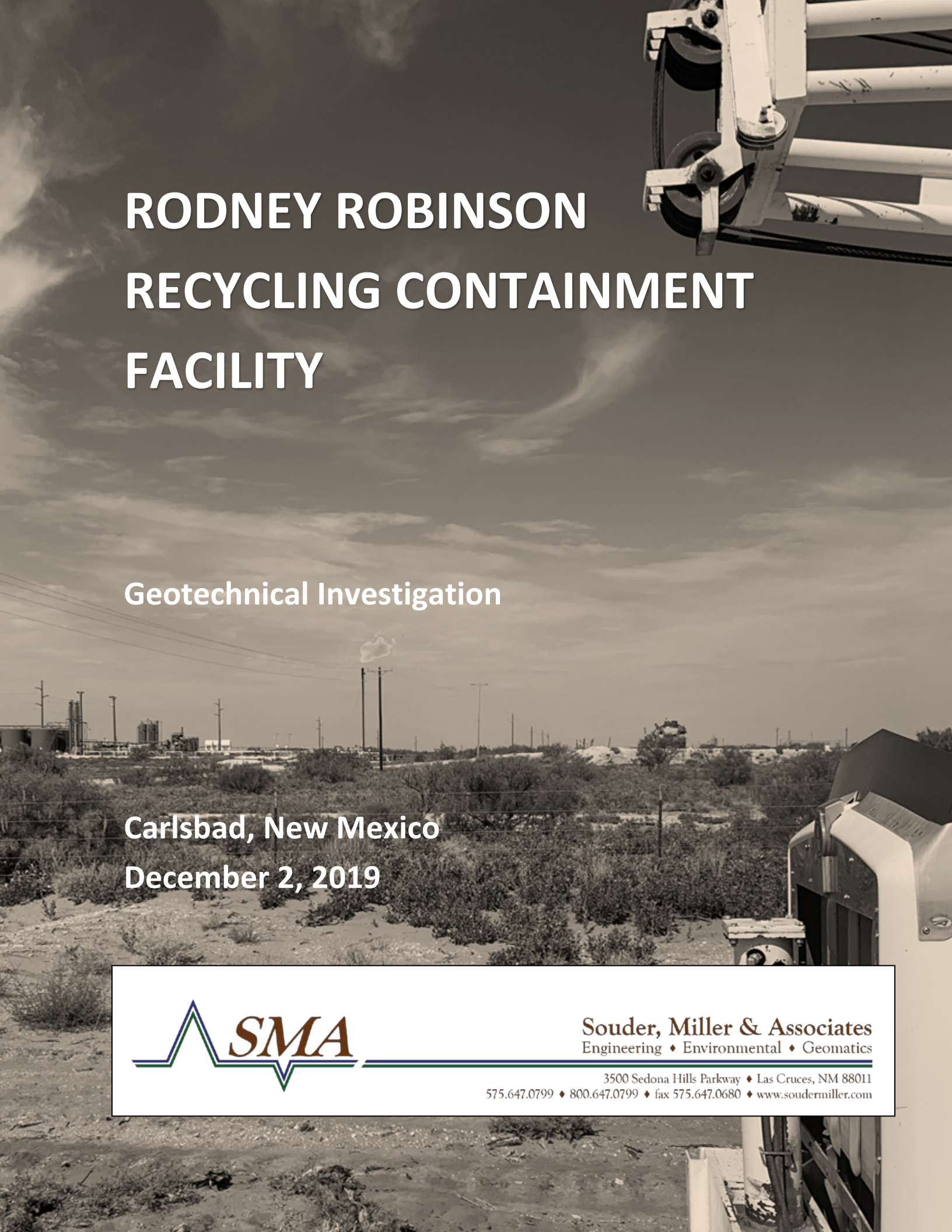


RODNEY ROBINSON RECYCLING CONTAINMENT FACILITY

Geotechnical Investigation

Carlsbad, New Mexico
December 2, 2019

SMA

Souder, Miller & Associates
Engineering ♦ Environmental ♦ Geomatics

3500 Sedona Hills Parkway ♦ Las Cruces, NM 88011
575.647.0799 ♦ 800.647.0799 ♦ fax 575.647.0680 ♦ www.soudermiller.com

Souder, Miller & Associates ♦ 3500 Sedona Hills Parkway ♦ Las Cruces, NM 88011
(575) 647-0799 ♦ (800) 647-0799 ♦ fax (575) 647-0680

December 2, 2019 #5E28189

Mr. Garrett Hunt
Matador Production Company
One Lincoln Centre
5400 LBJ Freeway, Suite 1500
Dallas, Texas 75240

RE: **Rodney Robinson Recycling Containment Facility**
Geotechnical Investigation Report

Dear Mr. Hunt:

Souder, Miller and Associates (SMA) is pleased to present the enclosed Geotechnical Investigation Report for the Rodney Robinson Recycling Containment Facility. The attached report analyzes the existing subgrade soils sampled from eight (8) soil test borings obtained within the development. Results from the subsurface investigation found that soils are predominately classified as silty sands. Due to the high percentage of silty sand materials within the project site, additional care and processing is recommended for the preparation of on-site materials prior to the construction of structures.

SMA understands the Owner anticipates the installation of three different structure types within the site and provided earthwork as well as applicable foundation system recommendations per structure type: earthen berms, water storage tank, treatment area. Existing materials could be utilized for the installation of the earthen berm and the treatment area under the pretense that the materials are overexcavated to the recommended depth as noted in Section 6.3 of the geotechnical investigation report, moisture treated, and recompacted.

SMA recommends the utilization of a gravel-based foundation system for the proposed water tank assuming the floor of the water tank is designed to rigidly support the lateral forces of the fluids within the tank. Please refer to Section 6.3.2 of the attached Geotechnical Investigation report for additional recommendations.

Should you have any questions, require any further information or if any portion of the report requires modification to meet your specific needs, please do not hesitate to contact our office.

Sincerely,

MILLER ENGINEERS, INC. D/B/A
SOUDER, MILLER & ASSOCIATES

Sarah V. Garduño, EIT
Staff Civil Designer
sarah.garduno@soudermiller.com

Paul J. Pompeo, PE
Senior Design Manager
paul.pompeo@soudermiller.com

Enc: Rodney Robinson Recycling Containment Facility Geotechnical Investigation Report

GEOTECHNICAL INVESTIGATION

RODNEY ROBINSON RECYCLING CONTAINMENT FACILITY

CARLSBAD, NEW MEXICO

Prepared for

Matador Production Company
One Lincoln Centre
5400 LBJ Freeway, Suite 1500
Dallas, Texas 75240

December 2, 2019

This document was prepared under the supervision and direction of the undersigned whose seal as a Professional Engineer, licensed to practice as such in the State of New Mexico, is affixed below.

Paul J. Pompeo, P.E.

11490 — NMPE Number

12/02/2019 — Date

GEOTECHNICAL INVESTIGATION REPORT
RODNEY ROBINSON RECYCLING
CONTAINMENT FACILITY

CARLSBAD, NEW MEXICO

DECEMBER 2, 2019

1.0 Introduction

Souder, Miller and Associates (SMA) was retained by Mr. Garrett Hunt of Matador Production Company to prepare the following geotechnical report. From the site's subsurface investigation through obtaining soil test borings, the nature of the substrata soils will be determined, and its characteristics ascertained. This information shall then be used for the design of a foundation system for a water storage tank, design recommendations for the water storage pit berms, and determination of the suitability of the native material for bedding and backfill. A project location map and boring location maps are in Appendix A.

