ALBUS-KEEFE & ASSOCIATES, INC
GEOTECHNICAL CONSULTANTS

November 18, 2019
J.N.: 2851.00

Mr. Scott Bering
C & C Development Co., LLC
14211 Yorba Street, Suite 200
Tustin, CA 92780

Subject: **Geotechnical Desktop Due-Diligence Report, Proposed Residential Development, 17861 Cartwright Road, Irvine, California.**

Dear Mr. Bering,

Albus-Keefe & Associates, Inc. is pleased to present to you our geotechnical desktop due-diligence report for the proposed development at the subject site. This report presents the results of our aerial photo and literature review. Conclusions relevant to the feasibility of the proposed site development are also presented herein based on the findings of our work.

1.0 SITE LOCATION AND DESCRIPTION

The subject site is located at 17861 Cartwright road, Irvine, California. The location of the site and its relationship to the surrounding areas are shown on Figure 1, Site Location Map. The site is roughly trapezoidal in shape with an area of about 1.7 acers. On the east, the site is bounded by Cartwright Road. On the west, north, and south, the site is bounded by parking lots of existing commercial properties.

Based on images from Google Earth, the site is currently occupied by a single-story commercial building approximately 20,000 square feet in areas with a paved parking lot to the south and west of this building. The site gently slopes eastward from approximately elevation 38 feet mean sea level (MSL) at the west to about elevation 34 feet (MSL) at Cartwright Ave. at the east.

A line of trees exists along the north and northwest property line. A narrow planter area including a few trees is present along the south property line. A planter area almost 30 feet in width with sparse vegetation separates the existing building from the sidewalk of Cartwright Ave. A small planter area with sparse vegetation and a few of trees and brushes exists at the center of the parking lot west of the existing building.

2.0 PROPOSED DEVELOPMENT

Specific information regarding the proposed development was not available to us at the time of this letter. Based on our understanding, site development is anticipated to consist of one multi-family structure at grade. The structure is anticipated to have three to four stories and may include parking at the first level and a podium deck to support the residential structure above. Associated interior

driveways, decorative hardscape, parking areas and underground utilities are also anticipated. No grading or structural plans were available in preparing of this proposal. However, we anticipate that minor rough grading of the site will be required to achieve future surface configuration and we expect future foundation loads will be relatively light to moderate.

FIGURE 1- SITE LOCATION MAP

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C & C Development Co., LLC
17861 Cartwright Road,
Irvine, California

NOT TO SCALE

3.0 RESEARCH

3.1 GENERAL

We have reviewed the referenced geologic publications, maps, historic aerial photographs, and previous reports for nearby sites as listed in the attached references. Information from these sources was utilized to development our findings and conclusions presented in this report.

3.2 AERIAL PHOTOGRAPHS

Our review of historical aerial photographs going back to 1946 indicates limited early development in the general vicinity of the site and land utilization almost exclusively for farming purposes at least until 1963. Between 1963 and 1972, major developments in the general vicinity of the site occurred. These include I-405 far south of the site and Main Street far north of it. However, the site remained undeveloped in this period. Sometime between 1972 and 1980, the existing building at the site and the parking lot were constructed, as well as Cartwright Avenue to the east of the site and several other properties in the general vicinity. Development in the area continued in different forms and rates ever since. However, the subject property did not experience any notable changes since the existing onsite building first appeared in aerial photos in 1980.

3.3 GEOLOGIC PUBLICATIONS

Based on Rogers (1965), the site is underlain by younger alluvium with a terrace deposit contact located about 1,800 feet to the southwest.

A review of the CDMG Seismic Hazard Zone Report 012 indicates that historical high groundwater level for the general site area is as shallow as 10 feet below the existing ground surface. This same publication indicates the site is located in a liquefaction hazard zone.

Reviewing the California Department of Conservation web site, the site is not shown within the bounds of an Alquist-Priolo Earthquake Fault Zone. The nearest AP fault zone is related to the Newport-Inglewood fault zone located approximately 8 miles to the west southwest.

