# Appendix E1 Geotechnical/Geologic Constraints Study (Petra Geotechnical)

# Appendices

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PETRA

# GEOTECHNICAL/GEOLOGIC CONSTRAINTS STUDY, WILSON CREEK SPECIFIC PLAN, SOUTH OF OAK GLEN ROAD BETWEEN 2ND AND BRYANT STREET, CITY OF YUCAIPA, SAN BERNARDINO COUNTY, CALIFORNIA

July 5, 2011
J.N. 204-11


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Engineers, Geologists
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Ms. Leah Boyer
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1580 Metro Drive
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**Subject: Geotechnical/Geologic Constraints Study, Wilson Creek Specific Plan, South of Oak Glen Road between 2nd and Bryant Street, City of Yucaipa, San Bernardino County, California**

Dear Ms. Boyer:

Petra Geotechnical, Inc. (Petra) is pleased to submit herewith our feasibility-level geotechnical/geologic constraints report for the proposed Wilson Creek Specific Plan (WCSP) project, located south of Oak Glen Road Between 2nd and Bryant Streets in the City of Yucaipa, California (Figure 1). This work was performed in accordance with the scope of work outlined in our Proposal No. 1047-11 dated March 29, 2011. The purposes of our study were to obtain available geotechnical and geologic information on the nature of the previous land usage and current soil conditions, to evaluate the potential geologic constraints that may affect development of the property, and to provide geologic and geotechnical mitigation recommendations for submittal with an Environmental Impact Report (EIR) for the WCSP.

This investigation included a site reconnaissance and preliminary subsurface exploration, as well as a review of published and unpublished literature, aerial photographs, and geologic maps pertaining to geologic and geotechnical hazards which may have an impact on the proposed development. This report presents the findings and opinions regarding the feasibility of the proposed project with respect to the geologic and geotechnical factors that may impact site development.

## Purpose and Scope of Services

The purpose of this study was to obtain preliminary information on the subsurface geologic and soil conditions within the project area in order to provide conclusions and recommendations for the feasibility of the proposed project to support the associated Environmental Impact Report (EIR).

The scope of our evaluation consisted of the following:

- Reconnaissance of the site to evaluate the existing conditions.
- Review of available published and unpublished geologic data, maps and geotechnical reports concerning geologic and soil conditions within and adjacent to the site which could have an impact on the proposed improvements.
- Review of sequential stereo-paired aerial photographs of the site and surrounding area.
- Excavation of five exploratory borings, utilizing a hollow-stem auger drill rig, to evaluate the stratigraphy of the subsurface soils and collect representative undisturbed and bulk samples for laboratory testing, within the proposed business park partner of the project.
- Log and visually classify soil materials encountered in the exploratory borings in accordance with the Unified Soil Classification System.
- Conduct preliminary laboratory testing of representative samples (bulk and undisturbed) obtained from the exploratory borings to determine their engineering properties.
- Perform preliminary engineering and geologic analysis of the data with respect to the planned development.
- Preparation of this feasibility report, including pertinent figures and appendices, presenting the results of our evaluation and recommendations for the proposed development.

**Location and Site Description**

The WCSP is an irregular shaped 84-acre parcel that is predominately vacant land and is bounded by 2nd Street to the west, Oak Glen Road to the north, Bryant Street to the east and an existing residential tract to the south. The general location and the recent condition of the site are shown on the attached Site Location Map, Figure 1, and Exploration Location Map, Figure 2. The WCSP project site can be separated into two distinct project areas: a 29-acre business park site and a 55-acre open-space and flood control basin site that are described in further detail below.

The proposed business park site is an irregular shaped parcel and is bounded on the south by Oak Glen Creek and is bordered by vacant open land to the south, an existing residential subdivision and the City maintenance yard to the west, undeveloped church property and a fire station to the east and a community center to the north. The southwest-northeast trending Wilson Creek essentially bisects the central portion of the business park site emanating from the concrete culvert box structure under Oak Glen Road.

Current access to the western portion of the site is by a locked chain link gate on 2nd Street and access to the eastern portion of the site is through the vacant, undeveloped church property. The site is presently vacant of any structures, however the majority of the central and western portion of the site has been greatly disturbed due to past use as a sand and gravel pit. Chain link fencing is located along the western property line and post and barbed wire fencing is located along the property line with the church property. An existing chain link stockade staging area is currently being used in the extreme northwest corner of the site. In addition an approximately 20-foot high sand stockpile is located near the center of the site and various dumped debris, including piles of wood, concrete and asphalt, were sporadically noted along the surface in the western portion of the site. Several dirt paths dissect the western portion of the site leading to and from the gravel pit area along the western bank of Wilson Creek. The business park site exhibits approximately 50 feet or more of topographic relief from the high point along Oak Glen Road and descending towards the southwest at the confluence of Wilson Creek and Oak Glen Creeks. Natural slope gradients on the site ranged from approximately 5:1 (horizontal: vertical [h:v]) along ridge tops to as steep as approximately 1:1 (h:v) along the sides of the Wilson Creek. Vegetation within the site ranges from a moderate to locally heavy growth of native weeds, scrub brush and occasional small trees. A stand of large trees is located along the northwest property line near the City maintenance yard.

The open-space/flood control basin portion of the WCSP is predominantly bounded on the north by Oak Glen Creek, by a dirt drive (unimproved 2nd Street) on the west, Bryant Street to the east and a natural ascending slope and a developed residential tract to the south. A small portion of the site is located north of Oak Glen Creek, south of the existing fire station and to the west of Bryant Street. The site is predominantly vacant with the exception of a Yucaipa Valley Water District well house and chain link stockade at the southwest corner of the property. Overhead utility poles are located along the east side of the unimproved portion of 2nd Street and two water transmission lines were observed in the low point of the road where Oak Glen Creek and Wilson Creek intersect and cross the road. Other underground utilities may also be present. Oak Glen Creek enters the site from the concrete culvert box structure under Bryant Street on the east. Topography ranges from nearly level to at steep as 1:1, slopes along the north bank of Oak Glen Creek, but generally descending at a slight gradiant to the west-southwest. Several dirt paths dissect the site and the southern and eastern boundaries of the site appear to be routinely brushed/cleared of vegetation either for access or fire control purposes. Scattered debris, trash and older wire fencing were periodically observed on the surface of the site or within Oak Glen Creek. Vegetation

on the site consists of a moderate to occasionally heavy growth of native brush with occasional small tree, to some areas within Oak Glen Creek that have stands of large tress.

**Proposed Development**

The current business park conceptual development plan will include five one- to two-story commercial office buildings, the extension of Sunnyside Drive, and appurtenant infrastructure to support the business park development, including underground utilities, parking lot/driveway areas and landscape areas. Existing 2nd Street will be extended south towards the southern property boundary and we assume a concrete culvert structure will span Oak Glen Creek. Wilson Creek will be realigned from its current southwest trending alignment to a northerly-southerly alignment draining south into Oak Glen Creek. Either a small bridge or a deep fill and concert culvert structure is anticipated to span the new Wilson Creek alignment. Site grading is anticipated to consist of overexcavation and recompaction of the existing upper portions of existing site soils in order to create level building pads for the planned commercial structures. Significant cuts and fills from the existing grades are anticipated.

A large, 200-acre-feet flood control detention basin is currently planned on the south side of Oak Glen Creek at the southwest corner of the property (RBF). The basin as planned will be approximately 675 feet wide, 1,040 feet in length and 20 feet in depth. Cuts from existing grades are anticipated, however minor fills may also be needed to form the top of the basin slopes. Currently, there are no plans for the basin improvements, however we assume that typical structures such as concrete spillways, storm drain pipe, access roads, fencing etc. will be proposed. In addition a habitat conservation area is planned north of Oak Glen Creek and south of the existing fire station and proposed business park. All other areas are to remain in a natural state.

**Literature Review**

Petra researched and reviewed available published and unpublished geologic data pertaining to regional geology, faulting and geologic hazards that may affect the site. The results of this review are included within the Findings section of this report.

