owes its existence to ongoing tectonic activity associated with the San Andres Fault system. The geomorphology of the San Bernardino Mountains attests to the youthful nature of this uplifted structural block which is bordered on the north by the North Frontal Fault system and on the south by the San Andreas fault.

Big Bear Valley is one of a series of east-west trending valleys in the eastern San Bernardino Mountains, believed to have formed largely by both high angle and low angle faults in the region. The valley is considered to be a bedrock enclosed basin filled with more than 500 feet of lucustrine and alluvial sediments derived from the surrounding mountainous areas.

Big Bear Lake, which borders the project area on the south, was created by construction of a dam in 1884 across Bear Creek. In 1912, an 80-foot high multiple-arch dam was constructed to replace the lower older dam. In the late 1980s, the Big Bear Lake Dam underwent a seismic retrofit, which included improvement of the foundation conditions beneath the downstream side of the dam. When full, the lake has an area of 2,960 acres, a volume of about 72,200 acre-feet, and a water surface elevation of 6,745 feet.

Topographically, the project area occupies the southernmost margin of a lobe-shaped, south-facing hillside that descends into Big Bear Lake. Natural slopes within the area display surface gradients ranging from 2:1 (horizontal to vertical) along the eastern margin of the site, to about 4:1 within the central and western portions, to more gentle gradients near the shoreline of Big Bear Lake. The highest point within the project area is at an elevation 6,962 feet above mean sea level (msl). Maximum relief between the northern margin of the property and the high water line (i.e. 6,745 feet msl) is approximately 215 feet.

There are two prominent, southerly flowing drainages transecting the project area. Surface gradients within these ephemeral drainage courses average of about 0.08 foot/foot.

The two major geologic units, that comprise the project area include older alluvium of Pliocene-late Miocene age (i.e. 1.5 to 5 million years old), and lesser amounts of Holocene age (present to 11,000 years ago) alluvium that occupies the bottom of the major active stream channels. The older alluvial deposits comprise approximately 90 percent of the project area and extend to the northern shoreline of the Big Bear Lake.

Based on a review of published relevant geologic, geotechnical data, as well as the findings from exploratory drilling, excavation of test pits and reconnaissance-level geologic mapping, there appears to be only limited geologic hazards on the property as it relates to site development. Possible geologic/geotechnical constraints to proposed residential development include potential instability of large cut slopes, soil erosion within the two major drainages that transect the property, and possible earthquake-induced seiche along the near shore portions of the site. Although the project area is located within the seismically active region of southern California, there are no documented active or potentially active faults transecting or projecting towards the project area.

2.2 GEOLOGIC MATERIALS

Surficial materials within the site consist of topsoil, slopewash materials and recent stream-laid alluvial deposits within the active stream channels. Older alluvial deposits underlie the entire site at relatively shallow depths. The distribution of the more significant deposits is shown on Figure 1 (Geologic Map). The designations shown below, in parenthesis, correspond to those shown on the Geologic Map.

Topsoil (not designated on Geologic Map)

Native topsoil which blankets much of the site consists mainly of sandy loam with angular gravel-to cobble-size fragments of quartzite derived from older bedrock formations. These soils are typically dry, porous, and loose, contain varying amounts of organic material, and range in thickness from about eight to ten inches. These soils are considered to be moderately erodible in their natural condition and considered too gravelly and cobbley for use as topsoil for landscaping.

Slopewash (Qsw)

Slopewash deposits consist of the downslope accumulation of eroded topsoil and sediments derived from the underlying older alluvial materials. Slopewash typically contains abundant organic debris and is considered moderately to highly compressible.

Slopewash occurs within broad drainage swales, and as widespread blanket deposits on the gentler, natural slope in the south central portion of the area. The compositions of these soil-like deposits reflect the composition of the older alluvial soils from which they are derived. Where observed in the exploratory test pits, slopewash deposits consist largely of an admixture of silty sand, angular gravel to cobble-size fragments of hard, crystalline bedrock. These soils range in thickness from one to four and a half feet, and are commonly dark brown to dark yellowish-brown in color, loose to medium dense, dry to slightly moist, porous, and contain varying amounts of roots and rootlets, and considered low to moderately compressible. Erodibility in their natural state is considered to be slight to moderate.

