

APPENDIX C:

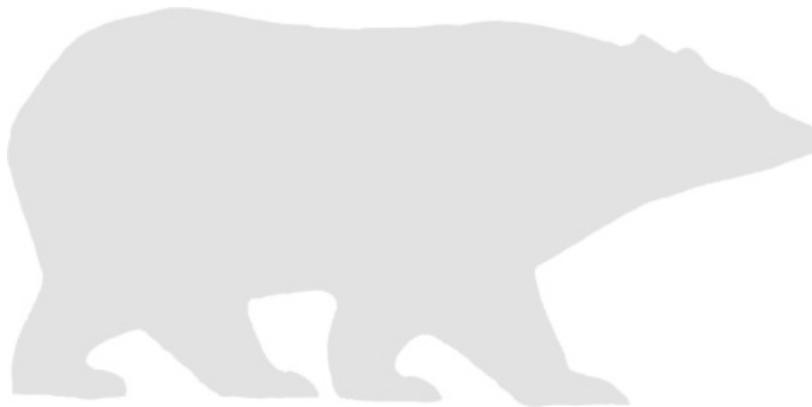
GEOTECHNICAL INVESTIGATION

Bruin Geotechnical Services, Inc.,
Geotechnical Investigation Report,
Proposed Multi-Family Apartment Complex,
Southeast Corner of Avenue R and Division Street,
Palmdale, California,
December 10, 2018.

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GEOTECHNICAL INVESTIGATION REPORT
PROPOSED
MULTI-FAMILY APARTMENT COMPLEX
SOUTHEAST CORNER OF AVENUE R
AND DIVISION STREET,
CITY OF PALMDALE, CALIFORNIA
APN 3010-030-023

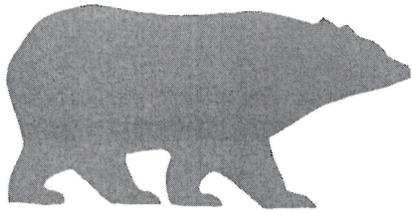
PREPARED FOR
META HOUSING CORPORATION



Prepared by:
BRUIN GEOTECHNICAL SERVICES, INC.
44732 Yucca Avenue
Lancaster, California 93534

December 10, 2018

J.N. 18-326



BRUIN GSI

**SOIL AND MATERIAL
TESTING AND INSPECTIONS**

December 10, 2018

J.N. 18-326

Mr. Scott Nakaatari
Meta Housing Corporation
11150 West Olympic Blvd., Ste. 620
Los Angeles, CA 90064

**Subject: Geotechnical Investigation Report for Proposed Multi-Family Apartment Complex Located at the Southeast Corner of Avenue R and Division Street, Palmdale, Los Angeles County, California
APN 3010-030-023**

Dear Mr. Nakaatari:

Presented herewith is the report of our Geotechnical Investigation Report for the subject project. Our work was performed in accordance with the scope of work outlined in our original proposal dated November 6, 2018.

This report presents the results of our field investigation, laboratory testing and our engineering judgment, opinions, conclusions and recommendations pertaining to the proposed development.

It has been a pleasure to be of service to you on this project. Should you have any questions regarding the contents of this report, or should you require additional information, please contact the undersigned at (661) 273-9078.

Respectfully submitted,

BRUIN GEOTECHNICAL SERVICES, INC.


Ryan D. Duke, P.E.
RDD/mes



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GEOTECHNICAL INVESTIGATION REPORT

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FIGURES

Figure 1	Vicinity Map
Figure 2	Boring Location Plan

APPENDIXES

Appendix A	Boring Logs and Classification Key
Appendix B	Laboratory Test Data
Appendix C	USGS Seismic Design Summary Report
Appendix D	General Earthwork and Grading Guidelines

**GEOTECHNICAL INVESTIGATION REPORT
MULTI-UNIT APARTMENT COMPLEX
SOUTHEAST CORNER OF AVENUE R AND DIVISION STREET
PALMDALE, CALIFORNIA
APN 3010-030-023**

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation performed by Bruin Geotechnical Services, Inc. for the proposed multi-unit residential development at the subject site based on discussions and preliminary site plans provided by the client. This report is specific to the proposed development.

The purpose of this investigation was to evaluate the on-site subsurface soil conditions relative to geotechnical engineering characteristics and to provide geotechnical recommendations relative to proposed development.

The scope of the authorized geotechnical investigation included the following tasks:

- performing a site reconnaissance
- conducting field subsurface exploration through soil borings and sampling
- laboratory testing program of selected soil samples
- performing engineering analyses of the data
- Preparing this Geotechnical Investigation Report

This study also includes a review of published and unpublished literature and geotechnical maps with respect to active and potentially active faults located in proximity to the site which may have impact on the seismic design of the proposed structure.

2.0 SITE LOCATION AND DESCRIPTION

The subject site, herein after referred to as Site, is located at the southeast corner of East Avenue R and Division Street in the city of Palmdale, Los Angeles County, California. The rectangular-shaped Site consists of approximately 4.73 acres. At the time of our investigation, the Site vegetation consisted of native desert flora consisting of a moderate covering of low weeds and bushes, with a grouping of junipers in the southeast quadrant. Evidence of brush clearing was observed along the south and east property lines, assumedly to comply with brush clearance standards required by the fire department. A dirt trail traversed the Site from southwest to northeast. The aforementioned site description is intended to be illustrative and is specifically not intended for use as a legal description of the Site.

The Site is located in a developed area of Palmdale, with single-family and multi-family developments in the vicinity of the subject site. The parcels immediately north and west were undeveloped. The parcel to the east contains a multi-family complex, and south was a single-family subdivision.

Access to the Site is from either East Avenue R or Division Street both of which are paved roads.

The Site topography is relatively flat and level with a general slope to the northeast with drainage by sheet flow at approximately one to two (1-2) percent across the Site. The elevation of the Site is approximately 2,718 feet above mean sea level near the center.

The general location of the subject site is shown on Figure 1.

3.0 PROPOSED GRADING AND CONSTRUCTION

Based on our review of the preliminary site plans and discussions, Bruin GSI understands that the structures will be two- and three-story multi-family units (apartments). We anticipate typical wood- or light gauge steel stud framing, with stucco and other light material finishes with conventional concrete continuous and isolated foundations and slab-on-grade floors. No basements are planned. We anticipate maximum structural loads of 2,000 pounds per lineal foot and 50 kips for isolated foundations.

Exterior improvements are anticipated to include concrete flatwork, landscape and hardscape areas, and asphalt-concrete parking and drive areas, as well as off-site roadway improvements. It is anticipated that the drainage will consist of sloped surfaces to drainage swales to an approved area. The proposed structures will be connected to a public sewer system and existing utilities lines from the street.

Due to the relatively flat topography, it appears the proposed earthwork will consist of conventional cut and fill methods to grade the Site, with anticipated maximum slope heights of approximately 1-2 feet to achieve design grades.

4.0 GEOTECHNICAL INVESTIGATION

The geotechnical investigation included a field subsurface exploration program and a laboratory testing program on soil samples collected. These programs were performed in accordance with our proposal for Geotechnical Investigation Report dated November 6, 2018. The scope of work did not include environmental assessment or investigation for the presence or absence of hazardous substances or toxic materials in structures, soil, surface water, groundwater or air, below or around the site. The field subsurface exploration and laboratory testing programs are described below.

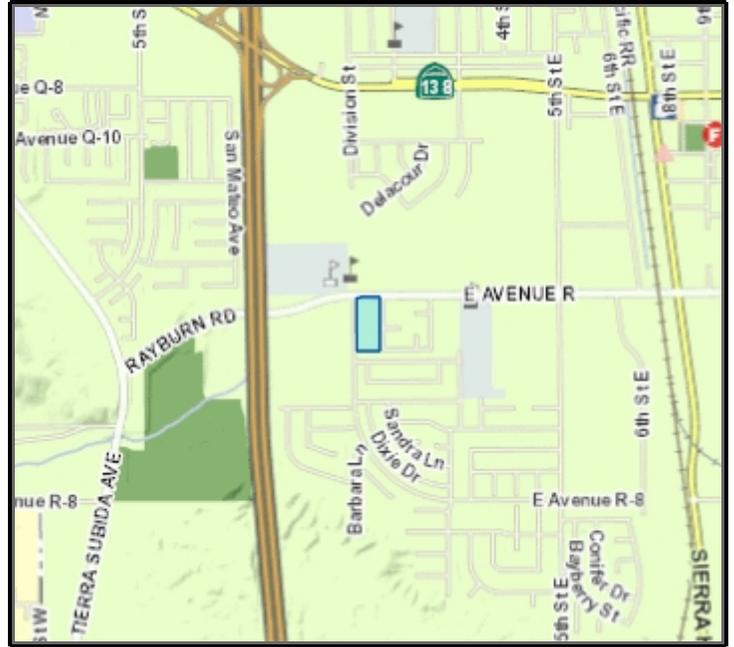
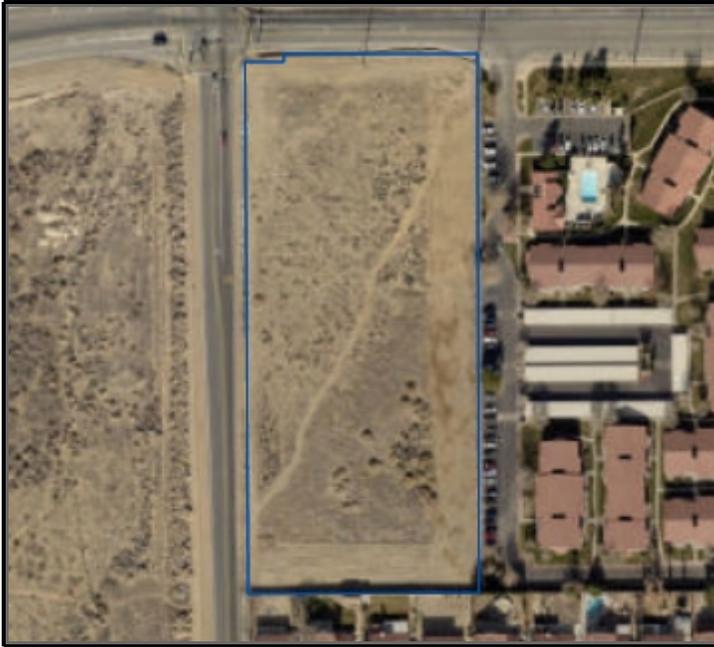
Parcel Profile Report

Report date: 11/7/2018 10:03:31 AM



APN: 3010-030-023

Address: VAC/COR AVE R/DIVISION ST PALMDALE CA 93550



Address: VAC/COR AVE R/DIVISION ST

City: PALMDALE CA

Owner:

Mailing Address:

Mailing City:

Lot Size Sq Ft: 205800

Lot Size Acres: 4.72

Legal Description:

SUB OF N 1/2 OF SEC 35 T 6N R 12W THAT PART (EX OF STS)
N OF S 60 ACS OF W 1/2 OF W 1/2 OF LOT 2

Use Code: 010V

Use Description: Single

Tax Rate Area: 07080

Transfer Date: 2003-04-11

Last Sale Date:

Last Sale Amount:

Building 1

Design Type:

Bedrooms:

Quality Class Shape:

Baths:

Year Built:

Bldg Sq Ft:

Units:

Effective Yr:

NOTE: The information and materials contained herein are provided as a public service to provide planning and zoning information for the unincorporated areas of Los Angeles County. Parcel information shown on this page is from the Assessor's Office. The County has made every reasonable effort to ensure the accuracy of the information and materials contained within.

4.1 Field Exploration Program

A site reconnaissance was made by our representative prior to instigating the field exploration program. The Site was observed and boundaries roughly located for purposes of underground utility locating. As required by law, Bruin GSI contacted Underground Service Alert (one-call notification service) to attain underground utility marking and clearance, a minimum of 72 hours prior to performing the field subsurface investigation.

The field exploration program was initiated on November 13, 2018, under the technical supervision of our engineer. A total of six (6) exploratory borings were drilled using a CME 75 drill rig with 8" hollow stem auger in accordance with generally accepted geotechnical exploration procedures (ASTM D 1452). The borings were advanced to maximum depths of thirty (30) feet below ground surface (bgs). The approximate locations of the borings within the area of the proposed construction were determined by sighting and pacing from existing site improvements, such as streets, and should be only considered accurate to the degree implied by the method used. The borings locations are shown on Figure 2.

Soil samples were obtained at various depth intervals, consisting of relatively undisturbed brass ring samples (Modified California split-spoon sampler) and Standard Penetration Test (SPT) samples driven by a 140 pound hammer falling 30 inches. After seating of the sampler, the number of blows required to drive the sampler one foot was recorded in 6-inch increments, in general accordance with procedures presented in ASTM D 1586.

Bulk samples were also collected at various depths from auger cuttings during drilling and represent a mixture of soils within the noted depths. The soil samples were returned to the laboratory for analysis and testing.

Final boring logs presented in Appendix A are Bruin GSI's interpretation of the field logs prepared by our representative during drilling, as well as laboratory test results. The stratification lines represent approximate boundaries between soil types. The actual soil transitions may be gradual.

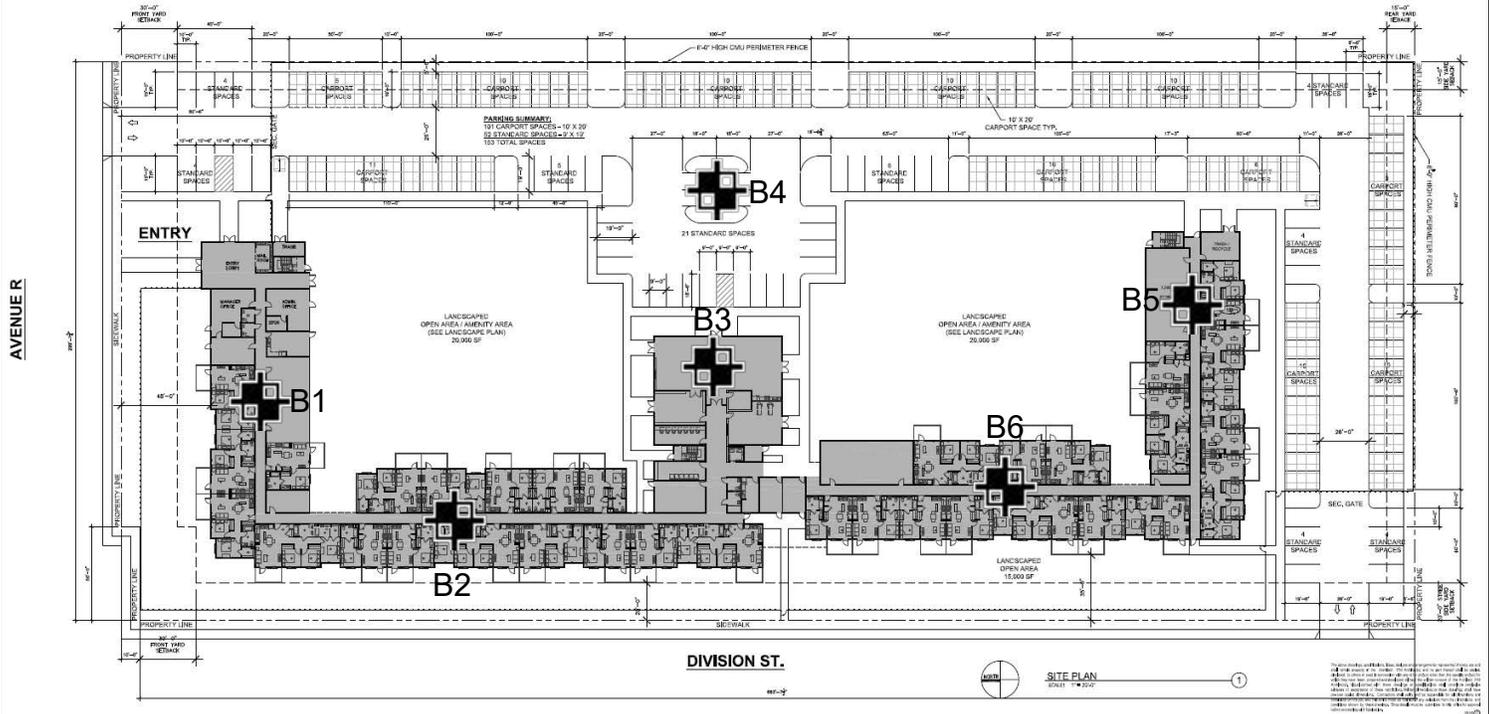
4.2 Laboratory Testing

The field boring logs and soil samples were reviewed to assess which samples would be analyzed further. The selected soil samples collected during drilling activities at the Site were then tested in the laboratory to assist in evaluating engineering properties of subsurface materials deemed within structural influence.

