Geotechnical Report for Data Gap Characterization at the Proposed Outfall 200 Mercury Treatment Facility Sites

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1.0 INTRODUCTION

1.1 BACKGROUND

The U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) is located within and adjacent to the corporate limits of the city of Oak Ridge, Tennessee. The ORR hosts three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project: the East Tennessee Technology Park (formerly the K-25 site); the Oak Ridge National Laboratory (ORNL); and the Y-12 National Security Complex (Y-12). The DOE, Oak Ridge Environmental Management office (OREM) proposes to construct a surface water treatment facility, Outfall 200 Mercury Treatment Facility, within the footprint of Y-12. The area proposed for construction of the Outfall 200 Mercury Treatment Facility is located in the south-central to south-eastern portion of the Y-12 site, as shown in Figure 1.

Historical missions of Y-12 have resulted in the release of mercury and other contaminants to the environment and contamination has been identified in soil, sediment, surface water, groundwater, buildings, drains, and sumps. Mercury continues to be released into the Upper East Fork Poplar Creek (UEFPC) from point (discrete) and non-point (diffuse) sources within Y-12. Mercury enters UEFPC from direct erosion of contaminated soil, migration of dissolved mercury through storm drains and several outfalls, and through shallow groundwater. The West End Mercury Area consists of former mercury use buildings located in the west end of the Y-12 main plant area, including mercury contaminated soils and storm sewers in the immediate vicinity. Residual mercury in the seventy year-old deteriorating storm drain infrastructure, infiltrating groundwater, and sediment-bound mercury are remobilized and transported through the storm drain network through Outfall 200 into the UEFPC. UEFPC and the Maynardville Limestone provide conduits for contaminant migration. Because of the toxicity and mobility of mercury contamination, several mercury source areas were identified as containing principal threat wastes per EPA guidance and were the focus of the Phase I Record of Decision (ROD) (DOE 2002).

Currently, the mercury contamination is considered the greatest environmental risk on the DOE ORR (it should be noted that the Phase II ROD for UEFPC [DOE 2006] included additional contaminants of concern such as cadmium, uranium, polychlorinated biphenyl compounds [PCBs], several radionuclides, and volatile organic compounds [VOCs]). The primary pathway of concern is surface water because the UEFPC flows directly from the Y-12 complex through the city of Oak Ridge. During 1998–2000, DOE prepared Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Remedial Investigation/Feasibility Study documents for the UEFPC Characterization Area focused on potential source units (i.e. areas of soil contamination and groundwater plumes) that potentially contribute to the transport of contaminants within and from the Characterization Area. In 2002, the UEFPC Characterization Area Phase I ROD (DOE 2002) was signed, outlining future cleanup actions.

Discharges from the West End Mercury Area are primary point source contributors to mercury flux in UEFPC. Outfall 200 is the integration point for storm sewer effluent entering UEFPC; and under dry weather (base) flow conditions is consistently the largest single source of mercury to the creek (URS/CH2M Oak Ridge LLC [UCOR] 2013).

Over the past two decades, DOE has implemented a series of projects that have reduced the concentrations of mercury measured at the site boundary at Station 17, the Y-12 National Pollutant Discharge Elimination System (NPDES) permit compliance point. While mercury concentrations in water at Station 17 have declined, the concentrations continue to exceed the surface water concentration goal specified in the UEFPC Characterization Area Phase I ROD. Until the West End Mercury Area discharge is collected and treated, mercury will continue to impact the sediment in UEFPC.
Figure 1. General location of the proposed Outfall 200 Mercury Treatment Facility.
Several significant measures are being implemented to address mercury flux in UEFPC. The National Nuclear Security Administration submitted plans to relocate and/or reduce raw water addition to UEFPC based on previous studies that showed a reduction in flow augmentation can achieve a corresponding reduction in mercury flux in UEFPC (DOE 2009). Additionally, DOE’s OREM has proposed and completed the conceptual design for a surface water treatment facility, the Outfall 200 Mercury Treatment Facility which will significantly reduce mercury loading to UEFPC.

1.2 SITE DESCRIPTION
The project site is located in the south-central portion of Y-12. Specifically, the project consists of two separate areas: the headworks area and the Mercury Treatment Facility area. The headworks area is located south of the Building 9204-1 and treatment facility area is located in the southeastern quadrant of the intersection of B Road and Second Street (former Building 9720-8 site). The headworks area will include a weir intake structure, grit removal chamber, storage tanks, and pumping station located adjacent to Outfall 200. The treatment facility will include an equalization tank, chemical reaction tanks, inclined plate clarifiers, clarifier effluent tank, treatment building, treated water tank, chemical storage, and various utilities located at the 9720-8 slab. These two areas will be connected with an above grade pipeline located along the south side of UEFPC.

The headworks area generally slopes gently downhill from the south to the UEFPC located on the north side of the project. The headworks area currently consists of bare earth, gravel, short grassed areas, remnants of past construction (building foundations and slabs), and multiple overhead utility lines. The treatment facility area generally slopes downhill from the north to the UEFPC located on the south side of the project. The treatment facility area currently consists of asphalt paved and concrete parking/drive areas, a non-operational rail-line, and graveled areas.

The Outfall 200 Mercury Treatment Facility areas are underlain by a relatively thin interval of clayey overburden soil which then overlies bedrock of the Conasauga Group (Upper Cambrian Age). The soil overburden thickness is typically less than 20 feet thick but it can be highly variable (DOE 1998). Specifically, the site is underlain by the Maynardville Limestone formation (see Figure 2), a member of the Conasauga Group. The Maynardville Limestone is composed of light gray to tan, massive-to-thinly-bedded limestone with lesser amounts of dolostone (USGS). In the Y-12 Plant area, the Maynardville Limestone varies from 418 to 450 feet in thickness. The Maynardville Limestone is soluble and dips to the southeast which has led to an irregular bedrock surface. Previous geotechnical drilling at the Outfall 200 area included rock coring in 29 borings (GEOServices 2016). The rock core obtained during coring operations revealed the underlying bedrock consisted of dark gray and gray limestone and dolomite with fractured and weathered zones. The recovery percentages and the rock quality designation (RQD) of the rock cores ranged from 0 to 100 percent, indicating a rock quality of very poor to excellent. During this previous phase of geotechnical characterization, multiple voids were encountered within the bedrock ranging from 2 inches to 10 feet in thickness.

1.3 SCOPE AND PURPOSE
DOE proposes to construct a treatment facility and associated headworks to address mercury at Outfall 200 and the UEFPC. A previous geotechnical investigation report (GEOServices 2016) documented soil and rock conditions at the site to support the design of this treatment facility and headworks. The purpose of this geotechnical investigation was to characterize the subsurface conditions to address remaining geotechnical data gaps to support final design for the treatment facility. The primary emphasis of the characterization was the depth to bedrock, presence and size of voids, and the nature of infilling of any voids.
Tasks under this scope included: performing rock coring at 22 locations; evaluating rock core and RQD; performing borehole geophysical logging; and delivering a technical report to DOE. This report provides field data and geophysical logging results for the geotechnical investigation conducted. The following sections of this report present discussions of the field exploration and site conditions. Following the text of this report, Appendix A presents the drilling logs and Appendix B presents a summary of the geophysical logging. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. No engineering recommendations, or designs, for foundation support of any proposed structures are provided.

Figure 2. Generalized Geology near Project Site (from United States Geological Survey)
2.0 CHARACTERIZATION PROGRAMS

2.1 GEOTECHNICAL FIELD INVESTIGATION

Prior to mobilizing drilling equipment, Strata-G and Tri-State Drilling, Inc. performed site visits to visually inspect the site surface conditions, note obstructions, and to mark the boring locations. Overhead power lines in the vicinity of Borings B-01 through B-04 were noted and addressed through lock-out/tag-out procedures. Several borings were relocated due to surface obstructions as noted in Section 3.3. The boring locations were provided by DOE and located in the field by Strata-G personnel. The surveyed as-drilled locations of the soil borings, determined by civil survey, are shown on the Boring Location Plan, included in Appendix C.

The subsurface investigation consisted of drilling 22 soil and rock borings at the subject site, designated as Borings B-01 through B-22. The number, depth, and general locations of the soil borings were originally selected by the Outfall 200 MTF design contractor. Field adjustment to the total drilling depth was made as necessary to ensure each boring reached the minimum required boring depth and the minimum penetration into rock (25 feet), per the project statement of work. Boring B-13 was terminated for reasons discussed in Section 3.3.

The drilling operations were performed by Tri-State Drilling, Inc., under the direction of Strata-G and observed by CTI and Associates, Inc., on November 3 – November 23, 2016 utilizing a truck-mounted drill rig. The soil borings were advanced using plugged hollow-stem augers until auger refusal and the depth noted accordingly. Rock coring was conducted using an HQ (2 7/8-inch) wireline system. When drilling through soil, auger cuttings were observed and logged according to visual inspection. No soil samples were obtained. When drilling through rock, core samples were obtained continuously, except where recovery was disrupted by encountered voids and loose materials, as described in the drilling logs (Appendix A). After completion of the drilling operations, an HW (4 1/2-inch) temporary casing was driven to auger refusal to facilitate geophysical logging at select borings. After the completion of geophysical logging (where applicable – see section 2.2) the boreholes were backfilled with a cement-bentonite grout mixture. In most locations, bentonite pellets were used to facilitate grouting above significant voids. Initial plans were to add an amount of grout up to 2.5-times the borehole volume and then use bentonite pellets in boreholes that required more material. After attempting to grout the first seven boreholes at the proposed treatment facility site, it was decided to add no more than 1.25-times the borehole volume prior to using the bentonite pellets (grout added to boreholes B-15, B-17, B-19, B-20, B-21, B-22 and the initial B-20 borehole required more than 2.5 times the borehole volume). The only boreholes that maintained the grout level within the upper 10-ft of the borehole following pumping were boreholes B-1, B-2, B-4, B-8, B-11, and B-12.

Soil and rock conditions observed in the test borings have been logged and are presented on the drilling logs included in Appendix A. These logs contain the detailed record of the observations made on site during drilling and should be consulted to understand the observations made with respect to encountered rock and voids during coring operations in each boring location. To aid in understanding the data presented on the drilling logs, “General Notes for Soil/Rock Classification,” describing nomenclature used in soil and rock descriptions, are included in Appendix D.

2.2 GEOPHYSICAL LOGGING PROGRAM

The geophysical logging program was directed towards collecting information to assist in identifying the presence, and size where possible, of voids and fractures in the bedrock, and determine the nature of void infilling. All geophysical logging was performed in general accordance with applicable ASTM test method standards. The geophysical logging included:
• Caliper logging (ASTM D6167)
• Natural gamma logging (ASTM D6274)

For this investigation, a Mount Sopris Matrix II logging system and Mount Sopris downhole probes were used. Tools were lowered to borehole using a winch with a single conductor cable. The caliper tool would be lowered to depth and data would be collected as the tool was raised. The gamma tool collected information in both directions of travel. The geophysical logging data were analyzed and processed using WellCAD software.

Caliper logging is used to generate a profile of the borehole diameter with depth. The tool measures the borehole diameter using three spring-loaded arms. Narrow enlargements in the borehole diameter can, in most cases, be attributed to fractures. Caliper logging can be conducted above and below the water table.

Natural gamma tools measure the gamma radiation from the formation. These logs can be used to discriminate between different formations by utilizing variations in the concentration of naturally occurring radioactive isotopes such as potassium, uranium and thorium. These logs are particularly useful for locating clay and shale formations since radioactive elements tend to concentrate in these types of materials. Natural gamma logging can be conducted in both cased and uncased boreholes, water-filled and dry.

DOE and the Outfall 200 MTF design contractor recommended logging eight boreholes along with an alternative in the event there were difficulties getting the probes to depth in a boring. There were initial concerns with whether the open boreholes would remain open and on November 8, 2016, a 1-inch diameter PVC pipe was run down three borings to determine if they were still open to the bottom of the borehole. The pipe reached bottom in all three borings, but it was evident the bottom portion of the borings contained thicker mud or debris. The team discussed the possibility of placing temporary casing in the boreholes which would have eliminated the ability to run a caliper log. However, it was decided to proceed with the open borehole logging as the caliper log data was needed.

Geophysical logging was conducted on November 15-16, 2016. Some of the boreholes selected for logging had obstructions or cave-ins and some were not completely vertical due to difficulties encountered with drilling through multiple voids. Decisions on which boreholes to log were made in consultation with the Outfall 200 MTF design contractor representative on site. Table 1 provides a list of recommended boreholes versus actual boreholes logged. Some factors prevented the recommended boreholes from being logged or precluded logging of the full depth of the boreholes. Because of several factors, including the lighter weight of the logging tools being lowered on a cable compared to the 1-inch PVC used to test the borehole integrity, length of the logging tools, and presence of voids (or other issues related to borehole integrity), only a few borings could be logged to total depth. The configuration of the downhole probes would occasionally not allow advancement through soft materials. Significant voids identified in the geotechnical boring logs also caused difficulty in geophysical logging.
<table>
<thead>
<tr>
<th>Recommended Borehole</th>
<th>Actual Borehole Logged</th>
<th>Approximate Depth Logged</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>B-2</td>
<td>59 ft.</td>
</tr>
<tr>
<td>B-3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>B-4</td>
<td>38 ft.</td>
</tr>
<tr>
<td>B-6</td>
<td>B-6</td>
<td>34 ft.</td>
</tr>
<tr>
<td>B-7</td>
<td>B-7</td>
<td>59 ft.&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>B-9</td>
<td>B-9</td>
<td>52 ft.</td>
</tr>
<tr>
<td>B-10</td>
<td>B-10</td>
<td>51 ft.&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>B-21</td>
<td>B-21</td>
<td>43 ft.</td>
</tr>
<tr>
<td>B-22</td>
<td>B-22</td>
<td>60 ft.</td>
</tr>
<tr>
<td>B-5&lt;sup&gt;a&lt;/sup&gt; (alternate)</td>
<td>B-11</td>
<td>54 ft.</td>
</tr>
</tbody>
</table>

<sup>a</sup> Boreholes B-1, B-3, and B-5 had obstructions at shallow depths and were not logged.

<sup>b</sup> In borehole B-7, the caliper tool reached 59 ft. but the gamma tool could only reach approximately 40 ft.

<sup>c</sup> In borehole B-10, the gamma tool reached 51 ft. but the caliper tool could only reach approximately 26 ft.

Geophysical logs are provided in Appendix B.
3.0 GENERAL SUBSURFACE CONDITIONS

3.1 ENCOUNTERED SOIL AND ROCK CONDITIONS

As discussed in Section 1.0, the Outfall 200 Mercury Treatment Facility areas are underlain by a relatively thin interval (5 To 26 feet) of clayey overburden soil which then overlies the Maynardville Limestone formation –massive-to-thinly-bedded limestone with lesser amounts of dolostone. Depth to auger refusal and depth to top of rock are recorded on the drilling logs (Appendix A) and summarized in Table 2. As noted in previous investigations, recovered rock cores consisted of dark gray and gray limestone and dolostone with fractured and weathered zones. The recovery percentages and the RQD of the rock cores varied significantly throughout this geotechnical data gap investigation.

Table 2. Depth to Top of Bedrock/Auger Refusal

<table>
<thead>
<tr>
<th>Borehole</th>
<th>As-Built Surface Elevation (ft. amsl.)</th>
<th>Depth to Auger Refusal (ft.)</th>
<th>Depth to Top of Rock (ft.)</th>
<th>Elevation of Top of Rock (ft. amsl.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>935.6</td>
<td>10.8</td>
<td>11.8</td>
<td>923.8</td>
</tr>
<tr>
<td>B-2</td>
<td>935.2</td>
<td>8</td>
<td>8.2</td>
<td>927.0</td>
</tr>
<tr>
<td>B-3</td>
<td>935.7</td>
<td>4.7</td>
<td>4.7</td>
<td>931.0</td>
</tr>
<tr>
<td>B-4</td>
<td>935.6</td>
<td>5.5</td>
<td>5.5</td>
<td>930.1</td>
</tr>
<tr>
<td>B-5</td>
<td>937.4</td>
<td>20.5</td>
<td>20.6</td>
<td>916.8</td>
</tr>
<tr>
<td>B-6</td>
<td>935.6</td>
<td>7.1*</td>
<td>15</td>
<td>920.6</td>
</tr>
<tr>
<td>B-7</td>
<td>936.0</td>
<td>17.8</td>
<td>17.8</td>
<td>918.2</td>
</tr>
<tr>
<td>B-8</td>
<td>935.1</td>
<td>19</td>
<td>18.8</td>
<td>916.3</td>
</tr>
<tr>
<td>B-9</td>
<td>935.6</td>
<td>22</td>
<td>24.6</td>
<td>911.0</td>
</tr>
<tr>
<td>B-10</td>
<td>935.7</td>
<td>17.2</td>
<td>17.2</td>
<td>918.5</td>
</tr>
<tr>
<td>B-11</td>
<td>935.5</td>
<td>20.9</td>
<td>21.9</td>
<td>913.6</td>
</tr>
<tr>
<td>B-12</td>
<td>935.7</td>
<td>27</td>
<td>26.3</td>
<td>909.4</td>
</tr>
<tr>
<td>B-14</td>
<td>935.8</td>
<td>26.8</td>
<td>26.5</td>
<td>909.3</td>
</tr>
<tr>
<td>B-15</td>
<td>926.4</td>
<td>18.5</td>
<td>18.6</td>
<td>907.8</td>
</tr>
<tr>
<td>B-16</td>
<td>926.6</td>
<td>17.3</td>
<td>17.2</td>
<td>909.4</td>
</tr>
<tr>
<td>B-17</td>
<td>926.4</td>
<td>16</td>
<td>16.1</td>
<td>910.3</td>
</tr>
<tr>
<td>B-18</td>
<td>926.3</td>
<td>7*</td>
<td>20.3</td>
<td>906.0</td>
</tr>
<tr>
<td>B-19</td>
<td>926.4</td>
<td>18</td>
<td>17.8</td>
<td>908.6</td>
</tr>
<tr>
<td>B-20A</td>
<td>926.0</td>
<td>5.3*</td>
<td>21.6</td>
<td>904.4</td>
</tr>
<tr>
<td>B-21</td>
<td>926.4</td>
<td>18.1</td>
<td>17.9</td>
<td>908.5</td>
</tr>
<tr>
<td>B-22</td>
<td>926.1</td>
<td>17.6</td>
<td>17.4</td>
<td>908.7</td>
</tr>
</tbody>
</table>

* Indicates locations where drillers switched to rock coring after encountering a boulder

3.2 ENCOUNTERED Voids

Voids in the rock were encountered in most of the borings. Table 3 summarizes the depth intervals where voids were encountered and characteristics of the void(s). Detailed information about the depth interval and character of voids is presented on the drillings logs (Appendix A).
<table>
<thead>
<tr>
<th>Borehole</th>
<th>Void Interval(s) (feet below ground surface)</th>
<th>Infilling/Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>16.7 17.2</td>
<td>No infilling</td>
</tr>
<tr>
<td>B-2</td>
<td>9.9   10.1</td>
<td>Some brown silty clay*, trace sand infilling</td>
</tr>
<tr>
<td></td>
<td>11.8  12.1</td>
<td>Some brown silty clay*, trace sand infilling</td>
</tr>
<tr>
<td>B-3</td>
<td>12.2  14</td>
<td>Brown medium stiff silty clay with highly fractured rock. Driller’s report: mud seam at 12.5’</td>
</tr>
<tr>
<td></td>
<td>37.3  37.8</td>
<td>No infilling</td>
</tr>
<tr>
<td>B-4</td>
<td>7.8   11.4</td>
<td>Some highly fractured rock with medium stiff to stiff brown silty clay infilling*</td>
</tr>
<tr>
<td></td>
<td>11.4  16.4</td>
<td>Some highly fractured rock with medium stiff to stiff brown silty clay infilling*</td>
</tr>
<tr>
<td>B-5</td>
<td>22.1  22.8</td>
<td>Some intensely fractured rock with medium stiff to stiff brown clay infilling</td>
</tr>
<tr>
<td></td>
<td>33.8  34.9</td>
<td>No infilling</td>
</tr>
<tr>
<td>B-6</td>
<td>38.6  40.4</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>54.7  55.7</td>
<td>No infilling. Driller’s report: likely lost core piece from 54.7’ to 55.7’</td>
</tr>
<tr>
<td></td>
<td>55.7  55.8</td>
<td>Some intensely fractured rock with grayish brown silty clay infilling</td>
</tr>
<tr>
<td></td>
<td>58    59.2</td>
<td>Some intensely fractured rock with medium stiff grayish brown silty clay infilling</td>
</tr>
<tr>
<td>B-7</td>
<td>32.6  34.9</td>
<td>No infilling**</td>
</tr>
<tr>
<td></td>
<td>35.6  40.5</td>
<td>No infilling*</td>
</tr>
<tr>
<td></td>
<td>45    46.1</td>
<td>Some intensely fractured rock, no infilling</td>
</tr>
<tr>
<td>B-8</td>
<td>59.1  62.7</td>
<td>Some soft gray clay infilling</td>
</tr>
<tr>
<td>B-9</td>
<td>30.4  30.8</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>21.7  24.6</td>
<td>No infilling**. Driller’s report: likely edge of cavity with brown silty clay infilling from overburden</td>
</tr>
<tr>
<td></td>
<td>36.2  37.3</td>
<td>Some intensely fractured rock, no infilling**. Driller’s report: mud seam</td>
</tr>
<tr>
<td></td>
<td>45.7  49</td>
<td>No infilling*. Driller’s report: likely lost core piece from 46.2’ to 46.6’</td>
</tr>
<tr>
<td></td>
<td>55.9  57.4</td>
<td>No infilling</td>
</tr>
</tbody>
</table>

