3.0 SUMMARY OF POTENTIAL GEOTECHNICAL IMPACTS AND MITIGATION MEASURES

This section summarizes the principal geotechnical conditions that occur in the project area. The potential impact that each condition may have on the site development is subjectively rated as less-than-significant or potentially significant. The California Geological Survey (formerly the California Division of Mines and Geology) has prepared guidelines for geologic and seismic considerations in environmental impact reports (CGS, 1975), in order to identify potential geologic hazards and assist in recognizing data needed for design analysis and mitigation measures. These guidelines have been used during preparation of in this report.

3.1 Seismic Hazards

3.1.1 Fault-Induced Ground Rupture

The site is not located within an Alquist-Priolo Earthquake Fault Zone. However, the site is located within an Earthquake Fault Zone for the Chicken Hill Fault based on our conversations with the City of Yucaipa’s Geologist. As such, the potential for fault induced ground rupture is considered to be a **potentially significant** impact.

Mitigation Measures: A detailed fault investigation addressing the presence and activity of the Chicken Hill Fault onsite will be required prior to construction onsite. Leighton will be performing this investigation in January of 2007. Based on that investigation, if an active fault is identified onsite, a structural setback from the fault will be established thus reducing the potential impact to the development due to earthquake induced ground rupture to **less than significant.**

3.1.2 Seismic Ground Shaking

The intensity of ground shaking at a given location depends on several factors, but primarily on the earthquake magnitude, the distance from the hypocenter to the site of interest, and the response characteristics of the soil or bedrock units underlying the site. The site is located within Seismic Zone 4 of the Uniform Building Code, 1997 edition. In the site area, the hazard posed by seismic shaking is considered high, due to the proximity of known active faults. Therefore, seismic ground shaking is considered to be a **potentially significant** impact.

Mitigation Measures: There is no realistic way in which the hazard of seismic shaking can be totally avoided. However, exposure to future ground shaking at the site is no greater than at many other sites in southern California. Furthermore, it should be recognized that while it is not considered feasible to make structures totally resistant to seismic shaking, they are designed not to collapse. The effects of seismic shaking on structures can be reduced through conformance with the recommendations of the geotechnical consultant for the project, the California/Uniform Building Code, and/or other local governing agencies' codes or requirements. This will promote safety in the event of a large earthquake and minimize damage. Design in accordance with these measures is expected to reduce the impact of ground shaking to **less than significant**.

3.1.3 Secondary Effects of Seismic Shaking

Secondary effects of seismic shaking are non-tectonic processes that are directly related to strong seismic shaking. Ground deformation, including fissures, settlement, displacement and loss of bearing strength are common expressions of these processes, and are among the leading causes of damage to structures during moderate to large earthquakes. Secondary effects leading to ground deformation include liquefaction, lateral spreading, settlement, and landsliding. Other hazards indirectly related to seismic shaking are inundation, tsunamis, and seiches.

Liquefaction. Liquefaction occurs when loose, cohesionless, water-saturated soils (generally fine-grained sand and silt) are subjected to strong seismic ground motion of significant duration. These soils essentially behave similar to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction more often occurs in earthquake-prone areas underlain by young sandy alluvium where the groundwater table is less than 50 feet below the ground surface.

Due to the presence of Wildwood Creek onsite, there is a potential that shallow (less than 50 feet) groundwater conditions may be present seasonally below the site. Due to this and the potential for strong seismic shaking to occur onsite, the potential for liquefaction to occur onsite is considered to be a **potentially significant** impact.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds. The investigation should evaluate the potential for liquefaction to occur onsite in accordance with the recommendations of the California Geological Survey. If portions of the site area identified as liquefiable, mitigation measures will be recommended by the project geotechnical consultant which will reduce the potential for liquefaction related distress to the proposed structures to **less than significant.**