Boring Location Map

Figure 2

N.T.S.



= Denotes Approximate Boring Location



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Project:
Meta Housing Corporation
 Proposed Multi-Family Apartment Building
 Southeast Corner of Avenue R and Division Street,
 Palmdale, Los Angeles County, California
 APN 3010-030-023

Job Number:
 18-326

Date:
 12/10/2018

The soil samples were classified in accordance with the Unified Soils Classification System and a testing program was established. The samples were tested to determine the following:

- In-situ moisture and dry unit weight determinations were determined in accordance with ASTM D 2937.
- Relative strength characteristics were estimated from results of direct shear tests (ASTM D 3080) performed on in-situ soil samples from the ring sampler and also bulk soil samples remolded to approximately 90 percent of the maximum dry density as determined by ASTM D 1557 test method.
- Consolidation potential was determined on select soil samples in accordance with ASTM D 2435. The samples were saturated at 2.4 KSF to check hydroconsolidation potential. The maximum load applied was 4.8 KSF. The soil samples were unloaded to 1.2 KSF to check rebound.
- Soil chemical analysis on a soil sample from the site was performed by Anaheim Test Lab, which included pH, resistivity, soluble sulfates and soluble chlorides as well as other chemical contents.

The following additional tests were performed:

- | | |
|---|-------------|
| • Identification of soils | ASTM D 2488 |
| • Expansion Index | ASTM D 4829 |
| • Maximum density -Optimum moisture | ASTM D 1557 |
| • Material Finer than the No. 200 Sieve | ASTM D 1140 |
| • Sand Equivalent Value | ASTM D 2419 |

Pertinent tabular and graphic test results are presented in Appendix B.

5.0 CONCLUSIONS

The following conclusions for the site are based on the results of the field exploration and laboratory testing programs and represent professional opinions.

5.1 Site and Subsurface Conditions

Native alluvial materials were encountered within all of our exploratory borings. The soil strata encountered consisted of interbedded layers of silty sand (SM) sandy silt (ML). The native materials were noted to be slightly moist to moist and loose or soft to dense or hard. The upper five to six (5-6) feet of soils were found to be relatively loose, low relative compaction and non-uniform. For more detailed descriptions of the subsurface materials refer to the boring logs in Appendix A.

5.2 Groundwater Conditions

Groundwater was not encountered in any of our exploratory borings, at least to the maximum depth explored (30 feet bgs). Bruin GSI reviewed available reports and electronic data bases to assess historic water level conditions in the vicinity of the Site. Sources reviewed included the historically highest groundwater contours prepared by County of Los Angeles, Department of Public Works, Water Resources Division electronic database, historically highest groundwater levels in the immediate site vicinity indicate that groundwater level at the site are over 100 feet bgs. Based on this information, groundwater is not a design factor for this project.

5.3 Soil Engineering Properties

Physical tests were performed on the bulk and relatively undisturbed samples to characterize the engineering properties of the native soils.

Moisture content and dry unit weight determinations were performed on samples to evaluate the in-situ unit weights of the different materials. Of the samples analyzed, moisture contents ranged 2-15 percent. In-place dry densities ranged 82 pounds per cubic foot (pcf) to 111 pcf. Moisture content and dry unit weight results are shown on the boring logs in Appendix A.

The expansion index tests (ASTM D 4829) indicate that the surficial soils are within the “very low” expansion category.

Consolidation test results reveal that some samples tested in the upper five to six (5-6) feet of soil has a moderate to high potential to hydroconsolidate.

6.0 REGIONAL GEOLOGY AND SEISMIC HAZARDS

The project site is located in a seismically active area typical of Southern California and likely to be subjected to a strong ground shaking due to earthquakes on nearby faults.

The San Andreas Fault zone is the largest active fault rift zone, which is several miles wide, and passes through the Antelope Valley south of the subject site, extending from the Gulf of Mexico through the western portion of the State of California to a point at Cape Mendocino in northern California. The San Andreas Fault is predicted to have an event every 100-200 years based on geologic records. The San Andreas Fault has had two major eruptions in the last 150 years: 1) in the Southern California area in 1857, and 2) in San Francisco in 1906. In each event, approximately 320 kilometers of surface rupture has taken place, as well as a horizontal displacement of approximately 9 meters. Additional faulting has occurred adjacent to the San Andreas Fault causing numerous events of various magnitudes throughout the length of the San Andreas Fault.

The project site is located in an area in which active seismic occurrences are recorded on a yearly basis. Seismic studies conducted show a major break along the San Andreas Fault could be responsible for an event of approximately 8.4 on the Richter scale. A seismic event of this magnitude could cause bedrock accelerations as large as 0.5g. Events of this magnitude are anticipated to occur approximately every 150 years. The last occurrence of this magnitude was in 1857.

No known active faults have been mapped across the subject site. The potential hazards due to active fault ground rupture are considered minimal. According to current publications by the State of California, the project site is not located within the Alquist-Priolo special studies zone.

6.1 IBC Design Parameters

The following coefficients have been estimated in accordance with the requirements of the 2016 CBC, utilizing the USGS U.S. Seismic Design Maps Application:

<http://earthquake.usgs.gov/designmaps/us/application.php>

The following seismic parameters are provided, based on the approximate latitude and longitude at the southwest corner of the subject site:

Latitude	34.5705°	
Longitude	118.1291°	
Spectral Response Acceleration, Short Period) - S_s	2.661g	0.2(sec)
Spectral Response Acceleration at 1 sec. - S_1	1.270g	1.0(sec)
Mapped Spectral Response, Short period - S_{Ds}	1.774g	0.2(sec)
Mapped Spectral Response at 1 sec. - S_{D1}	1.270g	1.0(sec)
Site Coefficient – F_A	1.0	
Site Coefficient – F_V	1.5	
Site Modified Spectral Response Acceleration, Short period - S_{MS}	2.661g	
Site Modified Spectral Response Acceleration, Short period - S_{M1}	1.905g	

Site Classification (2013 CBC, further defined in ASCE7-10, Chapter 20) = D

The actual method of seismic design should be determined by the Structural Engineer.

Refer to Appendix C for the Design Maps Summary Report provided by the USGS website.

6.2 Liquefaction Potential

Liquefaction is a seismic phenomenon in which loose, saturated, granular (non-cohesive) soils react as a fluid when subject to high-intensity ground shaking. Research and historical data indicate loose granular soils with a specific range of grain size distribution, saturated by a relatively shallow groundwater table are most susceptible to liquefaction.

The effects of liquefaction on level ground include settlement, sand boils and bearing capacity failures below structures.

In view of the relatively firm silty sand and sandy silt encountered in the borings, relative densities, and depth to static groundwater (over 100 feet), it is Bruin GSI's opinion that the potential for on-site liquefaction or seismically induced dynamic settlement should be negligible. Based on our review of the Seismic Hazards Map, Ritter Ranch Quadrangle, the Site is not located in an area requiring a liquefaction analysis.

6.2.1 Other Liquefaction Associated Hazards

Potential hazards associated with liquefaction include lateral spreading and slow slides, foundation bearing failure, and ground surface settlement. Considering the upper 50 feet of the native soils are not likely to liquefy, these hazards are not considered to be design factors for this project.

6.3 Other Secondary Seismic Hazards

Seismic hazards relative to earthquakes include landslides, ground lurching, tsunamis, seiches and seismic-induced settlement. As site topography is relatively flat, hazards from landslides are considered negligible. Ground lurching is generally associated with fault rupture and liquefaction. As these hazards are considered unlikely, it is Bruin GSI's opinion that the potential for ground lurching is low. Tsunami hazards are considered nonexistent due to the site location.

6.4 Soil Settlement

Differential soil settlement occurs when supporting soils are not uniform in density or classification and seismic shaking causes one type of soil to settle more than the other. When unaccounted for in design, such settlement can result in damage to structures, pavement and subsurface utilities. Soils with potential for hydroconsolidation can also cause differential settlement under loading conditions and the induction of moisture.

Recompaction of the upper site soils is intended to remedy most potentials of settlement due to structures supported on native soils with non-uniform densities, soil classifications and hydroconsolidation.

Settlement of structures founded on compacted fill will be relatively small, less than 1". Differential settlement is anticipated to be on the order of 50 percent of the total settlement in a thirty foot span. Most settlement should take place during construction.

6.5 Erosion

The subject site drainage occurs by minor sheet flow and erosion could occur. Appropriate analysis, grading and drainage design and site maintenance should minimize the sheet flow erosion potential.

7.0 111 STATEMENT

Subsequent to compliance with the recommendations provided in this report and based on the site reconnaissance, subsurface exploration, and laboratory analysis, it is our opinion the proposed structures will be safe from hazards associated with faulting, landslides, slippage, and settlement. The proposed development will not adversely impact the existing geologic stability of adjacent sites.

8.0 EFFECT OF PROPOSED GRADING ON ADJACENT PROPERTIES

It is our opinion that the proposed grading and construction will not adversely affect the stability of adjoining properties provided that grading and construction are performed in compliance with the recommendations presented herein.

9.0 OPINIONS AND CONCLUSIONS

Based upon the results of our investigation, the proposed development is considered feasible from a geotechnical standpoint provided the recommendations presented herein are incorporated into the design and construction. If changes in the design of the structure are made or variations of changed conditions are encountered during construction, Bruin GSI should be contacted to evaluate their effects on these recommendations.

As mentioned in Section 5.3, the upper five to six feet of soil were found to be non-uniform with some areas of the site soils subject to hydroconsolidation. Based on the laboratory testing and subsurface data obtained, it is Bruin GSI's opinion that the upper site soils will not provide a uniform soil support system without remediation through recompaction. In

order to provide a more uniform soil support system and minimize the potential for differential settlement, the proposed structures should be supported by a recompacted fill mat.

Provide the recommendations in this report are incorporated into the design and construction, it is Bruin GSI's opinion that conventional shallow (continuous and isolated) foundations may be designed to support the proposed structures. Refer to Section 11.2 for details and soil values regarding foundation design.

10.0 GEOTECHNICAL RECOMMENDATIONS

The following geotechnical engineering recommendations for the proposed development are based on observations from the field investigation program and the laboratory test results and our experience with sites of similar conditions.

The local Department of Building and Safety should be contacted prior to start of construction to assure the project is properly permitted and inspected during construction. Any grading performed at the site shall be in compliance with the recommendations provided in this report, the local building code and the Earthwork and Grading Specifications for Rough Grading presented in Appendix D.

Field observations and testing during rough-grading operations should be provided by Bruin GSI so a decision can be formed regarding the adequacy of the site preparation, the acceptability of fill materials, and the extent to which the earthwork construction and the degree of compaction comply with the project geotechnical specifications. **Any work related to grading performed without the full knowledge of, and under the supervision of the Geotechnical Consultant, may render the recommendations of this report invalid.**

10.1 Earthwork

Prior to any grading, the site should be cleared and grubbed of all vegetation. All pavements, vegetation, trash, debris and abandoned underground utilities shall be removed from the area to be graded and should not be incorporated into engineered fill.

Any depressions resulting from removals during grubbing process (trees etc.) shall be observed by the Geotechnical Consultant. Depressions requiring backfill within structural areas will require placement of engineered fill, observed and tested by the Geotechnical Consultant.

It is our professional opinion that the grading of the site can be performed with conventional earth-moving equipment.

10.2 Remedial Grading for Building Pads

To provide a more uniform bearing for the proposed structure foundations, slab-on-grade and structural retaining walls and, subsequent to clearing and grubbing of the area to be graded, the existing native soils shall be excavated to a depth of sixty (60) inches below existing grade or finish grade, whichever is lower. The excavation shall extend a minimum of five (5) feet beyond the limits of the proposed foundations, where obtainable. The bottom of the excavation shall be a level elevation.

The Geotechnical Consultant shall inspect the resulting surfaces prior to scarification and fill placement. A minimum of twenty four (24) inches of compacted fill is required beneath the proposed foundations.

Subsequent to approval of the resulting surface by the Geotechnical Consultant, the resulting soil surface shall be scarified (ripped) an additional twelve (12) inches, properly moisture conditioned or aerated to near optimum moisture content, and mechanically compacted with heavy compaction equipment to 90% relative compaction as determined by ASTM D 1557 test method. **Compaction shall be verified by testing.**

10.3 Remedial Grading for Flexible (Asphalt-Concrete) and Rigid (PCC) Pavement

Subsequent to clearing and grubbing the area to be graded, the existing native soils shall be excavated twelve (12) inches below existing grade or finish grade, whichever is lower. The exposed surface shall be scarified (ripped) an additional twelve (12) inches. The excavation shall extend a minimum of three (3) feet beyond the limits of the proposed pavement, where obtainable. The Geotechnical Consultant shall inspect the resulting surfaces prior to fill placement.

Subsequent to approval of the resulting surface by the Geotechnical Consultant, the resulting soil surface shall be properly moisture conditioned or aerated to near optimum moisture content, and mechanically compacted with heavy compaction equipment to 90% relative compaction (95% relative compaction beneath proposed PCC pavement in the upper twelve inches) as determined by ASTM D 1557 test method. **Compaction shall be verified by testing.**

10.4 Remedial Grading and Exterior Non-Traffic Bearing Concrete Flatwork (Sidewalks, Patios, Walkways, etc.)

Subsequent to clearing and grubbing the area to be graded, the existing native soils shall be excavated six (6) inches below existing grade or finish grade, whichever is lower. The exposed surface shall be scarified (ripped) an additional twelve (12)

inches. The excavation shall extend a minimum of two (2) feet beyond the limits of the proposed flatwork, were obtainable. The Geotechnical Consultant shall inspect the resulting surfaces prior to fill placement.

Subsequent to approval of the resulting surface by the Geotechnical Consultant, the resulting soil surface shall be properly moisture conditioned or aerated to near optimum moisture content, and mechanically compacted with mechanical compaction equipment to 90% relative compaction as determined by ASTM D 1557 test method. **Compaction shall be verified by testing.**

10.5 Fill Placement and Compaction Requirements

The excavated native soils may be used as engineered fill to backfill the excavation. Materials for engineered fill should be free of organic material, debris, and other deleterious substances, and should not contain rocks greater than 6 inches in maximum dimension.

All native soil shall be moisture conditioned or air dried as necessary to achieve near optimum moisture condition, placed in lifts (eight to ten inches, measured loose) and then compacted in place by mechanical compaction equipment to a minimum relative compaction of 90 percent (95% beneath PCC pavement) as determined in accordance with Test Method ASTM D 1557.

All import soil fill (meeting the requirements of Section 10.7) should be placed in 8-inch-thick maximum lifts measured loose, moisture conditioned or air dried as necessary to near optimum moisture condition, and then compacted in place to a minimum relative compaction of 90 percent (95% beneath PCC pavement) as determined in accordance with Test Method ASTM D 1557.

A representative of the project consultant should be present on-site during grading operations to verify proper placement and compaction of all fill, as well as to verify compliance with the other geotechnical recommendations presented herein.

10.6 Native Soil Shrinkage

A shrinkage factor of the upper site soils is estimated at fifteen to twenty (15-20) percent. This estimate is based on the limited data collected from the subsurface exploration and laboratory test data with an average degree of compaction of 92 percent and may vary depending on contractor methods.

During compaction, an additional one-half of an inch (1/2") subsidence of the underlying soil is estimated. Losses from site clearing and grubbing operations mat

effect quantity calculations and should be taken into account. Actual shrinkage of the soil may vary.