Alluvium (Qal)

Alluvial deposits occupy the bottom of two major and one minor drainage channels that transect the project area (see Geologic Map). These Holocene age, soil-like materials have been deposited, eroded and re-deposited by intermittently flowing streams within these drainages. Where encountered in exploratory borings B-2 and B-3, and exploratory test pit TP-7, these soils consist of crudely stratified layers and lenses of silty sand with varying amounts of angular gravel to cobble-size fragments of quartzite and marble. The alluvial soils are dark brown to dark yellowish-brown in color, comprised of fine to medium grain sand, dry to slightly moist, loose and moderately porous and contain numerous roots and rootlets. Where noted in the two borings and the test pit, the thickness of the alluvial soils in the study area ranges from about 3.5 to 17 feet (±). Exploratory boring B-1 encountered only surficial slopewash-type deposits (as described above).

Prior to this investigation, RGS Geosciences' (2001) geologic feasibility study indicated that these alluvial soils near the shoreline of Big Bear Lake are potentially susceptible to seismically-induced liquefaction. Each of these drainages was targeted, as close to the shoreline as considered practical, for exploratory drilling and standard penetration testing (SPT) testing in three (3) exploratory borings. These borings have been designated B-1, B-2 and B-3, the locations of which are shown on the Geologic Map.

The primary approach used in this study to assess liquefaction potential of the alluvial soils was based on an empirically based approach as presented by Seed and Idriss (1982). For this approach, SPT blowcounts (e.g. drive energy of a 140 pound weight falling a distance of 18 inches), as well as other seismic and overburden pressures at the point(s) of interest are needed for the assessment. For this study, SPT blowcounts were obtained at about five intervals in each of the three rotary-wash borings.

Based on the results of the SPT and visual observations of the soil samples, the recent (i.e. Holocene age) alluvial soils below a depth of approximately eight feet are not considered prone to settlement or seismically-induced liquefaction. The upper eight feet are considered moderately compressible, and are highly erodible. Given the gravelly/cobbley nature of the near surface alluvium, and the relative elevation as it relates to high water level in the lake (elevation 6,745 feet msl), the likelihood of seismically induced liquefaction of these sediments along, or inland, of the lake front is considered remote.

Older Alluvium (Toa_s Toa_f)

The entire project area is underlain to significant depths (greater than 400 feet) by what is referred to as Older Alluvium of Plio-Miocene age (as identified by Miller, et. al., 2001). These ancient deposits represent what remains of an extensive accumulation of alluvial (stream-laid) soil materials that had been eroded from adjacent bedrock highlands north of the project area. According to geologic mapping by the U.S. Geologic Survey (Miller, 2001), these alluvial deposits rest unconformably above granitic bedrock of Cretaceous age. Although well dissected, these deposits form an increasingly thickening wedge from north to south. According to water well logs (Geoscience Support Services, Inc., 2000), these sediments are over 400 feet thick near the shoreline and serve as the principal groundwater reservoir beneath the site.

Exposures of the older alluvial deposits are limited to small areas on the road cuts along Highway 38, and on several 12- to 18-foot high road cuts on Polique Canyon Road that leads in Holcomb Valley. No evidence of significant surficial or gross instability was observed either within the project area or along the roadway cuts. Many of these road cuts were quite steep, having inclinations exceeding 45°. However, the lower portions of these cut slopes were commonly covered with a talus apron displaying an inclination of about 33°.

In order to evaluate the near-surface lithologic makeup and bedding plane structure of these sedimentary deposits for the purpose of preliminarily assessing slope stability issues, six (6) exploratory backhoe pits were excavated within the property using a rubber-tired, Case 580 extend-a-hoe equipped with a 3 foot wide bucket. Each of the pits was situated within an area characterized by a certain type of topographic terrain and/or near a proposed cut slope, and varied in depth from about two to six feet below ground surface. All the pits were geologically logged and backfilled with the excavated materials. The location of each pit is shown on the Geologic Map.

