APPENDIX F

GEOTECHNICAL REPORT

KLEINFELDER
Bright People. Right Solutions.

November 16, 2018
Kleinfelder Project No.: 20192059.001A

Costco Wholesale
9 Corporate Park, Suite 230
Irvine, California 92606

Attention: Ms. Diana P. Salazar
Director of Real Estate Development

Subject: Geotechnical Study
Proposed Fuel Facility
Costco Wholesale Warehouse No. 122
2655 El Camino Real
Tustin, California
CW# 18-0212

Dear Ms. Salazar:

Kleinfelder is pleased to present this report summarizing our geotechnical study for the proposed fuel facility at Costco Wholesale Warehouse No. 122 located at 2655 El Camino Real in Tustin, California. The purpose of our geotechnical study was to evaluate subsurface soil and groundwater conditions at the project site to provide geotechnical recommendations for design and construction. The conclusions and recommendations presented in this report are subject to the limitations presented in Section 7.

We appreciate the opportunity to provide geotechnical engineering services to you on this project. If you have any questions regarding this report or if we can be of further service, please do not hesitate to contact Brian Crystal at (949) 727-4466, or Andy Franks, Kleinfelder's Client Account Manager for Costco, at (480) 650-4905.

Respectfully submitted,

KLEINFELDER

Daniel A. Castle, PE
Staff Engineer

Brian E. Crystal, PE, GE
Senior Project Manager

24411 Ridge Route Dr., Suite 225, Laguna Hills, CA 92653 p | 949.727.4466 f | 949.727.9242

GEOTECHNICAL STUDY
PROPOSED FUEL FACILITY
COSTCO WHOLESALE WAREHOUSE NO. 122
2655 EL CAMINO REAL
TUSTIN, CALIFORNIA
CW# 18-0212

KLF PROJECT NO. 20192059.001A

NOVEMBER 16, 2018

A Report Prepared for:

Costco Wholesale
9 Corporate Park, Suite 230
Irvine, California 92606

Geotechnical Study
Proposed Fuel Facility
Costco Wholesale Warehouse No. 122
2655 El Camino Real
Tustin, California
CW# 18-0212

Prepared by:

Daniel A. Castle, PE
Staff Engineer

Reviewed by:

Brian E. Crystal, PE, GE
Senior Project Manager

KLEINFELDER
24411 Ridge Route Drive, Suite 225
Laguna Hills, California 92653
Phone: 949.727.4466
Fax: 949.727.9242

November 16, 2018
Kleinfelder Project No. 20192059.001A

KLEINFELDER
Bright People. Right Solutions.

Geotechnical Investigation Summary Checklist for Costco Wholesale Projects

General Information

Costco Real Estate Main Contact:	Diana Salazar
Geotechnical Main Contact:	Brian Crystal (949-585-3113)
Geotechnical Engineer of Record:	Kleinfelder
Project Location:	2655 El Camino Real, Tustin, CA
CW#:	18-0212
Warehouse #:	122
Report Date:	November 16, 2018
Consultant Project/Document Number:	20192059.001A/IRV18R86544
Addendums (List):	

Report Purpose: ☐ Preliminary ☐ Draft ☒ Final ☐ Addendum/Revision

	Yes	No or NA	Describe/ Comments	Report Section
Pre-existing Conditions/Information				
Developer provided geotechnical report (describe):	☐	☒		1.2.1
Pre-existing development (describe)	☒	☐	Existing asphalt parking lot & retail development	2.1
Foundation type (describe):	☒	☐	Shallow & Deep	4.3
Performance Issues (describe):	☐	☒		
Environmental Issues (describe)	☐	☒		
Site Grading Records (stripping, compaction test results, field reports, etc.)	☐	☒		
Typical Building Structural Design Criteria				
Other (describe):	☐	☐	New fuel facility	1.1
Building size (describe):	☒	☐		1.1
Typical wall loading				
3 kips / foot* (Metal Buildings)	☐	☒		
4.5 kips / foot* (CMU or pre-cast)	☐	☒		
Typical column loading				
120 kips in non-snow regions	☐	☒		
150 kips in snow regions	☐	☒		
Typical canopy loading:	☐	☒	30 kips for fuel facility canopy	1.1
Typical floor slab loading				
500 pounds per square foot, (psf, total)	☐	☒		
250 psf (dead) at rack areas	☐	☒		
150 psf (dead) at non-rack areas	☐	☒		
350 psf (live)	☐	☒		
Paving Design (20-year life)				
Heavy Duty paving shall accommodate 30 trucks per day (Traffic Index of 7.0)	☒	☐		4.6.2
Light Duty paving shall accommodate 6,600 cars per day (Traffic Index of 5.0)	☒	☐		4.6.2

	Yes	No or NA	Describe/ Comments	Report Section
Performance Grade (PG) binder oil identified for local climate conditions	☒	☐	PG 64-10	4.6.3
Site Grading Conditions/Assumptions				
Deviations to Typical Criteria (list/describe):	☐	☒		
Design Finished Floor Elevation (FFE) (describe):	☐	☒		
Basis for FFE (assumed, per Civil) (describe):	☐	☒		
Effects of change to assumed FFE (describe):	☐	☒		
Maximum anticipated cuts (describe):	☐	☒		1.1
Maximum anticipated fills (describe):	☐	☒		
Cross sections prepared for sites that are not essentially flat	☐	☒		
Amount of import/export anticipated (describe):	☐	☒		
Frost Depth (describe):	☐	☒		
Retaining walls				
Number of walls (describe):	☐	☒		
Height/Length of walls (describe):	☐	☒		
Wall construction/type (describe):	☐	☒		
Cut/fill transition in pad (describe):	☐	☒		
Offsite Improvements (describe)	☐	☒		
Fieldwork/Results				
Costco Due Diligence Design Criteria				
Version (describe):	☒	☐	Version 2016, dated September 19, 2016	
Followed Criteria?	☒	☐		
Deviations to standard investigation (describe):	☐	☒		
Groundwater				
Depth (describe):	☒	☒	Approx. 29 feet below existing grade.	3.2
Perched	☐	☒		
Expected seasonal fluctuation (describe):	☒	☐		3.2
Piezometers installed?	☐	☒		
Unusual/Challenging Soils conditions encountered				
Moisture-sensitive soils	☒	☐		5.3
Undocumented fill	☐	☒		3.1.1
Unsuitable soils (require removal)	☐	☒		
Wet soils	☒	☐		5.3
Debris	☐	☒		

	Yes	No or NA	Describe/ Comments	Report Section
Bedrock/potential non-rippable conditions	☐	☒		
Refusal	☐	☒		
Collapsible soils	☐	☒		
Expansive soils	☐	☒	Low expansion potential in upper 5 feet	3.3.5
Compressible soils	☐	☒		
Liquefaction	☐	☒		
Sinkholes	☐	☒		
Other (describe):	☐	☒		
Potential Contamination Identified				
Soil	☐	☒		
Groundwater	☐	☒		
Restoration of Disturbed Areas				
Backfilled with soil	☒	☐		
Backfilled with grout	☒	☐		
Other (describe):	☐	☒		
Topsoil samples collected/analyzed	☐	☒		
Corrosivity testing performed/addressed	☒	☐	Corrosive to ferrous metals	4.7
Report				
Executive summary	☒	☐		E-1
Wet weather construction recommendations	☒	☐		5.2
Pad winterization/pad recommendations	☐	☒		
Frost protection recommendations	☐	☒		
Design Parameters				
Fill material parameters provided				
Structural fill (below foundations, slabs)	☒	☐		5.2.3
Site grading fill (below pavements, flatwork)	☒	☐		5.2.3
Select backfill (behind truck dock walls, foundations, grade beams, etc.)	☐	☒		
Trench backfill	☒	☐		5.2.6
Drainage fill	☐	☒		
Frost resistant fill	☐	☒		
Slab base aggregate	☐	☒		

	Yes	No or NA	Describe/ Comments	Report Section
Limits of debris/unsuitable removal provided	☐	☒		
Over-excavation/recompaction required	☐	☒		5.2.2
Depth (describe):	☐	☒		5.2.2
Extent (include cross-section diagram)	☐	☒		
Pad subgrade stabilization required (describe):	☐	☒	If needed	5.3
Surcharge	☐	☒		
Height (describe):	☐	☒		
Lateral extent (describe):	☐	☒		
Estimated duration (describe):	☐	☒		
Shallow Foundations	☒	☐		
psf allowable soil bearing pressure (describe):	☒	☐	3,000 psf	4.3.2
Deep Foundations	☐	☒		
Type (describe):	☒	☐	Drilled piles	4.4.3
Options and Value Engineering Matrix provided	☐	☒		
Floor Slabs				
Unreinforced (>2500 psf)	☐	☒		
Reinforced (describe why)	☐	☒		
Subgrade modulus (ksi/in) (describe):	☐	☒		
Base Material thickness (min 6") (describe):	☐	☒		
Seismic Conditions				
Governing Building Code (IBC, UBC, other)	☒	☐	2016 California Building Code	4.2
Geologic Hazard Identified	☐	☒		
Proximity to earthquake fault zone(s)	☐	☒		3.3
Proximity to seismic hazard zone(s)	☐	☒		3.3
Potential for liquefaction	☐	☒		3.3.4
Potential for lateral spreading	☐	☒		
Potential for seismic settlement	☒	☐	Anticipated to be less than ½ inch	3.3.4
Potential for slope stability/landslides	☐	☒		
Potential for groundshaking or geologic hazards	☒	☐	High	3.3
Retaining Walls	☐	☒		
Recommended Wall Types	☐	☒		

	Yes	No or NA	Describe/ Comments	Report Section
Recommend Kleinfelder Design	☐	☒		
Lateral earth pressure design values	☐	☒		
Active:	☐	☒		
At-rest:	☐	☒		
Passive:	☐	☒		
Seismic:	☐	☒		
Backfill material, placement requirements	☐	☒		
Drainage requirements and cross-section drawing	☐	☒		
Finger Drains	☒	☐		4.5
Required for frost	☐	☒		
Recommended for long term maintenance and constructability	☐	☒		
Pavement				
Pavement subgrade stabilization required (describe):	☐	☒	Proof-roll, scarify, and recompact	5.2.2
Costco asphalt mix design specified	☒	☐		4.6.3
Heavy and light duty pavement sections specified	☒	☐		4.6.2
Alternative pavement sections identified	☒	☐		4.6.4
Specification for offsite pavement sections included	☐	☒		
Data Gaps/Unknowns (describe):	☐	☒		

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS (Continued)

Section **Page**

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

This report presents the results of our geotechnical study for the proposed new fuel facility at Costco Wholesale Warehouse No. 122 located at 2655 El Camino Real in Tustin, California. The site is currently part of Costco's parking lot. The purpose of our study is to evaluate subsurface soil and groundwater conditions at the project site to provide geotechnical recommendations for design and construction. Our geotechnical study was based on the Costco Wholesale Development Requirements (CWDRs), Version 2016, dated September 19, 2016.

The new fueling facility will consist of four gasoline refueling islands each with four pumps, three 40,000-gallon underground storage tanks (UST), a fuel additive UST, a controller enclosure, and a canopy structure. New asphalt concrete and Portland cement concrete pavements will be constructed as well. In addition, a retail building located immediately adjacent to an existing supermarket southwest of the warehouse will be demolished for additional surface parking. Grading plans were not available at this time; however, we anticipate the finished grades surrounding the new facility will generally match the existing grades with grade changes of a foot or less for positive drainage.

Subsurface conditions at the site were explored by drilling five borings. The borings were drilled to depths between approximately 3½ and 51½ feet below the existing ground surface (bgs). Soil materials encountered during the subsurface explorations consisted of fill overlying alluvium. As observed in our borings, the fill consists generally of medium stiff to stiff clays with varying amounts of sand content and clayey sands. The alluvium consists of fine-grained medium stiff to very stiff clays with varying amounts of sand content and isolated thin layers of medium dense to dense sands, silty sands, and clayey sands with gravel. The upper clayey fill is considered to have a low expansion potential based on laboratory testing. Groundwater was encountered in Boring B-3 at a depth of approximately 29 feet bgs.

Based on the results of our field exploration, laboratory testing, and geotechnical analyses, it is our professional opinion that the proposed project is geotechnically feasible, provided the recommendations presented in this geotechnical report are incorporated into the project design and construction. The following key items were developed from our study.

- The proposed fuel facility may be supported on a conventional shallow foundation system. As an alternative, the canopy may be supported on drilled piles.

- Based on our field exploration and understanding of the regional geology, we classify the site as Site Class D. Seismic design parameters are provided in Table 1 in Section 4.2.
- Spread footing foundations for the fuel facility canopy and kiosks will bear on the existing soil at the site. Following excavation to foundation subgrade elevation, exposed subgrade should be observed by a representative of Kleinfelder to evaluate the presence of satisfactory materials at design elevations. If unsatisfactory material, such as soft or disturbed soil, debris or otherwise unsuitable soil is present at the base of the footing excavation, it should be overexcavated and replaced with structural fill, structural concrete, or a 2-sack sand-cement slurry to the depth determined by the Kleinfelder representative.
- For new pavement areas for the new fuel facility, we recommend that the exposed subgrade be proof-rolled with heavy construction equipment (e.g. loader or smooth-drum roller) to disclose areas of soft and yielding material. Where soft and yielding material is observed, it should be overexcavated and replaced as structural fill. After proof-rolling and/or prior to placement of fill, the subgrade should be scarified to a depth of 6 to 8 inches, moisture conditioned, and compacted in accordance to the compaction criteria below. The proof-rolling should extend beyond the proposed improvements a horizontal distance of at least 2 feet, if practicable.
- For pavement areas for the new surface parking area, we recommend that the existing soils be overexcavated to a depth of at least 12 inches below existing grade or 12 inches below the finished subgrade elevation, whichever is deeper, after the area has been stripped of construction debris and soft earth materials. Prior to placing fill, the exposed subgrade be proof-rolled with heavy construction equipment (e.g. loader or smooth-drum roller) to disclose areas of soft and yielding material. Where soft and yielding material is observed, it should be overexcavated and replaced as structural fill. The overexcavated soil may be reused as structural fill.
- Due to poor draining subgrade conditions, we recommend drainage inlets and catch basins include pavement underdrains as shown in Detail 16_16 of the CWDRs.
- Due to the difficulty of compacting clays and the potential for expansion, we do not recommend compacting clayey soils to at least 95 percent. Clayey soils should be compacted to at least 92 percent of the soils maximum dry unit weight (ASTM D1557) at moisture contents of at least the optimum moisture content. Compacting the onsite clayey sands to at least 92 percent relative compaction will achieve the necessary strength assumed in our design recommendations. The moisture content of the fill should be maintained at 2 percent above optimum during compaction. If both criteria (minimum

compaction and moisture content) are not within the specified tolerances, the fill should not be accepted, and the contractor should rework the material until the fill is placed within the specified tolerances.