Notes:  
*possible clay infilling also indicated by geophysical logs  
**possible open void also indicated by geophysical logs
Table 3 (continued). Void Intervals in Borings (B-10 through B-18)

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Void Interval(s) (feet below ground surface)</th>
<th>Infilling/Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-10</td>
<td>19.3            23.2</td>
<td>No infilling*</td>
</tr>
<tr>
<td></td>
<td>25.4            27.5</td>
<td>Intensely fractured rock with soft brown silty clay infilling. Driller’s report: likely lost core piece from 26.3’ to 27.4’</td>
</tr>
<tr>
<td></td>
<td>28.2            29.9</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>35.8            36.1</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>37              39.1</td>
<td>Some soft brown silty clay infilling* with highly fractured rock</td>
</tr>
<tr>
<td></td>
<td>58.5            58.6</td>
<td>Some gray clay infilling with intensely fractured rock</td>
</tr>
<tr>
<td>B-11</td>
<td>20.9            21.9</td>
<td>Some brown clayey silt infilling* with intensely fractured rock</td>
</tr>
<tr>
<td>B-12</td>
<td>33.8            34.6</td>
<td>No infilling</td>
</tr>
<tr>
<td>B-14</td>
<td>55              55.1</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>58.8            59.7</td>
<td>No infilling</td>
</tr>
<tr>
<td>B-15</td>
<td>20.2            20.5</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>20.9            25.9</td>
<td>No infilling**. Driller’s report: likely on the edge of cavity</td>
</tr>
<tr>
<td></td>
<td>30.8            32.2</td>
<td>Some intensely fractured rock, no infilling</td>
</tr>
<tr>
<td></td>
<td>34.4            35.9</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>35.9            47.1</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>49              49.5</td>
<td>No infilling</td>
</tr>
<tr>
<td>B-16</td>
<td>30.4            31</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>40.5            42.4</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>47              48.6</td>
<td>Some highly fractured rock, no infilling</td>
</tr>
<tr>
<td>B-17</td>
<td>32.3            35</td>
<td>Intensely fractured rock, no infilling. Driller’s report: possible brown silty sand infilling</td>
</tr>
<tr>
<td></td>
<td>35.4            36.3</td>
<td>No infilling recovered. Driller’s report: possible brown silty sand infilling</td>
</tr>
<tr>
<td></td>
<td>49.3            50.7</td>
<td>No infilling recovered. Driller’s report: possible brown silty clay infilling</td>
</tr>
<tr>
<td>B-18</td>
<td>8.4             20.3</td>
<td>No recovery. Driller’s report: possible overburden soil of grayish brown silty clay, began coring when boulder encountered</td>
</tr>
<tr>
<td></td>
<td>20.3            20.9</td>
<td>No infilling. Driller’s report: made contact with possible pinnacled rock from 20.3’ to 20.9’</td>
</tr>
<tr>
<td></td>
<td>20.9            22.2</td>
<td>Some very soft brown silty clay infilling with intensely fractured rock</td>
</tr>
<tr>
<td></td>
<td>22.6            27.2</td>
<td>No infilling</td>
</tr>
<tr>
<td></td>
<td>34.4            35.9</td>
<td>No infilling</td>
</tr>
</tbody>
</table>

Notes: *possible clay infilling also indicated by geophysical logs
**possible open void also indicated by geophysical logs
Table 3 (continued). Void Intervals in Borings (B-19 through B-22)

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Void Interval(s)</th>
<th>Infilling/Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(feet below ground surface)</td>
<td></td>
</tr>
<tr>
<td>B-19</td>
<td>22.4</td>
<td>23.5</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>30.8</td>
</tr>
<tr>
<td></td>
<td>41.1</td>
<td>41.3</td>
</tr>
<tr>
<td></td>
<td>44.3</td>
<td>51.2</td>
</tr>
<tr>
<td>B-20A</td>
<td>6.6</td>
<td>9.9</td>
</tr>
<tr>
<td></td>
<td>11.6</td>
<td>21.6</td>
</tr>
<tr>
<td></td>
<td>25.9</td>
<td>26.9</td>
</tr>
<tr>
<td></td>
<td>30.2</td>
<td>31.6</td>
</tr>
<tr>
<td></td>
<td>34.5</td>
<td>40.3</td>
</tr>
<tr>
<td>B-21</td>
<td>22.9</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>28.4</td>
<td>29.4</td>
</tr>
<tr>
<td>B-22</td>
<td>33</td>
<td>35.3</td>
</tr>
</tbody>
</table>

Notes:  *possible clay infilling also indicated by geophysical logs  
**possible open void also indicated by geophysical logs

### 3.3 OTHER OBSERVATIONS

During the course of soil boring and rock coring activities, the following additional observations were made for each of the following borings:

- **B-1**: Shifted boring 9 feet south of original location due to access restrictions.
- **B-2**: Shifted boring 10 feet south of original location due to access restrictions. Hydraulic leak detected after auger refusal. Ended drilling to resume drilling on the next day, following repairs. No changes in boring noted between days.
- **B-3**: Shifted boring 9.7 feet south of original location due to access restrictions.
- **B-4**: Shifted boring approximately 10 feet south of original location due to access restrictions.
- **B-5**: Shifted boring 2 feet east/downhill of original location due to access restrictions. Added bentonite to drilling fluid to blind highly permeable overburden soils previously causing fluid loss.
- **B-6**: Shifted boring 1.5 feet east/downhill of original location due to access restrictions.
- **B-8**: On run #4, return drilling fluid was clean, despite drilling mud being used for drilling.
- **B-10**: While coring B-10, noticed drilling fluid (water) coming out of B-11, which had a casing from the top of rock with 4.5’ stickup above ground surface. It was postulated that the fluid travelled from the moderately weathered portions of B-11 in interval 37.8’ to 38.4’, because this interval is about the same depth of the void encountered in B-10 from 37’ to 39.1’.
- **B-11**: Original location of B-11 had concrete underneath gravel; moved boring 4 feet east of original location.
- **B-13**: Was terminated at 3 feet depth due to a concrete obstruction. After relocating 15 feet east, another concrete obstruction was encountered at the same depth during drilling. Drilling at location B-13 was therefore discontinued.
- **B-15**: Brown muddy water was recovered in drilling fluid tank from void encountered in Run #1.
• B-18: Top of rock was indicated as 20.3’ although auger refusal was at 8.4’ due to encountering a boulder at 8.4’. Although there was no recovery using the HQ wireline system after encountering the boulder, the drillers reported that overburden soil was encountered.

• B-20: While drilling B-20, encountered a heavy gaged steel pipe at a depth of 10.5’. Drilling did not break the pipe. Abandoned hole and appropriate site representatives visited to consult on where the new boring should be drilled.

• B-20A: Shifted boring 3 feet west of B-20 location due to encountering a buried utility at the original location. At a depth between 6.6’ to 11.6’, the driller smelled a scent similar to lighter fluid and stopped drilling until the problem was resolved. Top of rock was indicated as 21.6’ although auger refusal was at 5.3’ due to encountering a boulder at 5.3’. Although there was no recovery using the HQ wireline system after encountering the boulder, the drillers reported that overburden soil was encountered.

• B-22: Industrial hygienist detected trichloroethylene (TCE) above acceptable levels in soil. Halted operations and continued on the next workday. No detection the next day.

3.4 HEADCUT ERODIBILITY INDEX

The engineering analysis consisted of calculating the headcut erodibility index (USDA Headcut Erodibility Index Manual 2001) for the rock encountered during the rock core drilling activities performed at the site. This information is presented to aid readers of this report in their assessment of anticipated working conditions when excavating at the site. The headcut erodibility index predicts the effort required for excavation of the rock, expressed in flywheel horsepower (hp), based on the strength of the rock, the RQD, the roughness and size of the joints in the rock, and the ground structure of joints in the rock strata. The calculation of the headcut erodibility index was performed for the top 5-foot interval from two representative core runs – one with relatively weathered and jointed rock and one with relatively intact rock – in order to bracket the anticipated excavation conditions based on the rock cores performed. The calculation of the headcut erodibility index is explained below.

The dimensionless headcut erodibility index is the scalar product of four indices and is calculated using Equation 1 (USDA Headcut Erodibility Index Manual 2001).

\[ K_h = M_s \times K_b \times K_d \times J_s \]  

where

- \( K_h \) = headcut erodibility index
- \( M_s \) = material strength number of the earth material
- \( K_b \) = block or particle size number
- \( K_d \) = discontinuity or interparticle bond shear strength number
- \( J_s \) = relative ground structure number

3.4.1 Material Strength Number

The dimensionless material strength number (\( M_s \)) for rocks is approximately defined using the uniaxial compressive strength (UCS) of rocks by Equation 2.

\[ M_s = UCS \quad \text{for } UCS > 10 \text{ MPa} \]  

where

\[ UCS = \text{uniaxial compressive strength of the intact rock sample [MPa]} \]

The range of UCS values determined from laboratory testing performed by GEOserives (2016) is used in this analysis to determine the overall range of anticipated headcut erodibility index \( (K_h) \) values. GEOserives (2016) tested selected rock cores and obtained values of UCS between 59 and 142 MPa. For this analysis, a value of 59 MPa is paired with the low RQD value and a value of 142 MPa is paired with the high RQD value to obtain the maximum and minimum estimates of \( K_h \).

### 3.4.2 Block or Particle Size Number

For rocks, the primary method to calculate the block number \( (K_b) \) is using Equation 3.

\[
K_b = \frac{RQD}{J_n}
\]  

(3)

where

- \( RQD = \text{rock quality designation [%]} \)
- \( J_n = \text{joint set number} \)

The RQD of all core runs was calculated as explained in the earlier sections and the results are presented in Appendix A. The joint set number is a scale factor accounting for the shape of the material units or the relative occurrence of different joint sets (USDA Headcut Erodibility Index Manual 2001). The joint set number of each core run was assigned in accordance with the USDA Headcut Erodibility Index Manual (2001) and is presented in Table 4.

### 3.4.3 Discontinuity or Interparticle Bond Shear Strength Number

The discontinuity or interparticle bond shear strength number \( (K_d) \) is calculated using Equation 4.

\[
K_d = \frac{J_r}{J_a}
\]  

(4)

where

- \( J_r = \text{joint roughness number} \)
- \( J_a = \text{joint alteration number} \)

The joint roughness number represents the degree of roughness of opposing faces of a rock discontinuity and the joint alteration number represents the degree of alteration of the materials that form the faces. General observations of the joint roughness and degree of alteration of materials were made during rock coring. Rock coring illustrations on the written boring logs provided further insight to these values. Both numbers were obtained from tables presented in the USDA Headcut Erodibility Index Manual (2001) and are presented in Table 4.
3.4.4 Relative Ground Structure Number

The relative ground structure number ($J_s$) represents the orientation of the effective dip of the least favorable discontinuity with respect to spillway flow. Most of the joint sets encountered at the site were inclined to about 40 degrees. The index, $J_s$, was accordingly selected for a representative core run, per USDA Headcut Erodibility Index Manual (2001) and is presented in Table 4.

The four indices were assigned to the representative core runs and the headcut erodibility index was calculated. In accordance with USDA Engineering Classification Manual (2012), each representative core run was assigned an excavation class and the minimum horsepower rating of equipment needed for rock excavation. All the relevant parameters for this analysis are presented in Table 4.

Based on the information presented in Table 4 and field observations during the geotechnical investigation, it was determined that the rock encountered at the project site can be excavated using conventional equipment with a minimum flywheel horsepower rating of 500, assuming equipment is heavy-duty, track-type backhoe or tractor equipped with a single tine, rear-mounted ripper (USDA Engineering Classification Manual 2012).

<table>
<thead>
<tr>
<th>Location</th>
<th>Core Run #</th>
<th>M_s</th>
<th>K_b</th>
<th>K_d</th>
<th>J_r</th>
<th>J_a</th>
<th>J_r/J_a</th>
<th>K_h</th>
<th>Excavation Class</th>
<th>Min. Equipment Power (hp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-3</td>
<td>1</td>
<td>142</td>
<td>100%</td>
<td>1</td>
<td>100</td>
<td>1.5</td>
<td>1.5</td>
<td>1</td>
<td>21,300</td>
<td>Drilling and blasting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;500</td>
</tr>
<tr>
<td>B-7</td>
<td>1</td>
<td>59</td>
<td>31%</td>
<td>2.73</td>
<td>11.36</td>
<td>1.5</td>
<td>1.5</td>
<td>0.49</td>
<td>492</td>
<td>Very hard ripping</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;350</td>
</tr>
</tbody>
</table>
4.0 REFERENCES


GEOTECHNICAL REPORT FOR DATA GAP
CHARACTERIZATION AT THE PROPOSED OUTFALL 200
MERCURY TREATMENT FACILITY SITES
January 2017

Appendix A – Boring Logs
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Topsoil and gray gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Auger refusal at 10.8' (possible boulder)</td>
<td>Brown silty clay, trace gravel and organics</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Top of rock at 11.8' fracture(20°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, trace brown silty clay</td>
<td>Run: 1 11.8 - 12.6 Recovery: 0.8 ft. Recovery: 100.0% RQD = 89.0%</td>
</tr>
<tr>
<td>13</td>
<td>fracture(65°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

---

**Legend**

- soil
- dolostone
- limestone
- void

---

**Notes:**
- Backfilled with grout using tremie method

**Backfilled with grout using tremie method**
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td>clay and calcite and/or dolomite at joints, totally healed veins, occasional totally healed calcite and/or dolomite veins</td>
<td>No. of Pieces: 3</td>
<td>1.59</td>
<td>922</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins, occasional totally healed calcite and/or dolomite veins</td>
<td>Pressure: 10 psi</td>
<td>1.78</td>
<td>921</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>fracture(0°)</td>
<td>void from 16.7' to 17.2', no infilling</td>
<td>Fluid Return: 100%</td>
<td>1.68</td>
<td>920</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>fracture(0°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins, occasional totally healed calcite and/or dolomite veins</td>
<td>Drilling Action: Smooth</td>
<td>1.4</td>
<td>919</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td>Total Time: 4m:54s</td>
<td>1.28</td>
<td>918</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Highly fractured fracture(65°)</td>
<td></td>
<td>Run: 2</td>
<td>1.24</td>
<td>917</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>fracture(40°)</td>
<td></td>
<td>12.6 - 17.6</td>
<td>1.08</td>
<td>916</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>fracture(35°)</td>
<td></td>
<td>Recovery: 4.5 ft.</td>
<td>1.75</td>
<td>915</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>fracture(70°)</td>
<td></td>
<td>Recovery: 90.0%</td>
<td>1.27</td>
<td>914</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td>RQD = 82.0%</td>
<td>1.78</td>
<td>913</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>fracture(20°)</td>
<td></td>
<td>No. of Pieces: 2</td>
<td>1.08</td>
<td>912</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td>Pressure: 10 psi</td>
<td>1.75</td>
<td>911</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td>Fluid Return: 0%</td>
<td>1.27</td>
<td>910</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td>Drilling Action: Smooth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Notes:
- Backfilled with grout using tremie method

Legend:
- soil
- dolostone
- limestone
- void

**Page 2 of 5**
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td></td>
<td>healed veins</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, unfractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins</td>
</tr>
</tbody>
</table>
| 27        | fracture(45°)                     |            | Run: 5 27.6 - 32.6  
Recovery: 5.1 ft.  
Recovery: 102.0%  
RQD = 100.0%  
No. of Pieces: 1  
Pressure: 12 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 10m:30s |
| 28        | fracture(0°)                      |            | Run: 6 32.6 - 37.6  
Recovery: 4.9 ft.  
Recovery: 98.0%  
RQD = 90.0%  
No. of Pieces: 9  
Pressure: 12 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 8m:36s |
| 29        |                                   |            | Run: 7 37.6 - 42.6  
Recovery: 5 ft.  
Recovery: 100.0%  
RQD = 100.0%  
No. of Pieces: 3 |
| 30        |                                   |            | Backfilled with grout using tremie method |

* Coring rate not recorded due to rod drop in this run  
** Rod drop in this interval  
+ Some of total time not recorded  

Page 3 of 5
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>fracture(30°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>fracture(25°)</td>
<td>Intensely fractured</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>fracture(15°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pressure: 12 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 4m:57s  

Run: 8  
42.6 - 47.6 ft.  
Recovery: 4.9 ft.  
Recovery: 98.0%  
RQD = 93.0%  
No. of Pieces: 5  
Pressure: 12 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 5m:24s  

Run: 9  
47.6 - 52.6 ft.  
Recovery: 4.9 ft.  
Recovery: 98.0%  
RQD = 98.0%  
No. of Pieces: 2  
Pressure: 12 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 4m:37s  

* Coring rate not recorded due to rod drop in this run  
** Rod drop in this interval  
* Some of total time not recorded  

Notes: Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>fracture(0°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, slightly to moderately fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, moderately healed veins with brown silty clay infill</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>fracture(70°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>End of boring recovery at 60'</td>
<td></td>
</tr>
</tbody>
</table>

Run: 10
52.6 - 57.6
Recovery: 5 ft.
Recovery: 100.0%
RQD = 100.0%
No. of Pieces: 3
Pressure: 12 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 5m:05s

Run: 11
57.6 - 60.2
Recovery: 2.6 ft.
Recovery: 100.0%
RQD = 83.3%
No. of Pieces: 4
Pressure: 12 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 3m:12s

Legend
- soil
- dolostone
- limestone
- void
Auger refusal at 8' 
Top of rock at 8.2'
fracture(20°)
fracture(45°)

Dark gray and light gray limestone and dolostone, fine grained, highly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

Void from 9.9' to 10.1', some brown silty clay, trace sand infilling

Hollow-Stem Auger refusal, no sample collected. Brown sandy silt

Run: 1
8.2 - 12.8
Recovery: 90.0%
RQD = 78.0%
No. of Pieces: 4
Pressure: 15 psi
Fluid Return: 80%
Drilling Action: Smooth
Total Time: 11m

Hydraulic leak detected after auger refusal. Ended drilling to begin on the next day, following repairs. No changes in boring noted between days.

