November 1, 2019 TES No.190598.001

Mr. Steve Deis
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Project: Proposed Fresno County Sheriff Area 2 Substation Complex
Fancher Creek Business Park
SWC of Armstrong and Harvey Avenue
Fresno, California

Subject: Geotechnical Investigation Report

Dear Mr. Deis:

The attached report presents the results of a geotechnical investigation for the construction of the proposed Fresno County Sheriff Area 2 Substation Complex to be located at the SWC of Armstrong and Harvey Avenue in Fresno, California. This report describes the investigation, findings, conclusions, and recommendations for use in project design and construction.

TECHNICON Engineering Services, Inc. (TECHNICON) appreciates the opportunity to provide geotechnical engineering services to the County of Fresno Department of Public Works and Planning during the design phase of this project. We trust this information meets your current needs. If there are any questions concerning the information presented in this report, please contact this office at your convenience.

Respectfully submitted,
TECHNICON Engineering Services, Inc.

Moussa Subeh-Tabor
Project Engineer

Salvador Alvarez, PE
Geotechnical Engineering Manager

MST:SA:vm

TECHNICON
ENGINEERING SERVICES, INC.

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED FRESNO COUNTY SHERIFF AREA 2 SUBSTATION COMPLEX
FANCHER CREEK BUSINESS PARK
SWC OF ARMSTRONG AND HARVEY AVENUE
FRESNO, CALIFORNIA

Prepared for:

County of Fresno Department of Public Works and Planning
2220 Tulare Street, 7th Floor
Fresno, CA 93721

November 1, 2019

TES No. 190598.001

GEOTECHNICAL & ENVIRONMENTAL ENGINEERING – CONSTRUCTION TESTING & INSPECTION

Prepared For:

County of Fresno Department of Public Works and Planning
2220 Tulare Street, 7th Floor
Fresno, CA 93721

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED FRESNO COUNTY SHERIFF AREA 2 SUBSTATION COMPLEX
FANCHER CREEK BUSINESS PARK
SWC OF ARMSTRONG AND HARVEY AVENUE
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TECHNICON PROJECT
TES No. 190598.001

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November 1, 2019

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FANCHER CREEK BUSINESS PARK
SWC OF ARMSTRONG AND HARVEY AVENUE
FRESNO, CALIFORNIA

1 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical investigation for the development of the proposed Fresno County Sheriff Area 2 Substation Complex located at the SWC of Armstrong and Harvey Avenue in Fresno, California. The purpose of the investigation was to explore and evaluate the subsurface conditions at the site and develop geotechnical engineering recommendations to aid in project design and construction.

The Vicinity Map, presented on Figure 1, shows the location of the project and the Site Map, presented on Figure 2, shows the proposed development and the approximate boring locations.

1.2 PROPOSED CONSTRUCTION

It is understood that the project involves the design and construction of four (4) new buildings. The proposed buildings will be 10,000, 15,500, 22,500, and 26,350 square foot, single story, steel-framed structures with concrete slab-on-grade floors. Maximum wall and column loads are anticipated to be less than 5 kips per foot and 50 kips, respectively. Appurtenant improvements are anticipated to include solar array covered parking, asphalt concrete pavements, underground utilities, hardscape, and landscape. It is anticipated that cuts and fills will be less than 2 feet to establish site grades.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this investigation was to explore the site subsurface conditions and to develop recommendations regarding design and preparation of construction plans and specifications. The report includes the following:

- A description of the proposed project including a Vicinity Map showing the location of the site, and a Site Map showing the project area and the exploration points for this investigation;
- A description of the site surface and subsurface conditions encountered during the field investigation, including boring logs;

- ❑ A summary of the field exploration and laboratory testing program;
- ❑ Discussion of regional and local geology including faults, seismicity, and liquefaction potential and associated effects;
- ❑ Recommended seismic design criteria;
- ❑ Recommendations for site preparation and earthwork, including the use of on-site soils for engineered fill and recommended import fill specifications;
- ❑ Recommendations for conventional spread footing design including bearing capacity of foundation soil for sustained loading, total combined loading, and anticipated settlement;
- ❑ Modulus of subgrade reaction for design of foundations as a beam on an elastic foundation;
- ❑ Resistance of lateral loads, including passive pressure and coefficient of friction;
- ❑ Recommended axial capacity, lateral capacity and settlement for use in design of pier foundations;
- ❑ Design factors for earth retaining structures;
- ❑ Design of concrete slabs-on-grade for buildings, including modulus of subgrade reaction;
- ❑ Comments on the corrosion potential of on-site soils to buried metal and concrete;
- ❑ Recommended asphalt concrete pavement sections for various traffic levels; and
- ❑ Comments on general site drainage.

The scope of services consisted of a field exploration program, laboratory testing, design analysis, and preparation of this written report as outlined in **TECHNICON'**s proposal dated June 3, 2019 (TES No. GP19-147).

2 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

The field exploration, conducted on September 27, 2019 consisted of drilling ten (10) exploratory test borings, and a site reconnaissance by a staff engineer. The test borings were drilled with a CME 45 truck-mounted drill rig using 7.5-inch hollow stem auger. The borings extended to depths of 11.5, 16.5, and 21.5 feet below existing ground surface (bgs). The approximate locations of the test boring and R-value locations are indicated on the Site Map, Figure 2.

The soils encountered in the borings were visually classified in the field and a continuous log was recorded. Relatively undisturbed samples were collected from the test borings at selected depths by driving a 2.5-inch I.D. split barrel sampler containing brass liners into the undisturbed soil with a 140-pound automatic hammer free falling a distance of 30 inches. In addition, samples of the subsurface soils were obtained using a 1.4-inch I.D. standard penetrometer, driven 18 inches in accordance with ASTM D1586 test procedures. The sampler was used without liners. Resistance to sampler penetration was noted as the number of blows per foot over the last 12 inches of sampler penetration on the boring logs. The blow counts listed in the boring logs have not been corrected for the effects of overburden pressure, rod length, sampler size, boring diameter, or hammer efficiency. Bulk samples were also retained from auger cuttings of the near surface soils at selected test boring locations for R-value and laboratory testing.

2.2 FIELD AND LABORATORY TESTING

Penetration rates, determined in general accordance with ASTM D1586, were used to aid in evaluating the consistency, compression, and strength characteristics of the foundation soils.

Laboratory tests were performed on selected near surface samples to evaluate their physical characteristics. The following laboratory tests were used to develop the design geotechnical parameters:

- Unit weight (ASTM D2937)
- Moisture Content (ASTM D2216)
- Sieve Analysis (ASTM C136)

- ❑ Direct Shear (ASTM D3080)
- ❑ Soluble Sulfate and Soluble Chloride Contents (California Test Method No. 417 & 422)
- ❑ pH and Minimum Resistivity (California Test Method No. 643)
- ❑ Expansion Index (ASTM D4829)
- ❑ Resistance Value (California Test Method No. 301)

The dry density and moisture content test results are shown on the boring logs in Appendix A. The soluble sulfate, soluble chloride, pH, and minimum resistivity test results are discussed in Section 6.7, “Corrosion Potential”. The remaining test results are provided in Appendix B.

3 SITE CONDITIONS

3.1 SURFACE CONDITIONS

The project site, located at the southwest corner of Armstrong and Harvey Avenue in Fresno, California consists of approximately 6 acres of undeveloped-empty land supporting moderate seasonal vegetation. The site is generally bounded by vacant land to the west, Turner Avenue to the south, E. Harvey Avenue to the north, and N. Armstrong Avenue to the east. The existing topography was relatively flat with a relative elevation approximately 6 inches above the adjacent roadways. The location of the proposed Fresno County Sheriff Area 2 Substation Complex is shown on the Site Map, Figure 2.

3.2 FEMA FLOOD ZONE

According to the Federal Emergency Management Agency (FEMA), the site is in a Zone X flood designation (Map Number 06019C1595H, dated February 18, 2009), indicating that the project area is within the 0.2 percent annual chance floodplain. The civil design engineer should plan site grades accordingly.

3.3 EARTH MATERIALS

According to a geologic map of California the site consists of recent Quaternary Great Valley fan deposits. The general earth material profile depicted by the subsurface exploration consisted of silty sand and clayey sand in the upper 10 feet underlain by a layer of sandy silt and silty sand to the depth explored of 21.5 feet. The fine-grained soils had a consistency of stiff to hard, and the coarse-grained soils had a relative density of loose to very dense.

The above is a general description of the earth material profile. A more detailed representation of the stratigraphy at the specific exploration locations is provided on the boring logs in Appendix A.

3.4 GROUNDWATER CONDITIONS

Groundwater was not encountered within the maximum depth of exploration, 21.5 feet below existing ground surface. The California Department of Water Resources “Groundwater Information Center Interactive Map Application” Fall 2018, indicates the depth to groundwater exceeds 80 feet below grade within the vicinity of the project. It is possible that groundwater

conditions at the site could vary between boring locations or could change at some time in the future due to variations in the rainfall, groundwater withdrawal, construction activities, or other factors not apparent at the time of the field reconnaissance. Based on the boring data collected for this investigation and the proposed development, groundwater is not anticipated to impact design or construction.

4 GEOLOGIC CONDITIONS

4.1 FAULTS LOCAL TO THE PROPOSED SITE

The project sites and its vicinity are located in an area traditionally characterized by relatively low seismic activity. The site is not located in an Alquist-Priolo Earthquake Fault Zone as established by the Alquist-Priolo Fault Zoning Act (Section 2622 of Chapter 7.5, Division 2 of the California Public Resources Code).

Based on review of published data and current understanding of the geologic framework and tectonic setting of the project, the primary sources of seismic shaking at this site are anticipated to be the Great Valley 14 fault (Kettleman Hills), the Kern Canyon fault, and the San Andreas Fault (Creeping Section), which are located approximately 81, 113, and 115 kilometers, respectively, from the site. The San Andreas Fault is considered the governing fault.

4.2 SEISMIC DESIGN CRITERIA

There are no geotechnical factors at this site that are unique and would necessitate special seismic consideration for design of the project. Use of 2016 California Building Code (CBC), and ASCE 7-10 design criteria would be appropriate, unless the designer deems more specific data (e.g. elastic response spectra or characteristic site period) necessary. Table 4.2-1 provides the recommended design parameters.

TABLE 4.2-1
2016 CBC/ASCE 7-10 SEISMIC DESIGN PARAMETERS

Seismic Item	Design Value	Seismic Item	Design Value
Site Class	D	Seismic Design Category	D
S_S	0.594	S_{MS}	0.787
S_1	0.246	S_{M1}	0.47
Site Coefficient, F_v	1.908	S_{DS}	0.524
Site Coefficient, F_a	1.325	S_{D1}	0.313

4.3 LIQUEFACTION POTENTIAL AND SEISMIC SETTLEMENT

In order for liquefaction due to ground shaking, and possible associated effects to occur, it is generally accepted that four conditions will exist:

- The subsurface soils are in a relatively loose state;
- The soils are saturated;
- The soils are fine, granular, and uniform; and
- Ground shaking of sufficient intensity should occur to act as a triggering mechanism.

Saturated granular sediments can experience liquefaction if subject to seismically induced ground motion of sufficient intensity and duration. Based on the relatively deep groundwater depth (estimated 80 feet), the consistency of the on-site soils (moderate to high relative density) and anticipated ground motion, analysis (Youd 2001) indicates that liquefaction and seismically induced settlement is unlikely, even in the event of a substantial increase in groundwater.