- Depending on time of year wet, unstable, or unsuitable soils may be encountered and may need to be removed. The contractor should be prepared to provide stabilization or other measures to stabilize wet soils as needed. Recommendations to stabilize wet or pumping subgrade are provided in Section 5.3.
- Based on our experience, it is common to encounter wet, unstable soils upon removal of site pavements or flatwork as a result of subsurface moisture becoming trapped beneath relatively impervious asphalt concrete or Portland cement concrete surfaces. The contractor should anticipate that pumping subgrade conditions may be encountered during site grading activities, and the subgrade may need to be stabilized. Recommendations to stabilize pumping subgrade are provided in Section 5.3.
- The minimum resistivity of the sample indicates that the soil may be highly corrosive to metals. The concentrations of soluble sulfates indicate that the subsurface soils represent a Class S0 exposure to sulfate attack on concrete in contact with the soil based on ACI 318-14 Table 19.3.1.1 (ACI, 2014). Therefore, in accordance with ACI Building Code 318-14, no special provisions for selection of cement type are required.
- Based on visual soil classification and laboratory testing of the soil samples collected during the prior field exploration, the onsite soils in the fill and alluvial soils consist primarily of fine-grained clays with varying amounts of sand and medium dense to dense clayey sands. Given the low infiltration capacity of the on-site soils, we recommend alternatives to infiltration Best Management Practices (BMPs), such as bio-filtration/bio-retention systems (bio-swales and planter boxes), be implemented at the project site.

The findings, conclusions, and recommendations presented in this executive summary should not be relied upon without consulting our geotechnical report for more detailed description of the geotechnical evaluation performed by Kleinfelder. The conclusions and recommendations presented in this report are subject to the limitations presented in Section 7.

1 INTRODUCTION

This report presents the results of our geotechnical study for the proposed fuel facility at Costco Wholesale Warehouse No. 122 located at 2655 El Camino Real in Tustin, California. The location of the project site is presented on Figure 1, Site Vicinity Map. The purpose of our study is to evaluate subsurface soil and groundwater conditions at the project site to provide geotechnical recommendations for design and construction. The scope of our services was presented in our proposal titled, "Proposal for Geotechnical Study, Proposed Fuel Facility, Costco Wholesale Warehouse No. 122, 2655 El Camino Real, Tustin, California 92782, CW# 18-0212," dated September 25, 2018.

Our report includes a description of the work performed, a discussion of the geotechnical conditions observed at the site, and recommendations developed from our engineering analyses of field and laboratory data. Our geotechnical study was based on the Costco Wholesale Development Requirements (CWDRs), Version 2016, dated September 19, 2016.

1.1 PROJECT DESCRIPTION

We understand Costco plans to construct a new fuel facility located to the south of the existing warehouse. The proposed fuel facility site is currently parking for the warehouse that is planned to be demolished to facilitate construction of the fuel facility. The new fueling facility will consist of four gasoline refueling islands each with four pumps, three 40,000-gallon underground storage tanks (USTs), a fuel additive UST, a controller enclosure, and a canopy structure. New asphalt concrete and Portland cement concrete pavements will be constructed as well. In addition, a retail building located immediately adjacent to the existing supermarket southwest of the warehouse will be demolished for additional surface parking.

Based on our experience with fuel facilities, the canopy for the service islands is typically founded on spread footings and the design is typically governed by overturning moments from wind and seismic loading. Typical column dead loads are anticipated to be approximately 4 kips and typical live loads are approximately 30 kips, which result in bearing pressures of less than 500 pounds per square (psf).

The tank excavation is anticipated to be approximately 16 feet deep. The tanks are planned to be placed on gravel bedding and anchored with "deadmen" anchors to resist potential buoyant forces. Grading plans were not provided; however, we anticipate the finished grades surrounding the new facility will generally match the existing grades with maximum grade changes of two feet or less.

1.2 SCOPE OF SERVICES

The scope of our geotechnical study consisted of a literature review, subsurface explorations, geotechnical laboratory testing, engineering evaluation and analysis, and preparation of this report. Studies to assess environmental hazards that may affect the soil and groundwater at the site are addressed under separate cover. A description of our scope of services performed for the geotechnical portion of the project follows.

1.2.1 Task 1 – Background Data Review

We reviewed readily-available published and unpublished geologic literature in our files and the files of public agencies, including selected publications prepared by the California Geological Survey (formerly known as the California Division of Mines and Geology) and the U.S. Geological Survey (USGS). We also reviewed readily available seismic and faulting information, including data for designated earthquake fault zones as well as our in-house database of faulting in the general site vicinity.

1.2.2 Task 2 – Field Exploration

Subsurface conditions at the site were explored by drilling five borings to depths between approximately 3½ and 51½ feet below the existing ground surface (bgs). The borings were drilled using truck-mounted hollow-stem-auger drilling equipment. The approximate locations of the explorations are presented on Figure 2. Boring B-4 (a proposed 10-foot boring) was not drilled due to safety concerns from an impending thunderstorm during our fieldwork.

Prior to commencement of the fieldwork, various geophysical techniques were used at the exploration locations to identify potential conflicts with subsurface structures. Exploration locations were also cleared for buried utilities through Underground Service Alert (USA).

A Kleinfelder engineer supervised the field operations and logged the explorations. Selected bulk and drive samples were retrieved and transported to our laboratory for further evaluation. The number of blows necessary to drive a Standard Penetration Test (SPT) sampler or a California-type sampler was recorded. Appendix A presents a description of the field exploration program, exploration logs, and a legend of terms and symbols used on the logs. Soil descriptions used on the logs result from field observations and data, as well as from laboratory test data. Stratification lines on the logs represent the approximate boundary between soil and/or rock types, and the actual transition may vary and can be gradual.

1.2.3 Task 3 – Laboratory Testing

Laboratory testing was performed on representative bulk and relatively undisturbed samples to assist in soil classification and development of engineering parameters for geotechnical design. Laboratory testing consisted of moisture content, dry unit weight, grain-size distribution, Atterberg limits, R-value, and preliminary corrosion potential tests (sulfate, pH, minimum resistivity, chloride content). Appendix B presents a summary of the testing performed.

1.2.4 Task 4 – Geotechnical Analyses

We analyzed field and laboratory data in conjunction with the assumed finished grades, facility layout, and assumed structural loads to provide geotechnical recommendations for the design and construction. We evaluated feasible foundation systems, including constructability and compatibility constraints, pavement support, and earthwork. Potential geologic hazards, including ground shaking, liquefaction potential, flood hazard, fault rupture hazard, and seismically-induced settlement were also evaluated. Seismic design parameters based on the 2016 California Building Code (CBC) are also presented.

1.2.5 Task 5 – Report Preparation

This report summarizes the work performed, data acquired, and our findings, conclusions, and geotechnical recommendations for the design and construction of the proposed addition. Our report includes the following items:

- Executive summary and geotechnical checklist per the CWDRs;
- Site Vicinity Map (Figure 1) and Exploration Location Map (Figure 2) showing the approximate exploration locations;
- Boring logs (Appendix A);
- Results of laboratory tests (Appendix B);
- Discussion of general site conditions;
- Discussion of general subsurface conditions as encountered in our field exploration, including the depth to groundwater;
- Discussion of geologic and seismic hazards;

- Recommendations for seismic design parameters in accordance with the 2016 CBC;
- Recommendations for site preparation, earthwork, temporary slope inclinations, fill placement, and compaction specifications;
- Recommendations for the excavation of subsurface soil deposits;
- Recommendations for the UST excavation side slopes, including temporary shoring recommendation;
- Recommendations for foundation design (shallow foundation and drilled pile), allowable bearing pressures, embedment depths, settlement estimates, and compatibility constraints under various loading conditions;
- Recommendations for flexible and rigid pavement structural sections for light- and heavy-duty pavement based on the traffic loading, as stated in the CWDRs;
- Preliminary evaluation of the corrosion potential of the on-site soils; and
- Recommendations for storm water management.

2 SITE CONDITIONS

2.1 SITE DESCRIPTION

The proposed fuel facility site is located southwest the existing Costco warehouse, as shown in Figure 2. The site is currently part of the existing parking lot. The area of the proposed fuel facility is bounded by the existing Costco warehouse parking lot to the northeast, El Modena Channel to the southeast, El Camino Real to the southwest, and an existing retail development to the northwest. The area of proposed parking lot expansion located southwest of the existing warehouse is currently occupied by an existing retail development.

2.2 SURFACE DRAINAGE CONDITIONS

Site drainage is currently by sheet flow over the developed lot into storm drains, or onto the adjacent bordering streets and into the local storm-drain system.

3 SUBSURFACE CONDITIONS

3.1 SUBSURFACE CONDITIONS

Subsurface conditions at the location of the proposed fuel facility consists of fill placed during previous grading at the site over alluvial material. A discussion of the subsurface materials encountered is presented in the following sections. Detailed descriptions of the deposits are provided in our boring logs presented in Appendix A.

3.1.1 Fill

Fill soils associated with previous site grading were encountered in our explorations during our field investigation. The fill consists generally of medium stiff to stiff clays with varying amounts of sand content and clayey sands. As observed in our borings, the fill depth encountered within our borings was approximately 7 to 9½ feet thick near the proposed fuel facility.

3.1.2 Alluvium

The fill is underlain by alluvial soils. The alluvium consists of fine-grained medium stiff to very stiff clays with varying amounts of sand content and isolated thin layers of medium dense to dense sands, silty sands, and clayey sands with varying amounts of gravel.

3.2 GROUNDWATER

During our subsurface exploration, groundwater was encountered within Boring B-3 at a depth approximately 29 feet bgs. Historic high groundwater levels in the area has been mapped at a depth approximately 20 feet below grade. Fluctuations of the groundwater level, localized zones of perched water, and increased soil moisture content should be anticipated during and following the rainy season.

3.3 ASSESSMENT OF POTENTIAL GEOLOGIC HAZARDS

3.3.1 Localized Faulting

The site is not located within or nearby a currently delineated State of California Alquist-Priolo Earthquake Fault Zone (CGS, 2018). Additionally, published regional geologic maps do not indicate faults within or nearby the site. Based on absence of known faults nearby the site, it is our opinion that the hazard with respects to fault rupture is low.

3.3.2 Flood Hazard

The Federal Emergency and Management Administration (FEMA) maintain a collection of Flood Insurance Rate Maps (FIRM), which cover the entire United States. These maps identify those areas which may be subjected to 100-year and 500-year cycle floods. Based on our review of the maps, the site is located within Zone X. Zone X is defined as an area of a 0.2 percent chance of flooding; an area of 1 percent annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 1 percent annual flood chance. The flood zone is based on our review of FEMA Map Number 06059C0281J (FEMA, 2009).

3.3.3 Landsliding

Landslides are ground failures (several tens to hundreds of feet deep) in which a (mass of earth material, including debris and often portions of bedrock) large section of a slope detaches and slides downhill. Landslides are not to be confused with minor surficial slope failures (slumps), which are usually limited to the topsoil zone and can occur on slopes composed of almost any geologic material. Landslides can cause damage to structures both above and below the slide mass. Structures above the slide area are typically damaged by undermining of foundations. Areas below a slide mass can be damaged by being overridden and crushed by the failed slope material.

Because the existing site consists of a relatively level pad with no significant nearby slopes, it is our opinion that the hazard with respects to landslides or other forms of natural slope instability is considered negligible.

3.3.4 Liquefaction and Seismic Settlement

The term liquefaction describes a phenomenon in which saturated, cohesionless soils temporarily lose shear strength (liquefy) due to increased pore water pressures induced by strong, cyclic ground motions during an earthquake. Structures founded on or above potentially liquefiable soils may experience bearing capacity failures due to the temporary loss of foundation support, vertical settlements (both total and differential), and/or undergo lateral spreading. The factors known to influence liquefaction potential include soil type, relative density, grain size, confining pressure, depth to groundwater, and the intensity and duration of the seismic ground shaking. Liquefaction is most prevalent in loose to medium dense, silty, sandy, and gravelly soils below the groundwater table.

Because of subsurface soils at the site are comprised of medium stiff to hard clays and sandy clays with medium plasticity, the potential for liquefaction is not considered a hazard at the site. Seismic settlement is anticipated to be less than ½ inch.

3.3.5 Expansive Soils

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors and may result in unacceptable settlement or heave of structures or concrete slabs supported on grade.

The fill soils in the upper 5 feet generally consisted of sandy clay to lean clay with varying amounts of sand. Based on the expansion index lab testing performed, the sandy clay and lean clay fill is considered to have a low expansion potential. Our recommendations include mitigation measures for the relatively low expansive soils.

3.3.6 Subsidence

The site is not located in an area of known ground subsidence due to the withdrawal of subsurface fluids. Accordingly, the potential for subsidence occurring at the site due to the withdrawal of oil, gas, or water is considered low.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

Based on the results of our field exploration, laboratory testing and engineering analyses conducted during this study, it is our professional opinion that the proposed project is geotechnically feasible, provided the recommendations presented in this report are incorporated into the project design and construction.

- The proposed fuel facility may be supported on a conventional shallow foundation system. As an alternative, the canopy may be supported on drilled piles.
- Spread footing foundations for the fuel facility canopy may bear on the existing soil at the site. Following excavation to foundation subgrade elevation, exposed subgrade should be observed by a representative of Kleinfelder to evaluate the presence of satisfactory materials at design elevations. If unsatisfactory material, such as soft or disturbed soil, debris or otherwise unsuitable soil is present at the base of the footing excavation, it should be overexcavated and replaced with structural fill, structural concrete, or a 2-sack sand-cement slurry to the depth determined by the Kleinfelder representative.
- For new pavement areas for the new fuel facility, we recommend that the exposed subgrade be proof-rolled with heavy construction equipment (e.g. loader or smooth-drum roller) to disclose areas of soft and yielding material after the area has been stripped of soft earth materials and debris. Where soft or yielding material are observed, the material should be overexcavated and replaced with structural fill. The proof-rolling should extend beyond the proposed improvements a horizontal distance of at least 2 feet, if practicable.
- For pavement areas for the new surface parking area, we recommend that the existing soils be overexcavated to a depth of at least 12 inches below existing grade or 12 inches below the finished subgrade elevation, whichever is deeper, after the area has been stripped of construction debris and soft earth materials. Prior to placing fill, the exposed subgrade be proof-rolled with heavy construction equipment (e.g. loader or smooth-drum roller) to disclose areas of soft and yielding material. Where soft and yielding material is observed, it should be overexcavated and replaced as structural fill. The overexcavated soil may be reused as structural fill.
- Due to poor draining subgrade conditions, we recommend drainage inlets and catch basins include pavement underdrains as shown in Detail 16_16 of the CWDRs.

- In the area of the proposed fuel facility, it is common to encounter wet, unstable soils upon removal of site pavements or flatwork as a result of subsurface moisture becoming trapped beneath relatively impervious asphalt concrete or Portland cement concrete surfaces. The contractor should anticipate that pumping subgrade conditions may be encountered during site grading activities, and the subgrade may need to be stabilized. Recommendations to stabilize pumping subgrade are provided in Section 5.3.
- Due to compaction difficulties, we do not recommend compacting the onsite clayey soils to 95 percent of the maximum dry unit weight (ASTM D1557), as required in the CWDRs. Onsite clayey soils should be compacted to at least 92 percent of the soils maximum dry unit weight (ASTM D1557). Compacting the onsite soils to at least 92 percent relative compaction will achieve the necessary strength assumed in our design recommendations.
- The minimum resistivity of the sample indicates that the soil may be highly corrosive to metals. The concentrations of soluble sulfates indicate that the subsurface soils represent a Class S0 exposure to sulfate attack on concrete in contact with the soil based on ACI 318-14 Table 19.3.1.1 (ACI, 2014). Therefore, in accordance with ACI Building Code 318-14, no special provisions for selection of cement type are required.
- Based on visual soil classification and laboratory testing of the soil samples collected during the prior field exploration, the onsite soils in the fill and alluvial soils consist primarily of fine-grained clays with varying amounts of sand and medium dense to dense clayey sands. Given the low infiltration capacity of the on-site soils, we recommend alternatives to infiltration Best Management Practices (BMPs), such as bio-filtration/bio-retention systems (bio-swales and planter boxes), be implemented at the project site.

