**ADDENDUM NO. 1**

August 25, 2023

Owner: City of Midwest City

Project Name: North Side Utilities Sanitary Sewer Project

Plummer Project No. 3435-003-01

This Addendum is a part of Contract and clarifies, corrects or modifies original Bid Documents, dated August 11, 2023. Acknowledge receipt of this addendum in the space provided on this form and include with your Bid Documents; failure to do so may subject bidder to disqualification.

**A. Clarifications and Questions:**

1. QUESTION: In the Pre-Bid Meeting held on April 22nd, the question was raised about allowing DR 13.5 HDPE pipe as alternative to fusible PVC.
    a. ANSWER: The answer was given that it would be allowed if submitted. After further discussion, HDPE will **not** be allowed as an alternative and fusible PVC will be the only allowable pipe material for the HDD and the force main.
2. QUESTION: Can the bid date be extended by a few days or a week to provide distance from the holiday weekend?
    a. ANSWER: The bid date will remain as originally listed in contract documents.
3. QUESTION: Can a lined concrete vault will be allowed as an alterternative to the composite polymer concrete wet well?
    a. ANSWER: Lined concrete vaults will not be allowed as an alternative. The lift station wet well must be a fully precast composite polymer concrete wet well.
4. QUESTION: Is the geotechnical report available?
    a. ANSWER: the Geotechnical Reportis provided as Attachment #1 to this addendum.
5. QUESTION: Can contractors look at the headworks connection site?
    a. ANSWER: Contractors may schedule appointments with plant personnel to allow for site visits to the site (including the headworks connection location).
6. QUESTION: Will the lift station have to handle rags (as mentioned in Section 43 25 13 of specifications)?
    a. ANSWER: The proposed lift station will primarily see meatpacking waste that has been pre-processed by a Dissolved Air Filtration (DAF) system, meaning that rags are not expected in the wastewater being handled by the proposed lift station. However, the requirement that the lift station must be able to handle rags is unchanged.
7. QUESTION: With the generator being natural gas driven, will the City handle everything past the meter, with the contractor tying into the meter?
    a. ANSWER: Contractor will coordinate with industrial owner and utilities to tie into existing gas and electrical lines. No additional permitting is expected.
8. QUESTION: Will contractor have to coordinate access with site owner, City or someone else?
    a. ANSWER: Contractor will have access to both sides of the project via 36th St. Contractor will be required to coordinate as follows:
        i. Access to the north project site (north of Crutcho Creek) will require coordination with industrial owner, their contractor, and City personnel.
        ii. Access to the south project site (south of Crutcho Creek) will require coordination with City personnel.

**B. Specifications Revisions:**

1. Attachment #1, Subsurface Geotechnical Investigation:
    a. Add Appendix #1, "Subsurface Geotechnical Investigation" dated December 2022, as Attachment #1 to specifications.
2. Section TC, Table of Contents:
    a. Remove the text "Precast Manholes" from Division 03, Concrete and replace with "Manholes and Vaults."
    b. Add the following text to the end of sheet TC-4: "Appendix #1: Subsurface Geotechnical Investigation."
3. Division 00, Bid:
    a. Remove Division 00 "BID" in its entirety and replace with Attachment #2, Division 00 "BID".
4. Section 03 40 00, Manholes and Vaults:
    a. Remove Section 03 40 00, "Precast Manholes" in its entirety and replace with Attachment #3, Section 03 40 00 "Manholes and Vaults" dated September 2023.
5. Section 43 05 25, Common Requirements for Pumps:
    a. Delete Section 43 05 25 "Common Requirements for Pumps" in its entirety. Replace with Attachment #4, Section 43 05 25 "Common Requirements for Pumps" dated September 2023.
6. Section 43 25 13, Submersible Centrifugal Pumps:
    a. Delete Section 43 25 13 "Submersible Centrifugal Pumps" in its entirety. Replace with Attachment #5, Section 43 25 13 "Submersible Centrifugal Pumps" dated September 2023.

**C. Plan Revisions:**

1. Sheet G-007, Bid Quantities:
    a. Remove Item 1 Quantity of "631 LF" and replace with quantity of "671 LF"
2. Sheet C-201, Lift Station Civil Site Work, Site and Yard Piping Plan:
    a. Remove text in callout saying "(6' CHAIN LINK SECURITY FENCE WITH MOW STRIP)" and replace with text saying "(8' CHAIN LINK SECURITY FENCE WITH MOW STRIP)."
3. Sheet M-100, Wet Well and Meter Vault Plan and Section:
    a. Remove Sheet M-100 in its entirety and replace with Attachment #5, Sheet M-100 dated 08/25/2023.
4. Sheet S-103, Foundation Plan & Details:
    a. Remove Detail 3 and all associated callouts. (Wet well foundation will be precast instead of the cast-in-place foundation shown.)

Attachments:

- Attachment #1: Subsurface Geotechnical Investigation
- Attachment #2: Division 00, BID
- Attachment #3: Section 03 40 00, Manholes and Vaults
- Attachment #4: Section 43 05 25, Common Requirements for Pumps
- Attachment #5: Section 43 25 13, Submersible Centrifugal Pumps
- Attachment #6: M-100

This addendum consists of 96 page(s)/sheet(s).

Alan Swartz

Approved by ENGINEER/ARCHITECT


Acknowledged by BIDDER

**END OF SECTION**

ENVIROTECH

ENGINEERING

# SUBSURFACE GEOTECHNICAL INVESTIGATION

## MIDWEST CITY WATERLINE

MIDWEST CITY, OKLAHOMA

PLUMMER

LICENSED PROFESSIONAL ENGINEER
TYLER WILLIAMS
26476
OKLAHOMA
12/29/2022

**REVISED DECEMBER 2022**

CA 1960
Expiration 06/30/2024
022240-00

# TABLE OF CONTENTS

## 1. INTRODUCTION

ENVIROTECH ENGINEERING & CONSULTING, INC., was retained by Plummer to conduct a subsurface investigation and provide geotechnical engineering services prior to the construction of a Waterline between NE 36th St and NE 23rd St in Midwest City, Oklahoma. A Project Location Map is included as *Figure 1*.

Eight (8) borings were identified by Plummer. The boring locations are depicted on the Boring Location Map included as *Figure 2*. The borings were drilled to a depth of 50.0-ft below ground surface; Standard Penetration Testing (SPT) was conducted at auger changes.

This report will serve to summarize the subsurface conditions encountered in all soil borings as well as the associated geotechnical data. In addition, soil strengths, foundation, and pavement recommendations will be provided.

## 2. SUBSURFACE EXPLORATION PROCEDURES

From November 29 to December 2, 2022, eight (8) borings were drilled utilizing a CME 75 truck-mounted rotary rig equipped with 6-in OD hollow-stem augers and 5-in OD solid-stem augers.

Representative soil samples were collected according to the split-barrel sampling procedure outlined in ASTM Specification D-1586. This procedure dictates that a 2-in OD split-barrel sampling spoon be driven into the ground with a 140-lb. hammer "free-falling" 30-in. The number of blows required to advance the sampling device the remaining 12-in of a typical 18-in sampling interval is termed the standard penetration resistance value. The standard penetration resistance value provides an indication of the in-place relative density of granular soils and, less accurately, the consistency of cohesive soils. These values are recorded on the boring logs included in *Appendix A*.

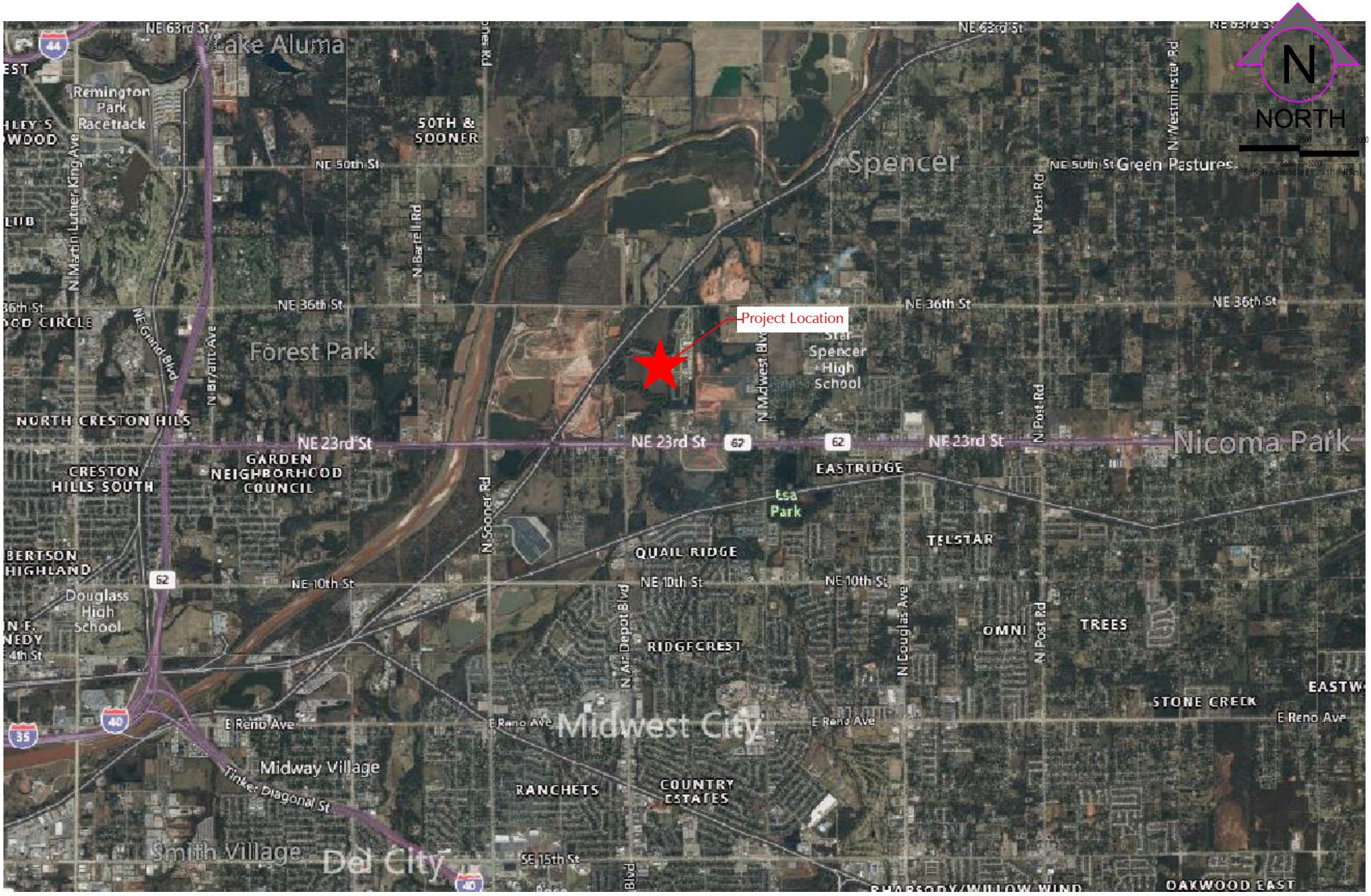
A standard 140-lb SPT "safety hammer" was used to advance the split-barrel sampling device. The efficiency of the "safety hammer" and the effect on the standard penetration resistance blow count (N) values have been considered in the interpretation and analysis of the subsurface information in this report.

Soil samples were collected from the borings utilizing the “grab sample” technique per ASTM D1452 and/or D6151. Thin-walled samples, Shelby Tubes, were pushed in each of the borings per ASTM D1587. The collected samples were labeled for identification, sealed to prevent moisture loss, and transported to ENVIROTECH’S soils laboratory for further examination, testing, and classification.

Field logs for each soil boring include visual classifications of the soil conditions encountered during drilling operations as well as the on-site technician’s interpretation of the stratigraphic conditions encountered between sampling intervals. The boring logs, included in *Appendix A,* represent an interpretation of the field logs and include modifications based on laboratory observations and testing. In addition, the referenced boring logs include soil descriptions, relative density and consistency evaluations, boring depths, sampling intervals, and groundwater conditions.

## 3. LABORATORY TESTING PROGRAM

Soil samples were collected from the borings utilizing either a split-barrel sampling device, a "grab sample" technique, or a Shelby Tube. A Percent Passing the No. 200 wet wash sieve analysis (ASTM




ENVIROTECH
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C.A. #1960 - Expiration Data: 6-30-2024

# Project Location Map

Midwest City Waterline
Northwest Quarter of Section 22, Township 12 North, Range 2 West,
I.M. Oklahoma County, OK

PLUMMER

Project No.
22.240-00

Figure 1


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C.A. #1960 - Expiration Data: 6-30-2024

# Boring Location Map

Midwest City Waterline
Northwest Quarter of Section 22, Township 12 North, Range 2 West,
I.M. Oklahoma County, OK

PLUMMER

Project No. 22.240-00

Figure 2

D-1140), Atterberg Limits tests (ASTM D-4318), and full sieve analyses were conducted to determine the soil classification in accordance with ASTM D-2487. The Atterberg Limits tests were conducted on the referenced samples in order to estimate the soil's shrink/swell potential. The bulk dry density was conducted per ASTM D698. Additionally, the unconfined compressive strength was performed per ASTM D2126. The results of these laboratory tests (conducted pursuant to appropriate ASTM standards) are included in *Appendix B*.

Soil classifications were conducted by an experienced technician and based on visual observations of the soils and results of the tests conducted. Soil descriptions are based on the Unified Soil Classification System (USCS).

## 4. GROUNDWATER CONDITIONS

The borings were monitored during, and subsequent to completion of, drilling operations for the presence of groundwater. Groundwater depths are listed below in *Table 4.1*.

**Table 4.1**
**GROUNDWATER CONDITIONS**

| Boring Location | Surface to Groundwater at Completion of Boring |
|---|---|
| Boring B-01 | 20.0-ft |
| Boring B-02 | 23.0-ft |
| Boring B-03 | 20.0-ft |
| Boring B-04 | 20.0-ft |
| Boring B-05 | 20.0-ft |
| Boring B-06 | 17.0-ft |
| Boring B-07 | 15.0-ft |
| Boring B-08 | 18.5-ft |

## 5. SITE AND SUBSURFACE CONDITIONS

This geologic setting is defined as the Oklahoma City Metro Area Quadrangle. The area older alluvium; unconsolidated deposits consisting of locally derived clay, silt, sand, and rarely gravel-sized sedimentary material. It represents slightly older terrace deposits than those formed in modern flood plains. It is predominately found adjacent to, and 5- to 10-ft above, modern alluvial deposits of major drainage systems. The area is rarely subject to flooding. The thickness can be as much as 50-ft. This material is from the Holocene Epoch of the Quaternary Period.

The laboratory analytical results and SPT tests yielded similar values for each stratum encountered during drilling operations. It is generally assumed that soil horizons are relatively uniform across the site.

**5.1. Boring B1.** Boring B1 encountered dark brown clay with sand (CH) from the surface to 8.5-ft. This material had a Plasticity Index (PI) of 45 at 6.0-ft. Light brown clay with sand (CL) was found from 8.5- to 15.0-ft, where the material became light brown sandy clay (CL) with a Plasticity Index (PI) of 13. Light brown sand (SP) was found from 20.0- to 35.0-ft. The material then became light brown sandstone. Auger refusal was encountered at 37.5-ft.

Groundwater was encountered in this boring at 20.0-ft. Detailed boring logs are included in *Appendix A*.

**5.2. Boring B2.** Boring B2 encountered light brown clay with sand (CL) from the surface to 10.0-ft. Light brown silty sand (SM) was found from 10.0- to 23.0-ft; this material was Non-Plastic (NP). Light brown sand (SP) was found from 23.0- to 41.0-ft. Red shale, locally known as redbed, was encountered at 41.0-ft. The boring was terminated at 50.0-ft. Groundwater was encountered in this boring at 23.0-ft. Detailed boring logs are included in *Appendix A*.

**5.3. Boring B3.** Boring B3 encountered dark brown clay (CH) from the surface to 2.0-ft. Light brown clay with sand (CL) was found from 2.0- to 15.0-ft. This material had a Plasticity Index (PI) of 11 at 6.0-ft. Brown clayey sand (SC) was encountered from 20.0- to 40.0-ft. Brown sandstone (SC) was encountered at 40.0-ft. Auger refusal was encountered at 41.0-ft. Groundwater was encountered in this boring at 20.0-ft. Detailed boring logs are included in *Appendix A*.

**5.4. Boring B4.** Boring B4 encountered dark brown clay (CH) from the surface to 5.0-ft. The material then became light brown silty sand (SM) from 5.0- to 19.0-ft. This material had a Plasticity Index (PI) of 2 at 5.0-ft. White brown sand (SP) was encountered from 19.0- to 25.0-ft. The material then became light brown sand (SP), which continued to 38.0-ft. Red/brown shale, locally known as redbed, was encountered at 38.0-ft. The boring was terminated at 50.0-ft. Groundwater was encountered in this boring at 20.0-ft. Detailed boring logs are included in *Appendix A*.

**5.5. Boring B5.** Boring B5 encountered dark brown clay (CH) from the surface to 5.0-ft. Light brown silty sand (SM) was encountered from 5.0- to 20.0-ft. This material was Non-Plastic (NP). Light brown sand (SP) was found from 20.0- to 38.0-ft. Red shale, locally known as redbed, was encountered at 38.0-ft. The boring was terminated at 50.0-ft. Groundwater was encountered in this boring at 20.0-ft. Detailed boring logs are included in *Appendix A*.

**5.6. Boring B6.** Boring B6 encountered light brown sandy clay (CH) from the surface to 10.0-ft. This material had a Plasticity Index (PI) of 43 at 5.0-ft. Light brown silty sand (SM) was found from 10.0- to 17.0-ft. The boring encountered light brown sand (SP) from 17.0- to 38.0-ft. Red shale, locally known as redbed, was encountered at 38.0-ft. The boring was terminated at 45.0-ft due to auger refusal. Groundwater was encountered in this boring at 17.0-ft. Detailed boring logs are included in *Appendix A*.

**5.7. Boring B7.** Boring B7 encountered dark brown clay (CH) from the surface to 2.5-ft. Brown clay (CL) was found from 2.5- to 10.0-ft, where the material then became light brown clay with sand (CL). This material continued to 20.0-ft, and had a Plasticity Index (PI) of 13 at 15.0-ft. Light brown silty sand (SM) was encountered from 20.0- to 25.0-ft. The material then became light brown sand (SP) which continued to 45.0-ft. Red shale, locally known as redbed, was encountered at 45.0-ft. The boring was terminated at 50.0-ft. Groundwater was encountered in this boring at 15.0-ft. Detailed boring logs are included in *Appendix A*.

**5.8. Boring B8.** Boring B8 encountered reddish brown sandy clay (CL) from the surface to 8.0-ft. This material had a Plasticity Index (PI) of 9 at 5.0-ft. Red sand with silt (SP-SM) was found from 8.0- to 18.5-ft. This material was Non-Plastic (NP). The boring then encountered red

sand (SP) from 18.5- to 48.0-ft. Red shale, locally known as redbed, was encountered at 48.0-ft. The boring was terminated at 50.0-ft. Groundwater was encountered in this boring at 18.5-ft. Detailed boring logs are included in *Appendix A*.

## 6. CONCLUSIONS AND RECOMMENDATIONS

**6.1 Site and Subgrade Preparation.** In the event there is a building onsite, site and building pad preparation should include clearing and grubbing of all vegetation and topsoil. A combination of ENVIROTECH'S experience and the laboratory geotechnical results indicates that soils similar to those onsite are expansive with moderate shrink/swell potential. Subgrade stabilization will be required for any building pads or pavement. Subgrade stabilization is clarified in *Section 6.6.2 – Soil Stabilization*.

Subsequent to placing any fill onsite and compacting the subgrade, ENVIROTECH recommends proof-rolling the site with a loaded (25-ton total weight) tandem-axel dump truck to locate any soft or unstable zones. The proof-rolling should be conducted in perpendicular rows with overlapping passes. In the event rutting or pumping is observed during proof-rolling activities, the material should be moisture-conditioned and re-compacted. Compaction of this material should be adjusted to within 2% of the optimum moisture content and 95% of the determined maximum dry density.

Extreme care should be taken during construction to ensure that wetting or drying of the bearing materials does not occur. In the event extreme wet, dry, or loose materials are observed in the bottom of the footing excavations prior to pouring the concrete, they should be removed. No standing water shall be allowed in the soil foundation. Any saturated soil shall be removed and replaced with select fill, as discussed below, prior to pouring concrete.

In the event backfill or additional fill material is required to raise the building pad elevation, that material should be an engineered-fill with a Plasticity Index (PI) between 5 and 15. All fill shall be placed in 8-in lifts and compacted to within 2% of optimum moisture content and 95% Standard Proctor dry density. If this material is placed as described herein, an allowable bearing capacity of 2,000-psf will be suitable for design purposes. The building pad's elevation should be higher than the adjacent ground to create positive drainage away from the buildings.

**6.2 Pipe Trench Backfill.** All trench backfill from 12-in above the top of pipe to the surface shall consist of the locally excavated material. Any particles larger than 3-in in diameter shall be removed from the backfill. Soil shall be placed in 12-in loose lifts and compacted to ±4% of the material optimum moisture content and to a minimum 90% of the material standard proctor dry density (ASTM D698). Compaction shall be verified for every other lift and once every 600 linear feet of trenching.

**6.2.1 Pipe Foundation.** Once the trench excavation is completed, the pipe foundation shall be verified at 90% of the standard proctor density. Compaction shall be verified for every other lift and once every 600 linear feet of trenching. In the event the required compacted effort is not achieved, the soil shall be excavated a minimum 18-

in below the design trench elevation and backfilled in accordance with *Section 6.2.2 - Pipe Embedment Backfill*.

**6.2.2 Pipe Embedment Backfill.** All initial backfill in the pipe embankment zone shall be coarse grained materials with a Plasticity Index (PI) less than 10. It is anticipated that the deeper portions of the locally excavated material will be suitable for the initial backfill zone with some material coming from other portions of the trenching area. No particles larger than 2-in should be permitted in the Pipe Embedment zone. Backfill shall be completed in 8-in loose lifts and all backfill shall be compacted to 95% standard proctor density with a moisture content with ±3%. Compaction shall be verified for every other lift and once every 600 linear feet of trenching.

**6.2.3 Final Backfill.** All final backfill shall consist of the locally excavated material. Any particles larger than 3-in in diameter shall be removed from the backfill. Soil shall be placed in 12-in loose lifts and compacted to ±4% of the material optimum moisture content and to a minimum 90% of the material standard proctor dry density (ASTM D698). Compaction shall be verified for every other lift and once every 600 linear feet of trenching.

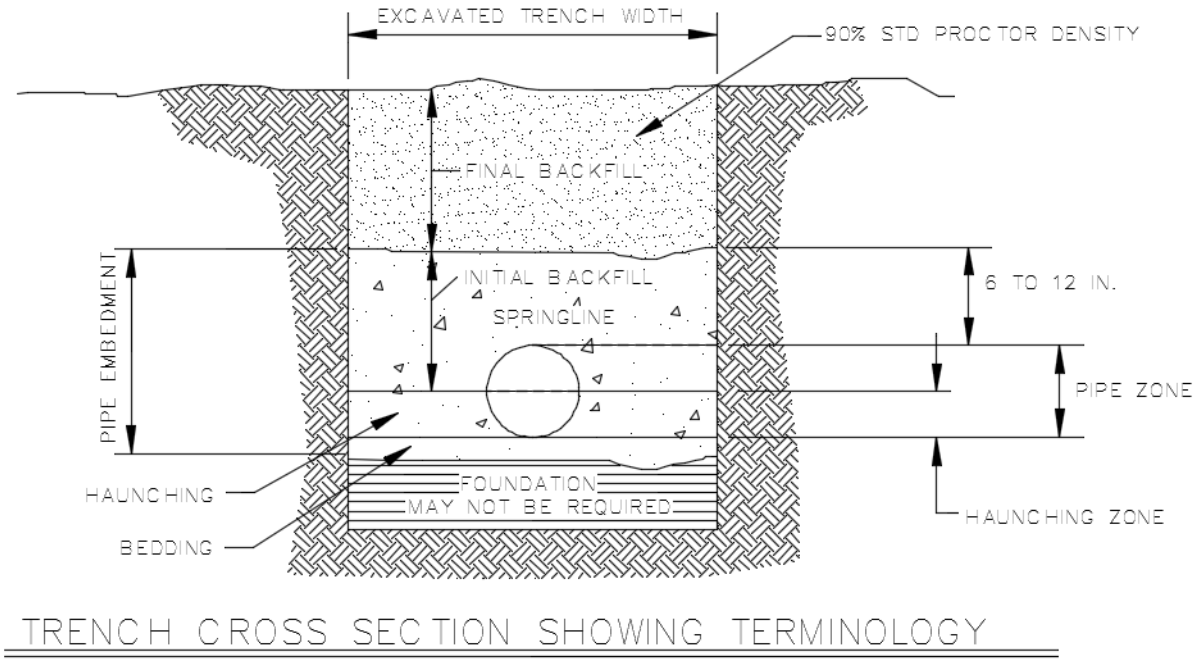


***Figure 6.2 Trench Backfill Schematic***

**6.3 Horizontal Directional Drilling.** The subsurface materials generally consist of medium to stiff clays, cohesive sands, and weathered sandstone and mudstone. The HDD contractor shall design the HDD profile to meet the project specifications and use the safest, most economical route.