3.4 PREVIOUS GEOTECHNICAL REPORTS

From our library, we found several previous geotechnical studies in the general area. The most notable reports consisted of one prepared by this firm for a site located about 3,000 feet to the northeast (AKA 2014), a report prepared by Petra Geosciences for a site located about 3,000 feet to the northwest (Petra 2017), and a report prepared by Twining Laboratories (Twining 2006) and one by Albus-Keefe (AKA 2006) for a site located about 3,000 feet to the east.

Exploration summarized in these earlier reports includes both hollow-stem auger borings and cone penetration testing (CPT) extending to a maximum depth of about 80 feet. The soil conditions were relatively similar in all three locations. Generally, the sites were covered by a thin cap of artificial fills that is underlain by alluvial soils. The soil profile generally consists of fine-grained soils with thin layers and lenses of granular soils to a depth of about 35 feet. From 35 to 50 feet, the soils often consist of granular materials. Below 50 feet, the soils generally consist of interbedded fine-grained and course-grained soils. Groundwater was usually encountered at a depth near 15 feet. All the reports also provide results of various laboratory testing.

4.0 FINDINGS

4.1 SUBSURFACE CONDITIONS

No site-specific subsurface data was located for the site. Based on data from the general area, the site is estimated to be covered by a mantle of fill associated with the existing and earlier development in this area. The fill is anticipated to be about 4 to 6 feet thick and is anticipated to be mostly composed of silty clay. The fill is expected to be underlain by natural alluvial soils. Generally, the alluvium is anticipated to consist of soft to medium stiff silty clay and sandy clay, with interlayers of loose to medium dense sand with various silt and clay content to a depth of at least 25 feet.

4.2 GROUNDWATER

No site-specific subsurface data was located for the site. Based on data from the general area, groundwater is anticipated to occur at a depth of about 15 feet below the existing ground surface. Over the past 10 years, groundwater does not appear to have varied much in depth. However, historical records indicate ground water could occur as shallow as 10 feet in the future.

4.3 FAULTING

Geologic literature does not indicate the presence of active faulting within the site. The site does not lie within an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo Earthquake Fault Zoning Act. Table 1 presents a summary of all the known seismically active faults within 10 miles of the site based on the 2008 National Seismic Hazards Maps.

TABLE 1
Summary of Faults

Name	Distance (miles)	Slip Rate (mm/yr.)	Preferred Dip (degrees)	Slip Sense	Rupture Top (km)	Fault Length (km)
San Joaquin Hills	0.51	0.5	23	thrust	2	27
Newport Inglewood Connected alt 2	6.87	1.3	90	strike slip	0	208
Newport-Inglewood, alt 1	6.99	1	88	strike slip	0	65
Newport Inglewood Connected alt 1	6.99	1.3	89	strike slip	0	208
Newport-Inglewood (Offshore)	7.44	1.5	90	strike slip	0	66

4.4 SEISMICITY

Probabilistic seismic analyses were performed utilizing the OSHPD US Seismic Design Maps web application based on ASCE7-10. These analyses result in the maximum credible earthquake peak ground acceleration PGA of 0.593g in accordance with Figure 22-7 of ASCE 7-10. For this range of PGA, the Site Amplification Factor, FPG_A, for Site Class D is 1.00. As result, the site-modified peak ground acceleration PGA_M = 1.00 x 0.593 = 0.593g. The mean event associated with a probability of exceedance equal to 2% over 50 years has a moment magnitude of 6.68 and the mean distance to the seismic source is 6.0 miles.

5.0 CONCLUSIONS

5.1 FEASIBILITY OF PROPOSED DEVELOPMENT

From a geotechnical point of view, the proposed residential site development is considered feasible provided appropriate geotechnical recommendations are incorporated into the design and construction of the project. Key issues that could have significant fiscal impacts on the geotechnical aspects of the proposed site development are discussed in the following sections of this report.

5.2 GEOLOGIC HAZARDS

5.2.1 Ground Rupture

No active faults are known to project through the site nor does the site lie within the bounds of an "Earthquake Fault Zone" as defined by the State of California in the Alquist-Priolo Earthquake Fault Zoning Act. As such, the potential for ground rupture due to fault displacement beneath the site is considered very low. The nearest zoned fault is the Newport Inglewood Fault located approximately 7 miles from the site.