The following opinions, conclusions, and recommendations are based on the properties of the materials encountered in the borings, the results of the laboratory-testing program, and our engineering analyses performed. Our recommendations regarding the geotechnical aspects of the design and construction of the project are presented in the following sections.

4.2 SEISMIC DESIGN CONSIDERATIONS

4.2.1 2016 CBC Seismic Design Parameters

Based on information obtained from the investigation, published geologic literature and maps, and on our interpretation of the ASCE/SEI 7-10 criteria, it is our opinion that the project site may be classified as Site Class D, Stiff Soil, according to Section 1613.3.2 of 2016 CBC and Table 20.3-1 of ASCE/SEI 7-10 (2010). Approximate coordinates for the site are noted below.

- Latitude: 33.7277°N
- Longitude: 117.7963°W

The Risk-Targeted Maximum Considered Earthquake (MCE_R) mapped spectral accelerations for 0.2 seconds and 1 second periods (S_s and S_1) were estimated using Section 1613.3 of the 2016 CBC and the U.S. Geological Survey (USGS) web based application (available at http://geohazards.usgs.gov/designmaps/us/application.php). The mapped acceleration values and associated soil amplification factors (F_a and F_v) based on the 2016 CBC and corresponding site modified spectral accelerations (S_{MS} and S_{M1}) and design spectral accelerations (S_{DS} and S_{D1}) are presented in Table 1.

Table 1
2016 CBC Seismic Design Parameters

DESIGN PARAMETER	RECOMMENDED VALUE
Site Class	D
S_s (g)	1.493
S_1 (g)	0.549
F_a	1.0
F_v	1.5
S_{MS} (g)	1.493
S_{M1} (g)	0.824
S_{DS} (g)	0.995
S_{D1} (g)	0.549
PGA_M (g)	0.544

4.3 FOUNDATIONS

4.3.1 General

Based on the results of our field exploration, laboratory testing, and geotechnical analyses, the proposed fueling facility may be supported on a conventional shallow foundation system. As an alternative, the canopy may be supported on drilled piles. New light poles may also be supported on short drilled piles. Recommendations for the design and construction of spread footings and drilled piles are presented below.

4.3.2 Shallow Foundations

Allowable Soil Bearing Pressure

Spread footings founded on the alluvium soils may be designed for a net allowable soil bearing pressure of 3,000 psf for dead plus sustained live loads. Footings should be established at a depth of at least 24 inches below the lowest adjacent exterior grade, whichever is lower. A one-third increase in the above bearing pressures can be used for wind or seismic loads. The footing dimension and reinforcement should be designed by the structural engineer; however, continuous footings should have minimum widths of 18 inches.

Estimated Settlement

We understand that new spread footing foundations for the canopy will be embedded approximately 6 to 7 feet below the finished grade. We estimate total static settlement for foundations designed and constructed in accordance with the recommendations presented above to be approximately ½ inch. Differential static settlement between similarly loaded footings is estimated to be less than ½ inch over 50 feet.

Lateral Resistance

Lateral load resistance may be derived from passive resistance along the vertical sides of the footings, friction acting at the base of the footing, or a combination of the two. An allowable passive resistance of 250 psf per foot of depth may be used for design. Allowable passive resistance values should not exceed 2,500 psf. An allowable coefficient of friction value of 0.30 between the base of the footings and the engineered fill soils can be used for sliding resistance using the dead load forces. Friction and Friction and passive resistance may be combined without reduction. We recommend that the first foot of soil cover be neglected in the passive resistance calculations if the ground surface is not protected from erosion or disturbance by a slab, pavement or in a similar manner.

4.3.3 Drilled Pile Foundations

Axial Capacity

The compressive axial capacity of drilled piles may be estimated based on an average allowable skin friction capacity of 400 pounds per square foot. The upper one foot of the skin friction capacity should be ignored. The uplift capacity may be estimated as 70 percent of the allowable compressive axial capacity. A one-third increase in the allowable capacities may be used for transient loading conditions such as wind or seismic loads.

Settlement

Static settlement of the proposed canopy supported on drilled piles, as recommended, is estimated to be less than ½ inch.

Lateral Resistance

The drilled pile foundations lateral resistance can be designed in general accordance with Section 1807.3 of the 2016 CBC. We recommend a lateral soil bearing pressure of 250 psf per foot of depth below grade in the upper 15 feet. The total lateral soil bearing pressure should not exceed 2,500 psf per pile. Since drilled piles will act as isolated pole foundations, the allowable lateral soil bearing pressure may be increased by a factor of 2 for short-term lateral loads provided the structure will not be adversely affected by ½ inch of lateral movement at the ground surface.

4.4 EXTERIOR FLATWORK

Prior to casting exterior flatwork, the subgrade soils should be scarified, moisture conditioned, and recompacted or overexcavated, as recommended in Section 5.2.2. Exterior concrete slabs for pedestrian traffic or landscape should be at least four inches thick. Weakened plane joints should be located at intervals of about 6 feet. Careful control of the water/cement ratio should be performed to avoid shrinkage cracking due to excess water or poor concrete finishing or curing. Unreinforced slabs should not be built in areas where further saturation may occur following construction.

4.5 SITE DRAINAGE

Foundation and slab performance depends greatly on proper irrigation and how well runoff water drains from the site. This drainage should be maintained both during construction and over the entire life of the project. The ground surface around structures should be graded such that water drains rapidly away from structures without ponding. The surface gradient needed to do this depends on the surface type and should follow CWDRs (Costco, 2016).

Due to poor draining subgrade conditions, we recommend drainage inlets and catch basins include pavement underdrains as shown in Detail 16_16 of the CWDRs.

We recommend that landscape planters either not be located adjacent to structures and pavement areas or be properly drained to area drains. Drought resistant plants and minimum watering are recommended for planters immediately adjacent to structures. No raised planters should be installed immediately adjacent to structures unless they are damp-proofed and have a drainpipe connected to an area drain outlet. Planters should be built such that water exiting from them will not seep into the foundation areas or beneath slabs and pavement. Otherwise, waterproofing the slab and walls should be considered. Roof water should be directed to fall on hardscape areas sloping to an area drain, or roof gutters and downspouts should be installed and routed to area drains. Roof downspouts and their associated drains should be isolated from other subdrain systems to avoid flooding. In any event, maintenance personnel should be instructed to limit irrigation to the minimum necessary to properly sustain landscaping plants. Should excessive irrigation, waterline breaks, or unusually high rainfall occur, saturated zones and "perched" groundwater may develop. Consequently, the site should be graded so that water drains away readily without saturating the foundation or landscaped areas. Potential sources of water such as water pipes, drains, and the like should be frequently examined for signs of leakage or damage. Any such leakage or damage should be promptly repaired. Wet utilities should also be designed to be watertight.

4.6 PAVEMENTS

The required pavement structural sections will depend on the expected wheel loads, volume of traffic, and subgrade soils. We have provided asphalt concrete pavement sections for traffic indices provided in the CWDRs (Costco, 2016). Positive drainage of the paved areas should be provided since moisture infiltration into the subgrade may decrease the life of pavements. Curbing located adjacent to paved areas should be founded in the subgrade, not the aggregate base, to provide a cutoff, which reduces water infiltration into the base course.

The following pavement sections provided above are based on the soil conditions encountered during our field investigation, our assumptions regarding final site grades, and limited laboratory testing.

4.6.1 Costco Design Parameters

We developed pavement design recommendations using traffic indices provided in the CWDRs (2016) based on the following assumptions:

- A 20-year pavement design life;

- Light-duty pavements subject to 6,600 passenger vehicle trips per year (Traffic Index of 5.0);
- Heavy-duty pavements subject to 30 tractor-trailer truck tips per day (Traffic Index of 7.0);
- For asphalt concrete pavements: an R-value of 10 based on laboratory testing and our local experience; and
- For Portland cement concrete (PCC) Pavements: a 28-day flexural strength (modulus of rupture determined by the third-point method) of at least 550 pounds per square inch (psi) (approximate compressive strength of 4,000 psi); a modulus of subgrade reaction (k value) of 75 pounds per cubic inch (pci); and interlock at the control joints.

4.6.2 Asphalt Concrete Pavement

We have developed new pavements sections using the Caltrans Highway Design Manual so that the new pavement sections are compatible with the existing pavement sections. Hot Mix Asphalt (HMA) should conform to requirements of the Costco Wholesale Specification Section 321216, Asphalt Paving. Table 2 presents recommended HMA pavement sections. Prior to placement of aggregate base, pavement subgrade should be prepared in accordance with Section 5.2.2.

Table 2
Asphalt Concrete Pavement Sections

TRAFFIC USE	TRAFFIC INDEX, TI	ASPHALT CONCRETE * (INCHES)	AGGREGATE BASE (INCHES)
Light-Duty Pavement	5.0	4.0	6.5
Heavy-Duty Pavement	7.0	6.5	10.5

* rounded to the nearest ½ inch.

4.6.3 Asphalt Performance Grade Binder

An asphalt performance grade (PG) binder of 64-10 should be used for the project. This recommendation was developed in accordance with Costco Wholesale Asphalt Paving Specification Section 321216. Air temperature data nearest the project site was used with the MERRA Climate Data option and the PG binder was selected using the FHWA program LTTPBind Online web-based tool based on the AASHTO M323-13 standard. The high-end and low-end temperature rating was selected to provide a reliability of at least 98 and 90 percent, respectively.

4.6.4 Portland Cement Concrete Pavement

We designed PCC pavement in accordance with the Portland Cement Association (PCA) Thickness Design for Concrete Pavements (PCA, 1984) using the design parameters stated above. For heavy-duty pavements, we recommend that PCC pavement should be comprised of 8.0 inches of PCC with 6 inches of aggregate base. Prior to placement of aggregate base, pavement subgrade should be prepared in accordance with Section 5.2.2.

4.6.5 Aggregate Base

Aggregate base materials should meet current Caltrans specifications for Class 2 aggregate base. Alternatively, the aggregate base course could meet the specifications for untreated base materials (crushed aggregate base or crushed miscellaneous base) as defined in Section 200-2 of the current edition of the Standard Specifications for Public Works Construction (Greenbook). Please note that Caltrans Class 2 aggregate base and crushed miscellaneous base (CMB) may utilize recycled materials. The use of recycled material requires Costco's approval.

4.7 SOIL CORROSION

The corrosion potential of the on-site materials to steel and buried concrete was preliminarily evaluated. Laboratory testing was performed on two representative soil samples to evaluate pH, minimum resistivity, chloride and soluble sulfate content. The test results are presented in Table 3.

Table 3
Corrosion Test Results

BORING	DEPTH (FT)	MINIMUM RESISTIVITY (OHM-CM)	PH	SOLUBLE SULFATE CONTENT (PPM)	SOLUBLE CHLORIDE CONTENT (PPM)
B-2	3	831	8.7	393	188
B-3	10	1,309	7.4	54	58

These tests are only an indicator of soil corrosivity for the samples tested. Other soils found on site may be more, less, or of a similar corrosive nature. Imported fill materials should be tested to confirm that their corrosion potential is not more severe than those noted.

Resistivity values less 1,000 ohm-cm are considered extremely corrosive to buried ferrous metals (NACE, 2006). The concentrations of soluble sulfates indicate that the subsurface soils represent a Class S0 exposure to sulfate attack on concrete in contact with the soil based on ACI 318-14 Table 19.3.1.1 (ACI, 2014). Therefore, in accordance with ACI Building Code 318-14, no special provisions for selection of cement type are required.

Kleinfelder's scope of services does not include corrosion engineering and, therefore, a detailed analysis of the corrosion test results is not included. We understand gasoline station equipment is constructed of corrosion resistant synthetic materials. We recommend the gasoline station designer review these results and consult a corrosion expert for further evaluation, if necessary.

4.8 STORMWATER MANAGEMENT

We have evaluated the potential for storm water infiltration/percolation into the subgrade soils at the subject project site in accordance with to the Orange County Technical Guidance Document (TGD) for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans, dated December 20, 2013. Pursuant to the TGD, an infiltration evaluation is a two-step process. The first step is to characterize the site to assess whether infiltration is feasible. If infiltration is feasible, then infiltration testing is needed to provide a design infiltration rate (step two).

Based on visual soil classification and laboratory testing of the soil samples collected during the prior field exploration, the onsite soils in the fill and alluvial soils consist primarily of fine-grained clays with varying amounts of sand and medium dense to dense clayey sands. Given the low infiltration capacity of the on-site soils, we recommend alternatives to infiltration Best Management Practices (BMPs), such as bio-filtration/bio-retention systems (bio-swales and planter boxes), be implemented at the project site.

If bio-filtration/bio-retention systems are employed, we recommend that the BMPs be built such that water exiting from them will not seep into the foundation areas or beneath slabs and pavement. If planters are located within 10 feet of structures or foundations, or adjacent to slabs and pavements, then some means of diverting water away from the structures, foundation soils, or soils that support slabs and pavements would be required, such as lining the planters.

5 CONSTRUCTION RECOMMENDATIONS

5.1 GENERAL

The following recommendations should be used by the contractor for construction of the project.

5.2 EARTHWORK

5.2.1 General

Site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, state or federal specifications, and the recommendations included in this report. References to maximum dry unit weights are established in accordance with the latest version of ASTM Standard Test Method D1557 (modified Proctor). The earthwork operations should be observed and tested by a representative of Kleinfelder.

The moisture content of the fill is considered very important, and therefore, both relative compaction and moisture content should be used to evaluate compaction acceptance. If both criteria are not within the specified tolerances, the fill should not be accepted, and the contractor should rework the material until the fill is placed within the specified tolerances.

5.2.2 Site Preparation

Abandoned utilities, existing pavements, foundations, and other existing improvements within the proposed fuel facility areas should be removed and the excavation(s) backfilled with engineered fill. Debris produced by demolition operations, including wood, steel, piping, plastics, etc., should be separated and disposed of off-site. Existing utility pipelines or conduits that extend beyond the limits of the proposed construction and are to be abandoned in place, should be plugged with non-shrinking cement grout to prevent migration of soil and/or water. Demolition, disposal and grading operations should be observed and tested by a representative of Kleinfelder. Areas to receive fill should be stripped of all dry, loose or soft earth materials and unsuitable fill materials to the satisfaction of a representative of Kleinfelder.

- <u>Pavement, Sidewalks and Other Flatwork Areas for the New Fuel Facility</u>: After the area has been stripped of soft earth materials and debris, we recommend that the exposed subgrade be proof-rolled with heavy construction equipment (e.g. loader or smooth-drum roller) to disclose areas of soft and yielding material. Where soft and yielding material is observed, it should be overexcavated and replaced as structural fill. After proof-rolling and/or prior to placement of fill, the subgrade should be scarified to a depth of 6 to 8 inches, moisture conditioned, and compacted in accordance to the compaction criteria below. The proof-rolling should extend beyond the proposed improvements a horizontal distance of at least 2 feet.

- Pavement, Sidewalks and Other Flatwork Areas for the New Surface Parking Area: We recommend that the existing soils be overexcavated to a depth of at least 12 inches below existing grade or 12 inches below the finished subgrade elevation, whichever is deeper, after the area has been stripped of construction debris and soft earth materials. Prior to placing fill, the exposed subgrade be proof-rolled with heavy construction equipment (e.g. loader or smooth-drum roller) to disclose areas of soft and yielding material. Where soft and yielding material is observed, it should be overexcavated and replaced as structural fill. The overexcavated soil may be reused as structural fill.

