignment, use the lab assignment ID & depths (above) for test results

Received 04/06/22 [illegible]

NOTES: 1. Exploration Number = designation for boring, test pit, etc. 2. Give range or average depth. 3. See reverse for details 4. Additional instructions required, such as compactive effort, See reverse for details.

Key: Test Status Key (shown by symbol or letter key): Guide to Test Specifications and Instructions

TEST ASSIGNED TEST IN PROGRESS TEST COMPLETED TEST FINALIZED

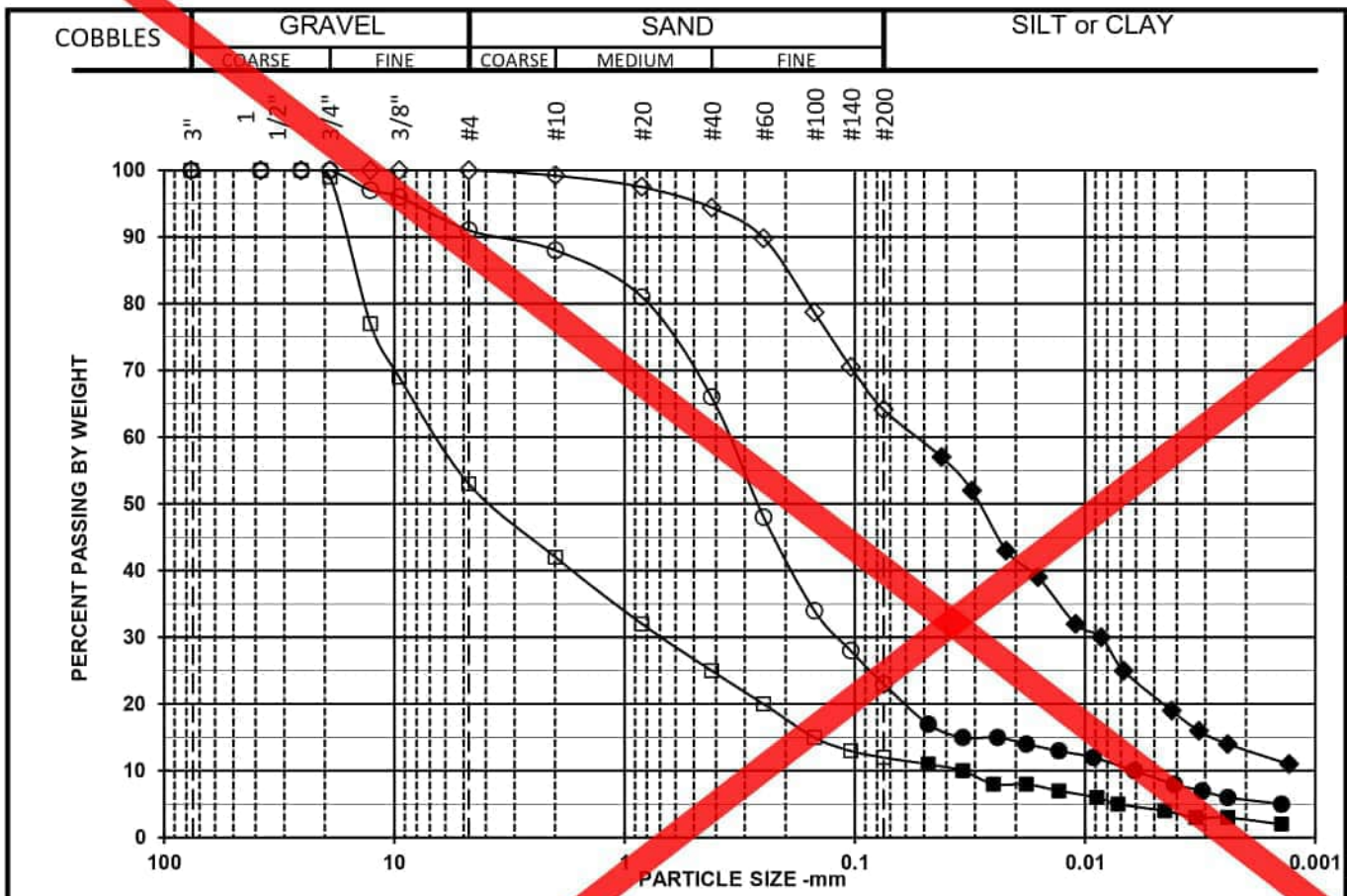


TerraSense, LLC
45 H Commerce Way Totowa, NJ 07512 (973) 812-1818

**ADT/Cascade #602.21.1013**
**CHPE - Randall's Island/Astoria-Rainey Borings**
**LABORATORY SOIL TESTING DATA SUMMARY**

| BORING NO. | SAMPLE NO. | DEPTH (ft) | IDENTIFICATION TESTS | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WATER CONTENT (%) | LIQUID LIMIT (-) | PLASTIC LIMIT (-) | PLAS. INDEX (-) | USCS SYMB. (1) | SIEVE MINUS NO. 200 (%) | HYDRO. % MINUS 2 μm (%) | ORGANIC CONTENT (burnoff) (%) | SPECIFIC GRAVITY (-) | |
| ~~AR-1~~ | ~~S-2~~ | ~~7-9~~ | ~~35.5~~ | | | | ~~GW-GC~~ | ~~12~~ | ~~3~~ | | | |
| ~~AR-1~~ | ~~S-3~~ | ~~9-11~~ | ~~27.8~~ | ~~37~~ | ~~23~~ | ~~14~~ | ~~CL~~ | ~~64.1~~ | ~~13~~ | | | |
| ~~AR-1~~ | ~~S-6~~ | ~~15-17~~ | ~~18.1~~ | | | | ~~SC~~ | ~~23~~ | ~~6~~ | | | |
| RA-2 | S-1 | 5-7 | 28.2 | | | | SC | 22 | 3 | | | |
| RA-2 | S-7 | 20-22 | 9.4 | | | | GP | 1 | | | | |
| RA-2 | S-11A | 40-41.5 | 71.0 | 70 | 32 | 38 | CH | 60 | 21 | 3.2 | 2.656 | |
| RA-2 | S-12 | 45-47 | 14.0 | | | | SM | 15 | 3 | | | |
| RA-3 | S-2 | 5-7 | 11.9 | | | | GP-GM | 6 | 1 | | | |
| RA-3 | S-3 | 7-9 | 4.9 | | | | GW | 2 | | | | |
| RA-3 | S-6 | 13-15 | 35.3 | 38 | 22 | 16 | CL | 68 | 10 | 2.6 | 2.691 | |
| RA-3 | S-9 | 26-26.5 | 6.6 | | | | GP-GM | 6 | 1 | | | |
| RA-4 | S-4 | 9-11 | 16.6 | | | | SM | 14 | 3 | | | |
| RA-4 | S-6 | 15-17 | 4.2 | | | | GP | 2 | | | | |
| RA-4 | S-9 | 30-32 | 15.1 | | | | SW-SM | 6 | 1 | | | |
| RA-4 | S-11 | 36-37 | 25.8 | | | | SP-SM | 10.5 | 2 | | | |
| RA-4 | S-12 | 45-46 | 24.5 | | | | SP | 4.2 | 1 | | | |
| | | | | | | | | | | | | |

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 35.5 | | | | GW-GC | | Gray, Well-graded gravel with clay and sand, Insufficient sample size | 04/08/22 |
| ◇ | 27.8 | 37 | 23 | 14 | CL | | Brown, Sandy lean clay | 04/08/22 |
| ○ | 18.1 | | | | SC | | Brown, Clayey sand, Insufficient sample size | 04/08/22 |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | AR-1 | AR-1 | AR-1 |
| Sample | S-2 | S-3 | S-6 |
| Depth | 7-9 | 9-11 | 15-17 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 47 | 0 | 9 |
| % SAND | 41 | 35.9 | 68 |
| %C SAND | 11 | 0.8 | 3 |
| %M SAND | 17 | 4.8 | 22 |
| %F SAND | 13 | 30.3 | 43 |
| % FINES | 12 | 64.1 | 23 |
| $D_{100}$ (mm) | 25.4 | 4.75 | 19.1 |
| $D_{60}$ (mm) | 6.44 | 0.054 | 0.352 |
| $D_{30}$ (mm) | 0.69 | 0.009 | 0.12 |
| $D_{10}$ (mm) | 0.034 | | 0.006 |
| Cc | 2.2 | | 6.7 |
| Cu | 189.4 | | 57.7 |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100.0 | 100 |
| 4" | 100 | 100.0 | 100 |
| 3" | 100 | 100.0 | 100 |
| 1 1/2" | 100 | 100.0 | 100 |
| 1" | 100 | 100.0 | 100 |
| 3/4" | 99 | 100.0 | 100 |
| 1/2" | 77 | 100.0 | 97 |
| 3/8" | 69 | 100.0 | 96 |
| #4 | 53 | 100.0 | 91 |
| #10 | 42 | 99.2 | 88 |
| #20 | 32 | 97.5 | 81 |
| #40 | 25 | 94.4 | 66 |
| #60 | 20 | 89.8 | 48 |
| #100 | 15 | 78.7 | 34 |
| #140 | 13 | 70.5 | 28 |
| #200 | 12 | 64.1 | 23 |
| 5μ m | 4 | 21 | 9 |
| 2μ m | 3 | 13 | 6 |
| 1μ m | 1 | 10 | 4 |

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

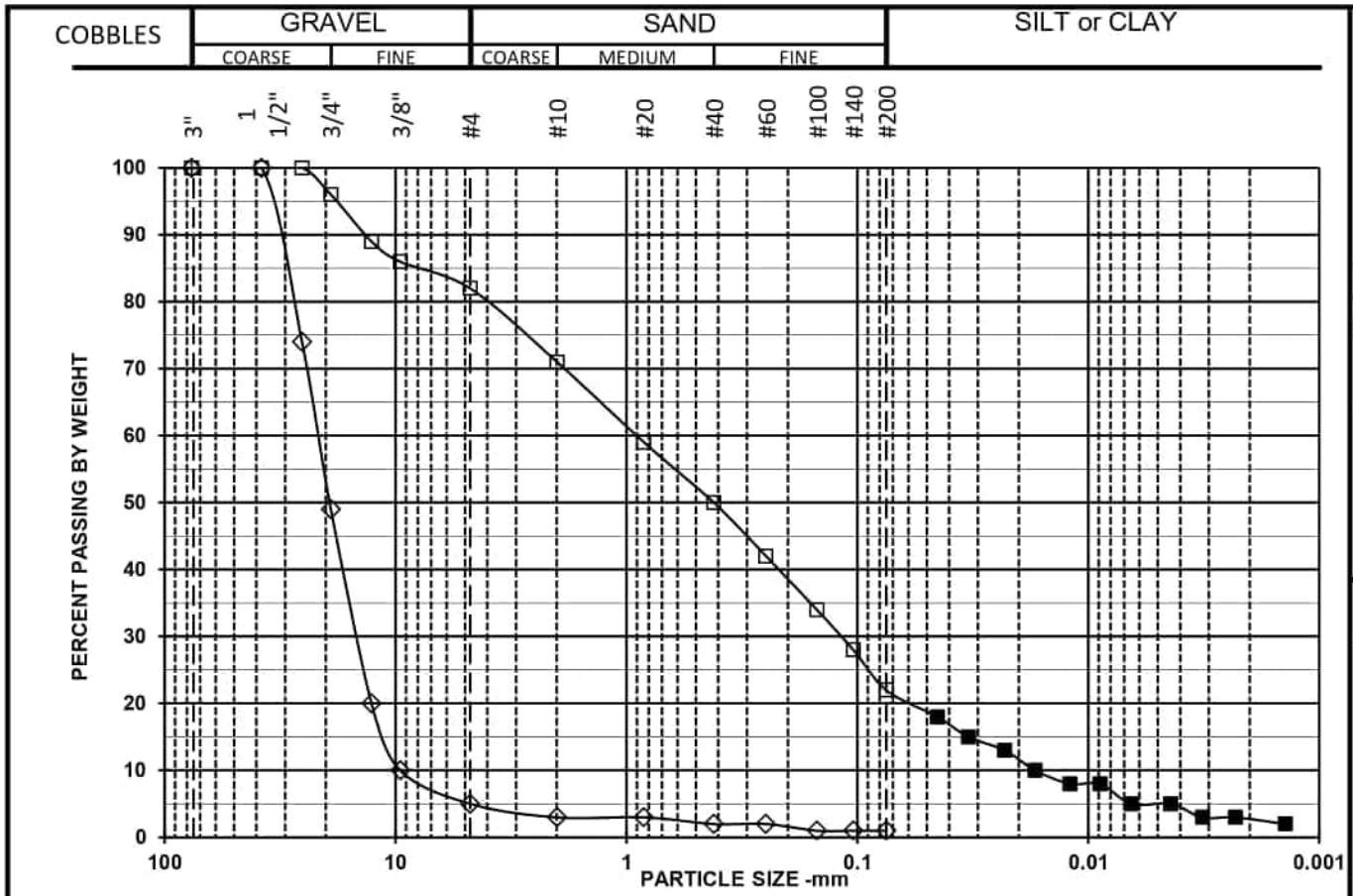
**ADT/Cascade** #602.21.1013

**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

TerraSense Analysis File: GrainSizeTSLV2

Siev4a.xlsx 4/26/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 28.2 | | | | SC | | Brown, Clayey sand with gravel, Insufficient sample size | 04/08/22 |
| ◇ | 9.4 | | | | GP | | Gray, Poorly graded gravel, Insufficient sample size | 04/08/22 |
| ○ | | | | | | | | |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | RA-2 | RA-2 | |
| Sample | S-1 | S-7 | |
| Depth | 5-7 | 20-22 | |
| % +3" | 0 | 0 | |
| % Gravel | 18 | 95 | |
| % SAND | 60 | 4 | |
| %C SAND | 11 | 2 | |
| %M SAND | 21 | 1 | |
| %F SAND | 28 | 1 | |
| % FINES | 22 | 1 | |
| $D_{100}$ (mm) | 25.4 | 38.1 | |
| $D_{60}$ (mm) | 0.904 | 21.6 | |
| $D_{30}$ (mm) | 0.12 | 15 | |
| $D_{10}$ (mm) | 0.017 | 9.5 | |
| Cc | 0.9 | 1.1 | |
| Cu | 53.2 | 2.3 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | |
| 4" | 100 | 100 | |
| 3" | 100 | 100 | |
| 1 1/2" | 100 | 100 | |
| 1" | 100 | 74 | |
| 3/4" | 96 | 49 | |
| 1/2" | 89 | 20 | |
| 3/8" | 86 | 10 | |
| #4 | 82 | 5 | |
| #10 | 71 | 3 | |
| #20 | 59 | 3 | |
| #40 | 50 | 2 | |
| #60 | 42 | 2 | |
| #100 | 34 | 1 | |
| #140 | 28 | 1 | |
| #200 | 22 | 1 | |
| 5μ m | 5 | | |
| 2μ m | 3 | | |
| 1μ m | 1 | | |

