Big Bend Dam (SD01092)

Missouri River, Fort Thompson, South Dakota

Geotechnical Data Report

Northwestern Division
Omaha District

Date: October 2022

Status: 95% STEP 1

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GEOTECHNICAL DATA REPORT

1. Disclaimer

This Geotechnical Data Report (GDR) contains actual subsurface and other information that was collected at or adjacent to the Site by the Government, or for the Government, for use in preparing the Contract Documents. This GDR attempts to contain only non-interpretative information. The GDR is a summary, the full-text non-interpretive documents, included in the non-interpretive appendices, are provided for completeness and for the information of the bidder. The Technical Data contained in this report upon whose accuracy the Contractor may rely are logs of borings, logs of trenches/test pits, geophysical information, contractor-reported lab results, SPT hammer results, original construction-era documents, recorded measurements of subsurface water levels, and contractor-reported optical camera images. If opinions, or interpretive or speculative non-factual comments or statements appear in the GDR, such opinions, comments, or statements are not operative parts of the GDR and do not have contractual standing. Subject to that exception, the GDR is a Contract Document.

2. Limitations

The Government does not represent that the boring and test pit/trench logs, field and laboratory test results and other available geologic information show the conditions that will be encountered in performing the work. The Government represents only that such information shows conditions at the locations of the borings, test pits/trenches, or other field data collection locations at the time that the data were collected. Each bidder must form their own opinion of the character of the work and of the materials to be excavated, make their own interpretations, and satisfy themselves by their own interpretations and research regarding all conditions affecting the work to be performed. The Contractor must assume all responsibility for deductions and conclusions as to the nature or condition of all earth, rock and other materials to be excavated and the difficulties of making and maintaining the required excavations, and of performing other work affected by the geology and subsurface conditions at the Site. The Contractor must assume that any kind of rock and soil may be encountered in excavations, including mud or other materials that are difficult to handle.

Limited Reliance by the Contractor on Technical Data Authorized: The Contractor may rely upon the general accuracy of the Technical Data contained in the GDR. Except for such reliance on this Technical Data, the Contractor may not rely upon or make any Claim against the Government with respect to:

a) the completeness of this report for the Contractor's purposes, including but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by the Contractor, and safety precautions and programs incident thereto, or
b) interpretations and opinions contained in this report, or
c) Any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

3. GDR Report Function

This report, the Geotechnical Data Report (GDR), functions as a summary of non-interpretative data that have been collected for this project in separate reports at different times. Some of the information within and attached was created by USACE, some by contractors working for USACE.

For more information, please see the full-text appendices that contain more detailed information in each report. They are referenced within the report.

4. Overview of Report Contents

The information in the Geotechnical Data Report includes available borehole, pump capacity tests, piezometer logs, Piezometer installation diagrams, relief well boring logs, relief well installation diagrams, relief well pump test data, soil laboratory testing, and other information from or relating to the relief well collector pipe system and nearby instrumentation.

The following information is included in this report:

- Subsurface Explorations
    - FY20 Geotechnical Investigation Report
    - FY21 Relief Well Pilot Hole Boring and Borrow Area Investigation Report
- Select Piezometer Data
- Select Relief Well Data
- Pump test capacity Reports
    - FY20 Dam Safety Instrumentation Rehabilitation Engineering Geology Report
- Geotechnical Lab Results
- Special Inspections and Reports
    - 1998 Braun Intech Piezometer Rehab and Response Test Report
    - 2010 Vibrating Wire Piezometer Installation Geologic Field Report
    - 2015 Camera Inspection Report for Relief Well Collector Pipe

SUBSURFACE INVESTIGATION

TOE DRAIN AND RELIEF WELL COLLECTOR PIPE REPLACEMENT GEOTECHNICAL REPORT

(AUG 2021)

US Army Corps of Engineers

Big Bend Dam (SD01092)

Missouri River, Fort Thompson, South Dakota
Embankment, Powerhouse, and Spillway

TOE DRAIN AND RELIEF WELL COLLECTOR PIPE REPLACEMENT

GEOTECHNICAL DATA REPORT

Northwestern Division
Omaha District

Status: FINAL
Report Date: JULY 2020
Revised August 2021

FOR OFFICIAL USE ONLY (FOUO)

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1. INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Omaha District has prepared this engineering geology report to document the results of a drilling program plan (DPP) conducted in support of a planned toe drain and relief well collector pipe replacement project at Big Bend Dam. The objective of the work outlined in the DPP and compiled in this engineering geology report was to provide additional geotechnical, hydrogeological, and hazardous, toxic, and radioactive waste (HTRW) data in the left abutment area of the dam in support of the drain replacement project. The findings from the field investigation as documented in this report will be utilized in conjunction with an analysis of existing site data to refine the team's understanding of the foundation and groundwater conditions which will aid in the design and construction of the replacement drains, including potential dewatering requirements.

1.1 Project Background

Big Bend Dam is a high hazard potential dam located on the Missouri River in Buffalo and Lyman Counties, South Dakota, approximately 20 miles upstream of the city of Chamberlain. Big Bend is one of six main stem dams on the Missouri River, and was authorized by the Flood Control Act approved 22 December 1944 (Public Law 534, 78th Congress 2nd Session) as part of the general comprehensive plan for flood control, irrigation, navigation, and hydropower in the Missouri River basin (Figure 1-1). The project was constructed from 1963 to 1966.

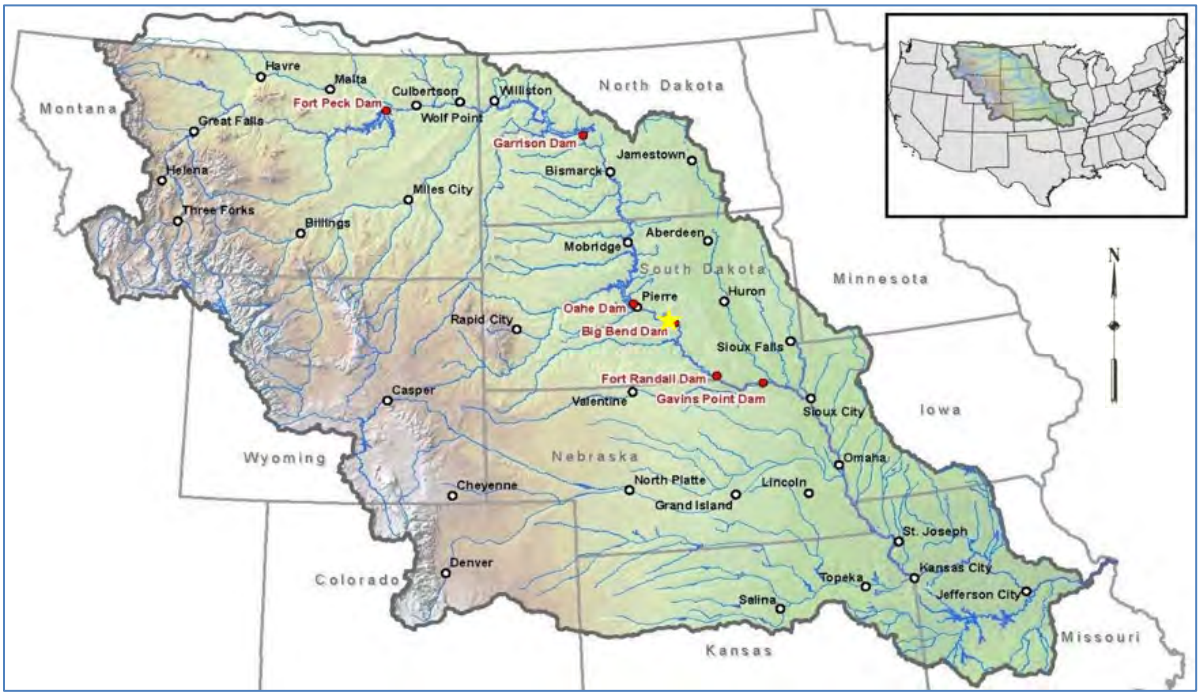


Figure 1-1: Big Bend Dam location map

1.2 Project Description

Big Bend Dam is a multiple purpose project consisting of a rolled earthfill embankment, hydroelectric generating power plant, spillway, and reservoir (Figure 1-2 and Figure 1-3). The reservoir has a capacity of 1,859,000 acre-feet for flood control, irrigation, conservation, navigation, power development, and other uses. Conventional outlet works structures were not constructed at Big Bend; releases are made through either the spillway or the power plant.

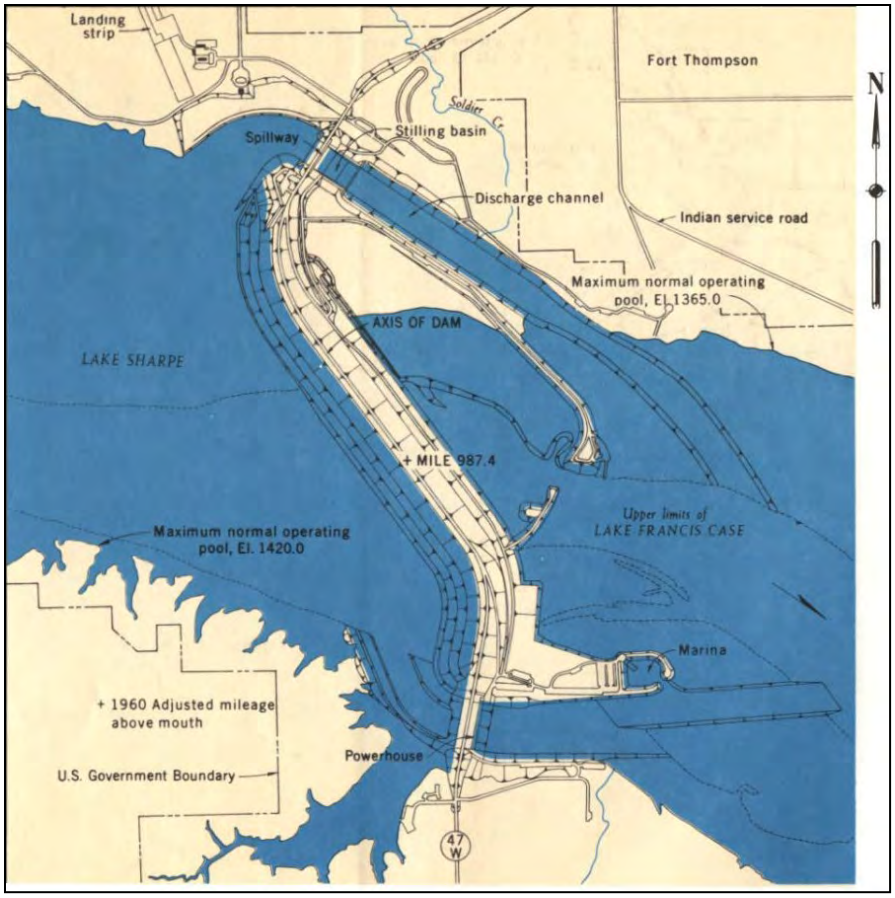


Figure 1-2: Project feature map

Figure 1-3: Aerial photo showing project features

1.2.1 Embankment

The rolled, zoned (Figure 1-4), earth-filled embankment is 10,570 feet long with a maximum height of 95 feet above the river channel and a crest width of 50 feet. The maximum width at the base of the embankment is 1,200 feet. The embankment makes a gentle S curve across the valley. The embankment was built upon dredged or dumped underwater pervious fill. A central impervious core extends from the pervious fill to five feet below the top of the dam. This core extends through the length of the embankment and transitions into a massive impervious section at the spillway and powerhouse tie-ins. The core is flanked on the downstream side by a pervious zone that ties into either the pervious downstream embankment fill or a horizontal downstream pervious blanket to provide drainage for seepage through the core. The top five feet of the embankment crest is composed of pervious fill connected to the downstream pervious drain to provide a frost-free base for the highway surface across the embankment.

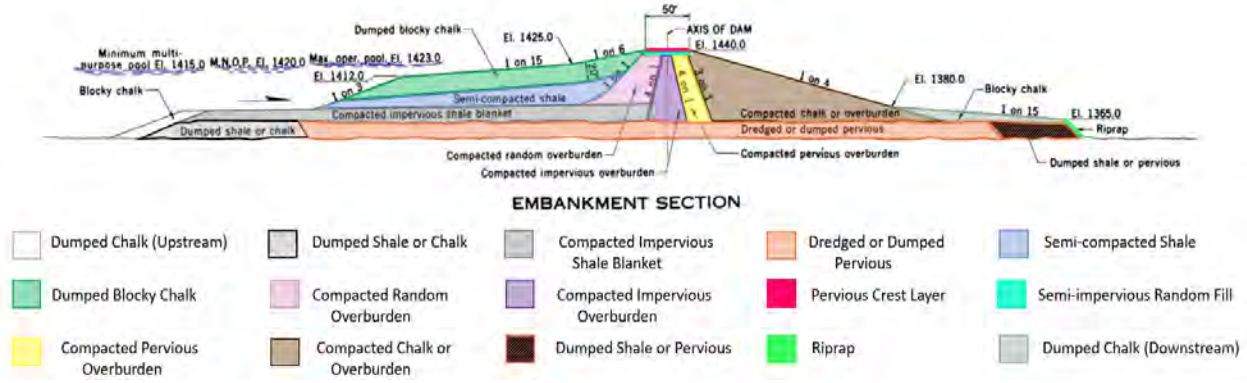


Figure 1-4: General embankment section

A minimum 10-foot-thick impervious blanket ties into the central impervious core and extends upstream 425 to 540 feet throughout the major portion of the embankment. Near the powerhouse area the blanket is thickened and excavated into bedrock and forms an impervious toe trench that prevents excessive seepage in the powerhouse area.

In the left abutment area near the spillway (Figure 1-5), a minimum 20-foot-thick upstream blanket is present over a portion of the right slope of the spillway approach channel. Above the upstream impervious blanket, the embankment is composed of a massive compacted shale section that is protected by 20 feet of dumped chalk. The downstream fill section consists primarily of random fill with a berm section of dumped chalk. The right abutment section, located between the right side of the powerhouse and the natural abutment ground surface, has 1V on 3H side slopes and is composed of random fill materials obtained from the right bank excavations.

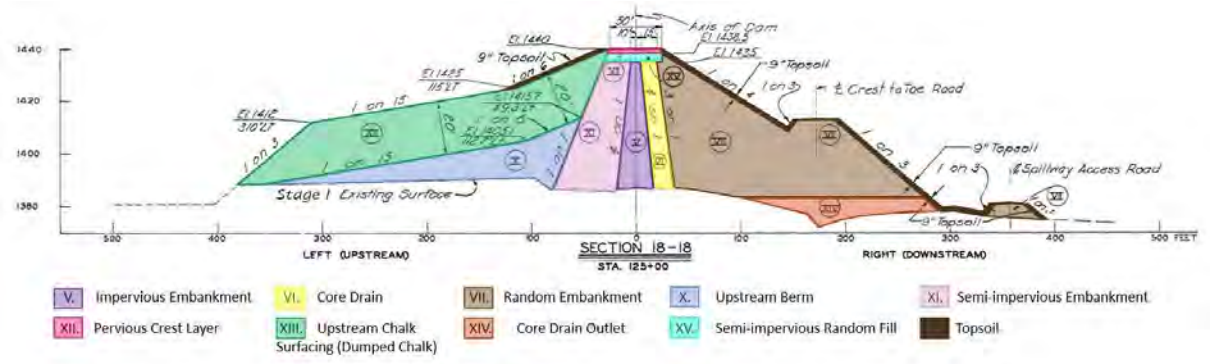


Figure 1-5: Left abutment embankment typical section (station 125+00)

1.2.2 Seepage Control Measures

Seepage through the embankment is controlled primarily by the impervious core, impervious upstream blanket, and the pervious drain section on the downstream side of the impervious core. Underseepage control is provided by the upstream impervious blanket, the chalk berm sections, the pervious blanket, and by pressure relief wells along the downstream toe of the embankment. Due to the relatively low head at Big Bend Dam and to the other underseepage control methods provided, a positive cutoff through the foundation sand was not determined to be necessary.

1.2.2.1 Pressure Relief Wells

The original system of pressure relief wells installed in 1963 extends a distance of 7,125 feet along the toe of the dam (Figure 1-6). The system was comprised of 68 relief wells spaced at intervals varying from 75 to 225 feet. The wells were installed to provide relief from any excess hydrostatic uplift pressures that may develop in the valley alluvial sands beneath the downstream impervious natural clay blanket. Between 2009 and 2012, the relief well system was modified with 35 additional relief wells. The current system has a total of 103 relief wells and extends a distance of 7,425 feet along the toe of the dam. The additional wells were installed between existing wells through the valley and in the left abutment. Spacing between the relief wells ranges from 35 to 200 feet.

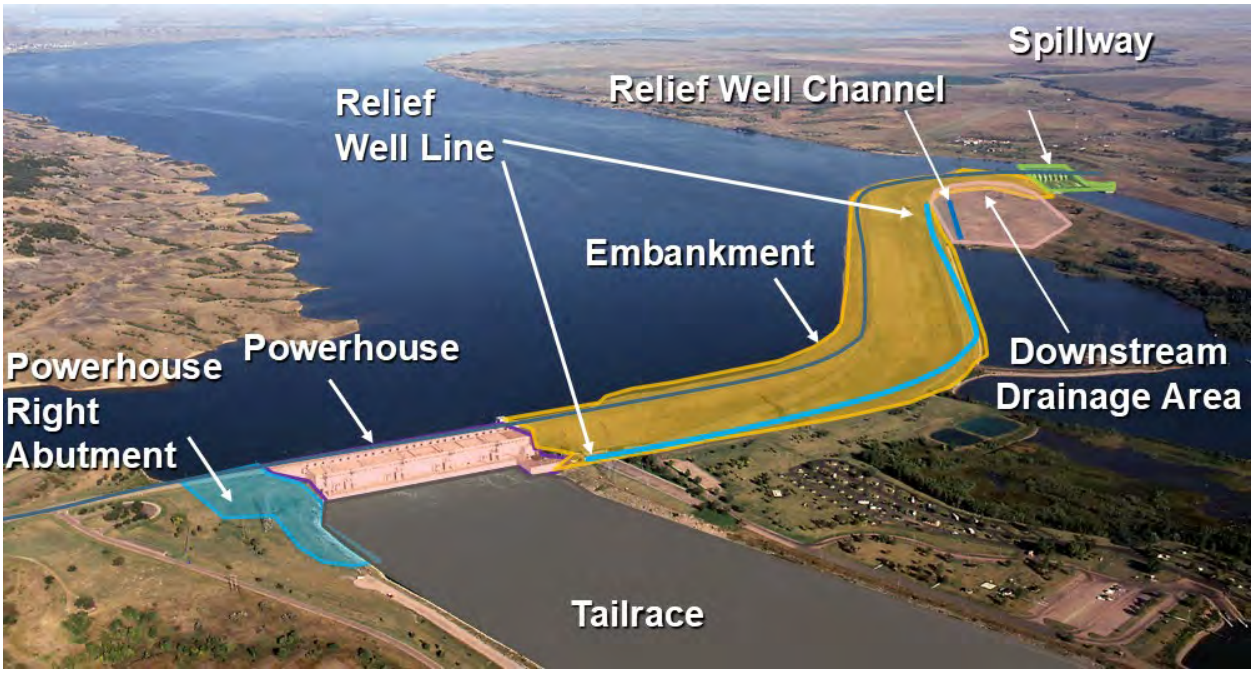


Figure 1-6: Project feature map showing location of relief well line and drains

1.2.2.2 Toe Drain and Left Abutment Relief Well Collector Subdrain System

Seepage was noted on the downstream left abutment shortly after the reservoir began filling during the winter of 1963 ("Downstream Drainage Area" in Figure 1-6). The downstream left abutment area became very marshy which detracted from public use and maintenance. To address the seepage issue, a toe drain and a left abutment relief well collector subdrain system were installed and completed in March 1965 (see Figure 1-7). The work also included lowering the outfalls for relief wells RW-67 and RW-68 and connecting them to the relief well collector subdrain system and grading the storm drainage channels into the relief well collector drainage channel.

The left abutment subdrain system was constructed with 8- to 15-inch-diameter perforated CMP. The toe drain is located between stations 125+00 and 128+00 on the west side of the spillway access road and

consists of four risers and approximately 420 feet of 8-inch-diameter and 250 feet of 12-inch-diameter perforated CMP pipe. The toe drain discharges into riser 4 which is part of the left abutment relief well collector subdrain system. The original left abutment relief well collector subdrain system consisted of two manholes, riser 4, and collected discharge from relief wells RW-67 and RW-68. The system discharged into the head of the relief well collector channel. In periodic inspections conducted after installation, the system was noted to be performing well in drying the area immediately adjacent to the embankment toe. During the 2011 flood event, a portion of the relief well collector system became inundated due to high tailwater. In 2010 and 2012, four additional relief wells were installed in the area (RW-67A, RW-67B, RW-68A, and RW-68B) to alleviate pressure observed in the left abutment. The additional relief wells were connected either to existing relief wells or to the relief well collector system.

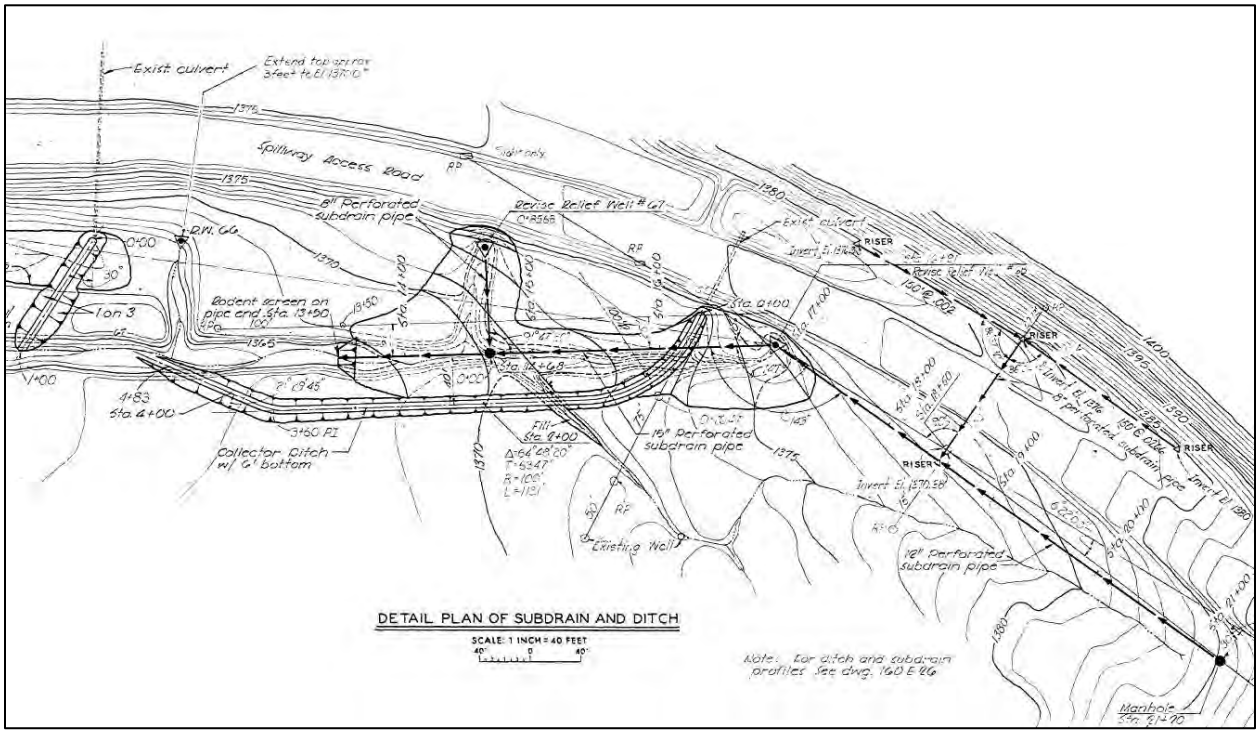


Figure 1-7: Plan view of toe drain and left abutment relief well collector subdrain system

1.2.2.2.1 2015 Camera Inspection

In 2015, a camera inspection was conducted on the relief well collector system. Over eight inches of sediment was reported to be present in the drain approximately 20 feet from the outfall which prohibited further inspection. The contractor subsequently jetted the pipe and was able to inspect additional segments. Significant biofouling was observed in the outfall line of relief wells RW-68B and RW-68A to the T-outfall as shown in Figure 1-8 (note that this section of pipe was not jetted prior to inspection). Overall, the footage showed the pipe itself to be in good condition. However, from an area approximately 95 feet south of MH-1 to relief well outfall RW-68A, the pipe appears to be pressurized (Figure 1-9 and Figure 1-10). The camera inspection showed multiple locations where water was observed to be shooting through the perforations. Pressurized areas where flow was observed above the flowline along the relief well collector drain are shown on Figure A1 in Appendix A.

The most pressurized area appears to be near relief well RW-68B, where water was observed shooting out of several perforations above the flowline in the pipe (Figure 1-10) indicating either an area of localized high pressure or inadequate collection efficiency of the drain possibly due to plugging. Piezometric levels near relief wells RW-68B and RW-68A typically range from four to five feet above the inverts of the

relief well collector pipe (see PZ-25R and PZ-19 on Figure A2 in Appendix A). It is possible that the filter material around the relief well collector pipe has become plugged over the 55 years since the system has been installed. The gradation of the filter material is unknown and it is unclear whether or not the filter material is compatible with embankment and foundation materials.

Based on the recent 2019 PA identifying backward erosion piping (BEP) through the left abutment as a potential risk-driving failure mode, along with the age of the system (55 years), and the current condition of the subdrain system (areas of pressurization), Omaha District Dam Safety has identified the replacement of the toe drain and left abutment relief well collector system as an interim risk reduction measure (IRRM).

Figure 1-8: Left abutment relief well collector system RW-68A to T-outfall

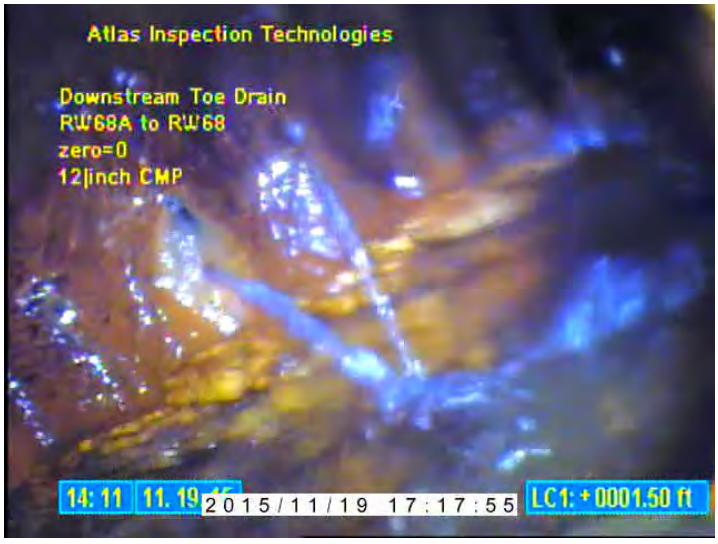


Figure 1-9: Left abutment relief well collector system pressurized area by RW-68A T-outfall

Figure 1-10: Left abutment relief well collector system pressurized area by RW-68B T-outfall

1.3 Risk Assessment Status

Previous risk assessments at Big Bend Dam consist of a Screening Portfolio Risk Assessment (SPRA) conducted in 2007, a Potential Failure Mode Analysis (PFMA) performed in 2009, and a Periodic Assessment (PA) conducted in July 2019 (note that the PA is still being drafted). Both the SPRA (2007) and the PFMA (2009) identified seepage and piping in the left abutment as probably inadequate (SPRA) or as a potential failure mode (PFMA).

The PA included a risk assessment in which 54 potential failure modes (PFMs) were identified. Of these, two of the five PFMs listed as risk drivers were also in the area of the left abutment seepage as described below:

- PFM 31: Plugged left abutment relief well subdrain system between stations 120+00 and 130+00 causes blowout resulting in backward erosion piping (BEP) through the foundation alluvium.
- PFM 32: Backward erosion piping (BEP) initiating at an unfiltered exit in the relief well channel in area of historic boils between stations 119+00 and 120+00.

For both PFMs, a large inflow event causes the reservoir to reach top of active storage (TAS) at elevation 1,423 feet local project datum (LPD). High pressures (which have historically been observed during normal pool conditions) exist in the left valley bank alluvial sand. There is a continuous alluvial sand layer between the upstream reservoir and the downstream left abutment bank. Vertical gradients are sufficient to initiate BEP at the left abutment.

The two failure modes (PFM 31 and PFM 32) are differentiated by the exit locations. For PFM 31, the relief well collector subdrain system between stations 120+00 and 130+00 is either plugged or ineffective at relieving the uplift pressures. Vertical exit gradients are sufficient to blow out the relatively thin clay blanket and initiate BEP of the foundation alluvial sands. For PFM 32, the uplift pressures are sufficient to blow out the natural clay blanket in the relief well channel exposing the valley alluvium in the vicinity of stations 119+00 and 120+00. This area was identified as a potential exit location due to historic pinboils at the bottom of the relief well channel. Global gradients would be sufficient for BEP of the foundation sands.

2. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE FIELD INVESTIGATION

In the 1970s and 1980s, kerosene was often added to piezometers at the dam that had water near the surface to prevent the water from freezing and bursting the pipes in the winter. Because several of these piezometers are in the location of the proposed toe drain replacement, specialized samples were also collected from the geotechnical borings to determine any impacts to the soil and groundwater from the kerosene in order to determine if any hazardous or toxic waste would be generated during construction and dewatering. According to project personnel, as the fuel would evaporate off more would be added, typically less than a gallon ever year or two (Figure 2-1). This procedure was phased out in the late-1980s as vibrating wire transducers were being installed in the open tube pipes and was discontinued completely sometime in 1992 or 1993.

BIG BEND DAM

~~OAHE DAM~~ AND LAKE WINTERIZED PIEZOMETERS
EQUIVALENT WATER SURFACE ELEVATIONS

Observed by J.G.R.
Observed on Dec. 1974

Antifreeze fluid Kerosene, Specific Gravity (SG) 0.75±
K = (1 -SG) X (Fluid Column); Depth To Equiv Water = (Depth To Fluid) + K

Piezometer	Depth To Water Feet	Depth To Fluid Feet	Fluid Column Feet	K	Depth To Equiv Water Feet	Top Pipe Elevation Feet	Equiv Water Surface Elevation Feet	Pipe Stickup feet
PZ-16	9.97	5.43	4.54	1.13	6.55			
PZ-17	11.82	5.42						
PZ-18	8.76	2.38						
PZ-19	16.22	5.76						
PZ-20	6.33	4.10						
PZ-21	6.36	2.16						
PZ-22	12.59	6.56						
PZ-24	13.31	7.45						
PZ-25	14.72	8.82						
D250RB	10.32	7.78						
D340RB	10.75	6.65						
D560RB	9.64	4.14						
D760RA	7.96	4.38						
D760RB	7.24	5.20						
D1160RB	6.79	4.56						
E560RA	10.06	5.02						
E560RB	7.07	6.32						
E960RB	12.25	8.39						

Figure 2-1: Log from 1974 showing amount of kerosene added to site piezometers

During recent routine maintenance operations, it was noted that diesel fuel was still present in some of the piezometers. Project staff later inspected the piezometers and identified two piezometers (J320Ra and J320Rb) with free product. Shallow piezometer J320Ra contained less than two inches of diesel fuel and deep piezometer J320Rb contained approximately five feet of diesel. The combined amount of diesel fuel equated to less than one gallon in the two-inch pipes.

After the diesel was identified, project staff began to remove the diesel by first dipping off the surface fluid. This was completed multiple times to allow for the remaining diesel fuel to rise to the surface. After the majority of the diesel fuel was removed in this manner, project staff used fuel-only absorbent pigs to collect the residual diesel. Project staff provided all information to the Department of Environment and Natural Resources (DENR) and proposed to continue to use the absorbent pigs to clean any residual fuel out of the piezometers until no further presence of fuel was observed. Based on the location of the piezometers, and fact that no adverse impacts have been identified, the DENR placed this case into the "No Further Action" category with the caveat that US Army Corps of Engineers may be responsible for conducting additional assessment and remediation any future problems arising from the remaining contamination.

2.1 HTW Field Investigation

To assess the impact of the diesel fuels on the soil and groundwater in the area of proposed construction, soil samples were collected at depths immediately above the groundwater table from all geotechnical borings drilled for this investigation. Groundwater grab samples were also collected from each open boring to determine any impacts to groundwater which will help determine any mitigation required during dewatering. Field investigation methods are provided in the following sections. An analysis of the results is provided as Appendix B.

2.1.1 HTRW Sample Collection

Environmental soil and groundwater samples were collected from all geotechnical borings drilled for this investigation. Soil and groundwater samples were analyzed for total petroleum hydrocarbons (TPH) of diesel range organics (DRO) from soil borings BH20-01 through BH20-12 as shown in Table 2-1. Soil samples were collected from the two-inch split spoon just above the water table (typically between 3 and 8 feet bgs) in borings BH20-01 through BH20-12. Fuel odor was only noted in one boring during drilling, BH20-12. Groundwater samples were collected as a grab sample from the top of the water column in the augers at the completion of drilling. Free product was not observed either while drilling or during water sampling. Samples were kept on ice at all times after the collection process and were shipped overnight under chain-of-custody to CT Laboratories in Baraboo, Wisconsin. Disposable nitrile gloves were worn when handling soil and groundwater samples. Air monitoring was not required.

Table 2-1: Soil and groundwater samples tested for TPH-DRO (SW846 8015C)

Boring Designation	Soil Sample ID	Soil Sample Container	Groundwater Sample ID	Groundwater Sample Container
BH20-01	BBSD-01A	4 oz. glass jar	BBSD-01B	1 liter amber glass jar
BH20-02	BBSD-02A	4 oz. glass jar	BBSD-02B	1 liter amber glass jar
	BBSD-00A[1]	4 oz. glass jar	BBSD-00B[2]	1 liter amber glass jar
BH20-03	BBSD-03A	4 oz. glass jar	BBSD-03B	1 liter amber glass jar
BH20-04	BBSD-04A	4 oz. glass jar	BBSD-04B	1 liter amber glass jar
BH20-05	BBSD-05A	4 oz. glass jar	BBSD-05B	1 liter amber glass jar
	BBSD-05A-MS	4 oz. glass jar	BBSD-05B-MS	1 liter amber glass jar
	BBSD-05A-MSD	4 oz. glass jar	BBSD-05B-MSD	1 liter amber glass jar
BH20-06	BBSD-06A	4 oz. glass jar	BBSD-06B	1 liter amber glass jar
BH20-07	BBSD-07A	4 oz. glass jar	BBSD-07B	1 liter amber glass jar
BH20-08	BBSD-08A	4 oz. glass jar	BBSD-08B	1 liter amber glass jar
	BBSD-XXA[3]	4 oz. glass jar	BBSD-XXB[4]	1 liter amber glass jar
BH20-09	BBSD-09A	4 oz. glass jar	BBSD-09B	1 liter amber glass jar
BH20-10	BBSD-10A	4 oz. glass jar	BBSD-10B	1 liter amber glass jar
BH20-11	BBSD-11A	4 oz. glass jar	BBSD-11B	1 liter amber glass jar
BH20-12	BBSD-12A	4 oz. glass jar	BBSD-12B	1 liter amber glass jar

[1]Duplicate sample from BH20-02A, [2]Duplicate sample from BH20-02B, [3]Duplicate sample from BH20-08A
[4]Duplicate sample from BH20-08B

2.1.1.1 Decontamination Procedures

Hollow-stem augers were steam cleaned at the boring location at the completion of drilling prior to moving to the next location. Disposable bailers used for groundwater sampling were not reused and were disposed of in the trash after use along with the disposable nitrile gloves. Split spoon samplers were decontaminated with distilled water and Liquinox between sampling intervals. Wastewater was discharged to the ground in the area of drilling.

2.1.1.2 Soil Cuttings

Soil cuttings from approximately two feet above to two feet below the water table were placed in a 55-gallon drum pending soil analysis. One 55-gallon drum of composite soil cuttings was collected and returned to the Omaha District Boatyard facility for storage. A drum inventory sheet was filled out with the drum numbered and identified. All other soils were disposed of by spreading them at the boring location as no visible impacts were noted nor was it suspected of being impacted due to the nature of the free product occurrence.

2.2 Results

The results of the HTRW sampling indicate the presence of TPH-DRO in soil and groundwater in the location of borings BH20-11 and BH20-12. The soil sample taken from BH20-12 (BBSD-12A) was analyzed at 2830 mg/kg and the groundwater grab sample was analyzed at 27,000 ug/L. The soil sample taken at BH20-11 (BBSD-11A) was analyzed at 96.9 mg/kg. Excavated soils with TPH concentrations greater than 10 mg/kg must be disposed of in accordance with the permitting requirements of the SDDNR Waste Management Program. The groundwater sample taken from BH20-12 (BBSD-12B) was analyzed at 27,000 ug/L. If dewatering is required during construction, groundwater in this area will be containerized and sampled for disposal procedures. The full report is included as Appendix C.

3. GEOTECHNICAL FIELD INVESTIGATION

The following section presents a summary of the geotechnical field investigation drilling scope and methodology. Intrusive activities into, in close proximity to, or through embankment dams and their foundations may pose significant risk to the structures if not implemented properly. To mitigate these risks, all drilling and sampling shall be conducted in accordance with EM 1110-1-1804, Geotechnical Investigations (1 January 2001); ER 1110-1-1807, Drilling in Earth Embankment Dams and Levees (31 July 2014); and specific guidance as referenced in this section.

3.1 Scope and Purpose

The geotechnical field investigation was designed to better define the site hydrogeology through geologic logging of the stratigraphy, the collection of blow count (N value) data, the collection of disturbed soil samples for laboratory analysis, and pump testing to obtain estimates of the hydraulic characteristics of the alluvial foundation. To obtain this information, 12 soil borings were advanced to approximately five to ten feet below the construction depth along the length of the toe drain and relief well collector pipe at approximate 100-foot intervals. Representative samples were collected from the soil borings for laboratory testing along with Standard Penetration Tests (SPTs) to obtain density information. Pump tests were also performed to determine estimates of hydraulic characteristics of the alluvial aquifer in the area of construction.

The geotechnical field investigation was conducted from June 1, 2020 through June 18, 2020 by the USACE, Omaha District drill crew. Boring locations were selected by the Project Dam Safety Engineer and staked by Big Bend Project Office personnel. Borings BH20-09, BH20-11, and BH20-12 had to be relocated from the original staked location 40 feet upstream, 50 feet upstream, and 10 feet upstream, respectively, due to overhead power lines located in the area of construction. According to the project office, the overhead lines are 69 kV which requires a minimum 15-foot offset according to EM 385-1-1 (2014). All borings were also cleared through 811 for digging prior to intrusive activities.

3.2 Geotechnical Soil Borings

A total of 12 soil borings (BH20-01 through BH20-12) were installed to log materials and obtain geotechnical samples (and HTRW samples as discussed in Section 2) to better characterize the foundation soils in the area of the proposed toe drain and relief well collector pipe replacement (Table 3-1). Boring locations are shown on Figure A1 in Appendix A.

Table 3-1: Soil Boring Designations, Locations, and Depths

Boring Designation	Northing	Easting	Ground Surface Elevation	Bottom Depth (ft)
BH20-01	629695.581	2199392.547	1384.278	10
BH20-02	629564.363	2199406.379	1381.688	10
BH20-03	629454.701	2199414.736	1379.711	10
BH20-04	629846.579	2199487.894	1386.423	20
BH20-05	629746.368	2199486.945	1382.581	20
BH20-06	629640.983	2199486.485	1380.097	20
BH20-07	629503.822	2199487.639	1379.089	20
BH20-08	629415.776	2199503.251	1376.959	15

Boring Designation	Northing	Easting	Ground Surface Elevation	Bottom Depth (ft)
BH20-09	629305.020	2199573.045	1373.840	15
BH20-10	629215.513	2199585.558	1373.094	15
BH20-11	629200.947[1]	2199634.202[1]	1369[1]	10
BH20-12	629059.710[1]	2199722.452[1]	1368[1]	10

[1]Estimated using hand-held GPS. Borings were relocated from surveyed location due to overhead power lines.

3.2.1 Drilling Methodology

Drilling and sampling of the foundation materials was accomplished with a Gus Pech 750C (Mite-e-Mite) drill rig equipped with 4 1/4-inch-ID HSA. Slight heave was noted in the augers during drilling through the sands; the drill crew was able to lift the augers with chains and reinsert the center bit to drill out the hole to depth without having to add water to the hole (since HTRW groundwater samples were to be collected at the completion of drilling). Drilling for sample collection and logging purposes was conducted in all borings using a 2-inch-diameter split spoon sampler.

Standard penetration tests were performed by dropping a 140-pound hammer a distance of 30 inches to advance a two-inch-diameter split spoon continuously in the upper 10 feet, then every 2.5 feet to the depth of the boring (if deeper than 10 feet). These penetration tests were performed in accordance with ASTM D 1586-11, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils." Uncorrected blow counts (N-values) were recorded on the drill log included in Appendix C.

3.2.1.1 SPT energy measurements

SPT energy measurements were obtained on the Gus Pech 750C (Mite-e-Mite), equipped with a Boart Longyear automatic hammer, on May 29th, 2019. SPT energy measurements on the Mite-e-Mite automatic hammer resulted in average energy transfer rate (ETR) of 82.6%, 84.1%, and 84.0% during standard operating procedures with the engine running at approximately 750 revolutions per minutes (rpm) for each testing interval. Standard deviations for each test interval were calculated to be 1.2%, 1.0%, and 0.7%, respectively. The overall average ETR of all valid measurements was 83.7% with a standard deviation of 1.1%. For SPT analysis and N-value corrections, it is recommended to use an ETR of 83.7% for the Mite-e-Mite automatic hammer.

3.2.2 Sampling Methodology

Sampling required for this field effort consisted of disturbed samples collected from all borings from each sampling interval and from all changes in material. Representative samples of the subsurface material were placed in pint sample jars and sealed airtight with at least three wraps of electrical tape. The jars were then placed in shipping boxes and hand delivered to the project engineer at the completion of work (along with applicable sample transmittal forms).

3.2.3 Boring Abandonment

Because the borings were located adjacent to both the toe drain and perforated relief well collector pipe, the use of grout was not permitted. All borings were backfilled with medium (3/8-inch) bentonite chips placed in the boring as the augers were removed. The number of bags required for each boring was calculated prior to backfilling (note that one 50-lb bag of chips should fill approximately 2 feet of an 8-inch hole). All borings took approximately the calculated amount of chips.

3.2.4 Cutting Disposal

Soil cuttings from approximately two feet above to two feet below the water table were placed in a 55-gallon drum pending soil TPH-DRO analysis. One 55-gallon drum of composite soil cuttings was collected and returned to the Omaha District Boatyard facility for storage. A drum inventory sheet was filled out with the drum numbered and identified. All other soils were disposed of by spreading them at the boring location. The site was restored to pre-investigation conditions prior to demobilization.

3.3 Laboratory Testing

Geotechnical samples collected during this field effort were sorted by the Dam Safety Engineer and select samples were sent to Terracon's Omaha laboratory for the following analysis:

- ASTM D6913 Sieve Analysis (washed)
- ASTM D422 Hydrometer Analysis
- ASTM D422 Combine Sieve/Hydrometer
- ASTM D4318 Atterberg Limits

Results are provided in Appendix D. Testing results are also provided on the drilling logs included as Appendix C.

3.4 Pump Testing

Pump testing was performed on several existing project relief wells (RW-66A, RW-67B, RW-68A, and RW-68B) to obtain an estimate of the hydraulic characteristics of the alluvium for dewatering efforts that may be required during future construction of the toe drain and relief well collector pipe replacement. Testing consisted of one six-hour pump test performed on existing relief well RW-67B (which included the installation of two observation wells [OW20-01 and OW20-02]), one four-hour pump test performed on existing relief well RW-68B (with drawdown measured in one existing piezometer [PZ-25R]), and single-well pump tests performed on existing relief wells RW-66A, RW-67B, RW-68A, and RW-68B. A pump test was also conducted using observation wells OW20-01 and OW20-02 to identify any variances in hydraulic parameters vertically in the formation. All pump tests were performed at constant pumping rates. The results of the testing are discussed in Section 5.3.

A summary of construction details and initial specific capacities for the relief wells is provided in Table 3-2. All of the relief wells tested were installed in 2010 or 2012 and were constructed with 40- or 50-slot Muni-Pak™ stainless steel well screens with a five-inch-diameter inner screen and a seven-inch-diameter outer screen. The blank casings consist of five-inch-diameter, Schedule-40, stainless steel flush-threaded pipe. The upper ten-foot-section of riser is five-inch-diameter, Schedule-40, PVC flush-treaded pipe. Locations are shown on Figure A1 in Appendix A. Results are discussed in Section 4.

It should be noted that all of the relief wells were rehabilitated and capacity tested prior to pump testing along with several other relief wells in the area of the drain replacement as documented in the FY20 Dam Safety Instrumentation Rehabilitation Engineering Geology Report (USACE, 2020). The post-rehabilitation specific capacities are also included in Table 3-2.

Table 3-2: Existing Relief Well Information (Pump Tests)

Relief Well Designation	Bottom Depth (ft bgs)	Screen Interval (ft bgs)	Initial Pumping Rate (gpm)/ Drawdown (ft)	Initial Average Specific Capacity (gpm/ft drawdown)	2020 Post-Rehab Pumping Rate (gpm)/ Drawdown (ft)	2020 Post-Rehab Specific Capacity (gpm/ft drawdown)
RW-66A	81.4	31.4-81.1	61/10.3	5.9	59.5/15.7	3.8
RW-67B	83.0	37.0-82.0	23/12.1	1.8	20.7/10.8	1.9
			35/18.7			
			49/28.2			
RW-68A	89.0	47.9-87.9	23.5/1.7 (13.8)	9.5	33/26.5	1.2
			33.6/4.0 (8.4)			
			45.7/7.4 (6.2)			
RW-68B	90.0	48.6-88.6	20.5/14.6	1.4	16.2/20.0	0.8
			31.2/19.5			
			41.4/30.8			

3.4.1 Observation Well Installation

Two observations wells (OW20-01 and OW20-02) were installed a distance of five and ten feet, respectively, from existing relief well RW-67B as shown on Figure A4 in Appendix A for the six-hour pump test. Drilling for the observation wells was accomplished with a Gus Pech 7500C (Mite-e-Mite) drill rig equipped with 4 1/4-inch-ID HSA. The borings were advanced using a center bit and logged from drill cuttings. The observation wells were constructed of two-inch nominal-diameter, Schedule 40, PVC casing with a ten-foot-long, 0.010-inch-slotted screen and 20-40 gradation clean silica sand filter pack (Table 3-3). The filter pack was tremied into place and extends approximately three feet above the top of the well screen. The remaining borehole annulus was backfilled with medium (3/8-inch) bentonite chips due to the proximity of the borings to the perforated drains. The observation wells were completed with 4-inch-square (observation wells) by 5-foot long locking steel protective covers. Construction diagrams are included in Appendix C. Both observation wells were developed and response tested at the completion of installation.

Table 3-3: Observation well construction details

Observation Well Designation	Northing	Easting	Distance from RW-67B	Bottom Depth (ft bgs)	Filter Pack Interval (ft bgs)	Screen Interval (ft bgs)
OW20-01	629356.653	2199535.284	5.0	20	7-20	9.4-19.4
OW20-02	629349.363	2199535.361	10.0	19.7	7-20	9.4-19.4

4. GEOLOGY

4.1 Site Geology

4.1.1 Overburden Deposits

The overburden soils at the dam site consist of residual clays, alluvial clays, silts and sands, and glacial outwash sand and gravel (Figure 4-1). The overburden materials are described below:

- Left abutment glacial deposits: In the upper reaches of the left abutment above the Pierre shale. Consist of silts, sands, and gravels, mantled locally with loess.
- Left bank flood plain deposits: Form part of the embankment foundation. Mantle of fat clay (CH) up to 25 feet thick overlying pervious valley alluvium.
- Pervious valley alluvium: Pervious alluvial deposits of the Missouri River. Consist primarily of silty fine sands that become coarser with depth, some gravel strata.
- Right bank overburden: In the upper reaches of the right abutment above the Pierre shale. Consists of fat clays (CH) derived from the underlying Pierre shale and silts, sands, and gravels (Good Soldier Creek).

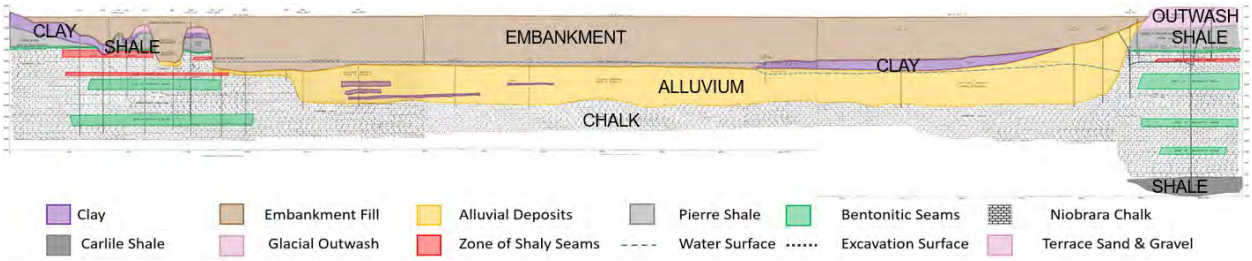


Figure 4-1: Geologic profile through centerline of dam (looking upstream)

4.1.2 Bedrock

Bedrock at the dam site consists of (in descending order): Pierre Formation shale, Niobrara Formation chalk, and Carlile Formation shale, all of Cretaceous age.

- Pierre Shale: Occurs in the spillway and powerhouse intake and discharge channels and beneath a short section of embankment on the right abutment. Gray to dark gray compaction-type shale composed chiefly of clay and silt constituents. Has well-defined bedding planes and numerous bentonite seams.
- Niobrara Chalk: Supports all of the appurtenant structures at the project. Lead gray, medium hard, impervious, argillaceous chalk or chalky shale derived chiefly from marine microorganisms and precipitates of calcium carbonate materials. Bentonite, bentonite clay, and shale seams occur throughout the formation.
- Carlile Shale: Unrelated to any structure foundation at the project (72 feet below the deepest part of the powerhouse foundation).

4.2 Project-Specific Geology

In the area of the drain replacement, the foundation geology consists an alluvial clay blanket overlying pervious sands with interbedded clay layers as shown in Table 4-1 and on the geologic profiles in Appendix A. The thickness of the clay blanket varies across the area of the investigation ranging from 0 to >10 feet. The blanket clays are predominantly lean (CL) or sandy lean clays (s[CL]) and occasionally contain sand and gravel. The alluvial sands beneath the clay blanket are predominantly silty and poorly graded fine sands (SM, SP-SM, and SP). Within the alluvial sands, clay layers composed of both lean

(CL) and fat (CH) clays are present. Available boring data is limited in this area (note that the relief well borings shown on the geologic profiles were logged from cuttings) but most of the available data indicates the presence of an intermediate clay layer approximately 20 feet thick separating the sand unit. Several thinner clay layers also appear to be present, though none appear to be laterally continuous. Fill material was also noted in several of the borings as discussed in the following section.

Table 4-1: Toe drain invert depth, materials encountered, interpreted zones, and clay blanket thickness

Boring Designation	Approximate Toe Drain Invert Depth (ft bgs)	Materials Encountered/ Depth (ft bgs)	Interpreted Zone	Approximate Clay Blanket Thickness (ft)
Toe Drain Borings				
BH20-01	3.5	CL (0-2) SP (2-3) (CL)s (3-5) SC (5-9) SP (9-10)	Random Embankment Fill Horizontal Drain Alluvial Clay Alluvial Clay/Sand Alluvial Sand	6.0
BH20-02	5.0	CL (0-4.5) SM (4.5-10)	Random Embankment Fill Alluvial Sand	0.0
BH20-03	2.5	CL (0-1) SM (1-3) SW-SM (3-4.5) CL (4.5-8) SM (8-10)	Random Embankment Fill Horizontal Drain Horizontal Drain Alluvial Clay Alluvial Sand	3.5
Relief Well Collector Pipe Borings				
BH20-04	10.0	CL-ML (0-2) CL (2-6) SC (6-6.5) SP-SM (6.5-10) SP (10-20)	Reworked clay /trench backfill Alluvial Clay Alluvial Clay/Sand Alluvial Sand Alluvial Sand	4.5
BH20-05	8.5	CL-ML (0-2) CL (2-5) CL-ML (5-6) SP (6-20)	Reworked clay /trench backfill Alluvial Clay Alluvial Clay Alluvial Sand	4.0
BH20-06	8.0	CL-ML (0-2.5) CL (2-6) (ML)s (6-8) SP (8-10) SP-SM (10-15) SP (15-20)	Reworked clay /trench backfill Alluvial Clay Alluvial Silt Alluvial Sand Alluvial Sand Alluvial Sand	4.0
BH20-07	9.5	CL-ML (0-3) (CL-ML)s (3-4) SP-SM (4-6) SP (6-18.5) SM (18.5-20)	Alluvial Clay Alluvial Clay Alluvial Sand Alluvial Sand Alluvial Sand	4.0
BH20-08	10.0	CL (0-4) SP-SM (4-6) SM (6-15)	Alluvial Clay Alluvial Sand Alluvial Sand	4.0

Boring Designation	Approximate Toe Drain Invert Depth (ft bgs)	Materials Encountered/ Depth (ft bgs)	Interpreted Zone	Approximate Clay Blanket Thickness (ft)
BH20-09	7.0	CL (0-3.5) S(CL) (3.5-4.2) CL (4.7-9) SM (9-10) SP (10-15)	Alluvial Clay Alluvial Clay Alluvial Clay Alluvial Sand Alluvial Sand	9.0
BH20-10	7.5	CL (0-6) SC (6-9.2) SP-SM (9.2-15)	Alluvial Clay Alluvial Clay/Sand Alluvial Sand	9.2
BH20-11	5.0	CL (0-2) g(CL)s (2-3.5) (SW-SM)g (3.5-4.5) CL (4.5-8) (CL)s (8-10)	Fill Fill Fill Alluvial Clay Alluvial Clay	>5.5
BH20-12	5.0	CL (0-3.5) (CL)s (3.5-6.9) CL (6.9-10)	Alluvial Clay Alluvial Clay Alluvial Clay	>10.0

Borings BH20-01 and BH20-03 were installed in the area of the toe drain (at the toe of the embankment) and consisted of one to two feet of random embankment fill (CL) overlying pervious drain material (SP, SM, and SW-SM). Beneath the fill material, foundation alluvial clays were encountered (CL) with thicknesses of 6.0 and 3.5 feet, respectively, overlying pervious alluvial sands (SP and SM). Boring BH20-02 was also installed in the area of the toe drain and consisted of 4.5 feet of embankment fill overlying alluvial sands (no pervious drain material or foundation alluvial clays were noted in this boring).

Borings BH20-04 through BH20-12 were installed further downstream in the area of the relief well collector pipe aligned from north (BH20-04) to south (BH20-12). Borings BH20-04, BH20-05, and BH20-06 were installed directly adjacent to the existing collector pipe and are believed to have encountered reworked clay (CL) trench backfill materials from approximately 0 to 2 feet bgs. Fill [CL, g(CL)s, and (SW-SM)g] is also believed to be present from 0 to 4.5 feet in boring BH20-11 which is located in area with previous erosion issues. Beneath the fill (where present) or ground surface (where fill is not present), alluvial clays (CL) were encountered with thicknesses that varied from 4 to 4.5 feet in the north borings (BH20-04 through BH20-08) to 9 to greater than 10 feet in the south borings (BH20-09 through BH20-12). Beneath the alluvial clays, alluvial sands (SP, SP-SM, and SP-SC) were encountered in all borings except BH20-11 and BH20-12 where the clay blanket is thickest.

4.2.1 N-values

Uncorrected blow counts in the alluvial clays ranged from weight of hammer (WOH) to 19 with an average of 4.6 (or soft to medium stiff). Uncorrected blow counts in the alluvial sands ranged from weight of hammer (WOH) to 15 with an average of 3.7 (very loose). SPT hammer efficiency on the Mite-e-Mite drill rig is 83.7 percent.

4.2.2 Laboratory Data

Of the 14 samples with gradation data in the alluvial sands, fines content ranged from 2 to 46 percent, with an average value of 12.4 percent. The majority of the sand classified as fine (between 0.075 and 0.475 mm) with percentages ranging from 41 to 85 percent with an average of 69 percent. Gravel was only present (<1 percent) in one of the samples. Moisture content in the sand samples ranged from 16.0 to 24.9 percent with an average of 22.4 percent. Liquid limits for three samples in the alluvial clay were 29, 30, and 33. Plasticity limits for the three samples were 18, 19, and 22. A plasticity index value of 11 was obtained from all samples. Laboratory data is included as Appendix D.

5. GROUNDWATER

The discussion that follows documents conditions observed at Big Bend Dam during the field investigation (June 2020) unless otherwise noted. Due to continuous reservoir loading, groundwater levels as reported in this section will fluctuate over time due to seasonal and operational variances in reservoir elevation. It should be noted that there are no cutoff features installed through the alluvial sands beneath the dam embankment.

5.1 Existing Piezometers

Several piezometers have been installed in the area of the drain to monitor pore pressures in the foundation. Groundwater levels in these piezometers are typically within four to eight feet of the ground surface in the area of construction (see plan view and geologic profiles in Appendix A). The groundwater elevations from piezometers in the area of construction as shown on the figures and reported in Table 5-1 are from the May 2020 groundwater sampling event when the reservoir was at 1,420.58 feet and tailwater was at 1,356.09 feet. The groundwater elevations shown are expected to be similar to elevations anticipated during the beginning of the typical field season in this area.

Table 5-1: Groundwater elevation data from the May 2020 sampling event

Piezometer Designation	Screen Depth (ft bgs)	Depth to Groundwater (ft TOC)	Groundwater Elevation (ft LPD)
J320Ra	14.6-19.6	9.5	1375.45
J320Rb	40.3-45.3	10.5	1375.51
J474Ra	37-42	5.6	1373.43
J474Rb	85-90	6.3	1373.65
J662Ra	19.5-24.5	14.2	1364.21*
J662Rb	Vibrating wire	Vibrating wire	1381.62*
J970Ra	37.2-47.2	8.2	1367.85
J970Rba-12	Vibrating wire	Vibrating wire	1367.50
PZ-19	37-42	7.4	1374.51
PZ-21	Vibrating wire	Vibrating wire	1368.87
PZ-25R	36.2-41.2	6.7	1376.44
PZ-28	Vibrating wire	Vibrating wire	1364.71
PZ-30	Vibrating wire	Vibrating wire	1366.25

*Note that these readings are considered suspect. Because they are not in the immediate area of construction, this is not a concern for this investigation; however, the piezometers are being investigated for possible replacement.

5.2 2020 Field Investigation

Groundwater was encountered during drilling of the geotechnical borings (BH20-01 through BH20-12) in June 2020 at depths between 4.0 and 7.7 feet bgs. It should be noted that these depths are based on observations during drilling as measured within the hollow stem augers and are to be considered approximate. In general, groundwater was encountered in the clay blanket materials as summarized in Table 5-2. Exception to this were boring BH20-02 where groundwater was encountered in the alluvial sands (no clay blanket is present at this boring location) and BH20-08 where groundwater was encountered in the alluvial sands below the clay blanket.

Table 5-2: Depth groundwater encountered during drilling

Boring Designation	Ground Surface Elevation (ft LPD)	Depth Groundwater Encountered (ft bgs)/ Elevation (ft LPD)	Materials Encountered/ Depth in ft bgs	Interpreted Zone
Toe Drain Borings				
BH20-01	1384.278	5.0/1379.3	CL (0-2) SP (2-3) (CL)s (3-5) SC (5-9) SP (9-10)	Random Embankment Fill Horizontal Drain Alluvial Clay Alluvial Clay/Sand Alluvial Sand
BH20-02	1381.688	7.7/1374.0	CL (0-4.5) SM (4.5-10)	Random Embankment Fill Alluvial Sand
BH20-03	1379.711	6.9/1372.8	CL (0-1) SM (1-3) SW-SM (3-4.5) CL (4.5-8) SM (8-10)	Random Embankment Fill Horizontal Drain Horizontal Drain Alluvial Clay Alluvial Sand
Relief Well Collector Pipe Borings				
BH20-04	1386.423	5.3/1381.1	CL-ML (0-2) CL (2-6) SC (6-6.5) SP-SM (6.5-10) SP (10-20)	Reworked clay /trench backfill Alluvial Clay Alluvial Clay/Sand Alluvial Sand Alluvial Sand
BH20-05	1382.581	5.0/1377.6	CL-ML (0-2) CL (2-5) CL-ML (5-6) SP (6-20)	Reworked clay /trench backfill Alluvial Clay Alluvial Clay Alluvial Sand
BH20-06	1380.097	5.4/1374.7	CL-ML (0-2.5) CL (2-6) (ML)s (6-8) SP (8-10) SP-SM (10-15) SP (15-20)	Reworked clay /trench backfill Alluvial Clay Alluvial Silt Alluvial Sand Alluvial Sand Alluvial Sand
BH20-07	1379.089	4.0/1375.1	CL-ML (0-3) (CL-ML)s (3-4) SP-SM (4-6) SP (6-18.5) SM (18.5-20)	Alluvial Clay Alluvial Clay Alluvial Sand Alluvial Sand Alluvial Sand
BH20-08	1376.959	5.7/1371.3	CL (0-4) SP-SM (4-6) SM (6-15)	Alluvial Clay Alluvial Sand Alluvial Sand
BH20-09	1373.840	6.5/1367.3	CL (0-3.5) S(CL) (3.5-4.2) CL (4.7-9) SM (9-10) SP (10-15)	Alluvial Clay Alluvial Clay Alluvial Clay Alluvial Sand Alluvial Sand

Boring Designation	Ground Surface Elevation (ft LPD)	Depth Groundwater Encountered (ft bgs)/ Elevation (ft LPD)	Materials Encountered/ Depth in ft bgs	Interpreted Zone
BH20-10	1373.094	5.8/1367.3	CL (0-6) SC (6-9.2) SP-SM (9.2-15)	Alluvial Clay Alluvial Clay/Sand Alluvial Sand
BH20-11	1369[1]	6.8/1362	CL (0-2) g(CL)s (2-3.5) (SW-SM)g (3.5-4.5) CL (4.5-8) (CL)s (8-10)	Fill Fill Fill Alluvial Clay Alluvial Clay
BH20-12	1368[1]	7.1/1361	CL (0-3.5) (CL)s (3.5-6.9) CL (6.9-10)	Alluvial Clay Alluvial Clay Alluvial Clay

[1]Estimated using hand-held GPS and LIDAR. Borings were relocated from surveyed location due to overhead power lines.
LPD = local project datum

5.3 Pump Testing

As noted in Section 3.4, pump testing was performed on several existing project relief wells and one of the shallow observation wells to determine the feasibility of potential dewatering techniques that may be needed during the replacement of the toe drain and relief well collector pipe. The pump tests were conducted to obtain estimates of hydraulic characteristics as well as to determine if any variances in these parameters were present laterally and vertically in the alluvium. Note that in the original DPP only two pump tests were to be performed, a constant rate test in relief well RW-67B and a constant rate test in relief well RW-66A. Additional pump tests were performed based on the results of the initial constant rate test in relief well RW-67B as discussed in Section 5.4.

Pump tests performed for this field effort consisted of the following:

- Six-hour constant rate pump test in relief well RW-67B with drawdown measured in observation wells OW20-01 and OW20-02. Associated testing performed included:
  - Single-well constant rate analysis on relief well RW-67B (to compare to initial test)
  - Four-hour constant rate pump test in observation well OW20-02 with drawdown measured in OW20-01 (to assess vertical variations in hydraulic parameters)
  - Four-hour constant rate pump test in relief well RW-68B with drawdown measured in existing piezometer PZ-25R (to assess lateral and vertical variations in hydraulic parameters)
    - Single-well constant rate analysis on relief well RW-68B (to compare to initial test)
- Two-hour constant rate pump tests in relief wells RW-66A and RW-68A

5.4 Constant-Rate Pump Test in RW-67B and Associated Testing

5.4.1 Six-Hour Pump Test on RW-67B (Observation Wells OW20-01 and OW20-02)

Two types of aquifer testing were initially completed on relief well RW-67B: a step-drawdown test and a constant-rate test. The step-drawdown test was conducted first to determine the optimum pumping rate for the constant-rate test. The pumping rate for relief well RW-67B selected based on the step drawdown test was 30.5 gpm resulting in a drawdown of approximately 20 feet in the relief well. The constant-rate test was run for 6 hours at 30.5 gpm with approximately 20.6 feet of drawdown in the relief well. Drawdown was measured in observation wells OW20-01 and OW20-02 (see Section 3.4.1). Discharge

water from the constant-rate test (~11,000 gallons) was directed into the relief well channel which is located downstream of the relief well collector pipe near relief well RW-66B (see Figure A1).

After extremely high and unrealistic transmissivity (T) and storativity (S) values were calculated from the constant-rate test data, it was determined that additional testing and analysis should be conducted to attempt to determine why such high T and S values were obtained. Boring log data in the area appears to show several clay layers present in the alluvial sands. The most likely explanation for the minimal drawdown observed in both observation wells OW20-01 and OW20-02 is the presence of a thin clay layer between the top of the relief well screen and the bottom of the observation well sensing zone which inhibited drawdown in the observation wells (resulting in high T and S values). To attempt to confirm this, additional testing was performed as outlined in the following sections.

5.4.2 Single-Well Pump Test (RW-67B)

The first step in determining the cause of the high T and S values was to obtain an additional estimate of T and K. To use this equation, water levels measured in relief well RW-67B during the constant-rate pump test were converted to drawdown and plotted respective to the time of the measurement.

A comparison of the hydraulic parameters calculated from the two tests on relief well RW-67B show more than an order of magnitude difference in both calculated T and K values. To further attempt to account for this variance, and to determine if a clay layer might be present between the shallow observation wells and the deeper relief well at this location, a constant-rate test was performed on the two shallow observation wells as discussed below.

5.4.3 Observation Well OW20-01 and OW20-02 Pump Test

In an attempt to assess the vertical variance of parameters in the alluvium, a pump test was performed on observation well OW20-02 with drawdown measured in OW20-01. Both observation wells are screened in the shallow alluvium from ~10 to 20 feet bgs and above the presumed clay layer and are 7 feet apart. The pumping rate for the constant-rate test in observation well OW20-02 was 9.0 gpm resulting in a drawdown of approximately 3.0 feet. Discharge water from the constant-rate test (~2,160 gallons) was directed into the relief well channel.

The results of this testing provide a general estimate of the hydraulic parameters in the upper 20 feet of the alluvium near relief well RW-67B in the area of the collector pipe replacement.

5.4.4 Four-Hour Pump Test Relief Well RW-68B (Observation Well PZ-25R)

In an attempt to gather additional information on the vertical and lateral variation in hydraulic characteristics, an additional pump test was performed on existing relief well RW-68B with drawdown measured in existing piezometer PZ-25R (located a distance of 8.5 feet from the relief well). Unlike observation wells OW20-01 and OW20-02 (which were screened in the shallow alluvium from ~10 to 20 feet bgs), piezometer PZ-25R is screened deeper in the alluvium (from ~36 to 41 feet bgs). This relief well/piezometer pair was selected to determine if more significant drawdown would be observed in a deeper observation point (piezometer PZ-25R) due to geologic conditions (i.e., below the upper clay layers).

The pumping rate for the constant-rate test on relief well RW-68B selected based on the capacity testing performed prior to this field effort was 24.0 gpm resulting in a drawdown of approximately 16 feet in the relief well. Discharge water from the constant-rate test (~5,760 gallons) was directed into the relief well channel.

The high values for T and S indicate that there are likely some clay layers present between the relief well and piezometer at this location (as shown on the profiles included in Appendix A).

5.4.5 Single-Well Pump Test (RW-68B)

To obtain an additional estimate of T and K, data from the constant-rate test on relief well RW-68B was analyzed using the equation as described in Section 5.4.2.

A comparison of the results of the two tests on relief well RW-68B show relatively good correlation in calculated T and K values (closer than RW-67B) and appear appropriate for the materials.

5.5 Single-well pump tests

5.6 Two-hour test in relief well RW-66A

A single-well pumping test was performed on relief well RW-66A to assess the amount of variability in permeability values across the construction area (note that this test was planned in the original DPP). The test was run for 2 hours at 60.1 gpm resulting in approximately 17 feet of drawdown.

5.7 Two-hour test in relief well RW-68A

A single-well pumping test was performed on relief well RW-68A to assess the amount of variability in permeability values across the construction area (note that this test was not planned in the original DPP). The test was run for 2 hours at 33.0 gpm resulting in approximately 26 feet of drawdown.

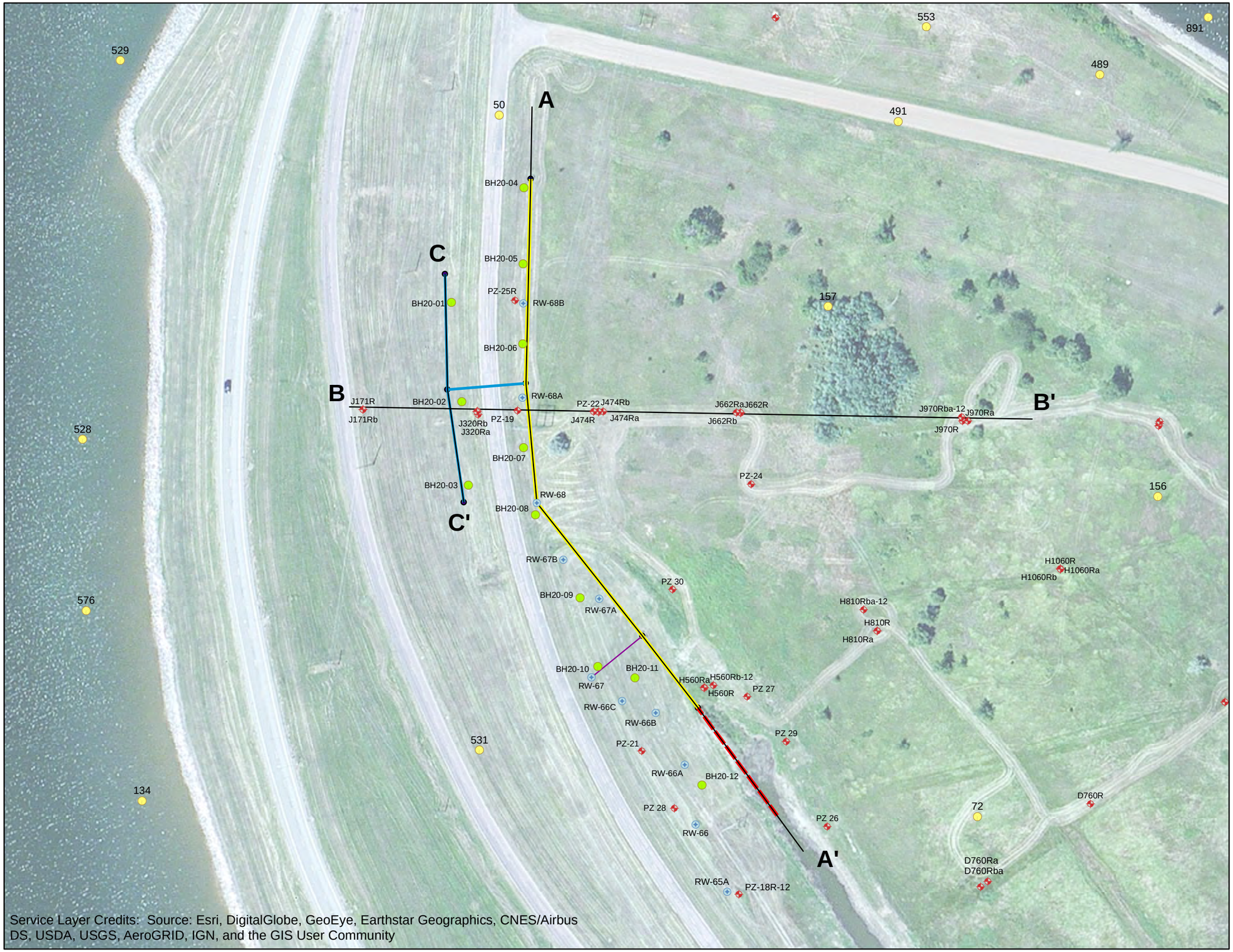
5.8 Summary

A summary of the calculated hydraulic parameters from available pump test data is included as Table 5-3. As discussed in Section 4.2, the alluvium in the area consists of an alluvial clay blanket overlying pervious sands with interbedded clay zones as shown in Table 4-1 and on the geologic profiles in Appendix A. Based on the drilling logs and available gradation data for the alluvial sands, fines content ranged from 2 to 46 percent, with an average value of 12.4 percent. The majority of the sand classified as fine (between 0.075 and 0.475 mm) with percentages ranging from 41 to 85 percent with an average of 69 percent fine sand.

Table 5-3: Summary of available pump tests

Pumping Well Designation	Description
RW-67B	Six-hour constant-rate pump test with drawdown measured in shallow observation wells OW20-01 and OW20-02
RW-67B	Six-hour, single-well, constant-rate pump test
OW20-02	Four-hour, constant-rate pump test with drawdown measured in shallow observation well OW20-01
RW-68B	Four-hour, constant-rate pump test with drawdown measured in deeper piezometer PZ-25R
RW-68B	Four-hour, single-well, constant-rate pump test
RW-66A	Two-hour, single-well, constant-rate pump test
RW-68A	Two-hour, single-well, constant-rate pump test

Appendix A: Location Map and Geologic Profiles



LEGEND

- 2020 Soil Boring
- Existing Piezometer
- Existing Relief Well
- Historical Soil Boring
- Geologic Profile Line
- Relief Well Collector Pipe
- Proposed Extension
- Toe Drain

N

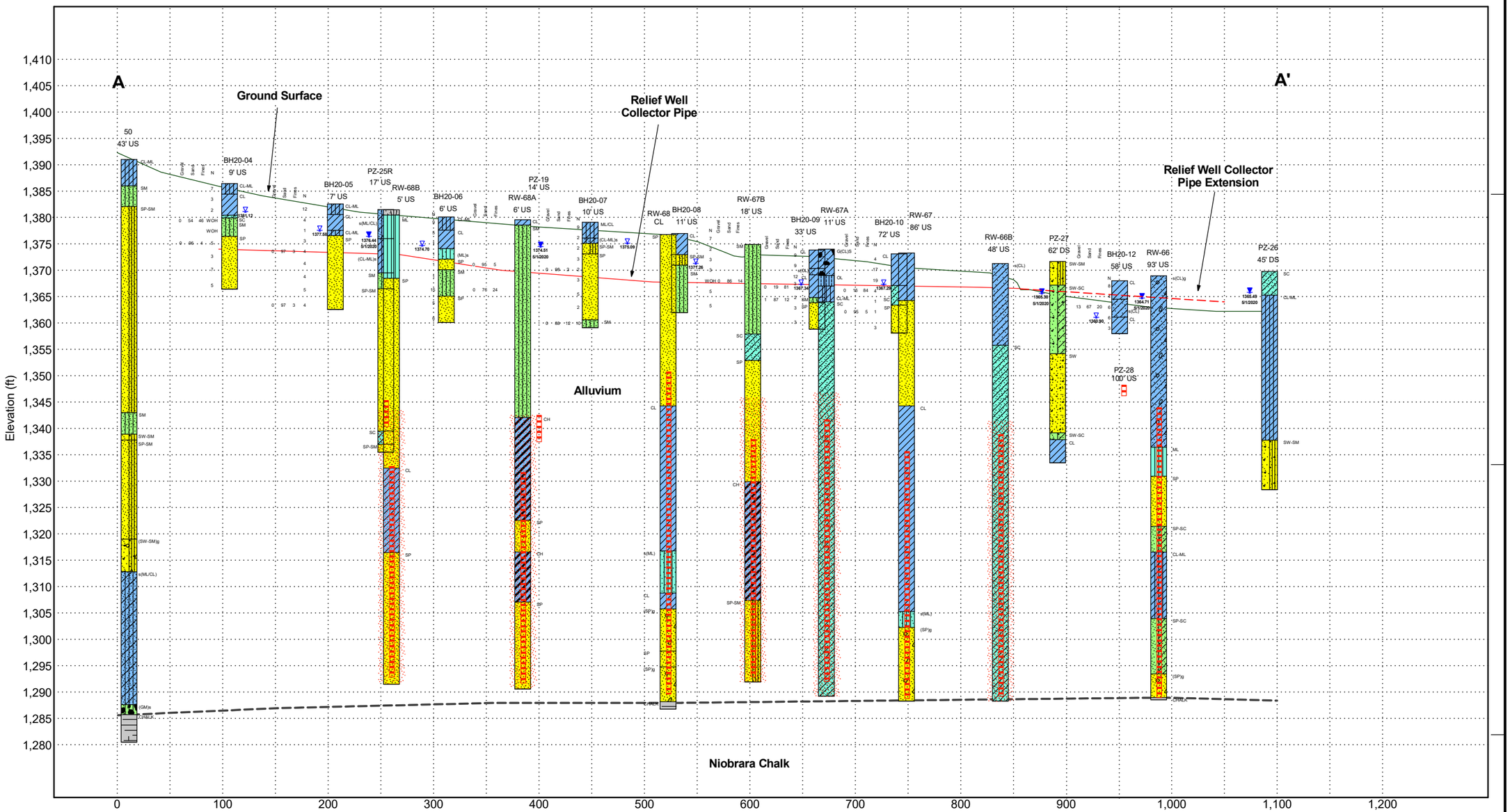
125 62.5 0 125 Ft

U.S. Army Corps of Engineers
Omaha District

Big Bend Dam
Fort Thompson, SD

Soil Boring and Profile Location Map

July 2020 | FIGURE A1



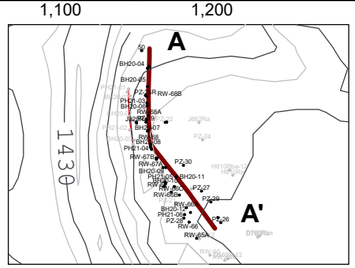
LITHOLOGY GRAPHICS

- (CL)g - Lean Clay with Gravel
- (CL)s - Lean Clay with Sand
- (CL-ML)s - Silty Clay with Sand
- (GC)s - Clayey Gravel with Sand
- CH - Fat Clay
- CL - Lean Clay
- CL-ML - Silty Clay
- g(CL)s - Gravelly Lean Clay with Sand
- g(CL-ML)s - Gravelly Silty Clay with Sand
- OL - Organic Silt/Clay
- s(CL) - Sandy Lean Clay
- s(CL)g - Sandy Lean Clay with Gravel
- SC - Clayey Sand
- (ML)s - Silt with Sand
- ML - Silt
- s(ML) - Sandy Silt
- s(ML/CL) - Sandy Clayey Silt
- (GM)s - Silty Gravel with Sand
- SM - Silty Sand
- SP-SC - Poorly Graded Sand with Clay
- SW-SC - Well-Graded Sand with Clay
- (SP)g - Poorly Graded Sand with Gravel
- (SW-SM)g - Well-Graded Sand with Silt and Gravel
- SP - Poorly Graded Sand
- SP-SM - Poorly Graded Sand with Silt
- SW - Well-Graded Sand
- SW-SM - Well-Graded Sand with Silt
- Chalk - Chalk or Marl
- CONCRETE - Concrete
- No Sample - No Sample
- Well Screen and Filter Pack
- Depth Groundwater Encountered During Drilling
- Groundwater Level Measured 5/1/2020

50.0 0.0 50.0 100.0 150.0
Horizontal Scale in Feet

Notes:

1. Elevations in Project Datum.
2. Vertical exaggeration ~5x.
3. Boring profiles projected to cross section line. US = upstream, DS = downstream.
4. Water levels from May 2020. Reservoir el. 1420.58. Tailwater el. 1356.09.



US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

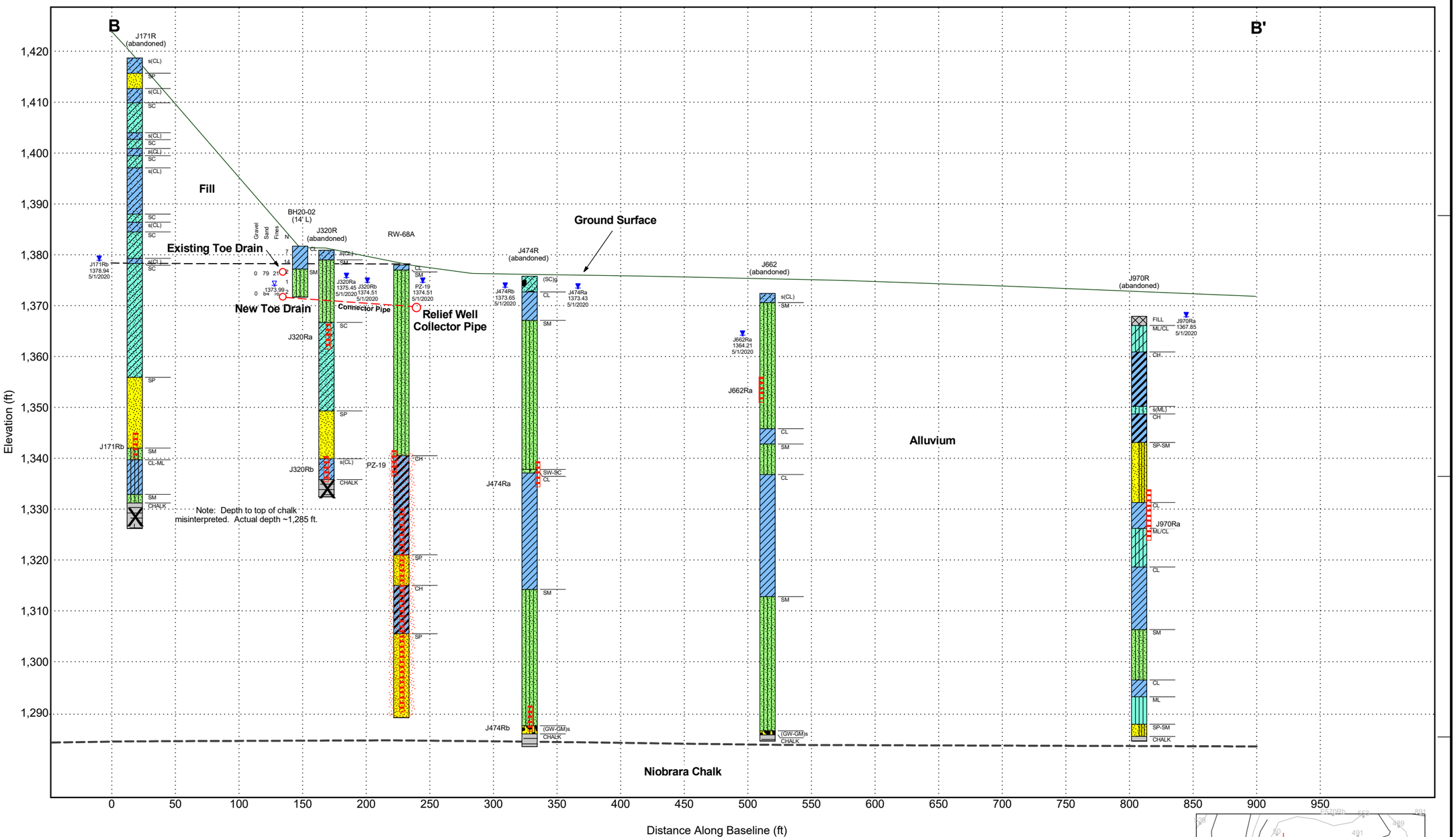
DESIGNED BY:
DWN BY:
SUBMITTED BY:
FILE NAME:
SIZE:
DATE: 8/4/21
CKD BY:
PLOT SCALE:
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
PLOT DATE:

DESCRIPTION | DATE | APPR | MARK

FY20 Toe Drain and RW Collector Pipe
Subsurface Investigation
Fort Thompson, SD
Geologic Profile A-A'

SHEET IDENTIFICATION NUMBER
A2

NWO_FENCE_B_SIZE_SENSING_ZONE_BIG_BEND_DRAIN_RW_REPLACEMENT.GPJ_USACE_NWO.GDT 2/10/21



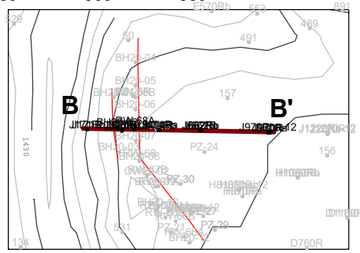
LITHOLOGY GRAPHICS

- CH - Fat Clay
- CL - Lean Clay
- CL-ML - Silty Clay
- s(CL) - Sandy Lean Clay
- SC - Clayey Sand
- (SC)g - Clayey Sand with Gravel
- ML - Silt
- ML/CL - Clayey Silt
- s(ML) - Sandy Silt
- SM - Silty Sand
- SW-SC - Well-Graded Sand with Clay
- (GW-GM)s - Well-Graded Gravel with Silt and Sand
- SP - Poorly Graded Sand
- SP-SM - Poorly Graded Sand with Silt
- Chalk - Chalk or Marl
- FILL - Fill
- No Sample - No Sample
- Depth Groundwater Encountered During Drilling
- Groundwater Level Measured 5/1/2020
- Well Screen and Filter Pack

40.0 0.0 40.0 80.0 120.0

Horizontal Scale in Feet

1. Elevations in Project Datum.
2. Vertical exaggeration 4x.
3. Boring profiles on centerline of alignment except BH20-02.
4. Water levels from May 2020. Reservoir el. 1420.58. Tailwater el. 1356.09.



US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

APPR | DATE | DESCRIPTION | MARK | APPR | DATE | DESCRIPTION | MARK

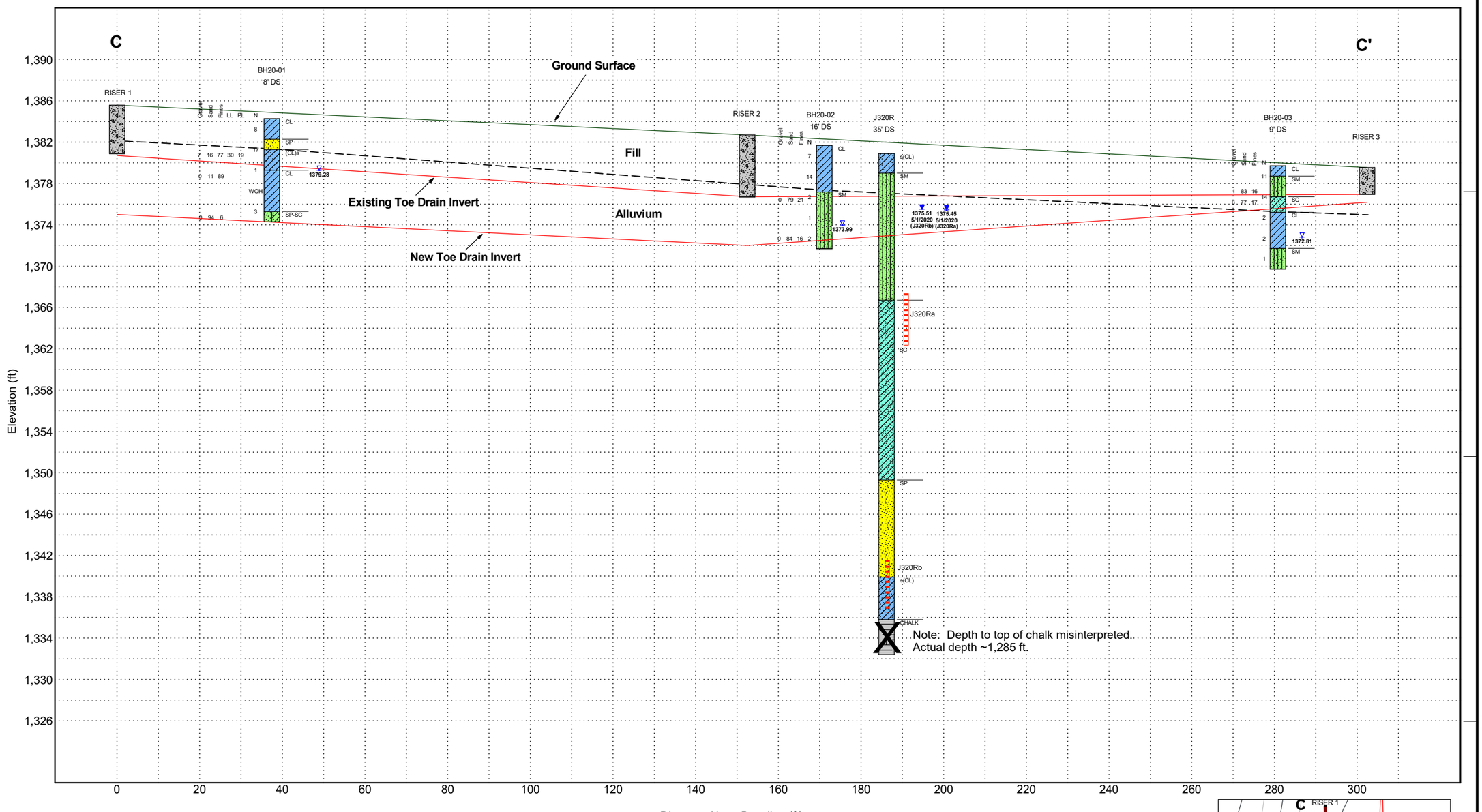
DESIGNED BY: | DRAWN BY: | CHKD BY: | SUBMITTED BY: | FILE NAME: | SIZE: | DATE: 8/4/21 | SOLICITATION NO.: | CONTRACT NO.: | FILE NUMBER: | PLOT SCALE: | PLOT DATE:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

FY20 Toe Drain and RW Collector Pipe
Subsurface Investigation
Fort Thompson, SD
Geologic Profile B-B'

SHEET IDENTIFICATION NUMBER
A3

NWO_FENCE_B_SIZE_SENSING_ZONE_BIG_BEND_DRAIN_REPLACEMENT.GPJ_USACE_NWO.GDT 7/2/20



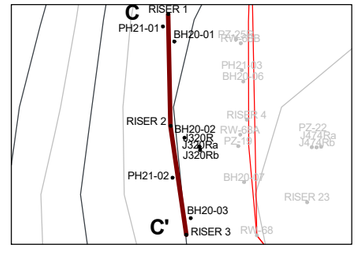
LITHOLOGY GRAPHICS

- (CL)s - Lean Clay with Sand
- CL - Lean Clay
- SC - Clayey Sand
- SM - Silty Sand
- SP - Poorly Graded Sand
- SW-SM - Well-Graded Sand with Silt
- Chalk - Chalk or Marl
- CONCRETE - Concrete
- No Sample - No Sample
- Well Screen and Filter Pack
- Depth Groundwater Encountered During Drilling
- Groundwater Level Measured 5/1/2020

12.5 0.0 12.5 25.0 37.5

Horizontal Scale in Feet

1. Elevations in Project Datum.
2. Vertical exaggeration 2.5x.
3. Boring profiles offset as indicated.
4. Water levels from May 2020. Reservoir el. 1420.58. Tailwater el. 1356.09.



US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

MARK	DESCRIPTION	DATE	APPR

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CORPS OF ENGINEERS
OMAHA, NEBRASKA

DESIGNED BY:
DWN BY: CKD BY:
SUBMITTED BY:
FILE NAME:
SIZE: PLOT SCALE:
DATE: 2/10/21
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
PLOT DATE:

FY20 Toe Drain and RW Collector Pipe Subsurface Investigation
Fort Thompson, SD
Geologic Profile C-C'

SHEET IDENTIFICATION NUMBER
A4

NWO_FENCE_B_SIZE_SENSING_ZONE_BIG_BEND_DRAIN_RW_REPLACEMENT.GPJ USACE_NWO.GDT 2/10/21

Appendix B: HTRW Sampling Report

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA NE
1616 CAPITOL AVENUE
OMAHA NE 68102-4901

REPLY TO ATTENTION OF

CENWO-EDG-S July 2020

MEMORANDUM FOR RECORD

SUBJECT: Big Bend Dam, Fort Thompson, South Dakota, Soil and Groundwater Sampling.

1. Introduction. Past use of diesel fuel in piezometers to prohibit freezing during winter months has caused concern about the condition of the groundwater and soil in the vicinity of the wells.

2. Scope of Work. This environmental sampling event is to test the soil and groundwater for total petroleum hydrocarbons with diesel range organics (TPH-DRO) from 12 soil borings located near piezometers and relief wells at the site.

3. Sampling Activities. The sampling team included the three man drill crew and a geologist. Soil samples were collected during 1-18 June 2020 and the locations of these samples are in Enclosure 1.

a. Soil samples were collected from each boring at the upper limit of the groundwater. The sampling list is in Enclosure 2.

b. Groundwater was collected as a grab sample from the bottom of the boring.

4. Analytical Data. Soil and groundwater samples were collected at the locations and analyzed using EPA SW-846 methods for TPH-DRO (8015C). CT Laboratories in Baraboo, Wisconsin provided the sample analysis.

a. A manual stage 2A validation of the laboratory data was performed in accordance with the DoD General Data Validation Guidelines and Quality Systems Manual V5.1. Results of the data validation are found in Enclosure 4. Based on the results of the validation, data are usable for the purpose of making a decision regarding the presence or absence of contamination and concentrations where special handling is required at the site.

b. A detection above the Regional Screening Level (RSL) for TPH-DRO was noted at boring location BBSD-11A and BBSD-12A. Refer to Enclosure 3 for the combined laboratory analytical report.

Detected Analyte Table
Derived from the Laboratory Analytical Report
(Enclosure 3)

Sample ID	DRO	Matrix	Method	Container
BBSD-01A	9.70 mg/kg J[6]	Soil	SW846 8015C	4 ounce glass jar No preservatives 14 day hold time
BBSD-02A	6.93 J			
BBSD-00A[1]	<17 U[5]			
BBSD-03A	7.05 J			
BBSD-04A	<18 U			
BBSD-05A	<18 U			
BBSD-05A-MS	224			
BBSD-05A-MSD	209			
BBSD-06A	<19 U			
BBSD-07A	<19 U			
BBSD-08A	<18 U			
BBSD-XXA[2]	<18 U			
BBSD-09A	7.50 J			
BBSD-10A	7.24 J			
BBSD-11A	**96.9**			
BBSD-12A	**2830**			
BBSD-01B	110 ug/L J	Water		1 liter amber glass jar No preservatives 7 day hold time
BBSD-02B	480			
BBSD-00B[3]	440			
BBSD-03B	270			
BBSD-04B	200 J			
BBSD-05B	1200			
BBSD-05B-MS	3890			
BBSD-05B-MSD	3860			
BBSD-06B	260 J			
BBSD-07B	520 J			
BBSD-08B	74 J			
BBSD-XXB[4]	67 J			
BBSD-09B	290 J			
BBSD-10B	420			
BBSD-11B	300			
BBSD-12B	27,000			

[1] – Duplicate sample for BBSD-02A
[2] – Duplicate sample for BBSD-08A
[3] – Duplicate sample for BBSD-02B
[4] – Duplicate sample for BBSD-08B
[5] - Analyte concentration was below detection limit
[6] – Estimated value

5. Interpretation and Evaluation.

a. The soil sample taken at BBSD-12A was analyzed at 2830 mg/kg and the groundwater from the same location was analyzed at 27,000 ug/L. The soil sample taken at BBSD-11A was analyzed at 96.9 mg/kg. Excavated soils with TPH

concentrations greater than 10 mg/kg must be disposed of in accordance with the permitting requirements of the SDDNR Waste Management Program.

b. The groundwater sample taken from BBSD-12B location was analyzed at 27,000 ug/L. If dewatering is required during construction, groundwater in this area will be containerized and sampled for disposal procedures.

c. During construction, excavated contaminated soil must be stockpiled and tested for contamination of TPH-DRO, BTEX and Naphthalene prior to disposition for acceptance to landfills. Undisturbed contaminated soil requires no special handling instructions. Tier I action levels* for soils are as follows:

Chemical of Concern	Action Level
Benzene	0.2 ppm
Toluene	15 ppm
Ethylbenzene	10 ppm
Xylenes	300 ppm
Naphthalene	25 ppm
TPH-DRO	10 ppm

* Taken from SDDNR Petroleum Assessment and Cleanup Handbook (Chapter 4)

6. Point of contact for this memorandum is the undersigned at (402) 995-2289.

4 Enclosures
1. Sampling Location Map
2. Sampling List
3. Laboratory Report
4. Laboratory Data Validation

THOMAS A. WEIRAUCH, EP, CESCO
Environmental Scientist
Military Munitions and Environmental Science Section

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ENCLOSURE 1

SAMPLING LOCATION MAP

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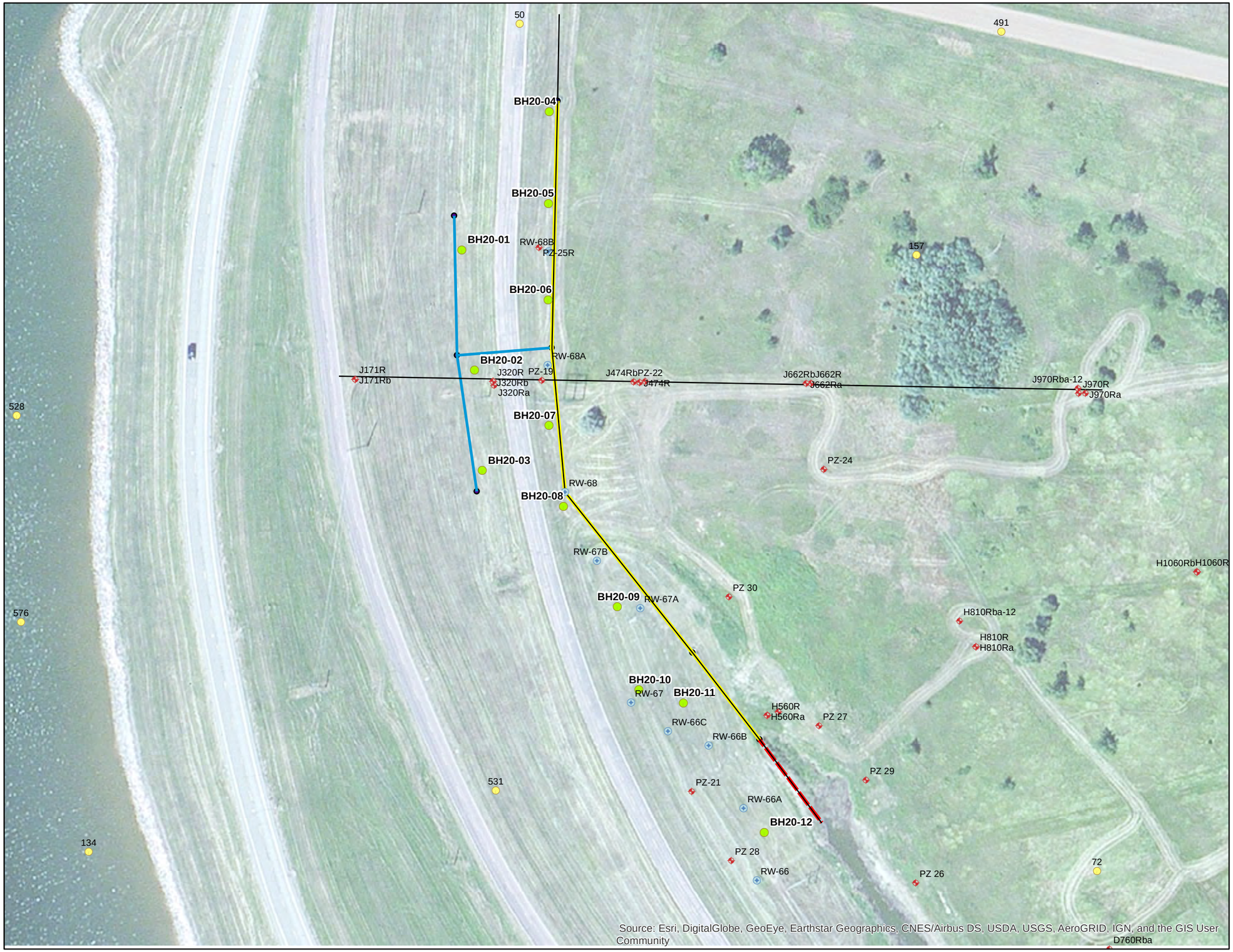

LEGEND

- Soil Boring (As-Drilled)
- Existing Relief Well
- Existing Piezometer
- Historical Soil Boring
- Relief Well Collector Pipe
- Proposed Extension
- Toe Drain
- Connector Pipe

N

100 50 0 100 Ft

U.S. Army Corps of Engineers
Omaha District

Big Bend Dam
Fort Thompson, SD

Soil Boring Location Map

July 2020 | FIGURE 1

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ENCLOSURE 2

SAMPLING LIST

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Sample ID	DRO	Matrix	Method	Container
BBSD-01A	9.70 mg/kg	Soil	SW846 8015C	4 ounce glass jar No preservatives 14 day hold time
BBSD-02A	6.93			
BBSD-00A[1]	<17			
BBSD-03A	7.05			
BBSD-04A	<18			
BBSD-05A	<18			
BBSD-05A-MS	224			
BBSD-05A-MSD	209			
BBSD-06A	<19			
BBSD-07A	<19			
BBSD-08A	<18			
BBSD-XXA[2]	<18			
BBSD-09A	7.50			
BBSD-10A	7.24			
BBSD-11A	**96.9**			
BBSD-12A	**2830**			
BBSD-01B	110 ug/L	Water		1 liter amber glass jar No preservatives 7 day hold time
BBSD-02B	480			
BBSD-00B[3]	440			
BBSD-03B	270			
BBSD-04B	200			
BBSD-05B	1200			
BBSD-05B-MS	3890			
BBSD-05B-MSD	3860			
BBSD-06B	260			
BBSD-07B	520			
BBSD-08B	74			
BBSD-XXB[4]	67			
BBSD-09B	290			
BBSD-10B	420			
BBSD-11B	300			
BBSD-12B	27,000			

[1] – Duplicate sample for BBSD-02A

[2] – Duplicate sample for BBSD-08A

[3] – Duplicate sample for BBSD-02B

[4] – Duplicate sample for BBSD-08B

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ENCLOSURE 3

LABORATORY REPORT

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CT LABORATORIES
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www.ctlaboratories.com

ANALYTICAL SUMMARY REPORT

This report at a minimum contains the following information:

Analytical Report of Test Results
Description of QC Qualifiers
Chain of Custody (copy)
Quality Control Summary (if applicable)
Case Narrative (if applicable)
Correspondence with Client (if applicable)

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for parameters where accreditation is required or available, unless otherwise noted in the case narrative.

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

ANALYTICAL SAMPLE DATA

USACE - OMAHA
TOM WEIRAUCH
1616 CAPITOL AVE
SUITE 9000
OMAHA, NE 68102-9000

Project Name: BIG BEND DAM TOE DRAIN REPLACEMENT
Project Phase: FORT THOMPSON, SD
Project #:
Folder #: 153747
Purchase Order #:
Contract #: 3357

Arrival Temperature: 3.2
Report Date: 06/18/2020
Date Received: 06/04/2020
Reprint Date: 06/19/2020

CT LAB#: 427712 Sample Description: BBSD-01B Client Sample #: Sampled: 06/02/2020 1105

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***110***	ug/L	34	100	200	200	1.00	J	06/08/2020 10:30	6/9/20 13:49	JJY	EPA 8015C
SURR: Octacosane	71	% Recovery	60			142	1.00		06/08/2020 10:30	6/9/20 13:49	JJY	EPA 8015C
Surr: Triacontane	63	% Recovery	29			140	1.00		06/08/2020 10:30	6/9/20 13:49	JJY	EPA 8015C

CT LAB#: 427714 Sample Description: BBSD-03B Client Sample #: Sampled: 06/03/2020 0845

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***270***	ug/L	34	100	200	200	1.00		06/08/2020 10:30	6/9/20 14:17	JJY	EPA 8015C
SURR: Octacosane	81	% Recovery	60			142	1.00		06/08/2020 10:30	6/9/20 14:17	JJY	EPA 8015C
Surr: Triacontane	74	% Recovery	29			140	1.00		06/08/2020 10:30	6/9/20 14:17	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 427715 Sample Description: BBSD-12B Client Sample #: Sampled: 06/03/2020 1023

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***27000***	ug/L	180	530	1100	1100	5.00		06/08/2020 10:30	6/9/20 16:09	JJY	EPA 8015C
SURR: Octacosane	26	% Recovery	60			142	1.00	S	06/08/2020 10:30	6/9/20 14:45	JJY	EPA 8015C
Surr: Triacontane	19	% Recovery	29			140	1.00	S	06/08/2020 10:30	6/9/20 14:45	JJY	EPA 8015C

CT LAB#: 427716 Sample Description: BBSD-02B Client Sample #: Sampled: 06/02/2020 1244

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***480***	ug/L	42	130	250	250	1.00		06/08/2020 10:30	6/9/20 15:13	JJY	EPA 8015C
SURR: Octacosane	25	% Recovery	60			142	1.00	S	06/08/2020 10:30	6/9/20 15:13	JJY	EPA 8015C
Surr: Triacontane	20	% Recovery	29			140	1.00	S	06/08/2020 10:30	6/9/20 15:13	JJY	EPA 8015C

CT LAB#: 427717 Sample Description: BBSD-00B Client Sample #: Sampled: 06/02/2020 1244

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***440***	ug/L	42	130	250	250	1.00		06/08/2020 10:30	6/9/20 18:02	JJY	EPA 8015C
SURR: Octacosane	29	% Recovery	60			142	1.00	S	06/08/2020 10:30	6/9/20 18:02	JJY	EPA 8015C
Surr: Triacontane	21	% Recovery	29			140	1.00	S	06/08/2020 10:30	6/9/20 18:02	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 427718 Sample Description: BBSD-00A Client Sample #: Sampled: 06/02/2020 1225

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***82.7***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	<17	mg/kg	5.8	17	46	46	1.00	U	06/16/2020 10:30	6/16/20 18:56	JJY	EPA 8015C
SURR: Octacosane	50	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 18:56	JJY	EPA 8015C
Surr: Triacontane	40	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 18:56	JJY	EPA 8015C

CT LAB#: 427719 Sample Description: BBSD-12A Client Sample #: Sampled: 06/03/2020 0941

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***83.6***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	***2830***	mg/kg	29	88	230	230	5.00		06/16/2020 10:30	6/17/20 11:56	JJY	EPA 8015C
SURR: Octacosane	81	% Recovery	44			125	5.00		06/16/2020 10:30	6/17/20 11:56	JJY	EPA 8015C
Surr: Triacontane	69	% Recovery	35			136	5.00		06/16/2020 10:30	6/17/20 11:56	JJY	EPA 8015C

CT LAB#: 427720 Sample Description: BBSD-02A Client Sample #: Sampled: 06/02/2020 1225

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***88.3***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 427720 Sample Description: BBSD-02A Client Sample #: Sampled: 06/02/2020 1225

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***6.93***	mg/kg	5.5	16	44	44	1.00	J	06/16/2020 10:30	6/16/20 19:52	JJY	EPA 8015C
SURR: Octacosane	55	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 19:52	JJY	EPA 8015C
Surr: Triacontane	43	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 19:52	JJY	EPA 8015C

CT LAB#: 427721 Sample Description: BBSD-01A Client Sample #: Sampled: 06/02/2020 1025

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***78.9***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	***9.70***	mg/kg	6.3	19	51	51	1.00	J	06/16/2020 10:30	6/16/20 20:19	JJY	EPA 8015C
SURR: Octacosane	53	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 20:19	JJY	EPA 8015C
Surr: Triacontane	45	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 20:19	JJY	EPA 8015C

CT LAB#: 427722 Sample Description: BBSD-03A Client Sample #: Sampled: 06/02/2020 1418

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***80.0***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 427722 Sample Description: BBSD-03A Client Sample #: Sampled: 06/02/2020 1418

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Diesel Range Organics	***7.05***	mg/kg	6.2	19	50	50	1.00	J	06/16/2020 10:30	6/16/20 20:47	JJY	EPA 8015C
SURR: Octacosane	54	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 20:47	JJY	EPA 8015C
Surr: Triacontane	45	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 20:47	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

Notes:

^ Indicates the laboratory is NELAP accredited for this analyte by the indicated matrix and method. DL (detection limit), LOD (limit of detection), loq (limit of quantitation) as defined by most recent DOD QSM version.

All samples were received intact and properly preserved unless otherwise noted. The results reported relate only to the samples tested. This report shall not be reproduced, except in full, without written approval of this laboratory. The Chain of Custody is attached.

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for the parameters where accreditation is required or available, unless noted in the case narrative.

Submitted by: Brett M. Szymanski
Project Manager
608-356-2760

QC Qualifiers

Code	Description
B	Analyte detected in the associated Method Blank.
C	Toxicity present in BOD sample.
D	Diluted Out.
E	Safe, No Total Coliform detected.
F	Unsafe, Total Coliform detected, no E. Coli detected.
G	Unsafe, Total Coliform detected and E. Coli detected.
H	Holding time exceeded.
I	Incubator temperature was outside acceptance limits during test period.
J	Estimated value.
L	Significant peaks were detected outside the chromatographic window.
M	Matrix spike and/or Matrix Spike Duplicate recovery outside acceptance limits.
N	Insufficient BOD oxygen depletion.
O	Complete BOD oxygen depletion.
P	Concentration of analyte differs more than 40% between primary and confirmation analysis.
Q	Laboratory Control Sample outside acceptance limits.
R	See Narrative at end of report.
S	Surrogate standard recovery outside acceptance limits due to apparent matrix effects.
T	Sample received with improper preservation or temperature.
U	Analyte concentration was below detection limit.
V	Raised Quantitation or Reporting Limit due to limited sample amount or dilution for matrix background interference.
W	Sample amount received was below program minimum.
X	Analyte exceeded calibration range.
Y	Replicate/Duplicate precision outside acceptance limits.
Z	Specified calibration criteria was not met.

Current CT Laboratories Certifications

Wisconsin (WDNR) Chemistry ID# 157066030
Wisconsin (DATCP) Bacteriology ID# 289
Louisiana NELAP (primary) ID# ACC20190002
Illinois NELAP Lab ID# 200073
Kansas NELAP Lab ID# E-10368
Virginia NELAP Lab ID# 460203
ISO/IEC 17025-2005 A2LA Cert # 3806.01
DoD-ELAP A2LA 3806.01
GA EPD Stipulation ID ACC20190002

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QC SUMMARY REPORT

USACE - OMAHA

Project Name: BIG BEND DAM TOE DRAIN REPLACEMENT

SDG #: 0 **Folder #: 153747** **Project #:**

Duplicate

Analytical Run #:	171971	Analysis Date:	06/15/2020	Prep Batch #:		Matrix:	SOIL
CTLab #:	432147	Analysis Time:	13:57	Prep Date/Time:		Method:	SW8000C
Parent Sample #:	427718	Analyst:	BMM	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Solids, Percent	83.0	%	82.7					0	8

Lab Control Spike Duplicate Water

Analytical Run #:	171977	Analysis Date:	06/09/2020	Prep Batch #:	76713	Matrix:	LIQUID
CTLab #:	427836	Analysis Time:	16:38	Prep Date/Time:	06/08/2020 10:30	Method:	SW8015
Parent Sample #:	427835	Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	1980	ug/L			2500	79	36 --- 132	4	30

Lab Control Spike Water

Analytical Run #:	171977	Analysis Date:	06/09/2020	Prep Batch #:	76713	Matrix:	LIQUID
CTLab #:	427835	Analysis Time:	13:21	Prep Date/Time:	06/08/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	1900	ug/L			2500	76	36 --- 132		30

Method Blank Water

Analytical Run #:	171977	Analysis Date:	06/09/2020	Prep Batch #:	76713	Matrix:	LIQUID
CTLab #:	427834	Analysis Time:	12:52	Prep Date/Time:	06/08/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	33	ug/L		U	0		100		

Lab Control Spike Soil

Analytical Run #:	172235	Analysis Date:	06/16/2020	Prep Batch #:	76752	Matrix:	SOLID
CTLab #:	428336	Analysis Time:	18:27	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	192	mg/kg			250	77	38 --- 132		30

Method Blank Soil

Analytical Run #:	172235	Analysis Date:	06/16/2020	Prep Batch #:	76752	Matrix:	SOLID
CTLab #:	428335	Analysis Time:	17:59	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	5	mg/kg		U	0		20		

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Sample Condition Report

Folder #: 153747
Client: USACE - OMAHA

Print Date / Time: 06/04/2020 12:37
Received Date / Time / By: 06/04/2020 11:30 CHB

Project Name: BIG BEND DAM TOE DRAIN REPLACEM
Project Phase: FORT THOMPSON, SD

Log-In Date / Time / By: 06/04/2020 12:08 JLS
Project #: PM: BMS

Coolers: 6380
Custody Seals Present : **Y**

Temperature: 3.2 C On Ice: **Y**
COC Present:? **Y** Complete? **Y**

Seal Intact? **Y**
Ship Method: FEDEX EXPRESS
Adequate Packaging: **Y**

Numbers: DATED AND SIGNED
Tracking Number: 806531978900
Temp Blank Enclosed? **Y**

Notes: THE SAMPLES WERE RECEIVED IN GOOD CONDITION ON ICE.

TWO CUSTODY SEALS WERE PRESENT AND INTACT UPON RECEIPT - BOTH WERE DATED 6/3/20 AND SIGNED.

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
427712 BBSD-01B	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **1**		
427714 BBSD-03B	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **1**		
427715 BBSD-12B	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **1**		
427716 BBSD-02B	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **1**		
427717 BBSD-00B	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **1**		
427718 BBSD-00A	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type	(***UNPRES GL***) = **1**		

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
427719 BBSD-12A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
427720 BBSD-02A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
427721 BBSD-01A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
427722 BBSD-03A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			

Condition Code	*Condition Description*
1	Sample Received OK

Rev. 02/2017

CHAIN OF CUSTODY

Page 1 of 1

Company: USACE - Omaha
Project Contact: Tom Weirauch
Telephone: 402 995 2289
Project Name: Big Bend Dam
Project #: Toe Drain Replacement
Location: Big Bend Dam S.D.
Sampled By: George Filipovich

CT LABORATORIES

1230 Lange Court, Baraboo, WI 53913
608-356-2760 Fax 608-356-2766
www.ctlaboratories.com

Folder # 153747
Company: USACE - OMAHA
Project: BIG BEND DAM
Logged By: JLS PM: BM

Program:
QSM RCRA SDWA NPDES
Solid Waste Other _____

PO #

Report To:
EMAIL: thomas.a.weirauch@
Company: USACE, ARMY, MIL
Address: USACE - Omaha D'sHct
1616 Capitol Ave, Omaha
NE 68102

Invoice To:*
EMAIL:
Company:
Address: Same as above

*Party listed is responsible for payment of invoice as per CT Laboratories' terms and conditions

Client Special Instructions

Matrix:
GW – groundwater SW - surface water WW - wastewater DW - drinking water
S - soil/sediment SL - sludge A - air M - misc/waste

Turnaround Time
(Normal) RUSH*
Date Needed: _____
Rush analysis requires prior CT Laboratories' approval
Surcharges:
24 hr 200%
2-3 days 100%
4-9 days 50%

Collection Date	Collection Time	Matrix	Grab/ Comp	Sample #	Sample ID Description	Filtered? Y/N	ANALYSES REQUESTED: TPH DRO	Total # Containers	Designated MS/MSD	CT Lab ID # (Lab use only)
							Fill in Spaces with Bottles per Test			
6/2/20	1105	GW	G	1	BBSD-01B	N	1			427712
6/3/20	0845	GW	G	1	BBSD-03B	N	1			427714
6/3/20	1023	GW	G	1	BBSD-12B	N	1			427715
6/2/20	1244	GW	G	1	BBSD-02B	N	1			427716
6/2/20	1244	GW	G	1	BBSD-00B	N	1			427717
6/2/20	1225	S	G	1	BBSD-00A		1			427718
6/3/20	0941	S	G	1	BBSD-12A		1			427719
6/2/20	1225	S	G	1	BBSD-02A		1			427720
6/2/20	1025	S	G	1	BBSD-01A		1			427721
6/2/20	1418	S	G	1	BBSD-03A		1			427722

Relinquished By:	Date/Time	Received By:	Date/Time
[signature]	6/3/20 1430	[signature]	6/4/2020 1208
Received by:	Date/Time	Received for Laboratory by: [signature]	Date/Time 6/4/2020 11:30

Lab Use Only
Ice Present (Yes) No
Temp 3.2 IR Gun 24
Cooler # G380

CT Laboratories Terms and Conditions

Where a purchaser (Client) places an order for laboratory, consulting or sampling services from CT Laboratories (CTL), CTL shall provide the ordered services pursuant to these Terms and Conditions, and the related Quotation, or as agreed in a negotiated contract. In the absence of a written agreement to the contrary, the Order constitutes an acceptance by the Client of CTL's offer to do business under these Terms and Conditions, and an agreement to be bound by these Terms and Conditions. No contrary or additional terms and conditions expressed in a Client's document shall be deemed to become a part of the contract created upon acceptance of these Terms and Conditions, unless accepted by CTL in advance of the start of the project and in writing.

1. ORDERS AND RECEIPT OF SAMPLES (Sample Acceptance Policy)

1.1 The Client may place the Order (i.e., specify a Scope of Work) either by submitting a purchase order to CTL in writing, by telephone (confirmed in writing) or by negotiated contract. Whichever option the Client selects for placing the Order, the Order shall not be valid unless it contains sufficient information to enable CTL to carry out the Client's requirements. It is the policy of CTL that samples not meeting the acceptance criteria, outlined in the NELAC standards and Section 5.8.3.2 of the DOD QSM, will not be accepted by the laboratory or will be qualified on the final report. All samples submitted to the laboratory must: (a) be accompanied by proper, full and complete documentation, including sample identification, location, date and time of collection, the collector's name, type of preservation (if any), type of sample, any special comments concerning the sample and any additional pertinent fields on the chain-of-custody. In the absence of any of the required information, the laboratory will attempt to contact the client to obtain the information; if unable to obtain the necessary information, the final report will be qualified. (b) samples must be labeled appropriately with a unique sample identification written with indelible ink on water resistant labels. If the laboratory cannot determine the identity of a sample, it may be rejected and the client will be contacted for further instructions or resampling. (c) samples must be in an appropriate sample container. If the container is inappropriate, the client will be contacted for further instructions or resampling. If analysis is possible, the final report will be qualified. CTL can provide a sampling guide containing approved containers and preservations for analytical methods requested. (d) adhere to method specified holding times. If samples are received with less than ¼ the holding time remaining for the requested test, CTL will make its best effort to analyze the samples and notify the client. If holding times are exceeded, the final report will be qualified. (e) contain adequate sample volume to perform the necessary testing. If sufficient volume is not present, the sample may be rejected and the client will be contacted for further instructions or resampling. If samples show signs of damage, contamination or inadequate preservation, the client will be notified. If analysis can be performed, the final report will be qualified. If not, the samples will be rejected and the client notified for further instructions or resampling. It is the Client's responsibility to understand and package samples correctly and provide the proper amount of temperature control (ice) suitable to current weather conditions.
1.2 CTL must be supplied with complete written disclosure of the known or suspected presence of any hazardous substances, as defined by applicable federal or state law. Where any samples which were not accompanied by the required disclosure, cause interruptions in the lab's ability to process work due to contamination of instruments or work areas, the Client will be responsible for the costs of clean up and recovery.
1.3 Prior to Sample Acceptance, the entire risk of loss or damage to samples remains with the Client. In no event will CTL have any responsibility or liability for the action or inaction of any carrier shipping or delivering any sample to or from CTL's premises. Client is responsible to assure that any sample containing any hazardous substance which is to be delivered to CTL's premises will be packaged, labeled, transported and delivered properly and in accordance with applicable laws.
1.4 Clients using CTL's shipping account(s) do so at their own risk and must purchase separate insurance if they do not wish to assume risk of loss. CTL will not assume any risk whatsoever for any samples outside of CTL's control and not successfully delivered to the laboratory within specified hold times.
1.5 CTL will not accept liability for any sample(s), except sample(s) damaged or broken by log-in staff prior to successful log-in of the sample(s) into the CTL- LIMS system. This includes, but may not be limited to: complete, valid COC documentation, all sample receiving issues being resolved from a delay caused by the Client in CTL's ability to log-in samples, including missed turnaround and hold times, delay in processing and, ultimately, additional charges to the Client.
1.6 CTL will only reject samples per directions from the Client. CTL's sole liability is to inform the Client of any sample receipt issues, and may provide an indication how proceeding with the analysis may affect results and final acceptance by the regulating agency. Ultimately, suitability for use is between the Client and the regulating agency(s).
1.7 Signing of this COC by the Client or Client's representative, or directions to CTL via email or Fax constitutes acceptance of these Terms and Conditions, and guarantees payment by the Client to CTL.

2. PAYMENT TERMS

2.1 Services performed by CTL will be in accordance with prices quoted and later confirmed in writing or as stated in the Price Schedule. Invoices may be submitted to Client upon completion of any sample delivery group. Payment in advance is required for all Clients except those whose credit has been established with CTL. For Clients with approved credit, payment terms are net 30 days from the date of invoice by CTL. All overdue payments are subject to an additional interest and service charge of one and one-half percent (1.5%) or the maximum rate permissible by law, per month or portion thereof from the due date until the date of payment. All fees are charged or billed directly to the Client. The billing of a third party will not be accepted without a statement, signed by the third party that acknowledges and accepts payment responsibility. CTL may suspend work and withhold delivery of data under this order at any time in the event Client fails to make timely payment of its invoices. Client shall be responsible for all costs and expenses of collection including reasonable attorney's fees. CTL reserves the right to refuse to proceed with work at any time based upon an unfavorable Client credit report.

3. CHANGE ORDERS, TERMINATION

3.1 Changes to the Scope of Work, price, or result delivery date may be initiated by CTL after Sample Acceptance due to any condition which conflicts with analytical, QA or other protocols warranted in these Terms and Conditions. CTL will not proceed with such changes until an agreement with the Client is reached on the amount of any cost, schedule change or technical change to the Scope of Work, and such agreement is documented in writing.
3.2 Changes to the Scope of Work, including but not limited to increasing or decreasing the work, changing test and analysis specification or acceleration in the performance of the work may be initiated by the Client after sample acceptance. Such a change will be documented in writing and may result in a change in cost and turnaround time commitment. CTL's acceptance of such changes is contingent upon technical feasibility and operational capacity.
3.3 Suspension or termination of all or any part of the work may be initiated by the Client. CTL will be compensated consistent with Section 2 of these Terms and Conditions. CTL will complete all work in progress and be paid in full for all work completed.

4. WARRANTIES AND LIABILITY

4.1 Where applicable, CTL will use analytical methodologies which are in substantial conformity with published test methods. CTL has implemented these methods in its Laboratory Quality Manuals and referenced Standard Operating Procedures and where the nature or composition of the sample requires it, CTL reserves the right to deviate from these methodologies as necessary or appropriate, based on the reasonable judgment of CTL, which deviations, if any, will be made on a basis consistent with recognized standards of the industry and/or CTL's Laboratory Quality Manuals. Client may request that CTL perform according to a mutually agreed Quality Assurance Project Plan (QAPP). In the event that samples arrive prior to agreement on a QAPP, CTL will proceed with analyses under its standard Quality Manuals then in effect, and CTL will not be responsible for any resampling or other charges if work must be repeated to comply with a subsequently finalized QAPP.
4.2 CTL shall start preparation and/or analysis within holding times provided that Sample Acceptance occurs within 48 hours of sampling or 1/2 of the holding time for the test, whichever is less. Samples received that do not meet this provision will be charged as expedited samples and the appropriate rate will be added accordingly. Where resolution of inconsistencies leading to Sample Acceptance does not occur within this period, CTL will use its best efforts to meet holding times and will proceed with the work provided that, in CTL's judgment, the chain-of-custody or definition of the Scope of Work provide sufficient guidance. Reanalysis of samples to comply with CTL's Quality Manuals will be deemed to have met holding times provided the initial analysis was performed within the applicable holding time. Where reanalysis demonstrates that sample matrix interference is the cause of failure to meet any Quality Manual requirements, the warranty will be deemed to have been met.
4.3 CTL warrants that it possesses and maintains all licenses and certifications which are required to perform services under these Terms and Conditions provided that such requirements are specified in writing to CTL prior to Sample Acceptance. CTL will notify the Client in writing of any decertification or revocation of any license, or notice of either, which affects work in progress.
4.4 The warranty obligations set forth in Sections 4.1, 4.2 and 4.3 are the sole and exclusive warranties given by CTL in connection with any services performed by CTL or any Results generated from such services, and CTL gives and makes NO OTHER REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. No representative of CTL is authorized to give or make any other representation or warranty or modify this warranty in any way.
4.5 Client's sole and exclusive remedy for the breach of warranty in connection with any services performed by CTL, will be limited to repeating any services performed, contingent on the Client's providing, at the request of CTL and at the Client's expense, additional sample(s) if necessary. Any reanalysis requested by the Client generating Results consistent with the original Results will be at the Client's expense. If resampling is necessary, CTL's liability for resampling costs will be limited to actual cost or one hundred or one hundred fifty dollars ($150) per sample, whichever is less.
4.6 CTL's liability for any and all causes of action arising hereunder, whether based in contract, tort, warranty, negligence or otherwise, shall be limited to the lesser amount of compensation for the services performed or $100,000. All claims, including those for negligence, shall be deemed waived unless suit thereon is filed within one year after CTL's completion of the services. Under no circumstances, whether arising in contract, tort (including negligence), or otherwise, shall CTL be responsible for loss of use, loss of profits, or for any special, indirect, incidental or consequential damages occasioned by the services performed or by application or use of the reports prepared.
4.7 In no event shall CTL have any responsibility or liability to the Client for any failure or delay in performance by CTL which results, directly or indirectly, in whole or in part, from any cause or circumstance beyond the reasonable control of CTL. Such causes and circumstances shall include, but not be limited to, acts of God, acts of Client, acts or orders of any governmental authority, strikes or other labor disputes, natural disasters, accidents, wars, civil disturbances, equipment breakdown, matrix interference or unknown highly contaminated samples that impact instrument operation, unavailability of supplies from usual suppliers, difficulties or delays in transportation, mail or delivery services, or any other cause beyond CTL's reasonable control.

5. RESULTS, WORK PRODUCT

5.1 Data or information provided to CTL or generated by services performed under this agreement shall only become the property of the Client upon receipt in full by CTL of payment for the whole Order. Ownership of any analytical method, QA/QC protocols, software programs or equipment developed by CTL for performance of work will be retained by CTL, and Client shall not disclose such information to any third party.
5.2 Data and sample materials provided by Client or at Client's request, and the result obtained by CTL shall be held in confidence (unless such information is generally available to the public or is in the public domain or Client has failed to pay CTL for all services rendered or is otherwise in breach of these Terms and Conditions), subject to any disclosure required by law or legal process.
5.3 Should the Results delivered by CTL be used by the Client or Client's client, even though subsequently determined not to meet the warranties described in these Terms and Conditions, then the compensation will be adjusted based upon mutual agreement. In no case shall the Client unreasonably withhold CTL's right to independently defend its data.
5.4 CTL reserves the right to subcontract services ordered by the Client to another laboratory or laboratories, if, in CTL's sole judgment, it is reasonably necessary, appropriate or advisable to do so, and with the Client's permission. CTL will in no way be liable for any subcontracted services and all applicable warranties, guarantees and insurance are those of the subcontracted laboratory.
5.5 CTL shall dispose of the Client's samples and extracts 30 days after the analytical report is issued, unless instructed to store them for an alternate period of time or to return such samples to the Client, in a manner consistent with U.S. Environmental Protection Agency regulations or other applicable Federal, state or local requirements. Additional charges will apply for samples or extracts stored longer than 30 days at the Clients request. Any samples for projects that are canceled or not accepted, or for which return was requested, will be returned to the Client at Client expense. CTL reserves the right to return to the Client any sample or unused portion of a sample that is not within CTL's permitted capability or the capabilities of CTL's designated waste disposal vendor(s), or will make arrangements to dispose of these samples at Client direction and expense.
5.6 Unless a different time period is agreed to in any order under these Terms and Conditions, CTL agrees to retain all records for five (5) years.
5.7 In the event that CTL is required to respond to legal process related to services for Client, Client agrees to reimburse CTL for hourly charges for personnel involved in the response and attorney fees reasonably incurred in obtaining advice concerning the response, preparation to testify, and appearances related to the legal process, travel and all reasonable expenses associated with the litigation.

6. INSURANCE

6.1 CTL shall maintain in force during the performance of services under these Terms and Conditions, Workers' Compensation and Employer's Liability Insurance in accordance with the laws of the states having jurisdiction over CTL's employees who are engaged in the performance of the work. CTL shall also maintain during such period, Comprehensive General and Contractual Liability (limit of $2,000,000 per occurrence/ aggregate), Comprehensive Automobile Liability, owned and hired, ($1,000,000 combined single limit), and Professional/Pollution Liability Insurance (limit of $5,000,000 per occurrence/aggregate). Any Client required changes to these limits or conditions will result in a change in cost to the Client.

7. AUDIT

7.1 Upon prior notice to CTL, the Client may audit and inspect CTL's records and accounts covering reimbursable costs related to work done for the Client, for a period of one (1) year after completion of the work. The purpose of any such audit shall be only for verification of such costs, and CTL shall not be required to provide access to cost records where prices are expressed as fixed fees or published unit prices.

Cooler Receipt Form

Ice Present YES NO

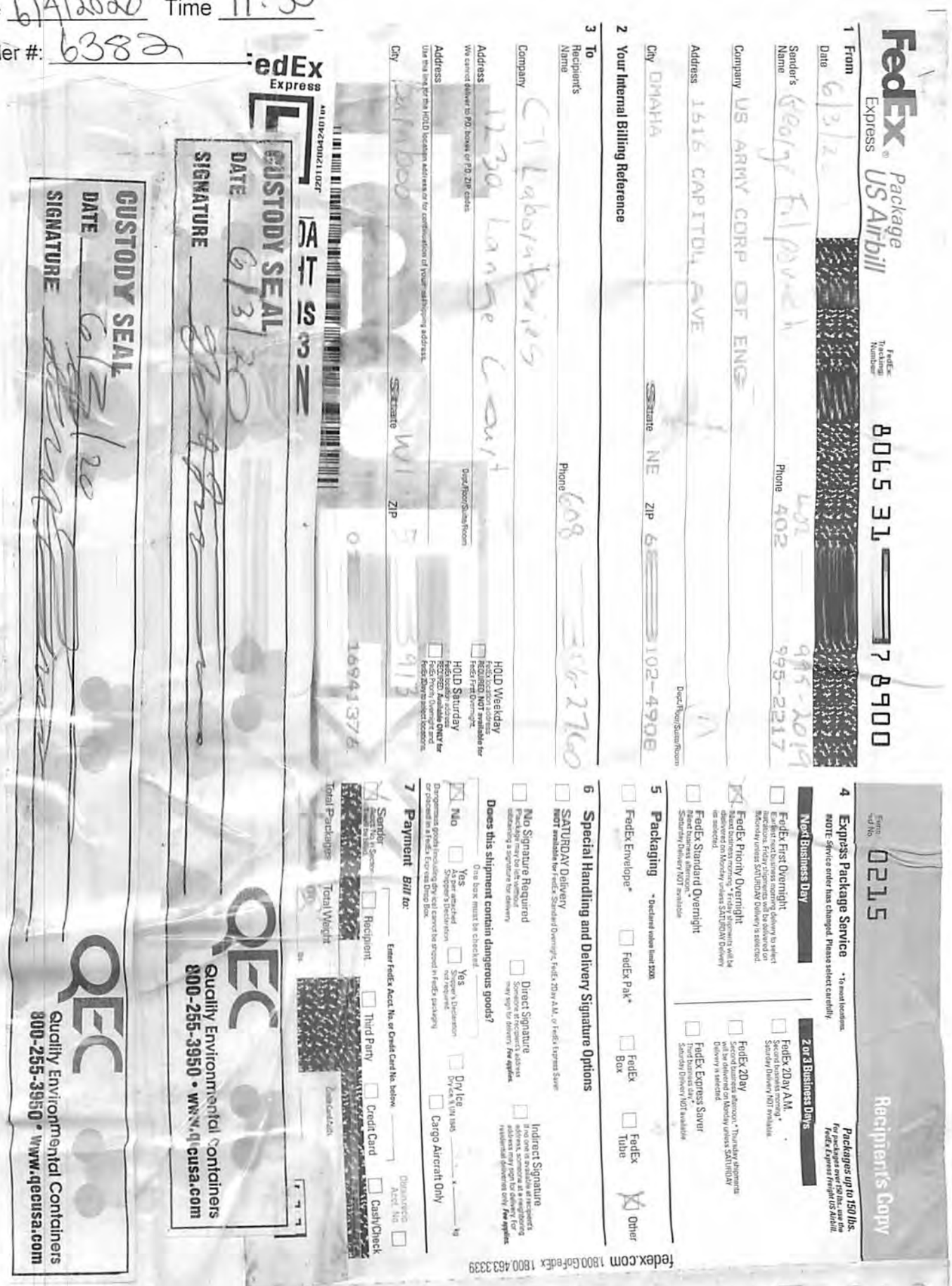
Temperature 3.2

IR Gun # 24

Initials CAB

Date 6/4/2020 Time 11:30

Cooler #: 6382



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www.ctlaboratories.com

ANALYTICAL SUMMARY REPORT

This report at a minimum contains the following information:

Analytical Report of Test Results
Description of QC Qualifiers
Chain of Custody (copy)
Quality Control Summary (if applicable)
Case Narrative (if applicable)
Correspondence with Client (if applicable)

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for parameters where accreditation is required or available, unless otherwise noted in the case narrative.

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

ANALYTICAL SAMPLE DATA

USACE - OMAHA
TOM WEIRAUCH
1616 CAPITOL AVE
SUITE 9000
OMAHA, NE 68102-9000

Project Name: BIG BEND DAM TOE DRAIN REPLACEMENT
Project Phase: FORT THOMPSON, SD
Project #:
Folder #: 153810
Purchase Order #:
Contract #: 3357

Arrival Temperature: 3.0
Report Date: 06/18/2020
Date Received: 06/06/2020
Reprint Date: 06/19/2020

CT LAB#: 428379 Sample Description: BBSD-11B Client Sample #: Sampled: 06/04/2020 1323

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***300***	ug/L	44	130	270	270	1.00		06/11/2020 13:00	6/12/20 13:16	JJY	EPA 8015C
SURR: Octacosane	67	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 13:16	JJY	EPA 8015C
Surr: Triacontane	59	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 13:16	JJY	EPA 8015C

CT LAB#: 428380 Sample Description: BBSD-10B Client Sample #: Sampled: 06/04/2020 1500

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***420***	ug/L	42	130	260	260	1.00		06/11/2020 13:00	6/12/20 13:44	JJY	EPA 8015C
SURR: Octacosane	72	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 13:44	JJY	EPA 8015C
Surr: Triacontane	64	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 13:44	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 428381 Sample Description: BBSD-07B Client Sample #: Sampled: 06/05/2020 1144

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***520***	ug/L	87	260	530	530	1.00	J	06/11/2020 13:00	6/12/20 14:12	JJY	EPA 8015C
SURR: Octacosane	83	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 14:12	JJY	EPA 8015C
Surr: Triacontane	74	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 14:12	JJY	EPA 8015C

CT LAB#: 428382 Sample Description: BBSD-09B Client Sample #: Sampled: 06/09/2020 0920

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***290***	ug/L	61	190	370	370	1.00	J	06/11/2020 13:00	6/12/20 14:40	JJY	EPA 8015C
SURR: Octacosane	82	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 14:40	JJY	EPA 8015C
Surr: Triacontane	75	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 14:40	JJY	EPA 8015C

CT LAB#: 428383 Sample Description: BBSD-11A Client Sample #: Sampled: 06/04/2020 1235

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***90.0***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	***96.9***	mg/kg	5.5	17	44	44	1.00		06/16/2020 10:30	6/16/20 21:15	JJY	EPA 8015C
SURR: Octacosane	66	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 21:15	JJY	EPA 8015C
Surr: Triacontane	56	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 21:15	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 428384 Sample Description: BBSD-10A Client Sample #: Sampled: 06/04/2020 1408

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***79.8***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	***7.24***	mg/kg	6.3	19	50	50	1.00	J	06/16/2020 10:30	6/16/20 21:43	JJY	EPA 8015C
SURR: Octacosane	54	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 21:43	JJY	EPA 8015C
Surr: Triacontane	46	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 21:43	JJY	EPA 8015C

CT LAB#: 428385 Sample Description: BBSD-XXA Client Sample #: Sampled: 06/05/2020 1345

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***83.5***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	<18	mg/kg	5.8	18	47	47	1.00	U	06/16/2020 10:30	6/16/20 22:39	JJY	EPA 8015C
SURR: Octacosane	68	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 22:39	JJY	EPA 8015C
Surr: Triacontane	58	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 22:39	JJY	EPA 8015C

CT LAB#: 428386 Sample Description: BBSD-08A Client Sample #: Sampled: 06/05/2020 1345

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***83.7***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 428386 Sample Description: BBSD-08A Client Sample #: Sampled: 06/05/2020 1345

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	<18	mg/kg	5.8	18	47	47	1.00	U	06/16/2020 10:30	6/16/20 23:06	JJY	EPA 8015C
SURR: Octacosane	65	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 23:06	JJY	EPA 8015C
Surr: Triacontane	56	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 23:06	JJY	EPA 8015C

CT LAB#: 428387 Sample Description: BBSD-09A Client Sample #: Sampled: 06/05/2020 0821

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***80.8***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												
Diesel Range Organics	***7.50***	mg/kg	6.2	19	49	49	1.00	J	06/16/2020 10:30	6/16/20 23:34	JJY	EPA 8015C
SURR: Octacosane	49	% Recovery	44			125	1.00		06/16/2020 10:30	6/16/20 23:34	JJY	EPA 8015C
Surr: Triacontane	40	% Recovery	35			136	1.00		06/16/2020 10:30	6/16/20 23:34	JJY	EPA 8015C

CT LAB#: 428388 Sample Description: BBSD-07A Client Sample #: Sampled: 06/05/2020 1018

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***79.7***	%	0.1	0.1	0.1	0.1	1.00			6/15/20 13:57	BMM	EPA 8000C
Organic Results												

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 428388 Sample Description: BBSD-07A Client Sample #: Sampled: 06/05/2020 1018

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Diesel Range Organics	<19	mg/kg	6.2	19	50	50	1.00	U	06/16/2020 10:30	6/17/20 00:02	JJY	EPA 8015C
SURR: Octacosane	53	% Recovery	44			125	1.00		06/16/2020 10:30	6/17/20 00:02	JJY	EPA 8015C
Surr: Triacontane	45	% Recovery	35			136	1.00		06/16/2020 10:30	6/17/20 00:02	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

Notes:

^ Indicates the laboratory is NELAP accredited for this analyte by the indicated matrix and method. DL (detection limit), LOD (limit of detection), loq (limit of quantitation) as defined by most recent DOD QSM version.

All samples were received intact and properly preserved unless otherwise noted. The results reported relate only to the samples tested. This report shall not be reproduced, except in full, without written approval of this laboratory. The Chain of Custody is attached.

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for the parameters where accreditation is required or available, unless noted in the case narrative.

Submitted by: Brett M. Szymanski
Project Manager
608-356-2760

QC Qualifiers

Code	Description
B	Analyte detected in the associated Method Blank.
C	Toxicity present in BOD sample.
D	Diluted Out.
E	Safe, No Total Coliform detected.
F	Unsafe, Total Coliform detected, no E. Coli detected.
G	Unsafe, Total Coliform detected and E. Coli detected.
H	Holding time exceeded.
I	Incubator temperature was outside acceptance limits during test period.
J	Estimated value.
L	Significant peaks were detected outside the chromatographic window.
M	Matrix spike and/or Matrix Spike Duplicate recovery outside acceptance limits.
N	Insufficient BOD oxygen depletion.
O	Complete BOD oxygen depletion.
P	Concentration of analyte differs more than 40% between primary and confirmation analysis.
Q	Laboratory Control Sample outside acceptance limits.
R	See Narrative at end of report.
S	Surrogate standard recovery outside acceptance limits due to apparent matrix effects.
T	Sample received with improper preservation or temperature.
U	Analyte concentration was below detection limit.
V	Raised Quantitation or Reporting Limit due to limited sample amount or dilution for matrix background interference.
W	Sample amount received was below program minimum.
X	Analyte exceeded calibration range.
Y	Replicate/Duplicate precision outside acceptance limits.
Z	Specified calibration criteria was not met.

Current CT Laboratories Certifications

Wisconsin (WDNR) Chemistry ID# 157066030
Wisconsin (DATCP) Bacteriology ID# 289
Louisiana NELAP (primary) ID# ACC20190002
Illinois NELAP Lab ID# 200073
Kansas NELAP Lab ID# E-10368
Virginia NELAP Lab ID# 460203
ISO/IEC 17025-2005 A2LA Cert # 3806.01
DoD-ELAP A2LA 3806.01
GA EPD Stipulation ID ACC20190002

CT LABORATORIES
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1230 Lange Court • Baraboo, WI 53913 • 608-356-2760
www.ctlaboratories.com

QC SUMMARY REPORT

USACE - OMAHA

Project Name: BIG BEND DAM TOE DRAIN REPLACEMENT

SDG #: 0 **Folder #: 153810** **Project #:**

Lab Control Spike Water

Analytical Run #:	172130	Analysis Date:	06/12/2020	Prep Batch #:	76788	Matrix:	LIQUID
CTLab #:	429624	Analysis Time:	12:48	Prep Date/Time:	06/11/2020 13:00	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	2060	ug/L			2500	82	36 --- 132		30

Method Blank Water

Analytical Run #:	172130	Analysis Date:	06/12/2020	Prep Batch #:	76788	Matrix:	LIQUID
CTLab #:	429623	Analysis Time:	12:20	Prep Date/Time:	06/11/2020 13:00	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	33	ug/L		U	0		100		

Lab Control Spike Soil

Analytical Run #:	172235	Analysis Date:	06/16/2020	Prep Batch #:	76752	Matrix:	SOLID
CTLab #:	428336	Analysis Time:	18:27	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	192	mg/kg			250	77	38 --- 132		30

Method Blank Soil

Analytical Run #:	172235	Analysis Date:	06/16/2020	Prep Batch #:	76752	Matrix:	SOLID
CTLab #:	428335	Analysis Time:	17:59	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	5	mg/kg		U	0		20		

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Sample Condition Report

Folder #: 153810
Client: USACE - OMAHA

Print Date / Time: 06/08/2020 08:59
Received Date / Time / By: 06/06/2020 10:30 JLS

Project Name: BIG BEND DAM TOE DRAIN REPLACEM
Project Phase: FORT THOMPSON, SD

Log-In Date / Time / By: 06/08/2020 08:58 EKB
Project #: PM: BMS

Coolers: 5425
Custody Seals Present : **Y**

Temperature: 3.0 C On Ice: **Y**
COC Present:? **Y** Complete? **Y**

Seal Intact? **Y**
Ship Method: FEDEX EXPRESS
Adequate Packaging: **Y**

Numbers: DATED AND SIGNED
Tracking Number: 806531978884
Temp Blank Enclosed? **Y**

Notes: THE SAMPLES WERE RECEIVED IN GOOD CONDITION ON ICE.

TWO CUSTODY SEALS WERE PRESENT AND INTACT UPON RECEIPT - BOTH WERE DATED 6/5/20 AND SIGNED.

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
428379 BBSD-11B	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
428380 BBSD-10B	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
428381 BBSD-07B	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
428382 BBSD-09B	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
428383 BBSD-11A	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
428384 BBSD-10A	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
428385 BBSD-XXA				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
428386 BBSD-08A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
428387 BBSD-09A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
428388 BBSD-07A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			

Condition Code	*Condition Description*
1	Sample Received OK

Rev. 02/2017

CHAIN OF CUSTODY

Page _____ of _____

Company: USACE - Omaha
Project Contact: Tom Weirauch
Telephone: 402 995 2289
Project Name: Big Bend Dam Toe Drain Replacement
Project #:
Location: Big Bend Dam SD
Sampled By: George Filpovik

CT LABORATORIES
1230 Lange Court, Baraboo, WI 53913
608-356-2760 Fax 608-356-2766
www.ctlaboratories.com

Folder # 153810
Company: USACE - OMAHA
Project: BIG BEND DAM TO DRA
Logged By: EKB PM: BM

Program:
QSM RCRA SDWA NPDES
Solid Waste Other _____

PO #

Report To: thomas.g.weirauch@
EMAIL: usace.army.mil
Company: USACE - Omaha District
Address: 1616 Capitol Ave, Omaha NE 68102

Invoice To:*
EMAIL:
Company: Same as above
Address:

*Party listed is responsible for payment of invoice as per CT Laboratories' terms and conditions

Client Special Instructions

Matrix:
GW – groundwater SW - surface water WW - wastewater DW - drinking water
S - soil/sediment SL - sludge A - air M - misc/waste

Turnaround Time
(Normal) RUSH*
Date Needed: _____
Rush analysis requires prior CT Laboratories' approval
Surcharges:
24 hr 200%
2-3 days 100%
4-9 days 50%

Collection Date	Collection Time	Matrix	Grab/ Comp	Sample #	Sample ID Description	Filtered? Y/N	ANALYSES REQUESTED: TPH DRO	Total # Containers	Designated MS/MSD	CT Lab ID # (Lab use only)
							Fill in Spaces with Bottles per Test			
6/4/20	1323	GW	G	1	BBSD-11B	N	1			428379
6/4/20	1500	GW	G	1	BBSD-10B	N	1			428380
6/5/20	1144	GW	G	1	BBSD-07B	N	1			428381
6/5/20	0920	GW	G	1	BBSD-09B	N	1			428382
6/4/20	1235	S	G	1	BBSD-11A		1			428383
6/4/20	1409	S	G	1	BBSD-10A		1			428384
6/5/20	1345	S	G	1	BBSD-XXA		1			428385
6/5/20	1345	S	G	1	BBSD-08A		1			428386
6/5/20	0821	S	G	1	BBSD-09A		1			428387
6/5/20	1018	S	G	1	BBSD-07A		1			428388

Relinquished By:	Date/Time	Received By:	Date/Time
[signature]	6/5/20 1455	[signature]	6/8/2020 1030
Received by:	Date/Time	Received for Laboratory by:	Date/Time
		[signature]	6-8-2020 0858

Lab Use Only
Ice Present (Yes) No
Temp 3.0 IR Gun 24
Cooler # 5425

CT Laboratories Terms and Conditions

Where a purchaser (Client) places an order for laboratory, consulting or sampling services from CT Laboratories (CTL), CTL shall provide the ordered services pursuant to these Terms and Conditions, and the related Quotation, or as agreed in a negotiated contract. In the absence of a written agreement to the contrary, the Order constitutes an acceptance by the Client of CTL's offer to do business under these Terms and Conditions, and an agreement to be bound by these Terms and Conditions. No contrary or additional terms and conditions expressed in a Client's document shall be deemed to become a part of the contract created upon acceptance of these Terms and Conditions, unless accepted by CTL in advance of the start of the project and in writing.

1. ORDERS AND RECEIPT OF SAMPLES (Sample Acceptance Policy)

1.1 The Client may place the Order (i.e., specify a Scope of Work) either by submitting a purchase order to CTL in writing, by telephone (confirmed in writing) or by negotiated contract. Whichever option the Client selects for placing the Order, the Order shall not be valid unless it contains sufficient information to enable CTL to carry out the Client's requirements. It is the policy of CTL that samples not meeting the acceptance criteria, outlined in the NELAC standards and Section 5.8.3.2 of the DOD QSM, will not be accepted by the laboratory or will be qualified on the final report. All samples submitted to the laboratory must: (a) be accompanied by proper, full and complete documentation, including sample identification, location, date and time of collection, the collector's name, type of preservation (if any), type of sample, any special comments concerning the sample and any additional pertinent fields on the chain-of-custody. In the absence of any of the required information, the laboratory will attempt to contact the client to obtain the information; if unable to obtain the necessary information, the final report will be qualified.
(b) samples must be labeled appropriately with a unique sample identification written with indelible ink on water resistant labels. If the laboratory cannot determine the identity of a sample, it may be rejected and the client will be contacted for further instructions or resampling. (c) samples must be in an appropriate sample container. If the container is inappropriate, the client will be contacted for further instructions or resampling. If analysis is possible, the final report will be qualified. CTL can provide a sampling guide containing approved containers and preservations for analytical methods requested. (d) adhere to method specified holding times. If samples are received with less than ½ the holding time remaining for the requested test, CTL will make its best effort to analyze the samples and notify the client. If holding times are exceeded, the final report will be qualified. (e) contain adequate sample volume to perform the necessary testing. If sufficient volume is not present, the sample may be rejected and the client will be contacted for further instructions or resampling. If samples show signs of damage, contamination or inadequate preservation, the client will be notified. If analysis can be performed, the final report will be qualified. If not, the samples will be rejected and the client notified for further instructions or resampling. It is the Client's responsibility to understand and package samples correctly and provide the proper amount of temperature control (ice) suitable to current weather conditions.
1.2 CTL must be supplied with complete written disclosure of the known or suspected presence of any hazardous substances, as defined by applicable federal or state law. Where any samples which were not accompanied by the required disclosure, cause interruptions in the lab's ability to process work due to contamination of instruments or work areas, the Client will be responsible for the costs of clean up and recovery.
1.3 Prior to Sample Acceptance, the entire risk of loss or damage to samples remains with the Client. In no event will CTL have any responsibility or liability for the action or inaction of any carrier shipping or delivering any sample to or from CTL's premises. Client is responsible to assure that any sample containing any hazardous substance which is to be delivered to CTL's premises will be packaged, labeled, transported and delivered properly and in accordance with applicable laws.
1.4 Clients using CTL's shipping account(s) do so at their own risk and must purchase separate insurance if they do not wish to assume risk of loss. CTL will not assume any risk whatsoever for any samples outside of CTL's control and not successfully delivered to the laboratory within specified hold times.
1.5 CTL will not accept liability for any sample(s), except sample(s) damaged or broken by log-in staff prior to successful log-in of the sample(s) into the CTL- LIMS system. This includes, but may not be limited to: complete, valid COC documentation; all sample receiving issues being resolved from a delay caused by the Client in CTL's ability to log-in samples, including missed turnaround and hold times, delay in processing and, ultimately, additional charges to the Client.
1.6 CTL will only reject samples per directions from the Client. CTL's sole liability is to inform the Client of any sample receipt issues, and may provide an indication how proceeding with the analysis may affect results and final acceptance by the regulating agency. Ultimately, suitability for use is between the Client and the regulating agency(s).
1.7 Signing of this COC by the Client or Client's representative, or directions to CTL via email or Fax constitutes acceptance of these Terms and Conditions, and guarantees payment by the Client to CTL.

2. PAYMENT TERMS

2.1 Services performed by CTL will be in accordance with prices quoted and later confirmed in writing or as stated in the Price Schedule. Invoices may be submitted to Client upon completion of any sample delivery group. Payment in advance is required for all Clients except those whose credit has been established with CTL. For Clients with approved credit, payment terms are net 30 days from the date of invoice by CTL. All overdue payments are subject to an additional interest and service charge of one and one-half percent (1.5%) or the maximum rate permissible by law, per month or portion thereof from the due date until the date of payment. All fees are charged or billed directly to the Client. The billing of a third party will not be accepted without a statement, signed by the third party that acknowledges and accepts payment responsibility. CTL may suspend work and withhold delivery of data under this order at any time in the event Client fails to make timely payment of its invoices. Client shall be responsible for all costs and expenses of collection including reasonable attorney's fees. CTL reserves the right to refuse to proceed with work at any time based upon an unfavorable Client credit report.

3. CHANGE ORDERS, TERMINATION

3.1 Changes to the Scope of Work, price, or result delivery date may be initiated by CTL after Sample Acceptance due to any condition which conflicts with analytical, QA or other protocols warranted in these Terms and Conditions. CTL will not proceed with such changes until an agreement with the Client is reached on the amount of any cost, schedule change or technical change to the Scope of Work, and such agreement is documented in writing.
3.2 Changes to the Scope of Work, including but not limited to increasing or decreasing the work, changing test and analysis specification or acceleration in the performance of the work may be initiated by the Client after sample acceptance. Such a change will be documented in writing and may result in a change in cost and turnaround time commitment. CTL's acceptance of such changes is contingent upon technical feasibility and operational capacity.
3.3 Suspension or termination of all or any part of the work may be initiated by the Client. CTL will be compensated consistent with Section 2 of these Terms and Conditions. CTL will complete all work in progress and be paid in full for all work completed.

4. WARRANTIES AND LIABILITY

4.1 Where applicable, CTL will use analytical methodologies which are in substantial conformity with published test methods. CTL has implemented these methods in its Laboratory Quality Manuals and referenced Standard Operating Procedures and where the nature or composition of the sample requires it, CTL reserves the right to deviate from these methodologies as necessary or appropriate, based on the reasonable judgment of CTL, which deviations, if any, will be made on a basis consistent with recognized standards of the industry and/or CTL's Laboratory Quality Manuals. Client may request that CTL perform according to a mutually agreed Quality Assurance Project Plan (QAPP). In the event that samples arrive prior to agreement on a QAPP, CTL will proceed with analyses under its standard Quality Manuals then in effect, and CTL will not be responsible for any resampling or other charges if work must be repeated to comply with a subsequently finalized QAPP.
4.2 CTL shall start preparation and/or analysis within holding times provided that Sample Acceptance occurs within 48 hours of sampling or 1/2 of the holding time for the test, whichever is less. Samples received that do not meet this provision will be charged as expedited samples and the appropriate rate will be added accordingly. Where resolution of inconsistencies leading to Sample Acceptance does not occur within this period, CTL will use its best efforts to meet holding times and will proceed with the work provided that, in CTL's judgment, the chain-of-custody or definition of the Scope of Work provide sufficient guidance. Reanalysis of samples to comply with CTL's Quality Manuals will be deemed to have met holding times provided the initial analysis was performed within the applicable holding time. Where reanalysis demonstrates that sample matrix interference is the cause of failure to meet any Quality Manual requirements, the warranty will be deemed to have been met.
4.3 CTL warrants that it possesses and maintains all licenses and certifications which are required to perform services under these Terms and Conditions provided that such requirements are specified in writing to CTL prior to Sample Acceptance. CTL will notify the Client in writing of any decertification or revocation of any license, or notice of either, which affects work in progress.
4.4 The warranty obligations set forth in Sections 4.1, 4.2 and 4.3 are the sole and exclusive warranties given by CTL in connection with any services performed by CTL or any Results generated from such services, and CTL gives and makes NO OTHER REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. No representative of CTL is authorized to give or make any other representation or warranty or modify this warranty in any way.
4.5 Client's sole and exclusive remedy for the breach of warranty in connection with any services performed by CTL, will be limited to repeating any services performed, contingent on the Client's providing, at the request of CTL and at the Client's expense, additional sample(s) if necessary. Any reanalysis requested by the Client generating Results consistent with the original Results will be at the Client's expense. If resampling is necessary, CTL's liability for resampling costs will be limited to actual cost or one hundred or one hundred fifty dollars ($150) per sample, whichever is less.
4.6 CTL's liability for any and all causes of action arising hereunder, whether based in contract, tort, warranty, negligence or otherwise, shall be limited to the lesser amount of compensation for the services performed or $100,000. All claims, including those for negligence, shall be deemed waived unless suit thereon is filed within one year after CTL's completion of the services. Under no circumstances, whether arising in contract, tort (including negligence), or otherwise, shall CTL be responsible for loss of use, loss of profits, or for any special, indirect, incidental or consequential damages occasioned by the services performed or by application or use of the reports prepared.
4.7 In no event shall CTL have any responsibility or liability to the Client for any failure or delay in performance by CTL which results, directly or indirectly, in whole or in part, from any cause or circumstance beyond the reasonable control of CTL. Such causes and circumstances shall include, but not be limited to, acts of God, acts of Client, acts or orders of any governmental authority, strikes or other labor disputes, natural disasters, accidents, wars, civil disturbances, equipment breakdown, matrix interference or unknown highly contaminated samples that impact instrument operation, unavailability of supplies from usual suppliers, difficulties or delays in transportation, mail or delivery services, or any other cause beyond CTL's reasonable control.

5. RESULTS, WORK PRODUCT

5.1 Data or information provided to CTL or generated by services performed under this agreement shall only become the property of the Client upon receipt in full by CTL of payment for the whole Order. Ownership of any analytical method, QA/QC protocols, software programs or equipment developed by CTL for performance of work will be retained by CTL, and Client shall not disclose such information to any third party.
5.2 Data and sample materials provided by Client or at Client's request, and the result obtained by CTL shall be held in confidence (unless such information is generally available to the public or is in the public domain or Client has failed to pay CTL for all services rendered or is otherwise in breach of these Terms and Conditions), subject to any disclosure required by law or legal process.
5.3 Should the Results delivered by CTL be used by the Client or Client's client, even though subsequently determined not to meet the warranties described in these Terms and Conditions, then the compensation will be adjusted based upon mutual agreement. In no case shall the Client unreasonably withhold CTL's right to independently defend its data.
5.4 CTL reserves the right to subcontract services ordered by the Client to another laboratory or laboratories, if, in CTL's sole judgment, it is reasonably necessary, appropriate or advisable to do so, and with the Client's permission. CTL will in no way be liable for any subcontracted services and all applicable warranties, guarantees and insurance are those of the subcontracted laboratory.
5.5 CTL shall dispose of the Client's samples and extracts 30 days after the analytical report is issued, unless instructed to store them for an alternate period of time or to return such samples to the Client, in a manner consistent with U.S. Environmental Protection Agency regulations or other applicable Federal, state or local requirements. Additional charges will apply for samples or extracts stored longer than 30 days at the Clients request. Any samples for projects that are canceled or not accepted, or for which return was requested, will be returned to the Client at Client expense. CTL reserves the right to return to the Client any sample or unused portion of a sample that is not within CTL's permitted capability or the capabilities of CTL's designated waste disposal vendor(s), or will make arrangements to dispose of these samples at Client direction and expense.
5.6 Unless a different time period is agreed to in any order under these Terms and Conditions, CTL agrees to retain all records for five (5) years.
5.7 In the event that CTL is required to respond to legal process related to services for Client, Client agrees to reimburse CTL for hourly charges for personnel involved in the response and attorney fees reasonably incurred in obtaining advice concerning the response, preparation to testify, and appearances related to the legal process, travel and all reasonable expenses associated with the litigation.

6. INSURANCE

6.1 CTL shall maintain in force during the performance of services under these Terms and Conditions, Workers' Compensation and Employer's Liability Insurance in accordance with the laws of the states having jurisdiction over CTL's employees who are engaged in the performance of the work. CTL shall also maintain during such period, Comprehensive General and Contractual Liability (limit of $2,000,000 per occurrence/ aggregate), Comprehensive Automobile Liability, owned and hired, ($1,000,000 combined single limit), and Professional/Pollution Liability Insurance (limit of $5,000,000 per occurrence/aggregate). Any Client required changes to these limits or conditions will result in a change in cost to the Client.

7. AUDIT

7.1 Upon prior notice to CTL, the Client may audit and inspect CTL's records and accounts covering reimbursable costs related to work done for the Client, for a period of one (1) year after completion of the work. The purpose of any such audit shall be only for verification of such costs, and CTL shall not be required to provide access to cost records where prices are expressed as fixed fees or published unit prices.


FedEx Express
Package US Airbill
FedEx Tracking Number
8065 3197 8884
Form No. 0215
Recipient's Copy
1 From
Date
Sender's Name
Phone
Company
Address
Dept./Floor/Suite/Room
City
State
ZIP
2 Your Internal Billing Reference
3 To
Recipient's Name
Phone
Company
Address
We cannot deliver to P.O. boxes or P.O. ZIP codes.
Dept./Floor/Suite/Room
Address
Use this line for the HOLD location address or for continuation of your shipping address.
City
State
ZIP
HOLD Weekday
FedEx location address REQUIRED. NOT available for FedEx First Overnight.
HOLD Saturday
FedEx location address REQUIRED. Available ONLY for FedEx Priority Overnight and FedEx 2Day to select locations.
4 Express Package Service
* To most locations.
NOTE: Service order has changed. Please select carefully.
Packages up to 150 lbs
For packages over 150 lbs., use the FedEx Express Freight US Airbill
Next Business Day
FedEx First Overnight
Earliest next business morning delivery to select locations. Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
FedEx Priority Overnight
Next business morning.* Friday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
FedEx Standard Overnight
Next business afternoon.* Saturday Delivery NOT available.
2 or 3 Business Days
FedEx 2Day A.M.
Second business morning.* Saturday Delivery NOT available.
FedEx 2Day
Second business afternoon.* Thursday shipments will be delivered on Monday unless SATURDAY Delivery is selected.
FedEx Express Saver
Third business day.* Saturday Delivery NOT available.
5 Packaging
* Declared value limit $500.
FedEx Envelope*
FedEx Pak*
FedEx Box
FedEx Tube
Other
6 Special Handling and Delivery Signature Options
SATURDAY Delivery
NOT available for FedEx Standard Overnight, FedEx 2Day A.M., or FedEx Express Saver
No Signature Required
Package may be left without obtaining a signature for delivery.
Direct Signature
Someone at recipient's address may sign for delivery. Fee applies.
Indirect Signature
If no one is available at recipient's address, someone at a neighboring address may sign for delivery. For residential deliveries only. Fee applies.
Does this shipment contain dangerous goods?
One box must be checked.
No
Yes
As per attached Shipper's Declaration
Yes
Shipper's Declaration not required
Dry Ice
Dry Ice, 9, UN 1845
x kg
Cargo Aircraft Only
Dangerous goods (including dry ice) cannot be shipped in FedEx packaging or placed in a FedEx Express Drop Box.
7 Payment
Bill to:
Enter FedEx Acct. No. or Credit Card No. below.
Sender
Acct. No. in Section 1 will be billed.
Recipient
Third Party
Total Packages
Total Weight
lbs.
to US$100 unless you declare a higher value. See the current
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FedEx Express
SATURDAY 12:00P
PRIORITY OVERNIGHT
AHS
53913
WI-US MSN
TRK# 8065 3197 8884
0215
XO LNRA
DEPT:
PO:
FedEx Saturday Delivery
SDR
RT 909
B97
12:00
8884

Cooler Receipt Form

Ice Present (YES) NO

Temperature 3.0

IR Gun # 24

Initials jes

Date 6/6/2020 Time 1030

Cooler #: 5425

CUSTODY SEAL
DATE 6/5/20
SIGNATURE

QEC
Quality Environmental Containe
800-255-3

CUSTODY SEAL
DATE 6/5/20
SIGNATURE

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Quality Environmental Containers
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www.ctlaboratories.com

ANALYTICAL SUMMARY REPORT

This report at a minimum contains the following information:

Analytical Report of Test Results
Description of QC Qualifiers
Chain of Custody (copy)
Quality Control Summary (if applicable)
Case Narrative (if applicable)
Correspondence with Client (if applicable)

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for parameters where accreditation is required or available, unless otherwise noted in the case narrative.

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

ANALYTICAL SAMPLE DATA

USACE - OMAHA
TOM WEIRAUCH
1616 CAPITOL AVE
SUITE 9000
OMAHA, NE 68102-9000

Project Name: BIG BEND DAM TOE DRAIN REPLACEMENT
Project Phase: FORT THOMPSON, SD
Project #:
Folder #: 153902
Purchase Order #:
Contract #: 3357

Arrival Temperature: 3.8
Report Date: 06/23/2020
Date Received: 06/10/2020
Reprint Date: 06/23/2020

CT LAB#: 429900 Sample Description: BBSD-06A Client Sample #: Sampled: 06/08/2020 0902

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***78.2***	%	0.1	0.1	0.1	0.1	1.00			6/22/20 16:10	BMS	EPA 8000C
Organic Results												
Diesel Range Organics	<19	mg/kg	6.3	19	50	50	1.00	U	06/16/2020 10:30	6/17/20 00:30	JJY	EPA 8015C
SURR: Octacosane	51	% Recovery	44			125	1.00		06/16/2020 10:30	6/17/20 00:30	JJY	EPA 8015C
Surr: Triacontane	43	% Recovery	35			136	1.00		06/16/2020 10:30	6/17/20 00:30	JJY	EPA 8015C

CT LAB#: 429901 Sample Description: BBSD-08B Client Sample #: Sampled: 06/08/2020 0818

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***74***	ug/L	34	100	200	200	1.00	J	06/11/2020 13:00	6/12/20 15:35	JJY	EPA 8015C
SURR: Octacosane	76	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 15:35	JJY	EPA 8015C
Surr: Triacontane	67	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 15:35	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 429902 Sample Description: BBSD-XXB Client Sample #: Sampled: 06/08/2020 0818

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***67***	ug/L	34	100	210	210	1.00	J	06/11/2020 13:00	6/12/20 16:03	JJY	EPA 8015C
SURR: Octacosane	53	% Recovery	60			142	1.00	S	06/11/2020 13:00	6/12/20 16:03	JJY	EPA 8015C
Surr: Triacontane	35	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 16:03	JJY	EPA 8015C

CT LAB#: 429903 Sample Description: BBSD-06B Client Sample #: Sampled: 06/08/2020 1017

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***260***	ug/L	94	290	570	570	1.00	J	06/11/2020 13:00	6/12/20 16:31	JJY	EPA 8015C
SURR: Octacosane	99	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 16:31	JJY	EPA 8015C
Surr: Triacontane	120	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 16:31	JJY	EPA 8015C

CT LAB#: 429904 Sample Description: BBSD-05A Client Sample #: Sampled: 06/08/2020 1112

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***79.8***	%	0.1	0.1	0.1	0.1	1.00			6/22/20 16:10	BMS	EPA 8000C
Organic Results												
Diesel Range Organics	<18	mg/kg	6.1	18	49	49	1.00	U	06/16/2020 10:30	6/17/20 01:25	JJY	EPA 8015C
SURR: Octacosane	57	% Recovery	44			125	1.00		06/16/2020 10:30	6/17/20 01:25	JJY	EPA 8015C
Surr: Triacontane	47	% Recovery	35			136	1.00		06/16/2020 10:30	6/17/20 01:25	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

CT LAB#: 429905 Sample Description: BBSD-05B Client Sample #: Sampled: 06/08/2020 1235

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***1200***	ug/L	75	230	450	450	1.00		06/11/2020 13:00	6/12/20 17:27	JJY	EPA 8015C
SURR: Octacosane	88	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 17:27	JJY	EPA 8015C
Surr: Triacontane	80	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 17:27	JJY	EPA 8015C

CT LAB#: 429906 Sample Description: BBSD-04A Client Sample #: Sampled: 06/08/2020 1342

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	***85.1***	%	0.1	0.1	0.1	0.1	1.00			6/22/20 16:10	BMS	EPA 8000C
Organic Results												
Diesel Range Organics	<18	mg/kg	5.9	18	47	47	1.00	U	06/16/2020 10:30	6/17/20 00:58	JJY	EPA 8015C
SURR: Octacosane	54	% Recovery	44			125	1.00		06/16/2020 10:30	6/17/20 00:58	JJY	EPA 8015C
Surr: Triacontane	44	% Recovery	35			136	1.00		06/16/2020 10:30	6/17/20 00:58	JJY	EPA 8015C

CT LAB#: 429907 Sample Description: BBSD-04B Client Sample #: Sampled: 06/08/2020 1450

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Organic Results												
Diesel Range Organics	***200***	ug/L	80	240	490	490	1.00	J	06/11/2020 13:00	6/12/20 16:59	JJY	EPA 8015C
SURR: Octacosane	120	% Recovery	60			142	1.00		06/11/2020 13:00	6/12/20 16:59	JJY	EPA 8015C
Surr: Triacontane	120	% Recovery	29			140	1.00		06/11/2020 13:00	6/12/20 16:59	JJY	EPA 8015C

Unless specifically stated to the contrary, soil/sediment/sludge sample results reported on a Dry Weight Basis

Notes:

^ Indicates the laboratory is NELAP accredited for this analyte by the indicated matrix and method. DL (detection limit), LOD (limit of detection), loq (limit of quantitation) as defined by most recent DOD QSM version.

All samples were received intact and properly preserved unless otherwise noted. The results reported relate only to the samples tested. This report shall not be reproduced, except in full, without written approval of this laboratory. The Chain of Custody is attached.

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for the parameters where accreditation is required or available, unless noted in the case narrative.

Submitted by: Brett M. Szymanski
Project Manager
608-356-2760

QC Qualifiers

Code	Description
B	Analyte detected in the associated Method Blank.
C	Toxicity present in BOD sample.
D	Diluted Out.
E	Safe, No Total Coliform detected.
F	Unsafe, Total Coliform detected, no E. Coli detected.
G	Unsafe, Total Coliform detected and E. Coli detected.
H	Holding time exceeded.
I	Incubator temperature was outside acceptance limits during test period.
J	Estimated value.
L	Significant peaks were detected outside the chromatographic window.
M	Matrix spike and/or Matrix Spike Duplicate recovery outside acceptance limits.
N	Insufficient BOD oxygen depletion.
O	Complete BOD oxygen depletion.
P	Concentration of analyte differs more than 40% between primary and confirmation analysis.
Q	Laboratory Control Sample outside acceptance limits.
R	See Narrative at end of report.
S	Surrogate standard recovery outside acceptance limits due to apparent matrix effects.
T	Sample received with improper preservation or temperature.
U	Analyte concentration was below detection limit.
V	Raised Quantitation or Reporting Limit due to limited sample amount or dilution for matrix background interference.
W	Sample amount received was below program minimum.
X	Analyte exceeded calibration range.
Y	Replicate/Duplicate precision outside acceptance limits.
Z	Specified calibration criteria was not met.

Current CT Laboratories Certifications

Wisconsin (WDNR) Chemistry ID# 157066030
Wisconsin (DATCP) Bacteriology ID# 289
Louisiana NELAP (primary) ID# ACC20190002
Illinois NELAP Lab ID# 200073
Kansas NELAP Lab ID# E-10368
Virginia NELAP Lab ID# 460203
ISO/IEC 17025-2005 A2LA Cert # 3806.01
DoD-ELAP A2LA 3806.01
GA EPD Stipulation ID ACC20190002

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QC SUMMARY REPORT

USACE - OMAHA

Project Name: BIG BEND DAM TOE DRAIN REPLACEMENT

SDG #: 0 **Folder #: 153902** **Project #:**

Duplicate

Analytical Run #:	172222	Analysis Date:	06/22/2020	Prep Batch #:		Matrix:	SOIL
CTLab #:	436059	Analysis Time:	16:10	Prep Date/Time:		Method:	SW8000C
Parent Sample #:	429904	Analyst:	BMS	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Solids, Percent	79.4	%	79.8					1	8

Lab Control Spike Water

Analytical Run #:	172130	Analysis Date:	06/12/2020	Prep Batch #:	76788	Matrix:	LIQUID
CTLab #:	429624	Analysis Time:	12:48	Prep Date/Time:	06/11/2020 13:00	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	2060	ug/L			2500	82	36 --- 132		30

Method Blank Water

Analytical Run #:	172130	Analysis Date:	06/12/2020	Prep Batch #:	76788	Matrix:	LIQUID
CTLab #:	429623	Analysis Time:	12:20	Prep Date/Time:	06/11/2020 13:00	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	33	ug/L		U	0		100		

Matrix Spike Duplicate Water

Analytical Run #:	172130	Analysis Date:	06/12/2020	Prep Batch #:	76788	Matrix:	GROUND WATER
CTLab #:	430508	Analysis Time:	18:23	Prep Date/Time:	06/11/2020 13:00	Method:	SW8015
Parent Sample #:	430506	Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	3860	ug/L	1200		3680	72	36 --- 132	2	30
SURR: Octacosane	96.0	% Recovery			100	96.0	60 --- 142		
Surr: Triacontane	91.5	% Recovery			100	91.5	29 --- 140		

Matrix Spike Water

Analytical Run #:	172130	Analysis Date:	06/12/2020	Prep Batch #:	76788	Matrix:	GROUND WATER
CTLab #:	430506	Analysis Time:	17:55	Prep Date/Time:	06/11/2020 13:00	Method:	SW8015
Parent Sample #:	429905	Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	3890	ug/L	1200		3620	74	36 --- 132		
SURR: Octacosane	80.7	% Recovery			100	80.7	60 --- 142		
Surr: Triacontane	66.1	% Recovery			100	66.1	29 --- 140		

Lab Control Spike Soil

Analytical Run #:	172235	Analysis Date:	06/16/2020	Prep Batch #:	76752	Matrix:	SOLID
CTLab #:	428336	Analysis Time:	18:27	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	192	mg/kg			250	77	38 --- 132		30

Method Blank Soil

Analytical Run #:	172235	Analysis Date:	06/16/2020	Prep Batch #:	76752	Matrix:	SOLID
CTLab #:	428335	Analysis Time:	17:59	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:		Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	5	mg/kg		U	0		20		

Matrix Spike Duplicate Soil

Analytical Run #:	172235	Analysis Date:	06/17/2020	Prep Batch #:	76752	Matrix:	SOIL
CTLab #:	431750	Analysis Time:	02:21	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:	431749	Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	209	mg/kg	BDL		310	67	38 --- 132	5	30
SURR: Octacosane	61.4	% Recovery			100	61.4	44 --- 125		
Surr: Triacontane	50.2	% Recovery			100	50.2	35 --- 136		

Matrix Spike Soil

Analytical Run #:	172235	Analysis Date:	06/17/2020	Prep Batch #:	76752	Matrix:	SOIL
CTLab #:	431749	Analysis Time:	01:53	Prep Date/Time:	06/16/2020 10:30	Method:	SW8015
Parent Sample #:	429904	Analyst:	JJY	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Diesel Range Organics	224	mg/kg	BDL		315	71	38 --- 132		
SURR: Octacosane	65.3	% Recovery			100	65.3	44 --- 125		
Surr: Triacontane	56.0	% Recovery			100	56.0	35 --- 136		

CT LABORATORIES
delivering more than data from your environmental analyses

Sample Condition Report

Folder #: 153902
Client: USACE - OMAHA

Print Date / Time: 06/10/2020 12:30
Received Date / Time / By: 06/10/2020 10:30 CHB

Project Name: BIG BEND DAM TOE DRAIN REPLACEM
Project Phase: FORT THOMPSON, SD

Log-In Date / Time / By: 06/10/2020 12:30 JLS
Project #: PM: BMS

Coolers: 5654
Custody Seals Present : **Y**

Temperature: 3.8 C On Ice: **Y**
COC Present:? **Y** Complete? **Y**

Seal Intact? **Y**
Ship Method: FEDEX EXPRESS
Adequate Packaging: **Y**

Numbers: DATED AND SIGNED
Tracking Number: 806531978895
Temp Blank Enclosed? **Y**

Notes: THE SAMPLES WERE RECEIVED IN GOOD CONDITION ON ICE.

TWO CUSTODY SEALS WERE PRESENT AND INTACT UPON RECEIPT - BOTH WERE DATED 6/9/20 AND SIGNED.

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
429900 BBSD-06A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
429901 BBSD-08B				
	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
429902 BBSD-XXB				
	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
429903 BBSD-06B				
	AMBER GL	1	/	DRO
	Total # of Containers of Type (*AMBER GL*) = 1			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
429904 BBSD-05A				
	UNPRES GL	1	/	DRO,%SOL
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type (*UNPRES GL*) = 2			
Sample ID / Description	**Container Type**	**Cond. Code**	**pH OK?/Filtered?**	**Tests**
429905 BBSD-05B				
	AMBER GL	1	/	DRO

	AMBER GL	1	/	DRO
	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **3**		

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
429906 BBSD-04A				
	UNPRES GL	1	/	DRO,%SOL
	Total # of Containers of Type	(***UNPRES GL***) = **1**		

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
429907 BBSD-04B				
	AMBER GL	1	/	DRO
	Total # of Containers of Type	(***AMBER GL***) = **1**		

Condition Code	*Condition Description*
1	Sample Received OK

Rev. 02/2017

CHAIN OF CUSTODY

Page _____ of _____

Company: USACE - Omaha
Project Contact: Tom Weirauch
Telephone: 402 995 2289
Project Name: Big Bend Dam Toe Drain Replacement
Project #:
Location: Big Bend Dam SD
Sampled By: George Filpovich

CT LABORATORIES
1230 Lange Court, Baraboo, WI 53913
608-356-2760 Fax 608-356-2766
www.ctlaboratories.com

Folder # 153902
Company: USACE - OMAHA
Project BIG BEND DAM
Logged By JLS PM: BM

Program:
QSM RCRA SDWA NPDES
Solid Waste Other _____

PO #

Report To: thomas.a.weirauch@usace.army.mil
Company: USACE - Omaha District
Address: 1616 Capitol Ave Omaha NE 68102
Invoice To:* Same as above
EMAIL:
Company:
Address:

*Party listed is responsible for payment of invoice as per CT Laboratories' terms and conditions

Client Special Instructions

Matrix:
GW – groundwater SW - surface water WW - wastewater DW - drinking water
S - soil/sediment SL - sludge A - air M - misc/waste

ANALYSES REQUESTED

Turnaround Time
Normal RUSH*
Date Needed: _____
Rush analysis requires prior CT Laboratories' approval
Surcharges:
24 hr 200%
2-3 days 100%
4-9 days 50%

Collection Date	Collection Time	Matrix	Grab/ Comp	Sample #	Sample ID Description	Filtered? Y/N	T/H - ORO	Total # Containers	Designated MS/MSD	CT Lab ID # (Lab use only)
							Fill in Spaces with Bottles per Test			
6/8/20	0902	S	G	1	BBSD-06A	N	1			429900
6/8/20	0818	GW	G	1	BBSD-08B	N	1			429901
6/8/20	0819	GW	G	1	BBSD-XXB	N	1			429902
6/8/20	1017	GW	G	1	BBSD-06B	N	1			429903
6/8/20	1112	S	G	1	BBSD-05A		1			429904
6/8/20	1112	S	G	1	BBSD-05A-MS/MSD		1		4	429904
6/8/20	1235	GW	G	1	BBSD-05B	N	1			429905
6/8/20	1235	GW	G	1	BBSD-05B-MS	N	1		4	429905
6/8/20	1235	GW	G	1	BBSD-05B-MSD	N	1		4	429905
6/8/20	1342	S	G	1	BBSD-04A		1			429906
6/8/20	1450	GW	G	1	BBSD-04B	N	1			429907

Relinquished By: [signature] Date/Time 6/9/20 1015
Received by: Date/Time
Received By: [signature] Date/Time 6/10/2020 1230
Received for Laboratory by: [signature] Date/Time 10:30 6/10/2020

Lab Use Only
Ice Present (Yes) No
Temp 3.6 IR Gun 27
Cooler #654

CT Laboratories Terms and Conditions

Where a purchaser (Client) places an order for laboratory, consulting or sampling services from CT Laboratories (CTL), CTL shall provide the ordered services pursuant to these Terms and Conditions, and the related Quotation, or as agreed in a negotiated contract. In the absence of a written agreement to the contrary, the Order constitutes an acceptance by the Client of CTL's offer to do business under these Terms and Conditions, and an agreement to be bound by these Terms and Conditions. No contrary or additional terms and conditions expressed in a Client's document shall be deemed to become a part of the contract created upon acceptance of these Terms and Conditions, unless accepted by CTL in advance of the start of the project and in writing.

1. ORDERS AND RECEIPT OF SAMPLES (Sample Acceptance Policy)

1.1 The Client may place the Order (i.e., specify a Scope of Work) either by submitting a purchase order to CTL in writing, by telephone (confirmed in writing) or by negotiated contract. Whichever option the Client selects for placing the Order, the Order shall not be valid unless it contains sufficient information to enable CTL to carry out the Client's requirements. It is the policy of CTL that samples not meeting the acceptance criteria, outlined in the NELAC standards and Section 5.8.3.2 of the DOD QSM, will not be accepted by the laboratory or will be qualified on the final report. All samples submitted to the laboratory must: (a) be accompanied by proper, full and complete documentation, including sample identification, location, date and time of collection, the collector's name, type of preservation (if any), type of sample, any special comments concerning the sample and any additional pertinent fields on the chain-of-custody. In the absence of any of the required information, the laboratory will attempt to contact the client to obtain the information; if unable to obtain the necessary information, the final report will be qualified. (b) samples must be labeled appropriately with a unique sample identification written with indelible ink on water resistant labels. If the laboratory cannot determine the identity of a sample, it may be rejected and the client will be contacted for further instructions or resampling. (c) samples must be in an appropriate sample container. If the container is inappropriate, the client will be contacted for further instructions or resampling. If analysis is possible, the final repost will be qualified. CTL can provide a sampling guide containing approved containers and preservations for analytical methods requested. (d) adhere to method specified holding times. If samples are received with less than ½ the holding time remaining for the requested test, CTL will make its best effort to analyze the samples and notify the client. If holding times are exceeded, the final report will be qualified. (e) contain adequate sample volume to perform the necessary testing. If sufficient volume is not present, the sample may be rejected and the client will be contacted for further instructions or resampling. If samples show signs of damage, contamination or inadequate preservation, the client will be notified. If analysis can be performed, the final report will be qualified. If not, the samples will be rejected and the client notified for further instructions or resampling. It is the Client's responsibility to understand and package samples correctly and provide the proper amount of temperature control (ice) suitable to current weather conditions.
1.2 CTL must be supplied with complete written disclosure of the known or suspected presence of any hazardous substances, as defined by applicable federal or state law. Where any samples which were not accompanied by the required disclosure, cause interruptions in the lab's ability to process work due to contamination of instruments or work areas, the Client will be responsible for the costs of clean up and recovery.
1.3 Prior to Sample Acceptance, the entire risk of loss or damage to samples remains with the Client. In no event will CTL have any responsibility or liability for the action or inaction of any carrier shipping or delivering any sample to or from CTL's premises. Client is responsible to assure that any sample containing any hazardous substance which is to be delivered to CTL's premises will be packaged, labeled, transported and delivered properly and in accordance with applicable laws.
1.4 Clients using CTL's shipping account(s) do so at their own risk and must purchase separate insurance if they do not wish to assume risk of loss. CTL will not assume any risk whatsoever for any samples outside of CTL's control and not successfully delivered to the laboratory within specified hold times.
1.5 CTL will not accept liability for any sample(s), except sample(s) damaged or broken by log-in staff prior to successful log-in of the sample(s) into the CTL- LIMS system. This includes, but may not be limited to: complete, valid COC documentation, all sample receiving issues being resolved from a delay caused by the Client in CTL's ability to log-in samples, including missed turnaround and hold times, delay in processing and, ultimately, additional charges to the Client.
1.6 CTL will only reject samples per directions from the Client. CTL's sole liability is to inform the Client of any sample receipt issues, and may provide an indication how proceeding with the analysis may affect results and final acceptance by the regulating agency. Ultimately, suitability for use is between the Client and the regulating agency(s).
1.7 Signing of this COC by the Client or Client's representative, or directions to CTL via email or Fax constitutes acceptance of these Terms and Conditions, and guarantees payment by the Client to CTL.

2. PAYMENT TERMS

2.1 Services performed by CTL will be in accordance with prices quoted and later confirmed in writing or as stated in the Price Schedule. Invoices may be submitted to Client upon completion of any sample delivery group. Payment in advance is required for all Clients except those whose credit has been established with CTL. For Clients with approved credit, payment terms are net 30 days from the date of invoice by CTL. All overdue payments are subject to an additional interest and service charge of one and one-half percent (1.5%) or the maximum rate permissible by law, per month or portion thereof from the due date until the date of payment. All fees are charged or billed directly to the Client. The billing of a third party will not be accepted without a statement, signed by the third party that acknowledges and accepts payment responsibility. CTL may suspend work and withhold delivery of data under this order at any time in the event Client fails to make timely payment of its invoices. Client shall be responsible for all costs and expenses of collection including reasonable attorney's fees. CTL reserves the right to refuse to proceed with work at any time based upon an unfavorable Client credit report.

3. CHANGE ORDERS, TERMINATION

3.1 Changes to the Scope of Work, price, or result delivery date may be initiated by CTL after Sample Acceptance due to any condition which conflicts with analytical, QA or other protocols warranted in these Terms and Conditions. CTL will not proceed with such changes until an agreement with the Client is reached on the amount of any cost, schedule change or technical change to the Scope of Work, and such agreement is documented in writing.
3.2 Changes to the Scope of Work, including but not limited to increasing or decreasing the work, changing test and analysis specification or acceleration in the performance of the work may be initiated by the Client after sample acceptance. Such a change will be documented in writing and may result in a change in cost and turnaround time commitment. CTL's acceptance of such changes is contingent upon technical feasibility and operational capacity.
3.3 Suspension or termination of all or any part of the work may be initiated by the Client. CTL will be compensated consistent with Section 2 of these Terms and Conditions. CTL will complete all work in progress and be paid in full for all work completed.

4. WARRANTIES AND LIABILITY

4.1 Where applicable, CTL will use analytical methodologies which are in substantial conformity with published test methods. CTL has implemented these methods in its Laboratory Quality Manuals and referenced Standard Operating Procedures and where the nature or composition of the sample requires it, CTL reserves the right to deviate from these methodologies as necessary or appropriate, based on the reasonable judgment of CTL, which deviations, if any, will be made on a basis consistent with recognized standards of the industry and/or CTL's Laboratory Quality Manuals. Client may request that CTL perform according to a mutually agreed Quality Assurance Project Plan (QAPP). In the event that samples arrive prior to agreement on a QAPP, CTL will proceed with analyses under its standard Quality Manuals then in effect, and CTL will not be responsible for any resampling or other charges if work must be repeated to comply with a subsequently finalized QAPP.
4.2 CTL shall start preparation and/or analysis within holding times provided that Sample Acceptance occurs within 48 hours of sampling or 1/2 of the holding time for the test, whichever is less. Samples received that do not meet this provision will be charged as expedited samples and the appropriate rate will be added accordingly. Where resolution of inconsistencies leading to Sample Acceptance does not occur within this period, CTL will use its best efforts to meet holding times and will proceed with the work provided that, in CTL's judgment, the chain-of-custody or definition of the Scope of Work provide sufficient guidance. Reanalysis of samples to comply with CTL's Quality Manuals will be deemed to have met holding times provided the initial analysis was performed within the applicable holding time. Where reanalysis demonstrates that sample matrix interference is the cause of failure to meet any Quality Manual requirements, the warranty will be deemed to have been met.
4.3 CTL warrants that it possesses and maintains all licenses and certifications which are required to perform services under these Terms and Conditions provided that such requirements are specified in writing to CTL prior to Sample Acceptance. CTL will notify the Client in writing of any decertification or revocation of any license, or notice of either, which affects work in progress.
4.4 The warranty obligations set forth in Sections 4.1, 4.2 and 4.3 are the sole and exclusive warranties given by CTL in connection with any services performed by CTL or any Results generated from such services, and CTL gives and makes NO OTHER REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. No representative of CTL is authorized to give or make any other representation or warranty or modify this warranty in any way.
4.5 Client's sole and exclusive remedy for the breach of warranty in connection with any services performed by CTL, will be limited to repeating any services performed, contingent on the Client's providing, at the request of CTL and at the Client's expense, additional sample(s) if necessary. Any reanalysis requested by the Client generating Results consistent with the original Results will be at the Client's expense. If resampling is necessary, CTL's liability for resampling costs will be limited to actual cost or one hundred or one hundred fifty dollars ($150) per sample, whichever is less.
4.6 CTL's liability for any and all causes of action arising hereunder, whether based in contract, tort, warranty, negligence or otherwise, shall be limited to the lesser amount of compensation for the services performed or $100,000. All claims, including those for negligence, shall be deemed waived unless suit thereon is filed within one year after CTL's completion of the services. Under no circumstances, whether arising in contract, tort (including negligence), or otherwise, shall CTL be responsible for loss of use, loss of profits, or for any special, indirect, incidental or consequential damages occasioned by the services performed or by application or use of the reports prepared.
4.7 In no event shall CTL have any responsibility or liability to the Client for any failure or delay in performance by CTL which results, directly or indirectly, in whole or in part, from any cause or circumstance beyond the reasonable control of CTL. Such causes and circumstances shall include, but not be limited to, acts of God, acts of Client, acts or orders of any governmental authority, strikes or other labor disputes, natural disasters, accidents, wars, civil disturbances, equipment breakdown, matrix interference or unknown highly contaminated samples that impact instrument operation, unavailability of supplies from usual suppliers, difficulties or delays in transportation, mail or delivery services, or any other cause beyond CTL's reasonable control.

5. RESULTS, WORK PRODUCT

5.1 Data or information provided to CTL or generated by services performed under this agreement shall only become the property of the Client upon receipt in full by CTL of payment for the whole Order. Ownership of any analytical method, QA/QC protocols, software programs or equipment developed by CTL for performance of work will be retained by CTL, and Client shall not disclose such information to any third party.
5.2 Data and sample materials provided by Client or at Client's request, and the result obtained by CTL shall be held in confidence (unless such information is generally available to the public or is in the public domain or Client has failed to pay CTL for all services rendered or is otherwise in breach of these Terms and Conditions), subject to any disclosure required by law or legal process.
5.3 Should the Results delivered by CTL be used by the Client or Client's client, even though subsequently determined not to meet the warranties described in these Terms and Conditions, then the compensation will be adjusted based upon mutual agreement. In no case shall the Client unreasonably withhold CTL's right to independently defend its data.
5.4 CTL reserves the right to subcontract services ordered by the Client to another laboratory or laboratories, if, in CTL's sole judgment, it is reasonably necessary, appropriate or advisable to do so, and with the Client's permission. CTL will in no way be liable for any subcontracted services and all applicable warranties, guarantees and insurance are those of the subcontracted laboratory.
5.5 CTL shall dispose of the Client's samples and extracts 30 days after the analytical report is issued, unless instructed to store them for an alternate period of time or to return such samples to the Client, in a manner consistent with U.S. Environmental Protection Agency regulations or other applicable Federal, state or local requirements. Additional charges will apply for samples or extracts stored longer than 30 days at the Clients request. Any samples for projects that are canceled or not accepted, or for which return was requested, will be returned to the Client at Client expense. CTL reserves the right to return to the Client any sample or unused portion of a sample that is not within CTL's permitted capability or the capabilities of CTL's designated waste disposal vendor(s), or will make arrangements to dispose of these samples at Client direction and expense.
5.6 Unless a different time period is agreed to in any order under these Terms and Conditions, CTL agrees to retain all records for five (5) years.
5.7 In the event that CTL is required to respond to legal process related to services for Client, Client agrees to reimburse CTL for hourly charges for personnel involved in the response and attorney fees reasonably incurred in obtaining advice concerning the response, preparation to testify, and appearances related to the legal process, travel and all reasonable expenses associated with the litigation.

6. INSURANCE

6.1 CTL shall maintain in force during the performance of services under these Terms and Conditions, Workers' Compensation and Employer's Liability Insurance in accordance with the laws of the states having jurisdiction over CTL's employees who are engaged in the performance of the work. CTL shall also maintain during such period, Comprehensive General and Contractual Liability (limit of $2,000,000 per occurrence/ aggregate), Comprehensive Automobile Liability, owned and hired, ($1,000,000 combined single limit), and Professional/Pollution Liability Insurance (limit of $5,000,000 per occurrence/aggregate). Any Client required changes to these limits or conditions will result in a change in cost to the Client.

7. AUDIT

7.1 Upon prior notice to CTL, the Client may audit and inspect CTL's records and accounts covering reimbursable costs related to work done for the Client, for a period of one (1) year after completion of the work. The purpose of any such audit shall be only for verification of such costs, and CTL shall not be required to provide access to cost records where prices are expressed as fixed fees or published unit prices.

Cooler Receipt Form

Ice Present (YES) NO

Temperature 3.8

IR Gun # 27

Initials CMB

Date 6/10/2020 Time 10:30

Cooler #: 5654

ENCLOSURE 4

LABORATORY DATA VALIDATION

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Big Bend Dam Data Validation Report

Laboratory SDG: 153747
Associated Batches: 76713, 76752
Date Verified: June 26, 2020
Validation stage: Stage 2A
Client: In house
Laboratory: CT Laboratories
Guidance: DoD QSM, Version 5.3
Applicable QAPP: N/A

Chemist/Verifier: Tony Sedlacek
Contractor Program Chemist (CPC): In house
Date QC review: June 26, 2020

Project Title: Big Bend Dam Toe Drain

Description of soil and groundwater samples received by the laboratory for analysis:

Sample ID #	Sample Date	Date Lab Received	Lab ID
BBSD-01B	6/2/20	6/4/20	427712
BBSD-03B	6/3/20	6/4/20	727714
BBSD-12B	6/3/20	6/4/20	427715
BBSD-02B	6/2/20	6/4/20	427716
BBSD-00B	6/2/20	6/4/20	427717
BBSD-00A	6/2/20	6/4/20	427718
BBSD-12A	6/3/20	6/4/20	427719
BBSD-02A	6/2/20	6/4/20	427720
BBSD-01A	6/2/20	6/4/20	427721
BBSD-03A	6/2/20	6/4/20	427722

Note: "Yes/No" answers that indicate a possible data quality issue are shaded. If answer falls in the shaded area, an explanation must be provided below each applicable question box. Also include if any discussion occurred with USACE project chemist for discussion or concurrence.

1.0 Laboratory Case Narrative *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Were any DoD-QSM deviations noted in the laboratory case narrative?		X		
Were DoD-QSM corrective actions followed if deviations were noted?		X		

2.0 Sample Documentation *(Cooler receipt)*

Verification Criteria	Yes	No	Page #
Were all samples documented correctly on the chain-of-custody (COC) and samples labels?	X		
Were samples relinquished properly on the COC?	X		
Were any issues noted in the cooler receipt form?		X	
Were samples received in the required temperature range?	X		

3.0 Method Blank *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Was one method blank run per method batch?	X		
Were analytes detected >1/2 the LOQ and either > 1/10 the amount measured in any sample or 1/10 the regulatory limit?		X	
Common laboratory contaminants (methylene chloride, 2-butanone, and acetone were less than 2X the LOQ?		X	

4.0 LCS *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Was a complete list of analytes including surrogates reported?	X		
Was one LCS run per preparatory batch?	X		
All detections were within DoD LCS criteria or if in-house criteria were used they were not greater than ± 3Xs the standard deviation of the mean LCS?	X		

Surrogates were not reported for LCS/LCSD samples. However, all LCS/LCSD recoveries were within evaluation criteria.

5.0 Matrix Spike and Matrix Spike Duplicate *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Was one MS and MSD run per preparatory batch per matrix?			X	
All detections were within DoD LCS criteria or if in-house criteria were used they were not greater than ± 3Xs the standard deviation of the mean LCS?			X	
MSD RPD was within control limits?			X	

6.0 Surrogates *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Surrogates were added to all samples, standards, blanks, field and lab QC samples?		X	
Surrogates were within the upper and lower control limits?		X	3

Surrogate recoveries for octacosane and triacontane were below evaluation criteria in samples BBSD-12B, BBSD-02B and BBSD-00B. TPH-DRO was detected in all associated samples and qualified, estimated "J". In addition, surrogate recoveries were not reported for LCS/LCSD or method blank samples. However, all LCS/LCSD recoveries were within evaluation criteria and all method blanks were nondetect.

Sample ID	Analyte	Qualification
BBSD-12B	TPH-DRO	**J**
BBSD-02B	TPH-DRO	**J**
BBSD-00B	TPH-DRO	**J**

7.0 Duplicate Precision *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Were laboratory duplicate samples within 20% RPD?	X			
Were LCS/LCSD PRD within 20% RPD?	X			
Were MS/MSD PRD within 20%?			X	

8.0 Additional Qualifications

Were additional qualifications applied or professional judgment used?

Field ID	Analyte	New RL	Qualification

9.0 Completeness

Verification Criteria	Yes	No	N/A	Page #
Were any data recommended for exclusion during the verification process?		X		
Were any samples lost, broken, or in any other manner in not verified?		X		
Were all sample analyses requested performed, the correct analyte lists used and correct sample preparation and analyses methods and units utilized?	X			

No data is recommended for exclusion. All samples arrived at the laboratory intact and within the specified preservation temperature range. The analytical laboratory performed all analyses requested.

Big Bend Dam Data Validation Report

Laboratory SDG: 153810
Associated Batches: 76788, 76752
Date Verified: June 29, 2020
Validation stage: Stage 2A
Client: In house
Laboratory: CT Laboratories
Guidance: DoD QSM, Version 5.3
Applicable QAPP: N/A

Chemist/Verifier: Tony Sedlacek
Contractor Program Chemist (CPC): In house
Date QC review: June 29, 2020

Project Title: Big Bend Dam Toe Drain

Description of soil and groundwater samples received by the laboratory for analysis:

Sample ID #	Sample Date	Date Lab Received	Lab ID
BBSD-11B	6/4/2020	6/8/2020	428379
BBSD-10B	6/4/2020	6/8/2020	428380
BBSD-07B	6/5/2020	6/8/2020	428381
BBSD-09B	6/5/2020	6/8/2020	428382
BBSD-11A	6/4/2020	6/8/2020	428383
BBSD-10A	6/4/2020	6/8/2020	428384
BBSD-XXA	6/5/2020	6/8/2020	428385
BBSD-08A	6/5/2020	6/8/2020	428386
BBSD-09A	6/5/2020	6/8/2020	428387
BBSD-07A	6/5/2020	6/8/2020	428388

Note: "Yes/No" answers that indicate a possible data quality issue are shaded. If answer falls in the shaded area, an explanation must be provided below each applicable question box. Also include if any discussion occurred with USACE project chemist for discussion or concurrence.

1.0 Laboratory Case Narrative *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Were any DoD-QSM deviations noted in the laboratory case narrative?		X		
Were DoD-QSM corrective actions followed if deviations were noted?		X		

2.0 Sample Documentation *(Cooler receipt)*

Verification Criteria	Yes	No	Page #
Were all samples documented correctly on the chain-of-custody (COC) and samples labels?	X		
Were samples relinquished properly on the COC?	X		
Were any issues noted in the cooler receipt form?		X	
Were samples received in the required temperature range?	X		

3.0 Method Blank *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Was one method blank run per method batch?	X		
Were analytes detected >1/2 the LOQ and either > 1/10 the amount measured in any sample or 1/10 the regulatory limit?		X	
Common laboratory contaminants (methylene chloride, 2-butanone, and acetone were less than 2X the LOQ?		X	

4.0 LCS *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Was a complete list of analytes including surrogates reported?		X	
Was one LCS run per preparatory batch?	X		
All detections were within DoD LCS criteria or if in-house criteria were used they were not greater than ± 3Xs the standard deviation of the mean LCS?	X		

Surrogates were not reported for LCS/LCSD samples. However, all LCS/LCSD recoveries were within evaluation criteria.

5.0 Matrix Spike and Matrix Spike Duplicate *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Was one MS and MSD run per preparatory batch per matrix?			X	
All detections were within DoD LCS criteria or if in-house criteria were used they were not greater than ± 3Xs the standard deviation of the mean LCS?			X	
MSD RPD was within control limits?			X	

6.0 Surrogates *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Surrogates were added to all samples, standards, blanks, field and lab QC samples?	X		
Surrogates were within the upper and lower control limits?	X		

Surrogate recoveries were not reported for LCS/LCSD or method blank samples. However, all LCS/LCSD recoveries were within evaluation criteria and all method blanks were nondetect.

Sample ID	Analyte	Qualification
		N/A

7.0 Duplicate Precision *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Were laboratory duplicate samples within 20% RPD?	X			
Were LCS/LCSD PRD within 20% RPD?	X			
Were MS/MSD PRD within 20%?			X	

8.0 Additional Qualifications

Were additional qualifications applied or professional judgment used?

Field ID	Analyte	New RL	Qualification

9.0 Completeness

Verification Criteria	Yes	No	N/A	Page #
Were any data recommended for exclusion during the verification process?		X		
Were any samples lost, broken, or in any other manner in not verified?		X		
Were all sample analyses requested performed, the correct analyte lists used and correct sample preparation and analyses methods and units utilized?	X			

No data is recommended for exclusion. All samples arrived at the laboratory intact and within the specified preservation temperature range. The analytical laboratory performed all analyses requested.

Big Bend Dam Data Validation Report

Laboratory SDG: 153902
Associated Batches: 76788, 76752
Date Verified: June 29, 2020
Validation stage: Stage 2A
Client: In house
Laboratory: CT Laboratories
Guidance: DoD QSM, Version 5.3
Applicable QAPP: N/A

Chemist/Verifier: Tony Sedlacek
Contractor Program Chemist (CPC): In house
Date QC review: June 29, 2020

Project Title: Big Bend Dam Toe Drain

Description of soil and groundwater samples received by the laboratory for analysis:

Sample ID #	Sample Date	Date Lab Received	Lab ID
BBSD-06A	6/8/2020	6/10/2020	429900
BBSD-08B	6/8/2020	6/10/2020	429901
BBSD-XXB	6/8/2020	6/10/2020	429902
BBSD-06B	6/8/2020	6/10/2020	429903
BBSD-05A	6/8/2020	6/10/2020	429904
BBSD-05B	6/8/2020	6/10/2020	429905
BBSD-04A	6/8/2020	6/10/2020	429906
BBSD-04B	6/8/2020	6/10/2020	429907

Note: "Yes/No" answers that indicate a possible data quality issue are shaded. If answer falls in the shaded area, an explanation must be provided below each applicable question box. Also include if any discussion occurred with USACE project chemist for discussion or concurrence.

1.0 Laboratory Case Narrative *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Were any DoD-QSM deviations noted in the laboratory case narrative?		X		
Were DoD-QSM corrective actions followed if deviations were noted?		X		

2.0 Sample Documentation *(Cooler receipt)*

Verification Criteria	Yes	No	Page #
Were all samples documented correctly on the chain-of-custody (COC) and samples labels?	X		
Were samples relinquished properly on the COC?	X		
Were any issues noted in the cooler receipt form?		X	
Were samples received in the required temperature range?	X		

3.0 Method Blank *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Was one method blank run per method batch?	X		
Were analytes detected >1/2 the LOQ and either > 1/10 the amount measured in any sample or 1/10 the regulatory limit?		X	
Common laboratory contaminants (methylene chloride, 2-butanone, and acetone were less than 2X the LOQ?		X	

4.0 LCS *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Was a complete list of analytes including surrogates reported?	X		
Was one LCS run per preparatory batch?	X		
All detections were within DoD LCS criteria or if in-house criteria were used they were not greater than ± 3Xs the standard deviation of the mean LCS?	X		

Surrogates were not reported for LCS/LCSD samples. However, all LCS/LCSD recoveries were within evaluation criteria.

5.0 Matrix Spike and Matrix Spike Duplicate *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Was one MS and MSD run per preparatory batch per matrix?	X			
All detections were within DoD LCS criteria or if in-house criteria were used they were not greater than ± 3Xs the standard deviation of the mean LCS?	X			
MSD RPD was within control limits?	X			

Samples BBSD-05A and BBSD-05B were spiked and analyzed for TPH-DRO. All MS/MSD recoveries and RPDs were within evaluation criteria. No qualifications were necessary.

6.0 Surrogates *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	Page #
Surrogates were added to all samples, standards, blanks, field and lab QC samples?		X	
Surrogates were within the upper and lower control limits?		X	3

Surrogate recovery for octacosane was below evaluation criteria in sample BBSD-XXB. TPH-DRO was detected in sample BBSD-XXB and qualified, estimated "J". In addition, surrogate recoveries were not reported for LCS/LCSD or method blank samples. However, all LCS/LCSD recoveries were within evaluation criteria and all method blanks were nondetect.

Sample ID	Analyte	Qualification
BBSD-XXB	TPH-DRO	**J**

7.0 Duplicate Precision *(Manual / ~~Electronic~~)*

Verification Criteria	Yes	No	N/A	Page #
Were laboratory duplicate samples within 20% RPD?	X			
Were LCS/LCSD PRD within 20% RPD?	X			
Were MS/MSD PRD within 20%?	X			

8.0 Additional Qualifications

Were additional qualifications applied or professional judgment used?

Field ID	Analyte	New RL	Qualification

9.0 Completeness

Verification Criteria	Yes	No	N/A	Page #
Were any data recommended for exclusion during the verification process?		X		
Were any samples lost, broken, or in any other manner in not verified?		X		
Were all sample analyses requested performed, the correct analyte lists used and correct sample preparation and analyses methods and units utilized?	X			

No data is recommended for exclusion. All samples arrived at the laboratory intact and within the specified preservation temperature range. The analytical laboratory performed all analyses requested.

Appendix C: Drilling Logs and Construction Diagrams

Boring Designation BH20-01

LAB TESTING LOG	DIVISION NWO	INSTALLATION Big Bend Dam	SHEET 1 OF 2 SHEETS

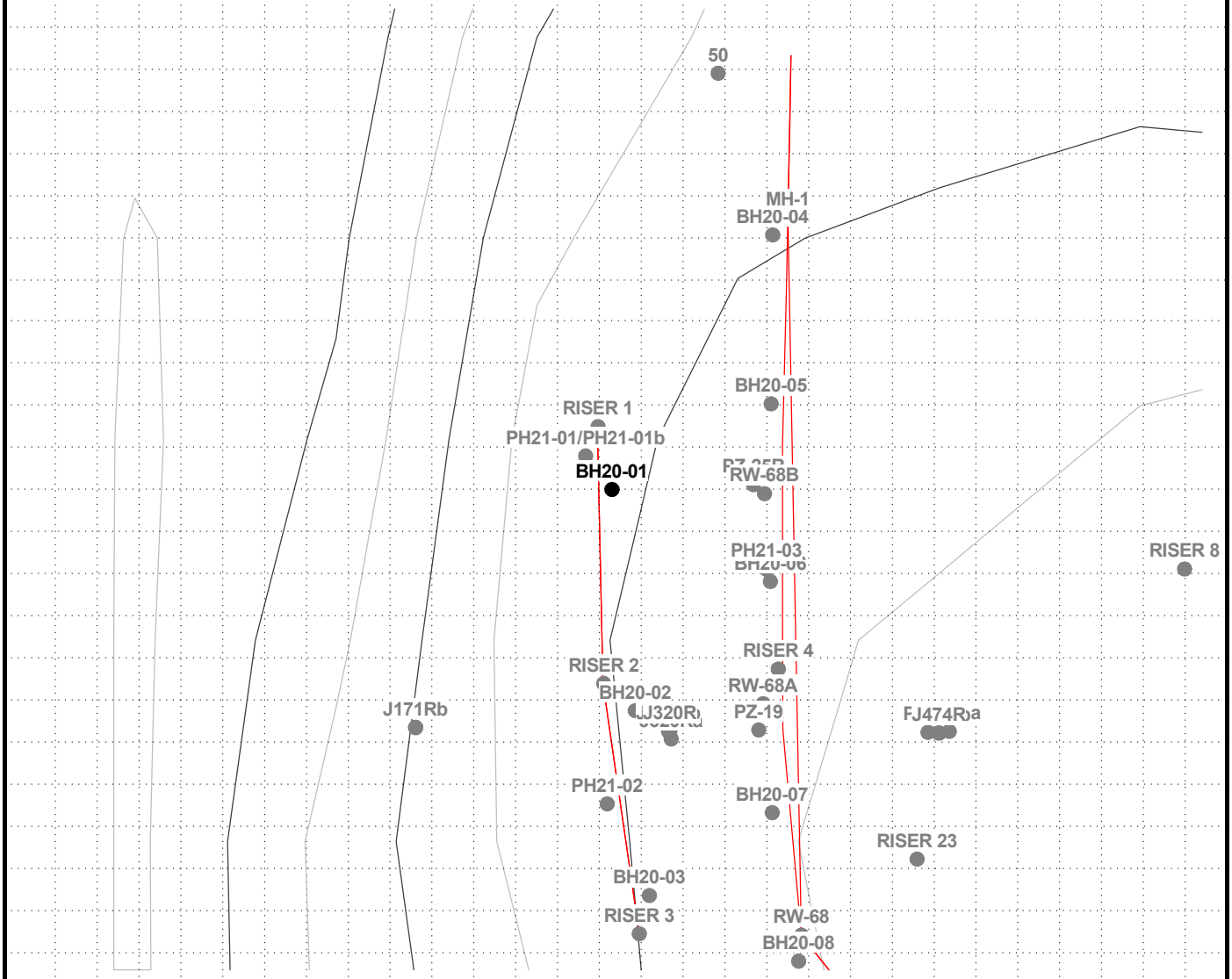
1. PROJECT FY21 Drain Replacement		9. COORDINATE SYSTEM State Plane	HORIZONTAL NAD83 / VERTICAL Project Datum
		10. SIZE AND TYPE OF BIT 4 1/4" ID HSA	
2. HOLE NUMBER BH20-01	LOCATION COORDINATES 629695.581N 2199392.547E	11. MANUFACTURER'S DESIGNATION OF DRILL Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED 7 / UNDISTURBED 0
4. NAME OF DRILLER Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED 6/2/20 / COMPLETED 6/2/20
6. THICKNESS OF OVERBURDEN ---		16. ELEVATION TOP OF BORING 1384.3	
7. DEPTH DRILLED INTO ROCK ---		17. TOTAL CORE RECOVERY FOR BORING N/A	
8. TOTAL DEPTH OF BORING 10 ft		18. SIGNATURE AND TITLE OF INSPECTOR George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 8 bags of bentonite chips.



PROJECT FY21 Drain Replacement Fort Thompson, SD

HOLE NO BH20-01

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 2 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1382.3	2.0	D-1	3 3 5 10	75		Lean clay (CL) low plasticity, medium stiff, dry, light brown, trace fine to medium sand, trace roots, Random Embankment Fill. @ 1 ft, no roots.								Start drilling on 6/2/20 at 1009 using 4 1/4 inch HSAs and 2 inch SPT.
1381.3	3.0	D-2	7 9			Poorly graded sand (SP) no plasticity, medium dense, dry, brown, medium grained, trace fine sand, Horizontal Drain.								
		D-3	8 9	75		Lean clay with sand ((CL)s) low plasticity, stiff, dry, light brown, trace fine to coarse sand, trace fine gravel, Alluvial Clay.	7.2	16.3	76.5	30	19	15	(CL)S	10YR 4/4 Dark Yellowish Brown Lean Clay with Sand
1379.3	5.0 ▽		1 1			@ 4 ft, soft.								Collect soil sample BBSD-01A from 4 to 5 feet.
		D-4	0 0	90		Clayey sand (SC) very soft, wet, Alluvial Sand/Clay.	0.0	10.6	89.4			40	SC	Clayey Sand
		D-5	0 0 0 0	100		@ 6 ft, no sand and gravel.								
		D-6	0 1											
1375.3	9.0	D-7	2 3	100		Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, brown, fine to medium grained, Alluvial Sand.	0.0	94.2	5.8				SP-SC	Stop drilling at 1055. Collect groundwater sample BBSD-01B from inside augers. 2.5Y 6/2 Light Brownish Gray Poorly Graded Sand with Clay
1374.3	10.0													

LAB TESTING LOG

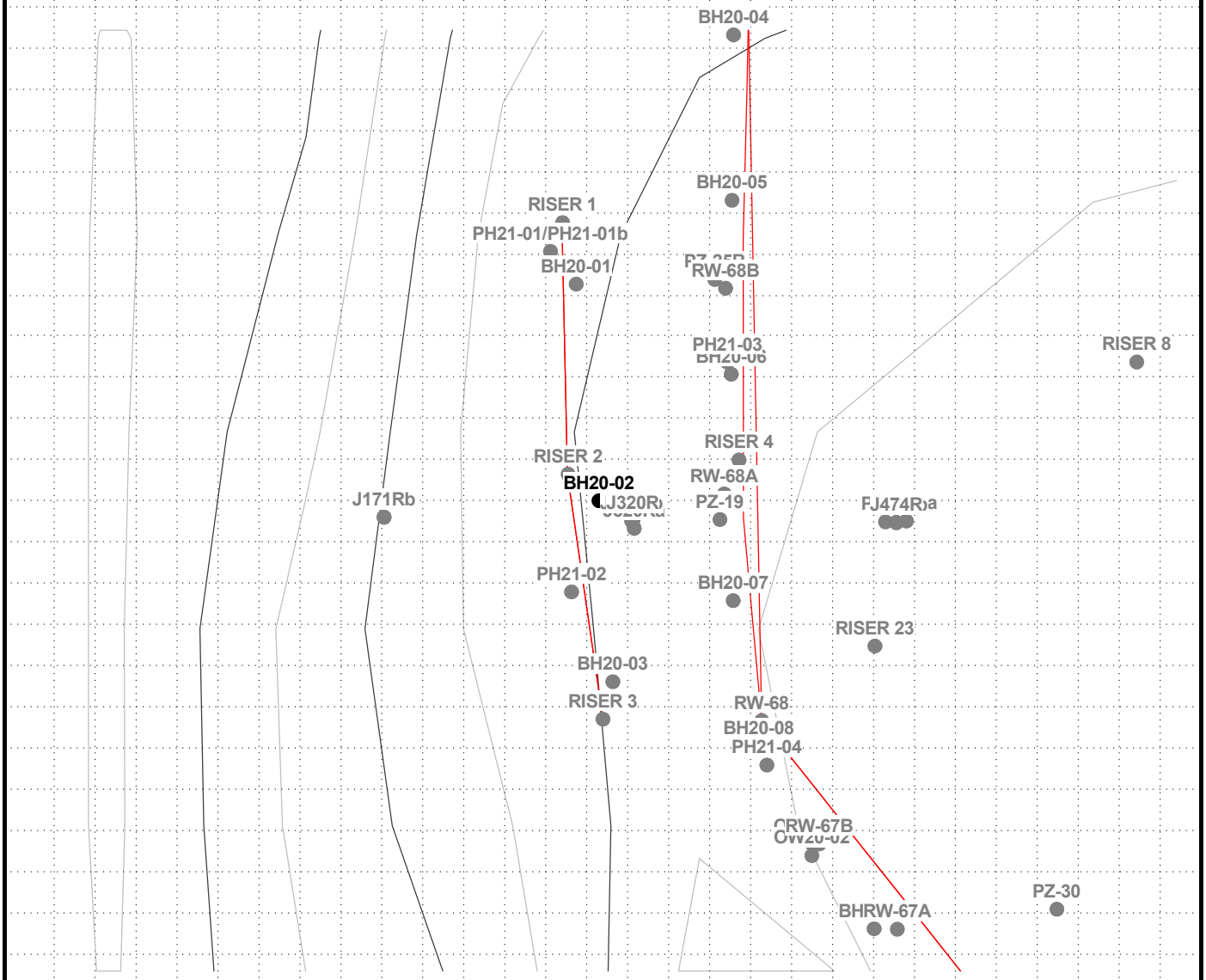
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET: 1 OF 2 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-02	LOCATION COORDINATES: 629564.363N 2199406.379E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 5 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/2/20 / COMPLETED: 6/2/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1381.7	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 10 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 9 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-02

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 2 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	2 3 4 6	85		Lean clay (CL) low plasticity, medium stiff, dry, brown, trace fine sand, trace roots, Random Embankment Fill.								Start drilling on 6/2/20 at 1205 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	6 7 7 7	100		@ 2 ft, stiff.								
1377.2	4.5		1			@ 4 ft, soft.								Collect soil sample BBSD-02A from 4 to 5 feet.
		D-3	1 1 3	100		Silty sand (SM) no plasticity, very loose, moist, fine grained, Alluvial Sand. @ 5 ft, wet.	0.0	78.9	21.1			21	SM	2.5Y 6/3 Light Yellowish Brown Silty Sand
		D-4	0 1 0 0	85										
1371.7	10.0	D-5	0 0 2 2	85			0.0	84.0	16.0				SM	2.5Y 6/2 Light Brownish Gray Silty Sand Stop drilling at 1244. Collect groundwater sample BBSD-02B from inside augers.

Boring Designation BH20-03

LAB TESTING LOG

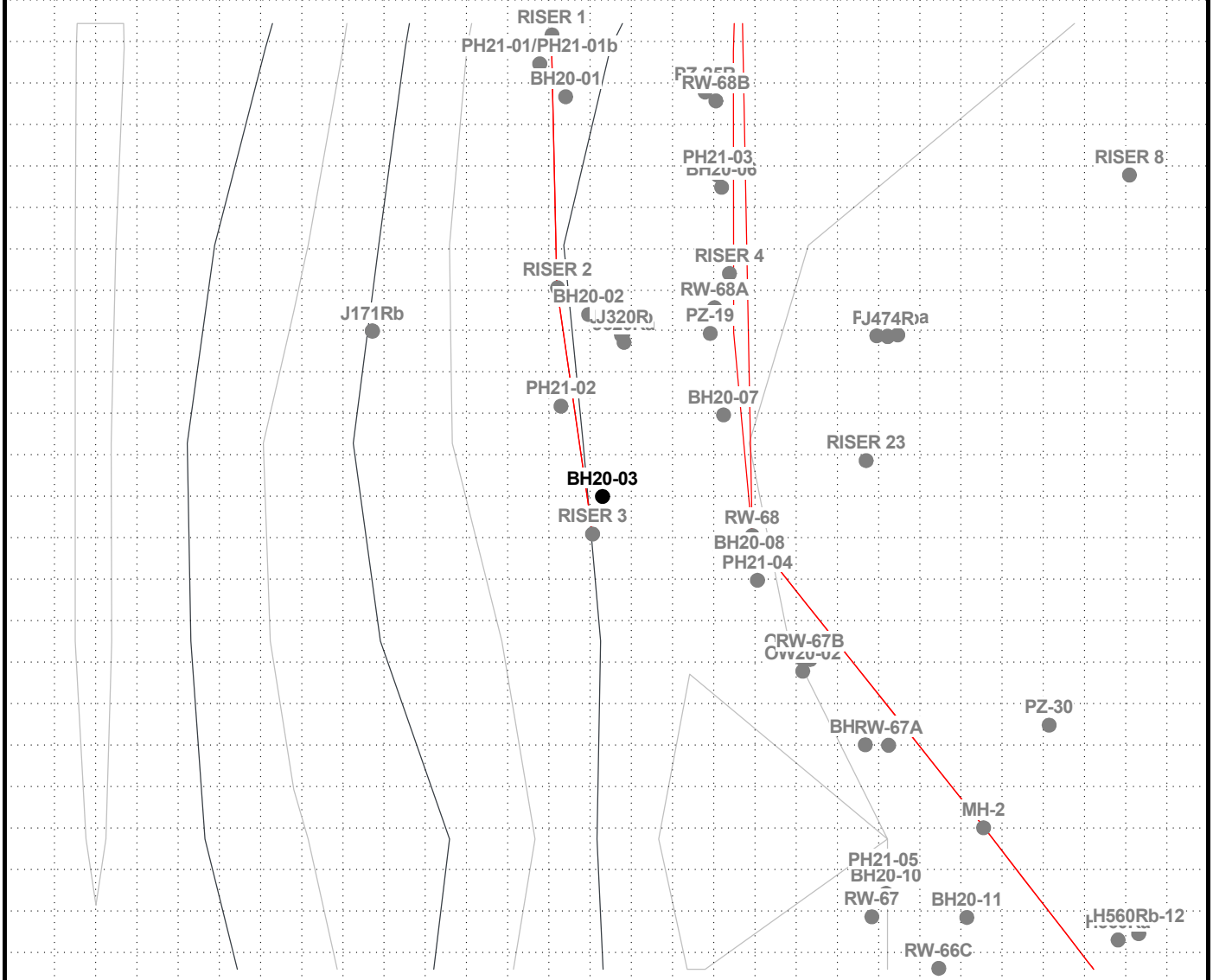
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 2 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-03	LOCATION COORDINATES: 629454.701N 2199414.736E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 7 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/2/20 / COMPLETED: 6/2/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1379.7	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 10 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 9 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-03

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam | SHEET 2 OF 2 SHEETS

PROJECT: FY21 Drain Replacement | COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1378.7	1.0	D-1	1 7	85		Lean clay (CL) medium plasticity, medium stiff, dry, brown, trace fine sand, trace roots, Random Embankment Fill.								Start drilling on 6/2/20 at 1405 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	4 6			Silty sand (SM) no plasticity, medium dense, dry, brown, medium grained, trace fine sand, Horizontal Drain.								
1376.7	3.0	D-3	7 8	100			0.7	82.8	16.5			14	SM	Silty Sand
		D-4	6 7			Clayey sand (SC) no plasticity, medium dense, moist, brown, fine to medium grained, some coarse sand, trace fine gravel, Horizontal Drain.	6.2	76.5	17.3				SC	10YR 4/4 Dark Yellowish Brown Clayey Sand
1375.2	4.5		1			@ 4 ft, very loose.								Collect soil sample BBSD-03A from 4 to 5 feet.
		D-5	1 1 1	100		Lean clay (CL) medium plasticity, very soft, wet, dark gray to black, Alluvial Clay.								
1371.7	8.0	D-6	0 1 1 1	100										
		D-7	0 0 1 3	100		Silty sand (SM) very loose, wet, brown, fine to medium grained, Alluvial Sand.								Stop drilling at 1445. Collect groundwater sample BBSD-03B from inside augers.
1369.7	10.0													

LAB TESTING LOG

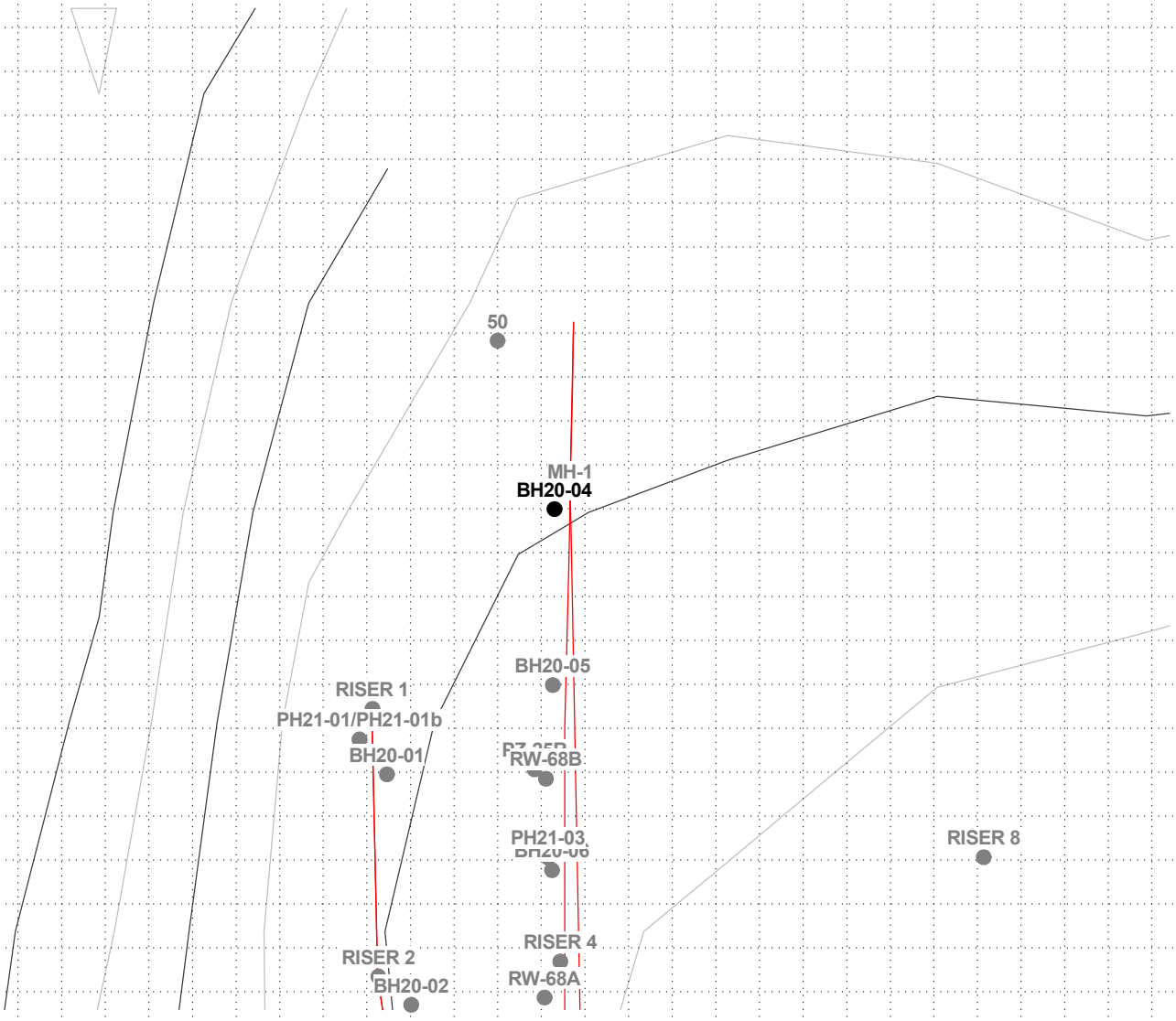
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 3 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-04 / LOCATION COORDINATES: 629846.579N 2199487.894E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)		
3. DRILLING AGENCY: USACE, Omaha District	12. TOTAL SAMPLES	DISTURBED: 10	UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley	13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED / DEG FROM VERTICAL: --- / BEARING	14. ELEVATION GROUND WATER		
	15. DATE BORING	STARTED: 6/8/20	COMPLETED: 6/8/20
6. THICKNESS OF OVERBURDEN: ---	16. ELEVATION TOP OF BORING: 1386.4		
7. DEPTH DRILLED INTO ROCK: ---	17. TOTAL CORE RECOVERY FOR BORING: N/A		
8. TOTAL DEPTH OF BORING: 20 ft	18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist		

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 8 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-04

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1384.4	2.0	D-1	3, 4, 3, 2	75		Silty clay (CL-ML) low plasticity, medium stiff, dry, olive brown, trace roots, Reworked clay /trench backfill.								Start drilling on 6/8/20 at 1330 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	1, 1, 2, 2	65		Lean clay (CL) medium plasticity, soft, dry, gray, Alluvial Clay. @ 3.5 ft, moist.								Collect soil sample BBSD-04A from 3.5 to 4 feet.
1380.4	6.0	D-3	1, 1, 1, 2	80		@ 5.3 ft, wet.								
1379.9	6.5	D-4	1			Clayey sand (SC) no plasticity, very loose, wet, brown, fine to coarse grained, trace fine gravel, Alluvial Clay.								
		D-5	0, 0, 0	70		Silty sand (SM) no plasticity, very loose, wet, gray, fine grained, Alluvial Sand.	0.0	54.1	45.9				SM	2.5Y 6/3 Light Yellowish Brown Silty Sand
1376.4	10.0	D-6	0, 0, 0, 1	75										

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, brown, fine grained, Alluvial Sand.								
		D-7	2 2 3	100			0.0	95.8	4.2			16	SP	10YR 4/4 Dark Yellowish Brown Poorly Graded Sand
		D-8	1 1 2	100										
		D-9	1 3 4	100										
		D-10	1 2 3	100										Stop drilling at 1435. Collect groundwater sample BBSD-04B from inside augers.
1366.4	20.0													

LAB TESTING LOG

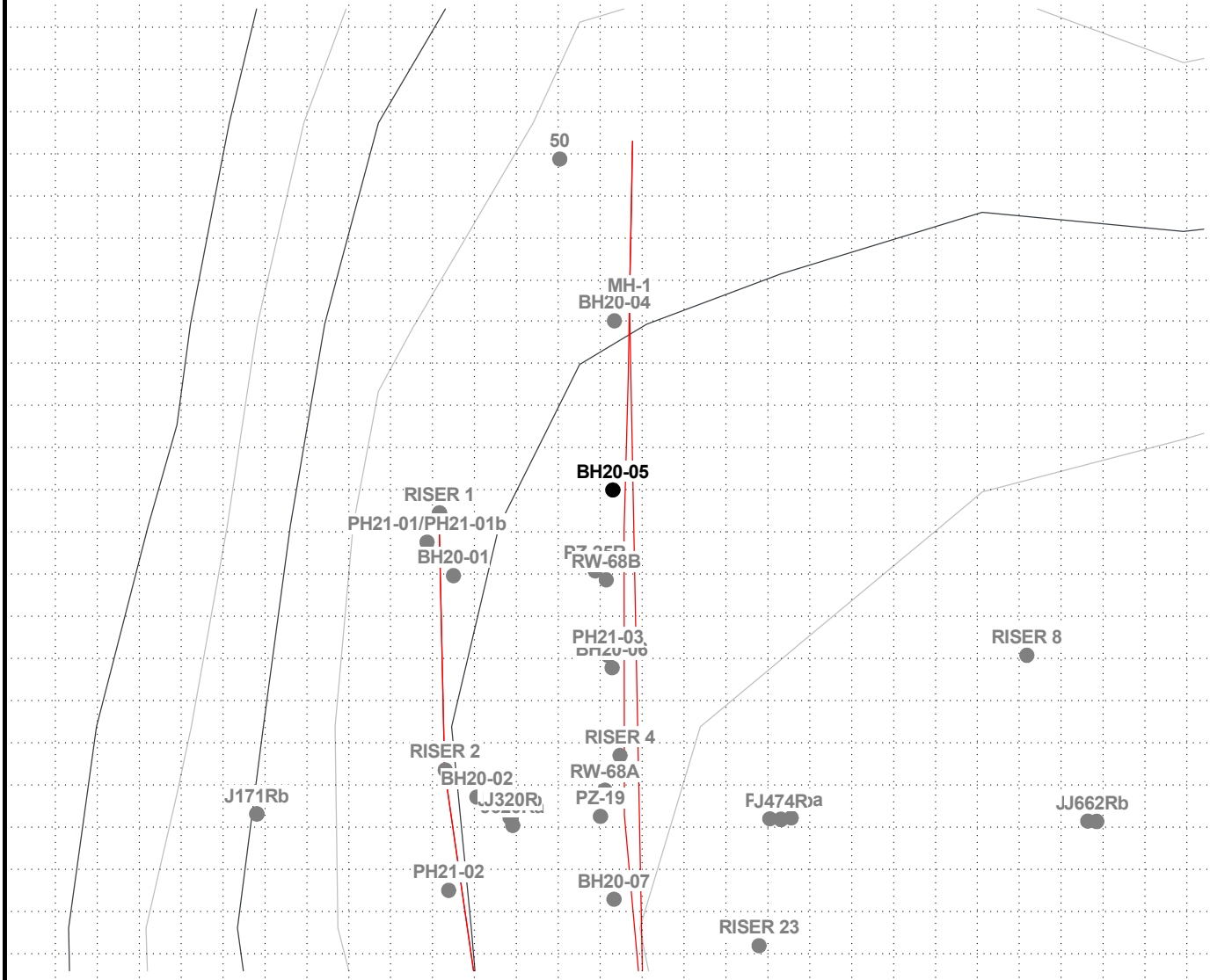
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET: 1 OF 3 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-05	LOCATION COORDINATES: 629746.368N 2199486.945E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 9 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/8/20 / COMPLETED: 6/8/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1382.6	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 20 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 14 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-05

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
			4			Silty clay (CL-ML) low plasticity, stiff, dry, olive brown, trace roots, Reworked clay /trench backfill.								Start drilling on 6/8/20 at 1055 using 4 1/4 inch HSAs and 2 inch SPT.
			4											
		D-1		95		@ 1 ft, no roots.								
			8											
			4											
1380.6	2.0													
			2			Lean clay (CL) medium plasticity, soft, moist, dark gray, Alluvial Clay.								
			2											
		D-2		100										
			2											
			3											
			1											Collect soil sample BBSD-05A/MS-MSD from 4 to 5 feet.
			1											
1377.6	5.0 ▽	D-3		65										
			0			Silty clay (CL-ML) low plasticity, very soft, wet, gray, Alluvial Clay.								
			1											
1376.6	6.0													
			1			Poorly graded sand (SP) no plasticity, very loose, wet, brown, fine grained, trace medium to coarse sand, Alluvial Sand.								
			1											
		D-4		70										
			2											
			1											
			1											
			1											
		D-5		85			0.0	96.8	3.2			23	SP	10YR 5/4 Yellowish Brown Poorly Graded Sand
			3											
			4											

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 3 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, brown, fine grained, trace medium sand, Alluvial Sand, (cont.).								
		D-6	2 2 2	87										
		D-7	0 2 2	87										
		D-8	2 2 3	100										Stop drilling at 1200. Collect groundwater sample BBSD-05B/MS-MSD from inside augers.
1362.6	20.0	D-9	1 2 2	93			0.0	96.7	3.3			25	SP	10YR 5/2 Grayish Brown Poorly Graded Sand

LAB TESTING LOG

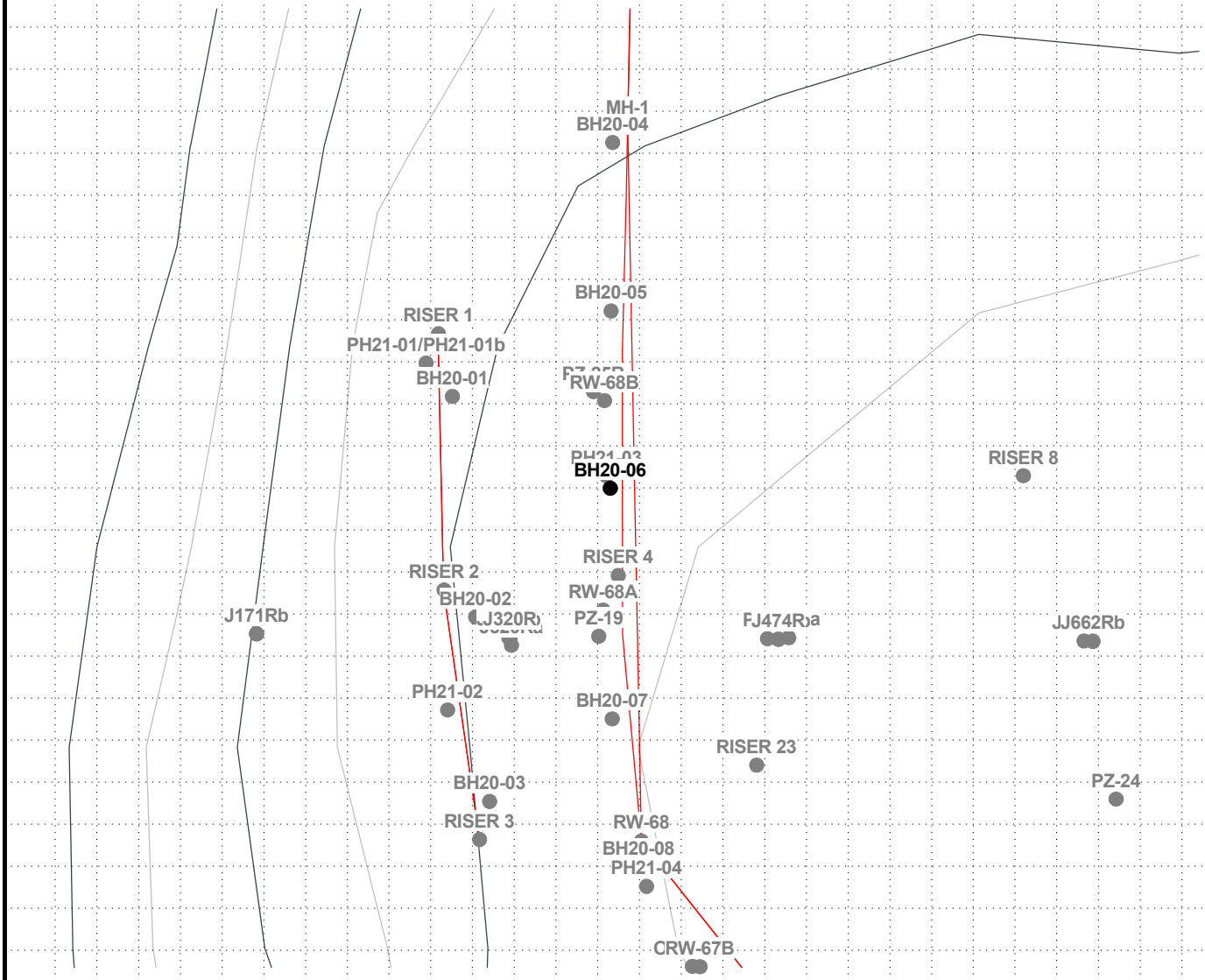
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 3 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-06	LOCATION COORDINATES: 629640.983N 2199486.485E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 10 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/8/20 / COMPLETED: 6/8/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1380.1	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 20 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 13 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-06

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	4 4 5 4	85		Silty clay (CL-ML) low plasticity, stiff, dry, olive brown, trace roots, Reworked clay /trench backfill. @ 1 ft, no roots.								Start drilling on 6/8/20 at 0850 using 4 1/4 inch HSAs and 2 inch SPT.
1377.6	2.5	D-2	5											
		D-3	2 3	85		Lean clay (CL) medium plasticity, medium stiff, dry, olive brown, Alluvial Clay.								
			2			@ 3.7 ft, very soft, moist.								Collect soil sample BBSD-06A from 3.5 to 4 feet.
		D-4	0 1 0 1	90		@ 5.4 ft, wet.								
1374.1	6.0													
		D-5	0 0 1 1	40		Silt with sand ((ML)s) no plasticity, very soft, wet, olive gray, fine grained, Alluvial Silt.								
1372.1	8.0													
		D-6	0 1 0 0	45		Poorly graded sand (SP) no plasticity, very loose, wet, olive brown, fine grained, Alluvial Sand.	0.0	95.2	4.8			24	SP	10YR 5/2 Grayish Brown Poorly Graded Sand
1370.1	10.0													

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty sand (SM) no plasticity, very loose, wet, brown, fine grained, Alluvial Sand.								
		D-7	0 1 0	80										
		D-8	5 7 8	73		@ 13 ft, medium dense.	0.0	75.9	24.1				SM	2.5Y 6/3 Light Yellowish Brown Silty Sand
1365.1	15.0													
						Poorly graded sand (SP) no plasticity, loose, wet, brown, fine grained, Alluvial Sand.								
		D-9	2 3 2	93										
		D-10	2 3 3	100										Stop drilling at 1002. Collect groundwater sample BBSD-06B from inside augers.
1360.1	20.0													

LAB TESTING LOG

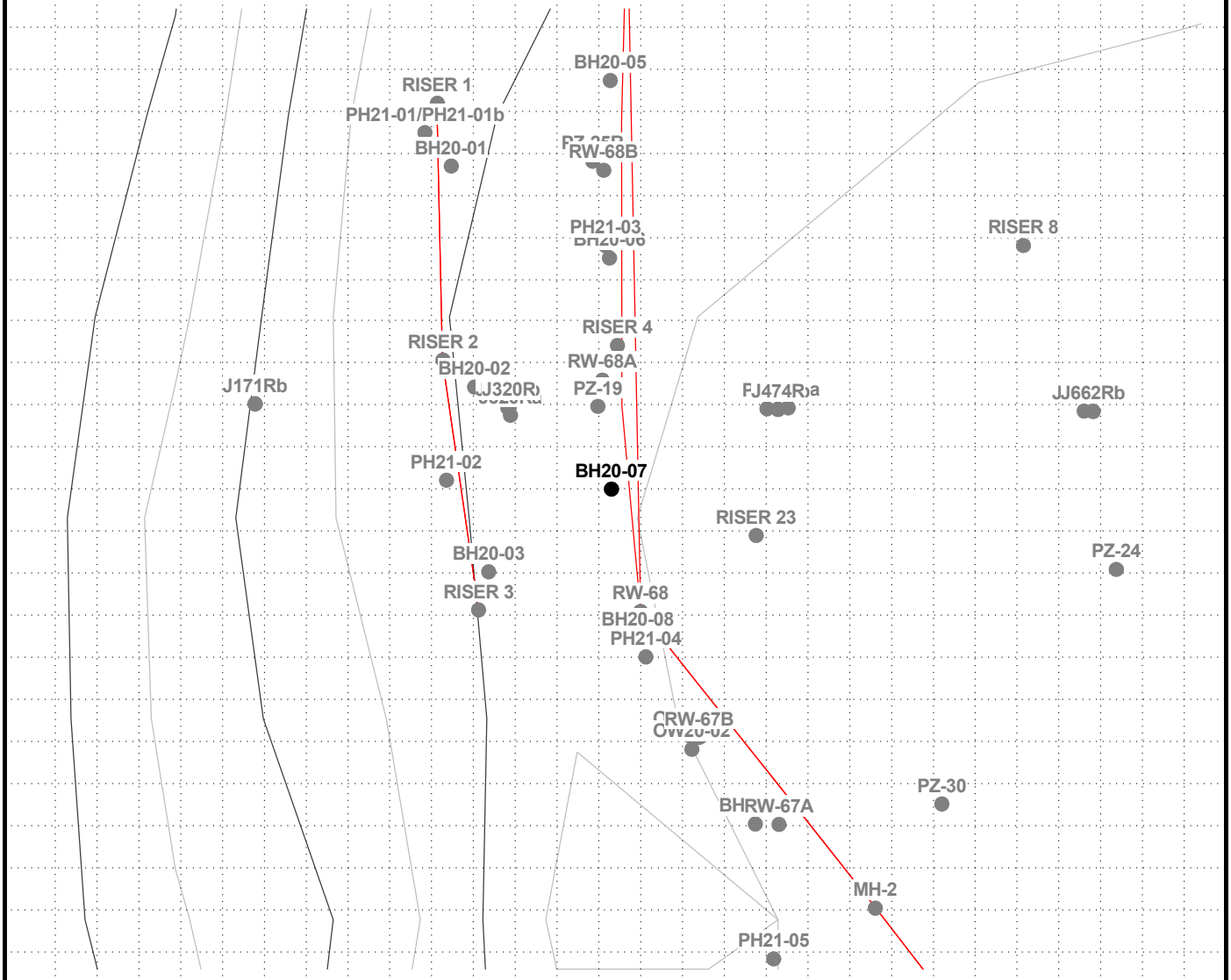
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 3 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-07	LOCATION COORDINATES: 629503.822N 2199487.639E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 10 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/5/20 / COMPLETED: 6/5/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1379.1	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 20 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 8 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-07

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	3 5 4 4	55		Silty clay (ML/CL) low plasticity, stiff, dry, brown, trace roots, Alluvial Clay. @ 0.5 ft, no roots.								Start drilling on 6/8/20 at 1003 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	2 1 1 3	75										
1376.1	3.0													
		D-3	1			Silty clay with sand ((CL-ML)s) low plasticity, soft, moist, brown, with fine sand, Alluvial Clay.								Collect soil sample BBSD-07A from 3 to 3.5 feet.
1375.1	4.0 ▽		3											
		D-4	2 1 1 2	80		Poorly graded sand with silt (SP-SM) no plasticity, very loose, wet, brown, fine grained, Alluvial Sand.								
1373.1	6.0													
		D-5	1 1 2 1	85		Poorly graded sand (SP) no plasticity, very loose, wet, brown, fine grained, Alluvial Sand.								
		D-6	1 1 1 1	90			0.0	97.7	2.3			24	SP	10YR 5/3 Brown Poorly Graded Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-7	0 1 2 3	90		Poorly graded sand (SP) no plasticity, very loose, wet, brown, fine grained, Alluvial Sand, (cont.).								
		D-8	1 2 3	100										
		D-9	0 1 1	93										
1360.6	18.5													Stop drilling at 1124. Collect groundwater sample BBSD-07B from inside augers.
		D-10	1 4 6	93		Silty sand (SM) no plasticity, loose, wet, brown, fine grained, Alluvial Sand.	0.0	87.7	12.3			24	SM	10YR 5/3 Brown Silty Sand
1359.1	20.0													

LAB TESTING LOG

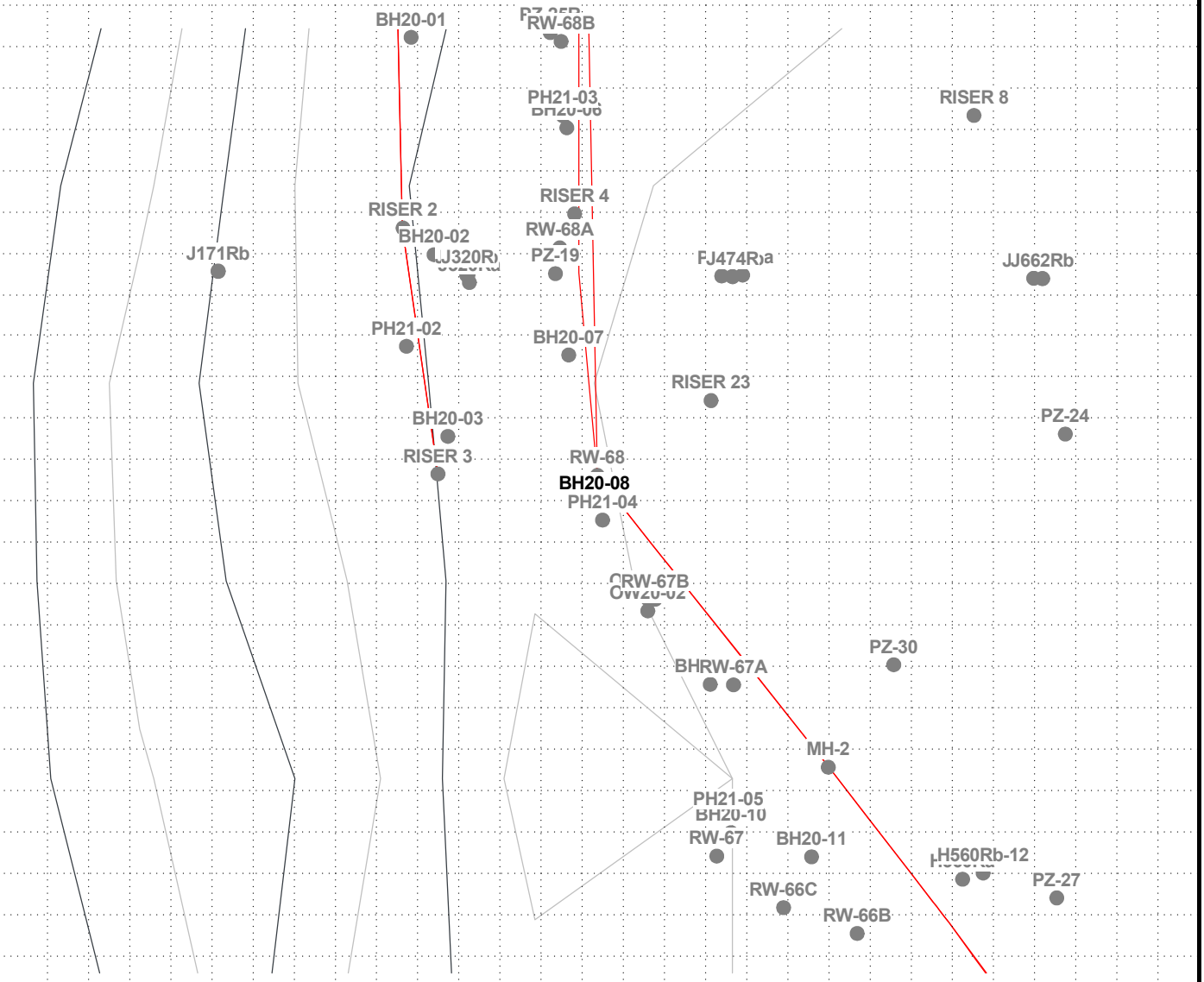
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET: 1 OF 3 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-08	LOCATION COORDINATES: 629415.776N 2199503.251E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 7 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/8/20 / COMPLETED: 6/8/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1377.0	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 15 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 11 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-08

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 2 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	3 3 4 3	80		Lean clay (CL) low plasticity, medium stiff, dry, brown, trace roots, Alluvial Clay. @ 1 ft, no roots.								Start drilling on 6/8/20 at 1320 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	1 1 1 1	80										
1373.0	4.0													
		D-3	1 1 2 1	85		Poorly graded sand with silt (SP-SM) no plasticity, very loose, moist, brown. @ 5.7 ft, wet.								Collect soil sample BBSD-08A/BBSD-XX from 4 to 5 feet.
1371.0	6.0													
		D-4	1 2 1 2	75		Silty sand (SM) no plasticity, very loose, wet, brown, Alluvial Sand.								
		D-5	0 0 0 1	70			0.0	85.7	14.3			26	SM	10YR 5/3 Brown Silty Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-6	1 2 3 3	75										
		D-7	1 2 3	100										
1362.0	15.0													Stop drilling at 1420. Collect groundwater sample BBSD-08B/BBSD-XXA from inside augers.

LAB TESTING LOG

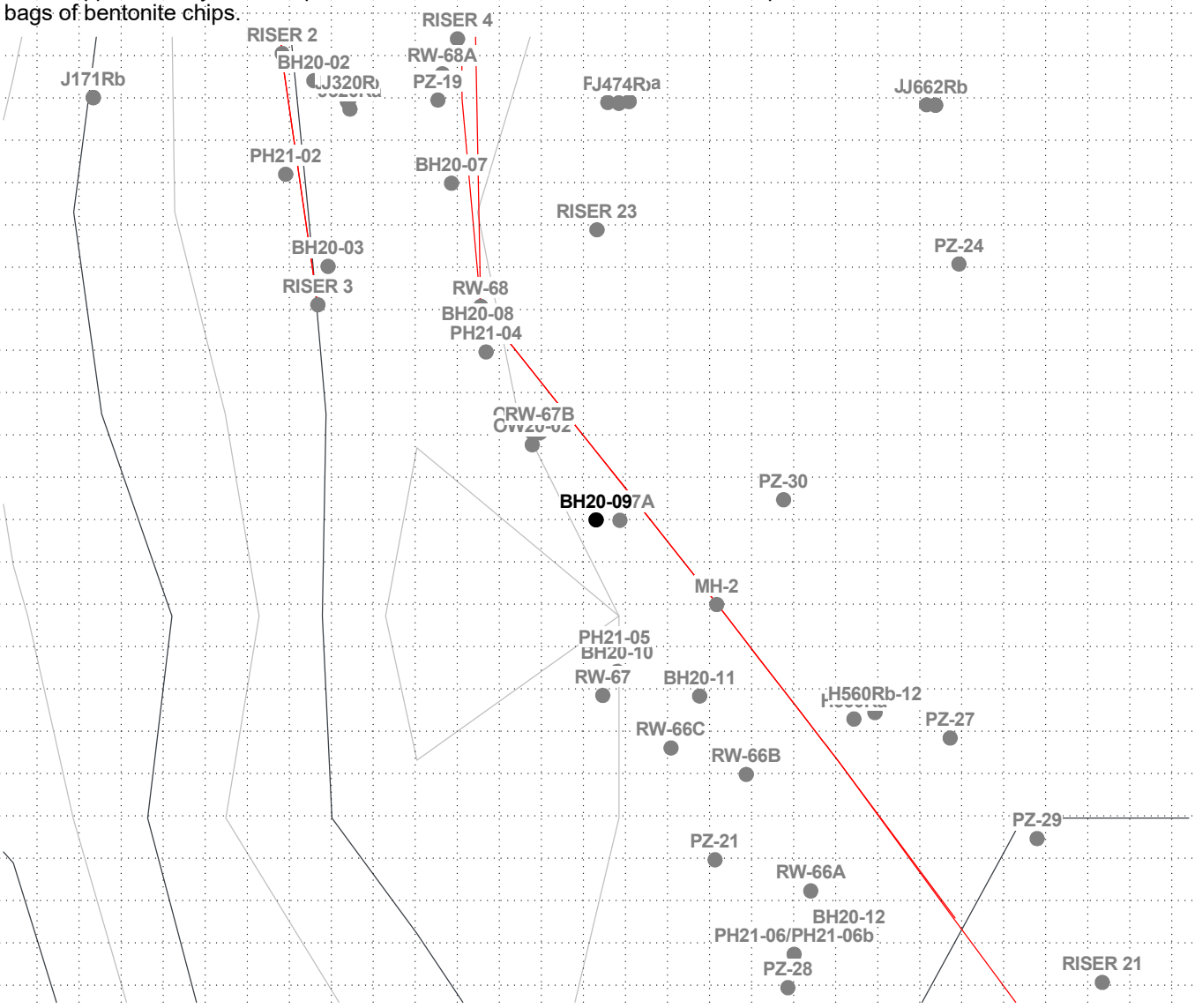
DIVISION: NWO		INSTALLATION: Big Bend Dam	SHEET 1 OF 3 SHEETS
1. PROJECT: FY21 Drain Replacement		9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83 / VERTICAL: Project Datum
		10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA	
2. HOLE NUMBER: BH20-09	LOCATION COORDINATES: 629305.020N 2199573.045E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 10 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: --- / BEARING	14. ELEVATION GROUND WATER	
		15. DATE BORING	STARTED: 6/5/20 / COMPLETED: 6/5/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1373.8	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 15 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Offset approximately 40 feet upstream from staked location due to overhead power lines/ditches - backfilled with 11 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD	HOLE NO: BH20-09

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	3 4 5 4	80		Lean clay (CL) low to medium plasticity, stiff, dry, brown, trace fine to coarse sand, trace roots, Alluvial Clay.								Start drilling on 6/5/20 at 0800 using 4 1/4 inch HSAs and 2 inch SPT.
						@ 1 ft, no roots.								
		D-2	4 4 5 6	100										
1370.3	3.5													
		D-3				Sandy lean clay (s(CL)) low plasticity, stiff, dry, brown, some fine to coarse sand, Alluvial Clay.								
		D-4	5 5 7 7	90										
1369.1	4.7													
		D-5				Lean clay (CL) medium plasticity, stiff, dry, dark gray, Alluvial Clay.								Collect soil sample BBSD-09A from 5.7 to 6 feet.
						@ 5.9 ft, moist. @ 6 ft, soft, olive brown.								
	▽	D-6	0 1 2 2	65			0.0	19.2	80.8	29	18	27	CL	Lean Clay
		D-7	0 1 1 1	80										
1364.8	9.0													
		D-8				Silty sand (SM) no plasticity, very loose, wet, olive gray, fine grained, Alluvial Sand.	0.9	87.0	12.1			21	SM	2.5Y 5/2 Grayish Brown Silty Sand
1363.8	10.0													

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-9	0 1 2 2	55		Poorly graded sand (SP) no plasticity, very loose, wet, brown, fine grained, Alluvial Sand.								
		D-10	0 1 2	100										
1358.8	15.0													Stop drilling at 0900. Collect groundwater sample BBSD-09B from inside augers.

LAB TESTING LOG

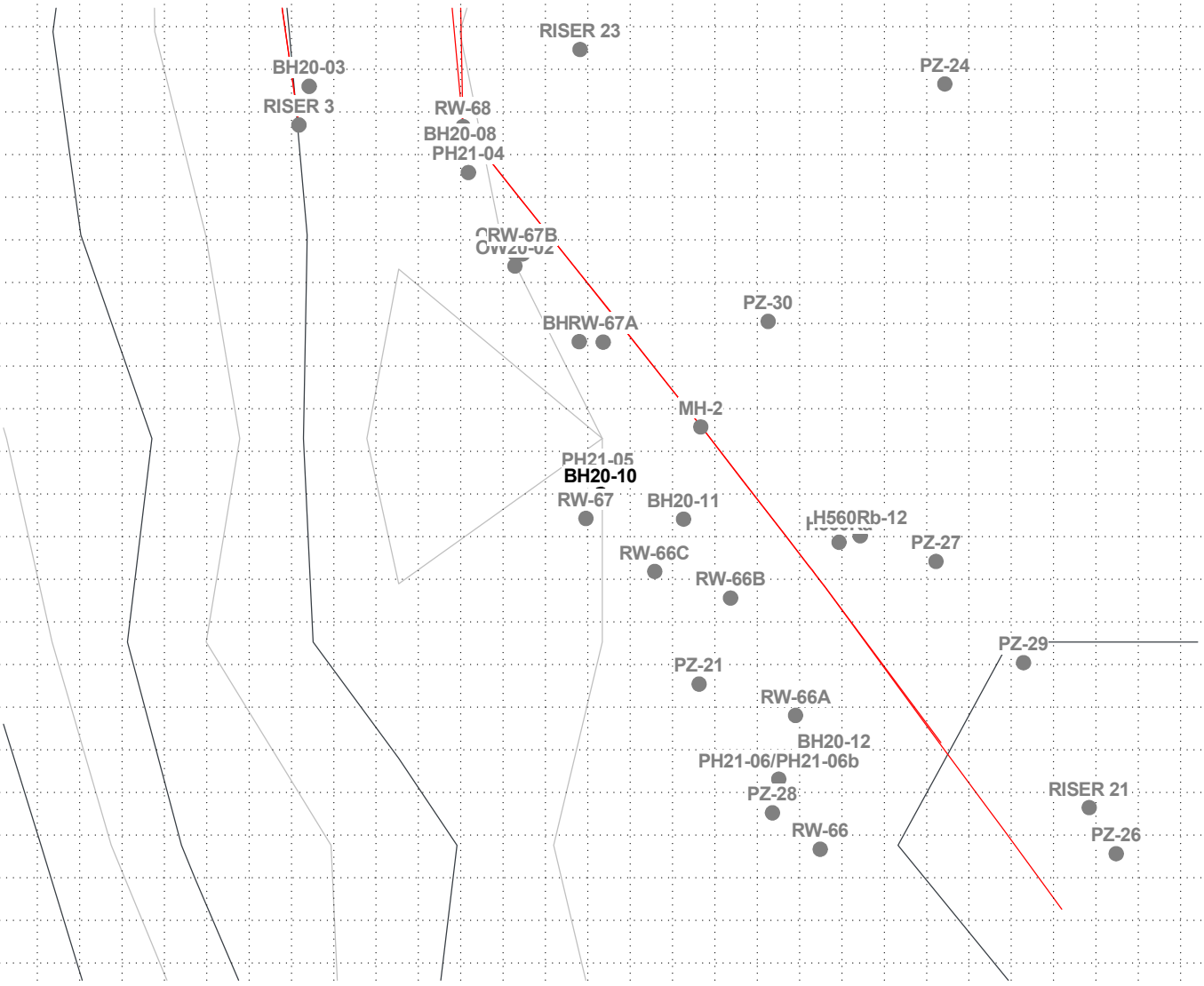
DIVISION: NWO		INSTALLATION: Big Bend Dam	SHEET 1 OF 3 SHEETS
1. PROJECT: FY21 Drain Replacement		9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83 / VERTICAL: Project Datum
		10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA	
2. HOLE NUMBER: BH20-10	LOCATION COORDINATES: 629215.513N 2199585.558E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 7 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: --- / BEARING	14. ELEVATION GROUND WATER	
		15. DATE BORING	STARTED: 6/4/20 / COMPLETED: 6/4/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1373.1	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 15 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled at staked location - backfilled with 11 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-10

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 3 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	1 2 2 4	55		Lean clay (CL) low plasticity, medium stiff, dry, brown, trace fine to medium sand, trace roots, Alluvial Clay. @ 1 ft, no roots.								Start drilling on 6/4/20 at 1356 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	3 7 10 15	90		@ 2.5 ft, stiff.								
		D-3	9 8 11 12	100		@ 4 ft, very stiff, dark gray to black.								Collect soil sample BBSD-10A from 5.6 to 6 feet.
1367.1	6.0													
		D-4	2 2 2 3	100		Clayey sand (SC) medium plasticity, soft, moist, medium gray, Alluvial Clay. @ 7.5 ft, wet.	0.0	15.9	84.1			27	SC	Clayey Sand
		D-5	0 1 0 1	50										
1363.4	9.7					Poorly graded sand (SP) no plasticity, very loose, wet, brown, fine Alluvial								

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 3 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-6	0 0 1 1	45		Sand.	0.0	95.0	5.0			21	SP-SM	10YR 5/2 Grayish Brown Poorly Graded Sand with Silt
		D-7	1 2 1	45										
1358.1	15.0													Stop drilling at 1452. Collect groundwater sample BBSD-10B from inside augers.

LAB TESTING LOG

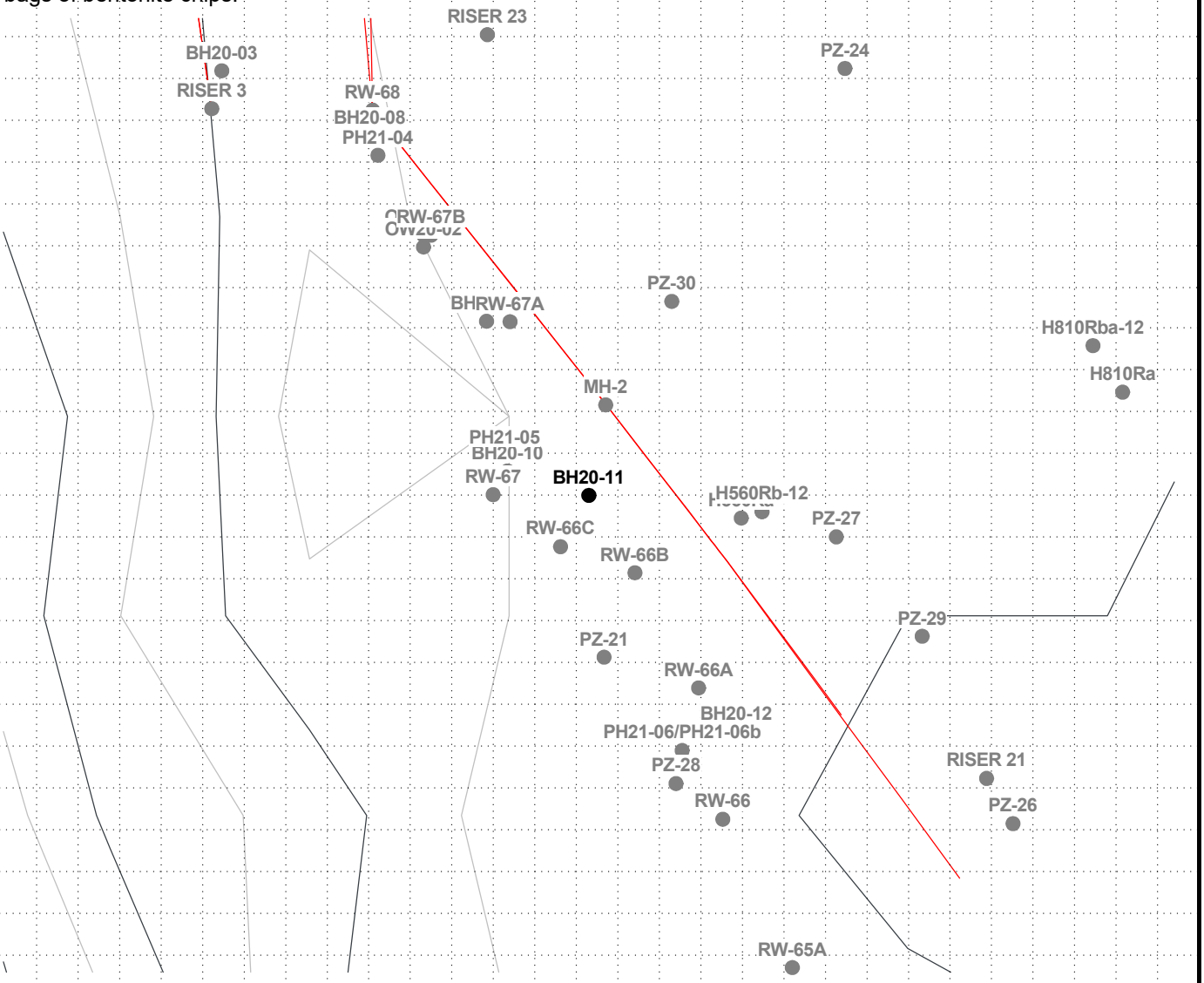
DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 2 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: BH20-11	LOCATION COORDINATES: 629200.947N 2199634.202E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 6 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 6/3/20 / COMPLETED: 6/4/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1369.0	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 10 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Offset approximately 50 feet upstream from staked location due to overhead power lines/ditches - backfilled with 6 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-11

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 2 OF 2 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1367.0	2.0	D-1	4 3 6 12	100		Lean clay (CL) low plasticity, stiff, dry, olive brown, trace fine to coarse sand, trace roots, Fill.								Start drilling on 6/3/20 at 1100 using 4 1/4 inch HSAs and 2 inch SPT.
1365.5	3.5	D-2	60/0.5	25		Gravelly silty clay with sand (g(CL-ML)s) no plasticity, hard, dry, olive brown, little fine to coarse sand, with fine to coarse gravel, Fill.								
1364.5	4.5	D-3	12			Well-graded sand with silt and gravel ((SW-SM)g) no plasticity, medium dense, moist, brown, fine to coarse grained, trace fine gravel, Fill. @ 4 ft, wet.								Collect soil sample BBSD-11A from 4 to 4.5 feet. Rig down for repairs until 6/4/20 at 1245.
		D-4	8 12 11	90		Lean clay (CL) medium plasticity, stiff, moist, olive brown to gray, Alluvial Clay.	0.0	9.9	90.1	33	22	19	CL	10YR 4/1 Dark Gray Lean Clay
1361.0	8.0	D-5	2 1 1 2	100		@ 6 ft, soft.								
1359.0	10.0	D-6	0 1 1 1	55		Sandy lean clay (s(CL)) low plasticity, very soft, wet, olive brown, fine grained, Alluvial Clay.								Stop drilling at 1310. Collect groundwater sample BBSD-11B from inside augers.

LAB TESTING LOG

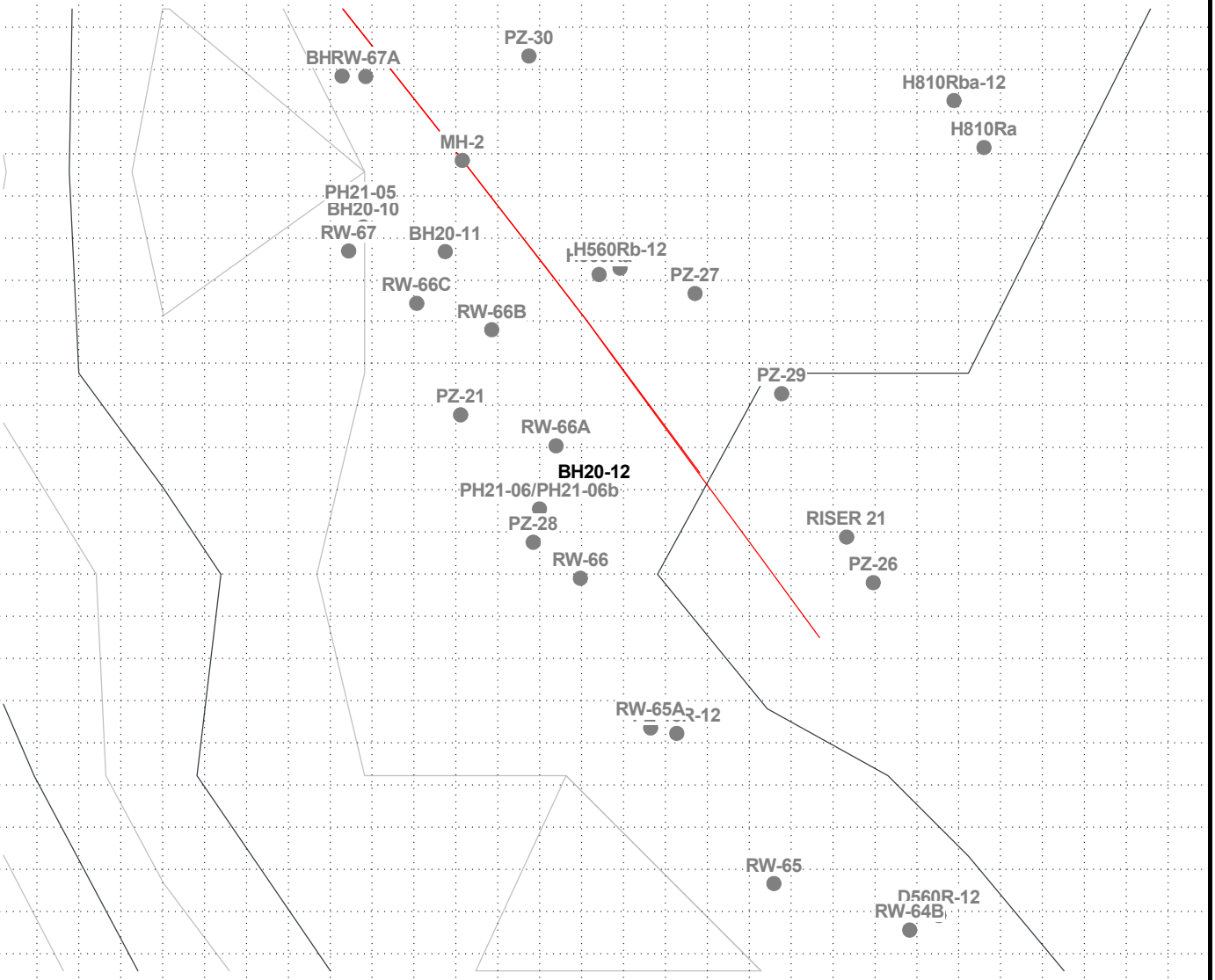
DIVISION: NWO		INSTALLATION: Big Bend Dam	SHEET 1 OF 2 SHEETS
1. PROJECT: FY21 Drain Replacement		9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83 / VERTICAL: Project Datum
		10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA	
2. HOLE NUMBER: BH20-12	LOCATION COORDINATES: 629059.710N 2199722.452E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 750C (Mite-e-Mite)	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 5 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
		14. ELEVATION GROUND WATER	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: --- / BEARING	15. DATE BORING	STARTED: 6/3/20 / COMPLETED: 6/3/20
6. THICKNESS OF OVERBURDEN: ---		16. ELEVATION TOP OF BORING: 1368.0	
7. DEPTH DRILLED INTO ROCK: ---		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 10 ft		18. SIGNATURE AND TITLE OF INSPECTOR: George Filpovich Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Offset approximately 10 feet upstream from staked location due to overhead power lines/ditches - backfilled with 7 bags of bentonite chips.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: BH20-12

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 2 OF 2 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

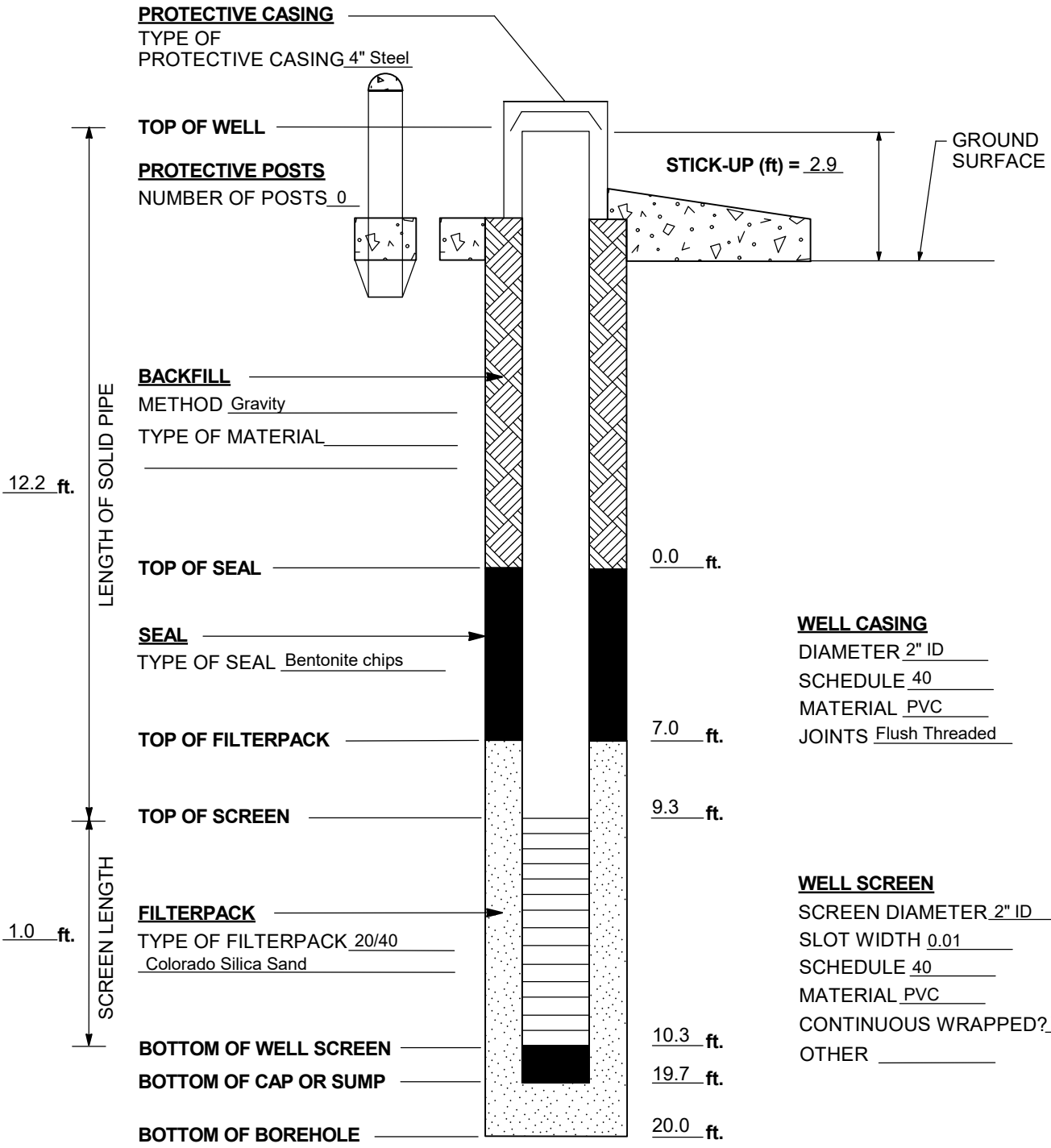
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-1	3 4 4 5	85		Lean clay (CL) low plasticity, medium stiff, dry, brown, trace fine to medium sand, trace roots. @ 1 ft, no roots.								Start drilling on 6/3/20 at 0930 using 4 1/4 inch HSAs and 2 inch SPT.
		D-2	1 2 2 3	90										
1364.5	3.5					Sandy lean clay (s(CL)) low plasticity, soft, moist, black, with fine to coarse sand, trace fine gravel, trace coarse gravel, Strong petroleum odor.								Collect soil sample BBSD-12A from 3.5 to 4 feet.
		D-3	1 2 4 5	75		@ 4.5 ft, wet.	5.6	67.0	19.9			20		Sand with Clay
1361.1	6.9	D-4	3 4 2 4	30		Lean clay (CL) medium plasticity, medium stiff, wet, brown to light gray.								
		D-5	0 1 2 2	100										Stop drilling at 1023. Collect groundwater sample BBSD-10B from inside augers.
1358.0	10.0													

PROJECT NAME			WELL NUMBER
Drain Replacement			OW20-01
LOCATION			**WELL LOCATION (Coordinates or Station)**
Big Bend Dam Fort Thompson, SD			629356.653N 2199535.284E NAD83
DATE INSTALLED	STARTED 6/10/20	COMPLETED 6/10/20	**TOP OF CASING ELEVATION**
TOTAL DEPTH OF BOREHOLE 20.0 ft bgs	**BORING DIAMETER** 8 in.		**SIGNATURE OF INSPECTOR/INSTALLER** George Filpovich

PIEZOMETER CONSTRUCTION DIAGRAM

NO SCALE
(ALL MEASUREMENTS FROM GROUND SURFACE)



NOTES
TOTAL VOLUME OF WATER ADDED DURING CONSTRUCTION (IF ANY)

MISC. INFORMATION

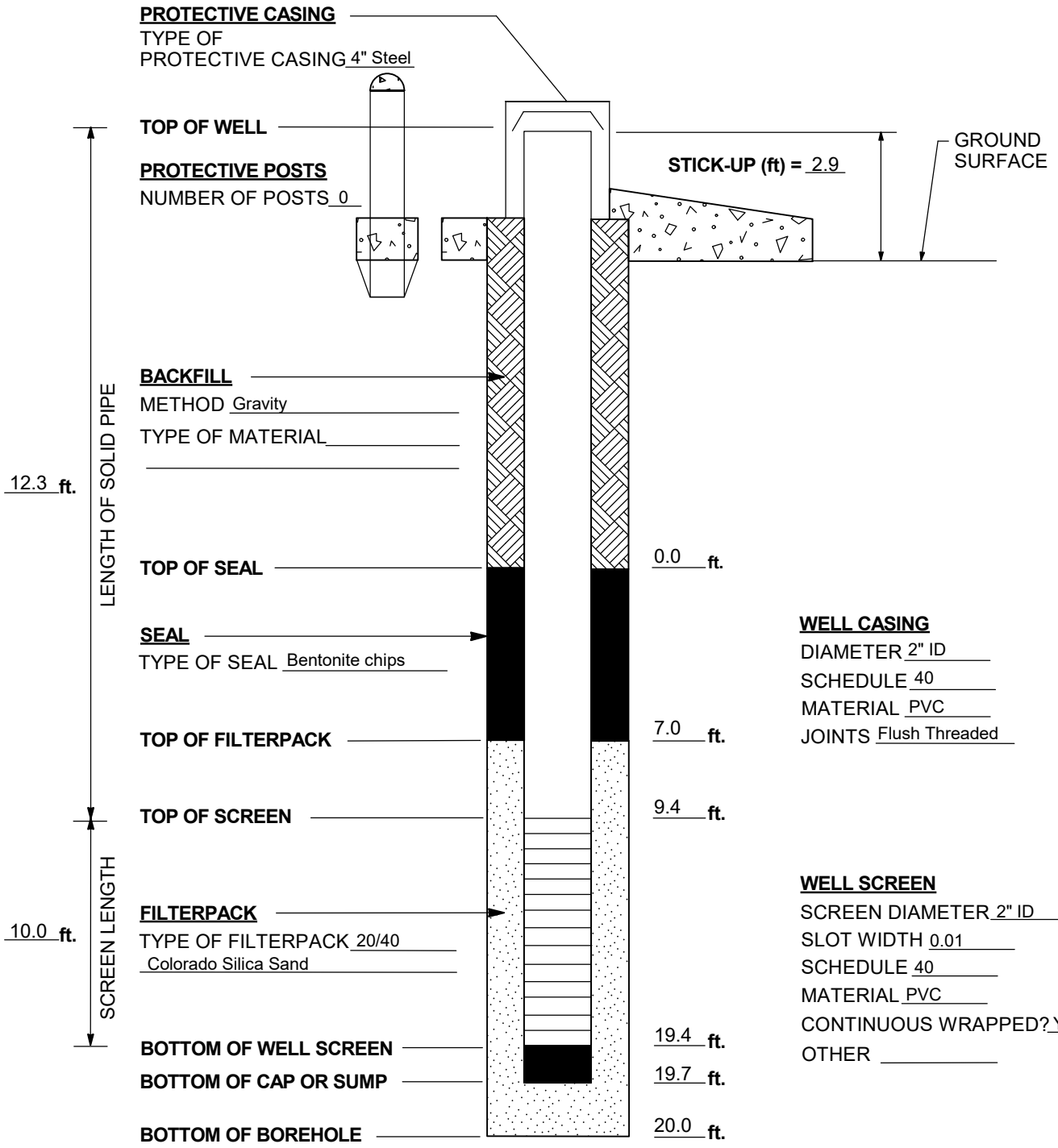
WATER LEVEL SUMMARY
OPEN BOREHOLE ---
AFTER INSTALLATION ---

Revised Mar 2011

PROJECT NAME			WELL NUMBER
Drain Replacement			OW20-02
LOCATION			WELL LOCATION (Coordinates or Station)
Big Bend Dam Fort Thompson, SD			629349.363N 2199535.361E NAD83
DATE INSTALLED	STARTED 6/10/20	COMPLETED 6/10/20	TOP OF CASING ELEVATION
TOTAL DEPTH OF BOREHOLE 20.0 ft bgs	BORING DIAMETER 8 in.		SIGNATURE OF INSPECTOR/INSTALLER George Filpovich

PIEZOMETER CONSTRUCTION DIAGRAM

NO SCALE
(ALL MEASUREMENTS FROM GROUND SURFACE)



WELL CASING
DIAMETER 2" ID
SCHEDULE 40
MATERIAL PVC
JOINTS Flush Threaded

WELL SCREEN
SCREEN DIAMETER 2" ID
SLOT WIDTH 0.01
SCHEDULE 40
MATERIAL PVC
CONTINUOUS WRAPPED? Yes
OTHER

NOTES
TOTAL VOLUME OF WATER ADDED DURING CONSTRUCTION (IF ANY)

MISC. INFORMATION

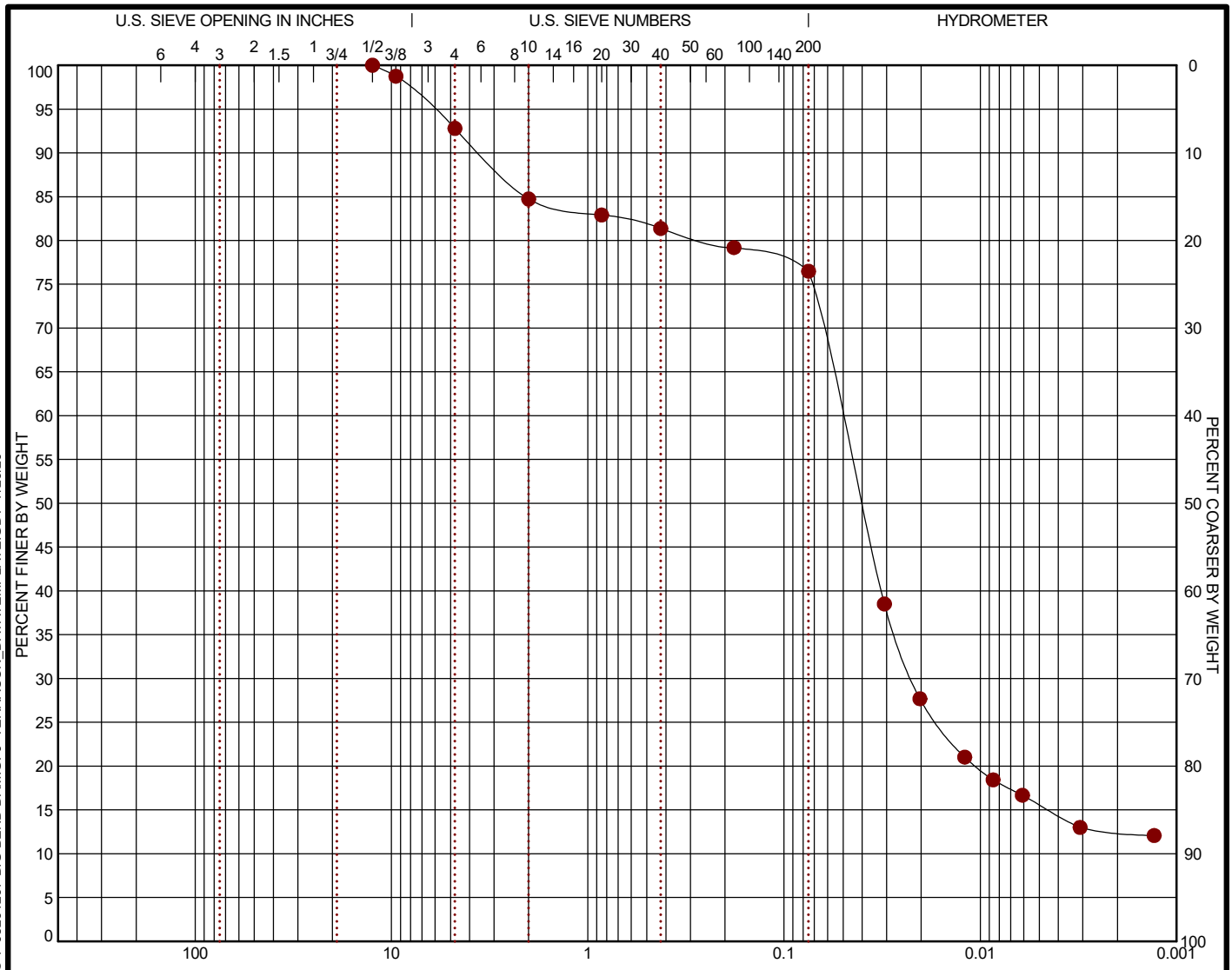
WATER LEVEL SUMMARY
OPEN BOREHOLE ---
AFTER INSTALLATION ---

Revised Mar 2011

Appendix D: Laboratory Data

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-01**	**3 - 4**	**0.0**	**7.2**	**16.3**	**60.9**		**15.6**	

	GRAIN SIZE
	●
D_{75}	**0.072**
D_{60}	**0.051**
D_{30}	**0.022**
D_{10}	
	COEFFICIENTS
C_C	
C_U	

● Sieve	● % Finer	Sieve	% Finer	Sieve	% Finer
1/2"	**100.0**				
3/8"	**98.74**				
#4	**92.79**				
#10	**84.73**				
#20	**82.91**				
#40	**81.37**				
	79.19				
	76.49				

SOIL DESCRIPTION

●

REMARKS

● 10YR 4/4 Dark Yellowish Brown

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05201207

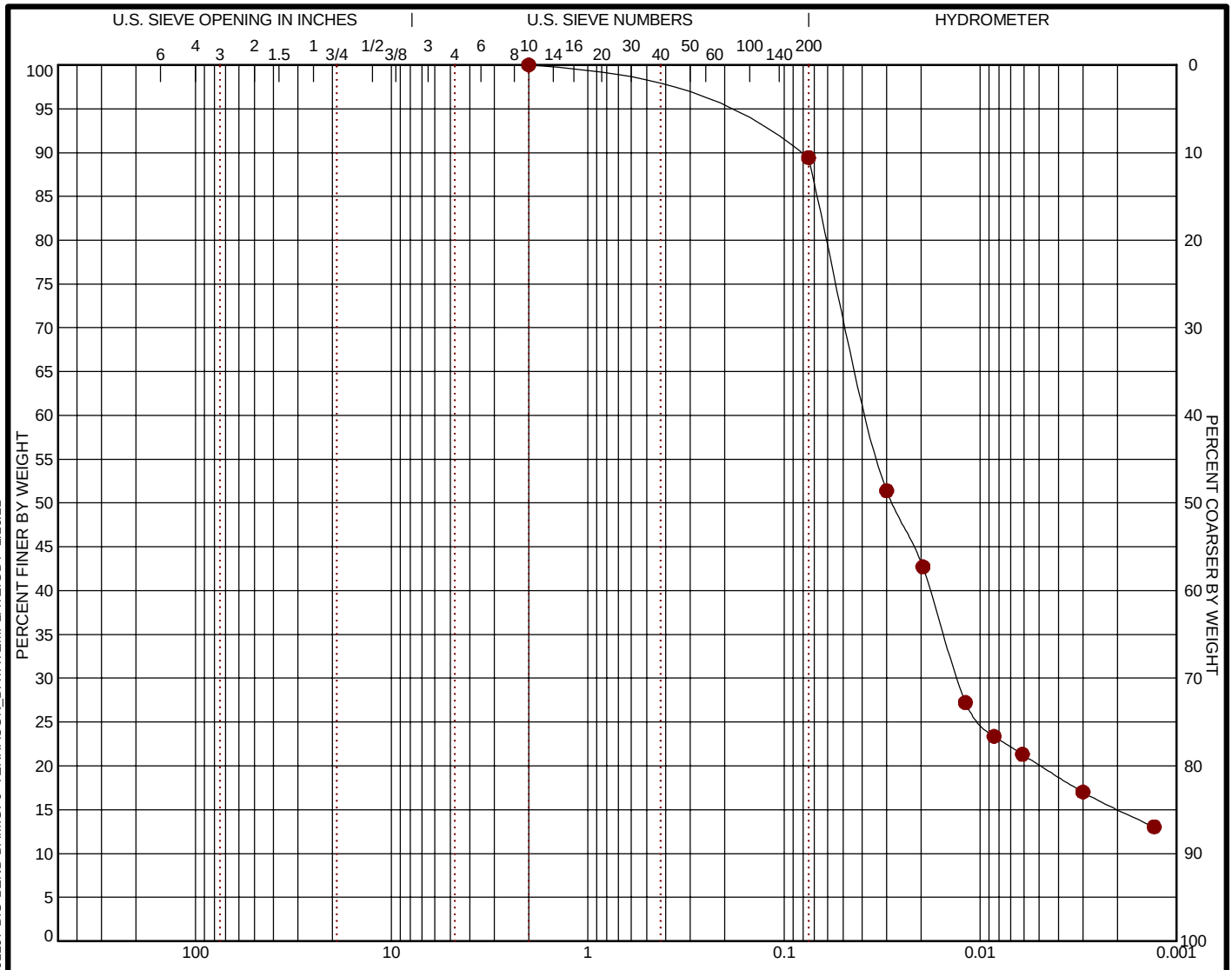
CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GADOT_GRAIN SIZE: USCS 1 05201207 BIG BEND DAM.GPJ TERRACON_DATATEMPLATE.GDT 7/20/20

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-01**	**5 - 6**	**0.0**	**0.0**	**10.6**	**69.3**		**20.1**	**CL**

	GRAIN SIZE
	●
D_{60}	**0.037**
D_{30}	**0.013**
D_{10}	
	COEFFICIENTS
C_C	
C_U	

● Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	**100.0**				
#200	**89.42**				

SOIL DESCRIPTION

● Lean Clay, Few Sand (CL)

REMARKS

● 2.5Y 3/2 Very Dark Grayish Brown

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05201207

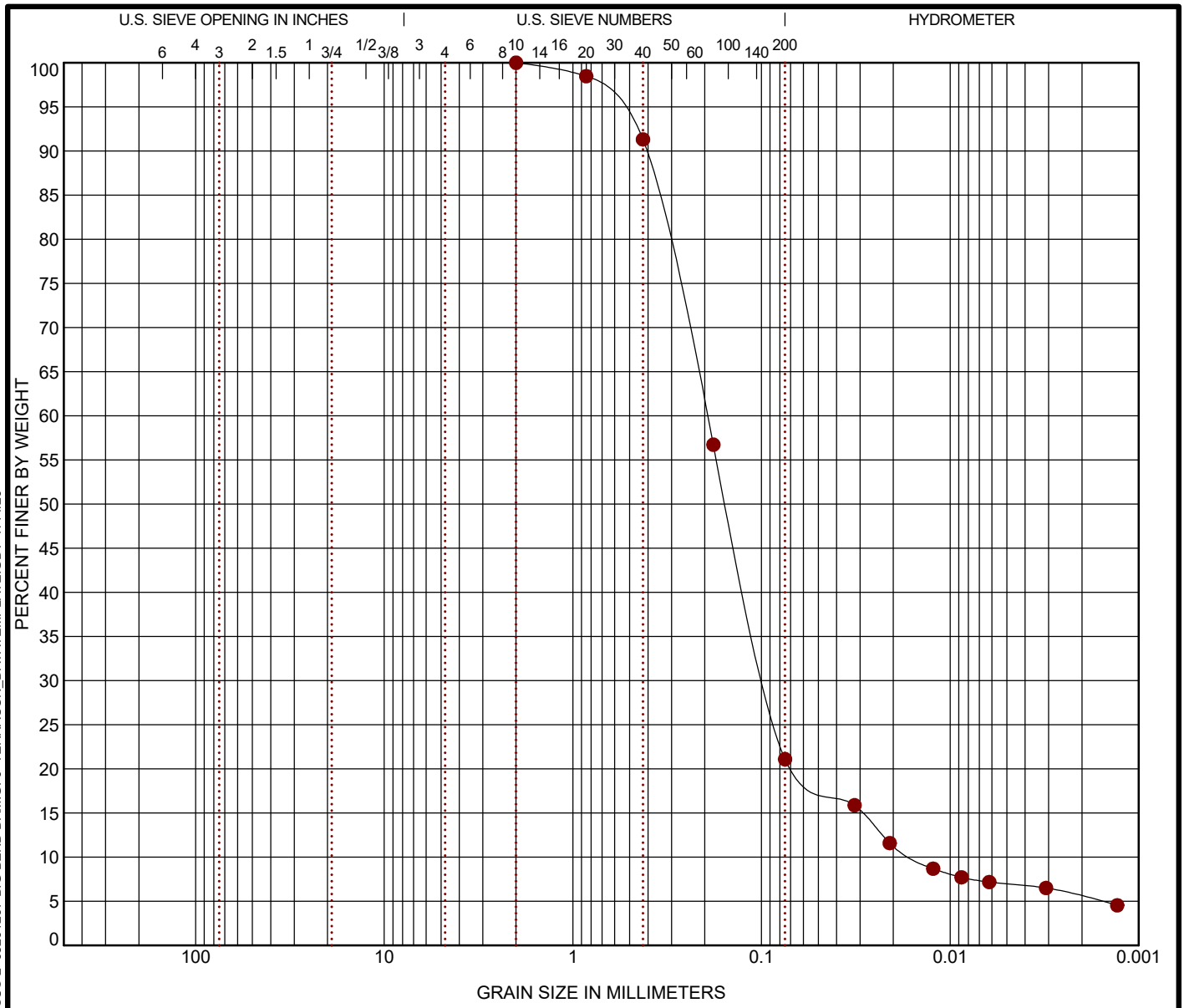
CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 05201207 BIG BEND DAM.GPJ TERRACON_DATATEMPLATE.GDT 2/26/21

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
BH20-02	4.5 - 6	SILTY SAND (SM)		NP	NP	NP	2.85	12.48

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
BH20-02	4.5 - 6	2	0.195	0.093	0.016	0.0	0.0	78.9	14.1		7.0

PROJECT: Big Bend Dam

SITE: 15080 A Circle
Omaha, NE

Terracon
15080 A Cir
Omaha, NE

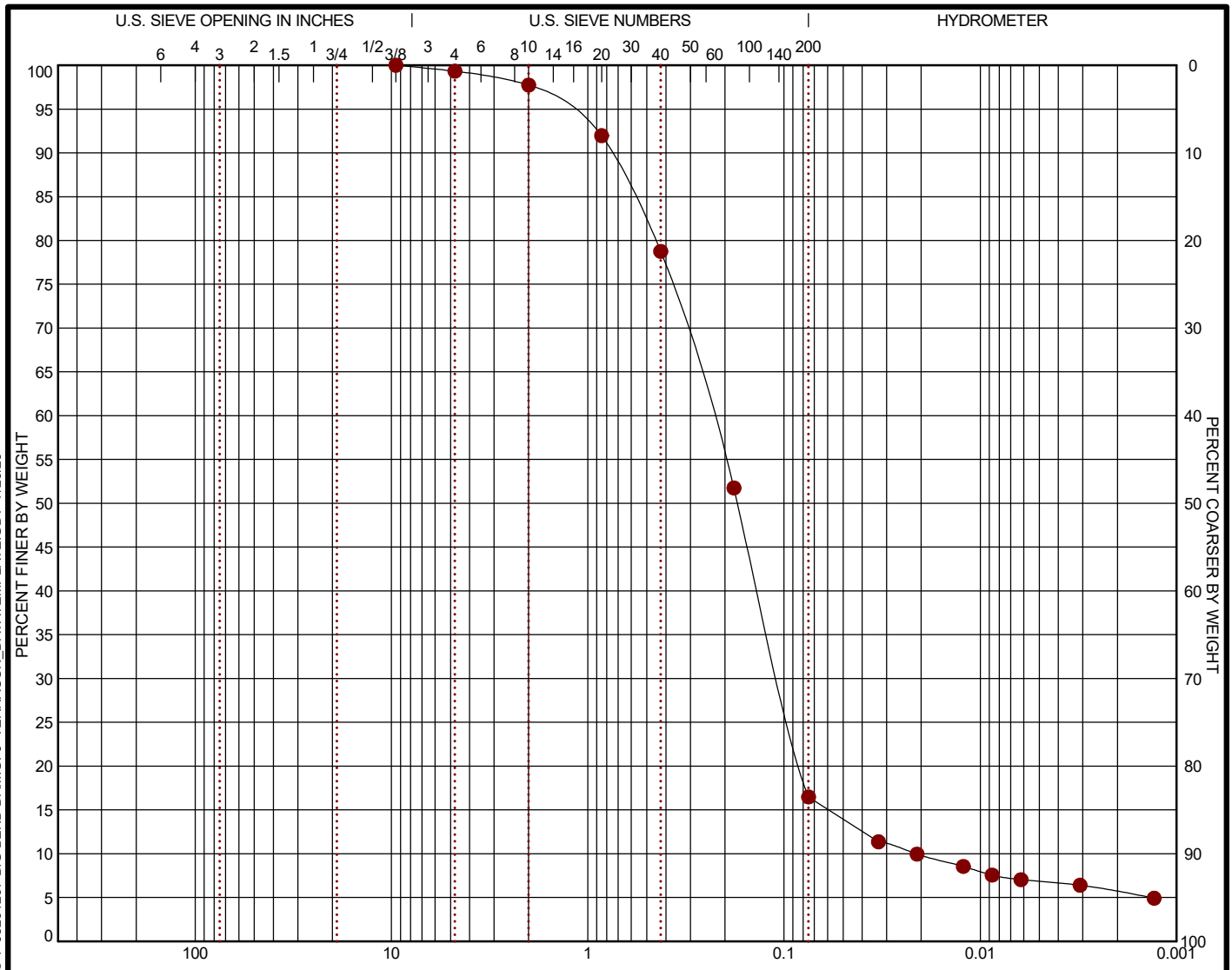
PROJECT NUMBER: 05201207

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-03**	**2 - 3.5**	**0.0**	**0.7**	**82.8**	**9.6**		**6.8**	**SM**

	GRAIN SIZE
	●
D_{75}	**0.377**
D_{60}	**0.234**
D_{30}	**0.105**
D_{10}	**0.021**
	COEFFICIENTS
C_C	**2.21**
C_U	**11.00**

●					
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/8"	**100.0**				
#4	**99.32**				
#10	**97.74**				
#20	**91.96**				
#40	**78.75**				
#80	**51.75**				
#200	**16.48**				

SOIL DESCRIPTION
● SILTY SAND (SM)

REMARKS
● 10YR 5/3 Brown

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05201207

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GADOT_GRAIN SIZE: USCS 1 05201207 BIG BEND DAM.GPJ TERRACON_DATATEMPLATE.GDT 7/20/20

PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0006
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

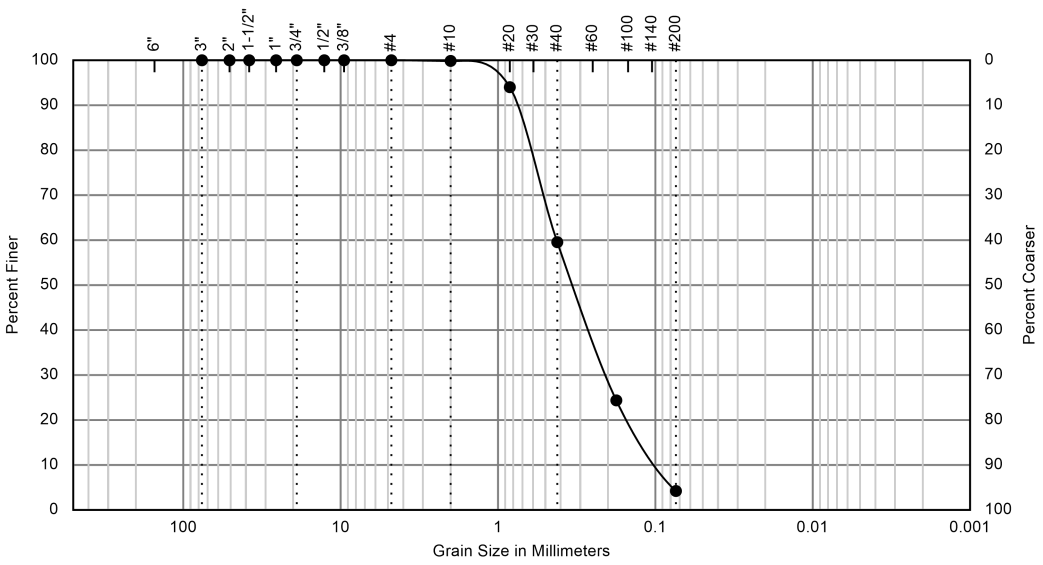
Sample Information

Sample Type: SPT
Sample Location: BH20-04. D-7, 10.5'-12.0'
Sample Description: 10YR 4/4 Dark Yellowish Brown Poorly Graded Sand (SP)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	94		
#40	60		
#80	24		
#200	4		



% Cobbles	% Gravel - 0.0		% Sand - 95.8			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.2	40.3	55.3	4.2

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.42	=0.21	=0.103	= 1.0	= 4.1	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0007
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

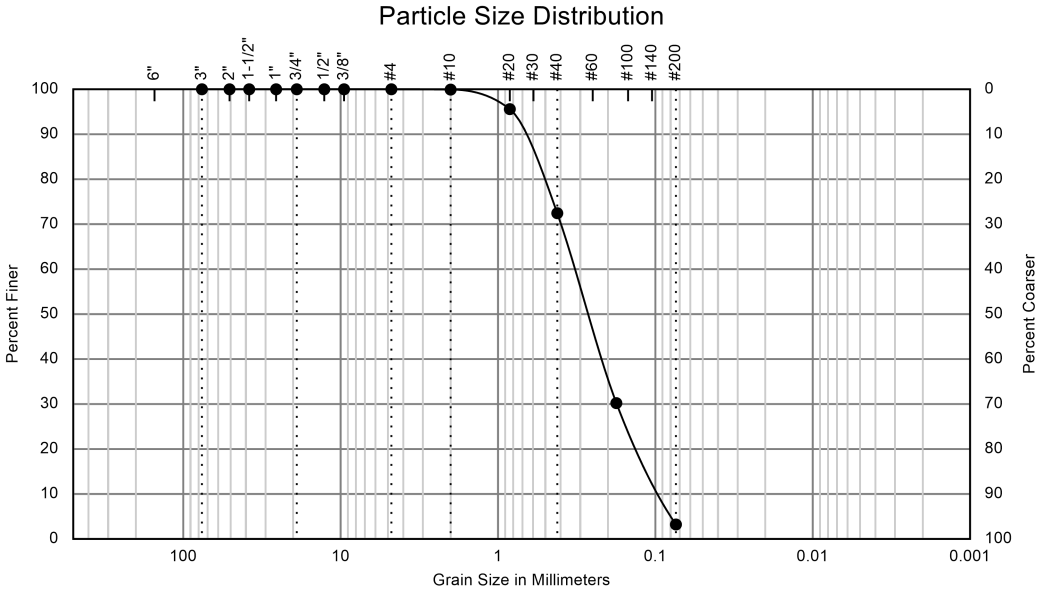
Sample Information

Sample Type: SPT
Sample Location: BH20-05, D-5, 8.0'-10.0'
Sample Description: 10YR 5/4 Yellowish Brown Poorly Graded Sand (SP)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	96		
#40	72		
#80	30		
#200	3		



% Cobbles	% Gravel - 0.0		% Sand - 96.8			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.1	27.5	69.2	3.2

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.32	=0.18	=0.097	= 1.0	= 3.3	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

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PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0008
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

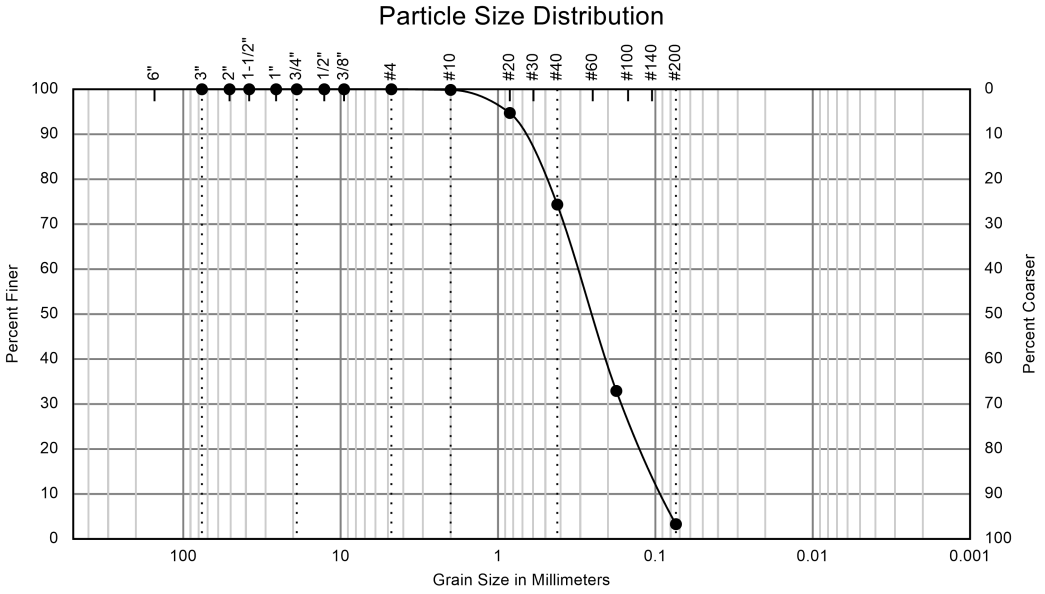
Sample Information

Sample Type: SPT
Sample Location: BH20-05, D-9, 18.5'-20.0'
Sample Description: 10YR 5/2 Grayish Brown Poorly-Graded Sand (SP)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	95		
#40	74		
#80	33		
#200	3		



% Cobbles	% Gravel - 0.0		% Sand - 96.7			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.1	25.5	71.1	3.3

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.31	=0.16	=0.093	= 0.9	= 3.3	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

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PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0009
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

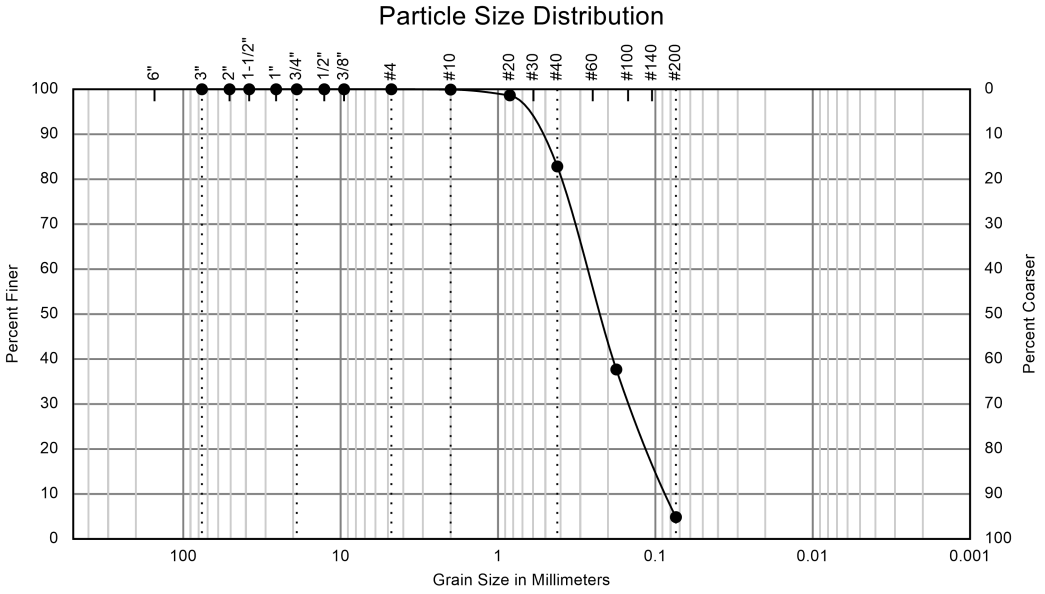
Sample Information

Sample Type: SPT
Sample Location: BH20-06, D-6, 8.0'-10.0'
Sample Description: 10YR 5/2 Grayish Brown Poorly-Graded Sand (SP)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	99		
#40	83		
#80	38		
#200	5		



% Cobbles	% Gravel - 0.0		% Sand - 95.2			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.1	17.1	78.0	4.8

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.27	=0.15	=0.087	= 1.0	= 3.1	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

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PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0010
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

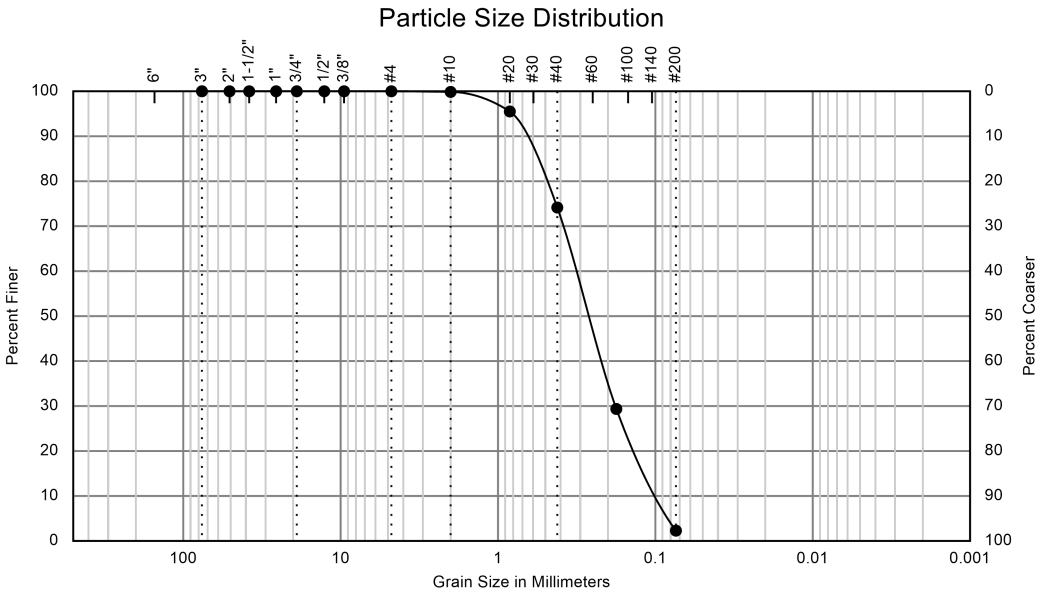
Sample Information

Sample Type: SPT
Sample Location: BH20-07, D-6, 8.0'-10.0'
Sample Description: 10YR 5/3 Brown
Poorly-Graded Sand (SP)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	96		
#40	74		
#80	29		
#200	2		



% Cobbles	% Gravel - 0.0		% Sand - 97.7			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.1	25.7	71.9	2.3

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.32	=0.18	=0.101	= 1.0	= 3.2	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0011
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

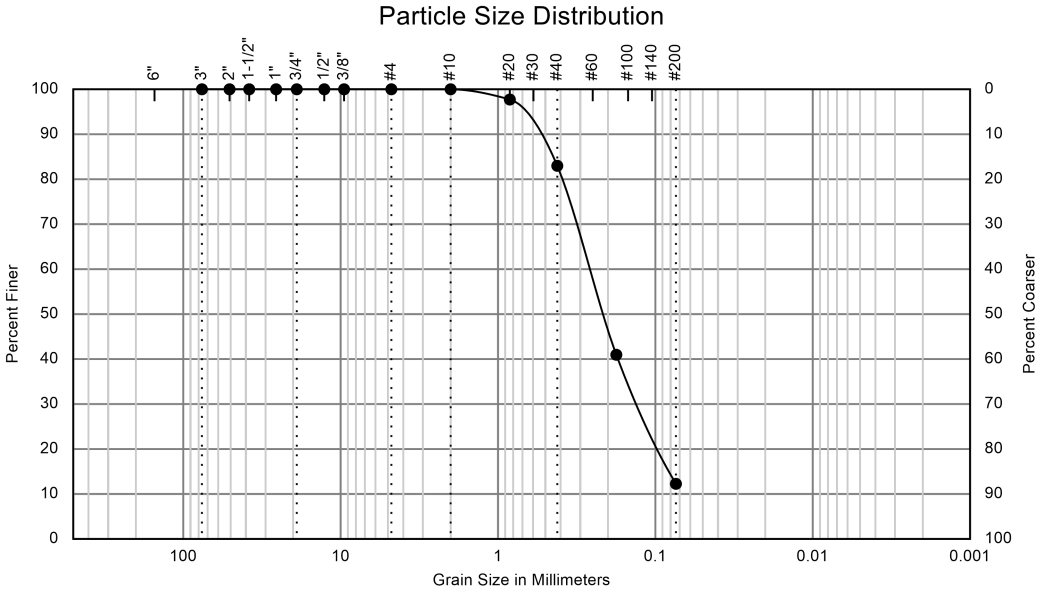
Sample Information

Sample Type: SPT
Sample Location: BH20-07, D-10, 18.5'-20.0'
Sample Description: 10YR 5/3 Brown Silty Sand (SM)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	98		
#40	83		
#80	41		
#200	12		



% Cobbles	% Gravel - 0.0		% Sand - 87.7			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.0	17.0	70.7	12.3

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.26	=0.13	=	=	=	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0012
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

Sample Information

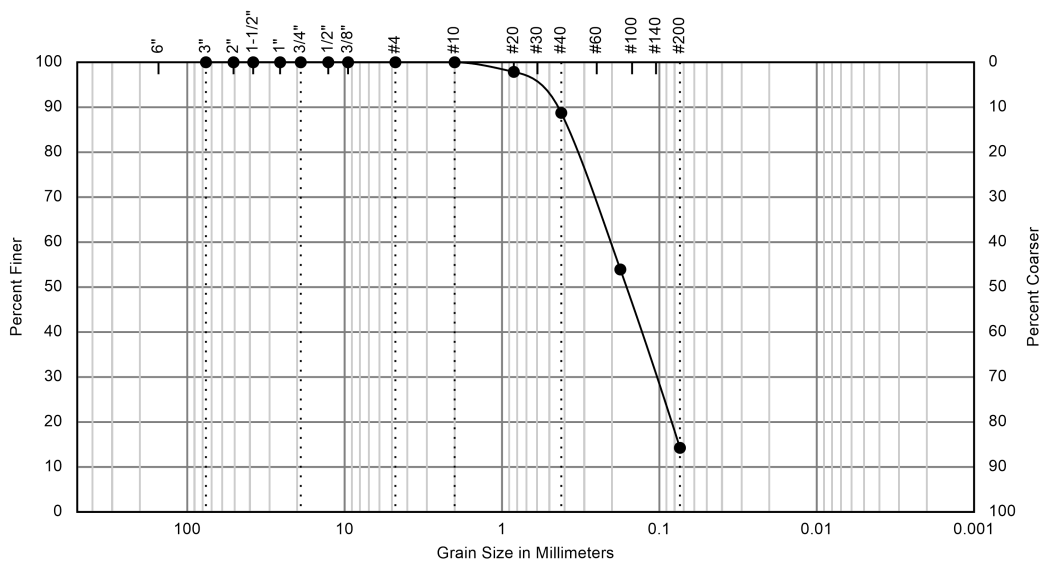
Sample Type: SPT
Sample Location: BH20-08, D-5, 8.0'-10.0'
Sample Description: 10YR 5/3 Brown Silty Sand (SM)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	98		
#40	89		
#80	54		
#200	14		

*



% Cobbles	% Gravel - 0.0		% Sand - 85.7			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.0	11.3	74.5	14.3

D_{60} =0.20	D_{30} =0.10	D_{10} =	C_c =	C_u =	FM =

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

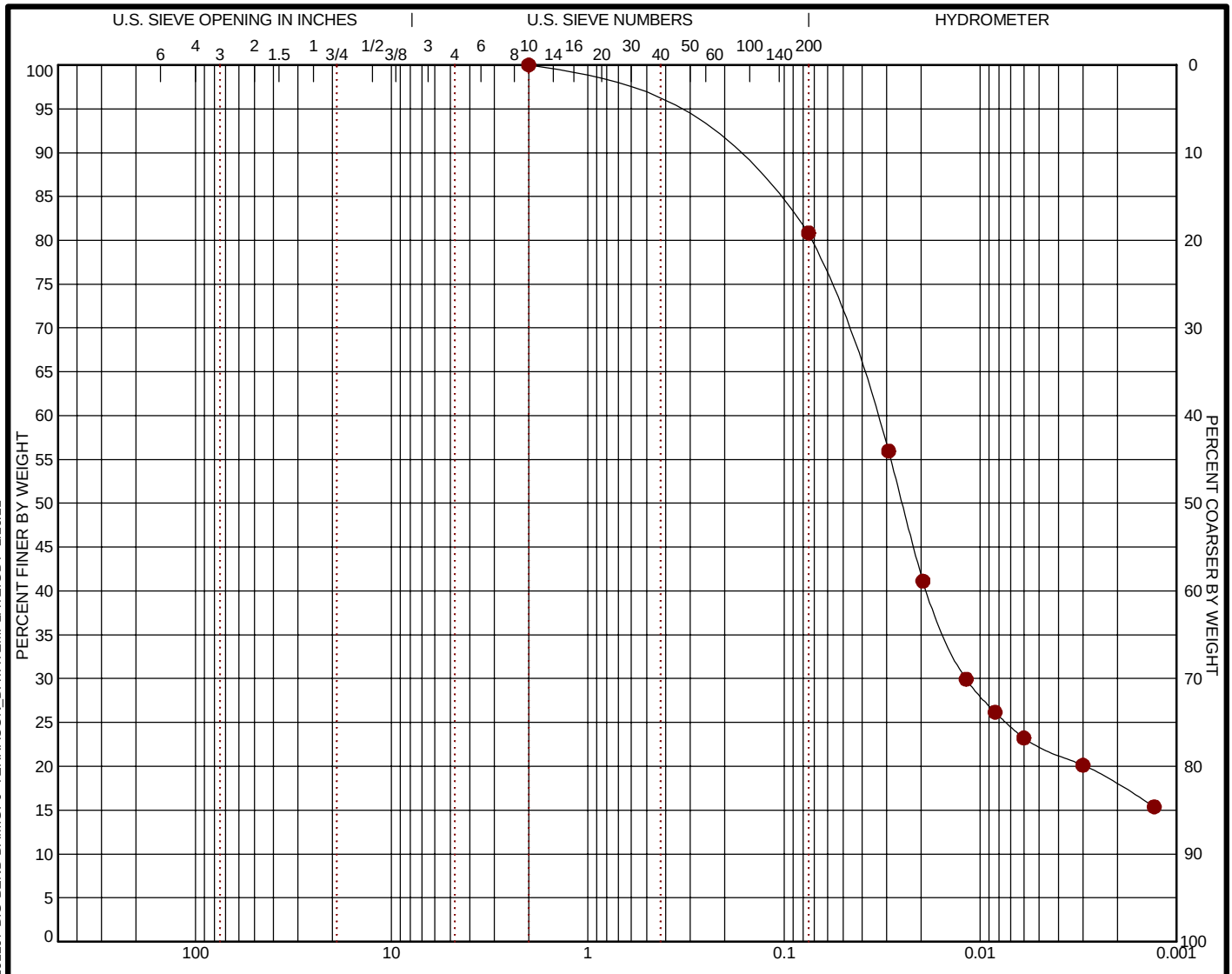
Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-09**	**6 - 8**	**0.0**	**0.0**	**19.2**	**58.4**		**22.4**	**CL**

	GRAIN SIZE
	●
D_{60}	**0.034**
D_{30}	**0.012**
D_{10}	
	COEFFICIENTS
C_C	
C_U	

● Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	**100.0**				
#200	**80.84**				

SOIL DESCRIPTION

● Lean Clay, Little Sand (CL)

REMARKS

● 2.5Y 4/3 Olive Brown

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05201207

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 05201207 BIG BEND DAM.GPJ TERRACON_DATATEMPLATE.GDT 2/26/21

PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0013
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

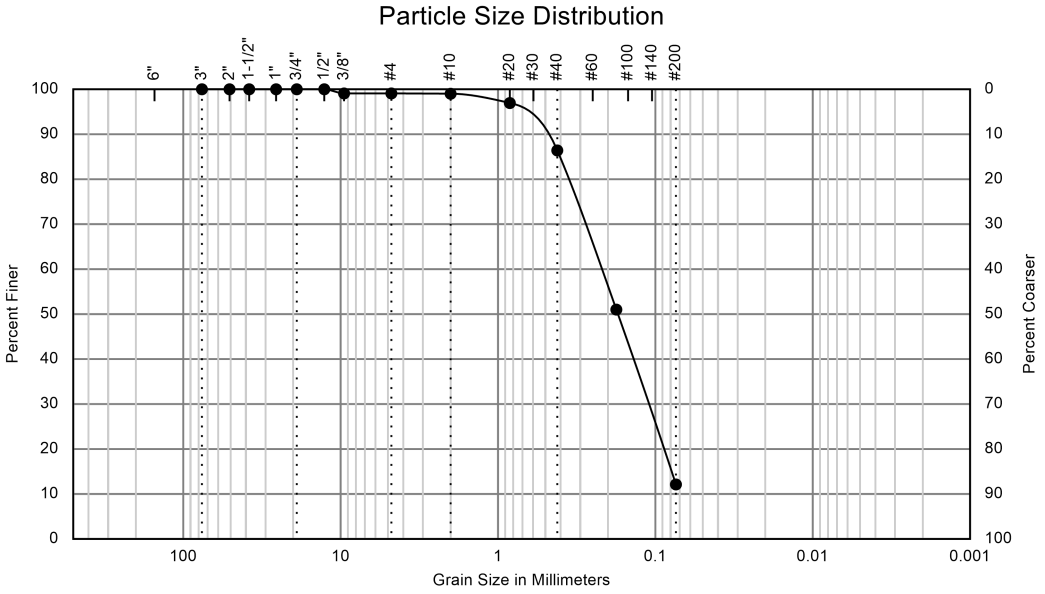
Sample Information

Sample Type: SPT
Sample Location: BH20-09, D-8, 9.0'-10.0'
Sample Description: 2.5Y 5/2 Grayish Brown Silty Sand (SM)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	99		
#4	99		
#10	99		
#20	97		
#40	86		
#80	51		
#200	12		



% Cobbles	% Gravel - 0.9		% Sand - 87.0			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.9	0.1	12.6	74.3	12.1

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.22	=0.11	=	=	=	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

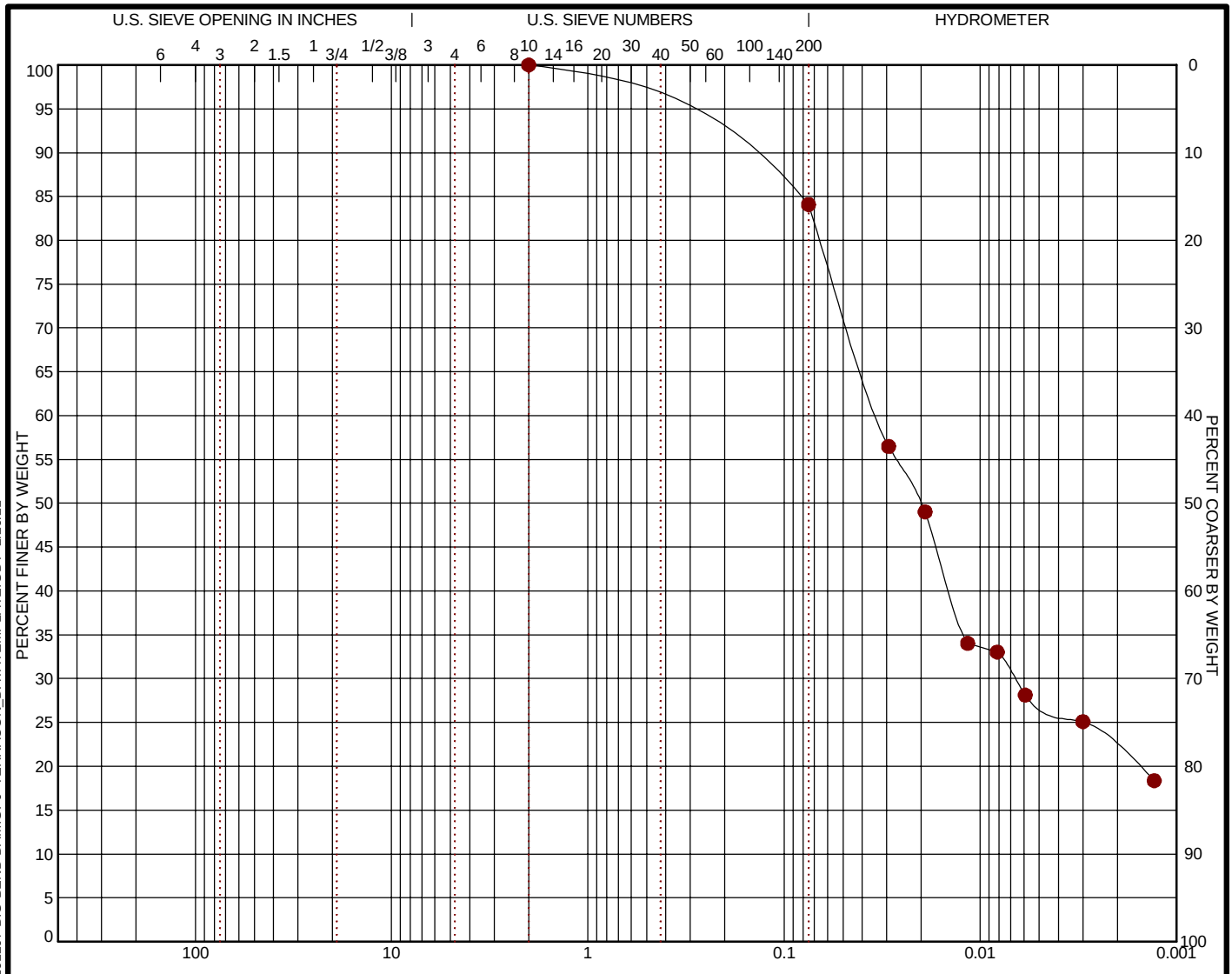
Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-10**	**6 - 8**	**0.0**	**0.0**	**15.9**	**56.7**		**27.4**	**CL**

	GRAIN SIZE
	●
D_{60}	**0.033**
D_{30}	**0.007**
D_{10}	
	COEFFICIENTS
C_C	
C_U	

● Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	**100.0**				
#200	**84.08**				

SOIL DESCRIPTION
● Lean Clay, Little Sand (CL)

REMARKS
● 10YR 4/2 Dark Grayish Brown

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05201207

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 05201207 BIG BEND DAM.GPJ TERRACON_DATATEMPLATE.GDT 2/26/21

PARTICLE SIZE DISTRIBUTION REPORT

Report Number: 05201207.0014
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

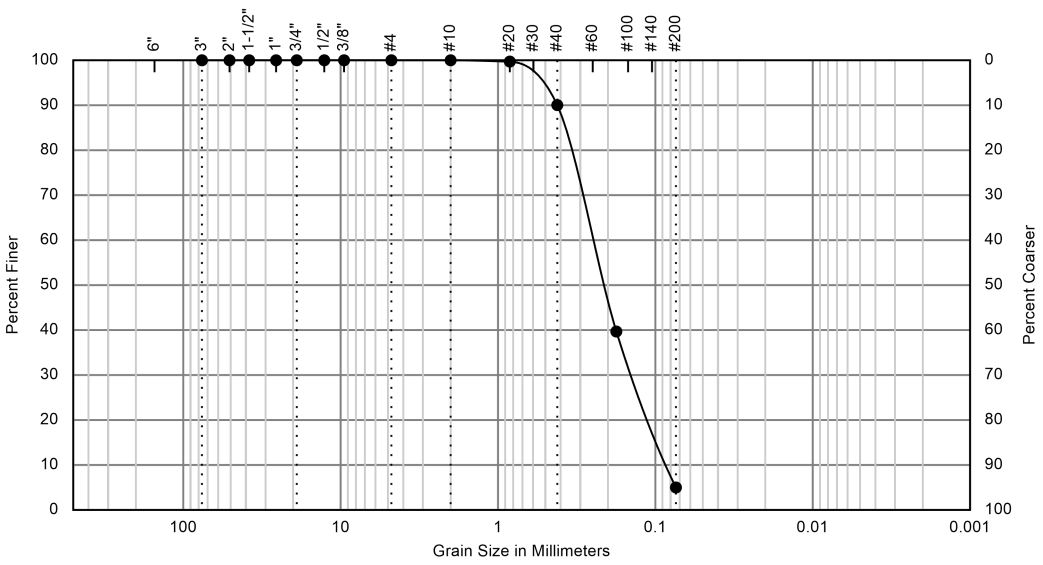
Sample Information

Sample Type: SPT
Sample Location: BH20-10, D-6, 10.0'-12.0'
Sample Description: 10YR 5/2 Grayish Brown
Poorly-Graded Sand with Silt (SP-SM)

Laboratory Test Data

Test Method: ASTM D422
Method: NA
Atterberg Limits:
Sample Preparation: Oven Dried
Sieving Method: Single Sieve-Set Sieving

Sieve Size	Percent Finer	Spec.*	Pass (X=Fail)
3"	100		
2"	100		
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	100		
3/8"	100		
#4	100		
#10	100		
#20	100		
#40	90		
#80	40		
#200	5		



% Cobbles	% Gravel - 0.0		% Sand - 95.0			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.0	0.0	10.0	85.0	5.0

D_{60}	D_{30}	D_{10}	C_c	C_u	FM
=0.25	=0.14	=0.086	= 0.9	= 2.9	=

*

Comments:

Services:
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE), Kristle P. Beaudet

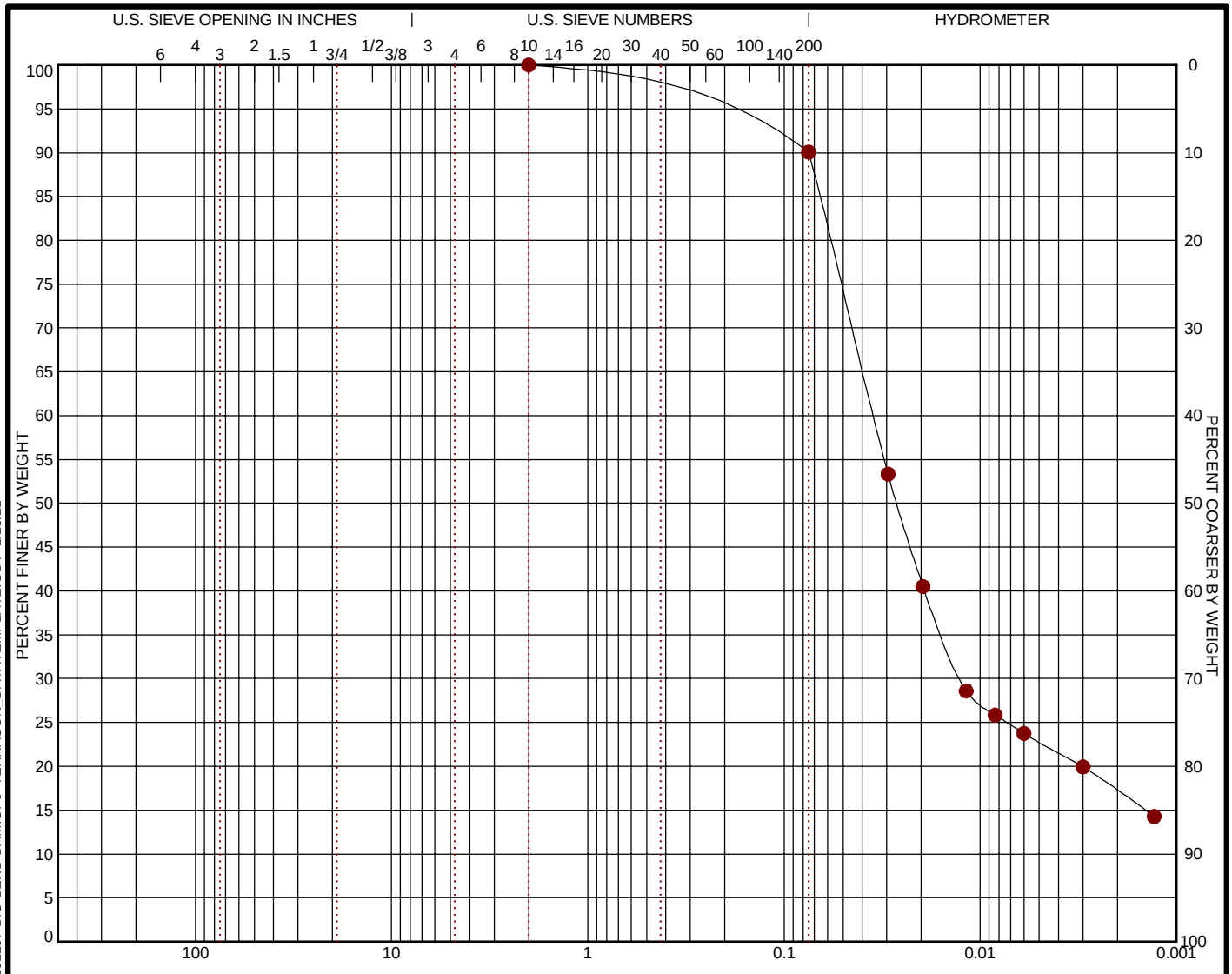
Reviewed By:
Rowden L. Miller
Project Manager

Test Methods:

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-11**	**4.5 - 6**	**0.0**	**0.0**	**9.9**	**67.3**		**22.7**	**CL**

	GRAIN SIZE
	●
D_{60}	**0.035**
D_{30}	**0.013**
D_{10}	
	COEFFICIENTS
C_C	
C_U	

● Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	**100.0**				
#200	**90.07**				

SOIL DESCRIPTION
● Lean Clay, Few Sand (CL)

REMARKS
● 10YR 4/1 Dark Gray

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

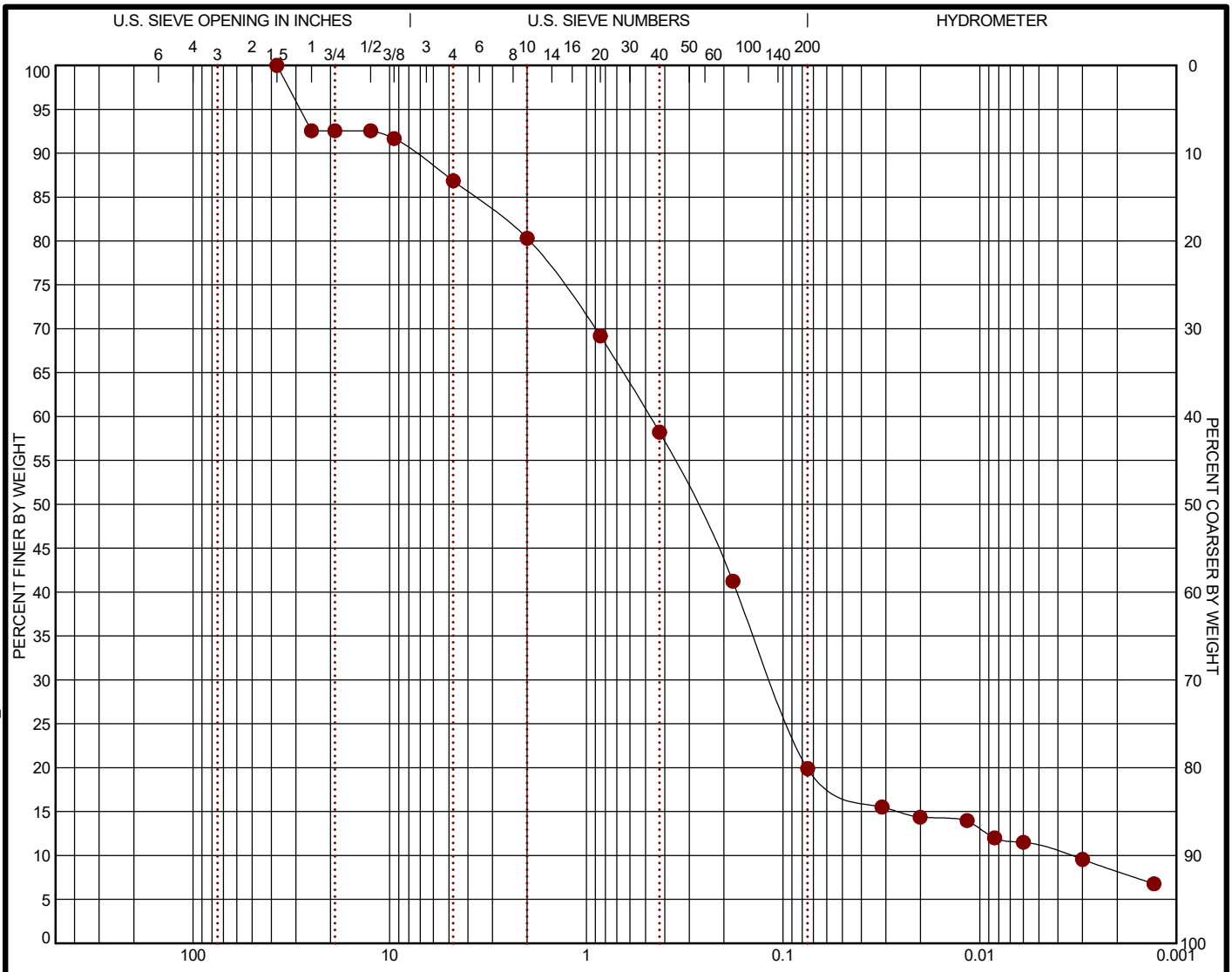
PROJECT NUMBER: 05201207

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-12**	**4 - 6**	**0.0**	**13.1**	**67.0**	**8.9**		**11.0**	

	GRAIN SIZE
	●
D_{60}	**0.476**
D_{30}	**0.113**
D_{10}	**0.004**
	COEFFICIENTS
C_C	**7.71**
C_U	**135.32**

● Sieve	● % Finer	Sieve	% Finer	Sieve	% Finer
1 1/2"	**100.0**				
1"	**92.55**				
3/4"	**92.55**				
1/2"	**92.55**				
3/8"	**91.67**				
#4	**86.85**				
#10	**80.3**				
#20	**69.19**				
#40	**58.22**				
#80	**41.25**				
#200	**19.9**				

SOIL DESCRIPTION

●

REMARKS

● 2.5Y 3/2 Very Dark Grayish Brown

PROJECT: Big Bend Dam

SITE: 33573 Northshore Road
Ft. Thompson, S.D. 57339-7910

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05201207

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 05201207 BIG BEND DAM.GPJ TERRACON_DATATEMPLATE.GDT 7/21/20

PLASTICITY TEST REPORT

Report Number: 05201207.0016
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

Material Information

Source of Material: Bore Hole
Proposed Use:
Soil Description: 10YR 4/4 Dark Yelloowish Brown
Classification: Lean Clay (CL)

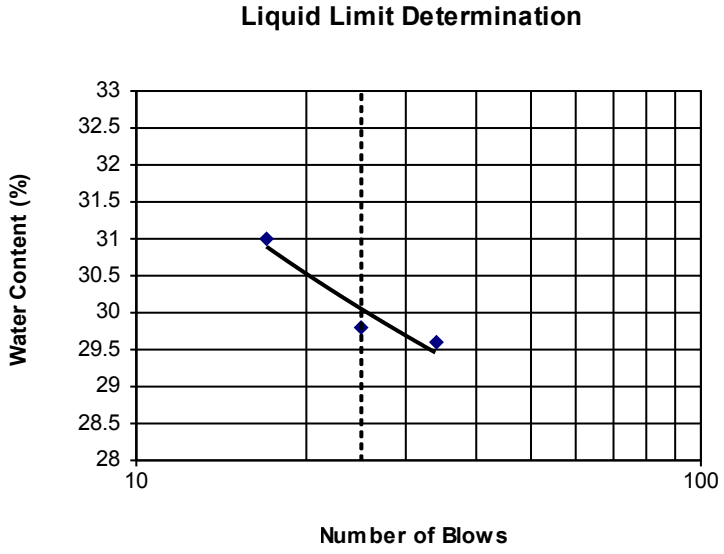
Sample Information

Sample Location: BH20-01 / D3 / 3-4ft
Sampled By: Client
Sample Date:

Laboratory Test Data

	Result	Requirements
Liquid Limit:	30	
Plastic Limit:	19	
Plasticity Index:	11	
In-Place Moist. (%):	15.1	

Liquid Limit Method: Method A
Sample Preparation: Dry



Comments:

Services:

Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE),
Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods: ASTM D4318

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

PLASTICITY TEST REPORT

Report Number: 05201207.0017
Service Date: 07/08/20
Report Date: 07/08/20
Task: 02 - Laboratory Soil / Aggregate Testing

Terracon
15080 A Cir
Omaha, NE 68144-5558
402-330-2202

Client

US Army Corps of Engineers (USACE)
Dam Safety Production Center, Dam Safety Section
Attn: Kristle P. Beaudet
1616 Capitol Ave
Omaha, NE 68102-4909

Project

Big Bend Dam
15080 A Circle
Omaha, NE

Project Number: 05201207

Material Information

Source of Material: Bore Hole
Proposed Use:
Soil Description: 10YR 4/1 Dark Gray
Classification: Lean Clay (CL)

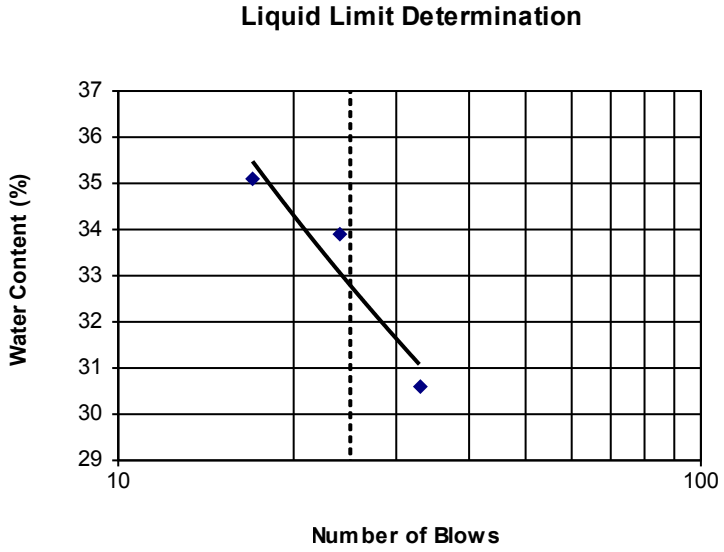
Sample Information

Sample Location: BH20-11 / D4 / 4.5-6ft
Sampled By: Client
Sample Date:

Laboratory Test Data

	Result	Requirements
Liquid Limit:	33	
Plastic Limit:	22	
Plasticity Index:	11	
In-Place Moist. (%):	19.0	

Liquid Limit Method: Method A
Sample Preparation: Dry



Comments:

Services:

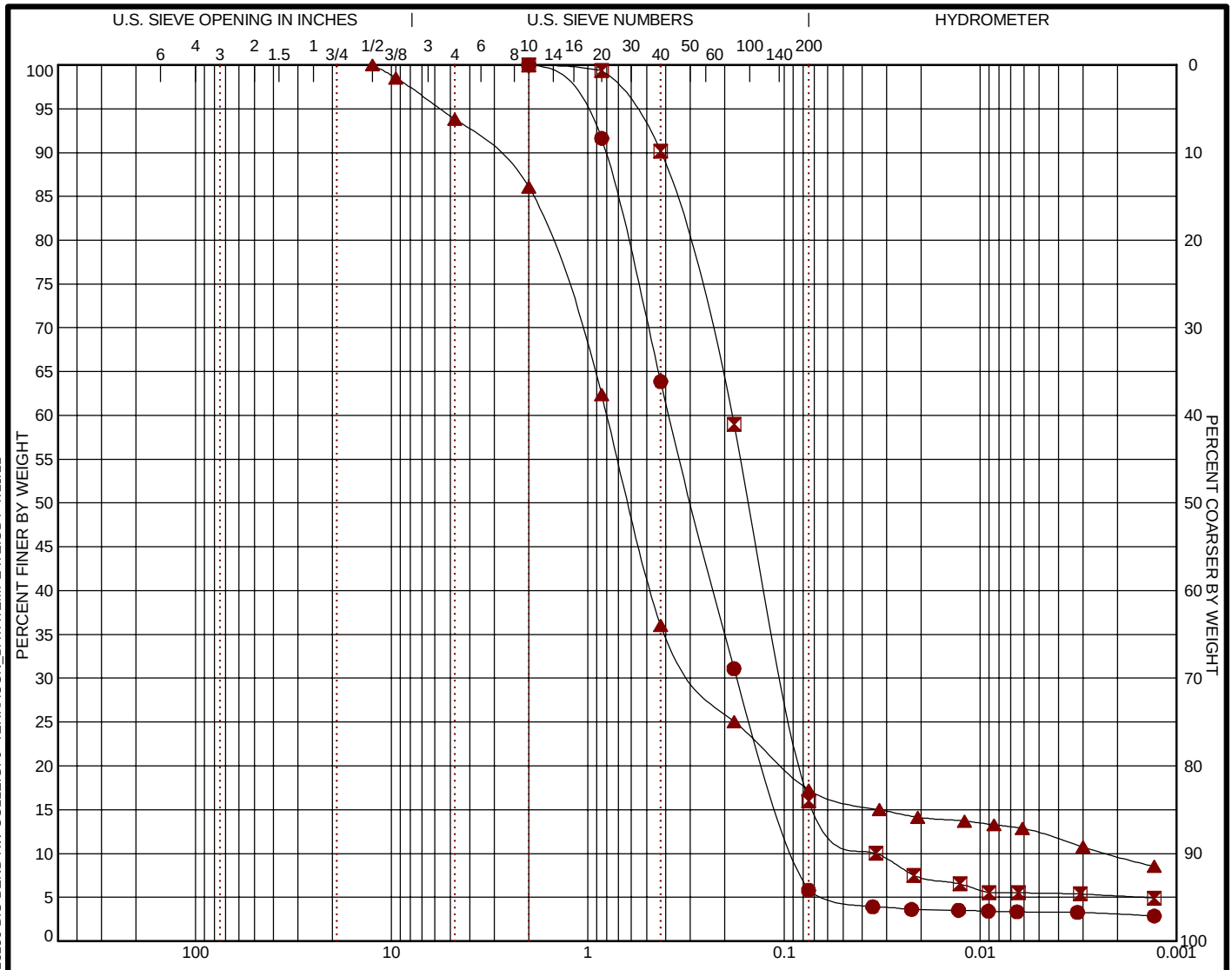
Terracon Rep.: Client
Reported To:
Contractor:
Report Distribution:
(1) US Army Corps of Engineers (USACE),
Kristle P. Beaudet

Reviewed By:
Rowden L. Miller
Project Manager

Test Methods: ASTM D4318

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-01**	**9 - 10**	**0.0**	**0.0**	**94.2**	**2.5**		**3.3**	**SP-SC**
⊠	**BH20-02**	**8 - 10**	**0.0**	**0.0**	**84.0**	**10.6**		**5.5**	**SM**
▲	**BH20-03**	**3 - 4**	**0.0**	**6.2**	**76.6**	**5.0**		**12.3**	**SC**

	GRAIN SIZE		
	●	⊠	▲
D_{60}	**0.384**	**0.185**	**0.798**
D_{30}	**0.173**	**0.1**	**0.265**
D_{10}	**0.087**	**0.034**	**0.002**
	COEFFICIENTS		
C_C	**0.90**	**1.58**	**38.79**
C_U	**4.43**	**5.45**	**351.77**

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	100.0	#10	100.0	1/2"	100.0
#20	91.62	#20	99.36	3/8"	98.53
#40	63.86	#40	90.16	#4	93.82
#80	31.09	#80	58.98	#10	86.08
#200	5.8	#200	16.03	#20	62.39
				#40	36.02
				#80	25.06
				#200	17.26

SOIL DESCRIPTION

- ● Poorly Graded Sand with Clay (SP-SC)
- ⊠ Silty Sand (SM)
- ▲ Clayey Sand (SC)

REMARKS

- ● 2.5Y 6/2 Light Grayish Brown
- ⊠ 2.5Y 6/2 Light Grayish Brown
- ▲ 10YR 4/4 Dark Yellowish Brown

PROJECT: Big Bend RW Collector Pipe Replacement FFP Pilot Hole

SITE: BIA Rd 4 and Native American Scenic Byway
Fort Thompson, SD

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05215156

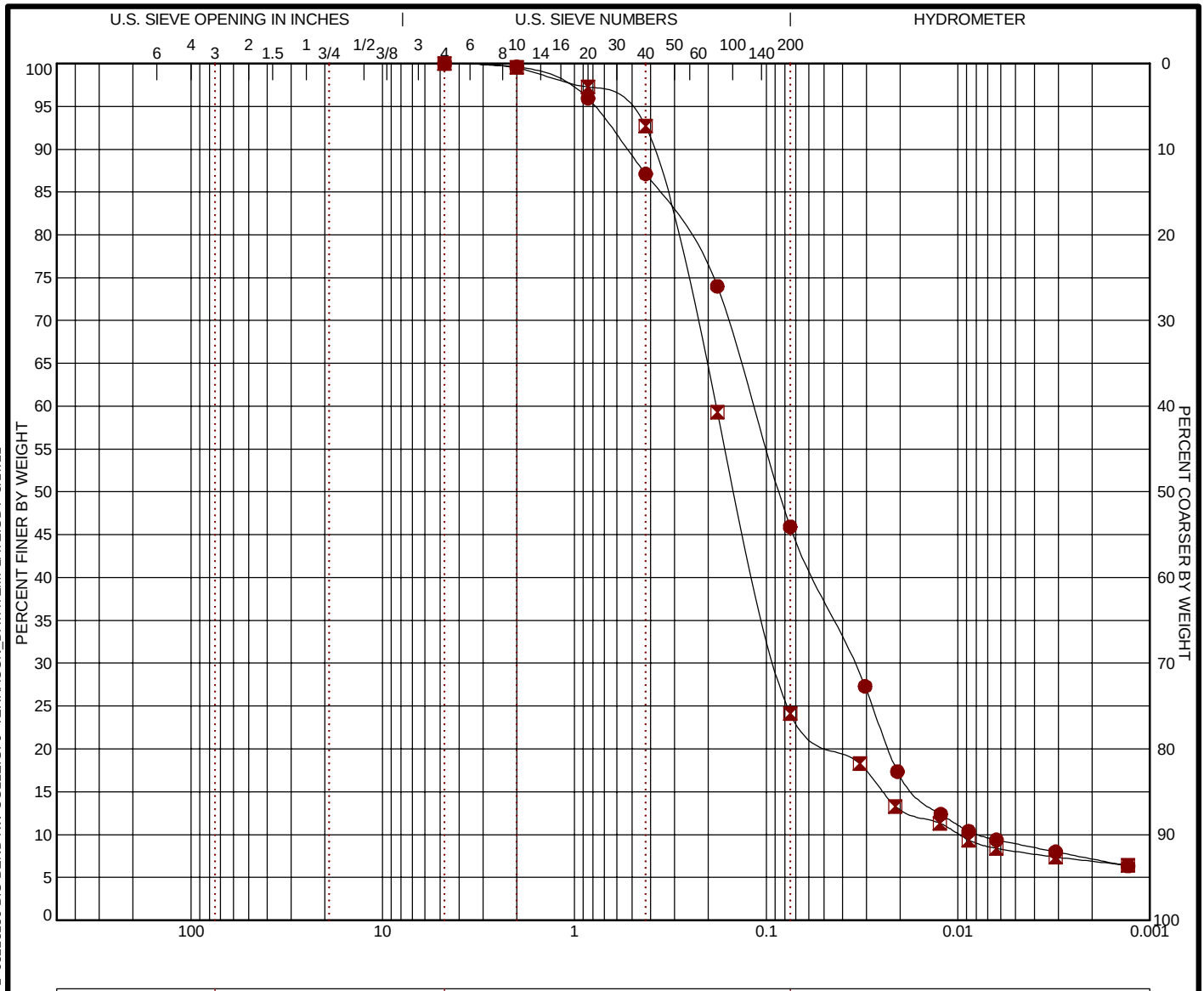
CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 05215156 BIG BEND RW COLLE.GPJ TERRACON_DATATEMPLATE.GDT 7/28/21

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**BH20-04**	**6.5 - 8.5**	**0.0**	**0.0**	**54.1**	**37.0**		**8.9**	**SM**
⊠	**BH20-06**	**13 - 14.5**	**0.0**	**0.0**	**75.9**	**16.1**		**8.1**	**SM**

	GRAIN SIZE	
	●	⊠
D_{60}	**0.116**	**0.183**
D_{30}	**0.035**	**0.087**
D_{10}	**0.008**	**0.01**
	COEFFICIENTS	
C_C	**1.34**	**4.18**
C_U	**15.05**	**18.60**

●		⊠			
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	100.0	#4	100.0		
#10	99.6	#10	99.53		
#20	95.93	#20	97.26		
#40	87.11	#40	92.68		
#80	73.99	#80	59.33		
#200	45.92	#200	24.12		

SOIL DESCRIPTION
- ● Silty Sand (SM)
- ⊠ Silty Sand (SM)

REMARKS
- ● 2.5Y 6/3 Light Yellowish Brown
- ⊠ 2.5Y 6/3 Light Yellowish Brown

PROJECT: Big Bend RW Collector Pipe Replacement FFP Pilot Hole

SITE: BIA Rd 4 and Native American Scenic Byway
Fort Thompson, SD

Terracon
15080 A Cir
Omaha, NE

PROJECT NUMBER: 05215156

CLIENT: US Army Corps of Engineers (USACE)
Omaha, NE

EXHIBIT: B-2

Appendix E: Pump Test Data

Step

RW 67B

RELIEF WELL CAPACITY/DRAWDOWN TEST DATA FORM

Project: Big Bend Dam FY20 RW Rehab & Repair	**Date:** 6/11/20
	Well ID: RW 67B
Location: Big Bend Dam, SD	**Initial Depth of Well:** 84.1
Monitoring Instrument: RW67B	**Weather:** SUNNY 70°
Static Water Level[2]: 6.10 TOTC overflowing	**Measured By:** R. Zagorec

	Step #1 Pumping Rate (gpm)	Step #2 Pumping Rate (gpm)	Step #3 Pumping Rate (gpm)	Step #4 Pumping Rate (gpm)	Step #5 Pumping Rate (gpm)
	25.3	24.9	32.7		
Time	**Depth To Water[1]**	**Depth To Water[1]**	**Depth To Water[1]**	**Depth To Water[1]**	**Depth To Water[1]**
0	20.10				
15 sec	20.55				
30 sec	20.81				
45 sec	21.01				
1 min	21.20	7 = 21.52			
2 min	21.51	8 = 21.50			
3 min	21.59	9 = 21.50			
4 min	21.65	↓			
5 min	21.70				
10 min		21.53			
15 min		21.55			
20 min		21.60			
25 min		21.60			
30 min		21.55			
35 min			28.18		
40 min					
45 min			28.22		
50 min			28.18		
55 min			28.25		
1 hr 0 min			28.25		

[1] All measurements in 0.01 feet. [2] Static water level recorded prior to capacity/drawdown test.

25 1st then 40 – 50

1:30 = 21.39

2:30 = 21.54

7 21.52 (24 gpm)

16 21.50
17 21.56
18 21.60
19 = 21.58

1:05 = 28.26
1:10 = 28.28
1:20 = 28.32
1:30 = 28.39

Comments: 60.01 = DTW

6.10 = DTOTC

RW From 67B
OW 20 – 01
Distance = 5.0 ft

OW 20 – 02
Distance = 9.8 ft

8
9
10

Screen 31 Bgs

84.1 DTB

pump @ 30

Start at 25

Try 30 gpm for Drawdown

RW 67B
6 HR Pump

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend DAM FY 20 RW Rehabs & Repair	**Date:** 6/13/20
	Well ID: RW67B
Location: Big Bend DAM, SD	**Initial Depth of Well:**
Monitoring Instrument: TEST WELL 2007 WATER LEVEL INDICATOR	**Weather:** 70-80° SUNNY
Static Water Level[2]: 6.10 Flowing over TOTC	**Measured By:** R. Zygowicz

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	0836	6.10			
30 sec				30.6	
1 min				↓	
1 min 30 sec				↓	
2 min				↓	
2 min 30 sec				↓	
3 min		24.95		↓	
4 min				↓	
5 min		25.40		↓	
6 min				↓	
7 min				↓	
8 min		25.55		30.6	
9 min				↓	
10 min		25.65		↓	
11 min		25.67		↓	
12 min		25.72		30.5	
13 min					
14 min					
15 min					
20 min		25.90		30.5	
25 min		25.96		30.5	
30 min					
35 min		26.07		30.5	
40 min		26.11		30.5	
45 min		26.12		30.5	
50 min		26.16		30.5	
55 min		26.20		30.5	
1 hr	0936	26.25		30.5	

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

OPENING
DTW = 6.05

DTOTC = 6.10

RW67B - 6 hr Pump

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend Dam F420 RW Rehab & Repair	**Date:** 6/12/20
Location: Big Bend Dam, SD	**Well ID:** RW67B

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min	0946	26.26		30.5	
1 hr 20 min		26.29		30.5	
1 hr 30 min		26.34		30.5	
1 hr 40 min		26.36		30.5	
1 hr 50 min		26.41		30.5	
2 hr	1036	26.43		30.5	
2 hr 30 min		26.50		30.5	
3 hr	1136	26.55		30.5	
3 hr 30 min		26.59		30.5	
4 hr	1236	26.62		30.5	
4 hr 30 min		26.63		30.5	
5 hr	1336	26.67		30.5	
5 hr 30 min		26.71		30.5	
6 hr	1436	26.69		30.5	Ended Test At 6 hrs / 30.5 gpm
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min					
5 min					Performed Rec Tests ON OW20-01 & OW20-02
10 min					
15 min					
20 min					
25 min					
30 min					
35 min					
40 min					
45 min					
50 min					
55 min					
1 hr					

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments: No Rec test on this RW AS per Project Geologist

OW 20-01

6 Hr Pump D.D

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend Dam FY 20 RW Rehab & Repair	**Date:** 6/13/20
	Well ID: OW 20-01
Location: Big Bend Dam SD	**Initial Depth of Well:**
Monitoring Instrument: Testwell 200ft WATER LEVEL INDICATOR	**Weather:** 70-80° SUNNY
Static Water Level[2]: 5.53	**Measured By:** A. Zygowicz

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	0836	5.53		~	
30 sec		5.53		30.6	→ IN RW67B
1 min		5.53		30.6	
1 min 30 sec		5.51		↓	
2 min		5.51			
2 min 30 sec		5.52			
3 min		5.52		↓	
4 min		5.52		30.6	
5 min		5.52			
6 min		5.53			
7 min		5.53			
8 min		5.54			
9 min		5.53			
10 min		5.54			
11 min		5.53		↓	
12 min		5.54		30.5	
13 min		5.54			
14 min		5.54			
15 min		5.54			
20 min		5.54			
25 min		5.55			
30 min		5.55			
35 min		5.56		↓	
40 min		5.56		30.5	
45 min		5.55			
50 min		5.56		30.5	
55 min		5.56		30.5	
1 hr	0936	5.56		30.5	→ IN RW67B

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

OPENING DTBW = 5.54

DTB = 22.49

2.85 STICKUP

RW 67B TOIC = 6.10

~~30.7~~

25.80
6.10
19.70

OW20-01
6 HR PUMP/D.D.

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend Dam FY20 RW Rehab & Repair	**Date:** 6/17/20
Location: Big Bend Dam, SD	**Well ID:** OW20-01

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min	0946	5.56		30.5 →	IN RW 67B
1 hr 20 min		5.57		30.5	
1 hr 30 min		5.57		30.5	
1 hr 40 min		5.57		30.5	
1 hr 50 min		5.56		30.5	
2 hr	1036	5.56		30.5	
2 hr 30 min		5.57		30.5	
3 hr		5.56		30.5	
3 hr 30 min		5.57		30.5	
4 hr		5.57		30.5	
4 hr 30 min		5.57		30.5	
5 hr		5.57		30.5	
5 hr 30 min		5.57		30.5	
6 hr		5.57		30.5 →	IN RW67B
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min					
5 min					
10 min					Rec IN
15 min		5.55			
20 min		5.55			
25 min		5.55			
30 min		5.55			2 MIN = 5.60
35 min		5.54			3 5.58
40 min		5.54			4 5.58
45 min		5.54			5 5.57
50 min		5.54			6 5.57
55 min		5.54			7 5.57
1 hr		5.54			8 5.56
					9 5.56
					10 5.56

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

START 5:53

11 5.56
12 5.56
13 5.56
14 5.56
15 5.55

57
0:24

OW 20-02
6 Hr Pump

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend DAM FY 20 RW Rehab + Repair	**Date:** 6/13/20
	Well ID: OW 20-02
Location: Big Bend Dam, SD	**Initial Depth of Well:**
Monitoring Instrument: TOSHWELL 300ft WATER LEVEL INDICATOR	**Weather:** 80° P. Cloudy
Static Water Level[2]: 5.80	**Measured By:** KYLE THOMAS

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec		5.50		30.6 → IN RW67B	
30 sec		5.50			
1 min		5.49			
1 min 30 sec		5.49			
2 min		5.48			
2 min 30 sec		5.48			
3 min		5.49			
4 min		5.49			
5 min		5.49			
6 min		5.50			
7 min		5.50			
8 min		5.50			
9 min		5.50			
10 min		5.50			
11 min		5.50			
12 min		5.50		30.5	
13 min		5.50			
14 min		5.50			
15 min		5.50			
20 min		5.51			
25 min		5.51			
30 min		5.51			
35 min		5.52			
40 min		5.52			
45 min		5.52			
50 min		5.52			
55 min		5.52			
1 hr		5.52		30.5 → IN RW67B	

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

Dtw opening = 5.50

DTB = 22.55

OW20-02 6 HR PUMP

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend Dam FY20 AW rehab + Repair	**Date:** 6/13/20
Location: Big Bend Dam, SD	**Well ID:** OW20-02

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min		5.52		30.5	→ TN AW671
1 hr 20 min		5.53		30.5	
1 hr 30 min		5.53		30.5	
1 hr 40 min		5.53		30.5	
1 hr 50 min		5.53		30.5	
2 hr		5.53		30.5	
2 hr 30 min		5.53		30.5	
3 hr		5.53		30.5	Ended TEST AT 6 HR
3 hr 30 min		5.54		30.5	
4 hr		5.53		30.5	
4 hr 30 min		5.63		30.5	30.5 gpm/6 HR
5 hr		5.53		30.5	
5 hr 30 min		5.53		30.5	
6 hr		5.53		30.5	
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min					
5 min					
10 min					
15 min		5.53		2 MW	5.55
20 min		5.52		3	5.55
25 min		5.51		4	5.54
30 min		5.51		5	5.54
35 min		5.50		6	5.54
40 min		5.50		7	5.54
45 min		5.50		8	5.53
50 min				9	5.53
55 min				10	5.53
1 hr					

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

START 5.50

11-5.53
12-5.53
13-5.53
14-5.53
15-5.53

OW20-01
pump test

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend Dam FY20 RW Rehab & Repair	**Date:** 6/22/20
	Well ID: OW20-01
Location: Big Bend Dam, SD	**Initial Depth of Well:**
Monitoring Instrument: Tostwell 2007 Water Level Indicator	**Weather:** 75° P. Cloudy
Static Water Level[2]: 5.57	**Measured By:** R. Zygowicz

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	1105	5.57			
30 sec		~~5.60~~ 5.60		9.0	
1 min		~~5.90~~ 5.94			
1 min 30 sec		5.96			
2 min		5.98			
2 min 30 sec		5.98			OW20-02- ~~8.24~~
3 min		5.99			
4 min		6.00			~~8~~.33
5 min		6.01			8.35
6 min		6.02		9.0	8.36
7 min		6.03			~~8~~.36
8 min		6.02			8.37
9 min		6.04			8.38
10 min		6.04			8.38
11 min		6.05			8.39
12 min		6.05		9.0	8.39
13 min		6.05			8.39
14 min		6.05			8.40
15 min		6.05			8.40
20 min		6.07			8.41
25 min		6.07		9.0	8.42
30 min		6.09			8.44
35 min		6.09			8.45
40 min		6.09			8.45
45 min		6.10			8.46
50 min		6.10			8.47
55 min		6.11			8.47
1 hr	1205	6.11		9.0	8.47

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

PUMP IN OW20-02 AT 15 ft below TOC
DTW IN OW20-02 AT START = 5.53

OW 20 01
Pump test

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend DAM RWs	**Date:** 6/22/20
Location: Big Bend DAM, SD	**Well ID:** OW 20 - 01

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min	1215	6.12		9.0	OW20-02 = 8.47
1 hr 20 min		6.13		9.0	8.48
1 hr 30 min		6.13		9.0	8.48
1 hr 40 min		6.13		9.0	8.48
1 hr 50 min		6.13		9.0	8.48
2 hr	1305	6.14		9.0	8.49
2 hr 30 min	1335	6.15		9.0	8.49
3 hr	1405	6.15		9.0	8.50
3 hr 30 min	1435	6.15		9.0	8.51
4 hr	1505	6.15		9.0	8.52
4 hr 30 min					
5 hr					
5 hr 30 min					Ended test
6 hr					After 4hrs
6 hr 30 min					as per project
7 hr					Geologist
7 hr 30 min					
8 hr					
RECOVERY					
0 min				OW20-02	OW20-01 OW20-02
5 min		5.70			0:30 = 5.80 5.68
10 min		5.67			1 min = 5.78 5.73
15 min		5.66		5.61	1:30 = 5.76 5.72
20 min		5.65		5.60	2 min = 5.74 5.70
25 min		5.64		5.59	2:30 = 5.73 5.68
30 min		5.63		5.58	3 min = 5.72 5.68
35 min		5.63		5.58	3:30 5.72 5.67
40 min		5.63		5.57	4 5.71 5.66
45 min		5.62		5.57	4:30 5.71 5.66
50 min		5.62		5.57	5:00 5.70 5.65
55 min		5.62		5.57	6 5.69 5.64
1 hr		5.61		5.56 5.56	7 5.69 5.64
1 hr 10 min		5.60		Pump STILL IN	8 5.68 5.63
1:50		5.61		5.58	9 5.68 5.63
		5.60			10 5.67 5.62
					11 5.67 5.62
					12 5.67 5.62
					13 5.66 5.61
					14 5.66 5.61

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

Note:

1:50 5.59 / 5.54

To whom it may concern;
When using Geotech Redi Flo 2 Geotech variable frequency drive controller & grundfos pump (2), generator cannot have GFCI on plugins or controller will not operate!

RW 68B DRAWDOWN 4 hr

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend Dam FY20 RW Rehab + Repair	**Date:** 6/17/20
	Well ID: RW68B
Location: Big Bend Dam, SD	**Initial Depth of Well:**
Monitoring Instrument: Testwell 200ft Water Level Indicator	**Weather:** 85° SUNNY Windy
Static Water Level[2]: 8.82 - Flowing over top	**Measured By:** R. Zygowicz

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	10:49	8.82		24.04	
30 sec		37.92		24.04	
1 min		37.92		24.04	
1 min 30 sec		37.93		24.04	
2 min		37.93		24.04	
2 min 30 sec		37.94		24.04	
3 min		37.94		24.04	
4 min		37.95		24.04	
5 min		37.96		24.04	
6 min		37.97		24.04	
7 min		37.98		24.04	
8 min		37.97		24.04	
9 min		37.98		24.04	
10 min	10:59	37.98		24.04	
11 min		38.01		24.04	
12 min		38.02		24.04	
13 min		38.03		24.04	
14 min		38.05		24.04	
15 min		38.07		24.04	
20 min		38.16		24.04	
25 min		38.22		24.04	
30 min	11:19	38.26		24.04	
35 min		38.31		24.04	
40 min		38.37		24.04	
45 min		38.40		24.04	
50 min		38.45		24.04	
55 min		38.48		24.04	
1 hr	11:49	38.51			

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

RW 68B
DJ 4 hr

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend Dam FY20 RW Rehabs & Repairs	**Date:** 6/17/20
Location: Big Bend Dam, SD	**Well ID:** RW 68B

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min	1159	38.56		24.04	
1 hr 20 min		38.62		24.04	
1 hr 30 min		38.66		24.04	
1 hr 40 min		38.71		24.04	
1 hr 50 min		38.75		24.04	
2 hr	1249	38.78		24.04	
2 hr 30 min		38.88		24.04	
3 hr	1349	38.92		24.04	
3 hr 30 min		39.02		24.04	
4 hr	1449	39.09		24.04	
4 hr 30 min					
5 hr					
5 hr 30 min					
6 hr					
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min	1450	39.10			
5 min					:30 26.93
10 min					1 MIN 20.93
15 min					1:30 16-20
20 min					
25 min					2 MIN 13.40
30 min					
35 min					3:30 2:30 10.38
40 min					
45 min					3 MIN 9.63
50 min				9.14	
55 min					4 8.78
1 hr					

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

5 8.29
6
7
8
9

Comments:

DTB AT END =
90.54 LT
90.55 RV

4:30
8.50
8.27
FULL RET IN 5.20 PM

PZ 25R

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project:	Big Bend DAM FY 20 RW Rehab & Repair	**Date:**	6/17/20
		Well ID:	PZ 25R
Location:	Big Bend DAM, SD	**Initial Depth of Well:**	44.2
Monitoring Instrument:	Testwell 2004 water level indicator	**Weather:**	78° P-Cloudy
Static Water Level[2]:	6.64	**Measured By:**	Kirk Thomas

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec		6.64			
30 sec		6.64		24.04	
1 min		6.65			
1 min 30 sec		6.65			
2 min		6.65			
2 min 30 sec		6.65			
3 min		6.65			
4 min		6.65			
5 min		6.65			
6 min		6.66			
7 min		6.66			
8 min		6.66			
9 min		6.66			
10 min		6.66			
11 min		6.66			
12 min		6.66			
13 min		6.66			
14 min		6.66			
15 min		6.66			
20 min		6.66			
25 min		6.66			
30 min		6.66			
35 min		6.66			
40 min		6.66			
45 min		6.65			
50 min		6.65			
55 min		6.66			
1 hr		6.66		24.04	

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

PZ25R

PZ

~~RELIEF~~ WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend DAM FY20 RWJ	**Date:** 6/17/20
Location: Big Bend DAM, SD	**Well ID:** PZ 25R

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min		6.66		24.04	
1 hr 20 min		6.66			
1 hr 30 min		6.66			
1 hr 40 min		6.66			
1 hr 50 min		6.66			
2 hr		6.66			
2 hr 30 min		6.66			
3 hr		6.66			
3 hr 30 min		6.66			
4 hr		6.66		24.04	
4 hr 30 min					
5 hr					
5 hr 30 min					
6 hr					
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min		6.66			30 6.66
5 min		6.66			1 6.66
10 min		6.66			
15 min		6.66			1:30 6.66
20 min		6.67			
25 min		6.68			2 6.67
30 min		6.68			
35 min		6.67	6.65		2:30 6.68
40 min		6.67	6.65		
45 min		6.67	6.65		3 6.68
50 min		6.67	6.65		
55 min			6.65		4 6.67
1 hr			6.65		

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

21 6.66
22 6.66
23 6.66
24 6.66
25 6.65
26 6.65
27 6.65
28 6.66
29 6.66
30 6.66

5 6.67
6 6.67
7 6.67
8 6.67
9 6.67
10 6.67

11 6.67
12 6.66
13 6.66
14 6.66
15 6.66
16 6.66
17 6.66
18 6.66 6.66

Comments:

RW 68B Recovered IN 5:20
from 39.10 Below TOC
RW68B is 8.5ft from PZ25R
DTB AT END = 44.13 Below TOC
from TOC

RW 66A

CONSTANT PUMPING RATE TEST

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend Dam FY20 RW Rehab & Repair	**Date:** 6/11/20
	Well ID: RW 66A
Location: Big Bend Dam, SD	**Initial Depth of Well:** 82.97
Monitoring Instrument: TestWell 200ft water level indicator	**Weather:** 75° SUNNY
Static Water Level[2]: TOIC = 5.24 flowing over TOIC 4.57 Inside LOC	**Measured By:** R-Zygowicz

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	1300	20.86		60.2	
30 sec		20.91			
1 min		20.93			
1 min 30 sec		20.96			Due to nature of this RW + Design Build,
2 min		21.00			
2 min 30 sec		21.04			
3 min		21.08			
4 min		21.10		60.2	Pumping Rate was established
5 min		21.10		60.1	
6 min		21.14			Before Drawdown
7 min		21.17			measurement
8 min		21.20			commenced
9 min		21.22			
10 min		21.22			
11 min		21.23			
12 min		21.25			
13 min		21.27			
14 min		21.29			
15 min		21.33		60.1	
20 min		21.35			
25 min		21.41			
30 min		21.43			
35 min		21.46			
40 min		21.49		60.1	
45 min		21.53			
50 min		21.55			
55 min		21.55			
1 hr	1400	21.65		60.1	

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

ALL Measurements from TLOC.

Large outer casing stick up = 1.57 (North Side)

DTWIV VAULT = 4.57'
DTOIC = 5.24'
DTB of VAULT = 5.50'
DTB = 82.97

RW 66A

RELIEF WELL CONSTANT RATE CAPACITY PUMPING TEST DATA FORM (Cont.)

Project: Big Bend Dam FY 20 RWs	Date: 6/11/20
Location: Big Bend DAM, SD	Well ID: RW 66A

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min	1410	21.59		60.1	
1 hr 20 min		21.54		60.1	
1 hr 30 min		21.58		60.1	
1 hr 40 min		21.62		60.1	
1 hr 50 min		21.64		60.1	
2 hr	1500	21.68		60.1	
2 hr 30 min					
3 hr					
3 hr 30 min					
4 hr					
4 hr 30 min					
5 hr					
5 hr 30 min					
6 hr					
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
		10.25	RECOVERY		
0 min		~~21.71~~			
5 min		5.24 IN 6 SEC			Rec =
10 min					0 FULL Rec
15 min					30 IN 6 SEC
20 min					1 MIN
25 min					2 MIN
30 min					3 MIN
35 min					
40 min					
45 min					
50 min					Rec to TOTC IN 6 SEC
55 min					
1 hr					

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

Rec affected by turning down pump to 30 gpm to set up rate for OW testing on RW67B

RW68B - FINAL

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend Dam FY20 RW Rehab & Repairs	**Date:** 6/16/20
	Well ID: RW68B
Location: Big Bend Dam, SD	**Initial Depth of Well:** 90.6
Monitoring Instrument: Test well 200ft water level indicator	**Weather:** 85° sunny windy
Static Water Level[2]: 8.22-Flowing over Top	**Measured By:** R. Zygowicz

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	1355	28.10		16.4	
30 sec		28.10		16.4	
1 min		28.01		16.4	Due to the design build & the nature of this RW, rate & level were allowed to stabilize before initiating timing sequence
1 min 30 sec		28.02		16.4	
2 min		28.03		16.4	
2 min 30 sec		28.04		16.4	
3 min		28.05		16.4	
4 min		28.03		16.4	
5 min		28.04		16.4	
6 min		28.05		16.4	
7 min		28.06		16.4	
8 min		28.04		16.4	
9 min		28.03		16.4	
10 min	1405	28.05		16.4	
11 min		28.06		16.4	
12 min		28.07		16.4	
13 min		28.08		16.4	
14 min		28.05		16.4	
15 min		28.04		16.4	
20 min		28.14		16.4	
25 min		28.18		16.4	
30 min	1425	28.25		~~16.3~~ 16.2	
35 min		28.23		16.2	
40 min		28.20		16.2	
45 min		28.15		16.2	
50 min		28.16		16.2	
55 min		28.15		16.2	
1 hr	1455	28.17		16.2	

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

INIT: 18ft 00/9.2gpm
PREVIOUS 19.5 08/3.9gpm

RW68B-FINAL

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend Dam RW Rehabs	**Date:** 6/16/20
Location: Big Bend Dam, SD	**Well ID:** RW68B

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min	1505	28.19		16.2	
1 hr 20 min		28.22		16.2	
1 hr 30 min	1525	28.29		16.2	
1 hr 40 min		28.30		16.2	
1 hr 50 min		28.32		16.2	
2 hr	1605	28.34		16.2	
2 hr 30 min	1635	28.42		16.2	ENDED TEST AT
3 hr					2 HRS 30 MIN
3 hr 30 min					16.2 GPM
4 hr					FOR 2 HRS
4 hr 30 min					
5 hr					
5 hr 30 min					
6 hr					
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min		28.43			REC:
5 min		15.10			30SEC 19.12
10 min					1 MIN 15.10
15 min					1 MIN 30 12.72
20 min					2 MIN 10.91
25 min					2:30 8.45
30 min					3:25 OVER TOP OF
35 min					INNER
40 min					CASING
45 min					AT 3:25
50 min					
55 min					
1 hr					

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments: NO LEAKAGE OBSERVED AT INNER 5" CASING + 36" WELL VAULT INTERFACE OR FLANGE ON BOTTOM OF WELL VAULT

DTB AT END=

RW68A - FINAL

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM

Project: Big Bend Dam, SD FY 20 RW Rehab & Repair	**Date:** 6/15/20
	Well ID: RW68A
Location: Big Bend Dam, SD	**Initial Depth of Well:**
Monitoring Instrument: Testwell 200ft Water Level Indicator	**Weather:** mostly cloudy 75-80°
Static Water Level[2]: 8.79	**Measured By:** R. Zygowicz

Flowing over TOIC

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
0 sec	1010	8.79			
30 sec		33.82		33.2	
1 min		33.99		33.1	
1 min 30 sec		34.05		33.1	
2 min		34.06		33.1	Due to design, build & nature of this RW the level & rate were brought to NEAR STABLE before initiating the pumping sequences
2 min 30 sec		34.08		33.1	
3 min		34.11		33.1	
4 min		34.11		33.1	
5 min		34.13		33.1	
6 min		34.18		33.1	
7 min		34.19		33.1	
8 min		34.20		33.1	
9 min		34.20		33.1	
10 min		34.21		33.1	
11 min		34.22		33.1	
12 min		34.24		33.1	
13 min		34.26		33.1	
14 min		34.26		33.1	
15 min		34.28		33.1	
20 min		34.35		33.0	
25 min		34.39		33.0	
30 min		34.42		33.0	
35 min		34.43		33.0	
40 min		34.41		33.0	
45 min		34.72		33.0	
50 min		34.65		33.0	
55 min		34.68		33.0	
1 hr	1110	34.65		33.0	

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

DtoIC = 8.79

DtWV = 8.66

DtB = 90.8

34.1
8.8
26.3

*LEAKS AROUND INNER CASING AT ~~TOP~~ BOTTOM OF VAULT

RW 68A - FINAL

RELIEF WELL CONSTANT RATE CAPACITY TEST DATA FORM (Cont.)

Project: Big Bend Dam RW Rehabs	**Date:** 6/15/20
Location: Big Bend Dam, SD	**Well ID:** RW 68A

Elapsed Time	Actual Time	Depth To Water[1]	Water Level Change[1]	Pumping Rate (gpm)	Comments
1 hr 10 min		34.68		33.0	
1 hr 20 min		34.79		33.0	
1 hr 30 min		34.87		33.0	
1 hr 40 min		34.88		33.0	
1 hr 50 min		34.93		33.0	
2 hr	1216	34.97		33.0	2:15= 35.02
2 hr 30 min	1240	35.09		33.0	
3 hr					
3 hr 30 min					
4 hr					Ended test
4 hr 30 min					AT 2 hrs 30 min
5 hr					
5 hr 30 min					CONSTANT RATE 33.0 GPM
6 hr					
6 hr 30 min					
7 hr					
7 hr 30 min					
8 hr					
RECOVERY					
0 min	1241	35.10			18.85
5 min		FULL REC IN 2:26			0:30 10.11
10 min					1 min 13.57 1:30
15 min					2 min 5.93 2:30 N/A
20 min					3 min NA
25 min					Full Rec IN 2:26
30 min					
35 min					DTOTC 8.79
40 min					
45 min					
50 min					
55 min					
1 hr					

[1]All measurements in 0.01 feet. [2]Static water level recorded prior to capacity/drawdown test.

Comments:

CLOSING DTB = 90.75

SUBSURFACE INVESTIGATION

FY21 RELIEF WELL PILOT HOLE BORING AND BORROW AREA INVESTIGATION

(AUG 2021)

Big Bend Dam (SD01092)

Missouri River, Fort Thompson, South Dakota
Embankment, Powerhouse, and Spillway

FY21 RELIEF WELL PILOT HOLE BORING AND BORROW AREA INVESTIGATION

GEOTECHNICAL DATA REPORT

Northwestern Division
Omaha District

Status: **FINAL**
Report Date: AUGUST 2021

FOR OFFICIAL USE ONLY (FOUO)

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1. INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Omaha District has developed this geotechnical data report to document the results of an FY21 drilling program plan to install six relief well pilot holes (PH21-01 through PH21-06) and three borrow area borings (BH21-01 through BH21-03) at Big Bend Dam in Fort Thompson, South Dakota. The six pilot holes were installed to obtain lithologic information and gradation data to aid in the design of six replacement and two new relief wells proposed for installation in the left abutment area of the dam. The relief wells will be installed at a later date in conjunction with the replacement of a toe drain and relief well collector pipe system in the same area.

The six relief wells targeted for replacement (RW-66, RW-66A, RW-67, RW-68, RW-68A, and RW-68B) were rehabilitated and capacity tested in 2020 and found to be at between 10% and 64% of original capacity. Three of the relief wells (RW-66, RW-67, and RW-68) are original wood-stave wells installed in 1963 that are nearing the end of their service life. The other three relief wells (RW-66A, RW-68A, and RW-68B) were installed in 2010 and 2012 to provide supplemental pressure relief between, and further north of, the original relief wells. Pilot holes were not drilled for any of these supplemental wells and no gradation data was obtained. The screen intervals and slot sizes were selected based on a qualitative assessment of the foundation materials including the design of the existing relief wells. A review of the design indicates that the supplemental wells were installed with screened zones across a middle intermediate clay unit and a lower sand unit in the foundation (with solid riser pipe across the upper sands). The design is similar to relief wells installed in the valley section of the dam; however, the foundation materials in those areas typically indicated a thicker upper clay blanket and a more limited intermediate clay zone that often contained more permeable layers interbedded. As such, the current supplemental relief wells are providing limited relief of the upper sands and are likely clogged from the clay materials present over the majority of the screened interval. For this reason, along with the significant decrease in capacity since installation, these three relief wells are also targeted for redesign and replacement.

The potential for two additional new relief wells to be installed in the area of the toe drain to provide supplemental pressure relief was also identified by the project dam safety engineer. After an analysis of all available data (including data collected for this investigation) it was determined that the two new toe drain relief wells would not be required as the replacement toe drain was shown to provide sufficient pressure relief (based on updated seepage analysis results).

2. PROJECT BACKGROUND

Big Bend Dam is a high hazard potential dam located on the Missouri River in Buffalo and Lyman Counties, South Dakota, approximately 20 miles upstream of the city of Chamberlain. Big Bend is one of six main stem dams on the Missouri River, and was authorized by the Flood Control Act approved 22 December 1944 (Public Law 534, 78th Congress 2nd Session) as part of the general comprehensive plan for flood control, irrigation, navigation, and hydropower in the Missouri River basin (Figure 1). The project was constructed from 1963 to 1966.

2.1 Project Description

Big Bend Dam is a multiple purpose project consisting of a rolled earthfill embankment, hydroelectric generating power plant, spillway, and reservoir (Figure 2 and Figure 3). The reservoir has a capacity of 1,859,000 acre feet for flood control, irrigation, conservation, navigation, power development, and other uses. Conventional outlet works structures were not constructed at Big Bend; releases are made either through the spillway or the power plant.

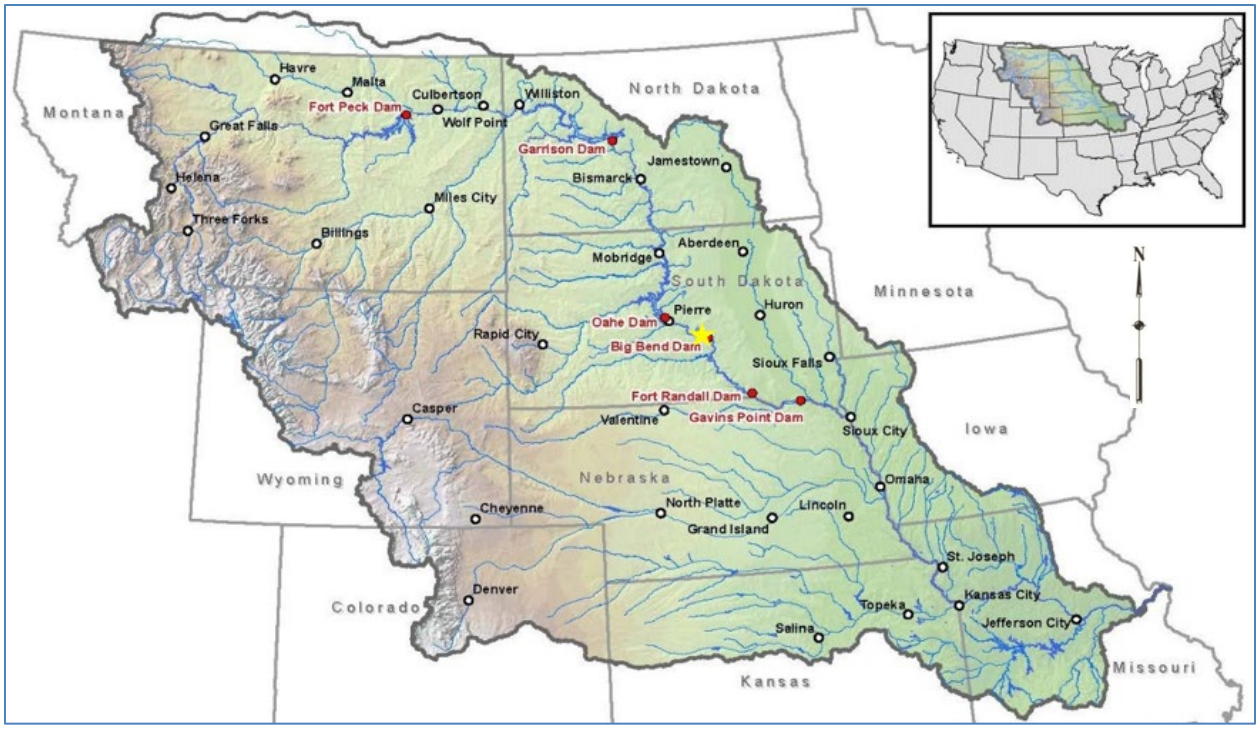


Figure 1: Big Bend Dam location map

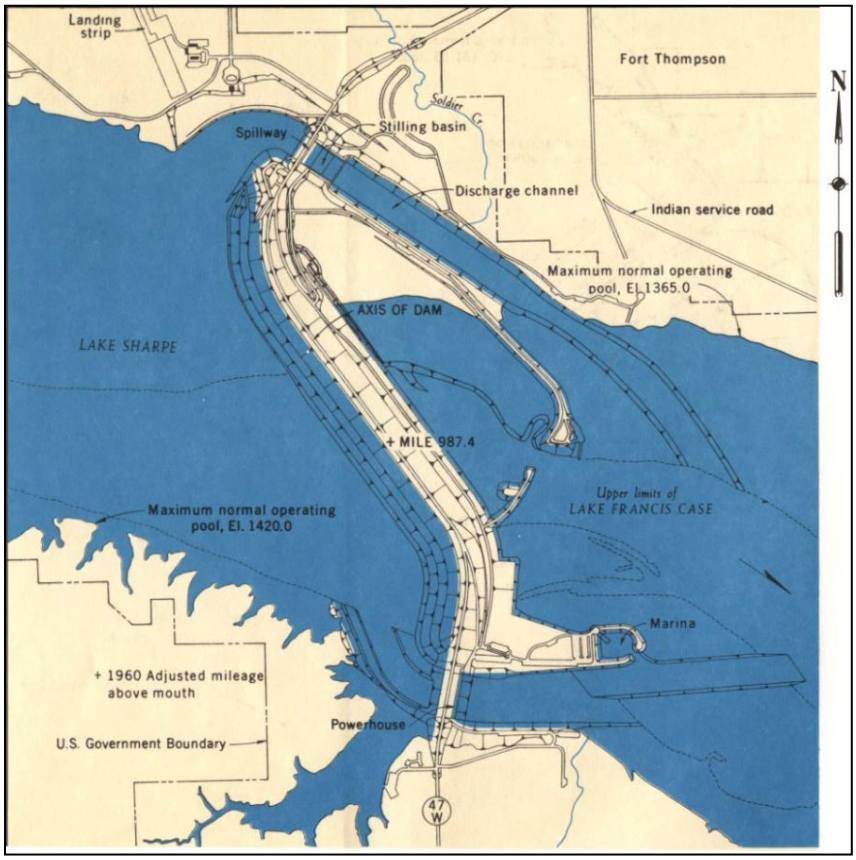


Figure 2: Project feature map

Figure 3: Aerial photo showing project features

2.1.1 Embankment

The rolled, zoned (Figure 4), earth-filled embankment is 10,570 feet long with a maximum height of 95 feet above the river channel and a crest width of 50 feet. The maximum width at the base of the embankment is 1,200 feet. The embankment makes a gentle S curve across the valley. The embankment was built upon dredged or dumped underwater pervious fill. A central impervious core extends from the pervious fill to five feet below the top of the dam. This core extends through the length of the embankment and transitions into a massive impervious section at the spillway and powerhouse tie-ins. The core is flanked on the downstream side by a pervious zone that ties into either the pervious downstream embankment fill or a horizontal downstream pervious blanket to provide drainage for seepage through the core. The top five feet of the embankment crest is composed of pervious fill connected to the downstream pervious drain to provide a frost-free base for the highway surface across the embankment.

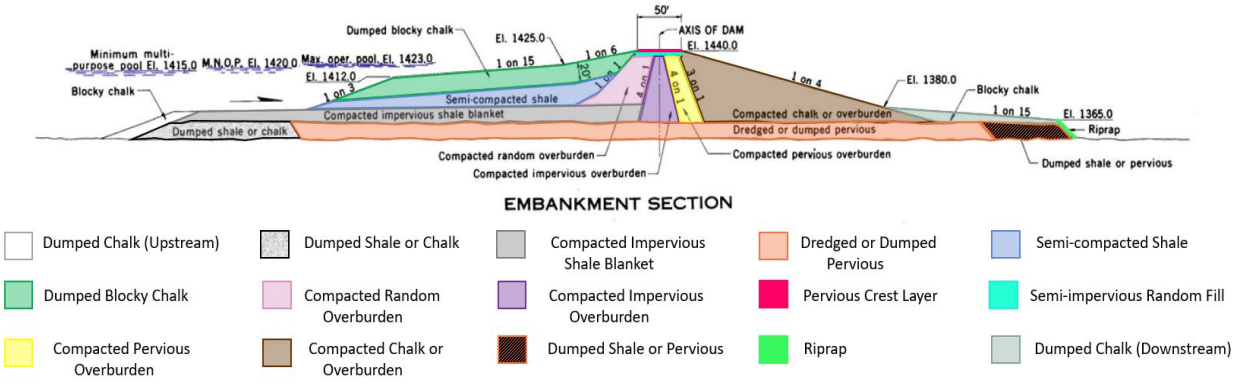


Figure 4: General embankment section

A minimum 10-foot-thick impervious blanket ties into the central impervious core and extends upstream 425 to 540 feet throughout the major portion of the embankment. Near the powerhouse area the blanket is thickened and excavated into bedrock and forms an impervious toe trench that prevents excessive seepage in the powerhouse area.

In the left abutment area near the spillway (Figure 5), a minimum 20-foot-thick upstream blanket is present over a portion of the right slope of the spillway approach channel. Above the upstream impervious blanket, the embankment is composed of a massive compacted shale section that is protected by 20 feet of dumped chalk. The downstream fill section consists primarily of random fill with a berm section of dumped chalk. The right abutment section, located between the right side of the powerhouse and the natural abutment ground surface, has 1V on 3H side slopes and is composed of random fill materials obtained from the right bank excavations.