We recommend monitoring the rough grading excavations by survey with comparison to grading contractor earthwork yardage estimates to determine a closer estimate of actual shrinkage so adjustments (if necessary) may be made during grading.

10.7 Fill Slope Construction and Stability

Provided all material is properly compacted as recommended, fill slopes may be constructed at a 2:1 (horizontal to vertical) gradient or flatter. Permanent cut slopes may be constructed at 2:1 or flatter. Fill slopes constructed as recommended at a slope ratio not exceeding 2:1 (horizontal: vertical), are expected to be both grossly and surficially stable and are expected to remain so under normal conditions.

Proper drainage should be planned so water is not allowed to flow over the tops of slopes. The slopes should be planted as soon as possible to minimize erosion and maintenance.

If slopes are planned steeper than 2:1, the Geotechnical Consultant shall be notified for slope stability determinations.

10.8 Imported Soils

If imported soils are required to complete the planned grading, these soils shall be free of organic matter and deleterious substances, meeting the following criteria:

- 100% passing a 2-inch sieve
- 60% to 100% passing the #4 sieve
- no more than 20% passing a #200 sieve
- expansion index less than 20
- liquid limit less than 35
- plasticity index less than 12
- R-value greater than 40
- Low corrosion potential
 - Soluble Sulfates less than 1,500 ppm
 - Soluble Chlorides less than 150 ppm
 - Minimum Resistivity greater than 8,000 ohm-cm

Prospective import soils should be observed, tested and pre-approved by this firm prior to importing the soils to the site. Final approval of the import soil will be given

once the material is on site either in place or adequate quantities to finish the grading.

10.9 Grading Observations and Testing

The grading of the site shall be observed and tested by the Geotechnical Consultant to verify compliance with the recommendations. Any grading performed without full knowledge of the Geotechnical Consultant may render the recommendations of this report invalid.

11.0 POST-GRADING AND DESIGN CONSIDERATIONS

11.1 Pad Drainage

A surface drainage system consisting of a combination of sloped concrete flatwork, swales and sheet flow gradients in landscape areas, and roof gutters and downspouts should be designed for the site. The roof gutters and downspouts should also be tied directly into the proposed area drain system. Drainage from structures should be designed at minimum 2% gradient to approved areas. The purpose of this drainage system will be to reduce water infiltration into the subgrade soils and to direct surface waters away from building foundations, walls and slope areas.

Concrete flatwork surfaces and paved sloped surfaces should be inclined at a minimum gradient of 1 percent away from the building foundations and similar structures. A minimum 12-inch-high berm should be maintained along the top of the descending slope to prevent any water from flowing over the slope.

The owner is advised that all irrigation and drainage devices should be properly maintained throughout the lifetime of the development.

11.2 Foundation Design Recommendations

The proposed structure shall be constructed on a conventional concrete foundation system. Provided the recommendations in this report are incorporated into site development, foundation for load bearing walls and interior columns constructed on compacted certified fill may be designed as follows:

11.2.1 Allowable Bearing Capacity

Continuous Foundations Design Values: An allowable “net” bearing capacity of 1,800 p.s.f. for two-story structures and 2,200 p.s.f. for three-story structures can be utilized for dead and sustained live loads. This value includes a minimum safety factor of three, and may be increased by 1/3 for total loads, including seismic forces.

Continuous foundations for two- and three-story structures should be embedded a minimum of eighteen inches and twenty four inches, respectively, below lowest adjacent soil elevation and be a minimum of fifteen inches in width for two-story structures and eighteen inches in width for three-story structures. Reinforcement shall consist of a minimum of two #4 bars, one top and one bottom. Actual depth, width, and reinforcement requirements for continuous foundations will be dependent on the Expansion Index of the bearing soils, applicable sections of the governing building code and requirements of the structural engineer.

The allowable bearing capacity for continuous foundations may be increased by 200 psf for each additional six inches of foundation depth and 200 psf for each additional one foot of foundation width. The allowable bearing capacity should not exceed 3,000 p.s.f. for continuous foundations to keep estimated settlements within allowable limits.

Isolated Pad (Column or Pier) Foundations Design Values: An allowable “net” bearing capacity of 2,200 p.s.f. for single-story structures and 2,600 p.s.f. for three-story structures and can be utilized for dead and sustained live loads. This value includes a minimum safety factor of three, and may be increased by 1/3 for total loads, including seismic forces.

Isolated foundations should be a minimum of twenty four inches square inches and embedded a minimum of twenty four inches for two-story structures and thirty inches for three-story structures below lowest adjacent soil elevation. Actual depth, width, and reinforcement requirements for continuous foundations will be dependent on the Expansion Index of the bearing soil, applicable sections of the governing building code and requirements of the structural engineer.

The allowable bearing capacity for continuous foundations may be increased by 250 psf for each additional six inches of foundation depth and 100 psf for each additional one foot of foundation width. The allowable bearing capacity should not exceed 3,000 p.s.f. for continuous foundations to keep estimated settlements within allowable limits.

11.2.2 Lateral Load Resistance

Lateral load resistance for the spread footings will be developed by passive soil pressure against sides of footings below grade and by friction acting at the base of the concrete footings bearing on compacted fill. An allowable passive pressure of 300 Z PSF, where Z = Depth (in feet) below finish grade. In passive pressure calculations, the upper one foot of soil should be subtracted from the depth, Z, unless confined by pavement or slab. An appropriate safety factor should be used for design calculations.

Friction along the foundation base may provide resistance to lateral loading. The coefficient of friction was estimated to be 0.30 for site soils compacted to 90% of the maximum dry density as determined by ASTM D 1557 test method, and may be used for dead load forces and includes a reduction factor of 1/3.

For design of building foundations, passive resistance may be combined with frictional resistance provided that a one-third reduction in the coefficient of friction is used.

11.2.3 Footing Reinforcement

Reinforcement for footings should be designed by the structural engineer based on the anticipated loading conditions and expansion index of the supporting soil. Preliminary expansion index for the native soil is categorized as "very low" as determined by ASTM D 4829. Footings should be reinforced with a minimum of two No. 4 bars, one top and one bottom.

11.2.4 Footing Observations

All footing trenches should be observed by a representative of the project geotechnical consultant to verify that they have been excavated into competent soils prior to placement of forms, reinforcement or concrete. The excavations should be trimmed neat, level and square. All loose, sloughed or moisture-softened soils and/or any construction debris should be removed prior to placing of concrete. **Excavated soils derived from footing and/or utility trenches should not be placed in building slab-on-grade areas or exterior concrete flatwork areas unless the soils are compacted to at least 90 percent of maximum dry density.**

11.2.5 Foundation Setbacks

Footings of structures (including retaining walls) located above a slope having a total height of 10 feet or less should have a minimum setback of 5 feet, measured from the outside edge of the footing bottom along a horizontal line to the face of the slope. For footings above slopes having a total height greater than 10 feet, the setback should be, at minimum, equal to one third of the total height of the slope but need not exceed 40 feet. Refer to the IBC Table 1805.3.1.

11.3 RETAINING WALLS AND STRUCTURES BELOW GRADE

The project may include shallow retaining walls or walls below grade (i.e. loading docks, light standards, flagpoles or similar structures supporting soil materials. These walls are anticipated to be shallow (i.e., approximately 10 feet or less in height). Design lateral earth pressures, backfill criteria, and drainage recommendations for walls below grade are presented.

11.3.1 Lateral Earth Pressures

	Driving Earth Pressure*	Resisting Earth Pressure*
Well-drained soil	40	300***
Well-drained soil (2:1 backfill)	50	
At-rest (restrained wall)	62**	

*Equivalent fluid pressure (PSF) per foot of soil height

**For design purposes, a wall is considered restrained if it prevented from movement greater than 0.002H (H= height of wall in feet) at the top of the wall.

***The upper one foot of soil should be subtracted from the depth, Z, unless confined by pavement or slab. This is an ultimate value.

Note: The pressures recommended above are based on the assumption that the backfill will be compacted to 90% of the maximum dry density. The use of select may lower the recommended driving earth pressure. The revisiting

pressure provided is an ultimate value. An appropriate factor of safety is recommended.

Friction acting along the base of the foundation may provide resistance to lateral loading. The coefficient of friction is estimated to be 0.30 for native soils compacted to 90% of the maximum dry density, and may be used with dead loads. This value may be increase by 1/3 for total loads, including seismic forces. Frictional and passive resistance may be combined without reduction.

The above values are for retaining walls that have been supplied with a proper subdrain system. All walls should be designed to support any adjacent structural surcharge loads imposed by other nearby walls, footings or vehicular traffic within a distance approximately equal to the height of the wall.

Retaining walls over six feet in height may need to be designed for a seismic load force that is applied to the static forces when the seismic shaking occurs. The geotechnical consultant should be contacted for retaining walls over six feet in height

11.3.2 Wall Backfill

Backfill behind shallow retaining walls or walls below grade should consist of non-expansive granular materials. Wall backfill should not contain organic material, rubble, debris, and rocks or cemented fragments larger than 3 inches in greatest dimension. In the case where no shoring was used, the granular backfill should extend outward from the base of the wall to ground surface at a 1:1 (horizontal: vertical) slope. The geotechnical consultant should be allowed the opportunity to sample and test and comment about the adequacy of the proposed imported backfill material once adequate quantities to complete the project are on site.

Backfill should be placed in lifts not exceeding 8 to 10 inches in thickness measured loose, moisture conditioned to above optimum moisture content and mechanically compacted with hand-operated equipment to minimum 90 percent of the maximum dry density as determined by ASTM D 1557. Walls below grade that are not free to deflect should be properly braced prior to placement and compaction of backfill. **Compaction should be verified by testing.**

11.3.3 Drainage and Waterproofing

It is recommended that waterproofing be provided behind the retaining walls to help reduce efflorescent formation.

Walls designed for drained earth pressures shall have adequate drainage provided behind the walls. Subdrains or weep holes at the base of the walls shall be incorporated into design. Wall backdrains shall be designed by a registered Civil Engineer.

12.0 CORROSION AND CHEMICAL ATTACK

Soluble sulfate, pH, resistivity and chloride concentration test results are presented in Appendix B. The Resistivity (CTM 643) test results on a bulk soil sample from the site indicated that on-site soils are corrosive when in contact with ferrous material (5,000 ohm-cm).

Corrosion test results also indicate that the surficial soils at the site have negligible sulfate attack potential (65 ppm) on concrete, according to the ACI 318 Table 4.3.1. Type II cement should be used in all concrete that may be in contact with the on-site soils.

Based on the preliminary chemical analysis performed on a sample of the native soil, foundation concrete shall consist of type II cement with a minimum compressive strength of 2,500 psi as indicated in the ACI 318 Table 4.3.1. A higher compressive strength may be required by the structural engineer. Additional soil chemical analysis during grading is recommended. The minimum concrete compressive strength should be determined by the structural engineer.

The chemical test results should be distributed to the project design team for their interpretations pertaining to the corrosivity or reactivity of the construction materials (ferrous metals, and piping). Chemical test results performed on a bulk soil sample obtained during the field investigation are presented in Appendix C.

13.0 EXCAVATIONS

It is Bruin GSI's opinion that standard construction techniques should be sufficient for site excavations. All excavations should be made in accordance with applicable regulations, including CAL/OSHA for and OSHA type "C" soil. Project safety is the contractor's responsibility and the owner. Bruin GSI will not be responsible for project safety.

The attention of contractors, particularly the underground contractors, should be drawn to the State of California Construction Safety Orders for "Excavations, Trenches, and

Earthwork.” Trenches or excavations greater than five (5) feet in depth should be shored or sloped back in accordance with OSHA Regulations prior to entry.

Open excavations, unshored or unshored (above the groundwater level) may be cut vertically to a maximum depth of no more than five feet. Excavations higher than five feet should be sloped back at a minimum 1.5:1 (horizontal to vertical) slope or flatter or shored. Sloughing will occur if the soil is dry or dries out while open. No excavation should be made within a 1:1 line projected outward from the toe of any existing foundation or structure.

No heavy equipment or other surcharge loads (i.e. excavation spoils) should be allowed within the top of slope a distance equal to the depth of the excavation, both measured from the top of the excavation.

Soil backfill around foundations or behind walls below grade should be placed in lifts not exceeding eight to ten inches, measured loose, moisture conditioned to near optimum moisture content and uniformly mechanically compacted to minimum 90% relative compaction as determined by ASTM D 1557 test method. Flooding or jetting is not recommended.

14.0 UTILITY TRENCHES AND BACKFILL

Standard construction techniques should be sufficient for site utility trench excavations. Utility trenches often settle even when backfill is placed under optimum conditions.

Trench backfill shall be moisture conditioned to near optimum moisture content, placed in lifts not exceeding eight to ten inches, measured loose, and uniformly compacted to minimum 90% of the maximum dry density with mechanical compaction equipment. **No flooding or jetting is not recommended.**

Backfill of public utilities within road right-of-ways or on the subject site should be placed in strict conformance with the requirements of the governing agency. As a minimum it is recommended that utility trench backfill should be moisture conditioned to near optimum moisture content, placed in lifts not exceeding eight to ten inches, measured loose, (depending on means of compaction) and uniformly compacted to minimum 90% of the maximum dry density with mechanical compaction equipment. If aggregate base is used for backfill material, it should be moisture conditioned to near optimum moisture content, placed in eight to ten inch lifts, measured loose, and uniformly compacted to minimum 95% of the maximum dry density using mechanical compaction equipment. **Compaction should be verified by testing.**

For purposes of this section of the report, “bedding” is defined as material placed in a trench up to one (1) foot above a utility pipe, and “backfill” is all material placed in the

trench above the bedding. Unless concrete bedding is required around utility pipes, free-draining sand should be used as bedding. Sand proposed for use as bedding should be tested in our laboratory to verify its suitability and measure its compaction characteristics. **Sand bedding should be compacted by mechanical means to achieve at least 90% relative compaction based on ASTM D 1557.**

Backfill operations should be observed and tested by the Geotechnical Consultant to monitor compliance with these recommendations.

Where utility trenches enter the footprint of the building, trenches should be backfilled through their entire depths with on-site fill materials, sand-cement slurry, or concrete rather than with any sand or gravel shading. This "Plug" of less- or non-permeable materials will mitigate the potential for water to migrate through the backfilled trenches from outside of the building to the areas beneath the foundations and floor slabs.

The backfill soil should be moisture conditioned to near optimum moisture content, placed in lifts not exceeding eight to ten inches, measured loose, (depending on means of compaction) and uniformly compacted to minimum 90% of the maximum dry density with mechanical compaction equipment.

15.0 INTERIOR CONCRETE SLAB-ON-GRADE

It should be understood that as a manufactured product, concrete will crack even under ideal conditions. It is our experience that shrinkage is more pronounced in the Antelope valley due to environmental conditions (high winds, daily extreme temperature differences and low humidity). Appropriate mix designs, placement procedures and concrete curing methods should be planned and implemented during construction in order to reduce the occurrence and magnitude of concrete shrinkage cracking.

Interior slab-on-grade construction should be supported by at five feet of compacted soil, prepared as recommended in Section 10.2 of this report.

15.1 Vapor Barrier and Water Proofing

It is recommended that a vapor retarded/waterproofing be placed below the concrete slab on grade. Vapor/moisture transmission through slabs does occur and can impact various components of the structure.

Vapor retarded/waterproofing designing and inspection of installation is not the responsibility of the geotechnical engineer (most often the responsibility of the architect). Bruin Geotechnical Services, Inc. does not practice in the field of water and moisture vapor transmission evaluation/mitigation. Therefore, we recommend that a qualified person/firm be engaged/consulted to evaluate the general and

specific water and moisture vapor transmission paths and any impact on the proposed development. This person/firm should provide recommendations for mitigation of potential adverse impact of water and moisture vapor transmission on various components of the structure ad deemed necessary. The actual waterproofing design shall be provided by the architect, structural engineer or contractor with experience in waterproofing.