Notes:
- Backfilled with grout using tremie method
- Soil: 60%
- Dolostone: 20%
- Limestone: 20%

Legend
- Soil
- Dolostone
- Limestone
- Void

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded
### Core Details and Lithology

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>fracture(0°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>fracture(15°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>fracture(30°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>Highly Fractured</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Drilling Details

<table>
<thead>
<tr>
<th>Run</th>
<th>Depth (ft)</th>
<th>Recovery</th>
<th>RQD</th>
<th>No. of Pieces</th>
<th>Pressure</th>
<th>Fluid Return</th>
<th>Drilling Action</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>12.8 - 17.8</td>
<td>4.9 ft.</td>
<td>98.0%</td>
<td>2</td>
<td>75 psi</td>
<td>80%</td>
<td>Smooth</td>
<td>11m</td>
</tr>
<tr>
<td>3</td>
<td>17.8 - 22.8</td>
<td>5.18 ft.</td>
<td>98.0%</td>
<td>4</td>
<td>15 psi</td>
<td>70%</td>
<td>Smooth</td>
<td>15m</td>
</tr>
<tr>
<td>4</td>
<td>22.8 - 27.8</td>
<td>5.05 ft.</td>
<td>96.0%</td>
<td>4</td>
<td>25 psi</td>
<td>70%</td>
<td>Smooth</td>
<td>6m</td>
</tr>
</tbody>
</table>

**Legends:**
- soil
- dolostone
- limestone

**Notes:**
- Coring rate not recorded due to rod drop in this run
- *Rod drop in this interval*
- Some of total time not recorded
- Backfilled with grout using tremie method
Dolomite at joints, totally healed veins

Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

Rate (min/ft) 2 4 6
Lithology soil dolostone limestone
Core Details Remarks
Depth (ft) Core Details Lithology Remarks Rate (min/ft) Elevation (ft)
26
27 fracture(0°)

28 fracture(0°)
Highly fractured
Some brown silt and sand infilling at open joint

29 fracture(50°)

30 fracture(50°)

31 fracture(50°)

32 fracture(45°)
Highly fractured
fracture(0°)

33 fracture(45°)

34 fracture(45°)

35 fracture(45°)

36 fracture(55°)

37 fracture(0°)

38 fracture(0°)

39 fracture(0°)
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 39        |              | Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | No. of Pieces: 5  
Pressure: 20 psi  
Drilling Action: Smooth  
Total Time: 3m:55s |
| 40        | fracture(0°) |           | 0.417   |
| 41        |              |           | 0.067   |
| 42        |              |           | 0.083   |
| 43        | fracture(0°) |           | 0.95    |
|           | Intensely fractured |           | 1.02    |
| 44        | Moderately healed fracture (70°) | Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | Run: 8  
42.8 - 47.8  
Recovery: 4.86 ft  
Recovery: 97.2%  
RQD = 96.0%  
No. of Pieces: 3  
Pressure: 27.5 psi  
Fluid Return: 80%  
Drilling Action: Smooth  
Total Time: 5m:15s |
| 45        |              |           | 1.05    |
| 46        |              |           | 1.13    |
| 47        | fracture(35°) |           | 0.417   |
| 48        | fracture(0°) |           |         |
| 49        | fracture(25°) |           |         |
| 50        | fracture(65°) | Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | Run: 9  
47.8 - 52.8  
Recovery: 5.2 ft  
Recovery: 104.0%  
RQD = 104.0%  
No. of Pieces: 4  
Pressure: 27.3 psi  
Fluid Return: 80%  
Drilling Action: Smooth  
Total Time: 5m:24s |
| 51        |              |           | 1.13    |
| 52        |              |           | 0.22    |

* Coring rate not recorded due to rod drop in this run  
** Rod drop in this interval  
+ Some of total time not recorded

---

**Legend**

- soil
- dolostone
- limestone
- void

**Notes:** Backfilled with grout using tremie method
Dark gray and light gray limestone and dolostone, fine grained, unfractured, hard, unweathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins.

End of boring recovery at 60.4'
Topsoil, gray gravel

Hollow-Stem Auger refusal, no sample collected. Brown silty sand

Auger refusal/Top of rock at 4.7', Intensely fractured at open joint, fracture(40°)

Dark gray and light gray limestone and dolostone, fine grained, unfractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

Run: 1
4.7 - 7.8
Recovery: 3.1 ft.
Recovery: 100.0%
RQD = 100.0%
No. of Pieces: 1
Pressure: 25 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 7m:45 +

fracture(50°)

Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

Run: 2
7.8 - 12.8
Recovery: 4.6 ft.
Recovery: 92.0%
RQD = 87.0%
No. of Pieces: 2
Pressure: 20 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 11m:40s

fracture(0°)

moderately weathered and some brown silty clay at open joint

fracture(30°)

void from 12.2' to 12.8', no infilling. Driller reported mud seam at 12.5'

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded

Notes:
Backfilled with grout using tremie method

Legend

soil  dolostone  limestone  void
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>fracture(55°)</td>
<td>some brown medium stiff silty clay and intensely fractured rock at open joint</td>
<td></td>
<td>2.15</td>
<td>922</td>
</tr>
<tr>
<td>15</td>
<td>fracture(45°)</td>
<td>some brown silty clay at open joint</td>
<td></td>
<td>2.15</td>
<td>921</td>
</tr>
<tr>
<td>16</td>
<td>fracture(35°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins</td>
<td>Run: 3 12.8 - 17.8</td>
<td>1.57</td>
<td>920</td>
</tr>
<tr>
<td>17</td>
<td>fracture(60°)</td>
<td></td>
<td></td>
<td>1.57</td>
<td>919</td>
</tr>
<tr>
<td>18</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
<td>1.59</td>
<td>918</td>
</tr>
<tr>
<td>19</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
<td>1.59</td>
<td>917</td>
</tr>
<tr>
<td>20</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
<td>1.08</td>
<td>916</td>
</tr>
<tr>
<td>21</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
<td>1.08</td>
<td>915</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>Intensely fractured</td>
<td></td>
<td>1.15</td>
<td>914</td>
</tr>
<tr>
<td>23</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
<td>1.15</td>
<td>913</td>
</tr>
<tr>
<td>24</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
<td>1.20</td>
<td>912</td>
</tr>
<tr>
<td>25</td>
<td>fracture(30°)</td>
<td></td>
<td></td>
<td>1.27</td>
<td>911</td>
</tr>
<tr>
<td>26</td>
<td>Brown silty clay staining</td>
<td></td>
<td></td>
<td>1.08</td>
<td>910</td>
</tr>
</tbody>
</table>

- **Coring rate not recorded due to rod drop in this run**
- **Rod drop in this interval**
- *Some of total time not recorded*

Notes: Backfilled with grout using tremie method
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>fracture(0°)</td>
<td>healed veins</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>Dark gray and light gray limestone and dolostone, fine grained, slightly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
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<td></td>
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<td>33</td>
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<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>driller reported fluid loss at 37.2'</td>
<td>void from 37.2' to 37.8', no infilling. Driller reported void from 37.4' to 37.8'</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Intensely fractured rock with trace brown silt and sand at open joint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Remarks

**Lithology**

- Dark gray and light gray limestone and dolostone, fine grained, unfractured, hard, unweathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins

**Run: 6**
- 27.8 - 32.8
- Recovery: 5.1 ft.
- Recovery: 102.0%
- RQD = 102.0%
- No. of Pieces: 1
- Pressure: 15 psi
- Fluid Return: 100%
- Drilling Action: Smooth
- Total Time: 9m:27s

**Run: 7**
- 32.8 - 37.8
- Recovery: 4.41666666666667 ft.
- Recovery: 88.3%
- RQD = 88.0%
- No. of Pieces: 2
- Pressure: 15 psi
- Fluid Return: 35%
- Drilling Action: Smooth
- Total Time: 8:03s +

**Run: 8**
- 37.8 - 42.8
- Recovery: 4.8 ft.
- Recovery: 96.0%
- RQD = 94.0%

---

### Notes:

- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded

---

### Legend

- Legend: soil dolostone limestone void

---

### Client Information

- Project Number: 1168070004
- Project Name: Y-12 Outfall 200
- Project Location: Oak Ridge, TN
- Client Name: Strata-G
- Date Started: 11/8/2016
- Time Started: 2:40 PM
- Logged By: A. Spears
- Completed: 11/9/2016
- Completed: 8:54 AM
- Checked By: K. Foye
**Core Details**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 39         |              | Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | No. of Pieces: 8  
Pressure: 40 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 8m:59s |
| 40         | fracture(0°) | Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | Run: 9  
42.8 - 47.8  
Recovery: 5.2 ft.  
Recovery: 104.0%  
RQD = 103.0%  
No. of Pieces: 1  
Pressure: 15 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 7m:18s |
| 41         | fracture(0°) | Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | Run: 10  
47.8 - 52.8  
Recovery: 5 ft.  
Recovery: 100.0%  
RQD = 100.0%  
No. of Pieces: 2  
Pressure: 15 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 8m:11s |
| 42         | fracture(30°) | Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | |
| 43         | Frequent moderately weathered veins with brown silty clay infilling | |
| 44         |              | Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silty clay and calcite and/or dolomite at joints, totally healed veins | |
| 45         |              | |
| 46         |              | |
| 47         |              | |
| 48         | fracture(0°) | |
| 49         | Partly healed vein | |
| 50         |              | |
| 51         |              | |
| 52         |              | |

**Legend**

- **soil**
- **limestone**
- **void**
- **dolostone**

**Notes:**
- Backfilled with grout using tremie method

---

*Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>fracture(0°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, trace brown silt, brown sand, and calcite and/or dolomite at joints, totally healed veins</td>
<td>Run: 11</td>
</tr>
<tr>
<td>53</td>
<td>Highly fractured</td>
<td></td>
<td>Recovery: 5 ft.</td>
</tr>
<tr>
<td>54</td>
<td>fracture(0°)</td>
<td></td>
<td>Recovery: 100.0%</td>
</tr>
<tr>
<td>55</td>
<td>Intensely fractured</td>
<td></td>
<td>RQD = 90.8%</td>
</tr>
<tr>
<td>56</td>
<td>Frequent moderately weathered veins with trace brown silt and sand infilling</td>
<td></td>
<td>No. of Pieces: 7</td>
</tr>
<tr>
<td>57</td>
<td>Mechanical breaks</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, slightly weathered, trace brown silt, brown clay, and calcite and/or dolomite at joints, totally healed veins</td>
<td>Run: 12</td>
</tr>
<tr>
<td>58</td>
<td>fracture(0°)</td>
<td>End of boring recovery at 60.2'</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Topsoil, gray gravel</td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>Auger refusal/Top of rock at 5.5' fracture(35°)</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, slightly weathered, trace brown silt, brown sand, organic roots and fibers, and calcite and/or dolomite in joints, totally healed veins, occasional calcite and/or void from 7.8' to 8.1', no infilling</td>
<td>Run: 1 5.3 - 7.8 Recovery: 2.5 ft. Recovery: 100.0% RQD = 100.0% No. of Pieces: 4 Pressure: 17 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 6m</td>
</tr>
<tr>
<td>7.8</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>fracture(30°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.4</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.4</td>
<td>void from 8.1' to 11.4', some highly fractured rock with medium stiff to stiff brown silty clay infilling, Driller reported mud seam from 8.8' to 16.5'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.7</td>
<td>void from 11.4' to 14.7', no infilling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded

**Legend**

- soil
- dolostone
- limestone
- void

**Notes:**

- Backfilled with grout using tremie method
void from 14.7' to 16.4', some highly fractured rock with medium stiff to stiff brown silty clay infilling

Dark gray and light gray limestone and dolostone, fine grained, unfractured, hard, slightly weathered, trace brown silt, brown sand, and calcite and/or dolomite in joints, frequent calcite and/or dolomite totally healed veins

Run: 4
17.8 - 22.8
Recovery: 4.8 ft.
Recovery: 96.0%
RQD = 92.5%
No. of Pieces: 3
Pressure: 50 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 9m:15s

Run: 5
22.8 - 27.8
Recovery: 5.2 ft.
Recovery: 104.0%
RQD = 100.0%
No. of Pieces: 4
Pressure: 17 psi
Fluid Return: 10%
Drilling Action: Smooth
Total Time: 6m:23s
Dark gray and light gray limestone and dolostone, fine grained, slightly to moderately fractured, hard, slightly weathered, totally healed veins, trace brown silty clay in joints, frequent calcite and/or dolomite totally healed veins.

Run: 6
27.8 - 32.8
Recovery: 5.13 ft.
Recovery: 102.6%
RQD = 101.7%
No. of Pieces: 3
Pressure: 18 psi
Fluid Return: 30%
Drilling Action: Smooth
Total Time: 6m:49s

Run: 7
32.8 - 37.8
Recovery: 4.85 ft.
Recovery: 97.0%
RQD = 97.0%
No. of Pieces: 3
Pressure: 17 psi
Fluid Return: 30%
Drilling Action: Smooth
Total Time: 6m

Run: 8
37.8 - 42.8
Recovery: 5.05 ft.
Recovery: 101.0%
RQD = 100.0%

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded

Backfilled with grout using tremie method  Page 3 of 5
Dark gray and light gray limestone and dolostone, fine grained, moderately to highly fractured, hard, slightly weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins

Lithology

Core Details

No. of Pieces: 5
Pressure: 17 psi
Fluid Return: 35%
Drilling Action: Smooth
Total Time: 6m

Remarks

Run: 9
42.8 - 47.8
Recovery: 5.15 ft.
Recovery: 103.0%
RQD = 100.0%
No. of Pieces: 2
Pressure: 17 psi
Fluid Return: 35%
Drilling Action: Smooth
Total Time: 5m:45s

Rate (min/ft)

Legend

- soil
- dolostone
- limestone
- void

Notes:
Backfilled with grout using tremie method

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

Backfilled with grout using tremie method

Notes:
**Core Details**

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<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
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<tbody>
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<tr>
<td>53</td>
<td>fracture(0°)</td>
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<tr>
<td>54</td>
<td>Highly fractured</td>
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<tr>
<td>55</td>
<td>fracture(20°)</td>
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</tr>
<tr>
<td>56</td>
<td>fracture(25°)</td>
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</tr>
<tr>
<td>57</td>
<td>fracture(35°)</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>fracture(40°)</td>
<td></td>
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<tr>
<td>59</td>
<td>fracture(50°)</td>
<td></td>
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<tr>
<td>60</td>
<td></td>
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<tr>
<td><strong>60.6</strong></td>
<td></td>
<td>End of boring recovery at 60.6'</td>
</tr>
</tbody>
</table>

**Remarks**

- Dark gray and light gray limestone and dolostone, fine grained, moderately fractured, hard, moderately weathered, totally healed veins, frequent calcite and/or dolomite totally healed veins

**Lithology**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.8 - 57.8</td>
<td>Run: 11</td>
<td></td>
</tr>
<tr>
<td>Recovery: 4.95 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery: 99.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQD = 94.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Pieces: 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure: 17 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid Return: 35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drilling Action: Smooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Time: 6m:01s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RQD = 94.0%**

**No. of Pieces: 6**

**Pressure: 17 psi**

**Fluid Return: 35%**

**Drilling Action: Smooth**

**Total Time: 6m:01s**

**Legend**

- soil
- dolostone
- limestone
- void

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

---

**Notes:**

- Backfilled with grout using tremie method
- Page 5 of 5

---

**Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN

**Drilling Method:** Hollow-Stem Auger / Rock Coring

**Core Size:** HQ 2 - 7/8"
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Overgrown weeds, gray gravel</td>
<td>Added bentonite to drilling fluid to blind highly permeable overburden soils previously causing fluid loss.</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>4</td>
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<tr>
<td>13</td>
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</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval + Some of total time not recorded

Notes: Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void

Project Number: 1168070004
Project Name: Y-12 Outfall 200
Project Location: Oak Ridge, TN
Client Name: Strata-G
Date Started: 11/11/2016
Time Started: 9:36 AM
Logged By: A. Spears
Completed: 11/11/2016
Checked By: K. Foye

Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
Drilling Method: Hollow-Stem Auger / Rock Coring
Drill Rig Model: CME 55
Core Size: HQ 2.75"/8"-HQ 2.0"/8" 4.0"/8" 6.0"/8"
Weather: Mostly Sunny 57°F

Borehole ID: B-05
Y-12 Outfall 200
Oak Ridge, TN
Strata-G
Project Number:
Project Name:
Project Location:
Client Name:
Date Started:
Time Started:
Logged By:
Completed:
Checked By:

Drilling Subcontractor:
Drilling Method:
Drill Rig Model:
Core Size:
Weather:

Tri-State Drilling, Inc., Chattanooga, TN
Hollow-Stem Auger / Rock Coring
CME 55
HQ 2.75"/8"-HQ 2.0"/8" 4.0"/8" 6.0"/8"
Mostly Sunny 57°F

Rate (min/ft) 2 4

Legend

- soil
- dolostone
- limestone
- void

Notes: Backfilled with grout using tremie method
Dark gray and light gray limestone, fine grained, hard, highly fractured, slightly weathered, frequent totally healed calcite and/or dolomite veins, some brown silt sand and calcite and/or dolomite in joints.

Void from 22.1' to 22.75', some intensely fractured rock with medium stiff to stiff brown clay infilling. Driller reported void from 20.9' to 23.5'.

Run: 1
20.7 - 25.6
Recovery: 4.35 ft.
Recovery: 88.8% 
RQD = 82.0%
No. of Pieces: 5
Pressure: 23 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 9m:06s

Run: 2

Legend

- soil
- dolostone
- limestone
- void

Notes:
Backfilled with grout using tremie method
Dark gray and light gray limestone, fine grained, hard, highly fractured, slightly weathered, frequent totally healed calcite and/or dolomite veins, some brown silty sand and calcite and/or dolomite in joints.

Dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, frequent totally healed styolite veins, frequent moderately healed veins with brown silty clay infilling.

void from 33.8' to 34.9', no infilling. Driller reported void from 33' to 35'.

Dark gray and light gray limestone, fine grained, moderately weathered, frequent totally healed styolite veins, frequent moderately healed veins with brown silty clay infilling.

void from 36.1' to 38.2', some intensely fractured rock, no infilling. Driller reported void from 36.1' to 38.2'.

Legend:
- Soil
- Dolostone
- Limestone
- Void
void from 39.05' to 39.4', some intensely fractured rock, no infilling

Light gray dolostone, fine grained, intensely fractured, occasional moderately healed veins with brown silty clay infilling

Light gray dolostone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling

Light gray dolostone, fine grained, highly to slightly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling

Light gray dolostone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling, some calcite and/or dolomite in joint, trace

Backfilled with grout using tremie method
Brown silty clay

Light gray and dark gray limestone, fine grained, highly fractured, moderately weathered, frequent moderately healed veins with brown silty clay infilling, some styolite in joints, some calcite and/or dolomite in joints

End of boring recovery at 60.6'
Project Number: 1168070004  
Project Name: Y-12 Outfall 200  
Project Location: Oak Ridge, TN  
Client Name: Strata-G  
Date Started: 11/10/2016  
Time Started: 1:05 PM  
Logged By: A. Spears  
Completed: 11/11/2016  
Completed: 8:45 AM  
Checked By: K. Foye

Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN  
Drill Rig Model: CME 55  
Core Size: HQ 2-7/8"  
Weather: Mostly Sunny 61°F

Borehole ID: B-06  
Y-12 Outfall 200  
Oak Ridge, TN  
Strata-G  
11/10/2016  
11/11/2016  
A. Spears  
K. Foye

**Coring rate not recorded due to rod drop in this run**  
**Rod drop in this interval**  
+ Some of total time not recorded

Notes: Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>driller reported fluid loss at 14'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Intensely fractured, highly weathered rock with brown silty clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Top of rock at 15' fracture(40°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Highly fractured fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Highly fractured fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Highly fractured fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>fracture(30°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Core Details**
- Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, trace brown silty clay in joints, totally healed veins, occasional totally healed calcite and/or dolomite veins.

**Remarks**
- Run: 1
  - Depth: 15 - 17.7 ft
  - Recovery: 2.7 ft
  - Recovery: 100.0%
  - RQD: 89.5%
  - No. of Pieces: 4
  - Pressure: 17 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 9m:25s

- Run: 2
  - Depth: 17.7 - 22.7 ft
  - Recovery: 5 ft
  - Recovery: 100.0%
  - RQD: 93.0%
  - No. of Pieces: 8
  - Pressure: 15 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 7m:27s

- Run: 3
  - Depth: 22.7 - 27.7 ft
  - Recovery: 5.2 ft
  - Recovery: 104.0%
  - RQD: 102.0%
  - No. of Pieces: 3
  - Pressure: 15 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 6m:07s

---

*Coring rate not recorded due to rod drop in this run
**Rod drop in this interval
+ Some of total time not recorded

**Notes:** Backfilled with grout using tremie method
<table>
<thead>
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<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>26</td>
<td>fracture(40°)</td>
<td>and/or dolomite veins</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>moderately fractured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>fracture(35°)</td>
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<tr>
<td>30</td>
<td>fracture(30°)</td>
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<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>fracture(30°)</td>
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<td>33</td>
<td>fracture(0°)</td>
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<td>fracture(55°)</td>
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<td>35</td>
<td>fracture(35°)</td>
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<td>36</td>
<td>fracture(45°)</td>
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<td>37</td>
<td>fracture(55°)</td>
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<tr>
<td>38</td>
<td>fracture(0°)</td>
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<tr>
<td>39</td>
<td>driller reported fluid loss at 38.6'</td>
<td></td>
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</table>

**Lithology**

- Dark gray and light gray limestone and dolostone, fine grained, hard, slightly to moderately fractured; slightly weathered, trace brown silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins.