**Aerial Photo Analysis**

Sequential black and white stereo, and individual-frame, aerial photographs (1949 to 1998) covering the site and surrounding area were obtained and reviewed by Petra. These photographs, obtained from Continental Aerial Photo, were at approximate scales ranging from 1 inch equals 1,500 feet to 1 inch equals 4,000 feet.

**Subsurface Exploration**

A subsurface exploration program was performed under the direction of an engineering geologist from Petra on April 29, 2011 within the proposed business park portion of the project. The exploration involved the excavation of five exploratory hollow-stem auger borings to depths of approximately 16.5 to 51.5 feet below existing grades. Earth materials encountered within the exploratory borings were classified and logged by an engineering geologist in accordance with the visual-manual procedures of the Unified Soil Classification System. The approximate locations of the exploratory borings are shown on Figure 2 and the logs for the boring are presented in Appendix A.

Disturbed bulk samples and relatively undisturbed ring samples of soil materials were collected for classification, laboratory testing and engineering analyses. Disturbed bulk samples were collected from the auger cuttings, sealed in plastic bags and transported to our laboratory for subsequent testing. Undisturbed samples were obtained using a 3-inch outside diameter modified California split-spoon soil sampler lined with brass rings. The soil sampler was driven with successive 30-inch drops of a free-fall, 140-pound automatic trip hammer. The central portions of the driven-core samples were placed in sealed containers and transported to our laboratory for testing. The number of blows required to drive the split-spoon sampler 18 inches into the soil were recorded for each 6-inch driving increment; however, the number of blows required to drive the sampler for the final 12 inches was noted in the boring logs as *Blows per Foot*.

Standard penetration tests were also performed in accordance with the American Society for Testing Materials Standard Procedure (ASTM) D1586. This method consisted of driving an unlined standard split-barrel sampler 18 inches into the soil with successive 30-inch drops of the 140-pound hammer. Blow counts were recorded for each 6-inch driving increment; however, the number of blows required to

drive the standard split-barrel sampler for the last 12 of the 18 inches was identified as the standard penetration resistance, or N-count, and recorded in the boring logs.

### Laboratory Testing

Preliminary laboratory tests included in-situ dry density and moisture content, expansion index and general soil corrosivity (soluble sulfate, soluble chloride, pH and resistivity). A description of laboratory test methods and summaries of the laboratory test data are presented in Appendix B and the in-situ dry density and moisture content results are presented on the boring logs (Appendix A).

## FINDINGS

### Previous Site Land Use

Based on our review of stero-paired aerial photographs the site was in an undisturbed natural state up until at least October of 1959. Mining activities for sand and gravel began in the central potion of the business park portion site between October 1959 and August 1968 and have continued to the present day. The present day channel configuration of Wilson Creek immediately north of the site was constructed between August 1968 and January 1976. The present day City yard adjacent to the northwest corner of the site was constructed and began operations between January 1976 and January 1980. Based on the latest aerial photo we reviewed, the residential tract to the west was graded and constructed sometime after October of 1998. The areas to the north, east and south of the gravel pit appear to have remained generally in their undisturbed natural state.

### Regional Geologic Setting

The subject property is situated within the San Gabriel Mountains Block (upper plate of the San Vincent thrust) within the northern part of the Peninsular Ranges Geomorphic Province. The San Gabriel Mountains Block is underlain by granitic and metamorphic crystalline rock that are Cretaceous in age or older. The block is bounded on the east-northeast by the San Andreas fault zone and the San Bernardino Mountains, and on the south-southwest by the Banning Fault and on the north-northwest by the Vincent Thrust. In closer proximity, the subject site is located with an area of northeast trending thrust faulting associated with the Vincent Thrust and the Crafton Hills Fault Zone. The site lies less than 1 mile east of the Crafton Hills, approximately 1 mile northwest of the Yucaipa Ridge, and approximately 2.5 miles southwest of the San Bernardino Mountains.

The site is located on the central portion of a narrow alluvial valley located between the Crafton Hills and Yucaipa Ridge. These Quaternary alluvial deposits extend southwest into the Yucaipa basin from the flanks of the San Bernardino Mountains. The active alluvial drainages Wilson Creek and Oak Glen Creek intersect at the southwest corner of the property.

**Local Geology and Subsurface Soil Conditions**

Earth materials encountered in the exploratory borings consisted of areas of undocumented fill underlain by natural alluvial deposits that extended to the maximum explored depth of 51.5 feet. The earth units encountered in our borings are described as follows:

- Undocumented Fill – Undocumented, uncompacted fills were encountered within Boring B-1, B-3 and B-4 to a maximum encountered depth of 6 feet. These materials generally consisted of loose, dry, dark brown to dark gray sand with silt and occasional chunks of asphalt and concrete. Due to the past site usage, deeper undocumented fill/stockpiles most likely exist beneath the current surface of the property most notably in the central portion of the site between boring B-2 and B-3.

- Alluvium – Native alluvial deposits was encountered either at the surface or directly underlying the undocumented fills to the maximum explored depth of 51.5 feet below grade. These materials consisted generally of yellowish brown to dark yellowish brown, slightly moist to moist, loose near the surface to very dense at depth, sands, sands with silt and silty sand mixtures with gravels to occasional small cobbles.

**Groundwater**

Static groundwater was not encountered during our field investigation to a maximum explored depth of 51.5 feet below the existing ground surface at both the B-1 and B-2 locations. Although the Wilson Creek and Oak Glen Creek stream beds were dry during our site investigation, periodic surface water flow will be present within these streams.

**Faulting**

The geologic structure of the southern California area is dominated mainly by northwest-trending faults associated with the San Andreas Fault system. Based on our review of published and unpublished geotechnical maps and literature pertaining to the site and regional geology, the site does not lie within the boundaries of an Earthquake Fault zone as defined by the State of California Alquist-Priolo Earthquake Fault Zoning Act. The closest AP zoned active faults to the site are shown on the Attached Figure 4 and include the Crafton Hills fault, approximately 3,500 feet to the northwest; the Chicken Hills

Fault, located approximately 2.8 kilometers (1.75 miles) to the southwest, the San Andreas fault (Southern and San Bernardino segments located approximately 4.9 kilometers (3 miles) to the northeast; and the San Jacinto fault – San Jacinto Valley segment located approximately 15.5 kilometers (9.6 miles) to the southwest.

However, two northeast trending concealed faults associated with the Chicken Hills Fault (City of Yucaipa, 2000, Matti et. al., 2003) are mapped within the northern portion of the project site (business park area) as depicted on the attached Fault Location Map, Figure 3. These faults are mapped as having Late Quaternary displacement but Holocene activity has not been ruled out; meaning they may be active or are at least considered potentially active. Based on our review of stero-paired aerial photographs, a strong lineament coincides with the southern of the two mapped fault strands.

**Seismic Hazard Analysis**

A probabilistic seismic hazard analysis (PSHA) was performed for the site in order to determine the ground-motions for the Design-Basis earthquakes. The Design-Basis Earthquake (DBE) ground motion is determined by probabilistic methods and defined as having a 10 percent chance of exceedance in 50 years. A probabilistic analysis incorporates uncertainties in time, recurrence intervals, size, and location (along faults) of hypothetical earthquakes. This method therefore accounts for the likelihood (rather than certainty) of occurrence and provides levels of ground acceleration that might be more reasonably hypothesized for a finite exposure period. The DBE ground-motion with a recurrence interval of about 475 years is used.