2.0 Scope of Work

The intent of the investigation is to obtain subsurface data at the site and provide recommendations for the installation of three structures which include a water storage tank, a water pit with earthen berms as well as a treatment area for heavy equipment at the Rodney Robinson Recycling Containment Facility. The extent of this subsurface study included the drilling of eight (8) soil test borings and the laboratory testing of these soil samples collected from the site. All testing and drilling was completed by technicians from the drilling and soils testing subcontractor, Southwest Engineering, Inc. (SEI). Further discussion of the findings is in Section 6.0. These findings include:

- A review of test procedures and the results of all testing conducted
- A review of site and subsurface conditions
- Boring logs and laboratory test results
- Foundation & earthwork recommendations

3.0 Site Description

A review of the project site was made by SMA personnel prior to drilling operations to document the current site conditions and characteristics. The project site is in Lea County, New Mexico. The proposed containment facility is found in Township 23S, Range 33E, Section 6. The project site is approximately 32 miles east of the City of Loving, approximately 9.5 miles northeast of the intersection of an unmarked roadway and Jal Highway. The immediate area is currently being developed for the Rodney Robinson Recycling Containment Facility and consists of vacant desert terrain. Property to the north, south, east and west are also vacant desert terrain. Development of the area includes site clearing, grading, installation of water storage tank, installation of a water pit and construction of drainage control features.

4.0 Investigation Procedures

The general field procedures employed by SEI are summarized in ASTM Specification D-420 entitled "Investigation and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in situ methods as well as borings.

A CME-85 Drilling Rig, mounted on a Kenworth T800, equipped with hollow-flight augers, penetration and soil sampling equipment was used on this project. Borings are drilled to obtain subsurface samples using one of three alternate techniques depending upon the subsurface conditions. These techniques are continuous 2¼ or 8¼ inch I.D. hollow stem augers, wash borings using roller cone or drag bits (mud or water) or continuous flight augers (ASTM D1452). These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by the SEI Chief Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observation of groundwater. It also contains the driller's interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information.

The soil and rock samples plus the field boring records are reviewed by the engineering staff at SMA. The staff classifies the soils in general accordance with the procedures outlined in ASTM Specification D2488 and prepares the final boring records which are the basis for all evaluations and recommendations. The final test boring records represent our interpretation of the contents of the field records based on the results of the engineering examination and test of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the boring locations. Also, the passage of time may result in a change in the subsurface soil and groundwater conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The actual transition between materials may be gradual. The boring records are included in Appendix B.

The borings were drilled using hollow-stem augers and solid-flight augers, as noted in the boring logs. Penetration testing and split barrel sampling were conducted in the borings at regular intervals.

The standard penetration test (SPT) provides an indication of the soil strength and compressibility. The SPT resistances and split barrel sampling are conducted simultaneously per ASTM D1586. At regular intervals, the drilling tools are removed, and soil samples obtained with a standard split tube sampler. The sampler is first seated six inches, to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling thirty inches. The number of hammer blows required to drive the sampler the final foot is recorded and is designated the "penetration resistance".

5.0 Subsurface Conditions

The subsurface condition of the project area was determined from eight (8) soil test borings. The boring locations were selected by SMA after a review of the project site. The soil test borings were drilled at various locations throughout the proposed subdivision. From the existing site grade, the soil test borings were advanced to a depth of 25 feet. The boring locations are shown on the location map in Appendix A.

Standard Penetration Tests were conducted in the borings at intervals in general accordance with ASTM D1586. Disturbed samples were obtained during this test and were used to classify the soils. The standard penetration resistances obtained provide a general indication of soil strength and compressibility.

The subsurface conditions encountered are shown in the boring logs in Appendix B. These records represent our interpretation of the subsurface conditions based on field logs, visual examination of field samples and laboratory testing of representative field samples. The lines designating the interface between various strata on the boring logs represent the approximate interface location. In reality, the transition between strata may actually be gradual.

5.1 Soil and Rock Conditions

The soil profile of the test holes shows the following:

Boring 1		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0'–7.5'	Reddish Silty Sand	SM
7.5'–10.0'	Whitish Tan Silty Sand w. Caliche Gravel	SM
10.0'–15.0'	Whitish Tan Silty Clayey Sand *(small caliche gravel)*	SC/SM
15.0'–20.0'	Whitish Tan Silty Clayey Sand *(small caliche gravel)*	SC/SM
20.0'–25.0'	Whitish Tan Silty Clayey Sand w. Caliche Gravel	SC/SM
25.0'- 26.5'	Whitish Tan Silty Clayey Sand w. Caliche Gravel	SC/SM

Boring 2		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0’–7.5’	Reddish Silty Sand	SM
7.5’–10.0’	Reddish Silty Sand	SM
10.0’–15.0’	Reddish Brown Silty Sand w. Caliche Gravel	SM
15.0’–20.0’	Whitish Tan Silty Sand w. Caliche Gravel	SM
20.0’–25.0’	Whitish Tan Silty Sand w. Caliche Gravel	SC/SM
25.0’- 25.5’	Whitish Tan Silty Clayey Sand	SC/SM

Boring 3		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0’–7.5’	Reddish Silty Sand	SM
7.5’–10.0’	Whitish Brown Silty Sand	SM
10.0’–15.0’	Whitish Tan Silty Sand w. Caliche Gravel	SM
15.0’–20.0’	Whitish Tan Silty Sand w. Caliche Gravel	SM
20.0’–25.0’	Whitish Tan Silty Sand w. Caliche Gravel	SM
25.0’- 25.5’	Whitish Tan Silty Sand w. Caliche Gravel	SM

Boring 4		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0’–7.5’	Reddish Poorly Graded Sand w. Silt	SP/SM
7.5’–10.0’	Reddish Poorly Graded Sand w. Silt	SP/SM
10.0’–15.0’	Reddish Silty Sand	SM
15.0’–20.0’	Reddish Silty Sand	SM
20.0’–21.5’	Whitish Tan Silty Sand w. Caliche Gravel	SM

Boring 5		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0’–7.5’	Reddish Poorly Graded Sand w. Silt	SP/SM
7.5’–10.0’	Reddish Poorly Graded Sand w. Silt	SP/SM
10.0’–15.0’	Reddish Brown Silty Clayey Sand	SC/SM
15.0’–20.0’	Reddish Brown Silty Sand	SM
20.0’–21.5’	Whitish Tan Silty Sand w. Caliche Gravel	SM

Boring 6		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0’–7.5’	Whitish Tan Silty Sand w. Caliche	SM
7.5’–10.0’	Whitish Tan Silty Sand w. Caliche	SM
10.0’–15.0’	Whitish Tan Silty Sand w. Caliche	SM
15.0’–20.0’	Whitish Tan Silty Sand w. Caliche	SM
20.0’–21.5’	Whitish Tan Silty Sand w. Caliche	SM

Boring 7		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0’–7.5’	Whitish Tan Silty Sand	SM
7.5’–10.0’	Whitish Tan Silty Sand w. Caliche Gravel	SM
10.0’–15.0’	Whitish Tan Silty Sand	SM
15.0’–20.0’	Whitish Tan Silty Sand	SM
20.0’–21.5’	Whitish Tan Silty Sand	SM

Boring 8		
Depth	Soil Description	Soil Classification
0.0'–2.5'	Reddish Poorly Graded w. Silt	SP/SM
2.5'–5.0'	Reddish Poorly Graded Sand w. Silt	SP/SM
5.0'–7.5'	Reddish Poorly Graded Sand w. Silt	SP/SM
7.5'–10.0'	Reddish Silty Sand	SM
10.0'–15.0'	Whitish Tan Silty Sand w. Caliche	SM
15.0'–20.0'	Whitish Tan Silty Sand w. Caliche	SM
20.0'–21.5'	Whitish Tan Silty Sand w. Caliche	SM

5.2 GROUND WATER

SMA understands that a proposed leak detection system will be placed beneath the primary liner within the water pit. As such, Soil Boring No. 4 was advanced to depth of 60-feet below the existing subgrade to locate ground water if present. Ground water was not encountered at the time of drilling within the project area.