Based on past experience, it is common to encounter wet, unstable soils upon removal of site pavements or flatwork as a result of subsurface moisture becoming trapped beneath relatively impervious asphalt concrete or Portland cement concrete surfaces. Perched groundwater may also develop above clayey soils, saturating near-surface materials. The contractor should anticipate that pumping subgrade conditions may be encountered during site grading activities, and the subgrade may need to be stabilized. Recommendations to stabilize pumping subgrade are provided in Section 5.3.

5.2.3 Foundation Excavations

Spread Footings

Following excavation to the foundation subgrade elevations, the exposed subgrade should be observed by a representative of the geotechnical engineer to evaluate the presence of satisfactory materials at design elevations. If unsatisfactory material, such as soft or disturbed soil, debris or otherwise unsuitable soil is present at the base of footing excavations, then unsuitable materials should be overexcavated and replaced (e.g. with structural concrete, 2-sack sand-cement slurry, structural fill) to the depth and extent determined by the geotechnical engineer. As a minimum, the contractor should be prepared to scarify, moisture condition, and re-compact the upper 12 inches of footing subgrade.

Drilled Piles

The performance and capacities of piles can be influenced significantly by the selected construction methods and procedures used. Construction methods that create large zones of disturbance around the drilled shafts can lead to lower than expected skin friction due to excessive stress relief around the shaft length. Drilling of the pile shafts should be accomplished using conventional heavy-duty excavation equipment maintained in good condition.

While clayey soils are not prone to caving, isolated pockets of sandy soils may cave during drilling of the pile shafts and temporary steel casing may be needed to stabilize the sides of the pile shaft. Concrete should be placed immediately after drilling of the hole is complete. The concrete should be pumped to the bottom of the drilled shaft using a down-hole tremie. If steel casing is used, the casing should be removed as the concrete is placed but the bottom of the casing should be kept at least 5 feet below the top of the concrete.

5.2.3 Fill Material and Compaction Criteria

The on-site soils, minus any debris, organic matter, or other deleterious materials, may be used in the site fills. Rock or other soil fragments greater than 3 inches in size should not be used in the fills. The presence of oversized materials, such as cobbles and boulders, should be anticipated.

Due to compaction difficulties, we do not recommend compacting the onsite clayey soils to 95 percent of the maximum dry unit weight (ASTM D1557), as required in the CWDRs. Onsite clayey soils should be compacted to at least 92 percent of the soils maximum dry unit weight (ASTM D1557). Compacting the onsite soils to at least 92 percent relative compaction will achieve the necessary strength assumed in our design recommendations.

The moisture content of the fill should be maintained at 2 percent above optimum during compaction. If both criteria (minimum compaction and moisture content) are not within the specified tolerances, the fill should not be accepted, and the contractor should rework the material until the fill is placed within the specified tolerances.

Fill should be placed in loose horizontal lifts not more than 8 inches thick (loose measurement). The prepared subgrade in paved areas should be covered with aggregate base within 24 hours to reduce drying of the subgrade soil. Utility trench backfill should be mechanically compacted. Flooding should not be permitted.

Based on past experiences, it is common to encounter wet, unstable soils upon removal of site pavements or flatwork as a result of subsurface moisture becoming trapped beneath relatively impervious asphalt concrete or Portland cement surfaces. Processing may require ripping the material, disking to break up clumps, and blending to attain uniform moisture contents necessary for compaction. Compaction of mass graded areas should be accomplished with a sheep's foot type roller compactor to aid in moisture conditioning.

Import materials, if required, should have an expansion index of less than 20 with no more than 30 percent of the particles passing the No. 200 sieve and no particles greater than 3 inches in maximum dimension. The maximum expansion index for imported soils may be modified by the project geotechnical engineer depending on its proposed use. Imported fill should be documented to be free of hazardous materials, including petroleum or petroleum byproducts, chemicals and harmful minerals. Kleinfelder should evaluate the proposed imported materials prior to their transportation and use on site.

5.2.4 Excavation Characteristics

The existing fill and alluvium deposits consist of medium stiff to very stiff clays with varying amounts of sand. The excavations for the USTs and foundations should be excavatable with conventional heavy-duty construction equipment. However, caving of the sidewalls during excavation in the may occur depending on conditions at the time of excavation and should be anticipated by the contractor.

A representative of Kleinfelder should be present during excavation in this area to observe the soil conditions. If soft, loose, or deleterious materials are encountered in the base of the excavation then the materials should be removed and replaced as compacted fill or otherwise remediated to provide competent bearing material under site improvements.

5.2.5 Temporary Excavations

All excavations must comply with applicable local, state, and federal safety regulations, including OSHA requirements. The responsibility for excavation safety and stability of temporary construction slopes lies solely with the contractor. We are providing this information below solely as a service to our client. Under no circumstances should this information provided be interpreted to mean that Kleinfelder is assuming responsibility for final engineering of excavations or shoring, construction site safety, or the contractors' activities; such responsibility is not being implied and should not be inferred.

Minor sloughing and/or raveling of slopes should be anticipated as they dry out. Where space for sloped embankments is not available, shoring will be necessary. In addition, excavations within a 1:1 plane extending downward from a horizontal distance of 2 feet beyond the bottom outer edge of existing improvements should not be attempted without bracing and/or underpinning the footings, as discussed above. The geotechnical engineer or their field representative should observe the excavations so that modifications can be made to the excavations, as necessary, based on variations in the encountered soil conditions. All applicable excavation safety requirements and regulations, including OSHA requirements, should be met.

All trench excavations should be braced and shored in accordance with good construction practice and all applicable safety ordinances and codes. Stockpiled (excavated) materials should be placed no closer to the edge of an excavation than a distance equal to the depth of the excavation, but no closer than 4 feet.

5.2.6 Trench Backfill

Pipe zone backfill (i.e. material beneath and in the immediate vicinity of the pipe) should consist of imported soil less than ¾-inch in maximum dimension. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of onsite soil or imported fill that meets the requirements for engineered fill provided above.

If imported material is used for trench zone backfill, we recommend it consist of silty sand. In general, gravel and cobble should not be used for trench zone backfill due to the potential for soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local building requirements and/or bedding requirements for specific types of pipes. We recommend the project civil engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Trench backfill should be placed and compacted in accordance with recommendations provided for engineered fill in Section 5.2.3. Mechanical compaction is recommended; ponding or jetting should be avoided, especially in areas supporting structural loads or beneath concrete slabs supported on grade, pavements, or other improvements.

5.3 UNSTABLE SUBGRADE CONDITIONS

It is common to encounter wet, unstable soils upon removal of site pavements or flatwork as a result of subsurface moisture becoming trapped beneath relatively impervious asphalt concrete or Portland cement concrete surfaces. Additionally, depending on time of year and weather conditions we anticipate that near surface soils may become saturated. Pumping subgrade conditions may be encountered during site grading activities, and the subgrade may need to be stabilized with geotextiles and crushed rock. Additionally, should grading be performed during or following periods of rainfall, the moisture content of the near-surface soils will also be significantly above the optimum moisture content. These conditions could seriously impede grading by causing an unstable subgrade condition. Typical remedial measures include the following:

- <u>Drying</u>: Drying unstable subgrade involves disking or ripping wet subgrade to a depth of approximately 18 to 24 inches and allowing the exposed soil to dry. Multiple passes of the equipment (likely on a daily basis) will be needed because as the surface of the soil dries, a crust forms that reduces further evaporation. Frequent disking will help prevent the formation of a crust and will promote drying. This process could take several days to several weeks depending on the depth of ripping, the number of passes, and the weather.
- <u>Removal and Replacement with Crushed Rock and Geotextile Fabric</u>: Unstable subgrade could be over-excavated 12 to 24 inches below existing grade and replaced with ¾- or 1-inch crushed rock underlain by geotextile fabric. The geotextile fabric should consist of a woven geotextile, such as Mirafi 600X or equivalent. The final depth of removal will depend upon the conditions observed in the field once over-excavation begins. The geotextile fabric should be placed in accordance with the manufacturer's recommendations.
- <u>Soil Treatment:</u> Unstable subgrade could be stabilized by mixing the upper 12 to 18 inches of the subgrade with Portland cement, Class C flyash or lime. For estimating purposes, an application rate of 10 to 12 percent Class C flyash, 3 to 5 percent high calcium quick lime, or 4 to 5 percent Portland cement may be used. Final application rates should be determined in the field at the time of construction in consultation with the geotechnical engineer. Chemical treatment should be performed by a specialty contractor experienced in this work. Since soil treatment uses the on-site soil, the expense of importing material can be avoided.

5.4 TEMPORARY SHORING

5.4.1 General

Temporary shoring may be required in areas adjacent to existing structures or improvements where excavations cannot be adequately sloped. Temporary shoring may consist of a turn-key shoring system, soldier piles and lagging, or other system. Recommendations for design of temporary shoring are presented below.

The shoring design should be provided by a civil engineer registered in the State of California and experienced in the design and construction of shoring under similar conditions. Once the final excavation and shoring plans are complete, the plans and design should be reviewed by Kleinfelder for conformance with the design intent and geotechnical recommendations provided herein.

5.4.2 Lateral Pressures

For the design of cantilevered shoring, an equivalent fluid pressure of 35 pounds per cubic foot (pcf) may be used for level backfill. Where the surface of the retained earth slopes up away from the shoring, a greater pressure should be used. Design data can be developed for additional cases when the design conditions are established.

In addition to the recommended earth pressure, any surcharge (live, including traffic, or dead load) located within a 1:1 plane drawn upward from the base of the shored excavation should be added to the lateral earth pressures. The lateral contribution of a uniform surcharge load located immediately behind the wall may be calculated by multiplying the surcharge by 0.5 for the level backfill condition. Lateral load contributions of surcharges located at a distance behind the shored wall may be provided once the load configurations and layouts are known. As a minimum, a 2-foot equivalent soil surcharge (250 psf) is recommended to account for nominal construction loads. It should be noted that the above pressures do not include hydrostatic pressure and assume groundwater will not be encountered in the excavation, or dewatering will be used to lower the ground water table below the bottom of the excavation. Groundwater was encountered at approximately 29 feet below ground surface.

5.4.3 Design of Soldier Piles

All soldier piles should extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. We recommend the required embedment depths be calculated based on the principles of force and moment equilibrium. For this method, the allowable passive pressure against soldier piles that extend below the level of excavation may be assumed to be a uniform pressure of 3,000 psf. To account for arching, the passive resistance may be assumed to act over a width 2.0 times the width of the embedded portion of the pile, provided adjacent piles are spaced at least 2.5 pile diameters, center-to-center.

Drilling of the soldier pile shafts could be accomplished using heavy-duty drilling equipment. The on-site soils below the base of the excavation include isolated sandy layers, which may subject to caving. In addition, groundwater was encountered at a depth of approximately 29 feet bgs. Temporary steel casing may be required to stabilize the sides of the pile shaft. Concrete for piles should be placed immediately after the drilling of the hole is complete. The concrete should be pumped to the bottom of the drilled shaft using a tremie. Once concrete pumping is initiated, a minimum head of 5 feet of concrete above the bottom of the tremie should be established and maintained throughout the concrete placement to prevent contamination of the concrete by soil inclusions. If steel casing is used, the casing should be removed as the concrete is placed.

To develop full lateral resistance, provisions should be taken to assure firm contact between the soldier piles and undisturbed materials. The concrete placed in the soldier pile excavations may be a lean-mix concrete. However, the concrete used in that portion of the soldier pile that is below the planned excavated level should provide sufficient strength to adequately transfer the imposed loads to the surrounding materials.

5.4.4 Lagging

Continuous treated timber lagging should be used between the soldier piles. The lagging should be installed as the excavation proceeds. If treated timber is used, the lagging may remain in place after backfilling. The lagging should be designed for the recommended earth pressure but limited to a maximum value of 400 psf.

5.4.5 Deflection

Shoring adjacent to existing structures or improvements should be designed and constructed to reduce potential movement. The shoring system designer should evaluate potential deflections in their design.

5.4.6 Monitoring

Some deflection of the shored excavation should be anticipated during the planned excavation. We recommend the project civil engineer perform a survey of all existing utilities and structures adjacent to the shored excavation. The purpose of this survey would be to evaluate the ability of existing utility lines or improvements to withstand horizontal movements associated with a shored excavation and to establish the baseline condition in case of unfounded claims of damage. If existing improvements are not capable of withstanding anticipated lateral movements, alternative shoring systems may be required.

Horizontal and vertical movements of the shoring system should be monitored by a licensed surveyor. The construction monitoring and performance of the shoring system are ultimately the contractor's responsibility. However, at a minimum, we recommend that the top of shoring be surveyed prior to excavation and that the top and bottom of the soldier beams be surveyed on a weekly basis until the shoring is not needed. Surveying should consist of measuring movements in vertical and two perpendicular horizontal directions.

5.5 EXTERIOR FLATWORK

Prior to casting exterior flatwork, the subgrade soils should be moisture conditioned and recompacted or overexcavated, as recommended in Section 5.2.2. The moisture content of the subgrade soils should be maintained at the required level until placement of any flatwork or engineered fill. Careful control of the water/cement ratio should be performed to avoid shrinkage cracking due to excess water or poor concrete finishing or curing. Unreinforced slabs should not be built in areas where further saturation may occur following construction.

5.6 PAVEMENTS

5.6.1 HMA Design

Hot Mix Asphalt (HMA) should conform to requirements of the Costco Wholesale Specification Section 321216, Asphalt Paving. Costco design guidelines require that the HMA section be placed in at least two lifts. The HMA specification allows the use of ½- or ¾-inch Nominal Maximum Aggregate Size (NMAS) mixes for the base course and ⅜- or ½-inch NMAS mixes for surface course. Section 1.3.C of the HMA specification requires a minimum asphalt concrete lift thickness of no less than 2 times the Maximum Size of Aggregate (MSA) of the HMA mix or 1¾ inches, whichever is greater. However, minimum lift thicknesses of 1½ inches will be allowed for ⅜- or ½-inch NMAS mixes. Section 2.1.B.4 of the HMA specification states that the optimum asphalt lift (or course) thickness shall be a minimum of 3 times the MSA of the HMA mix. However, lift thicknesses should not exceed 3 inches.

5.6.2 Construction Considerations

The pavement sections provided in Section 4.6 are contingent on the following recommendations being implemented during construction.

- Pavement subgrade should be prepared as recommended in Section 5.2.2.
- Subgrade soils should be in a stable, non-pumping condition at the time the aggregate base materials are placed and compacted.
- Aggregate base materials should be compacted to at least 95 percent relative compaction (ASTM D1557).
- Asphalt paving materials and placement methods should meet current Costco Wholesale Specifications Section 321216.
- Adequate drainage (both surface and subsurface) should be provided such that the subgrade soils and aggregate base materials are not allowed to become wet.

Note that pavement materials and construction must be completed in strict accordance with the Costco's specifications that contain very specific pavement material (asphalt, aggregate and concrete) criteria and construction practices to be used (compaction and material sampling). The general contractor and pavement construction subcontractor should be aware that asphalt and concrete mix designs must be submitted to the design architect and Kleinfelder at least 45 days prior to the scheduled production and laydown for review and approval.

6 ADDITIONAL SERVICES

6.1 PLANS AND SPECIFICATIONS REVIEW

We recommend that Kleinfelder perform a general review of the project plans and specifications before they are finalized to verify that our geotechnical recommendations have been properly interpreted and implemented during design. If we are not accorded the privilege of performing this review, we can assume no responsibility for misinterpretation of our recommendations.