**ADT/Cascade** #602.21.1013

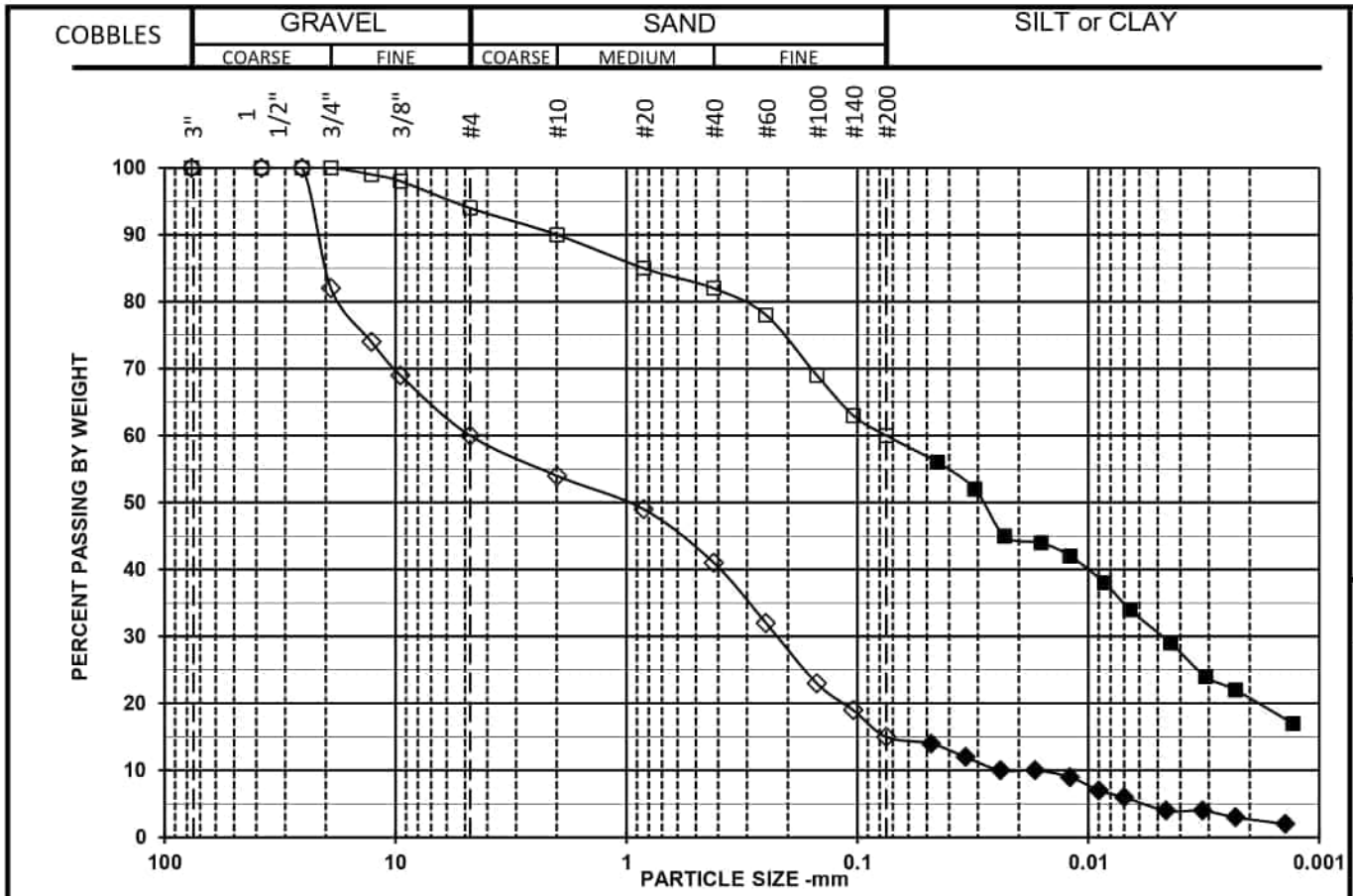
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev4b.xlsx 4/26/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 71.0 | 70 | 32 | 38 | CH | | Gray, Sandy fat clay | 04/08/22 |
| ◇ | 14.0 | | | | SM | | Gray, Silty sand with gravel, Insufficient sample size | 04/08/22 |
| ○ | | | | | | | | |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | RA-2 | RA-2 | |
| Sample | S-11A | S-12 | |
| Depth | 40-41.5 | 45-47 | |
| % +3" | 0 | 0 | |
| % Gravel | 6 | 40 | |
| % SAND | 34 | 45 | |
| %C SAND | 4 | 6 | |
| %M SAND | 8 | 13 | |
| %F SAND | 22 | 26 | |
| % FINES | 60 | 15 | |
| $D_{100}$ (mm) | 19.1 | 25.4 | |
| $D_{60}$ (mm) | 0.075 | 4.75 | |
| $D_{30}$ (mm) | 0.005 | 0.22 | |
| $D_{10}$ (mm) | | 0.024 | |
| Cc | | 0.4 | |
| Cu | | 197.9 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | |
| 4" | 100 | 100 | |
| 3" | 100 | 100 | |
| 1 1/2" | 100 | 100 | |
| 1" | 100 | 100 | |
| 3/4" | 100 | 82 | |
| 1/2" | 99 | 74 | |
| 3/8" | 98 | 69 | |
| #4 | 94 | 60 | |
| #10 | 90 | 54 | |
| #20 | 85 | 49 | |
| #40 | 82 | 41 | |
| #60 | 78 | 32 | |
| #100 | 69 | 23 | |
| #140 | 63 | 19 | |
| #200 | 60 | 15 | |
| 5μ m | 31 | 4 | |
| 2μ m | 21 | 3 | |
| 1μ m | 15 | 1 | |

**ADT/Cascade** #602.21.1013

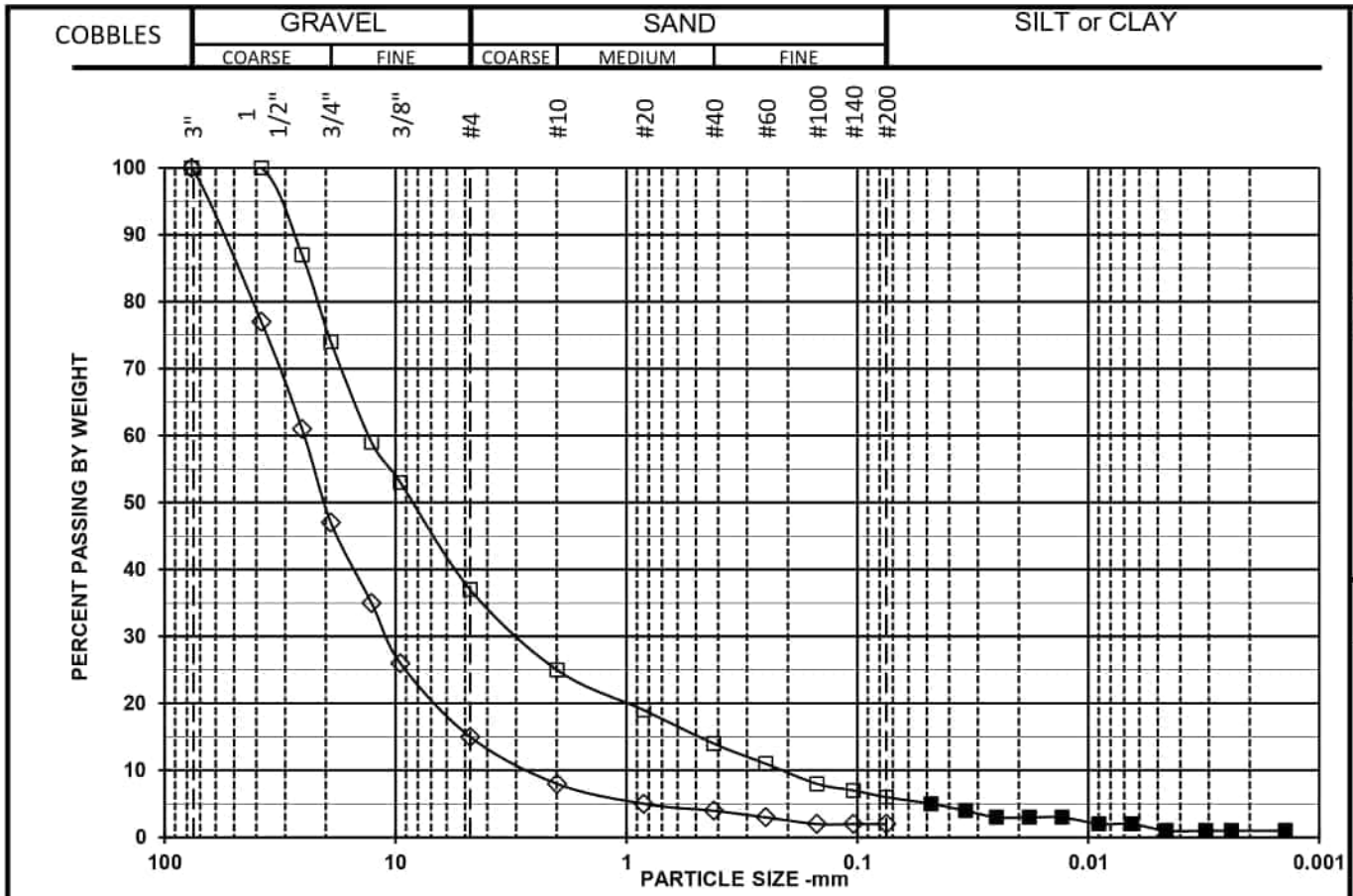
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev4c.xlsx 4/26/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | RA-3 | RA-3 | |
| Sample | S-2 | S-3 | |
| Depth | 5-7 | 7-9 | |
| % +3" | 0 | 0 | |
| % Gravel | 63 | 85 | |
| % SAND | 31 | 13 | |
| %C SAND | 12 | 7 | |
| %M SAND | 11 | 4 | |
| %F SAND | 8 | 2 | |
| % FINES | 6 | 2 | |
| $D_{100}$ (mm) | 38.1 | 76.2 | |
| $D_{60}$ (mm) | 13 | 24.9 | |
| $D_{30}$ (mm) | 2.9 | 11 | |
| $D_{10}$ (mm) | 0.21 | 2.6 | |
| Cc | 3.1 | 1.9 | |
| Cu | 61.9 | 9.6 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | |
| 4" | 100 | 100 | |
| 3" | 100 | 100 | |
| 1 1/2" | 100 | 77 | |
| 1" | 87 | 61 | |
| 3/4" | 74 | 47 | |
| 1/2" | 59 | 35 | |
| 3/8" | 53 | 26 | |
| #4 | 37 | 15 | |
| #10 | 25 | 8 | |
| #20 | 19 | 5 | |
| #40 | 14 | 4 | |
| #60 | 11 | 3 | |
| #100 | 8 | 2 | |
| #140 | 7 | 2 | |
| #200 | 6 | 2 | |
| 5μ m | 1 | | |
| 2μ m | 1 | | |
| 1μ m | 1 | | |

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 11.9 | | | | GP-GM | | Gray, Poorly graded gravel with silt and sand, Insufficient sample size | 04/11/22 |
| ◇ | 4.9 | | | | GW | | Gray, Well-graded gravel, Insufficient sample size | 04/08/22 |
| ○ | | | | | | | | |