**Remarks**

- Run: 4
  - Depth: 27.7 - 32.7
  - Recovery: 5 ft.
  - Recovery: 100.0%
  - RQD = 95.0%
  - No. of Pieces: 3
  - Pressure: 15 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 5m:47s

- Run: 5
  - Depth: 32.7 - 37.7
  - Recovery: 5.15 ft.
  - Recovery: 103.0%
  - RQD = 101.0%
  - No. of Pieces: 4
  - Pressure: 15 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 5m:46s

- Run: 6
  - Depth: 37.7 - 42.7
  - Recovery: 2.5 ft.
  - Recovery: 50.0%
  - RQD = 45.0%
  - No. of Pieces: 5

---

**Legend**

- soil
- dolostone
- limestone
- void

**Notes:**

- Backfilled with grout using tremie method
- Page 3 of 5
- *Coring rate not recorded due to rod drop in this run*
- **Rod drop in this interval**
- + Some of total time not recorded

---

<table>
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<th>Depth (ft)</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
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<tbody>
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<tr>
<td>Depth (ft)</td>
<td>Core Details</td>
<td>Lithology</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>39</td>
<td></td>
<td>weathered, some brown silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, slightly weathered, some brown silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins</td>
</tr>
<tr>
<td>41</td>
<td>fracture(20°)</td>
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</tr>
<tr>
<td>42</td>
<td>Highly fractured</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>fracture(35°)</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>fracture(40°)</td>
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<td>45</td>
<td>fracture(45°)</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Highly fractured</td>
<td></td>
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<tr>
<td>47</td>
<td>fracture(30°)</td>
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<tr>
<td>48</td>
<td>fracture(0°)</td>
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</tr>
<tr>
<td>49</td>
<td>Highly weathered to 50% diameter, edge of cavity</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Highly weathered to 1.5' diameter, edge of cavity</td>
<td>Driller reported lost circulation/block at 46.6', recovered core</td>
</tr>
<tr>
<td>51</td>
<td>Intensely fractured rock with brown silty clay at open joint</td>
<td>Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, highly weathered, with silty clay in joints, totally healed veins, frequent calcite and/or dolomite veins Core coated in brown silty clay, likely edge of cavity</td>
</tr>
<tr>
<td>52</td>
<td>Highly fractured, highly weathered, edge of cavity</td>
<td>void from 50.9' to 52.2', some intensely fractured rock, no infilling. Driller reported void from 51.1' to</td>
</tr>
</tbody>
</table>

**Corning rate not recorded due to rod drop in this run** **Rod drop in this interval**
+ Some of total time not recorded

** Backfilled with grout using tremie method

**Notes:**

**Legend:**

- soil
- dolostone
- limestone
- void

**Borehole ID:** B-06

**Project Number:** 1168070004

**Project Name:** Y-12 Outfall 200

**Client Name:** Strata-G

**Location:** Oak Ridge, TN

**Date Started:** 11/10/2016

**Time Started:** 1:05 PM

**Logged By:** A. Spears

**Date Completed:** 11/11/2016

**Completed:** 8:45 AM

**Checked By:** K. Foye

**Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN

**Drilling Method:** Hollow-Stem Auger / Rock Coring

**Drill Rig Model:** CME 55

**Core Size:** HQ 2 -7/8"

**Weather:** Mostly Sunny 61°F

**Pressure:** 10 psi

**Fluid Return:** 0%

**Drilling Action:** Smooth

**Total Time:** 9m

**Depth (ft) | Elevation (ft)**
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>896</td>
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<td>40</td>
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<tr>
<td>51</td>
<td>884</td>
</tr>
<tr>
<td>52</td>
<td>883</td>
</tr>
</tbody>
</table>

**Notes:**

- Core coated in brown silty clay, likely edge of cavity
- Hole backfilled with grout using tremie method
- **Rate (min/ft)**
- **Lithology**
- **Depth (ft)**
- **Elevation (ft)**
- **Legend**
- **Ground Elevation:** 935.62
- **Notes:** Backfilled with grout using tremie method
52.3'

Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, moderately weathered, some brown silty clay and calcite and/or dolomite in joints, totally healed veins, frequent calcite and/or dolomite veins

Core coated in gray void from 54.7' to 55.7', no infilling. Driller reported void at 55.7', likely lost core piece

Run: 9
52.7 - 55.7
Recovery: 2 ft.
Recovery: 66.7%
RQD = 64.0%
No. of Pieces: 2
Pressure: 55 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: Not Recorded

Highly weathered

Run: 10A
55.7 - 59.2
Recovery: 2.2 ft.
Recovery: 62.9%
RQD = 61.0%
No. of Pieces: 2
Pressure: 55 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 9m:52s

59.2', recovered core

Run: 10B
59.2 - 60.2
Recovery: 1.05 ft.
Recovery: 105.0%
RQD = 100.0%
No. of Pieces: 1
Pressure: 55 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 2m:59s

Fine grained, hard, moderately fractured, moderately weathered, some grayish brown silty clay in joints, frequently totally healed calcite and/or dolomite veins

End of boring recovery at 60.2'

Legend

- soil
- dolostone
- limestone
- void

Notes:
Backfilled with grout using tremie method
* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

**Remarks**

- Gray gravel

**Legend**

- soil
- dolostone
- limestone
- void

**Core Details**

- Depth (ft)
- Core Details
- Lithology
- Remarks
- Rate (min/ft)
- Elevation (ft)

**Depth (ft)**

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13

**Core Details**

- Water level at 10.7’ after drilling/before coring

**Lithology**

- Gray gravel

**Remarks**

- Hollow-Stem Auger to refusal, no sample collected.
- Light brown fine grained sand, brown coarse grained sand and silt, and brown silty clay

**Rate (min/ft)**

- 2
- 4

**Elevation (ft)**

- 936
- 935
- 934
- 933
- 932
- 931
- 930
- 929
- 928
- 927
- 926
- 925
- 924
- 923
### Lithology

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Water level at 17' during drilling</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Auger refusal/Top of rock at 17.8' fractured</td>
<td>Run: 1 17.8 - 20.8 Recovery: 2.85 ft Recovery: 95.0% RQD = 31.0% No. of Pieces: 4 Pressure: 45 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 9m:01s</td>
</tr>
<tr>
<td>19</td>
<td>fracture(60°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
</tr>
<tr>
<td>20</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
</tr>
<tr>
<td>21</td>
<td>fracture(50°)</td>
<td>Run: 2 20.8 - 22.7 Recovery: 1.9 ft Recovery: 100.0% RQD = 94.0% No. of Pieces: 2 Pressure: 45 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 3m:23s</td>
</tr>
<tr>
<td>22</td>
<td>fracture(55°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
</tr>
<tr>
<td>23</td>
<td>fracture(45°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
</tr>
<tr>
<td>24</td>
<td>fracture(35°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
</tr>
<tr>
<td>25</td>
<td>fracture(50°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
</tr>
</tbody>
</table>

**Legend**

- soil
- dolostone
- limestone
- void

**Notes:**

- Backfilled with grout using tremie method
- Coring rate not recorded due to rod drop in this run

**Backfilled with grout using tremie method**
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown sand and silt in joints, totally healed veins</td>
<td>Run: 4 27.7 - 32.7  Recovery: 5 ft.  RQD = 88.0%  No. of Pieces: 4</td>
</tr>
<tr>
<td>28</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown sand and silt in joints, totally healed veins</td>
<td>void from 32.6' to 34.9', no infilling. Driller reported void from 32.5' to 40.5'</td>
</tr>
<tr>
<td>30</td>
<td>fracture(35°)</td>
<td>Light gray and dark gray limestone, fine grained, highly fractured, hard, slightly weathered, trace brown sand and silt in joints, totally healed veins</td>
<td>Run: 5 32.7 - 37.7  Recovery: 0.7 ft.  RQD = 0.0%  No. of Pieces: 4</td>
</tr>
<tr>
<td>32</td>
<td>fracture(10°)</td>
<td>Light gray and dark gray limestone, fine grained, highly fractured, hard, slightly weathered, trace brown sand and silt in joints, totally healed veins</td>
<td>driller reported fluid loss at 35.6'</td>
</tr>
<tr>
<td>33</td>
<td>fracture(45°)</td>
<td>Light gray and dark gray limestone, fine grained, highly fractured, hard, slightly weathered, trace brown sand and silt in joints, totally healed veins</td>
<td>void from 35.6' to 37.7', no infilling</td>
</tr>
<tr>
<td>36</td>
<td>fracture(50°)</td>
<td>Light gray and dark gray limestone, fine grained, highly fractured, hard, slightly weathered, trace brown sand and silt in joints, totally healed veins</td>
<td>driller reported fluid loss at 35.6'</td>
</tr>
</tbody>
</table>

Notes: Backfilled with grout using tremie method.
Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins, and/or dolomite in joints.

void from 44.95' to 45.2', some intensely fractured rock, no infilling. Driller reported void from 45.2' to 46.1', some intensely fractured rock, no infilling. Driller reported void from 45.2' to 46.1'.

Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, slightly weathered, totally healed veins.

Run: 7
42.7 - 45.2 ft
Recovery: 2.5 ft
RQD = 45.0%
No. of Pieces: 7
Pressure: 15 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 11m:47s +

Run: 8
45.2 - 47.7 ft
Recovery: 1.55 ft
RQD = 32.0%
No. of Pieces: 1
Pressure: 15 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 4m:17s +

Run: 9
47.7 - 51.85 ft
Recovery: 4.15 ft
RQD = 100.0%
No. of Pieces: 4
Pressure: 15 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 9m:02s

Notes:
- Backfilled with grout using tremie method.
**Core Details**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>fracture(10°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, totally healed veins, slightly weathered</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>fracture(25°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>fracture(15°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, slightly to moderately fractured, slightly weathered, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>fracture(20°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, moderately healed veins, with trace brown silt in joints</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, moderately healed veins, with trace brown silt in joints</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>fracture(10°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, moderately healed veins, with trace brown silt in joints</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>fracture (angle not provided, &gt;0°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, moderately healed veins with trace brown silt in joints</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>fracture (angle not provided, &gt;0°)</td>
<td>Light gray and dark gray limestone and dolostone, fine grained, hard, moderately fractured, slightly weathered, moderately healed veins with trace brown silt in joints</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Driller reported fluid loss at 59.1'</td>
<td>Driller reported void from 59.1' to 60.8', some soft gray clay infilling. Driller reported void from 59.1' to 62.7'</td>
<td></td>
</tr>
</tbody>
</table>

**Drilling Details**

- **Run 10:**
  - Depth: 51.85 - 52.7 ft
  - Recovery: 0.85 ft
  - Recovery: 100.0%
  - No. of Pieces: 1
  - Pressure: 0 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: Not Recorded

- **Run 11:**
  - Depth: 52.7 - 57.7 ft
  - Recovery: 5 ft
  - Recovery: 100.0%
  - RQD: 0.0%
  - No. of Pieces: 4
  - Pressure: 15 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 5m:22s

- **Run 12:**
  - Depth: 57.7 - 62.7 ft
  - Recovery: 2.35 ft
  - Recovery: 47.0%
  - RQD: 91.0%
  - No. of Pieces: 3
  - Pressure: 15 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 1m:41s+

**Notes:**
- Backfilled with grout using tremie method
- Driller reported fluid loss at 59.1'
- Driller reported void from 59.1' to 62.7'

**Legend:**
- Soil
- Dolostone
- Limestone
- Void

**Drilling Method:** Hollow-Stem Auger / Rock Coring
**Drill Rig Model:** CME 55
**Core Size:** HQ 2-7/8"
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
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<tr>
<td>0</td>
<td></td>
<td>Gray gravel</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<td>13</td>
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</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  
** Rod drop in this interval  
+= Some of total time not recorded

**Notes:** Backfilled with grout using tremie method
Light gray and dark gray limestone; fine grained, hard, highly fractured, highly weathered, totally healed veins, frequent totally healed calcite and/or dolomite veins with brown silty clay infilling in joints.

Light gray dolostone, fine grained, highly fractured, moderately weathered, occasional styolite totally healed veins, some calcite, styolite, and brown silty clay in joint.

Notes:
Backfilled with grout using tremie method

Legend
- soil
- dolostone
- limestone
- void
Dark gray and light gray limestone and dolostone, fine grained, hard, highly fractured, moderately weathered, frequently totally healed veins with brown silty clay infilling

void from 30.4' to 30.8', no infilling. Driller reported void from 30.6' to 30.8'

Dark gray and light gray limestone and dolostone, fine grained, hard, moderately to highly fractured, moderately weathered, frequently totally healed styolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints

Run: 4
30.8 - 35.8
Recovery: 4.6 ft.
Recovery: 92.0%
RQD = 85.0%
No. of Pieces: 10
Pressure: 60 psi
Fluid Return: 90%
On run #4, return drilling fluid was clean, despite drilling mud being used for drilling.
Drilling Action: Smooth
Total Time: 11m

Run: 5
35.8 - 40.8
Recovery: 4.9 ft.
Recovery: 98.0%
RQD = 82.0%
No. of Pieces: 2
Pressure: 42 psi
Fluid Return: 90%
Drilling Action: Smooth
Total Time: 10m

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Notes: Backfilled with grout using tremie method

Legend
- soil
- dolostone
- limestone
- void

Rate (min/ft) 4 2
Core Details
- soil
- dolostone
- limestone

Lithology
- soil
- dolostone
- limestone

Remarks
- soil
- dolostone
- limestone

Depth (ft)
26 fracture(35°)
27
28 fracture(20°)
29 fracture(15°)
30 fracture(50°)
driller reported fluid loss at 30.6'
31 fracture(15°)
32 fracture(20°)
33 fracture(45°)
34 fracture(45°)
fracture(0°)
35 fracture(50°)
fracture(25°)
fracture(0°)
fracture(30°)
fracture(60°)
moderately fractured
36
37 fracture(15°)
moderately fractured
38 fracture(45°)
39

Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
Drilling Method: Hollow-Stem Auger / Rock Coring
Drill Rig Model: CME 55
Core Size: HQ 2 - 7/8"
Weather: Sunny 73°F

Run: 3
25.8 - 30.8
Recovery: 5.1 ft.
Recovery: 102.0%
No. of Pieces: 5
Pressure: 76 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 9m

Run: 4
30.8 - 35.8
Recovery: 4.6 ft.
Recovery: 92.0%
RQD = 85.0%
No. of Pieces: 10
Pressure: 60 psi
Fluid Return: 90%

On run #4, return drilling fluid was clean, despite drilling mud being used for drilling.
Drilling Action: Smooth
Total Time: 11m

Run: 5
35.8 - 40.8
Recovery: 4.9 ft.
Recovery: 98.0%
RQD = 82.0%
No. of Pieces: 2
Pressure: 42 psi
Fluid Return: 90%

Drilling Action: Smooth
Total Time: 10m

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Notes: Backfilled with grout using tremie method

Legend
- soil
- dolostone
- limestone
- void

Noting: 29268.14
Easting: 57781.86
Ground Elevation: 935.13

Page 3 of 5
**Core Details**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
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<tr>
<td>40</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, moderately weathered, frequently totally healed styolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Highly fractured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>Dark gray and light gray limestone and dolostone, fine grained, hard, moderately fractured, moderately weathered, frequently totally healed styolite veins, occasional calcite and/or dolomite seams, trace brown silty clay in joints</td>
<td></td>
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<tr>
<td>46</td>
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<td>47</td>
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<tr>
<td>52</td>
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</tr>
</tbody>
</table>

**Remarks**

- Run: 6
  - Depth: 40.8 - 45.8
  - Recovery: 5.3 ft.
  - Recovery: 106.0%
  - RQD = 104.0%
  - No. of Pieces: 2
  - Pressure: 20 psi
  - Fluid Return: 90%
  - Drilling Action: Smooth
  - Total Time: 7m

- Run: 7
  - Depth: 45.8 - 50.8
  - Recovery: 5 ft.
  - Recovery: 100.0%
  - RQD = 100.0%
  - No. of Pieces: 3
  - Pressure: 20 psi
  - Fluid Return: 90%
  - Drilling Action: Smooth
  - Total Time: 7m

**Notes:**
- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded
- Backfilled with grout using tremie method

**Legend**

- soil
- dolostone
- limestone
- void
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>Gray gravel</td>
<td></td>
<td></td>
<td>935</td>
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<td></td>
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<td>934</td>
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</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  
+ Some of total time not recorded

Notes:
- Hollow-Stem Auger to refusal, no sample collected.
- Brown sandy silt and brown silty clay

Legend:
- soil
- dolostone
- limestone
- void

Backfilled with grout using tremie method
Void from 21.7' to 24.6', no infilling. Driller reported likely edge of cavity with brown silty clay infilling from overburden, due encountering rock at 21.7'.

Run: 1
24.6 - 27.8
Recovery: 3.2 ft.
Recovery: 100.0%
RQD = 50.0%
No. of Pieces: 5

Light gray and dark gray limestone, fine grained,
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
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<tbody>
<tr>
<td>26</td>
<td>fracture(0°)</td>
<td>hard, moderately fractured, slightly weathered, trace calcite and/or dolomite in joints, totally healed veins</td>
<td>Pressure: 15 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 10m</td>
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<tr>
<td>27</td>
<td>fracture(45°) Intensely fractured fracture(21°)</td>
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<td>28</td>
<td>fracture(30°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, slightly weathered, trace calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
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</tr>
<tr>
<td>29</td>
<td>fracture(15°)</td>
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<td>30</td>
<td>fracture(15°)</td>
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<tr>
<td>31</td>
<td>fracture(15°) Open joint</td>
<td></td>
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<tr>
<td>32</td>
<td>fracture(0°)</td>
<td>Slightly fractured</td>
<td></td>
<td></td>
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<tr>
<td>33</td>
<td></td>
<td>Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, slightly weathered, trace calcite and/or dolomite in joints, occasionally moderately healed veins, totally healed veins</td>
<td></td>
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<td>34</td>
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<td>35</td>
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<tr>
<td>36</td>
<td>fracture(25°) Brown silty clay infilling</td>
<td>void from 36.2' to 37.3', some intensely fractured rock, no infilling. Driller reported mud seam</td>
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<td>37</td>
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<td>39</td>
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</tbody>
</table>

* Coring rate not recorded due to rod drop in this run    ** Rod drop in this interval
+ Some of total time not recorded

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### Additional Information

- **Borehole ID:** B-09
- **Project Number:** 1168070004
- **Project Name:** Y-12 Outfall 200
- **Project Location:** Oak Ridge, TN
- **Client Name:** Strata-G
- **Date Started:** 11/5/2016
- **Time Started:** 3:50 PM
- **Logged By:** A. Spears
- **Checked By:** K. Foye
- **Completed:** 11/7/2016
- **Completed:** 12:10 PM
- **Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN
- **Drilling Method:** Hollow-Stem Auger / Rock Coring
- **Drill Rig Model:** CME 55
- **Core Size:** HQ 2 - 7/8"
- **Weather:** Sunny 70°F
- **Strata-G Project Number:**
- **Project Name:**
- **Project Location:**
- **Client Name:**
- **Date Started:**
- **Time Started:**
- **Logged By:**
- **Checked By:**
- **Completed:**
- **Completed:**
- **Drilling Subcontractor:**
- **Drilling Method:**
- **Drill Rig Model:**
- **Core Size:**
- **Weather:**

---

### Notes
- Backfilled with grout using tremie method
- Void from 36.2' to 37.3', some intensely fractured rock, no infilling. Driller reported mud seam

### Legend
- soil
- dolostone
- limestone
- void
Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown and reddish brown silty clay, and calcite and/or dolomite in joints, totally healed veins.

Run: 5
42.8 - 47.8
Recovery: 2.95 ft.
Pressure: 50 psi
Fluid Return: 0%
No. of Pieces: 7
Drilling Action: Smooth
Total Time: 11m:01s +

No. of Pieces: 2
Pressure: 45 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 7m:15s +

Core coated in gray silty clay

Run: 6
47.8 - 52.8
Recovery: 3.85 ft.
Pressure: 25 psi
Fluid Return: 0%
No. of Pieces: 3
Drilling Action: Smooth
Total Time: 8m:54s +

Backfilled with grout using tremie method

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Notes:

Notes:
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace brown silty clay, brown sand, calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace brown silty clay, brown sand, and calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>fracture(50°)</td>
<td>void from 55.9' to 57.4', no infilling</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>fracture(37°)</td>
<td>Driller reported lost circulation/blocked at 55.8', recovered core</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>fracture(55°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, highly fractured, slightly weathered, trace brown silty clay, brown sand, calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>fracture(20°)</td>
<td>End of boring recovery at 60.1'</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Open joint</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Run: 7
52.8 - 57.8
Recovery: 5 ft.
RQD = 52.0%
No. of Pieces: 6
Pressure: 45 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 6m:18s +

Run: 8
57.8 - 60.2
Recovery: 2.3 ft.
Recovery: 95.8%
RQD = 82.0%
No. of Pieces: 2
Pressure: 25 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 25m

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* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded
Gray gravel

---

Hollow-Stem Auger to refusal, no sample collected. Brown sandy silt and brown silty clay
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Auger Refusal/Top of rock at 17.2' fracture (0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, highly fractured, slightly weathered, trace brown silty sand and calcite and/or dolomite in joints, totally healed veins</td>
<td>Run: 1 17.2 - 22.8  Recovery: 2 ft.  Recovery: 35.7%  RQD = 39.0%  No. of Pieces: 2  Pressure: 35 psi  Fluid Return: 100%  Drilling Action: Smooth  Total Time: Not Recorded</td>
</tr>
<tr>
<td>18</td>
<td>fracture (20°)</td>
<td>Light gray and brownish gray clay, fine grained, moderately to highly weathered, trace brown calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>fracture (20°)</td>
<td>Void from 19.3' to 22.8', no infilling, Driller reported void from 19.0' to 23.2'</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>fracture (60°)</td>
<td>Highly weathered to 50% diameter, edge of cavity</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Highly weathered to 50% diameter, edge of cavity</td>
<td>Light gray and brownish gray clay, fine grained, moderately to highly weathered, trace brown calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>fracture (0°)</td>
<td>Void from 22.8' to 23.2', no infilling</td>
<td>Run: 2 22.8 - 27.8  Recovery: 2.65 ft.  Recovery: 53.0%  RQD = 18.0%  No. of Pieces: 3  Pressure: 35 psi  Fluid Return: 100%  Drilling Action: Smooth  Total Time: 5m:06s</td>
</tr>
<tr>
<td>25</td>
<td>fracture (70°)</td>
<td>Highly weathered to 50% diameter, edge of cavity</td>
<td></td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded  Backfilled with grout using tremie method  Page 2 of 5
void from 25.4' to 26.3', 27.4' to 27.7'
Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins, likely edge of cavity
void from 28.2' to 29.9', no infilling. Driller reported void from 28.2' to 29.8'
Light gray and dark gray limestone, fine grained, hard, slightly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins
void from 35.8' to 36.1', no infilling. Driller reported void from 35.8' to 36.1'
trace brown silty clay staining in fracture
void from 35.8' to 36.1', no infilling. Driller reported void from 35.8' to 36.1'
Highly fractured
void from 37' to 37.8', some soft brown silty clay infilling with highly fractured rock. Driller reported void from 37.1' to 39.1'
void from 37.8' to 39.1', some soft brown silty clay infilling with highly fractured rock

---

** Backfilled with grout using tremie method
+ Some of total time not recorded
* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded
Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.

