Attachment #5
Geotechnical Report

Geotechnical Engineering Report

309th SWEG Office Building
HAFB, Utah
April 11, 2022
Terracon Project No. 61225006

Prepared for:
CRSA
Salt Lake City, Utah

Prepared by:
Terracon Consultants, Inc.
Midvale, Utah

April 11, 2022

CRSA
649 E. South Temple
Salt Lake City, Utah 84102

Attn: Mr. David Triplett – Senior Principal
P: (801) 746 6805
E: davet@crsa-us.com

Re: Geotechnical Engineering Report
309th SWEG Office Building
Hill Air Force Base
HAFB, Utah
Terracon Project No. 61225006

Dear Mr. Triplett:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P61225006 dated February 2, 2022. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Joshua D. White, P.E.
Project Engineer

John B. Mancini, P.E.
Principal

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	10,000 square foot reinforced CMU structure Max. Column loads: 100 kips, Max. Wall loads: 4 kips per lineal foot Little excavation other than foundation construction
Geotechnical Characterization	Some areas contain existing fill up to 4½ feet deep Groundwater not encountered
Earthwork	Remove existing fill where encountered. Existing lean clays can be used for engineered fill Clays are sensitive to moisture variation
Shallow Foundations	Shallow foundations will be sufficient Allowable bearing pressure = 1,800 psf Expected settlements: < 1-inch total, < ½-inch differential Detect and remove zones of fill as noted in **Earthwork**.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report

309th SWEG Office Building
Hill Air Force Base
HAFB, Utah

Terracon Project No. 61225006
April 11, 2022

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed 309th SWEG to be located at Hill Air Force Base in HAFB, Utah. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Excavation considerations
- Stormwater pond considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Lateral earth pressures
- Frost considerations
- Other

The geotechnical engineering Scope of Services for this project included the advancement of 2 exploratory borings and 3 hand augured test holes to depths ranging from approximately 6 to 26½ feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at Hill Air Force Base in HAFB, Utah. Site coordinates are Latitude: 41.134357°, Longitude: -112.014949° (approximate). See **Site Location**

Item	Description
Existing Improvements	Vacant area with existing detention pond.
Current Ground Cover	Bare soil
Existing Topography	Relatively flat elevations
Geology	Available geologic map indicates subsurface conditions consist of Quaternary Lake Bonneville deposits consisting of clay soils with occasional sand.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Information was provided by Mr. David Triplett via email dated 12/21/2021 with occasional updates from design team members.
Project Description	Project consists of construction of a new office facility for the 309th Software Engineering Group
Proposed Structure	The project includes a single-story building with a footprint of about 10,000 square feet. The building will be slab-on-grade (non-basement).
Building Construction	Reinforced Concrete Masonry Unit (CMU)
Finished Floor Elevation	Finished floor elevation is expected to be within 1 to 2 feet above existing site grade.
Maximum Loads	■ Columns: 100 kips (spaced at approximately 22 feet x 22 feet) ■ Walls: 3 to 4 klf ■ Floor: 150 psf typical
Grading/Slopes	None
Below-Grade Structures	None
Free-Standing Retaining Walls	None
Below-Grade Areas	Stormtech Below Ground Storm Water Retention System in the existing pond area to east of proposed building
Pavements	Asphalt Parking lot with light truck and passenger vehicles of 500 per day.
Estimated Start of Construction	2022

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Fill	Existing fill consisting of silty sand with gravel
2	Clay	Lean clay with varying amounts of sand and silt
3	Silt	Silt with vary amounts of sand and clay

Groundwater was not encountered during the subsurface exploration or for the short duration the borings were open. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times or at other locations.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Site Geology

The project site is located in central Davis County, Utah north of the town of Layton, Utah. Soil profile and geologic information from various sources follows.

Near Surface Soils

The Natural Resources Conservation Service Web Soil Survey (WSS) indicates the primary natural surficial soil unit present in portions of the project site is Kidman Fine Sandy Loam and Preston Fine Sand. The following table summarizes the general characteristics of these soils as described in the Web Soil Survey:

Soil Name	Parent Material	Landform Location	Drainage Class	Maximum Salinity	Shrink/Swell Potential	Depth to Seasonal High Water Table (feet)
Kidman Fine Sandy Loam	Lake sediment	Lake terraces tread	Well drained	Nonsaline to very slightly saline	None	More than 80 inches
Preston Fine Sand	Eolian deposits	Hills side slope	Excessively drained	Nonsaline to very slightly saline	None	More than 80 inches

Quaternary Geology

The site is located west of the Wasatch Mountains along the eastern margin of the Basin and Range physiographic province. The northwest portion of the Basin and Range province is situated north of the Colorado Plateau and is bounded by the Wasatch Mountains to the east. Formed during middle and late Tertiary time (1 million years (m.y.) to 23 m.y. ago), the Basin and Range province is dominated by fault-controlled topography. The topography consists of mountain ranges and relatively flat, broad alluvial valleys. These mountain ranges and valleys have evolved from generally complex movements and associated erosional and depositional processes. Structurally, the site lies within the Great Salt Lake Valley. Drainage flows along local streams and rivers and slope wash during late Tertiary time, coupled with structural activity and Lake Bonneville deposition, are generally responsible for the present-day topography within the basin. The site is located in an area mapped as having very low liquefaction potential [1].

- The geologic unit mapped [2] at the surface of the site is deltaic sand deposits of Provo shoreline age of Lake Bonneville. Deltaic materials generally consist of sand soils.
- The nearest known Quaternary fault is 5.7 miles east of the Weber Section of the greater Wasatch fault zone.[3]

[1] *Christenson, G.E., Shaw, L.M., 2008, Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah, Supplement Map to Utah Geological Survey Circular 106.*

[2] *U.S. Geological Survey, mapView, Geologic Map Portal, April 2022, https://ngmdbs.usgs.gov/mapview/*

[3] *U.S. Geological Survey, April 4, 2022, Interactive Fault Map, https://earthquake.usgs.gov/hazards/qfaults/*

Faults are mapped along the nearby mountain foothills, at the base of the Wasatch Mountains to the east, and within the Great Salt Lake. The activity of segments of the Wasatch Fault is believed to be infrequent, but studies indicate large (magnitude 7.0) earthquakes every 900 to 1,300 years.

Bedrock Geology

Bedrock was not encountered in the borings performed during this exploration, and due to the Basin and Range geologic province area, bedrock may not be present within 1,000 to 2,000 feet of ground surface in the locale.[5]

GEOTECHNICAL OVERVIEW

Based on the conditions encountered, the site is suitable for the proposed building.

Existing silty sand and gravel fill was encountered at borings B-01 and B-02 to depths of about 4½ feet. The fill appears to have been placed in a loose manner and we have no records to indicate the degree of control. We recommend removal and replacement of existing fills below all foundations. The **Shallow Foundations** section addresses support of the building bearing on a minimum of 12 inches of engineered fill extending to the native fine-grained soils or extending the footings to the native fine-grained soils.

In floor slab areas, existing granular fills may remain provided Owner accepts additional risk. Support of floor slabs and pavements on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by following the recommendations contained in this report. To take advantage of the cost benefit of not removing the entire amount of undocumented fill, the owner must be willing to accept the risk associated with building over the undocumented fills following the recommended reworking of the material. Should this be the case, development can be supported on a shallow foundation system. The **Floor Slabs** section addresses slab-on-grade support of the building.

The near surface, loose sandy existing fill and the native fine-grained soils could become unstable with typical earthwork and construction traffic, especially after precipitation events. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Pavements** section addresses the design of asphalt pavement systems.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed building areas and parking/driveway areas.

Following stripping and removal of existing fill materials, building foundation areas should be undercut to native soils in order remove the existing granular fill. Exposed foundation subgrade should be scarified to a depth of 8 inches, moisture conditioned, and recompacted prior to constructing new foundations.

In floor slab and pavement areas, the exposed subgrade should be proof rolled to identify soft or deflecting areas and further evaluate the effectiveness of the subgrade compaction. Proofrolling should be performed with a heavily loaded tandem axle dump truck or with similar approved construction equipment under the observation of the Terracon geotechnical engineer. If conditions are found to be unstable, these areas should be removed and replaced with properly placed and compacted Structural fill or stabilized using a combination of Stabilization Fill, geogrids and geotextiles. Soft spot stabilization, if needed, may be accomplished by placement of a bi-axial geogrid product such as those provided by Tensar® (TX grid) or Mirafi® on top of the subgrade and covered with a minimum 8-inch thick layer of the Stabilization Fill. A separation fabric, such as Mirafi® N-series, should be placed between the native soil and the geogrid to minimize migration of clayey soils into the Stabilization Fill.

Existing Fill

As noted in **Geotechnical Characterization**, borings B-01 and B-02 encountered existing fill to depths of about 4½ feet. The fill appears to have been placed in a loose manner and we have no records to indicate the degree of control. Support of footings on existing fill is not recommended.

Floor slabs and pavements constructed on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by following the recommendations contained in this report.

If the owner elects to construct the floor slabs and pavements on the existing fill, the following protocol should be followed. Once the planned grading has been completed, the area should be undercut 1 foot within the footing area and 2 feet within the building slab area and 5 feet beyond the lateral limits of the building area. Once materials have been removed, the entire area should be proofrolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. Once unsuitable materials have been remediated, and the subgrade has passed the proofroll test, the existing and undocumented fill that was removed can be evaluated for reuse as structural fill.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 5 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas. Earthen materials used for structural and general fill should meet the following material property requirements:

Fill Type [1]	Application	Requirements		
		Gradation		Plasticity
		Size	Percent finer by weight	
Structural Fill[2]	Below foundations, concrete slabs or other structural areas, and within 5 feet of the building perimeter	4 inch No. 4 Sieve No. 200 Sieve	100 25 - 60 < 15 max	Liquid Limit 20 max Plasticity Index 5 max
Stabilization Fill[2]	Fill used to stabilize soft, potentially pumping subgrade	4 inch No. 200 Sieve	100 5 max	-
Onsite Fill	General Fill unless it can meet Structural Fill requirements	4 inch No. 200 Sieve	100 < 35	Liquid Limit 35 max Plasticity Index 15 max
Drainage Fill	Gradation No. 1 from UFC 3-250-01 recommended for material used below pavements needed for drainage[3]	¾ inch ½ inch 3/8 inch No. 4 Sieve No. 8 Sieve No. 16 Sieve	100 (-5 tolerance) 78 (±8 tolerance) 63 (±8 tolerance) 38 (±8 tolerance) 19 (±6 tolerance) 4 (±4 tolerance)	-

Fill Type [1]	Application	Requirements		
		Gradation		Plasticity
		Size	Percent finer by weight	
On-Grade Slab Base Course	Immediately below on-grade slabs	In accordance with American Concrete Institute (ACI) 302.1R-15 and 360R-10		

1. All fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.
2. Crushed angular rock with more than 50 percent with two fractured faces as per ASTM D 5821.
3. Gradation 2 or 3 could also be used as found in Table 20-5 of UFC 3-250-01.

Materials proposed for use as Structural Fill should be tested to verify conformance with the materials requirements presented above.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as Structural fill
Minimum Compaction Requirements [1, 2, 3]	100% of maximum dry density for Structural Fill (cohesionless) soils per HAFB Design Standard Section 3.7.8 95% of max. below foundations, below floor slabs and pavements for native soils.	92% of max.
Water Content Range [1]	Low plasticity cohesive: -2% to +3% of optimum Granular: -3% to +3% of optimum	As required to achieve min. compaction requirements

1. Maximum density and optimum water content for cohesive soils determined by Method 106 of MIL-STD-621 using CE55 compaction effort or granular soils determined by Modified Proctor (ASTM D1557).

Utility Trench Backfill

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench

should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for

construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

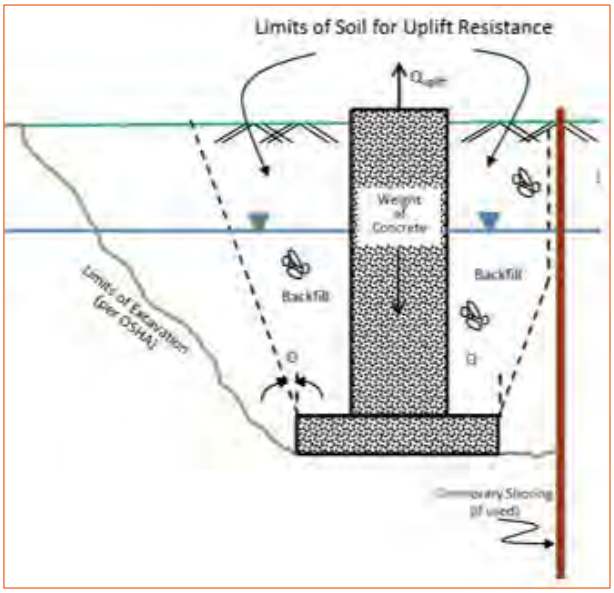
Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	1,800 psf (foundation bearing on native fine-grained soils or a minimum of 12 inches of Structural Fill over the native soils)
Required Bearing Stratum [3]	Undisturbed native soils or structural fill overlying the native fine-grained soils
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Maximum Foundation Dimensions	Columns: 120 inches Continuous: 60 inches
Ultimate Coefficient of Sliding Friction [5]	0.35 (Native Soil) 0.45 (Structural Fill)

Item	Description
Minimum Embedment below Finished Grade [6]	Exterior footings: 36 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About 1/2 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of 50 feet.

Design Parameters - Uplift Loads

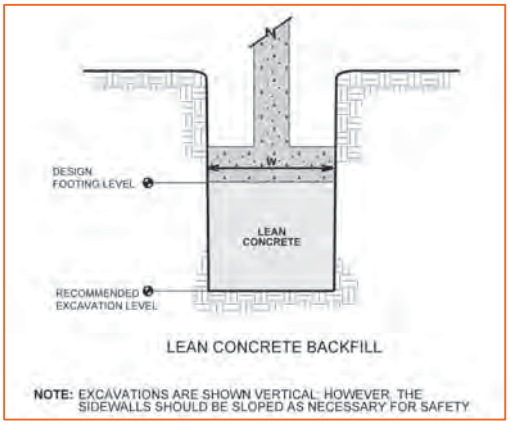
Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, θ, of 32 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 110 pcf should be used for the backfill.



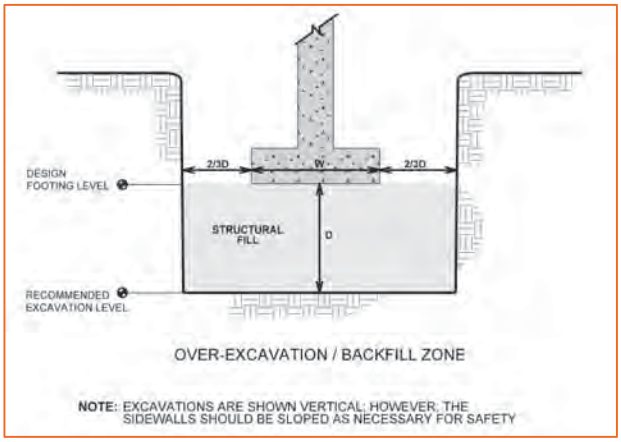
Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with structural fill material placed, as recommended in the **Earthwork** section.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 26½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area[3]. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

LIQUEFACTION

Based on the type of subsurface soils explored and published Liquefaction maps seen in **Supporting Information**, the site is mapped to have a very low liquefaction potential.

[3] *McDonald, Greg N., Ashland, Francis X., Earthquake Site-Conditions Map for the Wasatch Front Urban Corridor, Utah, Plate 1, Utah Geological Survey Special Study 125, 2008.*

FLOOR SLABS

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 6 inches of crushed gravel (Slab Base Course) underlain by properly prepared native soil, or Structural Fill extending to suitable native soils.
Estimated Modulus of Subgrade Reaction [2]	■ Native Subgrade: 125 pounds per square inch per inch (psi/in) ■ Structural Fill: 175 psi/in for point loads[3] (Structural Fill)

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted, but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Existing Fill** within **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

All paved areas should have adequate crown and slope to provide positive drainage and prevent ponding of surface water and infiltration below the pavement section. Water collection devices such as gutters and ditches should be incorporated into the parking lot design to prevent percolation of surface water below the pavement section.

Pavement Design Parameters

Pavement sections were developed using PCASE design methodology and traffic volumes summarized in the **Project Description** section. Pavement sections were developed for vehicular parking lot only. Pavement sections for truck traffic areas are not part of this scope of work. If actual truck traffic is determined for the site, we should be notified so the pavement sections can be modified for the truck traffic. The life span used during pavement calculations was 25 years according to UFC 3-201-01 Section 4-1. Design traffic and estimated 18-kip Equivalent Single Axle Loads (ESAL) are summarized in the following table:

Section	Design ESALs[1]	Equivalent Passes per day of passenger cars[2]
Automobile Parking (Light Duty)	52,000	500

1. Based on traffic conditions describe in the Project Description section.
2. See Pavement Calculations for more details on estimated traffic in Supporting Information.

We anticipate that the pavement subgrades will consist of existing native fine-grained silt and clayey soils, properly placed and compacted grading or Structural Fill prepared as discussed previously. Based on this understanding and the field blow counts and lab tests, a design California Bearing Ratio (CBR) value of 3.0 percent was conservatively chosen, which is equivalent to a subgrade resilient modulus of 5161 psi and a subgrade modulus k-value of 110 pound per cubic inch (pci). This CBR value represents the native soils or fill soils being prepared according to the recommendations presented in the **Earthwork** section.

Pavement Section Thicknesses

Long-term, the native fine-grained soils will provide generally poor support for pavements. With this in consideration we recommend the following minimum pavement sections, or approved equivalent, constructed on the properly prepared subgrade soils:

Traffic Area	Pavement Section Thickness (Inches)				
	Asphalt Cement	Aggregate Base	Drainage Layer	Separation Layer	Total Thickness
Automobile Parking (Light Duty)	4.0	8.0	4.0	4.0	20.0

Pavement Construction Considerations

As noted previously, native fine-grained soils generally provide relatively poor pavement support and are susceptible to rutting and pumping under repeated heavy vehicle traffic. Construction scheduling often involves grading and paving by separate contractors and can involve a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, or wetting of the subgrade soils between grading and paving can result in deterioration of the previously completed subgrade. A non-uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed.

Prior to placing fill for pavement sections, native clay soils should be scarified, moisture conditioned and compacted according to the recommendations presented in the **Earthwork** section. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by a Terracon representative immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

We recommend a program of observation and testing during construction to assist the owner managing the quality assurance of the construction. Pavement materials should be inspected and tested during construction and proper placement and compaction is essential to achieve the intended design life. A Terracon representative should observe proofrolling of the pavement subgrade prior to paving operations to help delineate soft or disturbed areas, and the pavement subgrade should be prepared in accordance with the recommendations presented in the **Earthwork** section.

Pavement sections have not been designed to support construction equipment. As such, the contractor should protect pavement areas from damage that may result from construction traffic.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade, and sidewalks. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs and connect them to the storm drainage system.
- Grade clayey subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.
- Place NFS materials in critical sidewalk areas.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary						
Boring	**Sample Depth (feet)**	**Soil Description**	**Soluble Sulfate (%)**	**Soluble Chloride (%)**	**Electrical Resistivity (Ω-cm)**	**pH**
B-1	5-6½	Lean Clay	293	69	5,472	7.7

Results of water-soluble sulfate testing indicate that samples of the on-site soils have an exposure class of S1 when classified in accordance with Table 19.3.1.1 of the American Concrete Institute (ACI) Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19. To improve sulfate resistance of concrete in severe sulfate exposure when Type V cement is not available, the following should be considered:

- Use of Type I-II modified cement for sulfate resistance
- Cement should have a tricalcium aluminate content of not more than 8%.