We have developed a recommended pairing of the maximum credible magnitude of the San Andreas fault and the estimated peak ground acceleration at the site, based on a 10 percent probability of being exceeded in 50 years (DBE – Design Based Earthquake). Our recommendation is based on three sources, the California Geological Survey website, the USGS NSHMP online Java Application version 5.1.0, and the online USGS deaggregation tools, our recommendation is shown in following table below. The online USGS NSHMP Java Application gives both the values based on the use of Sds over 2.5 per the building code section 1803.5.12.2 of the 2010 CBC, and a base motion input value for site class D soil profile for different probabilities of occurrence. The online USGS deaggregation tools use the 2008 fault database from USGS in comparison to the 2002 fault database utilized by the other tools from USGS, and CGS. The earthquake magnitudes used in the CGS and USGS 2002 fault database are based on fault models developed by the California Geological Survey (formally known as the California Division of Mines and

Geology) and the U.S. Geological Survey (USGS). These models are described in Peterson et al (1996) and Cao, et al. (2003). The deaggregation for the site shows a pga (peak ground acceleration) of 0.688 for a 10 percent chance of exceedance in 50 years, and the magnitude with the highest contribution is a 7.5. The magnitude chosen for our Maximum Credible Magnitude was one standard deviation above the mean magnitude.

| Maximum Credible Magnitude | Peak Horizontal Ground Acceleration |
|---|---|
| 7.5 | 0.679g to 0.688g |

**Seismic Design Parameters per 2010 CBC**

Structures within the site should be designed and constructed to resist the effects of seismic ground motions as provided in Section 1613 of the 2010 CBC. The method of design is dependent on the seismic zoning, site characteristics, occupancy category, building configuration, type of structural system and on the building height.

For structural design in accordance with the 2010 CBC, a computer program, Earthquake Ground Motion Parameters Version 5.1.0, developed by the United States Geological Survey (USGS, 2007) was utilized to provide ground motion parameters for the subject site. The program includes hazard curves, uniform hazard response spectra and design parameters for sites in the 50 United States, Puerto Rico and the United States Virgin Islands. Based on the latitude, longitude and site classification, seismic design parameters and spectral response for both short periods and 1-second periods are calculated including Mapped Spectral Response Acceleration Parameter, Site Coefficient, Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter and Design Spectral Response Acceleration Parameter. The program is based on USGS research and publications in cooperation with the California Geological Survey for evaluation of California faulting and seismicity (USGS, 1996a; 1996b; 2002; 2007).

The following 2010 CBC seismic design coefficients should be used for the proposed structures. These criteria are based on the site class as determined by existing subsurface geologic conditions, on the proximity of the site to the nearby faults and on the maximum moment magnitude and slip rate of the nearby faults.

| 2010 CBC Section 1613, Seismic Design Coefficients | |
|---|---|
| Site Latitude | 34.0463 |
| Site Longitude | -117.0404 |
| Site Class Definition (Table 1613.5.2) | D |
| Mapped Spectral Response Acceleration Parameter, $S_s$ (Figure 1613.5(3) for 0.2 second) | 1.852 |
| Mapped Spectral Response Acceleration Parameter, $S_1$ (Figure 1613.5(4) for 1.0 second) | 0.844 |
| Site Coefficient, $F_a$ (Table 1613.5.3 (1) short period) | 1.0 |
| Site Coefficient, $F_v$ (Table 1613.5.3 (2) 1-second period) | 1.5 |
| Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, $S_{MS}$ (Eq. 16-36) | 1.852 |
| Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, $S_{M1}$ (Eq. 16-37) | 1.265 |
| Design Spectral Response Acceleration Parameter, $S_{DS}$ (Eq. 16-38) | 1.235 |
| Design Spectral Response Acceleration Parameter, $S_{D1}$ (Eq. 16-39) | 0.844 |

## CONCLUSIONS AND RECOMMENDATIONS

### General Feasibility

Based on our research and review of pertinent geologic literature and on the preliminary subsurface investigation, development of the Wilson Creek Specific Plan is considered feasible from a geotechnical standpoint, however from a geologic standpoint, the presence of two potentially active faults is considered a potentially significant constraint with respect to the business park portion of the project. A detailed fault investigation should be conducted by a qualified professional geologist prior to the design phase of the project.

The portion of the site south of Oak Glen is to be developed as a natural area and flood control basin. There are no geotechnical constraints in this area that would significantly impact this portion of the proposed development.

In addition, there are a number of geologic/geotechnical constraints inherent to the property that should be considered during the design process. These constraints and other preliminary design considerations should be more thoroughly investigated at the design-level of planning and are discussed further below.

## Geologic and Geotechnical Considerations

### Fault Surface Rupture

The site is not located within a currently designated State of California Alquist-Priolo Earthquake Fault Zone (Hart, 1999). However, two concealed, and potentially active faults, have been mapped as projecting through the site and are depicted on Figure 3. *Subsurface fault trenching will required prior to the design level phase of planning in the planned business park area where two potentially active faults are mapped and/or are suspected.*

If these faults are located but proven to be inactive, or if there is no evidence of faulting, then the proposed development will not be constrained by a fault surface rupture hazard. If active fault strands are discovered then appropriate fault setbacks, and possibly strengthened foundations, will be required for structures for human occupancy. Typical setbacks are on the order of 50 feet on either side of the fault, however the setback distance also depends on the quality of the data and the type or complexity of the fault(s). Evidence of active faults does not preclude other forms of development such as roadways, landscaping areas, graded slopes etc.

### Seismic Shaking

The site is located within an active tectonic area of southern California with several significant faults capable of producing moderate to strong earthquakes. The San Andreas, Crafton Hills, Banning and San Jacinto faults are all in close proximity of the site and capable of producing strong ground motions. The site will likely be subjected to very strong seismically related ground shaking during the anticipated life span of the project and structures within the site should therefore be designed and constructed to resist the effects of strong ground motion in accordance with the 2010 California Building Code (CBC).

### Liquefaction and Seismically Induced Settlement

Liquefaction of soils can be caused by strong vibratory motion due to earthquakes. When solid particles in a saturated soil consolidate into a tighter package as a result of vibration due to an earthquake, the non-

compressible pore water between the particles will be squeezed out. If the soil has a high permeability, a sufficient amount of water will drain out of the pores to maintain inter-granular stresses and, thereby, the soil's shear strength. However, if the permeability is relatively low, then the water will not drain away quickly enough and pore water pressures will build as a result. If the pore water pressure rises to a level such that the shear strength of the soil becomes zero, then liquefaction is said to have occurred. Factors known to influence liquefaction potential include soil type and depth, grain size, relative density, ground-water level, degree of saturation, and both intensity and duration of ground shaking.

Based on a review of the San Bernardino County Geologic Hazard Overlays the site does not lie within zone that is susceptible to liquefaction. Based on the data obtained during our preliminary subsurface investigation, the potential for liquefaction induced settlement is considered very low due to the absence of a shallow groundwater table and the relative high density of the coarse grained alluvial soils at depth.

**Landslides and Secondary Effects of Seismic Activity**

No landslides have been mapped within or near the subject site and based on a review of the San Bernardino County Geologic Hazard Overlays the site does not lay within zone that is susceptible to landsliding. Secondary effects of seismic activity normally considered as possible hazards to a site include several types of ground failure. Various general types of ground failures, which might occur as a consequence of severe ground shaking at the site, include ground subsidence, ground lurching and lateral spreading. The probability of occurrence of each type of ground failure depends on the severity of the earthquake, distance from faults, topography, subsoils and groundwater conditions, in addition to other factors. Based on the site conditions, landsliding, ground subsidence, ground lurching and lateral spreading are considered unlikely at the site.

**Tsunamis and Seiches**

Inundation of the site due to tsunamis is considered negligible because the site is located approximately 55 miles from the Pacific Ocean at an elevation of approximately 2,650 feet msl. Furthermore, the site is not located in proximity to enclosed bodies of water; therefore, inundation of the site due to seiches during an earthquake event is also considered nil. We assume that design and construction of the existing water reservoir just northeast of the corner of the of the business park site was performed in accordance with recent California Building Code standards; however the project civil engineer should evaluate the

possibility of flooding in the event the tank ruptures due to seismic shaking during a significant seismic event.

**Groundwater**

Adverse effects on the proposed development resulting from the presence of shallow groundwater are not anticipated. However the site lies within the drainage course of both Wilson Creek and Oak Glen Creek and a flood plain review will likely be required. Local drainage considerations relative to the proposed development should be addressed by the project civil engineer.