**ADT/Cascade** #602.21.1013

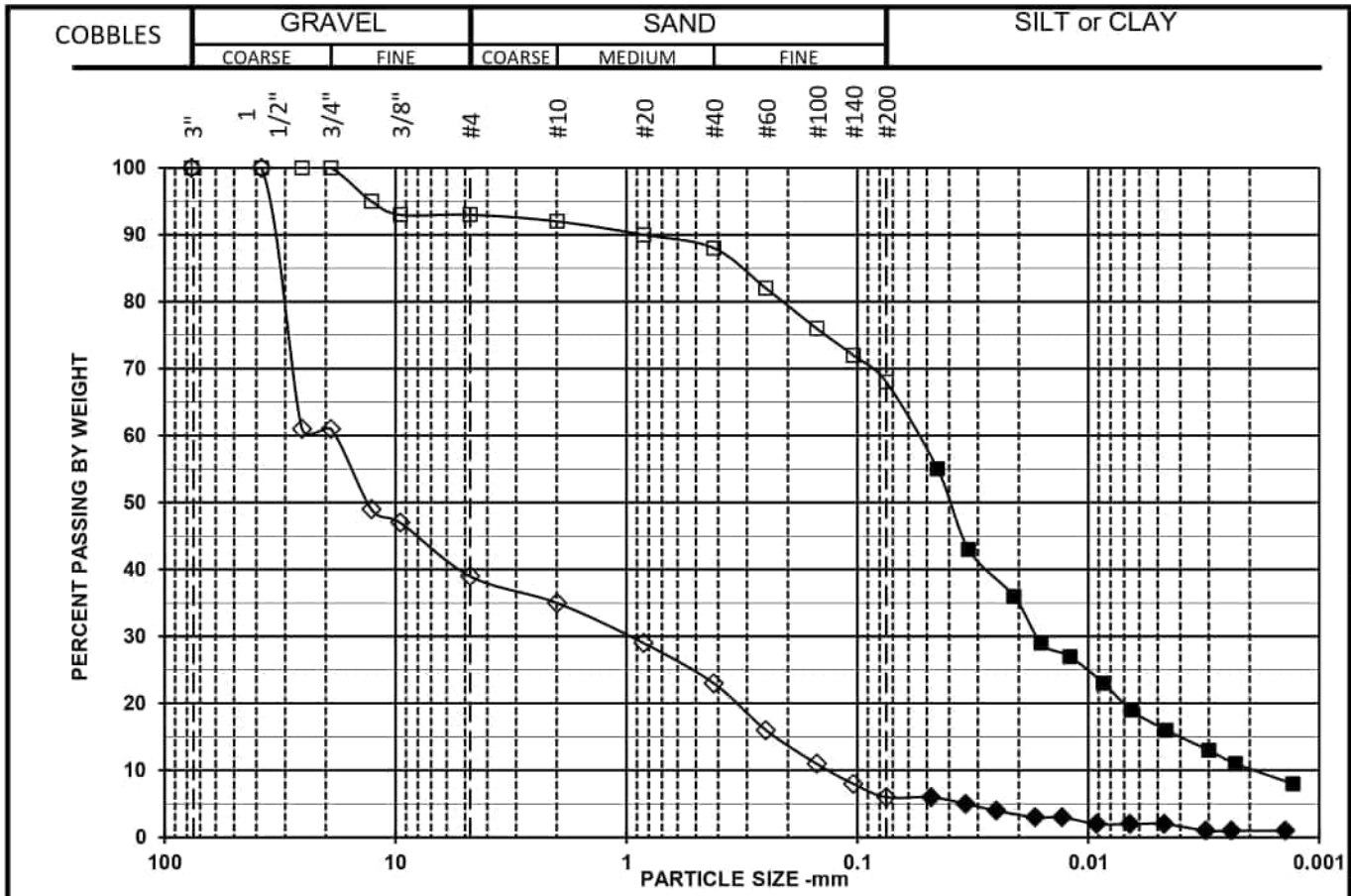
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev4d.xlsx 4/26/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 35.3 | 38 | 22 | 16 | CL | | Gray, Sandy lean clay, Insufficient sample size | 04/11/22 |
| ◇ | 6.6 | | | | GP-GM | | Brown, Poorly graded gravel with silt and sand, Insufficient sample size | 04/08/22 |
| ○ | | | | | | | | |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | RA-3 | RA-3 | |
| Sample | S-6 | S-9 | |
| Depth | 13-15 | 26-26.5 | |
| % +3" | 0 | 0 | |
| % Gravel | 7 | 61 | |
| % SAND | 25 | 33 | |
| %C SAND | 1 | 4 | |
| %M SAND | 4 | 12 | |
| %F SAND | 20 | 17 | |
| % FINES | 68 | 6 | |
| $D_{100}$ (mm) | 19.1 | 38.1 | |
| $D_{60}$ (mm) | 0.055 | 18.4 | |
| $D_{30}$ (mm) | 0.017 | 0.97 | |
| $D_{10}$ (mm) | 0.002 | 0.13 | |
| Cc | 2.8 | 0.4 | |
| Cu | 28.8 | 141.5 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | |
| 4" | 100 | 100 | |
| 3" | 100 | 100 | |
| 1 1/2" | 100 | 100 | |
| 1" | 100 | 61 | |
| 3/4" | 100 | 61 | |
| 1/2" | 95 | 49 | |
| 3/8" | 93 | 47 | |
| #4 | 93 | 39 | |
| #10 | 92 | 35 | |
| #20 | 90 | 29 | |
| #40 | 88 | 23 | |
| #60 | 82 | 16 | |
| #100 | 76 | 11 | |
| #140 | 72 | 8 | |
| #200 | 68 | 6 | |
| 5μ m | 17 | 2 | |
| 2μ m | 10 | 1 | |
| 1μ m | 7 | 1 | |

**ADT/Cascade** #602.21.1013

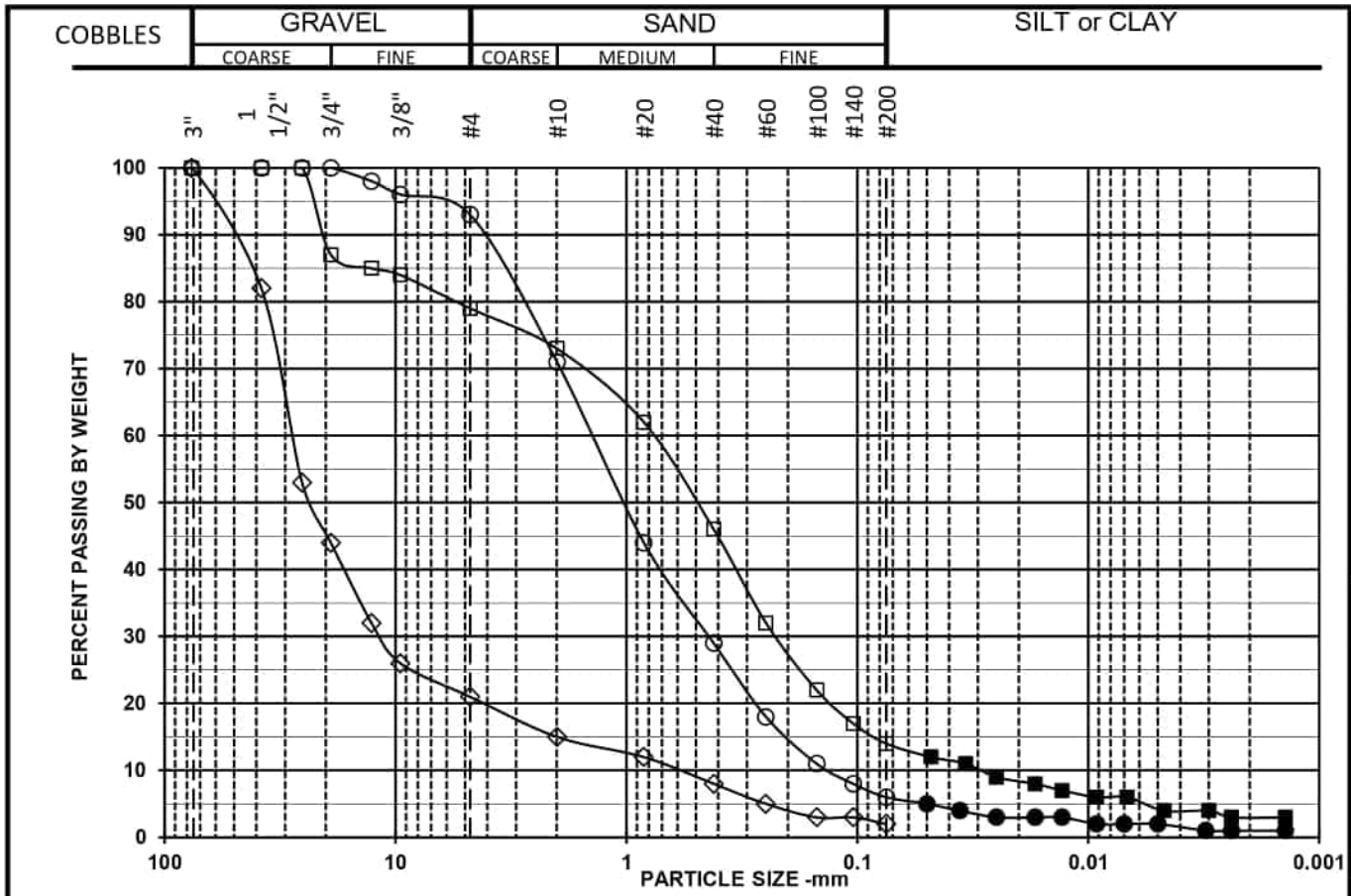
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev4e.xlsx 4/26/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 16.6 | | | | SM | | Brown, Silty sand with gravel, Insufficient sample size | 04/11/22 |
| ◇ | 4.2 | | | | GP | | Gray, Poorly graded gravel with sand, Insufficient sample size | 04/11/22 |
| ○ | 15.1 | | | | SW-SM | | Brown, Well-graded sand with silt, Insufficient sample size | 04/11/22 |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | RA-4 | RA-4 | RA-4 |
| Sample | S-4 | S-6 | S-9 |
| Depth | 9-11 | 15-17 | 30-32 |
| % +3" | 0 | 0 | 0 |
| % Gravel | 21 | 79 | 7 |
| % SAND | 65 | 19 | 87 |
| %C SAND | 6 | 6 | 22 |
| %M SAND | 27 | 7 | 42 |
| %F SAND | 32 | 6 | 23 |
| % FINES | 14 | 2 | 6 |
| $D_{100}$ (mm) | 25.4 | 76.2 | 19.1 |
| $D_{60}$ (mm) | 0.771 | 28 | 1.4 |
| $D_{30}$ (mm) | 0.22 | 12 | 0.44 |
| $D_{10}$ (mm) | 0.029 | 0.59 | 0.13 |
| Cc | 2.2 | 8.7 | 1.1 |
| Cu | 26.6 | 47.5 | 10.8 |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100 | 100 | 100 |
| 4" | 100 | 100 | 100 |
| 3" | 100 | 100 | 100 |
| 1 1/2" | 100 | 82 | 100 |
| 1" | 100 | 53 | 100 |
| 3/4" | 87 | 44 | 100 |
| 1/2" | 85 | 32 | 98 |
| 3/8" | 84 | 26 | 96 |
| #4 | 79 | 21 | 93 |
| #10 | 73 | 15 | 71 |
| #20 | 62 | 12 | 44 |
| #40 | 46 | 8 | 29 |
| #60 | 32 | 5 | 18 |
| #100 | 22 | 3 | 11 |
| #140 | 17 | 3 | 8 |
| #200 | 14 | 2 | 6 |
| 5μ m | 4 | | 2 |
| 2μ m | 3 | | 1 |
| 1μ m | 3 | | 1 |

**ADT/Cascade** #602.21.1013

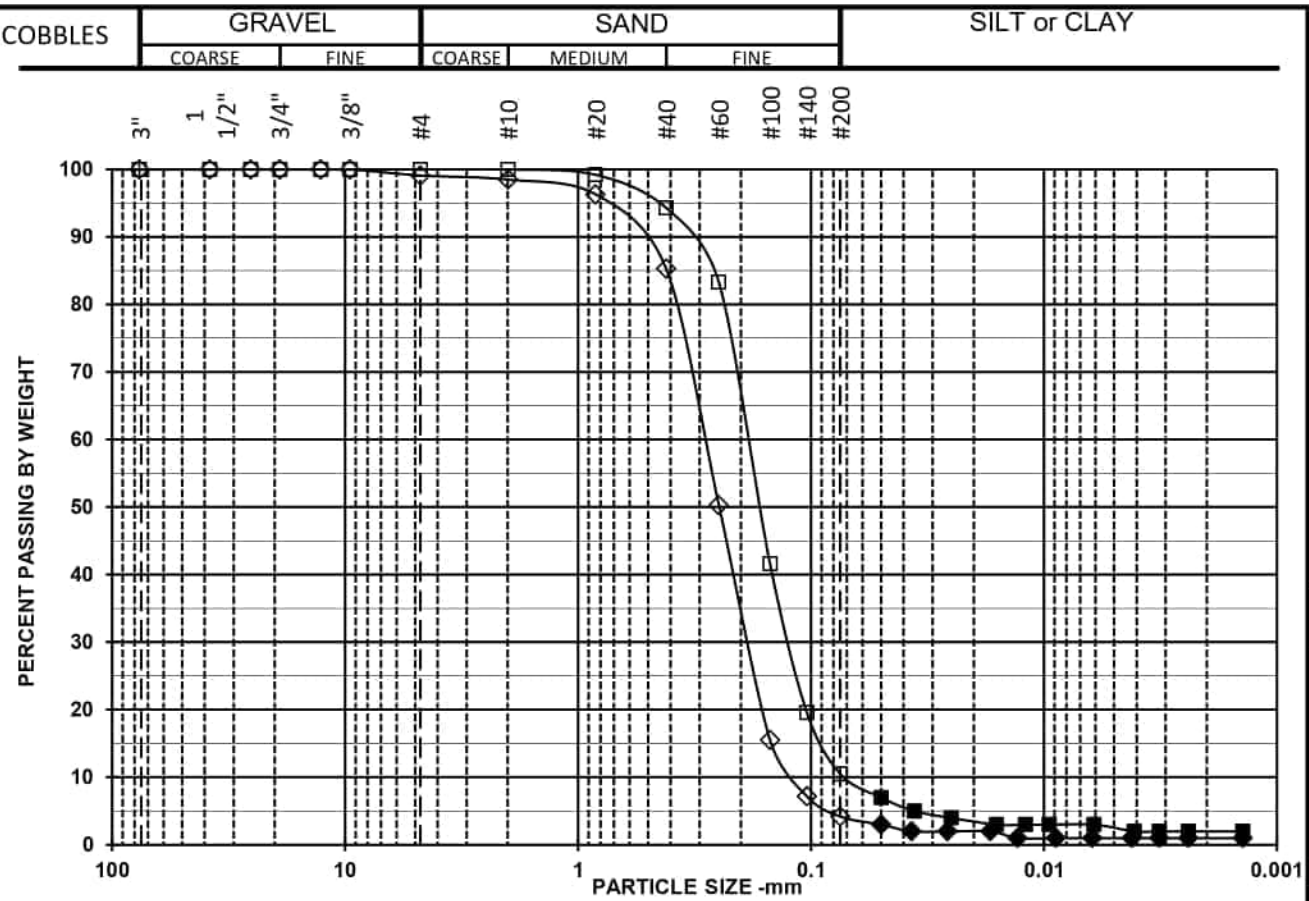
**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev4f.xlsx 4/26/2022




Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

| SYMBOL | w (%) | LL | PL | PI | USCS | AASHTO | USCS DESCRIPTION AND REMARKS | DATE |
|---|---|---|---|---|---|---|---|---|
| □ | 25.8 | | | | SP-SM | | Brown, Poorly graded sand with silt | 04/11/22 |
| ◇ | 24.5 | | | | SP | | Brown, Poorly graded sand | 04/11/22 |
| ○ | | | | | | | | |

| Symbol | □ | ◇ | ○ |
|---|---|---|---|
| Boring | RA-4 | RA-4 | |
| Sample | S-11 | S-12 | |
| Depth | 36-37 | 45-46 | |
| % +3" | 0 | 0 | |
| % Gravel | 0 | 0.9 | |
| % SAND | 89.5 | 94.9 | |
| %C SAND | 0 | 0.6 | |
| %M SAND | 5.7 | 13.2 | |
| %F SAND | 83.8 | 81.1 | |
| % FINES | 10.5 | 4.2 | |
| $D_{100}$ (mm) | 4.75 | 9.53 | |
| $D_{60}$ (mm) | 0.187 | 0.288 | |
| $D_{30}$ (mm) | 0.12 | 0.19 | |
| $D_{10}$ (mm) | 0.071 | 0.12 | |
| Cc | 1.1 | 1 | |
| Cu | 2.6 | 2.4 | |

| Sieve Size/ID # | Percent Finer Data | | |
|---|---|---|---|
| 6" | 100.0 | 100.0 | |
| 4" | 100.0 | 100.0 | |
| 3" | 100.0 | 100.0 | |
| 1 1/2" | 100.0 | 100.0 | |
| 1" | 100.0 | 100.0 | |
| 3/4" | 100.0 | 100.0 | |
| 1/2" | 100.0 | 100.0 | |
| 3/8" | 100.0 | 100.0 | |
| #4 | 100.0 | 99.1 | |
| #10 | 100.0 | 98.5 | |
| #20 | 99.2 | 96.3 | |
| #40 | 94.3 | 85.3 | |
| #60 | 83.3 | 50.3 | |
| #100 | 41.6 | 15.5 | |
| #140 | 19.6 | 7.2 | |
| #200 | 10.5 | 4.2 | |
| 5μ m | 3 | 1 | |
| 2μ m | 2 | 1 | |
| 1μ m | 2 | 1 | |

**ADT/Cascade** #602.21.1013

**TerraSense** #21004385A

CHPE - Randall's Island/Astoria-Rainey Borings

**PARTICLE SIZE DISTRIBUTION**
**ASTM D6913 & ASTM D7928**

TerraSense Analysis File: GrainSizeTSLV2

Siev4g.xlsx 4/26/2022

## Aquifer #602.21.1013
## CHPE - Randall's Island/Astoria-Rainey Borings
## SUMMARY OF ROCK TESTING

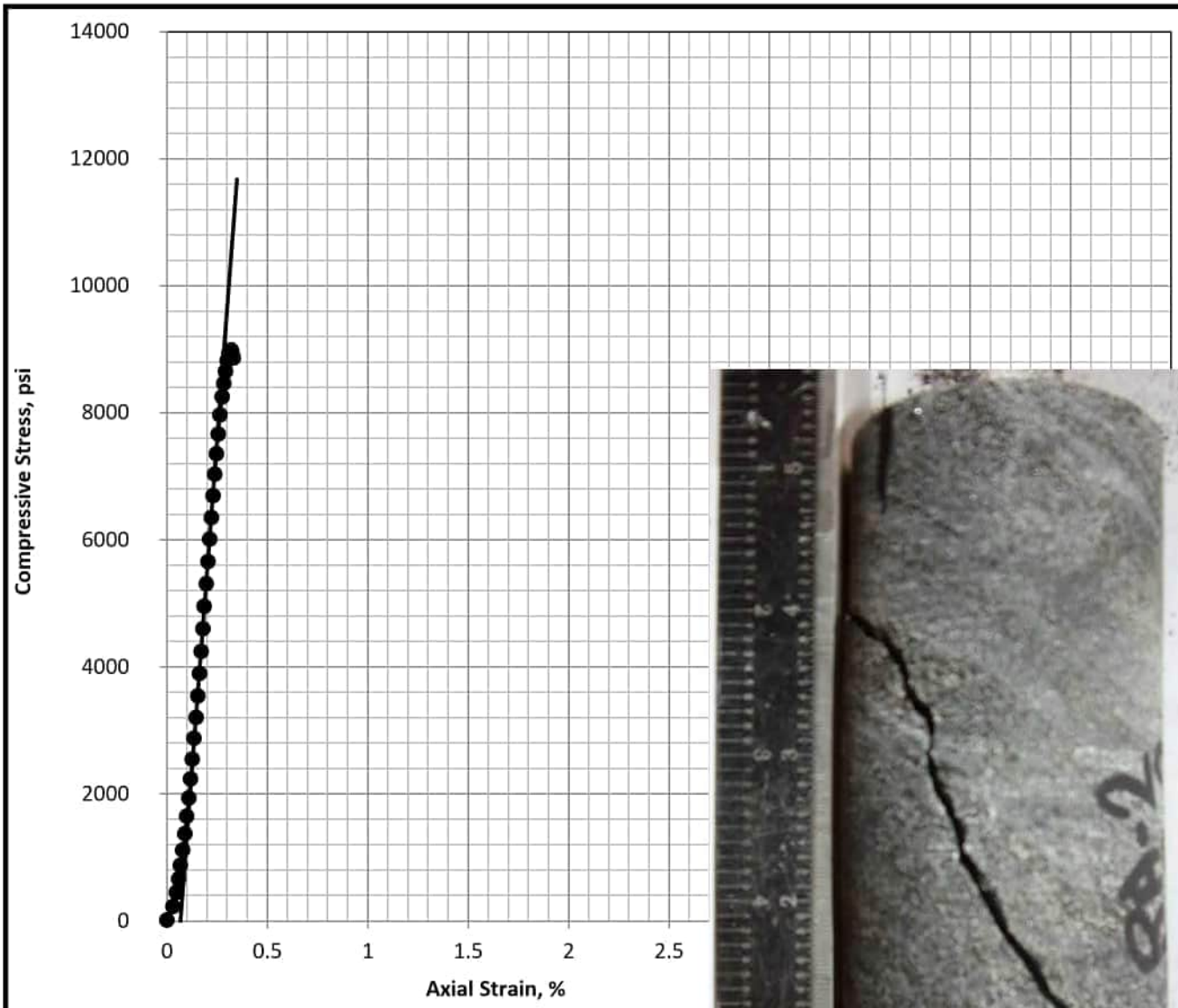
| SAMPLE IDENTIFICATION | | | STATE PROPERTIES | | | ENGINEERING PROPERTY TESTS | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Run | Depth | WATER CONTENT (1) | TOTAL UNIT WGT. | DRY UNIT WGT. | TEST TYPE (2) | HARDNESS TESTS Mohs HARDNESS | UNCONFINED COMPRESSION TESTS (ASTM D7012) COMPRESSIVE STRENGTH | AXIAL STRAIN @ FAILURE | ESTIMATED (5) ELASTIC MODULUS | |
| | | (ft-ft) | (%) | (pcf) | (pcf) | | (-) | (psi) | (%) | (psi) | |
| RA-2 | R-2 | 55-60 | | | | M | 8 | | | | |
| RA-2 | R-2 | 58.7-59.1 | 0.2 | 173 | 173 | UC | | 8990 | 0.25 | 4E+06 | |
| | | | | | | | | | | | |
| RA-2 | R-5 | 70-75 | | | | M | 9 | | | | |
| RA-2 | R-5 | 72.25-72.65 | 0.2 | 168 | 168 | UC | | 8880 | 0.22 | 5E+06 | |
| | | | | | | | | | | | |
| RA-3 | R-2 | 34-39 | | | | M | 7-8 | | | | |
| RA-3 | R-2 | 34.45-34.85 | 0.1 | 173 | 172 | UC | | 10280 | 0.18 | 6E+06 | |

Notes: (1) Water contents determined after trimming and shearing.
(2) Test Type Abbreviations: M: Mohs hardness, UC: Unconfined Compression test with estimated elastic moduli determination
(5) Modulus estimated based on corrected gross deformations.

Prepared by: JS
Reviewed by: DM
Date: 5/2/2022

TerraSense
45H Commerce Way
Totowa, NJ 07512

Project No.: 21004385A
File: RockSum4385-4




**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.24 | 173 | 173 | 4.436 | 1.973 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.10 | 0.25 | 8990 | 4E+06 |

Test by: DM
Test Date: Apr-14-22
Reviewed by: GET

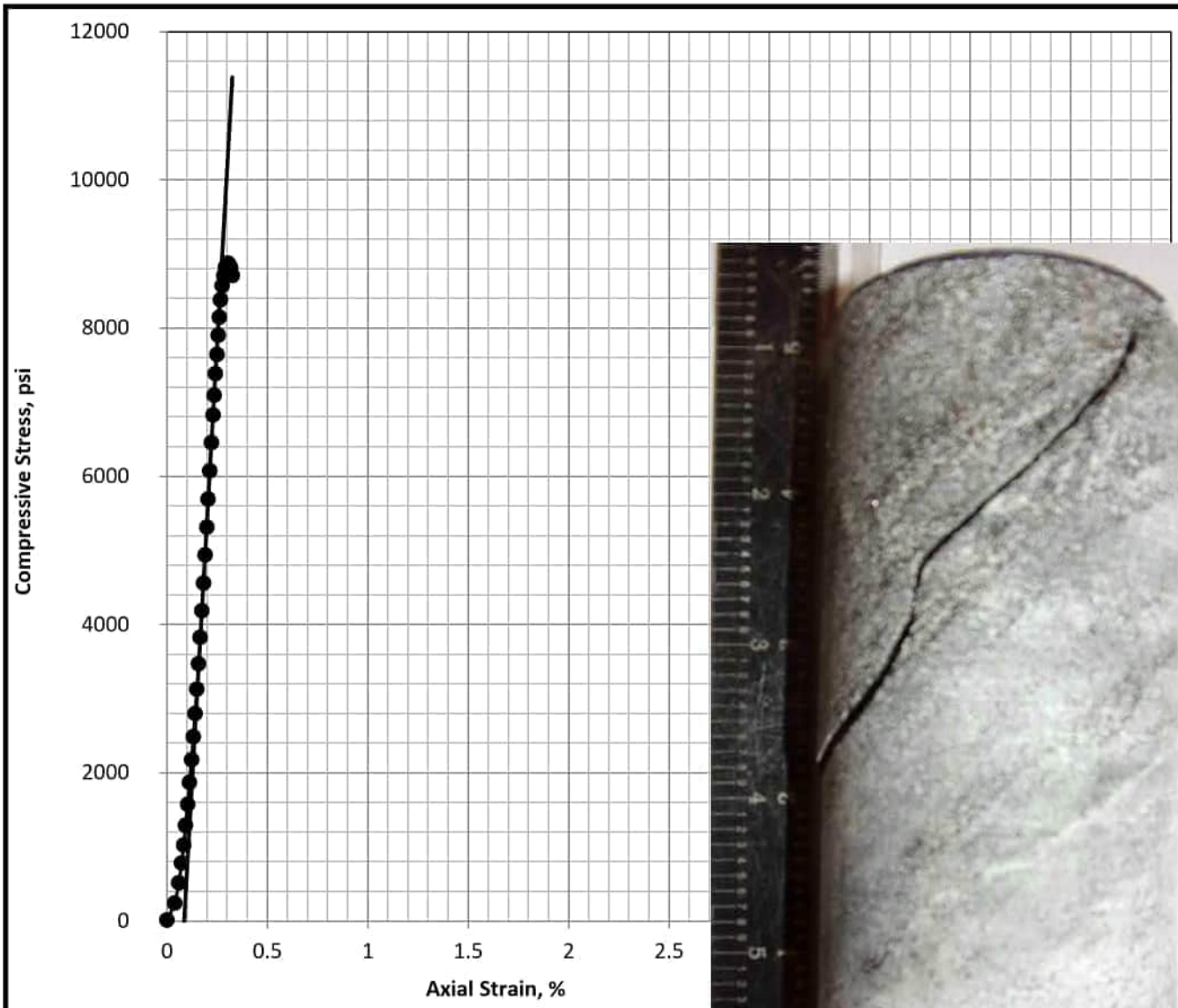
**ADT/Cascade**
**Project # 602.21.1013**

**TerraSense**
**Project # 21004385A**

**CHPE - Randall's Island/Astoria-Rainey Borings**

**COMPRESSIVE STRESS VS STRAIN**
**UNCONFINED COMPRESSIVE STRENGTH TEST**

**Boring: RA-2 Run: R-2**
**Depth 58.7-59.1 ft.**




**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.17 | 168 | 168 | 4.426 | 1.975 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.12 | 0.22 | 8880 | 5E+06 |