Lateral Spreading. Lateral spreading is a phenomenon where large blocks of intact, nonliquefied soil move downslope on a liquefied substrate of relatively large aerial extent. The mass moves toward an unconfined area, such as a descending slope or stream-cut bluff, and is known to move on slope gradients as gentle as 1 degree. We understand that Wildwood Creek will be realigned, however, the realignment will likely still result with stream bluffs present onsite. As such there is a potential hazard for lateral spreading to occur onsite and the hazard is considered to be a **potentially significant** impact.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds. The investigation should evaluate the potential for lateral spreading to occur onsite in accordance with the recommendations of the California Geological Survey. Based on that investigation, if it is determined that lateral spreads may occur onsite, mitigation measures will be recommended by the project geotechnical consultant which will reduce the potential for lateral spread related distress to **less than significant.**

Seismically Induced Settlement. Strong ground shaking can cause settlement by allowing sediment particles to become more tightly packed, thereby reducing pore space. Unconsolidated, loosely packed granular alluvial deposits are especially susceptible to this phenomenon. Poorly compacted artificial fills may also experience seismically induced settlement. If settlement occurs it could result in damage to structures. As such the risk associated with seismically induced settlement is considered to be **potentially significant.**

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds, this investigation should address the potential for seismically induced settlement onsite. Typical mitigation measures include overexecavtion of potentially compressible soils and foundation designs to limit distress of structures. Implementation of the overexcavation recommendations presented in future geotechnical reports for the project would reduce the potential for damage resulting from seismically induced settlement to be **less than significant**.

Seismically Induced Landslides. Marginally stable slopes may be subject to landsliding caused by seismic shaking. In most cases, this is limited to relatively shallow soil failures on the steeper natural slopes although deep-seated failures of oversteepened slopes are also possible. Due to the presence of the natural slopes along the southern portion of the site, the impact of seismically induced landslides is considered to be **potentially significant.**

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds. The investigation should evaluate the potential for seismically induced landslides to occur onsite and present mitigation measures, if necessary. We expect that the relocated Wildwood Creek would be located near the toe of slope along the southern limits of the site. If seismically induced landslides are determined to be a potential hazard to the site, the presence of the Creek would likely create a sufficient setback zone for potential seismically induced landslides and reduce the hazard to **less than significant.**

Seismically Induced Inundation: Strong seismic ground motion can cause dams and levees to fail, resulting in damage to structures and properties located downstream. No dams or levees exist within, or adjacent to the project area. As such, this hazard is considered to be **less than significant**.

Mitigation Measures: No special precautions or restrictions are required.

Tsunamis and seiches: A tsunami, or seismically generated sea wave, is generally created by a large, distant earthquake occurring near a deep ocean trough. A seiche is an earthquake-induced wave in a confined body of water, such as a lake or reservoir. Damage from tsunamis is confined to coastal areas that are 20 feet or less above sea level. Since the project is not located near the coast or any confined bodies of water, the risk of inundation from a tsunami or seiche is **less than significant**.

Mitigation Measures: No special precautions or restrictions are required.

3.2 Slope Stability

3.2.1 Stability of Natural Slopes

Marginally stable slopes may be subject to slope instability. These could be the result of adverse slope conditions, rock falls, or debris/mud flows after prolonged, heavy rainfall or strong seismic shaking. In the general site vicinity, however, these are expected to be limited to relatively shallow soil failures on the steeper natural slopes. Regional maps in the site area indicate the existing onsite slopes are composed of San Timoteo Formation bedrock. This unit is typically massive and generally has a low susceptible for slope failure unless oversteepened. No existing landslides have been mapped previously onsite, however, failures may be present locally onsite. However, if development encroaches the foothills onsite, the impact of slope failures is could be **potentially significant**.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds. This investigations should analyze this potential hazard in light of the proposed grading and present recommendations to protect the proposed structures located near natural slopes. There are numerous mitigation methods available, such as providing building setbacks (which may be created due to the Wildwood Creek realignment), constructing slope stability fills, flatting the gradient of slopes and/or constructing sediment diversion or collection devices. With an appropriate geotechnical investigation and implementation of design recommendations, the impact from unstable natural slopes can be reduced to **less than significant**.

