GEOTECHNICAL INVESTIGATION
PROPOSED KECK GRADUATE INSTITUTE
MIXED USE STUDENT HOUSING PROJECT
517 WHARTON DRIVE
CLAREMONT, CALIFORNIA

PREPARED FOR:
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CTE JOB NO. 40-3341G

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1.0 EXECUTIVE SUMMARY

This geotechnical report was performed to provide site-specific geotechnical information for the proposed Keck Graduate Mixed Use Student Housing project located in Claremont, California. Figure 1 shows the location of the site. The proposed development will consist of two four-story buildings and new parking areas. Selection of building foundations will be chosen by the structural engineer of record; however, based on the soil materials encountered in this investigation and the earthwork recommendations herein, it is anticipated that the buildings will be founded on conventional shallow footings with slab-on-grade base floors. However, if alternate foundation type is recommended, we will provide updated design parameters upon request.

Based on our investigation and review of geologic maps, the site is underlain by fill and alluvial fan deposits. Groundwater was not encountered during our investigation.

Based on our investigation, the proposed development at the site is considered feasible from a geotechnical standpoint, provided the recommendations herein are implemented during project design and construction.

2.0 INTRODUCTION AND SCOPE OF SERVICES

2.1 Introduction

CTE, South, Inc. has prepared this report for HP Real Estate Development, LLC. Presented herein are the results of the subsurface investigation performed as well as recommendations
regarding the geotechnical engineering and dynamic loading criteria for the proposed construction.

2.2 Scope of Services

Our scope of services included:

- Review of readily available geologic and geotechnical literature pertinent to the site.

- Explorations to determine subsurface soil, rock, and groundwater conditions to the depths influenced by the proposed development.

- Laboratory testing of representative soil samples to provide data to evaluate the geotechnical design characteristics of the site foundation soils.

- Definition of the general geology and evaluation of potential geologic hazards at the site.

- Preparation of this report detailing the investigation performed and providing conclusions and geotechnical engineering recommendations for design and construction. Included in the report are site geology and hazards, seismic effects and design parameters, earthwork recommendations, foundation design parameters including lateral resistance, retaining wall design parameters and pavement structure section recommendations.

3.0 SITE AND PROPOSED CONSTRUCTION

The site is located at 517 Wharton Drive in Claremont, California. The project is a mixed use student housing consisting of two four-story buildings and approximately 243 new parking spaces. The buildings will be constructed on a vacant parcel of land at the southwest corner of Wharton Drive and Bucknell Avenue. One of the parking areas will be west of the project site and the other will be an expansion of the parking lot southwest of the Technip office building at 555 West Arrow Highway. There will also be modifications to a small parking lot in front of the
Technip building. Other improvements will include a plaza, courtyard, retaining walls and surface and subsurface drainage.

4.0 FIELD AND LABORATORY INVESTIGATION

4.1 Field Investigation

Our field investigation was performed on June 30, 2016 and included nine (9) exploratory borings identified as B-1 through B-9. Borings B-7 and B-8 were drilled at the proposed Building 1. Borings B-4, B-5, B-6 and B-9 were drilled at the proposed Building 2. Borings B-1, B-2 and B-3 were drilled in the proposed parking and drive areas. The exploration locations are shown on Figure 2. Site preparation recommendations including anticipated excavations are presented in Section 6.2. Site infiltration areas were not known to us at the time of our investigation; however, a preliminary site infiltration assessment is presented in Section 6.10.

The explorations were excavated to investigate and obtain samples of the subsurface soils. The borings were excavated using a truck-mounted, eight-inch diameter, hollow-stem auger drill rig to a maximum explored depth of 51 feet below the existing surface.

Soils encountered within the explorations were classified in the field in accordance with the Unified Soil Classification System. The field descriptions were later modified (as appropriate) based on the results of our laboratory-testing program. In general, soil samples were obtained at 5-foot intervals with standard split spoon (SPT and California Modified) samplers. Specifics of the soils encountered can be found on the Exploration Logs, which are presented in Appendix A.
4.2 Laboratory Analyses
Laboratory tests were conducted on representative soil samples to evaluate their physical properties and engineering characteristics. Specific laboratory tests included: maximum dry density and optimum moisture content, in-place moisture and density, “R” value, expansion index, gradation, and chemical analyses. These tests were conducted to determine the properties and corrosivity of the on-site soils. Test method descriptions and laboratory results are presented in Appendix B and on the Exploration Logs.

5.0 GEOLOGY
5.1 General Physiographic Setting
Geomorphically, the site lies within the Transverse Ranges Geomorphic Province. The Transverse Ranges, unlike the rest of California, form an east-west trending unit. The San Andreas Fault system forms the northern boundary of the province. The province also subdivides into individual ranges, which are separated by alluviated, broad synclinal valleys, narrow stream canyons, and faults (Webb and Norris, 1990).

5.2 Site Geologic Conditions
Based on our investigation and review of geologic mapping (Morton and Miller, 2003), the site is underlain by undocumented artificial fill and young to old alluvial fan deposits. Refusal to drilling occurred in borings B-2 through B-8. These borings ranged from 2 to 14 feet deep. Boring B-9 was able to be drilled to a depth of 51 feet. Granitic bedrock was encountered in this
boring at 50 feet. Below is a brief description of the materials encountered during the investigation. More detailed descriptions are provided in the Exploration Logs in Appendix A.

5.2.1 Artificial Fill

Undocumented artificial fill was encountered in Borings B-4, B-6, B-8 and B-9. The fill consisted of silty sand and gravel and varied from 1-1/2 to 4 feet thick.

5.2.2 Young Alluvial Fan Deposits (Qyf)

Young (middle Holocene) alluvial fan deposits were encountered in each boring. The deposits consisted of medium dense to dense sand with gravel, gravel with sand, and scattered cobbles.

5.2.3 Old Alluvial Fan Deposits (Qof)

Old (late to middle Pleistocene) alluvial fan deposits were encountered in boring B-9 from approximately 20 to 50 feet below the surface. The deposits consisted of medium dense to dense silty sand.

5.2.4 Granitic Bedrock

Weathered granitic bedrock was encountered in boring B-9 at a depth of approximately 50 feet below the surface.
5.3 Groundwater Conditions
Groundwater was not encountered in the borings. Groundwater contour mapping (DMG, 2000) shows the depth to historically high groundwater to be approximately 200 feet. Groundwater levels will likely fluctuate during periods of high precipitation. Groundwater is not expected to impact the proposed development, although grading or construction could be adversely affected if performed during or following periods of wet weather.

5.4 Geologic Hazards
From our investigation, it appears that geologic hazards at the site are limited primarily to those caused by strong shaking from earthquake-generated ground motions. Presented here are the geologic hazards that are considered for potential impacts to site development.

5.4.1 Surface Fault Rupture
As defined by the California Geological Survey, an active fault is one that has had surface displacement within the Holocene Epoch (roughly the last 11,000 years). This definition is used in delineating Earthquake Fault Zones as mandated by the Alquist-Priolo Special Studies Zones Act of 1972 and revised in 1994 as the Alquist-Priolo Earthquake Fault Zoning Act. The name Special Studies Zones was changed to Earthquake Fault Zones as a result of a 1993 amendment. Special Publication - 42 was most recently revised in 2007 and is subject to periodic amendments. The intent of this act is to require fault investigations on sites located within Earthquake Fault Zones to preclude the construction of structures for human occupancy across the trace of an active fault. The site is not located in or adjacent to an Alquist-Priolo Earthquake Fault Zone.
Based on our site reconnaissance and review of the referenced literature, no known active fault traces underlie the site. Based on our investigation, the potential for surface rupture from displacement or fault movement beneath the proposed improvements is considered low.