In order to promote good building practices and alert the rest of the design/construction team of the appropriate standards and expect recommendations pertaining to vapor barriers/retarders, engineers (especially those aware of the issues surrounding blow-slab moisture protection and its effect on the success of their projects) should consider recommending and citing specific performance characteristics. The following paragraph includes criteria from the latest standards and expert recommendations and should be considered for use in your firm's own recommendations:

Vapor barrier shall consist of a minimum 15 mil extruded polyolefin plastic (no recycled content of woven materials permitted). Permeance as tested before and after mandatory conditions (ASTM E 17455 Section 7.1 and Sub-Paragraph 7.1.1-7.1.5): less than 0.01 perms [grains/(ft²-hr-inHg)] and comply with the ASTM E1745 Class A requirements. Install vapor barrier according to ASTM E1643, including proper perimeter seal. Basis of design: Stego Wrap Vapor Barrier 15 mil and Stego Crete Claw Tape (perimeter seal tape). Approved Alternatives: Vaporguard by Reef Industries, Sundance 15 mil Vapor Barrier by Sundance Inc.

The vapor barrier shall be covered with 2 inches of clean sand to aid in curing and prevent puncture. The sand shall be moistened prior to concrete placement.

15.2 Thickness and Joint Spacing

Concrete slab-on-grade should be at least 4 inches thick and provided with frequent construction joints or expansion joints. The slab-on-grade should have a minimum compressive strength of 2,500 psi at 28 days. More stringent requirements may be required by the structural engineer.

15.3 Reinforcement

Reinforcement of the slab-on-grade is contingent on the structural engineer's recommendations and the Expansion Index of the supporting soil. As a minimum, reinforcement should consist of No. 3 bars spaced 18 inches on center, both ways. The reinforcement should be positioned near the middle of the slabs by means of concrete chairs or brick. Additional reinforcement may be required by the structural engineer

15.4 Subgrade Preparation

As further measure to minimize cracking of concrete flatwork, the subgrade soils and all utility line trenches below concrete slab-on-grade areas should first be compacted to a minimum relative compaction of **90 percent** and then thoroughly moistened to achieve a moisture content that is near optimum moisture content. **A representative of the project geotechnical consultant should observe and verify the density and moisture content of the soils, and the depth or moisture penetration prior to pouring concrete.**

16.0 EXTERIOR CONCRETE FLATWORK (PATIOS, WALKWAYS, SIDEWALKS, etc.)

It should be understood that as a manufactured product, concrete will crack even under ideal conditions. It is our experience that shrinkage is more pronounced in the Antelope valley due to environmental conditions (high winds, daily extreme temperature differences and low humidity). Appropriate mix designs, placement procedures and concrete curing methods should be planned and implemented during construction in order to reduce the occurrence and magnitude of concrete shrinkage cracking.

Exterior slab-on-grade construction should be supported by at least 18 inches of compacted soil, prepared as recommended in Section 10.4 of this report. At locations where slabs cross trenches, observation and testing of trench backfill should be performed to confirm uniformity of conditions.

16.1 Thickness and Joint Spacing

To reduce the potential of unsightly cracking, concrete sidewalks, patio-type slabs should be at least 4 inches thick and provided with frequent construction joints or expansion joints, especially at area of re-entrant corners, to help control cracking. Exterior perimeter slabs should be designed relatively independent of the foundation stems (free-floating) to help cracking due to settlement and /or expansion.

16.2 Reinforcement

Reinforcement of the exterior slab-on-grade is contingent on the structural engineer's recommendations and the Expansion Index of the supporting soil. As a minimum, reinforcement should consist of No. 3 bars spaced 24 inches on center, both ways. The reinforcement should be positioned near the middle of the slabs by means of concrete chairs or brick. Additional reinforcement may be required by the structural engineer.

16.3 Subgrade Preparation

As further measure to minimize cracking of concrete flatwork, the subgrade soils below concrete flatwork areas should first be compacted to a minimum relative compaction of 90 percent and then thoroughly moistened to achieve a moisture content that is near optimum moisture content. Pre-wetting of the soils to a depth of six inches a maximum of 24 hours prior to concrete placement will promote uniform curing of the concrete and minimize the development of shrinkage cracks. **A representative of the project geotechnical consultant should observe and verify the density and moisture content of the soils, and the depth or moisture penetration a maximum of 24 hours prior to pouring concrete.**

17.0 RIGID (PCC) PAVEMENT

It should be understood that as a manufactured product, concrete will crack even under ideal conditions. It is our experience that shrinkage is more pronounced in the Antelope valley due to environmental conditions (high winds, daily extreme temperature differences and low humidity). Appropriate mix designs, placement procedures and concrete curing methods should be planned and implemented during construction in order to reduce the occurrence and magnitude of concrete shrinkage cracking.

Exterior slab-on-grade construction should be supported by at least 24 inches of compacted soil, prepared as recommended in Section 10.3 of this report. At locations where slabs cross trenches, observation and testing of trench backfill should be performed to confirm uniformity of conditions.

17.1 Thickness and Joint Spacing

To reduce the potential of unsightly cracking, rigid concrete pavement should be at least five inches thick (six inches thick in heavy truck areas) and provided with frequent construction joints or expansion joints, especially at area of re-entrant corners, to help control cracking. Perimeter pavement should be designed relatively independent of the foundation stems (free-floating) to help cracking due to settlement and /or expansion

17.2 Reinforcement

Reinforcement of the exterior pavement is contingent on the structural engineer's recommendations and the Expansion Index of the supporting soil. As a minimum, reinforcement should consist of No. 3 bars spaced 18 inches on center, both ways. The reinforcement should be positioned near the middle of the slabs by means of concrete chairs or brick. Additional reinforcement may be required by the structural engineer.

17.3 Subgrade Preparation

As further measure to minimize cracking of concrete flatwork, the upper twelve inches of subgrade soils below concrete flatwork areas should first be compacted to a minimum relative compaction of 95 percent and then thoroughly moistened to achieve a moisture content that is near optimum moisture content. Pre-wetting of the soils to a depth of six inches a maximum of 24 hours prior to concrete placement will promote uniform curing of the concrete and minimize the development of shrinkage cracks. **A representative of the project geotechnical consultant should observe and verify the density and moisture content of the soils, and the depth or moisture penetration a maximum of 24 hours prior to pouring concrete.**

18.0 PRELIMINARY FLEXIBLE PAVEMENT DESIGN

Asphalt-concrete pavements shall be designed per the Caltrans Highway Design Manual based on R-Value and Traffic Index. An R-value of the native soil of 13 was utilized for the preliminary structural pavement section. During grading as soils are mixed, soil samples should be obtained and tested for R-Value determination.

For pavement design, the preliminary flexible pavement layer thickness is as follows:

RECOMMENDED ASPHALT PAVEMENT SECTION LAYER THICKNESS

Pavement Material	Recommended Thickness (TI = 10.0) Major Arterial (Ave. R & Division Street)
Asphalt Concrete	6"
Class II Aggregate Base (R=78)	9"
Compacted Sub-base (R=50)	13"
Compacted Subgrade	24"

Pavement Material	Recommended Thickness (TI = 6.0) On-site Parking
Asphalt Concrete	3 ½"
Class II Aggregate Base (R=78)	6"
Compacted Sub-base (R=50)	8"
Compacted Subgrade	24"

Asphalt concrete should conform to Sections 203 and 302 of the latest edition of the Standard Specifications for Public Works Construction ("Greenbook").

Class II aggregate base should conform to Section 26 of the Caltrans Standard Specifications, latest edition. The sub-base should have a minimum R-value of 50. The aggregate base and sub-base material should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Method D 1557.

19.0 CONSTRUCTION CONSIDERATIONS

Based on our field exploration program, earthwork can be performed with conventional construction equipment.

19.1 Temporary Dewatering

Groundwater was not encountered in any of our borings to the maximum depth of our explorations. Based on the anticipated excavation depths, the need for temporary dewatering is considered low.

19.2 Construction Slopes

Excavations during construction should be conducted so that slope failure and excessive ground movement will not occur. The short-term stability of excavation depends on many factors, including slope angle, engineering characteristics of the subsoils, height of the excavation and length of time the excavation remains unsupported and exposed to equipment vibrations, rainfall and desiccation.

Where spacing permits, and providing that adjacent facilities are adequately supported, open excavations may be considered. In general, unsupported slopes for temporary construction excavations should not be expected to stand at an

inclination steeper than 1:1 (horizontal: vertical). The temporary excavation side walls may be cut vertically to a height of 3 feet and then laid back at a 1:1 slope ratio above a height of 3 feet.

Surcharge loads (equipment, spoil piles, etc.) should be kept away from the top of temporary excavations a horizontal distance equal to the depth of excavation. Surface drainage should be controlled along the top of temporary excavations to preclude wetting of the soils and erosion of the excavation faces. Even with the implementation of the above recommendations, sloughing of the surface of the temporary excavations may still occur, and workmen should be adequately protected from such sloughing.

19.3 Temporary Shoring

If shoring is considered, Bruin GSI should be notified in order to provide appropriate design parameters.

20.0 ADDITIONAL SERVICES

Final project plans and specifications should be reviewed prior to construction to confirm that the full intent of the recommendations presented herein have been applied to design and construction. This report is based on the assumption that an adequate testing and inspection program along with client consultation will be performed during final design and construction phases to verify compliance with the recommendations of this report.

Retaining Bruin GSI as the geotechnical consultant to provide additional services from preliminary design through project completion will assure continuity of services.

Additional services include:

- Consultation during design stages of the project.
- Review, stamp and signature of the grading and building plans.
- Observation and testing during rough grading, fine grading and trench backfill as well as placement of engineered fill.
- Consultation as required during construction.

Cost estimates can be prepared if requested. Please contact our office.

21.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report is based on the development plans provided to our office. If structure design changes or structure locations changes occur, the conclusion and recommendations in this report may not be considered valid unless the changes are reviewed and the conclusions of this report are modified or approved by the Geotechnical Consultant.

The subsurface conditions and characteristics described herein have been projected from individual borings or test pits placed across the subject property. Actual variations in the subsurface conditions and characteristics may occur.

If conditions encountered during construction differ from those described in this report, this office should be notified so as to consider the necessity for modifications. No responsibility for construction compliance with the design concepts, specifications, or recommendations is assumed unless on-site construction review is performed during the course of construction, which pertains to the specific recommendations contained herein.

It is recommended that Bruin GSI be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design specifications. If Bruin GSI is not accorded the privilege of making this recommended review, Bruin GSI can assume no responsibility for misinterpretation of the recommendations contained in this report.

This report has been prepared in accordance with generally accepted practice and standards in this community at this time. No warranties, either expressed or implied, are made as to the professional advice provided under the terms of the agreement and included in this report. This report has been prepared for the exclusive use of Meta Housing Corporation and their authorized agents. Unauthorized reproduction of any portion of this report without expressed written permission is prohibited.

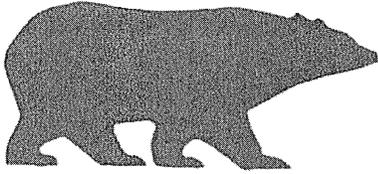
If parties other than Bruin GSI are engaged to provide construction geotechnical services, they must be notified that they will be required to assume complete responsibility for the geotechnical phase of the project by concurring with the findings and recommendations in this report or providing alternate recommendations.

22.0 CLOSURE

The conclusions, recommendations, and opinions presented herein are: (1) based upon our evaluation and interpretations of the limited data obtained from our field and laboratory programs; (2) based upon an interpolation of soil conditions between and beyond the borings; (3) are subject to confirmation of the actual conditions encountered during construction; and, (4) are based upon the assumption that sufficient observation and testing will be provided during the grading, infrastructure installation and building phases of site development.

APPENDIX A

Boring Logs and Classification Key



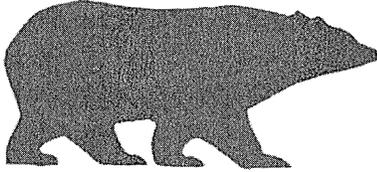
Bruin Geotechnical Services
 44732 Yucca Avenue
 Lancaster, CA 93534
 (661) 273-9078

Log of Boring 1

Sheet 1 of 1

Project: Mete Housing Corp.	Project Location: Ave R & Division St.	Project number: 18-326
Date(s) drilled: 11/13/18	Logged By: AM	Checked By: MS
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8"	Total Depth of Borehole: 20' bgs
Drill Rig Type: CME 75	Drilling Contractor: Choice Drilling	Hammer Data: 140#, 30" drop
Ground-water: None Encountered	Sampling Method(s): CSS	Notes:
Borehole Backfill: Native/ Cuttings	Location: See Figure 2	

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
0' - 5'		ML		Light brown fine to medium sandy silt w/ occ. coarse sand Soft, moist	8-10	90.1	12.4
5' - 10'		ML		Light brown fine to medium sandy silt Soft, moist	6-10	87.5	12.1
10' - 15'		ML		Light brown fine to medium sandy silt Soft, moist	11-16	82.7	11.1
15' - 20'		SM		Light brown slightly silty fine to coarse sand w/ #4 gravel & occ. 1/2" gravel Dense, slightly moist	11-18	110.6	2.8
20' - 25'		ML		Light brown fine sandy silt Firm, moist	6-11		
25' - 30'		ML		Brown fine to medium sandy silt w/ occ. #4 gravel Soft, slightly moist	9-11	90.9	6.6
30' - 35'		SM		Brown slightly silty fine to coarse sand w/ occ. #4-1/2" gravel Medium dense, moist	6-10	105.9	3.4
35' - 40'				Boring terminated @ 20' bgs No groundwater No caving			



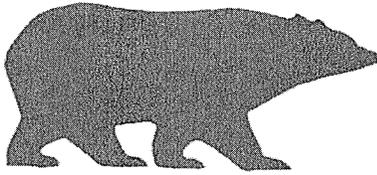
Bruin Geotechnical Services
 44732 Yucca Avenue
 Lancaster, CA 93534
 (661) 273-9078

Log of Boring 2

Sheet 1 of 1

Project: Mete Housing Corp.	Project Location: Ave R & Division St.	Project number: 18-326
Date(s) drilled: 11/13/18	Logged By: AM	Checked By: MS
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8"	Total Depth of Borehole: 15' bgs
Drill Rig Type: CME 75	Drilling Contractor: Choice Drilling	Hammer Data: 140#, 30" drop
Ground-water: None Encountered	Sampling Method(s): CSS	Notes:
Borehole Backfill: Native/ Cuttings	Location: See Figure 2	

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
5'		SM/ML	[Pattern]	Light brown very silty fine to medium sand w/ occ. coarse sand Medium dense, dry	8-9	99.2	4.2
		ML	[Pattern]	Light brown fine sandy silt w/ occ. coarse sand Very soft, slightly moist	6-8	83.0	5.2
		ML	[Pattern]	Light brown fine to medium sandy silt Firm, moist	8-12		
10'		SM/ML	[Pattern]	Brown very silty fine to medium sand w/ occ. coarse sand Medium dense, moist	6-9	89.3	5.3
		SM/ML	[Pattern]	Brown very silty fine to medium sand w/ coarse sand & occ. #4 gravel Medium dense, moist	6-11	106.3	7.9
15'		SM	[Pattern]	Brown very silty fine to medium sand w/ coarse sand & occ. #4 gravel Medium dense, moist	6-7	91.6	6.1
20'				Boring terminated @ 15' bgs No groundwater No caving			
25'							
30'							



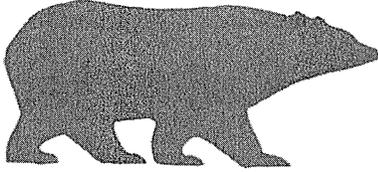
Bruin Geotechnical Services
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 Lancaster, CA 93534
 (661) 273-9078

Log of Boring 3

Sheet 1 of 1

Project: Mete Housing Corp.	Project Location: Ave R & Division St.	Project number: 18-326
Date(s) drilled: 11/13/18	Logged By: AM	Checked By: MS
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8"	Total Depth of Borehole: Refusal @ 9' bgs
Drill Rig Type: CME 75	Drilling Contractor: Choice Drilling	Hammer Data: 140#, 30" drop
Ground-water: None Encountered	Sampling Method(s): CSS	Notes:
Borehole Backfill: Native/ Cuttings	Location: See Figure 2	