**Areal Subsidence**

The subject site is not known to be located in an area with potential for ground subsidence due to withdrawal of fluids.

**Slope Stability**

Based on our observations, the exposed soils and natural slopes are considered to have favorable geologic structure and no evidence of landsliding was encountered. However, due to the granular nature of surficial soils, they may be subject to erosion and localized surficial instability. Further evaluation within specific areas of the site may be necessary during the design phase geotechnical investigation of the project depending of the proposed grading concept with regards to proposed large cut and/or fill slopes.

**Compressible Soils and Remedial Grading**

The undocumented fill and near-surface alluvial soils are surficially loose and inconsistent due to the uncompacted and variable nature of the fills and shallow underlying natural alluvial deposits. Accordingly, remedial grading of the near-surface compressible soils will be necessary for support of lightly loaded shallow foundations and engineered fills.

While subject to near-surface remedial grading, the site is generally suitable for the support of shallow, lightly to moderately loaded foundations, however, heavily loaded foundations, such as for large commercial structures or bridges, may require the use of other foundation systems. We recommend that a detailed geotechnical investigation be conducted when site the grading and foundation plans are developed to prepare site specific grading and foundation recommendations that are appropriate for the proposed construction.

**Erosion**

Site soils are granular in nature and are subject to erosion. During and following site development the erosion potential on graded slopes will require erosion control measures. Although grading plans have not been developed the following recommendations are standardized recommendations following site grading and may be considered for site development:

Precise Grading and Drainage Facilities

Surface drainage systems consisting of sloping concrete flatwork, graded earth swales and/or an underground area drain system are anticipated to be constructed to collect and direct all surface waters to the adjacent streets and storm drain facilities. In addition, the ground surface around the proposed buildings should be sloped at a positive gradient away from the structures. The purpose of the precise grading is to prevent ponding of surface water within the level areas of the site and against building foundations and associated site improvements. The drainage systems should be properly maintained throughout the life of the proposed development.

It should be emphasized that the slopes away from the structures and storm drain structures to be properly maintained, not to be obstructed, and that future improvements not to alter established gradients unless replaced with suitable alternative drainage systems.

Slope Landscaping and Maintenance

Adequate slope- and pad-drainage facilities are essential in the design of grading for the subject site. An anticipated rainfall equivalency on the order of 60 to 100 inches per year at the site can result due to irrigation. The overall stability of the graded slopes should not be adversely affected provided drainage provisions are properly constructed and maintained thereafter and provided engineered slopes are landscaped immediately following grading with a deep-rooted, drought-tolerant and maintenance-free plant species, as recommended by the project landscape architect. Additional comments and recommendations are presented below with respect to slope drainage, landscaping and irrigation.

A common type of slope failure in hillside areas is the surficial instability and usually involves the upper 1 to 6 feet. For a given gradient, these surficial slope failures are generally caused by a wide variety of conditions, such as overwatering, cyclic changes in moisture content and density of slope soils from both seasonal and irrigation-induced wetting and drying, soil expansiveness, time lapse between slope

construction and slope planting, type and spacing of plant materials used for slope protection, rainfall intensity and/or lack of a proper maintenance program. Based on this discussion, the following recommendations are presented to mitigate potential surficial slope failures.

- Proper drainage provisions for engineered slopes should consist of concrete terrace drains, downdrains and energy dissipaters (where required) constructed in accordance with the Grading Code of the City of Yucaipa. Provisions should also be made for construction of compacted-earth berms along the tops of engineered slopes.

- Permanent engineered slopes should be landscaped as soon as practical at the completion of grading. As noted, the landscaping should consist of a deep-rooted, drought-tolerant and maintenance-free plant species. If landscaping cannot be provided within a reasonable period of time, jute matting (or equivalent) or a spray-on product designed to seal slope surfaces should be considered as a temporary measure to inhibit surface erosion until such time permanent landscape plants have become well-established.

- Irrigation systems should be installed on the engineered slopes and a watering program then implemented which maintains a uniform, near-optimum moisture condition in the soils. Overwatering and subsequent saturation of the slope soils should be avoided. On the other hand, allowing the soils to dry-out is also detrimental to slope performance.

- Irrigation systems should be constructed at the surface only. Construction of sprinkler lines in trenches should not be allowed without prior approval from the geotechnical engineer and engineering geologist.

- A permanent slope-maintenance program should be initiated for major slopes not maintained by the development. Proper slope maintenance should include the care of drainage- and erosion-control provisions, rodent control and repair of leaking or damaged irrigation systems.

- Homeowners should be advised of the potential problems that can develop when drainage on the pads and slopes is altered. Drainage can be altered due to the placement of fill and construction of garden walls, retaining walls, walkways, patios and planters.

**Expansive Soils**

Based on the predominant soils types encountered at the site, granular sand with silt to silty sands with gravels, the expansion potential was found to be in the very low category, i.e. an expansion index of less than 20, based on one test performed in accordance with ASTM Test Method D4829. As such the design of slab-on-ground foundations will be exempt from the procedures outlined in the 2010 CBC Sections 1802.3.2 and 1805.8.2.

**Soil Corrosivity Screening**

As part of this investigation, one representative sample of near-surface soil was subjected to screening tests in order to provide a general assessment of soil corrosivity. The results of these tests, which include soluble sulfates and chlorides, pH and resistivity, are provided in Appendix B.

The following sections of this report present our geotechnical engineering interpretation of current codes and specifications that are commonly used in our industry in conjunction with limited laboratory testing for corrosive potential. It should be noted that Petra Geotechnical, Inc. does not practice corrosion engineering; therefore, the opinions and engineering judgment provided herein should be considered as general guidelines only. It is recommended that the project design professional (i.e., the architect and/or structural engineer) consider retaining a qualified corrosion engineer to conduct additional sampling and testing of near-surface soils during the final stages of site grading to provide a complete assessment of soil corrosivity. Recommendations to mitigate the detrimental effects of corrosive soils on concrete and buried metallic building materials (such as copper and ductile iron) placed in contact with site soils should be provided by the corrosion engineer as deemed appropriate.

Soluble Sulfate and Soil pH

The results of our laboratory testing performed in accordance with California Test Method No. 417 indicate onsite near-surface soils exhibit a water-soluble sulfate content of 0.004 percent. According to Table 4.2.1 of the ACI 318-08, the soils are thus categorized as Exposure Class S0 with respect to soluble sulfates and, therefore, a negligible exposure to sulfates may be expected for concrete placed in contact with these soil materials and specific requirements for cement type, maximum water-cement ratio, and minimum concrete compressive strength are not required.

The results of limited in-house testing performed in accordance with California Test Method No. 643 indicate that onsite soils are slightly alkaline (pH of 7.2). Based on this finding and according to Section 8.22.2 of Caltrans Bridge Design Specifications (BDS) requirements for the combined effects of soluble sulfates and pH as encountered within the site, no special requirements for cement type, water-cement ratio, or strength are needed.

**Chloride**

The results of tests performed in accordance with California Test Method No. 422 indicate that onsite soils exhibit a water-soluble chloride concentration of 125 parts per million (ppm). According to Table 4.2.1 of the ACI 318-08, concrete that is exposed to moisture but not to external sources of chloride should be categorized as Exposure Class C1 with respect to chlorides and, therefore, a **Mild** exposure to chlorides may be expected for concrete placed in contact with the onsite soil materials.

Section 1904.4 of CBC 2010 requires that reinforcement in concrete be protected from exposure to chlorides in accordance with Section 4.4 of ACI 318; however, Section 4.4 of ACI 318-08 is related to freeze-and-thaw conditions that are not applicable to the subject project. Therefore, no protection against chloride content is expected to be required. Further, according to Table 8.22.1 of Caltrans BDS no minimum concrete cover is specified when chloride concentration is less than 500 ppm.