5.4.2 Local and Regional Faulting
The California Geological Survey broadly groups faults as “Class A” or “Class B” (Cao et al, 2003). Class A faults are identified based upon relatively well-defined paleoseismic activity, and a fault slip rate of more than 5 millimeters per year (mm/yr). Class B faults are all other faults that are not defined as Class A faults. The following Table 1 presents the ten nearest active faults to the site and includes magnitude and fault classification.

<table>
<thead>
<tr>
<th>FAULT NAME</th>
<th>APPROXIMATE DISTANCE FROM SITE (mi)</th>
<th>MAXIMUM EARTHQUAKE MAGNITUDE</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Jose</td>
<td>1.9</td>
<td>6.4</td>
<td>B</td>
</tr>
<tr>
<td>Sierra Madre</td>
<td>4.3</td>
<td>7.2</td>
<td>B</td>
</tr>
<tr>
<td>Cucamonga</td>
<td>4.5</td>
<td>6.9</td>
<td>B</td>
</tr>
<tr>
<td>Chino-Central Avenue (Elsinore)</td>
<td>5.4</td>
<td>6.7</td>
<td>B</td>
</tr>
<tr>
<td>Whittier</td>
<td>13.5</td>
<td>6.8</td>
<td>A</td>
</tr>
<tr>
<td>Clamshell-Sawpit</td>
<td>14.4</td>
<td>6.5</td>
<td>B</td>
</tr>
<tr>
<td>Elysian Park Thrust</td>
<td>14.9</td>
<td>6.7</td>
<td>B</td>
</tr>
<tr>
<td>San Jacinto-San Bernardino</td>
<td>16.2</td>
<td>6.7</td>
<td>A</td>
</tr>
<tr>
<td>Elsinore-Glen-Ivy</td>
<td>17.3</td>
<td>6.8</td>
<td>A</td>
</tr>
<tr>
<td>Raymond</td>
<td>17.5</td>
<td>6.5</td>
<td>B</td>
</tr>
</tbody>
</table>
5.4.3 Liquefaction Evaluation
Liquefaction occurs when saturated fine sands, silts or low plasticity clays lose their physical strength during earthquake-induced shaking and behave as a liquid. This is due to loss of point-to-point grain contact and transfer of normal stress to the pore water. Liquefaction potential varies with groundwater level, soil type, material gradation, relative density, and the intensity and duration of ground shaking.

Based on the presence of medium dense to dense sand and gravel with cobbles and the absence of groundwater in the borings, the potential for liquefaction of site soils is considered low.

5.4.4 Seismic Settlement Evaluation
Seismic settlement (dynamic densification) occurs when loose to medium dense granular soils densify during seismic events. The site materials consisted predominantly of medium dense to dense sands and gravels with cobbles which are not considered likely to experience significant seismic settlement. We also expect that shallow loose or disturbed materials present on the site will be mitigated through removal and replacement with compacted fill, as recommended herein, in order to facilitate the proposed construction. Therefore, in our opinion, the potential for seismic settlement resulting in damage to site improvements is considered low.
5.4.5 Tsunami and Seiche Evaluation

Due to site elevation and distance from the Pacific Ocean, the site is not considered to be subject to damage from tsunamis. Based on the absence of large bodies of water in the area, seiche (oscillatory waves in standing bodies of water) damage is also not expected.

5.4.6 Landsliding

No features typically associated with landsliding were noted during the site investigation. In the reference review, no evidence of landslides was found to have occurred within the area of the site. Therefore, the potential for landsliding to affect the site is considered very low.

5.4.7 Compressible and Expansive Soils

Based on our investigation, site soils are expected to have low compressibility characteristics relative to the post-construction overburden. Based on the results of expansion index testing, site soils are anticipated to have very low expansion potential.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 General

Based on our investigation, the proposed construction on the site is feasible from a geotechnical standpoint, provided the recommendations in this report are incorporated into design and construction of the project. Preliminary recommendations for the design and construction of the proposed development are included in the subsequent sections of this report. Additional recommendations could be required based on the actual conditions encountered during earthwork and/or improvement construction.
6.2 Site Preparation

6.2.1 General

Prior to grading, the site should be cleared of debris and deleterious materials. In areas to receive structures or distress-sensitive improvements, surficial eroded, desiccated, burrowed, or otherwise loose or disturbed soils should be removed to the depth of competent material as recommended below in Section 6.2.2. Organic and other deleterious materials not suitable for use as structural backfill should be disposed of offsite at a legal disposal site.

6.2.2 Remedial Grading and Excavations

Due to the presence of disturbed surface soil and undocumented fill, and in order to provide uniform structural support, remedial grading will be required. The proposed building pads should be excavated to a depth of 5-feet below existing grade, or 3-feet below footing bottoms, whichever is greater. The excavations should extend laterally at least 5-feet beyond the foundation limits.

The soils exposed at the bottom of the over-excavations should be documented by a geotechnical representative of this office to determine their suitability. If unsuitable materials are encountered at the bottom of the excavation, they should be removed to the depth of competent natural material.
Based on review of the conceptual grading plan (adc, 2015) and remedial grading recommendations herein, building pad over-excavations are expected to be a minimum of 5 feet below existing grade. Excavations for the new parking lot southwest of the existing Technip building are anticipated to be approximately 2 to 12 feet below existing grades.

Temporary, unsurcharged excavations up to four feet deep may be cut vertically. Deeper excavations should be sloped back or shored. Temporary sloped excavations should be cut at a slope of 1:1 (horizontal:vertical) or flatter. Vehicles and storage loads should not be placed within 10 feet of the top of the excavation. If temporary slopes are to be maintained during the rainy season, berms are recommended along the tops of slopes to divert runoff water from entering the excavation and eroding the slope faces.

6.2.3 Preparation of Areas to Receive Fill
Exposed excavation bottoms and subgrade surfaces to receive fill should be scarified to a minimum depth of 8 inches, brought to +/- 2 percent of optimum moisture content and compacted to at least 90 percent of the maximum dry density as determined by ASTM D 1557.

6.2.4 Fill Placement and Compaction
Structural fill and backfill should be compacted to at least 90 percent of the maximum dry density (as determined by ASTM D 1557) at moisture content +/-2 percent of
optimum. The upper 12-inches of pavement subgrade should be compacted to at least 95 percent of the maximum dry density (per ASTM D 1557) at a moisture content of +/-2 percent of optimum. Compaction equipment should be appropriate for the materials being compacted. The optimum lift thickness for fill soils will be dependent on the type of compaction equipment being utilized. Generally, fill should be placed in uniform horizontal lifts not exceeding 8 inches in loose thickness. Placement and compaction of fill should be performed in general conformance with geotechnical recommendations and local ordinances.

Soils generated from on-site excavations are anticipated to be suitable for use as structural fill, provided they are free from debris and deleterious material. Rocks or other soil fragments greater than four inches in size should not be used in the fills. Proposed import material should be evaluated by the project geotechnical engineer prior to being placed at the site. Import materials should consist of non-corrosive, granular material with an expansion index less than 20.