6.2 CONSTRUCTION OBSERVATION AND TESTING

The construction process is an integral design component with respect to the geotechnical aspects of a project. Because geotechnical engineering is an inexact science due to the variability of natural processes, and because we sample only a limited portion of the soils affecting the performance of the proposed structure, unanticipated or changed conditions can be encountered during grading. Proper geotechnical observation and testing during construction are imperative to allow the geotechnical engineer the opportunity to verify assumptions made during the design process. Therefore, we recommend that Kleinfelder be retained during the construction of the proposed improvements to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study.

Our services are typically needed at the following stages of grading.

- After demolition;
- During grading;
- During the installation of temporary construction shoring;
- After the overexcavation, but prior to scarification;
- During utility trench backfill;
- During base placement and site paving; and
- After excavation for foundations.

7 LIMITATIONS

This geotechnical study has been prepared for the exclusive use of Costco Wholesale and their agents for specific application to the proposed fuel facility on-site relocation at Costco Wholesale Warehouse No. 122 located at 2655 El Camino Real in Tustin, California. The findings, conclusions and recommendations presented in this report were prepared in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

The scope of services was limited to a background data review and the field exploration described in Section 1.2. It should be recognized that definition and evaluation of subsurface conditions are difficult. Judgments leading to conclusions and recommendations are generally made with incomplete knowledge of the subsurface conditions present due to the limitations of data from field studies. The conclusions of this assessment are based on our field exploration and laboratory testing programs, and engineering analyses.

Kleinfelder offers various levels of investigative and engineering services to suit the varying needs of different clients. Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. Since detailed study and analysis involves greater expense, our clients participate in determining levels of service, which provide information for their purposes at acceptable levels of risk. The client and key members of the design team should discuss the issues covered in this report with Kleinfelder, so that the issues are understood and applied in a manner consistent with the owner's budget, tolerance of risk and expectations for future performance and maintenance.

Recommendations contained in this report are based on our field observations and subsurface explorations, limited laboratory tests, and our present knowledge of the proposed construction. It is possible that soil or groundwater conditions could vary between or beyond the points explored. If soil or groundwater conditions are encountered during construction that differ from those described herein, the client is responsible for ensuring that Kleinfelder is notified immediately so that we may reevaluate the recommendations of this report. If the scope of the proposed construction, including the estimated Traffic Index or locations of the improvements, changes from that described in this report, the conclusions and recommendations contained in this report are not considered valid until the changes are reviewed, and the conclusions of this report are modified or approved in writing, by Kleinfelder.

The scope of services for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

Kleinfelder cannot be responsible for interpretation by others of this report or the conditions encountered in the field. Kleinfelder must be retained so that all geotechnical aspects of construction will be monitored on a full-time basis by a representative from Kleinfelder, including site preparation, preparation of foundations, and placement of engineered fill and trench backfill. These services provide Kleinfelder the opportunity to observe the actual soil and groundwater conditions encountered during construction and to evaluate the applicability of the recommendations presented in this report to the site conditions. If Kleinfelder is not retained to provide these services, we will cease to be the engineer of record for this project and will assume no responsibility for any potential claim during or after construction on this project. If changed site conditions affect the recommendations presented herein, Kleinfelder must also be retained to perform a supplemental evaluation and to issue a revision to our original report.

This report, and any future addenda or reports regarding this site, may be made available to bidders to supply them with only the data contained in the report regarding subsurface conditions and laboratory test results at the point and time noted. Bidders may not rely on interpretations, opinion, recommendations, or conclusions contained in the report. Because of the limited nature of any subsurface study, the contractor may encounter conditions during construction which differ from those presented in this report. In such event, the contractor should promptly notify the owner so that Kleinfelder's geotechnical engineer can be contacted to confirm those conditions. We recommend the contractor describe the nature and extent of the differing conditions in writing and that the construction contract include provisions for dealing with differing conditions. Contingency funds should be reserved for potential problems during earthwork and foundation construction.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance, but in no event later than one year from the date of the report. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party, other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of this report and the nature of the new project, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and the client agrees to defend, indemnify, and hold harmless Kleinfelder from any claims or liability associated with such unauthorized use or non-compliance.

8 REFERENCES

American Concrete Institute (ACI), 2014, Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14).

American Society of Civil Engineers (ASCE), 2010, Minimum Design Load for Buildings and Other Structures (ASCE/SEI 7-10).

California Geologic Survey (CGS), 2002, Note 36, California Geomorphic Provinces.

California Geologic Survey (CGS), 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, released June 2003.

California Geological Survey (CGS), 2018, Earthquake Fault Zones - A Guide for Government Agencies, Property Owners/Developers, and Geoscience Practitioners for Assessing Fault Rupture Hazards in California: California Geological Survey Special Publication 42, 83p.

Costco Wholesale, 2016, Costco Wholesale Development Requirements, Version 2016, dated September 19, 2016.

FEMA, Map Service Center, 2009, Flood Insurance Rate Maps (FIRM), Flood Zone Panel 06059C0281J, FEMA Map Service Center, https://msc.fema.gov/portal

Jennings, C.W. and Bryant, W.A., 2010, Fault Activity Map of California, California Geological Survey, Scale 1:750,000.

International Code Council, Inc., 2016 California Building Code.

National Association of Corrosion Engineers (NACE), 2006, "Corrosion Basics, An Introduction, 2nd Edition" National Association of Corrosion Engineers.

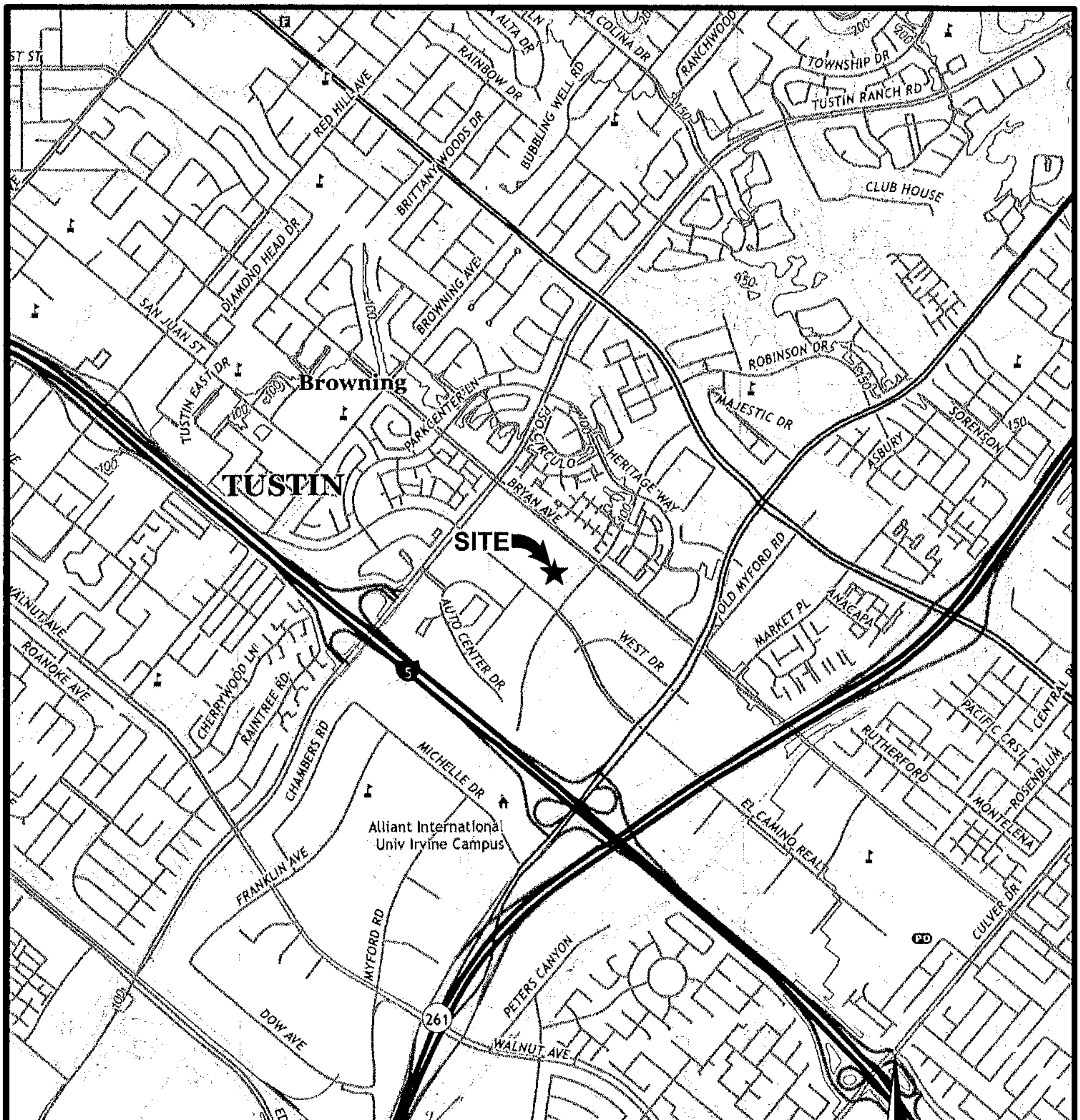
Norris, R.M. and Webb, R.W., 1990, Geology of California, John Wiley and Sons, Second Edition.

Portland Cement Association (PCA), 1984, Thickness Design for Concrete Highway and Street Pavements, Skokie, Illinois: Portland Cement Association.

United States Geological Survey (USGS), 2017, U.S. Seismic Design Maps website application, accessed via web October 2018, https://earthquake.usgs.gov/designmaps/us/application.php.

FIGURES

PLOTTED: 10/17/2018 2:38 PM BY: dean fahrney



SOURCE: U.S.G.S. 7.5' topographic series, Tustin, California quadrangle dated 2018.

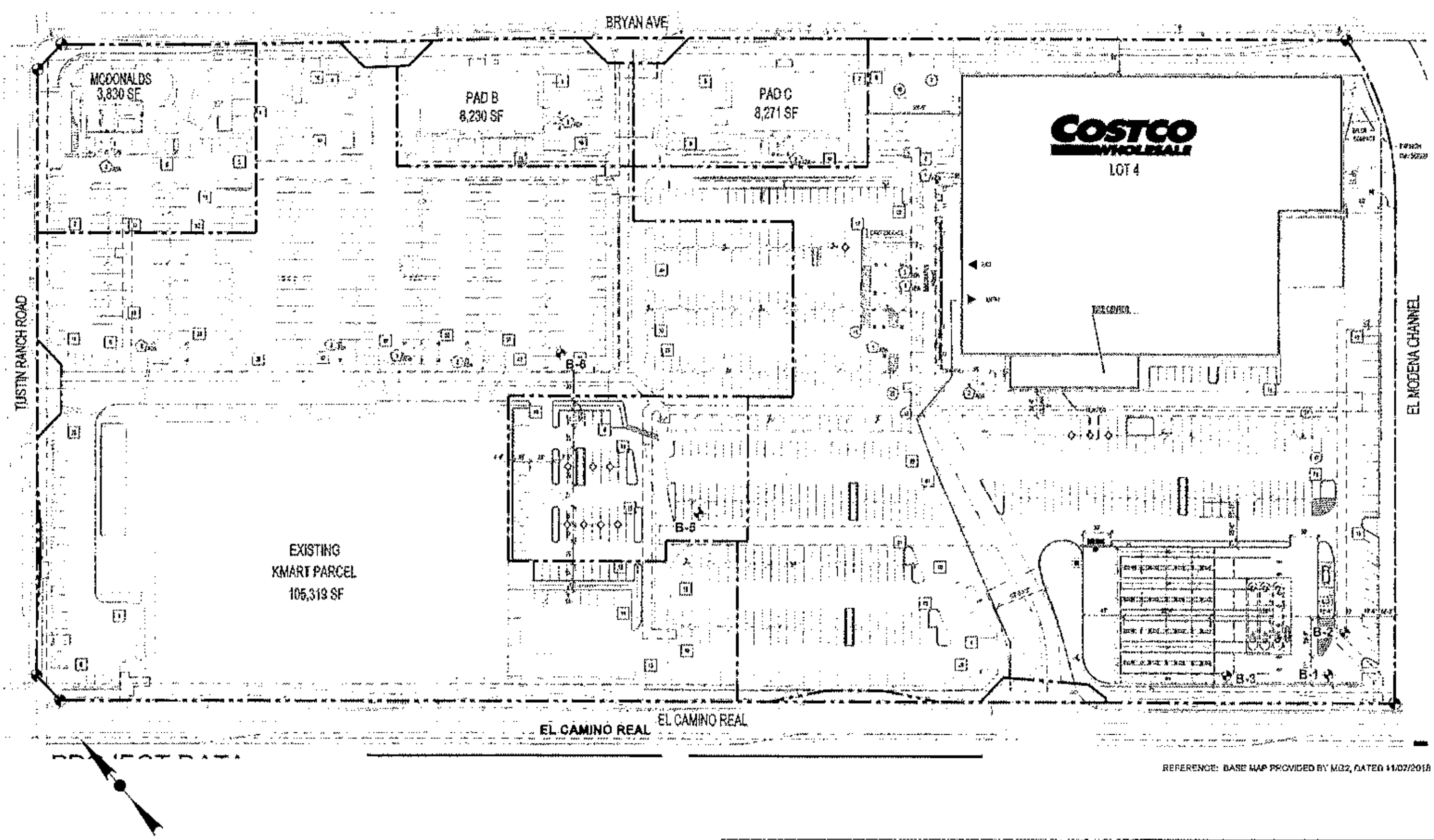
2,000 1,000 0 2,000

APPROXIMATE SCALE (feet)

KLEINFELDER
Bright People. Right Solutions.

PROJECT:	20192059	SITE VICINITY MAP	FIGURE
DRAWN BY:	DMF		1
CHECKED BY:	DC	COSTCO WHOLESALE WAREHOUSE No. 122 2655 EL CAMINO REAL TUSTIN, CALIFORNIA	
DATE:	10/2018		
REVISED:	10/2018		

CAD FILE: U:\Projects\CADD\CADD 2019\20192059\20192059_Costco-Tustin-Ranch.dwg



REFERENCE: BASE MAP PROVIDED BY MG2, DATED 11/07/2018

100 50 0 100

APPROXIMATE SCALE (feet)

EXPLANATION

B-6 ⊕ APPROXIMATE BORING LOCATION

NOTE: BORING B-4 WAS NOT DRILLED

KLEINFELDER
Bright People. Right Solutions.

PROJECT: 20192059	EXPLORATION LOCATION MAP		FIGURE
DRAWN BY: DMF			
CHECKED BY: DC	COSTCO WHOLESALE WAREHOUSE No. 122 2655 EL CAMINO REAL TUSTIN, CALIFORNIA		2
DATE: 10/2018			
REVISED: 10/2018			

PLOTTED: 11/15/2018 9:16 AM BY: dean fabrney

CAD FILE: U:\Projects\CADD\CADD 2019\20192059\20192059_Costco-Tustin-Ranch.dwg LAYOUT: 2

APPENDIX A
FIELD EXPLORATIONS

APPENDIX A
FIELD EXPLORATION

GENERAL

Our field exploration program consisted of five borings. It should be noted that Boring B-4 (a proposed 10-foot boring) was not drilled due to safety concerns from an impending thunderstorm during our fieldwork. The borings were excavated on October 12, 2018. Prior to commencement of the fieldwork, various geophysical techniques were used at the boring locations to identify potential conflicts with subsurface structures. The boring locations were also cleared for buried utilities through Underground Service Alert (USA).

The explorations were located as close to the proposed fuel facility area as possible. The borings were drilled to depths between approximately 3½ and 51½ feet bgs. The borings were drilled by Calpac Drilling of San Diego, California with a (B-61) truck-mounted, hollow-stem-auger (HSA) drilling equipment. The approximate locations of the explorations are presented on Figure 2, Exploration Location Map.