5.3 SOIL CHEMISTRY

No laboratory tests were performed to determine the chemical properties of the surface soils within the project area, although record data was reviewed to determine the general soil properties. Soil properties were determined from soil survey information accessed on-line via the United States Department of Agriculture Web Soil Survey at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. The soil(s) found within the project location are as follows:

Soil Chemistry Summary						
Soil Type	Soil Name	Hydrologic Soil Classification	pH Range	Salinity (milliohm/cm)	Risk of Corrosion Untreated Steel	Risk of Corrosion Concrete
KM	Kermit Soils & Dune Land	A	6.6 to 8.4	0.0 to 2.0	Moderate	Low

For these soil types, Type I or Type IA cement can be used for most concrete foundations. If drainage structures are anticipated to have moderate to high sulfate concentrations, Type II cement should be used.

6.0 Discussion and Recommendations

6.1 General Criteria

The primary objective of this report was to determine applicable design parameters for the foundation systems of light duty loads as well as foundation systems for the water storage tank based on the soil parameters determined during this investigation.

6.2 Project Development Criteria

Results from the subsurface investigation of the project site found that soils are predominately classified as medium dense sands and silt with low moistures. As such, the site soils are adequate for structures such as the treatment area and the earthen berm to be directly constructed on with the proper preparation of soils. Installation of the water storage tank will entail import of engineered granular fill materials. Engineered fill materials and native materials shall extend above the existing site grade allowing for adequate drainage conditions.

For freeze thaw conditions, the minimum perimeter footing embedment shall not be less than 18-inches below final finished site grade for shallow foundations. The maximum elevation difference between final slab grade and adjacent site grade shall not exceed 4-inches. This type of foundation could include but not be limited to spot footings, spread footings, continuous or grade beam footings, mat foundation systems and post-tension foundation systems. Any required fill materials will be from the project site and shall be installed per Section 7.0.

Foundation selection must satisfy two basic, independent criteria. First, the bearing pressure which includes the surcharge loads that are a result from the placement of existing and proposed fill materials that are transmitted to the foundation soils should not exceed an allowable bearing pressure. This allowable bearing pressure applies an adequate factor of safety that is applied to the soil shear strength. Secondly, the settlement due to consolidation of the underlying soils during the operating life of the structure must be within tolerable limits.

6.3 Site Development & Foundation Recommendations

It is SMA's understanding that the Owner anticipates the installation of three different structure types within the project site. The three different structures will include a water storage tank, a storage area as well as a water pit with an earthen berm. Based upon the anticipated loading SMA has prepared the following earthwork and foundation system recommendations per structure.

All fill and/or backfill materials if required and as a minimum, shall meet the requirements set forth in Section 7.0 and shall be placed in compacted layers not to exceed 6 inches in thickness. All fill materials shall be moisture treated to a level of +/- 2 percent of optimum and compacted to 95 percent of ASTM D1557. The top layer of native material below any excavated area shall be scarified, moisture treated to a level of +/- 2 percent of optimum and compacted to 95 percent of ASTM D1557.

6.3.1 Earthen Berms

Based upon the proposed location of the structure, recommendations have been provided based upon the soil boreholes B4 thru B8. Lab results determined the materials within the proposed location of the anticipated water pit are classified as medium dense sands. SMA recommends approximately 2-feet of existing material located beneath the proposed earthen berm be scarified, moisture treated and recompacted. Should the existing soil material be utilized as fill for the earthen berm, an anticipated 15% of volumetric loss due to compaction may occur.

6.3.2 Water Storage Tank

Based upon the proposed location of the structure, recommendations have been provided based upon the soil boreholes B3. Lab results determined the materials within the proposed location of the anticipated water storage tank are classified as medium dense sands.

The proposed water storage tank is approximately 160-feet in diameter with an anticipated storage volume of 224,599 cubic feet and an 11-feet water height. SMA recommends the installation of a gravel-based foundation system assuming the floor of the tank is designed to rigidly support the lateral forces of the fluids within the tank without the aid of a foundation system. Materials extending 10-feet around the outer edge of the tank shall be excavated to a depth of 1.5-feet. The in-situ material shall be proofrolled, moisture treated, and compacted to 95 percent optimum density. SMA recommends placing a 2.0-feet layer of ASHTO M43 Size 56 aggregate, in densified 0.5-feet lifts, extending 8-feet level surface that tapers to existing grade around the outer edge of the tank to create the densified gravel-based foundation system.

Should the anticipated tank and/or foundation system installed vary significantly from the information provided above, SMA should be contacted to further provide recommendations.

6.3.3 Treatment Area

Based upon the proposed location of the structure, recommendations have been provided based upon the soil boreholes B1 and B2. Lab results determined the materials within the proposed location of the anticipated heavy equipment parking area are classified as medium dense sands with silts. It is recommended that the top 1-feet of material be overexcavated, moisture treated and recompacted. Due to the anticipated loading, SMA recommends placing 8-inches of compacted base course on top improved soil materials in order to act as a driving surface for heavy equipment.

All fill and/or backfill materials if required and as a minimum, shall meet the requirements set forth in Section 7.0 and shall be placed in compacted layers not to exceed 6 inches in thickness. All fill materials shall be moisture treated to a level of +/- 2 percent of optimum and compacted to 95 percent of ASTM D1557. The top layer of native material below any excavated area shall be scarified, moisture treated to a level of +/- 2 percent of optimum and compacted to 95 percent of ASTM D1557.

6.4 TENSION LOADS

Uplift loads will be resisted only by the weight of structure and corresponding foundation design.

6.5 *LATERAL LOADS & RETAINING STRUCTURES*

The fill and/or backfill soils to be used on this project shall be cohesionless and follow the requirements of Section 7.0. The following values will be used for the design of retaining structures within the project area, as applicable.

Retaining Structure Design Parameters	
Allowable Bearing Capacity	1,500 psf
Soil Unit Weight(1)	118 pcf
Soil Angle of Internal Friction (2)	30º
Coefficient of Friction (Soil to Concrete) (3)	0.25
Active Earth Pressure, K_a (Level backfill)	40 pcf
Passive Earth Pressure, K_p (Level backfill)	354 pcf
At Rest Earth Pressure, K_o (Level backfill)	59 pcf

(1) – From historical proctor information of the surrounding area.
(2) – From "Foundation Analysis" by Bowels
(3) – From the International Building Code, Table 1806.2

6.6 *SEISMIC LOADS*

Seismic design considerations following the requirements of the 2015 NEHRP Provisions. Design values are calculated on the United State Geologic Survey website, "Earthquake Hazards Program" at https://seismicmaps.org/.