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
		SM/ML		Light brown fine to medium sandy silt w/ occ. coarse sand Firm, dry	6-7	83.8	6.1
5'		SM/ML		Brown fine to medium sandy silt w/ occ. coarse sand Firm, moist	4-6	84.7	8.1
		SM		Brown very silty fine to medium sand w/ occ. coarse sand (cemented) Dense, moist	50/4"	97.7	6.4
10'		SM		Brown silty fine to mediums and w/ coarse sand & occ. #4 gravel Medium dense, slightly moist	50/2"	106.7	2.8
15'				Boring Refusal @ 9' bgs No groundwater No caving			
20'							
25'							
30'							



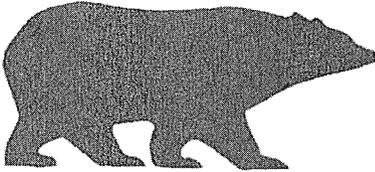
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Log of Boring 4

Sheet 1 of 1

Project: Mete Housing Corp.	Project Location: Ave R & Division St.	Project number: 18-326
Date(s) drilled: 11/13/18	Logged By: AM	Checked By: MS
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8"	Total Depth of Borehole: 10' bgs
Drill Rig Type: CME 75	Drilling Contractor: Choice Drilling	Hammer Data: 140#, 30" drop
Ground-water: None Encountered	Sampling Method(s): SPT	Notes:
Borehole Backfill: Native/ Cuttings	Location: See Figure 2	

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
5'		SM/ML	[Pattern]	Light brown very silty fine to medium sand w/ occ. coarse sand Loose, slightly moist	3-4-4		4.1
		ML	[Pattern]	Brown fine to medium sandy silt Firm, moist	2-4-4		13.5
		ML	[Pattern]	Brown fine to medium sandy silt Firm, moist	3-3-3		12.4
		ML/CL	[Pattern]	Brown fine to medium sandy silt w/ clay binder Firm, very moist	3-3-4		14.6
10'		SM	[Pattern]	Brown very silty fine to medium sand w/ coarse sand & occ. 3/8" gravel Loose, moist	3-3-6		6.8
15'				Boring terminated @ 10' bgs No groundwater No caving			
20'							
25'							
30'							



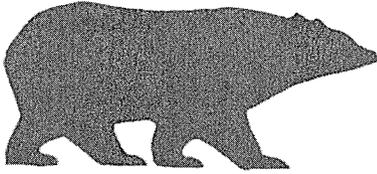
Bruin Geotechnical Services
 44732 Yucca Avenue
 Lancaster, CA 93534
 (661) 273-9078

Log of Boring 5

Sheet 1 of 1

Project: Mete Housing Corp.	Project Location: Ave R & Division St.	Project number: 18-326
Date(s) drilled: 11/13/18	Logged By: AM	Checked By: MS
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8"	Total Depth of Borehole: 20' bgs
Drill Rig Type: CME 75	Drilling Contractor: Choice Drilling	Hammer Data: 140#, 30" drop
Ground-water: None Encountered	Sampling Method(s): CSS	Notes:
Borehole Backfill: Native/ Cuttings	Location: See Figure 2	

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
5'		SM		Brown very silty fine to medium sand w/ occ. coarse sand Loose, moist	4-5		
		SM/ML		Brown very silty fine to medium sand w/ occ. coarse sand Loose, moist	5-7	101.6	10.9
		ML		Brown fine to medium sandy silt w/ occ. coarse sand Firm, moist	3-5	92.1	12.1
10'		SM		Brown slightly silty fine to medium sand w/ clay binder Loose, moist	5-6	97.5	14.5
		SM		Brown silty fine to medium sand w/ coarse sand & clay binder Medium dense, very moist	4-3	109.0	11.6
15'		SM		Moderate brown silty fine to coarse sand w/ clay binder Medium dense, moist	2-15	103.3	10.3
20'		SM		Yellowish brown slightly silty fine to coarse sand w/ clay binder Dense, moist	50/6"	111.6	9.7
25'				Boring terminated @ 20' bgs No groundwater No caving			
30'							



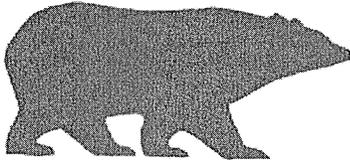
Bruin Geotechnical Services
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 Lancaster, CA 93534
 (661) 273-9078

Log of Boring 6

Sheet 1 of 1

Project: Mete Housing Corp.	Project Location: Ave R & Division St.	Project number: 18-326
Date(s) drilled: 11/13/18	Logged By: AM	Checked By: MS
Drilling Method: Hollow Stem Auger	Drill Bit Size/Type: 8"	Total Depth of Borehole: 10' bgs
Drill Rig Type: CME 75	Drilling Contractor: Choice Drilling	Hammer Data: 140#, 30" drop
Ground-water: None Encountered	Sampling Method(s): SPT	Notes:
Borehole Backfill: Native/ Cuttings	Location: See Figure 2	

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
5'		SM		Brown very silty fine to medium sand (slightly cemented) Loose, dry	2-2-2		5.3
		SM		Brown very silty fine to medium sand (slightly cemented) Loose, slightly moist	3-3-5		7.1
		SM		Brown very silty fine to medium sand w/ occ. coarse sand & #4 gravel Medium dense, moist	3-4-7		7.6
10'		SM		Brown silty fine to medium sand w/ clay binder Medium dense, moist	4-4-5		9.0
15'				Boring terminated @ 10' bgs No groundwater No caving			
20'							
25'							
30'							



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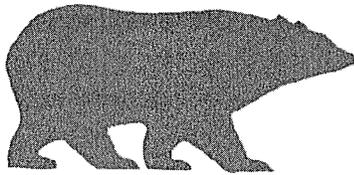
(661) 273-9078

Soils Key

Sheet 1 of 2

SOIL CLASSIFICATION KEY					
Major Divisions				Typical Names	
Coarse Grained Soils 50% or more larger than #200 sieve	Gravels More than half coarse-fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW		Well graded gravels, gravel-sand mixtures
			GP		Poorly graded gravels, gravel-sand mixtures
		Gravel with over 12% fines	GM		Silty gravels, poorly graded gravel-sand-silt mixtures
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures
	Sands More than half coarse-fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW		Well graded sands, gravelly sands
			SP		Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM		Silty sands, poorly graded sand-silt mixtures
			SC		Clayey sands, poorly graded sand-clay mixtures
Fine Grained Soils 50% or more smaller than #200 sieve	Silts and Clays Liquid limit less than 50		ML		Inorganic silts, rock flour, clayey silts
			CL		Inorganic clays of low to medium plasticity, sandy clays, silty clays
			OL		Organic clays and organic silty clays of low plasticity
	Silts and Clays Liquid limit greater than 50		MH		Inorganic silts, micaceous or diatomaceous fine sandy/silty soils, elastic silts
			CH		Inorganic clays with high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
Highly Organic Soils			Pt		Peat and other highly organic soils

CLASSIFICATION SYSTEM BASED ON UNIFIED SOIL CLASSIFICATION SYSTEM



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Key to Boring Log

Sheet 2 of 2

Depth	Sample	USCS	Graphic Log	Material Description	Penetration Resistance (Blows/6")	Dry Unit Weight pcf	Water Content %
1	2	3	4	5	6	7	8

COLUMN DESCRIPTIONS

- | | |
|--|--|
| <p>1 Depth: depth in feet below the ground surface.</p> <p>2 Sample: type of sample taken at depth incurred</p> <p>3 USCS: USCS symbol of the subsurface material.</p> <p>4 Grading Log: graphic depiction of the subsurface material encountered.</p> <p>5 Material Description: description of the material encountered. May include consistency, moisture color, and other descriptive text.</p> | <p>6 Blow Count/ft: number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.</p> <p>7 Dry Unit Weight pcf: dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.</p> <p>8 Water Content %: water content of the soil sample, expressed as a percentage of fry weight sample.</p> |
|--|--|

FIELD AND LABORATORY TEST ABBREVIATIONS

DIST= Disturbed
 N/A= Not Analyzed

CHEM= Chemical tests to assess corrosivity

-  California Split Spoon
-  Standard Penetration Test
-  Bulk Sample
-  Grab Sample

GENERAL NOTES

- Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
- Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

APPENDIX B

Laboratory Test Data

SUMMARY OF LABORATORY TEST RESULTS

SIEVE ANALYSIS Percent passing individual sieves

Sample I.D.	3/4"	1/2"	3/8"	#4	#10	#40	#100	#200
B1@8'	100	99	93	77	54	22	15	15
B1@15'			100	98	93	65	61	60
B1@20'	100	93	81	86	78	29	19	17
B3@9'			100	99	95	49	37	31
B4@10'		100	99	97	92	54	45	40
B5@9'			100	99	98	86	81	80
B6@7'	100	99	99	98	94	51	42	39
B6@5'			100	99	95	60	50	45

SAND EQUIVALENT

Sample I.D.	Sand Equivalent
B1@15'	18
B4@4'	3
B4@6'	2
B6@3'	12

EXPANSION INDEX

Sample	Expansion Index	Classification
E1@0-5'	0	Non-Expansive

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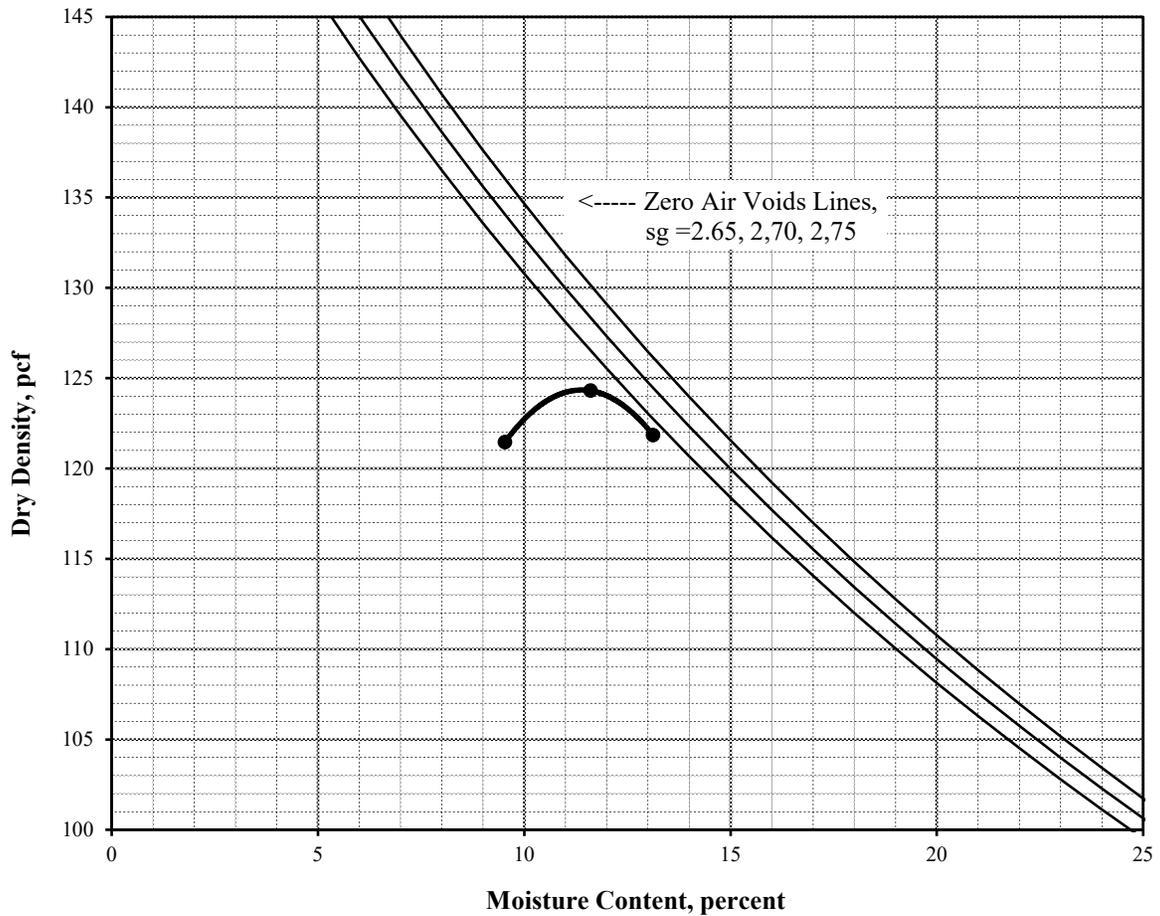
44732 Yucca Avenue
Lancaster, CA 93534
661-273-9078

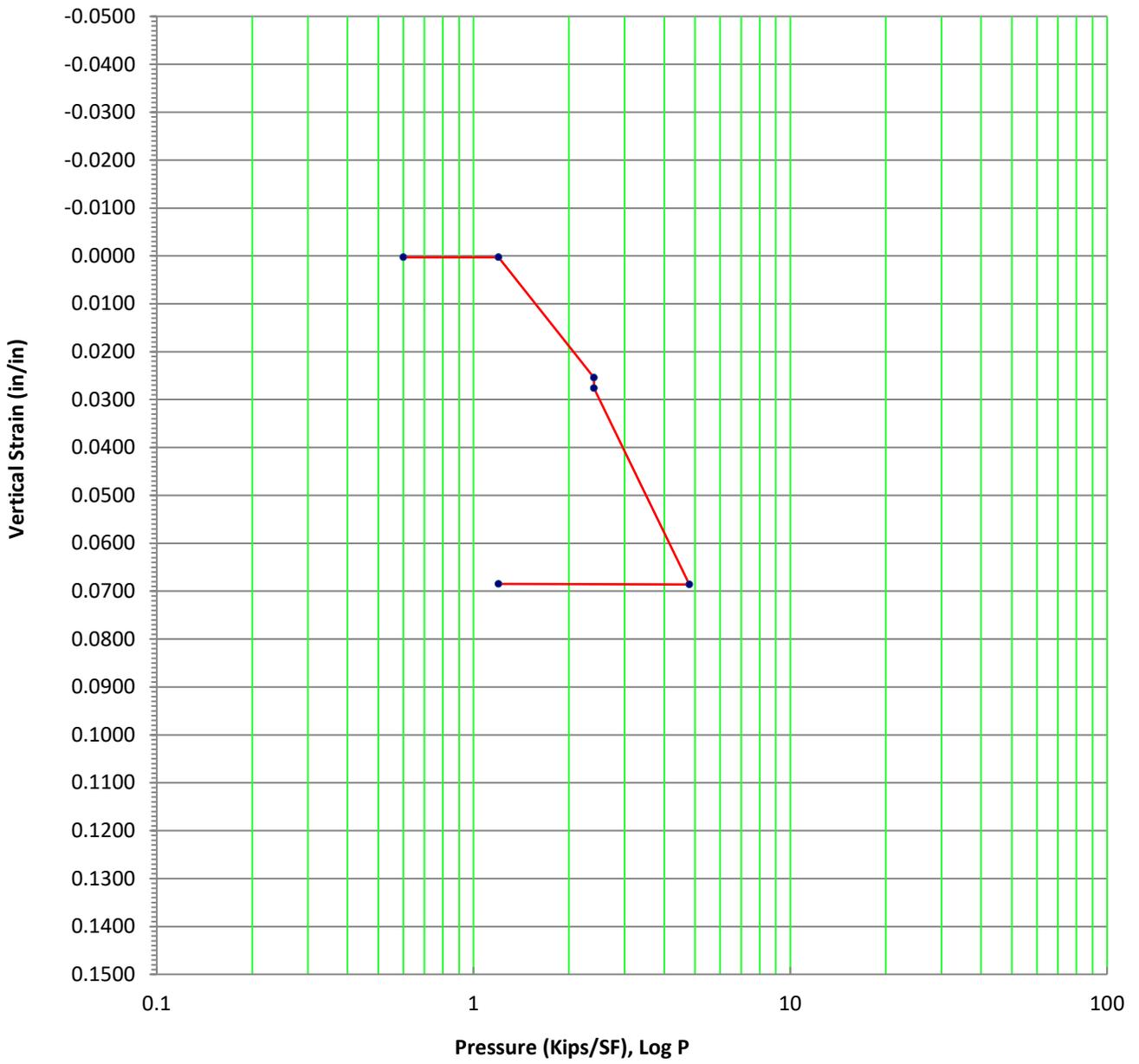
Maximum Density/Optimum Moisture Proctor ASTM D698/D1557