The logs for the borings are presented as Figure A-3 through A-8. An explanation to the log is presented as Figure A-1 and A-2. The Log of Boring describes the earth materials encountered, samples obtained and show field and laboratory tests performed. The log also shows the location, boring number, drilling date, and the name of the drilling subcontractor. The borings were logged by a Kleinfelder engineer using the Unified Soil Classification System. The boundaries between soil types shown on the log are approximate because the transition between different soil layers may be gradual. Bulk and drive samples of selected earth materials were obtained from the borings.

A California-type sampler was used to obtain drive samples of the soil encountered. This sampler consists of a 3-inch O.D., 2.4-inch I.D. split barrel shaft that is pushed or driven a total of 18 inches into the soil at the bottom of the boring. The soil was retained in six 1-inch brass rings for laboratory testing. An additional 2 inches of soil from each drive remained in the cutting shoe and was usually discarded after visually classifying the soil. The sampler was driven using a 140-pound hammer falling 30 inches. The total number of blows required to drive the sampler the final 12 inches is termed blow count and is recorded on the Log of Boring.

Samples were also obtained using a Standard Penetration Sampler (SPT). This sampler consists of a 2-inch O.D., 1⅜-inch I.D. split barrel shaft that is advanced into the soils at the bottom of the drill hole a total of 18 inches. The sampler was driven using a 140-pound hammer falling 30 inches. The total number of hammer blows required to drive the sampler the final 12 inches is termed the blow count (N) and is recorded on the Log of Boring. The procedures we employed in the field are generally consistent with those described in ASTM Standard Test Method D1586.

SAMPLER AND DRILLING METHOD GRAPHICS

- BULK / GRAB / BAG SAMPLE
- MODIFIED CALIFORNIA SAMPLER (2 or 2-1/2 in. (50.8 or 63.5 mm.) outer diameter)
- CALIFORNIA SAMPLER (3 in. (76.2 mm.) outer diameter)
- STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)
- HQ CORE SAMPLE (2.500 in. (63.5 mm.) core diameter)
- SHELBY TUBE SAMPLER
- HOLLOW STEM AUGER
- SOLID STEM AUGER
- WASH BORING
- SONIC CONTINUOUS SAMPLER

GROUND WATER GRAPHICS

- WATER LEVEL (level where first observed)
- WATER LEVEL (level after exploration completion)
- WATER LEVEL (additional levels after exploration)
- OBSERVED SEEPAGE

NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

ABBREVIATIONS

WOH - Weight of Hammer
WOR - Weight of Rod

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Division	Subdivision	Fines	Gradation	Group Symbol	Description
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu≥4 and 1≤Cc≤3	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu<4 and/ or 1>Cc>3	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu≥4 and 1≤Cc≤3	GW-GM	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu<4 and/ or 1>Cc>3	GP-GM	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES		GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu≥6 and 1≤Cc≤3	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu<6 and/ or 1>Cc>3	SP	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu≥6 and 1≤Cc≤3	SW-SM	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu<6 and/ or 1>Cc>3	SP-SM	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES		SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

Major Division	Subdivision	Group Symbol	Description
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

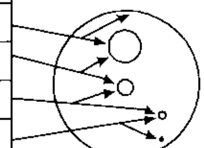
KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.: 20192059	GRAPHICS KEY	FIGURE
DRAWN BY: JZ		
CHECKED BY: DC	Costco Wholesale Warehouse No. 122 2655 El Camino Real Tustin, California 92782	A-1
DATE: 10/31/2018		
REVISED: -		

PLOTTED: 10/31/2018 01:39 PM BY: JHawkins
OFFICE FILTER: IRVINE
PROJECT NUMBER: 20192059.001A
gINT FILE: Klf_gint_master_2017
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [LEGEND 1 (GRAPHICS KEY) USCS_SOU_CAL]

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller



SECONDARY CONSTITUENT

Term of Use	AMOUNT: Secondary Constituent is Fine Grained	AMOUNT: Secondary Constituent is Coarse Grained
Trace	<5%	<15%
With	≥5 to <15%	≥15 to <30%
Modifier	≥15%	≥30%

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT - N_{60} (# blows / ft)	Pocket Pen (tsf)	UNCONFINED COMPRESSIVE STRENGTH (Q_u)(psf)	VISUAL / MANUAL CRITERIA
Very Soft	<2	PP < 0.25	<500	Thumb will penetrate more than 1 inch (25 mm). Extrudes between fingers when squeezed.
Soft	2 - 4	0.25 ≤ PP <0.5	500 - 1000	Thumb will penetrate soil about 1 inch (25 mm). Remolded by light finger pressure.
Medium Stiff	4 - 8	0.5 ≤ PP <1	1000 - 2000	Thumb will penetrate soil about 1/4 inch (6 mm). Remolded by strong finger pressure.
Stiff	8 - 15	1 ≤ PP <2	2000 - 4000	Can be imprinted with considerable pressure from thumb.
Very Stiff	15 - 30	2 ≤ PP <4	4000 - 8000	Thumb will not indent soil but readily indented with thumbnail.
Hard	>30	4 ≤ PP	>8000	Thumbnail will not indent soil.

FROM TERZAGHI AND PECK, 1948; LAMBE AND WHITMAN, 1969; FHWA, 2002; AND ASTM D2488

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12 - 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

FROM TERZAGHI AND PECK, 1948

PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit.
High (H)	> 50	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit.

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness.
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.

ANGULARITY

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 20192059	SOIL DESCRIPTION KEY	FIGURE
	DRAWN BY: JZ		
	CHECKED BY: DC	Costco Wholesale Warehouse No. 122 2655 El Camino Real Tustin, California 92782	A-2
	DATE: 10/31/2018		
	REVISED: -		

Date Begin - End: 10/12/2018	**Drilling Company:** Cal Pac		
Logged By: D. Castle	**Drill Crew:** Keith/James		
Hor.-Vert. Datum: Not Available	**Drilling Equipment:** Mobile B-61	**Hammer Type - Drop:** 140 lb. Auto - 30 in.	
Plunge: -90 degrees	**Drilling Method:** Hollow Stem Auger		
Weather: Sunny & Clear	**Auger Diameter:** 7.5 in. O.D.		

Latitude: 33.72708°
Longitude: -117.79631°
Approximate Ground Surface Elevation (ft.): 88.00
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Lithologic Description	Blow Counts(BC)= Uncorr. Blows/6 in. / Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	Water Content (%)	Dry Unit Wt. (pcf)	Additional Tests/ Remarks
	0	**ASPHALT**: 4.75-inches					Hand auger to 5 ft bgs.
		BASE COURSE: 7-inches			14.4		Expansion Index
85		**ARTIFICIAL FILL:** **Sandy Lean CLAY (CL)**: dark brown to dark reddish brown, dry to moist, little to some fine sand, concrete debris					
	5	stiff, rootlets present	BC=4 7 8 PP=4.5+	18"	14.6 / 14.7	105.7	
80		**ALLUVIUM:** **Lean CLAY with Sand (CL)**: fine-grained, brown and dark brown, dry to moist, medium stiff, few gypsum stringers	BC=4 6 7 PP=4.5+	18"	15.5	114.2	Pocket Vane Shear: (0.32)(2.5) = 0.80tsf; Unconfined Compression
	10	**Clayey SAND (SC)**: fine to medium-grained, medium plasticity, brown to yellowish brown, dry to moist, medium dense	BC=9 16 17	18"	6.8	117.7	
75		light brown gray, medium dense to dense	BC=7 13 22	18"	4.7	108.9	
	15	**Lean CLAY (CL)**: yellowish brown, stiff, medium to coarse sand lense within sandy clay; medium plasticity, brown, moist, trace fine sand	BC=4 10 8	18"	10.6	110.6	
70		medium plasticity, brown to dark brown, moist, stiff, few fine sand	BC=5 8 13 PP=4.0	18"	22.5	104.1	
	20	medium stiff	BC=3 6 10	18"	20.9	104.8	Unconfined Compression
		trace fine sand					Drilling vibrations
65							
	25	brown to yellowish brown, trace mica, trace sand	BC=3 5 10 PP=4.25	18"	16.3		

The boring was terminated at approximately 26.5 ft. below ground surface. Backfilled with cuttings and patched with rapid setting concrete dyed black

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.: 20192059	BORING LOG B-1	FIGURE A-3	
DRAWN BY: JZ			
CHECKED BY: DC	Costco Wholesale Warehouse No. 122, 2655 El Camino Real, Tustin, California 92782		
DATE: 10/31/2018			
REVISED: -		PAGE: 1 of 1	

BORING LOG B-2

Date Begin - End:	10/12/2018	**Drilling Company:**	Cal Pac
Logged By:	D. Castle	**Drill Crew:**	Keith/James
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	Mobile B-61
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger
Weather:	Sunny & Clear	**Auger Diameter:**	7.5 in. O.D.

Hammer Type - Drop: 140 lb. Auto - 30 in.

FIELD EXPLORATION

Latitude: 33.72715°
Longitude: -117.79612°
Approximate Ground Surface Elevation (ft.): 89.00
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		ASPHALT: 4.5-inches											Hand auger to 5 ft bgs.
		BASE COURSE: 8.5-inches											
85		**ARTIFICIAL FILL:** **Lean CLAY (CL)**: medium plasticity, dark brown, moist, few fine to medium sand, few fine to coarse, subrounded to rounded gravel	Bulk		6"		10.8						Corrosion
	5	dark brown to black, stiff		BC=4 10 10	16"		14.8	106.2					
80		light brownish gray, yellow splotches, pieces of concrete debris		BC=2 4 5	18"		15.9						
	10	**ALLUVIUM:** **Lean CLAY with Sand (CL)**: medium plasticity, mottled light brownish grey and yellowish brown, moist, stiff		BC=6 4 9	15"		13.9	114.1					Unconfined Compression
75		medium plasticity, moist, mottled light brownish gray and yellowish brown, caliche nodules and stringers present		BC=4 5 6	18"		11.8						
	15	**Sandy Lean CLAY (CL)**: medium plasticity, olive yellow to yellowish brown, moist, stiff, some fine to medium sand		BC=5 10 10	18"		7.6	109.7					
		Clayey SAND (SC): fine-grained, medium plasticity, yellowish brown, moist, medium dense											
70		**Lean CLAY (CL)**: medium plasticity, brown, moist, stiff		BC=2 5 8	17"		19.3						
	20	yellowish brown, iron oxide staining, slightly micaceous		BC=4 7 12	14"		14.2	95.4					
65		**Lean CLAY with Sand (CL)**: yellowish brown, moist, stiff, manganese oxide staining, little fine to medium sand, slightly micaceous											
	25			BC=3 7 10	14"		15.8	109.1					
60	30												
55													

LABORATORY RESULTS

The boring was terminated at approximately 26.5 ft. below ground surface. Backfilled with cuttings and patched with rapid setting concrete dyed black

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.:	20192059
DRAWN BY:	JZ
CHECKED BY:	DC
DATE:	10/31/2018
REVISED:	-

BORING LOG B-2

Costco Wholesale Warehouse No. 122
2655 El Camino Real
Tustin, California 92782

FIGURE A-4

PLOTTED: 10/31/2018 06:11 PM BY: DCastle
OFFICE FILTER: IRVINE
PROJECT NUMBER: 20192059.001A
gINT FILE: Klf_gint_master_2017
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [_KLF_BORING/TEST PIT SOIL LOG]

Date Begin - End:	10/12/2018	**Drilling Company:**	Cal Pac		**BORING LOG B-3**
Logged By:	D. Castle	**Drill Crew:**	Keith/James		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	Mobile B-61	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	Sunny & Clear	**Auger Diameter:**	7.5 in. O.D.		

FIELD EXPLORATION / LABORATORY RESULTS

Latitude: 33.72728°
Longitude: -117.79659°
Approximate Ground Surface Elevation (ft.): 88.00
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		ASPHALT: 4.5-inches											Hand auger to 5 ft bgs.
		BASE COURSE: 8.5-inches											
85		**ARTIFICIAL FILL:** **Clayey SAND (SC)**: fine to medium-grained, low to medium plasticity, brown, dry to moist	Bulk		6"		19.4						
		Sandy Lean CLAY (CL): medium plasticity, dark brown, dry to moist, little fine sand											
	5	**Lean CLAY (CL)**: medium plasticity, black, moist, medium stiff to stiff, iron oxide staining, 2-inch seem of medium sand, pieces of concrete debris	Sampler	BC=2 3 5 PP=3.25	18"								
80		**Sandy Lean CLAY (CL)**: medium plasticity, mottled yellowish brown with olive brown, moist, stiff, fine to medium-grained sandconcrete debris	Sampler	BC=3 5 5	18"		11.8			37			
	10	**ALLUVIUM:** **Sandy Lean CLAY (CL)**: medium plasticity, mottled yellowish brown with olive brown, moist, stiff, fine to coarse-grained sand, caliche stringers, slightly micaceous	Sampler	BC=4 5 7 PP=4.5+	18"								Corrosion
75		**Clayey SAND (SC)**: fine to coarse-grained, yellowish brown, moist, some medium plasticity clay fines	Sampler	BC=4 3 4	18"								
	15	**Lean CLAY (CL)**: medium plasticity, dark brown, moist, medium stiff, few fine sand; brown to dark brown, caliche stringers present	Sampler	BC=3 6 8 PP=4	18"		18.0				44	11	
70		stiff, sand stringers present	Sampler	BC=3 4 5	18"								
		Sandy CLAY (CL): medium plasticity, brown, moist, stiff, fine to medium sand, caliche stringers											
	20	**Lean CLAY (CL)**: low to medium plasticity, brown, moist, stiff, few fine to medium sand, gypsum stringers	Sampler	BC=2 4 6 PP=3.5	18"		19.7						
65													
		medium to high plasticity, brown to yellowish brown, caliche stringers, charcoal fragment present											
	25		Sampler	BC=3 4 5	18"						28	14	
60		(groundwater symbol)											
	30	wet, trace gravel	Sampler	BC=5 11 10	18"		26.0						
		Poorly Graded SAND with Gravel (SP): medium to coarse-grained, dark brown, wet, medium dense, fine, sub-rounded gravel					10.1			6.0			
55													

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.: 20192059	BORING LOG B-3	FIGURE
DRAWN BY: JZ		
CHECKED BY: DC	Costco Wholesale Warehouse No. 122 2655 El Camino Real Tustin, California 92782	A-5
DATE: 10/31/2018		
REVISED: -		PAGE: 1 of 2

Date Begin - End: 10/12/2018	**Drilling Company:** Cal Pac		
Logged By: D. Castle	**Drill Crew:** Keith/James		
Hor.-Vert. Datum: Not Available	**Drilling Equipment:** Mobile B-61	**Hammer Type - Drop:** 140 lb. Auto - 30 in.	
Plunge: -90 degrees	**Drilling Method:** Hollow Stem Auger		
Weather: Sunny & Clear	**Auger Diameter:** 7.5 in. O.D.		