Site Location Information		
Risk Category(1)	I, II, or III	
Site Soil Classification (2)	D	
Location	Latitude	Longitude
	32.33663°	-103.61763°
Seismic Design Parameters (g)		
S_S	S_{MS}	S_{DS}
0.172	0.279	0.184
S_1	S_{M1}	S_{D1}
0.044	0.105	0.07

(1) – From the International Building Code, Table 1806.2
(2) – From the International Building Code, Table 1613.5.2

6.7 SITE DRAINAGE

The site drainage patterns are generally to the southeast in a mild form. Final site development shall be such that water from storm events will not be allowed to saturate soils under or adjacent to foundation systems. Positive surface drainage shall be maintained ***at all times*** away from the structures with a minimum slope of 0.5 percent for concrete, 1.0 percent for asphalt pavement areas and 2.0 percent for earthen ground cover areas.

6.8 SETTLEMENT EVALUATION

Based on the soil properties found within the project site and the anticipated foundation loads, the following settlement values have been estimated for site development options using conventional foundation systems.

Estimated Settlement Values	
Estimated Total Settlement	1.5 inches
Estimated Differential Settlement	0.75 inches

These values assume that all earthwork construction within the project site meets the minimum specifications outlined in Section 7.0. As with most soils, any intrusion of water into the subgrade below foundations will cause a reduction in bearing capacity. The actual rate of decrease varies widely depending on the type of soil. This loss of bearing capacity can lead to differential settlement of the structure and could ultimately lead to failure. For these reasons, the final site areas shall be developed to account for proper drainage as outlined in Section 6.8.

7.0 Recommended Earthwork Specifications – Small Projects

7.1 GENERAL

7.1.1 Description of Work

A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for general earthwork construction including, but not limited to, the following:
   1. Site preparation.
   2. Excavation.
   3. Underpinning.
   4. Filling and backfilling.
   5. Grading.
   6. Soil Disposal.
   7. Clean Up

7.1.2 Definitions

A. Unsuitable Materials:
   1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 3 inches; organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within

2 percent of optimum moisture content at time of compaction, as defined by ASTM D1557.

2. Existing Subgrade (Except Footing Subgrade): Same materials as 7.1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
3. Existing Subgrade (Footings Only): Same as 7.1.2.A.1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to the Geotechnical Engineer's approval.

B. Building Earthwork: Earthwork operations required in area enclosed by a line located 5 feet outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.
C. Trench Earthwork: Trench work required for utility lines.
D. Site Earthwork: Earthwork operations required in area outside of a line located 5 feet outside of principal building perimeter and within new construction area with exceptions noted above.
E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1557, ASTM D2167, and ASTM D6938.
F. Fill: Satisfactory soil materials used to raise existing grades. In the project construction documents and drawings, the term "fill" means fill or backfill as appropriate.
G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the Project Engineer.
I. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular fill.
J. Structure: Buildings, foundations, slabs, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
K. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
L. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

7.1.3 Applicable Publications

A. The latest edition of the publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
B. American Society for Testing and Materials (ASTM):

D1557 ..... Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700 kN m/m3))

D2167 ..... Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

D2487 ..... Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)

D6938 ..... Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

7.2 PRODUCTS

7.2.1 Materials

A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.

B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, and SC, or any combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 110 pcf, a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.

C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, and SC, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 1 1/2-inch sieve and not more than 35 percent passing a No. 200 sieve, per ASTM D2940.

7.3 EXECUTION

7.3.1 Site Preparation

A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions.

B. Grubbing: Remove stumps and roots 3 inch and larger diameter. Undisturbed sound stumps, roots up to 3-inch diameter and nonperishable solid objects a minimum of 3 feet below subgrade or the bottom of foundation, slabs and pavements.

C. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations.

7.3.2 Excavation

A. Shoring, Sheeting and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Geotechnical Engineer, banks of excavations to protect workmen, banks, adjacent paving, structures and utilities.

1. Design of the temporary support of excavation system is the responsibility of the Contractor.
2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the Geotechnical Engineer.
3. Extend shoring and bracing to a minimum of 5 feet below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall provide a concrete footing, under disturbed foundations, as directed by Geotechnical Engineer, at no additional cost to the Owner. Do not remove shoring until permanent work in excavation has been inspected and approved by Geotechnical Engineer.

B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and

undisturbed until approval of permanent work has been received from Geotechnical Engineer. If the excavation becomes saturated, approval by the Geotechnical Engineer is also required before placement of the permanent work on all subgrades.

C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the Geotechnical Engineer.

D. Building Earthwork:
   1. Excavation shall be accomplished as required by drawings and specifications.
   2. Excavate foundation excavations to solid undisturbed subgrade.
   3. Remove loose or soft materials to a solid bottom.
   4. Fill excess cut under footings or foundations with properly compacted engineered fill.
   5. Do not tamp earth for backfilling in footing bottoms, except as specified.
   6. Slope grades to direct water away from excavations and to prevent ponding.

E. Trench Earthwork:
   1. Utility trenches:
      a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
      b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
      c. Support piping on undisturbed earth unless a mechanical support is shown.

F. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities and other items indicated to be removed; together with soil, boulders and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by the project drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements and for inspections. Remove subgrade materials that are determined as unsuitable by this specification and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the Geotechnical Engineer shall obtain samples of the material and determine the soil classification for each sample to determine whether it is unsuitable or not.
   1. Site Grading:
      a. Provide a smooth transition between adjacent existing grades and new grades.
      b. Cut out soft spots, fill low spots and trim high spots to comply with required surface tolerances.
      c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed.

7.3.3 Filling and Backfilling

A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions and deleterious materials have been removed from excavation. For fill and

backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, foundation drainage and pipes coming in contact with backfill have been installed and work inspected and approved by the Geotechnical Engineer.

B. Placing: Place materials in horizontal layers not exceeding 6 inches in compacted depth for material compacted by heavy compaction equipment, and not more than 4 inches in compacted depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen or contain frost.

C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 10 feet of new or existing building walls without prior approval of Geotechnical Engineer. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Compact soil to not less than the following percentages of maximum dry density, according ASTM D1557 as specified below:
    1. Fills, Embankments, and Backfill
        a. Under proposed structures, building slabs, steps and paved areas, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material in to 95 percent.
        b. Landscaped areas to 90 percent.
    2. Natural Ground (Cut or Existing)
        a. Under building slabs, steps and paved areas, top 6 inches of compacted material to 95 percent.

D. Construction Material Testing
    1. Proctor Testing
        a. A Proctor Test shall be completed in accordance with ASTM D1557 standards to determine applicable moisture to density relationship per each soil type located within the project area.
    2. Density Testing Frequency
        a. Soils located directly under building foundation systems and/or retaining wall systems shall have one proctor test performed every 150-linear foot of foundation per lift.
        b. Soils located directly under building pads shall have one proctor test performed every 5000 Ft^2 per lift.
        c. Soils not located under building pads shall be tested every 10,000 ft^2 per lift.