**Resistivity**

The minimum soil resistivity was determined in accordance with California Test Method No. 643 and was found to be 5,300 ohm-cm. This result indicates that onsite soils are moderately corrosive to ferrous metals and copper. As such, any ferrous metal or copper components of the proposed buildings within the site (such as cast iron pipes, ductile iron pipes, copper tubing, etc.) that are expected to be buried in direct contact with site soils need to be protected against the detrimental effects of **Moderately Corrosive** soil materials.

## RECCOMENDATION S FOR ADDITIONAL STUDY

The findings and conclusions presented in this feasibility evaluation are based on the research and preliminary investigation performed by Petra to support the Wilson Creek Specific Plan EIR. (Based on the presence of mapped potentially active fault strands within the site, a detailed fault investigation will be required within the business park area of the project to determine the activity level of the faults, if encountered, and provide appropriate mitigation measures as needed.) Additionally, when grading and foundation plans have been developed, additional geotechnical subsurface investigation, testing and analysis, will be necessary to provide detailed grading, foundation and seismic recommendations that are appropriate for the proposed construction.

## LIMITATIONS

This report is based on the project, as described, research of available geologic maps and data, and the preliminary geotechnical data obtained from our field and laboratory tests performed. The materials encountered on the project site and utilized in our laboratory evaluation are believed representative of the general area. However, soil materials can vary in characteristics between excavations, both laterally and vertically. As stated, when site plans have been developed, additional subsurface investigation and geotechnical testing and analysis, will be necessary.

The conclusions and opinions contained in this report are based on the results of the described geotechnical evaluations and represent our professional judgment. This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and in the same 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 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.

It has been a pleasure to be of service to you on this project. Should you have questions regarding the contents of this report or should you require additional information, please contact this office.

Respectfully submitted,

PETRA GEOTECHNICAL, INC.

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Distribution: (3) Addressee

Attachments: References
Figure 1 – Site Location Map
Figure 2 – Exploration Location Map
Figure 3 – Chicken Hills Fault Location Map
Figure 4 – Regional AP Zoned Active Fault Location Map

Appendix A – Boring Logs
Appendix B – Laboratory Test Criteria/Laboratory Test Data

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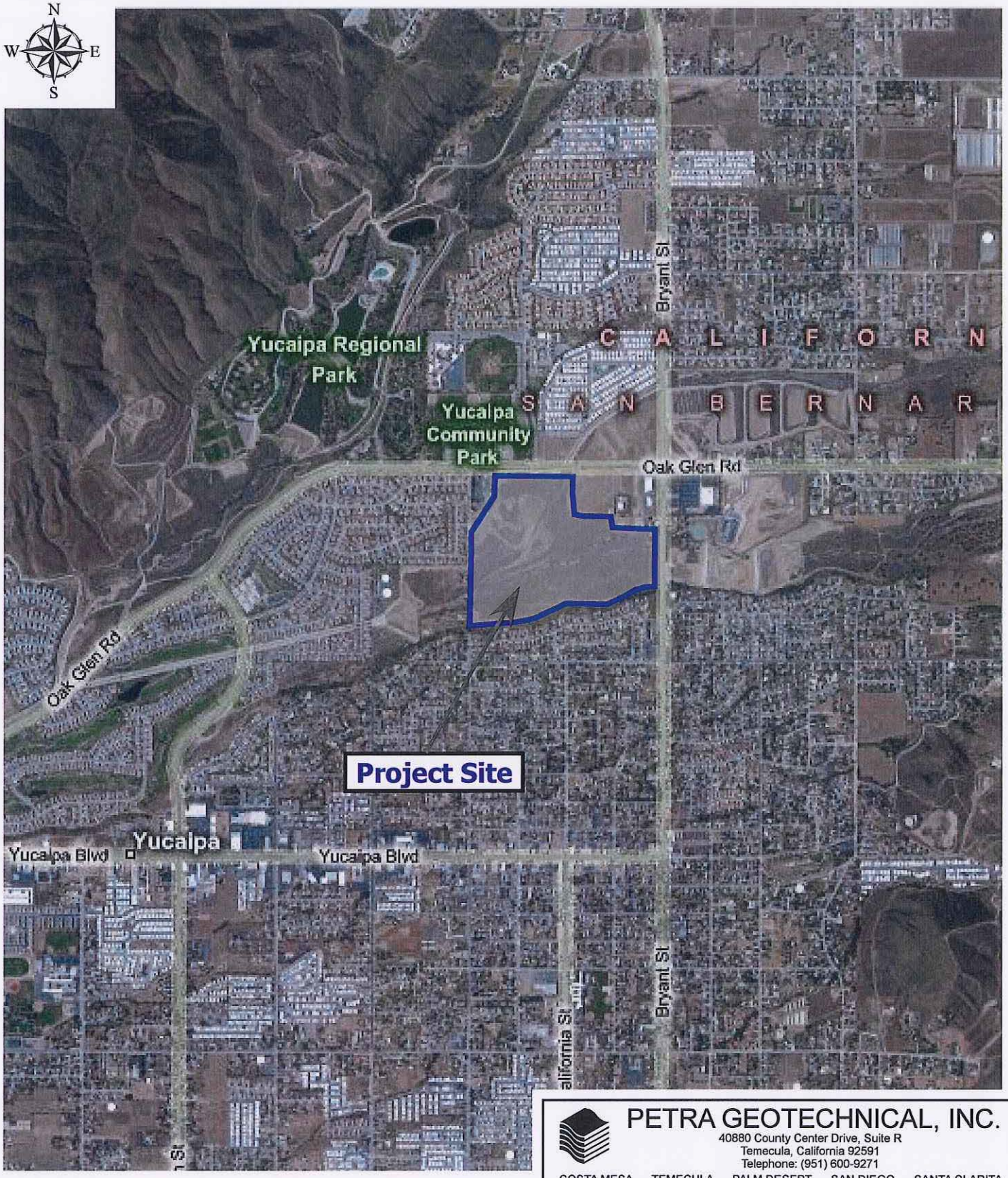