The main lithologic character of these ancient soils is represented by layers of clayey sand (labeled Toa_s on the Geologic Map) that contains varying amounts (up to about 10%) of angular, gravel to cobble-size fragments of quartzite derived from older bedrock that now forms discontinuous exposures along the ridgeline to the north of the project area. These older alluvial soils are commonly dark yellowish-brown to strong brown in color, are very dense (i.e.

over-consolidated), contain medium to coarse-grained sand particles, and are thinly to thickly bedded. Based on observations within exploratory test pit excavations, these soils were difficult to excavate below a depth of several feet.

Near the north-central portion of the study area the older alluvium is represented by fanglomerate-type deposits. These materials labeled (Toa_f on the Geologic Map) represent the eroded remnants of an ancient alluvial fan, consisting largely of angular to subangular cobble to gravel size quartzite fragments with about 30% silty sand. Similarly to the underlying clayey sand deposits, the fanglomerate is light brownish-yellow, dense, and is difficult to excavate past a depth of about 3 feet. These deposits appear to have limited areal extent, and form a relatively thin veneer atop the more extensive, older clayey sand (Toa_s) deposits.

Overall, there does not appear to be any major geotechnical-related constraints associated with the older alluvial deposits, except perhaps where clay deposits prove to be moderately or highly expansive and where significant cut slopes are planned, as discussed below.

2.3 GEOLOGIC STRUCTURE

The geologic structure within the project area is defined by the orientation of bedding planes within the older alluvium (Toa_s). Where observed in the exploratory test pits TP-2 and TP-5, located within the northern portion of the study area, bedding planes exposed near the bottom of each pit varied in strike between North 65°West (N65W), and east-west (EW), and dip to the south-southwest at 10° and 18°. In test pit TP-1, located near the shoreline of Big Bear Lake, bedding within the older alluvium appeared to be essentially horizontal. If these bedding plane attitudes are representative of the upland and shoreline areas of the project site, it would appear that the older alluvium has been folded into a roughly east-west- trending synclinal fold, the southern limb of which has been eroded away during the formation of Bear Valley. If true, this folding is judged to have occurred over a period of hundreds of thousands of years as a result of San Andreas tectonics. Conversely, this apparent variation in the dip of bedding planes could be a result of ancient faulting associated with uplift of the San Bernardino Mountains. However, no evidence of faulting, active or otherwise, has been documented within or adjacent to the project area.

If the bedding planes observed in the exploratory test pits are representative of the orientation of bedding within upland areas of the site, south-facing cut slopes associated with construction for the new alignment for State Highway 38, as well as internal streets north of the new highway, could present concerns related to slope stability. If bedding planes near the shoreline area, south of realigned State Highway 38, are essentially horizontal (as depicted in test pit TP-1), gross slope stability problems would not be anticipated. However, where significant cut slopes are planned, a site-specific subsurface investigation should be performed in order to evaluate the nature and extent of bedding planes and the presence of any weak clay layers.

2.4 GROUNDWATER

The eastern two-thirds of the project area lie within what is known, hydrologically, as the North Shore Sub area of Big Bear Lake. The western one-third lies within the Great Creek Sub area. According to Brown (1976; *in* AEG Annual Spring Field Trip Guidebook) the North Shore Sub area is similar in several respects to the Great Creek Sub area; a considerable amount of the water bearing (older alluvial) materials present is above the known groundwater surface. Only a band of these materials adjacent to Big Bear Lake are continuously saturated (Brown, 1976).

According to a recent geohydrologic investigation of the Moon Camp Area by Geoscience Support Services (GSS, 2000), the older alluvial deposits represent the main water-bearing formation beneath the site. Groundwater-level data from two U.S. Forest Service wells located within the project area suggest that Big Bear Lake provides recharge to the aquifer beneath the project area. Additional groundwater recharge emanates from gravity drainage from the higher elevations north of the Moon Camp area.

Based on the studies by GSS (2000), the main water-bearing zones within the older alluvial deposits consist of intermixed and interlayered sand and gravels. However, lithologic data from the two U.S. Forest Service wells indicate that these sand and gravel aquifers are not continuous over wide areas and tend to follow subsurface channels (GSS, 2000). In mid 2000 groundwater beneath the southern margin of the site was about 5 to 10 feet below the level in the lake. More recent groundwater level observations from the three exploratory borings drilled for the liquefaction analysis appears to be similar with respect to the level of the lake.