3.2.2 Stability of Proposed Slopes

Development plans were not available at the time of this report. However, if final design plans include the construction of manufactured slopes, significant slope stability constraints may be necessary. Consequently, the hazard posed by unstable manufactured slopes is considered to be **potentially significant**.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds. This investigations should analyze this potential hazard in light of the proposed grading and development plans and present recommendations to protect the proposed structures. If adverse geotechnical conditions are expected or encountered, slope stabilization measures should be implemented. These measures could including, providing building setbacks, the construction sediment diversion or collection devices, retaining walls, or designing slopes at flatter gradient and other measures. Slopes should be constructed in accordance with the recommendations of the project geotechnical engineer, California Building Code and any City and/or County guidelines. Implementation of slope stabilization measures during design and grading of the project will reduce the impact of slope instability in manufactured slopes to **less than significant**.

3.2.3 Stability of Temporary Slopes

Slope or sidewall failure in temporary excavations for underground utilities or other structures could occur in unconsolidated surficial soils. The risk of failure in temporary slopes is higher because they are generally cut at a much steeper gradient versus permanent manufactured slopes. Consequently, the hazard from temporary slopes is considered to be **potentially significant**.

Mitigation Measures: In areas where unconsolidated surficial soils are encountered and excavations are made for underground utilities, the excavation wall may be shored, with shoring designed to withstand the additional loads, or the excavation walls may be flattened to a shallower gradient. Excavation spoils should not be placed immediately adjacent to the excavation walls unless the excavation is shored to support the added load. Other measures used to reduce the potential for temporary slope failure include cutting and backfilling excavations in sections, and not leaving temporary excavations open for long periods of time. All Cal-OSHA regulations must be observed for excavations that will be entered by people. Following these measures is expected to reduce the impact posed by temporary slopes to **less than significant**.

3.3 Foundation Stability

3.3.1 Compressible Soils

When a load, such as fill soil or a building is placed, the underlying soil layers undergo a certain amount of compression. This compression is due to the deformation of the soil particles, the relocation of soil particles, and the expulsion of water or air from the void spaces between the grains. As a result, settlement can occur. Some of this settlement occurs immediately after a load is applied, while some of the settlement occurs over a period of time after placement of the load. For engineering applications, it is important to estimate the total amount of settlement that will occur upon placement of a given load, and the rate of compression (consolidation).

Based on our experience in the general site vicinity, we expect the upper portion of the surficial soils onsite to be slightly to moderately compressible. Organic material and uncompacted fills are also compressible, and are unsuitable for foundation support. Therefore, the impact posed by compressible soils is considered to be **potentially significant.**

Mitigation Measures: Overexcavation of potentially compressible soil will be required prior to construction onsite. All undocumented fill onsite is considered compressible and should be removed to firm, competent native material. Based on our experience in the general site vicinity, we would expect the overexcavation onsite to be on the order to three to seven feet below the existing ground surface. Actual removal depths should be based on the detailed geotechnical investigation for the project and on the actual site development plans. Implementation of the recommended removal and recompaction of the near surface soils should mitigate the significant portion of the soils that are prone to compression onsite. With the implementation of the recommended removals and overexcavation, the impact posed by compressible soils is expected to be **less than significant**.

3.3.2 Expansive Soils

Expansive soils underlying a foundation or slab, if left untreated, can cause damage to the structure, including heaving, tilting and cracking of the foundation. Differential movement in the building can result in damage to floors and walls, as well as door and window frames. Based on our experience in the general site vicinity, we expect the onsite soils to have a very low to low expansion potential. However, localized zones of expansive soil may be present onsite. Due to the potential for expansive soils on site, the impact from expansive soils is considered to be **potentially significant**.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds, this report should address the potential for expansive soils onsite. Typically, no mitigation measures are needed if soils at or near finished grade have a very low expansion potential. For soils with a higher expansion potential, typical mitigation measures include a stiffened foundation design (in accordance with the UBC), deepened footings, and/or presaturation of the building pad to a specified moisture content. Implementation of these measures as recommended by the geotechnical engineer, are expected to reduce the impact of expansive soils to **less than significant**.