**Core Details**

- **Depth (ft)**: 39
- **Lithology**: Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.
- **Remarks**: Soft brown silty clay infilling with highly fractured rock at open joint.

**Run 6**
- **Depth (ft)**: 42.8 - 47.8
- **Recovery**: 5 ft.
- **RQD**: 100.0%
- **No. of Pieces**: 4
- **Pressure**: 25 psi
- **Fluid Return**: 100%
- **Drilling Action**: Smooth
- **Total Time**: 4m:06s +

**Core Details**

- **Depth (ft)**: 43
- **Lithology**: Light gray and dark gray limestone, fine grained, hard, moderately to slightly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.
- **Remarks**: Fracture (0°)

**Run 7**
- **Depth (ft)**: 47.8 - 52.8
- **Recovery**: 5 ft.
- **RQD**: 87.0%
- **No. of Pieces**: 7
- **Pressure**: 25 psi
- **Fluid Return**: 0%
- **Drilling Action**: Smooth
- **Total Time**: 6m:36s +

**Core Details**

- **Depth (ft)**: 48
- **Lithology**: Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.
- **Remarks**: Fracture (35°)

**Core Details**

- **Depth (ft)**: 49
- **Lithology**: Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.
- **Remarks**: Driller reported fluid loss at 48.7° at highly weathered section from 48.7° to 48.8°.

**Core Details**

- **Depth (ft)**: 50
- **Lithology**: Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.
- **Remarks**: Fracture (40°)

**Core Details**

- **Depth (ft)**: 51
- **Lithology**: Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.
- **Remarks**: Fracture (40°)

**Legend**

- Soil
- Dolostone
- Limestone
- Void

**Notes:** Backfilled with grout using tremie method

**Backfilled with grout using tremie method**
Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, moderately weathered, trace brown silty clay and calcite and/or dolomite in joints, totally healed veins.

Run: 8
52.8 - 55.8
Recovery: 3 ft.
RQD = 100.0%
No. of Pieces: 10+
Pressure: 25 psi
Fluid Return: 50%
Drilling Action: Smooth
Total Time: Not Recorded

Run: 9
55.8 - 57.8
Recovery: 1.5 ft.
RQD = 75.0%
No. of Pieces: 2
Pressure: 25 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: Not Recorded

Run: 10
57.8 - 60
Recovery: 2.1 ft.
RQD = 96.0%
No. of Pieces: 8
Pressure: 25 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: Not Recorded

Notes:
+ Some of total time not recorded
* Rod drop in this interval
* Coring rate not recorded due to rod drop in this run

Legend
- soil
- dolostone
- limestone
- void

Backfilled with grout using tremie method
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<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
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<td>Gray gravel</td>
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</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  
+ Some of total time not recorded

Legend

- soil
- dolostone
- limestone
- void

Notes:
- Backfilled with grout using tremie method

** Project Number: 1168070004
** Project Name: Y-12 Outfall 200
** Project Location: Oak Ridge, TN
** Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
** Drilling Method: Hollow-Stem Auger / Rock Coring
** Drill Rig Model: CME 55
** Core Size: HQ 2 -7/8"
** Weather: Sunny 64°F

Borehole ID: B-11

Y-12 Outfall 200
Oak Ridge, TN

A. Spears
K. Foye

11/4/2016
4:40 PM

Tri-State Drilling, Inc., Chattanooga, TN
Hollow-Stem Auger / Rock Coring
CME 55
HQ 2 -7/8"
Sunny 64°F
after drilling

Run: 1
20.9 - 22.8
Recovery: 1.4 ft.
Recovery: 73.7%
RQD = 49.0%
No. of Pieces: 10+
Pressure: 15 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: Not Recorded

Run: 2
22.8 - 27.8
Recovery: 5 ft.
Recovery: 100.0%
RQD = 100.0%
No. of Pieces: 10+
Pressure: 75 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 9m:45s

Notes: Backfilled with grout using tremie method
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
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<td>healed veins</td>
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</tr>
<tr>
<td>27</td>
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</tr>
<tr>
<td>28</td>
<td>fracture(0°)</td>
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<tr>
<td>29</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
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<td>30</td>
<td>fracture(0°)</td>
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<td>32</td>
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<td>fracture(0°)</td>
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<td>fracture(45°)</td>
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<td>fracture(30°)</td>
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<td>36</td>
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<td>37</td>
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<tr>
<td>38</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Moderately weathered rock with some calcite and/or dolomite and trace brown silt at open joint</td>
<td>healed veins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fracture(70°)</td>
<td></td>
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</tr>
</tbody>
</table>

- Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins

### Remarks

- Run: 3
  - Depth: 27.8 - 32.8
  - Recovery: 5 ft.
  - Recovery: 100.0%
  - RQD = 87.0%
  - No. of Pieces: 5
  - Pressure: 65 psi
  - Fluid Return: 100%
  - Drilling Action: Smooth
  - Total Time: 10m:7s

- Run: 4
  - Depth: 32.8 - 37.8
  - Recovery: 5 ft.
  - Recovery: 100.0%
  - RQD = 96.0%
  - No. of Pieces: 3
  - Pressure: 50 psi
  - Fluid Return: 100%
  - Drilling Action: Smooth
  - Total Time: 5m:28s

- Run: 5
  - Depth: 37.8 - 42.8
  - Recovery: 5 ft.
  - Recovery: 100.0%
  - RQD = 87.0%

---

### Notes:

- Backfilled with grout using tremie method
- Sunny 64°F
- Drilled by: A. Spears
- Checked by: K. Foye

---

### Legend

- soil
- dolostone
- limestone
- void
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>fracture(70°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins</td>
<td>No. of Pieces: 7</td>
<td>2</td>
<td>896</td>
</tr>
<tr>
<td>39</td>
<td>fracture(20°)</td>
<td></td>
<td>Pressure: 25 psi</td>
<td>4</td>
<td>895</td>
</tr>
<tr>
<td>40</td>
<td>fracture(0°)</td>
<td></td>
<td>Drilling Action: Smooth</td>
<td></td>
<td>894</td>
</tr>
<tr>
<td>41</td>
<td>fracture(0°)</td>
<td></td>
<td>Total Time: 5m:33s</td>
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<td>893</td>
</tr>
<tr>
<td>42</td>
<td>fracture(30°)</td>
<td></td>
<td>Run: 6</td>
<td></td>
<td>892</td>
</tr>
<tr>
<td>43</td>
<td>fracture(40°)</td>
<td></td>
<td>42.8 - 47.8</td>
<td>*</td>
<td>891</td>
</tr>
<tr>
<td>44</td>
<td>fracture(75°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins</td>
<td>No. of Pieces: 10+</td>
<td>4</td>
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<tr>
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<td>fracture(0°)</td>
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<td>Pressure: 15 psi</td>
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<tr>
<td>45</td>
<td>fracture(45°)</td>
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<td>Fluid Return: 0%</td>
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<td>888</td>
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<tr>
<td>46</td>
<td>Open joint</td>
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<td>Drilling Action: Smooth</td>
<td></td>
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<tr>
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<td>fracture(45°)</td>
<td></td>
<td>Total Time: Not Recorded</td>
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<tr>
<td>47</td>
<td>fracture(25°)</td>
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<td>Run: 7</td>
<td></td>
<td>885</td>
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<tr>
<td>48</td>
<td>fracture(20°)</td>
<td></td>
<td>47.8 - 52.8</td>
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<tr>
<td>49</td>
<td>fracture(40°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, slightly to moderately fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins</td>
<td>No. of Pieces: 3</td>
<td></td>
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</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td>Pressure: 25 psi</td>
<td></td>
<td>884</td>
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<tr>
<td>51</td>
<td></td>
<td></td>
<td>Fluid Return: 0%</td>
<td></td>
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</tr>
<tr>
<td>52</td>
<td></td>
<td></td>
<td>Drilling Action: Smooth</td>
<td></td>
<td>884</td>
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<tr>
<td>52</td>
<td></td>
<td></td>
<td>Total Time: 5m:45s</td>
<td></td>
<td>884</td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded

---

Notes: Backfilled with grout using tremie method

Legend:
- soil
- dolostone
- limestone
- void

---

Page 4 of 5
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>fracture(30°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, slightly to highly fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
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<tr>
<td>53</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, slightly to highly fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins</td>
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<td>fracture(55°)</td>
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<tr>
<td>57</td>
<td>Slightly fractured</td>
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<td>58</td>
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<tr>
<td>59</td>
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<td>Light gray and dark gray limestone, fine grained, hard, slightly to highly fractured, slightly weathered, trace brown silt and calcite and/or dolomite in joints, totally healed veins</td>
<td></td>
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Run: 8
52.8 - 57.8
Recovery: 5 ft.
Recovery: 100.0%
RQD = 93.0%
No. of Pieces: 4
Pressure: 25 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 4m:49s

Run: 9
57.8 - 60.3
Recovery: 2.63 ft.
Recovery: 105.2%
RQD = 95.0%
No. of Pieces: 3
Pressure: 65 psi
Fluid Return: 75%
Drilling Action: Smooth
Total Time: Not Recorded

Notes:
- Backfilled with grout using tremie method
- Page 5 of 5

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Legend:
- soil
- dolostone
- limestone
- void
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<th>Remarks</th>
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- *Coring rate not recorded due to rod drop in this run*
- **Rod drop in this interval**
- + Some of total time not recorded

**Remarks:**
- Backfilled with grout using tremie method
- *Coring rate not recorded due to rod drop in this run*
- **Rod drop in this interval**
- + Some of total time not recorded

**Legend:**
- soil
- dolostone
- limestone
- void

**Notes:**
- Backfilled with grout using tremie method
- *Coring rate not recorded due to rod drop in this run*
- **Rod drop in this interval**
- + Some of total time not recorded
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<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
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<tbody>
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<td>13</td>
<td></td>
<td>refusal, no sample collected. Brown sandy silt, brown clayey silt, and brown silty clay</td>
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* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  
+ Some of total time not recorded

Notes:
- Backfilled with grout using tremie method
- Legend:
  - soil
  - dolostone
  - limestone
  - void
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Lithology</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>26</td>
<td>Top of rock 26.3' fracture(45°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, some calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>27</td>
<td>Driller reported fluid loss at 26.3' fracture(0°)</td>
<td>Run: 1 26.3 - 28.3 Recovery: 2 ft. Recovery: 100.0% RQD = 90.0% No. of Pieces: 3 Pressure: 60 psi Fluid Return: 80% Drilling Action: Smooth Total Time: 9m</td>
</tr>
<tr>
<td>28</td>
<td>Auger refusal at 27'</td>
<td>Run: 2 28.3 - 30.7 Recovery: 2.3 ft. Recovery: 95.8% RQD = 100.0% No. of Pieces: 3 Pressure: 20 psi Fluid Return: 70% Drilling Action: Smooth Total Time: 7m</td>
</tr>
<tr>
<td>29</td>
<td>fracture(35°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, highly fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>30</td>
<td>Driller reported lost circulation/blocked at 28.3'. recovered core</td>
<td>Run: 3 30.7 - 35.7 Recovery: 4.6 ft. Recovery: 92.0% RQD = 63.8% No. of Pieces: 7 Pressure: 40 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 11m</td>
</tr>
<tr>
<td>31</td>
<td>fracture(25°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>32</td>
<td>fracture(0°)</td>
<td>Run: 4 35.7 - 40.7 Recovery: 5.2 ft. Recovery: 104.0% RQD = 100.0% No. of Pieces: 4 Pressure: 15 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 11m</td>
</tr>
<tr>
<td>33</td>
<td>Highly fractured, highly weathered fracture(45°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>34</td>
<td>fracture(15°)</td>
<td>void from 33.8' to 34.6', no infilling. Driller reported void from 34.3' to 34.5'</td>
</tr>
<tr>
<td>35</td>
<td>Highly fractured fracture(45°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
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<tr>
<td>36</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>37</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>38</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
<tr>
<td>39</td>
<td>fracture(0°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, moderately weathered, trace calcite and/or dolomite and brown silty clay in joints, occasional totally healed calcite and/or dolomite veins, totally healed veins</td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of the total time not recorded

**Legend**

- **soil**
- **dolostone**
- **limestone**
- **void**

**Notes:**
Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
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<tbody>
<tr>
<td>39</td>
<td></td>
<td>healing veins</td>
<td></td>
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<tr>
<td>40</td>
<td>fracture(20°)</td>
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<tr>
<td>41</td>
<td>Highly Fractured</td>
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<tr>
<td>42</td>
<td>fracture(30°)</td>
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<tr>
<td>43</td>
<td>fracture(40°)</td>
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<td>fracture(0°)</td>
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<td>45</td>
<td>fracture(30°)</td>
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<td>46</td>
<td>Highly Fractured, highly weathered fracture(0°)</td>
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<tr>
<td>47</td>
<td>highly weathered from 1&quot; to 2.87&quot; diameter, edge of cavity</td>
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<td>fracture(35°)</td>
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<td>52</td>
<td>Highly Fractured fracture(40°)</td>
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</table>

Run: 5  
40.7 - 45.7  
Recovery: 5 ft.  
RQD = 94.0%  
No. of Pieces: 5  
Pressure: 15 psi  
Drilling Action: Smooth  
Total Time: 7m:52s

Run: 6  
45.7 - 50.7  
Recovery: 5 ft.  
RQD = 92.0%  
No. of Pieces: 4  
Pressure: 15 psi  
Drilling Action: Smooth  
Total Time: 7m

Run: 7  
50.7 - 55.7  
Recovery: 5 ft.  
RQD = 85.0%  
No. of Pieces: 9

Notes:
- Backfilled with grout using tremie method
- Legend:
  - soil
  - dolostone
  - limestone
  - void
Light gray and dark gray limestone, fine grained, hard, moderately to highly fractured, highly weathered, frequent totally healed calcite and/or dolomite veins, trace brown silty clay in joints, some calcite and/or dolomite in joints.

Pressure: 20 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 7m

Run: 8  
55.7 - 60.7  
Recovery: 5 ft.  
RQD = 100.0%  
No. of Pieces: 5  
Pressure: 20 psi  
Fluid Return: 0%  
Drilling Action: Smooth  
Total Time: 7m

End of boring recovery at 60.7'
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<th>Core Details</th>
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<th>Elevation (ft)</th>
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* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
Drill Rig Model: CME 55
Core Size: HQ 2 -7/8"
Weather: Partly Cloudy 30°F

Notes: Backfilled with grout using tremie method
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<td>26</td>
<td>Hollow-Stem Auger to refusal, no sample collected. brown silty clay</td>
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*Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

**Notes:**
- Driller reported fluid loss at 25.6'
- Backfilled with grout using tremie method

**Legend:**
- soil
- dolostone
- limestone
- void

---

**Project Details:**
- **Project Number:** 1168070004
- **Project Name:** Y-12 Outfall 200
- **Project Location:** Oak Ridge, TN
- **Client Name:** Strata-G
- **Date Started:** 11/21/2016
- **Time Started:** 8:50 AM
- **Logged By:** A. Spears
- **Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN
- **Drilling Method:** Hollow-Stem Auger / Rock Coring
- **Drill Rig Model:** CME 55
- **Core Size:** HQ 2 -7/8"
- **Weather:** Partly Cloudy 30°F
- **Ground Elevation:** 935.75

**Notes:**
- Backfilled with grout using tremie method
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<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
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<td>26</td>
<td>fracture(0°)</td>
<td>Highly fractured</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, trace calcite and/or dolomite and brown silty clay in joints, totally healed veins, frequent totally healed calcite and/or dolomite veins</td>
<td>Run: 1</td>
<td>2.65 - 29.3</td>
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<td>27</td>
<td>Top of rock</td>
<td>26.5' fracture(20°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, trace calcite and/or dolomite and brown silty clay in joints, totally healed veins, frequent totally healed calcite and/or dolomite veins</td>
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<td>29.3</td>
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<td>Auger refusal at 26.8'</td>
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<td>fracture(0°)</td>
<td>Intensely fractured fracture(40°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, trace calcite and/or dolomite and brown silty clay in joints, totally healed veins, frequent totally healed calcite and/or dolomite veins</td>
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<td>29.3 - 30.8</td>
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<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, trace calcite and/or dolomite and brown silty clay in joints, totally healed veins,</td>
<td>Run: 3</td>
<td>30.8 - 35.8</td>
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<td>31</td>
<td>fracture(0°)</td>
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<td>frequent totally healed calcite and/or dolomite veins</td>
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<td>32</td>
<td>fracture(65°)</td>
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<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, occasional moderately healed veins with brown silty clay infilling, some brown silty clay, styolite, and calcite and/or dolomite in joints, occasional total</td>
<td>Run: 4</td>
<td>35.8 - 40.8</td>
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<tr>
<td>33</td>
<td>fracture(30°)</td>
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**Legend**

- soil
- dolostone
- limestone
- void

---

*Coring rate not recorded due to rod drop in this run**

**Some of total time not recorded**

+ Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>fracture(0°)</td>
<td>and calcite and/or dolomite in joints, occasional total</td>
<td>Run: 5</td>
<td>2</td>
<td>896</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, occasional moderately healed veins with brown silty clay infilling, some brown silty clay, styolite, and calcite and/or dolomite in joints, occasional total</td>
<td>40.8 - 45.8</td>
<td>4.9 ft.</td>
<td>895</td>
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<td>41</td>
<td>fracture(20°)</td>
<td>Light gray and dark gray dolostone, fine grained, hard, moderately fractured, moderately weathered, frequent totally healed styolite veins, some brown silty clay, styolite, and calcite and/or dolomite in joints, occasional totally healed veins with orang</td>
<td>Run: 6</td>
<td>4</td>
<td>894</td>
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<tr>
<td>42</td>
<td>fracture(50°)</td>
<td></td>
<td>45.8 - 50.8</td>
<td>5.2 ft.</td>
<td>893</td>
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<td>43</td>
<td>fracture(0°)</td>
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<td>Recovery: 104.0%</td>
<td>102.0%</td>
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<tr>
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<td>fracture(5°)</td>
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<td>RQD = 102.0%</td>
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<td>45</td>
<td>fracture(35°)</td>
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<td>No. of Pieces: 4</td>
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<td>Pressure: 42 psi</td>
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<td>47</td>
<td>fracture(30°)</td>
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<td>Fluid Return: 0%</td>
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<td>48</td>
<td>fracture(0°)</td>
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<td>Drilling Action: Smooth</td>
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<td>49</td>
<td>fracture(0°)</td>
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<td>Total Time: 10m</td>
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<tr>
<td>50</td>
<td>fracture(0°)</td>
<td>Backfilled with grout using tremie method</td>
<td>Run: 7</td>
<td>1.4</td>
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<tr>
<td>51</td>
<td>fracture(0°)</td>
<td></td>
<td>50.8 - 55.8</td>
<td>4.75 ft.</td>
<td>884</td>
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<tr>
<td>52</td>
<td>fracture(0°)</td>
<td>Page 4 of 5</td>
<td>Recovery: 95.0%</td>
<td>94.0%</td>
<td>883</td>
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</table>

Legend:
- **soil**
- **dolostone**
- **limestone**
- **void**

Notes:
- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded

*Drill Rig Model: CME 55*
<table>
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<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
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</tr>
<tr>
<td>53</td>
<td>fracture(45°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, some brown silty clay, styolite, and calcite and/or dolomite in joints</td>
<td>No. of Pieces: 4</td>
<td>2</td>
<td>883</td>
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<tr>
<td>54</td>
<td>fracture(40°)</td>
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<tr>
<td>55</td>
<td>driller reported fluid loss at 54.9'</td>
<td>void 55' to 55.1', no infilling. Driller reported void from 54.7' to 55'</td>
<td>Run: 8</td>
<td>4</td>
<td>880</td>
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<td>56</td>
<td>fracture(30°)</td>
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<td>57</td>
<td>fracture(20°)</td>
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<td>58</td>
<td>fracture(15°)</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, some calcite and/or dolomite, grayish brown silty clay in joints, trace brown silty clay</td>
<td>Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, some calcite and/or dolomite, grayish brown silty clay in joints, trace brown silty clay</td>
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<tr>
<td>59</td>
<td>highly weathered from 1.5&quot; to 2.87&quot; diameter, edge of cavity</td>
<td>void 58.8' to 59.7', no infilling. Driller reported void from 58.2' to 59.6'</td>
<td>No. of Pieces: 7</td>
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<tr>
<td>60</td>
<td>driller reported fluid loss at 58.8'</td>
<td>End of boring recovery at 60.8'</td>
<td>Run: 8</td>
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<td>876</td>
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Notes:
- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded
- Backfilled with grout using tremie method

Legend
- soil
- dolostone
- limestone
- void
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Legend

- soil
- dolostone
- limestone
- void

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

Backfilled with grout using tremie method
Light gray and dark gray limestone, fine grained, hard, moderately fractured, some brown silty clay in joints, trace calcite and/or dolomite totally healed veins void from 20.2' to 20.5', no infilling.