6.2.5 Utility Trenches

Utility trenches should be excavated in accordance with the recommendations presented in Section 6.2.2. Backfill should be placed in loose lifts no greater than eight inches and mechanically compacted to a relative compaction of at least 90 percent of the maximum
dry density (per ASTM D 1557) at moisture content +/-2 percent of optimum moisture content.

6.3 Foundations and Slab Recommendations

6.3.1 General

Foundations and slabs for the proposed structures should be designed in accordance with structural considerations and the following minimum preliminary geotechnical recommendations. Foundations are expected to be supported in properly compacted fill material.

6.3.2 Shallow Foundations

Following site grading, it is our opinion that the use of isolated and continuous footings will be geotechnically suitable for the proposed structures. We recommend that continuous footings be constructed a minimum of 18 inches wide and be founded at least 24 inches below the lowest adjacent rough grade elevation. Isolated footings should be a minimum of 24 inches in dimension and founded at least 24 inches below rough grade elevation.

Foundation dimensions should be based on an allowable bearing pressure of 2,500 pounds per square foot (psf) for the minimum footing dimensions noted above. The allowable bearing value may be increased by one-third for short-duration loading which includes the effects of wind or seismic forces. Actual footing dimensions should be determined by the structural engineer.
Reinforcement within continuous footings should consist of a minimum of four number 4 bars, two located near the top of the footing and two located near the bottom. This minimum reinforcement is due to geotechnical conditions and is not to be used in lieu of that needed for structural considerations. Reinforcement for isolated footings should be determined by the structural engineer.

Lateral loads for structures supported on spread footings may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.35 may be used between foundations and the properly compacted fill supporting materials. The passive resistance of the soils may be assumed equal to the pressure developed by a fluid with a density of 300 pounds per cubic foot. A one-third increase in the passive value may be used for wind or seismic loads. The frictional resistance and the passive resistance may be combined without reduction in determining the total lateral resistance.

6.3.3 Settlement of Shallow Foundations
We have analyzed settlement potential during construction and for long-term performance. Construction settlement is expected to occur as loads are applied and structures are brought to their operational weight. Long-term settlement is expected to occur over time as a result of compression of wetted or partially saturated soil. Anticipated settlements are related to an applied bearing pressure of 2,500 psf.
It is anticipated that shallow foundations designed and constructed as recommended will experience maximum total settlement of 1 inch or less and differential static settlement of 1/2 inch or less over a distance of 40 feet or more.

6.3.4 Concrete Slabs-On-Grade
Concrete slabs-on-grade should be designed for the anticipated loading. Lightly loaded concrete slabs should measure a minimum of 5 inches thick and be reinforced with a minimum of number 3 reinforcing bars placed on 18-inch centers, each way at mid-slab height. An uncorrected modulus of subgrade reaction of 200 pci may be used for elastic design. Concrete slabs subjected to heavier loads may require thicker slab sections and/or increased reinforcement as per the project structural engineer. The correct placement of the reinforcement in the slab is vital for satisfactory performance under normal conditions.

In areas to receive moisture-sensitive floor coverings or used to store moisture-sensitive materials, a polyethylene or visqueen moisture vapor retarder (10-mil or thicker) should be placed beneath the slab. A four-inch layer of crushed rock or coarse clean sand should underlie the moisture vapor retarder. To protect the membrane during steel and concrete placement, a two-inch layer of sand may be placed over the moisture vapor retarder.

It is recommended that a water-cement ratio of 0.5 or less be used for concrete, and that the slab be moist-cured for at least five days in accordance with methods recommended
by the American Concrete Institute. On-site quality control should be used to confirm the design conditions.

6.3.5 Pipe Bedding and Thrust Blocks

We recommend that pipes be supported on a minimum of 6 inches of sand, gravel, or crushed rock. The pipe bedding material should be placed around the pipe, without voids, and to an elevation of at least 12 inches above the top of the pipe. The pipe bedding material should be compacted in accordance with the recommendations in the earthwork section of this report.

Thrust forces may be resisted by thrust blocks and the adjacent soil. Thrust blocks may be designed using a passive resistance in engineered fill equal to the pressure developed by a fluid with a density of 300 pounds per cubic foot (pcf).

6.4 Seismic Design Criteria

The seismic ground motion values listed in Table 2 below were derived in accordance with the ASCE 7-10 Standard that is incorporated into the California Building Code, 2013 (effective January 1, 2014). This was accomplished by establishing the Site Class based on the soil properties at the site, and then calculating the site coefficients and parameters using the United States Geological Survey Seismic Design Maps application for the 2013 CBC values. These
values are intended for the design of structures to resist the effects of earthquake ground motions. The site coordinates used in the application were 34.0931°N and 117.7220°W.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
<th>CBC REFERENCE (2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Class</td>
<td>D</td>
<td>ASCE 7, Chapter 20</td>
</tr>
<tr>
<td>Mapped Spectral Response Acceleration Parameter, $S_s$</td>
<td>2.685g</td>
<td>Figure 1613.3.1 (1)</td>
</tr>
<tr>
<td>Mapped Spectral Response Acceleration Parameter, $S_1$</td>
<td>0.993g</td>
<td>Figure 1613.3.1 (2)</td>
</tr>
<tr>
<td>Seismic Coefficient, $F_a$</td>
<td>1.000</td>
<td>Table 1613.3.3 (1)</td>
</tr>
<tr>
<td>Seismic Coefficient, $F_v$</td>
<td>1.500</td>
<td>Table 1613.3.3 (2)</td>
</tr>
<tr>
<td>MCE Spectral Response Acceleration Parameter, $S_{MS}$</td>
<td>2.685g</td>
<td>Section 1613.3.3</td>
</tr>
<tr>
<td>MCE Spectral Response Acceleration Parameter, $S_{M1}$</td>
<td>1.490g</td>
<td>Section 1613.3.3</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration, Parameter $S_{DS}$</td>
<td>1.790g</td>
<td>Section 1613.3.4</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration, Parameter $S_{DI}$</td>
<td>0.993g</td>
<td>Section 1613.3.4</td>
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<tr>
<td>Mapped MCE Geometric Peak Ground Acceleration, $PGA_M$</td>
<td>0.958g</td>
<td>ASCE 7, Chapter 11</td>
</tr>
<tr>
<td>Seismic Design Category</td>
<td>E</td>
<td>ASCE 7 Chapter 11</td>
</tr>
</tbody>
</table>

6.5 Vehicular Pavements
Pavement sections were evaluated using a design ‘R’ value of 50 correlating to a modulus of subgrade reaction of approximately 200 pci for site subgrade soil. The laboratory determined R value for site soil was 63. The pavement section recommendations are based on the assumption
that the subgrade soil (the top 12-inches minimum) will be compacted to a minimum of 95 percent of the maximum dry density (per ASTM D 1557).

If concrete pavement is used, it should have a minimum modulus of rupture (flexural strength) of 600 psi. We estimate that a 4,500 psi 28-day compressive strength concrete would generally provide the minimum required flexural strength; however, other mix designs could also meet the requirements. As such, we recommend that the contractor submit the proposed mix design with necessary documentation to offer a proper level of confidence in the proposed concrete materials. Recommended concrete pavement sections are presented below in Table 3.