Project Number: 18-326
Project Name: Meta Housing Corp
Lab ID Number: B1
Sample Location: B1 0'-5'
Description: Yellowish brown fine to medium sandy silt

October 11, 2018
ASTM D-1557 C
Rammer Type: 10#

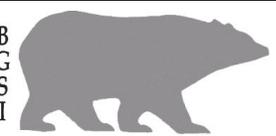
		<u>Sieve Size</u>	<u>% Retained</u>
Maximum Density:	124.5 pcf	3/4"	
Optimum Moisture:	11.5%	3/8"	
		#4	

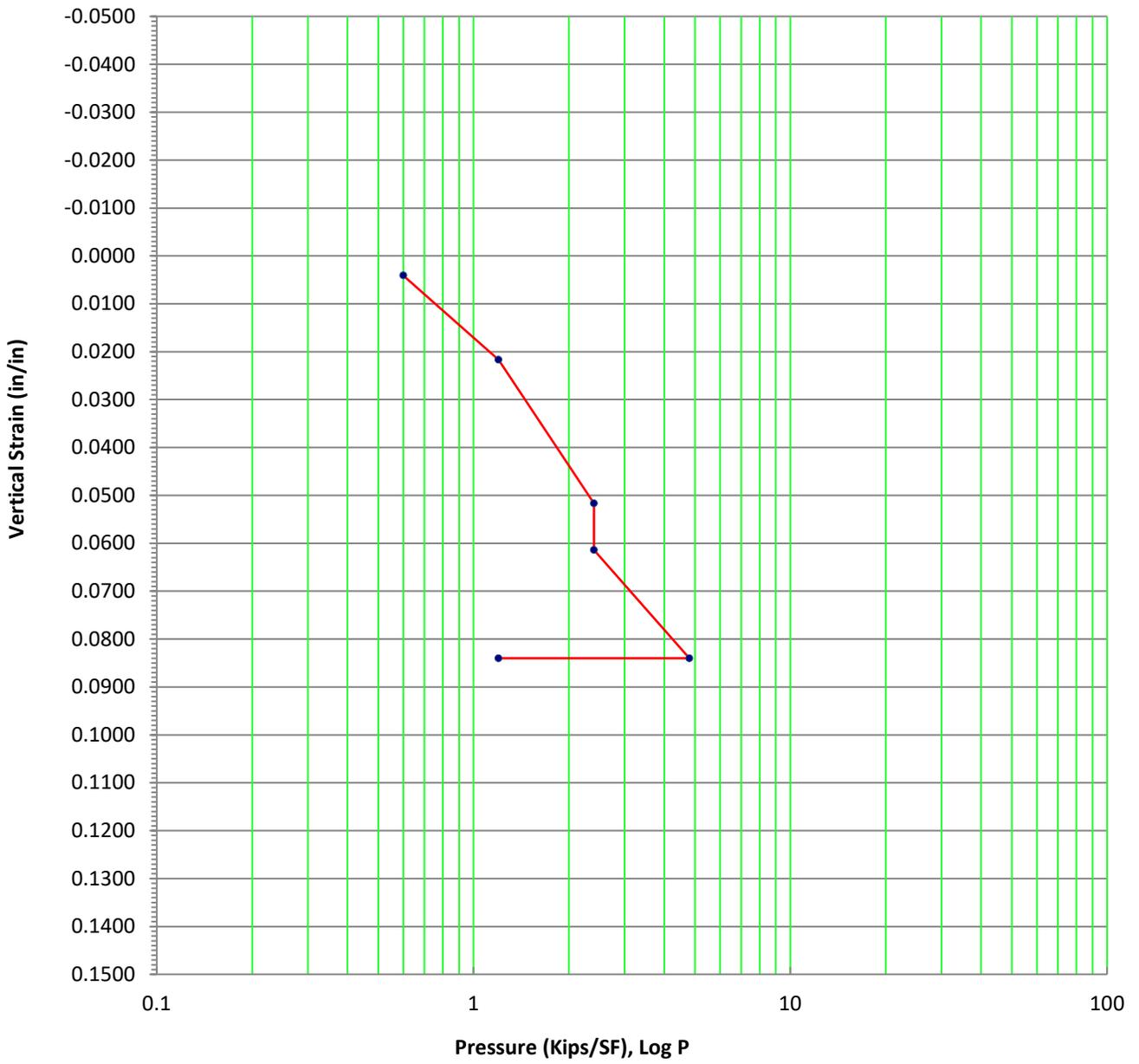




Sample location: B2@3'
 Material: ML/SM
 Initial Dry Density: 99.2 PCF
 Moisture Content: 4.2 %
 % Hydroconsolidation: 0.2 %

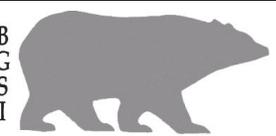
* Test Method: ASTM D-2435

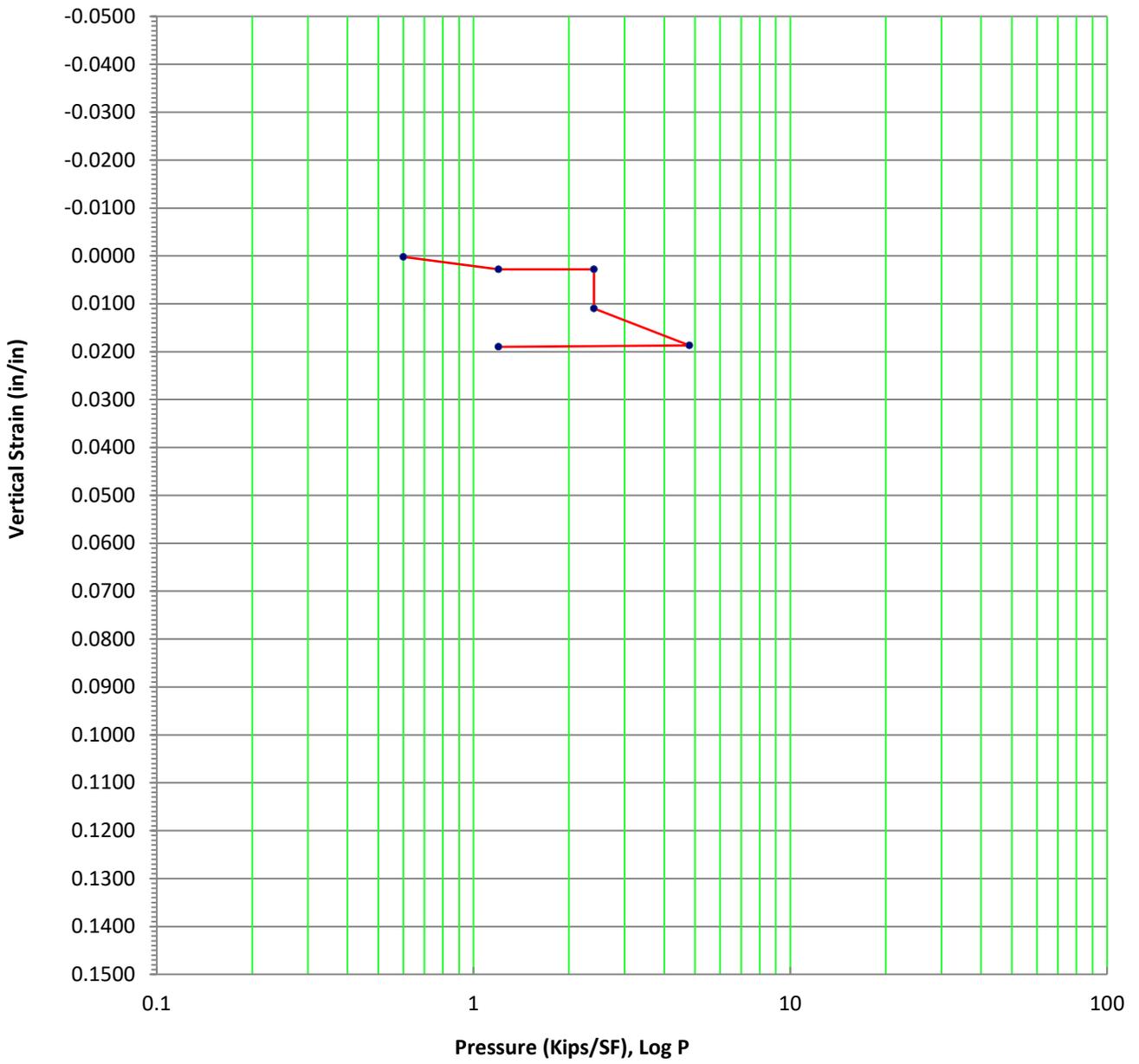
Consolidation Test	
METAHOUSING	
PALMDALE, CA	
B G S I	
12/13/2018	18-326



Sample location: B3@4'
 Material: ML/SM
 Initial Dry Density: 84.7 PCF
 Moisture Content: 8.1 %
 % Hydroconsolidation: 1.0 %

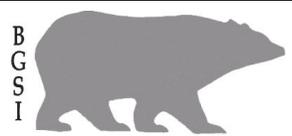
* Test Method: ASTM D-2435

Consolidation Test	
METAHOUSING	
PALMDALE, CA	
B G S I	
12/13/2018	18-326



Sample location: B5@5'
 Material: SM
 Initial Dry Density: 101.6 PCF
 Moisture Content: 10.9 %
 % Hydroconsolidation: 0.8 %

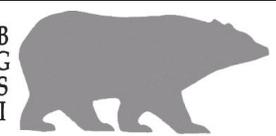
* Test Method: ASTM D-2435

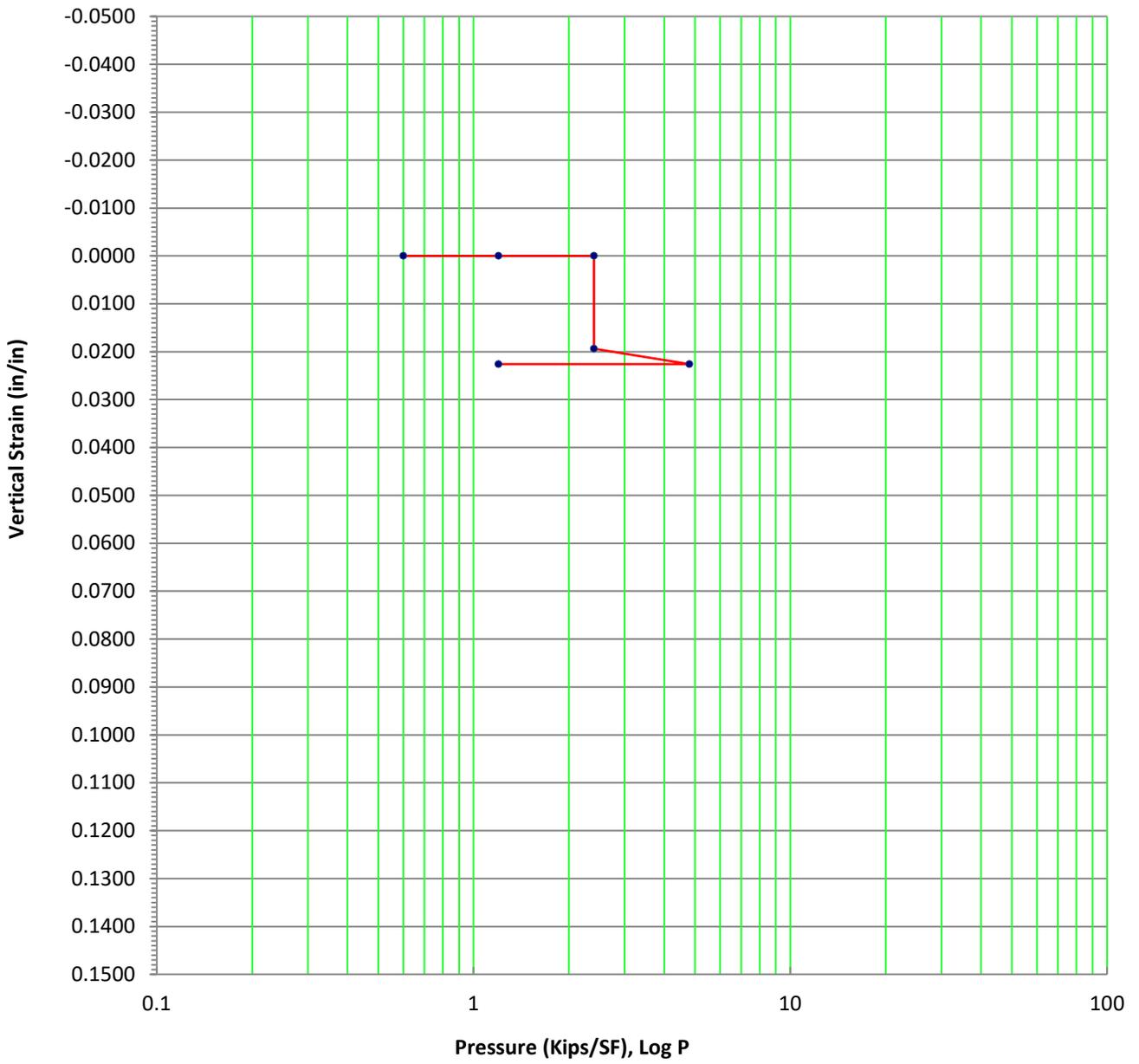
Consolidation Test	
METAHOUSING	
PALMDALE, CA	
	
12/13/2018	18-326



Sample location: B1@6'
 Material: ML
 Initial Dry Density: 82.1 PCF
 Moisture Content: 11.1 %
 % Hydroconsolidation: 7.4 %

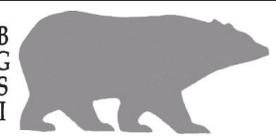
* Test Method: ASTM D-2435

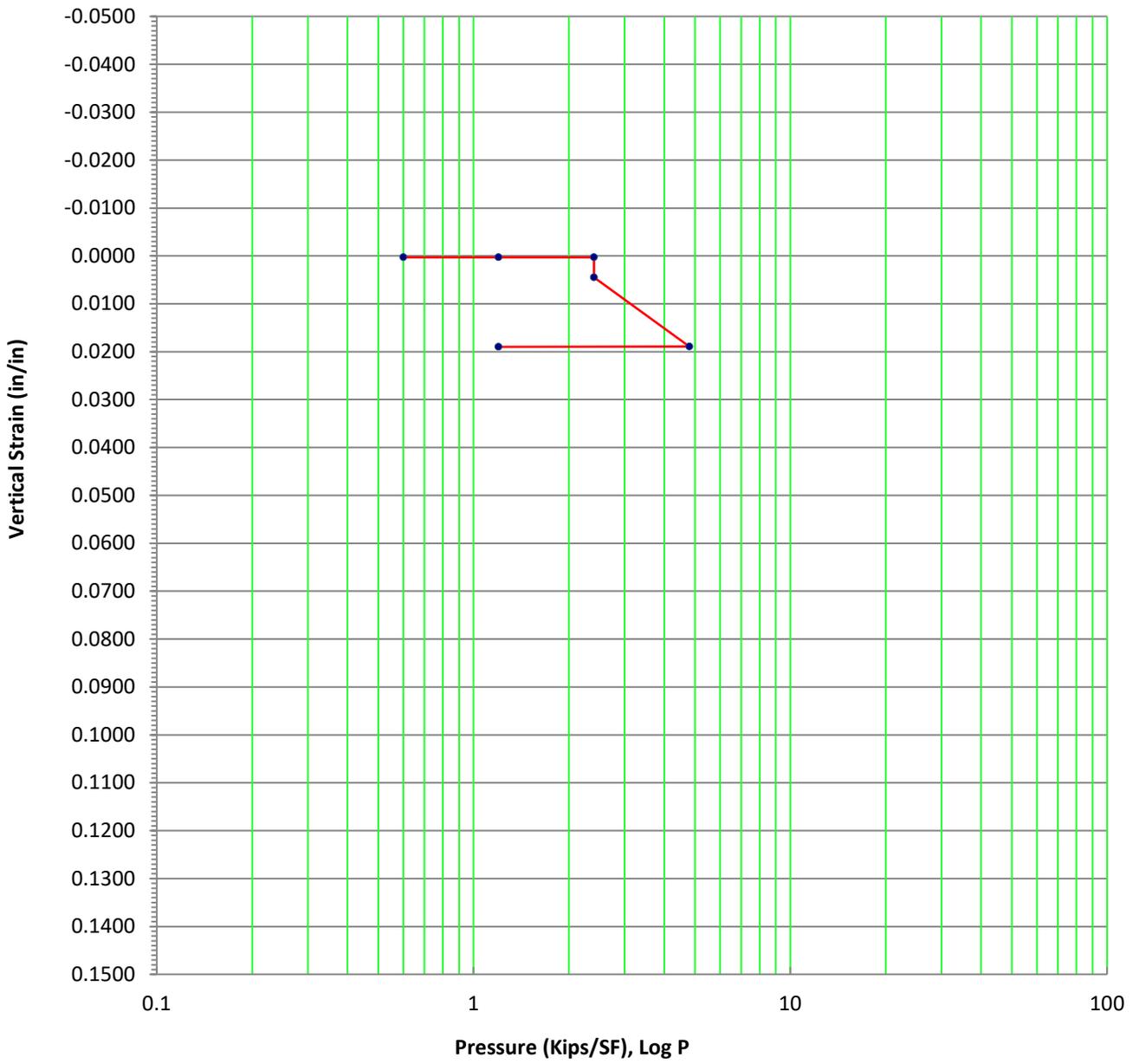
Consolidation Test	
METAHOUSING	
PALMDALE, CA	
B G S I	
12/13/2018	18-326



Sample location: B2@7'
 Material: ML
 Initial Dry Density: 97.7 PCF
 Moisture Content: 6.4 %
 % Hydroconsolidation: 1.9 %

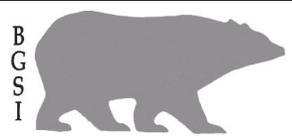
* Test Method: ASTM D-2435

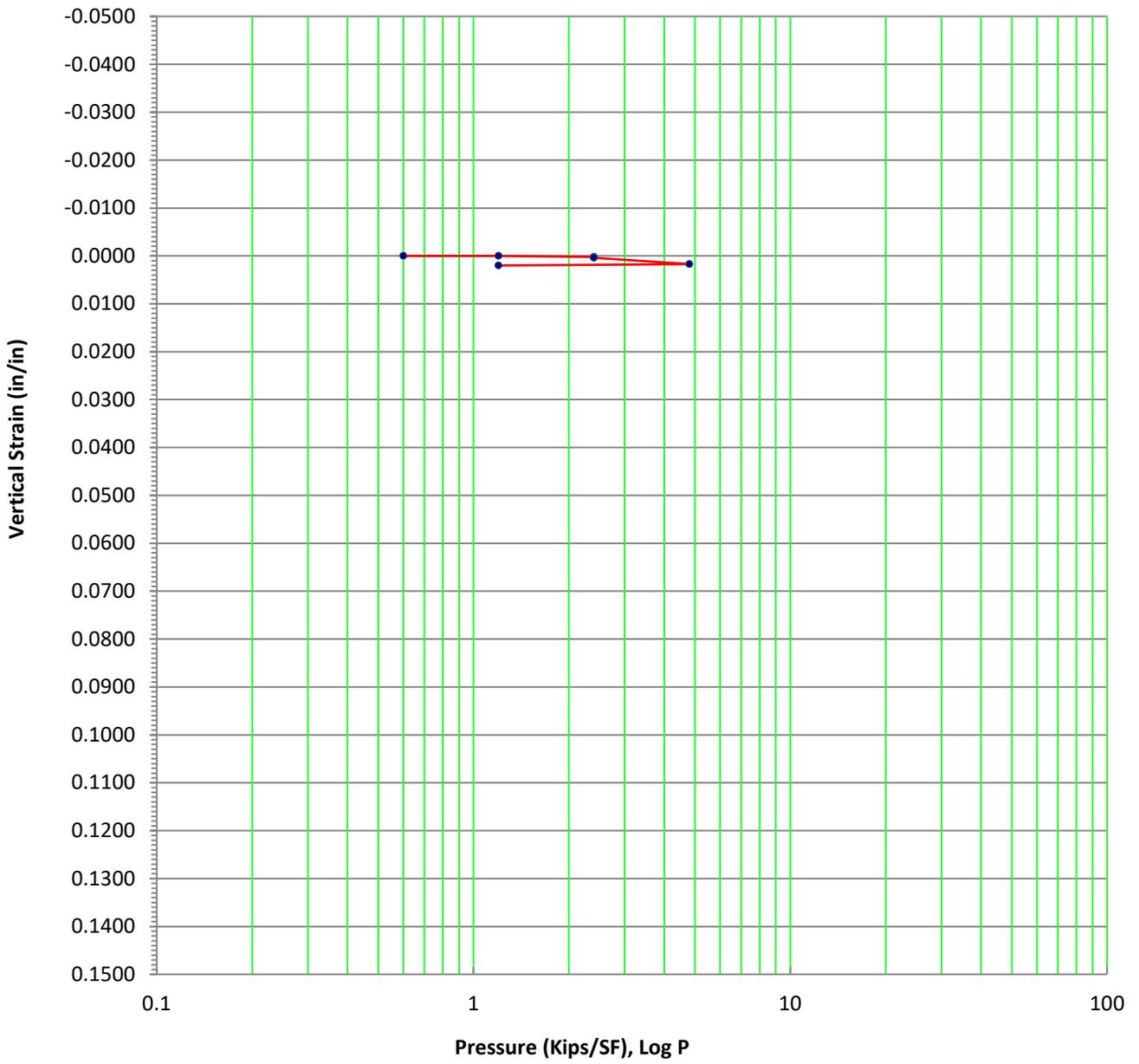
Consolidation Test	
METAHOUSING	
PALMDALE, CA	
B G S I	
12/13/2018	18-326



Sample location: B5@12'
 Material: ML
 Initial Dry Density: 109.0 PCF
 Moisture Content: 11.6 %
 % Hydroconsolidation: 0.4 %

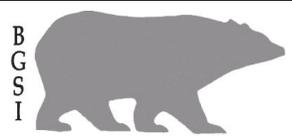
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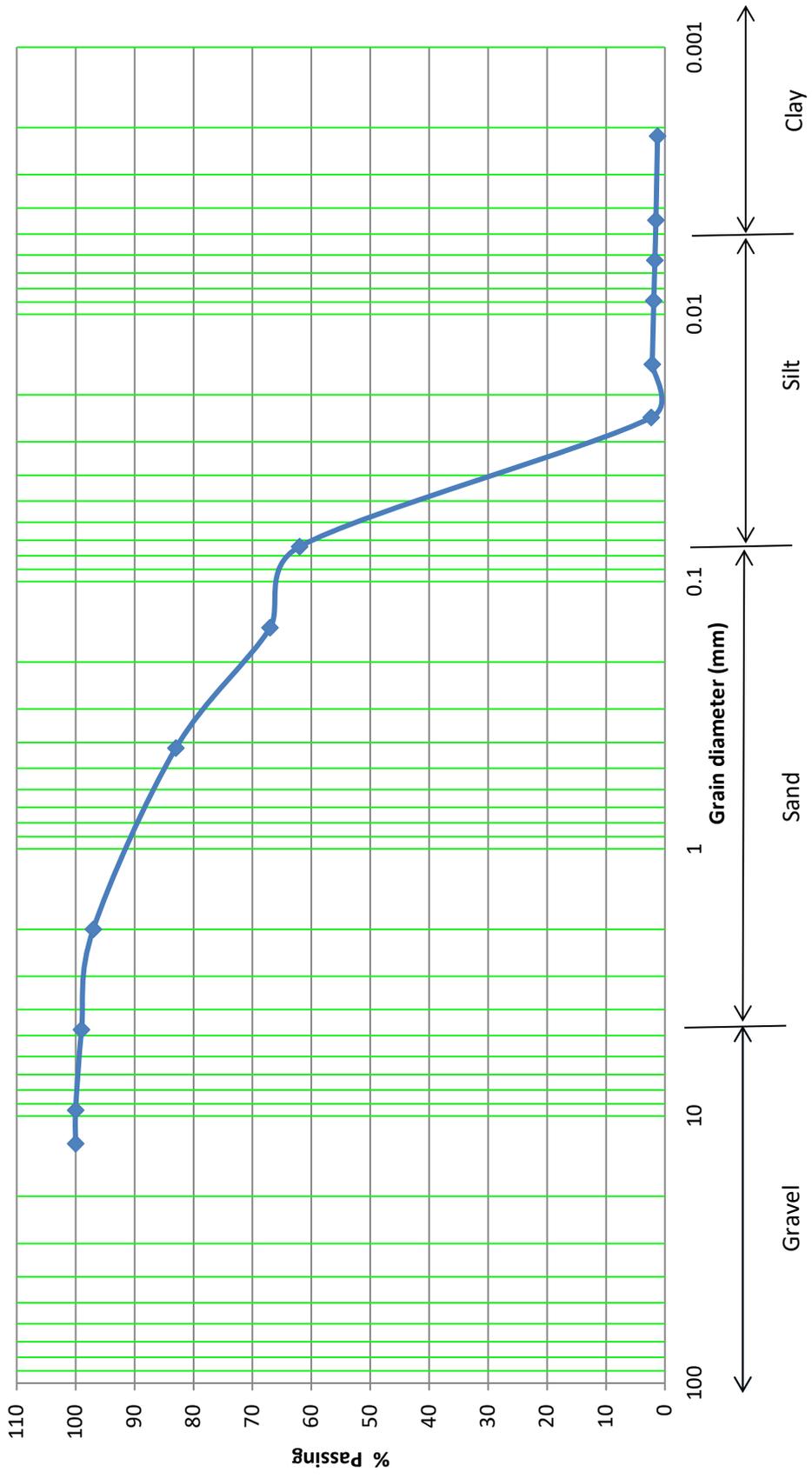
Consolidation Test	
METAHOUSING	
PALMDALE, CA	
	
12/13/2018	18-326



Sample location: B5@15'
 Material: SM
 Initial Dry Density: 121.3 PCF
 Moisture Content: 10.3 %
 % Hydroconsolidation: 0.0 %

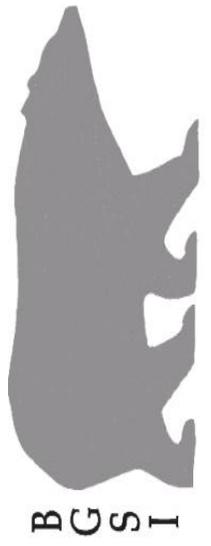
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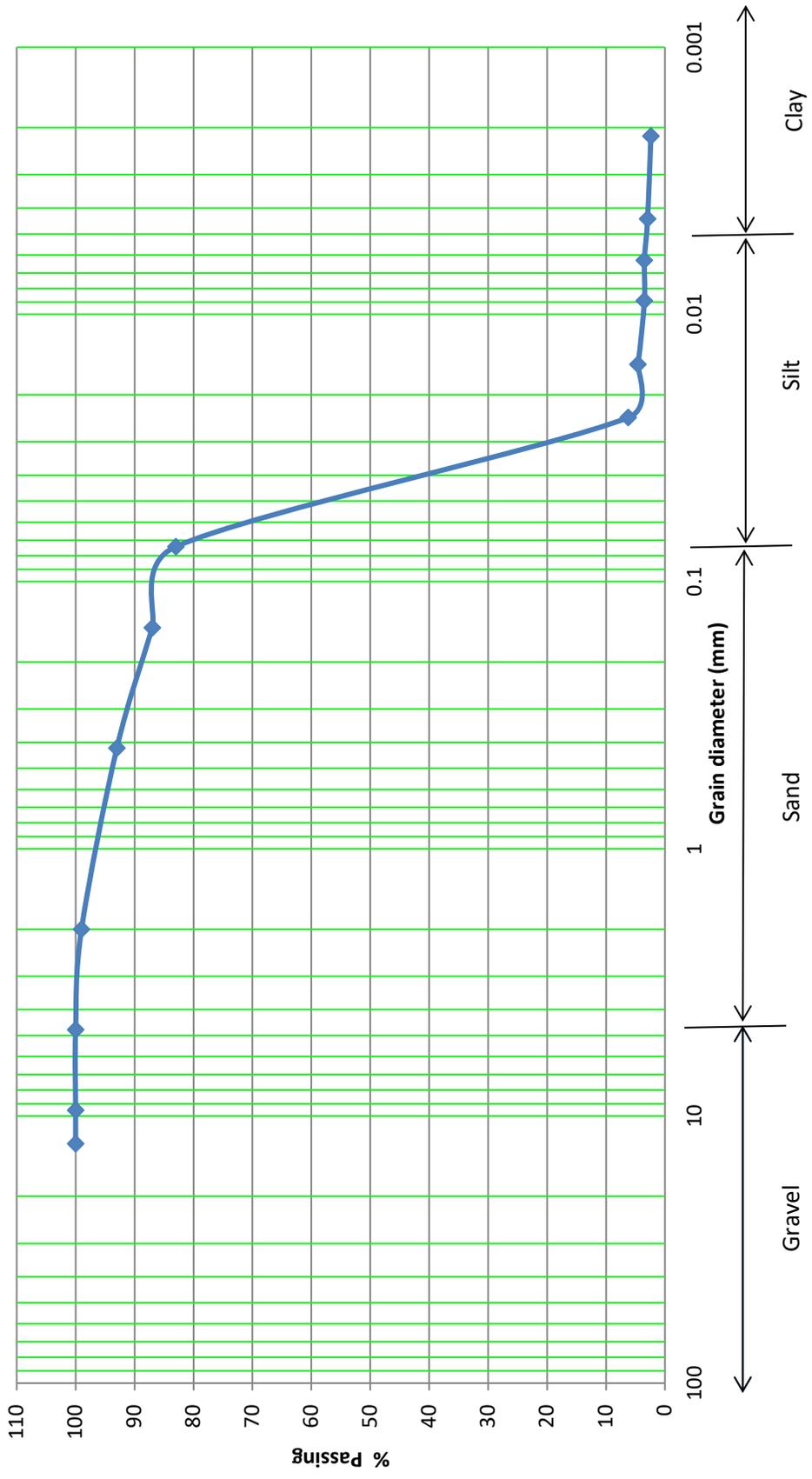
Consolidation Test	
METAHOUSING	
PALMDALE, CA	
	
12/13/2018	18-326



Grain Size Distribution Curve (ASTM D422)

Job Number: 18-326 Coefficient of Uniformity, Cu: 2
 Client Name: METAHOUSING Particle range, mm: 13
 Sample I.D.: BULK 1, 0'-5'
 Date: 12/13/2018 USCS: ML/SM