7.3.4 Grading

A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.

B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with SM, SM-SP, or SP.
C. Slope backfill outside building away from building walls for a minimum distance of 5 feet.
D. Finished grade shall be at least 6 inches below bottom line of window or other building wall openings unless greater depth is identified on architectural drawings.
E. Finish subgrade in a condition acceptable to Project Engineer at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.
H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 0.25 inches of indicated grades.

7.3.5 Disposal of Unsuitable and Excess Excavated Material

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off of the project site.
B. Place excess excavated materials suitable for fill and/or backfill on site where directed.
C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

7.3.6 Clean Up

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from the project site.

8.0 Limitations

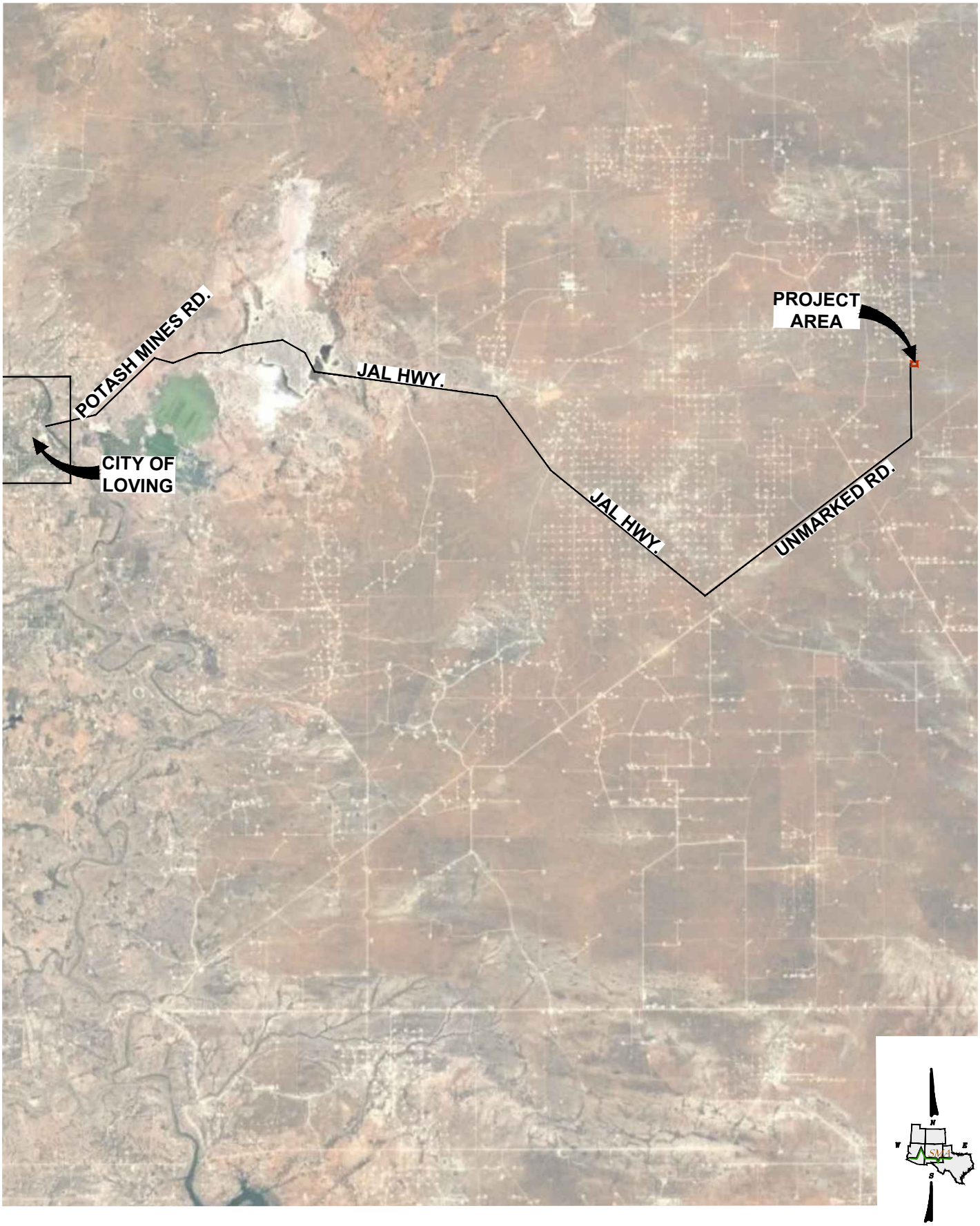
SMA prepared this report for the specific project and location aforementioned in Section 1 and Section 3. SMA conducted this study using the standard level of care and diligence normally practiced by recognized engineering firms now performing services of a similar nature under similar circumstances. This report, including all illustrations, is intended to be used in its entirety.

This report describes SMA's findings and conclusions about subsurface conditions at the locations identified and has based interpretation of the soil and groundwater conditions on data obtained from the borings drilled for this study. Although SMA has allowed for minor variations in subsurface conditions, recommendations may not be appropriate if soil conditions change or are found to significantly vary (as a result of localized geologic conditions) from those encountered during site evaluation. SMA recommends informing and retaining SMA if unanticipated soil conditions are encountered during construction and, if necessary, revise these conclusions.

SMA provided recommendations for foundation system designs based on soil conditions and assumptions of applied loads. Recommendations may not be appropriate if foundation types or loading changes. As such, SMA recommends informing and retaining SMA, when finalized site development and foundation loads are determined in order for SMA to revise soil design parameters, as applicable.

SMA prepared this report for the exclusive use of the Client and Structural Engineer. The purpose is to evaluate the design of the project as it relates to SMA's interpretation of the geotechnical aspects discussed here***. This report should be available to potential contractors for information only and not as a warranty of subsurface conditions***.

Appendix A
Figures



SMA
Engineering
Environmental
Surveying

SOUDER, MILLER & ASSOCIATES
3500 Sedona Hills Parkway
Las Cruces, NM 88011
Phone (575) 647-0799 Toll Free (800) 647-0799 Fax (575) 647-0680

VICINITY MAP

RODNEY ROBINSON
RECYCLING CONTAINMENT FACILITY
CARLSBAD, NEW MEXICO

Designed	Drawn	Checked
SVG	SVG	PJP

Date: SEPT. 2019
Scale: NTS
Project No: 5E28189
BM-1

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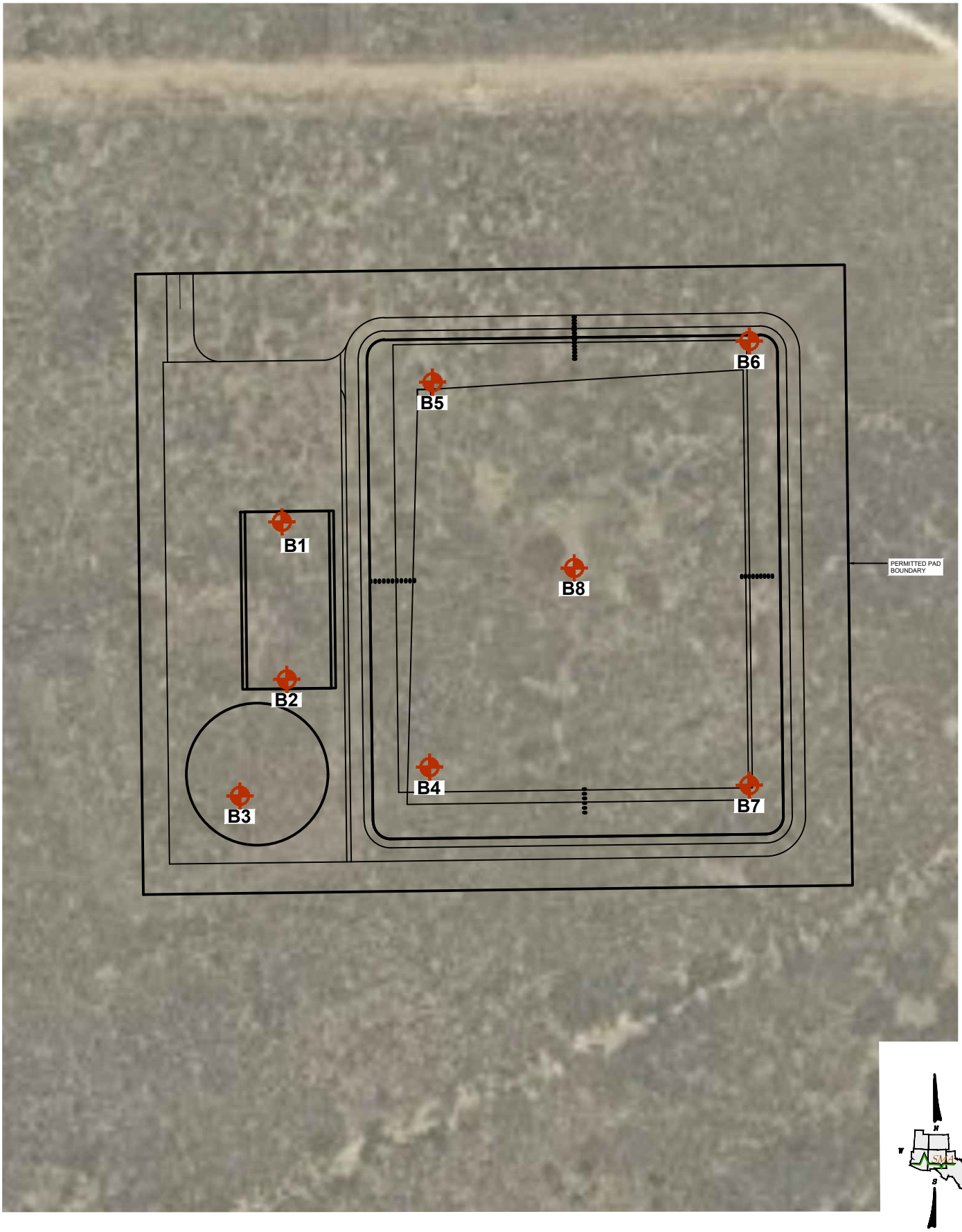

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& ASSOCIATES
3500 Sedona Hills Parkway
Las Cruces, NM 88011
Phone (575) 647-0799 Toll Free (800) 647-0799 Fax (575) 647-0680

BORE LOCATION MAP

RODNEY ROBINSON
RECYCLING CONTAINMENT FACILITY
CARLSBAD, NEW MEXICO

Designed	Drawn	Checked
SVG	SVG	PJP

Date: SEPT. 2019
Scale: 1" = 150'
Project No: 5E28189
BM-1

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Appendix B
Soil Boring Logs

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B1 - page 1
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				2.3.6					
0			S	9	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				2.3.8					
2.5			S	11	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				4.6.9					
5			S	15	S/NP	S/NP	1.8	SM	Reddish silty sand
6									
7				5.16.23					
7.5			S	39	S/NP	S/NP	3.6	SM	Whitish tan silty sand with caliche gravel
8									
9				12.19.19					
10			S	38	S/NP	S/NP	3.6	SC/SM	Whitish tan silty clayey sand
11									
12									
13									Small caliche gravel
14				5.29.50					
15			S	50+	S/NP	S/NP	3.9	SC/SM	Whitish tan silty clayey sand
16									
17									
18									Small caliche gravel
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table
Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B1 - page 2
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				16.12.23					
20			S	35	S/NP	S/NP	3.6	SC/SM	Whitish tan silty clayey sand with caliche gravel
21									
22									
23									
24				13.20.21					
25			S	41	S/NP	S/NP	4.2	SC/SM	Whitish tan silty clayey sand with caliche gravel
26.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B2 - page 1
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				1.4.7					
0			S	11	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				3.8.7					
2.5			S	15	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				3.8.12					
5			S	20	S/NP	S/NP	1.3	SM	Reddish silty sand
6									
7				10.21.26					
7.5			S	47	S/NP	S/NP	2.9	SM	Reddish silty sand
8									
9				15.18.23					
10			S	41	S/NP	S/NP	3.8	SM	Reddish brown silty sand with caliche gravel
11									
12									
13									
14				8.32.41					
15			S	50+	S/NP	S/NP	3.3	SM	Whitish tan silty sand with caliche gravel
16									
17									
18									
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B2 - page 2
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				18.26.24					
20			S	50	S/NP	S/NP	4.6	SC/SM	Whitish tan silty sand with caliche gravel
21									
22									
23									
24				19.28.23					
25			S	50+	S/NP	S/NP	3.8	SC/SM	Whitish tan silty clayey sand
26.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B3 - page 1
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.3.8					
0			S	11	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				1.6.6					
2.5			S	12	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				6.8.11					
5			S	19	S/NP	S/NP	1.0	SM	Reddish silty sand
6									
7				8.14.22					
7.5			S	36	S/NP	S/NP	2.8	SM	Whitish brown silty sand
8									
9				15.19.26					
10			S	45	S/NP	S/NP	3.2	SM	Whitish tan silty sand with caliche gravel
11									
12									
13									
14				22.32.28					
15			S	50+	S/NP	S/NP	3.5	SM	Whitish tan silty sand with caliche gravel
16									
17									
18									
19									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B3 - page 2
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				22.18.17					
20			S	35	S/NP	S/NP	3.7	SM	Whitish tan silty sand with caliche gravel
21									
22									
23									
24				17.24.20					
25			S	44	S/NP	S/NP	4.8	SM	Whitish tan silty sand with caliche gravel
26.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B4
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				1.2.4					
0			S	6	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				3.6.6					
2.5			S	12	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				9.8.6					
5			S	14	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
6									
7				6.12.10					
7.5			S	22	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
8									
9				4.6.13					
10			S	19	S/NP	S/NP	4.9	SM	Reddish silty sand
11									
12									
13									
14				12.18.29					
15			S	47	S/NP	S/NP	2.7	SM	Reddish silty sand
16									
17									
18									
19				17.19.17					
20			S	36	S/NP	S/NP	3.1	SM	Whitish tan silty sand with caliche gravel
21.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table
Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B5
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				2.2.2					
0			S	4	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				2.2.6					
2.5			S	8	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				4.6.9					
5			S	15	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
6									
7				4.8.9					
7.5			S	17	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
8									
9				7.12.14					
10			S	26	S/NP	S/NP	8.9	SC/SM	Reddish brown silty clayey sand
11									
12									
13									
14				21.19.20					
15			S	39	S/NP	S/NP	3.3	SM	Reddish brown silty sand
16									
17									
18									
19				9.12.14					
20			S	26	S/NP	S/NP	3.2	SM	Whitish tan silty sand with caliche gravel
21.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table
Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B6
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				2.6.6					
0			S	12	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				4.7.9					
2.5			S	16	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				12.16.20					
5			S	36	S/NP	S/NP	2.2	SM	Whitish tan silty sand with caliche
6									
7				14.18.16					
7.5			S	34	S/NP	S/NP	2.8	SM	Whitish tan silty sand with caliche
8									
9				12.23.34					
10			S	50+	S/NP	S/NP	2.8	SM	Whitish tan silty sand with caliche
11									
12									
13									
14				26.29.42					
15			S	50+	S/NP	S/NP	2.7	SM	Whitish tan silty sand with caliche
16									
17									
18									
19				16.19.22					
20			S	41	S/NP	S/NP	3.9	SM	Whitish tan silty sand with caliche
21.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table
Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B7
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				4.3.3					
0			S	6	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				4.6.9					
2.5			S	15	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				8.16.23					
5			S	39	S/NP	S/NP	1.9	SM	Whitish tan silty sand
6									
7				17.19.26					
7.5			S	45	S/NP	S/NP	3.0	SM	Whitish tan silty sand with caliche gravel
8									
9				22.18.16					
10			S	34	S/NP	S/NP	3.6	SM	Whitish tan silty sand
11									
12									
13									
14				20.16.17					
15			S	33	S/NP	S/NP	3.9	SM	Whitish tan silty sand
16									
17									
18									
19				14.18.17					
20			S	35	S/NP	S/NP	3.7	SM	Whitish tan silty sand
21.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table
Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Robinson Frac Pond	Date of Field Operations	21-Aug-19
Project Number	39070	Laboratory Number	B8
Client	Souder Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.3.6					
0			S	9	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
1									
2				4.7.6					
2.5			S	13	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
3									
4				7.9.17					
5			S	26	S/NP	S/NP	1.0	SP/SM	Reddish poorly graded sand with silt
6									
7				9.8.8					
7.5			S	16	S/NP	S/NP	1.0	SM	Reddish silty sand
8									
9				11.19.26					
10			S	45	S/NP	S/NP	2.8	SM	Whitish tan silty sand with caliche
11									
12									
13									
14				20.21.23					
15			S	44	S/NP	S/NP	2.8	SM	Whitish tan silty sand with caliche
16									
17									
18									
19				19.27.32					
20			S	50+	S/NP	S/NP	2.8	SM	Whitish tan silty sand with caliche
21.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table
Water Table at __ Below Existing Site Grade

Appendix C
Laboratory Analysis

APPENDIX C - LABORATORY ANALYSIS

SAMPLE HANDLING

After recovery, our engineering staff removed the soil samples from the samplers in field. They examined the samples, visually classified them, and preserved representative portions of each sample for laboratory testing. They also obtained strength estimates of most cohesive samples in the field using a calibrated hand penetrometer or a Torvane.

SOIL CLASSIFICATION

Soil Classifications provide a general guide to the engineering properties of various soil types. Representative samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our Test Boring Records.

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and index tests. Using these test results the soil can be classified according to the AASHTO, FAA, or Unified Classification Systems (ASTM D2487). These soil classifications and the in-place physical soil properties provide and index for estimating the behavior of the soil.

GRAIN SIZE TESTS

Grain size tests are performed to determine the distribution of particle sizes. The soil samples are prepared for testing according to ASTM D421 (dry preparation) or ASTM D2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Usually, these are sandy or gravelly soils. Materials passing the No. 200 sieve are the percent fines (silt and clay sizes). Using a hydrometer, these particles are suspended in water and the particle size distribution calculated from the measured settlement rate.

INDEX TESTING

Index tests are performed to determine the soil classification and plasticity characteristics. Generally, index tests are conducted on clayey and silty soils. The soil plasticity characteristics are defined by the Plastic Limit (PL) and the Liquid Limit (LL). The PL and LL are determined in accordance with ASTM D4318 and are referred to as the Atterberg Limits.

PHYSICAL SOIL PROPERTIES

The in-place physical properties are described by the specific gravity, wet unit weight, moisture content, dry unit weight, void ratio, and percent saturation of the soil. The specific gravity and moisture content are determined according to ASTM D854 and D2216, respectively. The wet unit weight is found by obtaining a known volume of the soil and dividing the wet sample weight by the known volume. The dry unit weight, void ratio and percent saturation are calculated values.

SOUTHWEST ENGINEERING, INC.

TABULATION OF LABORATORY LAB RESULTS

PROJECT: Robinson Frac Pond

PROJECT#: 39070

CLIENT: Souder Miller & Associates

21-Aug-19

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B1	0.0 - 2.5	1								100	97	90	11.8	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	97	25	11.5	S/NP	S/NP	SP/SM
	5.0 - 7.5	1.8								100	97	34	17.5	S/NP	S/NP	SM
	7.5 - 10.0	3.6						100	95	87	76	40	27	S/NP	S/NP	SM
	10.0 - 15.0	3.6					100	98	94	87	77	51	37.7	S/NP	S/NP	SC/SM
	15.0 - 20.0	3.9				100	99	99	94	88	84	54	40.5	S/NP	S/NP	SC/SM
	20.0 - 25.0	3.6			100	96	94	92	85	80	74	49	36.1	S/NP	S/NP	SC/SM
	25.0 - 26.5	4.2			100	98	95	89	81	80	72	50	37.8	S/NP	S/NP	SC/SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B2	0.0 - 2.5	1								100	97	27	10.2	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	97	28	11.3	S/NP	S/NP	SP/SM
	5.0 - 7.5	1.3								100	97	31	15	S/NP	S/NP	SM
	7.5 - 10.0	2.9					100	98	94	88	81	36	22.1	S/NP	S/NP	SM
	10.0 - 15.0	3.8			100	92	91	90	82	75	67	41	30.9	S/NP	S/NP	SM
	15.0 - 20.0	3.3				100	99	98	88	81	72	46	32.8	S/NP	S/NP	SM
	20.0 - 25.0	4.6				100	98	98	96	94	90	62	45.5	S/NP	S/NP	SC/SM
	25.0 - 26.5	3.8			100	99	96	96	94	90	87	62	43.8	S/NP	S/NP	SC/SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B3	0.0 - 2.5	1								100	97	24	10.8	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	97	25	10.1	S/NP	S/NP	SP/SM
	5.0 - 7.5	1								100	97	26	12.6	S/NP	S/NP	SM
	7.5 - 10.0	2.8				100	99	99	93	88	82	34	20.9	S/NP	S/NP	SM
	10.0 - 15.0	3.2			100	93	87	84	77	70	61	38	27.8	S/NP	S/NP	SM
	15.0 - 20.0	3.5					100	96	90	82	74	49	34.3	S/NP	S/NP	SM
	20.0 - 25.0	3.7				100	96	93	87	82	76	51	35.3	S/NP	S/NP	SM
	25.0 - 26.5	4.8				100	98	96	90	84	79	48	33	S/NP	S/NP	SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B4	0.0 - 2.5	1								100	96	29	11.3	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	96	23	8.7	S/NP	S/NP	SP/SM
	5.0 - 7.5	1								100	96	26	8.8	S/NP	S/NP	SP/SM
	7.5 - 10.0	1								100	96	24	8.4	S/NP	S/NP	SP/SM
	10.0 - 15.0	4.9								100	96	39	20.8	S/NP	S/NP	SM
	15.0 - 20.0	2.7								100	96	39	19	S/NP	S/NP	SM
	20.0 - 21.5	3.1				100	96	93	86	82	77	45	29.5	S/NP	S/NP	SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B5	0.0 - 2.5	1								100	96	24	8.8	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	96	25	9.4	S/NP	S/NP	SP/SM
	5.0 - 7.5	1								100	98	23	8.8	S/NP	S/NP	SP/SM
	7.5 - 10.0	1								100	96	25	8.4	S/NP	S/NP	SP/SM
	10.0 - 15.0	8.9								100	96	50	29.5	S/NP	S/NP	SC/SM
	15.0 - 20.0	3.3								100	97	43	17	S/NP	S/NP	SM
	20.0 - 21.5	3.2				100	99	95	91	86	80	47	29.8	S/NP	S/NP	SM

SOUTHWEST ENGINEERING, INC.

TABULATION OF LABORATORY LAB RESULTS

PROJECT: Robinson Frac Pond

PROJECT#: 39070

CLIENT: Souder Miller & Associates 21-Aug-19

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B6	0.0 - 2.5	1								100	96	30	10.7	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	96	29	11.1	S/NP	S/NP	SP/SM
	5.0 - 7.5	2.2				100	98	93	87	84	78	43	29.9	S/NP	S/NP	SM
	7.5 - 10.0	2.8				100	98	97	90	85	80	52	38.6	S/NP	S/NP	SM
	10.0 - 15.0	2.8				100	98	94	86	81	75	48	35.9	S/NP	S/NP	SM
	15.0 - 20.0	2.7				100	99	97	89	14	78	51	37.2	S/NP	S/NP	SM
	20.0 - 21.5	3.9				100	99	98	90	81	67	34	24.4	S/NP	S/NP	SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B7	0.0 - 2.5	1								100	93	30	10.6	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	96	27	10.7	S/NP	S/NP	SP/SM
	5.0 - 7.5	1.9					100	96	96	93	88	41	26.8	S/NP	S/NP	SM
	7.5 - 10.0	3					100	93	85	81	75	50	39	S/NP	S/NP	SM
	10.0 - 15.0	3.6					100	99	91	81	67	34	22.9	S/NP	S/NP	SM
	15.0 - 20.0	3.9				100	99	99	92	82	68	33	21.3	S/NP	S/NP	SM
	20.0 - 21.5	3.7					100	99	93	84	70	36	22.9	S/NP	S/NP	SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B8	0.0 - 2.5	1								100	96	28	10.2	S/NP	S/NP	SP/SM
	2.5 - 5.0	1								100	96	25	10.7	S/NP	S/NP	SP/SM
	5.0 - 7.5	1								100	96	27	10.7	S/NP	S/NP	SP/SM
	7.5 - 10.0	1								100	96	26	21.9	S/NP	S/NP	SM
	10.0 - 15.0	2.8				100	96	94	87	83	77	51	39.8	S/NP	S/NP	SM
	15.0 - 20.0	2.8				100	99	96	87	83	77	50	39.3	S/NP	S/NP	SM
	20.0 - 21.5	2.8					100	97	88	82	77	49	37.1	S/NP	S/NP	SM

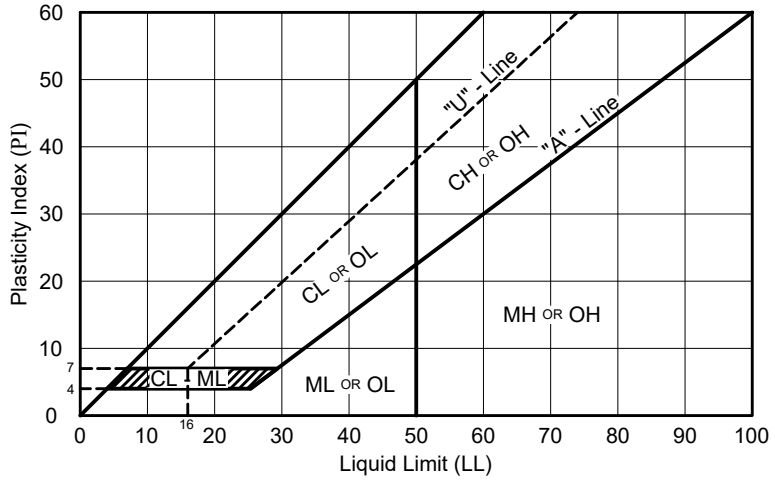
Appendix D
USCS Soil Classification System

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Test are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For more detailed description of the system, see "The Unified Soil Classification System", Corp of Engineers, US Army Technical Memorandum No.3-357 (revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well-graded gravels, gravel-sand mixtures, little or no fines
					GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (more than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well-graded sands, gravelly sands, little or no fines
					SP	Poorly-graded sands, gravelly sands, little or no fines
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (Limits Plot Below "A" Line Δ hatched zone on plasticity chart)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50%)			ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50%)			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CLAYS (Limits Plot Above "A" Line Δ hatched zone on plasticity chart)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50%)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		CLAYS OF LOW PLASTICITY (Liquid Limit More Than 50%)			CH	Inorganic clays of high plasticity, fat clays

NOTE: Coarse grained soils with between 5% and 12% passing the No. 200 sieve and fine grained soils with limits platting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	
Above 3 Inches	
Gravel	
3 In. to No. 4 Sieve	
Coarse Gravel	3 In. to ¾ In.
Fine Gravel	¾ In. to No. 4 Sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (Silt or Clay)	Below No. 200 Sieve

SMA Engineering Environmental Surveying

Souder, Miller & Associates
3500 Sedona Hills Parkway
Las Cruces, NM 88011
Phone (575) 647-0799 Toll Free (800) 647-0799 Fax (575) 647-0680

SMA

UNIFIED SOIL CLASSIFICATION SYSTEM

N/A

Designed	Drawn	Checked
PJP	AD	PJP

Date: Jan 2018

Scale: Horiz: N/A Vert: N/A

Project No:

SC-1

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Appendix E
Correlation of Penetration Resistance With Relative Density and Consistency

APPENDIX E

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

(Table 5.3 from Foundation Engineering, 2ND Edition, by Peck, Hanson, Thornburn)

	NO. OF BLOWS, N	RELATIVE DENSITY
	0 - 4	Very Loose
	5 - 10	Loose
Sands:	11 - 30	Firm
	31 - 50	Dense
	Over 50	Very Dense

		CONSISTENCY
	0 - 2	Very Soft
	3 - 4	Soft
Silts	5 - 8	Firm
&	9 - 15	Stiff
Clays:	16 - 30	Very Stiff
	31 - 50	Hard
	Over 50	Very Hard

PARTICAL SIZE IDENTIFICATION:

(ASTM D2487)

Boulders:	Greater than 300 mm
Cobbles:	75 mm to 300 mm
Gravel:	
Coarse -	19 mm to 75 mm
Fine -	4.75 mm to19 mm
Sands:	
Coarse -	2 mm to 4.75 mm
Medium -	0.425 mm to 2 mm
Fine -	0.075 mm to 0.425 mm
Silts & Clays:	Less than 0.075 mm