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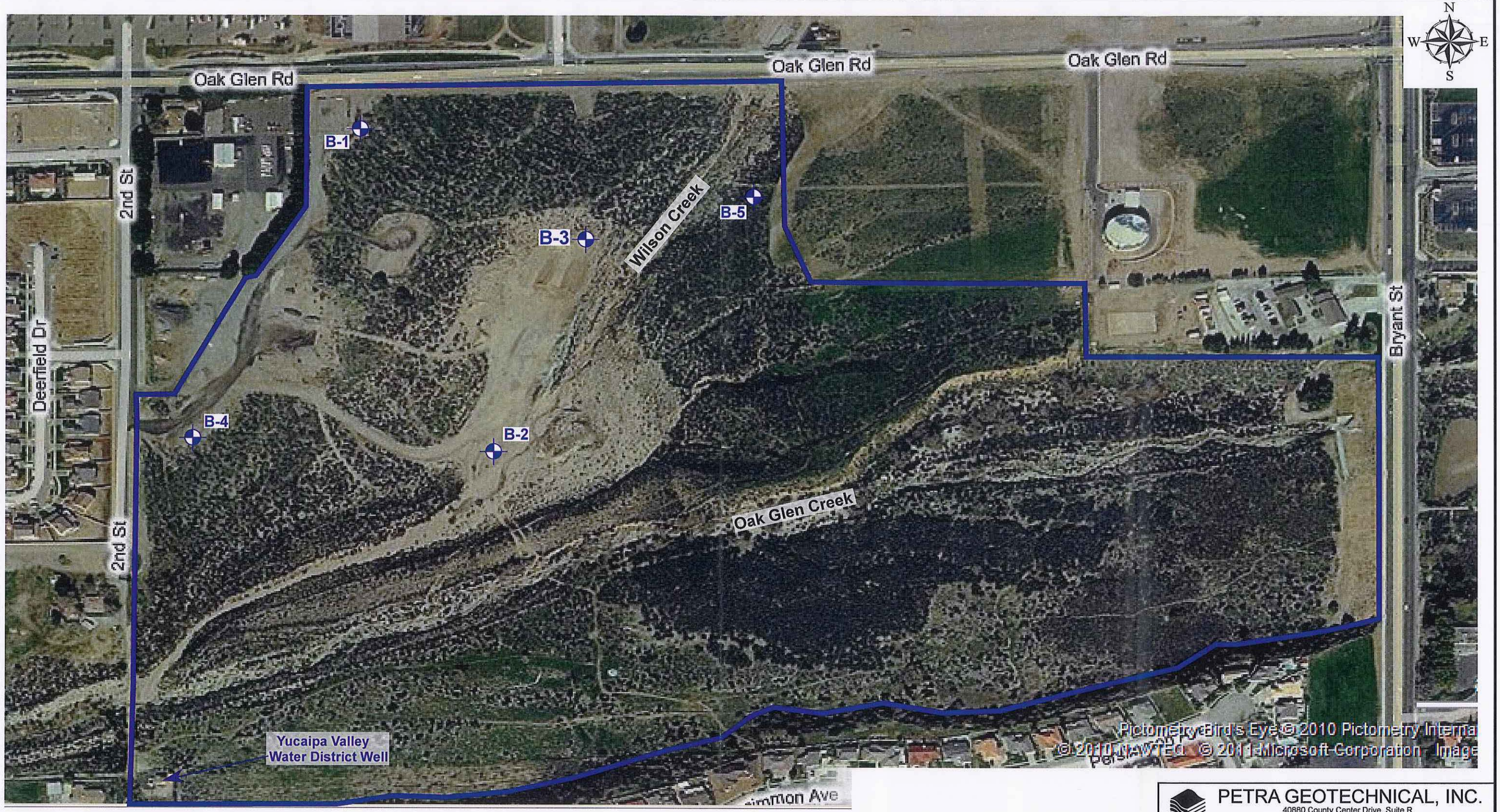
## SITE LOCATION MAP

Wilson Creek Specific Plan Project
South of Oak Glen Road between 2nd and Bryant Streets
City of Yucaipa, San Bernardino County, California

| | | |
|---|---|---|
| DATE: July 2011 | J.N.: 204-11 | Fig. 1 |
| DWG BY: DLJ | SCALE: None | |

Reference: Bing Maps, 2011




## EXPLANATION

B-5 Approximate Exploratory Hollow-Stem Auger Boring Location

Reference: Bing Maps 2011

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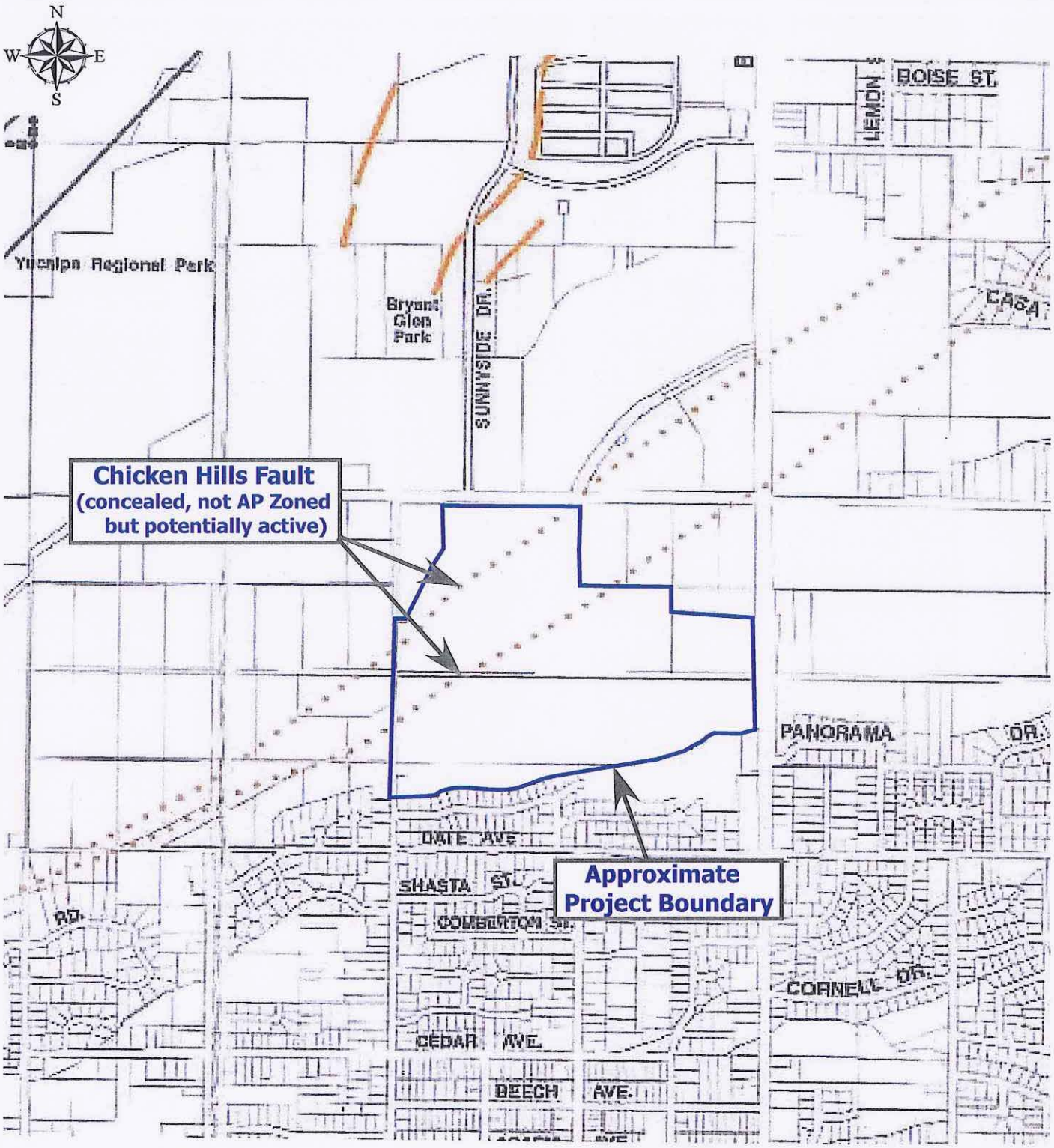
**EXPLORATION LOCATION MAP**

Wilson Creek Specific Plan Project
South of Oak Glen Road between 2nd and Bryant Streets
City of Yucaipa, San Bernardino County, California

| | | |
|---|---|---|
| DATE: July 2011 | J.N.: 204-11 | **Figure 2** |
| DWG BY: DLJ | SCALE: NTS | |