FIELD EXPLORATION / LABORATORY RESULTS

Latitude: 33.72728°
Longitude: -117.79659°
Approximate Ground Surface Elevation (ft.): 88.00
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			fine-grained, dark brown		BC=9 18 19	18"		24.6			13			
			Silty SAND with Gravel (SM): medium to coarse-grained, wet, dense, fine to coarse, sub-rounded gravel, predominantely fine											
50			**Lean CLAY (CL)**: medium plasticity, yellowish brown to brown with olive yellow mottles, wet, medium stiff											
	40				BC=2 2 3	18"						48	21	
45														
	45		yellowish brown, stiff		BC=2 4 6	18"								
40														
	50		medium stiff		BC=2 3 3	18"								
35														
	55													
30														
	60													
25														
	65													
20														

The boring was terminated at approximately 51.5 ft. below ground surface. Backfill with bentonite cement and patched with rapid setting concrete dyed black

GROUNDWATER LEVEL INFORMATION:
∇ Groundwater was observed at approximately 29.5 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 29.5 ft. below ground surface at the end of drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 20192059	BORING LOG B-3	FIGURE
	DRAWN BY: JZ		A-6
	CHECKED BY: DC	Costco Wholesale Warehouse No. 122 2655 El Camino Real Tustin, California 92782	
	DATE: 10/31/2018		
	REVISED: -		PAGE: 2 of 2

PLOTTED: 10/31/2018 09:12 PM BY: DCastle
OFFICE FILTER: IRVINE
PROJECT NUMBER: 20192059.001A
gINT FILE: Klf_gint_master_2017
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2017.GLB [_KLF_BORING/TEST PIT SOIL LOG]

Date Begin - End:	10/12/2018	Drilling Company:	Cal Pac	BORING LOG B-5
Logged By:	D. Castle	Drill Crew:	Keith/James	
Hor.-Vert. Datum:	Not Available	Drilling Equipment:	Hand Auger	
Plunge:	-90 degrees	Drilling Method:	Hand Auger	
Weather:	Sunny & Clear	Auger Diameter:	7 in. O.D.	

Latitude: 33.72924°
Longitude: -117.79769°
Approximate Ground Surface Elevation (ft.): 94.00
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Graphical Log	Lithologic Description (FIELD EXPLORATION)	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol (LABORATORY RESULTS)	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			ASPHALT: 3-inches											
			BASE COURSE: 6-inches											
			ARTIFICIAL FILL: **Silty SAND (SM)**: fine to medium-grained, non-plastic, brown, dry					11.4						
			Lean CLAY with Sand (CL): brown, dry to moist, little fine to medium sand at 2.5-feet becomes dark brown											
90														
	5													
85														
	10													
80														

The boring was terminated at approximately 3.5 ft. below ground surface. Backfilled with cuttings and patched with rapid setting concrete dyed black

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

Date Begin - End:	10/12/2018	**Drilling Company:**	Cal Pac
Logged By:	D. Castle	**Drill Crew:**	Keith/James
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	Hand Auger
Plunge:	-90 degrees	**Drilling Method:**	Hand Auger
Weather:	Sunny & Clear	**Auger Diameter:**	7 in. O.D.

BORING LOG B-6

Latitude: 33.72864°
Longitude: -117.79767°
Approximate Ground Surface Elevation (ft.): 91.00
Surface Condition: Asphalt

Approximate Elevation (feet)	Depth (feet)	Graphical Log	FIELD EXPLORATION: Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
			ASPHALT: 3.5-inches											
			BASE COURSE: 7-inches											
90			**ARTIFICIAL FILL:** **Lean CLAY with Sand (CL)**: medium plasticity, dark brown, moist					17.9						R-Value
85	5													
80	10													

The boring was terminated at approximately 3.5 ft. below ground surface. Backfilled with cuttings and patched with rapid setting concrete dyed black

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.

KLEINFELDER
Bright People. Right Solutions.

PROJECT NO.: 20192059	BORING LOG B-6	FIGURE	
DRAWN BY: JZ			
CHECKED BY: DC	Costco Wholesale Warehouse No. 122 2655 El Camino Real Tustin, California 92782	A-8	
DATE: 10/31/2018			
REVISED: -		PAGE: 1 of 1	

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

GENERAL

Laboratory tests were performed on selected samples as an aid in classifying the soils and to evaluate physical properties of the soils that may affect foundation design and construction procedures. The tests were performed in general conformance with the current ASTM or California Department of Transportation (Caltrans) standards by AP Engineering and Testing Inc. of Pomona, California. A description of the laboratory-testing program is presented below.

MOISTURE AND UNIT WEIGHT

Moisture content and dry unit weight testing was performed on a selected sample recovered from our borings. Moisture contents were determined in general accordance with ASTM Test Method D2216; dry unit weight was calculated using the entire weight of the samples collected in general accordance with ASTM Test Method D7263. Results of the testing are presented on the boring logs in Appendix A and as an attachment in this appendix.

PERCENT PASSING NO. 200 SIEVE

Selected samples were subject to a wash through the No. 200 sieve to determine the fines content of the onsite soils and to aid in classification of the soils. The percent finer than the No. 200 sieve was performed in accordance with ASTM Standard Test Method D1140. The results of the tests are presented on the boring logs in Appendix A and as an attachment in this appendix.

ATTERBERG LIMITS

Atterberg limits testing was performed on a selected soil samples to assist in classification. Testing was performed in general accordance with ASTM D4318. Results are presented on the boring logs in Appendix A and as an attachment in this appendix.

UNCONFINED COMPRESSION TEST

Unconfined compression testing was performed on relatively undisturbed samples to estimate the shear strength of the fine-grained soils. Testing was performed in general accordance with ASTM D2166. Results of the testing are attached to this appendix.

EXPANSION INDEX

Expansion index testing was performed on the near surface soils to evaluate the swell potential of the soils during inundation (saturation). Testing was performed in general accordance with ASTM D4829. Results of the testing are attached to this appendix.

R-VALUE TESTS

One resistance value (R-value) test was performed on a bulk soil sample obtained within the proposed fuel facility area to evaluate pavement support characteristics of the near-surface onsite soils. R-value tests were performed in accordance with Caltrans Standard Test Method 301. Results of the testing are attached to this appendix.

SOIL CORROSIVITY TESTS

A series of chemical tests were performed on selected samples of the near-surface soils to estimate pH, resistivity and sulfate and chloride contents. The samples were tested for pH and minimum resistivity, soluble chlorides, and soluble sulfates, respectively. Test results may be used by a qualified corrosion engineer to evaluate the general corrosion potential with respect to construction materials. The results of the tests are presented in Table 3 of Section 4.7 of the report and attached to this appendix.

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

MOISTURE AND DENSITY TEST RESULTS

Client: Kleinfelder
Project Name: Costco Tustin Ranch Gas OSR
Project No.: 20192059.001A

AP Lab No.: 18-1038
Date: 10/22/18

Boring No.	Sample No.	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)
B-1	1	1	14.4	NA
B-1	2	6	14.6	105.7
B-1	3	6.5	14.7	NA
B-1	4	8.5	15.5	114.2
B-1	5	11	6.8	117.7
B-1	6	13.5	4.7	108.9
B-1	7	16	10.6	110.6
B-1	8	18.5	22.5	104.1
B-1	9	21	20.9	104.8
B-1	10	25	16.3	NA
B-2	1	3	10.8	NA
B-2	2	6	14.8	106.2
B-2	3	7.5	15.9	NA
B-2	4	11	13.9	114.1
B-2	5	12.5	11.8	NA
B-2	6	16	7.6	109.7
B-2	7	17.5	19.3	NA
B-2	8	21	14.2	95.4
B-2	9	26	15.8	109.1
B-3	1	2	19.4	NA
B-3	3	7.5	11.8	NA
B-3	7	15	18.0	NA
B-3	10	20	19.7	NA
B-3	12	30	26.0	NA
B-3	13	30.75	10.1	NA
B-3	14	35	24.6	NA
B-5	1	1	11.4	NA
B-6	1	1	17.9	NA

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

PERCENT PASSING NO. 200 SIEVE

ASTM D1140

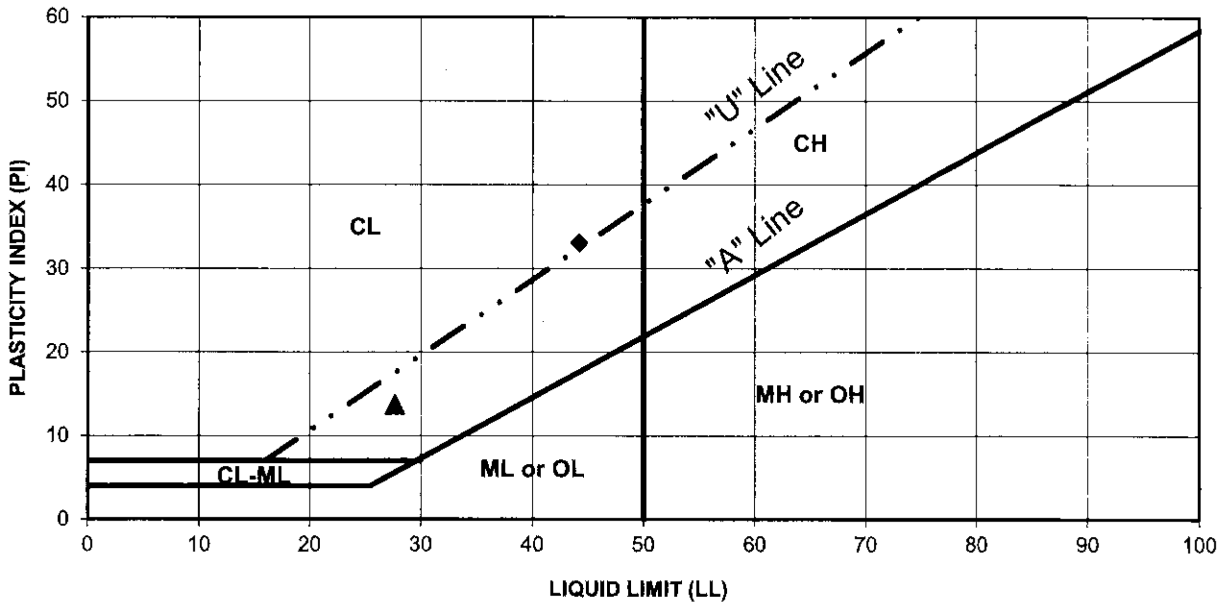
Client:	Kleinfelder	AP Lab No.:	18-1038
Project Name:	Costco Tustin Ranch Gas OSR	Test Date:	10/24/18
Project Number:	20192059.001A		

Boring No.	Sample No.	Depth (ft)	Percent Fines (%)
B-3	3	7.5	36.5
B-3	13	30.75	6.0
B-3	14	35	12.9

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

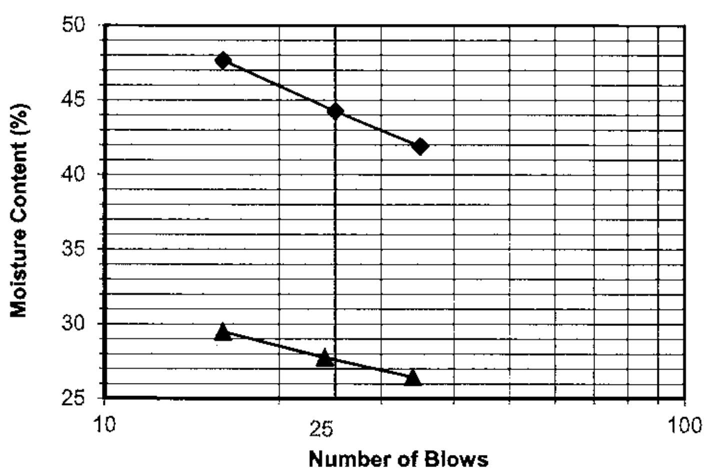
ATTERBERG LIMITS
ASTM D 4318

Project Name: Costco Tustin Ranch Gas OSR **Tested By:** DK Date: 10/28/18
Project No.: 20192059.001A **Checked By:** AP Date: 10/30/18



PROCEDURE USED

- [ ] Wet Preparation
- [X] Dry Preparation
- [X] Procedure A Multipoint Test
- [ ] Procedure B One-point Test

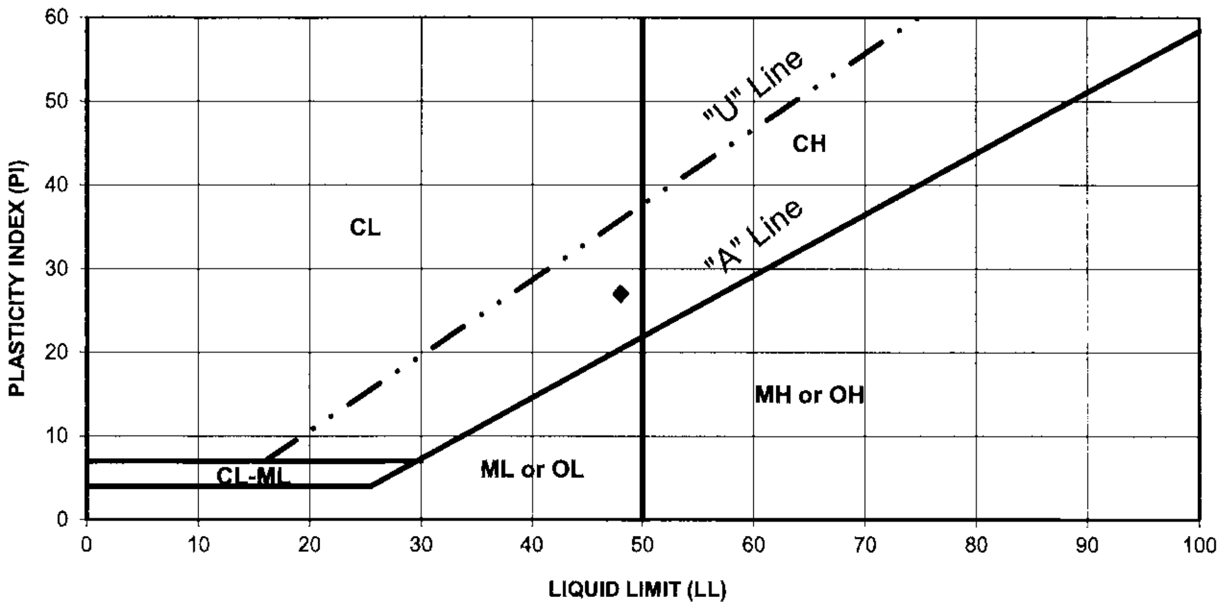


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
♦	B-3	7	15	44	11	33	CL
▲	B-3	11	25	28	14	14	CL

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

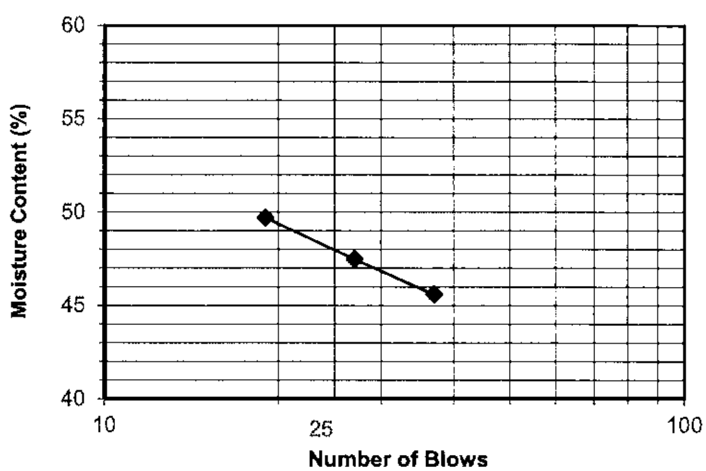
ATTERBERG LIMITS
ASTM D 4318

Project Name: Costco Tustin Ranch Gas OSR **Tested By:** DK Date: 10/28/18
Project No.: 20192059.001A **Checked By:** AP Date: 10/30/18