- Concrete mixture should contain at least 20% Class F fly ash.
- Provide air-entrainment of 4% to 7% by volume.
- Lower the water to cement ratio to 0.4 to 0.45.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

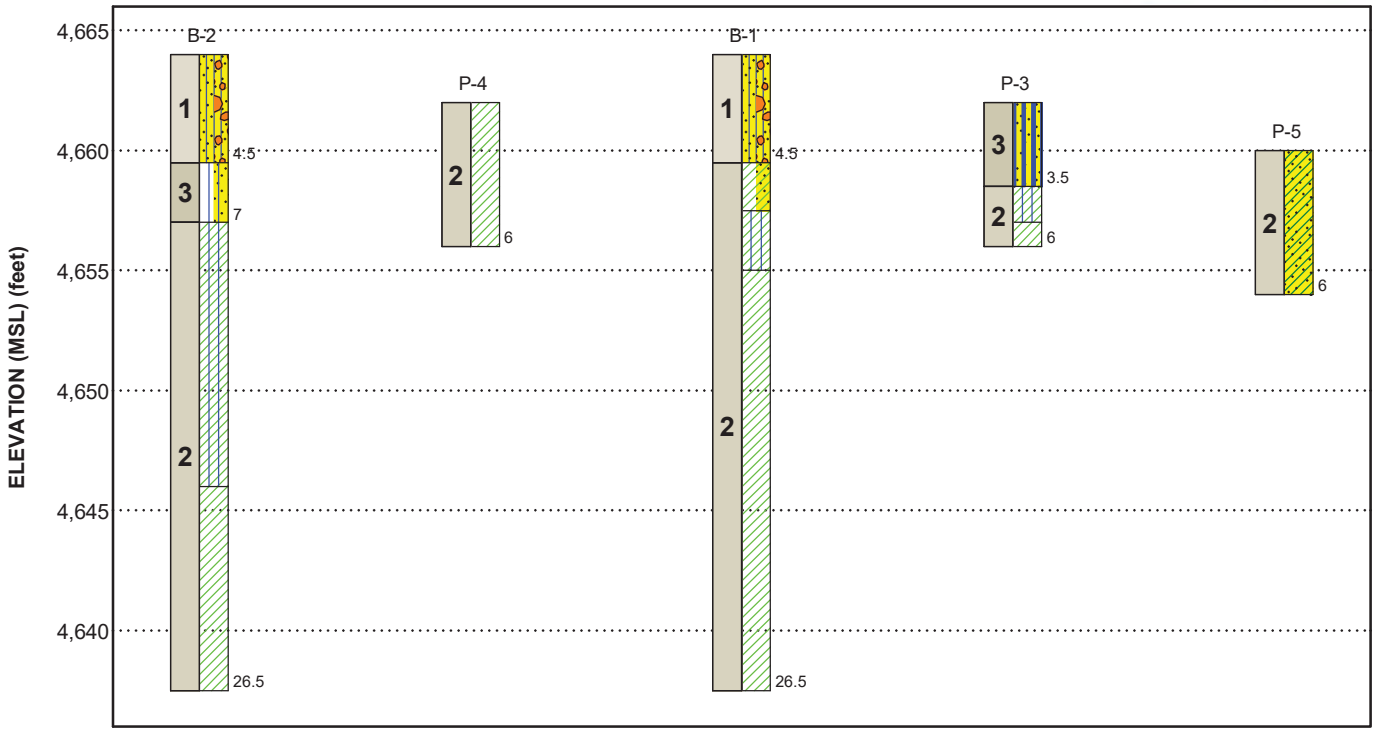
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

Contents:

GEOMODEL

CRSA - HAFB SWEG Office ■ Hill Air Force Base, UT
Terracon Project No. 61225006



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Fill	Clay/Sand disturbed
2	CL	Lean Clay with varying amounts of sand and silt
3	ML	Silt with varying amounts of sand and clay

LEGEND

- Silty Sand with Gravel
- Lean Clay with Sand
- Silty Clay
- Lean Clay
- Silt with Sand
- Sandy Silt
- Sandy Lean Clay

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Explorations	Boring Depth (feet)	Planned Location
2 borings	25 or auger refusal	utilities / buildings
3 hand augured test holes	6 or auger refusal	Retention pond areas

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from the provided topographic map. If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted rotary drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring lined sampler was used for sampling in the upper 10 feet. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Percolation Tests: Three percolation tests were completed at the boring locations P-3, P-4 and P-5 as shown on the Exploration Plan. An approximately four-inch diameter test hole was hand augered to approximately six feet below the existing site grade inside the existing detention ponds. A four-inch diameter, solid pvc, pipe was inserted, and the annular space between the soil and the exterior of the pipe was backfilled with bentonite chips and soil cuttings. The pipe was then filled with water and the soil allowed to saturate. After saturation, the pipe was refilled with water and the time required for the water level to drop incrementally was measured until a stabilized rate was achieved. Rates were considered to be stable when the rate of percolation appeared to be relatively constant.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2435/D2435M Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading
- Soil corrosivity tests including pH (ASTM G51), water soluble sulfate (ASTM C1580), sulfide ion (ASTM D4658), total salts (ASTM D1125), red-ox potential (ASTM D1498), chloride ion (ASTM D512) and Miller box resistivity (ASTM G187) on one sample (results summarized in the **Soil Corrosivity** section and test reports included in the **Exploration Results** section)

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

309th SWEG Office Building ■ HAFB, Utah
April 11, 2022 ■ Terracon Project No. 61225006

Terracon GeoReport

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

309th SWEG Office Building ■ HAFB, Utah
April 11, 2022 ■ Terracon Project No. 61225006

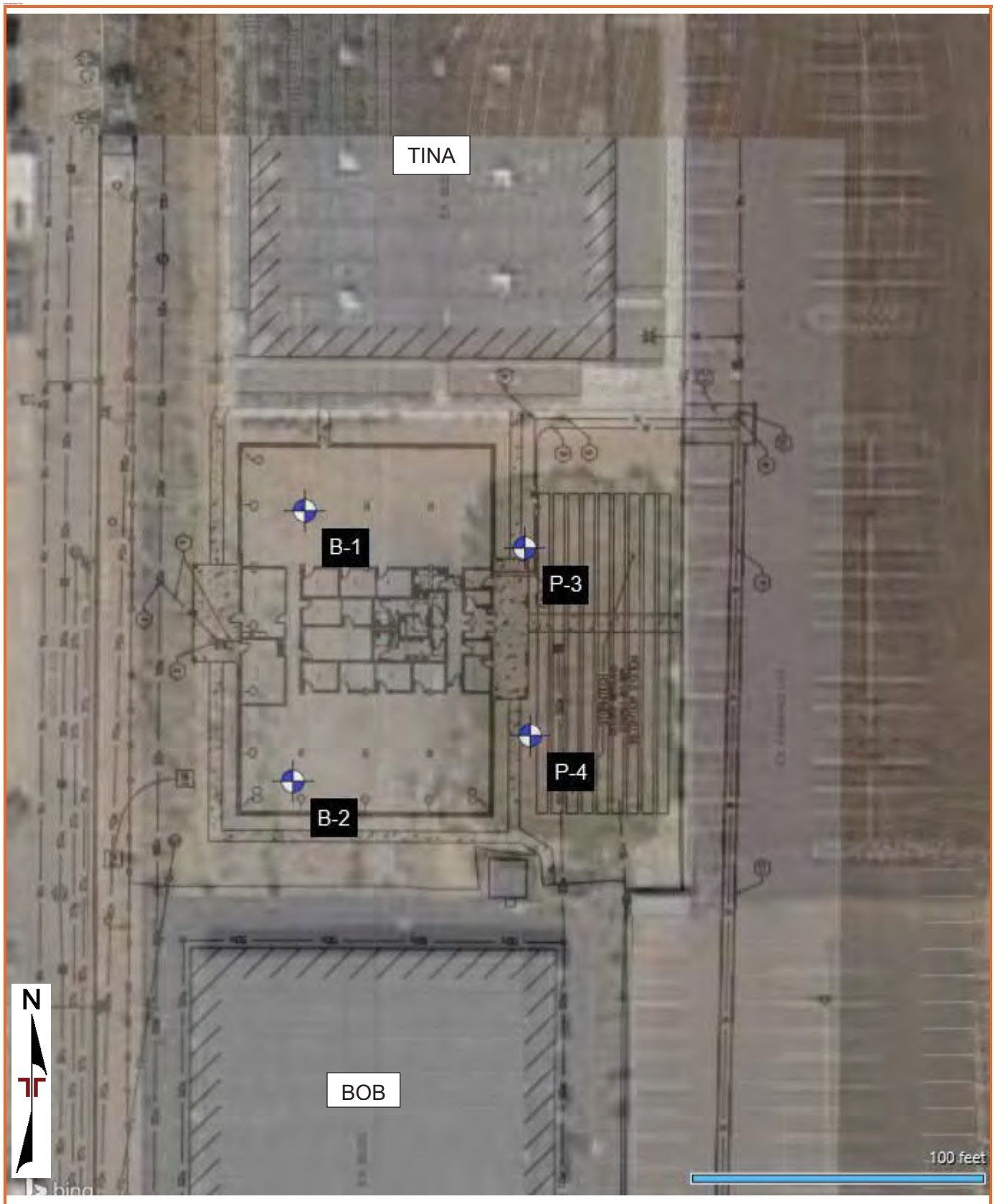


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

309th SWEG Office Building ■ HAFB, Utah
April 11, 2022 ■ Terracon Project No. 61225006

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

GEOLOGIC MAP OVERLAY

309th SWEG Office Building ■ HAFB, Utah
April 11, 2022 ■ Terracon Project No. 61225006

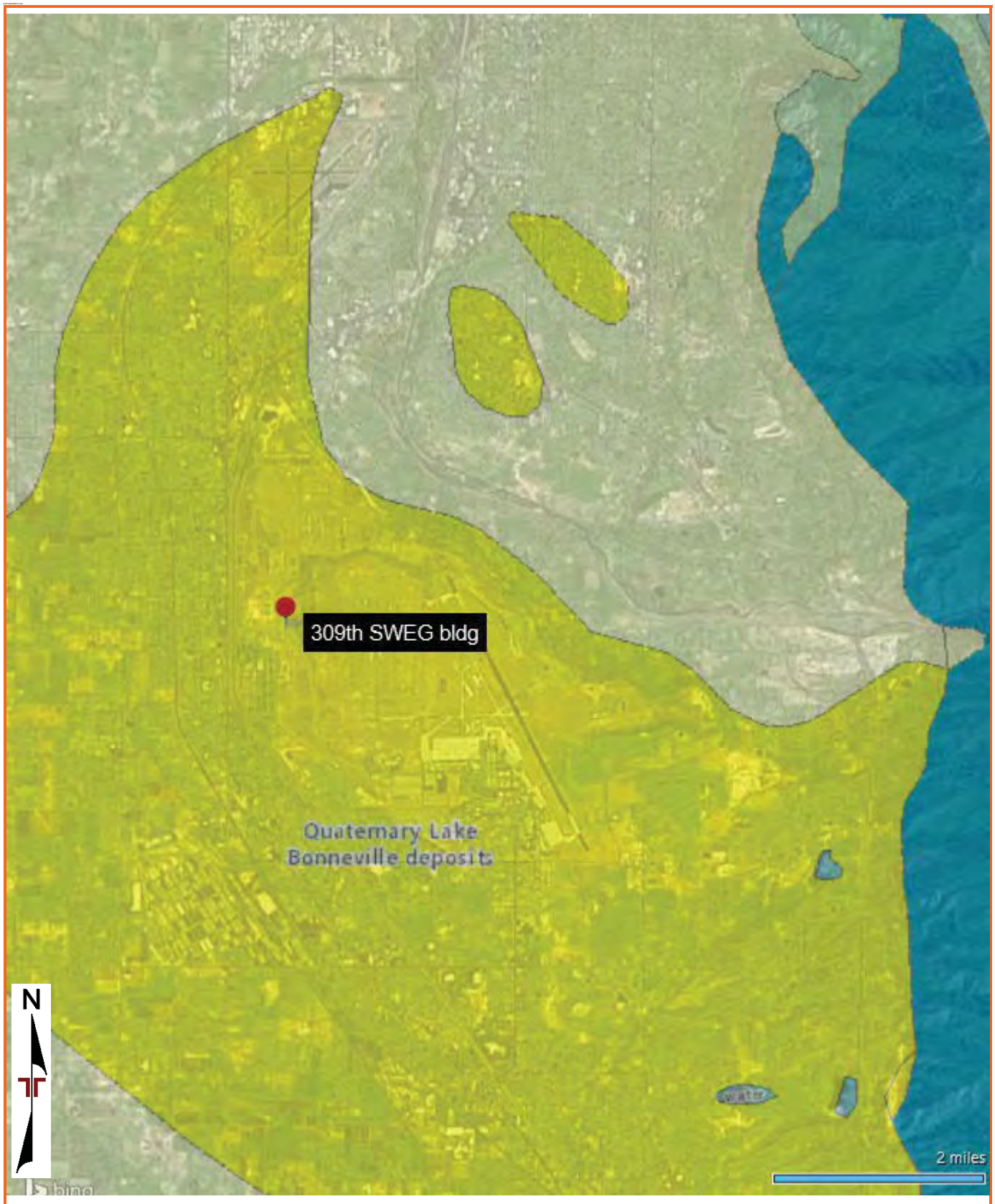


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: CRSA - HAFB SWEG Office

CLIENT: CRSA
Salt Lake City, UT

SITE: Indigo Street
Hill Air Force Base, UT

LOCATION See Exploration Plan

Latitude: 41.1345° Longitude: -112.0150°

Approximate Surface Elev.: 4664 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	N160	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1			**FILL - SILTY SAND WITH GRAVEL (SM)**, dark brown, loose									
		4.5	4659.5+/-				2-2-3 N=5	14				
			LEAN CLAY WITH SAND (CL), brown, medium stiff	5			1-2-3 N=5	14	15.5		26-18-8	71
		6.5	4657.5+/-									
			SILTY CLAY (CL-ML), trace sand, brown, stiff				3-6-7 N=13	35	22.2		27-21-6	87
		9.0	4655+/-									
2			**LEAN CLAY (CL)**, trace sand, brown, soft to stiff	10			3-4-8 N=12	33	24.3		31-19-12	90
				15			0-1-2 N=3	6	26.2		27-18-9	87
				20			0-3-2 N=5	7	25.5			
				25			2-3-3 N=6	7	24.5			
		26.5	4637.5+/-									
			Boring Terminated at 26.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 03-04-2022 | Boring Completed: 03-04-2022

Drill Rig: Geoprobe | Driller: Terracon

Project No.: 61225006

BORING LOG NO. B-2

PROJECT: CRSA - HAFB SWEG Office

CLIENT: CRSA
Salt Lake City, UT

SITE: Indigo Street
Hill Air Force Base, UT

LOCATION See Exploration Plan

Latitude: 41.1342° Longitude: -112.0150°

Approximate Surface Elev.: 4664 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	N160	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1		0	4664+/-									
			FILL - SILTY SAND WITH GRAVEL (SM), dark brown, loose									
							1-2-2 N=4	11				
		4.5	4659.5+/-									
3			**SILT WITH SAND (ML)**, brown, stiff	5			2-5-13		17.4		NP	71
		7.0	4657+/-									
2			**SILTY CLAY (CL-ML)**, brown, medium stiff						22.8		26-21-5	94
				10					21.7			
				15			1-2-4 N=6	11	25.3		25-19-6	91
		18.0	4646+/-									
			LEAN CLAY (CL), brown, medium stiff	20			0-2-3 N=5	7				
				25			0-3-3 N=6	7	27.1			
		26.5	4637.5+/-									
			Boring Terminated at 26.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Boring Started: 03-04-2022 | Boring Completed: 03-04-2022

Drill Rig: Geoprobe | Driller: Terracon

Project No.: 61225006

TEST PIT LOG NO. P-3

PROJECT: CRSA - HAFB SWEG Office

CLIENT: CRSA
Salt Lake City, UT

SITE: Indigo Street
Hill Air Force Base, UT

LOCATION See Exploration Plan

Latitude: 41.1345° Longitude: -112.0148°

Approximate Surface Elev.: 4662 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	N160	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
3			**SANDY SILT (ML)**, light orangish brown									
		3.5	4658.5+/-									
2			**SILTY CLAY (CL-ML)**, trace sand, orangish brown						23.8			93
		5.0	4657+/-	5								
		6.0	**LEAN CLAY (CL)**, orangish brown 4656+/-						24.8		28-20-8	90
			Test Pit Terminated at 6 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:
Percolation test at the bottom of hole

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Test Pit Started: 03-04-2022
Test Pit Completed: 03-04-2022
Excavator: Geoprobe
Operator: Terracon
Project No.: 61225006

TEST PIT LOG NO. P-4

PROJECT: CRSA - HAFB SWEG Office

CLIENT: CRSA
Salt Lake City, UT

SITE: Indigo Street
Hill Air Force Base, UT

LOCATION See Exploration Plan

Latitude: 41.1343° Longitude: -112.0148°

Approximate Surface Elev.: 4662 (Ft.) +/-

DEPTH ELEVATION (Ft.)

MODEL LAYER	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	N160	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2										
							23.8			89
		5					26.1			92

LEAN CLAY (CL), trace sand, orangish brown, stiff

6.0 4656+/-

Test Pit Terminated at 6 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:
Percolation test at the bottom of hole

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Test Pit Started: 03-04-2022 | Test Pit Completed: 03-04-2022

Excavator: Geoprobe | Operator: Terracon

Project No.: 61225006

TEST PIT LOG NO. P-5

PROJECT: CRSA - HAFB SWEG Office

CLIENT: CRSA
Salt Lake City, UT

SITE: Indigo Street
Hill Air Force Base, UT

LOCATION See Exploration Plan

Latitude: 41.1366° Longitude: -112.0147°

Approximate Surface Elev.: 4660 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	N160	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2			**SANDY LEAN CLAY (CL)**, orangish brown									
									24.2			84
		6.0	4654+/-	5								
			Test Pit Terminated at 6 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:
Percolation test at the bottom of hole

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

Test Pit Started: 03-04-2022
Test Pit Completed: 03-04-2022
Excavator: Geoprobe
Operator: Terracon
Project No.: 61225006

Field Percolation Rate Test

Terracon

Test Hole P3

Project Name: HAFB SWEG	Date: 03/4/2022
Terracon Project No.: 61225006	Hole Diameter (inches): 4
Eng./Tech.: Kris Powell	Hole Depth (inches): 72

Time	Length of Interval (min)	Total Time (min)	Beginning Depth to Water Surface (in)	Ending Depth to Water Surface (in)	Water Level Drop (in)	Percolation Rate During Interval (min/in)
11:00	30	0	0.00	0.00	0.00	
11:05	30	30	0.00	1.75	1.75	17.14
11:10	30	60	1.75	3.50	1.75	17.14
11:15	30	90	3.50	5.25	1.75	17.14
11:20	30	120	5.25	7.00	1.75	**17.14**
Lithology:						
	0 to 3.5 ft	Sandy Silt	(ML)			
	3.5 to 5 ft	Silty Clay	(CL-ML)			
	5 to 6 ft	Sandy Lean Clay		(CL)		

REMARKS: Bottom of test pit is approximately 6 feet below site grade.

Field Percolation Rate Test

Terracon

Test Hole P4

Project Name: HAFB SWEG	Date: 03/04/2022
Terracon Project No.: 61225006	Hole Diameter (inches): 4
Eng./Tech.: Kris Powell	Hole Depth (inches): 72

Time	Length of Interval (min)	Total Time (min)	Beginning Depth to Water Surface (in)	Ending Depth to Water Surface (in)	Water Level Drop (in)	Percolation Rate During Interval (min/in)
13:22	30	0	0.00	0.00	0.00	
13:27	30	30	0.00	0.38	0.38	80.00
13:32	30	60	0.38	0.63	0.25	120.00
13:37	30	90	0.63	0.88	0.25	120.00
13:42	30	120	0.88	1.13	0.25	**120.00**
Lithology:						
	0 to 6 ft	Sandy Lean Clay		(CL)		

REMARKS: Bottom of test hole is approximately 6 feet below site grade.

Field Percolation Rate Test

Terracon

Test Hole P5

Project Name: HAFB SWEG	Date: 03/04/2022
Terracon Project No.: 61225006	Hole Diameter (inches): 4
Eng./Tech.: Kris Powell	Hole Depth (inches): 72

Time	Length of Interval (min)	Total Time (min)	Beginning Depth to Water Surface (in)	Ending Depth to Water Surface (in)	Water Level Drop (in)	Percolation Rate During Interval (min/in)
13:22	30	0	0.00	0.00	0.00	
13:27	30	30	0.00	0.00	0.00	#DIV/0!
13:32	30	60	0.00	0.00	0.00	#DIV/0!
13:37	30	90	0.00	0.00	0.00	#DIV/0!
13:42	30	120	0.00	0.00	0.00	#DIV/0!
13:47	30	180	0.00	0.00	0.00	#DIV/0!
Lithology:						
	0 to 6 ft	Sandy Lean Clay		(CL)		

REMARKS: Bottom of test hole is approximately 6 feet below site grade.

Water Elevation never moved and northern pond contained existing water.

SUMMARY OF LABORATORY RESULTS

BORING ID	Depth (Ft.)	Soil Classification USCS	Water Content (%)	Unit Weight Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Fines	Unconfined Compressive Strength (tsf)	pH Analysis	Water Soluble Sulfate (mg/kg)	Water Soluble Chloride (mg/kg)	Water Soluble Salts (ppm)
B-1	5-6.5	LEAN CLAY with SAND(CL)	15.5		26	18	8			71.2					
B-1	7.5-9	SILTY CLAY(CL-ML)	22.2		27	21	6			86.8					
B-1	10-11.5	LEAN CLAY(CL)	24.3		31	19	12			89.7					
B-1	15-16.5	LEAN CLAY(CL)	26.2		27	18	9			86.9					
B-1	20-21.5	LEAN CLAY (CL)	25.5												
B-1	25-26.5	LEAN CLAY (CL)	24.5												
B-2	5-6.5	SILT with SAND(ML)	17.4		NP	NP	NP			71.3					
B-2	7.5-9.5	SILTY CLAY(CL-ML)	22.8		26	21	5			93.6					
B-2	10-11.5	SILTY CLAY (CL-ML)	21.7												
B-2	15-16.5	SILTY CLAY(CL-ML)	25.3		25	19	6			90.7					
B-2	25-26.5	LEAN CLAY (CL)	27.1												
P-3	4-5	SILTY CLAY (CL-ML)	23.8							92.5					
P-3	5-6	LEAN CLAY(CL)	24.8		28	20	8			89.8					
P-4	4-5	LEAN CLAY (CL)	23.8							89.4					
P-4	5-6	LEAN CLAY (CL)	26.1							91.8					
P-5	3-4	SANDY LEAN CLAY (CL)	24.2							83.7					

PROJECT: CRSA - HAFB SWEG Office

SITE: Indigo Street
Hill Air Force Base, UT

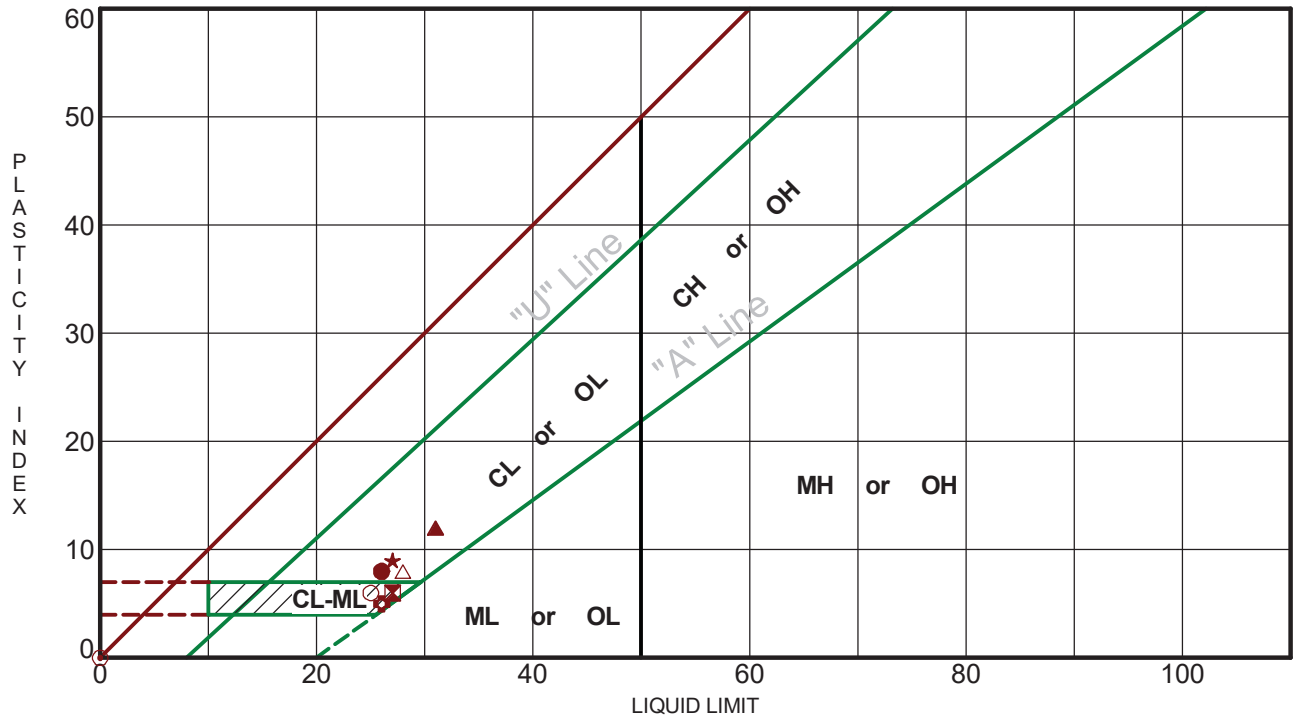
Terracon
6949 S High Tech Dr Ste 100
Midvale, UT
PH. 801-545-8500 FAX. 801-545-8600