**6.3.1 Drilling Fluid.** Clean water with appropriate additives should be used for the drilling fluid. The source of the freshwater should be approved by the owner prior to the commencement of the work. Water with a pH below 6 or with excessive calcium should be treated with the appropriate amount of sodium carbonate or equivalent. The water and additives should be mixed thoroughly and be absent of any clumps or clods. The viscosity of the fluid should be appropriate for strata. Depending on the HDD design, the strata may be medium clays, cohesive sands, or weathered sandstone and mudstone. Bentonite may be used for suspension of cutting and fluid loss control. Polymers may be used to increase viscosity and control swelling in clayey materials. Drilling fluid should not be recycled and should be hauled off the site.

**6.3.2 Contamination Control.** Due to the proximity of the HDD bores to onsite creeks, containment of the drilling fluid is critical. The drilling operations should be monitored continuously by experienced personnel trained in all aspects of the directional drilling process. These procedures include a very accurate monitoring and control system to track the progress and exact location of the drilling head at all times. Horizontal and vertical adjustments should be made throughout the procedure so that the drilling profile matches the planned profile. The specific weight of the drilling fluid should be adjusted throughout the procedure to maintain hydrological stability. In the event of a release of the drilling fluid, operations should stop immediately, and measures should be taken to contain the release. Containment of any release is the responsibility of the HDD contractor; however, below are some common measures:

- The drilling contractor should take immediate corrective action to contain the release
- Pits and/or berms should be constructed around the borehole entry point to contain drilling fluid
- Containment equipment, including earth moving equipment, portable pumps, hand tools, sandbags, should be readily available
- Any drilling fluid seepage should be removed using a vacuum truck and then transported to an approved disposal site

**6.4 Temporary Excavation & Shoring.** The anticipated HDD installations typically require entry and receiving pits. It is anticipated that conventional equipment could be used to excavate onsite soil materials. The materials to be excavated are anticipated to be medium to high plasticity clays near the surface. Stockpiled excavated soils and stockpiled materials should be kept a minimum of 25-ft from the pits to prevent excess surcharge loading. Sloping or Shoring of the pits should meet OSHA standards and will be the responsibility of the contractor based on their construction methods.

**6.5 Deep Excavation Work Areas.** In the event work areas are required at deep excavations (i.e. excavations deeper than 4-ft) the base of the work areas may need modification for proper support. Work areas nearing the 15- to 20-ft depths in the clay strata may become loose and soft. The contractor may need to modify the work area at deep excavations for personnel foot traffic. Modifying the work area is recommended by over excavating the area 12-in

below the working grade and backfilling with crushed rock. In the event heavy equipment is needed at deep elevations, the geotechnical engineer shall be notified to modify this recommendation.

**6.6 General Construction Recommendations.** Typical requirements that apply to all foundations are specified in the following sections of this report.

**6.6.1 Seismic Parameters.** The 2015 International Building Code (IBC) requires that masonry structures and components comply with the seismic requirements of that code. Site materials generally exhibit a factored Standard Penetration Resistance less than 50 and therefore, yield a Site Class Definition "D". The mapped maximum considered earthquake spectral response acceleration at short periods is 40.0% and 26.7% g at a one-second glance.

**6.6.2 Soil Stabilization.** All areas requiring soil stabilization shall be prepared as described in *Section 6.1 – Site and Subgrade Preparation*. The materials found in the upper strata of the site are classified as AASHTO A-7. Based on ODOT "OHD L-50 – Soil Stabilization Mix Design Procedure" for A-7 soils, ENVIROTECH recommends using 6% hydrated lime. It is recommended that, subsequent to completion of all rough site grading in areas of buildings or pavement, lime be evenly distributed over the subgrade surface. The lime shall be thoroughly mixed with the underlying subgrade to a depth of 10-in using a rotary style mixer. Mixing by means of "disking" or "windrowing" is generally less effective and thus discourage. During mixing, the subgrade shall be adjusted to 2% to 4% above optimum moisture. After the last increment of water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture. The material may then be lightly compacted to prevent evaporative moisture loss and should then be allowed to cure for 24- to 72-hours.

After the curing time has passed, the stabilized soil should be thoroughly remixed to the full depth. Determine the moisture content of the mixture; it should not be less than the optimum moisture content, nor more than 2% above. The stabilized subgrade shall be compacted to 95% of the maximum dry density as determined by a Standard Proctor (ASTM D698). The Standard Proctor should be performed on a lime/soil specimen, mixed to the same ratio as occurred in the field. Subsequent to compaction activities, the stabilized and compacted surface should be maintained to ensure that wetting or drying of the bearing materials does not occur.

**6.6.3 Construction Dewatering.** Dewatering may be required during construction. Groundwater is mostly found at a depth of 15- to 23-ft below the surface. The saturated zone is primarily comprised of sand (SP), silty sand (SM), and clayey sand (SC). Dewatering can typically be accomplished with sump pits and pumps locally at excavation sites or through multiple well points across the working area. Dewatering of excavations is normally the responsibility of the contractor and should be a design-build system based on the contractor's excavation and construction methods. The contractor should review the subsurface data based on their anticipated plan and obtain additional information if needed to design the required dewatering method.

The final dewatering method should be properly designed to prevent pumping silt and soil fines with the discharge water, or the discharge water should be managed in accordance with the projects Stormwater Pollution Prevention Plan (SWPPP).

## 7. GENERAL COMMENTS

The recommendations presented herein are based upon the data collected and additional references mentioned in the text of this report. Although it is generally assumed that homogeneity exists, it is recognized that this is rarely the case and variations may not become evident until construction activities commence. In the event any soils are encountered that are not similar to the ones described in this report, additional testing will become necessary.

This investigation was conducted, and this report prepared, for the exclusive use of Plummer for the specific application of constructing the Midwest City Waterline at the above-referenced site in Midwest City, Oklahoma. This report has been prepared in accordance with generally accepted geotechnical engineering practices. In the event the design or location of the project is altered, the conclusions and recommendations contained herein may not be valid and should be re-evaluated by ENVIROTECH prior to construction.

# APPENDIX A.

## BORING LOGS

# Boring Logs and Soil Classification Report

ENVIROTECH
ENGINEERING
2500 N. 11th Street Enid, OK 73701 (580) 234-8780 Fax (580) 237-4302 envirotechconsulting.com

## Envirotech Drilling Equipment

**CME-75**
-Hollow Stem Augers (6-in through 12-in)
-Solid Stem Augers (5-in through 12-in)
-Geotechnical Drilling
-Monitoring Well Installation
-Piezometers

** Envirotech also utlizes a GEFCO F6 with the same capabilities*

**Geoprobe 540U -Truck Mounted**
-Discrete Water Sampling (SP16 System)
-Discrete Vapor Sampling (PRT System)
-Single Rod MC5 Soil Sampling
-Concrete Coring

### USCS Soil Classifications (ASTM D2487)

*Listed below are the different classifications used in the following Boring Logs. Each pattern is specific to the given soil.*

- Well Graded Sand (SP)
- Poorly Grade Sand (SW)
- Well Graded Sand with Silt (SW-SM)
- Poorly Graded Sand with Silt (SP-SM)
- Well Graded Sand with Clay (SW-SC)
- Poorly Graded Sand with Clay (SP-SC)
- Silty Sand (SM)
- Clayey Sand (SC)
- Silty, Clayey Sand (SC-SM)
- Low Plasticity Clay (CL)
- Silty Clay (CL-ML)
- Low Plasticity Silt (ML)
- Fat Clay (CH)
- High Plasticity Silt (MH)

### Soil Sampling Methods

- Shelby Tube (ST) ASTM D1587
- Split Spoon Sampler (SS) ASTM D1586
- Grab Sample
- Macro Sampler (MC5)

| Boring | CLIENT : Plummer | | | WEATHER : Windy, Clear, 63° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50233° | |
| | PROJECT # : 022240-00 | | | W-97.40133° | |
| 1 | DATE START : 11/29/2022 | FINISH : 11/29/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 11:30 | FINISH : 15:00 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Dark Brown Clay with Sand | CH | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Dark Brown Clay with Sand<br>*Unconfined Compressive Strength 29.21 psi* | CH | | | | | | | |
| 6 | | | Dark Brown Clay with Sand | CH | 3-4-4<br>N=8 | Sample A | 35.0 | 63 | 18 | 45 | 77.3 |
| 7 | | | | | | | | | | | |
| 8 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | Light Brown Clay with Sand | CL | 2-4-4<br>N=8 | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | Light Brown Sandy Clay | CL | 2-3-5<br>N=8 | Sample B | 19.9 | 29 | 16 | 13 | 65.0 |
| 16 | | | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | Light Brown Sandy Clay | CL | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 21 | | | Light Brown Sand | SP | 3-4-4<br>N=8 | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | Light Brown Sand | SP | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | | | | | | | | | |
| 26 | | | Light Brown Sand | SP | 1-4-3<br>N=7 | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | Light Brown Sand | SP | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

*Standard Proctor (ASTM 698) Results for B1 0-6.5-ft:*

*Maximum Dry Density- 95.1 pcf*
*Optimum Moisture - 19.6%*

| Boring | CLIENT : Plummer | | WEATHER : Windy, Clear, 63° | ENVIROTECH ENGINEERING |
|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | LOCATION : N 35.50233° | |
| | PROJECT # : 022240-00 | | W-97.40133° | |
| 1 | DATE START : 11/29/2022 | FINISH : 11/29/2022 | LOGGED BY : J. Blankenship | 2500 N. 11th Street I Enid, OK 73701 |
| | TIME START : 11:30 | FINISH : 15:00 | DRILLED BY : TJ Horner | (580) 234-8780 I Fax (580) 237-4302 |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | METHOD : Rotary | |

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Light Brown Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Light Brown Sandstone | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | **Terminated Drilling at 37.5-ft** | | | | | | | | |
| 39 | | | **Auger Refusal Encountered** | | | | | | | | |
| 40 | | | *For the drill string utilized for this specific boring, auger refusal means the soils encountered at boring termination were of a consistency and density such that no signifcant advancement could be made without causing damage to the drill string.* | | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | | | | | | | | | |
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | | | | | | | | | |
| 50 | | | | | | | | | | | |
| 51 | | | | | | | | | | | |
| 52 | | | | | | | | | | | |
| 53 | | | | | | | | | | | |
| 54 | | | | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Cloudy, Windy, 40° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50426° | |
| | PROJECT # : 022240-00 | | | | W-97.40449° |
| 2 | DATE START : 12/1/2022 | FINISH : 12/1/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 9:30 | FINISH : 13:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

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| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Light Brown Clay with Sand | CL | 8-7-7 | | | | | | |
| 6 | | | | | N=14 | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | Light Brown Silty Sand<br>*Unconfined Compressive Strength 32.09 psi* | SM | | | | | | | |
| 11 | | | Light Brown Silty Sand | SM | 2-4-4 | | | | | | |
| 12 | | | | | N=8 | | | | | | |
| 13 | | | Light Brown Silty Sand | SM | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | Light Brown Silty Sand | SM | 4-4-4 | Sample C | 9.1 | NP | NP | NP | 33.6 |
| 16 | | | | | N=8 | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | Light Brown Silty Sand | SM | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | Light Brown Silty Sand | SM | 2-6-6 | | | | | | |
| 21 | | | | | N=12 | | | | | | |
| 22 | | | Light Brown Silty Sand | SM | | | | | | | |
| 23 | | | **Water Encountered at 23.0-ft** | | | | | | | | |
| 24 | | | Light Brown Sand | SP | | | | | | | |
| 25 | | | Light Brown Sand | SP | 6-11-11 | Sample D | 14.9 | NP | NP | NP | 3.7 |
| 26 | | | | | N=22 | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | Light Brown Sand | SP | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Cloudy, Windy, 40° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50426° | |
| | PROJECT # : 022240-00 | | | | W-97.40449° |
| 2 | DATE START : 12/1/2022 | FINISH : 12/1/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 9:30 | FINISH : 13:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

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2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Light Brown Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Light Brown Sand | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | | | | | | | | | |
| 39 | | | Light Brown Sand | SP | | | | | | | |
| 40 | | | | | | | | | | | |
| 41 | | | Red Shale | CL | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | Red Shale | CL | | | | | | | |
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | Red Shale | CL | | | | | | | |
| 50 | | | **Terminated Drilling at 50.0-ft** | | | | | | | | |
| 51 | | | *The auger string utilized was changed* | | | | | | | | |
| 52 | | | *to Solid Stem at 30.0-ft due to the* | | | | | | | | |
| 53 | | | *boring encountering flowing sands.* | | | | | | | | |
| 54 | | | **Water Encountered at 23.0-ft** | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Clear, Windy, 57° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50289° | |
| | PROJECT # : 022240-00 | | | | W-97.40456° |
| 3 | DATE START : 11/29/2022 | FINISH : 11/30/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 15:15 | FINISH : 9:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

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*Standard Proctor (ASTM 698) Results for B3 0.5-15.0-ft:*
*Maximum Dry Density- 111.6 pcf*
*Optimum Moisture - 12.7%*

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | Dark Brown Clay | CH | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Light Brown Clay with Sand<br>*Unconfined Compressive Strength 4.37 psi* | CL | | | | | | | |
| 6 | | | Light Brown Clay with Sand | CL | 4-6-5<br>N=11 | Sample E | 11.2 | 23 | 12 | 11 | 85.0 |
| 7 | | | | | | | | | | | |
| 8 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | Light Brown Clay with Sand | CL | 3-2-2<br>N=4 | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | Brown Clay with Sand | CL | 1-4-4<br>N=8 | Sample F | 31.1 | 55 | 19 | 36 | 71.6 |
| 16 | | | | | | | | | | | |
| 17 | | | Brown Clay with Sand | CL | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | Reddish Brown Sandy Clay | CL | | | | | | | |
| 20 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 21 | | | Brown Clayey Sand | SC | 1-1-1<br>N=2 | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | Brown Clayey Sand | SC | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | Brown Clayey Sand | SC | | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | Brown Clayey Sand | SC | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Clear, Windy, 57° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50289° | |
| | PROJECT # : 022240-00 | | | | W-97.40456° |
| 3 | DATE START : 11/29/2022 | FINISH : 11/30/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 15:15 | FINISH : 9:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

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| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Brown Clayey Sand | SC | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Brown Clayey Sand | SC | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | | | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | Brown Sandstone | SC | | | | | | | |
| 41 | | | **Terminated Drilling at 41.0-ft** | | | | | | | | |
| 42 | | | **Auger Refusal Encountered** | | | | | | | | |
| 43 | | | *For the drill string utilized for this specific boring, auger refusal means the soils encountered at boring termination were of a consistency and density such that no signifcant advancement could be made without causing damage to the drill string.* | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | | | | | | | | | |
| 46 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | | | | | | | | | |
| 50 | | | | | | | | | | | |
| 51 | | | | | | | | | | | |
| 52 | | | | | | | | | | | |
| 53 | | | | | | | | | | | |
| 54 | | | | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Windy, Clear, 25° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.499844° | |
| | PROJECT # : 022240-00 | | | W-97.405915° | |
| 4 | DATE START : 11/30/2022 | FINISH : 11/30/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 9:45 | FINISH : 12:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

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2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Dark Brown Clay | CH | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Light Brown Silty Sand | SM | 7-7-7 N=14 | Sample G | 9.0 | 18 | 16 | 2 | 45.9 |
| 6 | | | | | | | | | | | |
| 7 | | | Light Brown Silty Sand | SM | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | *Shelby Tube Collected Sample Unable to be Tested* | | | | | | | | |
| 11 | | | Light Brown Silty Sand | SM | 6-8-9 N=17 | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | Light Brown Silty Sand | SM | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | Light Brown Silty Sand | SM | 4-4-5 N=9 | | | | | | |
| 16 | | | | | | | | | | | |
| 17 | | | Light Brown Silty Sand | SM | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | White Brown Sand | SP | | | | | | | |
| 20 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 21 | | | White Brown Sand | SP | 5-3-7 N=10 | | | | | | |
| 22 | | | White Brown Sand | SP | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | Light Brown Sand | SP | | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

| Boring | CLIENT : Plummer | | | | WEATHER : Windy, Clear, 25° | |
|---|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | | LOCATION : N 35.499844° | |
| | PROJECT # : 022240-00 | | | | | W-97.405915° |
| 4 | DATE START : 11/30/2022 | FINISH : | 11/30/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 9:45 | FINISH : | 12:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : | CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
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| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Light Brown Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Light Brown Sand | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | Red/Brown Shale | CL | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | Red/Brown Shale | CL | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | Red/Brown Shale | CL | | | | | | | |
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | Red/Brown Shale | CL | | | | | | | |
| 50 | | | **Terminated Drilling at 50.0-ft** | | | | | | | | |
| 51 | | | *The auger string utilized was changed* | | | | | | | | |
| 52 | | | *to Solid Stem at 25.0-ft due to the* | | | | | | | | |
| 53 | | | *boring encountering flowing sands.* | | | | | | | | |
| 54 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Clear, Windy, 48° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.49871° | |
| | PROJECT # : 022240-00 | | | | W-97.40603° |
| 5 | DATE START : 11/30/2022 | FINISH : 12/1/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 16:00 | FINISH : 9:00 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Dark Brown Clay | CH | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Light Brown Silty Sand<br>*Unconfined Compressive Strength 7.64 psi* | SM | | | | | | | |
| 6 | | | Light Brown Silty Sand | SM | 3-4-6<br>N=10 | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | Light Brown Silty Sand | SM | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | Light Brown Silty Sand | SM | 5-6-6<br>N=12 | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | Light Brown Silty Sand | SM | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | Light Brown Silty Sand | SM | 3-4-4<br>N=8 | Sample H | 5.6 | NP | NP | NP | 19.2 |
| 16 | | | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | Light Brown Silty Sand | SM | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 21 | | | Light Brown Sand | SP | 1-1-2<br>N=3 | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | Light Brown Sand | SP | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | Light Brown Sand | SP | 2-5-7<br>N=12 | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | Light Brown Sand | SP | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

*Standard Proctor (ASTM 698) Results for B5 5.0-15.0-ft:*

*Maximum Dry Density- 109.9 pcf*
*Optimum Moisture - 12.4%*

| Boring | CLIENT : Plummer | | | WEATHER : Clear, Windy, 48° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.49871° | |
| | PROJECT # : 022240-00 | | | W-97.40603° | |
| 5 | DATE START : 11/30/2022 | FINISH : 12/1/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 16:00 | FINISH : 9:00 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Light Brown Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Light Brown Sand | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | Red Shale | CL | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | Red Shale | CL | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | Red Shale | CL | | | | | | | |
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | Red Shale | CL | | | | | | | |
| 50 | | | **Terminated Drilling at 50.0-ft** | | | | | | | | |
| 51 | | | *The auger string utilized was changed* | | | | | | | | |
| 52 | | | *to Solid Stem at 30.0-ft due to the* | | | | | | | | |
| 53 | | | *boring encountering flowing sands.* | | | | | | | | |
| 54 | | | **Water Encountered at 20.0-ft** | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Cloudy, Windy, 45° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50399° | |
| | PROJECT # : 022240-00 | | | | W-97.40217° |
| 6 | DATE START : 12/1/2022 | FINISH : 12/1/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 13:35 | FINISH : 17:45 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Light Brown Sandy Clay | CH | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Light Brown Sandy Clay | CH | 4-5-6 N=11 | Sample I | 29.5 | 64 | 21 | 43 | 52.9 |
| 6 | | | | | | | | | | | |
| 7 | | | Light Brown Sandy Clay | CH | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | Light Brown Silty Sand<br>*Unconfined Compressive Strength 5.60 psi* | SM | | | | | | | |
| 11 | | | Light Brown Silty Sand | SM | 4-4-5 N=9 | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | Light Brown Silty Sand | SM | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | Light Brown Silty Sand | SM | 3-6-5 N=11 | | | | | | |
| 16 | | | | | | | | | | | |
| 17 | | | **Water Encountered at 17.0-ft** | | | | | | | | |
| 18 | | | Light Brown Sand | SP | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | Light Brown Sand | SP | 2-3-5 N=8 | | | | | | |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | Light Brown Sand | SP | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | Light Brown Sand | SP | 1-4-5 N=9 | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | | | | | | | | | |
| 29 | | | Light Brown Sand | SP | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Cloudy, Windy, 45° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50399° | |
| | PROJECT # : 022240-00 | | | W-97.40217° | |
| 6 | DATE START : 12/1/2022 | FINISH : 12/1/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 13:35 | FINISH : 17:45 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Light Brown Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Light Brown Sand | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | Red Shale | CL | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | Red Shale | CL | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | Red Shale | CL | | | | | | | |
| 45 | | | | | | | | | | | |
| 46 | | | **Terminated Drilling at 45.0-ft** | | | | | | | | |
| 47 | | | **Auger Refusal Encountered** | | | | | | | | |
| 48 | | | *For the drill string utilized for this specific boring, auger refusal means the soils encountered at boring termination were of a consistency and density such that no signifcant advancement could be made without causing damage to the drill string. The auger string utilized was changed to Solid Stem at 30.0-ft due to the boring encountering flowing sands.* | | | | | | | | |
| 49 | | | | | | | | | | | |
| 50 | | | | | | | | | | | |
| 51 | | | **Water Encountered at 17.0-ft** | | | | | | | | |
| 52 | | | | | | | | | | | |
| 53 | | | | | | | | | | | |
| 54 | | | | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Windy, Clear, 63° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50233° | |
| | PROJECT # : 022240-00 | | | | W-97.40133° |
| 7 | DATE START : 11/29/2022 | FINISH : 11/29/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 11:30 | FINISH : 15:00 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

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2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | Dark Brown Clay | CH | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Brown Clay | CL | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Brown Clay<br>*Unconfined Compressive Strength 29.01 psi* | CL | | | | | | | |
| 6 | | | Brown Clay | CL | 6-8-8<br>N=16 | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | Brown Clay | CL | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | Light Brown Clay with Sand | CL | 3-3-4<br>N=7 | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | **Water Encountered at 15.0-ft** | | | | | | | | |
| 16 | | | Light Brown Clay with Sand | CL | 1-1-2<br>N=3 | Sample J | 24.5 | 24 | 11 | 13 | 82.4 |
| 17 | | | | | | | | | | | |
| 18 | | | Light Brown Clay with Sand | CL | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | Light Brown Silty Sand | SM | 15-16-11<br>N=27 | Sample K | 16.3 | NP | NP | NP | 15.6 |
| 21 | | | | | | | | | | | |
| 22 | | | Light Brown Silty Sand | SM | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | Light Brown Sand | SP | 2-4-9<br>N=13 | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | Light Brown Sand | SP | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Windy, Clear, 63° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50233° | |
| | PROJECT # : 022240-00 | | | | W-97.40133° |
| 7 | DATE START : 11/29/2022 | FINISH : 11/29/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 11:30 | FINISH : 15:00 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Light Brown Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Light Brown Sand | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | | | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | Light Brown Sand | SP | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | Reddish Brown Shale | CL | | | | | | | |
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | | | | | | | | | |
| 49 | | | Reddish Brown Shale | CL | | | | | | | |
| 50 | | | **Terminated Drilling at 50.0-ft** | | | | | | | | |
| 51 | | | *The auger string utilized was changed* | | | | | | | | |
| 52 | | | *to Solid Stem at 26.5-ft due to the* | | | | | | | | |
| 53 | | | *boring encountering flowing sands.* | | | | | | | | |
| 54 | | | **Water Encountered at 15.0-ft** | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

| Boring | CLIENT : Plummer | | | WEATHER : Clear, Windy, 40° | |
|---|---|---|---|---|---|
| | PROJECT : Midwest City Waterline | | | LOCATION : N 35.50422° | |
| | PROJECT # : 022240-00 | | | | W-97.39967° |
| 8 | DATE START : 11/30/2022 | FINISH : 11/30/2022 | | LOGGED BY : J. Blankenship | |
| | TIME START : 13:00 | FINISH : 15:30 | | DRILLED BY : TJ Horner | |
| | AUGER SIZE : 6-in HS & 5-in SS | RIG ID : CME 75 | | METHOD : Rotary | |