The results from GSS's (2000) geohydrologic investigation indicate the recoverable amount of groundwater in the Moon Camp area is estimated at 230 acre-feet per year. Based on the nature of the aquifer materials, thickness of the aquifer and the discharge rate of existing wells in the Moon Camp area, the potential to develop a 100 gallon per minute (gpm) water well supply is considered by GSS (2000) to be good. Chemical analyses of the groundwater from the two wells indicates that the groundwater is of superior quality, except for one well where the iron concentration (0.69 mg/l) exceeds the state maximum concentration limit for iron (0.3 mg/l) (GSS, 2000).

According to a hydrologic report by So & Associates Engineers, Inc. (SAE) (2002), the proposed project requires two new wells designed in accordance with Big Bear Lake Department of Water and Power (DWP) standards, and be capable of delivering a minimum of 72.0 gallons per minute. However, it has been reported by GSS (2000) that at least one of the existing on-site wells was constructed in accordance with DWP standards and capable of producing 100 gpm.

In order to assess the amount of recoverable water, the likely interconnection of the aquifer with Big Bear Lake, and the sustained yield of the aquifer, pump testing of at least one, or both, of the two existing wells will be required by DWP.

No individual private irrigation wells will be permitted within the proposed tract (SAE, 2002).

2.5 Mineral Resources

There are no economic metallic or non-metallic ore deposits within or directly adjacent to the project area. The potential for oil and/or gas deposits beneath the site is considered remote.

3.0 GEOLOGIC HAZARDS

General

The primary geologic hazards within the project area are those associated with possible slope instability for new slopes, soil erosion, strong ground motion from earthquakes, and potential seiche along the shoreline.

The project area is not situated within the County of San Bernardino Geologic Hazard (GH) Overlay District. For informational purposes only, the GH Overlay District was created to provide greater safety by establishing review procedures and setbacks for areas that are subject to potential geologic problems such as ground shaking, earthquake faults, liquefaction and subsidence.

3.1 Faulting and Seismicity

Hazards associated with earthquakes include primary hazards, such as ground shaking and surface rupture; and secondary hazards, such as liquefaction, seismically-induced settlement, landsliding, tsunamis, and seiches.

In accordance with the California Department of Conservation Division of Mines and Geology, a fault is a fracture in the crust of the earth along which rocks on one side have moved relative to those on the other side. Most faults are the result of repeated displacements over a long period of time. An inactive fault is a fault that has not experienced earthquake activity within the last three million years. In comparison, an active fault is one which has experienced earthquake activity in the past 11,000 years. A fault which has moved within the last two to three million years, but not proven by direct evidence to have moved within the last 11,000 years, is considered potentially active. No active or potentially active faults are located within or project towards the project area.

The project area, like most of Southern California is part of a seismically active region. The Alquist-Priolo Act of 1972 (now the Alquist-Priolo Earthquake Fault Zoning Act, Public Resources Code 2621-2624, Division 2 Chapter 7.5) regulates development near active faults so as to mitigate the hazard of surface fault-rupture. Under the Act, the State Geologist is required to delineate "special study zones along known active faults in California". The Act also requires that, prior to approval of a project, a geologic study be conducted to define and delineate any hazards from surface rupture. A geologist registered by the State of California, within or retained by the lead agency for the project must prepare this geologic report.
A 50-foot setback from any known trace of an active fault is required. The project area is not currently known to be located within an Alquist-Priolo Fault Rupture Hazard Zone, according to the California Division of Mines and Geology.

The Modified Mercalli intensity scale was developed in 1931 and measures the intensity of an earthquake's effects in a given locality, and is perhaps much more meaningful to the layman because it is based on actual observations of earthquake effects at specific places. On the Modified Mercalli intensity scale, values range from I to XII. The most commonly used adaptation covers the range of intensity from the conditions of "I –not felt except by very few, favorably situate," to "XII – damage total, lines of sight disturbed, objects thrown into the air". While an earthquake has only one magnitude, it can have many intensities, which decrease with distance from the epicenter.

Ground motions, on the other hand, are often measured in percentage of gravity (percent g), where g = 32 feet per second per second (980 cm/sec^2) on the earth.