PROJECT NUMBER: 61225006

CLIENT: CRSA
Salt Lake City, UT

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	5 - 6.5	26	18	8	71.2	CL	LEAN CLAY with SAND
⊠	B-1	7.5 - 9	27	21	6	86.8	CL-ML	SILTY CLAY
▲	B-1	10 - 11.5	31	19	12	89.7	CL	LEAN CLAY
★	B-1	15 - 16.5	27	18	9	86.9	CL	LEAN CLAY
⊙	B-2	5 - 6.5	NP	NP	NP	71.3	ML	SILT with SAND
✿	B-2	7.5 - 9.5	26	21	5	93.6	CL-ML	SILTY CLAY
○	B-2	15 - 16.5	25	19	6	90.7	CL-ML	SILTY CLAY
△	P-3	5 - 6	28	20	8	89.8	CL	LEAN CLAY

PROJECT: CRSA - HAFB SWEG Office

PROJECT NUMBER: 61225006

SITE: Indigo Street
Hill Air Force Base, UT

Terracon
6949 S High Tech Dr Ste 100
Midvale, UT

CLIENT: CRSA
Salt Lake City, UT

One-Dimensional Swell/Collapse of Soils
ASTM D2435 or D4546 - Method C

Terracon

Project:	HAFB SWEG Office	Test by:	CM/AW
No:	61225006	Reduced by:	CO
Location:	HAFB	Checked by:	JDW
Date:	3/16/2022	Comments:	Sat At 1000
		Machine:	68
Sample:	B-2	Sample type:	Elevation:
Depth (ft):	7.5	Inundation stress (psf):	1000
Lab description:	Brown Clay	Swell pressure (psf):	1000
Preparation procedure:	Cutting Ring	Test Method:	C
Liquid Limit:	26	Percent Fines:	93.6
Plastic Limit:	21	Large Particles:	---
Plastic Index:	5	USCS Classification:	Silty Cly (CL-ML)

Phase Relationships

	Initial	Final
Height , H (in)	1.000	0.878
Height, H (cm)	2.540	2.230
Diameter, D (in)	2.500	2.500
Diameter, D (cm)	6.350	6.350
Wt, wet soil + ring (g)	257.96	255.39
Weight of ring (g)	106.52	106.52
Wet soil + tare (g)	58.82	44.26
Dry soil + tare (g)	47.74	36.62
Tare (g)	1.64	1.78
Moisture Content, w (%)	24.0%	21.9%
Specific Gravity, Gs	2.65	2.65
Mass of Soil total (g)	151.4	148.9
Mass of dry solids (g)	122.1	122.1
Volume (cm^3)	80.4	70.6
Volume of water (cm^3)	29.3	26.8
Volume of solids (cm^3)	46.1	46.1
Volume of voids (cm^3)	34.4	24.5
Volume of air (cm^3)	5.0	-2.2
Area (cm^2)	31.7	31.7
Ht. solids, Hs (cm)	1.455	1.455
Void Ratio, e	0.746	0.533
Saturation, S (%)	85	109
Dry density (gm/cm^3)	1.518	1.729
Wet Unit Weigth (pcf)	117.5	131.6
Dry Unit Weight (pcf)	94.8	107.9

Deformation Results - Vertical Stress

Vert. stress (ksf)	Change in Height, ΔH (in)	Height, D (in)	Vertical strain (%)	Void Ratio
Seating	0	1.000	0.00	0.746
0.15	0.0043	0.996	0.43	0.738
0.25	0.0053	0.995	0.53	0.737
0.5	0.0091	0.991	0.91	0.730
0.75	0.0128	0.987	1.28	0.724
1	0.0193	0.981	1.93	0.712
1	0.0229	0.977	2.29	0.706
2	0.0302	0.970	3.02	0.693
4	0.0392	0.961	3.92	0.678
8	0.0492	0.951	4.92	0.660
16	0.0603	0.940	6.03	0.641
32	0.0890	0.911	8.90	0.590
64	0.1313	0.869	13.13	0.517
16	0.1288	0.871	12.88	0.521
4	0.1221	0.878	12.21	0.533

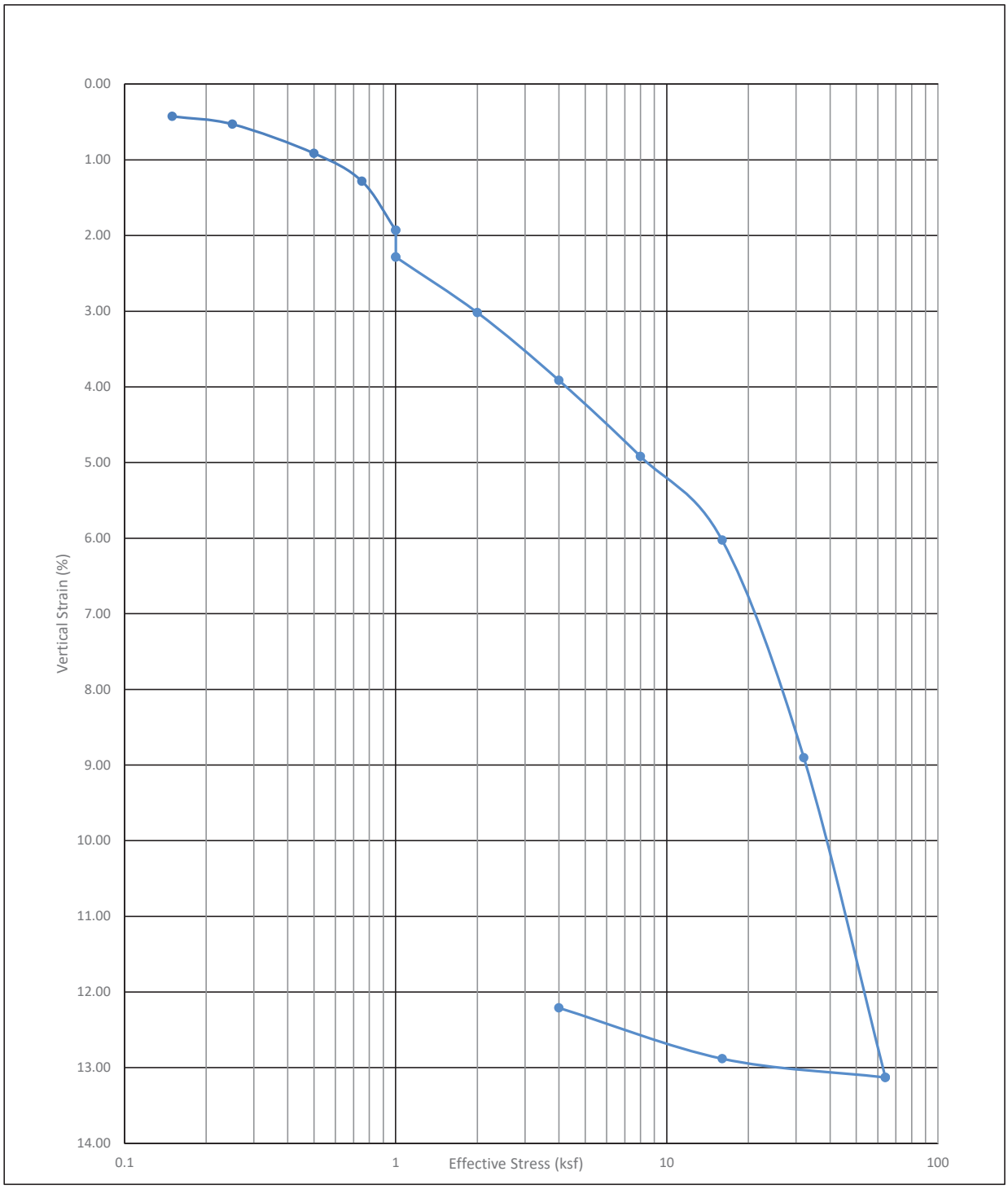
Collapse Strain -0.36 %
Collapse Load: 1000 psf

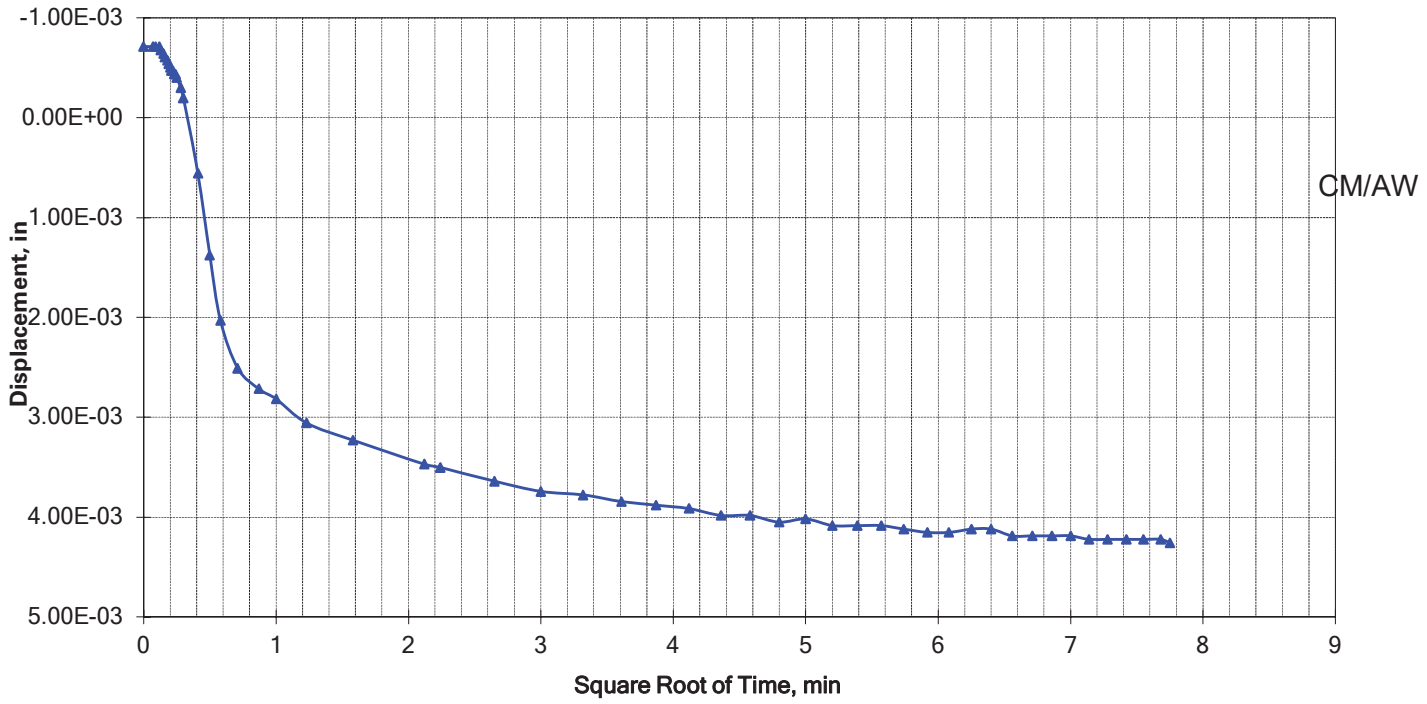
Comments:

One-Dimensional Swell/Collapse of Soils
ASTM D2435 or D4546 - Method C

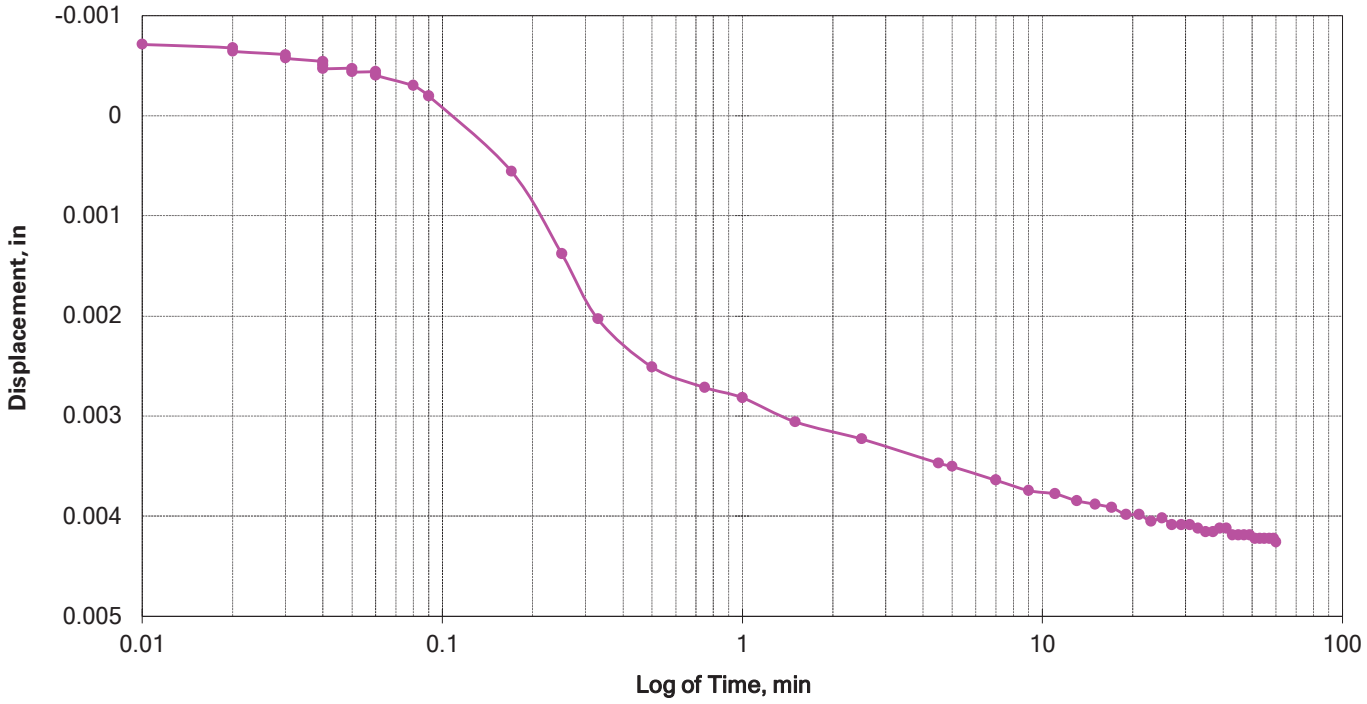
Terracon

Project: HAFB SWEG Office	Sample: B-2
No: 61225006	Depth (ft): 7.5





CM/AW

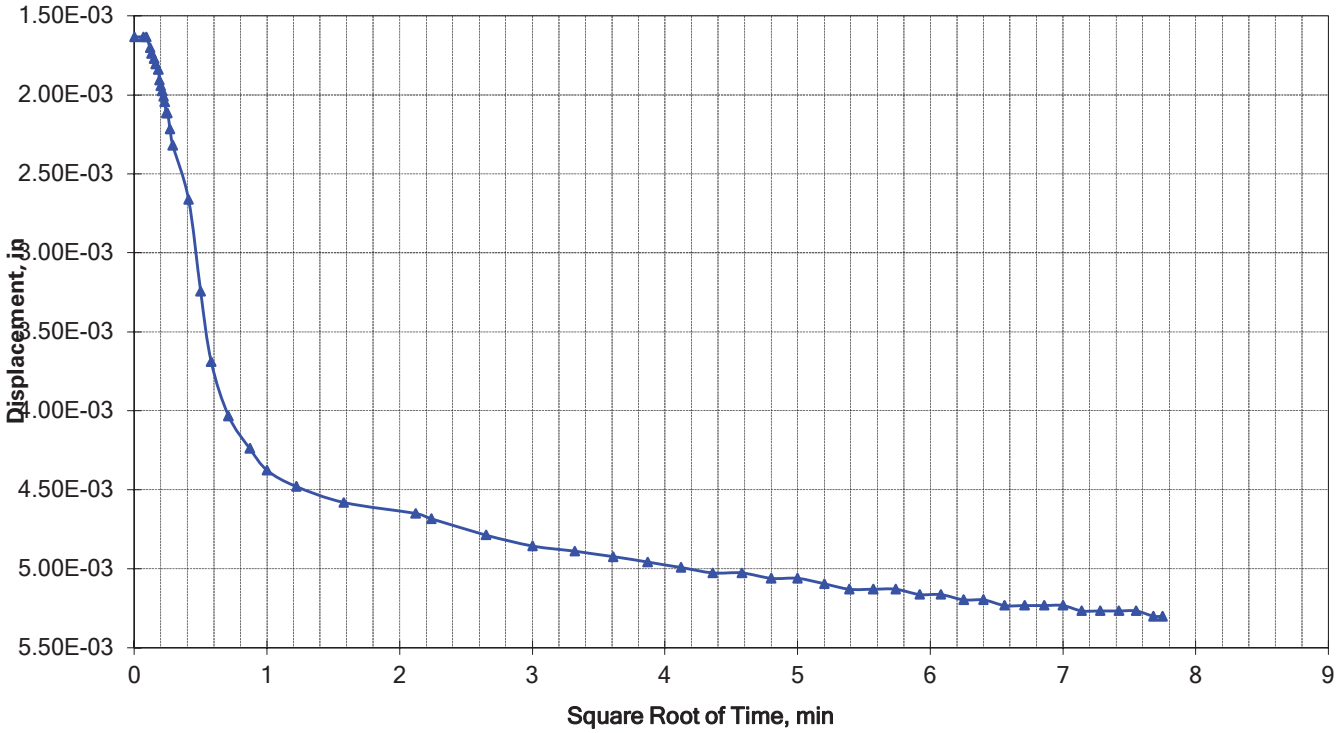


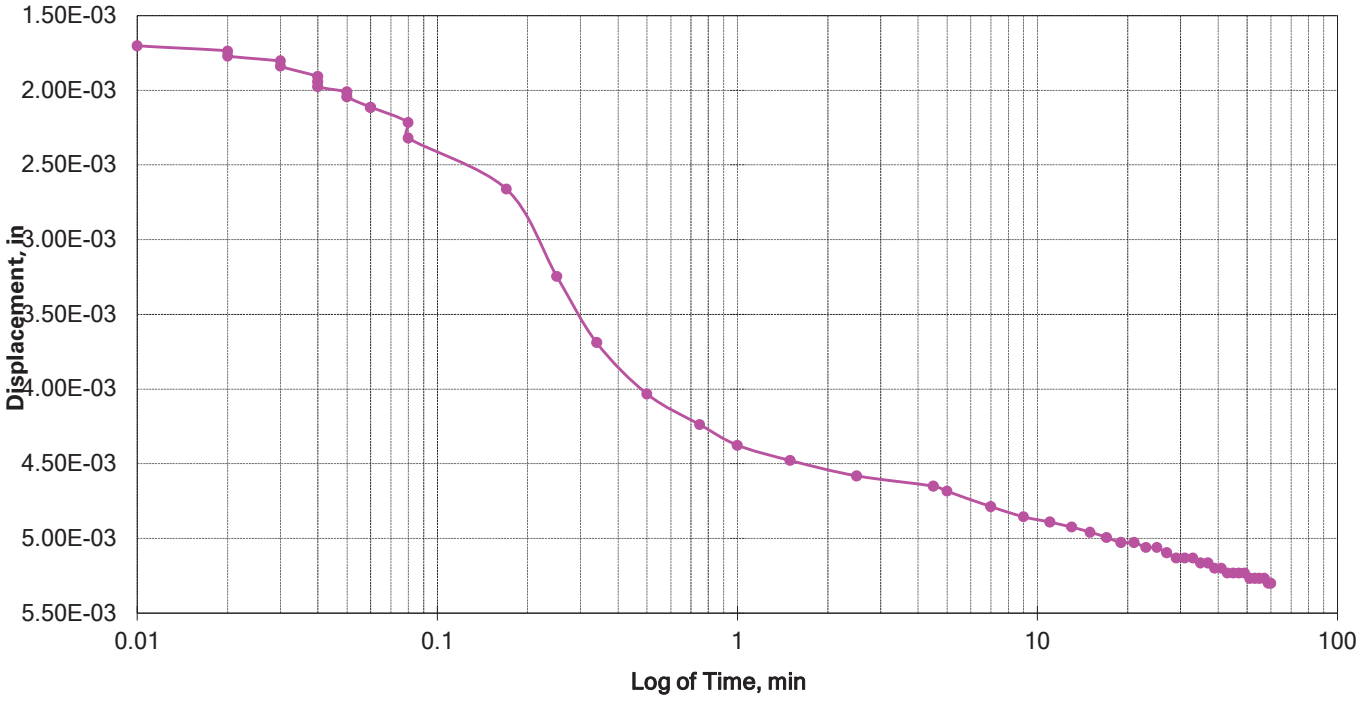
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 150 psf