5.2.2 Ground Shaking

The site lies in relative close proximity to several seismically active faults; therefore, during the life of the proposed structures, the property will probably experience similar moderate to occasionally high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region. Potential ground accelerations were estimated for the site and were presented earlier in this report. Design and construction in accordance with the current California Building Code (CBC) requirements is anticipated to adequately address potential ground shaking.

5.2.3 Liquefaction

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

- A source of ground shaking, such as an earthquake, capable of generating soil mass distortions.
- A relatively loose silty and/or sandy soil.

- A relative shallow groundwater table (within approximately 50 feet below ground surface) or completely saturated soil conditions that will allow positive pore pressure generation.

The liquefaction susceptibility of the subsurface soils was evaluated by analyzing the potential concurrent occurrence of the above-mentioned three basic factors. Since the site is expected to be underlain by some layers of loose granular soils that are below groundwater, and the site is anticipated to be subjected to strong ground shaking, liquefaction may occur during the design life of the project. Since most of the site soils are anticipated to be fine-grained, the anticipated magnitude of seismic settlement associated with liquefaction is estimated to be on the order of 1 to 3 inches. Due to the relatively level ground condition and thickness of overlying fine-grained soils, the potential for lateral spreading due to liquefaction is likely low.

Potential hazards created by the effects of liquefaction can be readily mitigated through the proper design and construction of the foundation system. Site with less than 4 to 6 inches of seismic settlement can generally use robust foundation systems such as mats, post-tension slabs, or spread footings that are tied in both direction with grade beams to mitigate the effects of liquefaction.

5.2.4 Landslide

Our review of published geologic maps indicates that landslides are not mapped at the project site and its immediate vicinity. Based on the gently sloping topography of the project site and the immediate vicinity, the potential for landslides at the site is deemed low.

5.2.5 Tsunami and Seiche

Tsunamis are long-period sea waves caused by rapid vertical seafloor movement usually triggered by fault rupture during earthquake. The geometry of coastlines and decrease in seafloor depth in coastal areas may convert the usually low-amplitude tsunami waves to very high and strong waves with devastating impact in the low-lying areas. Due to the inland location of the project site, tsunami risk is remote.

Earthquakes can produce waves – called seiche -- in enclosed bodies of water. The site is not near any enclosed body of water of significant size that can be subjected to seiche risk.

5.3 DESIGN AND CONSTRUCTION CONSIDERATIONS

5.3.1 Static Settlement

Under the anticipated current site conditions, we anticipate that total settlement of foundations for the structure would be on the order of 2 inches. This magnitude is somewhat beyond the customary tolerable limited for proposed site development. We anticipate that removal and recompaction of existing soils to a depth of about 3 feet below bottom of footings will reduce the total settlement to about 1 inch, a value considered within tolerable limits.

5.3.2 Excavation and Material Characteristics

In general, the existing near-surface soils should be considered unsuitable in their existing condition to support structural fills and site development. Additionally, the near-surface soils may contain varying expansion properties. This condition can be mitigated by removal and recompaction of unsuitable soils and providing a uniform fill blanket. Removal depths are generally anticipated to vary from about 1 in pavement areas to 6 feet in the building area.

Temporary construction slopes and trench excavations can likely be cut vertically up to a height of 5 feet within the onsite materials provided that no surcharging of the excavations is present. Temporary excavations greater than 5 feet in height will likely require side laybacks to 1:1 (H:V) or flatter to mitigate the potential for sloughing.

Where the presence of the existing offsite improvements limits removals of unsuitable materials adjacent the property lines, special grading techniques such as slot cutting, will be required adjacent to the property lines. Construction of perimeter site walls may require deepened footings or caissons and grade beams where removals are restricted by property boundaries.

Subsurface soils are anticipated to be relatively easy to excavate with conventional heavy earthmoving equipment. Removal and recompaction of the near-surface site materials will result in some moderate shrinkage. Design of site grading will require consideration of this loss when evaluating earthwork balance issues.

Moisture conditioning will likely be needed during recompaction, to achieve proper compaction. The soil may require drying or the additional of water depending on the moisture content of the existing near surface soils at the time of grading.

5.3.3 Expansion Characteristics of the Onsite Materials

Based on our experience and review of reports within the vicinity of the site, **Medium** expansion potential is anticipated from the near-surface onsite soil. The expansion characteristics influence the type and design of foundations, flatwork, and earth pressures for retaining walls. Adverse effects can be mitigated through the use of appropriate design parameters and construction details.