PROCEDURE USED

- [ ] Wet Preparation
- [X] Dry Preparation
- [X] Procedure A Multipoint Test
- [ ] Procedure B One-point Test

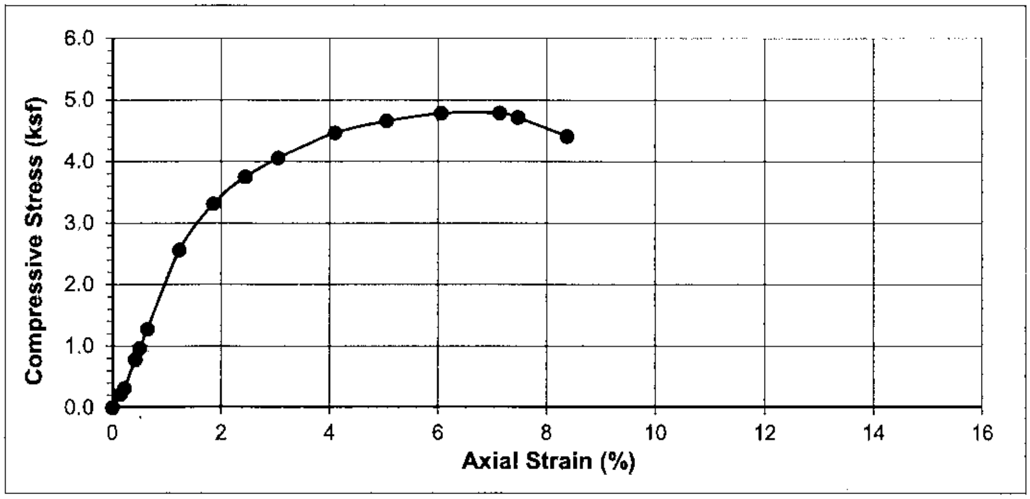


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
♦	B-3	16	40	48	21	27	CL

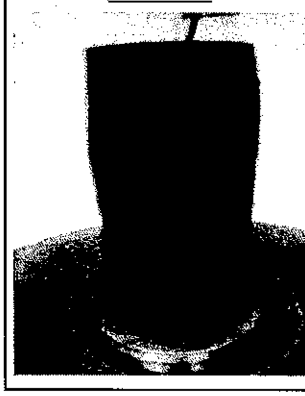
AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	Costco Tustin Ranch Gas OSR	Sample Type:	Mod Cal
Project No.:	20192059.001A	Soil Description	Clay
Boring No.:	B-1	Dry Density (pcf):	104.2
Sample No.:	9	Moisture Content (%)	20.9
Depth (feet):	21	Test Date:	10/29/18
Sample Diameter (inch):	2.422	Wt. Wet Soil+Container(gms)	895.34
Sample Height (inch):	4.953	Wt. Dry Soil+Container(gms)	765.2
Sample Weight (gms):	754.73	Wt. Container (gms)	141.77



After Test



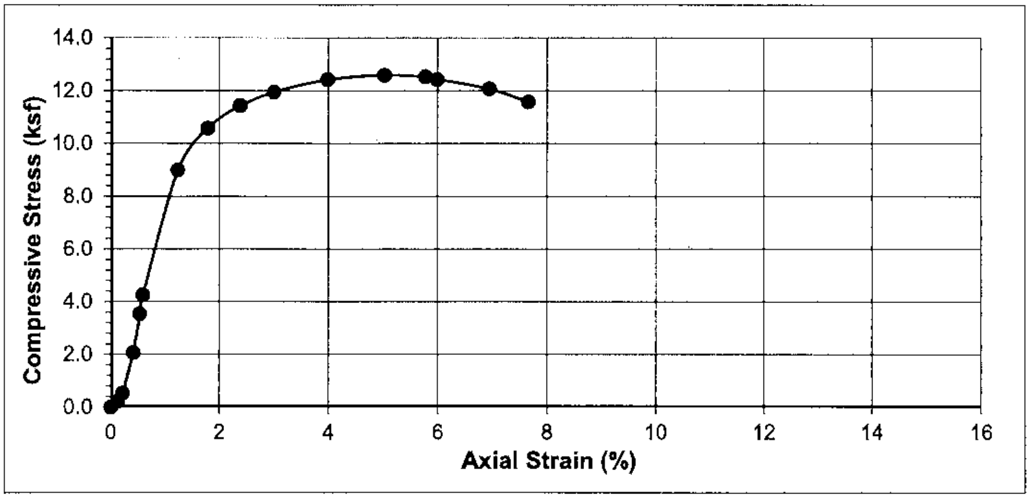
Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.61	0.00	0.00
7	0.008	4.61	0.22	0.16
10	0.011	4.62	0.31	0.22
25	0.021	4.63	0.78	0.42
31	0.025	4.63	0.96	0.50
41	0.032	4.64	1.27	0.65
83	0.061	4.66	2.56	1.23
108	0.092	4.69	3.31	1.86
123	0.121	4.72	3.75	2.44
134	0.151	4.75	4.06	3.05
149	0.203	4.80	4.47	4.10
157	0.250	4.85	4.66	5.05
163	0.300	4.90	4.79	6.06
165	0.353	4.96	4.79	7.13
163	0.370	4.98	4.71	7.47
154	0.415	5.03	4.41	8.38

Unconfined Compressive Strength (ksf) = **4.79**

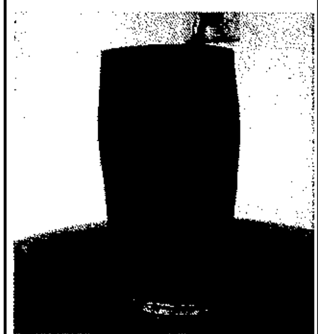
AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	Costco Tustin Ranch Gas OSR	Sample Type:	Mod Cal
Project No.:	20192059.001A	Soil Description	Clay
Boring No.:	B-1	Dry Density (pcf):	114.4
Sample No.:	4	Moisture Content (%)	15.5
Depth (feet):	8.5	Test Date:	10/29/18
Sample Diameter (inch):	2.413	Wt. Wet Soil+Container(gms)	948.02
Sample Height (inch):	5.042	Wt. Dry Soil+Container(gms)	840.58
Sample Weight (gms):	800.02	Wt. Container (gms)	149.17



After Test



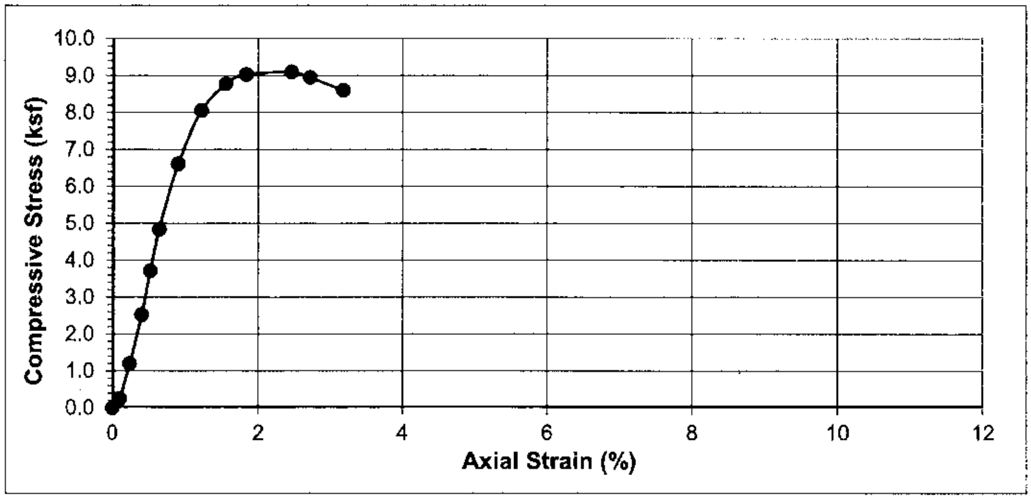
Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.57	0.00	0.00
7	0.007	4.58	0.22	0.14
17	0.011	4.58	0.53	0.22
66	0.021	4.59	2.07	0.42
113	0.027	4.60	3.54	0.54
136	0.030	4.60	4.26	0.60
289	0.062	4.63	8.99	1.23
342	0.090	4.66	10.58	1.79
372	0.120	4.68	11.44	2.38
391	0.151	4.71	11.94	2.99
411	0.201	4.76	12.43	3.99
421	0.253	4.81	12.59	5.02
422	0.291	4.85	12.52	5.77
420	0.302	4.86	12.43	5.99
412	0.350	4.91	12.07	6.94
398	0.386	4.95	11.57	7.66

Unconfined Compressive Strength (ksf) = **12.59**

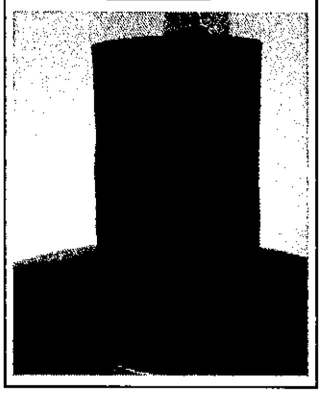
AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	Costco Tustin Ranch Gas OSR	Sample Type:	Mod Cal
Project No.:	20192059.001A	Soil Description	Clay
Boring No.:	B-2	Dry Density (pcf):	114.6
Sample No.:	4	Moisture Content (%)	13.9
Depth (feet):	11	Test Date:	10/29/18
Sample Diameter (inch):	2.409	Wt. Wet Soil+Container(gms)	958.33
Sample Height (inch):	4.990	Wt. Dry Soil+Container(gms)	863.03
Sample Weight (gms):	779.80	Wt. Container (gms)	179.74



After Test



Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.56	0.00	0.00
8	0.005	4.56	0.25	0.10
38	0.012	4.57	1.20	0.24
80	0.020	4.58	2.52	0.40
118	0.026	4.58	3.71	0.52
154	0.032	4.59	4.83	0.64
211	0.045	4.60	6.61	0.90
258	0.061	4.61	8.05	1.22
282	0.078	4.63	8.77	1.56
291	0.092	4.64	9.02	1.84
295	0.123	4.67	9.09	2.46
291	0.136	4.69	8.94	2.73
281	0.159	4.71	8.59	3.19

Unconfined Compressive Strength (ksf) = **9.09**

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

EXPANSION INDEX TEST RESULTS

ASTM D 4829

Client Name: Kleinfelder
Project Name: Costco Tustin Ranch Gas OSR
Project No.: 20192059.001A

AP Job No.: 18-1038
Date: 10/25/18

Boring No.	Sample No.	Depth (ft)	Soil Description	Molded Dry Density (pcf)	Molded Moisture Content (%)	Init. Degree Saturation (%)	Measured Expansion Index	Corrected Expansion Index
B-1	1	1	Sandy Clay	105.1	11.2	50.4	40	40

ASTM EXPANSION CLASSIFICATION

Expansion Index	Classification
0-20	V. Low
21-50	Low
51-90	Medium
91-130	High
>130	V. High

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

R-VALUE TEST DATA

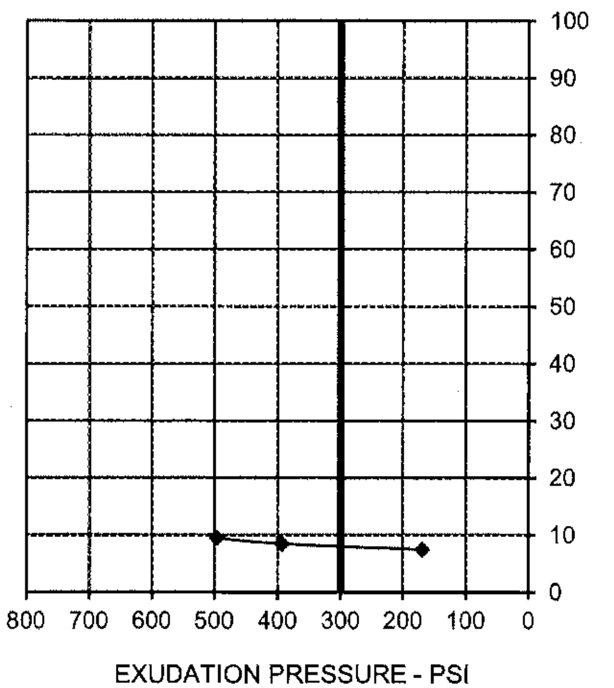
ASTM D2844

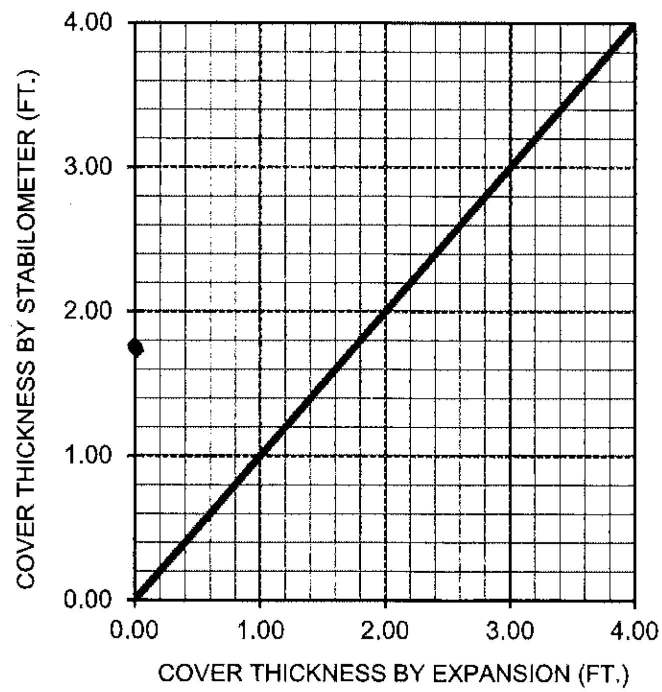
Project Name: Costco Tustin Ranch Gas OSR
Project Number: 20192059.001A
Boring No.: B-6
Sample No.: 1 Depth (ft.): 1
Location: N/A
Soil Description: Lean Clay

Tested By: ST Date: 10/19/18
Computed By: KM Date: 10/23/18
Checked By: AP Date: 10/30/18

Mold Number	G	H	I	
Water Added, g	53	39	34	
Compact Moisture(%)	23.3	21.7	21.1	
Compaction Gage Pressure, psi	50	50	50	
Exudation Pressure, psi	169	393	496	
Sample Height, Inches	2.6	2.6	2.6	
Gross Weight Mold, g	2889	2907	2854	
Tare Weight Mold, g	1827	1836	1818	
Net Sample Weight, g	1062	1071	1035	
Expansion, inchesx10^{-4}	0	2	4	
Stability 2,000 (160 psi)	60/140	60/140	60/139	
Turns Displacement	4.52	4.02	3.88	
R-Value Uncorrected	7	8	9	
R-Value Corrected	8	9	10	
Dry Density, pcf	100.4	102.5	99.6	
Traffic Index	8.0	8.0	8.0	
G.E. by Stability	1.77	1.75	1.73	
G.E. by Expansion	0.00	0.01	0.01	

R-VALUE	By Exudation:	8
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	8
Remarks	Gf = 1.34, and 0.0 % Retained on the ¾" *Not Applicable	





AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

CORROSION TEST RESULTS

Client Name: Kleinfelder
Project Name: Costco Tustin Ranch Gas OSR
Project No.: 20192059.001A

AP Job No.: 18-1038
Date: 10/29/18

Boring No.	Sample No.	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-2	1	3	CL	831	8.7	393	188
B-3	4	10	CL	1309	7.4	54	58

NOTES:
Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested