ALBUS-KEEFE & ASSOCIATES, INC
GEOTECHNICAL CONSULTANTS

April 20, 2020
J.N.: 2841.00

Mr. Chris Killian
National Community Renaissance
9421 Haven Avenue
Rancho Cucamonga, California 91730

Subject: **Revised Preliminary Geotechnical Investigation, Proposed Multi-Family Residential Development, 24551 Raymond Way, Lake Forest, California.**

Dear Mr. Killian,

Pursuant to your request, ***Albus-Keefe & Associates, Inc***. is pleased to present to you our preliminary geotechnical investigation report for the subject development. This report presents the results of our field investigation, laboratory testing, engineering analyses, as well as our preliminary geotechnical recommendations for design and construction of the subject development.

We appreciate this opportunity to be of service to you. If you have any questions regarding the contents of this report, please do not hesitate to call this office.

Sincerely,

ALBUS-KEEFE & ASSOCIATES, INC.

Paul Kim
Associate Engineer

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purposes of our preliminary geotechnical investigation were to evaluate geotechnical conditions within the project area and to provide conclusions and recommendations relevant to the design and construction of the proposed improvements at the subject site. The scope of this investigation included the following:

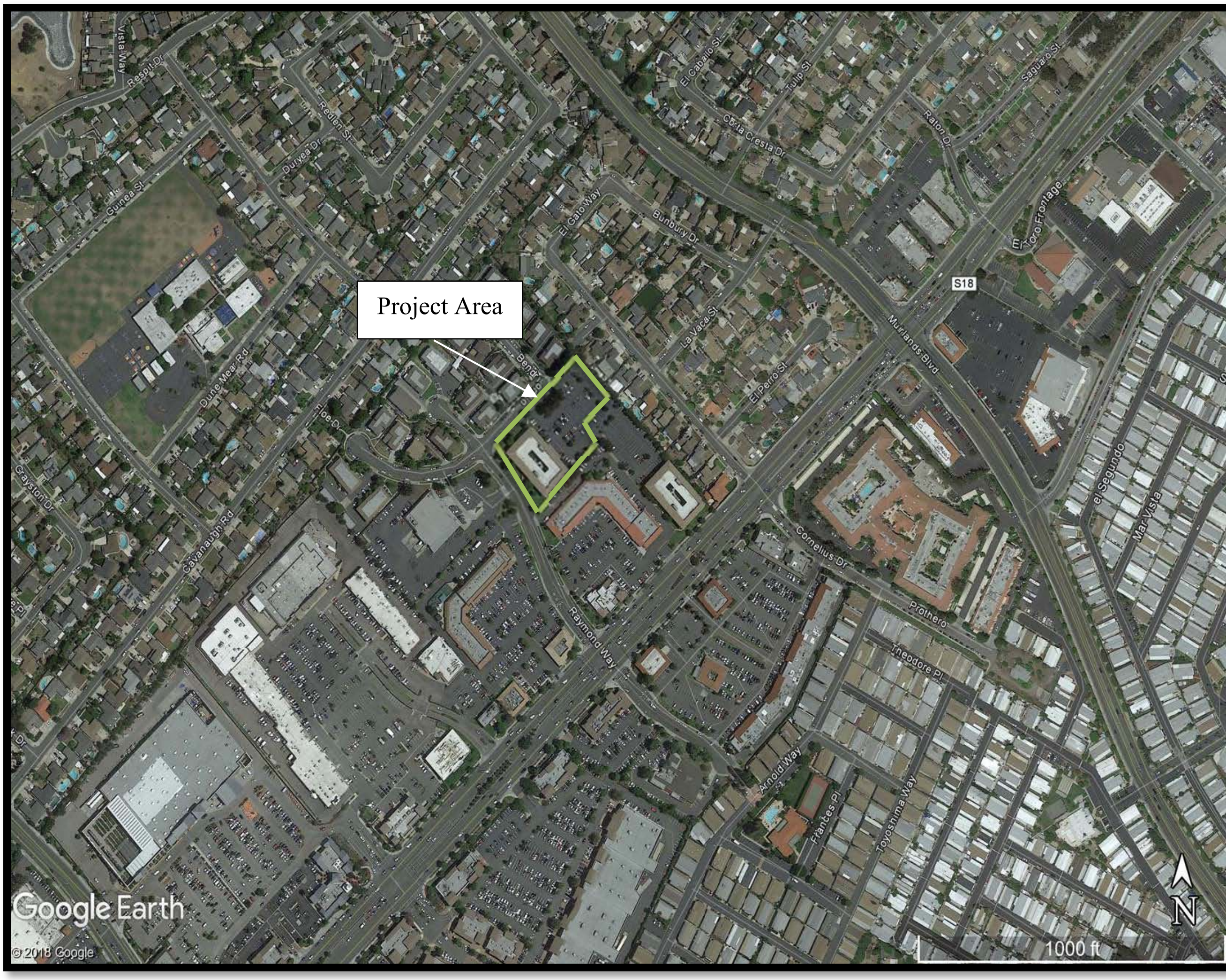
- Review of the referenced conceptual site plan
- Review of published geologic and seismic data for the site and surrounding area
- Review of historical aerial photographs
- Exploratory drilling and soil sampling
- Laboratory testing of selected soil samples
- Engineering analyses of data obtained from our review, exploration, and laboratory testing
- Evaluation of site seismicity, liquefaction, and settlement potential
- Preparation of this report

1.2 SITE LOCATION AND DESCRIPTION

The site is located at 24551 Raymond Way (APN 617-441-02), within the city of Lake Forest, California. The property is bordered by Raymond Way to the southwest, Packer Place to northwest, single family homes to northeast and northwest, a multi-tenant retail plaza to the southeast and a parking lot to the northeast. The location of the site and its relationship to the surrounding areas is shown on Figure 1, Site Location Map.

The site consists of an irregular-shaped property containing approximately 1.96 acres of land. The site is relatively flat with elevations ranging from EL391 to EL396 above mean sea level (based on Google Earth) descending to the west. Drainage within the site is generally directed as a sheet flow towards Packer Place. The site is currently occupied by 2-story commercial building and asphaltic parking lot.

Vegetation within the site consists of grass cover adjacent to the existing building. Several small trees and bushes are present throughout the site within the islands of the parking lot, adjacent to the existing building, and along the perimeter.



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SITE LOCATION MAP
Lake Forest
Proposed Multi-Family Residential Development
24551 Raymond Way,
Lake Forest, California

NOT TO SCALE
FIGURE 1

1.3 PROPOSED DEVELOPMENT

Based on the architectural site plans by RRM design group, the proposed development for the site will consist of a partial four-story residential building with an interior courtyard and playground area, on-grade parking lot, perimeter site walls, and underground utilities.

No grading or structural plans were available in preparing of this report. However, we anticipate that minor rough grading of the site will be required to achieve future surface configuration. We expect the proposed residential dwellings will be wood-framed structures with concrete slabs on grade yielding relatively light foundation loads.

2.0 INVESTIGATION

2.1 RESEARCH

We have reviewed the referenced geologic publications and maps (see references). Data from these sources were utilized to develop some of the findings and conclusions presented herein.

We have also reviewed available historical aerial photographs. The aerial photos indicate that as early as 1938, the site was vacant land. In the vicinity of the site, some areas of land were used for agricultural purposes. By 1967, the adjacent single-family residential properties to the northeast were developed. By 1980, the property was developed with the present-day commercial building and parking lot. The site has remained unchanged since then.

2.2 SUBSURFACE EXPLORATION

Subsurface exploration for this investigation was conducted on October 2nd, 2019, and consisted of the drilling of five (4) soil borings to depths ranging from approximately 11.5 to 51.5 feet below the existing ground surface (bgs). The borings were drilled using a truck-mounted, continuous flight, hollow-stem-auger drill rig. A representative of Albus-Keefe & Associates, Inc. logged the exploratory borings. Visual and tactile identifications were made of the materials encountered, and their descriptions are presented in the Exploration Logs in Appendix A. The approximate locations of the exploratory excavations completed by this firm are shown on the enclosed Geotechnical Map, Plate 1.

Bulk, relatively undisturbed and Standard Penetration Test (SPT) samples were obtained at selected depths within the exploratory borings for subsequent laboratory testing. Relatively undisturbed samples were obtained using a 3-inch O.D., 2.5-inch I.D., California split-spoon soil sampler lined with brass rings. SPT samples were obtained from the boring using a standard, unlined SPT soil sampler. During each sampling interval, the sampler was driven 18 inches with successive drops of a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler was recorded for each six inches of advancement. The total blow count for the lower 12 inches of advancement per soil sample is recorded on the exploration log. Samples were placed in sealed containers or plastic bags and transported to our laboratory for analyses. The borings were backfilled with auger cuttings upon completion of sampling.

2.3 LABORATORY TESTING

Selected samples of representative earth materials from our borings were tested in our laboratory. Tests consisted of USCS classification, in-situ moisture content and dry density, maximum dry density and optimum moisture content, consolidation/collapse, direct shear strength, grain size analysis, soluble sulfate content, and corrosivity testing (pH, chloride, and resistivity). Descriptions of laboratory testing and the test results are presented in Appendix B and on the Exploration Logs in Appendix A.

3.0 GEOLOGIC CONDITIONS

3.1 SOIL CONDITIONS

Descriptions of the earth materials encountered during our investigation are summarized below and are presented in detail on the Exploration Logs presented in Appendix A.

Soil materials encountered at the subject site consisted of approximately 6 feet of artificial fill over very old alluvial fan deposits. The artificial fill is predominately comprised of grayish brown and light brown silty sand. These fill materials typically were observed to be slightly moist and dense to very dense.

The very old alluvial fan deposits encountered are comprised of reddish-brown clayey sand/sandy clay. A layer of clay and silty sand was observed below a depth of 6 feet. Deeper portions of the very old alluvium fan consist of clayey sand and silty sand with variable some inner layers of clay and silt. The surficial very old alluvial fan materials are typically very dense and hard.

3.2 GROUNDWATER

Groundwater was encountered during this firm's subsurface exploration at the depth of 41 feet. Based on a review of the referenced CDMG Special Report, the site is mapped with a historical groundwater depth between 10 and 20 feet. Research of groundwater data from the State Water Resources Control Board GeoTracker database, indicates groundwater levels as shallow as 20 feet.

3.3 FAULTING

Geologic literature and field exploration do not indicate the presence of active faulting within the site. The site does not lie within an "Earthquake Fault Zone" as defined by the State of California in the Earthquake Fault Zoning Act. Table 3.1 presents a summary of all the known seismically active faults within 10 miles of the site.

TABLE 3.1
Summary of Active Faults

Name	Distance (miles)	Slip Rate (mm/yr.)	Preferred Dip (degrees)	Slip Sense	Rupture Top (km)	Fault Length (km)
San Joaquin Hills	0.18	0.5	23	thrust	2	27
Newport Inglewood Connected alt 1	9.66	1.3	89	strike slip	0	208
Newport Inglewood (Offshore)	9.66	1.5	90	strike slip	0	66
Newport Inglewood Connected alt 2	9.66	1.3	90	strike slip	0	208

4.0 ANALYSES

4.1 SEISMICITY

We have performed probabilistic seismic analyses utilizing the U.S. Seismic Design Maps web application by the U.S. Geological Survey (USGS). From our analyses, we obtain a PGA of 0.598g in accordance with Figure 22-7 of ASCE 7-10. The F_{PGA} factor for site class D with a PGA of 0.598g is 1.0. Therefore, the PGA_M = 1.0 x 0.598 = 0.598g. The mean event associated with a probability of exceedance equal to 2% over 50 years has a moment magnitude of 6.65 with a mean distance to the seismic source of 6.76 miles.

4.2 STATIC SETTLEMENT

Analyses were performed to evaluate potential for static settlement of the underlying very old alluvial fan deposits. Our analyses were based on the results of consolidation tests performed on selected samples from our borings as well as the recorded blow counts during the exploration. Results of our testing indicate the site materials have low compressibility. Based on the data from field exploration and laboratory testing, settlement is estimated to be less than 1.0 inch in the site.

5.0 CONCLUSIONS

5.1 FEASIBILITY OF PROPOSED DEVELOPMENT

From a geotechnical point of view, the proposed site development is considered feasible provided the recommendations presented in this report are incorporated into the design and construction of the project. Furthermore, it is also our opinion that the proposed development will not adversely impact the stability of adjoining properties if the recommendations presented in this report are incorporated into site development. Key issues that could have significant fiscal impacts on the geotechnical aspects of the proposed site development are discussed in the following sections of this report.

5.2 GEOLOGIC HAZARDS

5.2.1 Ground Rupture

No active faults are known to project through the site nor does the site lie within the bounds of an "Earthquake Fault Zone" as defined by the State of California in the Alquis-Priolo Earthquake Fault Zoning Act. As such, the potential for ground rupture due to fault displacement beneath the site is considered very low.

5.2.2 Ground Shaking

The site is located in a seismically active area that has historically been affected by moderate to occasionally high levels of ground motion. The site lies in relatively close proximity to several seismically active faults; therefore, during the life of the proposed development, the property will probably experience moderate to occasionally high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the southern California region. Design of proposed structures in accordance with the current CBC is anticipated to adequately mitigate concerns with ground shaking.

5.2.3 Landsliding

Geologic hazards associated with landsliding are not anticipated at the site due to not being located within an area identified by the California Geologic Survey (CGS) as having potential for seismic slope instability.

5.2.4 Liquefaction

Engineering research of soil liquefaction potential (Youd, et al., 2001) indicates that generally three basic factors must exist concurrently in order for liquefaction to occur. These factors include:

- A source of ground shaking, such as an earthquake, capable of generating soil mass distortions.
- A relatively loose silty and/or sandy soil.
- A relative shallow groundwater table (within approximately 50 feet below ground surface) or completely saturated soil conditions that will allow positive pore pressure generation.

The liquefaction susceptibility of the onsite soils was evaluated by analyzing the potential of concurrent occurrence of the above-mentioned three basic factors. The liquefaction evaluation for the site was completed under the guidance of Special Publication 117A: Guidelines for Evaluating and Mitigating Seismic Hazards in California (CDMG, 2008).

Based on the fine-grained nature of subsurface materials, the potential for liquefaction at the site is considered to be low. Additionally, the site is underlain by Pleistocene aged deposits, typically not susceptible to liquefaction. Furthermore, the site is not located within a San Diego Seismic Study liquefaction zone.

5.3 STATIC SETTLEMENT

The existing artificial fills consist of variable materials that are inadequately compacted for support of the proposed development in its current condition. Therefore, excavation and recompaction of the existing surficial soils to provide a uniform compacted blanket will be necessary. Provided grading and construction are performed in accordance with the recommendations provided herein, estimated total and differential settlement of proposed site improvements are anticipated to be less than 1 inch and ½ inch over 30 feet, respectively. These magnitudes of settlement are considered within tolerable limits of proposed site development.

5.4 EARTHWORK AND MATERIAL CHARACTERISTICS

Subsurface soils are anticipated to be relatively easy to excavate with conventional heavy earthmoving equipment. Most of these materials are below optimum moisture content with a few localized layers above optimum moisture content. Blending and the addition of water will be required to achieve proper compaction. Various debris is anticipated within the artificial fill and will likely require of hand picking to remove deleterious materials.

Off-site improvements exist near the property lines. The presence of the existing improvements may limit removals of unsuitable materials adjacent the property lines. Special grading techniques, such as slot cutting, underpinning, or other acceptable criteria may be required when grading adjacent the property lines.

Onsite disposal systems, clarifiers and other underground improvements may be present beneath the site. If encountered during future rough grading, these improvements will require proper abandonment or removal.

5.5 SHRINKAGE AND SUBSIDENCE

Volumetric changes in earth quantities will occur when excavated onsite soil materials are replaced as properly compacted fill. We estimate that the existing artificial fill soils will shrink less than 5 percent to negligible. Subsidence due to reprocessing of removal bottoms is anticipated to be negligible. The estimates of shrinkage and subsidence are intended as an aid for project engineers in determining earthwork quantities. However, these estimates should be used with some caution since they are not absolute values. Contingencies should be made for balancing earthwork quantities based on actual shrinkage and subsidence that occurs during the grading process.

5.6 SOIL EXPANSION

Based on our laboratory test results and USCS visual manual classification, the near-surface soils within the site are generally anticipated to possess a **Low** expansion potential. Additional testing for soil expansion will be required subsequent to rough grading and prior to construction of foundations and other concrete flatwork to confirm these conditions.

6.0 RECOMMENDATIONS

6.1 EARTHWORK

6.1.1 General Earthwork and Grading Specifications

All earthwork and grading should be performed in accordance with all applicable requirements of the grading codes of the City of Lake Forest, California and CAL OSHA, in addition to recommendations presented herein.

6.1.2 Pre-Grade Meeting and Geotechnical Observation

Prior to commencement of earthwork operations and foundation installation, we recommend a meeting be held between the City Inspector, general contractor, civil engineer, and geotechnical consultant to discuss proposed earthwork and logistics.

We also recommend that a geotechnical consultant be retained to provide soil engineering and engineering geologic services during site development. This is to observe compliance with the design specifications and recommendations, and to allow design changes in the event that subsurface conditions differ from those anticipated. If conditions are encountered during construction that appears to be different than those indicated in this report, the project geotechnical consultant should be notified immediately. Design and construction revisions may be required.

6.1.3 Site Clearing

All existing site improvements, including asphaltic concrete paving, structural foundations and underground utilities, should be removed from the areas to be developed prior to any grading activities. Existing underground utility lines within the project area that will be protected in place and that fall within a 1 to 1 (H:V) plane projected down from the edges of footings may be subject to surcharge loads. Under such conditions, this office should be made aware of these conditions for evaluation of potential surcharging. Supplemental recommendations may be required to protect such improvements in place.

The project geotechnical consultant should be notified at the appropriate times to provide observation services during clearing operations to verify compliance with the above recommendations. Voids created by clearing and excavation should be left open for observation by the geotechnical consultant. Should any unusual soil conditions or subsurface structures be encountered during site clearing or grading that are not described or anticipated herein, these conditions should be brought to the immediate attention of the project geotechnical consultant for corrective recommendations as needed.

Temporary construction equipment (office trailers, power poles, etc.) should be positioned to allow adequate room for clearing and recommended ground preparation to be performed for proposed structures, pavements, and hardscapes.

6.1.4 Site Preparation (Removals and Overexcavations)

In general, the upper 5 to 6 feet of earth materials are inadequately compacted for support of the proposed development in its current condition. These materials as well as any additional artificial fill soils, should be excavated from proposed building pads and site improvements, and recompacted as engineered compacted fill. Within the limits of pavement and free-standing/retaining walls, the existing artificial fill soils should be removed to a minimum depth of 2 foot below subgrade or footing, whichever is deeper. The actual depth of removal should be determined by the geotechnical consultant during grading.

The removals should extend laterally a distance of at least 5 feet beyond the limits of the proposed structures or a 1:1 projection down and away from the bottom of the footings, whichever is greater. Removals for roadways, retaining walls less than 3 feet in height and screen walls may be limited to the edge of the foundations or pavement. Upon review of more detailed site development plans, the depth of removals for roadways, short retaining walls, and screen walls may be lessened from the general removals described above.

Where removals are limited by existing structures, protected trees or property lines, special considerations may be required in the construction of affected improvements. Under such conditions, specific recommendations should be provided by this firm based on review of site-specific development plans.

Following removals/overexcavation, the exposed grade should first be scarified to a depth of 6 inches, brought to at least 110 percent of the optimum moisture content, and then compacted to at least 90 percent of the laboratory standard (ASTM D 1557).

6.1.5 Fill Placement

Materials excavated from the site may be reused as fill provided, they are free of deleterious materials and particles greater than 6 inches in maximum dimension (oversized materials). Asphaltic and concrete debris generated during site demolition or encountered within the existing fill can be incorporated within new fill soils during earthwork operations provided they are reduced to no more than 6 inches in maximum dimension. Such materials should be mixed thoroughly with fill soils to prevent nesting. All fill should be placed in lifts no greater than 8 inches in loose thickness, moisture conditioned to at least 110 percent of the optimum moisture content, then compacted in place to at least 90 percent of the laboratory standard. Each lift should be treated in a similar manner. Subsequent lifts should not be placed until the project geotechnical consultant has approved the preceding lift.

6.1.6 Import Materials

If import materials are required to achieve the proposed finish grades, the proposed import soils should have an Expansion Index (EI, ASTM D 4829) less than 30 and possess negligible soluble sulfate concentrations. Import sources should be indicated to the geotechnical consultant prior to hauling the materials to the site so that appropriate testing and evaluation of the fill materials can be performed in advance.

6.1.7 Temporary Excavations

Temporary construction slopes or trench excavations in site materials may be cut vertically up to a height of 4 feet provided that no surcharging of the excavations is present. Temporary slopes over 4 feet in height should be laid back to 1:1 (H:V) or flatter and evaluated by the geotechnical consultant.

Excavations should not be left open for prolonged periods of time. The project geotechnical consultant should observe all temporary cuts to confirm anticipated conditions and to provide alternate recommendations if conditions dictate. All excavations should conform to the requirements of CAL OSHA.

Where temporary excavations cannot accommodate a 1:1 layback or where surcharging occurs, shoring, slot cutting, underpinning, or other methods should be used. Specific recommendations for other options if considered should be provided by the geotechnical consultant based on review of the final design plans.

6.2 SEISMIC DESIGN PARAMETERS

For design of the project in accordance with Chapter 16 of the 2016 CBC, the table below presents the seismic design factors.

TABLE 6.1
CBC 2016 SEISMIC DESIGN PARAMETERS

Parameter	Value
Site Class	D
Mapped MCE Spectral Response Acceleration, short periods, S_S	1.466
Mapped MCE Spectral Response Acceleration, at 1-sec. period, S_1	0.546
Site Coefficient, Fa	1.0
Site Coefficient, Fv	1.5
Adjusted MCE Spectral Response Acceleration, short periods, S_{MS}	1.466
Adjusted MCE Spectral Response Acceleration, at 1-sec. period, S_{M1}	0.82
Design Spectral Response Acceleration, short periods, S_{DS}	0977
Design Spectral Response Acceleration, at 1-sec. period, S_{D1}	0.546
MCE = Maximum Considered Earthquake	

6.3 FOUNDATION DESIGN

6.3.1 General

The following recommendations are provided for preliminary design purposes. These recommendations have been based on the site materials exposed during our investigation, our understanding of the proposed development, and the assumption that the recommendations presented herein are incorporated into the design and construction of the project. Final recommendations should be provided by the project geotechnical consultant following review of final foundation plans as well as observation and testing of site materials during grading. Depending upon the design plans and actual site conditions, the recommendations provided herein may require modification.

6.3.2 Soil Expansion

The recommendations presented herein are based on soils with a **Low** expansion potential (EI≤40, PI≤18). Following site grading, additional testing of site soils should be performed by the project geotechnical consultant to confirm the basis of these recommendations. If site soils with higher expansion potentials are encountered or imported to the site, the recommendations contained herein may require modification.

6.3.3 Settlement

Under normal static conditions, the foundation system should be designed to tolerate a total settlement of 1 inch and a differential settlement of 1/2-inch over 30 feet. These estimated magnitudes of settlement should be considered by the structural engineer in design of the proposed structures at the site.

6.3.4 Allowable Bearing Value

Provided foundations are bearing into engineered fill, a bearing value of 2,700 pounds per square foot (psf) may be used for continuous and pad footings a minimum width of 12 inches and founded at a minimum depth of 12 inches below the lowest adjacent grade. This value may be increased by 200 psf and 500 psf for each additional foot in width and depth, respectively, up to a maximum value of 4,000 psf. Recommended allowable bearing values include both dead and live loads, and may be increased by one-third for wind and seismic forces.

6.3.5 Lateral Resistance

Provided site grading is performed and that foundations are founded in engineered fill, a passive earth pressure of 250 pounds per square foot per foot of depth (psf/ft) up to a maximum value of 2,200 pounds per square foot (psf) may be used to determine lateral bearing for footings. This value may be increased by one-third when designing for wind and seismic forces. A coefficient of friction of 0.37 times the dead load forces may also be used between concrete and the supporting soils to determine lateral sliding resistance. No increase in the coefficient of friction should be used when designing for wind and seismic forces.

The above values are based on footings placed directly against compacted fill or competent native soils. In the case where footing sides are formed, all backfill against the footings should be compacted to at least 90 percent of the laboratory standard.

6.3.6 Conventional Spread Foundations and Slabs on Grade

All exterior and interior continuous footings should have a minimum width of 12 inches and minimum embedment of 12 inches below lowest adjacent grade. All continuous footings for habitable structures should be reinforced with a minimum of one No. 4 bar on top and one No. 4 bar on the bottom.

All spread footings used to support columns should have a minimum width of 18 inches and minimum embedment of 12 inches below lowest adjacent grade. All spread footings in habitable structures should be tied in both directions with a grade beam having a minimum depth and width of 12 inches. The grade beams should be reinforced with a minimum of one No. 4 bar on top and one No. 4 bar on the bottom. Reinforcing of the grade beams should hook into the footings.

Slabs on grade should have a minimum thickness of 4 inches and be reinforced with a minimum of No. 3 bars spaced at 18 inches center to center. Slabs on grade in habitable structures should be hooked to the underlying grade beams on a minimum spacing of 24 inches or poured monolithically with the grade beams.

Interior grade beams as required by the WRI method should be provided in both directions at a maximum spacing of 22 feet. Design of the slab in accordance with the WRI method may use an effective PI of 20. This value already accounts for the factors for ground slope and over-consolidation. All slabs on grade that may have moisture sensitive coverings should be underlain with a minimum of 10-mil moisture vapor retarder conforming to ASTM E 1745, Class A. A minimum of four (4) inches of clean sand having a sand equivalent (SE) of at least 30 should be placed under the membrane. An additional one inch of the sand (SE>30) may be placed over the vapor barrier to aid in the uniform curing of the slab if preferred. This vapor barrier system is anticipated to be suitable for most flooring finishes that can accommodate some vapor emissions. However, this system may emit more than 4 pounds of water per 1000 sq. ft. and therefore, may not be suitable for all flooring finishes. Additional steps should be taken if such vapor emission levels are too high for anticipated flooring finishes.

Prior to placing concrete, the subgrade below all floor slab areas should be moisture-conditioned to achieve a moisture content that is at least 110 percent of the optimum moisture content. This moisture content should be maintained a minimum depth of 12 inches below the bottoms of the slabs.

6.3.7 Post-Tensioned Slab/Mat on grade

Alternatively, a post-tension slab may be utilized. Perimeter edge beams for the post-tensioned slabs should have a minimum effective width of 12 inches and be founded at a minimum depth of 18 inches below the lowest adjacent final ground surface. Interior beams may be founded at a minimum depth of 12 inches below the tops of the finish floor slabs. Where a post-tensioned mat is utilized, the exterior edge of the mat should be embedded at least 8 inches below the lowest adjacent grade. The thickness of the floor slab/mat should be determined by the project structural engineer; however, we recommend a minimum slab thickness of 5.0 inches.

Design of the mat may be based on a modulus of subgrade reaction (Kv1) of 100 pounds per cubic inch (pci). The modulus is based on an effective loading area of 1 foot by 1 foot. The modulus may be adjusted for other effective loading areas using the equation provided below.

$$k_b(pci) = 100\left\{\frac{b+1}{2b}\right\}^2$$

where "b" is the effective width of loading (minimum dimension) in feet.

Concrete floor slabs in areas to receive carpet, tile, or other moisture sensitive coverings should be underlain with a minimum of 10-mil moisture vapor retarder conforming to ASTM E 1745, Class A. The membrane should be properly lapped, sealed, and underlain within a layer of sand at least 4 inches thick. Where a mat is used and has a thickness of at least 8 inches, the sand may be limited to 2 inches. One inch of sand may be placed over the membrane to aid in the curing of the concrete. The sand should have a SE no less than 30. This vapor retarder system is anticipated to be suitable for most flooring finishes that can accommodate some vapor emissions. However, this system may emit more than 4 pounds of water per 1000 sq. ft. and therefore, may not be suitable for all flooring finishes. Additional steps should be taken if such vapor emission levels are too high for anticipated flooring finishes.

Prior to placing concrete, subgrade soils below slab-on-grade/mat areas should be thoroughly moistened to provide moisture contents at least 110 percent of the optimum moisture content to a depth of 12 inches.

Based on the guidelines provided in the "Design of Post-Tensioned Slabs-on-Ground" 3rd Edition by Post-Tensioning Institute, the em and ym values are summarized in Table 6.2.

TABLE 6.2
PTI Design Parameters

Parameter	Value
Edge Lift Moisture Variation Distance, e_m	8.0 feet
Edge Lift, y_m	0.754 inches
Center Lift Moisture Variation Distance, e_m	4.2 feet
Center Lift, y_m	1.182 inches

6.3.8 Foundation Observations

Foundation excavation should be observed by the project geotechnical consultant to verify that they have been excavated into competent bearing soils and to the minimum embedment recommended above. These observations should be performed prior to placement of forms or reinforcement. The excavations should be trimmed neat, level and square. Loose, sloughed or moisture-softened materials and debris should be removed prior to placing concrete.

6.4 RETAINING AND SCREENING WALLS

6.4.1 General

The following preliminary design and construction recommendations are provided for general retaining and screen walls supported by engineered compacted fill or competent native soils. Final wall designs specific to the site development should be provided for review once completed. The structural engineer and architect should provide appropriate recommendations for sealing at all joints and applying moisture-proofing material on the back of the walls.

6.4.2 Allowable Bearing Value and Lateral Resistance

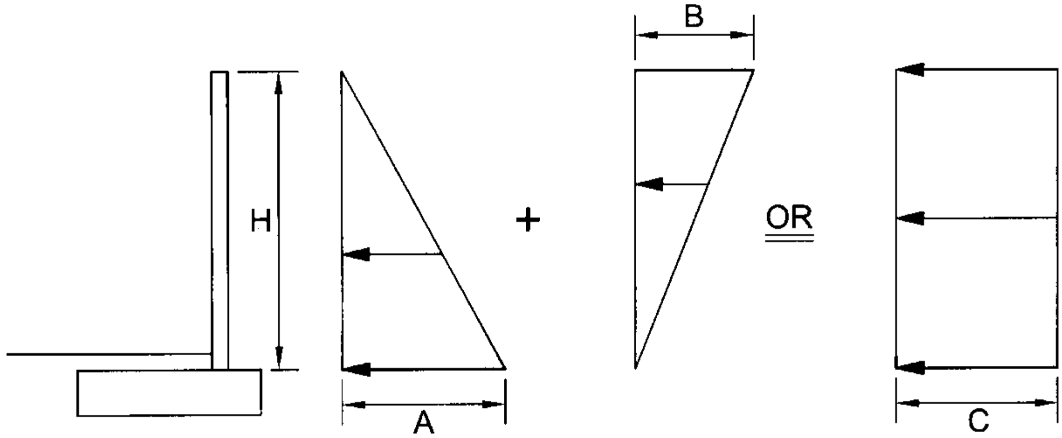
Design of retaining and screen walls may utilize the bearing and lateral resistance values provided in Section 6.3.4 and 6.3.5. Lateral resistance for walls along property lines, where lateral removals are restricted should be reduced by 50%.

6.4.3 Active Earth Pressures

Static and seismic active earth pressures for level backfill and 2:1 (H:V) backfill conditions are provided in Table 6.3. Based on the 2016 CBC, walls that retain less than 6 feet need not be designed for seismic earth pressures. Seismic earth pressures provided herein are based on the method provided by Seed & Whitman (1970) using a peak ground acceleration (PGA) of 0.35 g, for 10% probability of exceedance in 50 years. The values provided in Table 6.4 are based on drained backfill conditions and do not consider hydrostatic pressure. Furthermore, retaining walls should be designed to support adjacent surcharge loads imposed by other nearby footings or traffic loads in addition to the earth pressure.

TABLE 6.3

SEISMIC EARTH PRESSURES
Pressure Diagram



Static Component | Seismic Component | Total Force

Pressure Values
Walls Up To 10 Feet High

Value	Backfill Condition	
	Level	2H:1V Slope
A	40H	68H
B	11H	11H
C	26H	40H

Note:
H is in feet and resulting pressure is in psf. Design may utilize either the sum of the static component and the seismic component force diagrams or the total force diagram above. SEAOSC has suggested using a load factor of 1.7 for the static component and 1.0 for the seismic component. The actual load factors should be determined by the structural engineer.

6.4.4 Drainage and Moisture-Proofing

Retaining walls should be constructed with a perforated pipe and gravel subdrain to prevent entrapment of water in the backfill. The perforated pipe should consist of 4-inch-diameter, ABS SDR-35 or PVC Schedule 40 with the perforations laid down. The pipe should be embedded in ¾- to 1½-inch open-graded gravel wrapped in filter fabric. The gravel should be at least one foot wide and extend at least one foot up the wall above the footing and drainage outlet. Drainage gravel and piping should not be placed below outlets and weepholes. Filter fabric should consist of Mirafi 140N, or equal. Outlet pipes should be directed to positive drainage devices.

The use of weepholes may be considered in locations where aesthetic issues from potential nuisance water are not a concern. Weepholes should be 2 inches in diameter and provided at least every 6 feet on center. Where weepholes are used, perforated pipe may be omitted from the gravel subdrain.

Retaining walls supporting backfill should also be coated with a moisture-proofing compound or covered with such material to inhibit infiltration of moisture through the walls. Moisture-proofing material should cover any portion of the back of wall that will be in contact with soil and should lap over and onto the top of footing. A drainage panel should be provided between the soil backfill and water proofing. The panel should extend from the top of the backdrain gravel up to within 12 inches of finish grade. The top of footing should be finished smooth with a trowel to inhibit the infiltration of water through the wall. The project structural engineer should provide specific recommendations for moisture-proofing, water stops, and joint details.

6.4.5 Footing Reinforcement and Wall Jointing

All continuous footings should be reinforced with a minimum of two No. 4 bars, one top and one bottom. Walls should be provided with cold joints spaced no more than 40 feet apart. Wall finishes and capping materials should not extend across the cold joint. The structural engineer may require different reinforcement or jointing and should dictate if greater than the recommendations provided herein. Where recommended removals are limited due to space restrictions, greater reinforcement and closer jointing may be recommended. Specific recommendations should be provided by the geotechnical consultant during grading based on as-built conditions exposed in the field.

6.4.6 Footing Observations

Footing excavations should be observed by the project geotechnical consultant to verify that they have been excavated into competent bearing soils and to the minimum embedment recommended herein. These observations should be performed prior to placement of forms or reinforcement. The excavations should be trimmed neat, level and square. Loose, sloughed or moisture-softened materials and debris should be removed prior to placing concrete.

6.4.7 Retaining Wall Backfill

Onsite soils may generally be used for backfill of retaining walls. The project geotechnical consultant should approve all backfill used for retaining walls. Wall backfill should be moisture-conditioned to slightly over the optimum moisture content; placed in lifts no greater than 12 inches in thickness, and then mechanically compacted with appropriate equipment to at least 90 percent of the laboratory standard. Hand-operated compaction equipment should be used to compact the backfill placed immediately adjacent the wall to avoid damage to the wall. Flooding or jetting of backfill material is not recommended.

6.5 EXTERIOR FLATWORK

Exterior flatwork should be a minimum 4 inches thick. Cold joints or saw cuts should be provided at least every 7 feet in each direction. Flatwork having a minimum dimension more than 7 feet should be reinforced with No. 3 bars spaced 18 inches center to center each way or 6-inch by 6-inch, W4 by W4 welded wire mesh. Special jointing detail should be provided in areas of block-outs, notches, or other irregularities to avoid cracking at points of high stress Subgrade soils below flatwork should be thoroughly moistened to at least 110 percent of the optimum moisture content to a depth of 12 inches. Moistening should be accomplished by lightly spraying the area over a period of a few days just prior to pouring concrete. The geotechnical consultant should observe and verify the density and moisture content of subgrade soils prior to pouring concrete to ensure that the required compaction and pre-moistening recommendations have been met.

Drainage from flatwork areas should be directed to local area drains and/or other appropriate collection devices designed to carry runoff water to the street or other approved drainage structures. The concrete flatwork should also be sloped at a minimum gradient of 1 percent away from building foundations and retaining walls.

6.6 CONCRETE MIX DESIGN

Laboratory testing of onsite soil indicates **negligible** soluble sulfate content. Concrete designed to follow the procedures provided in ACI 318, Section 4.3, Table 4.3.1 for **negligible** sulfate exposure are anticipated to be adequate for mitigation of sulfate attack on concrete. Upon completion of rough grading, an evaluation of as-graded conditions and further laboratory testing will be required for the site to confirm or modify the conclusions provided in this section.

6.7 CORROSION

Results of preliminary testing of soils for pH, chloride, and minimum resistivity indicate the site is potentially **Corrosive** to metals that are in contact or close proximity to onsite soils. As such, specific recommendations should be obtained from a corrosion specialist if construction will include metals that will be near or in direct contact with site soils.

6.8 PRELIMINARY PAVEMENT DESIGN

6.8.1 Preliminary Pavement Structural Sections

Based on the soil conditions present at the site and estimated traffic index, preliminary pavement structural sections are recommended in the table below. An assumed “R-value” of 20 utilized for the near-surface soil in this preliminary pavement design. The sections provided in Table 6.4 are for planning purposes only and should be re-evaluated subsequent to site grading. Final pavement sections should be based on actual R-value testing of in-place soils and analysis of anticipated traffic.

6.8.2 Subgrade Preparation

Prior to placement of pavement elements, subgrade soils should be moisture-conditioned to at least 110 percent of the optimum moisture content then compacted to at least 90 percent of the laboratory determined maximum dry density. Areas observed to pump or yield under vehicle traffic should be removed and replaced with firm and unyielding compacted soil or aggregate base materials.

TABLE 6.4
PRELIMINARY PAVEMENT STRUCTURAL SECTIONS

Location	Traffic Index	AC (inches)	PCC (inches)	Concrete Pavers (mm)	AB (inches)
Entry and Main Driveway	5	3.0 4.0 -- --	-- -- 6.5 --	-- -- -- 80.0	8.0 6.0 -- 9.0
Parking Stalls	--	3.0	--	--	5.0

AC - Asphaltic Concrete AB - Aggregate Base

6.8.3 Aggregate Base

Aggregate base should be moisture conditioned to slightly over the optimum moisture content, placed in lifts no greater than 6 inches in thickness, then compacted to at least 95 percent of the laboratory standard (ASTM D 1557). Aggregate base materials should be Class 2 Aggregate Base conforming to Section 26-1 of the latest edition of the Caltrans Standard Specifications, Crushed Aggregate Base conforming to Section 200-2.2 of the latest edition of the Standard Specifications for Public Works Construction (Greenbook) or Crushed Miscellaneous Base conforming to Section 200-2.4 of the Greenbook.

6.8.4 Asphaltic Concrete

Paving asphalt should be PG 64-10. Asphaltic concrete materials should conform to Section 203-6 of the Greenbook and construction should conform to Section 302 of the Greenbook.

6.8.5 Concrete Pavers

Concrete pavers should conform to the requirements of ASTM C 936. Construction of the pavers, including bedding sand, should follow manufacturer’s specifications. Typical thickness of bedding sand is about 1 inch. The gradation of bedding sand should meet the requirement in Table 6.5.

Construction of edge restraints should also follow manufacturer’s specifications. As a minimum, restraints should be provided along the perimeter of concrete pavers and where there is a change in the paving materials.

TABLE 6.5
Gradation of Bedding for Pavers

Sieve Size	Percent Passing
⅜”	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	5 - 30
No. 100	0 - 10
No. 200	0 - 1

6.8.6 Portland Cement Concrete

Portland cement concrete used to construct concrete paving should conform to Section 201 of the Greenbook and should have a minimum compressive strength of 3,250 pounds per square inch (psi) at 28 days. Reinforcement and jointing of concrete pavement sections should be designed according to the minimum recommendations provided by the Portland Cement Association (PCA). For rigid pavement, transverse and longitudinal contraction joints should be provided at spacing no greater than 15 feet. Score joints may be constructed by saw cutting to a depth of ¼ of the slab thickness. Expansion/cold joints may be used in lieu of score joints. Such joints should be properly sealed and provided with a key or dowels. Where traffic will traverse over edges of concrete paving (not including joints), the edges should be thickened by 20% of the design thickness toward the edge over a horizontal distance of 5 feet.

Trash pickup areas should be provided with a concrete slab where the bins will be picked up and extend at least 3 feet past the front wheel landing areas. The slab should be at least 8 inches thick and be reinforced with No. 4 bars spaced at 24 inches on centers, both ways. The slabs should be provided transverse and longitudinal joints spacing as specified above. Dowels or a keyway should be provided at all cold joints.

6.9 POST GRADING CONSIDERATIONS

6.9.1 Site Drainage and Irrigation

The ground immediately adjacent to foundations should be provided with positive drainage away from the structures in accordance with 2016 CBC, Section 1804.3. No rain or excess water should be allowed to pond against structures such as walls, foundations, flatwork, etc.

Excessive irrigation water can be detrimental to the performance of the proposed site development. Water applied in excess of the needs of vegetation will tend to percolate into the ground. Such percolation can lead to nuisance seepage and shallow perched groundwater. Seepage can form on slope faces, on the faces of retaining walls, in streets, or other low-lying areas. These conditions could lead to adverse effects such as the formation of stagnant water that breeds insects, distress or damage of trees, surface erosion, slope instability, discoloration and salt buildup on wall faces, and premature failure of pavement. Excessive watering can also lead to elevated vapor emissions within buildings that can damage flooring finishes or lead to mold growth inside the home.

Key factors that can help mitigate the potential for adverse effects of overwatering include the judicious use of water for irrigation, use of irrigation systems that are appropriate for the type of vegetation and geometric configuration of the planted area, the use of soil amendments to enhance moisture retention, use of low-water demand vegetation, regular use of appropriate fertilizers, and seasonal adjustments of irrigation systems to match the water requirements of vegetation. Specific recommendations should be provided by a landscape architect or other knowledgeable professional.

6.9.2 Utility Trenches

Trench excavations should be constructed in accordance with the recommendations contained in Section 6.1.7 of this report. Trench excavations must also conform to the requirements of Cal/OSHA.

Trench backfill materials and compaction criteria should conform to the requirements of the local municipalities. As a minimum, utility trench backfill should be compacted to at least 90 percent of the laboratory standard. Materials placed within the pipe zone (6 inches below and 12 inches above the pipe) should consist of particles no greater than ¾ inches and have a SE of at least 30. The materials within the pipe zone should be moisture-conditioned and compacted by hand-operated compaction equipment. Above the pipe zone (>1 foot above pipe), the backfill may consist of general fill materials. Trench backfill should be moisture-conditioned to slightly over the optimum moisture content, placed in lifts no greater than 12 inches in thickness, and then mechanically compacted with appropriate equipment to at least 90 percent of the laboratory standard. For trenches with sloped walls, backfill material should be placed in lifts no greater than 8 inches in loose thickness, and then compacted by rolling with a sheepsfoot roller or similar equipment. The project geotechnical consultant should perform density testing along with probing to verify that adequate compaction has been achieved.

Within shallow trenches (less than 18 inches deep) where pipes may be damaged by heavy compaction equipment, imported clean sand having a SE of 30 or greater may be utilized. The sand should be placed in the trench, thoroughly watered, and then compacted with a vibratory compactor. For utility trenches located below a 1:1 (H:V) plane projecting downward from the outside edge of the adjacent footing base or crossing footing trenches, concrete or slurry should be used as trench backfill.

6.10 PLAN REVIEW AND CONSTRUCTION SERVICES

We recommend ***Albus-Keefe & Associates, Inc.*** be engaged to review any future development plans, including foundation plans prior to construction. This is to verify that the assumptions of this report are valid and that the preliminary conclusions and recommendations contained in this report have been properly interpreted and are incorporated into the project plans and specifications. If we are not provided the opportunity to review these documents, we take no responsibility for misinterpretation of our preliminary conclusions and recommendations.

We recommend that a geotechnical consultant be retained to provide soil engineering services during construction of the project. These services are to observe compliance with the design, specifications or recommendations, and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

If the project plans change significantly from the assumed development described herein, the project geotechnical consultant should review our preliminary design recommendations and their applicability to the revised construction. If conditions are encountered during construction that appear to be different than those indicated in this report or subsequent design reports, the project geotechnical consultant should be notified immediately. Design and construction revisions may be required.

7.0 LIMITATIONS

This report is based on the proposed development and geotechnical data as described herein. The materials encountered on the project site, described in other literature, and utilized in our laboratory testing for this investigation are believed representative of the total project area, and the conclusions and recommendations contained in this report are presented on that basis. However, soil and bedrock materials can vary in characteristics between points of exploration, both laterally and vertically, and those variations could affect the conclusions and recommendations contained herein. As such, observation and testing by a geotechnical consultant during the grading and construction phases of the project are essential to confirming the basis of this report.

This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty. This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein.

This report has been prepared for the exclusive use of **National Community Renaissance** and their project consultants in the planning and design of the proposed development. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes. This report is subject to review by the controlling governmental agency.

Respectfully submitted,

ALBUS-KEEFE & ASSOCIATES, INC

Paul Hyun Jin Kim
Associate Engineer
G.E. 3106

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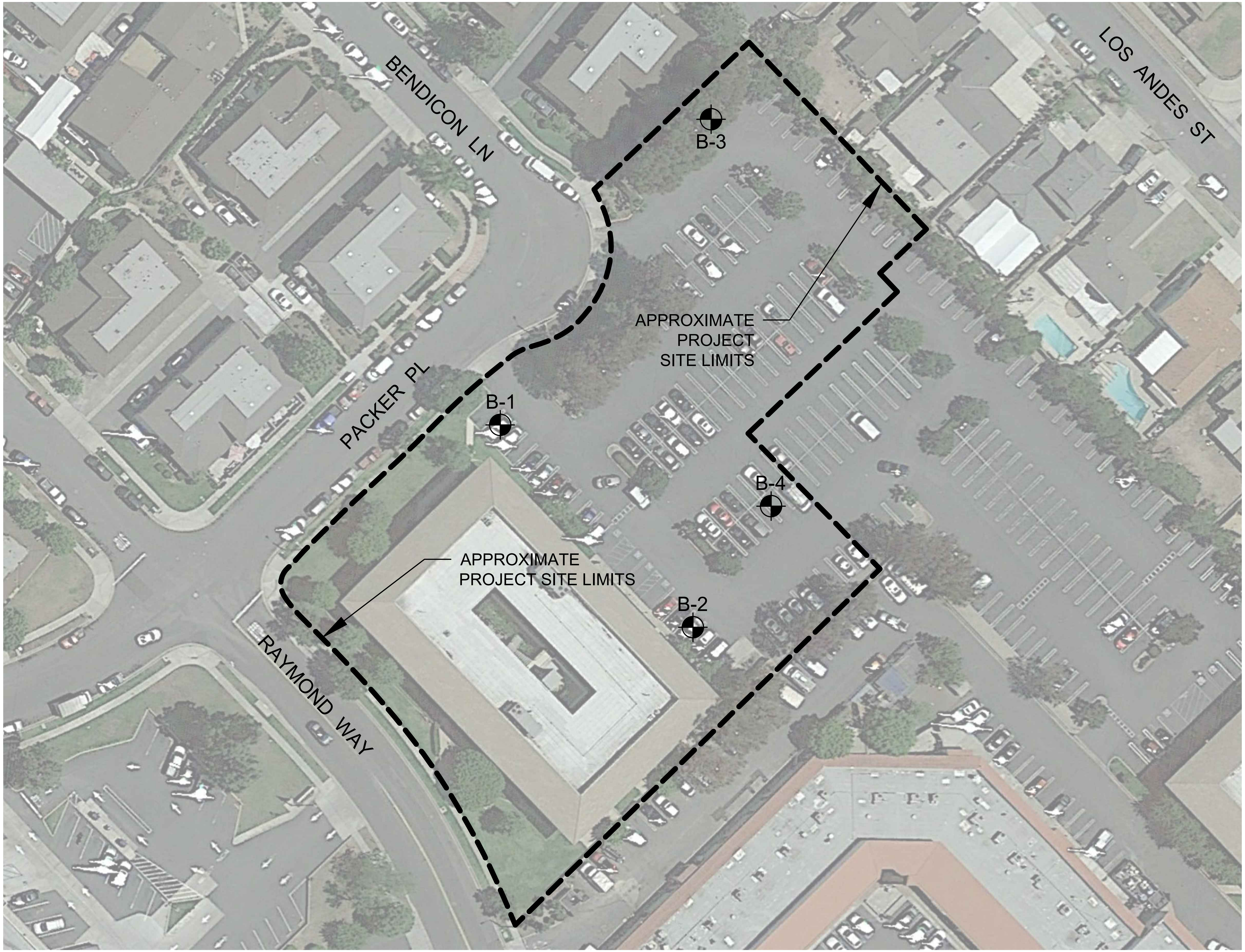

EXPLANATION
(Locations Approximate)

- Exploratory Boring

ALBUS-KEEFE & ASSOCIATES, INC.
GEOTECHNICAL CONSULTANTS

GEOTECHNICAL MAP

Job No.: 2841.00	Date: 04/20/20	Plate: 1

APPENDIX A

EXPLORATION BORING LOGS

EXPLORATION LOG

Project:		Location:
Address:		Elevation:
Job Number:	Client:	Date:
Drill Method:	Driving Weight:	Logged By:

Depth (feet)	Lith-ology	Material Description	Water	Samples			Laboratory Tests		
				Blows Per Foot	Core	Bulk	Moisture Content (%)	Dry Density (pcf)	Other Lab Tests
		EXPLANATION							
		Solid lines separate geologic units and/or material types.							
5		Dashed lines indicate unknown depth of geologic unit change or material type change.							
		Solid black rectangle in Core column represents California Split Spoon sampler (2.5in ID, 3in OD).							
		Double triangle in core column represents SPT sampler.							
10		**Vertical Lines** in core column represents Shelby sampler.							
		Solid black rectangle in Bulk column respresents large bag sample.							
15		**Other Laboratory Tests:** Max = Maximum Dry Density/Optimum Moisture Content EI = Expansion Index SO4 = Soluble Sulfate Content DSR = Direct Shear, Remolded DS = Direct Shear, Undisturbed SA = Sieve Analysis (1" through #200 sieve) Hydro = Particle Size Analysis (SA with Hydrometer) 200 = Percent Passing #200 Sieve Consol = Consolidation SE = Sand Equivalent Rval = R-Value ATT = Atterberg Limits							
20									

EXPLORATION LOG

Project: 4-Story Multi-Family Housing Development		Location: B-1
Address: 24551 Raymond Way, Lake Forest, CA 92630		Elevation: 395
Job Number: 2841.00	Client: National Community Renaissance	Date: 10/2/2019
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: SD

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		<u>Asphalt (AC):</u> Black				■			SO4 DS pH Resist Ch
		ARTIFICIAL FILL (Af) <u>Silty Sand (SM):</u> Mottled olive brown, reddish brown, and light brown, slightly moist, very dense, fine to medium grained sand, clay nodules, trace pin-hole poros		80/ 10"	■	■	11.1	116	
		@ 4 ft, light grayincreased clay content		76/ 8"	■	■	10.2	111.2	Consol
5									
		VERY OLD ALLUVIAL FAN DEPOSITS (Qvof) <u>Sandy Clay (CL):</u> Gray, moist, hard, fine grained sand		72/ 11"	■		12.8	118.2	
		<u>Clayey Sand (SC):</u> Mottled gray and reddish gray, slightly moist, very dense, fine to medium grained sand, caliche							
10		<u>Clayey Sand/ Sandy Clay (SC/CL):</u> yellowish gray, slightly moist, very dense/ hard, trace coarse grained sand, iron oxide stainings		73/ 8"	■		11		
		<u>Clayey Sand (SC):</u> Light brown, slightly moist, dense, fine to coarse grained sand, iron oxide stainings							
15		@ 15 ft, reddish brown, moist		29	⧗				SA Hydro
		<u>Clayey Sand :</u> Mottled olive brown and gray, moist, very dense, fine to coarse grained sand, increased medium grained sand, some silt inner layers, increased clay							
20				36	⧗				SA Hydro

EXPLORATION LOG

Project: 4-Story Multi-Family Housing Development		Location: B-1
Address: 24551 Raymond Way, Lake Forest, CA 92630		Elevation: 395
Job Number: 2841.00	Client: National Community Renaissance	Date: 10/2/2019
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: SD

Depth (feet)	Lithology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		@ 25 ft, caliche		43	X				
30				45	X				SA Hydro
35		@ 35 ft, , moist to very moist		56	X				
		Silty Clay/ Clayey Silt (CL/ ML-CL): Light brown, slightly moist to moist, hard, iron oxide stainings, trace magnesium oxide							
40			▽	31	X				
45				37	X				

Albus-Keefe & Associates, Inc.

EXPLORATION LOG

Project: 4-Story Multi-Family Housing Development		Location: B-1
Address: 24551 Raymond Way, Lake Forest, CA 92630		Elevation: 395
Job Number: 2841.00	Client: National Community Renaissance	Date: 10/2/2019
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: SD

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
				35					
		End of boring at depth of 51.5 ft. Groundwater encountered at depth of 41 ft. Backfilled with soil cuttings and patched with asphalt.							

EXPLORATION LOG

Project: 4-Story Multi-Family Housing Development		Location: B-2
Address: 24551 Raymond Way, Lake Forest, CA 92630		Elevation: 399
Job Number: 2841.00	Client: National Community Renaissance	Date: 10/2/2019
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: SD

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt (AC): Black							
		Gravel wth Silt and Sand (CAB): Dark brown							
		ARTIFICIAL FILL (Af) Silty Sand (SM): Light brown, moist, dense, fine to medium grained sand, some clay, iron oxide stainings, caliche		35	X		12.8	109.1	
				79	X		11.2	111.3	
5		**Very Old Alluvium fan Deposits (Qovf)** Clay (CL): Reddish brown, slightly moist, hard		81	X		6.4	124.4	
		Clayey Sand/ Sandy Clay (SC/CL): Mottled dark brown and reddish brown, slightly moist to moist, very dense/hard, trace silt, caliche							
10		Silty Clay with Sand (CL-ML): Reddish brown, moist, hard, fine to medium sand, pin-hole poros, caliche		81	X		13.5	105.6	
		Sandy Silt (ML): Light brown, slightly moist to moist, hard, some clay, caliche, trace fine grained sand							
		End of boring at depth of 11.5 ft. No groundwater encountered. Backfilled with soil cuttings.							

EXPLORATION LOG

Project: 4-Story Multi-Family Housing Development		Location: B-3
Address: 24551 Raymond Way, Lake Forest, CA 92630		Elevation: 394
Job Number: 2841.00	Client: National Community Renaissance	Date: 10/2/2019
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: SD

Depth (feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		Asphalt (AC): Black							
		Gravel with Silt and Sand (CAB): Dark brown							
		Very Old Alluvium fan Deposits (Qovf) Clayey Sand/ Sandy Clay (SC/CL): mottled brown, dark brown, reddish brown and gray, slightly moist to mosit, very dense/hard, fine to coarse grained sand, caliche, brick		72/ 8"			11.2	119.6	
5				76/ 11"			7	113	
		Silty Sand (SM): Light reddish brown, slightly moist to mosit, very dense, fine to coarse sand, some clay, iron oxide stainings, caliche, rootlets, rock fragments		57			9.9	120.1	
		@ 6 ft, dense							
		Clayey Sand (SC): Gray, slightly moist to mosi, very dense, fine to medium sand, caliche, rock fragments							
10				75/ 8"			12.1	113.6	
		Sand (SP): Light brown, moist, dense, trace clay, clay nodules							
15				31					
		End of boring at depth of 16.5 ft. No groundwater encountered. Backfilled with soil cuttings.							

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EXPLORATION LOG

Project: 4-Story Multi-Family Housing Development		Location: B-4
Address: 24551 Raymond Way, Lake Forest, CA 92630		Elevation: 401
Job Number: 2841.00	Client: National Community Renaissance	Date: 10/2/2019
Drill Method: Hollow-Stem Auger	Driving Weight: 140 lbs / 30 in	Logged By: SD

Depth (feet)	Material Description	Water	Blows Per Foot	Core	Bulk	Moisture Content (%)	Dry Density (pcf)	Other Lab Tests
	Asphalt (AC): Black							
	Gravel with Silt and Sand (CAB): Dark brown							
	Very Old Alluvium fan Deposits (Qovf) Clayey Sand with Gravel (SC): Dark gray, moist, dense, fine to coarse grained sand		62			11.9	118.9	
5	Silty Sand (SM): Dark gray, moist, very dense, fine grained sand, some gravel, rootlets, mica present, pin-hole poros		79			7.8	127.9	Consol
	@ 6 ft, medium dense		25			15.8	114.9	Consol
	Silty Sand with Clay (SM): Dark gray, moist, medium dense, trace gravel, caliche							
10			36			13.8	117	
	@ 11 ft, Light reddish browndecreased in clay content							
15	@ 15 ft, Light brownno gravel		20					
20			20					
	End of boring at depth of 21.5 ft. No groundwater encountered. Backfilled with soil cuttings.							

Albus-Keefe & Associates, Inc.

Plate A-7

APPENDIX B

LABORATORY TEST PROGRAM

LABORATORY TESTING PROGRAM

Soil Classification

Soils encountered within the exploratory borings were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D2488). The samples were re-examined in the laboratory and classifications reviewed and then revised where appropriate. The assigned group symbols are presented in the Boring Logs provided in Appendix A.

In Situ Moisture and Density

Moisture content and dry density of in-place soil materials were determined in representative strata. Test data are summarized on the Boring Logs provided in Appendix A.

Maximum Dry Density and Optimum Moisture Content

Maximum dry density and optimum moisture content of onsite soils were determined for one selected sample in general accordance with Method A of ASTM D1557. Pertinent test values are given on Table B.

Grain-Size Analyses

Grain size analyses were performed on selected samples of site materials. These tests were performed in accordance with ASTM D 422. Results are graphically presented on Plate B.

Consolidation

Consolidation tests were performed for selected soil samples in general conformance with ASTM D 2435. Axial loads were applied in several increments to a laterally restrained 1-inch-high sample. Loads were applied in geometric progression by doubling the previous load, and the resulting deformations were recorded at selected time intervals. The test samples were inundated at selected loads to evaluate the effects of a sudden increase in moisture content (hydro-consolidation potential). Results of the tests are graphically presented on Plates B-2 to B-5.

Direct Shear

The Coulomb shear strength parameters, angle of internal friction and cohesion, were determined for a bulk sample obtained from one our borings. The tests were performed in general conformance with Test Method ASTM D 3080. The sample was remolded to 90 percent of maximum dry density and at the optimum moisture content. Three specimens were prepared for each test, artificially saturated, and then sheared under varied loads at an appropriate constant rate of strain. Results are graphically presented on Plate B-6.

Expansion Potential

An Expansion Index test was performed on a selected sample in accordance with ASTM D 4829. The test result and expansion potential are presented on Table B.

Corrosion

Select samples were tested for minimum resistivity, chloride, and pH in accordance with California Test Method 643. Results of these tests are provided in Table B.

Soluble Sulfate Content

A chemical analysis was performed on a selected soil sample to determine soluble sulfate content. The test was performed in accordance with California Test Method (CTM) 417. The test result is included in Table B.

Percent Passing No. 200 Sieve

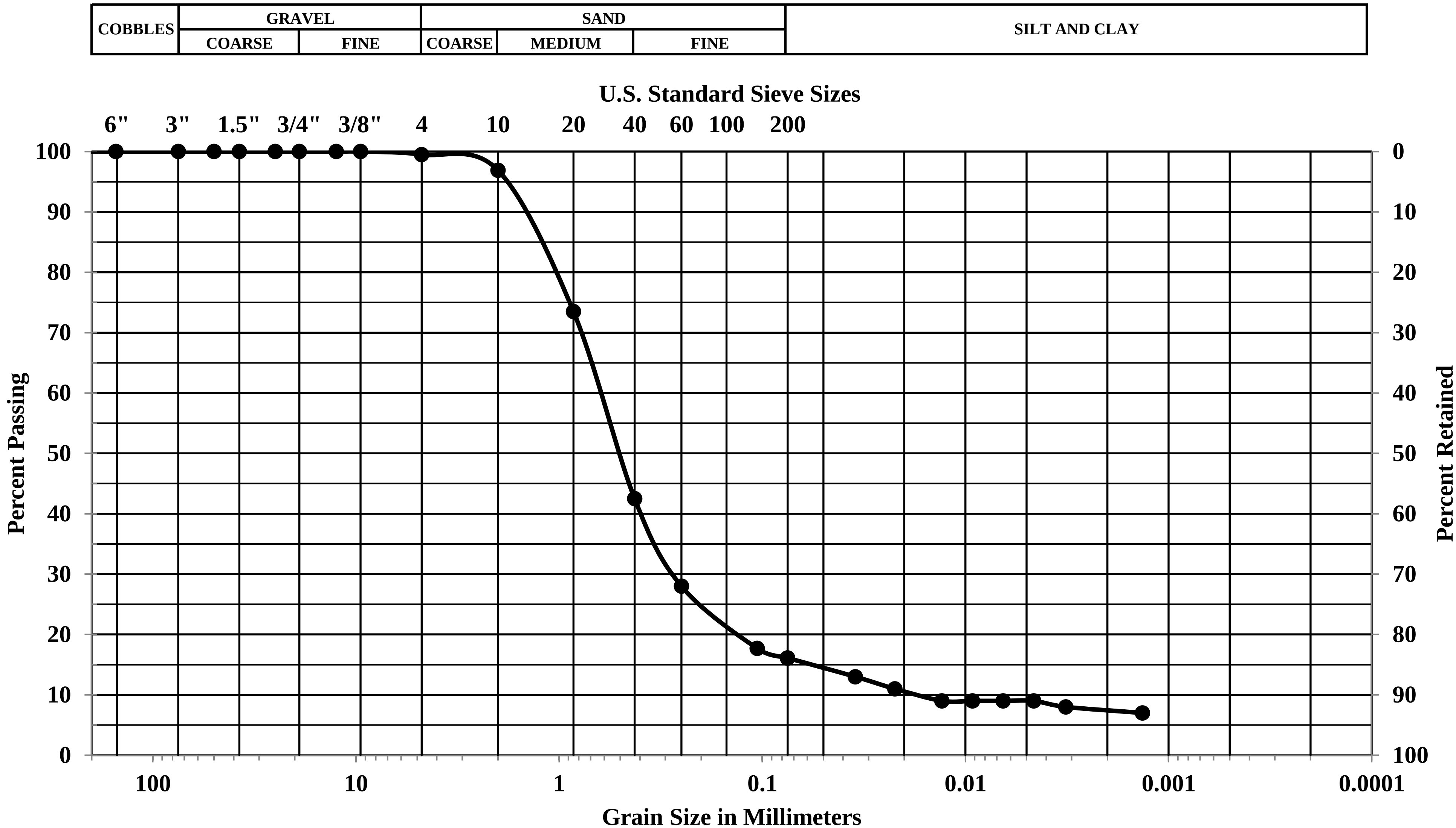
Percent of material passing the No. 200 sieve was determined on selected samples to verify visual classifications performed in the field. These tests were performed in accordance with ASTM D 1140. Test results are presented on Table B.

TABLE B
SUMMARY OF LABORATORY TEST RESULTS

Boring Number	Depth (feet)	Soil Type	Test Results	
B-1	0-5	Silty Sand (SM)	Maximum Dry Density (pcf): Optimum Moisture Content (%): Soluble Sulfate Content (%): Sulfate Exposure: pH: Minimum Resistivity: Chloride: Expansion Index: Expansion Potential:	124.5 11.0 0.000 Negligible 7.22 1700 Ohm-cm 10.0 ppm 30 Low
B-1	15	Clayey Sand (SC)	Percent Passing #200 Sieve:	16.3 %
B-1	20	Clayey Sand (SC)	Percent Passing #200 Sieve:	28.3%
B-1	30	Clayey Sand (SC)	Percent Passing #200 Sieve:	22.2%

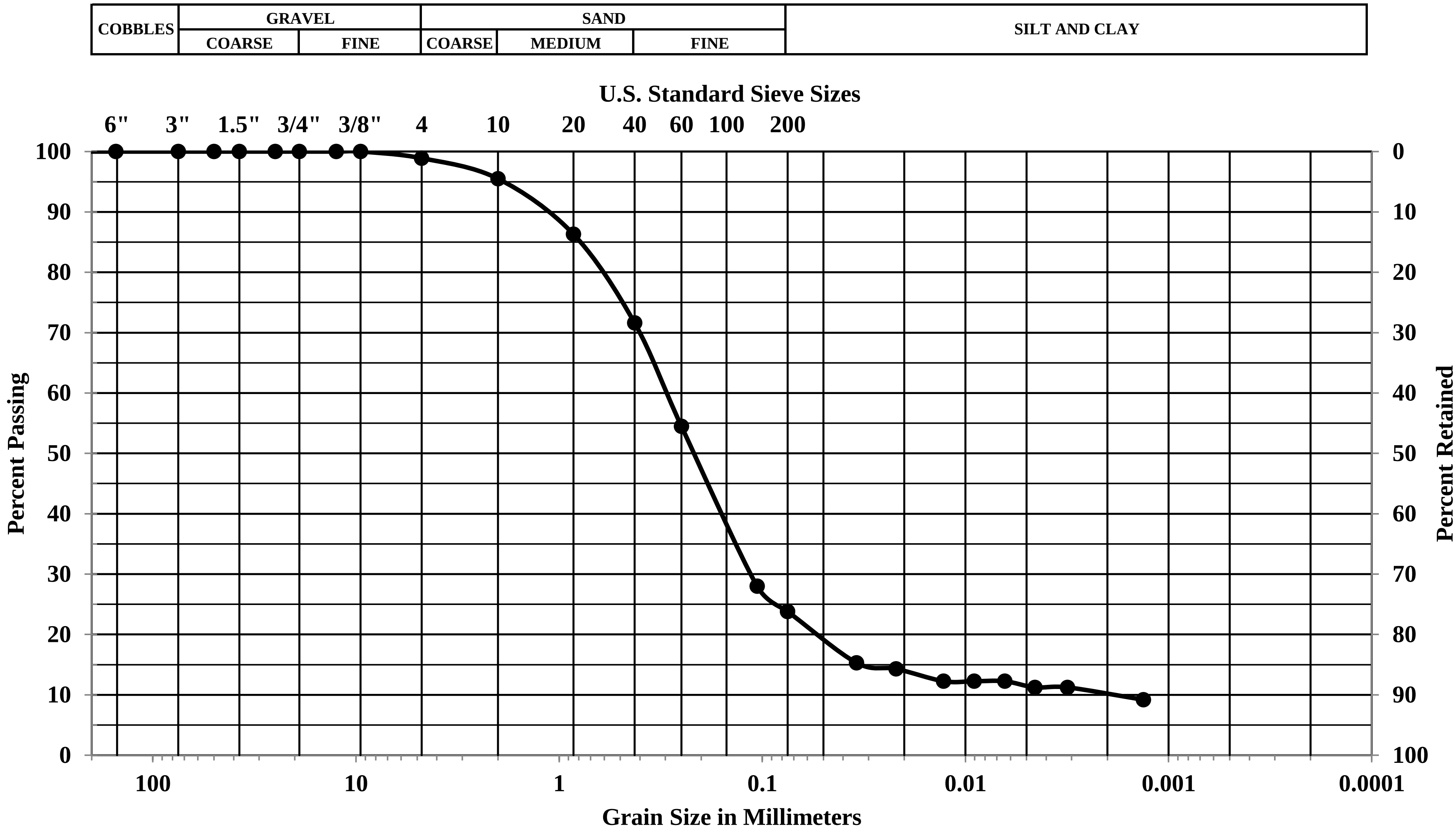
Additional laboratory test results are provided on the boring logs provided in Appendix A and on the Plates that follow.

GRAIN SIZE DISTRIBUTION



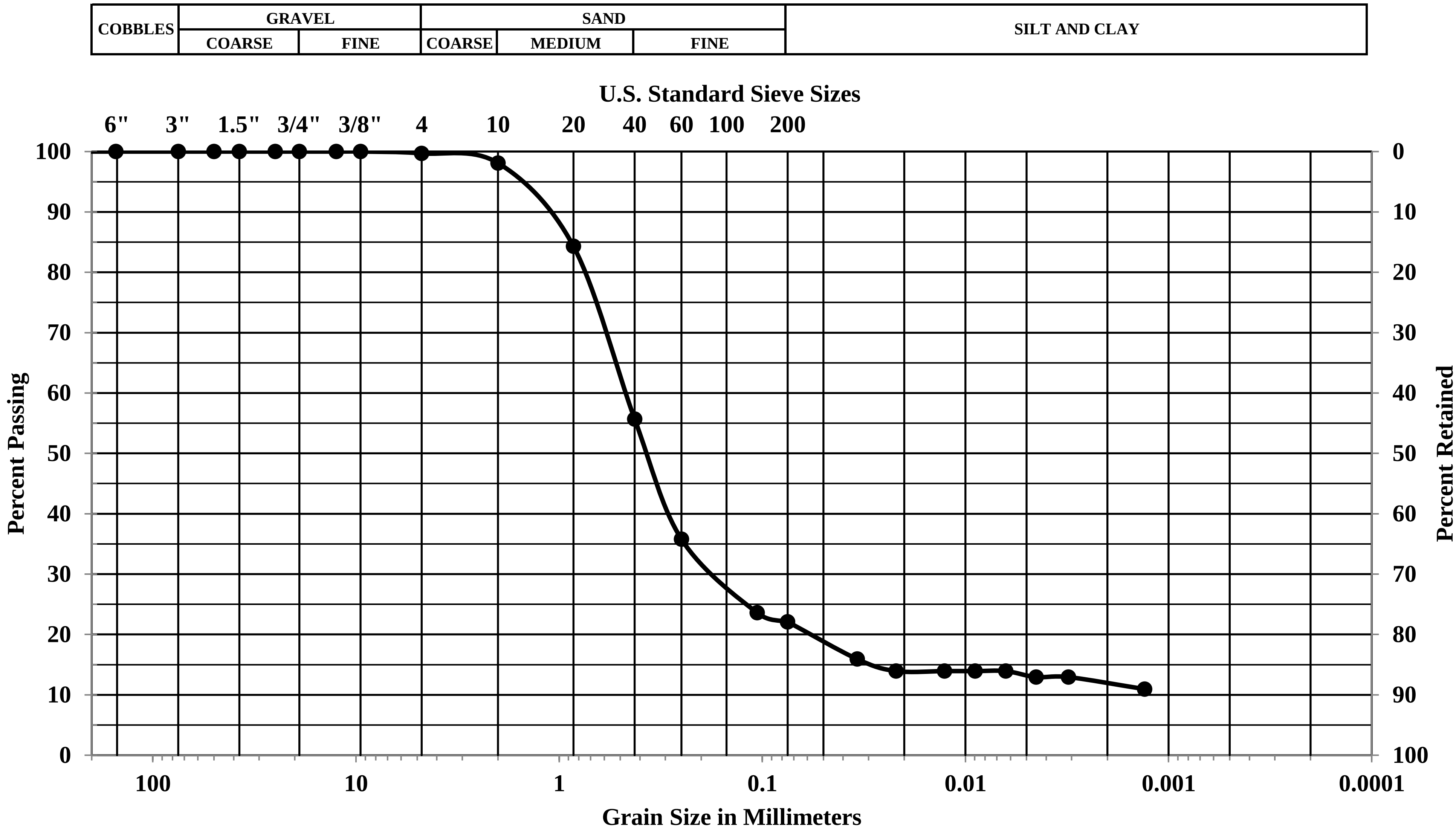
Job Number	Location	Depth	Description
2841.00	B-1	15	Clayey Sand (SC)

GRAIN SIZE DISTRIBUTION



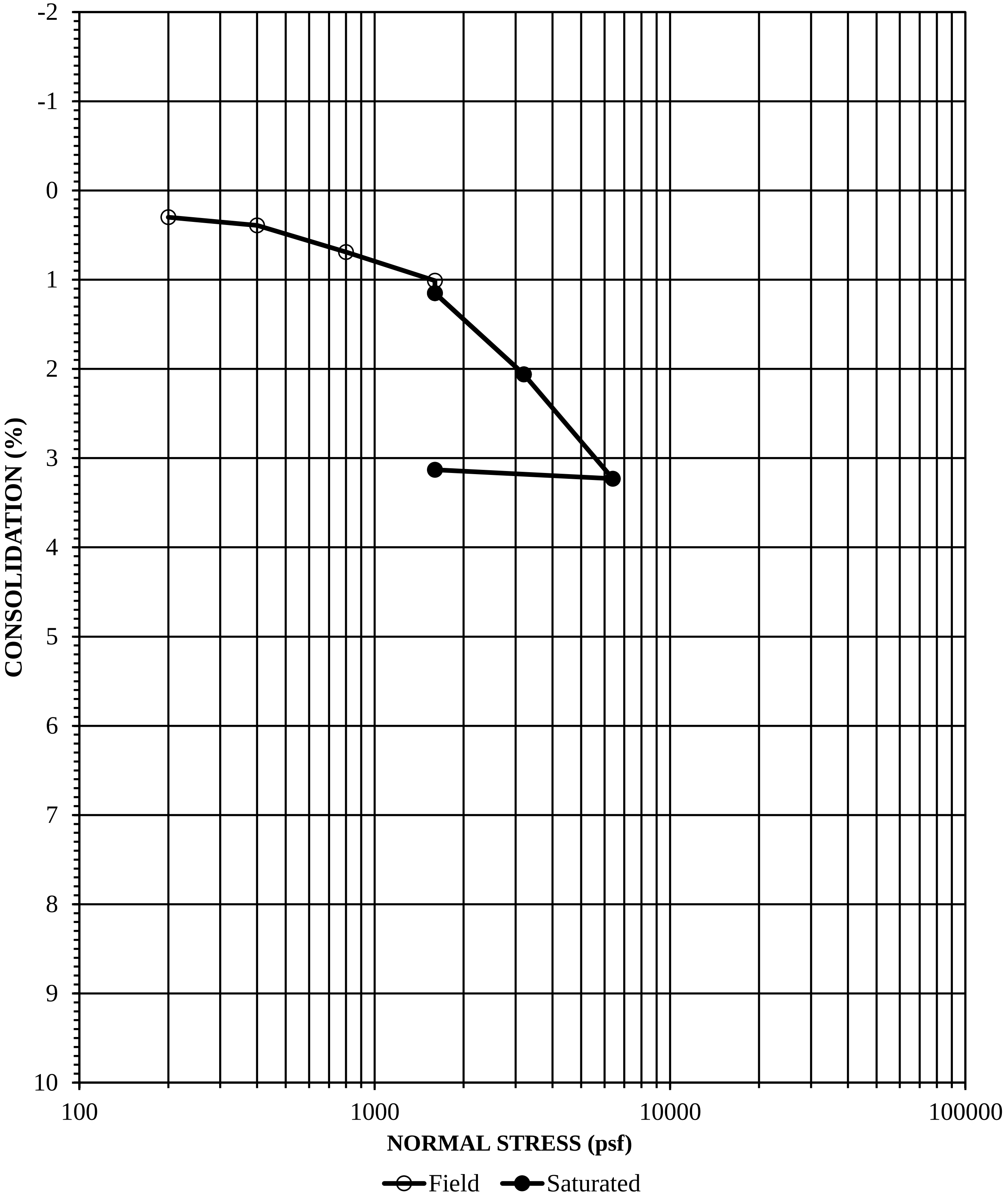
Job Number	Location	Depth	Description
2841.00	B-1	20	Clayey Sand (SC)

GRAIN SIZE DISTRIBUTION



Job Number	Location	Depth	Description
2841.00	B-1	30	Clayey Sand (SC)

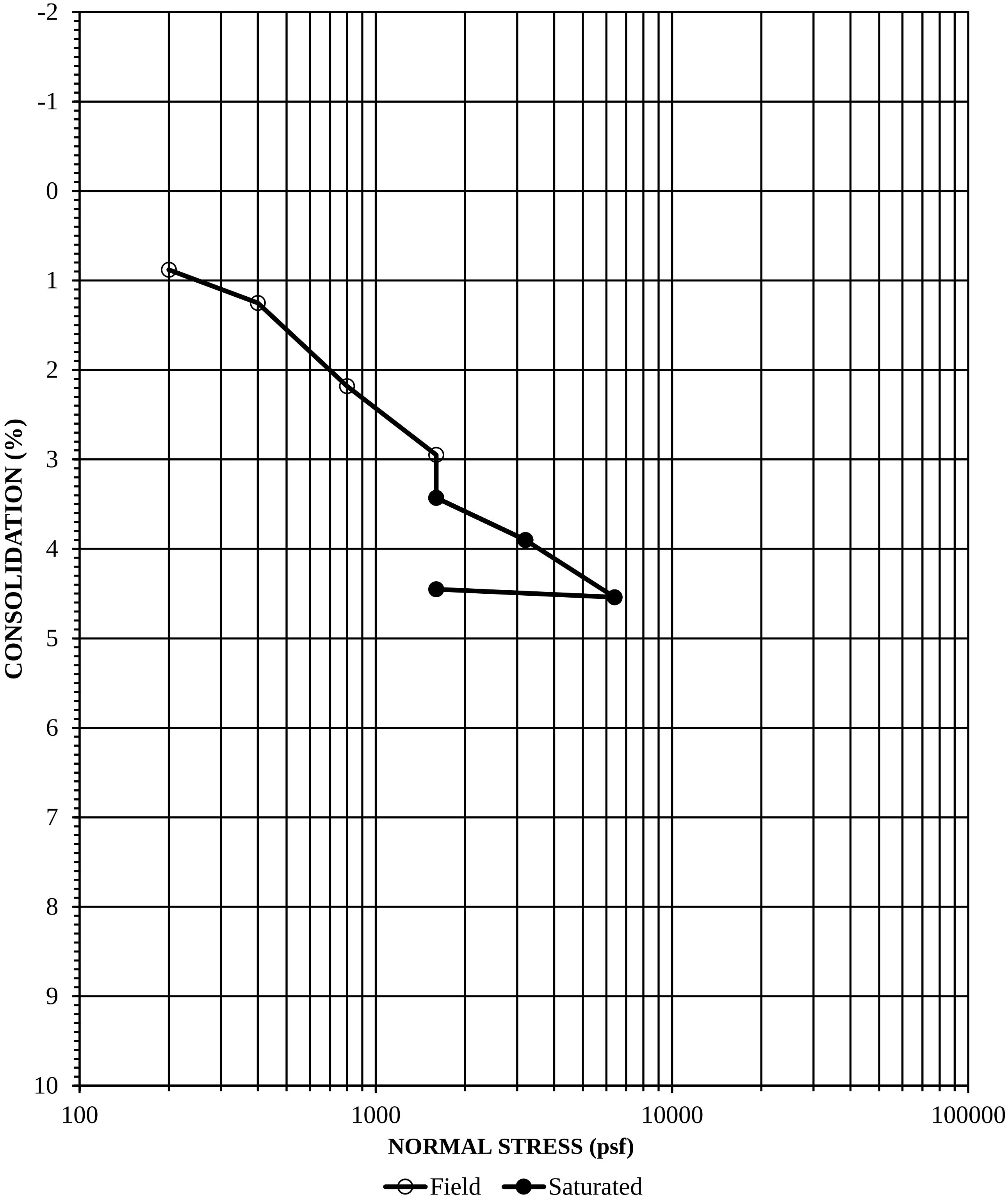
CONSOLIDATION



Job Number	Location	Depth	Description
2841.00	B-1	4	Silty Sand (SM)

Initial Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Concent (%)
117.9	10.5	12.4

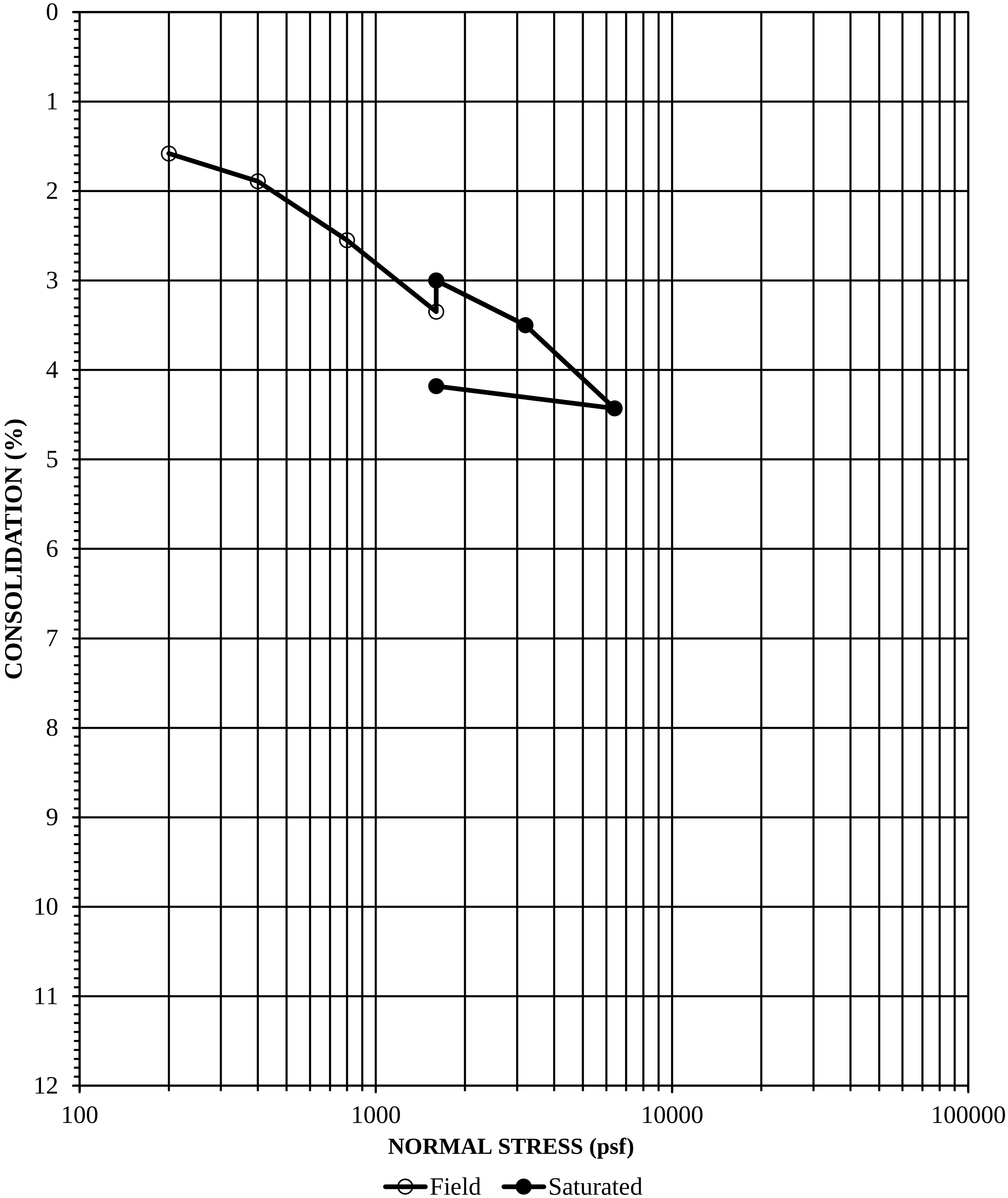
CONSOLIDATION



Job Number	Location	Depth	Description
2841.00	B-4	4	Silty Sand (SM)

Initial Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Concent (%)
123.8	9.5	9.2

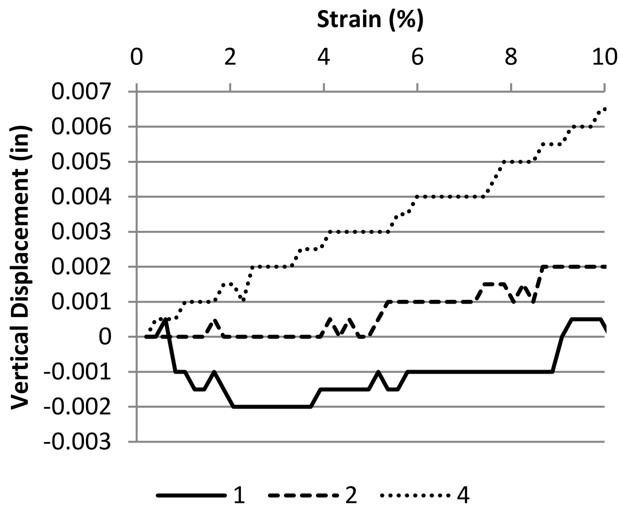
CONSOLIDATION

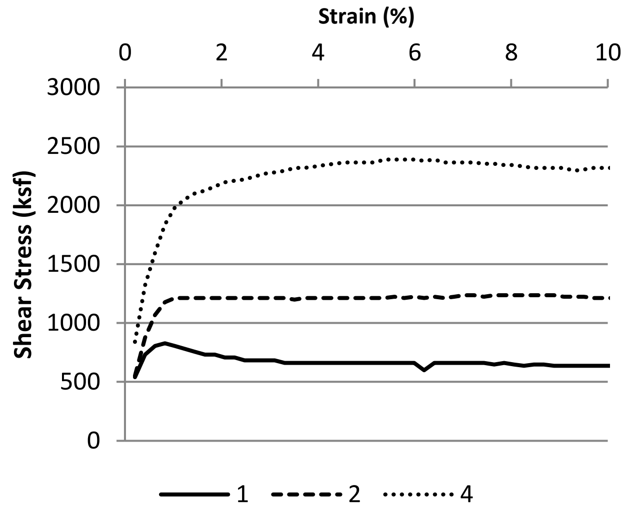


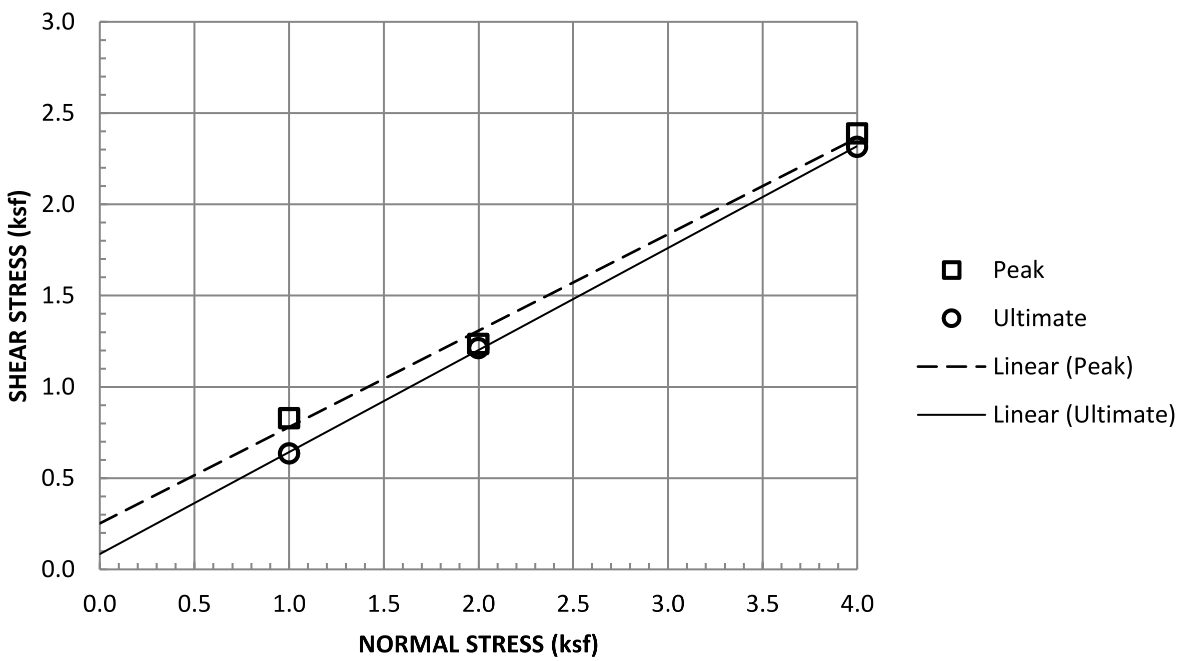
Job Number	Location	Depth	Description
2841.00	B-4	6	Silty Sand with Clay (SM)

Initial Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Concent (%)
111.2	17.3	17.2

DIRECT SHEAR







Sample Type:	Remolded 90% of 124.5 @ 11%, Saturated		
Normal Stress (ksf)	1	2	4
Peak Shear Stress (ksf)	0.828	1.236	2.388
Peak Displacement (in)	0.002	0.002	0.007
Ultimate Shear Stress (ksf)	0.636	1.212	2.316
Ultimate Displacement (in)	0.25	0.25	0.25
Initial Dry Density (pcf)	112.1	112.1	112.1
Initial Moisture Content (%)	11	11	11
Final Moisture Content (%)	14.8	15.1	15.2
Strain Rate (in/min)	0.01		

Job Number	Location	Depth	Description
2841.00	B-1	0-5	Silty Sand (SM)