5 EARTHWORK

5.1 GENERAL

Based on the laboratory data, field exploration, and geotechnical analyses conducted for this investigation, it is geotechnically feasible to construct the proposed improvements as currently envisioned. Provided that the recommendations presented in this report are incorporated into the project design and construction, use of shallow spread and continuous reinforced concrete footings bearing on undisturbed native soil or approved engineered fill are considered appropriate for structural support.

Recommendations regarding site grading are presented in subsequent sections of this report. All reference to relative compaction, maximum density, and optimum moisture is based on ASTM Test Method D1557. Earthwork should encompass all areas to receive fill or to support proposed improvements and should extend horizontally a minimum distance of 5 feet beyond the perimeter of the improvements.

5.2 EXPANSIVE SOILS

The investigation has revealed a surface horizon of moderately expansive silty sand with clay soil. These expansive soils are susceptible to volume changes associated with changes in soil moisture content. The potential for future differential movement resulting from these soils can be reduced to normally tolerable levels by following the moisture conditioning and compaction recommendations presented in this report. Moisture conditioning and compaction mitigation implemented during grading should be consistent with the expansiveness determined. Careful attention must be paid to future maintenance, including a site drainage and irrigation practices.

Note that the moisture content attained during grading and building pad preparation should be maintained between the completion of grading and the placement of the vapor retarder, concrete slabs, and footings. If the moisture content is not maintained between the conclusion of grading and the start of building construction, the moisture content and compaction will need to be re-established prior to building construction.

5.3 SITE PREPARATION

5.3.1 Demolition of Existing Trees and Structures

Where project improvements dictate removal of exiting trees, the root areas should be thoroughly cleared of root balls as well as isolated roots greater than ½ - inch in diameter as well as concentrated smaller diameter roots and root mats, depending on the volume of smaller roots encountered. The amount of soil lost or disturbed with removal will likely vary with the moisture conditions at the time of removal, soil type, and the methods of removal. The root system removal may disturb a significant quantity of soil. It is suggested a tree service and demolition contractor be contacted for more detailed information regarding the typical soil loss and disturbance associated with tree removal.

Following removal of underground utilities, structure demolition, and tree removal, disturbed soils should be mitigated as described in Sections 5.3.3 and 5.3.4.

5.3.2 Stripping

All surface vegetation and any miscellaneous surface obstructions should be removed from the project area, prior to any site grading. It is anticipated that stripping of vegetation could involve the upper 1 to 3 inches of the site. Surface strippings should not be incorporated into fill unless they can be sufficiently blended to result in an organic content less than 3 percent by weight (ASTM D2974). Stripped topsoil, with an organic content between 3 and 12 percent by weight, may be stockpiled and used as non-structural fill (i.e. landscaped areas). If used in landscape areas, soil with an organic content between 3 and 12 percent should be placed with 2 feet of finished grade and at least 5 feet outside of building perimeters. Soil with an organic content greater than 12 percent by weight should be excluded from fill.

5.3.3 Disturbed Soil, Undocumented Fill and Subsurface Obstructions

Initial site grading should include a reasonable search to locate and remove any undocumented fill soils, abandoned underground structures, existing utilities, etc., that may exist within the area of construction. All underground utilities should be rerouted beyond the perimeter of the proposed improvements and all previous trench backfill and any loose soils generated by the utility removal should be removed to expose undisturbed native soil. Any subsurface obstructions should be removed from the project area. Any areas or pockets of soft or loose soils, void spaces made by burrowing animals, undocumented fill, or other disturbed soil that is

encountered, should be excavated to expose firm native material. Care should be taken during site grading to mitigate (e.g. excavate and recompact) all soil disturbed by stripping and demolition. Excavations for removal of any unsuitable conditions should be dish-shaped and backfilled with engineered fill (see Section 5.4).

5.3.4 Over-excavation

Over-excavation is typically reserved for soils that, in their natural state, will not provide adequate bearing for structures. The foundation soils at the project site should provide adequate bearing for the proposed improvements. Therefore, provided the recommendations in sections 5.3.2 and 5.3.3 are followed, no general over-excavation of the overall site is required.

5.3.5 Scarification and Compaction

After stripping the site, and performing any other removals, the exposed subgrade soil to receive fill or areas to support proposed foundations/improvements should be scarified to a minimum depth of 12 inches, uniformly moisture conditioned to at, or above optimum moisture, proof rolled to detect soft or pliant areas, and compacted to the requirements for engineered fill (Section 5.4). Soft or pliant areas should be mitigated in accordance with Section 5.3.3.

5.3.6 Construction Considerations

Should site grading be performed during or subsequent to wet weather, near-surface site soils may be significantly above optimum moisture content. These conditions could hamper equipment maneuverability and efforts to compact site soils to the recommended compaction criteria. Disking to aerate, chemical treatment, replacement with drier material, stabilization with a geotextile fabric or grid, or other methods may be required to mitigate the effects of excessive soil moisture and facilitate earthwork operations. Any consideration of chemical treatment (e.g. lime) to facilitate construction would require additional soil chemistry evaluation and could affect landscape areas and some construction materials.

5.4 ENGINEERED FILL

5.4.1 Materials

All engineered fill soils should be nearly free of organic or other deleterious debris and less than 3 inches in maximum dimension. The on-site soil exclusive debris may be used as engineered fill, provided it contains less than 3 percent organics by weight (ASTM D2974).

Should any imported material be used for engineered fill, it should be sampled and tested by a representative of the project Geotechnical Engineer prior to being transported to the site. Table 5.4-1 provides general criteria for imported soil.

TABLE 5.4-1
IMPORT FILL CRITERIA

<table>
<tr><th colspan="4">Gradation
(ASTM C136)</th></tr>
<tr><th colspan="2">Sieve Size</th><th colspan="2">Percent Passing</th></tr>
<tr><td colspan="2">76 mm (3-inch)</td><td colspan="2">100</td></tr>
<tr><td colspan="2">19 mm (¾-inch)</td><td colspan="2">80 – 100</td></tr>
<tr><td colspan="2">No. 4</td><td colspan="2">60 – 100</td></tr>
<tr><td colspan="2">No. 200</td><td colspan="2">20 – 50</td></tr>
<tr><td colspan="2" rowspan="2">Expansion Index
(ASTM D4829)</td><td colspan="2">Plasticity
(ASTM D4318)</td></tr>
<tr><td>Liquid Limit</td><td>Plasticity Index</td></tr>
<tr><td colspan="2">< 20</td><td>< 25</td><td>< 9</td></tr>
<tr><th colspan="4">Organic Content
(ASTM D 2974)</th></tr>
<tr><td colspan="4">< 3% by dry weight</td></tr>
<tr><th colspan="4">Corrosivity</th></tr>
<tr><th>pH</th><th>Minimum Resistivity (ohm-cm)</th><th>Soluble Sulfate (ppm)</th><th>Soluble Chloride (ppm)</th></tr>
<tr><td>6 to 8</td><td>> 2,000</td><td>< 2,000</td><td>< 500</td></tr>
<tr><th colspan="4">Resistance Value
California Test Method No. 301</th></tr>
<tr><td colspan="4">Minimum R-value = 8</td></tr>
</table>

The import criteria for corrosion are typical threshold limits for non-corrosive soil. Should corrosion concentrations of import soils fall outside of the threshold limits indicated above, revised protection measures will be necessary.

5.4.2 Compaction Criteria

Soils used as engineered fill should be uniformly moisture-conditioned to at least 4 percent above optimum moisture, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to at between 88 and 92 percent relative compaction. Disking and/or blending may be required to uniformly moisture condition soils used for engineered fill. The actual level of moisture conditions and compaction will be based on the expansion potential and moisture density relationships determined during grading. The general intent is to bring the expansive material to about 80 to 85 percent saturation at the time of construction.

5.5 TEMPORARY EXCAVATIONS

5.5.1 General

All excavations must comply with applicable local, State, and Federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. The information provided is a service to the client. Under no circumstances should the information provided be interpreted to mean that **TECHNICON** is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

5.5.2 Excavations and Slopes

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, State, and/or Federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations).

All excavations should be constructed and maintained in conformance with current OSHA requirements (29 CFR Part 1926) for a Type C soil. If excavations encounter saturated soils or

groundwater, temporary excavations will have to be laid back or shored and the trench dewatered to maintain stability.

5.5.3 Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should be kept sufficiently away from the top of any excavation to prevent any unanticipated surcharging. If it is necessary to encroach upon the top of an excavation, **TECHNICON** can provide comments on slope gradients or loads on shoring to address surcharging, if provided with the geometry. Shoring, bracing, or underpinning required for the project (if any), should be designed by a professional engineer registered in the State of California.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff should be collected and disposed of outside the construction limits.

5.6 TRENCH BACKFILL

5.6.1 Materials

Pipe zone backfill (i.e., material beneath and in the immediate vicinity of the pipe) should consist of soil compatible with design requirements for the specific types of pipes. It is recommended that the project designer or pipe supplier develop the material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this investigation. Randomly excavated near surface soil will likely be Class III material per ASTM D2321.

Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of native soil which meets the requirements for engineered fill.

5.6.2 Compaction Criteria

All trench backfill should be placed and compacted in accordance with recommendations provided for engineered fill. Trench backfill deeper than 5 feet should be to at least 95 percent relative compaction. Mechanical compaction is recommended; ponding or jetting should not be used.

6 DESIGN RECOMMENDATIONS

6.1 GENERAL

The proposed structures may be supported by shallow spread or continuous reinforced concrete footings bearing on undisturbed native soil or approved engineered fill. The following recommendations are based on the assumption that the recommendations in Section 5, “Earthwork,” have been implemented. Recommendations regarding the geotechnical aspects of design are presented in subsequent sections.

6.2 SPREAD FOUNDATIONS

Based on the expansive nature of the foundation soils, it is recommended that footings consist of continuous reinforced foundation, embedded at least 18 inches below the lowest adjacent grade. Continuous footings should be reinforced with one #4 bar near the top and one #4 bar near the bottom (2 bars total). Foundation depths and reinforcement should also satisfy structural and constructability considerations. Subgrade within 6 inches of the bottom of footings and within footing sidewalls should have moisture content of at least 4 percent above optimum, immediately prior to placing the footing concrete.

These recommendations are based on engineering judgement and experience associated with expansive soil and are not based on any structural analysis. Any additional reinforcement for structural considerations should be provided by the structural engineer. The recommendations should be reviewed by the project structural engineer or building designer and they should concur with the recommendations provided.

6.3 SPREAD FOUNDATIONS

6.3.1 Allowable Vertical Bearing Pressures and Settlements

Generally, two geotechnical issues determine the design bearing pressure for conventional spread footing foundations: strength of the foundation soil, and tolerable settlement. For lightly loaded structures, design bearing may be determined by constructability considerations or code-required minimum dimensions.

The bearing capacity, based only on the shear strength of the soil, will be dependent upon the footing geometry. Table 6.3-1 presents the values for the bearing capacity for static loading

which includes dead load plus live load (D.L. + L.L.) and total combined loading (D.L. + L.L. + transient loading, such as wind or seismic).

TABLE 6.3-1
BEARING CAPACITY

	Bearing Capacity (psf)
Static Loading	2,000
Total Combined Loading	3,000
Unfactored Ultimate Bearing	6,000

The above values are appropriate for design using the Basic and Alternative Load Combinations in Section 1605.3 of the 2016 CBC. Analysis, based on methods by Schmertmann, determined the following estimated static settlement based on a range of assumed design bearing and estimated structural loads. Settlement is expected to occur rapidly with load application. The estimated settlements presented in Table 6.3-2 are based on the assumption that the sustained load of footings is equal to 80 percent of the total load.