<table>
<thead>
<tr>
<th>Traffic Area</th>
<th>Assumed Traffic Index</th>
<th>Design Modulus of Subgrade Reaction (pci)</th>
<th>PCC Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking</td>
<td>5.0</td>
<td>200</td>
<td>6.0</td>
</tr>
<tr>
<td>Driveways</td>
<td>6.0</td>
<td>200</td>
<td>6.0</td>
</tr>
</tbody>
</table>

An unreinforced pavement with the minimum thickness indicated above should generally be constructed with maximum joint spacing of 24 times the pavement thickness, in both directions, and in nearly square patterns. As an alternative, the concrete pavement could be constructed
with typical minimal reinforcement consisting of #4 bars at 18 inches, on-center, both ways, at or above mid-slab height and with proper concrete cover.

Recommended asphalt concrete pavement sections are presented below in Table 4.

<table>
<thead>
<tr>
<th>Traffic Area</th>
<th>Assumed Traffic Index</th>
<th>Design ‘R’ Value</th>
<th>AC Thickness (inches)</th>
<th>Aggregate Base Thickness* (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking Areas</td>
<td>5.0</td>
<td>50</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Roadways</td>
<td>6.0</td>
<td>50</td>
<td>3.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

* Minimum R Value of 78.

In addition, it is recommended that pavement areas conform to the following criteria:

- Placement and construction of the recommended pavement section should be performed in accordance with the Standard Specifications for Public Works Construction (Greenbook, latest edition).

- Aggregate base should conform to the specification for Caltrans Class 2 Aggregate Base (Caltrans, 2010) or Greenbook Crushed Aggregate Base (CAB).

- Pavement sections are prepared assuming that periodic maintenance will be done, including sealing of cracks and other measures.
6.6 Retaining Walls
If retaining walls are proposed, the following recommendations should be incorporated into
design and construction. For the design of walls where the surface of the backfill is level, it may
be assumed that the on-site sandy soils will exert an active lateral pressure equal to that
developed by a fluid with a density of 40 pounds per cubic foot (pcf). The active pressure should
be used for walls free to yield at the top at least 0.2 percent of the wall height. For walls
restrained at the top so that such movement is not permitted, a pressure corresponding to an
equivalent fluid density of 60 pcf should be used, based on at-rest soil conditions. These
pressures should be increased by 20 pcf for walls retaining soils inclined at 2:1
(horizontal:vertical).

Retaining walls over six feet high should be designed for earthquake forces. Lateral pressures on
cantilever retaining walls (yielding walls) due to earthquake motions may be calculated based on
work by Seed and Whitman (1970). The total lateral thrust against a properly drained and
backfilled cantilever retaining wall above the groundwater level can be expressed as:

\[ P_{AE} = P_A + \Delta P_{AE} \]
For non-yielding (or “restrained”) walls, the total lateral thrust may be similarly calculated based on work by Wood (1973):

\[ P_{KE} = P_K + \Delta P_{KE} \]

Where:

\[ P_A = \text{Static Active Thrust} \]
\[ P_K = \text{Static Restrained Wall Thrust} \]
\[ \Delta P_{AE} = \text{Dynamic Active Thrust Increment} = (3/8) k_h \gamma H^2 \]
\[ \Delta P_{KE} = \text{Dynamic Restrained Thrust Increment} = k_h \gamma H^2 \]
\[ k_h = 2/3 \text{ Peak Ground Acceleration} = 2/3 (PGA_M) = 0.64g \]
\[ H = \text{Total Height of the Wall} \]
\[ \gamma = \text{Total Unit Weight of Soil} \approx 135 \text{ pounds per cubic foot} \]

The increment of dynamic thrust in both cases should be distributed as an inverted triangle, with a resultant located at 0.6H above the bottom of the wall.

Recommendations for waterproofing the walls to reduce moisture infiltration should be provided by the project architect or structural engineer.

We recommend that walls be backfilled with soil having an expansion index of 20 or less with less than 30 percent passing the #200 sieve. The backfill area should include the zone defined by a 1:1 sloping plane, extended back from the base of the wall footing. Wall backfill should be
compacted to at least 90 percent relative compaction, based on ASTM D 1557. Backfill should not be placed until walls have achieved adequate structural strength. Heavy compaction equipment, which could cause distress to walls, should not be used. The recommended lateral earth pressures presented herein assume that drainage will be provided behind the walls to prevent the accumulation of hydrostatic pressures. A backdrain system (similar to that shown on Figure 3) should be provided to reduce the potential for the accumulation of hydrostatic pressures.

6.7 Corrosive Soils
Sulfate-containing solutions or soil can have a deleterious effect on the in-service performance of concrete. In order to evaluate the foundation environment, a representative sample of site soil was laboratory tested for pH, resistivity, soluble sulfate and chloride. The results of the tests are summarized in Table 5.

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>pH</th>
<th>Resistivity (ohm-cm)</th>
<th>Sulfate (ppm)</th>
<th>Chloride (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-6 @ 2-5 ft.</td>
<td>6.6</td>
<td>5,400</td>
<td>21</td>
<td>24</td>
</tr>
</tbody>
</table>

Based on ACI 18 Building Code and Commentary Table 4.3.1, sulfate exposure of less than 150 ppm is considered negligible. We recommend that Type II or Type V cement be used. The concrete should also have maximum water-cementitious material ratio of 0.50 and a minimum compressive strength of 4000 psi. We further recommend that at least a 3-inch thick concrete
cover be maintained over the reinforcing steel in concrete in contact with the soil.

Based on the results of the resistivity tests, site soil appears to be moderately corrosive to ferrous metals. We recommend plastic pipes be used. CTE does not practice in the field of corrosion engineering. Therefore, a corrosion engineer could be consulted to determine the appropriate protection for metallic improvements in contact with site soils.

6.8 Exterior Flatwork

Exterior concrete flatwork should have a minimum thickness of four inches, unless otherwise specified by the project architect. To reduce the potential for distress to exterior flatwork caused by minor settlement of foundation soils, we recommend that such flatwork be installed with crack-control joints at appropriate spacing as recommended by the structural engineer. Flatwork, such as driveways, sidewalks, and architectural features, should be installed with crack control joints. The upper six inches of subgrade should be prepared in accordance with the earthwork recommendations provided herein. Positive drainage should be established and maintained adjacent to flatwork as per the recommendations of the project civil engineer of record.

6.9 Drainage

Positive drainage at a slope of 2 percent or more should be established for a minimum distance of five feet away from structures and improvements, and as recommended by the project civil engineer of record. To facilitate this, the proper use of construction elements such as roof drains, downspouts, earthen and/or concrete swales, sloped external slabs-on-grade, and subdrains may
be employed. The project civil engineer should thoroughly evaluate the on-site drainage and make provisions as necessary to keep surface water from entering structural areas.

6.10 Preliminary Infiltration Assessment
Site infiltration areas were not known to us at the time of our investigation. However, a preliminary infiltration assessment is presented here based on the soil conditions encountered in the soil borings. Two infiltration systems are proposed, one will be a basin located east of the new Technip parking lot, and the other an underground infiltration system beneath pavement located south of the proposed buildings. The bottoms of the systems are anticipated to be at elevations between 5 and 10 feet below existing or proposed grades. Based on the soils encountered in the upper 10 feet across the site, consisting of sands and gravels, we anticipate soil infiltration rates to be 0.5 inch/hour or faster. Percolation/infiltration testing will be needed to confirm anticipated infiltration rates for design of systems.

6.11 Plan Review
CTE should be authorized to review project grading and foundation plans and the project specifications before the start of earthwork to identify potential conflicts with the recommendations contained in this report.

7.0 LIMITATIONS
The recommendations provided in this report are based on the anticipated construction and the subsurface conditions found in our explorations. The interpolated subsurface conditions should be checked in the field during construction to document that conditions are as anticipated.
Recommendations provided in this report are based on the understanding and assumption that CTE will provide the observation and testing services for the project. Earthwork should be observed and tested to document that grading activity has been performed according to the recommendations contained within this report. The project geotechnical engineer should evaluate footing excavations prior to placement of reinforcing steel.

The field evaluation, laboratory testing and geotechnical analysis presented in this report have been conducted according to current engineering practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in this area. No other warranty, expressed or implied, is made regarding the conclusions, recommendations and opinions expressed in this report. Variations may exist and conditions not observed or described in this report may be encountered during construction.

This report is applicable to the site for a period of three years after the issue date provided the project remains as described herein. Modifications to the standard of practice and regulatory requirements may necessitate an update to this report prior to the three years from issue.

Our conclusions and recommendations are based on an analysis of the observed conditions. If conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if required, will be provided upon request. CTE
should review project specifications for earthwork, foundation, and shoring-related activities prior to the solicitation of construction bids.

We appreciate this opportunity to be of service on this project. If you have any questions regarding this report, please do not hesitate to contact the undersigned.

Respectfully submitted,
Construction Testing & Engineering, South, Inc.

Clifford A. Craft, GE #243  Vincent J. Patula, CEG #2057
Senior Geotechnical Engineer  Senior Engineering Geologist

Robert L. Ellerbusch
Staff Geologist
REFERENCES

1. Architecture Design Collaborative (adc), 2015, Conceptual Grading Plan, Sheet C1.0, Keck Graduate Institute Mixed-Use, August 19.


4. California Division of Mines and Geology (DMG), 2000, Seismic Hazard Zone Report for the Ontario 7.5-Minute Quadrangle, Los Angeles County, California.


RETAILING WALL DRAIN DETAIL
KECK GRADUATE INSTITUTE STUDENT HOUSING
CLAREMONT, CALIFORNIA

Job No. 40-3341  Date JULY 2016  Figure 3

RETAINING WALL

WALL BACKFILL COMPACTED TO 90% RELATIVE COMPACTION

FINISH GRADE

3/4" GRAVEL SURROUNDED BY FILTER FABRIC (MIRAFI 140 N, OR EQUIVALENT)

WALL FOOTING

1' MIN

4" DIA PERFORATED PVC PIPE (SCHEDULE 40 OR EQUIVALENT) LAID WITH PERFORATIONS DOWN. MINIMUM 1% GRADIENT TO SUITABLE OUTLET.

MINIMUM 6" LAYER OF 3/4" GRAVEL UNDERLYING PIPE.
APPENDIX A

FIELD EXPLORATION METHODS AND EXPLORATION LOGS
Soil Boring Methods
Relatively “Undisturbed” Soil Samples
Relatively “undisturbed” soil samples were collected using a modified California-drive sampler (2.4-inch inside diameter, 3-inch outside diameter) lined with sample rings. Drive sampling was conducted in general accordance with ASTM D-3550. The steel sampler was driven into the bottom of the borehole with successive drops of a 140-pound weight falling 30-inches. Blow counts (N) required for sampler penetration are shown on the boring logs in the column “Blows/Foot.” The soil was retained in brass rings (2.4 inches in diameter, 1.0 inch in height) and sealed in waterproof plastic containers for shipment to the CTE, South, Inc. geotechnical laboratory.

Disturbed Soil Sampling
Bulk soil samples were collected for laboratory analysis using two methods. Standard Penetration Tests (SPT) were performed according to ASTM D-1586 at selected depths in the borings using a standard (1.4-inches inside diameter, 2-inches outside diameter) split-barrel sampler. The steel sampler was driven into the bottom of the borehole with successive drops of a 140-pound weight falling 30-inches. Blow counts (N) required for sampler penetration are shown on the boring logs in the column “Blows/Foot.” Samples collected in this manner were placed in sealed plastic bags. Bulk soil samples of the drill cuttings were also collected in large plastic bags. The disturbed soil samples were returned to the CTE, South, Inc. geotechnical laboratory for analysis.
### DEFINITION OF TERMS

<table>
<thead>
<tr>
<th>PRIMARY DIVISIONS</th>
<th>SYMBOLS</th>
<th>SECONDARY DIVISIONS</th>
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<tr>
<td>GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE</td>
<td>GW</td>
<td>WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES</td>
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<tr>
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<td>GP</td>
<td>POORLY GRADED GRAVELS OR GRAVEL SAND MIXTURES, LITTLE OR NO FINES</td>
</tr>
<tr>
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<td>GM</td>
<td>SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, NON-PLASTIC FINES</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, PLASTIC FINES</td>
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<td></td>
<td>SC</td>
<td>CLAYEY SANDS, SAND-CLAY MIXTURES, PLASTIC FINES</td>
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<td>SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50</td>
<td>ML</td>
<td>INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, SLIGHTLY PLASTIC CLAYEY SILTS</td>
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<tr>
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<td>CL</td>
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<td>OL</td>
<td>ORGANIC SILTS AND ORGANIC CLAYS OF LOW PLASTICITY</td>
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<tr>
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<td>MH</td>
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<td>CH</td>
<td>INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS</td>
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<td></td>
<td>OH</td>
<td>ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTY CLAYS</td>
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### GRAIN SIZES

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<tr>
<th>BOULDERS</th>
<th>COBBLES</th>
<th>GRAVEL</th>
<th>SAND</th>
<th>SILTS AND CLAYS</th>
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<td>12&quot;</td>
<td>3&quot;</td>
<td>3/4&quot;</td>
<td>4</td>
<td>10</td>
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<tr>
<td>CLEAR SQUARE SIEVE OPENING</td>
<td>U.S. STANDARD SIEVE SIZE</td>
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### ADDITIONAL TESTS

(OTHER THAN TEST PIT AND BORING LOG COLUMN HEADINGS)

- MAX - Maximum Dry Density
- GS- Grain Size Distribution
- SE- Sand Equivalent
- EI- Expansion Index
- CHM- Sulfate and Chloride Content, pH, Resistivity
- COR - Corrosivity
- SD- Sample Disturbed
- PM- Permeability
- SG- Specific Gravity
- HA- Hydrometer Analysis
- AL- Atterberg Limits
- RV- R-Value
- CN- Consolidation
- CP- Collapse Potential
- HC- Hydrocollapse
- RDS- Remolded Direct Shear
- PP- Pocket Penetrometer
- WA- Wash Analysis
- DS- Direct Shear
- UC- Unconfined Compression
- MD- Moisture Density
- M- Moisture
- SC- Swell Compression
- OL- Organic Impurities
BORING LEGEND

- Block or Chunk Sample
- Bulk Sample
- Standard Penetration Test
- Modified Split-Barrel Drive Sampler (Cal Sampler)
- Groundwater Table
- Soil Type or Classification Change
- Formation Change ([Approximate boundaries queried (?)])

Quotes are placed around classifications where the soils exist in situ as bedrock.
## BORING: B-1

### Description

**4.5" AC / 5" Base**

<table>
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<tr>
<th>Depth (Feet)</th>
<th>Bulk Type</th>
<th>Dry Density (pcf)</th>
<th>Moisture (%)</th>
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<td>2.7</td>
<td></td>
<td>RV</td>
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<tr>
<td>7</td>
<td>SM</td>
<td>2.7</td>
<td></td>
<td>RV</td>
</tr>
<tr>
<td>12</td>
<td>SM</td>
<td>2.7</td>
<td></td>
<td>RV</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>1.2</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>17</td>
<td>M</td>
<td>1.2</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>1.2</td>
<td></td>
<td>M</td>
</tr>
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</table>

- **Young Alluvial Fan Deposits (Qyf)**
- Silty SAND with Gravel, medium dense, damp, dark brown.
- Silty SAND with Gravel, dense, dry, dark brown.
- Total Depth = 6.5 ft. below surface.
- Groundwater not encountered.
- Bore hole backfilled with soil cuttings and capped with asphalt patch.
### BORING: B-2

#### DESCRIPTION

**Turf**

Young Alluvial Fan Deposits (Qyf)

Silty SAND with Gravel, medium dense, moist, dark brown.

Refusal (rock) at 4' below surface.

Groundwater not encountered.

Bore hole backfilled with soil cuttings.
**BORING: B-3**

### DESCRIPTION

<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bulk</th>
<th>Sample</th>
<th>Driven</th>
<th>Blows/6 inches</th>
<th>Dry Density (pcf)</th>
<th>Moisture (%)</th>
<th>U.S.C.S. Symbol</th>
<th>Graphic Log</th>
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<tr>
<td>0</td>
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<td>Turf</td>
<td>Young Alluvial Fan Deposits (Qyf)</td>
<td>GRAVEL with Sand and Cobbles.</td>
<td>Refusal (rock) at 2' below surface.</td>
<td>Groundwater not encountered.</td>
<td>Bore hole backfilled with soil cuttings.</td>
<td></td>
</tr>
<tr>
<td>5</td>
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<td></td>
<td></td>
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**Laboratory Tests**
### BORING: B-4

#### DESCRIPTION

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<th>Depth (Feet)</th>
<th>Bulk Type</th>
<th>Dry Blows/6 inches</th>
<th>Moisture (%)</th>
<th>U.S.C.S. Symbol</th>
<th>Graphic Log</th>
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<tr>
<td>0</td>
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<tr>
<td>3</td>
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<td></td>
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<tr>
<td>17</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>M</td>
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<tr>
<td>30</td>
<td>M</td>
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</tbody>
</table>

#### Laboratory Tests

- **Artificial Fill**
  - Silty SAND with Gravel.
- **Young Alluvial Fan Deposits (Qyr)**
  - GRAVEL with Sand, damp, dark brown.
  - GRAVEL with Sand, dry, dark brown, scattered cobbles.
  - very rocky from 7 ft. to 10 ft.
- **Silty SAND with Gravel, dense, dry, brown.**
  - Refusal (rock) at 13’ below surface.
  - Groundwater not encountered.
  - Bore hole backfilled with soil cuttings.

### Notes

- MAX, EI GS
- MD
- Bore hole backfilled with soil cuttings.
BORING: B-5

DESCRIPTION

GP Young Alluvial Fan Deposits (Qyf)

GRAVEL with SAND, damp, dark brown, scattered cobbles.

Refusal (rock) at 4’ below surface.
Groundwater not encountered.
Bore hole backfilled with soil cuttings.
<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bulk Density (pcf)</th>
<th>Moisture (%)</th>
<th>U.S.C.S. Symbol</th>
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<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>121.1</td>
<td>3.4</td>
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<td>Artificial Fill</td>
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<tr>
<td></td>
<td>Silty SAND with Gravel, damp, dark brown.</td>
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</tr>
<tr>
<td>10</td>
<td>12.1</td>
<td>2.4</td>
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<td>Young Alluvial Fan Deposits (Qyf)</td>
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<tr>
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<td>Silty SAND with Gravel, damp, brown.</td>
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</tr>
<tr>
<td>14</td>
<td>2.4</td>
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<td>SM</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Silty SAND with Gravel, medium dense, damp, brown.</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>2.4</td>
<td></td>
<td>GP</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>very rocky from 7 ft to 9 ft.</td>
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<td></td>
</tr>
<tr>
<td>18</td>
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<td></td>
</tr>
<tr>
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<td>Silty SAND with Gravel, medium dense, damp, orange-brown.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
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<td>GP</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>very rocky from 12 ft to 14 ft.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Refusal (rock) at 14' below surface.
Groundwater not encountered.
Bore hole backfilled with soil cuttings.
BORING: B-7

DESCRIPTION

SM: Young Alluvial Fan Deposits (Qyf)

Silty SAND with Gravel, damp, brown.

GS

Refusal (rock) at 4' below surface.
Groundwater not encountered.
Bore hole backfilled with soil cuttings.
<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bulk Sample Type</th>
<th>Blows/6 inches</th>
<th>Dry Density (pcf)</th>
<th>Moisture (%)</th>
<th>U.S.C.S. Symbol</th>
<th>Graphic Log</th>
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<td>0</td>
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<td>40</td>
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<td>Refusal (rock) at 7' below surface.</td>
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<td>Bore hole backfilled with soil cuttings.</td>
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<td>~129' msl</td>
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#### DESCRIPTION

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<td>18</td>
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<td></td>
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</tbody>
</table>

**Artificial Fill**
- Silty SAND with Gravel, damp, brown.

**Young Alluvial Fan Deposits (Qyf)**
- (no recovery)
- Silty SAND with Gravel, medium dense, moist, brown.
  (as observed from cuttings)
- very rocky from 7 ft. to 10 ft.

**Old Alluvial Fan Deposits (Qof)**
- Silty SAND, dense, moist, orange-brown.

- GRAVEL with Sand, damp, brown.

- Silty SAND with Gravel, dense, damp, brown.

- Silty SAND with Gravel, damp, brown.

- Silty SAND, dense, moist, orange-brown.
### BORING: B-9 Cont'd.

<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bulk Driven</th>
<th>Dry Density (pcf)</th>
<th>Moisture (%)</th>
<th>U.S.C.S. Symbol</th>
<th>Graphic Log</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-25</td>
<td>12</td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
<td>Silty SAND, dense, moist, orange-brown. M</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>12.1</td>
<td></td>
<td></td>
<td></td>
<td>hard drilling from 25 ft. to 40 ft. M</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Silty SAND, medium dense, moist, orange-brown. M</td>
</tr>
<tr>
<td>-30</td>
<td>7</td>
<td></td>
<td>16.0</td>
<td></td>
<td></td>
<td>Silty SAND, medium dense, very moist, orange-brown. M</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Granitic Bedrock</td>
</tr>
</tbody>
</table>

**Granitic Bedrock** B-9b
<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Bulk</th>
<th>Sample</th>
<th>Type</th>
<th>Blows/6 inches</th>
<th>Moisture (%)</th>
<th>U.S.C.S. Symbol</th>
<th>Graphic Log</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| 50          | 28   | 50     |      |                | 5.6          |                |             | Granitic Bedrock  
weathered, moist, orange-brown and gray. | M  
Total Depth = 51 ft. below surface.  
Groundwater not encountered.  
Bore hole backfilled with soil cuttings. |
APPENDIX B

LABORATORY METHODS AND RESULTS
APPENDIX B
LABORATORY METHODS AND RESULTS

Laboratory tests were performed on selected soil samples to evaluate their engineering properties. Tests were performed following test methods of the American Society for Testing and Materials (ASTM), or other accepted standards. The following presents a brief description of the various test methods used. Laboratory results are presented in the following section of this Appendix.

Chemical Analysis
Soil materials were collected and tested for Sulfate and Chloride content, pH, and Resistivity.

Classification
Soils were classified visually according to the Unified Soil Classification System. Visual classifications were supplemented by laboratory testing of selected samples according to ASTM D 2487.

Expansion Index
Expansion Index testing was performed on a selected sample of the on-site soils according to ASTM D 4829.

In-Place Moisture/Density
The in-place moisture content and dry unit weight of selected relatively undisturbed samples in accordance with ASTM D 2216 and D 2937, respectively.

Moisture & Density Relations (Modified Proctor)
Moisture and density relations test was performed on a selected sample to determine the maximum dry density and optimum moisture content. The test was conducted in accordance with ASTM D 1557, method C.

Resistance “R” Value
The resistance “R”-value was measured by the CTM 301. The graphically determined “R” value at an exudation pressure of 300 pounds per square inch is the value used for pavement section calculation.

Sieve Analysis
Sieve analyses were performed on selected samples according to ASTM C 136 to determine grain-size distribution.
# REPORT OF RESISTANCE 'R' VALUE-EXPANSION PRESSURE

**Project Name:** Keck Graduate Institute  
**Project No.:** 40-3341  
**Sample Location:** B-1 @ 1-4'  
**Soil Description:** Dark Brown Silty Sand w/ Gravel  
**Test Procedure:** Cal 301  
**Lab No.:** 26413  
**Sampled By:** Not Submitted  
**Submitted By:** Not Submitted  
**Tested By:** Julian Carmona  
**Reviewed By:** Erik Campbell  
**Date:** 6/30/2016

<table>
<thead>
<tr>
<th>Specimen/ Mold No.</th>
<th>C</th>
<th>1</th>
<th>D</th>
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</thead>
<tbody>
<tr>
<td>Compactor Air Pressure, ft.lbs.</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Initial Moisture, %</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Wet Weight / Tare (g)</td>
<td>1945.5</td>
<td>1945.5</td>
<td>1945.5</td>
</tr>
<tr>
<td>Dry Weight / Tare (g)</td>
<td>1933.9</td>
<td>1933.9</td>
<td>1933.9</td>
</tr>
<tr>
<td>Tare (g)</td>
<td>745.9</td>
<td>745.9</td>
<td>745.9</td>
</tr>
<tr>
<td>Water Added, ml</td>
<td>70</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>Moisture at Compaction, %</td>
<td>6.9</td>
<td>7.3</td>
<td>7.7</td>
</tr>
<tr>
<td>Wt. Of Briquette and Mold, g</td>
<td>3181</td>
<td>3293</td>
<td>3256</td>
</tr>
<tr>
<td>Wt. Of Mold, g</td>
<td>2047</td>
<td>2111</td>
<td>2090</td>
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<tr>
<td>Wt. Of Briquette,g</td>
<td>1134</td>
<td>1183</td>
<td>1167</td>
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<td>Height of Briquette, in</td>
<td>2.45</td>
<td>2.50</td>
<td>2.40</td>
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<td>Dry Density,pcf</td>
<td>131.3</td>
<td>133.7</td>
<td>136.8</td>
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<td>Stabilometer PH @ 1000 lbs</td>
<td>12</td>
<td>28</td>
<td>30</td>
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<tr>
<td>Stabilometer PH @ 2000 lbs</td>
<td>20</td>
<td>40</td>
<td>52</td>
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<td>Displacement</td>
<td>3.86</td>
<td>4.80</td>
<td>4.88</td>
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<td>R' Value</td>
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<td>51</td>
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<tr>
<td>Corrected 'R' Value</td>
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<td>60</td>
<td>51</td>
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<tr>
<td>Exudation Pressure, lbs</td>
<td>9997</td>
<td>2954</td>
<td>1800</td>
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<tr>
<td>Exudation Pressure, psi</td>
<td>800</td>
<td>236</td>
<td>144</td>
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<tr>
<td>Stabilometer Thickness - ft</td>
<td>0.18</td>
<td>0.38</td>
<td>0.47</td>
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<tr>
<td>Expansion Pressure</td>
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</tr>
<tr>
<td>Expansion Press, Thick-ft</td>
<td>0.00</td>
<td>0.00</td>
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<p>| | | |</p>
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<thead>
<tr>
<th></th>
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<tr>
<td>Exudation</td>
<td>63</td>
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<tr>
<td>Expansion</td>
<td>100</td>
<td></td>
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<tr>
<td>R-value</td>
<td>63</td>
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</tbody>
</table>

- **TI:** 4.5  
- **Expansion:** 100

**Cover Thickness by Expansion Pressure-Feet**  
**Expansion From Graph:** 0

---

**R VALUE @ 300 LBS/IN2**

**EXUDATION PRESSURE, LBS/IN2**

---

**Erik Campbell**  
*Laboratory Manager*
LABORATORY COMPACTION OF SOIL (MODIFIED PROCTOR)
ASTM D 1557

Project Name: Keck Graduate Institute Housing
CTE Project No.: 40-3341
Lab No.: 8275
Sample No.: B-4 @ 1-5 ft.
Sample Description: Gravel with Sand

<table>
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<tr>
<th>TEST NO.</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Wt. of Mold (lbs)</td>
<td>6.059</td>
<td>6.059</td>
<td>6.059</td>
<td>6.059</td>
</tr>
<tr>
<td>Net Wt. of Soil (lbs)</td>
<td>10.308</td>
<td>10.727</td>
<td>10.960</td>
<td>10.688</td>
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<tr>
<td>Wet Wt. of Soil + Cont. (g)</td>
<td>1360.2</td>
<td>1883.3</td>
<td>1947.2</td>
<td>1975.5</td>
</tr>
<tr>
<td>Dry Wt. of Soil + Cont. (g)</td>
<td>1330.9</td>
<td>1812.2</td>
<td>1852.6</td>
<td>1845.9</td>
</tr>
<tr>
<td>Wt. of Container (g)</td>
<td>498.7</td>
<td>498.7</td>
<td>498.7</td>
<td>498.7</td>
</tr>
</tbody>
</table>

| Moisture Content (%) | 3.5 | 5.4 | 7.0 | 9.6 |
| Wet Density (pcf) | 137.4 | 143.0 | 146.1 | 142.5 |
| Dry Density (pcf) | 132.8 | 135.7 | 136.6 | 130.0 |

PROCEDURE USED

- **Procedure A**
  Soil Passing 4 in. (4.75 mm) Sieve
  Mold: 4 in. (101.6 mm) diameter
  Layers: 5 (five)
  Blows per layer: 25 (twenty-five)
  May be used if No.4 retained <= 25%

- **Procedure B**
  Soil Passing 3/8 in. (9.5 mm) Sieve
  Mold: 4 in. (101.6 mm) diameter
  Layers: 5 (five)
  Blows per layer: 25 (twenty-five)
  May be used if 3/8" retained <= 25%

- **Procedure C**
  Soil Passing 3/4 in. (19.0 mm) Sieve
  Mold: 6 in. (152.4 mm) diameter
  Layers: 5 (five)
  Blows per layer: 56 (fifty-six)
  May be used if 3/4" retained <= 30%

OVERSIZE FRACTION
Total Sample Weight (g): 12573

<table>
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<th>Weight Retained (g)</th>
<th>Percent Retained</th>
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<td>3379</td>
<td>26.9</td>
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<tr>
<td>Plus 3/8&quot;</td>
<td></td>
</tr>
<tr>
<td>Plus #4</td>
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</table>

Maximum Dry Density (pcf): 137.0
Optimum Moisture Content (%): 6.5
Rock Correction Applied per ASTM D 4718
Maximum Dry Density (pcf): 144.0
Optimum Moisture Content (%): 5.0
PARTICLE SIZE ANALYSIS

<table>
<thead>
<tr>
<th>Sample Designation</th>
<th>Sample Depth (feet)</th>
<th>Symbol</th>
<th>Liquid Limit (%)</th>
<th>Plasticity Index</th>
<th>Classification</th>
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<tr>
<td>B-4</td>
<td>1-5</td>
<td>●</td>
<td>NP</td>
<td>NP</td>
<td>GP</td>
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<tr>
<td></td>
<td></td>
<td>■</td>
<td>Cu=217</td>
<td>Cc=0.4</td>
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CTE JOB NUMBER: 40-3341  KGI
PARTICLE SIZE ANALYSIS

<table>
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<tr>
<th>Sample Designation</th>
<th>Sample Depth (feet)</th>
<th>Symbol</th>
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<th>Plasticity Index</th>
<th>Classification</th>
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<td>B-6</td>
<td>5</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>SM</td>
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CTE JOB NUMBER: 40-3341  KGI
EXPANSION INDEX TEST

CTE Project Number: 40-3341

Project Name: Keck Graduate Institute Housing

Sample ID: B-4 @ 1-5 ft.

Test Start Date: 7-8-2016
Time: 7:30 am
Initial Reading: 0.0045

Test Finish Date: 7-9-2016
Time: 7:30 am
Final Reading: 0.0045

Specimen Moisture Content: 7.7 %
Specimen Dry Density: 117.4 pcf
Specimen Percent Saturation: 51.9 %

Expansion (inches): 0.0000

Expansion Index: 0

Expansion Potential: Very Low
Attached is the analytical report for the sample(s) received for your project. Below is a list of the individual sample descriptions with the corresponding laboratory number(s). Also, enclosed is a copy of the Chain of Custody document (if received with your sample(s)). Please note any unused portion of the sample(s) may be responsibly discarded after 30 days from the above report date, unless you have requested otherwise.

Thank you for the opportunity to serve your analytical needs. If you have any questions or concerns regarding this report please contact our client service department.

Sample Identification

<table>
<thead>
<tr>
<th>Lab Sample #</th>
<th>Client Sample ID</th>
<th>Matrix</th>
<th>Date Sampled</th>
<th>By</th>
<th>Date Submitted</th>
<th>By</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6G0131-01</td>
<td>40-3341: B-6 @ 2-5'</td>
<td>Soil</td>
<td>06/30/16 11:00</td>
<td>Rob Ellerbusch</td>
<td>07/05/16 12:50</td>
<td>R. Ellerbusch</td>
</tr>
</tbody>
</table>
Client Name: Construction Testing & Eng., Inc.
Contact: Robert Ellersbach
Address: 14538 Meridian Parkway, Suite A
          Riverside, CA 92518
Report Date: 08-Jul-2016

Analytical Report: Page 2 of 3
Project Name: Const. Test.-Soils
Project Number: Keck Graduate Institute - Claremont, CA
Work Order Number: B6G0131
Received on Ice (Y/N): No
Temp: °C

**Laboratory Reference Number**
B6G0131-01

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<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Matrix</th>
<th>Sampled Date/Time</th>
<th>Received Date/Time</th>
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<tbody>
<tr>
<td>40-3341: B-6 @ 2-5'</td>
<td>Soil</td>
<td>06/30/16 11:00</td>
<td>07/05/16 12:50</td>
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</tbody>
</table>

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<table>
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<tr>
<th>Analyte(s)</th>
<th>Result</th>
<th>RDL</th>
<th>Units</th>
<th>Method</th>
<th>Analysis Date</th>
<th>Analyst</th>
<th>Flag</th>
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<tr>
<td>Saturated Paste pH</td>
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<td>0.1</td>
<td>pH Units</td>
<td>S-1.10 W.S.</td>
<td>07/07/16 17:41</td>
<td>nhb</td>
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<tr>
<td>Minimum Resistivity</td>
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<td>10</td>
<td>ohm-cm</td>
<td>Cal Trans 643</td>
<td>07/07/16 17:41</td>
<td>nhb</td>
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</tr>
<tr>
<td>Water Extract Chloride</td>
<td>24</td>
<td>10</td>
<td>ppm</td>
<td>Ion Chromat.</td>
<td>07/08/16 02:09</td>
<td>ss</td>
<td>N-SAG, N_WEX</td>
</tr>
<tr>
<td>Sulfate</td>
<td>21</td>
<td>10</td>
<td>ppm</td>
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<td>07/08/16 02:09</td>
<td>ss</td>
<td>N-SAG, N_WEX</td>
</tr>
</tbody>
</table>
Client Name: Construction Testing & Eng., Inc.
Contact: Robert Ellerbusch
Address: 14538 Meridian Parkway, Suite A
Riverside, CA 92518

Report Date: 08-Jul-2016

Analytical Report: Page 3 of 3
Project Name: Const. Test.-Soils
Project Number: Keck Graduate Institute - Claremont, CA
Work Order Number: B6G0131
Received on Ice (Y/N): No
Temp: °C

Notes and Definitions

N_WEX: Analyte determined on a 1:10 water extract from the sample.

N-SAG: Results reported in ppm are expressed on an air dried soil basis.

ND: Analyte NOT DETECTED at or above the Method Detection Limit (if MDL is reported), otherwise at or above the Reportable Detection Limit (RDL)

NR: Not Reported

RDL: Reportable Detection Limit

MDL: Method Detection Limit

*: NELAP does not offer accreditation for this analyte/method/matrix combination

Approval

Enclosed are the analytical results for the submitted sample(s). Babcock Laboratories certify the data presented as part of this report meet the minimum quality standards in the referenced analytical methods. Any exceptions have been noted. Babcock Laboratories and its officers and employees assume no responsibility and make no warranty, express or implied, for uses or interpretations made by any recipients, intended or unintended, of this report.

A. Guerra

cc: mailing
P.O. Box 432
Riverside, CA 92502-0432

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6100 Quail Valley Court
Riverside, CA 92507-0704

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F 951 653 1662
www.babcocklabs.com

e-Short_No_Alias.rpt
CA ELAP No. 2698
EPA No. CA00102
NELAP No. OR4035
LACSD No. 10119