Test by: DM
Test Date: Apr-19-22
Reviewed by: GET

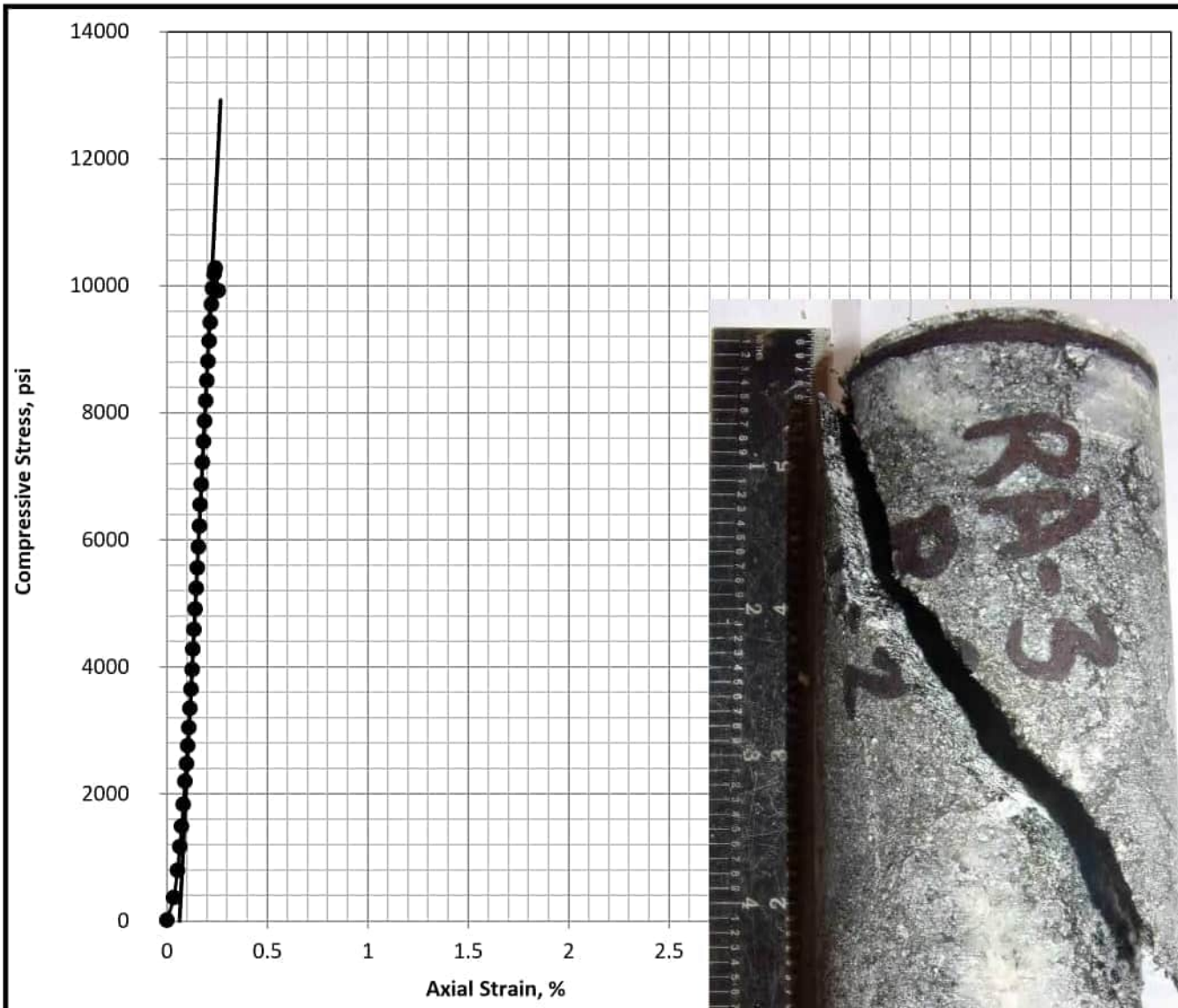
**ADT/Cascade**
**Project # 602.21.1013**

**TerraSense**
**Project # 21004385A**

**CHPE - Randall's Island/Astoria-Rainey Borings**

**COMPRESSIVE STRESS VS STRAIN**
**UNCONFINED COMPRESSIVE STRENGTH TEST**

**Boring: RA-2 Run: R-5**
**Depth 72.25-72.65 ft.**




**Specimen Information**

| Water Content (%) | Wet Unit Weight (pcf) | Dry Unit Weight (pcf) | Length (inch) | Diameter (inch) |
|---|---|---|---|---|
| 0.12 | 173 | 172 | 4.446 | 1.960 |

Specimen meets ASTM D4543 shape tolerances

**FAILURE PHOTO**

**Test Summary**

| Strain Rate (%/min) | Corrected Strain Strain to Peak (%) | $q_u$ (psi) | Estimated (shown) Elastic Modulus (psi) |
|---|---|---|---|
| 0.10 | 0.18 | 10280 | 6E+06 |

Test by: DM
Test Date: Apr-19-22
Reviewed by: GET

**ADT/Cascade**
**Project # 602.21.1013**

**TerraSense**
**Project # 21004385A**

**CHPE - Randall's Island/Astoria-Rainey Borings**

**COMPRESSIVE STRESS VS STRAIN**
**UNCONFINED COMPRESSIVE STRENGTH TEST**

**Boring: RA-3 Run: R-2**
**Depth 34.45-34.85 ft.**

# Appendix F – Investigation Derived Waste Disposal Documentation

5/19 4812995

**NON-HAZARDOUS WASTE MANIFEST**

1. Generator ID Number: V S Q G
2. Page 1 of 1
3. Emergency Response Phone: (267) 406-0083
4. Waste Tracking Number: 43846

5. Generator's Name and Mailing Address
CHPE LLC
Pieter Schuyler Building, 600 Broadway
Albany NY 12207
Generator's Phone: ~~347 920-6550~~

Att: Ayokunie Kafi

Generator's Site Address (if different than mailing address)
CHPE LLC
31-01 20th Avenue
Astoria NY 11105

6. Transporter 1 Company Name: ~~Innovative Recycling Technologies, Inc.~~ — U.S. EPA ID Number: ~~NYR000134940~~
7. Transporter 2 Company Name: ~~Republic Environmental Systems (Trans Group)LLC~~ — U.S. EPA ID Number: ~~PAD982661381~~
8. Designated Facility Name and Site Address
Republic Environmental Systems (PA), LLC
2869 Sandstone Drive
Hatfield PA 19440
Facility's Phone: ~~215 822-8995~~ — U.S. EPA ID Number: ~~PAD085680592~~

| | 9. Waste Shipping Name and Description | 10. Containers No. | 10. Containers Type | 11. Total Quantity | 12. Unit Wt./Vol. |
|---|---|---|---|---|---|
| 1. | Non Hazardous Drill Cuttings Non-DOT Regulated Material | 2 | DM | 300 | P |
| 2. | Non Hazardous Drill Cuttings Non-DOT Regulated Material | 2 | DM | 600 | P |
| 3. | Non Hazardous Drill Cuttings Non-DOT Regulated Material | 2 | DM | 600 | P |
| 4. | | | | | |

13. Special Handling Instructions and Additional Information
9.1) 1790803-Boring AR-1 9.3) 1790825-Boring RA-3 & RA-4
9.2) 1790827-Boring RA-2
Doc# 309272-22

**14. GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offeror's Printed/Typed Name: Francis McShane On behalf of — Signature: [signature] — Month 5 Day 11 Year 22

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Francis McShane — Signature: [signature] — Month 5 Day 11 Year 22
Transporter 2 Printed/Typed Name: JESSICA PHUNG — Signature: Jessica Phung — Month 5 Day 18 Year 22

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
17b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
17c. Signature of Alternate Facility (or Generator) — Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: MALVEY HUTTON — Signature: [signature] — Month 05 Day 19 Year 22

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

169-BLC-O 6 10498 (Rev. 9/09)

DESIGNATED FACILITY TO GENERATOR

# CERTIFICATE OF TREATMENT, RECYCLING, AND/OR DISPOSAL

CleanEarth



**Generator:** 688885 - CHPE LLC
31-01 20TH AVENUE (BORING AR-1
ASTORIA NY, 11105
**EPA ID:** CESQG

**Facility:** REPUBLIC ENV SYS (PA) LLC
2869 SANDSTONE DRIVE
HATFIELD PA, 19440
**EPA ID:** PAD085690592

**Manifest #:** 43846
**Waste Receipt #:** HAT-D5365
**Date Received:** 05/19/2022

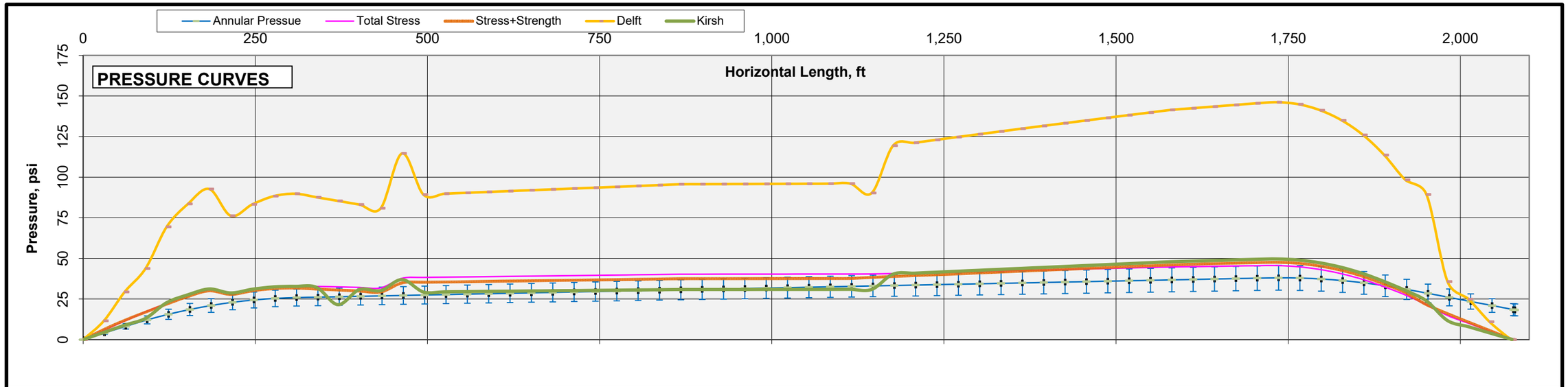
| Line | Profile | Material Description | Treatment/ Disposal Description |
|---|---|---|---|
| 1 | 1790823-00 | NON HAZARDOUS DRILL CUUTTINGS, NON DOT REGULATED MATERIAL | H141 STORAGE, BULKING, AND/OR TRANSFER OFF-SITE - NO TREATMENT/RECOVERY/BLENDING |
| 2 | 1790827-00 | NON HAZARDOUS DRILL CUUTTINGS, NON DOT REGULATED MATERIAL | H141 STORAGE, BULKING, AND/OR TRANSFER OFF-SITE - NO TREATMENT/RECOVERY/BLENDING |
| 3 | 1790825-00 | NON HAZARDOUS DRILL CUUTTINGS, NON DOT REGULATED MATERIAL | H141 STORAGE, BULKING, AND/OR TRANSFER OFF-SITE - NO TREATMENT/RECOVERY/BLENDING |

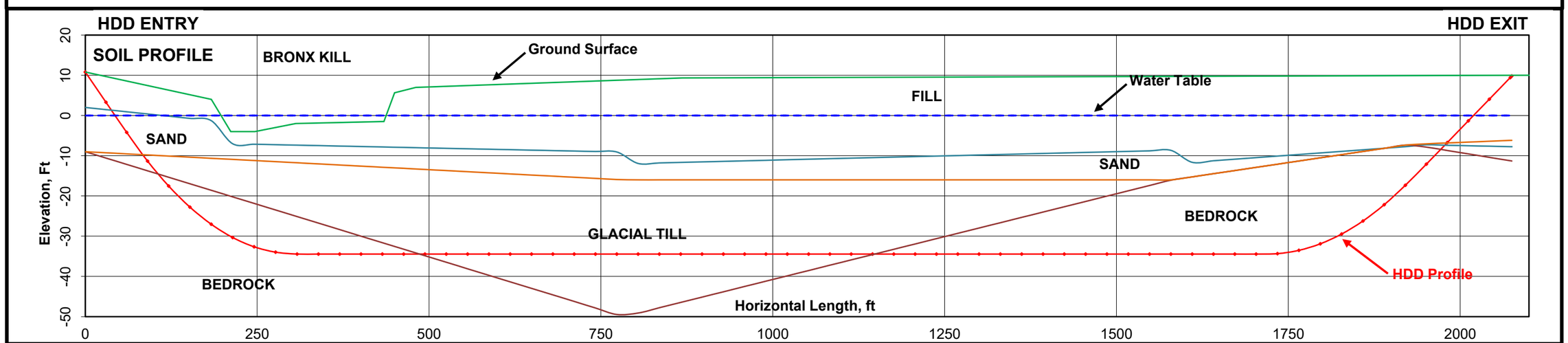
**Name:** MARCIA THOMAS

**Signature :** Marcia Thomas

**Title :** Logistic Coordinator

# APPENDIX C
ANNULAR PRESSURE ANALYSES




ISSUED: Final Design

**Notes:**

1. Geology is interpreted from project data.
2. The error bars represent a 20% variance in slurry density.
3. Ground surface data obtained from project survey data.
4. Subsurface data from Geotechnical Reports. Properties are interpreted from field and laboratory data.
5. Pump rate, pilot hole diameter, fluid density are estimated: actual values may vary depending on Contractor field operations.
6. See Table 1, *'Submittal Notes'* for detailed references on geotechnical and surveying data.