Auger refusal at 18.5'
Top of rock 18.5'

Run 1
18.6 - 20.9
Recovery: 2.05 ft.
Recovery: 89.1%
RQD = 65.0%
No. of Pieces: 2
Pressure: 36 psi
Fluid Return: 100%
Brown muddy water was recovered in drilling fluid tank in void on Run #1
Drilling Action: Smooth
Total Time: 5m

Run 2
20.9 - 25.9
Recovery: 5 ft.
Recovery: 0.0%
RQD = 0.0%
No. of Pieces: 0
Pressure: 17 psi
Fluid Return: 35%
Drilling Action: Smooth
Total Time: 9m

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded
 Backfilled with grout using tremie method
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Lithology</th>
</tr>
</thead>
</table>
| 26        | fracture(45°)  
  Intensely fractured rock at open joint |
| 27        |<br>28<br>29<br>30<br>31<br>32<br>33<br>34<br>35<br>36<br>37<br>38<br>39 | Light gray and dark gray limestone, fine grained, hard, moderately fractured, slightly weathered, occasional totally healed calcite and/or dolomite veins |
| 31        | Driller reported fluid loss at 31', some intensely fractured rock, no infilling. Driller reported void from 31' to 32.2' |
| 34        | Light gray and dark gray limestone, fine grained, hard, highly fractured, slightly weathered, occasional totally healed calcite and/or dolomite veins |
| 35        | Driller reported fluid loss at 34.4' |

### Remarks

- **Run: 2**
  - 25.9 - 30.9
  - Recovery: 5 ft.
  - Recovery: 100.0%
  - RQD = 94.0%
  - No. of Pieces: 7
  - Pressure: 19 psi
  - Fluid Return: 20%
  - Drilling Action: Smooth
  - Total Time: 24m

- **Run: 3**
  - 30.9 - 35.9
  - Recovery: 2.55 ft.
  - Recovery: 51.0%
  - RQD = 33.0%
  - No. of Pieces: 8
  - Pressure: 22 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 14m

- **Run: 4**
  - 35.9 - 49.5
  - Recovery: 1.9 ft.
  - Recovery: 14.0%
  - RQD = 7.0%
  - No. of Pieces: 5
  - Pressure: 20 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 33m

---

**Legend**

- Soil
- Dolostone
- Limestone
- Void

---

*Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  + Some of total time not recorded  Backfilled with grout using tremie method
void from 35.9’ to 47.1, no infilling

Light gray and dark gray limestone, fine grained, hard, highly fractured, highly weathered, some brown silty clay and calcite and/or dolomite in joints, frequent moderately healed veins with brown silty clay infilling

void from 49’ to 49.5’, no infilling. Driller reported void from 49’ to 49.5’

End of boring recovery at 49’
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<th>Core Details</th>
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<th>Remarks</th>
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Hollow-Stem Auger to refusal, no sample collected. Brown clayey silt

Notes:
- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval

Legend:
- soil
- dolostone
- limestone
- void

Notes:
- Backfilled with grout using tremie method
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 - 17</td>
<td>Top of rock 17.2' fracture(40°)</td>
</tr>
<tr>
<td>18 - 20.5</td>
<td>Auger refusal at 17.3' fracture(35°)</td>
</tr>
<tr>
<td>18 - 21.5</td>
<td>fracture(15°)</td>
</tr>
<tr>
<td>21.5 - 26</td>
<td>fracture(20°)</td>
</tr>
<tr>
<td>22 - 24</td>
<td>fracture(0°)</td>
</tr>
<tr>
<td>23 - 25</td>
<td>fracture(0°)</td>
</tr>
<tr>
<td>25 - 26</td>
<td>fracture(0°)</td>
</tr>
<tr>
<td>26</td>
<td>fracture(70°)</td>
</tr>
</tbody>
</table>

### Lithology

1. Light and dark gray limestone, fine grained, moderately fractured, slightly weathered, hard, totally healed veins, occasional totally healed calcite and/or dolomite veins, some brown silty sand, calcite and/or dolomite, and styolite.

Run: 1
- Depth: 17.2 - 21 ft.
- Recovery: 3.8 ft.
- Recovery: 100.0%
- RQD: 86.0%
- No. of Pieces: 7
- Pressure: 27 psi
- Fluid Return: 100%
- Drilling Action: Smooth
- Total Time: 6m

Run: 2
- Depth: 21 - 26 ft.
- Recovery: 5 ft.
- Recovery: 100.0%
- RQD: 88.0%
- No. of Pieces: 7
- Pressure: 28 psi
- Fluid Return: 100%
- Drilling Action: Smooth
- Total Time: 4m
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>fracture(0°)</td>
<td>Light and dark gray limestone, fine grained, slightly to moderately fractured, moderately weathered, hard, totally healed veins, occasional totally healed calcite and/or dolomite veins, trace calcite and/or dolomite, styolite, and brown silty clay in joints</td>
<td>Run: 3</td>
<td>26 - 31</td>
<td>900</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>899</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>898</td>
</tr>
<tr>
<td>29</td>
<td>fracture(80°)</td>
<td></td>
<td></td>
<td></td>
<td>897</td>
</tr>
<tr>
<td>30</td>
<td>driller reported fluid loss at 30.2'</td>
<td>void from 30.4' to 31', no infilling. Driller reported void from 30.2' to 30.8'</td>
<td>Run: 4</td>
<td>31 - 36</td>
<td>896</td>
</tr>
<tr>
<td>31</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
<td></td>
<td>895</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>894</td>
</tr>
<tr>
<td>33</td>
<td>fracture(75°)</td>
<td>Light and dark gray limestone, fine grained, moderately fractured, moderately weathered, hard, frequent moderately healed veins with brown silty clay infilling, trace calcite and/or dolomite, styolite, and brown silty clay in joints</td>
<td>Run: 5</td>
<td>36 - 41</td>
<td>893</td>
</tr>
<tr>
<td>34</td>
<td>fracture(70°)</td>
<td></td>
<td></td>
<td></td>
<td>892</td>
</tr>
<tr>
<td>35</td>
<td>highly fractured</td>
<td></td>
<td></td>
<td></td>
<td>891</td>
</tr>
<tr>
<td>36</td>
<td>fracture(65°)</td>
<td></td>
<td></td>
<td></td>
<td>890</td>
</tr>
<tr>
<td>37</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
<td></td>
<td>889</td>
</tr>
<tr>
<td>38</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
<td></td>
<td>888</td>
</tr>
<tr>
<td>39</td>
<td></td>
<td>Light and dark gray limestone, fine grained, slightly to moderately fractured, moderately weathered, hard, totally healed veins, trace calcite and/or dolomite, styolite, and brown silty clay in joints</td>
<td>Run: 6</td>
<td>36 - 41</td>
<td>887</td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Notes:
- Backfilled with grout using tremie method
- Page 3 of 5
- Driller reported fluid loss at 30.2'
- Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
- Drilling Method: Hollow-Stem Auger / Rock Coring
- Drill Rig Model: CME 55
- Core Size: HQ 2 - 7/8"
- Weather: Sunny 72°F

Legend:
- soil
- dolostone
- limestone
- void
### Core Details and Lithology

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>fracture(40°)</td>
<td>and brown silty clay in joints</td>
<td>void from 40.5' to 41', no infilling. Driller reported void from 40.6' to 42.2', no infilling.</td>
</tr>
<tr>
<td>40</td>
<td>fracture(30°)</td>
<td></td>
<td>void from 41' to 42.4', no infilling</td>
</tr>
<tr>
<td>41</td>
<td>fracture(60°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>fracture(55°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>fracture(50°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>fracture(50°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks**
- **Run:** 6
- **Recovery:** 3.6 ft.
- **RQD:** 72.0%
- **No. of Pieces:** 3
- **Pressure:** 20 psi
- **Fluid Return:** 0%
- **Drilling Action:** Smooth
- **Total Time:** 5m

**Remarks**
- **Run:** 7
- **Recovery:** 2.5 ft.
- **RQD:** 49.0%
- **No. of Pieces:** 6
- **Pressure:** 22 psi
- **Fluid Return:** 0%
- **Drilling Action:** Smooth
- **Total Time:** 5m

---

### Technical Details

- **Project Number:** 1168070004
- **Project Name:** Y-12 Outfall 200
- **Project Location:** Oak Ridge, TN
- **Client Name:** Strata-G
- **Date Started:** 11/17/2016
- **Completed:** 11/17/2016
- **Logged By:** A. Spears
- **Checked By:** K. Foye
- **Backfilled with grout using tremie method**

---

### Legend
- **Legend**
  - soil
  - dolostone
  - limestone
  - void

---

**Notes:**
- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded

**Additional Details**
- **Northing:** 28993.82
- **Easting:** 61431.31
- **Ground Elevation:** 926.58

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**Page 4 of 5**

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**Backfilled with grout using tremie method**
Pavement cored
Asphalt and concrete

Hollow-Stem Auger to refusal, no sample collected.
Brown clayey silt

Notes:
- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded
Light and dark gray limestone and dolostone, fine grained, slightly to moderately fractured, slightly weathered, hard, trace brown silty clay and calcite and/or dolomite in joints.

Run: 1
16.1 - 20.7
Recovery: 4.6 ft.
Recovery: 100.0%
RQD = 100.0%
No. of Pieces: 2
Pressure: 27 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 11m

Run: 2
20.7 - 25.7
Recovery: 5 ft.
Recovery: 100.0%
RQD = 100.0%
No. of Pieces: 4
Pressure: 22 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 5m:32s

Run: 3

Notes:
Backfilled with grout using tremie method

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

Legend
- soil
- dolostone
- limestone
- void
Light and dark gray limestone and dolostone, fine grained, highly fractured, slightly weathered, hard, some calcite and/or dolomite trace styolite and trace brown silty clay

Run: 4
30.7 - 35.7
Recovery: 1.9 ft.
Recovery: 38.0%
RQD = 100.0%
No. of Pieces: 4
Pressure: 25 psi
Fluid Return: 100%
Drilling Action: Smooth
Total Time: 6m:25s

void from 32.3' to 35', intensely fractured rock, no infilling. Driller reported void from 32.3' to 35' with possible brown silty sand

Run: 5
35.7 - 40.7
Recovery: 4.4 ft.
Recovery: 88.0%
RQD = 90.0%
No. of Pieces: 3
Pressure: 55 psi
Fluid Return: 90%
Drilling Action: Smooth
Total Time: 7m

Light and dark gray limestone and dolostone, fine grained, moderately fractured, moderately weathered clay, hard, some calcite and/or dolomite

Legend

- soil
- dolostone
- limestone
- void

Notes:
- Backfilled with grout using tremie method
- Page 3 of 5
Light and dark gray limestone and dolostone, fine grained, slightly fractured, slightly weathered clay, hard, some calcite and/or dolomite trace stylolite and trace brown silty clay

Light and dark gray limestone and dolostone, fine grained, moderately fractured, moderately weathered, hard, some brown silty clay in joints, trace calcite and/or dolomite, and some brown silty clay in joints

void from 49.3' to 50.7', no infilling. Driller reported void from 48.8' to 50.6' with possible brown silty clay infilling
End of boring recovery at 49.3'

Run: 6
40.7 - 45.7
Recovery: 5 ft.
RQD = 100.0%
No. of Pieces: 4
Pressure: 67 psi
Fluid Return: 90%
Drilling Action: Smooth
Total Time: 6m:56s

Run: 7
45.7 - 50.7
Recovery: 3.55 ft.
RQD = 90.0%
No. of Pieces: 4
Pressure: 23 psi
Fluid Return: 90%
Drilling Action: Smooth
Total Time: 4m:19s

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Drilled reported fluid loss at 49.3'

Backfilled with grout using tremie method

Legend

Notes:
**Core Details**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pavement cored</td>
<td>Asphalt and concrete</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lithology**

- Pavement cored
- Asphalt and concrete
- Hollow-Stem Auger to refusal, no sample collected.
- Brown to grayish brown clayey silt
- Boulders, some brown silty clay infilling at joints
- Medium stiff to soft grayish brown silty clay
- Void from 8.4' to 10.9', no infilling. Driller reported void from 7.6' to 20.3' with possible overburden soil of grayish brown silty clay

**Remarks**

- Run: 1
  - Depth: 6.9 - 10.9
  - Recovery: 1.45 ft
  - Recovery: 36.3%
  - RQD = 8.0%
  - No. of Pieces: 2
  - Pressure: 60-100 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 4m:59s +

- Run: 2
  - Depth: 10.9 - 20.9
  - Recovery: 0 ft.
  - Recovery: 0.0%
  - RQD = 0.0%
  - No. of Pieces: 0
  - Pressure: 60-100 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 4m:09s +

**Legend**

- Soil
- Dolostone
- Limestone
- Void

**Notes:**

- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded

**Backfilled with grout using tremie method**

**Legend**

- Soil
- Dolostone
- Limestone
- Void
void from 10.9' to 20.3', no infilling.

void from 20.3' to 20.9', no infilling. Driller reported made contact with possible pinnacled rock from 20.3' to 20.9'.

void from 20.9' to 22.2', some very soft brown silty clay infilling with intensely fractured rock. Driller reported void from 20.9' to 22.1'.

void from 22.6' to 25.9', no infilling. Driller reported void from 23.1' to 27.2'.

dark gray and light gray limestone, fine grained, highly fractured, highly weathered, hard, some brown silty clay in joints, occasional totally healed calcite and/or dolomite veins.

** Rod drop in this interval

Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>fracture(30°)</td>
<td>void from 25.9' to 27.2', some highly fractured rock, no infilling</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>fracture(60°)</td>
<td>dark gray and light gray limestone, fine grained, highly to moderately fractured, moderately weathered, hard, some brown silty clay in joints, occasional totally healed calcite and/or dolomite veins</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>fracture(30°), driller reported fluid loss at 28'</td>
<td>dark gray and light gray limestone, fine grained, highly to moderately fractured, moderately weathered, hard, some brown silty clay in joints, occasional totally healed calcite and/or dolomite veins</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>fracture(60°), Open joint, fracture(0°), Open joint</td>
<td>Intensely fractured, moderately fractured, highly weathered to 50% diameter from 32.9' to 33.2'</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>fracture(0°), Open joint, fracture(40°), Open joint</td>
<td>Moderately fractured, highly weathered to 50% diameter from 32.9' to 33.2'</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>fracture(0°), fracture(40°), Open joint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>fracture(0°), driller reported fluid loss at 34.4'</td>
<td>void from 34.4' to 35.9', no infilling. Driller reported void from 34.4' to 35.9'</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>fracture(20°)</td>
<td>dark gray and light gray limestone, fine grained, slightly to moderately fractured, slightly weathered, hard, trace brown silty clay, stonelite,</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- soil
- dolostone
- limestone
- void

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded
and calcite and/or dolomite in joints

dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered, hard, some calcite and/or dolomite in joints, trace stylolite and brown silty clay

Run: 8
40.9 - 45.9
Recovery: 5 ft.
Recovery: 100.0%
RQD = 95.0%
No. of Pieces: 6
Pressure: 23 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 4m +

Run: 9
45.9 - 50.9
Recovery: 4.9 ft.
Recovery: 96.0%
RQD = 96.0%
No. of Pieces: 5
Pressure: 22 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 7m

Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pavement cored</td>
<td>Asphalt and concrete</td>
<td></td>
<td></td>
<td>926</td>
</tr>
<tr>
<td></td>
<td>Hollow-Stem Auger to refusal, no sample collected.</td>
<td>Gray gravelly clay</td>
<td></td>
<td></td>
<td>925</td>
</tr>
</tbody>
</table>

Notes:
- Backfilled with grout using tremie method

Legend:
- soil
- dolostone
- limestone
- void

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Project Number: 1168070004
Project Name: Y-12 Outfall 200
Project Location: Oak Ridge, TN
Drilling Subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
Drilling Method: Hollow-Stem Auger / Rock Coring
Drill Rig Model: CME 55
Core Size: HQ 2 -7/8"
Weather: Cloudy 41°F

Borehole ID: B-19
Y-12 Outfall 200
Oak Ridge, TN
Tri-State Drilling, Inc., Chattanooga, TN
Hollow-Stem Auger / Rock Coring
CME 55
HQ 2 -7/8"
Cloudy 41°F

Notes:
- Backfilled with grout using tremie method

Legend:
- soil
- dolostone
- limestone
- void
**Core Details**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Top of rock 17.8'</td>
<td>dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, hard, totally healed veins, trace brown silty clay and calcite and/or dolomite in joints</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Auger refusal at 18'</td>
<td>Run: 1 17.8 - 20.8  Recovery: 2.95 ft.  Recovery: 98.3%  RQD = 78.0%  No. of Pieces: 3  Pressure: 22 psi  Fluid Return: 100%  Drilling Action: 100%  Total Time: 6m</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Highly weathered to 1&quot; diameter, edge of cavity</td>
<td>dark gray and light gray limestone, fine grained, moderately to highly fractured, hard, totally healed veins, some gray silty clay and calcite and/or dolomite in joints</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>fracture(15°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks**

- Core Details
- Lithology
- Remarks
- Rate (min/ft)
- Elevation (ft)

**Notes:**

- Backfilled with grout using tremie method
- Page 2 of 5
- Soil
- Dolostone
- Limestone
- Void
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>fracture(0°)</td>
<td>dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, hard, totally healed veins, trace brown silty clay and calcite and/or dolomite in joints</td>
<td>Run: 3 25.8 - 30.8  Recovery: 2.3 ft.  Recovery: 46.0%  RQD = 44.0%  No. of Pieces: 5  Pressure: 25 psi  Fluid Return: 0%  Drilling Action: Smooth  Total Time: 5m:43s</td>
<td>2</td>
<td>900</td>
</tr>
<tr>
<td>27</td>
<td>fracture(35°)</td>
<td>void from 28' to 30.8', some intensely fractured rock, no infilling. Driller reported void from 28' to 30.4'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>fracture(45°)</td>
<td>Intensely fractured rock at open joint</td>
<td>Run: 4 30.8 - 35.8  Recovery: 5.3 ft.  Recovery: 106.0%  RQD = 90.0%  No. of Pieces: 7  Pressure: 25 psi  Fluid Return: 0%  Drilling Action: Smooth  Total Time: 6m</td>
<td>4</td>
<td>899</td>
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<tr>
<td>29</td>
<td>fracture(0°)</td>
<td></td>
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</tr>
<tr>
<td>30</td>
<td>fracture(45°)</td>
<td>dark gray and light gray limestone, fine grained, moderately to highly fractured, moderately weathered, hard, totally healed veins, frequent calcite and/or dolomite totally healed veins, occasional moderately healed veins, coated in brown silty clay</td>
<td>Run: 5 35.8 - 40.8  Recovery: 5.15 ft.  Recovery: 103.0%  RQD = 97.0%  No. of Pieces: 3  Pressure: 25 psi  Fluid Return: 0%  Drilling Action: Smooth  Total Time: 6m:43s</td>
<td>1.34</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>fracture(0°)</td>
<td></td>
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<td>32</td>
<td>fracture(45°)</td>
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<td>33</td>
<td>fracture(40°)</td>
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<tr>
<td>34</td>
<td>fracture(50°)</td>
<td></td>
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</tr>
<tr>
<td>35</td>
<td>Highly weathered to 2&quot; diameter, edge of cavity</td>
<td></td>
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<tr>
<td>36</td>
<td>fracture(60°)</td>
<td>dark gray and light gray limestone, fine grained, moderately fractured, moderately weathered, hard, totally healed veins, some calcite and/or</td>
<td>Run: 6 35.8 - 40.8  Recovery: 5.15 ft.  Recovery: 103.0%  RQD = 97.0%  No. of Pieces: 3  Pressure: 25 psi  Fluid Return: 0%  Drilling Action: Smooth  Total Time: 6m:43s</td>
<td>4</td>
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</table>

**Legend**

- soil
- dolostone
- limestone
- void

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded
fracture(60°)

fracture(20°)
Highly fractured

fracture(20°)

fracture(65°)
Intensely fractured rock at open joint

void from 41.1' to 41.3',
some highly fractured rock,
no infilling. Driller reported
void from 41.1' to 41.3'

Run: 5
40.8 - 45.8
Recovery: 3.4 ft.
Recovery: 68.0%
RQD = 48.0%
No. of Pieces: 3
Pressure: 25 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 8m:02s

void from 44.3' to 51.2',
some highly fractured rock,
no infilling. Driller reported
void from 44.3' to 51.2' and
likely reached pinnacle at
51.2'
End of boring recovery at
44.3'

fracture(50°)

fracture(20°)

fracture(60°)

dolomite in joints, trace silty
clay in joints

void from 44.3' to 51.2',
some highly fractured rock,
moderately weathered,
hard, totally healed veins,
some calcite and/or
dolomite in joints, trace silty
clay in joints

for 44.3'

Notes:
Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone

- void
### Core Details

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pavement cored</td>
</tr>
<tr>
<td>1</td>
<td>Asphalt and concrete</td>
</tr>
<tr>
<td>2</td>
<td>Hollow-Stem Auger to refusal, no sample collected. Brown sand, gray gravel, and brown silty clay</td>
</tr>
<tr>
<td>3</td>
<td>Boulder</td>
</tr>
<tr>
<td>4</td>
<td>Intensely fractured rock with brown silty clay at joints. Driller reported that recovery is likely part of boulder</td>
</tr>
<tr>
<td>5</td>
<td>Void from 6.6' to 9.9', some intensely fractured rock, no infilling. Driller reported void from 6.6' to 9.6' is likely part of overburden soil</td>
</tr>
<tr>
<td>6</td>
<td>Fracture(0°)</td>
</tr>
<tr>
<td>7</td>
<td>Driller reported lost circulation/blocked at 5.8', recovered core</td>
</tr>
<tr>
<td>8</td>
<td>Boulders, some brown silty clay infilling at joints</td>
</tr>
<tr>
<td>9</td>
<td>Fracture(40°)</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Fracture(75°)</td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

### Lithology

- **Pavement cored**
- **Asphalt and concrete**
- **Hollow-Stem Auger to refusal, no sample collected. Brown sand, gray gravel, and brown silty clay**
- **Boulder**
- **Intensely fractured rock with brown silty clay at joints. Driller reported that recovery is likely part of boulder**
- **Void from 6.6' to 9.9', some intensely fractured rock, no infilling. Driller reported void from 6.6' to 9.6' is likely part of overburden soil**
- **Boulders, some brown silty clay infilling at joints**

### Remarks

- **Run: 1**
  - **5.3 - 5.8**
  - Recovery: 0.5 ft.
  - Recovery: 100.0%
  - RQD = 0.0%
  - No. of Pieces: 1
  - Pressure: 25 psi
  - Fluid Return: 100%
  - Drilling Action: Smooth
  - Total Time: N/A
- **Run: 2**
  - **5.8 - 6.6**
  - Recovery: 0.8 ft.
  - Recovery: 100.0%
  - RQD = 0.0%
  - No. of Pieces: 2
  - Pressure: 25 psi
  - Fluid Return: 100%
  - Drilling Action: Smooth
  - Total Time: 1m:56s
- **Run: 3**
  - **6.6 - 11.6**
  - Recovery: 1.8 ft.
  - Recovery: 36.0%
  - RQD = 25.0%
  - No. of Pieces: 2
  - Pressure: 25 psi
  - Fluid Return: 100%
  - Drilling Action: Smooth
  - Total Time: 8m:48s
  - At a depth between 6.6' to 11.6', driller smelled scent similar to lighter fluid, halted operations, and continued on the next workday.
- **Run: 4**

**Legend**

- Soil
- Dolostone
- Limestone
- Void

**Notes:**

- Coring rate not recorded due to rod drop in this run
- Rod drop in this interval
- Some of total time not recorded
- Backfilled with grout using tremie method

**Project Information**

- **Project Number:** 1168070004
- **Project Name:** Y-12 Outfall 200
- **Project Location:** Oak Ridge, TN
- **Client Name:** Strata-G
- **Date Started:** 11/15/2016
- **Time Started:** 4:25 PM
- **Logged By:** A. Spears
- **Completed:** 11/16/2016
- **Checked By:** K. Foye

**Drilling Information**

- **Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN
- **Drilling Method:** Hollow-Stem Auger / Rock Coring
- **Drill Rig Model:** CME 55
- **Core Size:** HQ 2 - 7/8"  
- **Weather:** Sunny 31°F
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td>Medium stiff brown silty clay with intensely fractured rock. Driller reported void from 11.6' to 21.6' is likely part of overburden soil</td>
<td></td>
<td></td>
<td>913</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Medium stiff brown silty clay with intensely fractured rock.</td>
<td></td>
<td></td>
<td>912</td>
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<tr>
<td>15</td>
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<td>19</td>
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<td></td>
<td></td>
<td>907</td>
</tr>
<tr>
<td>20</td>
<td>Top of rock 21.6'</td>
<td>fracture(25°)</td>
<td>Run: 5</td>
<td>Recovery: 1.4 ft.</td>
<td>906</td>
</tr>
<tr>
<td>21</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
<td>Recovery: 28.0%</td>
<td>905</td>
</tr>
<tr>
<td>22</td>
<td>fracture(25°)</td>
<td></td>
<td></td>
<td>RQD = 0.0%</td>
<td>904</td>
</tr>
<tr>
<td>23</td>
<td>Moderately fractured</td>
<td></td>
<td></td>
<td>No. of Pieces: 0</td>
<td>903</td>
</tr>
<tr>
<td>24</td>
<td>fracture(20°)</td>
<td></td>
<td></td>
<td>Pressure: 75 psi</td>
<td>902</td>
</tr>
<tr>
<td>25</td>
<td>fracture(0°)</td>
<td></td>
<td></td>
<td>Fluid Return: 0%</td>
<td>901</td>
</tr>
<tr>
<td>26</td>
<td>fracture(30°)</td>
<td></td>
<td></td>
<td>Drilling Action: Smooth</td>
<td></td>
</tr>
</tbody>
</table>

Run: 6
21.6 - 26.6
Recovery: 4.25 ft.
Recovery: 85.0%
RQD = 63.0%
No. of Pieces: 6
Pressure: 27 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 13m:48s

Notes:
Backfilled with grout using tremie method
Page 2 of 5

Legend:
- soil
- dolostone
- limestone
- void

* Coring rate not recorded due to rod drop in this run
** Rod drop in this interval
+ Some of total time not recorded

Deep penetrating drilling subcontractor: Tri-State Drilling, Inc., Chattanooga, TN
Drilling method: Hollow-Stem Auger / Rock Coring
Drill rig model: CME 55
Core size: HQ 2 - 7/8"
Weather: Sunny 31°F
**Core Details**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Driller reported fluid loss at 25.85'</td>
</tr>
<tr>
<td>27</td>
<td>Soft grayish brown infilling at open joint fracture(25°)</td>
</tr>
<tr>
<td>28</td>
<td>Light gray dolostone, fine grained, moderately hard, slightly fractured, slightly weathered, occasional calcite and/or dolomite veins, some grayish brown silty clay at joints</td>
</tr>
<tr>
<td>29</td>
<td>Soft grayish brown infilling at open joint fracture(60°)</td>
</tr>
<tr>
<td>30</td>
<td>Light gray and dark gray, limestone, moderately to highly fractured, moderately weathered, trace brown silty clay is calcite and/or dolomite in joints</td>
</tr>
<tr>
<td>31</td>
<td>Soft grayish brown infilling at open joint fracture(35°)</td>
</tr>
<tr>
<td>32</td>
<td>Light gray and dark gray, limestone, moderately to highly fractured, moderately weathered, trace brown silty clay is calcite and/or dolomite in joints</td>
</tr>
<tr>
<td>33</td>
<td>Fracture(0°)</td>
</tr>
<tr>
<td>34</td>
<td>Fracture(15°)</td>
</tr>
<tr>
<td>35</td>
<td>Fracture(0°) Fracture(30°) Driller reported fluid loss at 34.5'</td>
</tr>
<tr>
<td>36</td>
<td>Void from 34.5' to 36.6', no infilling. Driller reported void from 33.1' to 39.3'</td>
</tr>
<tr>
<td>37</td>
<td>Void from 36.6' to 40.3', no infilling</td>
</tr>
</tbody>
</table>

**Remarks**

- Run: 7
  - 26.6 - 31.6
  - Recovery: 3.6 ft.
  - Recovery: 72.0%
  - RQD = 66.0%
  - No. of Pieces: 1
  - Pressure: 27 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 10m:50s

- Run: 8
  - 31.6 - 36.6
  - Recovery: 2.85 ft.
  - Recovery: 57.0%
  - RQD = 47.0%
  - No. of Pieces: 8
  - Pressure: 32 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: 5m:52s

- Run: 9
  - 36.6 - 41.6
  - Recovery: 2 ft.
  - Recovery: 40.0%
  - RQD = 27.0%
  - No. of Pieces: 1
  - Pressure: 33 psi
  - Fluid Return: 0%
  - Drilling Action: Smooth
  - Total Time: N/A

**Legend**

- soil
- dolostone
- limestone
- void

**Backfilled with grout using tremie method**
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>39</td>
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</tr>
<tr>
<td>40</td>
<td>fracture(0°)</td>
<td></td>
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</tr>
<tr>
<td>41</td>
<td>fracture(0°)</td>
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<td>42</td>
<td>fracture(0°)</td>
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<td>43</td>
<td>fracture(0°)</td>
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<tr>
<td>44</td>
<td>fracture(0°)</td>
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<tr>
<td>45</td>
<td>fracture(45°)</td>
<td>light gray and dark gray, limestone, moderately fractured, moderately weathered, trace brown silty clay is calcite and/or dolomite in joints</td>
<td>Run: 10 41.6 - 46.6 Recovery: 5 ft. Recovery: 100.0% RQD = 93.3% No. of Pieces: 3 Pressure: 22 psi Drilling Action: Smooth Total Time: 9m:20s</td>
</tr>
<tr>
<td>46</td>
<td>fracture(45°)</td>
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<td>fracture(0°)</td>
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<tr>
<td>48</td>
<td>fracture(35°)</td>
<td>light gray and dark gray, limestone, moderately to highly fractured, moderately weathered, trace brown silty clay is calcite and/or dolomite in joints</td>
<td>Run: 11 46.6 - 50.6 Recovery: 3.9 ft. Recovery: 97.5% RQD = 94.0% No. of Pieces: 6 Pressure: 22 psi Fluid Return: 0% Drilling Action: Smooth Total Time: 8m:43s</td>
</tr>
<tr>
<td>49</td>
<td>fracture(15°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
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<td>52</td>
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</table>

- **Coring rate not recorded due to rod drop in this run**
- **Rod drop in this interval**
- + Some of total time not recorded
- Backfilled with grout using tremie method
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
<th>Rate (min/ft)</th>
<th>Elevation (ft)</th>
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<tbody>
<tr>
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<td>Pavement cored</td>
<td>Asphalt and concrete</td>
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<td>926</td>
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</table>

**Corning rate not recorded due to rod drop in this run**  
**Rod drop in this interval**

+ Some of total time not recorded

Notes:
- Backfilled with grout using tremie method.
<table>
<thead>
<tr>
<th>Depth  (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td></td>
<td>dark gray and light gray limestone, fine grained, highly fractured, slightly weathered, hard, some calcite and/or dolomite in joints, trace grayish brown clay in joints</td>
<td>Run: 3  25.9 - 30.9  Recovery: 3.9 ft.  Recovery: 78.0%  RQD = 64.0%  No. of Pieces: 8  Pressure: 24 psi  Fluid Return: 0%  Drilling Action: Smooth  Total Time: 7m:25s</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>fracture(0°)</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>fracture(50°)</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>highly weathered to 0.75&quot; diameter, edge of cavity</td>
<td>void from 28.4' to 29.4', no infilling. Driller reported void from 28.5' to 29.2'</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>fracture(55°)</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>fracture(70°)</td>
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</tr>
<tr>
<td>32</td>
<td></td>
<td>Intensely fractured</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td></td>
<td>Moderately fractured</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>fracture(55°)</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>fracture(50°)</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td></td>
<td>fracture(40°)</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td></td>
<td>fracture(0°)</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td></td>
<td>fracture(0°)</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td></td>
<td>fracture(30°)</td>
<td></td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval  
+ Some of total time not recorded

---

**Notes:**
- Backfilled with grout using tremie method
- Page 3 of 5

---

**Legend:**
- soil
- dolostone
- limestone
- void
Dark gray and light gray limestone, fine grained, moderately fractured, hard, some styolite in joints, trace calcite and/or dolomite in joints.

**Remarks**
- Run: 6
- Depth: 40.9 - 45.9 ft
- Recovery: 5 ft
- RQD: 100.0%
- No. of Pieces: 4
- Pressure: 24 psi
- Fluid Return: 0%
- Drilling Action: Smooth
- Total Time: 6m:32s

Dark gray and light gray limestone, fine grained, moderately to highly weathered, hard, trace styolite, calcite and/or dolomite and brown silty clay in joints.

**Remarks**
- Run: 7
- Depth: 45.9 - 50.9 ft
- Recovery: 5 ft
- RQD: 71.0%
- No. of Pieces: 8
- Pressure: 56 psi
- Fluid Return: 0%
- Drilling Action: Smooth
- Total Time: 6m:13s

**Legend**
- soil
- dolostone
- limestone
- void

---

**Notes:**
- Backfilled with grout using tremie method

---

**Borehole ID:** B-21
**Project Number:** 1168070004
**Project Name:** Y-12 Outfall 200
**Project Location:** Oak Ridge, TN
**Client Name:** Strata-G
**Date Started:** 11/14/2016
**Completed:** 11/14/2016
**Time Started:** 1:15 PM
**Completed:** 4:30 PM
**Logged By:** A. Spears
**Checked By:** K. Foye
**Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN
**Drilling Method:** Hollow-Stem Auger / Rock Coring
**Core Size:** HQ 2.7/8"
**Weather:** Mostly Sunny 63°F

---

**Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN
**Drilling Method:** Hollow-Stem Auger / Rock Coring
**Core Size:** HQ 2.7/8"
**Weather:** Mostly Sunny 63°F

---

**Notes:**
- Backfilled with grout using tremie method

---

**Legend**
- soil
- dolostone
- limestone
- void

---

**Borehole ID:** B-21
**Project Number:** 1168070004
**Project Name:** Y-12 Outfall 200
**Project Location:** Oak Ridge, TN
**Client Name:** Strata-G
**Date Started:** 11/14/2016
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**Checked By:** K. Foye
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**Core Size:** HQ 2.7/8"
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---

**Notes:**
- Backfilled with grout using tremie method

---

**Legend**
- soil
- dolostone
- limestone
- void

---

**Borehole ID:** B-21
**Project Number:** 1168070004
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**Core Size:** HQ 2.7/8"
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---

**Notes:**
- Backfilled with grout using tremie method

---

**Legend**
- soil
- dolostone
- limestone
- void
dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered, hard, trace styolite, calcite and/or dolomite and brown silty clay in joints, occasional joints with some styolite, calcite and/or dolomite and brown silty clay

Run: 9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9
55.9 - 60.9

Legends:
- soil
- dolostone
- limestone
- void

Notes:
Backfilled with grout using tremie method
Page 5 of 5
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pavement cored</td>
<td>Asphalt and concrete</td>
<td>Industrial hygienist detected trichloroethylene (TCE) above acceptable levels in soil, halted operations and continued on the next workday. No detection the next day</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
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<td>4</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
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<tr>
<td>13</td>
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<td></td>
<td></td>
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</tbody>
</table>

* Coring rate not recorded due to rod drop in this run  ** Rod drop in this interval
+ Some of total time not recorded

Backfilled with grout using tremie method

Legend

- soil
- dolostone
- limestone
- void
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Core Details</th>
<th>Lithology</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Top of rock 17.4' fracture(20°)</td>
<td>dark gray and light gray limestone, fine grained, moderately fractured, slightly weathered joints, hard, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, frequent totally healed stylolite healed veins</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Auger refusal at 17.8' fracture(40°)</td>
<td>Run: 1 17.4 - 21.2 Recovery: 3.6 ft. Recovery: 94.7% RQD = 95.0% No. of Pieces: 4 Pressure: 26 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 15m</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>fracture(35°)</td>
<td>dark gray and light gray limestone, fine grained, moderately to highly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, frequent totally healed stylolite healed veins</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>fracture(15°)</td>
<td>Run: 2 21.2 - 26.2 Recovery: 5.1 ft. Recovery: 102.0% RQD = 81.0% No. of Pieces: 11 Pressure: 30 psi Fluid Return: 100% Drilling Action: Smooth Total Time: 7m:28s</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>fracture(35°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>fracture(15°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>fracture(45°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>fracture(40°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>fracture(35°)</td>
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<tr>
<td></td>
<td>fracture(30°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fracture(30°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fracture(55°)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Coring rate not recorded due to rod drop in this run ** Rod drop in this interval + Some of total time not recorded

---

**Legend**

- soil
- dolostone
- limestone
- void

**Notes:**

- Backfilled with grout using tremie method

---

**Project Number:** 1168070004  
**Project Name:** Y-12 Outfall 200  
**Project Location:** Oak Ridge, TN  
**Client Name:** Strata-G  
**Date Started:** 11/12/2016  
**Completed:** 11/14/2016  
**Logged By:** A. Spears  
**Checked By:** K. Foye  
**Drilling Subcontractor:** Tri-State Drilling, Inc., Chattanooga, TN  
**Drill Rig Model:** CME 55  
**Core Size:** HQ 2 - 7/8"  
**Weather:** Sunny 39°F  
**Elevation:** 913 ft  
**Backfilled with grout using tremie method**
dark gray and light gray limestone, fine grained, highly fractured, hard, slightly weathered, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, frequent totally healed styolite healed veins

void from 33.0' to 35.3', no infilling. Driller reported void from 33.2' to 34.2', likely edge of rock because drillers did not experience casing drop

light gray dolostone, moderately fractured

some grayish brown silty clay with trace sand at open joint

light gray dolostone, moderately fractured, slightly weathered, occasional totally healed

---

**Legend**

- soil
- dolostone
- limestone
- void

---

**Notes:** Backfilled with grout using tremie method
veins with brown silty clay infilling

dark gray and light gray limestone and dolostone, fine grained, slightly fractured to moderately, slightly weathered, hard, some brown silty clay at top, trace brown silty clay and calcite and/or dolomite in joints, occasional moderately healed veins, fr

dark gray and light gray limestone and dolostone, fine grained, moderately to slightly fractured, slightly weathered, hard, some calcite and/or dolomite in joints

Notes:
Backfilled with grout using tremie method
dark gray and light gray limestone and dolostone, fine grained, moderately fractured, slightly weathered, hard, occasional totally healed styolite veins, trace calcite and/or dolomite, styolite and brown silty clay in joints

Run: 9
56.2 - 60.2
Recovery: 4.1 ft.
Recovery: 102.5%
RQD = 100.0%
No. of Pieces: 4
Pressure: 26 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 6m:44s

End of boring recovery at 60.2

56.2 - 60.2
Recovery: 4.1 ft.
Recovery: 102.5%
RQD = 100.0%
No. of Pieces: 4
Pressure: 26 psi
Fluid Return: 0%
Drilling Action: Smooth
Total Time: 6m:44s

Backfilled with grout using tremie method

Notes:

Legend:

- soil
- dolostone
- limestone
- void
GEOTECHNICAL REPORT FOR DATA GAP
CHARACTERIZATION AT THE PROPOSED OUTFALL 200
MERCURY TREATMENT FACILITY SITES
January 2017

Appendix B – Geophysical Logging Report
Geophysical Logging Report

Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22

Outfall 200 Mercury Treatment Facility Sites

Y-12, Oak Ridge, Tennessee

Performed for:

Strata-G

November 29, 2016
# Geophysical Logging Report

Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22

Outfall 200 Mercury Treatment Facility Sites

Y-12, Oak Ridge, Tennessee

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</tr>
</thead>
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<td>Executive Summary</td>
<td>iii</td>
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<td>1.0 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2.0 Equipment and Methodology</td>
<td>1</td>
</tr>
<tr>
<td>2.1 Mechanical 3-Arm Caliper</td>
<td>1</td>
</tr>
<tr>
<td>2.2 Natural Gamma</td>
<td>1</td>
</tr>
<tr>
<td>3.0 Field Procedures</td>
<td>2</td>
</tr>
<tr>
<td>4.0 Data Processing and Results</td>
<td>3</td>
</tr>
</tbody>
</table>

**Appendices**

Appendix 1   Geophysical Logs
This report, entitled “Geophysical Logging Report, Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22, Outfall 200 Mercury Treatment Facility Sites, Y-12, Oak Ridge, Tennessee” has been prepared for Strata-G located in Knoxville, Tennessee. It has been prepared under the supervision of Mr. Jorgen Bergstrom at the request of and the exclusive use of Strata-G. This report has been prepared in accordance with accepted quality control practices and has been reviewed by the undersigned.

GEL Geophysics, LLC
A Member of the GEL Group, Inc.

Jorgen Bergstrom
Senior Geophysicist

Matthew J. Wolf
Chief Technology Officer

November 29, 2016

Date
EXECUTIVE SUMMARY

GEL Geophysics performed geophysical borehole logging services in nine borings at the Outfall 200 Mercury treatment facility sites at Y-12, Oak Ridge, Tennessee on November 15-16, 2016. The geophysical logs consisted of mechanical 3-arm caliper and natural gamma. For this investigation, GEL Geophysics used a Mount Sopris logging system for collecting the data and WellCAD v. 5.1 for analyzing the data. WellCAD is manufactured by Advanced Logic Technology.

Several boreholes could not be logged to the total depth due to cave-ins. In a couple of boreholes, the holes caved in during logging causing differences in the total depth logged with each tool.

The logging data was analyzed to determine the location and aperture of borehole openings presumably caused by voids or fractures, and assess if the voids or fractures appear to be open or clay-filled. Overall, increases in caliper readings with no corresponding increase in natural gamma reading were interpreted as possibly open void or fracture. Increases in caliper readings with a corresponding increase in natural gamma reading were interpreted as possible clay-filled void or fracture.
Geophysical Logging Report
Borings B-2, B-4, B-6, B-7, B-9, B-10, B-11, B-21, and B-22
Outfall 200 Mercury Treatment Facility Sites
Y-12, Oak Ridge, Tennessee

1.0 INTRODUCTION

GEL Geophysics performed geophysical borehole logging services in nine borings, at the Outfall 200 Mercury treatment facility sites at Y-12, Oak Ridge, Tennessee. The geophysical logs consisted of mechanical 3-arm caliper and natural gamma. The field investigations were performed on November 15-16, 2016. The logging data was analyzed to determine the location and aperture of borehole openings presumably caused by voids or fractures, and assess if the voids or fractures appear to be open or clay-filled.

2.0 EQUIPMENT AND METHODOLOGY

The information below is an overview of the geophysical methodologies used for this investigation. The intent of this overview is to give the reader a better understanding of each method, and background information as to what is actually measured, the resolution of the method, and the limitations imposed by site-specific subsurface conditions.

2.1 Mechanical 3-arm caliper
Caliper logging is used to generate a profile of the borehole diameter with depth. The tool measures the borehole diameter using three spring-loaded arms. Narrow enlargements in the borehole diameter can, in most cases, be attributed to fractures. Caliper logging can be conducted above and below the water surface.

2.2 Natural Gamma
Natural gamma tools measure the gamma radiation from the formation. These logs can be used to discriminate between different formations by utilizing variations in the concentration of naturally occurring radioactive isotopes such as potassium, uranium and thorium. These logs are particularly popular for correlating logs and locating clay and shale formations since radioactive elements tend to concentrate in these materials. Natural gamma logging can be conducted in cased and uncased boreholes, water-filled and dry.
3.0 FIELD PROCEDURES

For this investigation, GEL Geophysics used a Mount Sopris logging system for collecting the data and WellCAD v. 5.1 for analyzing the data. WellCAD is manufactured by Advanced Logic Technology. The following equipment was used onsite:

- Data Acquisition System: Matrix data logger
- Logging Winch: MX system with 1,500 feet of cable
- Mechanical 3-arm caliper: QL40-CAL
- Natural Gamma: 2PGA

Several boreholes could not be logged to the total depth due to cave-ins before or between logging runs. In a couple of boreholes, the holes caved in during or after logging with one tool causing differences in the total depth logged with subsequent tools.

A summary of the borehole configurations is provided below. All depth measurements are referenced from ground surface. All borings were surface cased to the overburden and bedrock/competent rock interface with an approximately 4-inch casing and open uncased hole below the casing.

Logging Configuration Summary

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Borehole diameter (in)* (open hole)</th>
<th>Casing Depth (ft)*</th>
<th>Total depth logged (ft)</th>
<th>Reported total depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-2</td>
<td>3.5</td>
<td>7.6</td>
<td>58.8</td>
<td>60.0</td>
</tr>
<tr>
<td>B-4</td>
<td>3.5</td>
<td>Appr. 4.6</td>
<td>38.3</td>
<td>60.0</td>
</tr>
<tr>
<td>B-6</td>
<td>3.5</td>
<td>6.9</td>
<td>34.3</td>
<td>60.0</td>
</tr>
<tr>
<td>B-7</td>
<td>3.8 to 46' 3.5 below 46'</td>
<td>17.5</td>
<td>58.5 (caliper) 40.4 (gamma)</td>
<td>60.0</td>
</tr>
<tr>
<td>B-9</td>
<td>3.8</td>
<td>21.6</td>
<td>51.9</td>
<td>60.0</td>
</tr>
<tr>
<td>B-10</td>
<td>3.8</td>
<td>17.6</td>
<td>50.9 (gamma) 25.6 (caliper)</td>
<td>60.0</td>
</tr>
<tr>
<td>B-11</td>
<td>3.5</td>
<td>20.7</td>
<td>54.3</td>
<td>60.0</td>
</tr>
<tr>
<td>B-21</td>
<td>3.8 to 30' 3.5 below 30'</td>
<td>18.1</td>
<td>42.7</td>
<td>60.0</td>
</tr>
<tr>
<td>B-22</td>
<td>3.5</td>
<td>17.1</td>
<td>59.7</td>
<td>60.0</td>
</tr>
</tbody>
</table>

*Based on caliper logging
4.0 DATA PROCESSING AND RESULTS

Increases in caliper readings with no corresponding increase in natural gamma reading were interpreted as possibly open void or fracture. Increases in caliper readings with a corresponding increase in natural gamma reading were interpreted as possible clay-filled void or fracture. There was one void or fracture detected in boring B-7 at a depth where only caliper data was collected (45.5 feet below ground surface). Without the natural gamma data, it could not be assessed if this void or fracture was open or clay-filled. Also, there was one section with increased natural gamma readings detected in boring B-10 at a depth where only natural gamma data was collected (38.2 feet below ground surface). This section was interpreted as possible clay-filled void or fracture. One reason for this interpretation is that the natural gamma response looks very similar to the response at 46.7 feet and 48.5 feet in the adjacent boring B-9 (where both logs were available). A summary of the detected voids and fractures are provided below.

**B-2**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Aperture (mm)</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>8.1</td>
<td>150</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>9.9</td>
<td>105</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>11.9</td>
<td>80</td>
<td>Possibly clay-filled</td>
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**B-4**

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<th>Depth (ft)</th>
<th>Aperture (mm)</th>
<th>Comment</th>
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<tbody>
<tr>
<td>10.9</td>
<td>250</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>12.0</td>
<td>130</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>14.8</td>
<td>1120</td>
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**B-6**

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<th>Depth (ft)</th>
<th>Aperture (mm)</th>
<th>Comment</th>
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<tbody>
<tr>
<td>7.5</td>
<td>190</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>11.9</td>
<td>990</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>14.2</td>
<td>140</td>
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**B-7**

<table>
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<tr>
<th>Depth (ft)</th>
<th>Aperture (mm)</th>
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<tbody>
<tr>
<td>17.9</td>
<td>150</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>33.7</td>
<td>550</td>
<td>Possibly open</td>
</tr>
</tbody>
</table>
Possibly clay-filled
Possibly clay-filled
Open or clay-filled (caliper only)

### B-9

<table>
<thead>
<tr>
<th>Depth</th>
<th>Aperture</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.4</td>
<td>820</td>
<td>Possibly open</td>
</tr>
<tr>
<td>36.6</td>
<td>370</td>
<td>Possibly open</td>
</tr>
<tr>
<td>46.7</td>
<td>560</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>48.5</td>
<td>70</td>
<td>Possibly clay-filled</td>
</tr>
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### B-10

<table>
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<th>Comment</th>
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<td>90</td>
<td>Possibly clay-filled</td>
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<tr>
<td>21.4</td>
<td>300</td>
<td>Possibly clay-filled</td>
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<tr>
<td>23.3</td>
<td>470</td>
<td>Possibly clay-filled</td>
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<tr>
<td>25.2</td>
<td>90</td>
<td>Possibly open</td>
</tr>
<tr>
<td>38.2</td>
<td>830</td>
<td>Possible clay-filled (gamma only)</td>
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### B-11

<table>
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<th>Comment</th>
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<tbody>
<tr>
<td>21.7</td>
<td>500</td>
<td>Possibly clay-filled</td>
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### B-21

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<th>Depth</th>
<th>Aperture</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.4</td>
<td>60</td>
<td>Possibly open</td>
</tr>
<tr>
<td>24.0</td>
<td>250</td>
<td>Possibly clay-filled</td>
</tr>
<tr>
<td>28.3</td>
<td>310</td>
<td>Possibly open</td>
</tr>
<tr>
<td>29.8</td>
<td>120</td>
<td>Possibly open</td>
</tr>
</tbody>
</table>

### B-22

<table>
<thead>
<tr>
<th>Depth</th>
<th>Aperture</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.2</td>
<td>650</td>
<td>Possibly open</td>
</tr>
</tbody>
</table>
APPENDIX 1
Depth: 1ft to 100ft

Caliper: 36 in

Natural Gamma: 0.2 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0 5.2 5.4 5.6 5.8 6.0 6.2 6.4 6.6 6.8 7.0 7.2 7.4 7.6 8.0 8.2 8.4 8.6 8.8 9.0 9.2 9.4 9.6 9.8 10.0

Fractures and voids:

Bottom of casing: Boring ID: B-2

**LEGEND**

- Void or fracture. Possibly open
- Void or fracture. Possibly clay-filled
- Void or fracture. Open or clay-filled (only caliper data)
- Possible clay-filled void or fracture (only natural gamma data)
Depth: 1ft:100ft
Caliper: 36 in
Natural Gamma: 02 0 0 cps
Fractures and Voids:

LEGEND:
- Void or fracture. Possibly open
- Void or fracture. Possibly clay-filled
- Void or fracture. Open or clay-filled (only caliper data)
- Possible clay-filled void or fracture (only natural gamma data)
Depth: 1 ft to 100 ft

Caliper: 36 in

Natural Gamma: 02 0 0 cps

Fractures and voids:

0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0 28.0 30.0 32.0 34.0 36.0 38.0 40.0 42.0 44.0 46.0 48.0 50.0 52.0 54.0 56.0 58.0 60.0 62.0 64.0 66.0 68.0 70.0 72.0 74.0 76 0

Bottom of casing: Boring ID: B-7
Depth: 1 ft to 100 ft
Caliper: 36 in
Natural Gamma: 0.2 to 0.0 cps
Fractures and voids: 0.0 to 2.0

Bottom of casing: Boring ID: B-10

LEGEND:
- Void or fracture, Possibly open
- Void or fracture, Possibly clay-filled
- Void or fracture, Open or clay-filled (only caliper data)
- Possible clay-filled void or fracture (only natural gamma data)
Depth
1 ft: 100 ft

Caliper
36 in

Natural Gamma
0 0 0 cps

Fractures and voids
0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0 28.0 30.0 32.0 34.0 36.0 38.0 40.0 42.0 44.0 46.0 48.0 50.0 52.0 54.0 56.0 58.0 60.0 62.0 64.0 66.0 68.0 70.0 72.0 74.0 76.0

Bottom of casing
Boring ID: B-11
Depth: 1 ft to 100 ft

Natural Gamma: 02 0 0 cps

Caliper: 36 in

Fractures and voids:

- 0.0
- 2.0
- 4.0
- 6.0
- 8.0
- 10.0
- 12.0
- 14.0
- 16.0
- 18.0
- 20.0
- 22.0
- 24.0
- 26.0
- 28.0
- 30.0
- 32.0
- 34.0
- 36.0
- 38.0
- 40.0
- 42.0
- 44.0
- 46.0
- 48.0
- 50.0
- 52.0
- 54.0
- 56.0
- 58.0
- 60.0
- 62.0
- 64.0
- 66.0
- 68.0
- 70.0
- 72.0
- 74.0
- 76.0

Bottom of casing:

Boring ID: B-22

LEGEND:
- Void or fracture. Possibly open
- Void or fracture. Possibly clay-filled
- Void or fracture. Open or clay-filled (only caliper data)
- Possible clay-filled void or fracture (only natural gamma data)
Appendix C – Boring Location Plan
**AS-BUILT SURVEY GEOTECHNICAL SOIL BORINGS**
**Y12 OUTFALL 200 MERCURY TREATMENT FACILITY**

**12/1/2016**

<table>
<thead>
<tr>
<th>Borehole ID</th>
<th>Y-12 Grid Easting (ft)</th>
<th>Y-12 Grid Northing (ft)</th>
<th>Elevation (ft amsl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>57771.7</td>
<td>29296.3</td>
<td>935.55</td>
</tr>
<tr>
<td>B-2</td>
<td>57808.5</td>
<td>29291.3</td>
<td>935.18</td>
</tr>
<tr>
<td>B-3</td>
<td>57836.8</td>
<td>29286.1</td>
<td>935.69</td>
</tr>
<tr>
<td>B-4</td>
<td>57900.5</td>
<td>29279.8</td>
<td>935.63</td>
</tr>
<tr>
<td>B-5</td>
<td>57740.1</td>
<td>29254.6</td>
<td>937.38</td>
</tr>
<tr>
<td>B-6</td>
<td>57758.7</td>
<td>29262.7</td>
<td>935.62</td>
</tr>
<tr>
<td>B-7</td>
<td>57760.8</td>
<td>29234.8</td>
<td>936.00</td>
</tr>
<tr>
<td>B-8</td>
<td>57781.9</td>
<td>29268.1</td>
<td>935.13</td>
</tr>
<tr>
<td>B-9</td>
<td>57800.4</td>
<td>29233.0</td>
<td>935.62</td>
</tr>
<tr>
<td>B-10</td>
<td>57820.8</td>
<td>29244.0</td>
<td>935.67</td>
</tr>
<tr>
<td>B-11</td>
<td>57837.2</td>
<td>29253.3</td>
<td>935.46</td>
</tr>
<tr>
<td>B-12</td>
<td>57854.7</td>
<td>29211.8</td>
<td>935.70</td>
</tr>
<tr>
<td>B-14</td>
<td>57926.3</td>
<td>29209.3</td>
<td>935.75</td>
</tr>
<tr>
<td>B-15</td>
<td>61392.9</td>
<td>29008.9</td>
<td>926.38</td>
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<tr>
<td>B-16</td>
<td>61431.3</td>
<td>28993.8</td>
<td>926.58</td>
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<tr>
<td>B-17</td>
<td>61461.9</td>
<td>29014.2</td>
<td>926.39</td>
</tr>
<tr>
<td>B-18</td>
<td>61465.8</td>
<td>28974.8</td>
<td>926.34</td>
</tr>
<tr>
<td>B-19</td>
<td>61555.5</td>
<td>29007.9</td>
<td>926.37</td>
</tr>
<tr>
<td>B-20</td>
<td>61531.3</td>
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<td>926.04</td>
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<td>61385.1</td>
<td>28961.0</td>
<td>926.43</td>
</tr>
<tr>
<td>B-22</td>
<td>61414.4</td>
<td>28931.2</td>
<td>926.14</td>
</tr>
</tbody>
</table>

ft = feet  
amsl = above mean sea level

Final, completed boring locations were surveyed to the nearest 0.05-ft. amsl as-built elevation and 0.1-ft. horizontally using Y-12 coordinates. Y-12 control point 176 was used for vertical control (NAVD29 datum). Survey performed by Barge Waggoner Sumner & Cannon, Knoxville, Tennessee on December 1, 2016.
Borehole locations at the Headworks Area.
Borehole locations at the Outfall 200 Mercury Treatment Facility Area.
Appendix D – General Notes for Soil/Rock Classification
GENERAL NOTES FOR SOIL/ROCK CLASSIFICATION

GROUNDWATER: Observations, if any, are made at the times indicated on logs. Porosity of soil strata, weather conditions and site topography may cause changes in the water levels.

SOIL CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. For fine-grained soils (silt, clay and combinations thereof), the classification is primarily based upon plasticity. For coarse-grained soils (sand and gravel), the classification is based upon particle size distribution. Minor soil constituents are reported as “trace” (0-5%), “some” (5-12%) and “with” (15-29%). Where the minor constituents are in excess of 29%, an adjective is used preceding the major constituent name (i.e. for sands containing 35% silt, the soil is classified as silty sand). In some cases, consistency terms such as very soft, soft, medium stiff, stiff, very stiff, or hard may be used to describe cohesive soils (silt and clay), terms such as very loose, loose, medium dense, dense, or very dense may be used to describe cohesionless soils (sand). For the purposes of describing infilling, these consistency terms are relative, and not based on Standard Penetration Resistances (N) or unconfined compressive strength tests.

PARTICLE SIZE DISTRIBUTION

<table>
<thead>
<tr>
<th>Classification</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Greater than 12 inches</td>
</tr>
<tr>
<td>Cobble</td>
<td>3 inches to 12 inches</td>
</tr>
<tr>
<td>Gravel</td>
<td>No. 4 (4.75mm) to 3 inches</td>
</tr>
<tr>
<td>Sand</td>
<td>No. 200 (0.075mm) to No. 4 (4.75mm)</td>
</tr>
<tr>
<td>Silt</td>
<td>0.005mm to 0.075mm</td>
</tr>
<tr>
<td>Clay</td>
<td>size is less than 0.005mm</td>
</tr>
</tbody>
</table>

ROCK CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. However, information about local geologic formations can also be used to confirm classifications. Sedimentary, igneous, and metamorphic rock are determined by their color, texture, structure, particle shape and size, mineral composition, cement/matrix, and properties during inspection and/or testing. The occurrence of cementing veins is reported as “occasional” for one or less per foot of depth and “frequent” for more than one per foot of depth.

<table>
<thead>
<tr>
<th>Fracture Density</th>
<th>Rock Hardness</th>
<th>Rock Quality (RQD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfractured</td>
<td>Very Soft</td>
<td>Deformed by hand, scratched with a fingernail</td>
</tr>
<tr>
<td>Slightly fractured</td>
<td>Soft</td>
<td>Scratched with a fingernail, crumbles with geologic pick</td>
</tr>
<tr>
<td>Moderately fractured</td>
<td>Moderately Hard</td>
<td>Scratched easily with a knife or steel nail</td>
</tr>
<tr>
<td>Highly fractured</td>
<td>Hard</td>
<td>Broken with one hammer blow, difficulty scratching with knife</td>
</tr>
<tr>
<td>Intensely fractured</td>
<td>Very Hard</td>
<td>Broken with several hammer blows, cannot be scratched with knife or steel nail</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of Weathering</th>
<th>Fracture Healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unweathered</td>
<td>No evidence of any chemical or mechanical alteration</td>
</tr>
<tr>
<td>Slightly Weathered</td>
<td>Slight discoloration on surface, slight alteration at fractures, less than 10 percent of rock volume altered</td>
</tr>
<tr>
<td>Moderately Weathered</td>
<td>Moderate discoloring, 10 percent to 50 percent of rock volume altered</td>
</tr>
<tr>
<td>Highly Weathered</td>
<td>Highly discolored, more than 50 percent of rock volume altered</td>
</tr>
<tr>
<td>Totally Healed Veins</td>
<td>Fracture re-cemented</td>
</tr>
<tr>
<td>Moderately Healed Veins</td>
<td>Greater than 50% of fracture material re-cemented</td>
</tr>
<tr>
<td>Partly Healed Veins</td>
<td>Less than 50% of fracture material re-cemented</td>
</tr>
<tr>
<td>Open Joint</td>
<td>Fracture without cementation, rock does not fit together with adjacent core pieces without open spaces</td>
</tr>
</tbody>
</table>