Ground shaking accompanying earthquakes on nearby faults can be expected to be felt within the project site. However, the intensity of ground shaking would depend upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property.

A listing of active faults considered capable of producing strong ground motion at the site, their distances from the project site, and the maximum expected earthquake along each fault is presented in Table 1. Also presented are generalized evaluations of maximum ground shaking on site for the maximum earthquakes, and generalized predictions of the likelihood of such events occurring.

TABLE 1

SUMMARY OF FAULT AND GENERALIZED EARTHQUAKE INFORMATION FOR THE MOON CAMP PROJECT SITE

Name	Miles(direction from site)	Maximum Magnitude	Expected Level of Ground Shaking	Likelihood
North Frontal (Western Segment)	6.5 (north)	7.0	High	Moderate
Helendale	8.0 (east)	7.3	High	Moderate
San Andreas	14 (south)	7.3	High	High
Pinto Mountain	18 (southeast)	7.0	Moderate	Moderate
San Jacinto	25 (southwest)	6.7	Moderate	High

The most severe ground shaking would be expected to accompany a large earthquake on the North Frontal Fault. An earthquake magnitude of 7.0 on this fault could produce Modified Mercallli intensities in the range of VIII to X within the property, and a maximum horizontal ground acceleration between 0.6 and 1.22 (Hilltop Geotechnical 2001). Damage from ground rupture on-site is extremely unlikely because no known active faults cross the property.

Secondary earthquake hazards, which include liquefaction, ground lurching, lateral spreading, seismically induced settlement, tsunamis, and earthquake induced landsliding, are discussed in the following sections.

Liquefaction

Seismic ground shaking of relatively loose, granular soils that are saturated or submerged can cause the soils to liquefy and temporarily behave as a dense fluid. Liquefaction is caused by a sudden temporary increase in pore water pressure due to seismic densification or other displacement of submerged granular soils. Liquefaction more often occurs in earthquake prone areas underlain by young alluvium where the groundwater table is higher than 50 feet below the ground surface. The borings for this EIR were drilled in accordance with the "Guidelines for Evaluating and Mitigating Seismic Hazards in California, 1997" published by the Division of Mines and Geology (DMG) of the Department of Conservation. These guidelines are otherwise known as SP 117 (Special Publication 117). Our procedures for analyzing liquefaction potential at the site conform to the "Recommended Procedures for Implementation of DMG Special Publication 117" produced by the Southern California Earthquake Center (SCEC) in 1999. As mentioned in the introduction section of this report, rotary wash drilling techniques were used to advance the borings for this project and Standard Penetration Tests (SPTs) were conducted in general accordance with ASTM D1586. A standard sampler driven by automatic hammer was used to perform the SPTs. Previous measurements by the drilling company rated the hammer energy at 75 to 80 percent. The SCEC recommends the use of the 1985 simplified procedures by Seed and others to analyze liquefaction potential. Typically, the methodology is to determine a corrected blowcount $(N_1)_{60}$and use a recommended relationship between the corrected SPT blow count and the equivalent uniform cyclic stress ratio necessary to trigger liquefaction during a 7½-magnitude earthquake. The graphical summary of this relationship shows that for $(N_1)_{60}$ greater than 30, the potential for earthquake-induced liquefaction is practically non existent. Field SPT values were corrected for sampler type, drill rod lengths, hammer type and release system, and overburden stresses to generate the corrected value $(N_1)_{60}$.

SPT data for this project show generally high blowcount. Consequently, corrected SPT blowcounts yielded $(N_1)_{60}$ values that were greater than 30. Based on the results of the SPT data obtained from the exploratory borings, as well as observations within the exploratory test pits, there are no conditions within the project area that could promote liquefaction. Although shallow groundwater is present beneath the shoreline portions of the property, the lithologic character of the older alluvial materials that underlie the entire shoreline area of the project is such that the potential for liquefaction is considered remote.

The only possible exception could be very small areas directly at the lake-shoreline interface and the mouth of the major alluvial channels. However, only one of these areas lies within the project area (refer to Geologic Map). Given the nature of the lithologic conditions and high SPT blowcounts encountered in exploratory boring B-3 near the mouth of this channel, the lateral extent of any loose, saturated alluvial soils would be very limited. The likelihood of liquefaction-induced impacts in this area is considered low.

Ground Lurching

Certain soils have been observed to move in a wave-like manner in response to intense seismic ground shaking, forming ridges or cracks on the ground surface. Areas underlain by thick accumulations of colluvium and alluvium appear to be more susceptible to ground lurching than bedrock. Under strong seismic ground motion conditions, lurching can be expected within loose, cohesionless solids, or in clay-rich soils with high moisture content. Generally, only lightly loaded structures such as pavement, fences, pipelines and walkways are damaged by ground lurching; more heavily loaded structures appear to resist such deformation. Ground lurching may occur where deposits of loose alluvium exist on the project site, such as within the two major alluviated channels that transect the project area (see Geologic Map).

Lateral Spreading

Lateral spreading involves the lateral displacement of surficial blocks of sediment as a result of liquefaction in a subsurface layer. As previously stated the liquefaction potential within the project area, however, is considered to be remote.

Seismically Induced Ground Settlement

Strong ground shaking can cause settlement by allowing sediment particles to become more tightly packed, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits are especially susceptible to this phenomenon. Poorly compacted artificial fills may also experience seismically induced settlement. Unconsolidated soils such as modern alluvial soils within the two active stream channels are subject to seismically induced ground settlement.

Tsunamis

A tsunami is a seismic sea-wave caused by sea-bottom deformations that are associated with earthquakes beneath the ocean floor. The hazard from tsunamis is considered nonexistent, given the large distance from the Pacific Ocean.

Seiching

Seiching involves an enclosed body of water oscillating due to groundshaking, usually following an earthquake. Lakes and water towers are typical bodies of water affected by seiching. Because of the proximity of the subject site to Big Bear Lake, the site is susceptible to damage from seiching. The largest amplitude of ground motion associated with a seismic event in this area is anticipated to be related to a major earthquake along the North Frontal Fault zone.

Other Geologic Hazards

Landslides

No landslides are known to exist within the upgradient of the site. Field reconnaissance did not disclose the presence of older, existing landslides within or near the subject property. Aerial photographic analyses performed as part of this study also did not disclose any existing landslides or slumps in the project area.

4.0 THRESHOLDS OF SIGNIFICANCE

Earth resource and/or topographic impact resulting from the proposed project could be considered significant if any of the following occur:

- exposure of people or property to substantial geological hazards, such as landslides, mudslides, ground failure or similar hazards, or soil and/or seismic conditions so unfavorable that they could not be overcome by design using reasonable construction and/or maintenance practices;
- location of a structure within a mapped hazard area or within a structural setback zone;
- location of a structure within an Alquist-Priolo Fault-Rupture Hazard Zone, or within a known active fault zone, or an area characterized by surface rupture that might be related to a fault;
- triggering or acceleration of geologic processes, such as landslides or erosion that could result in slope failure;

- substantial irreversible disturbance of the soil materials at the site or adjacent sites, such that their use is compromised;
- modification of the surface soils such that abnormal amounts of windborne or waterborne soils are removed from the site;
- earthquake induced ground shaking capable of causing ground rupture, liquefaction, settlement, or surface cracks resulting in the substantial damage to people and/or property;
- deformation of foundations by expansive soils (those characterized by shrink/swell potential); and
- modification of the on-site (i.e., grading) in a manner that results in decreased stability for adjacent residential enclaves.

5.0 IMPACTS

The level of geotechnical and landform information contained herein is adequate to analyze the potential project effects on earth resources and landforms, and to determine appropriate mitigation measures. For certain items, the project geotechnical engineer should perform further testing and review of on-site conditions as part of the final design work. This additional work will further refine details for site design, but is not anticipated to alter the conclusions of significance contained herein. In accordance with CEQA case law, this later additional refinement is not a deferral of mitigation. Rather, it is a design refinement, consistent with the commitment to mitigation included in this EIR.

According to the County's RFP, the project proposes a 95-lot residential subdivision on the north shore of Big Bear Lake, in the community of Fawnskin, in the County of San Bernardino. The project site consists of approximately 62.43 acres in the north ½ of Section 13, Township 2 North, Range 1 West, San Bernardino Base Meridian. The Applicant proposes 92 numbered and 3 lettered lots. The lots are to be sold individually and development of lots and construction of homes will be by custom design. Numbered lots will range in size from 0.17 to 2.11 acres. Highway 38 will be realigned as part of the project. Furthermore, development will likely require a remedial grading plan.

The conceptual grading plan prepared by Hicks and Hartwick, Inc. (dated 6/6/01) indicates the creation of numerous, southerly-facing, 2:1 (horizontal to vertical) cut and fill slopes adjacent to the realigned portion of State Highway 38 and the two (2) roadways internal to the development. Based on the nature of bedding planes observed within the older alluvial deposits in test pits TP-2 and TP-5, southerly-facing cut slopes north of the realigned section of

State Highway 38 may be grossly unstable. If so, the lots adjacent to these cut slopes could be significantly impacted.

There are also a number of other short- and long-term impacts to the current physical/geological setting that can be generally expected from grading and development activities. These are described in the following impacts sections.

5.1 Effects Found Not To Be Significant

Liquefaction

Based on the results of the data obtained from the exploratory borings and test pits, liquefaction is not considered to be a significant impact due to its low potential within the project site.

5.2 Potentially Significant Impacts

The most significant potential impacts to site development would be caused by changes in existing topography, erosion of surficial soil deposits, ground shaking from nearby seismic sources, and potential seiche along the shoreline properties. Impacts to the existing groundwater conditions beneath the site may include increased amounts of recharge to the underlying aquifer(s) as a result of widespread landscape irrigation or leaky buried water transmission lines. If groundwater from onsite wells is to provide the water supply to the project area, additional studies will be necessary to assess the impacts to the underlying aquifer as a result of groundwater withdrawals. In any event, no significant impact to groundwater quality is anticipated.

5.2.1 Slope Stability

Given the apparent southerly inclination of bedding planes within the older alluvial deposits, south-facing, manufactured cut slopes could be grossly unstable. If weak clay layers within the older alluvium were found to be dipping out-of-slope, in what is referred to as "daylighted bedding", slope failures could occur and encroach into adjacent lots.

The most proven methods to mitigate such conditions would be to construct 2:1 (horizontal to vertical) buttressed slopes using on-site native soil materials, or constructing geotextile-reinforced soil buttresses where cut slopes are planned. Either of these methods, as well as a number of other forms of proven slope reinforcement methods would reduce this impact to a less-than-significant level.

5.2.2 Soil Erosion

The younger alluvial deposits within the two major stream channels are highly erodible. Adverse surface drainage could promote accelerated soil erosion which could undermine proposed structures and lead to increased sedimentation within Big Bear Lake. This impact would be considered significant if not mitigated.

Mitigation measures, such as the removal and recompaction of these soils, providing adequate surface drainage away from these soils, or covering them with a roadway would reduce this impact to a less-than-significant-level.

5.2.3 Ground Shaking

Given the highly seismic character of the Southern California Region, moderate to severe ground shaking can be expected within the project area due to moderate to large earthquakes on the nearby North Frontal, Helendale, or San Andreas fault zones. This impact would be considered significant if not mitigated. In order to reduce this impact a less-than-significant-level, all structures for human occupancy should be constructed in accordance with seismic design standards set forth in the latest edition of the Uniform Building Code.

5.2.4 Seiche

Seiche-induced run up along the shoreline properties adjacent Big Bear Lake could conceivably occur due to significant ground motion from a major earthquake on nearby faults. The amount of potential run up would be dependant on the slope of the near-shore environment (i.e. shoreline angle), the height of the lake level at the time of the seismic event, and the severity of oscillation of seismically-induced waves.

Prior to development, an adequate evaluation of seiche needs to be completed by the project geotechnical engineer.

5.3 CONSTRUCTION RELATED IMPACTS

Grading activities within the project area would create significant changes to the current landforms/topography. The greatest changes to existing topography would occur where grading of slopes and associated interior streets and the realignment of Highway 38 is planned. Only by avoidance can impacts to topography related to grading be mitigated and/or reduced to a less-than-significant level.

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