**Basis of Calculations**

| | |
|---|---|
| 6.53 in | Pilot Hole Diameter |
| 3.50 in | Drill Rod Diameter |
| 6.5 | Pilot Bit Diameter |
| 74.0 pcf | Unit Weight Drill Fluid |
| 400 gal/min | Pump Rate |
| 2079.21 ft | Plan Length |
| 2086.98 ft | Path Length |

9.89 ppg

**Bore Logs**

BR-1
BR-2
BR-3
BA-103
BA-104

Print Date: 7/27/2023 5:46

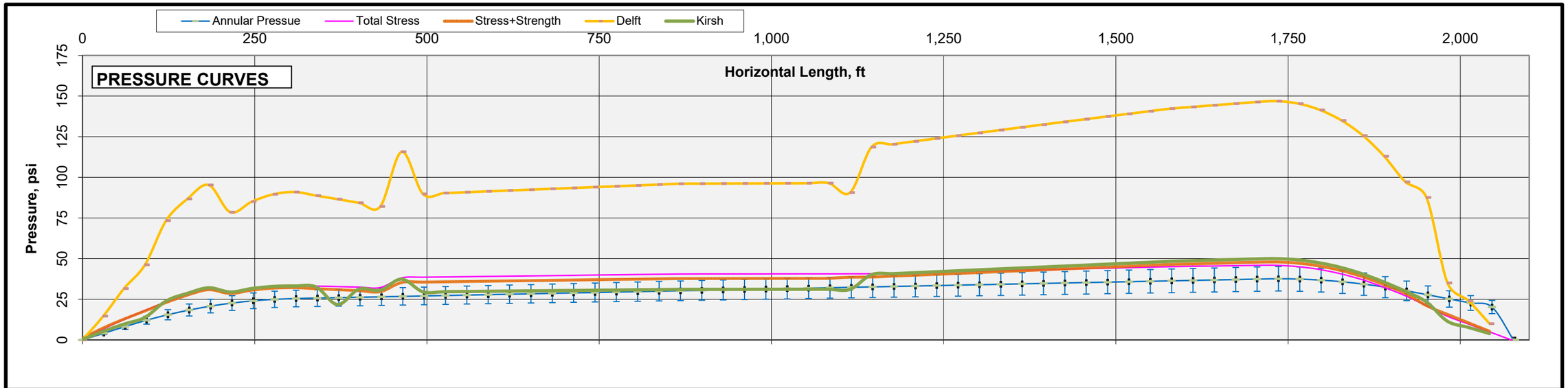

BRIERLEY ASSOCIATES
*Creating Space Underground*
167 S. River Road, Suite 8
Bedford, NH 03110
603.206.5775 (O)

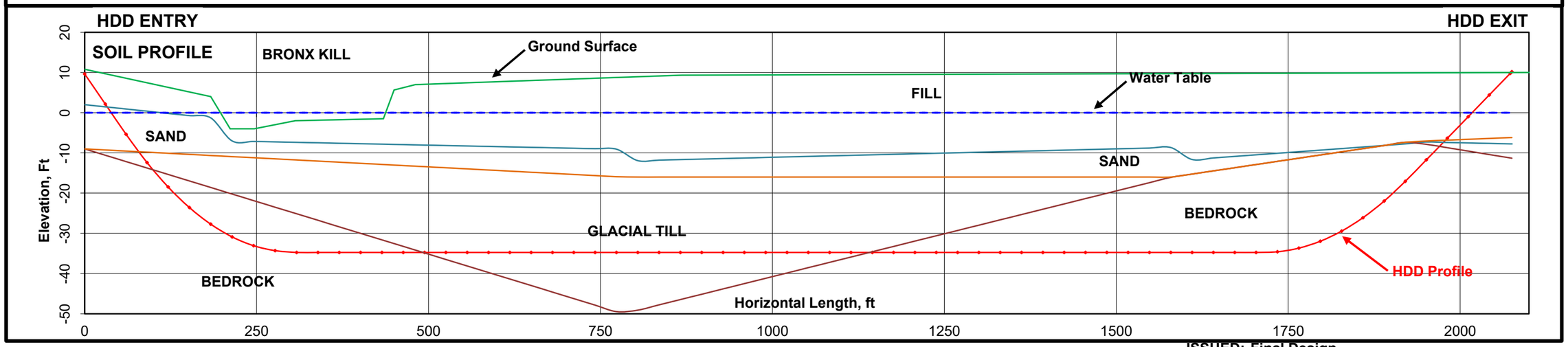

Champlain Hudson Power Express Package 8
Transition Vault 5 to Astoria Converter Station
HDD #134 Conduit 2

**ANNULAR PRESSURE AND FORMATION PRESSURE CURVES**
**Champlain Hudson Power Express Package 8**
**HDD #134 Conduit 2**
**Cable Duct**

Revision 1

C:\Users\nstrater\Downloads\[CHPE PK 8 #134 Circuit #2R1_ABL.xlsx]TS HDPE PULL




ISSUED: Final Design

**Notes:**

1. Geology is interpreted from project data.
2. The error bars represent a 20% variance in slurry density.
3. Ground surface data obtained from project survey data.
4. Subsurface data from Geotechnical Reports. Properties are interpreted from field and laboratory data.
5. Pump rate, pilot hole diameter, fluid density are estimated: actual values may vary depending on Contractor field operations.
6. See Table 1, *'Submittal Notes'* for detailed references on geotechnical and surveying data.

**Basis of Calculations**

| | |
|---|---|
| 6.53 in | Pilot Hole Diameter |
| 3.50 in | Drill Rod Diameter |
| 6.5 | Pilot Bit Diameter |
| 74.0 pcf | Unit Weight Drill Fluid |
| 400 gal/min | Pump Rate |
| 2079.27 ft | Plan Length |
| 2086.97 ft | Path Length |

9.89 ppg

**Bore Logs**

BR-1
BR-2
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BA-103
BA-104

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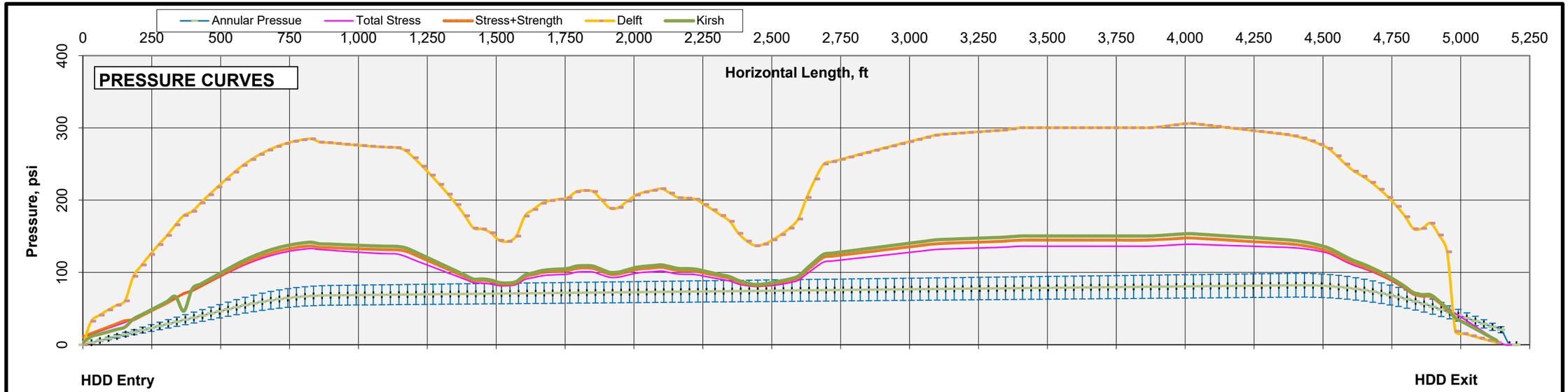
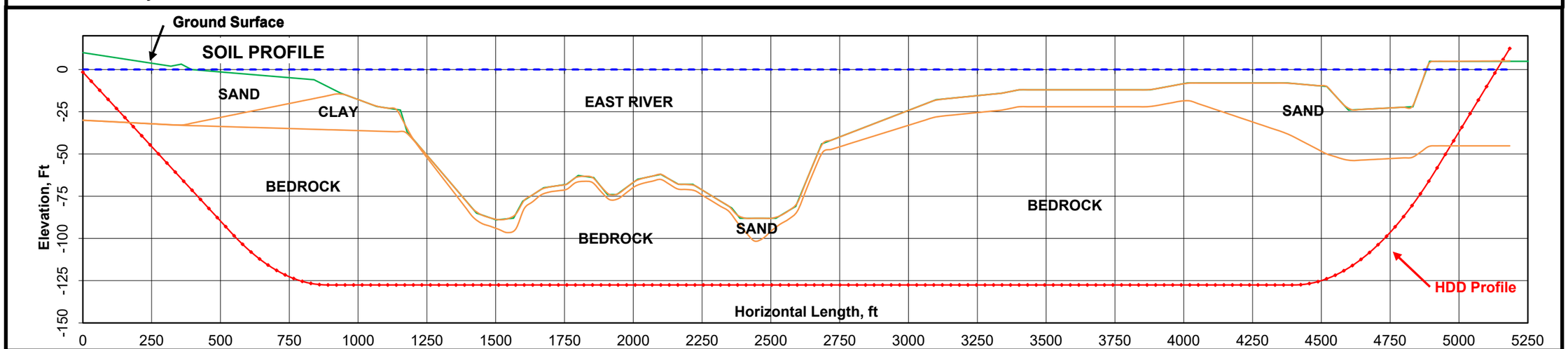
Champlain Hudson Power Express Package 8
Transition Vault 5 to Astoria Converter Station
HDD #134 Conduit 1

**ANNULAR PRESSURE AND FORMATION PRESSURE CURVES**
**Champlain Hudson Power Express Package 8**
**HDD #134 Conduit 1**
**Cable Duct**

Revision 1

C:\Users\nstrater\Downloads\[CHPE PK 8 #134 Circuit #1_ABL.xlsx]T5 HDPE PULL




ISSUED: Draft Design

**Notes:**

1. Geology is interpreted from project data
2. The error bars represent possible range of slurry density
3. Ground surface data obtained from project survey data
4. Subsurface data from Geotechnical Report, Properties are interpreted from field and laboratory data as presented in Table 4.
5. Pump rate, pilot hole diameter, fluid density are estimated actual values may vary depending on Contractor field operations. The error bars provide an estimate of the full range of possible fluid properties for a given pump rate.

**Basis of annulur pressure calculations**

| | | |
|---|---|---|
| 9.92 in | Pilot Hole Diameter | |
| 74.0 pcf | Unit Weight Drill Fluid | 9.89 ppg |
| 400 gal/min | Pump Rate | |
| 5.00 in | Drill Rod Diameter | |
| 20% | for APC curve | |

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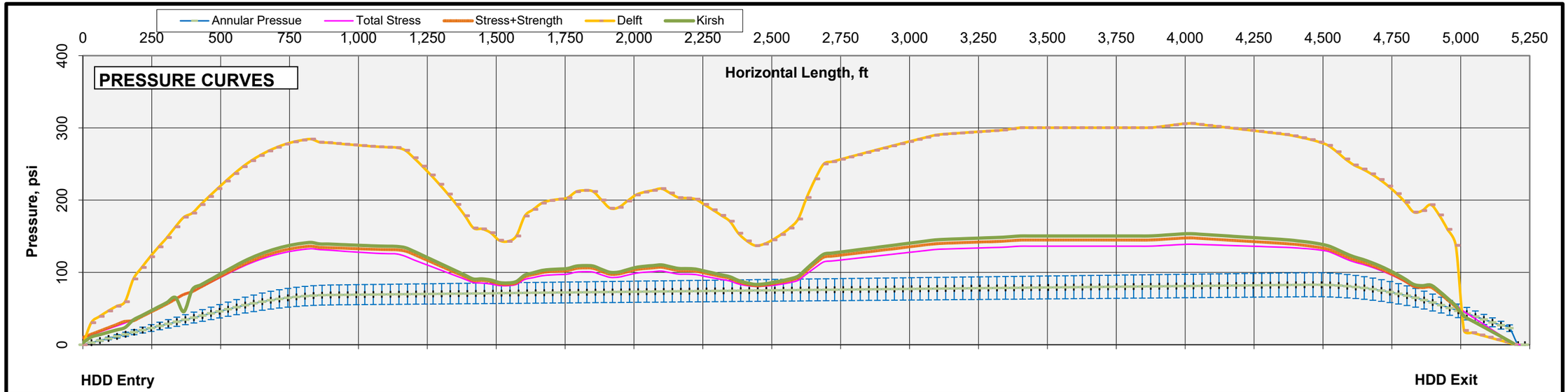
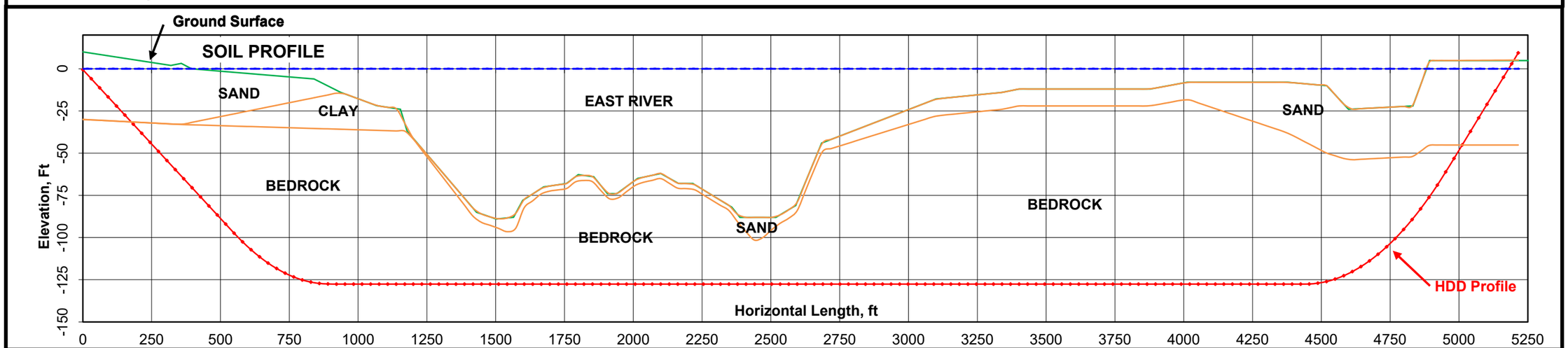
CHPE Package 8
HDD #135
NYC, NY

**ANNULAR PRESSURE AND FORMATION PRESSURE CURVES**
**HDD #135**
**Circuit #1**

Revision 1

F:\Proposals\CHPE - Kiewit\Package 8 - Randalls Island\CHPE PK 8 #135 v_4-22-22 circuit 1.xlsx]T1 Comments




ISSUED: Draft Design

**Notes:**

1. Geology is interpreted from project data
2. The error bars represent possible range of slurry density
3. Ground surface data obtained from project survey data
4. Subsurface data from Geotechnical Report, Properties are interpreted from field and laboratory data as presented in Table 4.
5. Pump rate, pilot hole diameter, fluid density are estimated actual values may vary depending on Contractor field operations. The error bars provide an estimate of the full range of possible fluid properties for a given pump rate.