3.3.3 Corrosive Soils

Corrosive soils contain constituents or physical characteristics that react with concrete (water-soluble sulfates) or ferrous metals (chlorides, low pH levels and low electrical resistivity). Based on our experience in the general site vicinity, the onsite soils may be corrosive, consequently, the hazard to structures and underground improvements from corrosive soil is expected to be **potentially significant**.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds which should address the potential for corrosive soils onsite. Based on that investigation, all concrete in contact with the soil should be designed based on Table 19-A-4 of the UBC. All metals in contact with corrosive soil should be designed based on the results of the soil corrosivity testing and subsequent recommendations of the manufacturer or a corrosion engineer. Implementing these measures during the design and construction of the project is expected to reduce this impact to **less than significant**.

3.3.4 Erosion

Most native soils onsite, as well as fill slopes constructed with native soils, will have a moderate susceptibility to erosion. These materials will be particularly prone to erosion during the site development, especially during heavy rains. Therefore, the impact of erosion at the site is considered to be **potentially significant**.

Mitigation Measures: The potential for erosion can typically be reduced by appropriate paving of exposed ground surfaces, landscaping, providing terraces on slopes, placing berms or V-ditches at the tops of slopes, and installing adequate storm drain systems. Graded slopes should be protected until healthy plant growth is established. Typically protection can be provided by the use of sprayed polymers, straw waddles, jute mesh or by other measures.

Temporary erosion control measures should be provided during construction, as required by current grading codes. Such measures typically include temporary catchment basins and/or sandbagging to control runoff and contain sediment transport within the project site. Correct implementation of these erosion control measures is expected to reduce the impact resulting from erosion to **less than significant**.

3.3.5 Rippability and Oversized Rock

The onsite surficial soils and near-surface fractured and weathered bedrock materials located south of Wildwood Creek are expected to be rippable with modern earthmoving equipment. However, if deeper cuts are planned within the bedrock in the southern portion of the site, rock which could be difficult to excavate may be encountered. Based on our experience in the general site vicinity, oversized materials (rock or rock fragments larger than 8 inches in dimension) are not expected within the alluvial soils onsite, however, may be generated in potential bedrock cut areas. Such materials typically require special handling and placement or disposal offsite during grading. Therefore, although limited, rippability and oversized rock disposal is considered to be a **potentially significant** impact.

Mitigation Measures: A detailed geotechnical investigation for the site will be required as the project proceeds. This investigations should analyze the rippability of the onsite earth units and the presence of oversized materials based on the actual development and grading plans. In general, oversized rocks and relatively hard rock are not expected onsite. If relatively hard rock is encountered in the shallower cuts in the southern portion of the site, it can typically be graded with heavy ripping to achieve design grade. Oversized rocks can typically be placed in deeper fills or in non-structural areas of the development. Once implemented, mitigation measures such as these are expected to reduce the impact from hard rock and oversized rock to **less than significant**.

3.3.6 Regional Subsidence

Regional ground subsidence general occurs due to rapid and intensive removal of subterranean fluids, typically water or oil. It is generally attributed to the consolidation of sediments as the fluid in the sediment is removed. The total load of the soils in partially saturated or saturated deposits is born by their granular structure and the fluid. When the fluid is removed, the load is born by the sediment alone and it settles. No reports of regional subsidence have been reported in the site vicinity, and lack of intense removal of significant quantities of water or oil in the area makes the potential for ground subsidence very low and less **than a significant impact**.

Mitigation Measures: None required.