ENVIROTECH ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| 2 | | | Reddish Brown Sandy Clay | CL | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | Reddish Brown Sandy Clay | CL | 3-3-4 N=7 | Sample L | 11.8 | 22 | 13 | 9 | 53.1 |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | Red Sand with Silt | SP-SM | | Sample M | 3.9 | NP | NP | NP | 8.8 |
| 9 | | | | | | | | | | | |
| 10 | | | *Shelby Tube Collected Sample Unable to be Tested* | | | | | | | | |
| 11 | | | Red Sand with Silt | SP-SM | 27-Ref | Sample M | 3.9 | NP | NP | NP | 8.8 |
| 12 | | | *Refusal Encountered, 10 Blows with No Advancement* | | | | | | | | |
| 13 | | | Red Sand with Silt | SP-SM | | Sample M | 3.9 | NP | NP | NP | 8.8 |
| 14 | | | | | | | | | | | |
| 15 | | | Red Sand with Silt | SP-SM | 17-Ref | Sample M | 3.9 | NP | NP | NP | 8.8 |
| 16 | | | *Refusal Encountered, 10 Blows with No Advancement* | | | | | | | | |
| 17 | | | Red Sand with Silt | SP-SM | | Sample M | 3.9 | NP | NP | NP | 8.8 |
| 18 | | | **Water Encountered at 18.5-ft** | | | | | | | | |
| 19 | | | Red Sand | SP | | | | | | | |
| 20 | | | Red Sand | SP | 10-Ref | | | | | | |
| 21 | | | *Refusal Encountered, 10 Blows with No Advancement* | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | Red Sand | SP | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | Red Sand | SP | | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | | | | | | | | | |
| 29 | | | Red Sand | SP | | | | | | | |
| 30 | | | ***Continued on Next Page*** | | | | | | | | |

*Standard Proctor (ASTM 698) Results for B8 0-8.0-ft:*

*Maximum Dry Density- 119.1 pcf*
*Optimum Moisture - 10.4%*

| Boring | CLIENT : Plummer | WEATHER : Clear, Windy, 40° |
|---|---|---|
| | PROJECT : Midwest City Waterline | LOCATION : N 35.50422° |
| | PROJECT # : 022240-00 | W-97.39967° |
| 8 | DATE START : 11/30/2022 FINISH : 11/30/2022 | LOGGED BY : J. Blankenship |
| | TIME START : 13:00 FINISH : 15:30 | DRILLED BY : TJ Horner |
| | AUGER SIZE : 6-in HS & 5-in SS RIG ID : CME 75 | METHOD : Rotary |

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| Depth (Ft.) | Sample Type | Soil Log | Visual Description | USCS | Field Results | Sample ID | Moisture (%) | LL | PL | PI | Passing 200 Sieve (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | | | | | | | | | |
| 31 | | | Red Sand | SP | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | Red Sand | SP | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | | | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | Red Sand | SP | | | | | | | |
| 41 | | | | | | | | | | | |
| 42 | | | | | | | | | | | |
| 43 | | | | | | | | | | | |
| 44 | | | | | | | | | | | |
| 45 | | | Red Sand | SP | | | | | | | |
| 46 | | | | | | | | | | | |
| 47 | | | | | | | | | | | |
| 48 | | | Red Shale | CL | | | | | | | |
| 49 | | | | | | | | | | | |
| 50 | | | **Terminated Drilling at 50.0-ft** | | | | | | | | |
| 51 | | | *The auger string utilized was changed* | | | | | | | | |
| 52 | | | *to Solid Stem at 25.0-ft due to* | | | | | | | | |
| 53 | | | *repeated Split Spoon Refusal.* | | | | | | | | |
| 54 | | | **Water Encountered at 18.5-ft** | | | | | | | | |
| 55 | | | | | | | | | | | |
| 56 | | | | | | | | | | | |
| 57 | | | | | | | | | | | |
| 58 | | | | | | | | | | | |
| 59 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |

# APPENDIX B.

## LABORATORY ANALYTICAL RESULTS

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample A, B1, 6-6.5-ft |
| Project: | 022240-00 | | | Sample Description: | Dark Brown Clay with Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 12/2/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 35.0% |

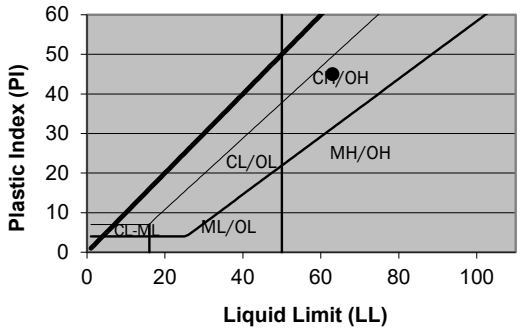
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 76.6% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | -8 | Spec |
| Liquid Limit | 63 | - |
| Plastic Limit | 18 | - |
| Plasticity Index | 45 | - |

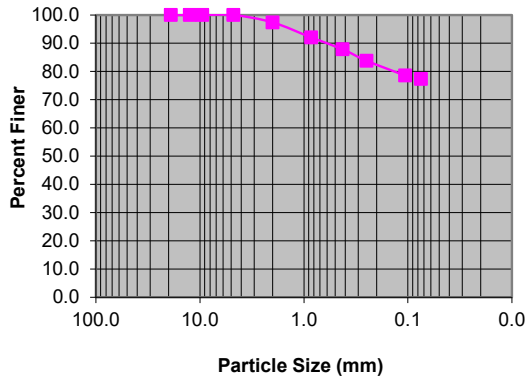
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 97.4 | - |
| No. 20 | 0.850 | 92.1 | - |
| No. 40 | 0.425 | 87.9 | - |
| No. 60 | 0.250 | 83.8 | - |
| No. 140 | 0.106 | 78.6 | - |
| No. 200 | 0.075 | 77.3 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**CH - Fat Clay with Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample B, B1, 15-16.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Sandy Clay |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 12/2/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 19.9% |

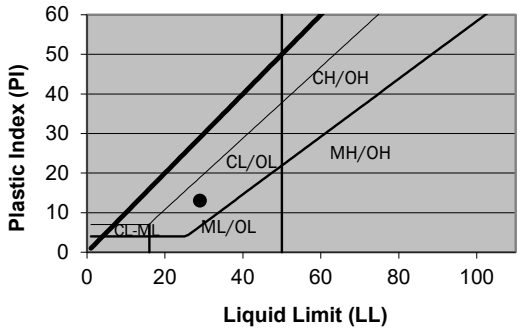
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 63.9% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | -4 | Spec |
| Liquid Limit | 29 | - |
| Plastic Limit | 16 | - |
| Plasticity Index | 13 | - |

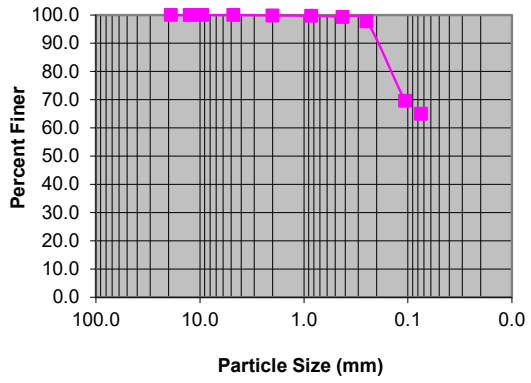
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 99.9 | - |
| No. 20 | 0.850 | 99.7 | - |
| No. 40 | 0.425 | 99.3 | - |
| No. 60 | 0.250 | 97.8 | - |
| No. 140 | 0.106 | 69.6 | - |
| No. 200 | 0.075 | 65.0 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**CL - Sandy Lean Clay**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample C, B2, 15-16.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Silty Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 12/1/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 9.1% |

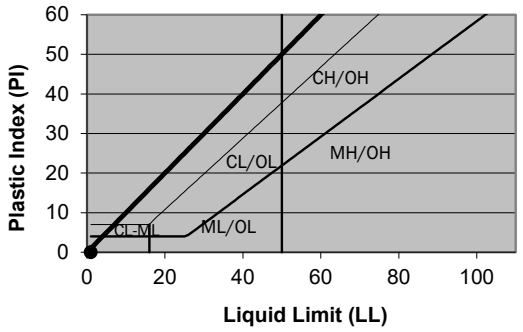
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 32.9% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | N/A | Spec |
| Liquid Limit | Non-Plastic | - |
| Plastic Limit | Non-Plastic | - |
| Plasticity Index | Non-Plastic | - |

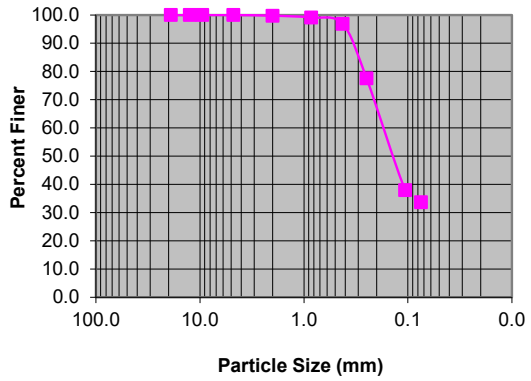
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 99.8 | - |
| No. 20 | 0.850 | 99.1 | - |
| No. 40 | 0.425 | 96.9 | - |
| No. 60 | 0.250 | 77.6 | - |
| No. 140 | 0.106 | 37.9 | - |
| No. 200 | 0.075 | 33.6 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**SM - Silty Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

## *Sample Information*

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample D, B2, 25-26.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 12/1/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

### Natural Moisture Content (ASTM D-2216)

| | |
|---|---|
| Natural Moisture | 14.9% |

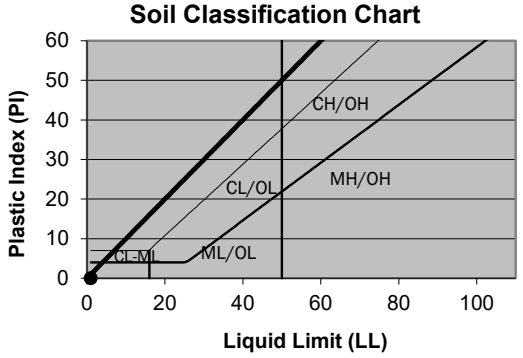
### % Passing No. 200 Sieve (ASTM D-1140)

| | |
|---|---|
| % passing No. 200 | 3.5% |

### Atterberg Limits Test Results (ASTM D-4318)

| | | |
|---|---|---|
| Flow Index | N/A | Spec |
| Liquid Limit | Non-Plastic | - |
| Plastic Limit | Non-Plastic | - |
| Plasticity Index | Non-Plastic | - |

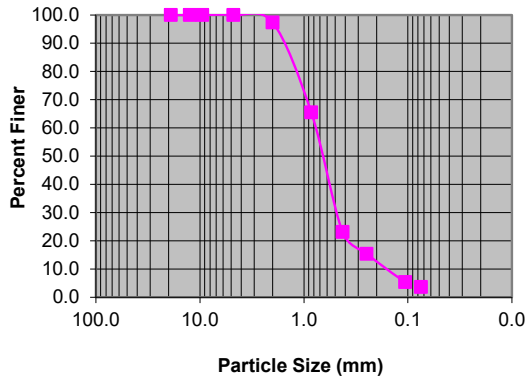
### Soil Classification Chart




### Particle Size Analysis (ASTM D-6913, C-136)

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 97.4 | - |
| No. 20 | 0.850 | 65.6 | - |
| No. 40 | 0.425 | 23.1 | - |
| No. 60 | 0.250 | 15.5 | - |
| No. 140 | 0.106 | 5.4 | - |
| No. 200 | 0.075 | 3.7 | - |
| Pan | 0.000 | 0.0 | - |

### Grain Size Analysis




### Cumulative Particle-Size Distribution (ASTM D-2487)

| | |
|---|---|
| Cu | 4.59 |
| Cc | 1.74 |

### Unified Soil Classification (ASTM D-2487)

**SP - Poorly Graded Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

## *Sample Information*

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample E, B3, 6-7.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Clay with Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/29/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

### Natural Moisture Content (ASTM D-2216)

| | |
|---|---|
| Natural Moisture | 11.2% |

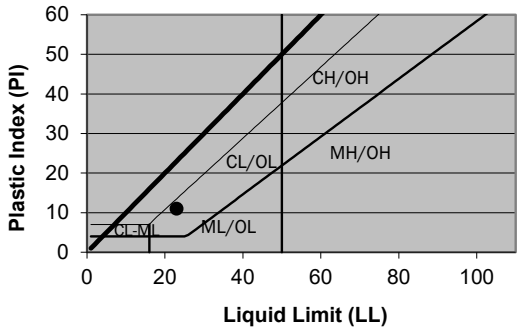
### % Passing No. 200 Sieve (ASTM D-1140)

| | |
|---|---|
| % passing No. 200 | 82.0% |

### Atterberg Limits Test Results (ASTM D-4318)

| | | |
|---|---|---|
| Flow Index | -2 | Spec |
| Liquid Limit | 23 | - |
| Plastic Limit | 12 | - |
| Plasticity Index | 11 | - |

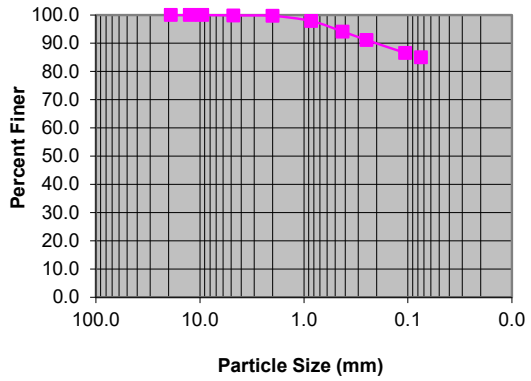
### Soil Classification Chart




### Particle Size Analysis (ASTM D-6913, C-136)

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 99.9 | - |
| No. 10 | 2.000 | 99.7 | - |
| No. 20 | 0.850 | 97.9 | - |
| No. 40 | 0.425 | 94.2 | - |
| No. 60 | 0.250 | 91.2 | - |
| No. 140 | 0.106 | 86.6 | - |
| No. 200 | 0.075 | 85.0 | - |
| Pan | 0.000 | 0.0 | - |

### Grain Size Analysis




### Cumulative Particle-Size Distribution (ASTM D-2487)

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

### Unified Soil Classification (ASTM D-2487)

**CL - Lean Clay with Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

## *Sample Information*

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample F, B3, 15-16.5-ft |
| Project: | 022240-00 | | | Sample Description: | Brown Clay with Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/29/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

### Natural Moisture Content (ASTM D-2216)

| | |
|---|---|
| Natural Moisture | 31.1% |

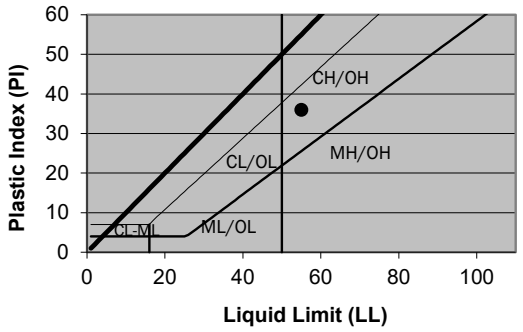
### % Passing No. 200 Sieve (ASTM D-1140)

| | |
|---|---|
| % passing No. 200 | 71.4% |

### Atterberg Limits Test Results (ASTM D-4318)

| | | |
|---|---|---|
| Flow Index | -4 | Spec |
| Liquid Limit | 55 | - |
| Plastic Limit | 19 | - |
| Plasticity Index | 36 | - |

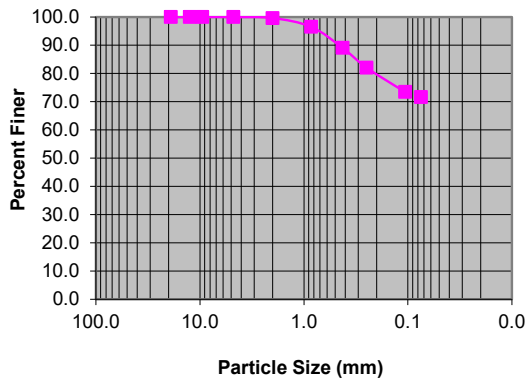
### Soil Classification Chart




### Particle Size Analysis (ASTM D-6913, C-136)

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 99.6 | - |
| No. 20 | 0.850 | 96.5 | - |
| No. 40 | 0.425 | 89.1 | - |
| No. 60 | 0.250 | 82.1 | - |
| No. 140 | 0.106 | 73.5 | - |
| No. 200 | 0.075 | 71.6 | - |
| Pan | 0.000 | 0.0 | - |

### Grain Size Analysis




### Cumulative Particle-Size Distribution (ASTM D-2487)

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

### Unified Soil Classification (ASTM D-2487)

**CH - Fat Clay with Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

## *Sample Information*

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample G, B4, 5-6.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Silty Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/30/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

### Natural Moisture Content (ASTM D-2216)

| | |
|---|---|
| Natural Moisture | 9.0% |

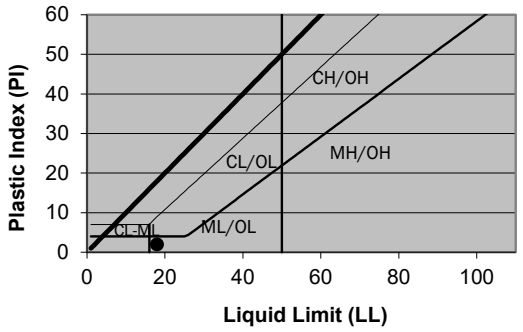
### % Passing No. 200 Sieve (ASTM D-1140)

| | |
|---|---|
| % passing No. 200 | 45.3% |

### Atterberg Limits Test Results (ASTM D-4318)

| | | |
|---|---|---|
| Flow Index | -7 | Spec |
| Liquid Limit | 18 | - |
| Plastic Limit | 16 | - |
| Plasticity Index | 2 | - |

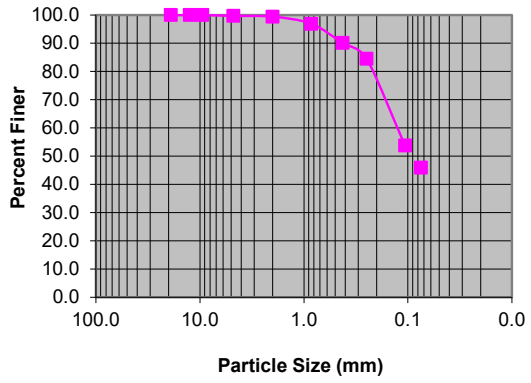
### Soil Classification Chart




### Particle Size Analysis (ASTM D-6913, C-136)

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 99.7 | - |
| No. 10 | 2.000 | 99.4 | - |
| No. 20 | 0.850 | 96.9 | - |
| No. 40 | 0.425 | 90.1 | - |
| No. 60 | 0.250 | 84.6 | - |
| No. 140 | 0.106 | 53.8 | - |
| No. 200 | 0.075 | 45.9 | - |
| Pan | 0.000 | 0.0 | - |

### Grain Size Analysis




### Cumulative Particle-Size Distribution (ASTM D-2487)

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

### Unified Soil Classification (ASTM D-2487)

**SM - Silty Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample H, B5, 15-16.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Silty Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/30/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 5.6% |

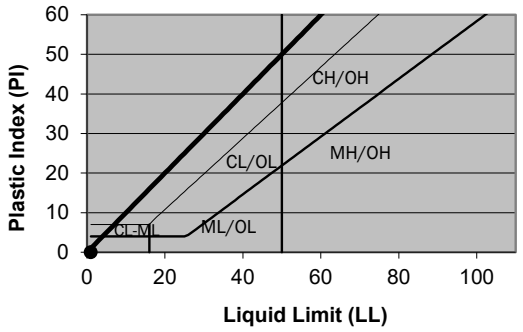
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 17.3% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | N/A | Spec |
| Liquid Limit | Non-Plastic | - |
| Plastic Limit | Non-Plastic | - |
| Plasticity Index | Non-Plastic | - |

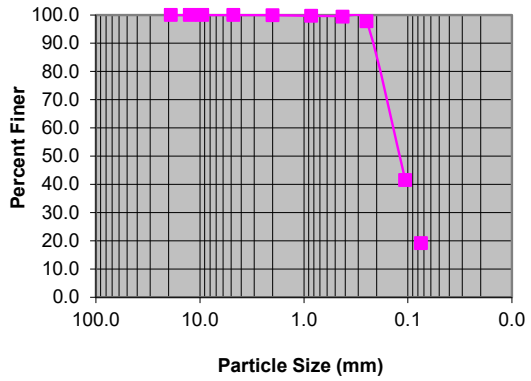
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 100.0 | - |
| No. 20 | 0.850 | 99.7 | - |
| No. 40 | 0.425 | 99.5 | - |
| No. 60 | 0.250 | 97.8 | - |
| No. 140 | 0.106 | 41.5 | - |
| No. 200 | 0.075 | 19.2 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**SM - Silty Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

## *Sample Information*

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample I, B6, 5-6.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Sandy Clay |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 12/1/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

### Natural Moisture Content (ASTM D-2216)

| | |
|---|---|
| Natural Moisture | 29.5% |

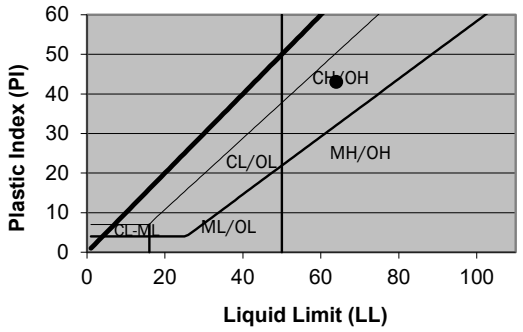
### % Passing No. 200 Sieve (ASTM D-1140)

| | |
|---|---|
| % passing No. 200 | 52.6% |

### Atterberg Limits Test Results (ASTM D-4318)

| | | |
|---|---|---|
| Flow Index | -11 | Spec |
| Liquid Limit | 64 | - |
| Plastic Limit | 21 | - |
| Plasticity Index | 43 | - |

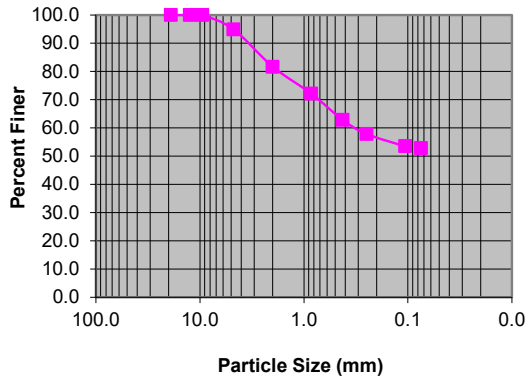
### Soil Classification Chart




### Particle Size Analysis (ASTM D-6913, C-136)

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 95.0 | - |
| No. 10 | 2.000 | 81.7 | - |
| No. 20 | 0.850 | 72.2 | - |
| No. 40 | 0.425 | 62.9 | - |
| No. 60 | 0.250 | 57.9 | - |
| No. 140 | 0.106 | 53.6 | - |
| No. 200 | 0.075 | 52.9 | - |
| Pan | 0.000 | 0.0 | - |

### Grain Size Analysis




### Cumulative Particle-Size Distribution (ASTM D-2487)

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

### Unified Soil Classification (ASTM D-2487)

**CH - Sandy Fat Clay**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample J, B7, 15-16.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Clay with Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/29/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 24.5% |

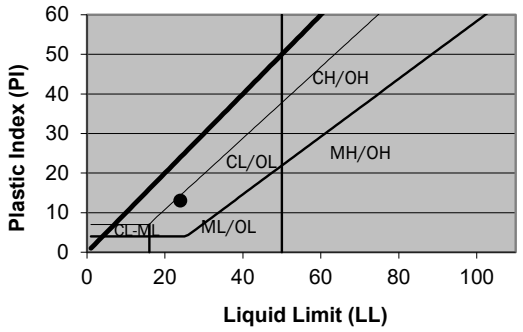
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 81.1% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | -2 | Spec |
| Liquid Limit | 24 | - |
| Plastic Limit | 11 | - |
| Plasticity Index | 13 | - |