**Basis of annulur pressure calculations**

| | | |
|---|---|---|
| 9.92 in | Pilot Hole Diameter | |
| 74.0 pcf | Unit Weight Drill Fluid | 9.89 ppg |
| 400 gal/min | Pump Rate | |
| 5.00 in | Drill Rod Diameter | |
| 20% | for APC curve | |

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CHPE Package 8
HDD #135
NYC, NY

**ANNULAR PRESSURE AND FORMATION PRESSURE CURVES**
**HDD #135**
**Circuit #2**

Revision 1

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**APPENDIX D**
CONDUIT PULLBACK ANALYSES

## Pull Geometry

| Tail | $L_{tail}$ | Lengths (Path) 300.0 ft | V. Angle | Azimuth | EL Overbend | Radius, R 1,100.0 ft |
|---|---|---|---|---|---|---|
| EXIT | L1 = | 153.0 ft | 10.000 | 143.770 | 10.000 | 0.0 ft |
| PVT2 | L2 = | 209.4 ft | 10.000 | 143.770 | -16.569 | 0.0 ft |
| PVC2 | L3 = | 1414.5 ft | 0.000 | 143.770 | -34.800 | 1,200.0 ft |
| PVT1 | L4 = | 244.3 ft | 0.000 | 143.770 | -34.800 | 0.0 ft |
| PVC1 | L5 = | 65.7 ft | -14.000 | 143.770 | -5.096 | 1,000.0 ft |
| Entry | L6 = | 0.0 ft | -14.000 | 143.770 | 10.800 | 0.0 ft |
| | L7 = | | | | | |
| | L8 = | | | | | |
| | L9 = | | | | | |
| | L10 = | | | | | |
| | L11 = | | | | | |
| | L12 = | | | | | |

Tail String Drag = $L_{tail}*\nu_G$ = 60.00 Lb

LT = 2086.977 ft

**INPUT: Assumed Friction Factors**

$\nu_G$ = 0.20 dry + rollers

$\nu_b$ = 0.40 drill fluid in hole

$\nu_c$ = 0.40 in hole no fluid

**INPUT: Assumed Hydrokinetic Drag**

$\tau_f$ = 0.005 psi Drill Fluid Shear Stress

**INPUT: Pipe Properties**

Material HDPE IPS

Safe Pull Max. Stress, $\sigma_{PM}$ 1,150 psi PPI Table 1 12hr @ 73Deg F

Pile/Bundle Diam. 10.8 in PIPE PIPE/BUNDLE

DR = $D_O/t_{min}$ = 9.0

Section Area for Pull, $in^2$ 37.71 in2 Ducts not Included

12 Hr Pullback Modulus, $E_T$ = 63,000 psi @T = 73 deg F

Poisson Ratio, $\mu$ = 0.45

Ovality Factor, $f_o$ = 0.915 1%

Buckling Safety, N = 2.0

**INPUT: Assumed Fluid Densities/Elevations**

Ballast Density 62.428 pcf ***Estimated for pull***

Drill Fluid Density 78.0 pcf ***Estimated for pull***

Drill fluid elevation, $H_F$ = 10.00 ft

Ballast Water El., $H_W$ = 0.00 ft

Lowest Invert El., $El_m$ = -34.80 ft

**Calculated Pipe and Fluid Properties**

Fluid Drag OD Perimeter Length, P 33.77 in

ASTM 1962 Fluid Unit Drag, $q_d$ = 2.03 lb/ft

ASTM 1962 EQ 18: Hydrokinetic, $\Delta T$ = 0.37 lb/ft

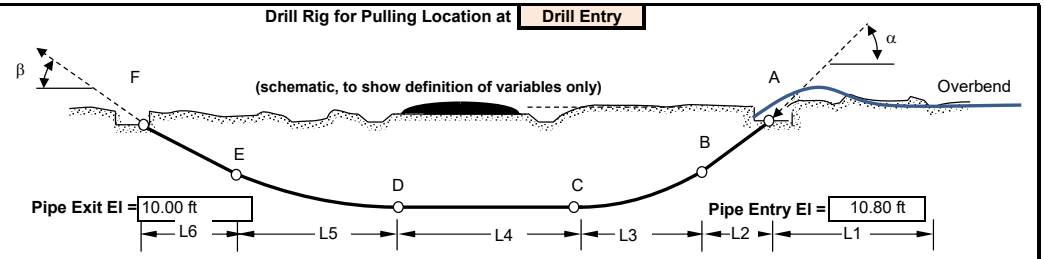
**Pull Condition** 1 Pipe 1 Ballasted and not Ballasted

**Calculated Buoyant Weights**

| | Pipe | Air Filled | Ballasted |
|---|---|---|---|
| On Ground, $w_a/w_{af}$ = | | 15.69 Lb/LF | 38.69 Lb/LF |
| In Hole with Drill Fluid, $w_b/w_{bf}$ = | | -33.47 Lb/LF | -10.47 Lb/LF |

**NOTES:** 1 - Calculations were done in general accordance with ASTMF-1962 as modified to account for invert tangent section, independent vertical curves, and fluid drag. ASTM applies hydrokinetic pressure as shear per unit pipe length requiring a back calculation to determine actual pull force based on average pipe area.

**Drill Rig for Pulling Location at** Drill Entry




## Calculated Pull Force

| POINT | Pull Force, $F_D$ No Ballast | Max Tensile Stress, $\sigma_T$ | ASSESS $\sigma_T < \sigma_{PM}$ | Pull Force, $F_B$ Ballasted Pipe | Max Tensile Stress, $\sigma_T$ | ASSESS $\sigma_T < \sigma_{PM}$ | ASSESS $F_x$ < SPS Air | ASSESS $F_x$ < SPS Ballast |
|---|---|---|---|---|---|---|---|---|
| EXIT | 6,739 lb | 188 psi | OK | 6,739 lb | 188 psi | OK | OK | OK |
| PVT2 | 8,462 lb | 236 psi | OK | 7,978 lb | 223 psi | OK | OK | OK |
| PVC2 | 28,577 lb | 821 psi | OK | 15,080 lb | 444 psi | OK | OK | OK |
| PVT1 | 32,072 lb | 895 psi | OK | 16,326 lb | 455 psi | OK | OK | OK |
| PVC1 | 31,119 lb | 896 psi | OK | 15,601 lb | 463 psi | OK | OK | OK |
| Entry | 31,119 lb | 868 psi | OK | 14,990 lb | 418 psi | OK | OK | OK |

**ASSESS** Pull Restricted Buckling Capacity, $P_{PA} > \Delta P$ **invert** $P_{PA} = P_A F_R$ = 105.68 psi

| | |
|---|---|
| Ballasted | OK |
| No Ballast | OK |

Maximum tensile stress during pullback = $\sigma_t = (F_T/\pi t_m(D_{OD}-t_m))+E_T D_{OD}/2R$ PPI Ch 12 Eq 16

**Calculated Material Design Limits For Designed Drill Path**

Safe Pull Strength, SPS = 41,235 lb $SSPS = \sigma_{PM}\pi D_{OD}^2((1/DR)-(1/DR^2))$

Allowable Short Term Unconstrained Buckling, $P_A$ = 141.18 psi $P_A = (2E_T/(1-\mu^2))(1/(DR-1))^3(f_o/N)$

Maximum 12 hour Pull Stress Reduction, $F_R$ = 0.748593154 $F_R = (5.57-(r+1.09)^2)^{1/2}-1.09$

r = 0.38972133 $r = \sigma_T/2*SPS$

Maximum applied pull Stress, $\sigma_T$ = 896 psi From Pull Force Calculations

Ballasted Max. Differential Pressure on Pipe, $\Delta P_B$ **invert** = 9.18 psi (-) indicates extra differential capacity

Unballasted Max. Differential Pressure on Pipe, $\Delta P_U$ **invert** = 24.27 psi (-) indicates extra differential capacity

**Calculated Drill Hole Diameter Assumed for Calculations**

$D_H$ = 18.0 in

$D_O$<8" Use $D_H=D_O+4"$; 8"<$D_O$<24" Use $D_H=1.5*D_O$; $D_O$>24" Use $D_H=D_O+12"$

**ISSUE: Final Design**

BRIERLEY ASSOCIATES
*Creating Space Underground*

Brierley Associates
167 S. River Road, Suite 8
Bedford, NH 03110

**ESTIMATED PULLING FORCE**
**Champlain Hudson Power Express Package 8**
**HDD #134 Conduit 2**
**Cable Duct**

Revision 1 TBD

## Pull Geometry

| Lengths (Path) | | | V. Angle | Azimuth | EL | Radius, R |
|---|---|---|---|---|---|---|
| **Tail** | $L_{tail}$ | **300.0 ft** | | | **Overbend** | **1,100.0 ft** |
| EXIT | L1 = | 156.6 ft | 10.000 | 143.773 | 10.420 | 0.0 ft |
| PVT2 | L2 = | 209.4 ft | 10.000 | 143.773 | -16.769 | 0.0 ft |
| PVC2 | L3 = | 1414.8 ft | 0.000 | 143.773 | -35.000 | 1,200.0 ft |
| PVT1 | L4 = | 244.3 ft | 0.000 | 143.773 | -35.000 | 0.0 ft |
| PVC1 | L5 = | 61.8 ft | -14.000 | 143.773 | -5.296 | 1,000.0 ft |
| Entry | L6 = | 0.0 ft | -14.000 | 143.773 | 9.650 | 0.0 ft |
| | L7 = | | | | | |
| | L8 = | | | | | |
| | L9 = | | | | | |
| | L10 = | | | | | |
| | L11 = | | | | | |
| | L12 = | | | | | |

Tail String Drag = $L_{tail}*\nu_G$ = 60.00 Lb

LT = 2086.967 ft

**INPUT: Assumed Friction Factors**

$\nu_G$ = 0.20 dry + rollers

$\nu_b$ = 0.40 drill fluid in hole

$\nu_c$ = 0.40 in hole no fluid

**INPUT: Assumed Hydrokinetic Drag**

$\tau_f$ = 0.005 psi Drill Fluid Shear Stress

**INPUT: Pipe Properties**

Material **HDPE** IPS

Safe Pull Max. Stress, $\sigma_{PM}$ 1,150 psi PPI Table 1 12hr @ 73Deg F

Pile/Bundle Diam. 14.3 in BUNDLE PIPE/BUNDLE

DR = $D_O/t_{min}$ = 9.0

Section Area for Pull, $in^2$ 41.69 in2 Ducts not Included

12 Hr Pullback Modulus, $E_T$ = 63,000 psi @T = 73 deg F

Poisson Ratio, $\mu$ = 0.45

Ovality Factor, $f_o$ = 0.915 1%

Buckling Safety, N = 2.0

**INPUT: Assumed Fluid Densities/Elevations**

Ballast Density 62.428 pcf ***Estimated for pull***

Drill Fluid Density 78.0 pcf ***Estimated for pull***

Drill fluid elevation, $H_F$ = 9.00 ft

Ballast Water El., $H_W$ = 0.00 ft

Lowest Invert El., $El_m$ = -35.00 ft

**Calculated Pipe and Fluid Properties**

Fluid Drag OD Perimeter Length, P 44.77 in

ASTM 1962 Fluid Unit Drag, $q_d$ = 2.69 lb/ft

ASTM 1962 EQ 18: Hydrokinetic, $\Delta T$ = 0.49 lb/ft

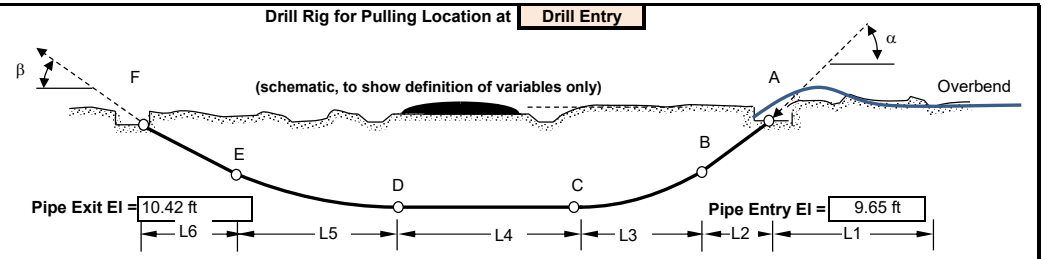
**Pull Condition** 1 Pipe 1 Ballasted and not Ballasted

**Calculated Buoyant Weights**

| | Pipe | Air Filled | Ballasted |
|---|---|---|---|
| On Ground, $w_a/w_{af}$ = | | 15.69 Lb/LF | 38.69 Lb/LF |
| In Hole with Drill Fluid, $w_b/w_{bf}$ = | | -33.47 Lb/LF | -10.47 Lb/LF |

**NOTES:** 1 - Calculations were done in general accordance with ASTMF-1962 as modified to account for invert tangent section, independent vertical curves, and fluid drag. ASTM applies hydrokinetic pressure as shear per unit pipe length requiring a back calculation to determine actual pull force based on average pipe area.