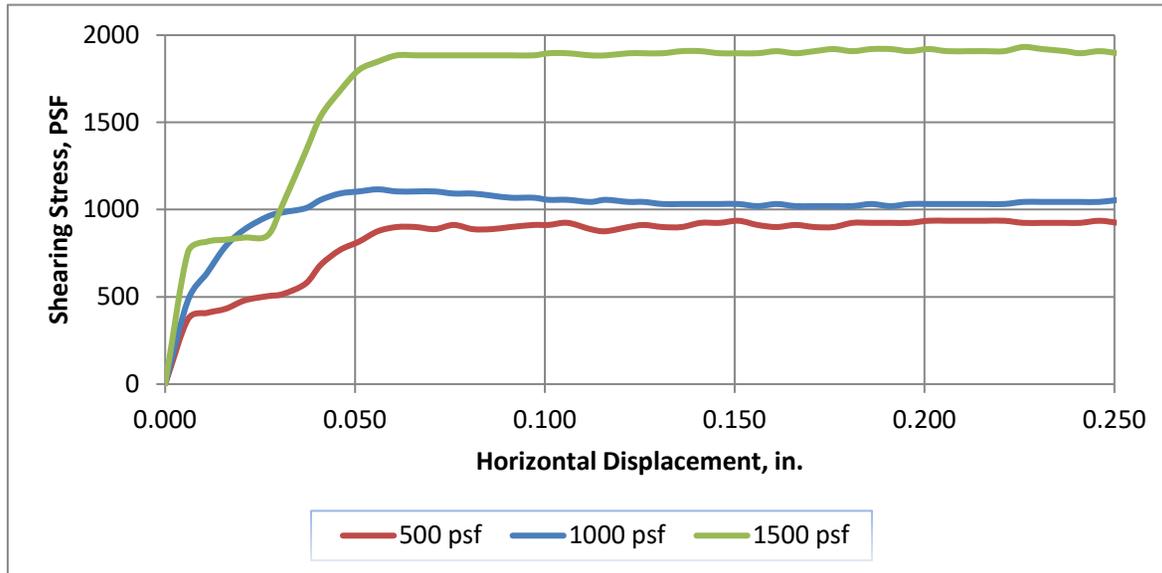
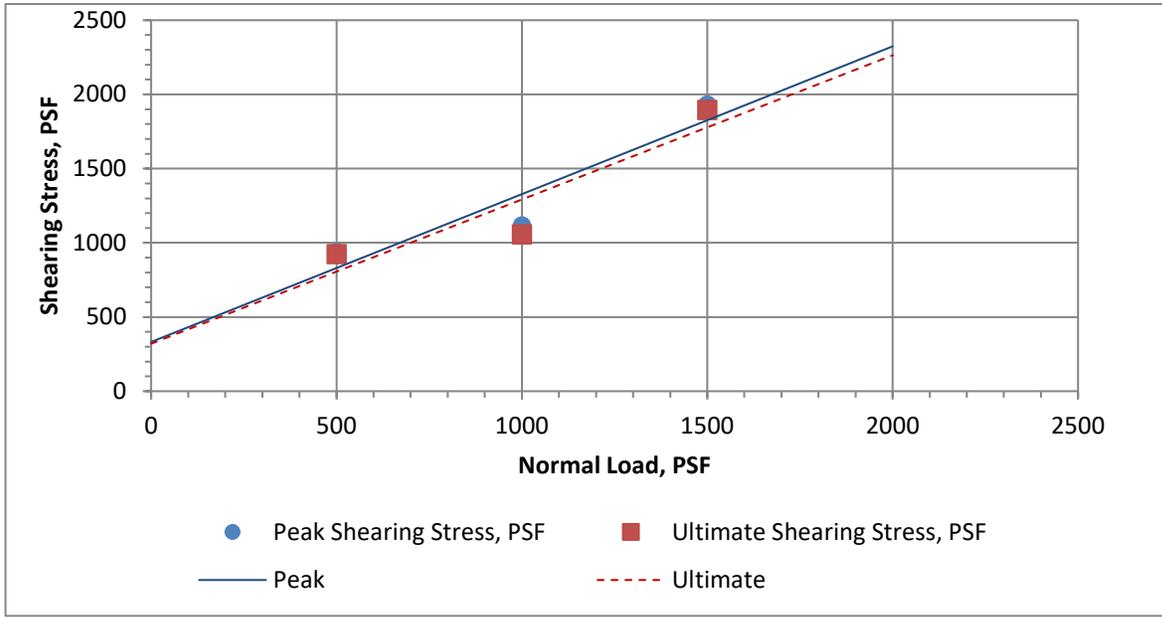




Grain Size Distribution Curve (ASTM D422)

Job Number: 18-326 Coefficient of Uniformity, Cu: 2
 Client Name: METAHOUSING Particle range, mm: 13
 Sample I.D.: B2@5'
 Date: 12/13/2018 USCS: ML





SHEAR DATA

Sample ID	Symbol	Depth, feet	Dry Density, PCF *	Average deg. of saturation %
B1	●	0'-5'	119	8

* Sample remolded to 90% relative compaction as determined by ASTM D-1557 Test Method

	Peak	Ultimate
Angle of friction, (degrees)	48	47
Cohesive Strength (PSF)	332	320

Direct Shear Test

METAHOUSING

PALMDALE, CA



11/29/2018

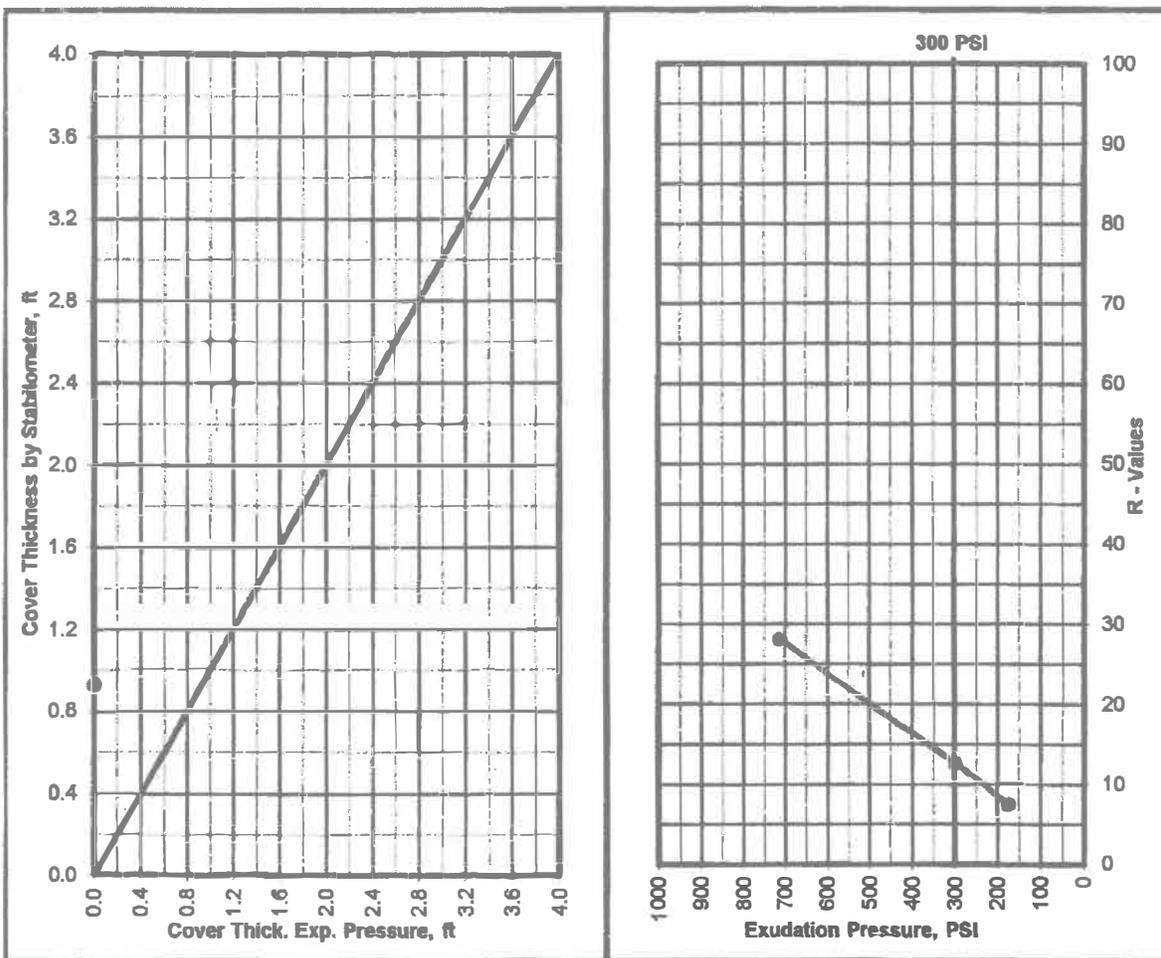
18-326

R - VALUE TEST ASTM D - 2844 / CAL 301

Project Number : 12618116
 Project Name : Bruin Geotechnical
 Date : 11/14/2018
 Sample Location/Curve Number : #18-326 B-4 Bulk 0-5'
 Soil Classification : sandy silt

TEST	A	B	C
Percent Moisture @ Compaction, %	13.1	14.1	12.1
Dry Density, lbm/cu.ft.	119.7	117.1	120.4
Exudation Pressure, psi	299	175	713
Expansion Pressure, (Dial Reading)	0	0	0
Expansion Pressure, psf	0	0	0
Resistance Value R	13	8	28

R Value at 300 PSI Exudation Pressure	13
R Value by Expansion Pressure (TI =): 5	Expansion Pressure nil



ANAHEIM TEST LAB, INC

196 Technology Drive, Unit D
Irvine, CA 92618
PHONE (949) 336-6544

BRUIN GEOTECHNICAL SERVICES, INC.
44732 Yucca Avenue
Lancaster, CA 93534

DATE: 11/26/18

P.O. NO.: TRANSMITTAL

LAB NO.: C-2451

SPECIFICATION: CTM-417/422/643

MATERIAL: Soil

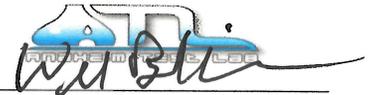
PROJECT#: 18-326
Meta Housing
Ave. R & Davidson
Palmdale, CA

ANALYTICAL REPORT

CORROSION SERIES SUMMARY OF DATA

	pH	SOLUBLE SULFATES per CT. 417 ppm	SOLUBLE CHLORIDES per CT. 422 ppm	MIN. RESISTIVITY per CT. 643 ohm-cm
B-1 @ 0-5'	6.8	65	12	5,000

RESPECTFULLY SUBMITTED



WES BRIDGER CHEMIST

APPENDIX C

USGS Seismic Design Summary Report

USGS Design Maps Summary Report

User-Specified Input

Report Title 18-326 Meta Housing Corporation
Wed November 7, 2018 18:05:43 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 34.5705°N, 118.1291°W

Site Soil Classification Site Class D – “Stiff Soil”

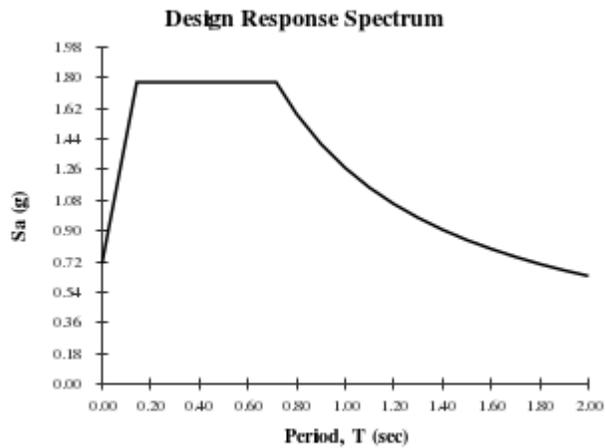
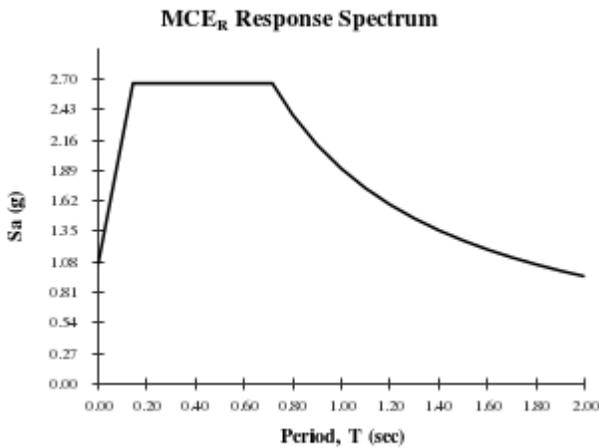
Risk Category I/II/III



USGS-Provided Output

$S_S = 2.661 \text{ g}$	$S_{MS} = 2.661 \text{ g}$	$S_{DS} = 1.774 \text{ g}$
$S_1 = 1.270 \text{ g}$	$S_{M1} = 1.905 \text{ g}$	$S_{D1} = 1.270 \text{ g}$

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the “2009 NEHRP” building code reference document.



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.



Design Maps Detailed Report

2012/2015 International Building Code (34.5705°N, 118.1291°W)

Site Class D – “Stiff Soil”, Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_s) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From [Figure 1613.3.1\(1\)](#) ^[1]

$$S_s = 2.661 \text{ g}$$

From [Figure 1613.3.1\(2\)](#) ^[2]

$$S_1 = 1.270 \text{ g}$$

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	\bar{v}_s	\bar{N} or \bar{N}_{ch}	\bar{s}_u
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
Any profile with more than 10 ft of soil having the characteristics:			
<ul style="list-style-type: none"> • Plasticity index $PI > 20$, • Moisture content $w \geq 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf 			
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_s

For Site Class = D and $S_s = 2.661$ g, $F_a = 1.000$

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1-s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight-line interpolation for intermediate values of S_1

For Site Class = D and $S_1 = 1.270$ g, $F_v = 1.500$

Equation (16-37):

$$S_{MS} = F_a S_s = 1.000 \times 2.661 = 2.661 \text{ g}$$

Equation (16-38):

$$S_{M1} = F_v S_1 = 1.500 \times 1.270 = 1.905 \text{ g}$$

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39):

$$S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 2.661 = 1.774 \text{ g}$$

Equation (16-40):

$$S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 1.905 = 1.270 \text{ g}$$

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)

SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

For Risk Category = I and $S_{DS} = 1.774 g$, Seismic Design Category = D

TABLE 1613.3.5(2)

SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D

For Risk Category = I and $S_{D1} = 1.270 g$, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category \equiv "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = E

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. Figure 1613.3.1(1): [https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1\(1\).pdf](https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf)
2. Figure 1613.3.1(2): [https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1\(2\).pdf](https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf)

APPENDIX D

General Earthwork and Grading Guidelines

Earthwork and Grading Specifications for Rough Grading

1.0 General

1.1 **Intent:** These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 **The Geotechnical Consultant of Record:** Prior to commencement of work, the owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the “work plan” prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observations, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to confirm that the attained level of compaction is being accomplished as specified. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 **The Earthwork Contractor:** The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the project plans and specifications. The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of “equipment” of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of

grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultants, unsatisfactory conditions, such as unsuitable soil, improper moisture-condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in the specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified. It is the contractor's sole responsibility to provide proper fill compaction.

2.0 **Preparation of Areas to be Filled**

- 2.1 **Clearing and Grubbing:** Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 10 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminant dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed. The contractor is responsible for all hazardous waste relating to his work. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Client should acquire the services of a qualified environmental assessor.

- 2.2 **Processing:** Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free from oversize material and the working surface is reasonably uniform, flat, and free from uneven features that would inhibit uniform compaction.

- 2.3 **Overexcavation:** In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by the Geotechnical Consultant during grading.
- 2.4 **Benching:** Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.
- 2.5 **Evaluation/Acceptance of Fill Areas:** All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 **Fill Material**

- 3.1 **General:** Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.
- 3.2 **Oversize:** Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.
- 3.3 **Import:** If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical report(s). The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so the suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

- 4.1 **Fill Layers:** Approved fill material shall be placed in areas prepared to receive fill in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates that grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.
- 4.2 **Fill Moisture Conditioning:** Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain relatively uniform moisture content within 2% of optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557-91).
- 4.3 **Compaction of Fill:** After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557-91). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.
- 4.4 **Compaction of Fill Slopes:** In addition to normal compaction procedures specified above, compaction of slopes, shall be accomplished by backrolling of slopes with sheepfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557-91.
- 4.5 **Compaction Testing:** Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).
- 4.6 **Frequency of Compaction Testing:** Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.
- 4.7 **Compaction Test Locations:** The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land survey/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

- 7.1** The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations.
- 7.2** All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding Material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.
- 7.3** The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.
- 7.4** The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.
- 7.5** Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.