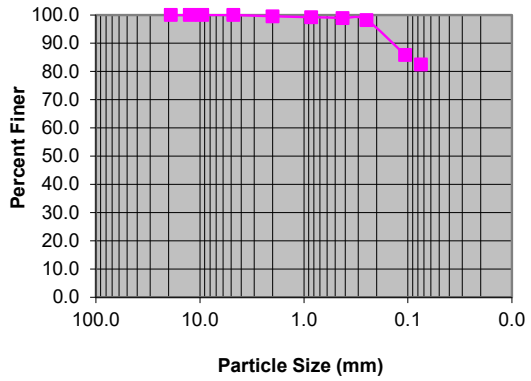
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 99.6 | - |
| No. 20 | 0.850 | 99.2 | - |
| No. 40 | 0.425 | 99.0 | - |
| No. 60 | 0.250 | 98.2 | - |
| No. 140 | 0.106 | 85.9 | - |
| No. 200 | 0.075 | 82.4 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**CL - Lean Clay with Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample K, B7, 20-21.5-ft |
| Project: | 022240-00 | | | Sample Description: | Light Brown Silty Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/29/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 16.3% |

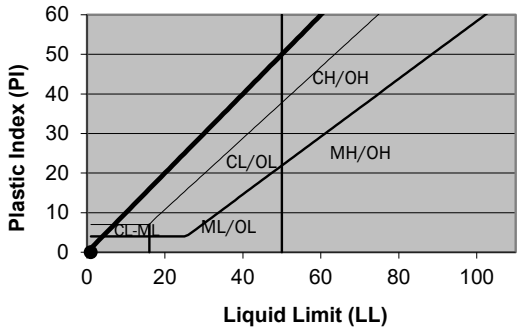
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 15.3% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | N/A | Spec |
| Liquid Limit | Non-Plastic | - |
| Plastic Limit | Non-Plastic | - |
| Plasticity Index | Non-Plastic | - |

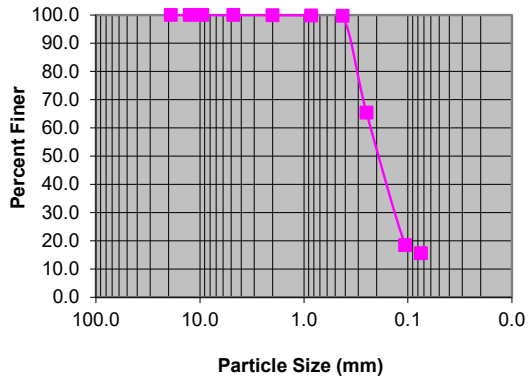
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 100.0 | - |
| No. 20 | 0.850 | 99.9 | - |
| No. 40 | 0.425 | 99.7 | - |
| No. 60 | 0.250 | 65.4 | - |
| No. 140 | 0.106 | 18.5 | - |
| No. 200 | 0.075 | 15.6 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**SM - Silty Sand**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample L, B8, 5-6.5-ft |
| Project: | 022240-00 | | | Sample Description: | Reddish Brown Sandy Clay |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/30/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Natural Moisture Content (ASTM D-2216)**

| | |
|---|---|
| Natural Moisture | 11.8% |

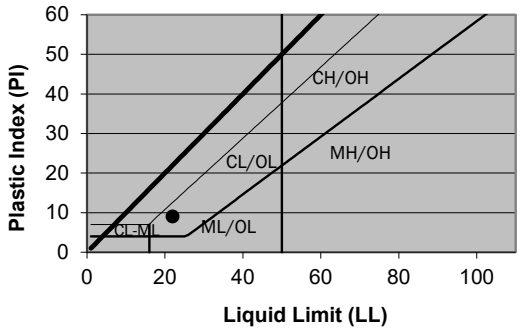
**% Passing No. 200 Sieve (ASTM D-1140)**

| | |
|---|---|
| % passing No. 200 | 52.4% |

**Atterberg Limits Test Results (ASTM D-4318)**

| | | |
|---|---|---|
| Flow Index | -2 | Spec |
| Liquid Limit | 22 | - |
| Plastic Limit | 13 | - |
| Plasticity Index | 9 | - |

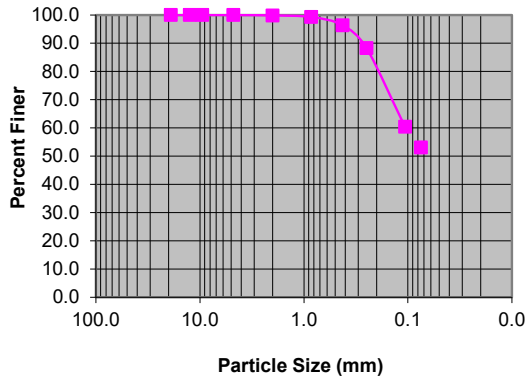
**Soil Classification Chart**




**Particle Size Analysis (ASTM D-6913, C-136)**

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 99.9 | - |
| No. 20 | 0.850 | 99.3 | - |
| No. 40 | 0.425 | 96.4 | - |
| No. 60 | 0.250 | 88.3 | - |
| No. 140 | 0.106 | 60.4 | - |
| No. 200 | 0.075 | 53.1 | - |
| Pan | 0.000 | 0.0 | - |

**Grain Size Analysis**




**Cumulative Particle-Size Distribution (ASTM D-2487)**

| | |
|---|---|
| Cu | N/A |
| Cc | N/A |

**Unified Soil Classification (ASTM D-2487)**

**CL - Sandy Lean Clay**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Classification of Soils (USCS)

(ASTM D-2487)

ENVIROTECH
ENGINEERING
2500 N. 11th Street I Enid, OK 73701
(580) 234-8780 I Fax (580) 237-4302

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

## *Sample Information*

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | Sample M, B8, 8-18.5-ft |
| Project: | 022240-00 | | | Sample Description: | Red Sand with Silt |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/30/2022 |
| Tested By: | SA/CC/RC/JB/CL | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

### Natural Moisture Content (ASTM D-2216)

| | |
|---|---|
| Natural Moisture | 3.9% |

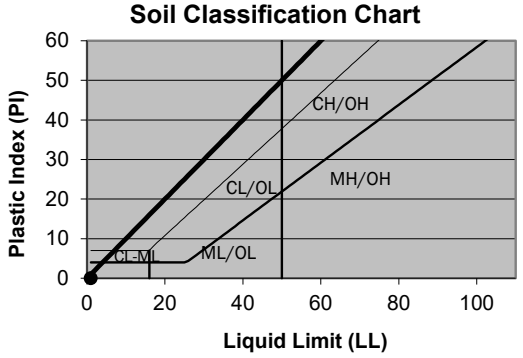
### % Passing No. 200 Sieve (ASTM D-1140)

| | |
|---|---|
| % passing No. 200 | 8.3% |

### Atterberg Limits Test Results (ASTM D-4318)

| | | |
|---|---|---|
| Flow Index | N/A | Spec |
| Liquid Limit | Non-Plastic | - |
| Plastic Limit | Non-Plastic | - |
| Plasticity Index | Non-Plastic | - |

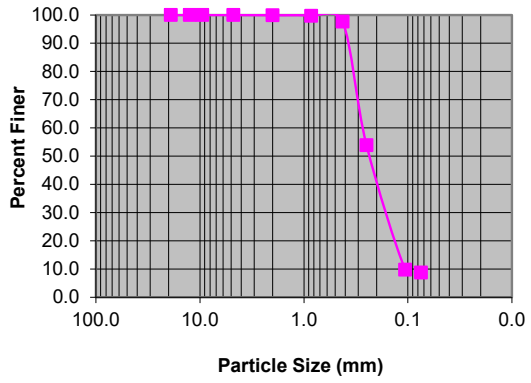
### Soil Classification Chart




### Particle Size Analysis (ASTM D-6913, C-136)

| Sieve No | Sieve Opening | % Passing | Spec |
|---|---|---|---|
| 3/4 | 19.000 | 100.0 | - |
| 1/2 | 12.500 | 100.0 | - |
| 3/8 | 9.500 | 100.0 | - |
| No. 4 | 4.750 | 100.0 | - |
| No. 10 | 2.000 | 99.9 | - |
| No. 20 | 0.850 | 99.7 | - |
| No. 40 | 0.425 | 97.7 | - |
| No. 60 | 0.250 | 53.9 | - |
| No. 140 | 0.106 | 9.8 | - |
| No. 200 | 0.075 | 8.8 | - |
| Pan | 0.000 | 0.0 | - |

### Grain Size Analysis




### Cumulative Particle-Size Distribution (ASTM D-2487)

| | |
|---|---|
| Cu | 2.55 |
| Cc | 0.94 |

### Unified Soil Classification (ASTM D-2487)

**SP-SM - Poorly Graded Sand with Silt**

Deviations from ASTM:

Envirotech - Project Manager

12/8/2022

Date

# Standard Proctor

(ASTM D-698 / AASHTO T-99) Manual Rammer

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

**Client:** Plummer

**Address:** 531 Couch Dr, Ste 200, OKC, OK 73102

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B1, 0-6.5-ft |
| Project: | 022240-00 | | | Sample Desc: | Dark Brown Clay with Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 12/2/2022 |
| Tested By: | C. Lunday | Date: | 12/7/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Sample Preparation:**

| | | |
|---|---|---|
| Unified Soils Classification System Symbol per ASTM D-2488 | CH | Classification Symbol |
| Method of Soil Preparation | Dry | Wet Prep or Dry Prep |
| Percent Retained on the No. 4 Sieve | 0 | % Retained |
| Percent Retained on the 3/8-in. Sieve | | % Retained |
| Percent Retained on the 3/4-in. Sieve | | % Retained |
| Was Percent Retained Estimated or Tested Per ASTM C-136 | Estimated | Estimated / Tested |
| Manual Rammer Utilized | 831 | ID Number |
| Scale Utilized | 1112 / 1308 | ID Number |
| Testing Method Utilized Per paragraph 1.3 | A | Method A, B or C |

**DENSITY DATA** (lbs)

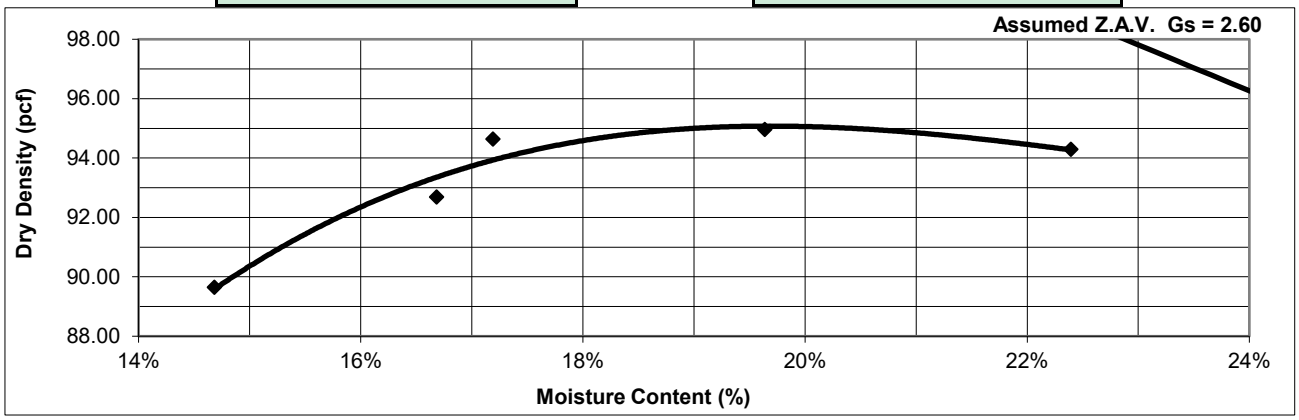
| **Mold No.** | 841 | **Mold Volume:** | 0.03334 | **Mold Calibration Date:** | 6/2/2022 |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Mold + Wet Soil | 13.11 | 13.29 | 13.38 | 13.47 | 13.53 | |
| Mold Wt. | 9.69 | 9.69 | 9.69 | 9.69 | 9.69 | |
| Wet Soil | 3.43 | 3.61 | 3.70 | 3.79 | 3.85 | |
| lbs/cu. ft. (wet) | 102.81 | 108.15 | 110.91 | 113.61 | 115.41 | |
| lbs/cu. ft. (dry) | 89.65 | 92.69 | 94.64 | 94.96 | 94.29 | |

**MOISTURE DATA** (grams)

| | | | | | | |
|---|---|---|---|---|---|---|
| Tin No. | M36 | M110 | M22 | B511 | M120 | |
| Wet Soil + Tin | 249.86 | 193.01 | 159.76 | 161.30 | 172.40 | |
| Dry Soil + Tin | 224.38 | 172.56 | 143.66 | 143.10 | 149.97 | |
| Tin Wt. | 50.85 | 49.98 | 50.00 | 50.42 | 49.80 | |
| Dry Soil | 173.53 | 122.58 | 93.66 | 92.68 | 100.17 | |
| % Moisture | 14.7% | 16.7% | 17.2% | 19.6% | 22.4% | |

| **MAXIMUM DRY DENSITY (PCF)** | **OPTIMUM MOISTURE CONTENT (%)** |
|---|---|
| **95.1** | **19.6%** |




**Envirotech - Project Manager**

**12/8/2022**
**Date**

Revision 7 - 12/2022

# Standard Proctor

(ASTM D-698 / AASHTO T-99) Manual Rammer

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

**Client:** Plummer

**Address:** 531 Couch Dr, Ste 200, OKC, OK 73102

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B3, 0.5-15-ft |
| Project: | 022240-00 | | | Sample Desc: | Light Brown Clay with Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/29/2022 |
| Tested By: | CL/JB | Date: | 12/6/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Sample Preparation:**

| | | |
|---|---|---|
| Unified Soils Classification System Symbol per ASTM D-2488 | CL | Classification Symbol |
| Method of Soil Preparation | Dry | Wet Prep or Dry Prep |
| Percent Retained on the No. 4 Sieve | 1 | % Retained |
| Percent Retained on the 3/8-in. Sieve | | % Retained |
| Percent Retained on the 3/4-in. Sieve | | % Retained |
| Was Percent Retained Estimated or Tested Per ASTM C-136 | Estimated | Estimated / Tested |
| Manual Rammer Utilized | 831 | ID Number |
| Scale Utilized | 1112 / 1308 | ID Number |
| Testing Method Utilized Per paragraph 1.3 | A | Method A, B or C |

**DENSITY DATA** (lbs)

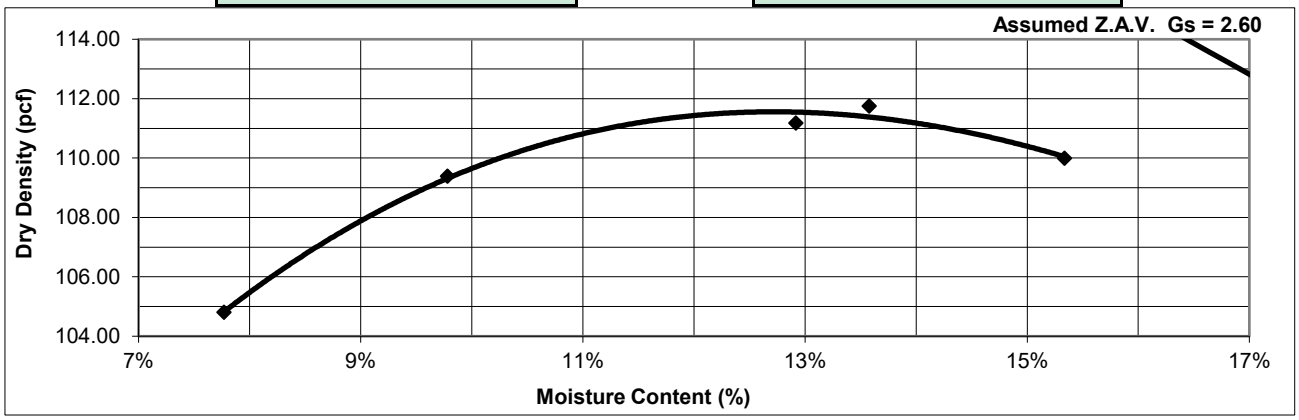
| **Mold No.** | 841 | **Mold Volume:** | 0.03334 | **Mold Calibration Date:** | 6/2/2022 |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Mold + Wet Soil | 13.46 | 13.69 | 13.88 | 13.92 | 13.92 | |
| Mold Wt. | 9.69 | 9.69 | 9.69 | 9.69 | 9.69 | |
| Wet Soil | 3.77 | 4.00 | 4.19 | 4.23 | 4.23 | |
| lbs/cu. ft. (wet) | 112.95 | 120.09 | 125.54 | 126.92 | 126.86 | |
| lbs/cu. ft. (dry) | 104.80 | 109.39 | 111.18 | 111.75 | 109.99 | |

**MOISTURE DATA** (grams)

| Tin No. | M45 | M63 | M166 | M20 | M18 | |
|---|---|---|---|---|---|---|
| Wet Soil + Tin | 220.54 | 253.30 | 178.43 | 205.17 | 188.40 | |
| Dry Soil + Tin | 208.22 | 235.17 | 163.74 | 186.60 | 170.03 | |
| Tin Wt. | 49.66 | 49.82 | 50.01 | 49.82 | 50.25 | |
| Dry Soil | 158.56 | 185.35 | 113.73 | 136.78 | 119.78 | |
| % Moisture | 7.8% | 9.8% | 12.9% | 13.6% | 15.3% | |

| **MAXIMUM DRY DENSITY (PCF)** | **OPTIMUM MOISTURE CONTENT (%)** |
|---|---|
| **111.6** | **12.7%** |




**Envirotech - Project Manager**

**12/8/2022**
**Date**

# Standard Proctor

(ASTM D-698 / AASHTO T-99) Manual Rammer

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

**Client:** Plummer

**Address:** 531 Couch Dr, Ste 200, OKC, OK 73102

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B5, 5-15-ft |
| Project: | 022240-00 | | | Sample Desc: | Light Brown Silty Sand |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/30/2022 |
| Tested By: | J. Blankenship | Date: | 12/6/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Sample Preparation:**

| | | |
|---|---|---|
| Unified Soils Classification System Symbol per ASTM D-2488 | SM | Classification Symbol |
| Method of Soil Preparation | Dry | Wet Prep or Dry Prep |
| Percent Retained on the No. 4 Sieve | 0 | % Retained |
| Percent Retained on the 3/8-in. Sieve | | % Retained |
| Percent Retained on the 3/4-in. Sieve | | % Retained |
| Was Percent Retained Estimated or Tested Per ASTM C-136 | Estimated | Estimated / Tested |
| Manual Rammer Utilized | 831 | ID Number |
| Scale Utilized | 1112 / 1308 | ID Number |
| Testing Method Utilized Per paragraph 1.3 | A | Method A, B or C |

**DENSITY DATA** (lbs)

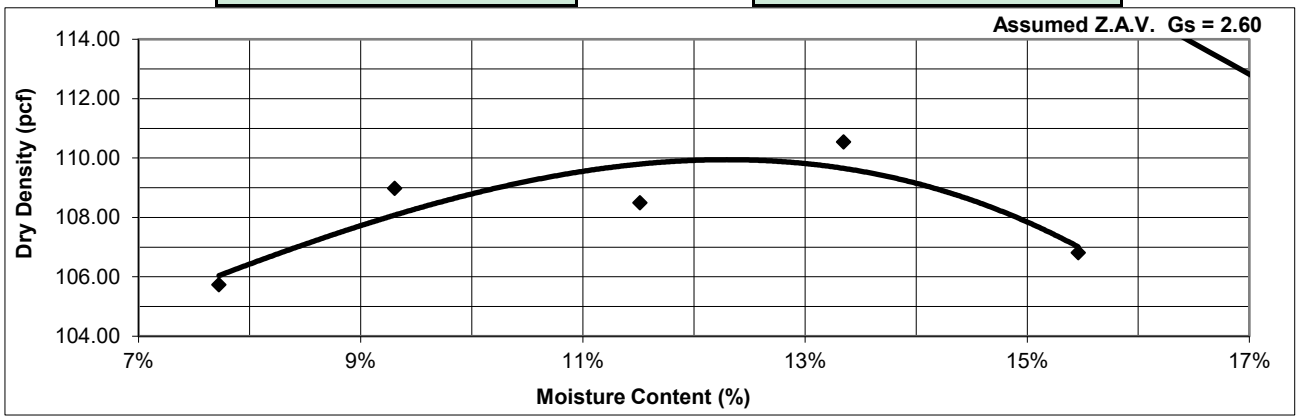
| **Mold No.** | 841 | **Mold Volume:** | 0.03334 | **Mold Calibration Date:** | 6/2/2022 |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Mold + Wet Soil | 13.36 | 13.49 | 13.66 | 13.72 | 13.87 | 13.80 |
| Mold Wt. | 9.69 | 9.69 | 9.69 | 9.69 | 9.69 | 9.69 |
| Wet Soil | 3.67 | 3.80 | 3.97 | 4.03 | 4.18 | 4.11 |
| lbs/cu. ft. (wet) | 110.01 | 113.91 | 119.13 | 120.98 | 125.30 | 123.32 |
| lbs/cu. ft. (dry) | 104.37 | 105.74 | 108.99 | 108.49 | 110.55 | 106.81 |

**MOISTURE DATA** (grams)

| Tin No. | M32 | M3 | M8 | M48 | M14 | M35 |
|---|---|---|---|---|---|---|
| Wet Soil + Tin | 159.30 | 189.06 | 170.87 | 215.14 | 221.55 | 217.74 |
| Dry Soil + Tin | 153.73 | 179.12 | 160.56 | 198.10 | 201.34 | 195.24 |
| Tin Wt. | 50.59 | 50.43 | 49.75 | 50.09 | 49.93 | 49.70 |
| Dry Soil | 103.14 | 128.69 | 110.81 | 148.01 | 151.41 | 145.54 |
| % Moisture | 5.4% | 7.7% | 9.3% | 11.5% | 13.3% | 15.5% |

| **MAXIMUM DRY DENSITY (PCF)** | **OPTIMUM MOISTURE CONTENT (%)** |
|---|---|
| **109.9** | **12.4%** |




**Envirotech - Project Manager**

**12/8/2022**
**Date**

Revision 7 - 12/2022

# Standard Proctor

(ASTM D-698 / AASHTO T-99) Manual Rammer

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B8, 0-8-ft |
| Project: | 022240-00 | | | Sample Desc: | Reddish Brown Sandy Clay |
| Project Location: | Midwest City Waterline | | | Sampling Date: | 11/30/2022 |
| Tested By: | J. Blankenship | Date: | 12/7/2022 | Sampled By: | TJ Horner |
| Reviewed By: | T. Williams | Date: | 12/8/2022 | Date Received: | 12/2/2022 |

**Sample Preparation:**

| | | |
|---|---|---|
| Unified Soils Classification System Symbol per ASTM D-2488 | CL | Classification Symbol |
| Method of Soil Preparation | Dry | Wet Prep or Dry Prep |
| Percent Retained on the No. 4 Sieve | 0 | % Retained |
| Percent Retained on the 3/8-in. Sieve | | % Retained |
| Percent Retained on the 3/4-in. Sieve | | % Retained |
| Was Percent Retained Estimated or Tested Per ASTM C-136 | Estimated | Estimated / Tested |
| Manual Rammer Utilized | 831 | ID Number |
| Scale Utilized | 1112 / 1308 | ID Number |
| Testing Method Utilized Per paragraph 1.3 | A | Method A, B or C |

**DENSITY DATA** (lbs)

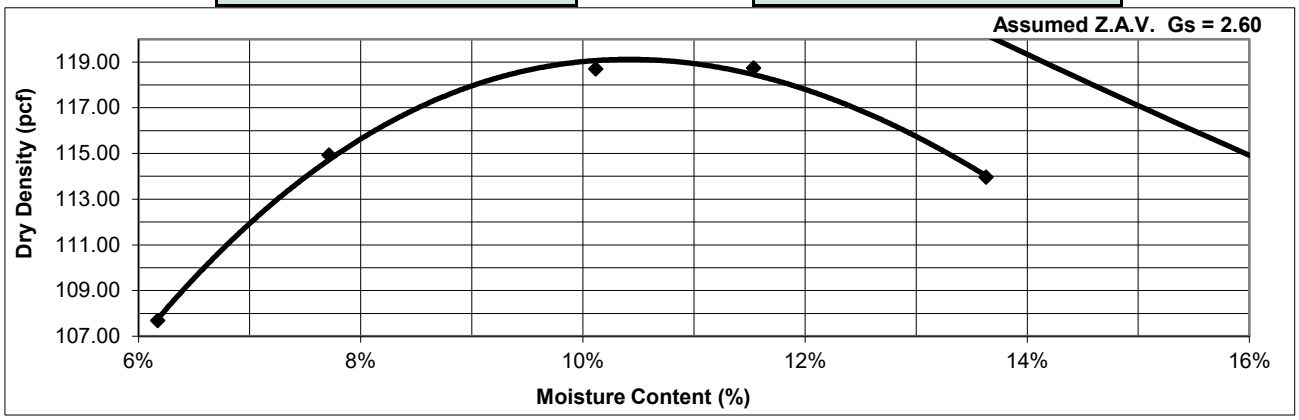
| **Mold No.** | 841 | **Mold Volume:** | 0.03334 | **Mold Calibration Date:** | 6/2/2022 |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Mold + Wet Soil | 13.50 | 13.81 | 14.04 | 14.10 | 14.00 | |
| Mold Wt. | 9.69 | 9.69 | 9.69 | 9.69 | 9.69 | |
| Wet Soil | 3.81 | 4.13 | 4.36 | 4.42 | 4.32 | |
| lbs/cu. ft. (wet) | 114.33 | 123.80 | 130.70 | 132.44 | 129.50 | |
| lbs/cu. ft. (dry) | 107.68 | 114.94 | 118.70 | 118.74 | 113.97 | |