**Drill Rig for Pulling Location at** **Drill Entry**




## Calculated Pull Force

| POINT | Pull Force, $F_D$ No Ballast | Max Tensile Stress, $\sigma_T$ | ASSESS $\sigma_T < \sigma_{PM}$ | Pull Force, $F_B$ Ballasted Pipe | Max Tensile Stress, $\sigma_T$ | ASSESS $\sigma_T < \sigma_{PM}$ | ASSESS $F_x$ < SPS Air | ASSESS $F_x$ < SPS Ballast |
|---|---|---|---|---|---|---|---|---|
| EXIT | 6,739 lb | 138 psi | OK | 6,739 lb | 138 psi | OK | OK | OK |
| PVT2 | 8,337 lb | 170 psi | OK | 9,556 lb | 195 psi | OK | OK | OK |
| PVC2 | 30,324 lb | 650 psi | OK | 18,526 lb | 409 psi | OK | OK | OK |
| PVT1 | 34,141 lb | 697 psi | OK | 20,096 lb | 410 psi | OK | OK | OK |
| PVC1 | 33,037 lb | 712 psi | OK | 19,152 lb | 428 psi | OK | OK | OK |
| Entry | 31,878 lb | 651 psi | OK | 17,698 lb | 361 psi | OK | OK | OK |

**ASSESS** Pull Restricted Buckling Capacity, $P_{PA} > \Delta P$ **invert** $P_{PA} = P_A F_R$ = 114.40 psi

| | |
|---|---|
| Ballasted | OK |
| No Ballast | OK |

Maximum tensile stress during pullback = $\sigma_t = (F_T/\pi t_m(D_{OD}-t_m))+E_T D_{OD}/2R$ PPI Ch 12 Eq 16

**Calculated Material Design Limits For Designed Drill Path**

Safe Pull Strength, SPS = 72,457 lb $SSPS = \sigma_{PM}\pi D_{OD}^2((1/DR)-(1/DR^2))$

Allowable Short Term Unconstrained Buckling, $P_A$ = 141.18 psi $P_A = (2E_T/(1-\mu^2))(1/(DR-1))^3(f_o/N)$

Maximum 12 hour Pull Stress Reduction, $F_R$ = 0.810324499 $F_R = (5.57-(r+1.09)^2)^{1/2}-1.09$

r = 0.309559501 $r = \sigma_T/2*SPS$

Maximum applied pull Stress, $\sigma_T$ = 712 psi From Pull Force Calculations

Ballasted Max. Differential Pressure on Pipe, $\Delta P_B$ **invert** = 8.66 psi (-) indicates extra differential capacity

Unballasted Max. Differential Pressure on Pipe, $\Delta P_U$ **invert** = 23.83 psi (-) indicates extra differential capacity

**Calculated Drill Hole Diameter Assumed for Calculations**

$D_H$ = 22.0 in

$D_O$<8" Use $D_H=D_O+4"$; 8"<$D_O$<24" Use $D_H=1.5*D_O$; $D_O$>24" Use $D_H=D_O+12"$

**ISSUE: Final Design**

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*Creating Space Underground*

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**ESTIMATED PULLING FORCE**
**Champlain Hudson Power Express Package 8**
**HDD #134 Conduit 1**
**Cable Duct**

Revision 1 TBD

# PULL FORCE & STRESS ASSESSMENT

Pull Direction: Drill Exit to Entry

INPUT: Drill Exit to Entry' or 'Drill Entry to Exit'

| Lengths - Path | |
|---|---|
| Tail String | 0 ft |
| L1 = | 5258.44 ft |
| L2 = | 275.68 ft |
| L3 = | 523.60 ft |
| L4 = | 3545.07 ft |
| L5 = | 349.07 ft |
| L6 = | 565.02 ft |
| LT = | 5258.44 ft |

Overbend radius = NA

| Angles (+) clockwise | | Radius (ft) |
|---|---|---|
| α = | -15.0 ˚ | 2000 |
| χ = | 0 | |
| β = | 10.0 ˚ | 2000 |
| Assess Pipeside Ground Slope Angle | | |
| OK | | |

| POINT | No Ballast Force | No Ballast Stress | Ballasted Force | Ballasted Stress | |
|---|---|---|---|---|---|
| T(A) | 3,758 lb | Acceptable | 3,758 lb | Acceptable | *No Ballast above ground surface* |
| T(B) | 9,168 lb | Acceptable | 15,391 lb | Acceptable | |
| T(C ) | 31,628 lb | Acceptable | 32,722 lb | Acceptable | |
| T(D) | 188,040 lb | Acceptable | 143,336 lb | Acceptable | |
| T(E) | 217,806 lb | Acceptable | 150,993 lb | Acceptable | |
| T(F) | 250,628 lb | Acceptable | 164,359 lb | Acceptable | |
| Maximum Pull Force | 250,628 lb | Unballasted | 164,359 lb | Ballasted | |
| Operational Stress Assessment | Acceptable | | | | |

**Friction Factors**

| | | |
|---|---|---|
| $\tau_f$ = | 0.0250 psi | Fluid Friction |
| $\mu_a$ = | 0.007 | (dry + rollers) |
| $\mu_b$ = | 0.30 | (wet in hole) |
| $\mu_s$ = | 0.3 | soil |

**Assumptions**

| | | | | |
|---|---|---|---|---|
| Drill Fluid $\gamma_F$ = | 74.8 pcf | 10.00 lb/gal | Elev., Df = | 5.00 ft |
| Ballast Water $\gamma_w$ = | 62.4 pcf | 8.34 lb/gal | Elev., Db = | 5.00 ft |

**Carrier Pipe**

| | | |
|---|---|---|
| DENSITY $\gamma$ = | 489.5 pcf | |
| Pipe OD Dia. = | 20.000 in | 1.667 ft |
| Modulus, E | 29,000,000 psi | |
| Strength, SMYS | 42,000 psi | Allowable stress 30,240 psi |

| | Pipe 1 | Pipe 2 | Pipe 3 |
|---|---|---|---|
| Pipe OD = | 20.00 in | | |
| Pipe Wall, WT = | 0.375 in | | |
| Pipe ID Dia. = | 19.250 in | | |
| Perimeter, Pp = | 5.24 ft | 62.832 in | |
| $w_f$ = | 163.19 lb/ft | Displaced fluid weight | |
| $w_b$ = | 126.12 lb/ft | Ballast weight | |

**Calculated Buoyant Forces**

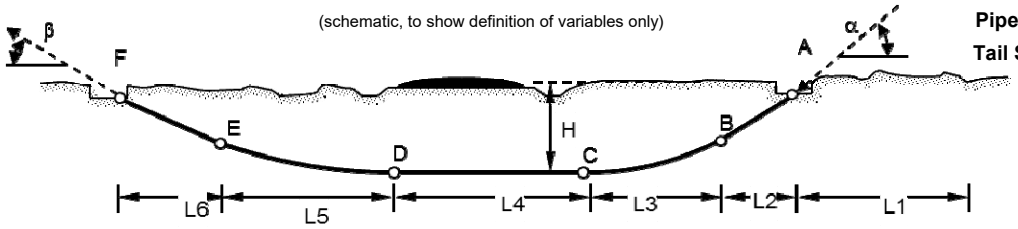
| Pipe | Air Filled | Ballasted |
|---|---|---|
| On Ground, $w_a/w_{af}$ = | 78.60 lb/ft | 204.72 Lb/LF |
| In Hole with Drill Fluid, $w_b/w_{bf}$ = | -84.59 lb/ft | 41.53 lb/ft |

Rigside

(schematic, to show definition of variables only)

Pipeside

Tail String




Bottom Tangent Angle, χ = 0

Drill Entry Elevation = -0.50 ft

Drill Exit Elevation = 10.50 ft

Invert Elevation = -129.00 ft

Pipe Entry Elevation, $E_P$ = 10.50 ft

End of Tail String Ground Elevation at Pipe Entry, $E_{TS}$ = -0.50 ft

**Calculated Drill Hole Diameter Assumed for Calculations**

$D_H$ = 30 $D_O$<8" Use $D_H$=$D_O$+4"; 8"<$D_O$<24" Use $D_H$=1.5*$D_O$; $D_O$>24" Use $D_H$=$D_O$+12"

NOTE: Reamers and hole openers typically constructed in 2" increments. If calculation results in odd hole diameter, result is rounded up to next even number.

Notes:

1 - Calculations were done in general accordance with "Installation of Pipelines by Horizontal Directional Drilling - An Engineering Guide" by the Pipeline Research Committee, dated April 15, 1995 and as revised in November 2008.

2 - See pipe stress assessment for detailed calculations for pull back stress and overbend calculations for specific overbend stress assessment.

**ISSUE: Constructability Assessment**

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CHPE Package 8
HDD #135
NYC, NY

**CASING ASSESSMENT**
**ANTICIPATED PULLING FORCE**
**HDD #135** **STEEL PIPE**

Revision 0 2/28/2020

F:\Proposals\CHPE - Kiewit\Package 8 - Randall's Island\[Copy of BCD_HDDSingle_R0_3282020 Steel Conduit #2.xlsx]Inputs

# PULL FORCE & STRESS ASSESSMENT

Pull Direction: Drill Exit to Entry

INPUT: Drill Exit to Entry' or 'Drill Entry to Exit'

| Lengths - Path | |
|---|---|
| Tail String | 0 ft |
| L1 = | 5228.03 ft |
| L2 = | 287.66 ft |
| L3 = | 523.60 ft |
| L4 = | 3508.44 ft |
| L5 = | 349.07 ft |
| L6 = | 559.27 ft |
| LT = | 5228.03 ft |

Overbend radius = NA

| Angles (+) clockwise | | Radius (ft) |
|---|---|---|
| α = | -15.0 ˚ | 2000 |
| χ = | 0 | |
| β = | 10.0 ˚ | 2000 |
| **Assess Pipeside Ground Slope Angle** | | |
| OK | | |

| POINT | No Ballast Force | No Ballast Stress | Ballasted Force | Ballasted Stress | |
|---|---|---|---|---|---|
| T(A) | 4,063 lb | Acceptable | 4,063 lb | Acceptable | *No Ballast above ground surface* |
| T(B) | 9,445 lb | Acceptable | 16,223 lb | Acceptable | |
| T(C ) | 31,878 lb | Acceptable | 33,527 lb | Acceptable | |
| T(D) | 186,637 lb | Acceptable | 142,961 lb | Acceptable | |
| T(E) | 216,210 lb | Acceptable | 150,425 lb | Acceptable | |
| T(F) | 248,672 lb | Acceptable | 163,630 lb | Acceptable | |
| **Maximum Pull Force** | 248,672 lb | Unballasted | 163,630 lb | Ballasted | |
| **Operational Stress Assessment** | Acceptable | | | | |

**Friction Factors**

| | | |
|---|---|---|
| $\tau_f$ = | 0.0250 psi | Fluid Friction |
| $\mu_a$ = | 0.007 | (dry + rollers) |
| $\mu_b$ = | 0.30 | (wet in hole) |
| $\mu_s$ = | 0.3 | soil |

**Assumptions**

| | | | | |
|---|---|---|---|---|
| Drill Fluid $\gamma_F$ = | 74.8 pcf | 10.00 lb/gal | Elev., Df = | 5.00 ft |
| Ballast Water $\gamma_w$ = | 62.4 pcf | 8.34 lb/gal | Elev., Db = | 5.00 ft |

**Carrier Pipe**

| | | |
|---|---|---|
| DENSITY $\gamma$ = | 489.5 pcf | |
| Pipe OD Dia. = | 20.000 in | 1.667 ft |
| Modulus, E | 29,000,000 psi | |
| Strength, SMYS | 42,000 psi | Allowable stress 30,240 psi |

| | Pipe 1 | Pipe 2 | Pipe 3 |
|---|---|---|---|
| Pipe OD = | 20.00 in | | |
| Pipe Wall, WT = | 0.375 in | | |
| Pipe ID Dia. = | 19.250 in | | |
| Perimeter, Pp = | 5.24 ft | 62.832 in | |
| $w_f$ = | 163.19 lb/ft | Displaced fluid weight | |
| $w_b$ = | 126.12 lb/ft | Ballast weight | |

**Calculated Buoyant Forces**

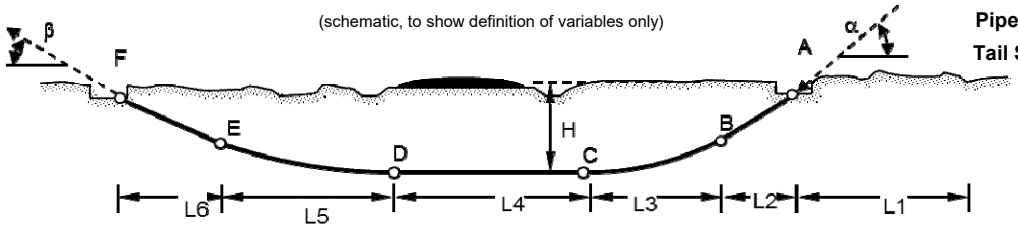
| Pipe | Air Filled | Ballasted |
|---|---|---|
| On Ground, $w_a/w_{af}$ = | 78.60 lb/ft | 204.72 Lb/LF |
| In Hole with Drill Fluid, $w_b/w_{bf}$ = | -84.59 lb/ft | 41.53 lb/ft |

Rigside

(schematic, to show definition of variables only)

Pipeside

Tail String




Bottom Tangent Angle, χ = 0

| | |
|---|---|
| Drill Entry Elevation = | -1.50 ft |
| Drill Exit Elevation = | 13.60 ft |
| Invert Elevation = | -129.00 ft |

| | |
|---|---|
| Pipe Entry Elevation, $E_P$ = | 13.60 ft |
| End of Tail String Ground Elevation at Pipe Entry, $E_{TS}$ = | -1.50 ft |

**Calculated Drill Hole Diameter Assumed for Calculations**

$D_H$ = 30 $D_O$<8" Use $D_H$=$D_O$+4"; 8"<$D_O$<24" Use $D_H$=1.5*$D_O$; $D_O$>24" Use $D_H$=$D_O$+12"

NOTE: Reamers and hole openers typically constructed in 2" increments. If calculation results in odd hole diameter, result is rounded up to next even number.

Notes:

1 - Calculations were done in general accordance with "Installation of Pipelines by Horizontal Directional Drilling - An Engineering Guide" by the Pipeline Research Committee, dated April 15, 1995 and as revised in November 2008.

2 - See pipe stress assessment for detailed calculations for pull back stress and overbend calculations for specific overbend stress assessment.

**ISSUE: Constructability Assessment**

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CHPE Package 8
HDD #135
NYC, NY

**CASING ASSESSMENT**
**ANTICIPATED PULLING FORCE**
**HDD #135** **STEEL PIPE**

Revision 0 2/28/2020

F:\Proposals\CHPE - Kiewit\Package 8 - Randall's Island\[Copy of BCD_HDDSingle_R0_3282020 Steel Conduit #1.xlsx]T5 Steel Pull