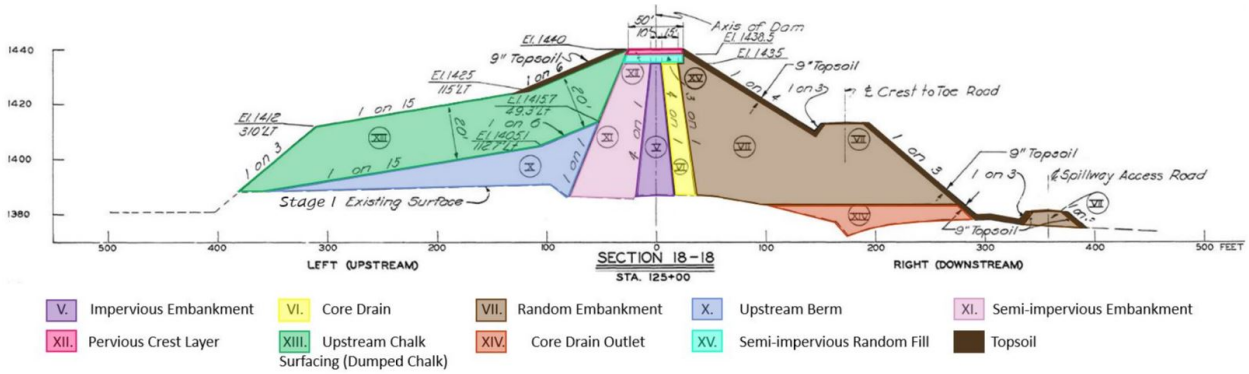


Figure 5: Left abutment embankment typical section (station 125+00)

2.1.2 Seepage Control Measures

Seepage through the embankment is controlled primarily by the impervious core, impervious upstream blanket, and the pervious drain section on the downstream side of the impervious core. Underseepage control is provided by the upstream impervious blanket, the chalk berm sections, the pervious blanket, and by pressure relief wells along the downstream toe of the embankment. Due to the relatively low head at Big Bend Dam and to the other underseepage control methods provided, a positive cutoff through the foundation sand was not determined to be necessary.

2.1.2.1 Pressure Relief Wells

The original system of pressure relief wells was installed in 1963 and extends a distance of 7,125 feet along the toe of the dam (Figure 6). The system was comprised of 68 relief wells spaced at intervals varying from 75 to 225 feet. The wells were installed to provide relief from any excess hydrostatic uplift pressures that may develop in the valley alluvial sands beneath the downstream impervious natural clay blanket. Between 2009 and 2012, the relief well system was modified with 35 additional relief wells. The current system has a total of 103 relief wells and extends a distance of 7,425 feet along the toe of the dam. The additional wells were installed between existing wells through the valley and in the left abutment. Spacing between the relief wells ranges from 35 to 200 feet.

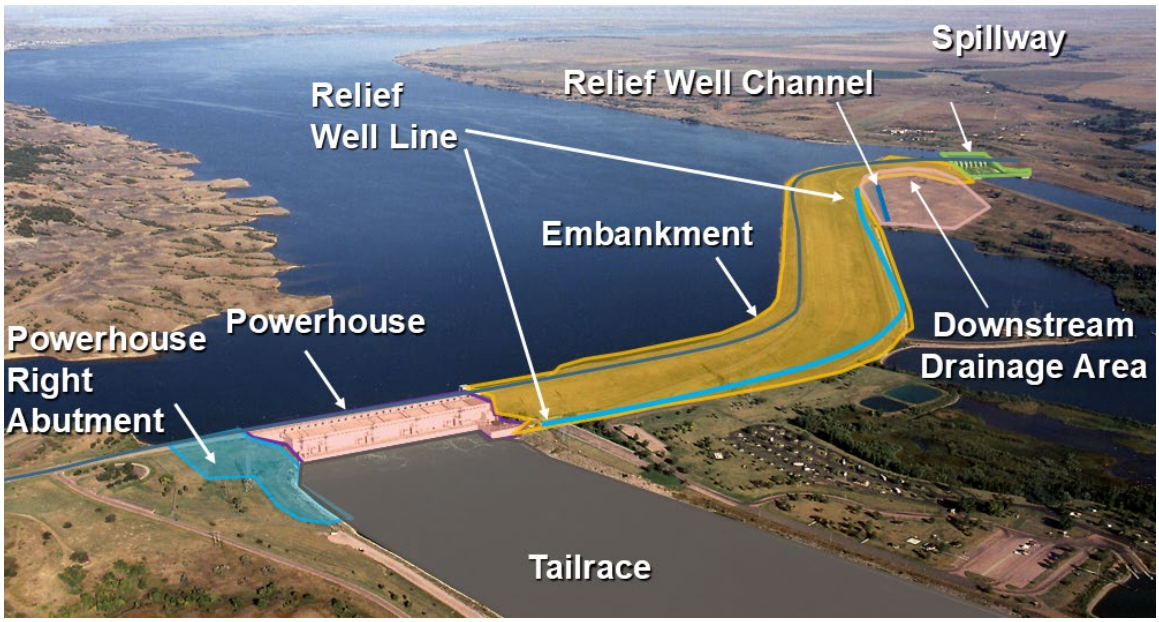


Figure 6: Project feature map showing location of relief well line and drains

3. PILOT BORING FIELD INVESTIGATION METHODOLOGY

3.1 Methodology

A summary of the field effort for the pilot hole installation is provided in the following sections. Intrusive activities into, in close proximity to, or through embankment dams and their foundations may pose significant risk to the structures if not implemented properly. To mitigate these risks, all drilling and sampling shall be conducted in accordance with EM 1110-1-1804, Geotechnical Investigations (1 January 2001); ER 1110-1-1807, Drilling in Earth Embankment Dams and Levees (31 July 2014); EM 1110-2-1914, Design, Construction, and Maintenance of Relief Wells (29 May 1992) and specific guidance as referenced in these sections. Field work was completed in the spring of 2021 (April 23 to May 10) when the reservoir was relatively low. All work was completed by the USACE, Omaha District drill crew.

Six relief well pilot holes (PH21-01 through PH21-06) were advanced to obtain lithologic information and gradation data to aid in the design of six replacement and two new relief wells (later determined not to be required) in the left abutment area of the dam. Pilot hole designations, locations, and bottom depths are provided on Table 1. Locations are shown on Figure 7 and in Appendix A. All pilot holes except PH21-02 (see Section 4) bottomed at the top of the Niobrara chalk, which was confirmed by standard penetration testing (SPT) prior to terminating the hole. Several of the pilot holes were located adjacent to borings drilled and sampled for the toe drain and relief well collector pipe replacement investigation performed in 2020; therefore, samples were not required in the upper 15 to 20 feet of three of the pilot holes as noted in Table 1.

Offset borings were required for two of the pilot holes. Pilot hole offset PH21-01b was drilled adjacent to PH21-01 to verify the presence of a bedrock high indicated by available boring logs in the area (see Section 4). An offset boring was also required for boring PH21-06 due to confusion with the boring designation (the crew thought they were set up on PH21-05 which did not require sampling in the upper 15 feet). The offset borings were combined to create a single drill log.

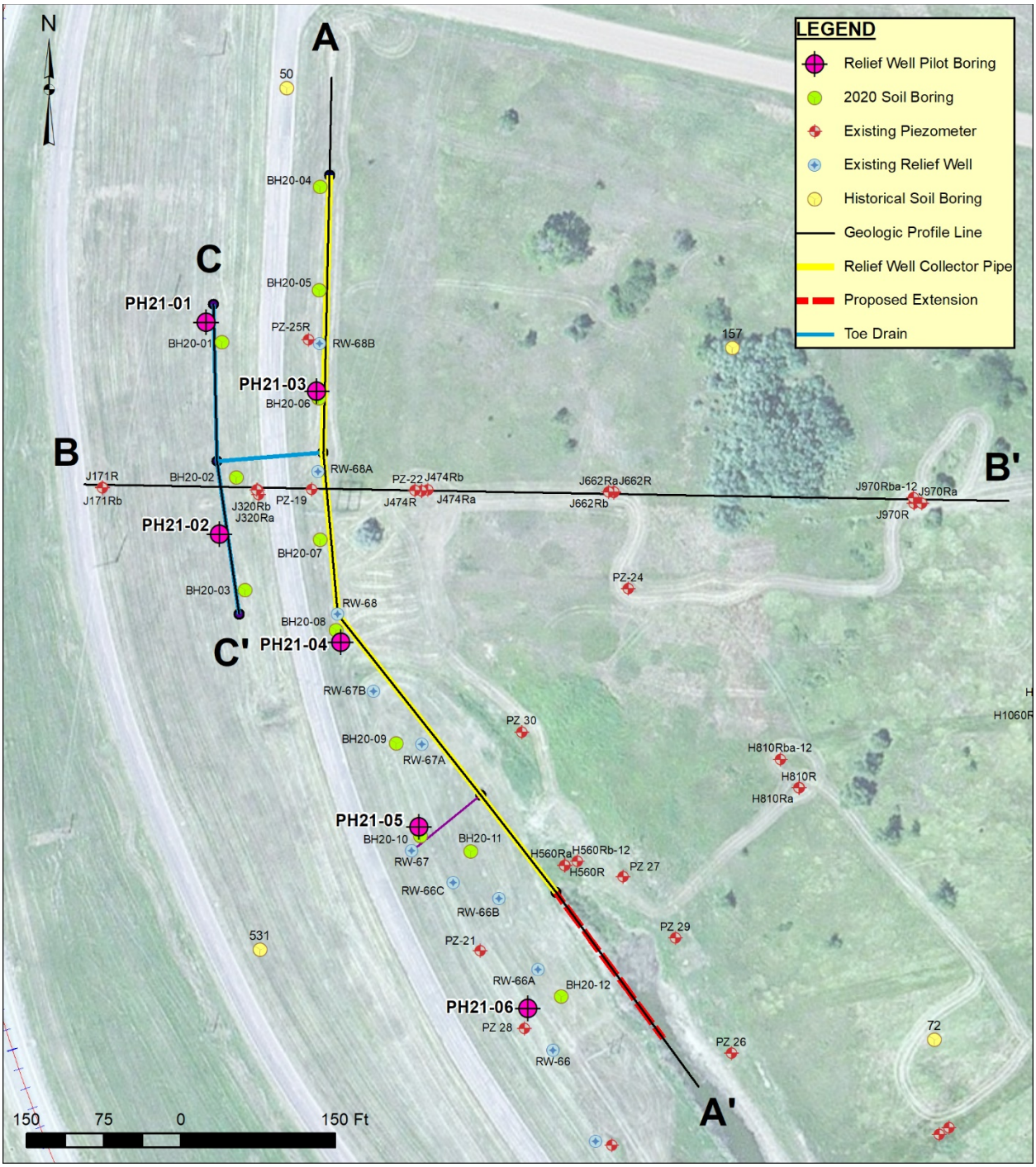


Figure 7: Pilot hole boring and project feature locations (See Appendix A for full-size figure)

Table 1: Pilot hole designations, locations, and depths

Designation	Northing[1]	Easting[1]	Ground Surface Elevation (ft)	Boring Depth (ft)	Sampling Notes
PH21-01/ PH21-01b	629715.453	2199376.913	1386.346	101.4	SPTs every 2.5 ft to 10 ft, every 5 ft after to bedrock
PH21-02	629509.085	2199389.721	1381.842	54.5	SPTs every 2.5 ft to 10 ft, every 5 ft after to bedrock
PH21-03	629648.267	2199484.17	1379.531	93.8	Adjacent to BH20-06 (logged to 20 ft). Log from cuttings to 23 ft, SPTs every 5 ft after to bedrock
PH21-04	629404.179	2199508.072	1375.706	89.9	Adjacent to BH20-08 (logged to 15 ft). Log from cuttings to 18 ft, SPTs every 5 ft after to bedrock
PH21-05	629224.907	2199583.922	1372.293	87.9	Adjacent to BH20-10 (logged to 15 ft). Log from cuttings to 18 ft, SPTs every 5 ft after to bedrock
PH21-06/ PH21-06b	629048.465	2199690.013	1368.882	83.1	SPTs every 2.5 ft to 10 ft, every 5 ft after to bedrock

[1]Coordinates in state plane South Dakota South 4002 US Survey feet

3.1.1 Drilling and Sampling Methodology

Drilling and sampling of the embankment and foundation materials was accomplished with a Gus Pech 1300C drill rig equipped with 4 1/4-inch-ID HSA. Drilling for sample collection and logging purposes was conducted in all borings using a 2-inch-diameter split spoon sampler. Standard penetration tests were performed by dropping a 140-pound hammer a distance of 30 inches to advance a two-inch-diameter split spoon every 2.5 feet in the upper 10 feet, then every 5 feet to the depth of the boring (except where previously sampled as noted in Table 1). These penetration tests were performed in accordance with ASTM D 1586-11, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils." Blow counts were recorded on the drill log.

During drilling, circulating drilling fluids were not utilized; however, clean water was added to the inside of the auger column to provide a positive pressure head within the auger column to offset the hydrostatic pressure of the saturated zone. The added water helped stabilize the formation by minimizing heaving sand conditions and ensuring that a representative sample was collected; thereby ensuring that depth control was maintained and an accurate sample reflective of the subsurface conditions at the depths indicated was obtained.

3.1.2 Geotechnical Sample Collection and Retention

Sampling required for this field effort consisted of disturbed samples collected at the intervals specified in Table 1. Disturbed soil samples were collected from all borings from each sampling interval and from all changes in material. A total of 262 samples were collected and select samples were hand delivered to Terracon in Omaha, Nebraska for testing.

3.1.3 Boring Abandonment

Because the borings are located adjacent to both the toe drain and perforated relief well collector pipe, the use of grout was only permitted at depths up to 15 feet below ground surface. Below 15 feet, all borings were backfilled by tremie grouting with cement-bentonite grout at the ratio of 7 gallons of water to 94 lbs.

of Portland Cement to 3-5% bentonite. Above 15 feet, all borings were backfilled with medium (3/8-inch) bentonite chips that were placed in the boring as the augers were removed.

3.1.4 Cutting Disposal

Soil cuttings were piled by the boring locations and disposed of by the project office at the completion of drilling. Note that none of the cuttings were noted to have visual or olfactory evidence of fuel contamination so none of the soil cuttings were drummed as discussed in Section 4.4.

4. SITE HYDROGEOLOGICAL CONDITIONS

4.1 Overburden Deposits

The overburden soils at the dam site consist of residual clays, alluvial clays, silts and sands, and glacial outwash sand and gravel (Figure 8). The overburden materials are described below:

- Left abutment glacial deposits: In the upper reaches of the left abutment above the Pierre shale. Consist of silts, sands, and gravels, mantled locally with loess.
- Left bank flood plain deposits: Form part of the embankment foundation. Mantle of fat clay (CH) up to 25 feet thick overlying pervious valley alluvium.
- Pervious valley alluvium: Pervious alluvial deposits of the Missouri River. Consist primarily of silty fine sands that become coarser with depth, some gravel strata.
- Right bank overburden: In the upper reaches of the right abutment above the Pierre shale. Consists of fat clays (CH) derived from the underlying Pierre shale and silts, sands, and gravels (Good Soldier Creek).

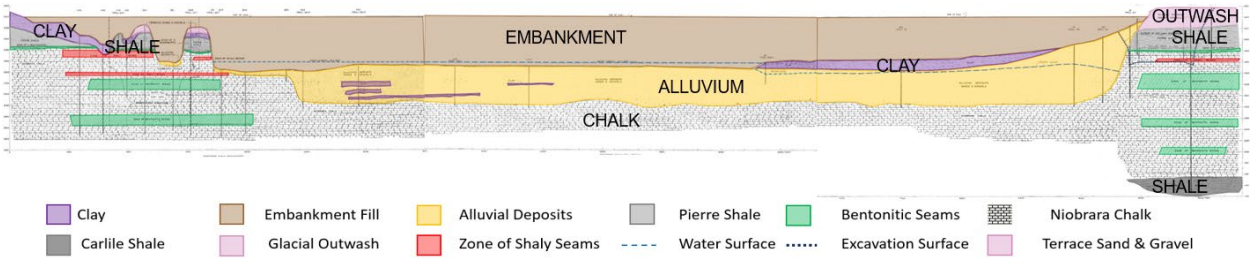


Figure 8: Geologic profile through centerline of dam (looking upstream)

4.2 Bedrock

Bedrock at the dam site consists of (in descending order): Pierre Formation shale, Niobrara Formation chalk, and Carlile Formation shale, all of Cretaceous age.

- Pierre Shale: Occurs in the spillway and powerhouse intake and discharge channels and beneath a short section of embankment on the right abutment. Gray to dark gray compaction-type shale composed chiefly of clay and silt constituents. Has well-defined bedding planes and numerous bentonite seams.
- Niobrara Chalk: Supports all of the appurtenant structures at the project. Lead gray, medium hard, impervious, argillaceous chalk or chalky shale derived chiefly from marine microorganisms and precipitates of calcium carbonate materials. Bentonite, bentonite clay, and shale seams occur throughout the formation.
- Carlile Shale: Unrelated to any structure foundation at the project (72 feet below the deepest part of the powerhouse foundation).

4.3 Project-Specific Geology

In the area of the relief well replacements, the foundation geology consists an alluvial clay blanket overlying alluvial sands (upper), alluvial clays and silts, alluvial sands (lower), and Niobrara Formation chalk as shown in Table 2 and on the geologic profiles in Appendix A. The thickness of the upper clay blanket (from available borings) varies across the area of the investigation ranging from 0 to >10 feet. The blanket clays are predominantly lean (CL) or sandy lean clays (s[CL]) and occasionally contain silt, sand, and gravel. The alluvial sands beneath the clay blanket are predominantly silty and poorly graded fine sands (SM, SP-SM, SP-SC, and SP) and vary in thickness from about 20 to 35 feet. An intermediate clay layer that is about 20 to 40 feet in thickness is present beneath the upper alluvial sands and is believed to act as a confining unit over most of the investigation area. Beneath the intermediate clays, a lower alluvial sand is present. The lower sand is more variable than the upper sands and contains both poorly and well-graded sands with silt and clay as well as gravel closer to the lower contact with the Niobrara chalk.

Niobrara chalk was encountered in all borings around elevation 1,285 feet. It was originally believed that a bedrock high was present beneath the embankment based on piezometer logs for J171R and J320R (see Cross Section B-B' in Appendix A). According to the logs, chalk was encountered at elevations between 1,330 and 1,335 feet. Boring PH21-01 and PH21-02 were both advanced through the area of the bedrock high and terminated in a stiff clay that was thought to be weathered chalk (note that the chalk is described as being clayey). These were also the first borings drilled and the chalk had not yet been observed by the field geologist. After a review of the logs and discussions with the field geologist, it was determined that an additional offset boring (PH21-01b) be advanced adjacent to PH21-01 to a depth below the clay to verify if the previously interpreted bedrock surface was incorrect. Boring PH21-01b was advanced through the clay unit into a lower sand. Confirmed bedrock was encountered at elevation 1,285 feet (the interpreted surface as noted in logs J171R and J320R is incorrect).

Table 2: Boring depth, materials encountered, and interpreted zones

Boring Designation	Bottom Depth (ft bgs)	Materials Encountered (Depth) (ft bgs)	Interpreted Zone
PH21-01/PH21-01b	101.4	CL-ML (0-1.5) (SW)g, SP-SC, SC-SM (1.5-5.9) (CL)s (5.9-12.5) SP-SC (12.5-48.3) CL-ML, CL, CH, ML (48.3-79) SP-SM, SP w/ interbedded CL, CL-ML) Chalk (100.9-101.4)	Random Embankment Fill Horizontal Drain Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-02	54.5	CL-ML (0.5-1) SC (1-4) CL, ML (4-8.1) SP-SC, SP (8.1-38.2) ML/CL, CL-ML, CL/CH, ML (38.2-54.5)	Random Embankment Fill Horizontal Drain Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate)
PH21-03	93.8	CL-ML (0-8) SP-SM, SP-SC (8-42) CL-ML, SP-SC, CL/CH, ML (42-71) SM, SP, SP-SM, (GC-GM)s, (GW)s, (GW-GC)s (71-92.8) Chalk (92.8-93.8)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-04	89.9	CL/CH, CL-ML (0-7.5) SP, SM (7.5-32.5) CL-ML, CH, ML (32.5-62.5) SP-SM, SP, SC, SW, SW-SC (62.5-89.2) Chalk (89.2-89.9)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation

Boring Designation	Bottom Depth (ft bgs)	Materials Encountered (Depth) (ft bgs)	Interpreted Zone
PH21-05	87.9	CL, (CL-ML)s, SC (0-11) SP, SM (11-28) ML/CL, CL-ML, CL/CH, CL, ML (28-74) SP-SM, SM, SP, SW-SM (74-86) Chalk (86-87.9)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-06/PH21-06b	83.1	CL, s(CL), [(SW)g 2.5-4] (0-8) SM, SP-SC (8-27) CL, (CL)s, ML/CL, (CL-ML)s, SP-SC (27-44.9) S(ML), SP, SP-SM, SC, SC-SM, (SP)g, SW-SM, SW-SC, GW-GC (44.9-82.5) Chalk (82.5-83.1)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation

4.3.1 N-values

Uncorrected blow counts in the alluvial clays ranged from 1 to 4 in the blanket beneath the toe drain and from 14 to 39 in boring PH21-06/PH21-06b (note that the upper materials were not sampled in borings PH21-03 through PH21-05 because they were drilled adjacent to previously drilled boings. Uncorrected blow counts in the upper alluvial sands ranged from weight of hammer (WOH) to 18 with an average of 6.5 (loose). Uncorrected blow counts in the intermediate clays ranged from 4 to 32 with an average of 12.1 (stiff). Uncorrected blow counts in the lower alluvial sands ranged from 2 to refusal (60 blows with less than 0.5 foot of penetration – most likely due to the presence of gravels) with an average of 24.8 (medium dense). Refusal was encountered in the chalk in all borings where it was encountered with between 0.3 and 0.4 feet of penetration.

SPT hammer efficiency on the Gus Pech 1300C drill rig (Gus Pech 3) was recorded in July 2019 at 87.1%.

4.3.2 Laboratory Data

Of the 26 samples with gradation data in the alluvial sands, fines content ranged from 2 to 20 percent, with an average value of 11.4 percent. The majority of the sand classified as fine (between 0.075 and 0.475 mm) with percentages ranging from 8 to 88% with an average of 67.6%. Gravel was not present in any of the samples. Liquid limits for three samples in the alluvial clay ranged from 26 to 32. Plasticity limits for the three samples ranged from 18 to 22. A plasticity index value of between 8 and 13 was obtained from all samples. Laboratory data is included as Appendix D.

4.4 Hazardous, Toxic, and Radioactive Waste Sampling

In the 1970s and 1980s, kerosene was often added to piezometers at the dam that had water near the surface to prevent the water from freezing and bursting the pipes in the winter. Because several of these piezometers are in the location of the proposed toe drain replacement, specialized samples were also collected from the geotechnical borings to determine any impacts to the soil and groundwater from the kerosene in order to determine if any hazardous or toxic waste would be generated during construction and dewatering. According to project personnel, as the fuel would evaporate off more would be added, typically less than a gallon ever year or two. This procedure was phased out in the late-1980s as vibrating wire transducers were being installed in the open tube pipes and was discontinued completely sometime in 1992 or 1993.

During recent routine maintenance operations, it was noted that diesel fuel was still present in some of the piezometers. Project staff later inspected the piezometers and identified two piezometers (J320Ra and J320Rb) with free product. Shallow piezometer J320Ra contained less than two inches of diesel fuel and

deep piezometer J320Rb contained approximately five feet of diesel. The combined amount of diesel fuel equated to less than one gallon in the two-inch pipes.

After the diesel was identified, project staff began to remove the diesel by first dipping off the surface fluid. This was completed multiple times to allow for the remaining diesel fuel to rise to the surface. After the majority of the diesel fuel was removed in this manner, project staff used fuel-only absorbent pigs to collect the residual diesel. Project staff provided all information to the Department of Environment and Natural Resources (DENR) and proposed to continue to use the absorbent pigs to clean any residual fuel out of the piezometers until no further presence of fuel was observed. Based on the location of the piezometers, and fact that no adverse impacts have been identified, the DENR placed this case into the "No Further Action" category with the caveat that US Army Corps of Engineers may be responsible for conducting additional assessment and remediation any future problems arising from the remaining contamination.

4.4.1 FY20 HTRW Sampling Results

The results of HTRW sampling performed during the FY20 field investigation, as documented in the FY20 Engineering Geology Report (USACE, 2020) indicated the presence of TPH-DRO in soil and groundwater in the location of borings BH20-11 and BH20-12 (see Figure 7). The soil sample taken from BH20-12 (BBSD-12A) was analyzed at 2830 mg/kg and the groundwater grab sample was analyzed at 27,000 ug/L. The soil sample taken at BH20-11 (BBSD-11A) was analyzed at 96.9 mg/kg.

4.4.2 FY21 HTRW Field Investigation

To further assess the impact of the diesel fuels on the soil and groundwater in the area of proposed construction, soil samples were to be collected at depths immediately above the groundwater table from all geotechnical borings drilled for this investigation if any visual or olfactory evidence of soil contamination was noted. Because no evidence of soil contamination was noted in any of the borings, no HTRW samples were collected. However, one composite soil sample was taken from a composite drum stored on site from the FY20 investigation to obtain additional fuel compound data for disposal options. The soil sample was analyzed for total petroleum hydrocarbons (TPH) of diesel range organics (DRO), BTEX, and naphthalene as summarized in Table 3. A report documenting the results of the soil sampling is included as Appendix D.

Table 3: Soil samples collected for TPH-DRO, BTEX, and naphthalene

Boring Designation	Soil Sample ID	Soil Sample Container
FY20 IDW Drum		
Existing IDW drum from FY20*	BB2-IDW	1x4 oz. glass jar (no preservatives – no headspace) 2x5-gram Terra Core samples (methanol-preserved) **Composite sample from three different soil intervals in drum. Mixed soil in clean/decontaminated container. Collected samples from composite.**

5. BORROW AREA SOIL BORING FIELD INVESTIGATION METHODOLOGY

Borings were also advanced at three locations to attempt to identify a potential borrow source for use during construction of the replacement toe drain and relief well collector pipe. The three soil borings (BH21-01 through BHB21-03) were advanced to obtain lithologic information and geotechnical data to determine the suitability of soils in the area north of the project office for use as a borrow source. Soil boring designations, locations, and depths are provided on Table 4. Locations are shown on Figure 9 and Figure 10. Borings BH21-01 and BH21-02 encountered sand near the surface and boring BH21-03 encountered shale at the surface. None of the three locations are suitable for borrow.

Table 4: Borrow area soil boring designations, locations, and depths

Designation	Latitude	Longitude	Bottom Depth (ft)
BH21-01	44.06936	-99.45989	10
BH21-02	44.06782	-99.46099	10
BH21-03	44.03312	-99.44648	10

Figure 9: Borrow area soil boring locations BH21-01 and BH21-02 (north of project office)

Figure 10: Borrow area soil boring location BH21-03 (south of dam near tower)

6. GROUNDWATER

The discussion that follows documents conditions observed at Big Bend Dam during the field investigation (April and May 2021) unless otherwise noted. Due to continuous reservoir loading, groundwater levels as reported in this section will fluctuate over time due to seasonal and operational variances in reservoir elevation. It should be noted that there are no cutoff features installed through the alluvial sands beneath the dam embankment.

6.1 Existing Piezometers

Several piezometers have been installed in the area of the drain to monitor pore pressures in the foundation. Groundwater levels in these piezometers are typically within four to eight feet of the ground surface in the area of construction (see plan view and geologic profiles in Appendix A). The groundwater elevations from piezometers in the area of construction as shown on the figures and reported in Table 5 are from the May 2021 groundwater sampling event when the reservoir was at 1,420.62 feet and tailwater was at 1,355.20 feet. The groundwater elevations shown are expected to be similar to elevations anticipated during the beginning of the typical field season in this area.

Table 5: Groundwater elevation data from the May 2021 sampling event

Piezometer Designation	Screen Depth (ft bgs)	Depth to Groundwater (ft TOC)	Groundwater Elevation (ft LPD)
J320Ra	14.6-19.6	9.3	1375.65
J320Rb	40.3-45.3	10.3	1375.71
J474Ra	37-42	5.6	1373.43
J474Rb	85-90	6.1	1373.85
J662Ra	19.5-24.5	14.7	1363.71*
J662Rb	Vibrating wire	Vibrating wire	1381.86*
J970Ra	37.2-47.2	8.2	1367.85
J970Rba-12	Vibrating wire	Vibrating wire	1367.94
PZ-19	37-42	7.4	1374.51
PZ-21	Vibrating wire	Vibrating wire	1368.97
PZ-25R	36.2-41.2	6.6	1376.54
PZ-28	Vibrating wire	Vibrating wire	1364.84
PZ-30	Vibrating wire	Vibrating wire	1366.29

*Note that these readings are considered suspect. Because they are not in the immediate area of construction, this is not a concern for this investigation; however, the piezometers are being investigated for possible replacement.

6.2 FY21 Field Investigation

Groundwater was encountered during drilling of the pilot borings (PH21-01 through PH21-06) in May 2021 at depths between 4.9 and 8.0 feet bgs. It should be noted that these depths are based on observations during drilling as measured within the hollow stem augers and are to be considered approximate. In general, groundwater was encountered in the clay blanket materials as summarized in Table 6.

Table 6: Depth groundwater encountered during drilling

Boring	Ground Surface Elevation (ft LPD)	Depth Groundwater Encountered (ft bgs)/ Elevation (ft LPD)	Materials Encountered/ Depth in ft bgs	Interpreted Zone
PH21-01/ PH21-01b	1386.346	8.0/1378.3	CL-ML (0-1.5) (SW)g, SP, SM (1.5-5.9) (CL-ML)s (5.9-12.5) SP-SM (12.5-48.3) CL-ML, CL, CH, ML (48.3-79) SP-SM, SP w/ interbedded CL, CL-ML) Chalk (100.9-101.4)	Random Embankment Fill Horizontal Drain Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-02	1381.842	5.5/1376.3	CL-ML (0.5-1) SW, SP-SM (1-4) CL/CH, ML (4-8.1) SP-SM, SP (8.1-38.2) ML/CL, CL-ML, CL/CH, ML (38.2-54.5)	Random Embankment Fill Horizontal Drain Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate)

Boring	Ground Surface Elevation (ft LPD)	Depth Groundwater Encountered (ft bgs)/ Elevation (ft LPD)	Materials Encountered/ Depth in ft bgs	Interpreted Zone
PH21-03	1379.531	6.4/1373.1	CL-ML (0-8) SP-SM (8-42) CL-ML, SP-SC, CL/CH, ML (42-71) SP-SM, SP, (GC-GM)s, (GW)s, (GW-GC)s (71-92.8) Chalk (92.8-93.8)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-04	1375.706	4.9/1370.8	CL/CH, CL-ML (0-7.5) SP, SM (7.5-32.5) CL-ML, CH, ML (32.5-62.5) SP-SM, SP, SC, SW, SW-SC (62.5-89.2) Chalk (89.2-89.9)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-05	1372.293	8.0/1364.3	CL, (CL-ML)s, SC (0-11) SP, SM (11-28) ML/CL, CL-ML, CL/CH, CL, ML (28-74) SP-SM, SP, SW (74-86) Chalk (86-87.9)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation
PH21-06/ PH21-06b	1368.882	8.0/1360.9	CL, CL-ML, [(SW)g 2.5-4] (0-8) SP, SP-SM (8-27) CL, (CL)s, ML/CL, (CL-ML)s, SP-SC (27-44.9) ML, SP, SP-SM, SC-SM, (SP)g, SW, GW-GC (44.9-82.5) Chalk (82.5-83.1)	Alluvial Clay (Blanket) Alluvial Sand (Upper) Alluvial Clay (Intermediate) Alluvial Sand (Lower) Niobrara Formation

7. RELIEF WELL DESIGN

The six replacement relief wells were designed following the requirements identified in EM 1110-2-1914, Design, Construction, and Maintenance of Relief Wells and modified using professional judgment. Through this evaluation, it was determined that the use of 30-slot screen for all replacement relief wells would be most efficient and effective given the range of available gradation data. The filter pack will be Northern Filter .60-.80, Red Flint #30 WS, or an equivalent gradation mix. Planned screen and filter pack design details are provided in Table 7.

The replacement relief well screened intervals were adjusted from the original relief well intervals based on new information obtained during the field investigations performed in FY20 and FY21. Based on these investigations, it was determined that two sand zones were present in the toe drain and relief well collector pipe area separated by a confining clay unit. A review of the data indicated that the existing relief wells installed in the area were installed primarily through the middle confining clay and lower sand zones (not in the upper sands). It appears that most of the relief wells were installed to mimic the screened intervals in the valley section where the geology consists of a more consistent upper clay blanket overlying a large sand deposit. Based on the revised cross section (Figure A.5 in Appendix A), replacement relief wells RW-68BR, RW-68AR, RW-68R, RW67R, and RW-66AR were designed to screen the entire upper sand zone interval, providing additional pressure relief in the area of the relief well collector pipe. Because the upper sand zone is absent in the area of relief well RW-66R, this well was designed to intercept the lower sand zone because it more closely mimics the geology observed in the valley section (thick clay blanket overlying continuous sands). Design details are provided in Table 8.

Note that the design details provided are tentative and are subject to change.

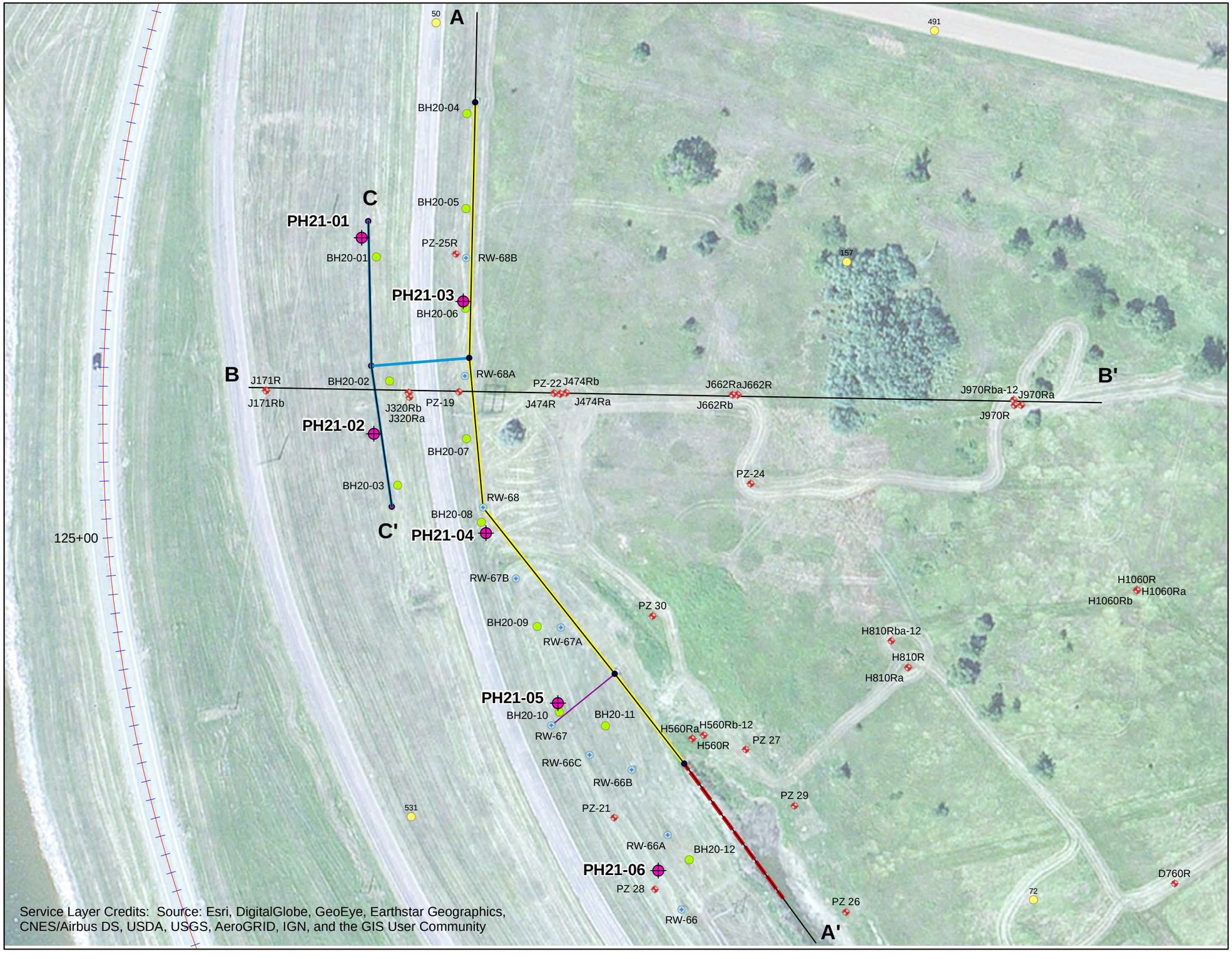
Table 7: Planned replacement relief well screen and filter pack design

Relief Well Designation	Northing	Easting	Outfall/Top of Riser Elevation	Slot Size	Intake Area (assume 8-inch diameter) in sq in per ft	Filter Pack
RW-66R	629016.842	2199708.202	1366.13	30	94	Northern Filter .60-.80)/ Red Flint #30 WS
RW-66AR	629077.486	2199705.581	1366.44	30	94	Northern Filter .60-.80)/ Red Flint #30 WS
RW-67R	629201.354	2199590.088	1366.00	30	94	Northern Filter .60-.80)/ Red Flint #30 WS
RW-68R	629441.882	2199493.711	1367.96	30	94	Northern Filter .60-.80/ Red Flint #30 WS/
RW-68AR	629577.490	2199484.510	1372.81	30	94	Northern Filter .60-.80/ Red Flint #30 WS/
RW-68BR	629686.284	2199487.587	1374.67	30	94	Northern Filter .60-.80/ Red Flint #30 WS/

Table 8: Planned replacement relief well construction details (**Revised October 2022**)

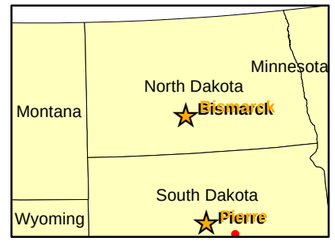
Relief Well Desig-nation	Ground Surface Elevation (LPD)	Depth to Outfall Invert/ Top of Relief Well Riser	Depth to Base of Relief Well Manhole	Depth from ground surface to bottom of blanket	Depth from ground surface to base of aquifer	Blank Casing Interval	Screen Interval	Sump Interval	Filter Pack Interval	Seal Interval
RW-66R	1369	2.9	4.9	9	**83**	**0-58**	**58-78 (20 ft)**	**78-83**	**50-83**	**0-50**
RW-66AR	1370	3.6	5.6	9	28	0-16	16-26 (10 ft)	26-31	11-31	0-11
RW-67R	1373	7.0	9.0	12	29	0-18	18-28 (10 ft)	28-33	15-28	0-15
RW-68R	1377	9.0	11.0	4	**32**	**0-17**	**17-32 (15 ft)**	**32-37**	**14-37**	**0-14**
RW-68AR	1380	7.2	9.2	7	38	0-16	16-36 (20 ft)	36-41	13-41	0-13
RW-68BR	1381	6.3	8.3	8	44	0-18	18-43 (25 ft)	43-48	13-48	0-13

Appendix A: Location Maps and Cross Sections



LEGEND

- Relief Well Pilot Boring
- 2020 Soil Boring
- Existing Piezometer
- Existing Relief Well
- Historical Soil Boring
- Geologic Profile Line
- Manhole
- Relief Well Collector Pipe
- Proposed Extension
- Toe Drain
- Connector Pipe
- RW67 Outfall Pipe
- Toe Drain Riser



N

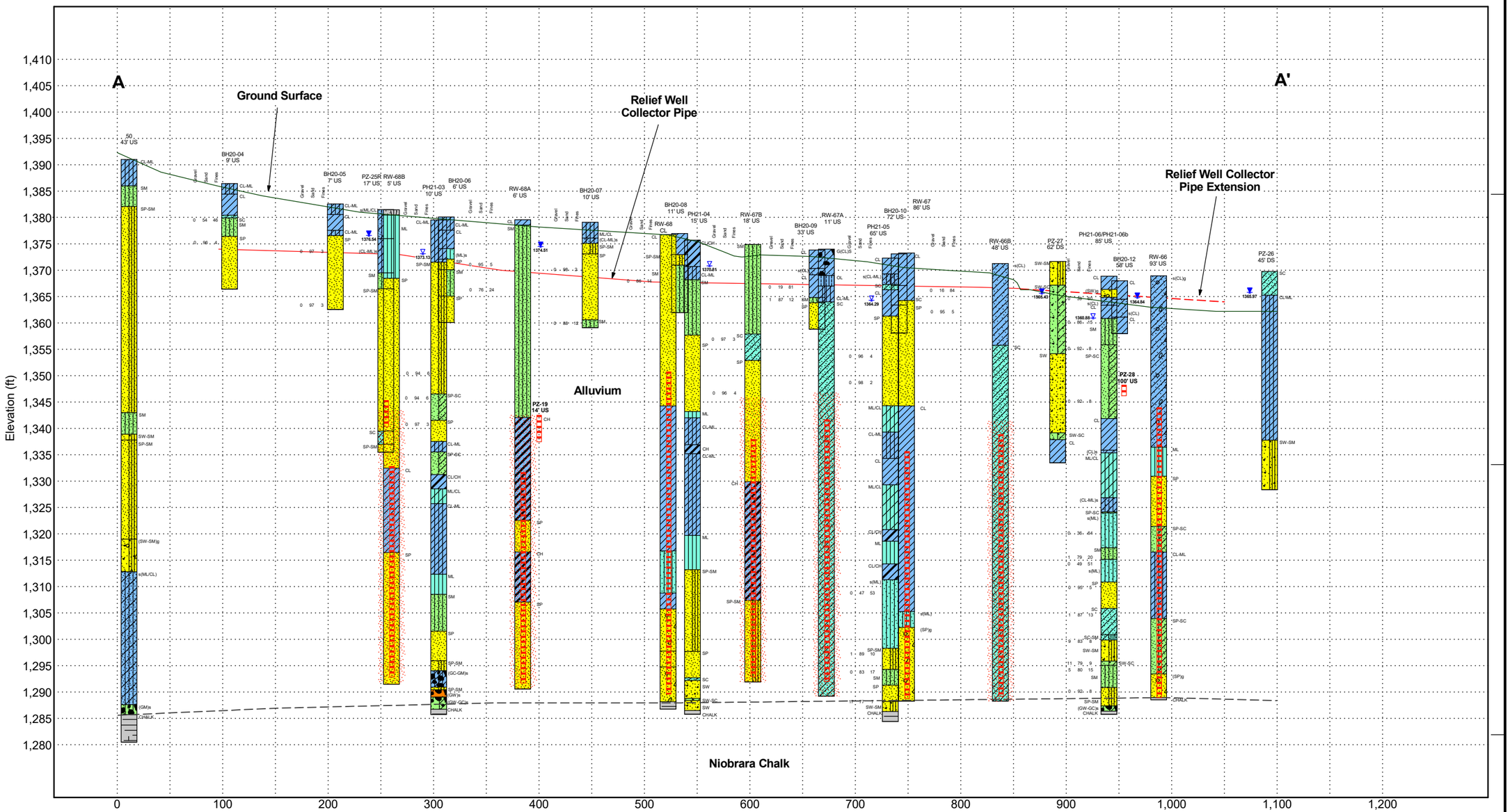
100 50 0 100 Ft

U.S. Army Corps of Engineers
Omaha District

Big Bend Dam
Ft Thompson, SD

Soil Boring Location Map

August 2021 | FIGURE A1



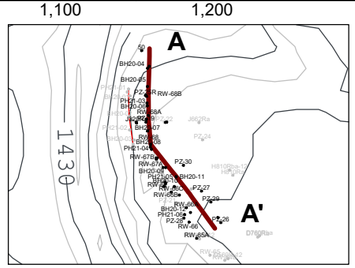
LITHOLOGY GRAPHICS

- (CL)g - Lean Clay with Gravel
- (CL)s - Lean Clay with Sand
- (CL-ML)s - Silty Clay with Sand
- (GC)s - Clayey Gravel with Sand
- CH - Fat Clay
- CL - Lean Clay
- CL-ML - Silty Clay
- g(CL)s - Gravelly Lean Clay with Sand
- g(CL-ML)s - Gravelly Silty Clay with Sand
- OL - Organic Silt/Clay
- s(CL) - Sandy Lean Clay
- s(CL)g - Sandy Lean Clay with Gravel
- SC - Clayey Sand
- (ML)s - Silt with Sand
- ML - Silt
- s(ML) - Sandy Silt
- s(ML/CL) - Sandy Clayey Silt
- (GM)s - Silty Gravel with Sand
- SM - Silty Sand
- SP-SC - Poorly Graded Sand with Clay
- SW-SC - Well-Graded Sand with Clay
- (SP)g - Poorly Graded Sand with Gravel
- (SW-SM)g - Well-Graded Sand with Silt and Gravel
- SP - Poorly Graded Sand
- SP-SM - Poorly Graded Sand with Silt
- SW - Well-Graded Sand
- SW-SM - Well-Graded Sand with Silt
- Chalk - Chalk or Marl
- CONCRETE - Concrete
- No Sample - No Sample
- Well Screen and Filter Pack
- Depth Groundwater Encountered During Drilling
- Groundwater Level Measured May 2021

50.0 0.0 50.0 100.0 150.0
Horizontal Scale in Feet

Notes:

1. Elevations in Project Datum.
2. Vertical exaggeration ~5x.
3. Boring profiles projected to cross section line. US = upstream, DS = downstream.
4. Water levels from May 2021. Reservoir el. 1420.62. Tailwater el. 1355.20.



US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

MARK	DESCRIPTION	DATE	APPR

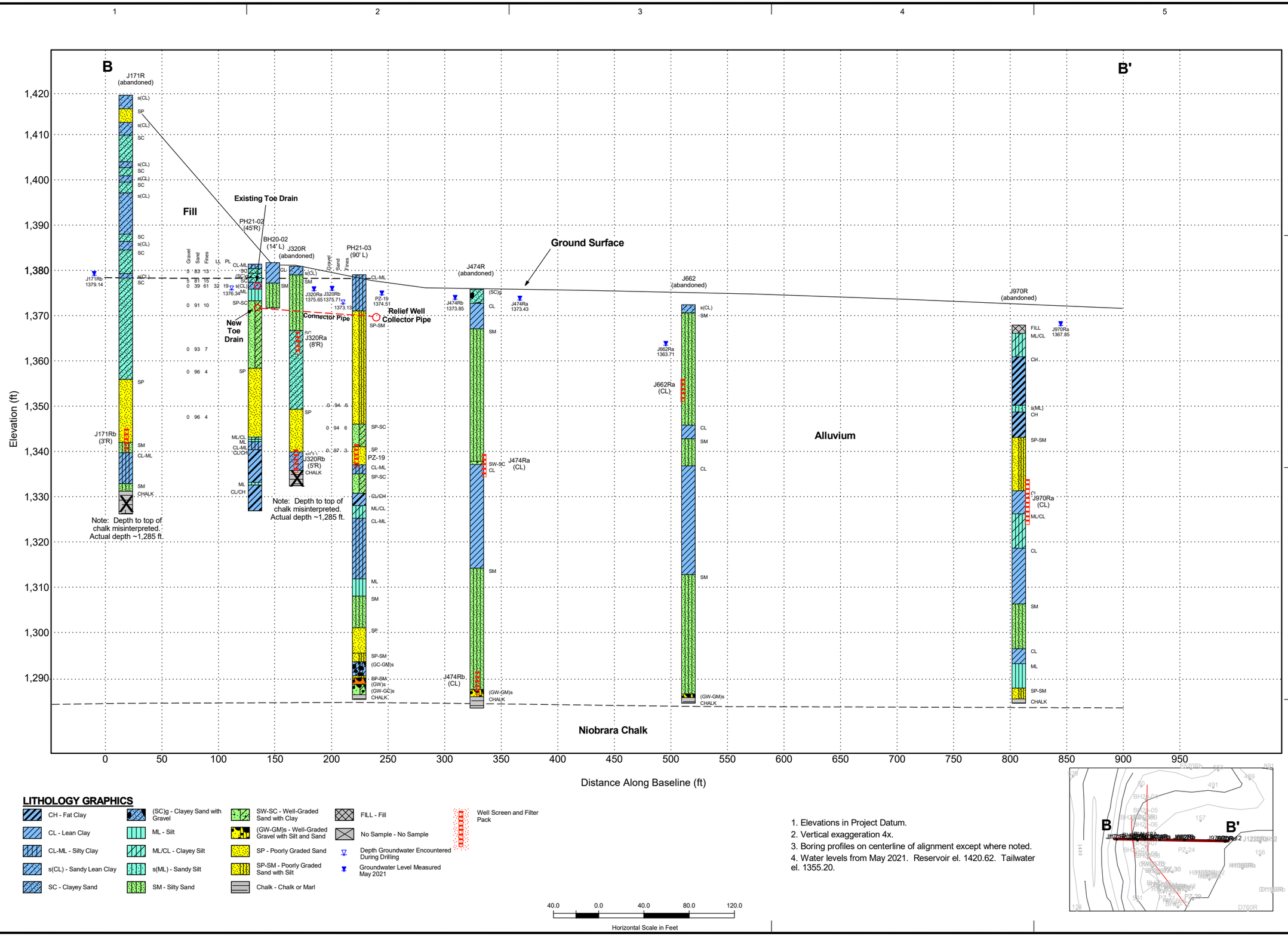
DESIGNED BY:
DRWN BY:
CKD BY:
SUBMITTED BY:
FILE NAME:
SIZE:
PLOT SCALE:
PLOT DATE:
DATE: 8/4/21
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

FY21 Toe Drain and RW Collector Pipe
Subsurface Investigation
Fort Thompson, SD
Geologic Profile A-A'

SHEET IDENTIFICATION NUMBER
A2

NWO_FENCE_B_SIZE_SENSING_ZONE_BIG_BEND_DRAIN_RW_REPLACEMENT.GPJ_USACE_NWO.GDT 2/10/21



LITHOLOGY GRAPHICS

- CH - Fat Clay
- CL - Lean Clay
- CL-ML - Silty Clay
- s(CL) - Sandy Lean Clay
- SC - Clayey Sand
- (SC)g - Clayey Sand with Gravel
- ML - Silt
- ML/CL - Clayey Silt
- s(ML) - Sandy Silt
- SM - Silty Sand
- SW-SC - Well-Graded Sand with Clay
- (GW-GM)s - Well-Graded Gravel with Silt and Sand
- SP - Poorly Graded Sand
- SP-SM - Poorly Graded Sand with Silt
- Chalk - Chalk or Marl
- FILL - Fill
- No Sample - No Sample
- Depth Groundwater Encountered During Drilling
- Groundwater Level Measured May 2021
- Well Screen and Filter Pack

40.0 0.0 40.0 80.0 120.0

Horizontal Scale in Feet

1. Elevations in Project Datum.
2. Vertical exaggeration 4x.
3. Boring profiles on centerline of alignment except where noted.
4. Water levels from May 2021. Reservoir el. 1420.62. Tailwater el. 1355.20.

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: | DATE: 8/4/21
DWN BY: | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
FILE NAME: | FILE NUMBER: | PLOT DATE:
SIZE: | PLOT SCALE:

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

FY21 Toe Drain and RW Collector Pipe
Subsurface Investigation

Fort Thompson, SD
Geologic Profile B-B'

SHEET IDENTIFICATION NUMBER
A3

NWO_FENCE_B_SIZE_SENSING_ZONE_BIG_BEND_DRAIN_REPLACEMENT.GPJ USACE_NWO.GDT 7/21/20

C

C'

RISER 1

PH21-01/PH21-01b (10' US)

BH20-01 (10' DS)

RISER 2

BH20-02 (15' DS)

PH21-02 (10' US)

BH20-03 (10' DS)

RISER 3

Ground Surface

Existing Toe Drain Invert

New Toe Drain Invert

Elevation (ft)

1,440
1,430
1,420
1,410
1,400
1,390
1,380
1,370
1,360
1,350
1,340
1,330
1,320
1,310
1,300
1,290

0
50
100
150
200
250
300

Distance Along Baseline (ft)

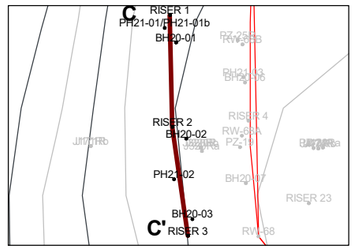
LITHOLOGY GRAPHICS

- (CL)s - Lean Clay with Sand
- CH - Fat Clay
- CL - Lean Clay
- CL-ML - Silty Clay
- CL/CH - Lean to Fat Clay
- s(CL) - Sandy Lean Clay
- SC - Clayey Sand
- (ML)s - Silt with Sand
- (SC)g - Clayey Sand with Gravel
- ML - Silt
- ML/CL - Clayey Silt
- SC-SM - Silty, Clayey Sand
- SM - Silty Sand
- SP-SC - Poorly Graded Sand with Clay
- (SW)g - Well-Graded Sand with Gravel
- SP - Poorly Graded Sand
- SP-SM - Poorly Graded Sand with Silt
- (GW)s - Well-Graded Gravel with Sand (GW)
- Chalk - Chalk or Marl
- CONCRETE - Concrete
- Well Screen and Filter Pack
- Depth Groundwater Encountered During Drilling

12.5 0.0 12.5 25.0 37.5

Horizontal Scale in Feet

1. Elevations in Project Datum.
2. Vertical exaggeration 2.5x.
3. Boring profiles offset as indicated.
4. Water levels from May 2020. Reservoir el. 1420.58. Tailwater el. 1356.09.



US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

	APPR	DATE	DESCRIPTION

	APPR	DATE	DESCRIPTION

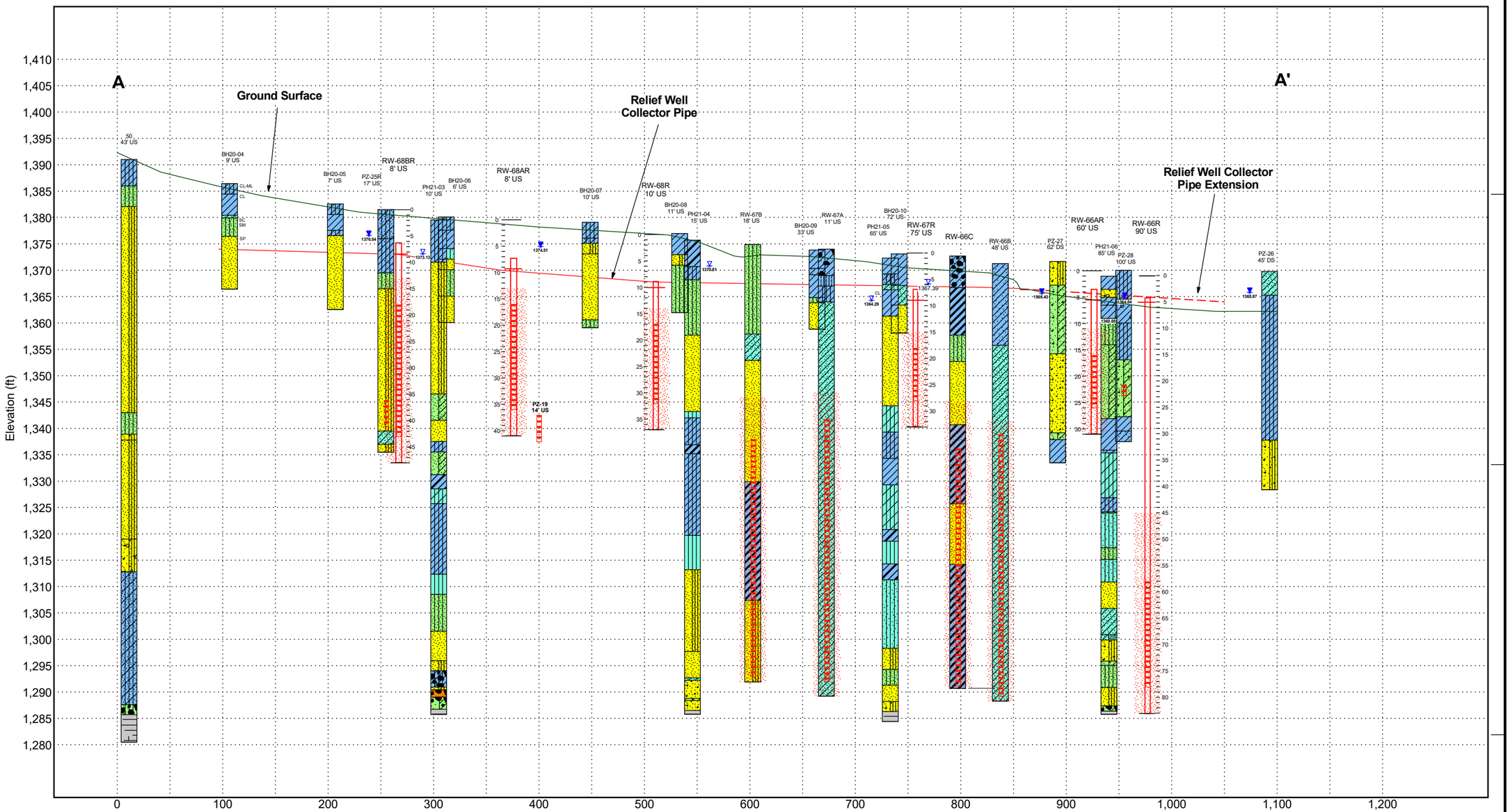
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
FILE NAME:
DATE: 2/10/21
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
PLOT SCALE:
PLOT DATE:
SIZE:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

FY21 Toe Drain and RW Collector Pipe
Subsurface Investigation
Fort Thompson, SD
Geologic Profile C-C'

SHEET IDENTIFICATION NUMBER
A4

NWO_FENCE_B_SIZE_BIG_BEND_DRAIN_RW_REPLACEMENT.GPJ_USACE_NWO.GDT 8/9/21



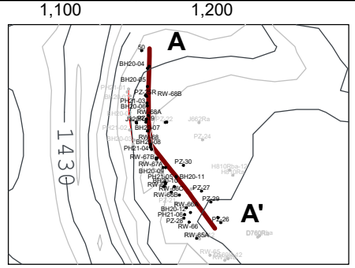
LITHOLOGY GRAPHICS

- (CL)g - Lean Clay with Gravel
- (CL)s - Lean Clay with Sand
- (CL-ML)s - Silty Clay with Sand
- (GC)s - Clayey Gravel with Sand
- CH - Fat Clay
- CL - Lean Clay
- CL-ML - Silty Clay
- g(CL)s - Gravelly Lean Clay with Sand
- g(CL-ML)s - Gravelly Silty Clay with Sand
- OL - Organic Silt/Clay
- s(CL) - Sandy Lean Clay
- s(CL)g - Sandy Lean Clay with Gravel
- SC - Clayey Sand
- (ML)s - Silt with Sand
- ML - Silt
- s(ML) - Sandy Silt
- s(ML/CL) - Sandy Clayey Silt
- (GM)s - Silty Gravel with Sand
- SM - Silty Sand
- SP-SC - Poorly Graded Sand with Clay
- SW-SC - Well-Graded Sand with Clay
- (SP)g - Poorly Graded Sand with Gravel
- (SW-SM)g - Well-Graded Sand with Silt and Gravel
- SP - Poorly Graded Sand
- SP-SM - Poorly Graded Sand with Silt
- SW - Well-Graded Sand
- SW-SM - Well-Graded Sand with Silt
- Chalk - Chalk or Marl
- CONCRETE - Concrete
- No Sample - No Sample
- Well Screen and Filter Pack
- Depth Groundwater Encountered During Drilling
- Groundwater Level Measured May 2021

50.0 0.0 50.0 100.0 150.0
Horizontal Scale in Feet

Notes:

1. Elevations in Project Datum.
2. Vertical exaggeration ~5x.
3. Boring profiles projected to cross section line. US = upstream, DS = downstream.
4. Water levels from May 2021. Reservoir el. 1420.62. Tailwater el. 1355.20.



US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY:	DATE: 8/4/21
DWN BY:	CKD BY:
SUBMITTED BY:	CONTRACT NO.:
FILE NAME:	FILE NUMBER:
SIZE:	PLOT SCALE:

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA, NEBRASKA

FY21 Toe Drain and RW Collector Pipe Replacement Relief Wells

Fort Thompson, SD

Geologic Profile A-A'

SHEET IDENTIFICATION NUMBER
A5

NWO_FENCE_B_SIZE_SENSING_ZONE_BIG_BEND_DRAIN_RW_REPLACEMENT.GPJ_USACE_NWO.GDT 2/10/21

Appendix B: Drilling Logs

LAB TESTING LOG

DIVISION: NWO

INSTALLATION: Big Bend Dam

SHEET 1 OF 12 SHEETS

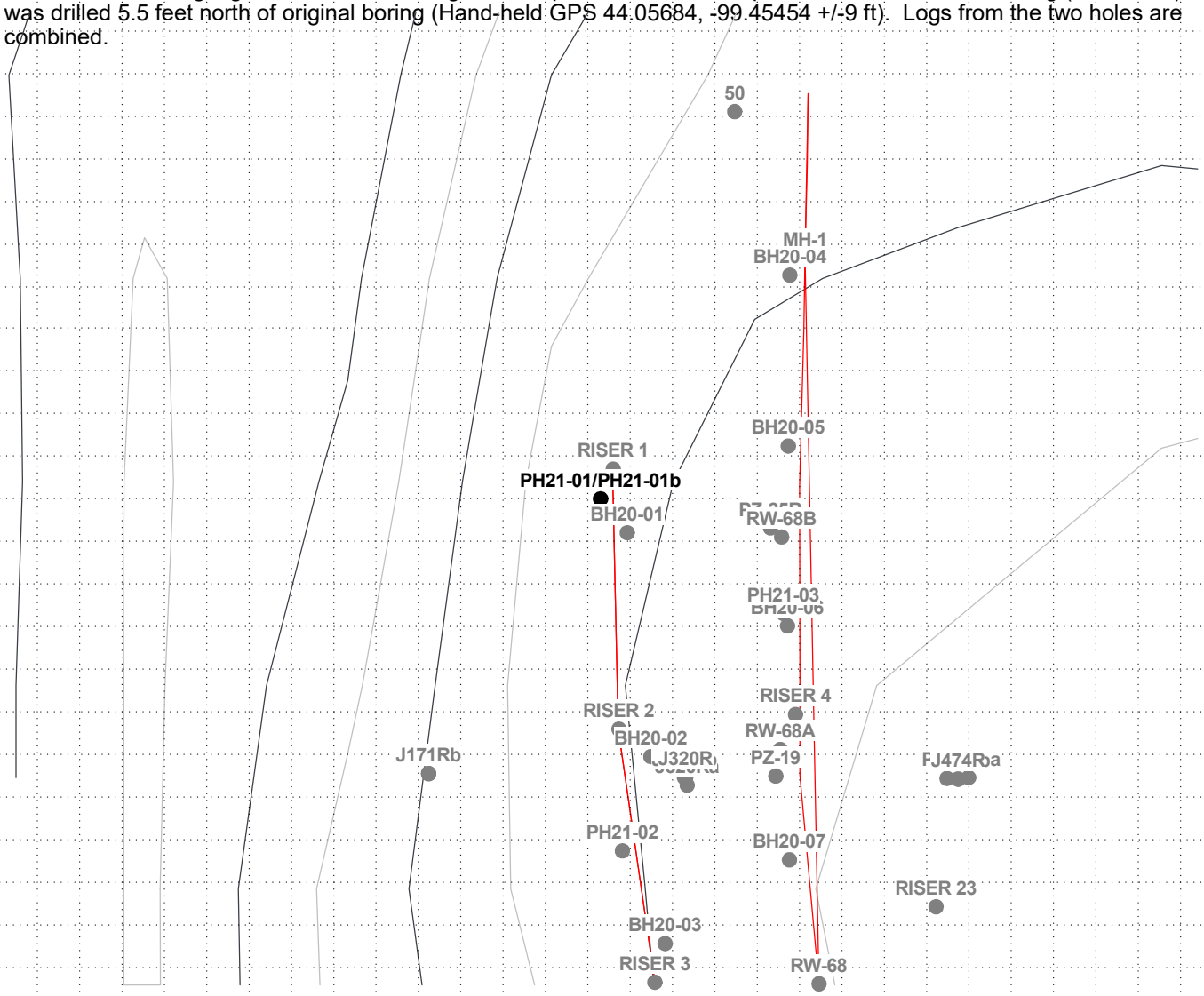
1. PROJECT	FY21 Drain Replacement
2. HOLE NUMBER	PH21-01/PH21-01b
LOCATION COORDINATES	629715.453N 2199376.913E
3. DRILLING AGENCY	USACE, Omaha District
4. NAME OF DRILLER	Josh Taylor
5. DIRECTION OF BORING	☒ VERTICAL ☐ INCLINED
DEG FROM VERTICAL	---
BEARING	
6. THICKNESS OF OVERBURDEN	100.9 ft
7. DEPTH DRILLED INTO ROCK	0.5 ft
8. TOTAL DEPTH OF BORING	101.4 ft
9. COORDINATE SYSTEM	State Plane
HORIZONTAL	NAD83
VERTICAL	Project Datum
10. SIZE AND TYPE OF BIT	4 1/4" ID HSA
11. MANUFACTURER'S DESIGNATION OF DRILL	Gus Pech 1300C
12. TOTAL SAMPLES	
DISTURBED	40
UNDISTURBED	0
13. TOTAL NUMBER CORE BOXES	
14. ELEVATION GROUND WATER	
15. DATE BORING STARTED	4/22/21
COMPLETED	4/30/21
16. ELEVATION TOP OF BORING	1386.3
17. TOTAL CORE RECOVERY FOR BORING	N/A
18. SIGNATURE AND TITLE OF INSPECTOR	Robert Zygowicz Geologist

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Hand-held GPS 44.05770, -99.45504 +/-9 ft (PH21-01). After boring was drilled, it was determined that existing boring information showing high bedrock in area might be suspect. To confirm depth to bedrock an offset boring (PH21-01b) was drilled 5.5 feet north of original boring (Hand-held GPS 44.05684, -99.45454 +/-9 ft). Logs from the two holes are combined.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: PH21-01/PH21-01b

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty clay (CL-ML) low to medium plasticity, soft, moist, grayish brown, Random Embankment Fill.								
		D-1	1 3	80										
1384.8	1.5													
1384.6	1.7	D-2				Well-graded sand with gravel ((SW)g) no plasticity, loose, dry, dark grayish brown, fine to coarse grained, Horizontal Drain.								
		D-3	4				0.0	84.7	15.3				SC	2.5Y 4/3 Olive Brown Clayey Sand
						Poorly graded sand with clay (SP-SC) no plasticity, loose, moist, brown, fine grained, trace medium sand, Horizontal Drain.								
		D-4	7 8	100			0.0	92.1	7.9				SP-SC	10YR 4/2 Dark Grayish Brown Poorly Graded Sand with Clay
1382.2	4.1													
		D-5	12			Silty clayey sand (SC-SM) no plasticity, medium dense, moist, gray, fine grained, trace medium sand, Horizontal Drain.								
		D-6	9				0.0	84.9	15.1				SC-SM	2.5Y 5/2 Grayish Brown Silty, Clayey Sand
1380.4	5.9													
		D-7	8 10	100		Lean clay with sand ((CL)s) low to medium plasticity, very stiff, moist, gray, with fine to coarse sand, trace fine gravel, Alluvial Clay (Blanket).								
		D-8	0 2 2	100		Lean clay with sand ((CL)s) medium to high plasticity, soft, wet, dark gray, trace silt, Alluvial Clay (Blanket). @ 8.5 ft, gray.	0.0	17.2	82.8	30	22		CL	2.5Y 5/1 Gray Lean Clay with Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 3 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay with sand ((CL)s) medium to high plasticity, soft, wet, gray, trace silt, Alluvial Clay (Blanket), (cont.).								
1373.8	12.5					Poorly graded sand with clay (SP-SC) no plasticity, very loose, wet, brownish gray, fine grained, trace medium to coarse sand, trace clay, Alluvial Sand (Upper).								Free water in boring at top of sand (12.5 ft). Water in augers at 9.8 feet and rising. ~0.5 foot of heave after run. Add water.
		D-9	0 1 2	80										
														~1 ft heave after run. Add water.
		D-10	2 5 9	87		@ 18 ft, medium dense.	0.0	94.3	5.7				SP-SC	2.5Y 6/2 Light Brownish Gray Poorly Graded Sand with Clay

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 4 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with clay (SP-SC) no plasticity, medium dense, wet, brownish gray, fine grained, trace medium to coarse sand, trace clay, Alluvial Sand (Upper), (cont.).							
														~1 ft heave after run. Add water.
			2			@ 23 ft, loose.								Augers sank when running spoon.
		D-11	4	73										
			2											
														~1 ft heave after run. Add water.
			2			@ 28 ft, no coarse sand.								
		D-12	3	47			0.0	94.2	5.8				SP-SC	2.5Y 4/3 Olive Brown Poorly Graded Sand with Clay
			4											

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 5 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, brownish gray, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper), (cont.).								
						@ 33 ft, medium dense.								
		D-13	5 6 7	93										
						@ 38 ft, loose.								
		D-14	1 3 5	67			0.0	92.5	7.5				SP-SC	2.5Y 4/3 Olive Brown Poorly Graded Sand with Clay

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 6 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, brownish gray, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper), (cont.).								
		D-15	2 2 5	33										Stop for day at 44.5 ft on 4/22/21. Resume 4/23/21.
														~0.5 ft heave after run. Add water.
1338.0	48.3	D-16	8			@ 48 ft, medium dense.								
		D-17	9 9	67		Silty clay (CL-ML) low to medium plasticity, very stiff, moist, gray, few fine sand, Alluvial Clay (Intermediate).								

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 7 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty clay (CL-ML) low to medium plasticity, very stiff, moist, gray, few fine sand, Alluvial Clay (Intermediate), (cont.).								
		D-18	4 12	87										
1334.8	51.5													
		D-19	20			Poorly graded sand with silt (SP-SM) no to low plasticity, medium dense, moist, gray, fine grained, trace medium sand, trace clay, Alluvial Clay (Intermediate).								
		D-20	3 5	100										
1332.4	53.9													
		D-21	6			Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, Alluvial Clay (Intermediate).								
		D-22	4 6	100										
1330.0	56.3													
		D-23	8			Fat clay (CH) high plasticity, very stiff, moist, gray, trace white spots, Alluvial Clay (Intermediate).								
		D-24	6 8 10	100										Auger torque increased.

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 8 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean to fat clay (CL/CH) high plasticity, stiff, moist, light gray to gray, trace white spots.								
		D-25	3 4 6	100										
1323.3	63.0													
		D-1(b)	5 4 5	100		Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray mottled with green, trace organics, Alluvial Clay (Intermediate).								Information below 63 feet is from offset boring PH21-01b (5.5 feet north)
1319.3	67.0					Silt with sand ((ML)s) no plasticity, medium dense, moist, gray to olive gray, fine grained, trace clay, trace organics, trace lignite, Alluvial Clay (Intermediate).								Spoon sank from weight of rods from 68 to 70 feet. Split spoon driven from 70-71.5 feet.

60 61 62 63 64 65 66 67 68 69 70

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 9 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
		D-2(b)	2 9 12	100		Silt with sand ((ML)s) no plasticity, medium dense, moist, gray to olive gray, fine grained, trace clay, trace organics, trace lignite, Alluvial Clay (Intermediate), (cont.).								~1 ft heave after run. Add water.
1313.3	73.0													
		D-3(b)	5 6 7	100		Silt (ML) no plasticity, medium dense, wet, gray, few clay, trace lignite, Alluvial Clay (Intermediate).								
		D-4(b)	3 12	100		@ 78 ft, more clay.								
1307.3	79.0													
		D-5(b)	18			Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, gray, fine grained, trace clay, trace lignite, Alluvial Sand (Lower).								

70 71 72 73 74 75 76 77 78 79 80

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 10 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, gray, fine grained, trace clay, trace lignite, Alluvial Sand (Lower), (cont.).								~1.5 ft heave after run. Add water.
		D-6(b)	5 5 9	100										
														~2 ft heave after run. Add water.
1298.3	88.0													
		D-7(b)	5 6	87		Poorly graded sand (SP) no plasticity, medium dense, wet, brownish gray to gray, fine grained, little medium sand, trace fines, trace lignite, Alluvial Sand (Lower).								
1297.1	89.2													
		D-8(b)	6			Lean clay (CL) medium plasticity, stiff, moist, gray, Alluvial Sand (Lower).								

80 81 82 83 84 85 86 87 88 89 90

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 11 OF 12 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay (CL) medium plasticity, stiff, moist, gray, Alluvial Sand (Lower), (cont.).								
1295.3	91.0					Poorly graded sand (SP) no plasticity, medium dense, wet, gray, fine grained, with medium sand, trace lignite, Alluvial Sand (Lower).								~1 ft heave after run. Add water.
		D-9(b)	2 6	100										
1292.2	94.1													Driller indicated increased torque ~94 feet.
		D-10(b)	8			Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray, Alluvial Sand (Lower).								
1289.8	96.5					Poorly graded sand (SP) no plasticity, medium dense, wet, gray, fine grained, few medum to coarse sand, Alluvial Sand (Lower).								Driller indicated augers grinding on gravel ~96.5 feet to 100 feet.
		D-11(b)	2											
1287.9	98.4													
1287.7	98.6	D-12(b)				Fat clay (CH) high plasticity, very stiff, moist, gray, Alluvial Sand (Lower).								
			20	87		Well-graded gravel with sand ((GW)s) no plasticity, very dense, wet, dark brown to grayish brown, fine to coarse grained, with fine to coarse sand, Alluvial Sand (Lower).								
		D-13(b)	37											

90 91 92 93 94 95 96 97 98 99 100

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 12 OF 12 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1285.8	100.5					Well-graded gravel with sand ((GW)s) no plasticity, very dense, wet, dark brown to grayish brown, fine to coarse grained, with fine to coarse sand, Alluvial Sand (Lower), (cont.).								Driller indicated augers grinding on gravel ~96.5 feet to 100 feet.
1285.4	100.9	D-14(b)	18	100		Poorly graded sand (SP) no plasticity, medium dense, wet, grayish brown, fine grained, few medium to coarse sand, little weathered chalk, Alluvial Sand (Lower).								
1284.9	101.4	D-15(b)	60/0.4			Chalk (CHALK) hard, moist, gray, massive, pearly luster, Niobrara Chalk.								

100

101

Boring Designation PH21-02

LAB TESTING LOG	DIVISION NWO	INSTALLATION Big Bend Dam	SHEET 1 OF 7 SHEETS

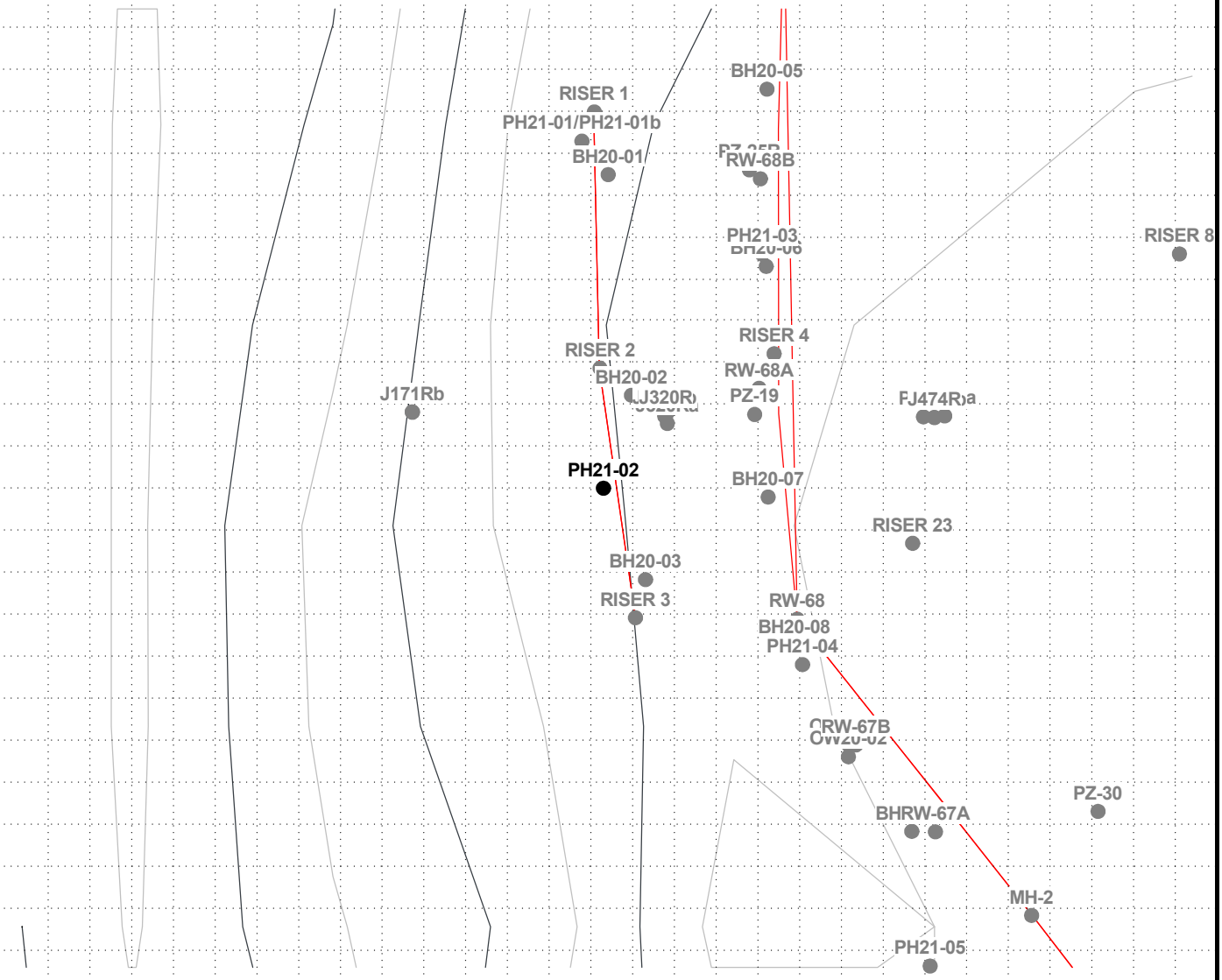
1. PROJECT FY21 Drain Replacement		9. COORDINATE SYSTEM State Plane	HORIZONTAL NAD83 / VERTICAL Project Datum
		10. SIZE AND TYPE OF BIT 4 1/4" ID HSA	
2. HOLE NUMBER PH21-02	LOCATION COORDINATES 629509.085N 2199389.721E	11. MANUFACTURER'S DESIGNATION OF DRILL Gus Pech 1300C	
3. DRILLING AGENCY USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED 21 / UNDISTURBED 0
4. NAME OF DRILLER Josh Taylor		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL --- / BEARING	14. ELEVATION GROUND WATER	
		15. DATE BORING	STARTED 4/24/21 / COMPLETED 4/24/21
6. THICKNESS OF OVERBURDEN 54.5 ft		16. ELEVATION TOP OF BORING 1381.8	
7. DEPTH DRILLED INTO ROCK ---		17. TOTAL CORE RECOVERY FOR BORING N/A	
8. TOTAL DEPTH OF BORING 54.5 ft		18. SIGNATURE AND TITLE OF INSPECTOR Robert Zygowicz Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Hand-held GPS 44.05712, -99.45499 +/-9 ft



PROJECT	HOLE NO
FY21 Drain Replacement Fort Thompson, SD	PH21-02

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam | SHEET 2 OF 7 SHEETS

PROJECT: FY21 Drain Replacement | COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1380.8	1.0	D-1	1			Silty clay (CL-ML) low to medium plasticity, soft, moist, gray to dark gray, little fine to coarse sand, Random Embankment Fill.								
1379.8	2.0	D-2	3 5	67		Clayey sand (SC) no plasticity, loose, dry, brown, fine to medium grained, trace coarse sand, trace fine gravel, trace clay nodules, Horizontal Drain.	4.5	82.5	13.0				SC	10YR 4/4 Dark Yellowish Brown Clayey Sand
1378.8	3.0					Clayey sand with gravel ((SC)g) no plasticity, loose, dry, brown, fine to medium grained, trace coarse sand, trace fine gravel, trace clay nodules, Horizontal Drain.								Grinding on gravelly sand from 2 to 3 ft.
1377.8	4.0	D-3	6 8	100		Clayey sand (SC) no plasticity, medium dense, moist, brown, fine grained, trace medium to coarse sand, Horizontal Drain.	4.9	80.6	14.5				SC	2.5Y 5/1 Gray Clayey Sand
1376.3	5.5 ▽	D-4	7			Sandy lean clay (s(CL)) medium to high plasticity, stiff, moist, gray, trace silt, trace fine to coarse sand, trace coarse gravel, black at 4.3 ft, Alluvial Clay (Blanket).	0.0	39.3	60.7	32	19		CL	2.5Y 4/1 Dark Gray Sandy Lean Clay
1373.7	8.1	D-5	1 1 0	93		Silt (ML) no plasticity, very soft, wet, gray, trace fine sand, trace roots, Alluvial Clay (Blanket).								No odor from soils above water table.
		D-6	1			Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, grayish brown, fine grained, trace clay, Alluvial Sand (Upper).								Spoon is wet. Water rising after run.
		D-7	2 2	87			0.0	90.5	9.5				SP-SC	2.5Y 6/2 Light Brownish Gray Poorly Graded Sand with Clay

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 3 OF 7 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, grayish brown, fine grained, trace clay, Alluvial Sand (Upper), (cont.).								
														~2 ft heave. Add water to augers.
		D-8	2 2 4	73		@ 13 ft, trace medium sand, few clay.								
														No heave.
		D-9	1 1 2	67			0.0	93.2	6.8				SP-SC	2.5Y 5/3 Light Olive Brown Poorly Graded Sand with Clay

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam | SHEET 4 OF 7 SHEETS

PROJECT: FY21 Drain Replacement | COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1358.8	23.0					Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, grayish brown, fine grained, few clay, Alluvial Sand (Upper).								No heave.
		D-10	1 1 3	67		Poorly graded sand (SP) no plasticity, loose, wet, brown, fine grained, few medium sand, trace silt, trace clay, Alluvial Sand (Upper).	0.0	95.9	4.1				SP	2.5Y 5/2 Grayish Brown Poorly Graded Sand
		D-11	2 2 2	40										~1 ft heave. Add water to augers.

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 5 OF 7 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, brown, fine grained, few medium sand, trace silt, Alluvial Sand (Upper).								
														~0.5 ft heave. Add water to augers.
		D-12	3 3 6	73		@ 33 ft, grayish brown.	0.0	96.0	4.0				SP	2.5Y 5/2 Grayish Brown Poorly Graded Sand
														~1.75 ft heave. Add water to augers.
1343.6	38.2	D-13	2	100		@ 38 ft, fine to medium grained, trace coarse sand, trace clay.								
1343.1	38.7	D-14	5			Clayey silt (ML/CL) no to low plasticity, medium stiff, moist, brownish gray, trace fine sand, Alluvial Clay (Intermediate).								
1342.6	39.2	D-15	2			Silt (ML) no plasticity, loose, wet, grayish brown, little clay, Alluvial Clay (Intermediate).								
		D-16				Silty clay (CL-ML) low to medium plasticity, medium stiff, moist, brown mottled with gray, iron oxide staining, Alluvial Clay (Intermediate).								

30 31 32 33 34 35 36 37 38 39 40

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 6 OF 7 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty clay (CL-ML) low to medium plasticity, medium stiff, moist, brown mottled with gray, iron oxide staining, Alluvial Clay (Intermediate), (cont.).								
1340.8	41.0					Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, trace silt, Alluvial Clay (Intermediate).								
		D-17	4 5 6	100										
1333.6	48.2	D-18	0			Silt (ML) no plasticity, very loose, wet, gray, Alluvial Clay (Intermediate).								
1333.0	48.8		2	100										
		D-19	5			Lean to fat clay (CL/CH) medium to high plasticity, medium stiff, moist, gray, trace white spots, trace silt, trace organics, Alluvial Clay (Intermediate).								

40 41 42 43 44 45 46 47 48 49 50

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 7 OF 7 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean to fat clay (CL/CH) medium to high plasticity, medium stiff, moist, gray, trace white spots, trace silt, trace organics, Alluvial Clay (Intermediate), (cont.).								
		D-20	3											
		D-21	6 7	100		@ 53.7 ft, stiff.								
1327.3	54.5													

50 51 52 53 54

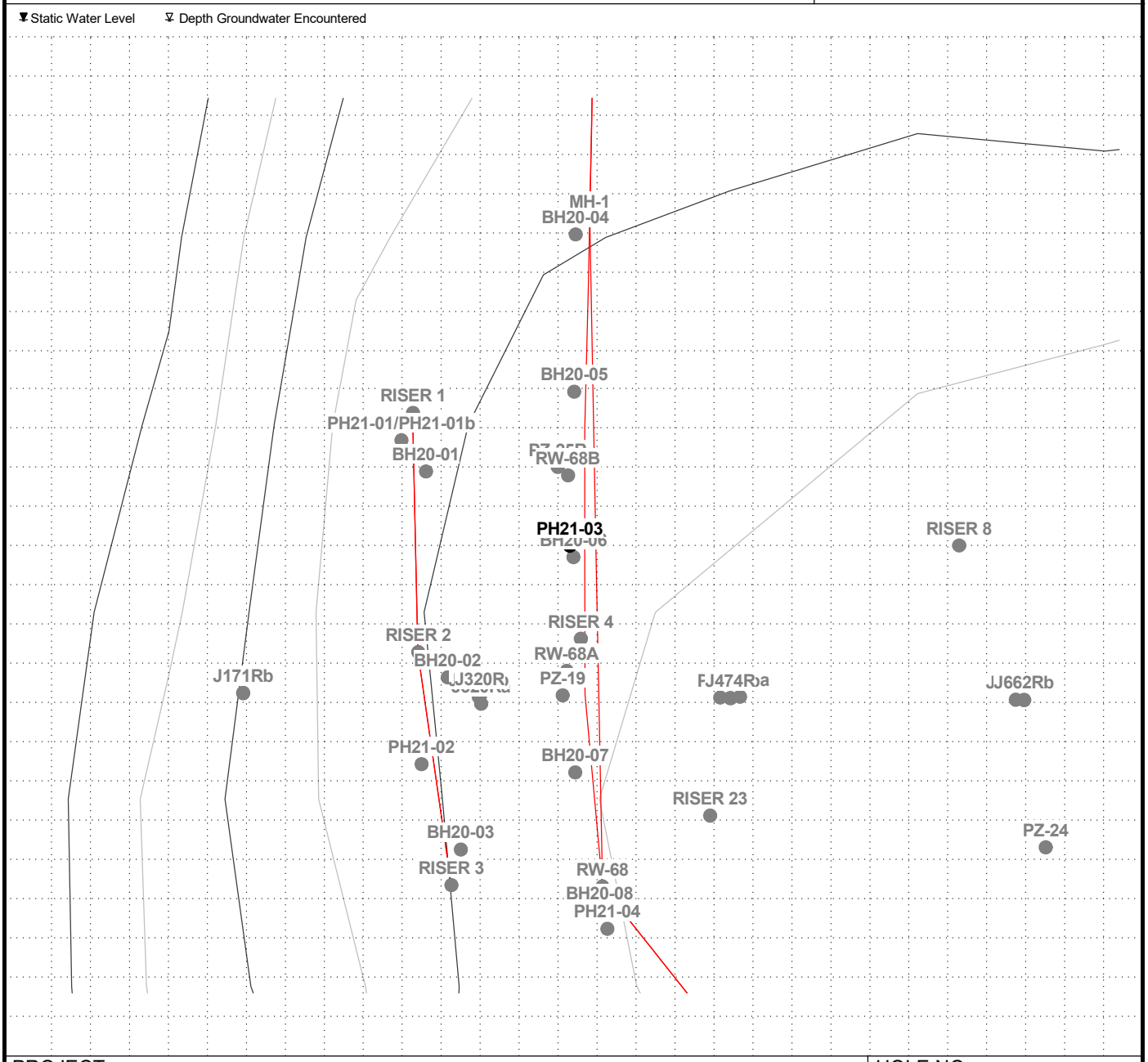
Boring Designation PH21-03

LAB TESTING LOG	DIVISION NWO	INSTALLATION Big Bend Dam	SHEET 1 OF 11 SHEETS

1. PROJECT FY21 Drain Replacement		9. COORDINATE SYSTEM State Plane	HORIZONTAL NAD83 / VERTICAL Project Datum
		10. SIZE AND TYPE OF BIT 4 1/4" ID HSA	
2. HOLE NUMBER PH21-03	LOCATION COORDINATES 629648.267N 2199484.170E	11. MANUFACTURER'S DESIGNATION OF DRILL Gus Pech 1300C	
3. DRILLING AGENCY USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED 22 / UNDISTURBED 0
4. NAME OF DRILLER Josh Taylor		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL --- / BEARING	14. ELEVATION GROUND WATER	
		15. DATE BORING	STARTED 4/26/21 / COMPLETED 4/27/21
6. THICKNESS OF OVERBURDEN 92.8 ft		16. ELEVATION TOP OF BORING 1379.5	
7. DEPTH DRILLED INTO ROCK 1 ft		17. TOTAL CORE RECOVERY FOR BORING N/A	
8. TOTAL DEPTH OF BORING 93.8 ft		18. SIGNATURE AND TITLE OF INSPECTOR Robert Zygowicz Geologist	

LOCATION SKETCH/COMMENTS

SCALE:



PROJECT	HOLE NO
FY21 Drain Replacement Fort Thompson, SD	PH21-03

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 2 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty clay (CL-ML) medium plasticity, stiff, moist, grayish brown, trace fine sand, trace roots, Alluvial Clay (Blanket).								Logged from cuttings to 23 ft (adjacent to BH20-06.
						@ 3 ft, no roots.								No odor or staining above water table.
						@ 4.5 ft, medium stiff, dark brownish gray.								
						@ 6 ft, soft, gray.								
1371.5	8.0					Poorly graded sand with silt (SP-SM) no plasticity, wet, gray, fine grained, Alluvial Sand (Upper).								Water at 8 ft on but and rising to 6.4 ft

0 1 2 3 4 5 6 7 8 9 10

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 3 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, wet, gray, fine grained, Alluvial Sand (Upper), (cont.).								

10 11 12 13 14 15 16 17 18 19 20

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 4 OF 11 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, wet, gray, fine grained, Alluvial Sand (Upper), (cont.).								
														~2 ft heave. Added water to augers.
		D-1	2 1 3	60		@ 23 ft, loose, brown, fine grained, trace medium sand, trace clay.								
		D-2	1 2 5	60			0.0	93.8	6.2				SP-SM	2.5Y 4/3 Olive Brown Poorly Graded Sand with Silt

20 21 22 23 24 25 26 27 28 29 30

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 5 OF 11 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, loose, wet, brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper), (cont.).								
1346.5	33.0													
		D-3	1 3 5	60		Poorly graded sand with clay (SP-SC) no plasticity, loose, wet, brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper).	0.0	94.0	6.0				SP-SC	2.5Y 4/3 Olive Brown Poorly Graded Sand with Clay
														~1 ft heave. Added water to augers.
1341.5	38.0													
		D-4	2 4 9	60		Poorly graded sand (SP) no plasticity, medium dense, wet, brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper).	0.0	97.0	3.0				SP	2.5Y 5/2 Grayish Brown Poorly Graded Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 6 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper), (cont.).								
1337.5	42.0					Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray, trace fine sand, Alluvial Clay (Intermediate).								Clay in bit at 42 ft.
		D-5	3 9	100										
1335.5	44.0					Poorly graded sand with clay (SP-SC) low plasticity, medium dense, wet, gray, fine grained, trace silt, Alluvial Clay (Intermediate).								
		D-6	13											
														No heave.
1331.2	48.3	D-7	2			Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, trace white spots, trace black staining, trace silt, Alluvial Clay (Intermediate).								
		D-8	5 7	100										

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 7 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, trace white spots, trace black staining, trace silt, Alluvial Clay (Intermediate).								
1328.5	51.0					Clayey silt (ML/CL) low plasticity, soft, wet, gray, Alluvial Clay (Intermediate).								
		D-9	0 5	100										
1325.7	53.8	D-10	6			Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray, Alluvial Clay (Intermediate).								Stop for day 4/26/21. Resume 4/27/21.
		D-11	0 2 5	73		@ 58 ft, low plasticity, medium stiff, with black striations.								

50 51 52 53 54 55 56 57 58 59 60

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 8 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty clay (CL-ML) no to low plasticity, medium stiff, moist, gray, with black striations, Alluvial Clay (Intermediate).								
						@ 63 ft.								SPT sank to 64.5 feet from weight of rods. Ran spoon from 64.5-66 ft.
		D-12	2 5 6	100		@ 65.5 ft, no striations.								
1312.3	67.2													~1 ft heave. Added water to augers.
						Silt (ML) no plasticity, medium dense, moist, gray, trace fine sand, trace clay, Alluvial Clay (Intermediate).								
		D-13	3 3 11	87										

60 61 62 63 64 65 66 67 68 69 70

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 9 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1308.5	71.0													
						Silty sand (SM) no plasticity, medium dense, wet, gray, fine grained, with black laminations, Alluvial Sand (Lower).								Driller indicated "stiffened up" at 71 ft.
		D-14	2 6 12	100										SPT sank to 74.5 feet from weight of rods. Ran spoon from 74.5-76 ft.
1301.5	78.0													~10 ft heave. Washed out with tremie pipe. Added water to augers.
		D-15	8 15 18	60		Poorly graded sand (SP) no plasticity, dense, wet, olive gray, fine grained, trace medium sand, trace fines, trace lignite, Alluvial Sand (Lower).								

70 71 72 73 74 75 76 77 78 79 80

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 10 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, dense, wet, olive gray, fine grained, trace medium sand, trace fines, trace lignite, Alluvial Sand (Lower), (cont.).								
														~3 ft heave. Added water to augers.
1295.9	83.6	D-16	12											
		D-17	20 18	73		Poorly graded sand with silt (SP-SM) no plasticity, dense, wet, gray, fine grained, trace clay, Alluvial Sand (Lower).								
1294.0	85.5					Silty clayey gravel with sand ((GC-GM)s) no plasticity, dense, wet, gray, fine to coarse grained, trace clay, with fine to coarse sand, with black laminations, Alluvial Sand (Lower).								Driller indicated "stiffened up" at 85.5 ft.
														~4.5 ft heave. Washed out with tremie pipe. Added water to augers.
1290.9	88.6	D-18	8											
1290.4	89.1	D-19	14	80		Poorly graded sand with silt (SP-SM) no plasticity, dense, wet, olive gray, fine grained, trace clay, with black laminations, Alluvial Sand (Lower).								Augers grinding 89-89.5 ft.
		D-20	29			Well-graded gravel with sand ((GW)s) no plasticity, dense, wet, light grayish brown, fine to coarse grained, with fine to coarse sand, trace fines, Alluvial Sand (Lower).								

80 81 82 83 84 85 86 87 88 89 90

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 11 OF 11 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1289.0	90.5					Well-graded gravel with sand ((GW)s) no plasticity, dense, wet, light grayish brown, fine to coarse grained, with fine to coarse sand, trace fines, Alluvial Sand (Lower), (cont.).								~0.3 ft heave. Added water to augers.
		D-21	28 28 27	87		Well-graded gravel with clay and sand ((GW-GC)s) no plasticity, very dense, wet, orangish brown with gray, fine to coarse grained, with fine to coarse sand, trace silt, Alluvial Sand (Lower).								
1286.7	92.8					Chalk (CHALK) hard, gray, massive, Niobrara Chalk.								Augers grinding on gravel.
1285.7	93.8	D-22	35 60/0.3	100										

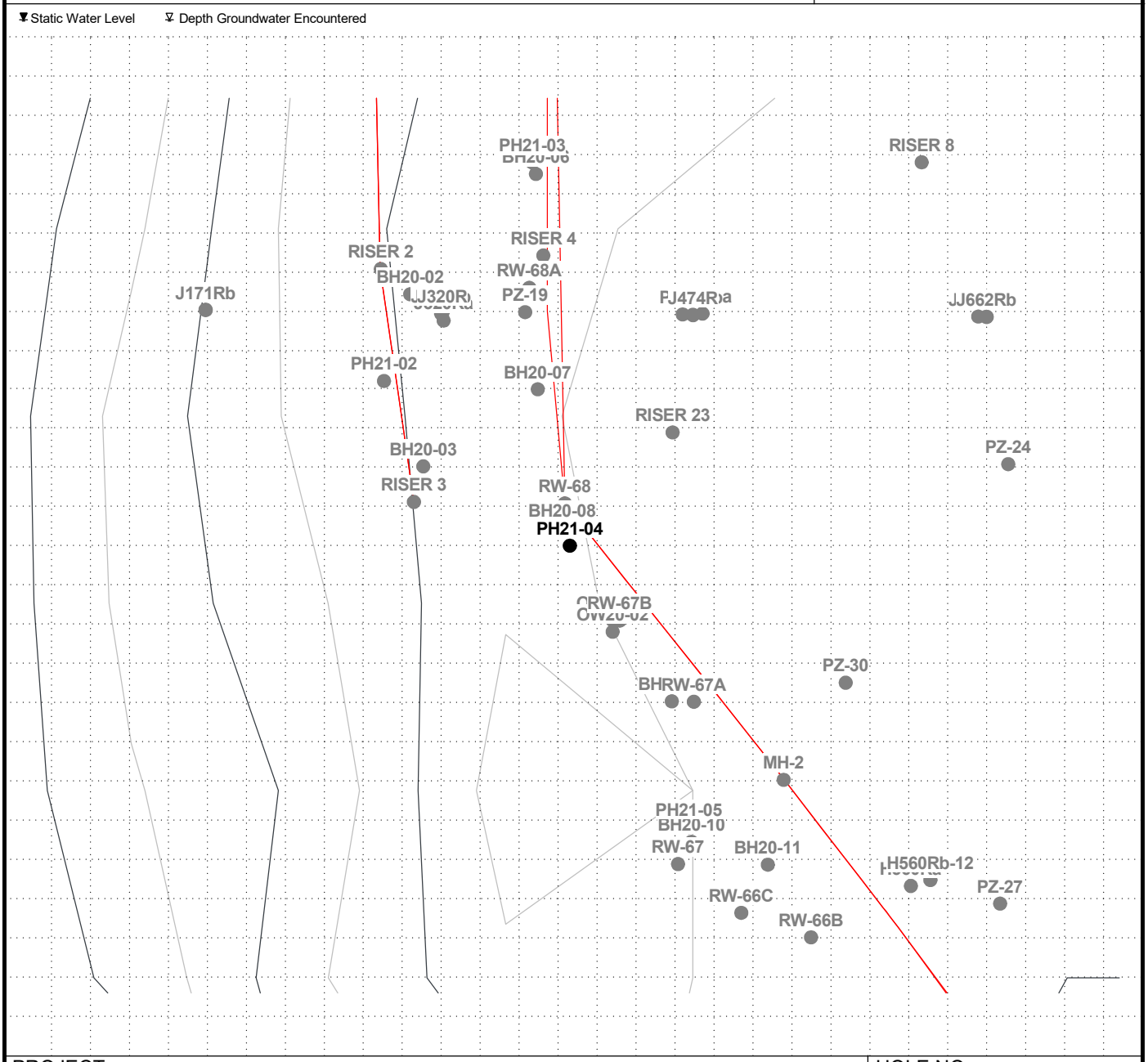
90 91 92 93

LAB TESTING LOG

DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 10 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: PH21-04	LOCATION COORDINATES: 629404.179N 2199508.072E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 1300C	
3. DRILLING AGENCY: USACE, Omaha District	12. TOTAL SAMPLES	DISTURBED: 19	UNDISTURBED: 0
4. NAME OF DRILLER: Josh Taylor	13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
	15. DATE BORING	STARTED: 4/28/21	COMPLETED: 4/29/21
6. THICKNESS OF OVERBURDEN: 89.2 ft	16. ELEVATION TOP OF BORING: 1375.7		
7. DEPTH DRILLED INTO ROCK: 0.7 ft	17. TOTAL CORE RECOVERY FOR BORING: N/A		
8. TOTAL DEPTH OF BORING: 89.9 ft	18. SIGNATURE AND TITLE OF INSPECTOR: Robert Zygowicz Geologist		

LOCATION SKETCH/COMMENTS

SCALE:



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: PH21-04

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 2 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, dark brown, little silt, trace roots, Alluvial Clay (Blanket).								Logged from cuttings from 0-18 ft.
						@ 3 ft, no roots.								No odors or staining above water table.
1370.7	5.0 ▽					Silty clay (CL-ML) low plasticity, soft, light gray, few fine sand, Alluvial Clay (Blanket).								
1368.2	7.5					Silty sand (SM) no plasticity, wet, brownish gray, fine to medium grained, few clay, Alluvial Sand (Upper).								

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 3 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty sand (SM) no plasticity, wet, brownish gray, fine to medium grained, few clay, Alluvial Sand (Upper), (cont.).								
1357.7	18.0													~2 ft heave. Added water to augers.
			0			Poorly graded sand (SP) no plasticity, loose, wet, grayish brown, fine grained, trace silt, trace clay, Alluvial Sand (Upper).								
		D-1	0	7			0.0	97.3	2.7				SP	2.5Y 6/1 Dark Gray Poorly Graded Sand Utilized sucker bailer to obtain sample of material.
			0											

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam | SHEET 4 OF 10 SHEETS

PROJECT: FY21 Drain Replacement | COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, grayish brown, fine grained, trace silt, trace clay, Alluvial Sand (Upper), (cont.).								
		D-2	0 1 1	60										~1 ft heave. Added water to augers.
		D-3	6 3 5	67			0.0	95.8	4.2				SP	2.5Y 6/1 Dark Gray Poorly Graded Sand

20 21 22 23 24 25 26 27 28 29 30

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 5 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, grayish brown, fine grained, trace silt, trace clay, Alluvial Sand (Upper), (cont.).								
1343.2	32.5													~0.2 ft heave. Added water to augers.
		D-4	2			Silt (ML) no plasticity, loose, wet, gray, few fine sand, trace clay, iron oxide staining, iron oxide nodules, Alluvial Clay (Intermediate).								
1342.0	33.7	D-5	2 3	100		Clayey silt (ML/CL) Alluvial Clay (Intermediate).								
		D-6	3 4	100		Silty clay (CL-ML) low to medium plasticity, medium stiff, moist, gray, trace fine sand, Alluvial Clay (Intermediate).								
1336.9	38.8	D-7	5			Fat clay (CH) high plasticity, stiff, moist, gray, no sand, Alluvial Clay (Intermediate).								

30 31 32 33 34 35 36 37 38 39 40

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 6 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1335.2	40.5					Fat clay (CH) high plasticity, stiff, moist, gray, no sand, Alluvial Clay (Intermediate), (cont.).								
						Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray, trace fine sand, Alluvial Clay (Intermediate).								
		D-8	4 6 7	100										Split spoon dropped to 45 ft with weight of rods. Ran SPT from 45-46.5 ft.
		D-9	4 6 8	100		@ 49 ft, soft zone from 49 to 49.1 ft.								

40 41 42 43 44 45 46 47 48 49 50

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 7 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray, trace fine sand, Alluvial Clay (Intermediate).								
		D-10	3 6 7	100										
1319.7	56.0					Silt (ML) no plasticity, medium dense, wet, gray, few clay, with black laminations, Alluvial Clay (Intermediate).								Split spoon dropped to 60 ft with weight of rods. Ran SPT from 60-61.5 ft.

50 51 52 53 54 55 56 57 58 59 60

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 8 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
			3			Silt (ML) no plasticity, medium dense, wet, gray, few clay, with black laminations, Alluvial Clay (Intermediate), (cont.).								
		D-11	6	100										
			10											
														~6 ft heave. Washed out with tremie pipe. Added water to augers.
1313.2	62.5					Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, gray, fine to medium grained, trace clay, Alluvial Sand (Lower).								
			4											
		D-12	9	100										
			14											
														~1 ft heave. Added water to augers.
						@ 68 ft, few clay.								
			1											
		D-13	4	80										
			7											

60 61 62 63 64 65 66 67 68 69 70

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 9 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, gray, fine to medium grained, little clay, Alluvial Sand (Lower).								~2.5 ft heave. Added water to augers.
		D-14	2 11 14	100		@ 74.2 ft, with black streaking.								
														~1 ft heave. Added water to augers.
1297.7	78.0					Poorly graded sand (SP) no plasticity, loose, wet, gray, fine grained, trace medium to coarse sand, trace detrital lignite, trace clay chunks, trace silt, Alluvial Sand (Lower).								
		D-15	1 3 5	100										

70 71 72 73 74 75 76 77 78 79 80

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 10 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

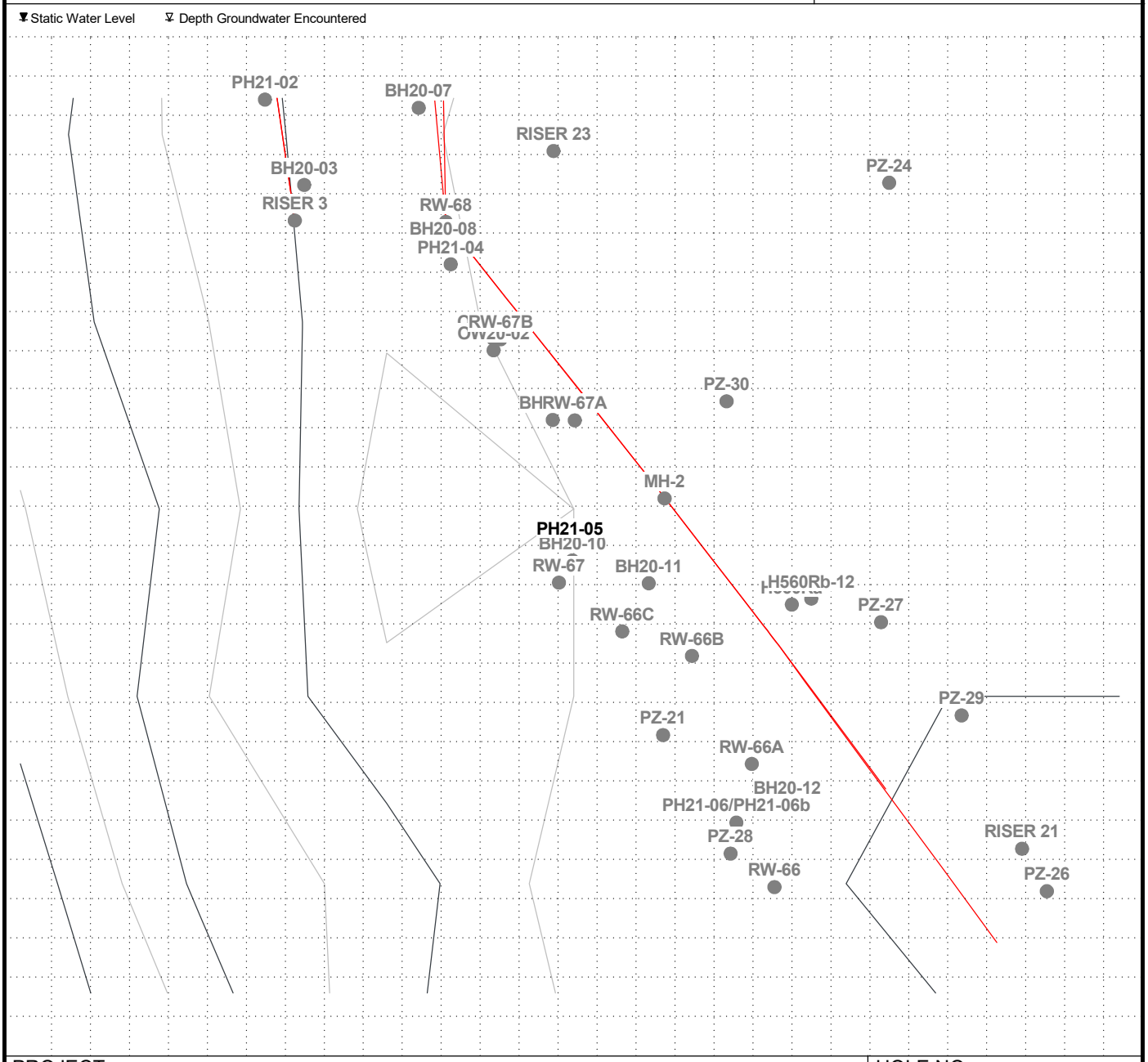
ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, gray, fine grained, trace medium to coarse sand, trace detrital lignite, trace clay chunks, trace silt, Alluvial Sand (Lower), (cont.).								
1292.7	83.0													~2 ft heave. Added water to augers.
1292.2	83.5		4			Clayey sand (SC) Alluvial Sand (Lower).								
		D-16	8	100		Well-graded sand (SW) no plasticity, medium dense, wet, grayish brown, fine to coarse grained, trace fine gravel, trace silt, Alluvial Sand (Lower).								
			12											
														~3 ft heave. Added water to augers.
														Split spoon dropped to 86.5 ft with weight of rods. Ran SPT from 86.5-88 ft.
1288.8	86.9		1											
1288.4	87.3	D-17	3	100		Well-graded sand with clay (SW-SC) Alluvial Sand (Lower).								
			6			Well-graded sand (SW) no plasticity, medium dense, wet, grayish brown, fine to coarse grained, trace fine gravel, trace silt, Alluvial Sand (Lower).								
														Augers grinding on gravel.
1286.5	89.2	D-18												~4 ft heave. Added water to augers.
			25											
		D-19		100		Chalk (CHALK) hard, moist, gray, Niobrara Chalk.								
1285.8	89.9		60/0.4											

LAB TESTING LOG

DIVISION: NWO	INSTALLATION: Big Bend Dam	SHEET 1 OF 10 SHEETS	
1. PROJECT: FY21 Drain Replacement	9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83	VERTICAL: Project Datum
	10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA		
2. HOLE NUMBER: PH21-05	LOCATION COORDINATES: 629224.907N 2199583.922E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 1300C	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 17 / UNDISTURBED: 0
4. NAME OF DRILLER: Aaron Friedley		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: ---	BEARING	14. ELEVATION GROUND WATER
		15. DATE BORING	STARTED: 5/7/21 / COMPLETED: 5/7/21
6. THICKNESS OF OVERBURDEN: 87 ft		16. ELEVATION TOP OF BORING: 1372.3	
7. DEPTH DRILLED INTO ROCK: 0.9 ft		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 87.9 ft		18. SIGNATURE AND TITLE OF INSPECTOR: Robert Zygowicz Geologist	

LOCATION SKETCH/COMMENTS

SCALE:



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: PH21-05

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 2 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay (CL) medium plasticity, medium stiff, moist, brown, little silt, trace fine to coarse sand, trace fine gravel, trace roots, Alluvial Clay (Blanket).								Drill from cuttings to 18 ft (adjacent to logged boring). No petroleum odor or staining noted.
1369.3	3.0					Sandy silty lean clay (s(CL-ML)) medium plasticity, stiff, moist, dark brown, with fine gravel, with fine to coarse sand, trace roots, Alluvial Clay (Blanket).								Augers grinding on gravel from 2.5-5.5 ft.
1367.3	5.0					Clayey sand (SC) low plasticity, moist, brown to dark brown, fine to coarse grained, trace fine gravel, Alluvial Clay (Blanket).								
1366.3	6.0					Lean clay (CL) medium plasticity, stiff, moist, dark gray to black, few silt, trace fine to coarse sand, trace fine gravel, Alluvial Clay (Blanket).								
						@ 8 ft, low to medium plasticity, soft, moist, gray, trace fine gravel.								

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 3 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay (CL) medium plasticity, soft, moist, gray, trace fine sand, trace silt, Alluvial Clay (Blanket).								
1361.3	11.0					Poorly graded sand (SP) no plasticity, loose, wet, grayish brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper).								Groundwater at 11 ft on bit.
														~4 ft heave. Added water.
						@ 18 ft, very loose.								
		D-1	5 1 1	47			0.0	96.2	3.8				SP	2.5Y 5/1 Gray Poorly Graded Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 4 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, very loose, wet, grayish brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper).								No heave.
		D-2	1 2 2	73		@ 23 ft, brown, few medium sand, trace silt.	0.0	97.6	2.4				SP	2.5Y 5/1 Gray Poorly Graded Sand
														~1 ft heave. Added water.
1344.3	28.0					Clayey silt (ML/CL) no plasticity, soft, wet, trace fine sand, Alluvial Clay (Intermediate).								
		D-3	2 2 3	60										

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 5 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Clayey silt (ML/CL) no plasticity, soft, wet, trace fine sand, Alluvial Clay (Intermediate).								~1 ft heave. Added water.
1339.3	33.0													
		D-4	3 4 5	100		Silty clay (CL-ML) low to medium plasticity, stiff, moist, gray, Alluvial Clay (Intermediate).								
1334.3	38.0													
		D-5	3 4 5	100		Lean clay (CL) medium plasticity, stiff, moist, gray, Alluvial Clay (Intermediate).								

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 6 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay (CL) medium plasticity, stiff, moist, gray, Alluvial Clay (Intermediate), (cont.).								
1329.3	43.0													
		D-6	3 4 5	100		Clayey silt (ML/CL) no to low plasticity, medium stiff, moist, gray, Alluvial Clay (Intermediate).								
		D-7	0 3 5	100										Driller noted change at 47 feet. Spoon sank 0.5 ft. Collected SPT from 48.5-50 ft.

40 41 42 43 44 45 46 47 48 49 50

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 7 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1320.8	51.5					Clayey silt (ML/CL) no to low plasticity, medium stiff, moist, gray, Alluvial Clay (Intermediate), (cont.).								
1318.6	53.7	D-8	1			Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, trace silt, trace black spotting, Alluvial Clay (Intermediate).								
1314.3	58.0	D-9	4 6	100		Silt (ML) no plasticity, loose, wet, gray, with black laminations, few clay, Alluvial Clay (Intermediate).								
		D-10	3 4 5	100		Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, trace silt, trace black spotting, Alluvial Clay (Intermediate).								

50 51 52 53 54 55 56 57 58 59 60

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 8 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1311.3	61.0					Lean to fat clay (CL/CH) medium to high plasticity, stiff, moist, gray, trace silt, trace black spotting, Alluvial Clay (Intermediate).								
						Sandy silt (s(ML)) no plasticity, loose, wet, gray, trace clay, trace black laminations, Alluvial Clay (Intermediate).								
		D-11	0 1 3	100			0.0	46.9	53.1				ML	Grey 1 4/N Dark Gray Sandy Silt
		D-12	3 6 8	100		@ 68 ft, medium dense, trace wood.								

60 61 62 63 64 65 66 67 68 69 70

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 9 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silt (ML) no plasticity, medium dense, wet, gray, trace wood, Alluvial Sand (Lower), (cont.).								25 feet of heave. Added water.
1298.3	74.0					Poorly graded sand with silt (SP-SM) no plasticity, loose, wet, gray, fine grained, trace medium to coarse sand, trace detrital lignite, trace silt, trace clay, Alluvial Sand (Lower).								Spoon sank 1.5 ft. Collected SPT from 74.5-76 ft.
		D-13	1 2 3	100			0.9	88.9	10.2				SP-SM	Grey 1 5/N Gray Poorly Graded Sand with Silt
														25 feet of heave. Added water.
1294.3	78.0					Silty sand (SM) no plasticity, medium dense, wet, gray, fine grained, trace medium to coarse sand, trace detrital lignite, Alluvial Sand (Lower).								
		D-14	4 6 8	73			0.0	82.7	17.3				SM	2.5Y 5/1 Gray Silty Sand

70 71 72 73 74 75 76 77 78 79 80

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 10 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane | HORIZONTAL: NAD83 | VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1291.3	81.0					Silty sand (SM) no plasticity, medium dense, wet, gray, fine grained, trace medium to coarse sand, trace detrital lignite, Alluvial Sand (Lower), (cont.).								
						Poorly graded sand (SP) no plasticity, medium dense, wet, gray, fine grained, trace medium to coarse sand, trace detrital lignite, trace silt, trace clay, Alluvial Sand (Lower).								Slight grinding on gravel.
1288.2	84.1	D-15	2 5	67										
		D-16	11			Well-graded gravel with silt (SW-SM) no plasticity, medium dense, wet, orangish brown, fine to coarse grained, little fine gravel, trace silt, trace clay, Alluvial Sand (Lower).	16.5	76.5	7.0				SW-SM	2.5Y 4/1 Dark Gray Well Graded Sand with Silt and Gravel
1286.3	86.0					Chalk (CHALK) hard, moist, gray, Niobrara Chalk.								Firmed up at 86 ft.
		D-17	30 60/0.4	100										Chalk had slight diesely odor.
1284.4	87.9													

80 81 82 83 84 85 86 87

LAB TESTING LOG

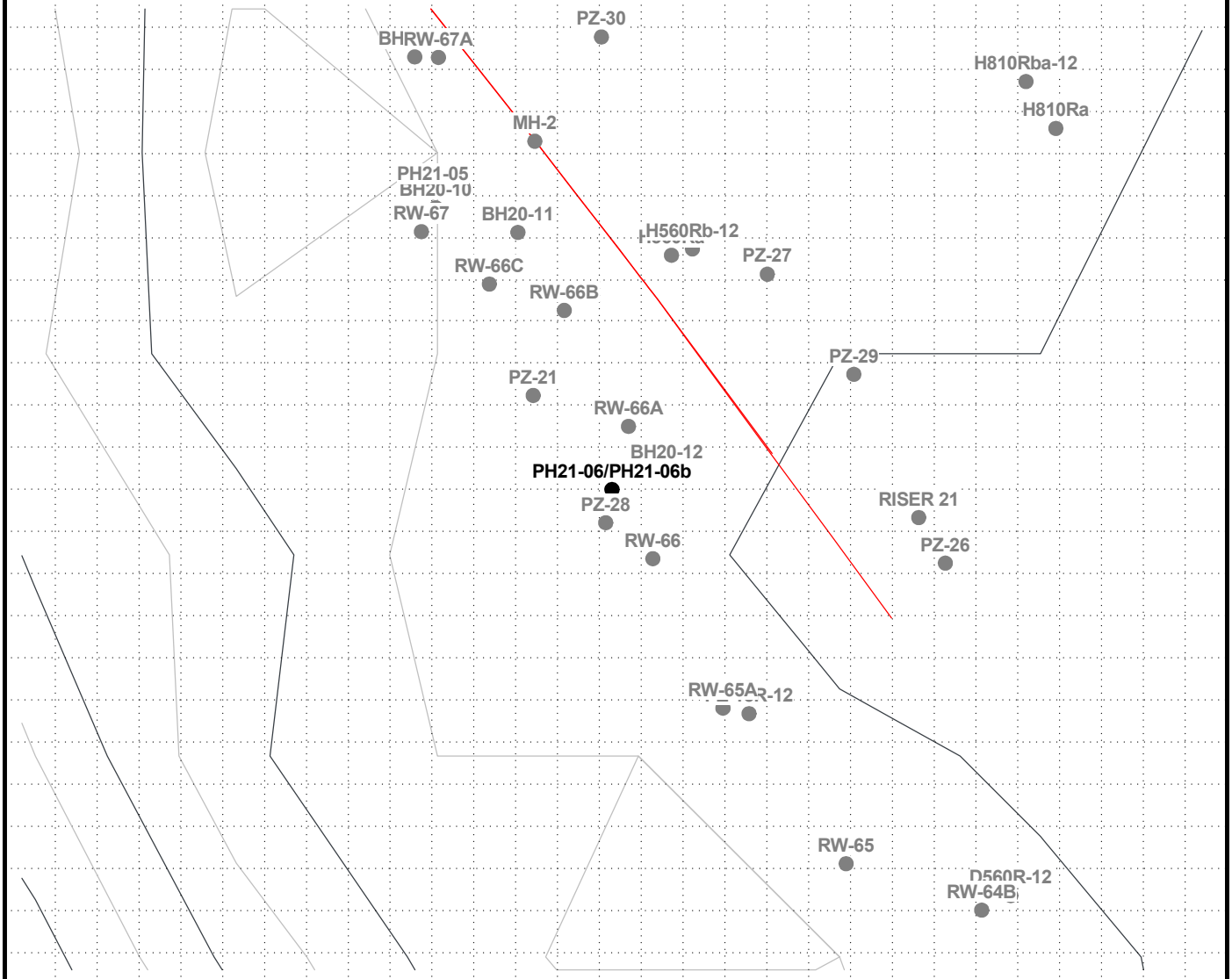
DIVISION: NWO		INSTALLATION: Big Bend Dam	SHEET 1 OF 10 SHEETS
1. PROJECT: FY21 Drain Replacement		9. COORDINATE SYSTEM: State Plane	HORIZONTAL: NAD83 / VERTICAL: Project Datum
		10. SIZE AND TYPE OF BIT: 4 1/4" ID HSA	
2. HOLE NUMBER: PH21-06/PH21-06b	LOCATION COORDINATES: 629048.465N 2199690.013E	11. MANUFACTURER'S DESIGNATION OF DRILL: Gus Pech 1300C	
3. DRILLING AGENCY: USACE, Omaha District		12. TOTAL SAMPLES	DISTURBED: 26 / UNDISTURBED: 0
4. NAME OF DRILLER: Josh Taylor		13. TOTAL NUMBER CORE BOXES	
5. DIRECTION OF BORING: ☒ VERTICAL ☐ INCLINED	DEG FROM VERTICAL: --- / BEARING	14. ELEVATION GROUND WATER	
		15. DATE BORING	STARTED: 5/3/21 / COMPLETED: 5/4/21
6. THICKNESS OF OVERBURDEN: 82.5 ft		16. ELEVATION TOP OF BORING: 1368.9	
7. DEPTH DRILLED INTO ROCK: 0.6 ft		17. TOTAL CORE RECOVERY FOR BORING: N/A	
8. TOTAL DEPTH OF BORING: 83.1 ft		18. SIGNATURE AND TITLE OF INSPECTOR: Robert Zygowicz Geologist	

LOCATION SKETCH/COMMENTS

SCALE:

Static Water Level Depth Groundwater Encountered

Drilled PH21-06b (offset 5.5 feet) to collect missed sampling intervals from 0 to 18 feet. Logs combined.



PROJECT: FY21 Drain Replacement Fort Thompson, SD

HOLE NO: PH21-06/PH21-06b

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 2 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay (CL) medium plasticity, stiff, moist, dark brown, little silt, little fine to coarse sand, trace fine gravel, trace roots, Alluvial Clay (Blanket).								No petroleum odor or staining observed in either boring.
		D-1(b)	3 7 7	100										
1366.4	2.5													
						Well-graded sand with gravel ((SW)g) no plasticity, dense, dry, black to orangish brown, fine to coarse grained, with fine to coarse gravel, trace fines, occasional cobbles, Alluvial Clay (Blanket).								Gravel/small cobbles grinding on augers 2.5 -5.5 ft.
		D-2(b)	23 24	100										
1364.9	4.0													
		D-3(b)	15			Sandy lean clay (s(CL)) low to medium plasticity, hard, dry, gray, trace fine to coarse sand, Alluvial Clay (Blanket).	0.3	39.5	60.2	26	18		CL	2.5Y 5/1 Gray Sandy Lean Clay
1363.4	5.5													
						Lean clay (CL) medium plasticity, stiff, moist, dark gray, few silt, Alluvial Clay (Blanket).								
		D-4(b)	4 6 7	87										
1360.9	8.0 ▽													
						Silty sand (SM) no plasticity, very loose, wet, light grayish brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper).								Spoon is wet at 8 ft.
		D-5(b)	0 0 0	67			0.0	85.5	14.5				SM	2.5Y 5/2 Grayish Brown Silty Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 3 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Silty sand (SM) no plasticity, very loose, wet, light grayish brown, fine grained, trace medium sand, trace clay, Alluvial Sand (Upper), (cont.).								~3.5 ft of heave. Added water.
1355.9	13.0													
		D-6(b)	3 0 1	53		Poorly graded sand with clay (SP-SC) no plasticity, very loose, wet, grayish brown, fine grained, trace clay, trace silt, Alluvial Sand (Upper).	0.0	91.9	8.1				SP-SC	2.5Y 5/2 Grayish Brown Poorly Graded Sand with Clay
														~5 ft heave. Add water.
		D-1	5 1 1	100										

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 4 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with clay (SP-SC) no plasticity, very loose, wet, grayish brown, fine grained, trace clay, trace silt, Alluvial Sand (Upper), (cont.).								~2 ft heave. Add water.
		D-2	10 10 6	73		@ 23 ft, medium dense.	0.0	92.1	7.9				SP-SC	2.5Y 4/3 Olive Brown Poorly Graded Sand with Clay
1341.9	27.0					Lean clay (CL) medium plasticity, stiff, moist, brownish gray, trace silt and FeO staining from 28-28.5 ft, Alluvial Clay (Intermediate).								~0.5 ft heave. Add water.
		D-3	1 5 6	87										

20 21 22 23 24 25 26 27 28 29 30

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 5 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Lean clay (CL) medium plasticity, stiff, moist, brownish gray, Alluvial Clay (Intermediate), (cont.).								
1335.9	33.0													
1335.4	33.5	D-4	1			Lean clay with sand ((CL)s) low plasticity, medium stiff, moist, gray, fine grained, few medium sand, trace coarse sand, Alluvial Clay (Intermediate).								
		D-5	2 4	100		Clayey silt (ML/CL) no plasticity, loose, wet, brownish gray, trace fine sand, gray with black streaking at 33.5 ft, Alluvial Clay (Intermediate).								
		D-6	0 3 3	100		@ 38 ft, gray to dark gray, no sand.								

30 31 32 33 34 35 36 37 38 39 40

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 6 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Clayey silt (ML/CL) no plasticity, loose, wet, gray to dark gray, Alluvial Clay (Intermediate), (cont.).								
1326.9	42.0					Silty clay with sand ((CL-ML)s) low to medium plasticity, stiff, moist, dark gray, few fine to coarse sand, trace fine gravel, Alluvial Clay (Intermediate).								Spoon sank 1.5 ft. Drove from 44.5-46 ft.
1324.2	44.7	D-7	2			Poorly graded sand with clay (SP-SC) no plasticity, medium dense, wet, fine to medium grained, trace coarse sand, trace fine gravel, trace detrital lignite, Alluvial Clay (Intermediate).								
1324.0	44.9	D-8	6 7	100		Sandy silt (s(ML)) no plasticity, medium dense, wet, gray, trace clay, Alluvial Sand (Lower).								~6 ft heave. Add water.
		D-9	1 4 7	100		@ 48 ft, trace fine sand, few clay, with black laminations.	0.0	35.6	64.4				ML	2.5Y 5/1 Gray Sandy Silt

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 7 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Sandy silt (s(ML)) no plasticity, medium dense, wet, gray, trace fine sand, few clay, with black laminations, Alluvial Sand (Lower), (cont.).								
1317.4	51.5					Silty sand (SM) no plasticity, loose, wet, gray, fine grained, few medium sand, trace coarse sand, trace detrital lignite, trace clay, Alluvial Sand (Lower).								
		D-10	1 4	100			1.1	79.3	19.6				SM	~2 ft heave. Add water. 2.5Y 3/1 Very Dark Gray Silty Sand
1315.2	53.7	D-11	5			Sandy silt (s(ML)) no plasticity, loose, wet, gray, trace clay, Alluvial Sand (Lower).	0.0	48.7	51.3				ML	2.5Y 3/1 Very Dark Gray Sandy Silt
														~14 ft heave. Add water.
1310.9	58.0	D-12	3 1 1 5	100		Poorly graded sand (SP) no plasticity, loose, wet, gray, fine grained, trace silt, trace clay, trace detrital lignite, Alluvial Sand (Lower).	0.0	95.2	4.8				SP	2.5Y 3/1 Very Dark Gray Poorly Graded Sand

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 8 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand (SP) no plasticity, loose, wet, gray, fine grained, trace medium to coarse sand, trace silt, trace clay, trace detrital lignite, Alluvial Sand (Lower).							~8.5 ft heave. Add water.
1305.9	63.0					Clayey sand (SC) no plasticity, medium dense, wet, gray, fine grained, trace medium to coarse sand, trace clay, trace detrital lignite, with black laminations, Alluvial Sand (Lower).								
		D-13	6 9 17	100			0.5	86.9	12.6				SC	2.5Y 3/2 Very Dark Grayish Brown Clayey Sand
1300.9	68.0													
		D-14	3 6	87		Silty clayey sand (SC-SM) no plasticity, medium dense, wet, gray, fine grained, few medium to coarse sand, with detrital lignite, Alluvial Sand (Lower).								
1299.9	69.0													
		D-15	13			Well-graded sand with silt (SW-SM) no plasticity, medium dense, wet, brown, fine grained, with medium to coarse sand, few silt, trace clay, few detrital lignite, Alluvial Sand (Lower).	9.0	82.7	8.3				SW-SM	10YR 5/2 Grayish Brown Well Graded Sand with Silt

60 61 62 63 64 65 66 67 68 69 70

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam
SHEET 9 OF 10 SHEETS
PROJECT: FY21 Drain Replacement
COORDINATE SYSTEM: State Plane
HORIZONTAL: NAD83
VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
1295.9	73.0					Well-graded sand with silt (SW-SM) no plasticity, medium dense, wet, brown, fine grained, with medium to coarse sand, few silt, trace clay, few detrital lignite, Alluvial Sand (Lower), (cont.).								
1295.1	73.8	D-16	5 6	87		Well-graded sand with clay (SW-SC) no plasticity, medium dense, wet, brown, fine to coarse grained, trace fine gravel, trace detrital lignite, with clay chunks, trace silt, Alluvial Sand (Lower).	11.4	79.3	9.3				SW-SC	10YR 5/2 Grayish Brown Well Graded Sand with Clay
		D-17	9			Silty sand (SM) no plasticity, medium dense, wet, gray, fine grained, trace clay, Alluvial Sand (Lower).	4.9	79.9	15.2				SM	2.5Y 4/2 Dark Grayish Brown Silty Sand
1290.9	78.0													
		D-18	4 7 9	100		Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, brown, fine grained, with medium to coarse sand, trace detrital lignite, trace silt, trace clay, clay chunks from 79.3 to 79.5 ft, Alluvial Sand (Lower).	0.2	92.1	7.7				SP-SM	2.5Y 5/2 Grayish Brown Poorly Graded Sand with Silt

70 71 72 73 74 75 76 77 78 79 80

LAB TESTING LOG (Cont Sheet)

INSTALLATION: Big Bend Dam

SHEET 10 OF 10 SHEETS

PROJECT: FY21 Drain Replacement

COORDINATE SYSTEM: State Plane

HORIZONTAL: NAD83

VERTICAL: Project Datum

ELEV	DEPTH	Sample No.	Blows/ 0.5 ft	% REC	LEGEND	FIELD CLASSIFICATION OF MATERIALS (Description)	Laboratory: Gravel	Sand	Fines	LL	PL	MC	ASTM Class	REMARKS/LAB DESCRIPTION
						Poorly graded sand with silt (SP-SM) no plasticity, medium dense, wet, brown, fine grained, with medium to coarse sand, trace detrital lignite, trace silt, trace clay, Alluvial Sand (Lower), (cont.).							
1287.4	81.5													
						Well-graded gravel with clay and sand ((GW-GC)s) no plasticity, dense, wet, gray, fine to coarse grained, with fine to coarse sand, Alluvial Sand (Lower).							
1286.4	82.5	D-19	6	100										
		D-20	60/0.4			Chalk (CHALK) hard, moist, gray, Niobrara Chalk.								
1285.8	83.1													

80 81 82 83