**MOISTURE DATA** (grams)

| Tin No. | MAA | A6 | JL | M23 | K | |
|---|---|---|---|---|---|---|
| Wet Soil + Tin | 227.45 | 232.10 | 285.75 | 244.39 | 290.43 | |
| Dry Soil + Tin | 217.13 | 219.08 | 264.04 | 224.26 | 261.60 | |
| Tin Wt. | 49.92 | 50.33 | 49.42 | 49.78 | 50.07 | |
| Dry Soil | 167.21 | 168.75 | 214.62 | 174.48 | 211.53 | |
| % Moisture | 6.2% | 7.7% | 10.1% | 11.5% | 13.6% | |

| **MAXIMUM DRY DENSITY (PCF)** | **OPTIMUM MOISTURE CONTENT (%)** |
|---|---|
| **119.1** | **10.4%** |




**Envirotech - Project Manager**

**12/8/2022**
**Date**

Revision 7 - 12/2022

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

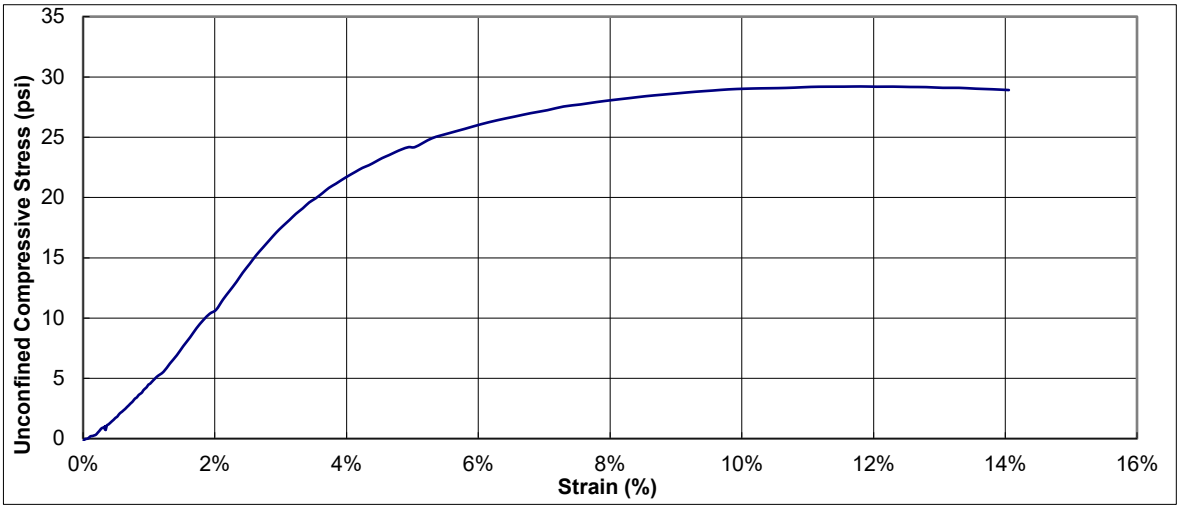
***Sample Information***

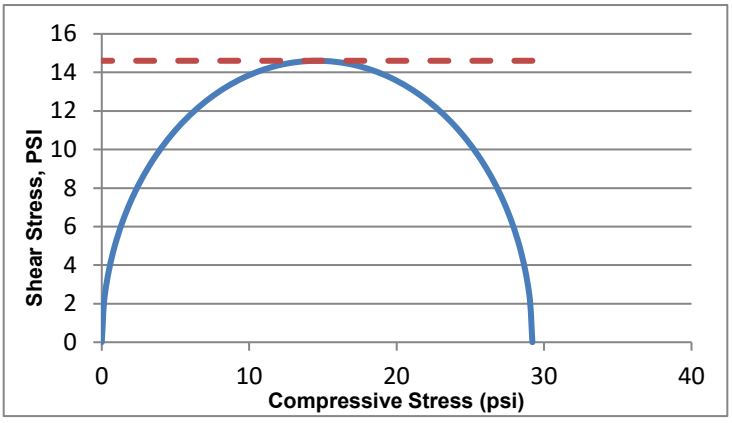
| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B1, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Dark Brown Clay with Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 12/2/2022 |
| Tested By: | RU | Date: | 12/05/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

| **Sample Condition** | | |
|---|---|---|
| Avg. Diameter (in) | $D_o$ | 1.87 |
| Avg. Height (in) | $H_o$ | 3.77 |
| Avg. Moisture Content | $w_o$ | 33.0% |
| Bulk Density (pcf) | $\gamma$total | 119.42 |
| Dry Density (pcf) | $\gamma$dry | 89.82 |
| Saturation (%) | S | 103.8% |
| Void Ratio | $e_o$ | 0.84 |
| Specific Gravity | $G_s$ | 2.65 |

| **Stress at Failure** | |
|---|---|
| Unconfined Comp. Strength (psi) | 29.21 |
| Axial Strain at Failure (%) | 11.81 |
| **Total Stresses at Failure** | |
| Major Principal Stress, (psi) | 29.21 |
| Minor Principal Stress, (psi) | 0.0 |
| Undrained Shear Strength, Su (psi) | 14.60 |

Note: Specific Gravity is assumed. Moisture content taken from cuttings.




Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B1, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Dark Brown Clay with Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 12/2/2022 |
| Tested By: | RU | Date: | 12/05/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

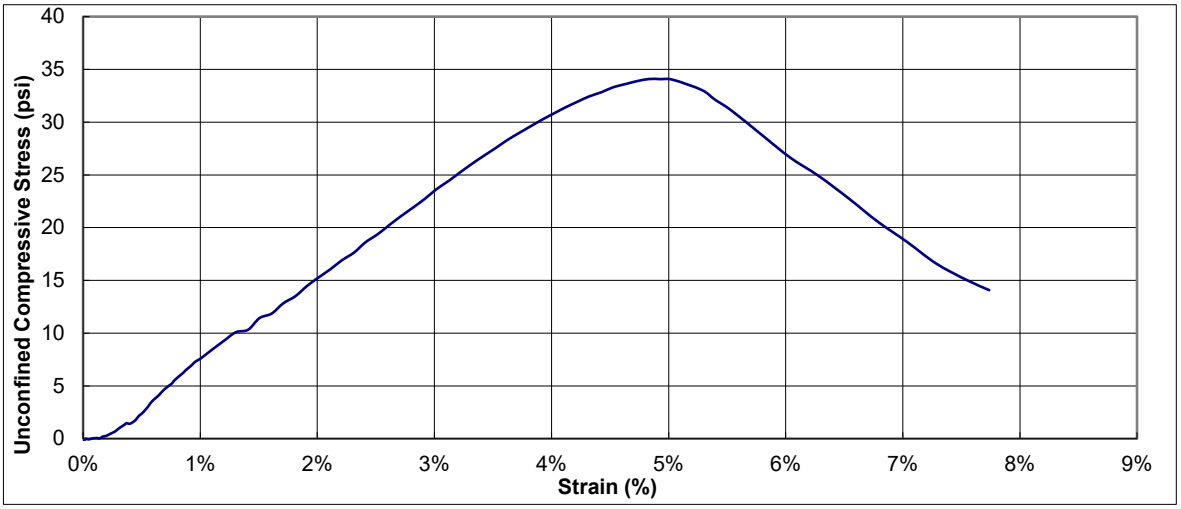
***Sample Information***

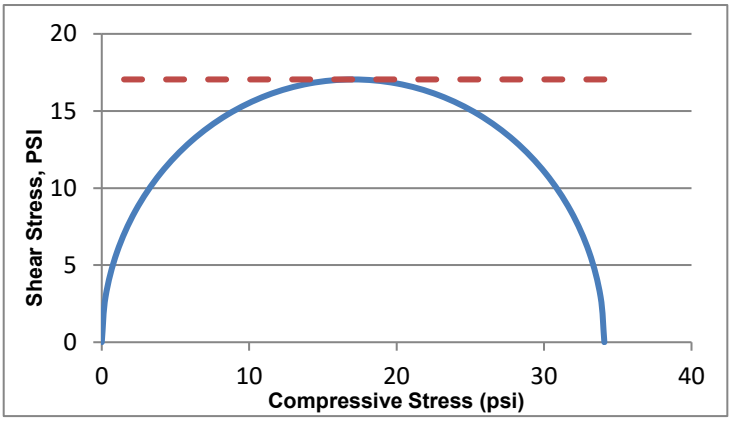
| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B2, 10-11-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Silty Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 12/1/2022 |
| Tested By: | RU | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

| **Sample Condition** | | |
|---|---|---|
| Avg. Diameter (in) | $D_o$ | 1.86 |
| Avg. Height (in) | $H_o$ | 3.74 |
| Avg. Moisture Content | $w_o$ | 14.2% |
| Bulk Density (pcf) | $\gamma$total | 124.09 |
| Dry Density (pcf) | $\gamma$dry | 108.67 |
| Saturation (%) | S | 72.1% |
| Void Ratio | $e_o$ | 0.52 |
| Specific Gravity | $G_s$ | 2.65 |

| **Stress at Failure** | |
|---|---|
| Unconfined Comp. Strength (psi) | 34.09 |
| Axial Strain at Failure (%) | 4.83 |
| **Total Stresses at Failure** | |
| Major Principal Stress, (psi) | 34.09 |
| Minor Principal Stress, (psi) | 0.0 |
| Undrained Shear Strength, Su (psi) | 17.04 |

Note: Specific Gravity is assumed. Moisture content taken from cuttings.




Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B2, 10-11-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Silty Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 12/1/2022 |
| Tested By: | RU | Date: | 12/5/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

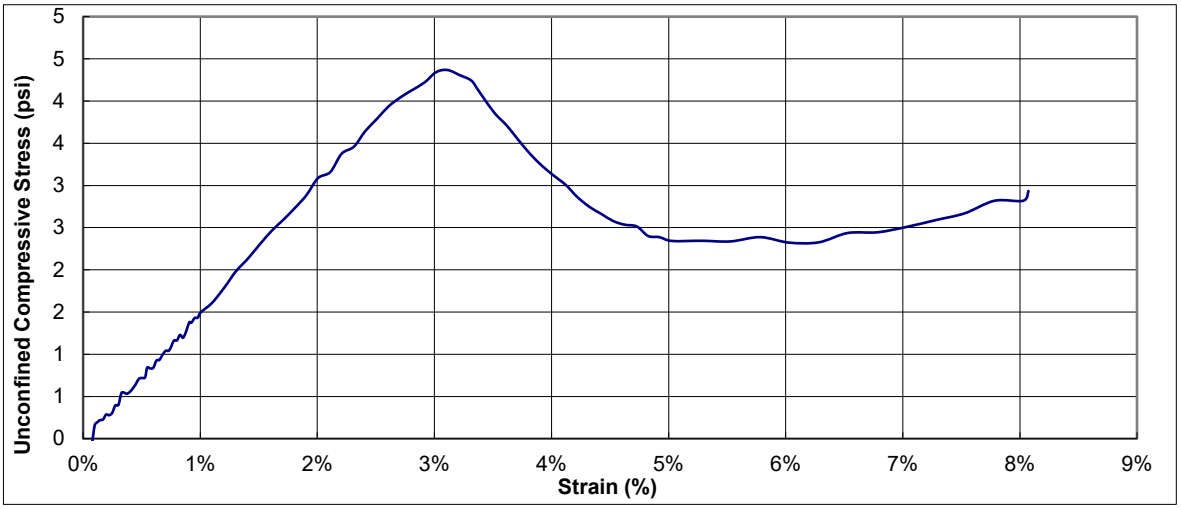
***Sample Information***

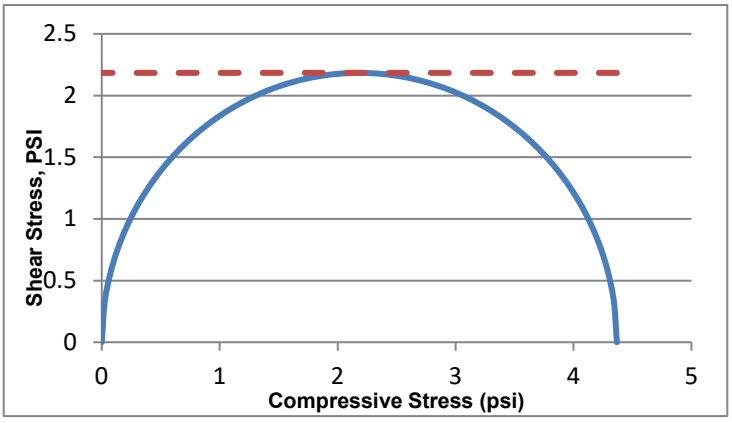
| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B3, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Clay with Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 11/29/2022 |
| Tested By: | RU | Date: | 12/07/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

| **Sample Condition** | | |
|---|---|---|
| Avg. Diameter (in) | $D_o$ | 1.85 |
| Avg. Height (in) | $H_o$ | 2.30 |
| Avg. Moisture Content | $w_o$ | 18.5% |
| Bulk Density (pcf) | $\gamma$total | 115.48 |
| Dry Density (pcf) | $\gamma$dry | 97.46 |
| Saturation (%) | S | 70.3% |
| Void Ratio | $e_o$ | 0.70 |
| Specific Gravity | $G_s$ | 2.65 |

| **Stress at Failure** | |
|---|---|
| Unconfined Comp. Strength (psi) | 4.37 |
| Axial Strain at Failure (%) | 3.11 |
| **Total Stresses at Failure** | |
| Major Principal Stress, (psi) | 4.37 |
| Minor Principal Stress, (psi) | 0.0 |
| Undrained Shear Strength, Su (psi) | 2.18 |

Note: Specific Gravity is assumed. Moisture content taken from cuttings.

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12/8/2022
Date

# Unconfined Compressive Strength

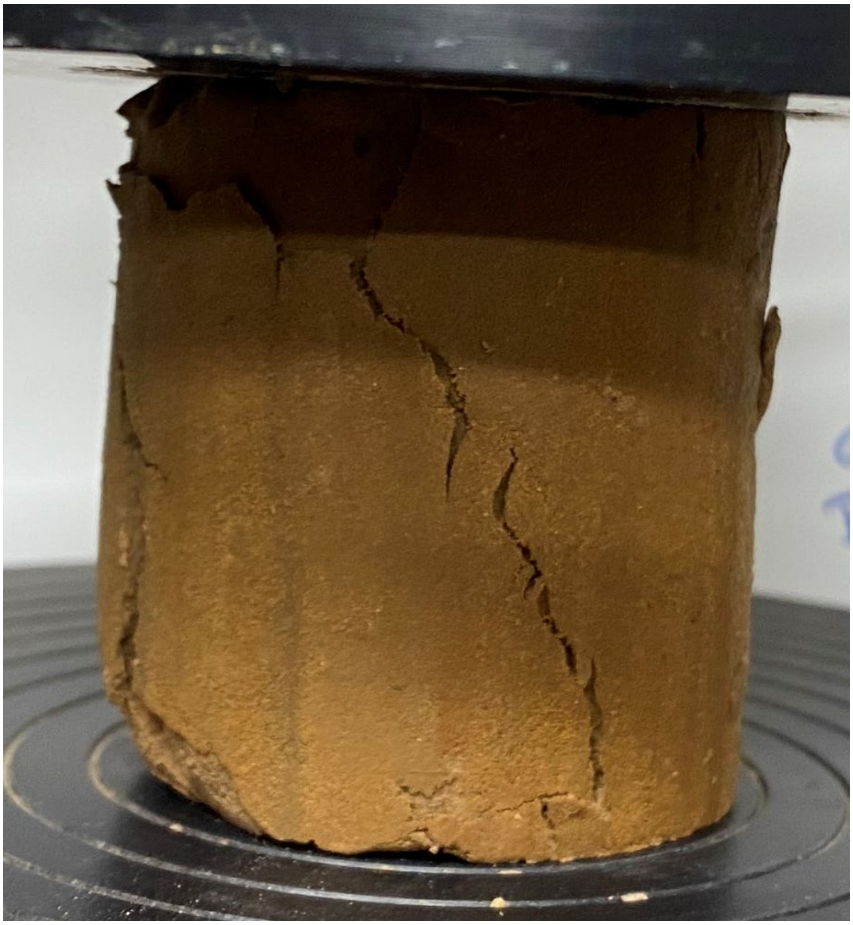
(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B3, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Clay with Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 11/29/2022 |
| Tested By: | RU | Date: | 12/07/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |



Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

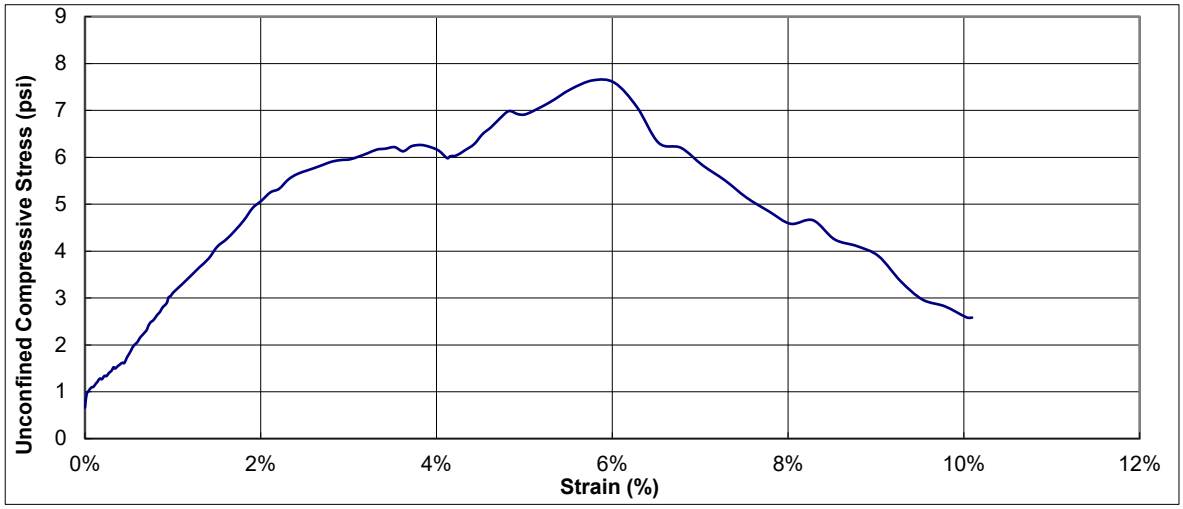
***Sample Information***

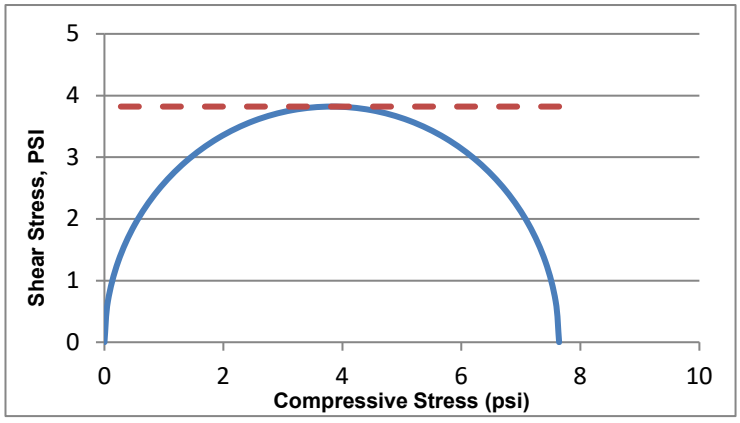
| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B5, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Silty Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 11/30/2022 |
| Tested By: | RU | Date: | 12/07/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

| **Sample Condition** | | |
|---|---|---|
| Avg. Diameter (in) | $D_o$ | 1.88 |
| Avg. Height (in) | $H_o$ | 3.42 |
| Avg. Moisture Content | $w_o$ | 4.7% |
| Bulk Density (pcf) | $\gamma$total | 91.24 |
| Dry Density (pcf) | $\gamma$dry | 87.13 |
| Saturation (%) | S | 13.9% |
| Void Ratio | $e_o$ | 0.90 |
| Specific Gravity | $G_s$ | 2.65 |

| **Stress at Failure** | |
|---|---|
| Unconfined Comp. Strength (psi) | 7.64 |
| Axial Strain at Failure (%) | 5.78 |
| **Total Stresses at Failure** | |
| Major Principal Stress, (psi) | 7.64 |
| Minor Principal Stress, (psi) | 0.0 |
| Undrained Shear Strength, Su (psi) | 3.82 |

Note: Specific Gravity is assumed. Moisture content taken from cuttings.




Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

| ***Sample Information*** | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B5, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Silty Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 11/30/2022 |
| Tested By: | RU | Date: | 12/07/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

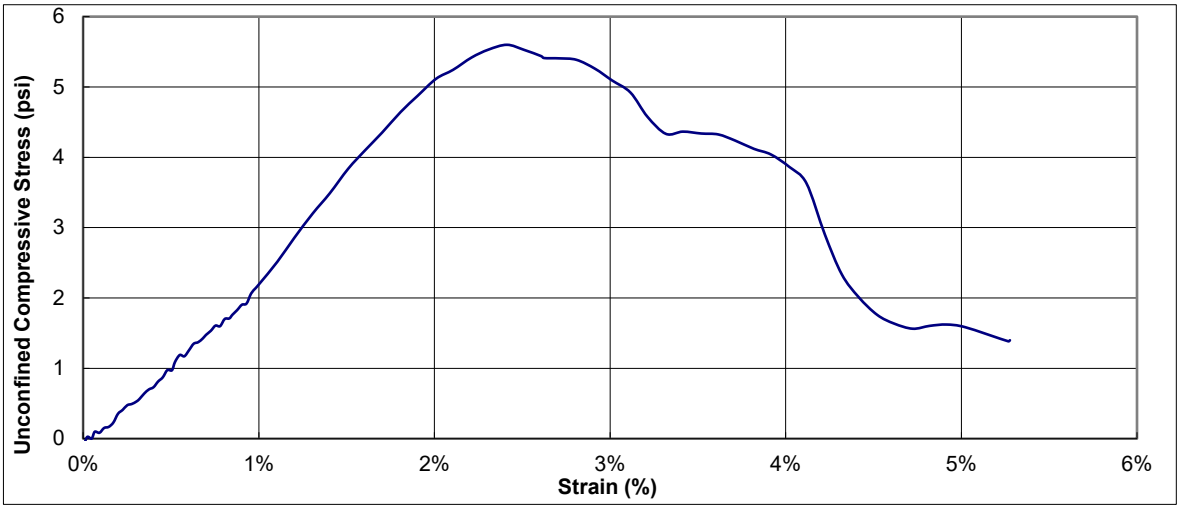
***Sample Information***

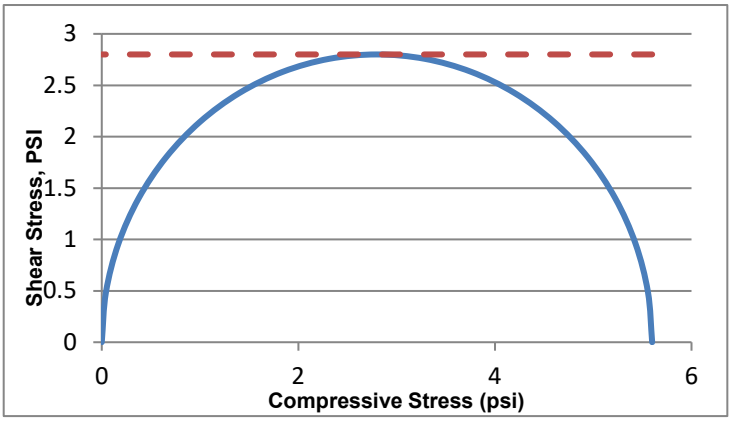
| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B6, 10-11-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Silty Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 12/1/2022 |
| Tested By: | RU | Date: | 12/07/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

| **Sample Condition** | | |
|---|---|---|
| Avg. Diameter (in) | $D_o$ | 1.85 |
| Avg. Height (in) | $H_o$ | 3.76 |
| Avg. Moisture Content | $w_o$ | 9.4% |
| Bulk Density (pcf) | $\gamma$total | 113.39 |
| Dry Density (pcf) | $\gamma$dry | 103.64 |
| Saturation (%) | S | 41.9% |
| Void Ratio | $e_o$ | 0.60 |
| Specific Gravity | $G_s$ | 2.65 |

| **Stress at Failure** | |
|---|---|
| Unconfined Comp. Strength (psi) | 5.60 |
| Axial Strain at Failure (%) | 2.41 |
| **Total Stresses at Failure** | |
| Major Principal Stress, (psi) | 5.60 |
| Minor Principal Stress, (psi) | 0.0 |
| Undrained Shear Strength, Su (psi) | 2.80 |

Note: Specific Gravity is assumed. Moisture content taken from cuttings.




Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

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(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

| ***Sample Information*** | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B6, 10-11-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Light Brown Silty Sand |
| Project Number: | 022240-00 | | | Sampling Date: | 12/1/2022 |
| Tested By: | RU | Date: | 12/07/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

(ASTM D-2166)

ENVIROTECH
ENGINEERING
2500 N. 11th Street, Enid, OK 73701
(580) 234-8780

| | |
|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

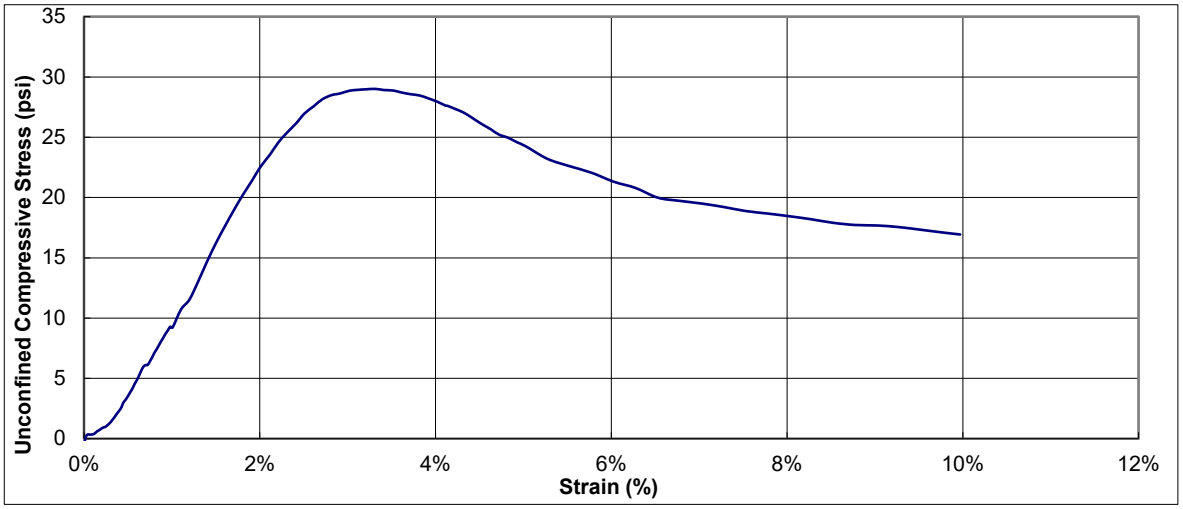
***Sample Information***

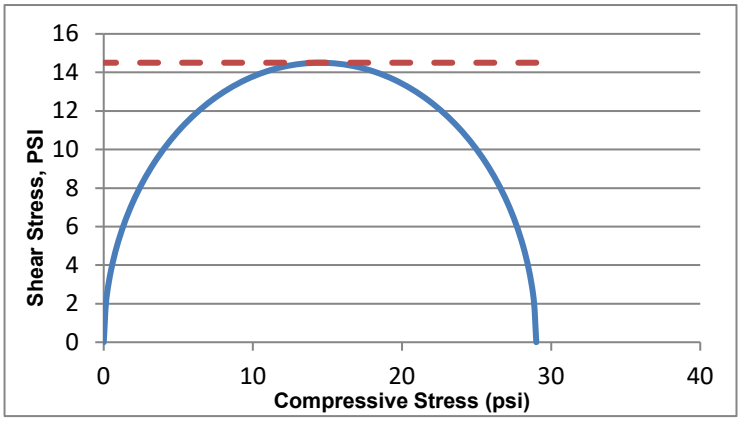
| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B7, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Brown Clay |
| Project Number: | 022240-00 | | | Sampling Date: | 11/29/2022 |
| Tested By: | RU | Date: | 12/7/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

| **Sample Condition** | | |
|---|---|---|
| Avg. Diameter (in) | $D_o$ | 1.87 |
| Avg. Height (in) | $H_o$ | 3.79 |
| Avg. Moisture Content | $w_o$ | 27.9% |
| Bulk Density (pcf) | $\gamma$total | 116.71 |
| Dry Density (pcf) | $\gamma$dry | 91.26 |
| Saturation (%) | S | 91.0% |
| Void Ratio | $e_o$ | 0.81 |
| Specific Gravity | $G_s$ | 2.65 |

| **Stress at Failure** | |
|---|---|
| Unconfined Comp. Strength (psi) | 29.01 |
| Axial Strain at Failure (%) | 3.32 |
| **Total Stresses at Failure** | |
| Major Principal Stress, (psi) | 29.01 |
| Minor Principal Stress, (psi) | 0.0 |
| Undrained Shear Strength, Su (psi) | 14.50 |

Note: Specific Gravity is assumed. Moisture content taken from cuttings.




Envirotech - Project Manager

12/8/2022
Date

# Unconfined Compressive Strength

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|---|---|
| **Client:** | Plummer |
| **Address:** | 531 Couch Dr, Ste 200, OKC, OK 73102 |

***Sample Information***

| | | | | | |
|---|---|---|---|---|---|
| Contact Name: | Chris Ferguson | | | Sample ID: | B7, 5-6-ft |
| Project: | Midwest City Waterline | | | Sample Description: | Brown Clay |
| Project Number: | 022240-00 | | | Sampling Date: | 11/29/2022 |
| Tested By: | RU | Date: | 12/7/2022 | Sampled By: | TJ Horner |
| Reviewed By: | TW | Date: | 12/8/2022 | Date Received: | 12/2/2022 |
| Rate of Strain (%/min) | | | 1%/min | Type of Specimen: | Shelby Tube |

Envirotech - Project Manager

12/8/2022
Date

**BID**

Proposal of _____

_____ (hereinafter called BIDDER"),

organized and existing under the laws of the State of _____

doing business as * _____

To the **CITY OF MIDWEST CITY** (hereinafter called "CITY").

In compliance with your Advertisement for Bids, BIDDER hereby proposes to perform all work for the construction of the following:

**NORTH SIDE UTILITIES SANITARY SEWER PROJECT**

in strict accordance with the CONTRACT DOCUMENTS, within the time set forth therein, and at the prices stated below.

By submission of this BID, each BIDDER certifies, and in the case of joint BID each party thereto certifies as to his own organization, that this BID has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this BID with any other BIDDER or with any competitor.

BIDDER hereby agrees to commence work under the contract documents on or before a date to be specified in the NOTICE TO PROCEED and to substantially complete the PROJECT within 210 calendar days after the Notice to Proceed and fully complete the PROJECT within 270 calendar days after the Notice to Proceed. In the event of the PROJECT being substantially complete with the exception of the emergency generator, the CITY will pause PROJECT calendar until the emergency generator is onsite, pending the following requirements:

1. The CONTRACTOR is able to provide a Purchase Order for the generator within 60 days of NOTICE TO PROCEED.
2. The CONTRACTOR is able to provide an emergency rental generator within 8 hours upon notification by the CITY.

BIDDER further agrees to pay as liquidated damages the sum of One Hundred Dollars ($100.00) per day for each consecutive calendar day thereafter as provided in Section 14 of the General Conditions.

BIDDER acknowledges receipt of the following ADDENDUM:

_____

_____

*** Insert "a corporation," "a partnership" or "an individual" as applicable.**

BIDDER agrees to perform all the work described in the CONTRACT DOCUMENTS for the unit prices or lump sum as indicated on the detailed bid form. The CITY shall have the option to deduct any or all of the bid items at the unit cost or lump sum provided by the BIDDER.

BASE BID TOTAL (from DBF-1) $_____

_____
(Total dollars written)

Respectfully submitted:

_____ _____
Signature Address

_____ _____
Title Date

_____
License Number (if applicable)

(SEAL - If Bid is by a Corporation)

ATTEST: _____

**SECTION 03 40 00**
**MANHOLES AND VAULTS**

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies manholes for waterline vaults, and other utility vaults as required and shown on the Drawings. This Section includes the following:

1. Precast reinforced concrete manholes.
2. Precast reinforced concrete vaults

1.2 RELATED SECTIONS

A. Section 01 45 00 “Quality Control”

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M 306 – Specification for Drainage Structure Castings
2. HS20-44 – Truck Loading

B. ASTM International (ASTM):

1. A48 – Specification for Gray Iron Castings
2. A536 – Specification for Ductile Iron Castings
3. C76 – Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
4. C150 – Specification for Portland Cement
5. C443 – Specification for Concrete Pipe and Manholes, Using Rubber Gaskets
6. C478 – Specification for Precast Concrete Manhole Sections
7. C890 – Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
8. C915 – Specification for Precast Concrete Water and Wastewater Structures
9. C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
10. C923 – Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
11. C990 – Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
12. C1577 – Precast Reinforced Concrete Monolithic Box Sections for Culverts and Storm Drains
13. D3753 – Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells

1.4 DESIGN CRITERIA

A. Desing Criteria:

1. Design calculations for the structures shall be prepared and sealed by a registered Professional Engineer in the state where the project is located.
2. Conform to following building codes: IBC, ACI 318, ACI 350, ASCE-7, and local and state design standards.
3. Precast structures shall be designed to resist buoyancy assuming groundwater at

ground surface.

4. Equivalent Liquid Pressure: per Geotechnical recommendations prepared for this project, unless otherwise noted on plans.

1.5 SUBMITTALS

A. ACTION SUBMITTALS:

1. Shop Drawings: For manholes and vaults: Include plans, elevations, sections, details, and attachments to other work. Shop drawings shall be sealed by a Professional Engineer registered in the state where the project is located.
2. Provide design of joint or joints, including design and durometer hardness of the rubber gasket proposed.
3. Provide product data for precast riser sections, covers, frames, grade rings, and pipe sleeves.
4. For castings furnish manufacturer's certification stating the casting meets the proof-load testing requirements of AASHTO M306.

1.6 PERFORMANCE REQUIREMENTS

A. Manhole rings, covers, and appurtenances shall be designed to meet AASHTO M306.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Joint Materials. Store gaskets and sealants in as cool, clean, and shaded place as practicable, preferably at 70 degrees F or less. Store lubricant in accordance with manufacturer's recommended temperature range.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Standard Precast Concrete Manholes: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Designed Precast Concrete Manholes: ASTM C913; designed according to ASTM C890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Cement: ASTM C150, Type II.
3. Diameter: 48-inches minimum, unless otherwise indicated.
4. Base Section: 12-inches, or as shown on the Drawings.
5. Riser Sections: Minimum wall thickness shall be as listed under Wall "B" in the "Class Tables" of ASTM C76, and lengths to provide depth indicated.
6. Top Section: Cone type top, unless otherwise indicated in plans.
7. Resilient Pipe Connectors: In accordance with ASTM C923, cast or fitted into manhole walls, for each pipe connection. The resilient connector shall provide an airtight seal that eliminates infiltration and exfiltration.
8. Steps: Unless otherwise noted, manhole steps shall not be provided.
9. Joints: Conform to the joint specification of ASTM C478, use rubber gaskets of the round O-ring design complying with requirements of ASTM C443. The joints shall be furnished and installed with the bell down to resist groundwater infiltration. All joints shall be sealed with an approved non-shrink grout on the inside and the outside of the manhole. Grade rings shall be mortared to each other and on the inside and

outside to provide a waterproof seal.

10. Lifting Lugs: Manhole sections and cones may be furnished with lift lugs or lift holes. If lift holes are provided, they shall be plugged with a nonmetallic, non-shrink grout.
11. Apply a bituminous damp proofing coating to the exterior surfaces of the precast manhole sections. Apply the coating to the buried portion of the precast manhole. Care shall be taken to apply the coating in accordance with manufacturers recommendations. All exposed sections of the precast manhole shall not be painted, unless otherwise indicated.
    a. Approved manufacturers:
        1) Carboline – Topcoat Bitumastic 50
        2) Or approved equal.
12. Grout: Non-shrink grout: Unless otherwise noted grout shall be non-shrink and in accordance with specification SECTION 03 60 00 - GROUT, NON-SHRINK.

## 2.2 MANHOLE FRAMES AND COVERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work.

B. Construction: Unless otherwise specified or indicated on the Drawings, provide:
1. Manhole Frame, Ring, and Cover:
    a. Include indented top design with lettering cast into cover identifying service, with wording equivalent to “SANITARY SEWER”, or as indicated on the Drawings.
    b. Manhole Cover and Frame shall be watertight and the cover shall be able to be bolted to the frame.
2. Material: Composite frames and covers
3. Frame, ring, and cover shall meet proof-load testing requirements of AASHTO M 306.
4. Frame, ring, and cover shall be powder coated black from the factory. Field applied coatings are not permitted.
5. Cover shall be solid casting with no holes.
6. Frame shall be bolted to the precast manhole top per manufacturer’s recommendation. Install a neoprene O-ring gasket between the frame and precast concrete manhole top prior to bolting.

## 2.3 PRECAST CONCRETE VAULTS

A. Standard Precast Concrete Wet wells and Vaults: ASTM C 1577 precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Cement: ASTM C 150, Type II.
2. Base Slab: 10-inch minimum thickness or as recommended by manufacturer, in accordance with ASTM C1577.
3. Riser Sections: Minimum wall thickness shall be as listed under Table 1 in the of ASTM C 1577, with lengths to provide depth indicated.
4. Top Section: 7-inch minimum thickness or as recommended by manufacturer, in accordance with ASTM C1577 with penetrations as shown in the drawings.
5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
6. Resilient Pipe Connectors: In accordance with ASTM C 923, cast or fitted into the

vault or wet well walls, for each pipe connection. The resilient connector shall provide an airtight seal that eliminates infiltration and exfiltration.

7. Joints: Conform to the joint specification of ASTM C 900.
8. Lifting Lugs: sections may be furnished with lift lugs or lift holes. If lift holes are provided, they shall be plugged with a nonmetallic, non-shrink grout.
9. When designated on the Drawings, apply a corrosion resistant material to the interior surfaces of the vault or wet well.

B. Contractor shall coordinate the location of penetrations and hatches with the vault manufacturer during the submittal phase.

2.4 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II or I/II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000-psi minimum, with 0.45 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Ballast: Portland cement design mix, 3000-psi minimum, with 0.58 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.5 MORTAR

A. Mortar: Furnish mortar comprised of one part Portland cement, ASTM C150, Type II, IIA, or I-II, and two parts clean sand.

PART 3 - EXECUTION

3.1 GENERAL

A. Manhole Types and Requirements:
1. Manholes for sanitary service may be precast reinforced concrete construction in accordance with the Drawing requirements.
2. Vaults shall be cast-in-place or precast in accordance with the Drawing requirements.

3.2 INSTALLATION

A. Base: Construct either cast-on-site or monolithic round, precast reinforced concrete base section. The base shall have a minimum thickness indicated above and projects no less than 6 inches beyond the outside walls of the base to form a flange intended to resist uplift.
1. The precast concrete base shall have suitable cutouts or openings to receive all pipes and connections. The lowest edge of openings shall be no less than 6 inches above the inside surface of the floor of the base.

B. Precast Manholes and Vaults:

1. Construct precast manholes and vaults of the sizes and configuration at the locations in accordance with ASTM C 478 and as indicated on the Drawings.
2. Provide required pipe connections and invert channels as shown on the Drawings and described in this Section.
3. Provide bituminous water proofing to exterior surfaces.
4. Test completed structures.

C. Invert channels construction:

1. Invert channels shall be smooth, accurately shaped, and in accordance with the Drawings.
2. Invert may be formed directly in the concrete of the manhole base, shaped by mortar, or constructed by laying a section of pipe through the manhole and cutting the top half after the concrete base is constructed and set.
3. Changes in directions and grade will consist of the largest curve radius the manhole diameter will permit.
4. Free vertical drop from any branch or service line shall not exceed one half the mainline pipe diameter measured from the mainline upstream invert.
5. The top of the base outside the flow channels shall be steeply sloped to the channels.

D. Piping Connections:

1. Where piping is connected to a manhole, wet well or vault, provide resilient connector in accordance with ASTM C 923.
    a. Available Manufacturer:
        1) Press Seal Gasket Corporation, Fort Wayne, Indiana; PSX Manhole Connector.
        2) Trelleborg Pipe Seals Milford, Inc., Milford New Hampshire
2. When manhole, wet well or vault base is concrete and cast around the pipe, install an adapter gasket to serve as a watertight seal (water stop) between pipe and concrete.
3. When resilient connectors cannot be made for manhole, wet well or vault connections, ensure the pipe does not extend any further than five feet from outside the manhole, wet well or vault wall or base. Provide a concrete cradle within one foot of the pipe end. Extend the concrete manhole base to support the cradle. Provide manufacturer's recommended adapter shall be used to connect the pipe to the manhole pipe.
4. Where the main line (lowest line) passes straight through manhole, or the degree of deflection is less than 5 degrees, and no other line invert enters below the centerline of the main line, lay the main line continuous through manhole.
5. When the degree of deflection is greater than 5 degrees, or the invert of another line enters at or below the centerline, terminate the main line laying such that the pipe ends are flushed with the inside manhole wall.

E. Field Connections to Manholes:

1. Cut neat opening in manhole no larger than necessary to insert pipe.
2. Utilize PVC sleeves with rubber gaskets and abrasive silica outer coating. After installing new lines, place concrete collar around pipe on outside of manhole to seal

joint. Make collar approximately 8 inches wide by 8 inches deep.

3. Use concrete having minimum compressive strength of 3000-psi at 28-days.
4. Modify invert channel in manhole to provide smooth transition into or out of new pipe.

3.3 TESTING

A. Manholes shall be tested in accordance with Division 01 Section 01 45 00 “Quality Control”.

3.4 MANHOLE FRAMES AND COVERS

A. Provide manhole frame and cover at the location of the type as indicated on the Drawings.

B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops above finished surface elsewhere as indicated in Drawings.

C. The Contractor shall submit a request to the Engineer and be approved prior to ordering any materials for the manhole. Ring hold down bolts (4 minimum) shall pass through the grade rings into the top of the cone.

D. A manhole where personnel entry is anticipated cover shall have at least a 36-inches clear opening, unless otherwise shown on Drawings.

E. Either adjust manhole cover and frame or adjust roadway surface to obtain a smooth transition if manhole located in roadway. Adjust surrounding grade, filling any depressions, around manhole.

F. Remove construction debris, trash, and plugs from manhole prior to placing in service.

**END OF SECTION**

**SECTION 43 05 25**
**COMMON REQUIREMENTS FOR PUMPS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Scope of Work:

1. This Section provides requirements common to the pumping unit specification sections of Division 43. In addition to the specific requirements of the individual pumping unit specification sections. The CONTRACTOR shall be responsible for ensuring all pumping units comply with the requirements of this Section. The detailed equipment specifications shall govern where this section conflicts with detailed sections.
2. CONTRACTOR shall furnish and install all tools, equipment, materials, and supplies and shall perform all labor necessary for the installation, testing, and placing into operation of all pumps and pumping appurtenances, complete and operable, in accordance with the requirements of the Contact Documents.

B. Related Sections:

1. Division 40 Section 40 05 00 General Requirements for Plant and Station Piping Systems" for basic piping requirements associated with equipment systems, along with the individual piping sections.
2. Division 40 Section 40 12 16.40 "Miscellaneous Valves and Appurtenances" for basic valve requirements associated with equipment systems, along with the individual valve sections.
3. Division 43 Section 43 25 13 "Submersible Centrifugal Pump" for specific pump requirements.

1.3 REFERENCES

A. Reference Specifications, Standards, Codes, and Regulations:

1. Various Project sections contain references to specifications, standards, codes, regulations, and other documentation and shall be considered a part of those sections as specified and modified.
2. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly.
3. In the event of conflict between the requirements of the Project specification sections and those of the listed documents, the requirements of the Project specification sections shall prevail.
4. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Opening of Bid. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was

discontinued.

B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications.
   1. American Society for Testing and Materials (ASTM).
   2. American Public Health Association (APHA).
   3. American National Standards Institute (ANSI).
   4. American Society of Mechanical Engineers (ASME).
   5. American Water Works Association (AWWA).
   6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
   7. American Welding Society (AWS).
   8. National Fire Protection Association (NFPA).
   9. Federal Specifications (FS).
   10. National Electrical Manufacturers Association (NEMA).
   11. Rubber Manufacturers of America (RMA).
   12. Manufacturer's published recommendations and specifications.
   13. General Industry Safety Orders (OSHA).

C. The following standards are referred to in the various Project specification sections:
   1. American National standards Institute (ANSI):
      a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250.
      b. B16.5 – Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys.
   2. American Society of Mechanical Engineers (ASME):
      a. B31.3 – Process Piping
   3. ASTM International, Inc. (ASTM):
      a. A 48 – Specification for Gray Iron Castings
      b. A 470 – Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts.
      c. A 536 – Specification for Ductile Iron Castings.
      d. E 448 – Standard Practice for Scleroscope Hardness Testing of Metallic Materials.
      e. B 62 – Specification for Composition Bronze or Ounce Metal Castings.
   4. Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 112 – Test Procedure for Polyphase Induction Motors and Generators.
      b. 115 – Test Procedure for Synchronous Machines.
   6. National Electrical Manufacturer’s Association (NEMA): MG-1, Motors and Generators.
   7. National Fire Protection Association (NFPA): NFPA 70, National Electric Code.
   8. National Sanitation Foundation (NSF): NSF 61, Drinking Water Components – Health Effects.

1.4 SUBMITTALS

A. The information requested in the various Project specification sections shall be prepared and submitted in accordance with the requirements described in the following paragraphs.

B. Equipment and Related Lists: Lists are included for the convenience of the ENGINEER and CONTRACTOR and are not complete listings of all pumps, equipment, devices and material to be provided under this Contract. The CONTRACTOR agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of the Project.

C. Manufacturer Installation Instructions: Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the pumping units.

D. Pump Submittal Requirements: Following are supplemental requirements for pumping unit submittals.

1. Manufacturer to indicate points on the head/capacity curves, and the limits recommended for stable operation which the pumps may be operated without surge, cavitation and vibration. The stable operating range shall be as wide as possible based on the pumps actual hydraulic and mechanical tests.
2. Pump detailed description and specification.
3. Electrical data, including power, signal, and control wiring diagrams, with terminals and numbers.
4. Assembly drawings including shaft size, seal, coupling, anchor bolt plan, part nomenclature, material list, outline dimensions and shipping weights.
5. Installation drawings including manufacturer's recommended dimensions and spacing of the anti-vortex baffling underneath and between each pump, and pump shelf (if needed). The installation drawings shall also include the installed pump positioning taking into account the actual dimensions of the pump, base elbow, discharge piping, guide rails, and guide bar bracket to ensure the pump can be pulled without interference from the discharge piping and pump hatch.
6. Bearing life calculations.
7. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and include any motor specifications.
8. Documentation demonstrating factory finish is equivalent to finish system specified in this Section.

E. Information Submittals:

1. Manufacturer's Certification of Compliance.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's Instructions for installation.
4. Manufacturer's Certificate of Proper Installation.
5. Qualification Data: For manufacturer and manufacturer's representative.
6. Suggested spare parts list to maintain the equipment in service for a period of two years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current pricing information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

8. Warranties and service agreements.
9. Design calculations for pump base and anchorage signed and sealed by a Professional Engineer.

F. Operation and Maintenance Data: For each pumping system to include in operation and maintenance manuals in accordance with Division 1 Section 01 78 23 “Operation and Maintenance Data.”

G. Guarantees and Warranties: After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the pumping units will operate within the published efficiencies, heads, and flow ranges and meet these specifications.

1.5 QUALITY ASSURANCE

A. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine.

B. Manufacturer Qualifications: Unless otherwise specified in the individual specification sections;
1. All equipment shall be the product of a manufacturer which has been in the design, fabrication, assembly, testing, start-up and service of full scale pumping units with at least fifteen (15) North American installations of the type, model, and size specified for a period of not less than five (5) years prior to the bid date of this Contract.
2. A list of similar installations shall be furnished with the shop drawing submittal, including names and telephone numbers of contacts.
3. Certified to ISO 9001 by an accredited certification agency.

C. Installer Qualifications:
1. Unless otherwise specified in the individual specification sections; CONTRACTOR shall provide a manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Manufacturer’s representative shall ~~be~~ provide for each pumping unit, 10 Hp and larger for the periods indicated in the individual specification section.

D. Source Limitations: Pumping units of each type specified as specified in the individual specification sections shall be supplied by a single manufacturer. This does not require that all equipment be manufactured by a single manufacturer, but does require that the manufacturer of the system shall be responsible for the complete system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle and store equipment components in accordance with shop drawings, and manufacturer’s written instructions.

B. Special requirements for the storage and handling of pumping units will be provided in the specified pumping unit section.

1.7 PROJECT CONDITIONS

A. Structural Performance: All equipment, supports, anchors and fasteners shall be of

adequate size and strength to withstand loads associated with starting, turbulence, debris, thrusts from liquid movement, thermal expansion and contraction, vibration, and other loads encountered under operating conditions.

B. Operation: Equipment shall be designed and capable of either continuous or intermittent operation.

C. System Arrangement:

1. The equipment, sizes, materials, and arrangements described in the individual specification sections are typically based on recommendations by equipment manufacturers and shall be considered minimum limits of acceptability. The equipment MANUFACTURER shall be responsible for design, arrangement, and performance of all equipment supplied under this section.

2. Modifications to structural design due to a manufacturer's varying space requirements, foundation requirements, floor slope requirements, dimension changes, or other requirements to fit manufacturer specific requirements shall be coordinated by CONTRACTOR and included in the Bid.

3. The CONTRACTOR shall be responsible for any modifications to the piping, electrical, structural, and mechanical layouts to accommodate, as well reimbursement to OWNER for additional charges by ENGINEER for additional work required for accomplishing the changes.

D. Environmental Conditions:

1. All equipment, including controls and drives specified herein, shall be specifically designed for the service and the environment to be encountered.

2. When installed in wastewater treatment areas, the environment will be moist, and corrosive, exhibiting hydrogen sulfide and other corrosive gases encountered in municipal wastewater treatment plants.

3. Designed and capable of operation at ambient temperatures of 0°F to 110°F.

4. Furnish heat tracing and insulation as required, if required for exterior installation. Insulation alone shall not be sufficient to fulfill freeze protection provisions of this section.

E. Field Measurements, Existing Facilities Installation: Verify actual dimensions of openings, adjacent facilities and equipment, utilities and related items by field measurements before fabrication as applicable.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components that fail(s) in materials or workmanship within specified warranty period.

1. Standard Warranty Period: ~~Two~~ Five (~~2~~5) years from date of Final Completion. Standard warranty shall be Non-Pro Rated with unlimited hours of operation.

~~2. Extended Warranty Period: Required when experience is below requirements stated in Quality Assurance paragraph. Three (3) years starting at the completion of the Standard Warranty Period. Extended Warranty Period may be Pro-Rated.~~

B. Cost for the removal, shipment, ~~repair~~repair, and installation by CONTRACTOR shall be included in warranty, as well as correction of defective work.

1.9 SPARE PARTS AND TOOLS

A. Tools: Provide special tools necessary for maintenance and repair of the pumps shall be furnished as a part of the work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:

1. Refer to the spare parts list in Paragraph 1.7 of Section 43 25 13 Submersible Centrifugal Pumps.
2. Furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER, only, after expiration of the guaranty period.
3. Any spare parts which the CONTRACTOR was permitted to use for startup activities shall be replaced by the CONTRACTOR prior to the OWNER's acceptance of beneficial use of the equipment.
4. During the term of this Contract the CONTRACTOR shall notify the ENGINEER in writing about any manufacturer's modification of the approved spare parts, such as part number, interchangeability, model change or others. If the ENGINEER determines that the modified parts are no longer applicable to the supplied equipment, the CONTRACTOR at its expense shall provide applicable spare parts.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall furnish and install only such equipment as the designated single manufacturer certifies is suitable for use with its equipment and the service conditions.

B. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than five (5) successful installations of its equipment of comparable nature to that offered under this Contract.

C. All combinations of manufactured equipment which are provided under these specifications shall be entirely compatible, and the CONTRACTOR and the designated single manufacturer shall be responsible for the compatible and successful operation of the various components of the units conforming to specified requirements. Each unit of equipment shall incorporate all basic mechanisms, coupling, electric motor or engine drive and unit mounting. All necessary mountings and appurtenances shall be included.

D. Where two or more units of the same type and/or size of equipment are required, such units shall all be produced by the same manufacturer.

E. Tolerance: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts.

F. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following minimum finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces

in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

G. Noise Level:

1. When the equipment is in operation, no single piece of equipment shall exceed the OSHA noise level requirements for a one hour exposure, and the regulatory agency having jurisdiction where the Project is located.

## 2.2 PUMPING UNIT REQUIREMENTS

A. Materials: All materials furnished as part of the pumping equipment shall be suitable for its intended use and service. Materials not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and, unless otherwise specified in the individual specification section, shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A48, or equal.
2. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.
3. All anchor bolts, nuts and washers shall be Type 316 stainless steel, unless otherwise specified.
4. Buried or submerged bolts, nuts and washers shall be Type 316 stainless steel.

B. Bearings: Unless otherwise specified, bearings shall comply with the requirements listed below.

1. Be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified.
2. Rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings.
3. Have a minimum L-10 rating life of ~~100~~50,000 hours. The rating life shall be determined using the maximum equipment operating speed.
4. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.
5. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60° C and equipped with a filler pipe and an external level indicator gage.

C. Couplings:

1. General: Pumps with a driver greater than 1/2 HP, and where the input shaft of a

driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling.

2. Requirements:

a. Accommodate angular misalignment, parallel misalignment and end float, and cushions shock loads and dampens torsion vibrations.

b. Consist of a tire with synthetic tension members bonded together in rubber; flexible member attached to flanges by means of clamping rings and cap screws; and flanges attached to the stub shaft by means of taperlock bushings which provide the equivalent of a shrunk-on fit.

c. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

d. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, provide Thomas-Rex, Falk Steel Flex, or equal couplings will be acceptable.

D. Flanges: Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.

E. Lubrication:

1. Vertical pump shafts shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals.

2. For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inch and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of bottom bearing.

F. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

G. Vortex Suppressors: Vertical pumps with insufficient submergence shall be furnished with vortex suppressors.

H. Drains: All gland seals, air valves, and cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

I. Seals: Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. Unless specified otherwise, stuffing boxes and mechanical seals shall be selected for highest reliability and for rugged service, conforming to the requirements set forth in this paragraph.

1. Stuffing Boxes: Where stuffing boxes are specified for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application.

a. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

b. Description: Stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing.

c. Stuffing boxes shall be face attached.

d. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified above for the applicable pump and operating conditions.

e. Lantern Rings: Bronze or Teflon, two-piece construction, and provided with tapped holes to facilitate removal.

f. Packing: Unless otherwise specified, the packing material shall be die-molded packing rings of interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following specification:

1) Shaft speeds - up to 2500 fpm

2) Temperature - up to 500 degrees F

3) pH range - 0-14

g. Glands: Bronze, two piece split construction.

h. Impeller end of the packing on all but line-shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

2. Mechanical Seals:

a. Description: Mechanical seal shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area.

b. Mechanical seals shall be the split cartridge type, requiring no field assembly, other than assembly around the shaft and insertion into the pump. Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastalloy C.

c. Rotary Faces: Ceramic, tungsten carbide, or silicon carbide.

d. Stationary Faces: Ceramic, tungsten carbide, or silicon carbide.

e. Elastomers: Ethylene propylene or fluorocarbon.

f. Service Operation: Full vacuum to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.

g. Unless otherwise specified, mechanical seals for pumping equipment shall be self-aligning, self-centering, single, Chesterton 442, AES or equivalent.

h. Mechanical seals for all pumps (except lineshaft pumps where the seal barrier fluid is used for lineshaft bearing lubrication) shall be fitted with SpiralTrac Version F, N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

i. Unless the pump manufacturer recommends a better seal for a specific application, the following mechanical seals shall be furnished with the pumps:

Sewage, Sludge, or Wastewater Pumps: Double seals

~~Wastewater Pumps:~~

1)

j. For all seal arrangements, a buffer fluid must be circulated a minimum 20 psi above suction pressure, or as required by manufacturer, in order to maintain reliable seal performance.

3. Shaft Sleeve:
    a. Section of shaft or impeller hub extending through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve, having a Brinell hardness of not less than 500.
    b. Sleeve held to the shaft to prevent rotation and gasketed to prevent leakage between the shaft and the sleeve.
    c. Minimum shaft sleeve thickness shall be 3/8 inch.

2.3 PUMP APPURTENANCES

A. Manufacturer Nameplate: Each pump shall be equipped with a stainless steel nameplate indicating rated head and flow, impeller size, pump speed, manufacturer's name and model number, and other appurtenant information.

B. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear 1/4-inch die-stamped equipment identification number indicated in this Section and/or on the Drawings.

C. Lifting Lugs: Individual equipment and/or each field disassemble part weighing over 80 pounds shall be provided with lifting lugs.

D. Anchor Bolts: Provide template and Type 316 stainless steel anchors as shown on the Drawings. Size and embedment of anchor bolts shall be designed by the pump manufacturer.

E. Initial Supply of Lubricants: Manufacturer shall indicate types, brands, and quantities of initial lubricants, oil, grease, etc. necessary to startup equipment. CONTRACTOR shall provide and install the recommended lubricants and shall comply with all manufacturer recommended procedures.

F. Solenoid Valves: The pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from motor control panel to solenoid.

G. Pressure Gages: Gage taps shall be provided on the suction and discharge sides of pumps (except sample pumps, sump pumps, and hot water circulating pumps) and shall be equipped with pressure gages installed at pump suction and discharge lines.
    1. Pressure gages shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
    2. Pressure gauges shall be furnished in conformance with Division 40 Section 40 73 13 “Pressure Gauges”.
    3. Pump suctions shall be equipped with compound gages. Where subject to shock or vibrations, provide a snubber, which is wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

H. Guards: Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of minimum 14-gage galvanized steel or fiberglass; designed to be readily removable to facilitate maintenance of moving parts.

I. Safety Signs: Provide the following safety signs in accordance with Division 10 Section 10 14 00 “Signs”:

1. Equipment with guarded moving parts which operates automatically or by remote control shall be identified signs reading "CAUTION - EQUIPMENT STARTS AND STOPS AUTOMATICALLY."
2. Place a caution sign on the guard reading “CAUTION- KEEP GUARD IN PLACE.”

2.4 SOURCE QUALITY CONTROL

A. CONTRACTOR shall be responsible for the coordination of the following tests of each of each pump, drive, and motor:

B. General: Tests shall be performed in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute. Tests shall be performed on the actual assembled unit from shut-off head condition to 150 percent of the required maximum design capacity. Prototype model tests will not be acceptable.

C. Factory Tests of Pumps:
1. All pumps and motors of sizes 10 to 125 hp (inclusive) shall be factory-tested in accordance with the above specifications. Submit the Certified test data to the ENGINEER. This data shall include, but not be limited to the following:
a. Hydrostatic test with data recorded. Pump casing tested at 150 percent of shutoff head. Test pressure maintained for not less than five minutes.
b. Hydraulic test with a minimum of 5 readings between shutoff head and 125 percent of the maximum design capacity, recorded on data sheets as defined by the Hydraulic Institute, signed, dated, and certified.
c. Certified pumps curves showing head/flow, bhp, efficiency, [NPSH] curves. [NPSH required shall be at least 5 feet of water absolute less than NPSH available.]
d. Certification that the pump hp demand will not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
2. Vibration Test: Dynamically balance rotating parts of each pump and its driving unit before final assembly. Limits; Complete rotating assembly, including drive unit and motor, shall be less than 90 percent of limits established in the Hydraulic Institute Standards.

D. Factory Tests of Motors: All motors of sizes 10 hp and larger, shall be assembled, tested, and certified at the factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 and ANSI/IEEE 115 standards, including heat run and efficiency tests. All computations shall be recorded and provide certified and dated copies of the test results to the ENGINEER.

E. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger, shall be factory-tested as complete, assembled units, as specified above, and witnessed by the ENGINEER and the OWNER.
1. Manufacturer shall provide the ENGINEER a minimum of two (2) weeks notification prior to the test.
2. All costs for OWNER and ENGINEER shall be borne by the CONTRACTOR and included in the bid price. Such costs shall include travel and subsistence for two people but shall exclude any salaries. Provide copies of the test results to the ENGINEER and no equipment shall be shipped until the test data have been approved.

F. Acceptance: In the event of failure of any pump to meet any of the individual section

requirements or efficiencies, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be factory re-tested at no additional compensation, until found satisfactory.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Install and adjust equipment in accordance with the Drawings, approved shop drawings, and the manufacturer's instructions. Do not operate the equipment until the installation is approved by the manufacturer's representative.

### 3.2 INSTALLATION

A. Assemble and install equipment in accordance with the manufacturer's instructions and the following:

1. Support all piping independently of the pump.
2. Level baseplate by means of steel wedges (steel plates and steel shims). Wedge taper not greater the 1/4-inch per foot. Use double wedges to provide a level bearing surface. Accomplish wedging so that there is no change of level or springing of the base elbow when anchor bolts are tightened.
3. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
4. After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, non-shrinking grout of the proper category, as specified in Division 3 Section 03 60 00 "Grout, Non-Shrink." Remove wedges after grout is set and pack void with grout.
5. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment functions correctly under no load conditions. Turn rotating equipment by hand to check. Complete cleaning and testing of piping systems. Inspect and clean equipment, devices, piping, and structures of debris and foreign material.
6. Remove temporary bracing supports and other construction debris that may damage equipment.
7. Remove protective coatings and oils used for protection during shipment and installation.
8. Flush, fill, and grease lubricated systems in accordance with manufacturer's instructions.

B. Seal Water Connections: Provide seal water ping, valves, flow indicator, pressure and flow control devices, to pump packing for units handling slurries, grit, water containing sand or solids, and as specified in the drawings in accordance with the Standard Details.

C. Base Plate Drains: Provide drain line from pumping unit base to the floor drain.

D. Install temporary connections and devices required to fill, operate, checkout and drain the system. Provide temporary valves, gauges, piping, test equipment, and other materials and equipment necessary to conduct testing and startup.

E. Equipment

1. Check equipment for correct direction of rotation and freedom of moving parts.
2. Align equipment to Manufacturer's tolerances. Adjust clearances and torques.
3. Check installation prior to start-up for conformance to manufacturer's instructions.
4. Adjust or modify equipment to ensure proper operation.

F. Correct any deficiencies or problems noted in manufacturer's representative's installation reports.

3.3 PROTECTIVE COATING

A. Provide polyurethane, pigmented (over epoxy zinc rich primer and high build epoxy) in accordance with Division 9 Section 09 91 00 “Painting and Protective Coatings.” Pump shall receive surface preparation, prime coat and finish coat in factory.

B. Shop painted items which suffered damage to the shop coating shall be touched up as specified in Division 9 Section 09 91 00 “Painting and Protective Coatings.”

3.4 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump as described below and in accordance with Division 1 Section 01 75 00 “Equipment Testing and Startup”.

1. Pumping units shall be field tested after installation, to demonstrate satisfactory operation, without causing excessive noise, vibration, cavitation, and overheating of the bearings.
2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
3. Vibration Test:
    a. Test units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual facility structures and foundations provided, shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes exceeding the limits specified.
    b. Any vibration shall be within the amplitude limits recommended in the Hydraulic Institute Standards and it shall be recorded at a minimum of four (4) pumping conditions defined by the ENGINEER.
    c. If units exhibit vibration in excess of the limits specified adjust, or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.
    d. Flow Output: Measured by plant instrumentation and storage volumes.

B. Performance Test: In accordance with Hydraulic Institute Standards.

1. Place each piece of equipment in the system in operation until the entire system is functioning. All components shall continue to operate without alarms or shut downs, except as intended, for eight consecutive hours to be considered started up.
2. Operate the equipment through the design performance range. Adjust, balance, and calibrate and verify that the equipment, safety devices, controls, and process system operate within the design conditions.
3. Each safety device shall be tested for proper setting and signal. Response shall be

checked for each equipment item and alarm. Simulation signals may be used to check equipment and alarm responses.

4. Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, pump suction head, and pump discharge head, for at least four (4) pumping conditions at each pump rpm. Each power lead to the motor shall be checked for proper current balance.

5. Bearing temperatures shall be determined by a contact-type thermometer. A running time of at least 20 minutes shall be maintained for this test, unless liquid volume available is insufficient for a complete test. Bearing temperatures shall not exceed 180°F at any point during the test.

C. A copy of all information from functional tests, including data, worksheets, and other materials shall be turned over to the OWNER at the completion of the testing program.

## 3.5 MANUFACTURER'S SERVICES

A. Manufacturers services shall comply with the following:

1. Manufacturer's representative shall be provided present at Project site or classroom designated by OWNER, and depending of the Construction Schedule, provide the number of trips required to provide the minimum person-days listed in the individual specification sections, travel time excluded.

B. Inspection, Startup, and Field Adjustment: CONTRACTOR shall demonstrate that all equipment meets the specified performance requirements. CONTRACTOR shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment and shall visit the site of work to perform the following tasks.

1. Assist the CONTRACTOR in the installation of the equipment.
2. Inspect, check, adjust if necessary and approve the equipment installation.
3. Start-up and field-test the equipment for proper operation, efficiency, and capacity.
4. Perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the ENGINEER.
5. Instruct OWNER's personnel in the operation and maintenance of the equipment. Instruction prior to system testing of the equipment shall include step-by-step troubleshooting procedures with all necessary equipment testing.

C. Manufacture's Certificates:

1. Provide equipment manufacturer's Certificate of Installation stating that the equipment is installed per the manufacturer's recommendations and in accordance with the Drawings and Specifications.
2. Provide equipment manufacturer's Certificate of Performance stating that the equipment meets or exceeds the performance requirements as defined hereinbefore.

## 3.6 FACILITY STARTUP

A. Startup of the facility shall be in accordance with Division 1 Section 01 75 25 "Equipment Testing and Startup." After initial startup under the supervision of a qualified representative of the pump manufacturer, a preliminary "running-in" period will be provided for the CONTRACTOR, per the Contract Documents, to make field tests and necessary adjustments. At the end of the specified period of operation, the pumps will be accepted if, in the opinion

of the ENGINEER, the pumps have operated satisfactorily without excessive power input, wear, lubrication, or undue attention required for this operation, and if all rotating parts operate without excessive vibration or noise at any operating speed and head, including shutoff.

**END OF SECTION**

**SECTION 43 25 13**
**SUBMERSIBLE CENTRIFUGAL PUMPS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Furnish, install, check-out, start-up, test, place in operation and perform quarterly warranty inspections for the following lift station:

1. Three (3) submersible centrifugal vertical close-coupled sewage pumps with non-clog semi-open multi-vane self-cleaning impellers designed to transport wastewater with fibrous materials, with bottom inlets and side discharge, complete with submersible motors, submersible cables, and all necessary discharge base elbows, guide rail brackets, lifting chain with cable, anchors bolts, and accessories for wet pit operation.

B. Section Includes:

1. Submersible pumping units.
2. Discharge base elbow, discharge pipe, guide rails, brackets, lifting chain with cable, anchors bolts, and accessories for wet pit operation.
3. Control and power cables, cable holder and accessories for wet pit operation.
4. Installation, startup, testing, and placing in service assistance.
5. Training of Owner’s personnel.

C. Related Sections:

1. Division 43, Section 43 05 25 - "Common Requirements for Pumps"

### 1.3 REFERENCES

A. References: Following is a list of standards, which might be referenced in this Section:

1. American Bearing Manufacturer’s Association (ABMA):
   a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   b. 11 – Load Ratings and Fatigue Life for Roller Bearings.
2. ASTM International (ASTM):
   a. A48 – Specification for Gray Iron Castings.
   b. A572 – Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
3. National Electrical Manufacturer’s Association (NEMA): MG-1, Motors and Generators.
4. National Fire Protection Association (NFPA): NFPA 70, National Electric Code.

### 1.4 COMMON REQUIREMENTS

A. Refer to Division 43 Section 43 05 25 “Common Requirements for Pumps” for additional information for pumping units not specified in this Section. CONTRACTOR shall be responsible for ensuring the pumping units comply with the requirements of the referenced Section, in addition to the specific requirements as specified in this Section.

B. Refer to the above Section for information regarding the following:

1. Part 1: Submittals; quality assurance; project conditions; coordination; equipment delivery, handling, and storage; project conditions; design requirements; special warranties; and spare parts and tools.
2. Part 2: General requirements for pumping unit components; pump appurtenances; and source quality control.
3. Part 3: General requirements; installation of pumping units; manufacturer's services; field testing; and related work.
4. This Section will provide specific requirements for this Work.

1.5 SYSTEM DESCRIPTION

A. Design Requirements:

1. Summary:
   a. Provide the following pumping systems at the locations shown on the drawings:
      1) Three (3) non-clog, submersible pumps to be installed in the wastewater lift station as shown on the plans.
   b. Rail and Lifting System: For submersible pump installation provide a rail and lifting system, along with the power and control cables and accessories.
   c. Refer to P&ID's, Drawings, and Instrumentation Sections regarding the control logic and description for additional pump monitoring and control information as applicable.
2. Equipment shall be designed and capable of both continuous and intermittent wet pit operation as indicated on Drawings. Grit and other abrasive materials should be expected to be present as should rags, large solids and stringy material. The presence of these items will not be considered as abnormal, unanticipated or abusive with regard to the equipment operation and warranty.
3. All equipment supports, anchors and fasteners shall be Type 316 stainless steel and shall be of adequate strength to withstand loads associated with starting, turbulence, thrusts from liquid movement, thermal expansion and contraction and other loads encountered under normal operating conditions.
4. The equipment, sizes, materials, and arrangements described in this specification section are based on recommendations by equipment manufacturers and shall be considered minimum limits of acceptability. The equipment manufacturer shall be responsible for design, arrangement, and performance of all equipment supplied under this section. Arrangements other than those shown on plans shall be subject to ENGINEER's approval.

1.6 PERFORMANCE REQUIREMENTS

A. General Performance:

1. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water to a depth of 65 feet without loss of watertight integrity.
2. Pumping Unit System: Comply with performance requirements specified, as determined by testing assemblies representing those indicated for this Project.

B. Specific Performance Requirements: Refer to attached Pump Data Sheet after "END OF SECTION".

1.7 SPARE PARTS AND TOOLS

A. The following spare parts shall be furnished for each size of pump provided under this specification:
   1. Mechanical seal or seal repairs kit with all seal faces and O-rings.
   2. Upper and lower bearings set.
   3. Special tools required for maintenance or adjustment.
   4. Other items as recommended by manufacturer.

B. Furnish three (3) sets of spare parts for the lift station pumps.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components that fail(s) in materials or workmanship within specified warranty period.
   1. Standard Warranty Period: Two (2) years from date of Final Completion. Standard warranty shall be Non-Pro Rated with unlimited hours of operation. The cost of removal, shipment, repair, and installation by CONTRACTOR shall be included in the warranty and correction of defective work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   1. Flygt Corporation
   2. Flowserve
   3. KSB

2.2 PUMP CONSTRUCTION DETAILS

A. Type: Vertical, non-clogging, centrifugal sewage pump with bottom inlet and side discharge; direct driven by integral squirrel cage, electric induction motor. Pumping system shall include pump, motor, bearings, quick removal system, anchor bolts and all accessories specified herein.

B. Casing, Volute, and Stator Housing:
   1. Gray cast iron, ASTM A48, Class 30, Class 35B, or Class 40B, capable of prolonged resistance to raw sewage.
   2. Suction and discharge flanges shall be 125 lb and meet ANSI Standard B16.1.
   3. All nuts, bolts, washers, and other fastening devices supplied with pumps shall be stainless steel.
   4. Mating surfaces requiring watertight seal shall be machined and fitted with Buna-N O-rings. Paper gaskets, elliptical O-rings, grease, or other devices will be acceptable.

C. Shaft:
   1. Stainless steel; ASTM A 276, Type 416 or Type 420, or ASTM A 479, Type 431, with motor and pump shaft of one piece construction without joints or stubs attached. Carbon steel shafts or shafts with sleeves of any type are not acceptable.
   2. Shaft shall be dynamically balanced and shall be amply sized to minimize shaft deflection.

D. Bearings: Provide minimum of two (2) permanently lubricated bearings consisting of upper

radial bearings and lower thrust bearings rated for B-10 life of 50,000 hours in accordance with AFBMA.

E. Shaft Seal System:
   1. A tandem mechanical seal system consisting of two totally independent seal assemblies shall be provided that operate in a lubricant reservoir.
   2. Upper shaft seal consisting of stationary Tungsten carbide ring and rotating carbon ring or a rotating silicon carbide ring and a stationary carbon ring operating in an oil chamber below stator housing.
   3. Lower shaft seal consisting of stationary and rotating Tungsten carbide and silicon carbide rings designed to seal pumped liquid from stator housing.
   4. Each seal shall be held in place by its own independent stainless steel spring system.
   5. Oil chamber shaft sealing system shall be designed to prevent overfilling and to provide lubricant application capability. Provide drain and inspection plugs accessible from the outside.
   6. Seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable.

F. Impeller:
   1. ASTM A 532, Alloy III A, 25% chrome cast iron, 316 stainless steel or ACI-ASTM CA6NM Grade 410 hardened stainless steel; solids handling double vane or vortex non-clog type.
   2. Impeller vane shall be smooth, finished throughout, and free form sharp edges.
   3. Key driven and held to shaft by a streamlined impeller washer and bolt assembly designed to reduce friction in the suction eye of the impeller, such that the impeller cannot unscrew or be loosened by torque either forward or reverse rotation.
   4. Capable of passing the specified solid non-deformable sphere size through the bottom inlet between two shrouds as listed in the Pump Parameter Schedule.

G. Insert Ring (For Non-Vortex Impellers):
   1. The volute shall have a replaceable suction cover insert ring.
   2. The insert ring shall be cast of ASTM A 532, Alloy III A, 25% chrome cast iron or ACI-ASTM CA6NM Grade 410 hardened stainless steel and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

H. Drive Motor:
   1. Motor Horsepower: As required so the nameplate horsepower rating is not exceeded at any head-capacity point on the pump curve.
   2. Operation: Capable of operating with motor exposed to atmosphere and dry (no liquid around stator pump for cooling) for a minimum of ten (10) continuous minutes without damage to motor or seal.
   3. Enclosure: Submersible.
   4. Mounting: Vertical
   5. Motor Design:
      a. Power Supply: 480V, 3-phase, 60-Hz, unless otherwise indicated on Drawings.
      b. Squirrel-cage, induction motor, enclosed in a waterproof housing, for submersible application, meeting requirements of NEMA MG 1. Certified for continuous duty with a Service Factor of 1.15.

c. Air filled; constructed with moisture-resistant NEMA H insulation and Class H slot liners; constructed to NEMA B design standards.

d. Copper wound stator shall be either double or triple dipped in epoxy enamel and baked to withstand a temperature of 180°C (Class H) as defined in NEMA MG-1. Each winding phase or layer shall be laced with Type H glass lined paper.

e. Rotor shall be statically and dynamically balanced after fabrication and utilize aluminum bars and short circuit rings.

f. Designed for continuous duty capable of sustaining 30 starts per hour (Unlimited starts with VFD) at a minimum ambient temperature rise of 40°C.

g. Motors shall be capable of uninterrupted operation with a voltage drop of 10%.

h. Power cables entering the motor shall connect to individual terminal pins, which separates the incoming service from the motor.

i. Motor shall bear the Factory Mutual explosion-proof label certifying its use in a Class 1, Division 2, Groups C & D hazardous location.

j. Provide lifting eye.

k. Cooling system (if required on Pump Data Sheet):

1) Provide Type 304 stainless steel motor cooling jacket, encircling the stator housing, to provide for heat dissipation, regardless of the pump installation.

2) The cooling system shall be self-contained, using a closed loop cooling system and coolant to allow for running under full load conditions at 100% duty cycle with the motor exposed to air and/or in liquid temperatures up to 104°F.

3) The internal circulation of the pumped liquid as coolant is not acceptable. The use of fans, blowers or exposed cooling systems is not acceptable.

I. Motor Protection Devices:

1. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% of float sump capacity, signaling the need to schedule an inspection.

2. The thermal switches and float switch shall be connected to a motor protection relay unit provided by the pump supplier. The motor projection relays shall be mounted in the enclosures alongside the pump motor controllers.

J. Power and Control Cables:

1. Provide power and control cables in lengths to run un-spliced from the pump to the junction box or pump control panel. Cables shall terminate with conductor sleeves that bundle the entire group of strands of each phase to improve termination at the control panel.

2. The power cable shall be of a shielded design in which an overall tinned copper shield is included and each phase conductor is shielded with an aluminum coated foil wrap. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater, conforming to NEC and ICEA standards for loads, resistance under submersion against sewage, and heat and

chemical resistant.

3. Provide stainless steel cable grips for supporting cable at the top brackets.
4. Cable entry seal to be watertight and submersible.
    a. The cable entry chamber junction shall be separate from the motor chamber. The chamber junction shall be sealed from the motor chamber with a terminal board or the motor leads shall be staggered and sealed in a manner which prevents wicking.
    b. Type recommended in Factory Mutual Research Corporation for Explosion Proof Certification.

## 2.3 ACCESSORY EQUIPMENT

A. General Description: Consist of a discharge elbow that mounts in the bottom of the wet pit, a replaceable pump coupling, guide rails and supports, along with hardware required for a complete and operational system. Connections to piping shall be standard ANSI flanges.

B. Discharge Elbow: Cast iron, ASTM A48, Class 30B or higher; with 125-lb ANSI flanges.
1. Designed to support full weight of pump, providing a leak proof seal connection.
2. Pump connection to the base mounted discharge connection shall be automatic when the pump is lowered into place, and shall be easily disconnected without the need for personnel to enter the wet well.
3. Sealing of pumping unit to discharge elbow shall be accomplished by a simple linear downward motion of the pump.
4. Provide a sliding guide bracket of Type 304 stainless steel, ductile iron, or cast iron with epoxy coating for each pump as integral part of pump.
5. Provide Type 316 anchor bolts, size determined by pump manufacturer.
6. See data sheet and plans for connection type and size.

C. Pump Coupling: Cast iron construction, located between the pump discharge flange and the vertical face of the discharge base. Designed to seal against the vertical face of the discharge base using either a metal-to-metal contact or replaceable Buna-N compressible seal.

D. Guide Rail and Pump Lifting Assemblies:
1. Provide guide rail assemblies, complete with guide rail supports and anchor brackets, as required producing a complete and properly functioning system based on the sump dimensions and geometry as shown on the Drawings.
2. Provide Type 316 stainless steel guide rails supported by Type 316 stainless steel support brackets. Guide rails shall be Schedule 40 pipe. Provide intermediate support brackets for installations deeper than 20 feet. Anchor bolts shall be Type 316 stainless steel.
3. Lower guide rail support shall be integral with pump discharge base.
4. Provide each pump with the indicated manufacturer's accessories as listed below. Type and size shall be as recommended by the manufacturer.
    a. Upper guide bar holder.
    b. Electrode device holder.
    c. Lifting bale (Type 304 stainless steel) for safety cable.
    d. "Grip eye" pump lifting-chain positive recovery system of sufficient length and capacity for lifting pump from the wet well employing the hoist.
    e. Intermediate guide bar supports, as required.

f. Individual 316 stainless steel cable holder for each pump cable.

E. Equipment Identification Plate: 16-gauge Type 316 stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

2.4 FACTORY FINISH

A. Exterior ferrous surfaces shall receive the following Factory applied coating system:

1. Surface Preparation: Blasting per ISO 12944-4; Standard Cleanliness Grade 2.5; Minimum Peak to Valley Height 70 microns.
2. Coating System: Manufacturer’s standard coating system for the intended service conditions.
3. Provide touch up coating material, with the pumps, for CONTRACTOR'S use during installation.

B. Paint bases, piping and other surfaces in accordance with Division 9 Section 09 90 00 “Painting.”

2.5 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all pumping units and control panels to be furnished. Include test data sheets, curve test results, performance test logs, certified by a factory test engineer.

B. Performance Test:

1. All internal components including the pumps, motors, valves, piping and controls will be tested as a fully assembled, coated, and complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational tests shall simulate actual performance anticipated for the complete station.
2. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test.
3. At least one point shall be obtained as near as possible to each specified condition.
4. Results of the performance test shall be certified by a Registered Professional Engineer and submitted for approval prior to shipment. Upon request from the engineer, the operational test may be witnessed by the engineer, and/or representatives of his choice, at the manufacturer's facility.
5. The pump test acceptance grade shall be Grade 1U, as defined by the most recent Hydraulic Institute Pump Standard 11.6 "Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests".

C. Hydrostatic Test: Pump casing tested at 150 percent of shutoff head. Test pressure maintained for not less than five minutes.

D. Control Panels: If supplied by manufacturer, factory testing of the completed control panels shall be accomplished by the manufacturer prior to shipment.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Refer to Section 43 05 25 "Common Requirements for Pumps".

3.2 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Project site or classroom designated by OWNER, for minimum person-days listed below, travel time excluded:

| No. Person Days | Work Description |
|---|---|
| **1** | Installation assistance and inspection. |
| **1** | Functional and performance testing. |
| **1/4** | Pre-startup classroom or site training. |
| **1** | Facility startup. |
| **1/4** | Post-startup training of OWNER'S personnel. |
| **4** | Post-startup quarterly warranty inspections (8). |

B. Manufacturer shall perform quarterly visits to perform warranty inspection of each installed pump, including but not limited to, amperage, flow and pressure, and motor protection devices components (seal failure and winding thermal sensors) from beginning of warranty period described in Section 43 05 25 and ending at the end of the warranty period.

3.3 SUPPLEMENT

A. The Pump Data Sheet included after "END OF SECTION" shall be part of this section.

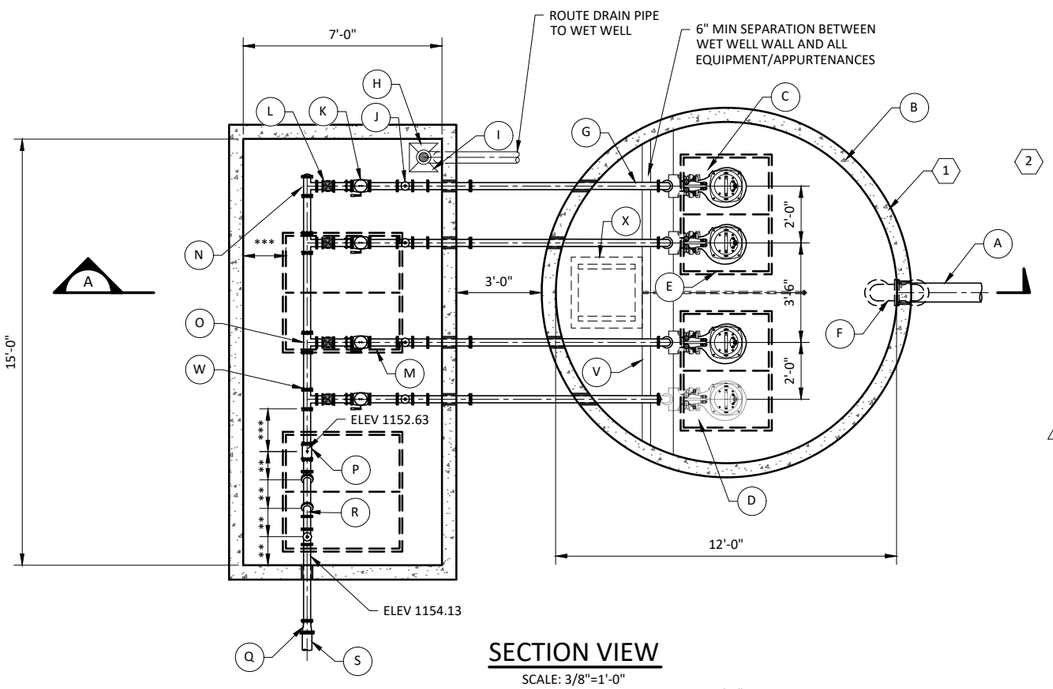
**END OF SECTION**

**PUMP DATA SHEET**
**SUBMERSIBLE CENTRIFUGAL PUMP**

| **Equipment Tag Number(s)** | PMP-101, PMP-102, PMP-103[1] |
|---|---|
| Quantity | 3 |
| Pump Name | See Note 1 |
| **Type** | |
| **Service Conditions** | |
| Liquid Pumped | Wastewater |
| Liquid Temperature, deg F | Max: 100 Min: 60 |
| Largest Diameter Solid Pump shall be capable of Passing, inches | 3” |
| Abrasive (Y/N) | Y |
| Possible Scale Buildup (Y/N) | Y |
| Explosion-proof (Y/N) | Y |
| Continuous Duty (Y/N) | Y |
| **Performance Requirements** | |
| Capacity at Primary Condition of Service, gpm | 90 |
| Total Head at Primary Condition, Ft. | 38 |
| Minimum Wire to Water Efficiency at Primary Condition, % | 40 |
| Capacity at Secondary Condition of Service, gpm | 170-200 |
| Total Head at Secondary Condition, Ft. | 28 |
| Shutoff Pressure, Minimum, Ft. | 46 |
| Pump Speed, Maximum, rpm | 1,800 |
| Motor HP, Minimum | 7.5 |
| Constant Speed (Y/N) | N |
| Adjustable Speed (Y/N) | Y |
| **Construction Details and Accessories** | |
| Cable Grips | 316 Stainless Steel |
| Suction (Size, Rating, Facing) | 3" |
| Discharge Base Elbow (Size, Rating, Facing) | 3" |
| Hydrostatic Test Pressure (psig) | 1.5 times shutoff head |
| Field Testing (Required/Not Required) | Required |
| Control Panel (Y/N) | N |
| Cooling System Required (Y/N) | N |

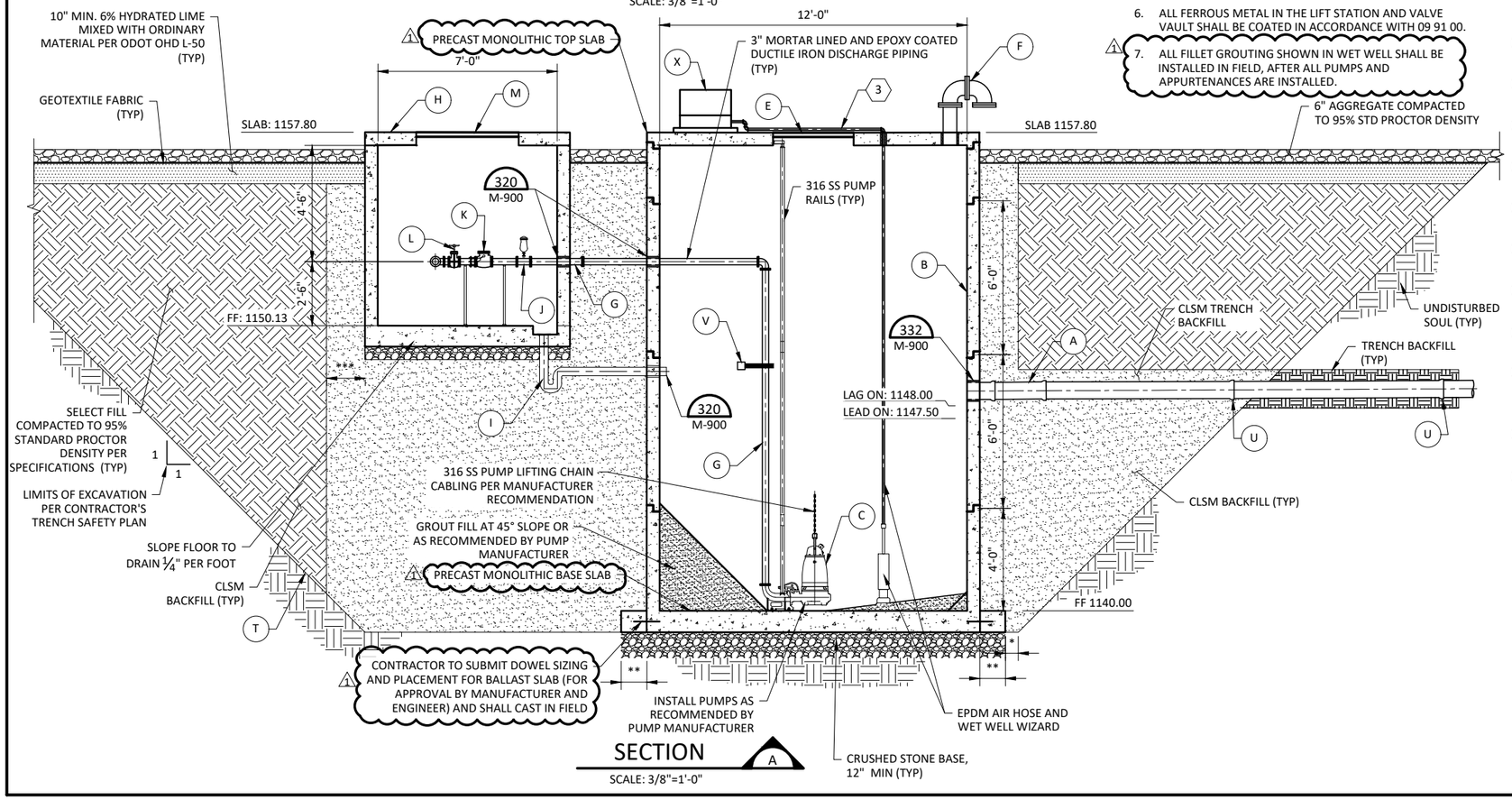
NOTES

1. Coordinate with Owner for equipment tag numbers and pump name.
2. Contractor shall coordinate with pump manufacturer to confirm hatch clear opening size and hatch location to allow for pump manufacturer’s recommended pump clearance through hatch. Pump removal shall be achievable without rotating pump or disconnecting prematurely from guide rails.




## SECTION VIEW

SCALE: 3/8"=1'-0"




## SECTION A

SCALE: 3/8"=1'-0"

DISTANCE MEASUREMENTS:

* 0.5 FEET

** 1.0 FEET

*** 1.5 FEET

NOTES BY SYMBOL "1":

1. SEE SERIES E-100 SHEETS FOR ELECTRICAL PENETRATIONS AND JUNCTIONS BOXES.
2. SELECT FILL, AGGREGATE, CLSM, AND GEOTEXTILE FABRIC NOT SHOWN IN TOP VIEW FOR CLARITY.
3. CONTRACTOR SHALL ROUTE 304 SS WET WELL WIZARD PIPING BETWEEN HATCHES. PIPING SIZE SHALL BE PER WET WELL WIZARD MANUFACTURER. SECURE PIPING TO THE WET WELL LID WITH STAINLESS STEEL STRAPS. CORE DRILL WET WELL LID AND ROUTE PIPING THROUGH HOLE. SECURE PIPING IN HOLE WITH LINK SEAL PER DETAIL 326 ON SHEET M-900. TRANSITION TO EPDM AIR HOSE.

NOTES:

1. REFER TO SPECIFICATIONS FOR BACKFILL REQUIREMENTS.
2. CONTRACTOR SHALL COORDINATE FINAL HATCH SIZES AND LOCATIONS AS WELL AS ALL ADDITIONAL PENETRATIONS WITH WET WELL, VALVE VAULT, AND PUMP MANUFACTURERS DURING SUBMITTAL PERIOD.
3. TOP SLAB ELEVATION FOR BOTH STRUCTURES SHALL BE AT LEAST 8" AND NO MORE THAN 12" ABOVE FINISHED GRADE, WITH THE SEAMS BETWEEN THE VAULT LIDS AND WALLS ENTIRELY ABOVE FINISHED GRADE.
4. ALL DI DISCHARGE PIPING SHALL BE FLANGED UNLESS NOTED OTHERWISE.
5. CONTRACTOR MAY SUBSTITUTE DI LIFT STATION DISCHARGE PIPING WITH FLANGED 316 SCH 80 S.S. PIPING AT NO ADDITIONAL COST.
6. ALL FERROUS METAL IN THE LIFT STATION AND VALVE VAULT SHALL BE COATED IN ACCORDANCE WITH 09 91 00.
7. ALL FILLET GROUTING SHOWN IN WET WELL SHALL BE INSTALLED IN FIELD, AFTER ALL PUMPS AND APPURTENANCES ARE INSTALLED.

| PROPOSED LIFT STATION COMPONENTS | | QUANTITY |
|---|---|---|
| A | PROPOSED 8" PVC GRAVITY SEWER (SEE SHEET C-102) | 1 |
| B | 12' DIA PRECAST POLYMER CONCRETE WET WELL WITH PRECAST TOP AND BOTTOM SLABS | 1 |
| C | SUBMERSIBLE PUMP | 3 |
| D | FUTURE SUBMERSIBLE PUMP AND APPURTENANCES | 1 |
| E | DOUBLE LEAF 36"x48" EJCO HATCH (OR APPROVED EQUAL) WITH FALL PROTECTION | 2 |
| F | 4" STAINLESS STEEL VENT | 1 |
| G | 3" DI FLANGED DISCHARGE PIPING AND FITTINGS | 4 |
| H | 15'x7' PRECAST PORTLAND CEMENT VAULT WITH CAST-IN-PLACE TOP AND BOTTOM SLABS (SEE SERIES "S" SHEETS FOR REFERENCE) (CONTRACTOR MAY SUPPLY FULLY PRECAST STRUCTURE IN LIEU OF CAST-IN-PLACE SLABS) | 1 |
| I | 12" FLOOR DRAIN AND 6" DUCTILE IRON DRAIN PIPE PER DETAIL 368 ON SHEET M-901 | 1 |
| J | 1" COMBINATION AIR/VACUUM VALVE AND DI PIPING | 5 |
| K | 3" CUSHIONED SWING TYPE CHECK VALVE WITH DI SPOOL PIECE | 4 |
| L | 3" PLUG VALVE, WITH FLANGED JOINTS | 5 |
| M | DOUBLE LEAF 48"x48" EJCO ACCESS HATCH (OR APPROVED EQUAL) WITH FALL PROTECTION | 2 |
| N | 4" DI BLIND FLANGE | 2 |
| O | 3"x3" DI FLANGED TEE | 4 |
| P | 3" FLANGED MAGNETIC FLOW METER | 1 |
| Q | 3"x4" DI FLANGED REDUCER | 1 |
| R | 3" FLANGED DI 45° BEND | 2 |
| S | PROPOSED 4" FORCE MAIN (SEE SHEETS C-100 AND C-101) | 1 |
| T | GEOTEXTILE FABRIC AT LIMITS OF EXCAVATION | 1 |
| U | PIPE JOINT AT EACH CHANGE IN PIPE EMBEDMENT | 4 |
| V | PRECAST 316 STAINLESS STEEL SUPPORT INSTALLED PER WET WELL SUPPLIER AND IN ACCORDANCE WITH SPECIFICATION SECTION 40 05 07 | 2 |
| W | 3" FLANGED COUPLING ADAPTER | 9 |
| X | WET WELL WIZARD BLOWER, PIPING, AND PROTECTION COVER | 1 |

PLUMMER
531 COUCH DR. STE 200 | OKLAHOMA CITY, OK 73102
405.440.2725 | OKLAHOMA FIRM NO. 1097

| NO. | DATE | REVISION | BY |
|---|---|---|---|
| 1 | 08/23 | ADDENDUM #1 | RGW |

CITY OF MIDWEST CITY
100 N MIDWEST BOULEVARD, MIDWEST CITY, OK 73110

CITY OF MIDWEST CITY
NORTH SIDE UTILITIES SANITARY SEWER PROJECT

LIFT STATION MECHANICAL
WET WELL AND METER VAULT PLAN AND SECTION

ROBERT WEINERT 31596 LICENSED PROFESSIONAL ENGINEER OKLAHOMA 08/25/2023

IF THIS BAR DOES NOT MEASURE ONE INCH, DRAWING IS NOT TO LABELED SCALE

| | |
|---|---|
| DESIGNED | R. WEINERT |
| DRAWN | F. CAVE |
| CHECKED | G. FARAH |
| REVIEWED | A. SWARTZ |

Seq. 14 36
Dwg. No. M-100
3435-003-01

ATTACHMENT #6

PRINTED: 8/25/2023 1:30 PM C:\Users\fcave\DCVACCDocs\Plummer Associates\3435-003-01 MWC_Utility_PH1\Project Files\Plummer\Sheets\MECHANICAL\M-LIFT STATION LAYOUT.dwg SAVED: 7/12/2023 9:54 AM SAVED BY: Fcave USER: Cave, Forrest