5.3.4 Concrete Mix Design and Corrosion

Based on our experience and review of reports within the vicinity of the site, indicates soluble sulfate content is anticipated to be more than 0.20% but less than 2.0%. As such, concrete will likely require design for Severe sulfate exposure in accordance with ACI 318.

Soils at the site are also anticipated to be severely corrosive to metals. If metal components will be in contact with site soils, they will likely require mitigation measures such as polyvinyl wrapping as recommended by a corrosion specialist.

5.3.5 Percolation Characteristics

Because of relatively shallow depth of historically high groundwater (approximately 10 feet below grade) and fine-grained soils present in the upper 15 feet, infiltration of stormwater at the site will not be feasible. Treatment of storm water quality will require the use of other options such as bio-filtration.

6.0 LIMITATIONS

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

This report summarizes several geotechnical topics that should be beneficial for project planning and budgetary evaluations. *The information presented herein is intended only for a preliminary feasibility evaluation and **is not** intended to satisfy the requirements of a site specific and detailed geotechnical investigation required for further planning and permitting.*

This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty.

This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein.

This report has been prepared for the exclusive use of **C & C development Co., LLC** to assist the project consultants in determining the feasibility of the proposed development. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

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

Sincerely,

ALBUS-KEEFE & ASSOCIATES, INC.

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Associate Engineer
GE 3111

David E. Albus
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7.0 REFERENCES

Publications

Historical Aerial Photos (https://www.historicaerials.com/viewer)

California Department of Conservation, Division of Mines and Geology, Seismic Hazard Report 012, "Seismic Hazard Evaluation of the Tustin Quadrangle, Orange County, California", 2001.

California Geologic Survey, Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, 2008.

OSHPD Seismic Design Maps (2019): https://seismicmaps.org/

Rogers, Thomas H (1965), Geologic Map of California, Olaf P Jenkins Edition, Santa Ana Sheet, CDMG, scalte 1:250,000

Seed, H.B., Idriss, I.M., "Ground Motions and Soil Liquefaction During Earthquakes," published by the EERI, dated December 1982.

Southern California Earthquake Center (SCEC), University of Southern California, *Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California*, March 1999.

State Water Resources Control Board GeoTracker database (2019): http://geotracker.waterboards.ca.gov/gama/gamamap/public/

Tokimatsu, K. & Seed, H.B., "Evaluation of Settlement in Sands Due to Earthquake Shaking", Journel of Geotechnical Engineering, Vol. 113, No. 8, August, 1987

Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., and Stokoe, K.H., *Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils*, ASCE Journal of Geotechnical and Geoenvironmental Engineering, October, 2001.

Reports

Albus-Keefe & Associates, Inc. (2014), *Preliminary Geotechnical Investigation, Proposed Multi-Family Residential Development, 17275 Derian Avenue, Irvine, California,* May 19, 2014 (JN: 2277.00)

Albus-Keefe & Associates, Inc. (2006), *Preliminary Geotechnical Investigation, Proposed Multi-Story Residential Complex, 2838 and 2852 Kelvin Avenue, City of Irvine, California,* dated August 16, 2006 (J.N. 1549.00)

Petra Geosciences, Inc. (2017), *Updated Geotechnical Investigation. Proposed Residential Development, 17822 Gillette Avenue, Irvine, California,* dated January 11, 2017 (J.N. 15-212)

Twining Laboratories (2006), *Geotechnical Engineering Evaluation Report, Proposed Kelvin Medical Center, Parcel 2 Lot 16, Tract 8018, 2838 Kelvin Avenue, Irvine, CA,* dated May 18, 2006.

Aerial Photographs

Photo Source	Date Flown
Historic Aerials	1946
Historic Aerials	1952
Historic Aerials	1963
Historic Aerials	1972
Historic Aerials	1980
Historic Aerials	1994
Historic Aerials	2002
Historic Aerials	2003
Historic Aerials	2004
Historic Aerials	2005
Historic Aerials	2009
Historic Aerials	2010
Historic Aerials	2012
Historic Aerials	2014
Historic Aerials	2016