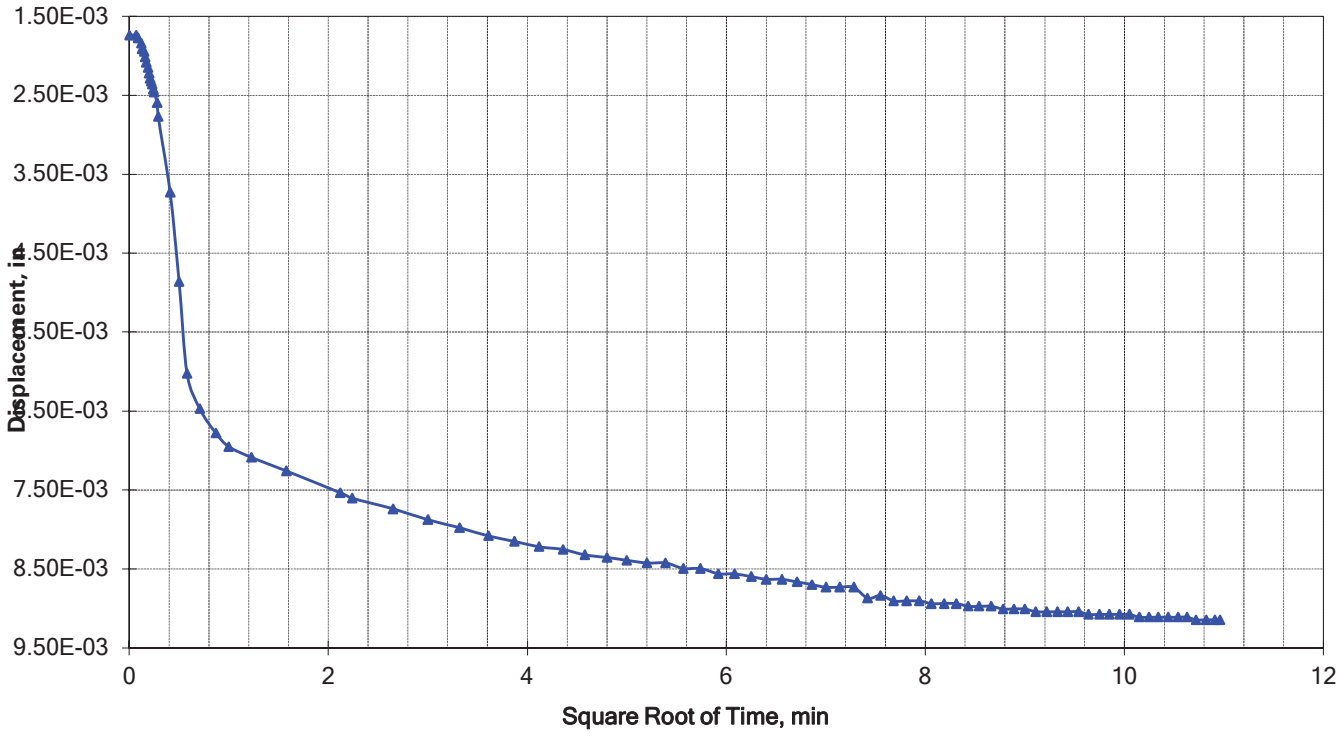


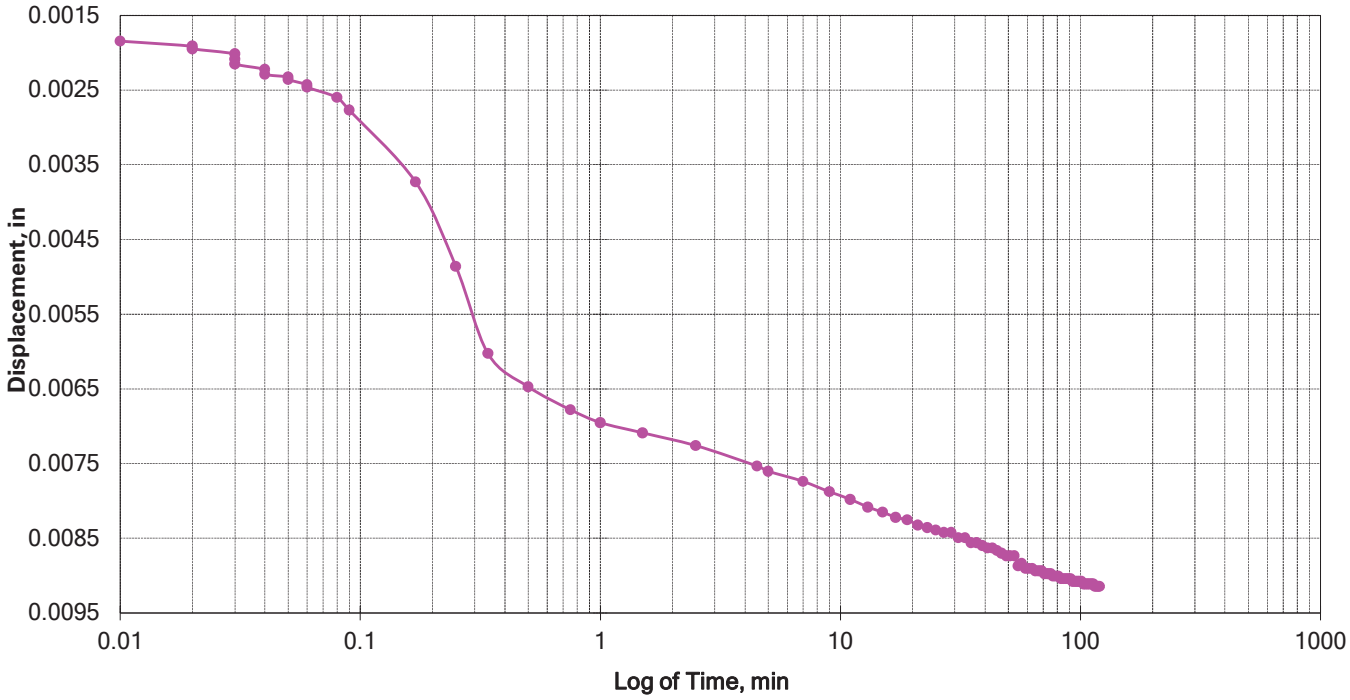
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 250 psf



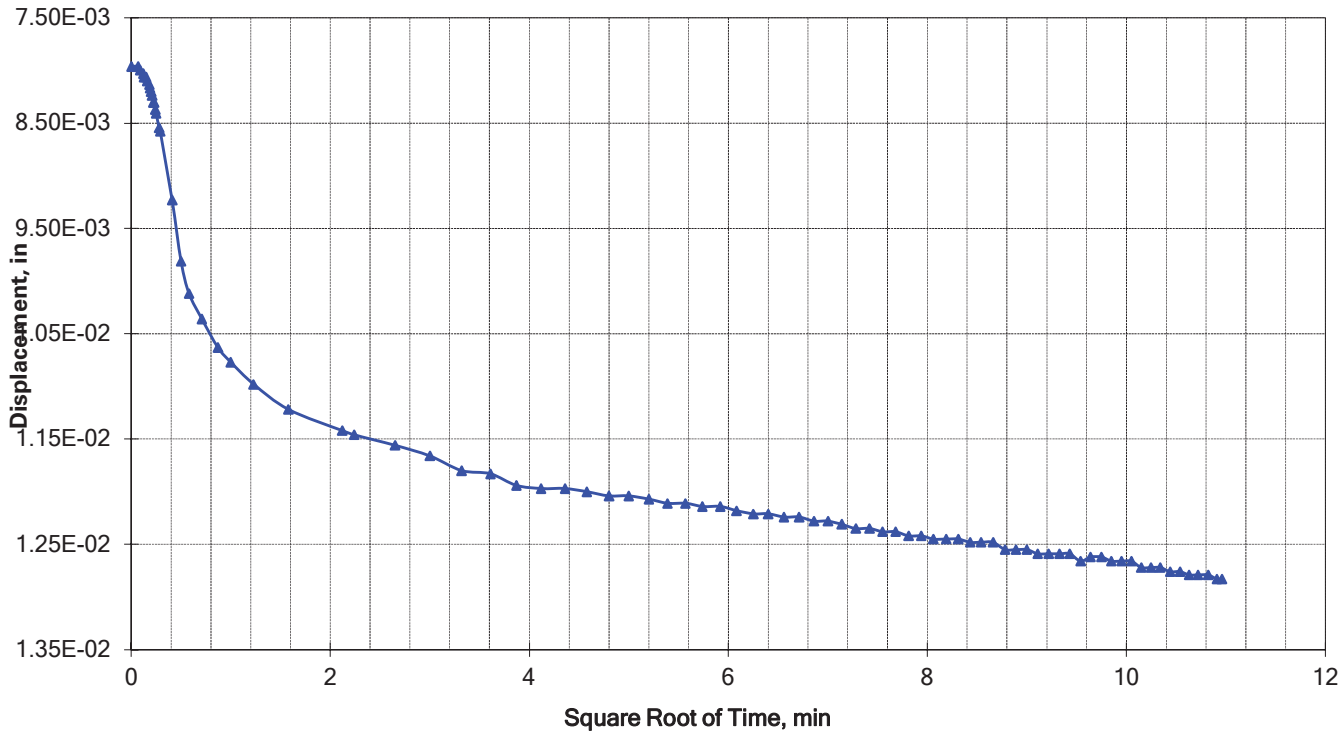


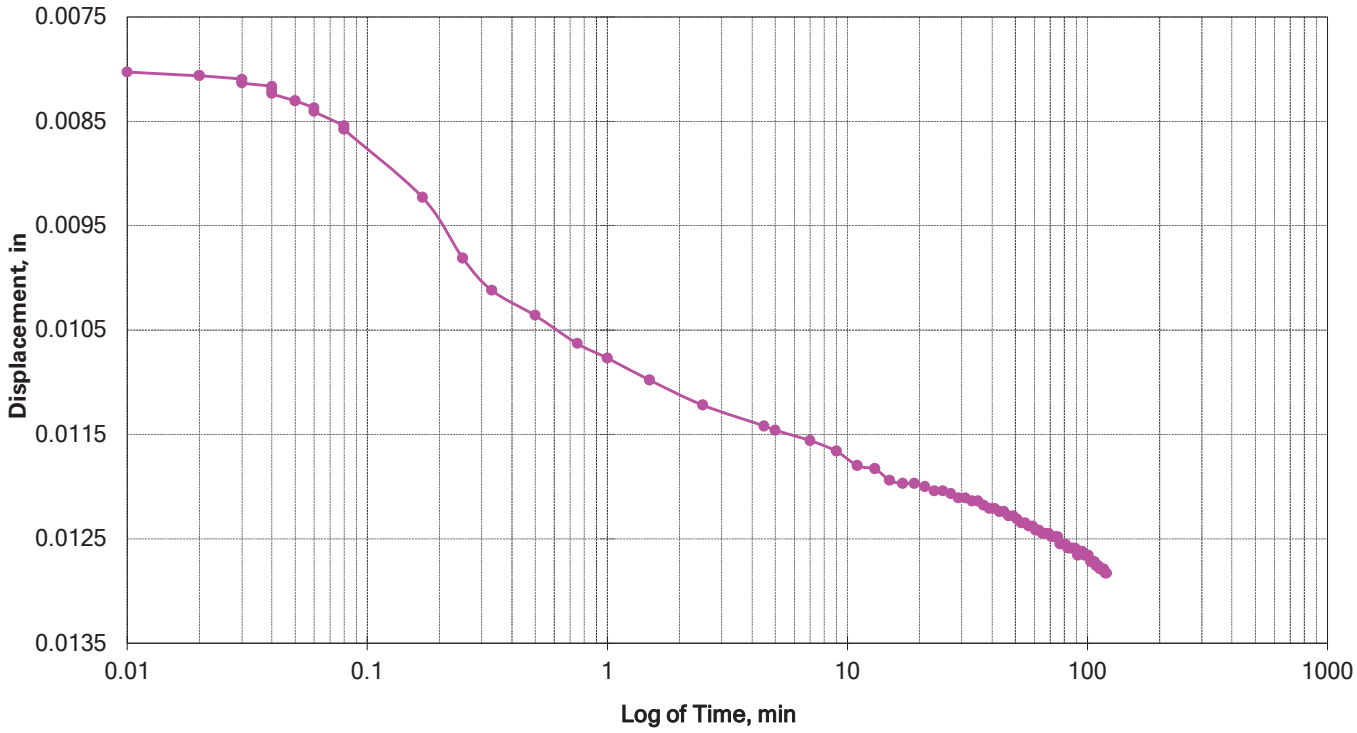
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 500 psf



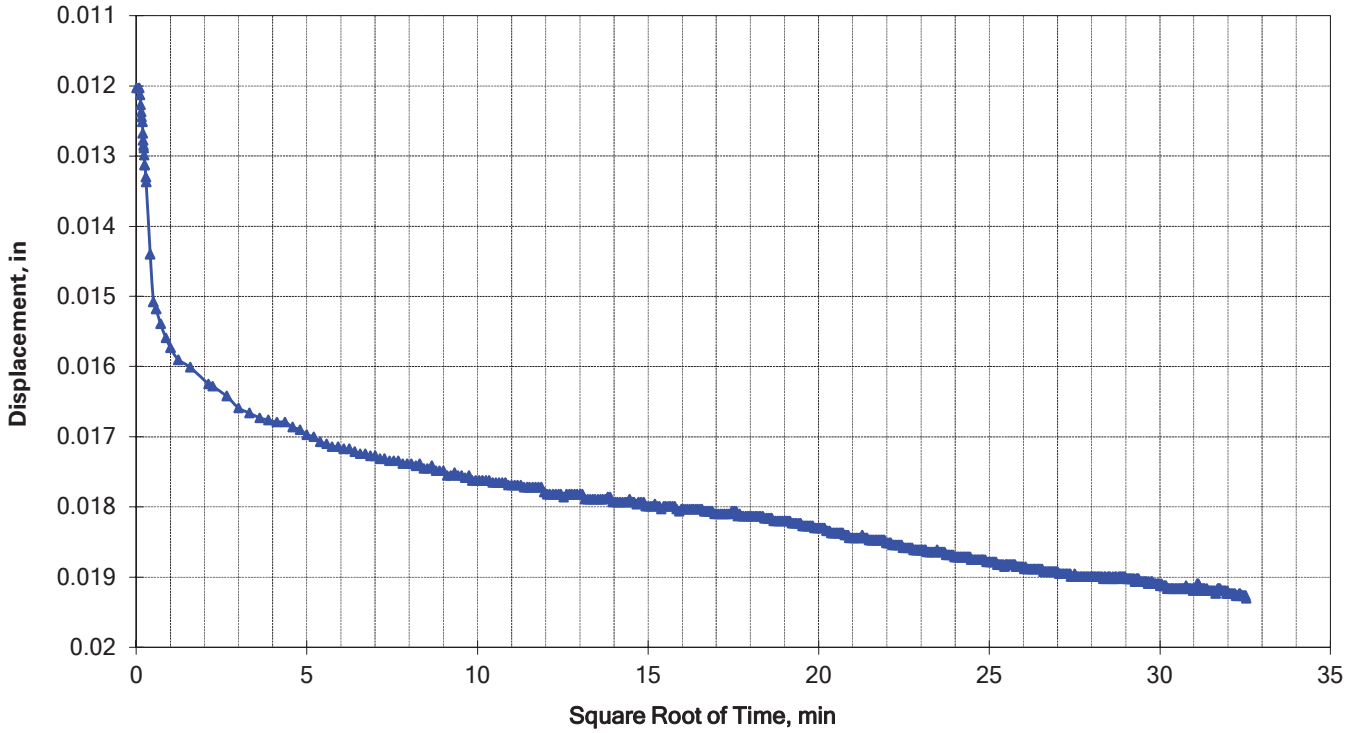


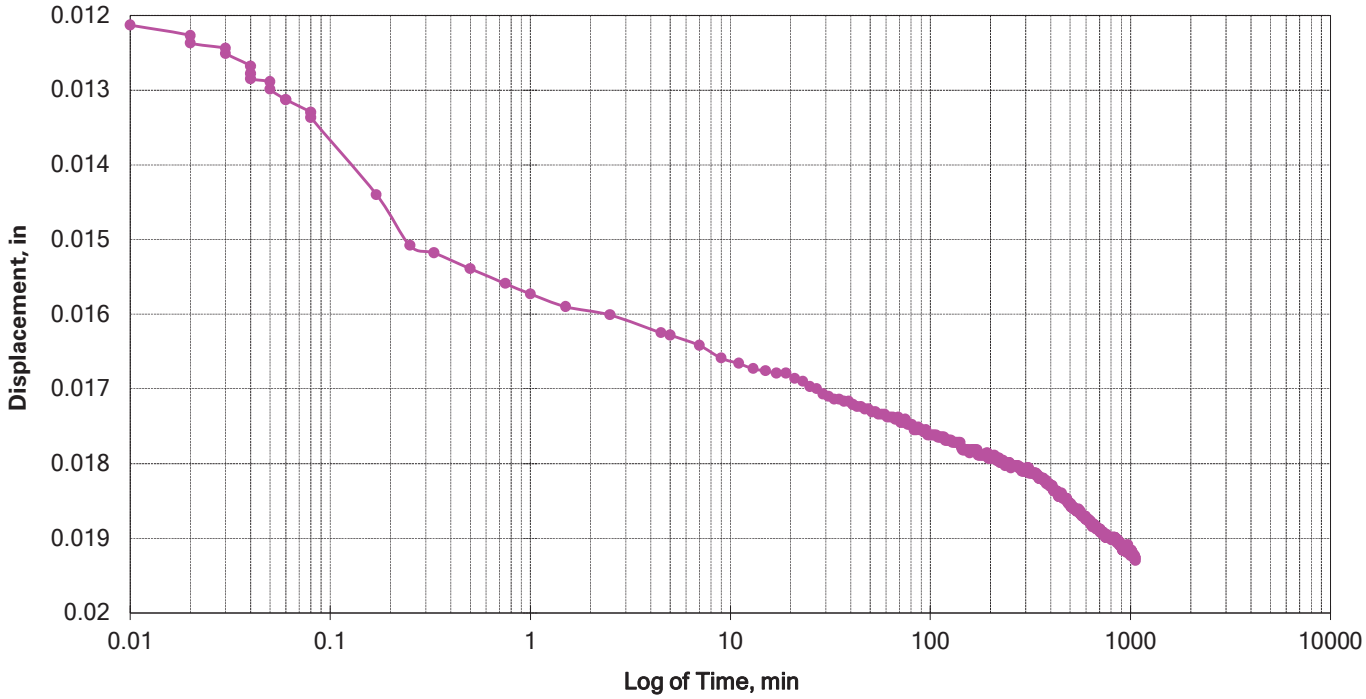
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 750 psf



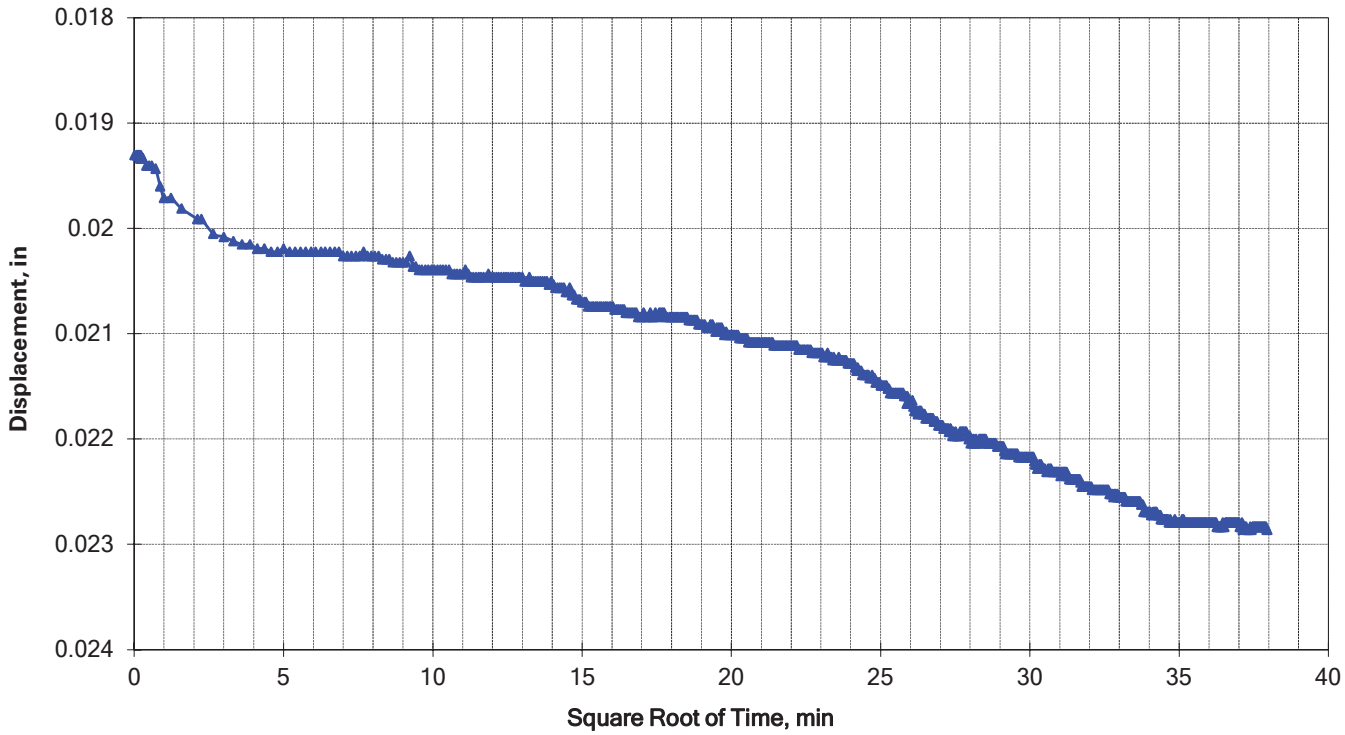


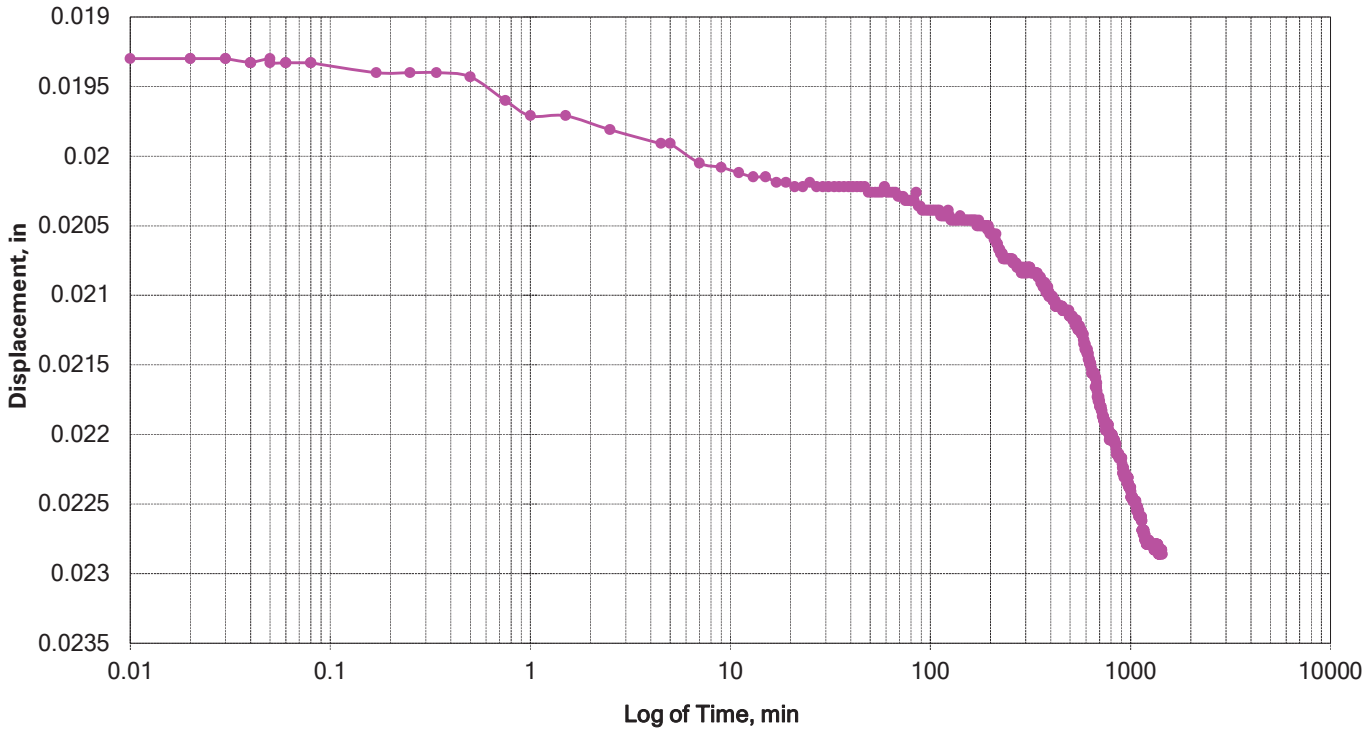
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 1000 psf



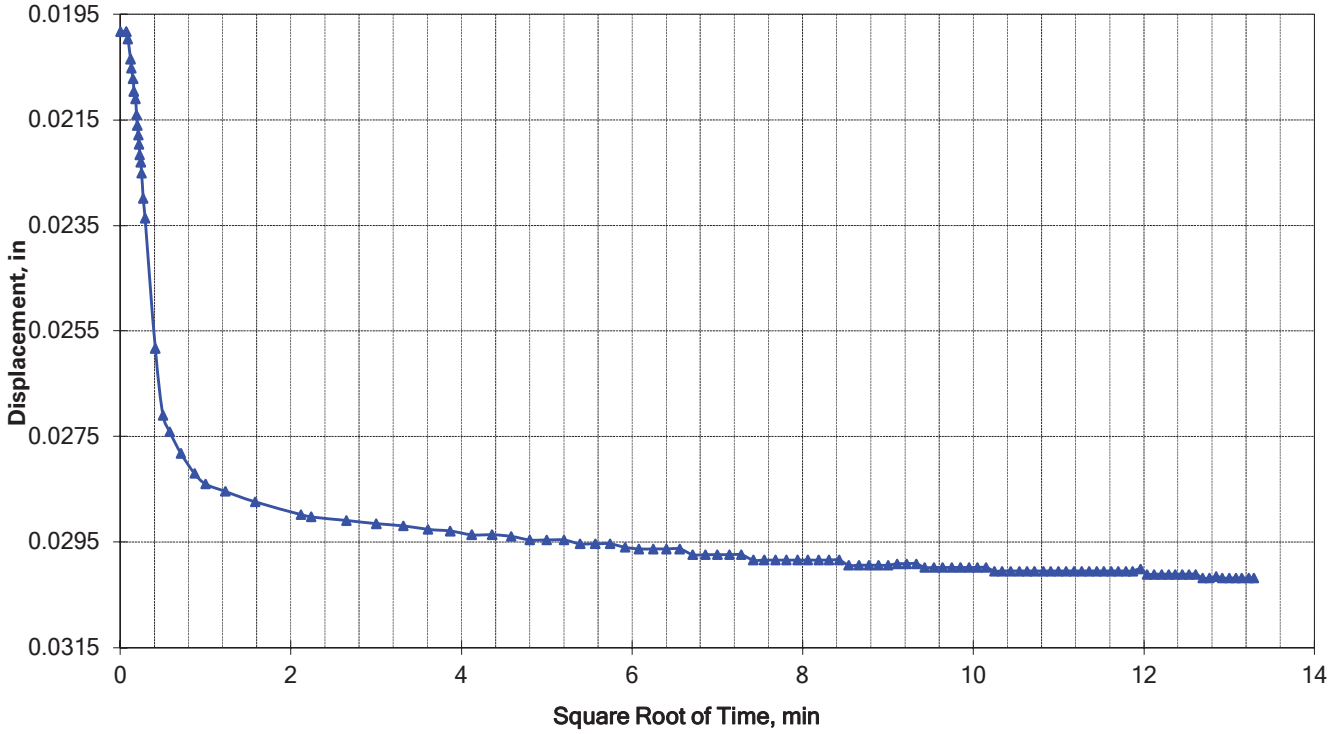


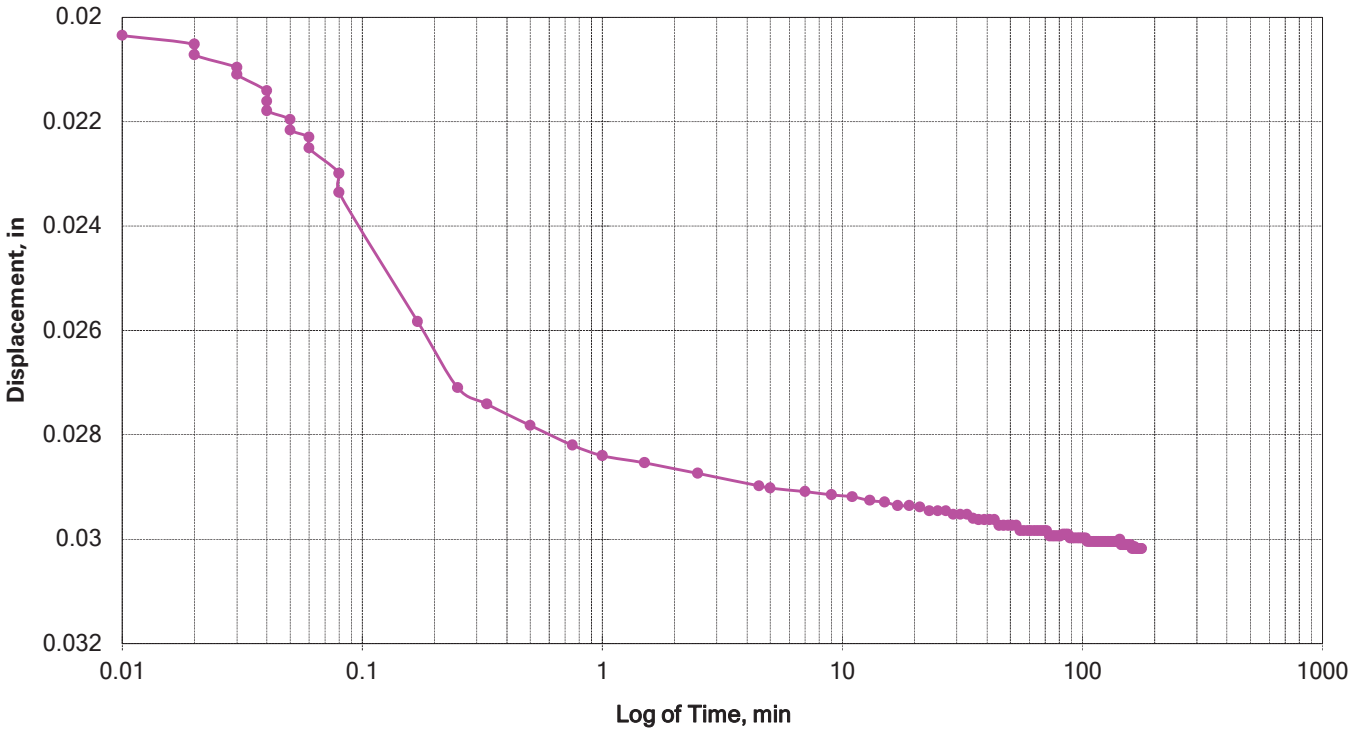
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 1000 psf



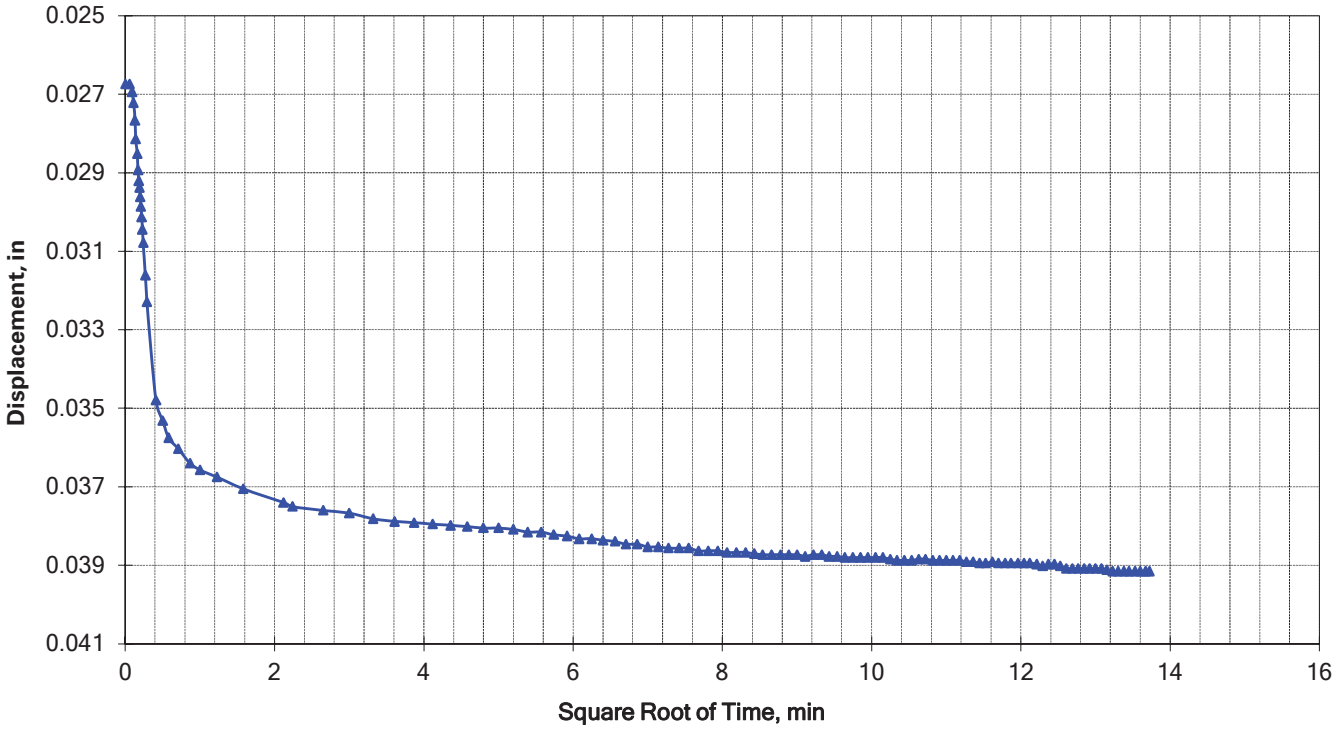


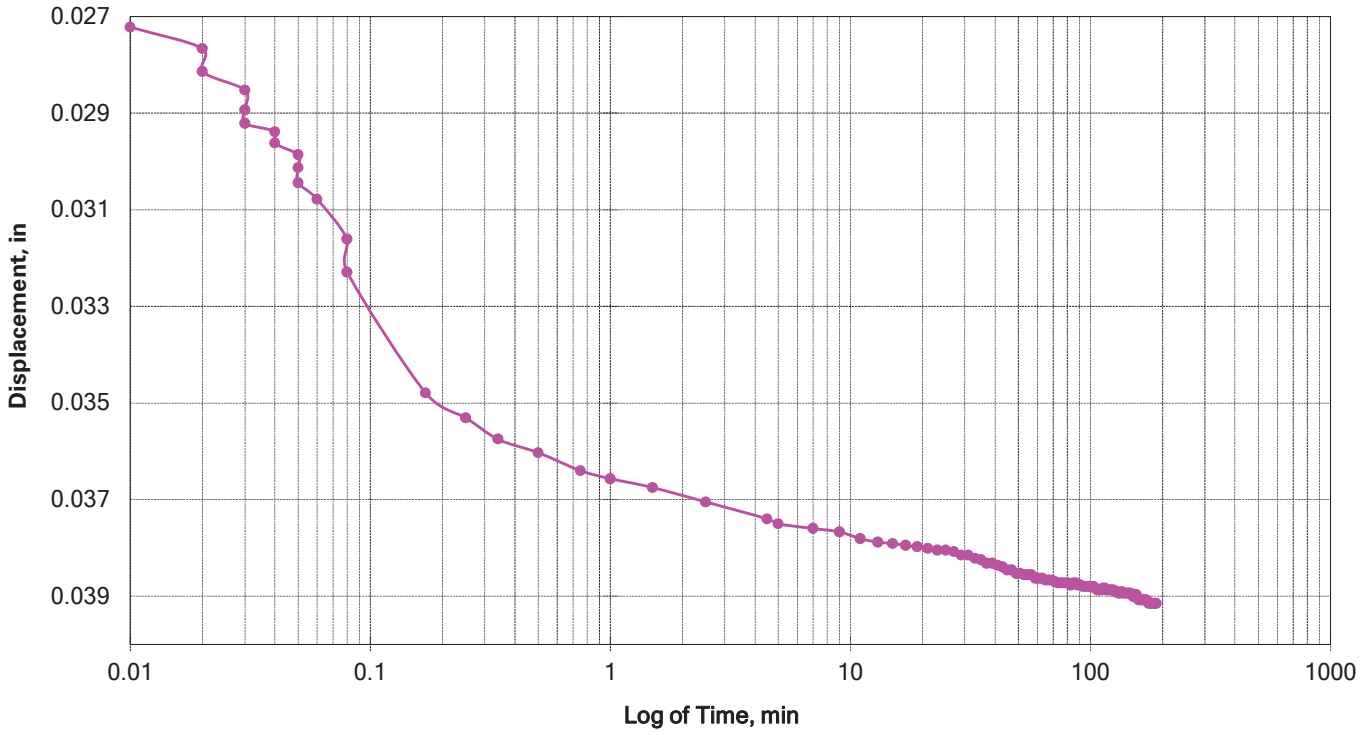
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 2000 psf



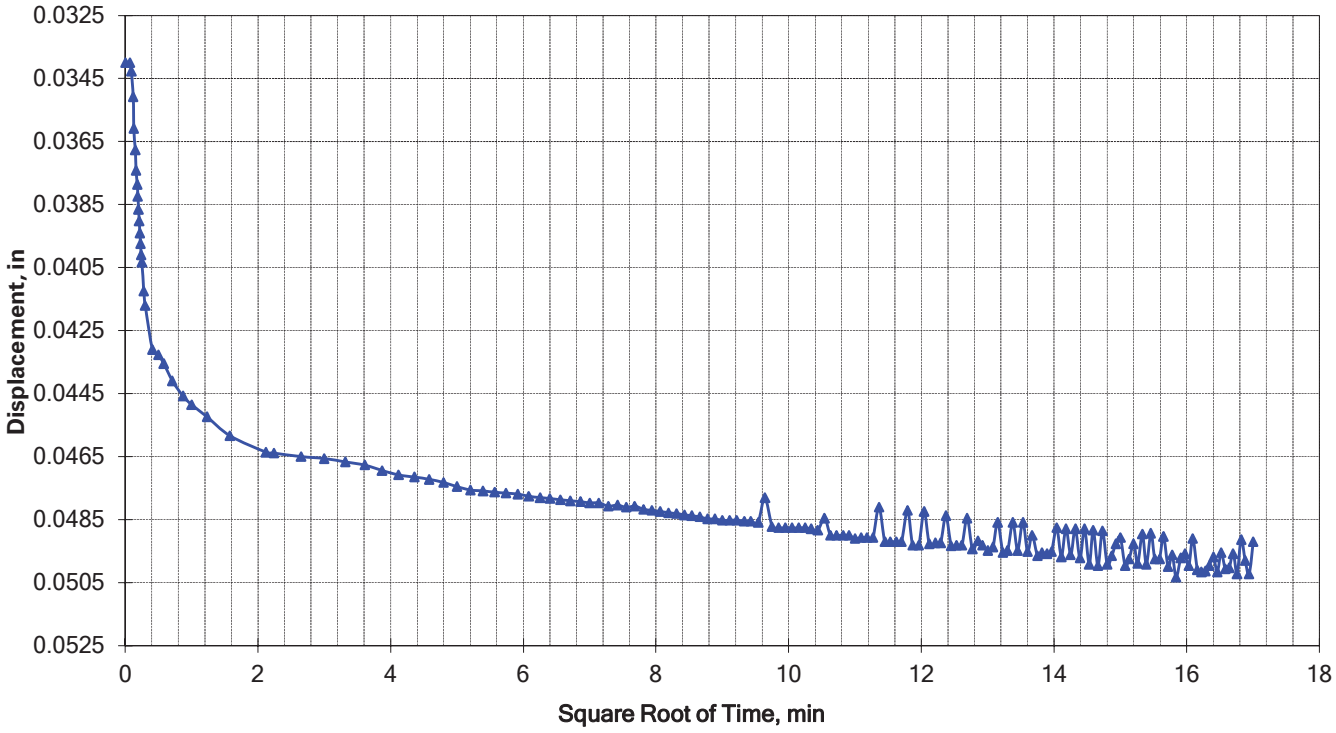


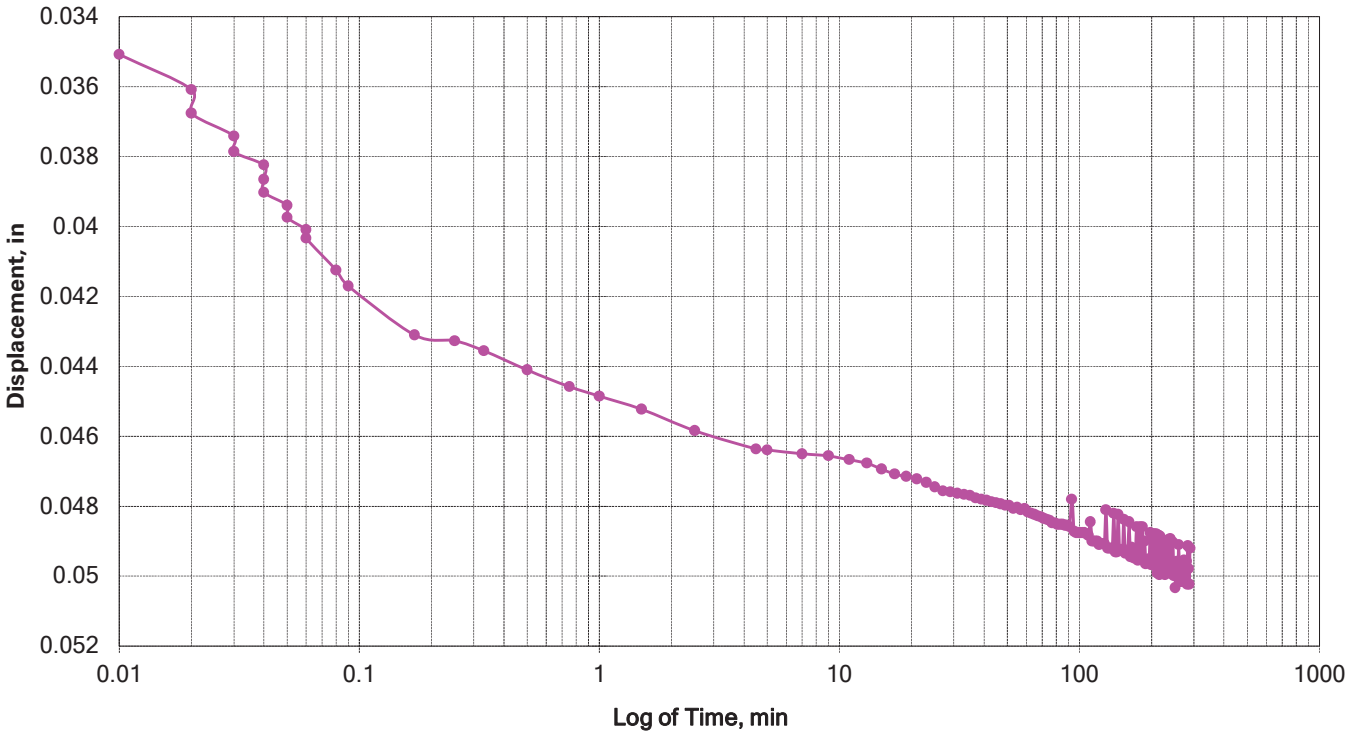
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 4000 psf



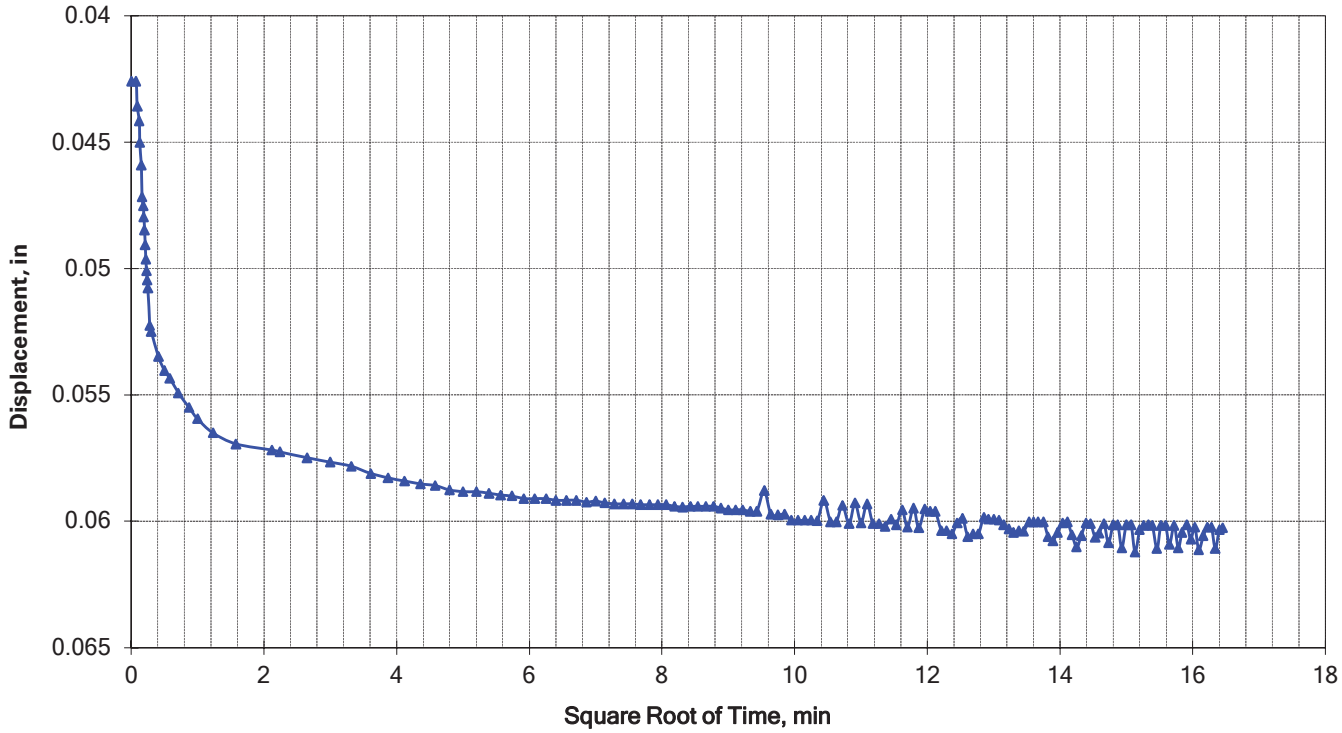


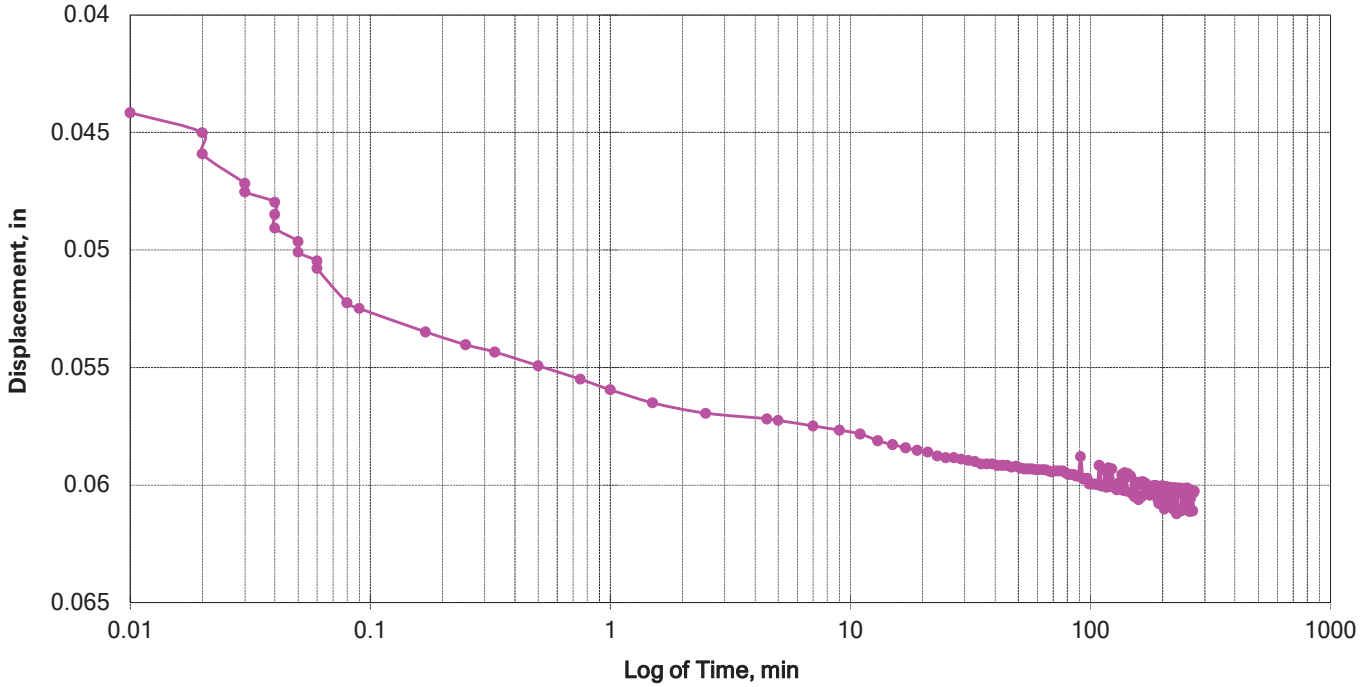
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 8000 psf



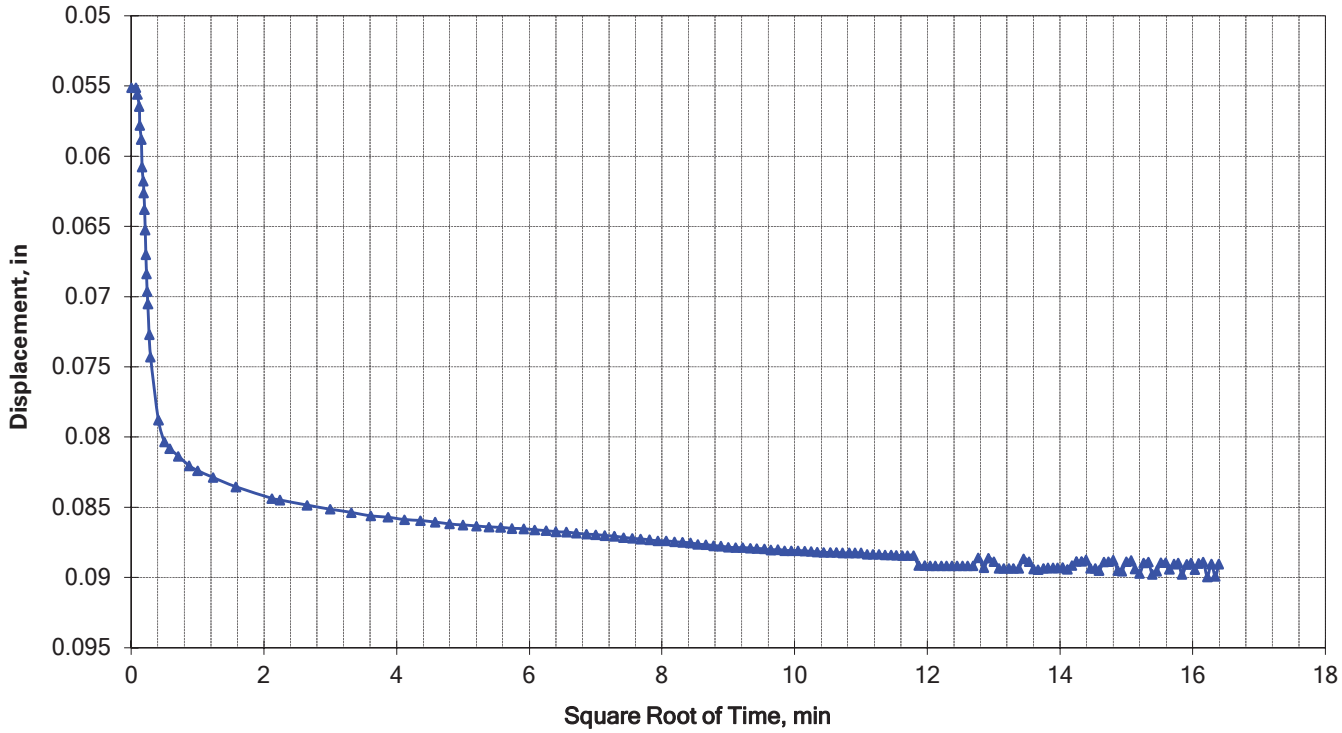


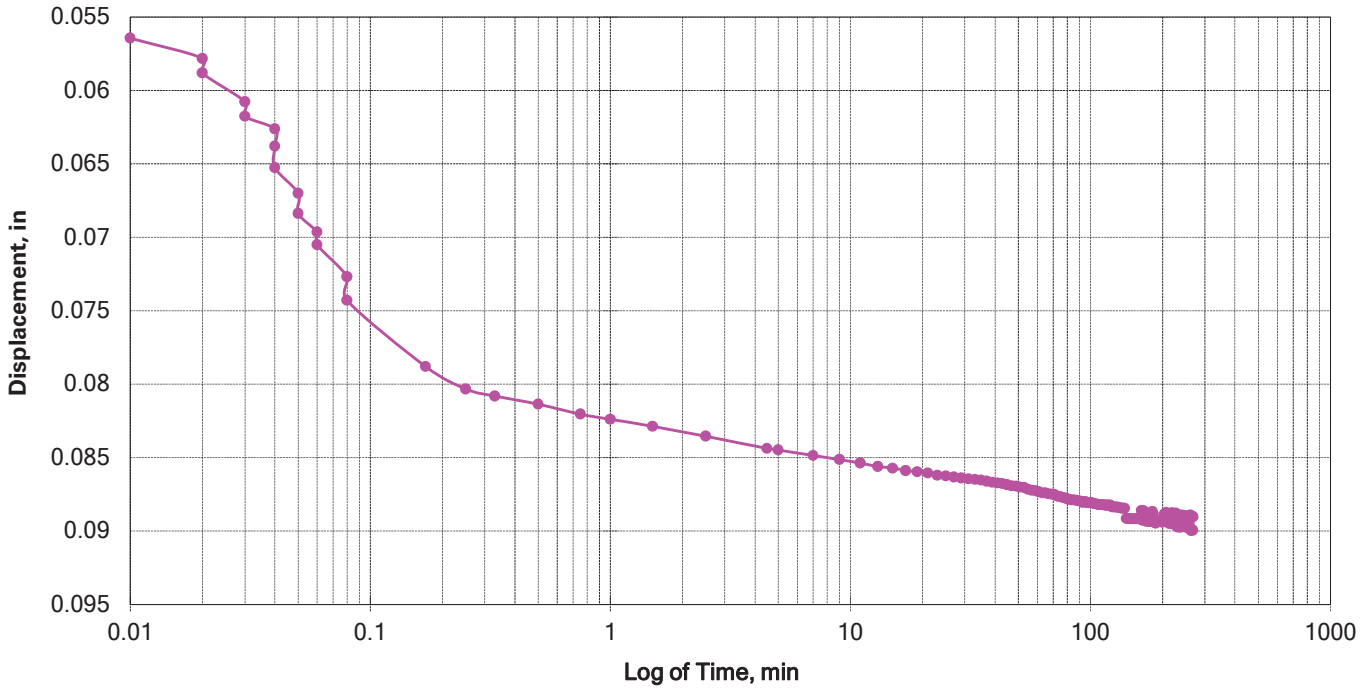
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 16000 psf



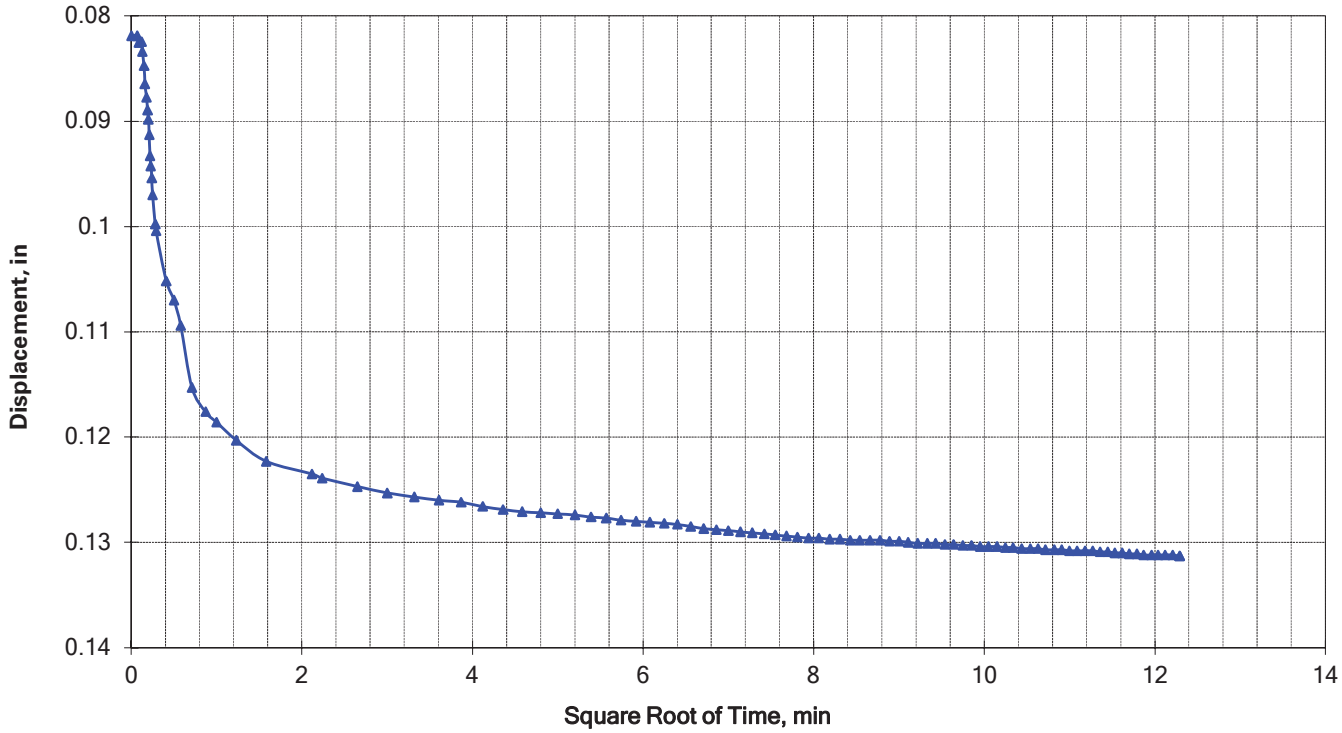


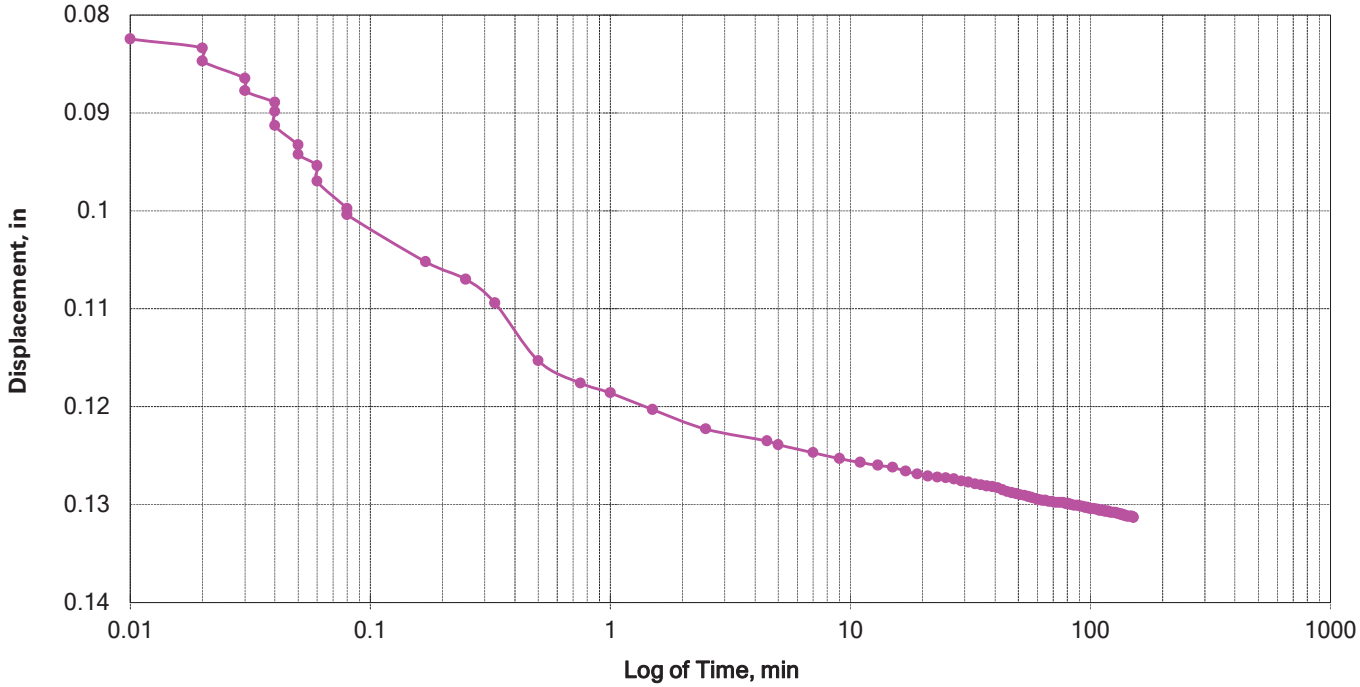
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 32000 psf



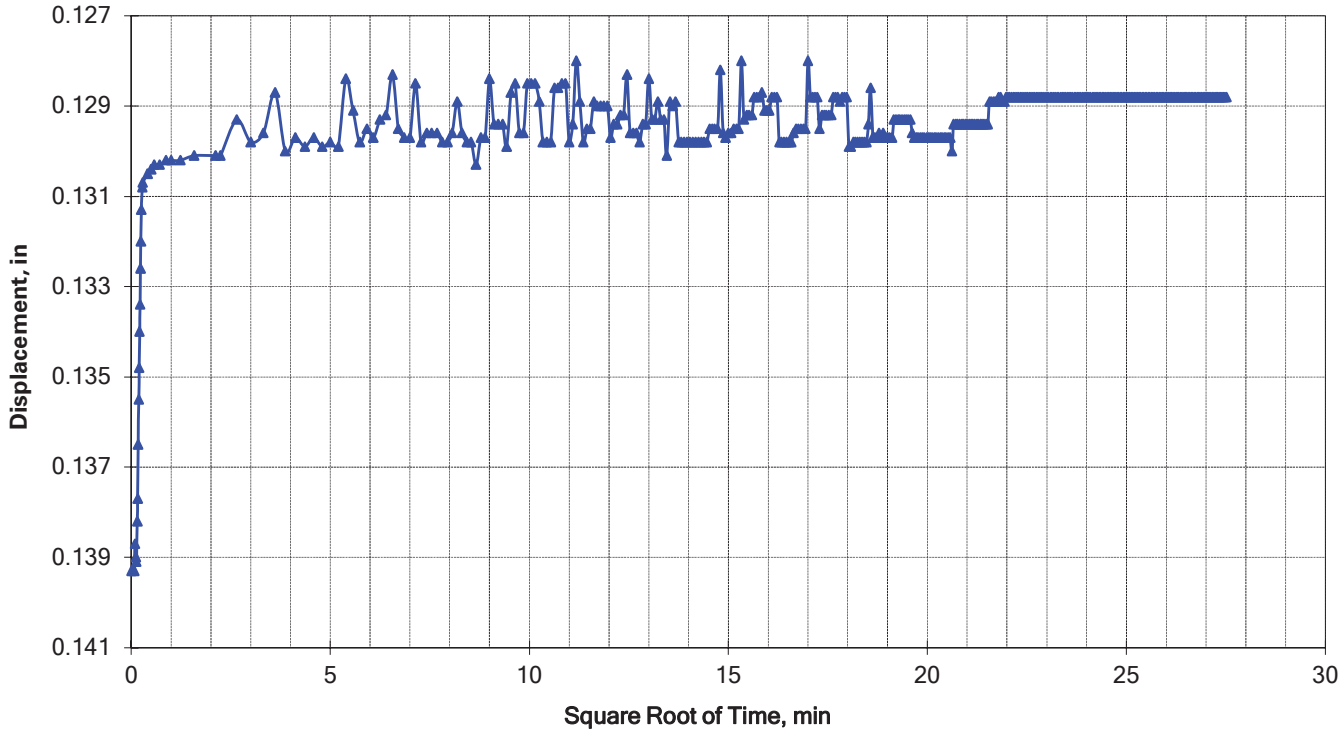


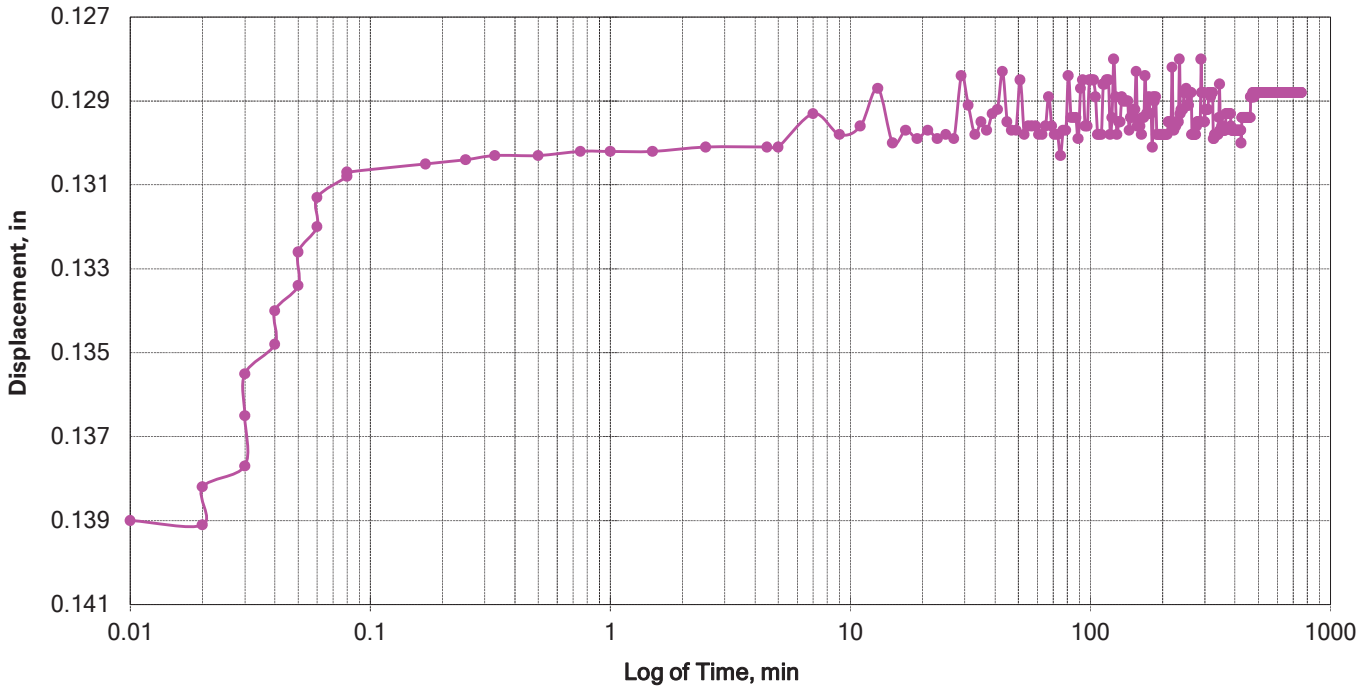
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 64000 psf



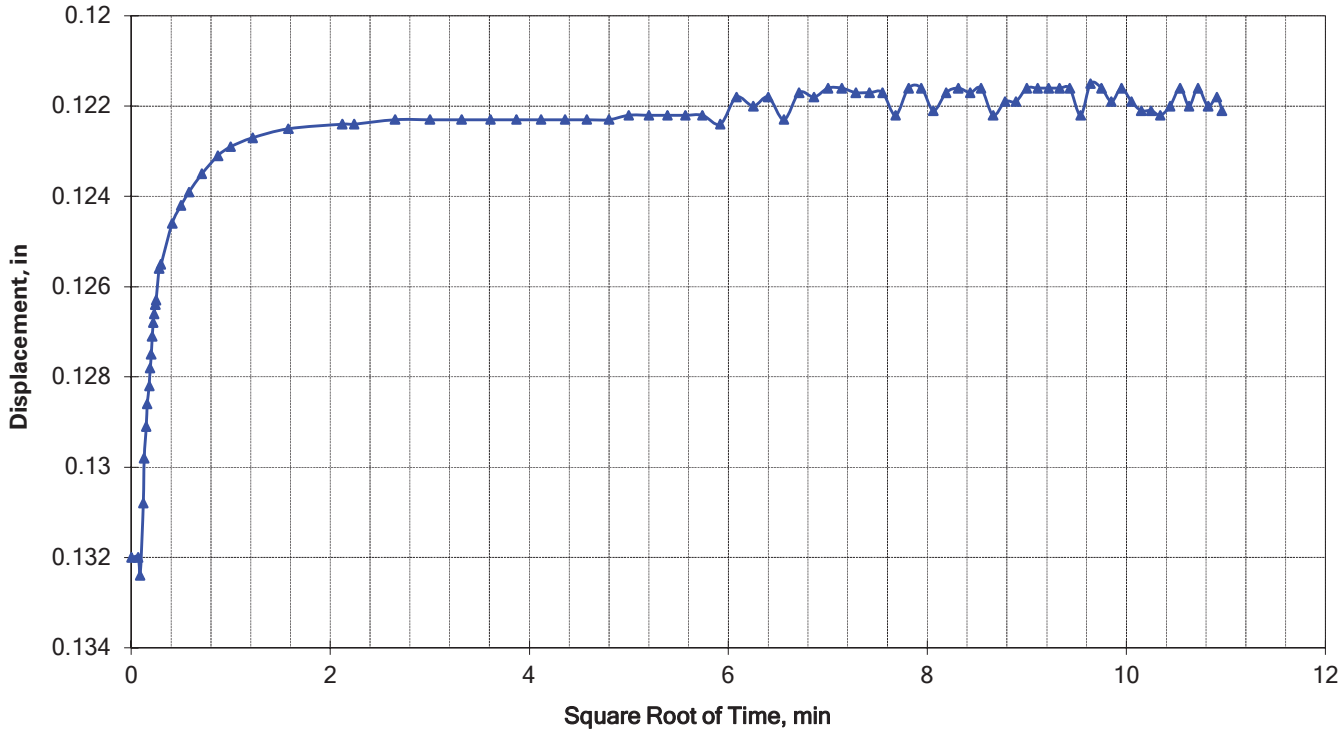


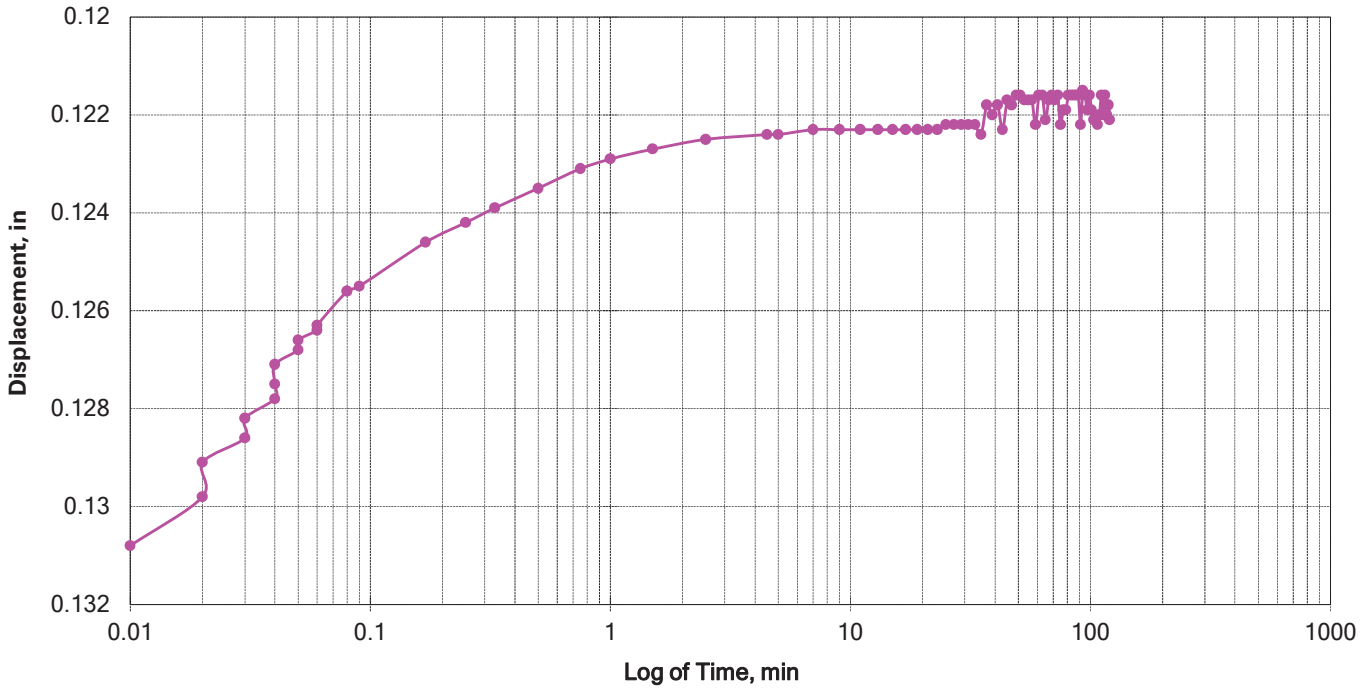
TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 16000 psf





TIMED CONSOLIDATION TEST RESULTS

Terracon

Project Name: HAFB SWEG Office
Project No.: 61225006
Location: HAFB
Sample: B-2 at 7.5'

Applied Stress: 4000 psf

CHEMICAL LABORATORY TEST REPORT

Project Number: 61225006
Service Date: 03/22/22
Report Date: 03/24/22

Terracon
10400 State Highway 191
Midland, Texas 79707
432-684-9600

Client

CRSA
175 South Main Street Suite 300
Salt Lake City, UT 84111

Project

CRSA - HAFB SWEG Office
Indigo Street
Hill Air Force Base, UT

Sample Location	B-1
Sample Depth (ft.)	5-6.5
pH Analysis, ASTM - G51-18	7.7
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	293
Sulfides, ASTM - D4658-15, (mg/kg)	nil
Chlorides, ASTM D 512 , (mg/kg)	69
RedOx, ASTM D-1498, (mV)	+436
Total Salts, ASTM D1125-14, (mg/kg)	371
Resistivity, ASTM G187, (ohm-cm)	5,472

Analyzed By: Zach Robertson

Zach Robertson
Engineering Technician III

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

1.0 CALCULATION PACKAGE – 309TH SWEG BUILDING, HAFB, UTAH

Designed: JDW
Checked: JBM

Complete geotechnical analyses for:

2. Blow Count Correction
3 Shallow Foundations
   a. Settlement
4. Seismic Considerations
5. Liquefaction Analysis
6. Pavements

2.0 BLOW COUNT CORRECTION

Rig: Terracon GeoProbe 3100GT

See following pages for most recent Hammer Calibration (20).

See the following calculation pages for B-01 and B-02 (2).

N-Value Corrections & Correlations

PROJECT INFORMATION

Project Name:	309th SWEG
Project Number:	61225006
Notes:	B-01
Date:	3/4/2022

N-Values, Hammer Energy, and Correction Information

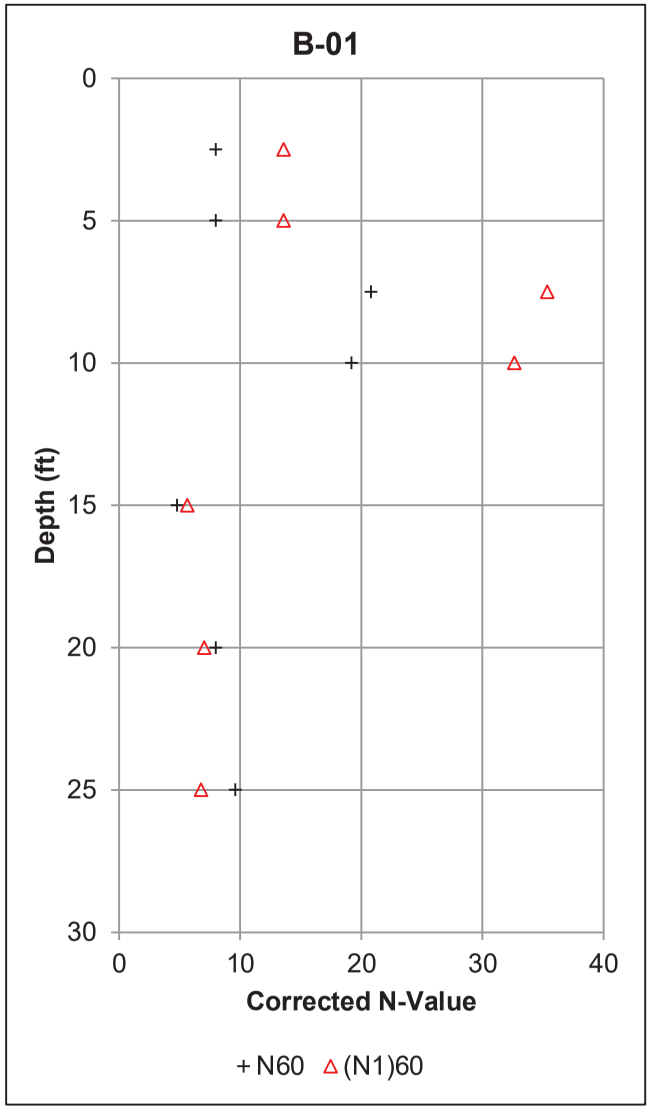
Hammer Efficiency	96%
Overburden Exponent (n)	1.0
Max Overburden Correction	1.7

☑ Plot N60

☑ Plot (N1)60

Elevation (ft)	Depth (ft)	Raw N-Value	σ'	N_{60}	$(N_1)_{60}$
4661.5	2.5	5	300	8	14
4659	5	5	600	8	14
4656.5	7.5	13	900	21	35
4654	10	12	1200	19	33
4649	15	3	1800	5	6
4644	20	5	2400	8	7
4639	25	6	3000	10	7

Plot of N_{60} and $(N_1)_{60}$



N-Value Corrections & Correlations

PROJECT INFORMATION

Project Name:	309th SWEG
Project Number:	61225006
Notes:	B-02
Date:	4/4/2022

N-Values, Hammer Energy, and Correction Information

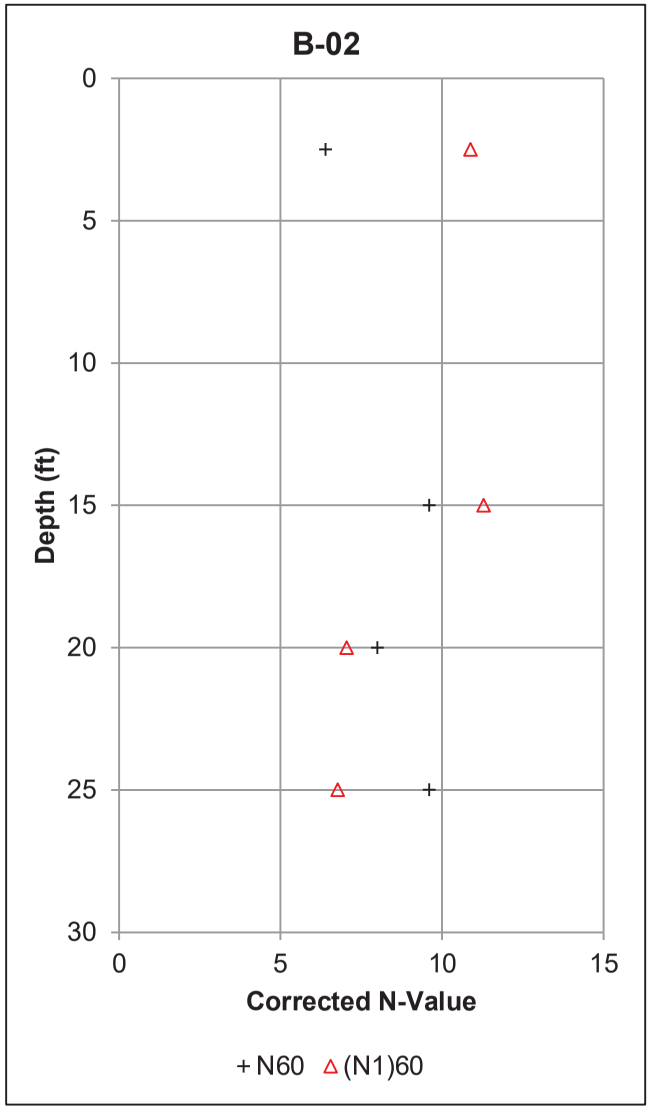
Hammer Efficiency	96%
Overburden Exponent (n)	1.0
Max Overburden Correction	1.7

☑ Plot N60

☑ Plot (N1)60

Elevation (ft)	Depth (ft)	Raw N-Value	σ'	N_{60}	$(N_1)_{60}$
4661.5	2.5	4	300	6	11
4659	5		600		
4649	15	6	1800	10	11
4644	20	5	2400	8	7
4639	25	6	3000	10	7

Plot of N_{60} and $(N_1)_{60}$



3.0 SHALLOW FOUNDATIONS

Estimated Loads:

- See Report Section **Project Description**
  - Columns: 100 kips
  - Walls: 3 to 4 kips per linear foot (klf)
  - Slabs: 150 pounds per square foot (psf)

Building Construction:

- See Report Section **Project Description**
  - Load- bearing masonry walls
  - Steel frame with slab on grade

Bearing Soils

Native fine-grained soils:

B-01 – Fills to 4.5 feet below existing site grade over Lean Clays
B-02 – Fills to 4.5 feet below existing site grade over Silt with Sand
P-03, P-04 and P-05 – Clays to 6 feet below existing site grade
Based on the 1.0 feet of compacted sand soils over the native clays and silts
Estimated Cohesion = 1,100 psf
Unit Weight = 120 pcf
Factor of Safety used for Bearing Analysis = 3.0

12" Structural fill or recompacted fill soils:

Based on our boreholes, loose sandy fills exist to approximately 4.5 feet below site grade. If these sandy soils can be re-used or replaced with structural fill, compacted according to Earthwork section in report in approximately 12 inches depth on the native fine-grained soils. Based on the expected soils at the base of the foundations will be non-consistent soils. We recommend that soils are all based on either fine-grained soils or coarse-grained soils but not both.

Maximum Settlement: 1 inch

See following 2 pages for Bearing calculation sheets.
See the following 5 pages for Settlement calculation sheets.

Gross Bearing Capacity

PROJECT INFORMATION

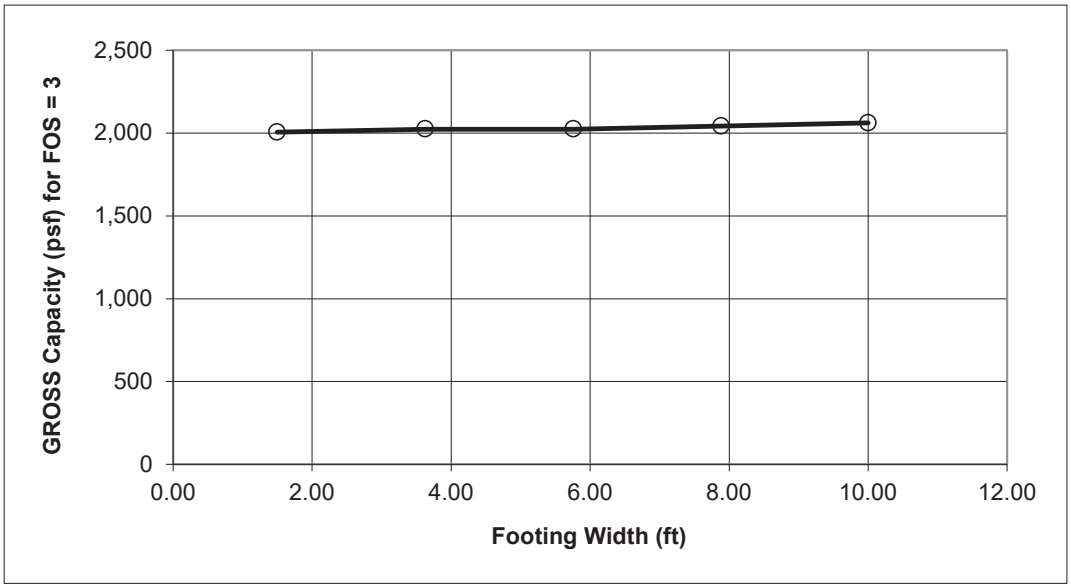
Project Name:	309th SWEG Building
Project Number:	61225006
Notes:	Horizontal ground surface
Date:	April 4, 2022

Soil Properties, Footing Dimensions, and Groundwater

Symbol	Value	Units	Definition
c	1100	psf	Cohesion
ϕ		degrees	Drained Friction Angle
γ_{above}	120	pcf	Unit Weight of Soil above Footing
γ_{below}	120	pcf	Unit Weight of Soil below Footing
D_f	3	feet	Depth of Footing from Ground Surface
D_w	50	feet	Depth to Groundwater from Ground Surface
B_{min}	1.5	feet	Minimum Footing Width
B_{max}	10	feet	Maximum Footing Width
L	80	feet	Footing Length
FOS	3.0	none	Factor of Safety

☑ Check if the soils above the footing are as competent as those below the footing.

☐ Check if local or punching shear is possible. See Figure C10.6.3.1.2b-1 on the Instructions sheet.



Notes

1. Calculations are based on Section 10.6.3.1.2 of AASHTO 2010 (Vesic factors).
2. User can differentiate between soil unit weight above and below footing.
3. Inclination factors are assumed to be 1.0. User must manually input overides.
4. Values for d_q are linearly interpolated based on D_f/B and ϕ (see Table 10.6.3.1.2a-4).
5. See Calculation Sheet for a summary of all other variables.

Shallow Foundation Bearing Capacity (Gross)

PROJECT INFORMATION

Project Name:	**309th SWEG Building**
Project Number:	**61225006**
Notes:	**Horizontal ground surface**
Date:	**April 4, 2022**

Governing Equations

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma \quad BN_{\gamma m} C_{w\gamma}$$

$$N_{cm} = N_c s_c i_c$$

$$N_{qm} = N_q s_q d_q i_q$$

$$N_\gamma m = N_\gamma s_\gamma i_\gamma$$

See the instructions sheet for a definition of variables.