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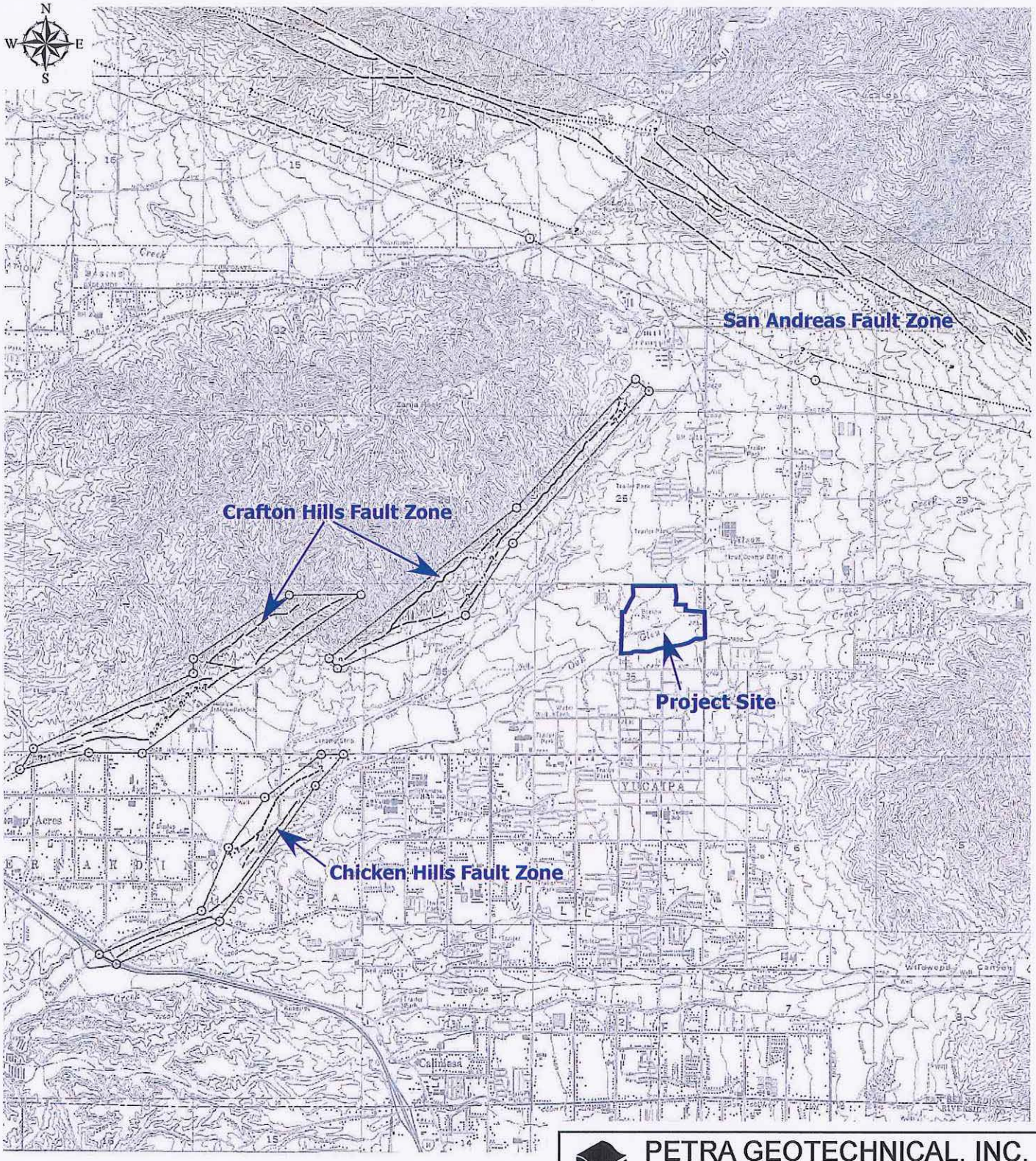
**CHICKEN HILLS**
**FAULT LOCATION MAP**

Wilson Creek Specific Plan Project
South of Oak Glen Road between 2nd and Bryant Streets
City of Yucaipa, San Bernardino County, California

| DATE: July 2011 | J.N.: 204-11 | Figure 3 |
|---|---|---|
| DWG BY: DLJ | SCALE: None | |

Reference: City of Yucaipa, 2000, Fault Rupture Hazard Zones, Compiled by D. Scott Magorien, CEG, dated August 14

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**REGIONAL AP ZONED ACTIVE FAULT LOCATION MAP**

Wilson Creek Specific Plan Project
South of Oak Glen Road between 2nd and Bryant Streets
City of Yucaipa, San Bernardino County, California

| | | |
|---|---|---|
| DATE: July 2011 | J.N.: 204-11 | **Figure 4** |
| DWG BY: DLJ | SCALE: None | |

Reference: California Division of Mines and Gelogy, Special Studies Zones, Yucaipa Quadrangle, Revised Official Map, effective January 1, 1979.

# APPENDIX A

## BORING LOGS

PETRA

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-1** | |
| Location: **Northwest Corner of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | **ARTIFICIAL FILL (Af)**<br>SAND with Silt (SP-SM): light gray, loose, dry; occassional small cobbles. | | | | | | | |
| 2 | | **ALLUVIUM (Qal)**<br>Silty SAND (SM): dark yellowish brown, slighltly mooist, loose; fine sand, trace fine gravel, friable. | | 8 | ■ | | 16.1 | 99.9 | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | dark brown, moist, medium dense; fine to medium sand, trace fine to coarse gravel, friable. | | 14 | ■ | | 7.4 | 107.6 | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | trace cobbles. | | | | | | | |
| 10 | | dark yellowish brown. | | 27 | ■ | | 8.7 | 119.3 | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | SAND with Silt (SP-SM): yellowish brown, slightly moist, very dense; fine to coarse sand, trace fine gravel. | | | | | | | |
| 15 | | | | 91 | ■ | | 4.4 | 121.1 | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | 90 | ■ | | 6.4 | 122.9 | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | | | | | | | | | |

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

**PLATE A-1**

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-1** | |
| Location: **Northwest Corner of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 26 | | SAND with Silt (SP-SM): yellowish brown, slightly moist, very dense; fine to coarse sand with fine to coarse gravel. | | 49 | | | | | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 | | Silty SAND (SM): dark yellowish brown, slightly moist, very dense; fine to medium sand, trace coarse sand to fine gravel. | | 76 | | | | | |
| 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 33 | | | | | | | | | |
| 34 | | Sand with SILT (SP-SM): yellowish brown, slightly moist, very dense; fine to coarse sand with gravel. | | | | | | | |
| 35 | | | | 33 | | | | | |
| 36 | | | | 50-5" | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | | | | | | | | | |
| 40 | | | | | | | | | |
| 41 | | SAND (SP): yellowish brown, slightly moist, very dense; fine to coarse sand, trace fine gravel. | | 53 | | | | | |
| 42 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | | | 70 | | | | | |
| 46 | | | | | | | | | |
| 47 | | | | | | | | | |
| 48 | | | | | | | | | |
| 49 | | | | | | | | | |

PLATE A-2

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | | Boring No.: **B-1** |
| Location: **Northwest Corner of Site** | | | Elevation: **N/A** |
| Job No.: **204-11** | Client: **The Planning Center** | | Date: **4/29/11** |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | | Logged By: **DLJ** |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | Silty SAND (SM): dark yellowish brown, slightly moist, very dense; fine to medium sand, trace coarse sand to fine gravel. | | 22 | | | | | |
| | | Total Depth 50.5 Feet<br>No Groundwater Encountered<br>Boring Backfilled with Cuttings. | | | | | | | |

PLATE A-3

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: | **B-2** |
| Location: **Southern End of Site** | | Elevation: | **N/A** |
| Job No.: **204-11** | Client: **The Planning Center** | Date: | **4/29/11** |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: | **DLJ** |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | **ALLUVIUM (Qal)** SAND (SP): brown, slightly moist, dense; fine to coarse sand with fine to coarse gravel, trace cobble. | | | | | | | |
| 2 | | | | 53 | ■ | ■ | 3.1 | 117.6 | |
| 3 | | | | | ■ | ■ | | | |
| 4 | | | | | | | | | |
| 5 | | SAND with Silt (SP-SM): dark yellowish brown, slightly moist, medium dense; fine to medium sand, trace coarse sand and fine gravel, friable. | | 22 | ■ | | 7.8 | 118.7 | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | graditional contact. Silty SAND (SM): dark yellowish brown, slightly moist, medium dense; fine to medium sand, trace coarse sand and fine gravel. | | 33 | ■ | | 9.2 | 118.7 | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 | | SAND with Silt (SP-SM): dark yellowish brown, slightly moist, medium dense; fine to coarse sand, trace fine gravel, friable. | | 28 | ■ | | 9.4 | 115.4 | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | less friable. | | 59 | ■ | | 3.9 | 118.6 | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | | | | | | | | | |

PLATE A-4

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-2** | |
| Location: **Southern End of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 26 | | SAND with Silt (SM): brown, slightly moist, very dense; fine to medium sand, trace corse sand and fine gravel. | | 83 | | | 4.8 | 116.5 | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 | | dark yellowish brown, medium dense; fine to coarse sand. | | 27 | | | | | |
| 31 | | | | | | | | | |
| 32 | | | | | | | | | |
| 33 | | | | | | | | | |
| 34 | | | | | | | | | |
| 35 | | dense. | | 34 | | | | | |
| 36 | | | | | | | | | |
| 37 | | | | | | | | | |
| 38 | | | | | | | | | |
| 39 | | | | | | | | | |
| 40 | | Silty SAND (SM): dark yellowish brown, moist, medium dense; fine to medium sand, trace coarse sand and fine gravel. | | 22 | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |
| 45 | | SAND (SP): brown, slightly moist, very dense; fine to coarse. | | 33 | | | 3.6 | 118.8 | |
| 46 | | | | 50-5" | | | | | |
| 47 | | | | | | | | | |
| 48 | | | | | | | | | |
| 49 | | | | | | | | | |

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

PLATE A-5

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-2** | |
| Location: **Southern End of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| — 51 | | dark yellowish brown, with fine to coarse gravel. | | 28 | | | | | |
| | | Total Depth 51.5 Feet<br>No Groundwater Encountered<br>Boring Backfilled with Cuttings. | | | | | | | |

PLATE A-6

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-3** | |
| Location: **Borrow Pit Area** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | **UNDOCUMENTED FILL (Afu)** SAND with Silt (SP-SM): dark gray, slightly moist, medium dense; with asphalt, concrete chunks etc.. | | 14 | | | | | |
| 5 | | | | 57 | | | 3.6 | 121.5 | |
| 6 | | **ALLUVIUM (Qal)** SAND with Silt (SP-SM): dark yellowish brown, slightly moist, dense; fine to coarse sand with fine to coarse gravel. | | | | | | | |
| 10 | | SAND (SP): light yellowish brown, slightly moist, very dense; fine to coarse sand trace fine to coarse gravel. | | 77 | | | 2.9 | 121.8 | |
| 15 | | Silty SAND (SM): dark yellowish brown, moist, very dense; fine to medium sand, trace coarse sand and fine gravel. | | 67 | | | 9.3 | 120.3 | |
| 20 | | SAND (SP): dark yellowish brown, slightly moist, very dense; fine to coarse sand with fine to coarse gravel. | | 80 | | | 3.0 | 124.0 | |
| 24 | | | | | | | | | |

PLATE A-7

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-3** | |
| Location: **Borrow Pit Area** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 30 | | | | | |
| — 26 | | Total Depth 26.5 Feet<br>No Groundwater Encountered<br>Boring Backfilled with Cuttings. | | | | | | | |

PLATE A-8

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-4** | |
| Location: **Western Edge of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | **UNDOCUMENTED FILL (Afu)** | | | | | | | |
| 2 | | SAND with Silt (SP-SM): dark brown, moist, loose; fine to coarse sand, with gravel and asphalt. | | 6 | ■ | | 7.4 | 108.2 | |
| 3 | | | | | | | | | |
| 4 | | **ALLUVIUM (Qal)** | | | | | | | |
| 5 | | SAND (SP): yellowish brown, slightly moist, medium dense; fine to coarse sand with fine to coarse gravel. | | 16 | ■ | | 3.5 | 110.3 | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | SAND with Silt (SP-SM): dark yellowish brown, slightly moist, dense; fine to coarse sand with fine to coarse gravel. | | 51 | ■ | | 4.8 | 120.6 | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 | | SAND (SP): yellowish brown, slightly moist, dense; fine to coarse sand, trace fine gravel. | | 45 | ■ | | 4.3 | 115.4 | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | with fine to coarse gravels. | | 35 | ■ | | 3.3 | 120.2 | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | | | | | | | | | |

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

**PLATE A-9**

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-4** | |
| Location: **Western Edge of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 26 | | SAND with Silt (SP-SM): dark yellowish brown, slightly moist, very dense; fine to coarse sand, trace fine gravel. | | 68 | | | 4.5 | 111.0 | |
| | | Total Depth 26.5 Feet<br>No Groundwater Encountered<br>Boring Backfilled with Cuttings. | | | | | | | |

PLATE A-10

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

# EXPLORATION LOG

| | | | |
|---|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-5** | |
| Location: **Northeast Corner of Site** | | Elevation: **N/A** | |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** | |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** | |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | **ALLUVIUM (Qal)**<br>SAND with Silt (SP-SM): dark yellowish brown, moist, loose; fine to medium sand trace coarse sand to coarse gravel. | | 8 | | | 6.8 | 112.5 | EI, Chem |
| 5 | | slightly moist; fine to coarse sand. | | 10 | | | 5.0 | 107.9 | |
| 10 | | Silty SAND (SM): dark yellowish brown, moist, medium dense; fine to medium sand, trace coarse sand and fine gravel. | | 16 | | | 9.8 | 114.8 | |
| 15 | | SAND with Silt (SP-SM): yellowish brown, moist, medium dense; fine to coarse sand with fine to coarse gravel. | | 26 | | | 7.2 | 120.2 | |
| 20 | | very dense. | | 69 | | | 6.4 | 116.5 | |

PLATE A-11

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

# EXPLORATION LOG

| | | |
|---|---|---|
| Project: **Wilson Creek Business Park** | | Boring No.: **B-5** |
| Location: **Northeast Corner of Site** | | Elevation: **N/A** |
| Job No.: **204-11** | Client: **The Planning Center** | Date: **4/29/11** |
| Drill Method: **Hollow-Stem Auger** | Driving Weight: **140 lbs / 30 in** | Logged By: **DLJ** |

| Depth (Feet) | Lith-ology | Material Description | Water | Samples: Blows Per Foot | Samples: Core | Samples: Bulk | Laboratory Tests: Moisture Content (%) | Laboratory Tests: Dry Density (pcf) | Laboratory Tests: Other Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| 26 | | very dense. | | 80 | ■ | | 10.7 | 117.8 | |
| | | Total Depth 26.5 Feet<br>No Groundwater Encountered<br>Boring Backfilled with Cuttings. | | | | | | | |

PLATE A-12

EXPLORATION LOG - V2 204-11.GPJ PETRA.GDT 7/5/11

# APPENDIX B

## LABORATORY TEST CRITERIA/LABORATORY TEST DATA

## Laboratory Test Criteria

### Soil Classification

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

### In-Situ Moisture and Density

Moisture content and unit dry density of in-place soils were determined in representative strata. Test data are summarized in the Boring Logs (Appendix A).

### Expansion Index

Expansion index tests were performed on selected samples of soil in accordance with ASTM D4829. Expansion potential classifications were determined from 2010 CBC Section 1803.5.3 on the basis of the expansion index values. Test results and expansion potentials are presented on Plate B-1.

### Corrosion Tests

Chemical analyses were performed on a selected sample to determine concentrations of soluble sulfate and chloride, as well as pH and resistivity. These tests were performed in accordance with California Test Method Nos. 417 (sulfate), 422 (chloride) and 643 (pH and resistivity). Test results are included on Plate B-1.

## EXPANSION INDEX TEST DATA

| Boring/Depth (feet) | Soil Type | Expansion[1] Index | Expansion[2] Potential |
|---|---|---|---|
| B-5 @ 0-5 | Dark Yellowish Brown SAND with silt, trace gravels | 1 | Very Low |

(1) PER ASTM D4829
(2) PER 2010 CBC Section 1803.5.3

## CORROSION TESTS

| Boring/Depth (feet) | Sulfate[3] (%) | Chloride[4] (ppm) | pH[5] | Resistivity[5] (ohm-cm) | Corrosivity Potential |
|---|---|---|---|---|---|
| B-5 @ 0-5 | 0.004 | 125 | 7.2 | 5,300 | concrete: Negligible<br>steel: Moderate |

(3) PER CALIFORNIA TEST METHOD NO. 417
(4) PER CALIFORNIA TEST METHOD NO. 422
(5) PER CALIFORNIA TEST METHOD NO. 643