TABLE 6.3-2
ESTIMATED SETTLEMENT

Footing Type	Loading (DL +LL)	Design Bearing (psf)	Estimated Settlement (inch)
Strip	To 5 kips/ft	To 2,000	Less than 0.50
Square	To 50 kips	To 2,000	Less than 0.50

The differential settlement between similarly loaded footings is anticipated to be less than 50 percent of the total settlement. If deemed necessary by the design engineer, **TECHNICON** can provide the estimated settlement for other loading conditions.

If evaluating the foundation as a beam on an elastic foundation, a modulus of subgrade reaction, K_p (B_p = 1 foot), of 350 pci can be used for undisturbed on-site soil. The subgrade modulus is most appropriately applicable to consideration of static loads with deformations within an elastic range.

6.3.2 Lateral Resistance

Lateral loads applied to foundations can be resisted by a combination of passive lateral bearing and base friction. The allowable and ultimate passive pressures and frictional coefficients for the footings are presented in Table 6.3-3.

TABLE 6.3-3
PASSIVE PRESSURES AND FRICTIONAL COEFFICIENTS

	Allowable		Ultimate
	Static	Total Combined	
Frictional Coefficient	0.20	0.24	0.31
Passive Pressure (psf/ft)	129	172	259
Lateral Translation Needed to Develop Passive Pressure	0.005 D	0.005 D	0.005 D

Note: 1) D is the footing depth (ft),

Passive resistance should not be used within the top 12 inches of footing unless abutted by concrete flatwork due to expansive soil conditions. If the deflection resulting from the strain necessary to develop the passive pressure is beyond structural tolerance, additional passive pressure values could be provided based on tolerable deflection. The passive pressure and frictional resistance can be used in combination. The allowable values already incorporate a factor of safety and, as such, would be compared directly to the driving loads. If analytical approaches require the input of a safety factor, the ultimate values would be used.

6.3.3 Design and Construction Considerations

Prior to placing steel or concrete, footing excavations should be cleaned of all debris, loose or soft soil, and water. All footing excavations should be observed by a representative of the project Geotechnical Engineer immediately prior to placing steel or concrete. The purpose of these observations is to check that the bearing soils encountered in the foundation excavations are similar to those assumed in analysis and to verify the recommendations contained herein are implemented during construction.

6.4 EARTH RETAINING STRUCTURES

If project improvements will include retained earth systems, the lateral earth pressure against retaining structures will be dependent upon the ability of the wall to deflect. Presented in Table 6.4-1 are the active, at-rest, and braced lateral earth pressures for on-site soil. The active pressure is applicable to walls able to rotate 0.0005 radians at the top or bottom. The at-rest soil pressure is applicable to retaining structures that are fully fixed against both rotation and translation. Walls restrained from translation at the top and bottom, but able to deflect 0.0005 radian between restrained points should be designed for the braced lateral pressure.

TABLE 6.4-1
LATERAL EARTH PRESSURES

	Lateral Earth Pressures
Active Pressure (psf/ft of depth)	50
At-Rest Pressure (psf/ft of depth)	90
Braced Pressure (psf)	35 H

Note: H in the expression represents the retained height in feet (measured from finished grade to bottom of footing).

The recommended values incorporate saturated soil conditions but not the lateral pressure due to hydrostatic forces. Wall backfill should be adequately drained.

Retaining wall foundation design can utilize the passive pressures and sliding resistance given in Table 6.3-3 and the bearing capacities given in Table 6.3-1. When utilizing the bearing capacities of Table 6.3-1, the static loading value represents the average bearing for the footing and the total combined loading value presents the allowable maximum toe pressure.

6.5 CONCRETE SLABS-ON-GRADE

6.5.1 Subgrade Preparation

Slabs-on-grade should be supported on recompacted soils or engineered fill placed as described in Section 5 of this report. Subgrade soil within 24 inches of pad grade should have a moisture content of at least 4 percent above optimum, immediately prior to placing the slab concrete or placing the vapor retarding membrane.

6.5.2 Capillary and Moisture/Vapor Break

Considering the groundwater depth and soil types, a capillary break (i.e. clean sand or gravel layer) is considered unnecessary.

In areas to receive moisture-sensitive floor coverings, it is recommended that the subgrade be covered by a vapor retarding membrane meeting the specifications of ASTM E1745, (Class C with minimum puncture resistance of 475 grams), such as Fortifiber Building Systems Group 10 Mil, “Moistop Ultra®”, Stego Industries 10 mil “Stego Wrap™”, W.R. Meadows Sealtight 10 mil “Perminator®”, or equivalent. The subgrade surface should be smooth and care should be exercised to avoid tearing, ripping, or otherwise puncturing the vapor retarding membrane. If the vapor retarding membrane becomes torn or disturbed, it should be removed and replaced or properly patched. All laps, splices, and utility penetrations should be properly sealed according to the manufacturer specifications.

The vapor retarding membrane could be covered with approximately 1 to 2 inches of saturated surface dry (SSD) sand to protect it during construction. Concrete should not be placed if sand overlying the membrane has been allowed to attain a moisture content greater than about 5 percent (due to precipitation or excessive moistening). In addition, penetrations through the concrete slab shall be sealed or protected to prevent inadvertently introducing excess water into the sand cushion layer due to curing water, wash-off water, rainfall, etc. Excessive water beneath interior floor slabs could result in future significant vapor transmission through the slab, adversely affecting moisture-sensitive floor coverings and could inhibit proper concrete curing.

According to American Concrete Institute ACI 302.2R-06, concrete could be placed directly on the vapor retarding membrane to minimize the potential for developing a reservoir of moisture in the sand layer that could lead to future moisture entrapment and potential moisture and flooring problems. If concrete is placed directly on the membrane, care shall be taken to not damage the membrane and special concrete curing methods implemented to minimize potential slab curing problems. If the protective sand layer is not used, the building designer should be in agreement. Many slab designers feel the sand cushion is important to proper concrete curing as well as minimizing slab curling issues.

It should be noted that, although the slab support discussed above is currently the industry standard, this system might not be completely effective in preventing floor slab moisture vapor transmission problems. This system will not necessarily assure that floor slab moisture

transmission rates will meet floor-covering manufacturer standards and that indoor humidity levels will not inhibit mold growth. A qualified specialist(s) with knowledge of slab moisture protection systems, flooring design and other potential components that may be influenced by moisture, should address these post-construction conditions separately. The purpose of a geotechnical investigation is to address subgrade conditions only, and consequently, it does not evaluate future potential conditions.

6.5.3 Conventional Slab Design

To accommodate the potential for expansive soils, the minimum reinforcement of concrete floor slabs should consist of #3 bars at 24 inches on center in both principle directions or equivalent. The reinforcement is based on engineering judgement and experience with expansive soils, not on any structural analysis. The reinforcement assumes a nominal slab thickness of 4 to 5 inches. Slab thickness and reinforcement must also satisfy structural considerations.

A modulus of subgrade reaction, Kp (Bp = 1 foot), of 350 pci may be used for elastic analysis of slabs on properly compacted native subgrade soil. Slab concrete should have good density, a low water/cement ratio, and proper curing to promote a low porosity.

6.6 CORROSION POTENTIAL

A soil sample obtained from the near surface site soil was tested to evaluate pH, minimum electrical resistivity, and soluble sulfate and chloride content.

The pH of the soil tested was 6.99 and the minimum electrical resistivity was 1,811 ohm-cm. These values are generally representative of an environment that would be mildly corrosive to buried unprotected metals. An example of the potential soil corrosion is provided by utilizing methods provided in Caltrans California Test 643, “Method for Estimating the Service Life of Steel Culverts”. The method indicates an 18-gauge steel zinc-coated culvert is estimated to have a maintenance-free service life (years to perforation) of 20 years. If project improvements will involve metal that comes into contact with the on-site soil, the design should consider the potential soil corrosiveness described.

Test results suggest that nondetectable levels of soluble sulfates and low levels of soluble chlorides (<5 ppm) are present in on-site soils. Normal cement (Type II) should be adequate for

foundation concrete that comes in contact with the onsite soils. Reinforcement cover need not be increased for concrete that comes in contact with the on-site soil.

Corrosion is dependent upon a complex variety of conditions, which are beyond the geotechnical practice. Consequently, a qualified corrosion engineer should be consulted if the owner desires more specific recommendations.

6.7 PAVEMENT DESIGN

6.7.1 Design R-value and Traffic Assumptions

The R-value for the on-site soil was evaluated in the laboratory on bulk samples of subgrade soil taken at five (5) locations from the upper 3 feet of soils throughout the site. The tested soil had measured R-values of 8, 11, 11, 15, and 16. The laboratory testing conformed to Caltrans Test Method 301. An R-value of 8 is recommended for pavement design.

Detailed vehicular load and frequency information was not provided for this project at the time this report was prepared. Traffic on the site is anticipated to consist of parking and drives for automobiles and regular delivery truck traffic and trash collection traffic. Consequently, a range of pavement sections have been provided based on Traffic Indexes (T.I.'s) of 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5 and 8.0. These traffic design assumptions should be reviewed for compatibility with the actual development, and revised pavement sections developed, as necessary.

6.7.2 Asphalt Concrete Pavement Design

Flexible pavement design recommendations have been developed fort the given T.I.’s based upon the California Department of Transportation (Caltrans) design procedures and a design R-value of 8. The flexible asphalt concrete pavement sections associated with the assumed T.I.’s for on-site asphalt pavements are summarized in Table 6.7-1.

TABLE 6.7-1
RECOMMENDED MINIMUM PAVEMENT SECTIONS

Traffic Index	Asphalt Concrete (inches)	Aggregate Base – Class 2 (inches)
4.5	2.5	8.5
5.0	2.5	10.5
5.5	3.0	11.0
6.0	3.0	13.0
6.5	3.5	14.0
7.0	4.0	14.5
7.5	4.0	16.5
8.0	4.5	17.5

The design criteria assumes a 20-year design period and that normal maintenance (crack sealing, etc.) is performed. The traffic index is a measure of the volume of truck traffic that will be applied to a pavement section in the design life. The allowable average daily truck traffic (ADTT) for the assumed traffic indexes is presented in Table 6.7-2.

TABLE 6.8-2
AVERAGE DAILY TRUCK TRAFFIC

Traffic Index	2-Axle Vehicle	or	3-Axle Vehicle	or	5-Axle Vehicle
4.5	2.2		0.8		0.2
5.0	5.2		2.0		0.5
5.5	11.6		4.3		1.1
6.0	24.1		9.0		2.4
6.5	47.3		17.7		4.7
7.0	88.1		33.0		8.8
7.5	157.3		59.0		15.8
8.0	270.6		101.5		27.1

The flexible pavement should conform to and be placed in accordance with the Caltrans Standard Specifications, 2015. The aggregate base (Class 2) should comply with the specifications in Sections 26. The aggregate base and upper 12 inches of subgrade should be

compacted to a minimum of 95 percent relative compaction as determined by Caltrans Test Method 216 (Dry determination) or ASTM D1557 test procedures.

6.7.3 Portland Cement Concrete Pavement Design

Portland cement concrete pavement (PCCP) may be desirable at entry points, delivery docks, trash collection areas and other locations where tight-turning, heavy vehicles may be maneuvering.

Design recommendations for PCCP are based on standards developed by the American Concrete Institute. Considering areas subject to truck traffic, Table 6.7-3 provides the rigid concrete pavement sections for light to moderate commercial usage.

TABLE 6.7-3
RECOMMENDED MINIMUM PAVEMENT SECTIONS

Truck Usage	Average Daily Truck Traffic (ADTT)	Portland Cement Concrete (inches)	Aggregate Base – Class 2 Min. R-value 78 (inches)
Light Duty	1	4.5	4.0
Medium	10	5.0	4.0
Heavy Duty	25	6.0	6.0

6.7.4 Moisture Considerations

The pavement design should consider both the vehicular loading, as well as the environmental factors. The vehicular loading will depend on the amount and type of traffic anticipated for the pavement design life. Environmental factors include the potential for moisture variations beneath the pavement structural section. It is recommended that all pavement areas conform to the following criteria:

- ❑ All trench backfill, including utility and sprinkler lines, should be properly placed and adequately compacted to provide a stable subgrade.
- ❑ Adequate drainage should be provided to prevent surface water from ponding and saturating the subgrade soil.
- ❑ A periodic maintenance program should be incorporated.
- ❑ All concrete curbs separating pavement and landscaped areas should extend to the subgrade.

6.7.5 Construction Considerations

In the event unstable (pumping) subgrades are encountered within planned pavement areas, we recommend a heavy, rubber-tired vehicle (typically a loaded water truck) be used to test the load/deflection characteristics of the finished subgrade materials. It is recommended this vehicle have a minimum rear axle load (at the time of testing) of 16,000 pounds with tires inflated to at least 65 psi pressure. If the tested surface shows a visible deflection extending more than 6 inches from the wheel track at the time of loading, or a visible crack remains after loading, corrective measures should be implemented. Such measures could include disking to aerate, chemical treatment, replacement with drier material, or other methods. It is recommended **TECHNICON** be retained to assist in developing which method (or methods) would be applicable for this project.

6.8 SITE DRAINAGE

Providing and maintaining adequate site drainage to prevent entrapment and ponding of surface water and excessive moisture migration into the subgrade soil is very important. Poor perimeter or surface drainage could cause reduced subgrade support. The design and construction needs to provide the basis for good drainage. This includes:

- Sufficient pad height to allow for proper drainage
- Defined drainage gradients away from the structure to points of conveyance, such as drainage swales and/or area drains and discharge pipe
- Roof drainage connected to proper areas of discharge

The owners/maintenance personnel must maintain the established drainage by not blocking or obstructing gradients away from structures without providing some alternative drainage means (e.g. area drains and subsurface pipes). If planter areas are established near the structures, it is important to prevent surface run-off from entering the planter. Where planted areas are adjacent to the structures, care must be taken not to over irrigate and to maintain a leak-free sprinkler piping system. Consideration should be given to use of low volume emitter irrigation systems for planters. Well-maintained low-volume emitter irrigation (drip system) is best suited for planters adjacent to structures. Watering practices must strive to promote a uniform moisture condition year around.

7 ADDITIONAL SERVICES

7.1 DESIGN REVIEW AND CONSULTATION

It is recommended that **TECHNICON** be retained to review those portions of the contract drawings and specifications that pertain to earthwork, foundations, and pavement prior to finalization to determine whether they are consistent with our recommendations.

7.2 CONSTRUCTION OBSERVATION AND TESTING

It is recommended that a representative of **TECHNICON** observe the excavation, earthwork, foundation, and pavement phases of work to determine that the subsurface conditions are compatible with those used in the analysis and design. **TECHNICON** can conduct the necessary field testing and provide results on a timely basis so that action necessary to remedy indicated deficiencies can be taken in accordance with the plans and specifications. Upon completion of the work, a written summary of our observations, field testing, and conclusions regarding the conformance of the completed work to the intent of the plans and specifications will be provided. This additional service is not part of this current contractual agreement. **TECHNICON** will not be responsible for establishing or confirming building or foundations depths or locations unless retained to do so.

8 LIMITATIONS

The conclusions and recommendations presented in this report are based on the information provided regarding the proposed construction, and the results of our field and laboratory investigation, combined with interpolation of the subsurface conditions between boring locations. The nature and extent of the variations between borings may not become evident until construction. If variations or undesirable conditions are encountered during construction, our firm should be notified promptly so that these conditions can be reviewed and our recommendations reconsidered where necessary. The unexpected conditions frequently require additional expenditures for proper construction of the project. **TECHNICON Engineering Services, Inc.** will not assume any responsibility for errors or omissions if the final extent and depth of earthwork is not determined by our firm at the time of construction due to said variations or undesirable conditions encountered.

If the proposed construction is relocated or redesigned, or if there is a substantial lapse of time between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes, or construction operations at or adjacent to the site, the conclusions and recommendations contained in this report should be considered invalid unless the changes are reviewed and our conclusions and recommendations modified or approved in writing. Such conditions may require additional field and laboratory investigations to determine if our conclusions and recommendations are applicable considering the changed conditions or time lapse.

It is the responsibility of the contractor to provide safe working conditions with respect to excavation slope stability. This report does not relieve the contractors of responsibility for temporary excavation construction, bracing and shoring in accordance with CAL OSHA requirements.

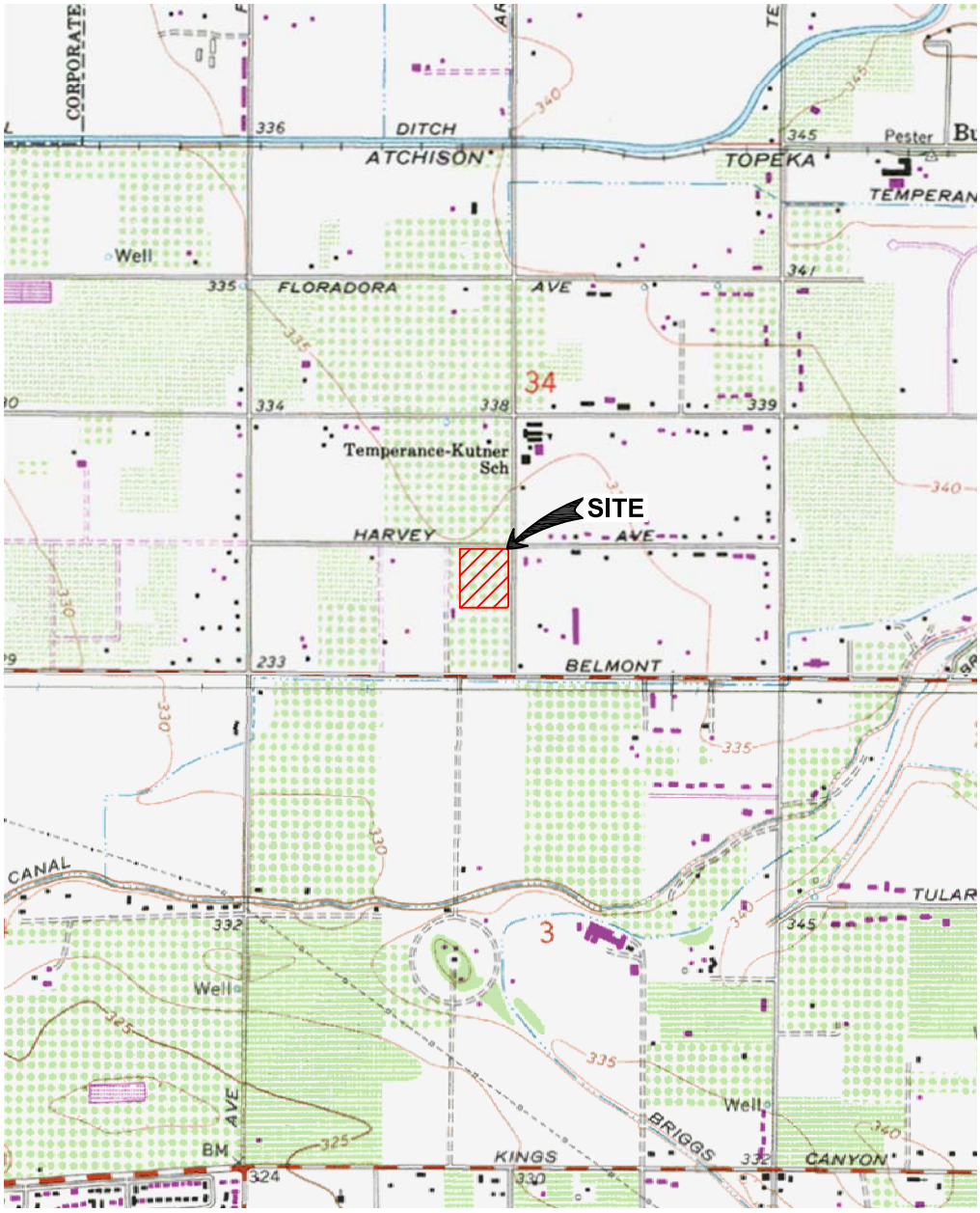
Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. This report should not be construed as an environmental audit or study.

This report has been prepared for the sole use by the County of Fresno Department of Public Works and Planning and their designated consultants for the proposed Fresno County Sheriff Area 2 Substation Complex to be located at the southwest corner of Armstrong and Harvey Avenue in Fresno, California. Recommendations presented in this report should not be extrapolated to other areas or used for other projects without prior review. This report has been prepared with the intent that the firm of **TECHNICON** will be performing the construction testing and observation for the complete project. If, however, another firm or individual(s) should be retained or employed to use this geotechnical investigation report for the purpose of construction testing and observation, notice is hereby given that **TECHNICON** will not assume any responsibility for errors or omissions, if any, which may occur and which could have been avoided, corrected, or mitigated if **TECHNICON**, had performed the work. This notice also applies to the misuse or misinterpretation of the conclusions and recommendations outlined in this report. Furthermore, the other firm or individual(s) performing construction testing and observation should accept transfer of responsibility of the work, as required by the California Building Code, in writing to the project owner and **TECHNICON**. The firm accepting transfer of responsibility should perform additional investigation(s) as may be necessary to develop their own conclusions, evaluations, and recommendations for design and construction.

FIGURE 1

&

FIGURE 2



LAT.: 36.7529°N, LONG.: 119.6738°W, 34-T13S-R21E, MDB&M, USGS MAP: CLOVIS, DATE: 1964, PHOTO REV.: 1981

NORTH

TECHNICON ENGINEERING SERVICES, INC.	PROJECT: 190598	VICINITY MAP PROPOSED FRESNO COUNTY SHERIFF AREA 2 SUBSTATION COMPLEX SWC OF ARMSTRONG & HARVEY AVENUE FRESNO, CALIFORNIA	FIGURE 1 NTS
	SOURCE: USGS TOPOGRAPHIC MAPS		

E. HARVEY AVENUE

N. ARMSTRONG AVENUE

▲ =R-VALUE LOCATIONS

⊕ =SOIL BORING LOCATIONS

NORTH

SCALE: 1"=100'

0' 50' 100'

TECHNICON ENGINEERING SERVICES, INC.	PROJECT: 190598 SOURCE: THE COUNTY OF FRESNO	SITE MAP PROPOSED FRESNO COUNTY SHERIFF AREA 2 SUBSTATION COMPLEX SWC OF ARMSTRONG & HARVEY AVENUE FRESNO, CALIFORNIA	FIGURE 2

BORING LOGS AND LOG KEY

APPENDIX A

TECHNICON Engineering Services, Inc.
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KEY TO SYMBOLS

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
DATE OF EXPLORATION 9/24/2019
PROJECT LOCATION Fresno, CA
PROJECT NUMBER 190598

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

		FILL
	SW	WELL GRADED SAND
	SP	POORLY GRADED SAND
	SM	SILTY SAND
	SC	CLAYEY SAND
	PT	PEAT
	OL	LOW PLASTICITY ORGANIC SILT
	OH	HIGH PLASTICITY ORGANIC SILT
	ML	LOW PLASTICITY SILT
	MH	HIGH PLASTICITY SILT
	GW	WELL GRADED GRAVEL
	GP	POORLY GRADED GRAVEL
	GM	SILTY GRAVEL
	GC	CLAYEY GRAVEL
	CL	LOW PLASTICITY CLAY
	CH	HIGH PLASTICITY CLAY

SAMPLER SYMBOLS

- STANDARD PENETRATION TEST
- CALIFORNIA SAMPLER
- MODIFIED CALIFORNIA SAMPLER
- SHELBY TUBE SAMPLER
- ROCK CORE BARREL
- BULK SAMPLE

- Water Level at Time of Drilling
- Water Level at End of Drilling
- Water Level After 24 Hours
- Assumed stratum line
- Observed stratum line

Note 1: The degree of saturation shown on the boring logs is based on an assumed specific gravity of 2.65. The actual degree of saturation may vary.

Note 2: The stratum lines shown on the logs represent the approximate boundary between soil types; the actual in-situ transition may be gradual.

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
S - DEGREE OF SATURATION (%)
NP - NON PLASTIC
-200 PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION

TECHNICON Engineering Services, Inc.
4539 N Brawley Ave #108
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BORING B 1

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 16.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0	CAL	11-15-23 (38)		**Silty SAND (SM)** - dense, brown, moist, fine to medium grained, trace clay	124.5	6.2	S = 50 %	
5	SPT	3-5-6 (11)		Medium dense				
10	CAL	3-7-7 (14)		Light brown, increased silt, without clay	118.1	9.5	S = 63 %	
15	SPT	19-26-26 (52)		Very dense, brown, trace clay				

NOTES:
1. Bottom of boring at 16.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

TECHNICON Engineering Services, Inc.
4539 N Brawley Ave #108
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BORING B 2

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 11.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0	CAL	9-9-11 (20)		**Silty SAND (SM)** - medium dense, brown, moist, fine to medium grained, trace clay	111.9	5.6	S = 31 %	
5	SPT	4-10-10 (20)						
10	SPT	9-14-17 (31)		**Clayey SAND (SC)** - dense, light brown, moist, fine to medium grained				

NOTES:
1. Bottom of boring at 11.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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4539 N Brawley Ave #108
Fresno, CA 93722
Telephone: 559-276-9311

BORING B 3

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 11.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Clayey SAND (SC)** - medium dense, dark brown, moist, fine to medium grained				
	CAL	10-16-18 (34)			114.8	6.6	S = 40 %	
5								
	CAL	5-6-9 (15)			116.2	10.3	S = 65 %	
10				**Sandy SILT (ML)** - stiff, light brown, moist, fine grained				
	SPT	5-6-6 (12)						

NOTES:
1. Bottom of boring at 11.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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BORING B 4

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 21.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - medium dense, brown, moist, fine to medium grained, trace clay				
	CAL	11-11-13 (24)			121.4	9.0	S = 66 %	
5								
	CAL	3-4-6 (10)		Loose, no clay	107.9	4.7	S = 24 %	
10								
	SPT	10-20-17 (37)		Dense, light brown				
15								
	CAL	6-10-12 (22)		Medium dense				
20								
	SPT	5-11-12 (23)		Brown, trace clay, iron oxide staining				

NOTES:
1. Bottom of boring at 21.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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4539 N Brawley Ave #108
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BORING B 5

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 16.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - medium dense, brown, moist, fine to medium grained, trace clay				
	CAL	7-8-9 (17)			115.8	8.0	S = 49 %	
5								
	SPT	7-7-11 (18)		Light brown				
10								
	CAL	8-16-19 (35)		Dense	122.3	5.7	S = 43 %	
15								
	SPT	5-5-10 (15)		Medium dense				

NOTES:
1. Bottom of boring at 16.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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BORING B 6

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 16.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - dense, brown, moist, fine to medium grained, trace clay				
	GB CAL	8-13-18 (31)			120.2	5.7	S = 41 %	
5	SPT	4-9-13 (22)		Medium dense, no clay, iron oxide staining				
10				**Sandy SILT (ML)** - hard, light brown, moist, fine grained, iron oxide staining				
	CAL	16-28-27 (55)			144.1	12.7	S = 228 %	
15				**Silty SAND (SM)** - medium dense, light grayish brown, moist, fine to medium grained, iron oxide staining				
	SPT	6-11-17 (28)						

NOTES:
1. Bottom of boring at 16.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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BORING B 7

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 11.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0	CAL	13-17-18 (35)		**Silty SAND (SM)** - dense, brown, moist, fine to medium grained, trace clay	110.3	9.1	S = 48 %	
5	SPT	2-2-3 (5)		Loose, reddish brown, iron oxide staining				
10	CAL	14-17-31 (48)		Dense, medium plasticity	121.4	14.7	S = 108 %	

NOTES:
1. Bottom of boring at 11.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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BORING B 8

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 11.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - medium dense, brown, moist, fine to medium grained				
	CAL	8-13-16 (29)			117.7	9.1	S = 59 %	
5				**Sandy SILT (ML)** - hard, brown, moist, fine grained, iron oxide staining				
	SPT	14-21-25 (46)						
10				**Silty SAND (SM)** - medium dense, brown, moist, fine to medium grained				
	CAL	9-9-11 (20)			113.4	14.6	S = 84 %	

NOTES:
1. Bottom of boring at 11.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

TECHNICON Engineering Services, Inc.
4539 N Brawley Ave #108
Fresno, CA 93722
Telephone: 559-276-9311

BORING B 9

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 16.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - dense, dark brown, moist, fine to medium grained, trace clay				
	CAL	14-18-21 (39)			129.5	7.1	S = 68 %	
5								
	SPT	6-13-17 (30)		Light brown				
10								
	CAL	10-17-22 (39)			118.9	11.9	S = 81 %	
15								
	SPT	9-12-14 (26)		Medium dense				

NOTES:
1. Bottom of boring at 16.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

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BORING B10

PROJECT NAME Fresno County Sheriff Area 2 Substation Complex
PROJECT NUMBER 190598
PROJECT LOCATION Fresno, CA
SURFACE DESCRIPTION Flat with Moderate Vegetation
DATE STARTED 9/24/19 **COMPLETED** 9/24/19
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 45
BORING DEPTH 21.5 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY K. Rasmussen **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - medium dense, dark brown, moist, fine to medium grained				
	GB CAL	6-8-12 (20)			107.7	8.1	S = 40 %	
5	CAL	14-50		Very dense, light brown	124.6	8.1	S = 66 %	
10	SPT	6-8-8 (16)		**Sandy SILT (ML)** - stiff, light brown, moist, fine grained				
15	CAL	7-15-26 (41)		**Silty SAND (SM)** - dense, grayish brown, moist, fine to coarse grained, with medium to coarse sand				
20	SPT	12-21-26 (47)		Brown, fine to medium grained, low plasticity				

NOTES:
1. Bottom of boring at 21.5 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 9/24/19.

LABORATORY TESTS

APPENDIX B

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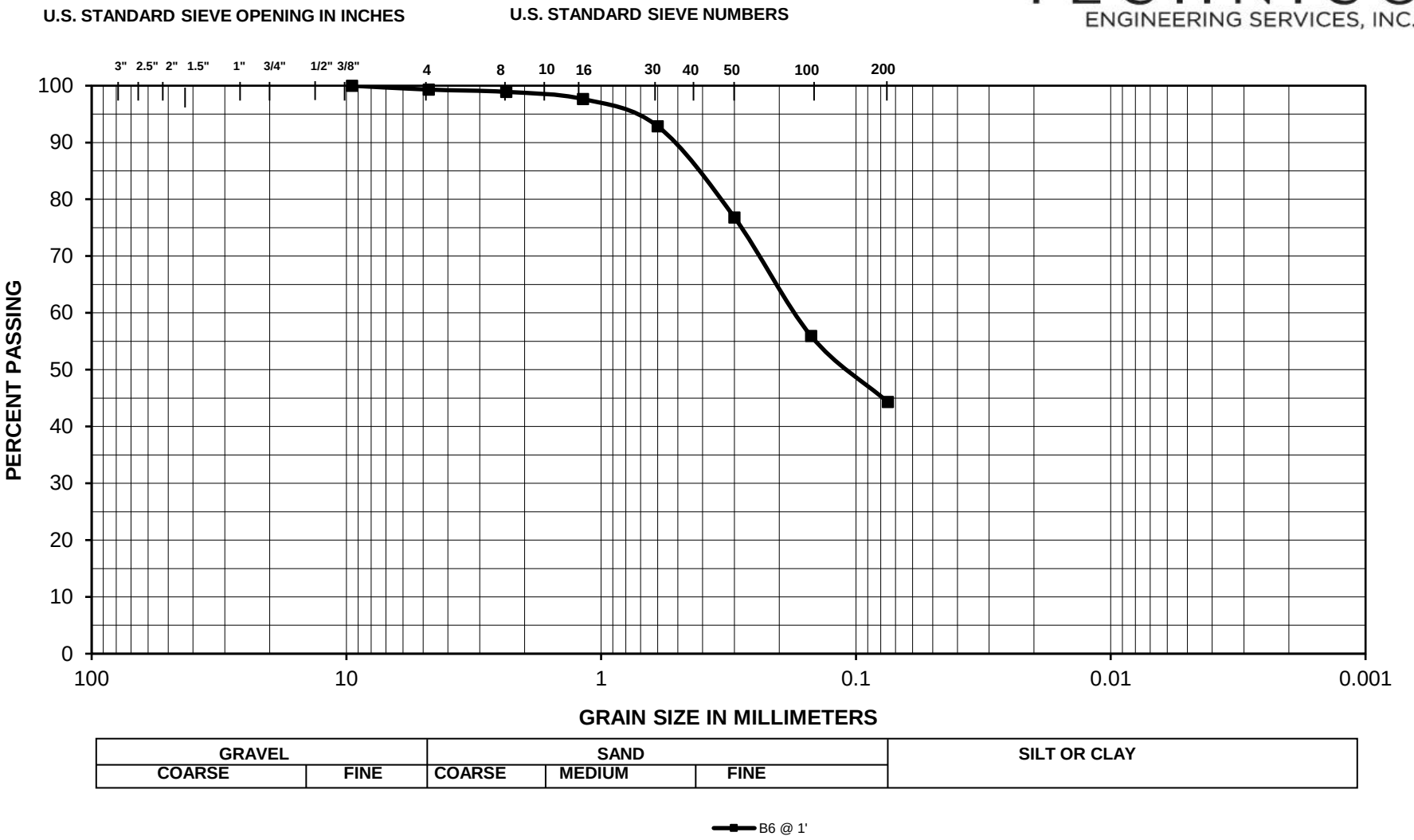

Sample No.	Classification	% Gravel	% Sand	% Fines	% Moist.	LL	PL	PI	Project	Fresno Co. Area 2
B6 @ 1'	Silty SAND (SM)	0.7	55.0	44.3	5.7					Fresno, CA
									TES No.	190598
									Date	9/26/2019

TECHNICON
ENGINEERING SERVICES, INC.

Sieve Analysis for Coarse and Fine Aggregate
ASTM C 136

Project	Fresno Co. Area 2	Technician	W.J.
	Fresno, CA	Date	9/26/2019
TES No.	190598	Sample No.	B6 @ 1'
Lab No.		Remarks	Silty SAND (SM)

	Weight (lbs. or grams)	Maximum Sieve Size	Minimum Weight of Test Specimen, lbs. (kg)
Total Dry Sample + Tare Wt.		Sand	1.0 (0.5)
Tare Weight		3/8"	2.0 (1.0)
Total Dry Sample Wt.	189.1	1/2"	4.0 (2.0)
Initial Weight Fine Aggregate Before Wash		3/4"	11.0 (5.0)
		1"	22.0 (10.0)
Final Weight Fine Aggregate After Wash	106.25	1 1/2"	33.0 (15.0)
		2"	44.0 (20.0)

Sieve Size	Cumulative Weight Retained	Individual % Retained	Cumulative % Retained	Cumulative % Passing	Specs.
3 in.		0.0	0.0	100.0	
2 1/2 in.		0.0	0.0	100.0	
2 in.		0.0	0.0	100.0	
1 1/2 in.		0.0	0.0	100.0	
1 in.		0.0	0.0	100.0	
3/4 in.		0.0	0.0	100.0	
1/2 in.		0.0	0.0	100.0	
3/8 in.		0.0	0.0	100.0	
#4	1.3	0.7	0.7	99.3	
#8	2.1	0.4	1.1	98.9	
#16	4.4	1.3	2.3	97.7	
#30	13.5	4.8	7.1	92.9	
#50	43.9	16.0	23.2	76.8	
#100	83.3	20.9	44.1	55.9	
#200	105.3	11.6	55.7	44.3	
Pan					

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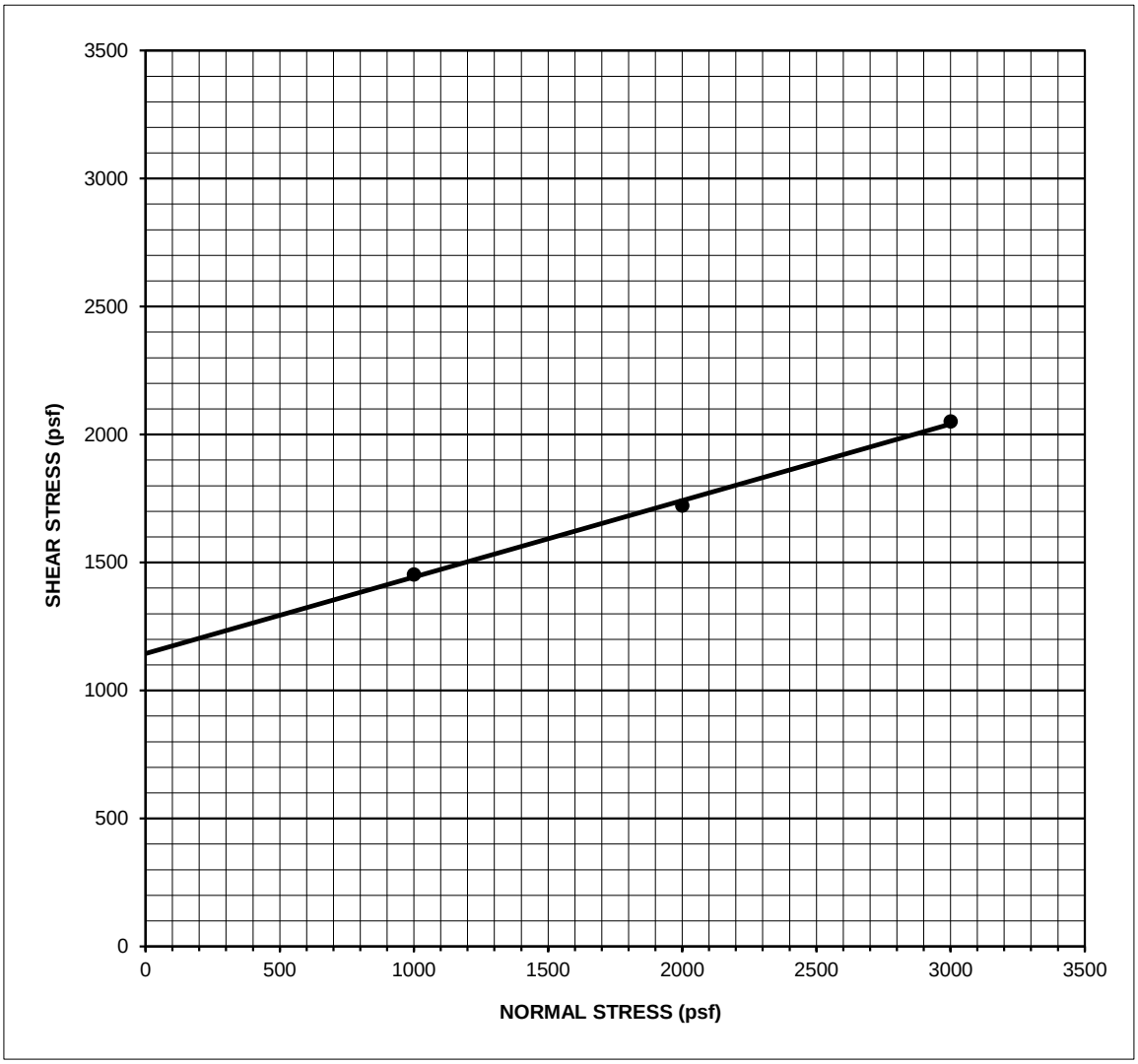
Direct Shear Test

ASTM D3080



Project	Fresno Co. Area 2
TES No.	190598
Sample Date	9/26/2019
Sample No.	B6 @ 1'
Description	Silty SAND (SM)

Cohesion (psf)	**1140**
Internal Friction Angle (ϕ)	**17**

Specimen	A	B	C	D	E
Dry Density (pcf)	120.2	120.2	120.2	---	---
Initial Water Content (%)	5.8	5.8	5.8	---	---
Final Water Content (%)	15.9	14.4	14.3	---	---
Normal Stress (pcf)	1000	2000	3000	---	---
Maximum Shear (pcf)	1453	1722	2051	---	---

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Method for Estimating the Service Life of Steel Culverts
Caltrans California Test 643

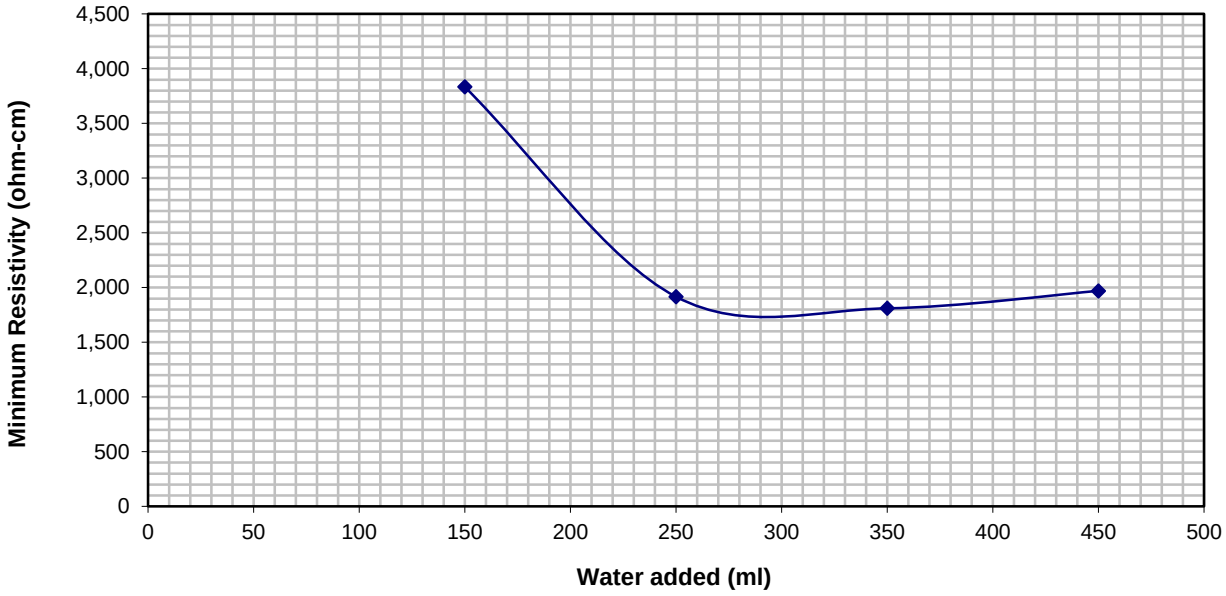
Project Name	Fresno Co. Area 2	Sample Location	B10 @ 0'-3'
Project Number	190598	Test Date	10/13/2019
Sample Date	9/25/2019	Tested By	W.J.
Sampled By	K. Rassmusen	Material Description	Silty SAND (SM)

Sample Condition	**As Received**	**Minimum Resistivity**					
Water Added (ml)	0	150	250	350	450		
Resistance (ohm)	960,000	3,600	1,800	1,700	1,850		
Resistivity (ohm-cm)	1,022,400	3,834	1,917	1,811	1,970		

Minimum Resistivity (ohm-cm) 1,811 | **Field Resistivity (ohm-cm)**

pH = 6.99 **EC = 6.86**

Box Constant=1.065



Years to perforation*	20

* Caltrans California Test 643 - Method for Estimating the Service Life of Steel Culverts

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Chemical Analysis

SO_4 - Modified Caltrans 417 & CL - Modified Caltrans 417/422

Project	Fresno Co. Area 2	Technician	W. Juan de Dios
	Fresno, CA	Date	10/16/2019
TES No.	190598	Remarks	Silty SAND (SM)

Sample Location	Soluble Sulfate SO_4-S		Soluble Chloride Cl	
B10 @ 0'-3'	ND	mg/Kg	3.5	mg/Kg
B10 @ 0'-3'	ND	mg/Kg	1.8	mg/Kg
B10 @ 0'-3'	ND	mg/Kg	3.5	mg/Kg
Average	**ND**	**mg/Kg**	**2.93**	**mg/Kg**

ND = Nondetectable

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Expansion Index Test
UBC Standard 29-2 / ASTM D4829

Project Fresno Co. Area 2
TES No. 190598
Lab No.

Technician W.J.
Date 10/14/2019
Sample No. B10 @ 0'-3'
Remarks Silty SAND (SM)

Water Added (ml)	Dry Back			
Wt. Of Soil + Mold (g)	788.0			
Wt. of Mold (g)	368.3			
Wt. of Soil (g)	419.7			
Wt. of Soil (lb)	0.925			
Wet Density (pcf)	126.6			
Moisture Sample, wet (g)	200.0			
Moisture Sample, dry (g)	183.0			
Moisture Content (%)	9.3			
Dry Density (pcf)	115.8			
Specific Gravity	2.7			
Degree of Saturation (%)	**55.3**			

Time	Dial Reading
10/14/19 13:45	0.0000
10/14/19 14:45	0.0355
10/15/19 8:30	0.0522
10/15/19 10:00	0.0525
10/15/19 12:00	0.0528
10/15/19 13:00	0.0528
FINAL	0.0528

Expansion meas. = 0.0528
Exp. Index meas. = 52.8
Exp. Index 50 = 56.6

EXPANSION INDEX = 56.6

Expansion Potential Table	
Expansion Index	Potential Expansion
0-20	**Very Low**
21-50	Low
51-90	Medium
91-130	High
>130	Very High

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Expansion Index Test
UBC Standard 29-2 / ASTM D4829

Project: Fresno Co. Area 2
TES No.: 190598
Lab No.:
Technician: W.J.
Date: 10/14/2019
Sample No.: B6 @ 0'-3'
Remarks: Silty SAND (SM)

Water Added (ml)	Dry Back			
Wt. Of Soil + Mold (g)	784.5			
Wt. of Mold (g)	366.8			
Wt. of Soil (g)	417.7			
Wt. of Soil (lb)	0.921			
Wet Density (pcf)	126.0			
Moisture Sample, wet (g)	200.0			
Moisture Sample, dry (g)	184.8			
Moisture Content (%)	8.2			
Dry Density (pcf)	116.4			
Specific Gravity	2.7			
Degree of Saturation (%)	**49.7**			

Time	Dial Reading
10/14/19 10:00	0.0000
10/14/19 11:00	0.0268
10/14/19 14:45	0.0294
10/15/19 8:35	0.0310
10/15/19 10:00	0.0312
FINAL	0.0312

Expansion meas. = 0.0312
Exp. Index meas. = 31.2
Exp. Index 50 = 31.1

EXPANSION INDEX = 31.1

Expansion Potential Table	
Expansion Index	Potential Expansion
0-20	**Very Low**
21-50	Low
51-90	Medium
91-130	High
>130	Very High

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TECHNICON
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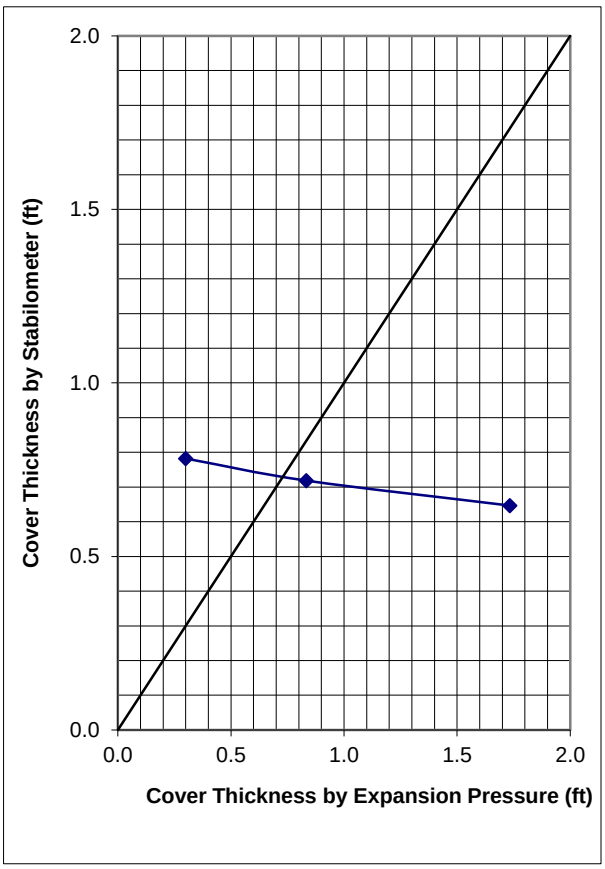
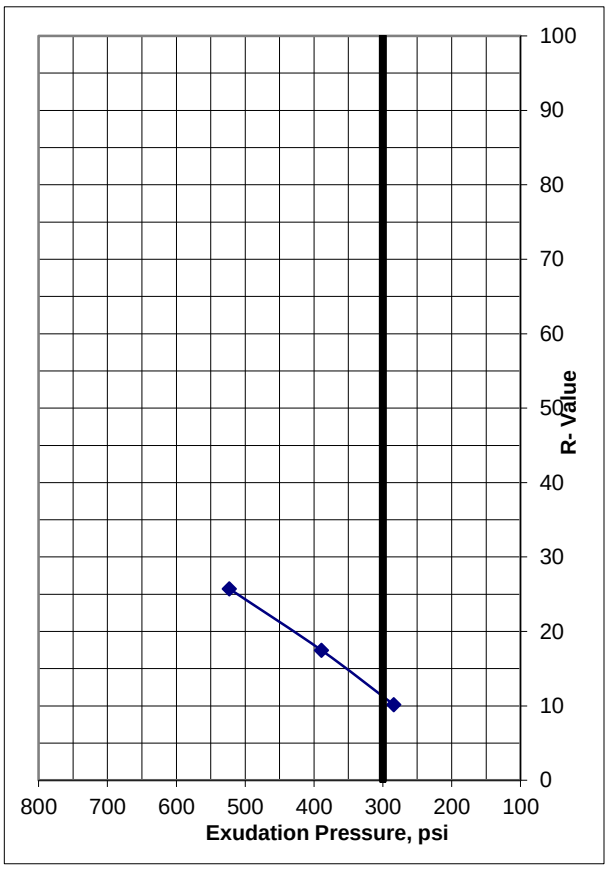
Resistance *R* - Value and Expansion Pressure of Compacted Soils

ASTM D2844-94, Cal 301

Project Name	Fresno Co. Area 2	Lab ID Number	19-358
Project Number	190598	Sample Location	RV-1 @ 0'-3'
Sample Date	9/27/19	Tested By	F.M.
Sampled By	K. Rassumsen	Date Tested	10/1/2019
Material Description	Silty SAND (SM)		





Specimen	1	2	3
Exudation Pressure, psi	523	389	284
Moisture at Test, %	13.3	14.5	17.0
Dry Density, pcf	121.9	118.5	112.7
Expansion Pressure, psf	225	108	39
Thickness by Stabilometer, ft.	0.6	0.7	0.8
Thickness by Expansion Pressure, ft.	1.7	0.8	0.3
R-Value by Stabilometer	26	17	10
R-Value by Expansion Pressure (TI=4.5)	NA		
R-Value at 300 psi Exudation Pressure	11		

Controlling R-Value	**11**

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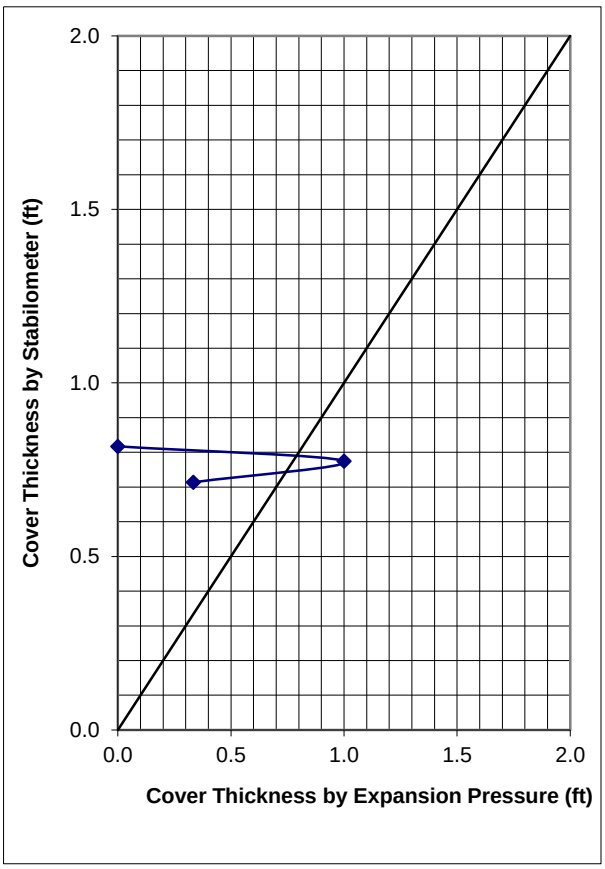
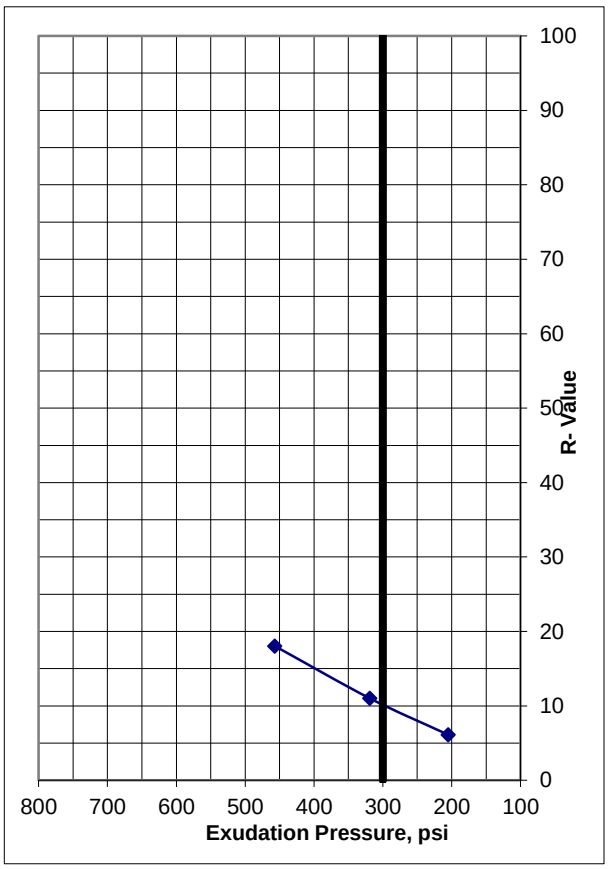
Resistance *R* - Value and Expansion Pressure of Compacted Soils

ASTM D2844-94, Cal 301

Project Name	Fresno Co. Area 2	Lab ID Number	19-358
Project Number	190598	Sample Location	RV-2 @ 0'-3'
Sample Date	9/27/19	Tested By	F.M.
Sampled By	K. Rassumsen	Date Tested	10/1/2019
Material Description	Silty SAND (SM)		





Specimen	1	2	3
Exudation Pressure, psi	457	319	205
Moisture at Test, %	10.8	12.4	14.6
Dry Density, pcf	126.5	121.1	116.3
Expansion Pressure, psf	43	130	0
Thickness by Stabilometer, ft.	0.7	0.8	0.8
Thickness by Expansion Pressure, ft.	0.3	1.0	0.0
R-Value by Stabilometer	18	11	6
R-Value by Expansion Pressure (TI=4.5)	8		
R-Value at 300 psi Exudation Pressure	10		

Controlling R-Value	**8**

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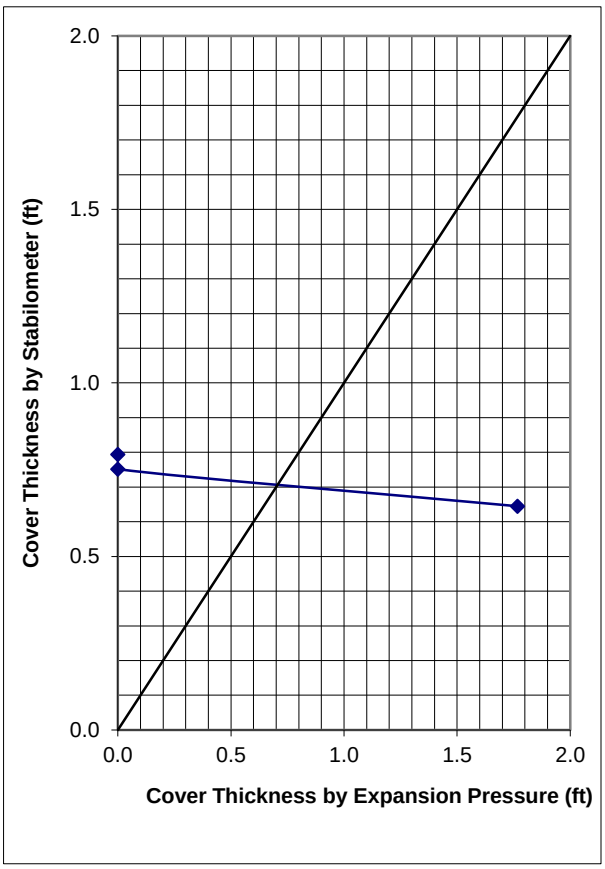
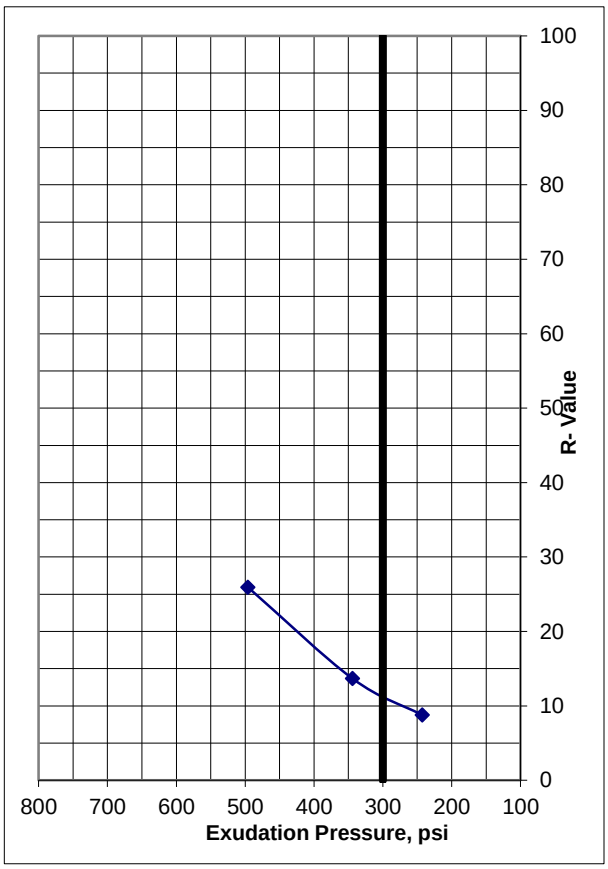
Resistance *R* - Value and Expansion Pressure of Compacted Soils

ASTM D2844-94, Cal 301

Project Name	Fresno Co. Area 2	Lab ID Number	19-358
Project Number	190598	Sample Location	RV-3 @ 0'-3'
Sample Date	9/27/19	Tested By	F.M.
Sampled By	K. Rassumsen	Date Tested	10/1/2019
Material Description	Silty SAND (SM)		





Specimen	1	2	3
Exudation Pressure, psi	496	344	243
Moisture at Test, %	12.4	13.8	15.1
Dry Density, pcf	456.4	118.5	113.6
Expansion Pressure, psf	229	0	0
Thickness by Stabilometer, ft.	0.6	0.8	0.8
Thickness by Expansion Pressure, ft.	1.8	0.0	0.0
R-Value by Stabilometer	26	14	9
R-Value by Expansion Pressure (TI=4.5)	NA		
R-Value at 300 psi Exudation Pressure	11		

Controlling R-Value	**11**

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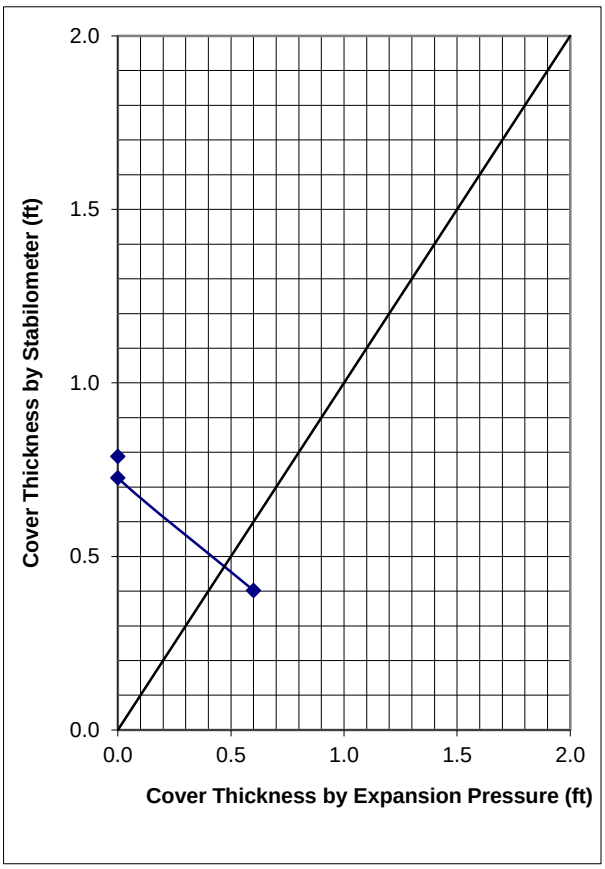
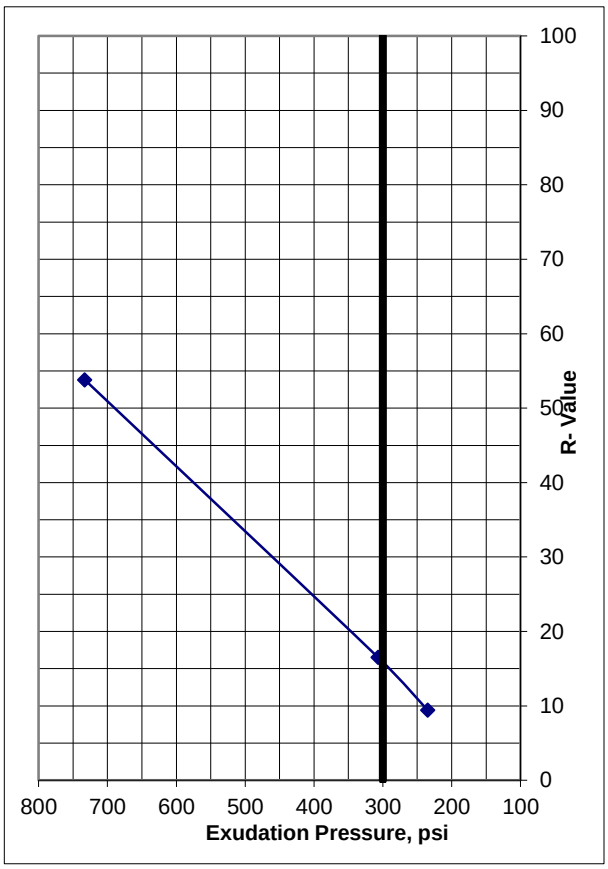
Resistance *R* - Value and Expansion Pressure of Compacted Soils

ASTM D2844-94, Cal 301

Project Name	Fresno Co. Area 2	Lab ID Number	19-358
Project Number	190598	Sample Location	RV-4 @ 0'-3'
Sample Date	9/27/19	Tested By	F.M.
Sampled By	K. Rassumsen	Date Tested	10/4/2019
Material Description	Silty SAND (SM)		





Specimen	1	2	3
Exudation Pressure, psi	733	307	235
Moisture at Test, %	9.1	10.4	11.4
Dry Density, pcf	131.0	126.3	124.4
Expansion Pressure, psf	78	0	0
Thickness by Stabilometer, ft.	0.4	0.7	0.8
Thickness by Expansion Pressure, ft.	0.6	0.0	0.0
R-Value by Stabilometer	54	17	9
R-Value by Expansion Pressure (TI=4.5)	NA		
R-Value at 300 psi Exudation Pressure	15		

Controlling R-Value	**15**

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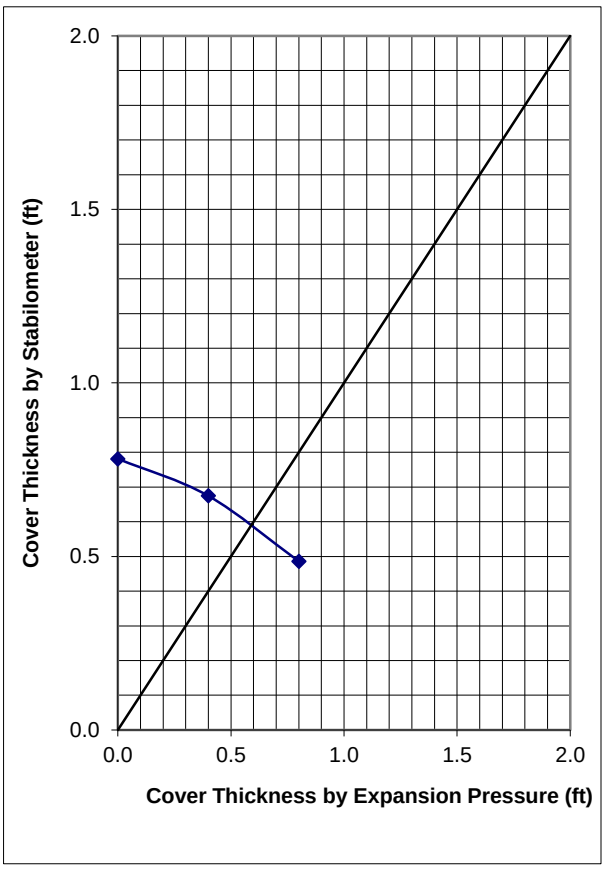
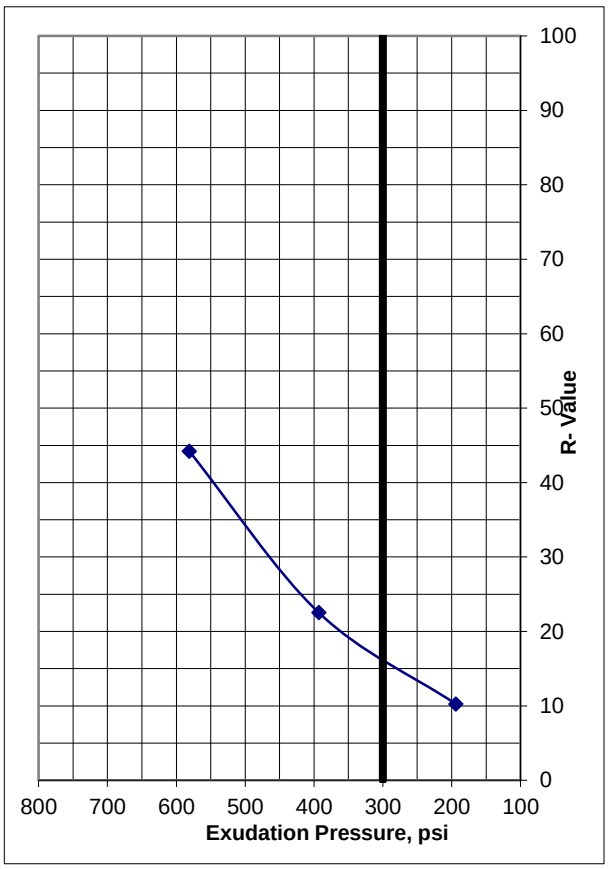
Resistance *R* - Value and Expansion Pressure of Compacted Soils

ASTM D2844-94, Cal 301

Project Name	Fresno Co. Area 2	Lab ID Number	19-358
Project Number	190598	Sample Location	RV-5 @ 0'-3'
Sample Date	9/27/19	Tested By	F.M.
Sampled By	K. Rassumsen	Date Tested	10/4/2019
Material Description	Silty SAND (SM)		





Specimen	1	2	3
Exudation Pressure, psi	581	393	194
Moisture at Test, %	9.7	10.8	12.1
Dry Density, pcf	129.0	127.0	122.4
Expansion Pressure, psf	104	52	0
Thickness by Stabilometer, ft.	0.5	0.7	0.8
Thickness by Expansion Pressure, ft.	0.8	0.4	0.0
R-Value by Stabilometer	44	23	10
R-Value by Expansion Pressure (TI=4.5)	NA		
R-Value at 300 psi Exudation Pressure	16		

Controlling R-Value	**16**

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