Parameter Values and Results of Equations for GROSS Capacity

Design phi = 0	Width = 1.5'	Width = 3.63'	Width = 5.76'	Width = 7.89'	Width = 10'
c	1100	1100	1100	1100	1100
N_c	5.14	5.14	5.14	5.14	5.14
s_c	1.00	1.01	1.01	1.02	1.03
i_c	1.00	1.00	1.00	1.00	1.00
$cN_cs_ci_c$	5,654	5,711	5,711	5,767	5,824

γ_{above}	120	120	120	120	120
D_f	3.00	3.00	3.00	3.00	3.00
N_q	1.00	1.00	1.00	1.00	1.00
s_q	1.00	1.00	1.00	1.00	1.00
d_q	1.00	1.00	1.00	1.00	1.00
i_q	1.00	1.00	1.00	1.00	1.00
C_{wq}	1.00	1.00	1.00	1.00	1.00
$\gamma_{above}D_fN_qs_qd_qi_qC_{wq}$	360	360	360	360	360

γ_{below}	120	120	120	120	120
B	1.50	3.63	5.76	7.89	10.00
N_γ	0.00	0.00	0.00	0.00	0.00
s_γ	1.00	1.00	1.00	1.00	1.00
i_γ	1.00	1.00	1.00	1.00	1.00
$C_{w\gamma}$	1.00	1.00	1.00	1.00	1.00
$0.5\gamma_{below}BN_\gamma s_\gamma i_\gamma C_{w\gamma}$	0	0	0	0	0

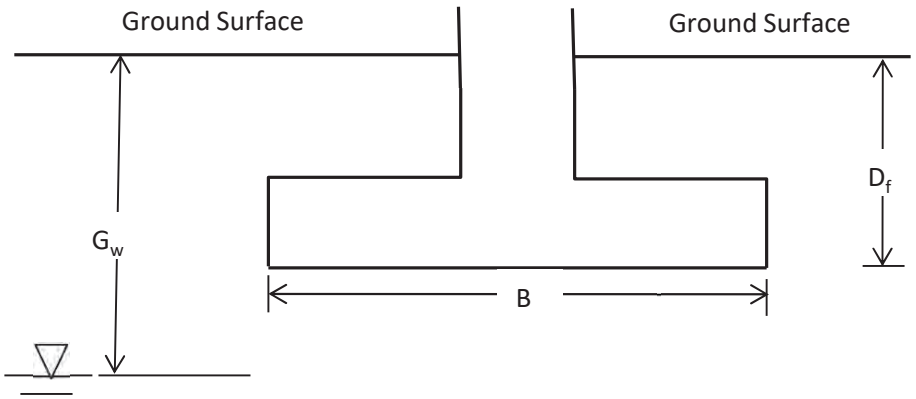
Gross Bearing Capacity	**Width = 1.5'**	**Width = 3.63'**	**Width = 5.76'**	**Width = 7.89'**	**Width = 10'**
Ultimate (psf)	**6,014**	**6,071**	**6,071**	**6,127**	**6,184**
Gross Allowable (psf), FOS = 3	**2,005**	**2,024**	**2,024**	**2,042**	**2,061**

Shallow Foundation Settlement

PROJECT INFORMATION

Project	CRSA 309th SWEG
Project No.	61225006
Notes/Location	HAFB, Utah
Date	4/1/2022

Definition of Footing Variables



Footing Input Parameters

Symbol	Value	Units	Description
B_{min}	1.50	ft	Minimum Footing Width
B_{max}	10.00	ft	Maximum Footing Width
Footing length defined by:	(•) Fixed Footing Length ( ) Fixed Length to Width (L/B) Ratio		
Length	80.00	ft	Fixed Footing Length
D_f	3.00	ft	Depth of Footing (from ground surface)
G_w	50.00	ft	Depth to Groundwater (from ground surface)
Selected Analysis Method:	Fixed Settlement		
Settlement	1.00	in	Design settlement
Stress Distribution Method:	Boussinesq		
Perform Analysis	***Click to Perform Analysis***		

Shallow Foundation Settlement

PROJECT INFORMATION

Project	CRSA 309th SWEG
Project No.	61225006
Notes/Location	HAFB, Utah
Date	4/1/2022

Depth of Footing and Depth to Groundwater

Click to Analyze

Footing is 3 feet below the ground surface. Groundwater is 50 feet below the ground surface.

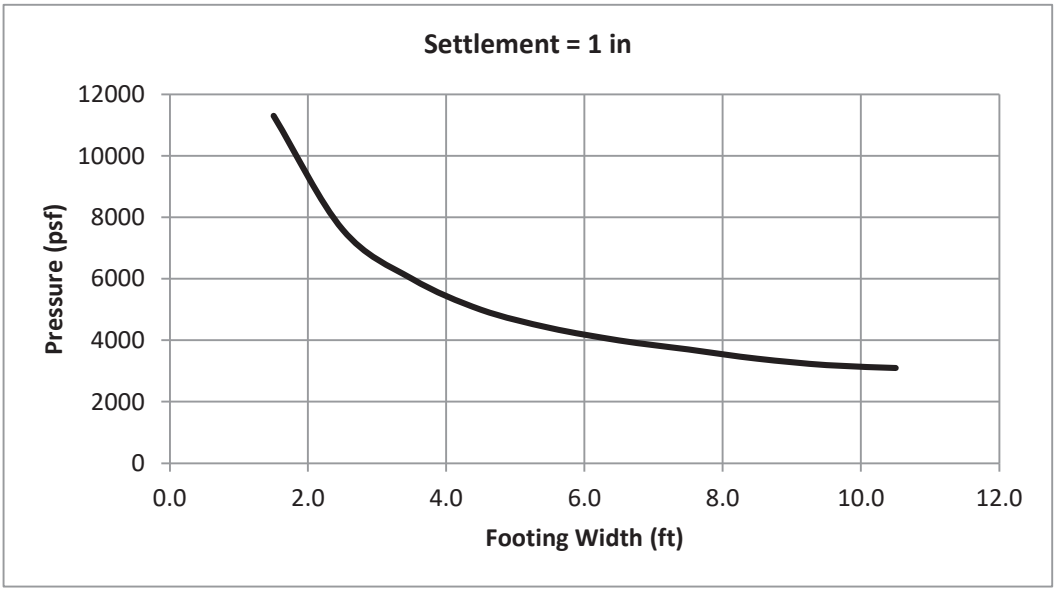
Soil Input Parameters

Top (ft)	Bottom (ft)	γ_{moist} (pcf)	Method	N-Value (corrected)	Hough Type	Cεc	Cεr	OCR
0.0	4.5	125	Hough	14	Clean well graded fine to coarse SAND			
4.5	7.0	110	Direct	8	Sandy CLAY	0.01	0.008	10
7.0	9.0	110	Direct	21	Sandy CLAY	0.01	0.008	9.8
9.0	13.0	120	Direct	19	Sandy CLAY	0.01	0.008	7.2
13.0	18.0	120	Direct	5	Sandy CLAY	0.01	0.008	5.2
18.0	23.0	120	Direct	8	Sandy CLAY	0.01	0.008	3.9
23.0	30.0	110	Direct	10	Sandy CLAY	0.01	0.008	3.2

Settlement Results

PROJECT INFORMATION

Project	CRSA 309th SWEG
Project No.	61225006
Notes/Location	HAFB, Utah
Date	4/1/2022



Boussinesq Stress Distribution Method

Dimensions, Pressure, and Settlement

Width (ft)	Length (ft)	Pressure (psf)	Settlement (in)
1.5	80	11300	1.0
2.5	80	7600	1.0
3.5	80	6000	1.0
4.5	80	5000	1.0
5.5	80	4400	1.0
6.5	80	4000	1.0
7.5	80	3700	1.0
8.5	80	3400	1.0
9.5	80	3200	1.0
10.5	80	3100	1.0

Stress and Settlement Calculation Output

Project:	CRSA 309th SWEG	Notes	HAFB, Utah
Number:	61225006	Date:	4/1/2022

Width (ft)	Length (ft)	Mid Point Depth (ft)	σ_o' (psf)	σ_p' (psf)	$\Delta\sigma$' (psf)	σ_f' (psf)	Settlement (in)
1.5	80.0	3.75	469	469	9247	9716	0.4
1.5	80.0	5.75	700	7000	3741	4441	0.2
1.5	80.0	8.00	948	9286	2126	3074	0.1
1.5	80.0	11.00	1298	9342	1340	2638	0.1
1.5	80.0	15.50	1838	9555	859	2696	0.1
1.5	80.0	20.50	2438	9506	610	3047	0.0
1.5	80.0	26.50	3123	9992	446	3569	0.0
				Summary:	11300	Boussinesq	1.0
2.5	80.0	3.75	469	469	7120	7589	0.4
2.5	80.0	5.75	700	7000	3887	4587	0.2
2.5	80.0	8.00	948	9286	2323	3271	0.1
2.5	80.0	11.00	1298	9342	1487	2785	0.1
2.5	80.0	15.50	1838	9555	958	2796	0.1
2.5	80.0	20.50	2438	9506	682	3119	0.1
2.5	80.0	26.50	3123	9992	500	3622	0.0
				Summary:	7600	Boussinesq	1.0
3.5	80.0	3.75	469	469	5836	6305	0.4
3.5	80.0	5.75	700	7000	3895	4595	0.2
3.5	80.0	8.00	948	9286	2477	3424	0.1
3.5	80.0	11.00	1298	9342	1619	2917	0.1
3.5	80.0	15.50	1838	9555	1053	2890	0.1
3.5	80.0	20.50	2438	9506	751	3189	0.1
3.5	80.0	26.50	3123	9992	551	3674	0.0
				Summary:	6000	Boussinesq	1.0
4.5	80.0	3.75	469	469	4931	5400	0.3
4.5	80.0	5.75	700	7000	3743	4443	0.2
4.5	80.0	8.00	948	9286	2537	3484	0.1
4.5	80.0	11.00	1298	9342	1701	2999	0.1
4.5	80.0	15.50	1838	9555	1118	2956	0.1
4.5	80.0	20.50	2438	9506	801	3239	0.1
4.5	80.0	26.50	3123	9992	589	3712	0.1
				Summary:	5000	Boussinesq	1.0
5.5	80.0	3.75	469	469	4365	4834	0.3
5.5	80.0	5.75	700	7000	3601	4301	0.2
5.5	80.0	8.00	948	9286	2591	3539	0.1
5.5	80.0	11.00	1298	9342	1787	3085	0.1
5.5	80	15.50	1838	9555	1191	3028	0.1
5.5	80	20.50	2438	9506	857	3295	0.1
5.5	80	26.50	3123	9992	632	3754	0.1
				Summary:	4400	Boussinesq	1.0
6.5	80	3.75	469	469	3980	4449	0.3
6.5	80	5.75	700	7000	3467	4167	0.2

6.5	80	3.75	469	469	3980	4449	0.3
6.5	80	5.75	700	7000	3467	4167	0.2
6.5	80	8.00	948	9286	2631	3579	0.1
6.5	80	11.00	1298	9342	1869	3167	0.1
6.5	80	15.50	1838	9555	1264	3101	0.1
6.5	80	20.50	2438	9506	915	3353	0.1
6.5	80	26.50	3123	9992	676	3799	0.1
				Summary:	4000	Boussinesq	1.0

7.5	80	3.75	469	469	3688	4157	0.3
7.5	80	5.75	700	7000	3333	4033	0.2
7.5	80	8	948	9286	2646	3594	0.1
7.5	80	11	1298	9342	1936	3234	0.2
7.5	80	15.5	1838	9555	1331	3168	0.1
7.5	80	20.5	2438	9506	970	3407	0.1
7.5	80	26.5	3123	9992	719	3841	0.1
				Summary:	3700	Boussinesq	1.0

8.5	80	3.75	469	469	3392	3861	0.3
8.5	80	5.75	700	7000	3144	3844	0.2
8.5	80	8	948	9286	2593	3540	0.1
8.5	80	11	1298	9342	1953	3250	0.2
8.5	80	15.5	1838	9555	1365	3202	0.1
8.5	80	20.5	2438	9506	1001	3439	0.1
8.5	80	26.5	3123	9992	745	3868	0.1
				Summary:	3400	Boussinesq	1.0

9.5	80	3.75	469	469	3195	3664	0.3
9.5	80	5.75	700	7000	3014	3714	0.2
9.5	80	8	948	9286	2565	3512	0.1
9.5	80	11	1298	9342	1984	3282	0.2
9.5	80	15.5	1838	9555	1412	3249	0.1
9.5	80	20.5	2438	9506	1044	3481	0.1
9.5	80	26.5	3123	9992	780	3902	0.1
				Summary:	3200	Boussinesq	1.0

10.5	80	3.75	469	469	3096	3565	0.3
10.5	80	5.75	700	7000	2959	3659	0.2
10.5	80	8	948	9286	2583	3531	0.1
10.5	80	11	1298	9342	2050	3347	0.2
10.5	80	15.5	1838	9555	1484	3322	0.1
10.5	80	20.5	2438	9506	1106	3544	0.1
10.5	80	26.5	3123	9992	830	3952	0.1
				Summary:	3100	Boussinesq	1.0

4.0 SEISMIC CONSIDERATIONS

Based on the map created by McDonald, Greg N., Ashland, Francis X., *Earthquake Site-Conditions Map for the Wasatch Front Urban Corridor*, Utah, Plate 1, Utah Geological Survey Special Study 125, 2008 seen in the following page with the project site located.

SITE CLASS – USGS MAP OVERLAY

309th SWEG Office Building ■ HAFB, Utah
April 11, 2022 ■ Terracon Project No. 61225006

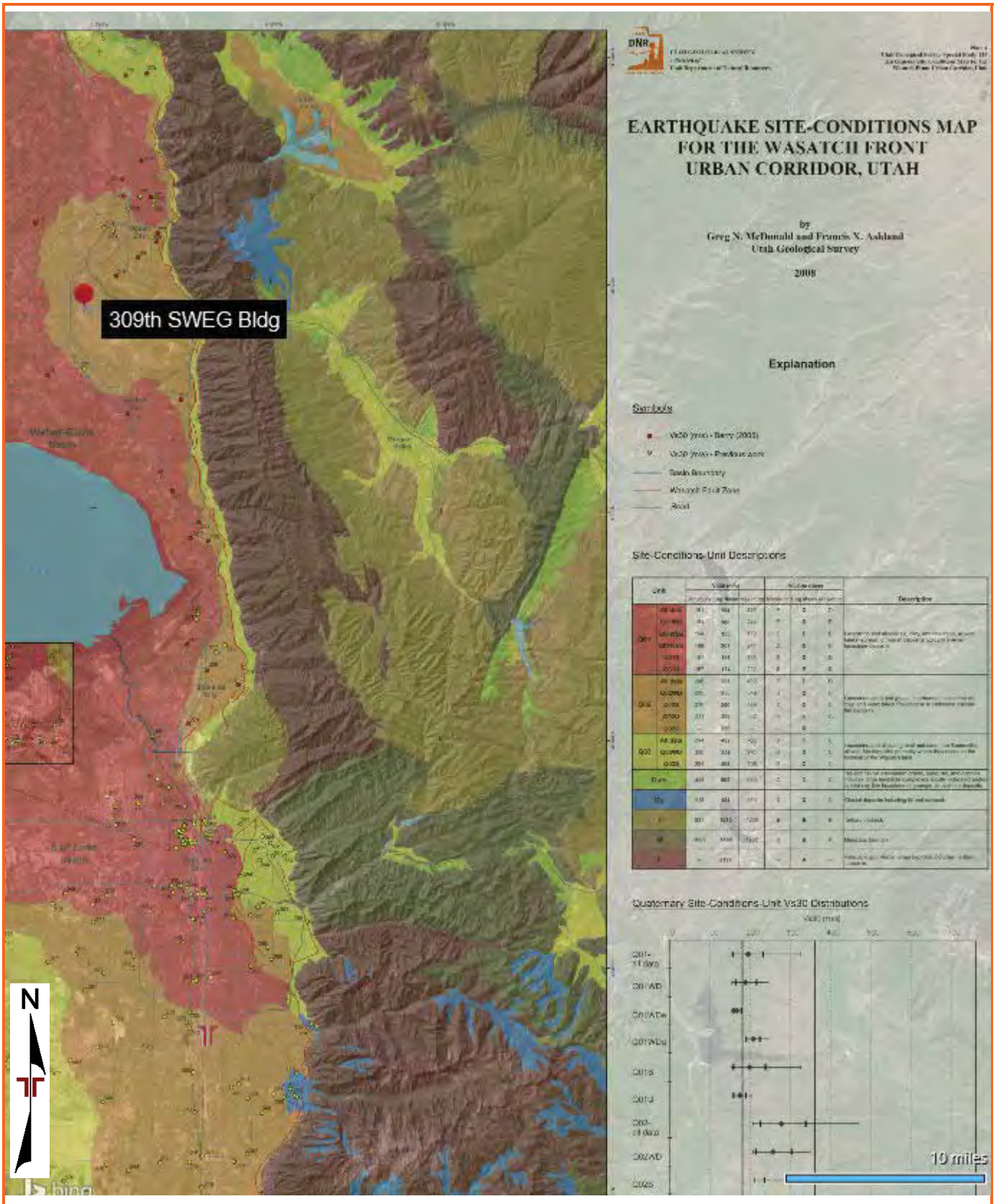


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

5.0 LIQUEFACTION POTENTIAL ANALYSIS

1. The following image is based on the published map by Christenson, G.E., Shaw, L.M., 2008, Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah, Supplement Map to Utah Geological Survey Circular 106.
2. The Project site is located on a Very Low Potential (VLP) area for liquefaction potential according to the published map.

6.0 PAVEMENT CALCULATIONS

Using local Utah Department Of Transportation method based on AASHTO methods for the parking lot area.

Design Life: 25 years

AASHTO 1993 ESAL Calculator for Flexible Pavements

Vehicle Description	Traffic Volume			Analysis	Axle Load and Type						Gross	Equivalency Factors			ESAL's
	Quantity in the Design Lane	Days per Week	Weeks per Year	Period (years)	Axle 1 (kips)		Axle 2 (kips)		Axle 3 (kips)		Weight (pounds)	Axle 1	Axle 2	Axle 3	
Passenger car	**350**	**7**	**52**	**25**	2	S	2	S			4,000	0.0002	0.0002	0	1,274
Pick-up truck or van	**150**	**7**	**52**	**25**	2	S	4	S			6,000	0.0002	0.003	0	4,368
Recreational vehicle					4	S	4	S			8,000	0.003	0.003	0	0
School bus					6	S	14	S			20,000	0.012	0.338	0	0
TARC bus					8	S	14	S			22,000	0.035	0.338	0	0
Greyhound MC-12 bus					13.4	S	18.4	S	6	S	37,800	0.2897	1.118	0.012	0
Package delivery truck	**10**	**7**	**52**	**25**	4	S	14	S			18,000	0.003	0.338	0	31,031
Beverage delivery truck					6	S	12	S	12	S	30,000	0.012	0.177	0.177	0
Garbage/dumpster truck	**2**	**2**	**52**	**25**	20	S	35	T			55,000	1.59	1.225	0	14,638
Concrete truck (full)					20	S	48	R			68,000	1.59	0.992	0	0
Dump truck (full)					20	S	48	R			68,000	1.59	0.992	0	0
Semi-tractor (no trailer)					8	S	2	T			10,000	0.035	0	0	0
Semi-tractor trailer (empty)					8	S	8	T	6	T	22,000	0.035	0.003	0.001	0
Semi-tractor trailer					12	S	34	T	34	T	80,000	0.177	1.07	1.07	0
User Defined					6	S	29	s	20	T	55,000	0.012	8.655	0.117	0
User Defined					8	S	8	T		T	16,000	0.035	0.003	0	0
Vehicle type H10					4	S	16	S			20,000	0.003	0.598	0	0
Vehicle type H15					6	S	24	S			30,000	0.012	3.62	0	0
Vehicle type H20					8	S	32	S			40,000	0.035	13.5	0	0
Vehicle type 3					16	S	34	T			50,000	0.598	1.07	0	0
Vehicle type HS15					6	S	24	S	24	S	54,000	0.012	3.62	3.62	0
Vehicle type HS20					8	S	32	S	32	S	72,000	0.035	13.5	13.5	0
Vehicle type 3S2					10	S	31	T	31	T	72,000	0.085	0.723	0.723	0

Terminal Serviceability, r_t	**2.0**
Assumed Structural Number, SN	**2**
Traffic Growth Rate, %/yr	**0**

Summary:		
Total AASHTO ESAL's		**51,311**
	Superpave	**ESAL Class 1**
Traffic Category	**Light Duty Pavement**	

Project: Proposed Dollar General Stor Location: East Wareham, Massachusetts

Job No.: J3135123 Date: 4/7/2014

Terracon

Pavement Design (AASHTO 1993 Method)

Design Inputs

			Asphalt		Concrete	
CBR, Calculated Mr	3.0	Mr =	5161 psi	K =	110	pci
Sugrade Support Used		Mr =	5161 psi	K =	110	pci
Reliability (%) =			90		90	
Standard Deviation		So =	0.42		0.35	
Initial Serviceability =		Po =	4.2		4.5	WM = 4.2
Terminal Serviceability =		P_t =	2.0		2.5	WM = 2.0
Design Serviceability Loss, =		ΔPSI =	2.2		2.0	

Asphalt Layer Coefficients	a_1 = 0.40	AC Surface and Binder
	a_2 = 0.40	AC Base
	a_2 = 0.10	Aggregate Base
	a_3 = 0.08	Subbase

Concrete Compressive Strength	4000	psi
Modulus of Elasticity of Concrete =	3,605	ksi
Modulus of Rupture of Concrete: =	580	psi
Load Transfer ("J" Factor)	4.2	See Table 1
Drainage Coefficient	1.0	See Table 2

Pavement Thickness Designs

Traffic Category - Flexible Pavement **Light Duty Pavement**

Asphalt Section Traffic (18 kip ESAL) = 52,000 *Calculated ESALs =* **51,311**

Flexible Pavement Section

	Drainage, m	D_i	
AC Surface + Binder		**2.0**	in
Asphalt Base		**2.0**	in
Aggregate Base	1.0	**8.0**	in
Subbase	1.0	**0.0**	in

Solve for SN required

Structural Number **2.40** **OK**

Required 2.38

Rigid Pavement Section

Traffic Category - Rigid Pavement **Rigid - Heavy Duty Pavement**

Concrete Section Traffic (18 kip ESAL) = *Calculated ESALs =* **30,787**

Concrete Thickness, D_{PCC} 5.00

Solve for DPCC

Calculated to less than minimum!!

Click button to solve for slab Thicknes