DRAFT
Site-Specific Groundwater Recharge Evaluation
APN # 021-141-05
Scotts Valley, California

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APPENDICES

CERTIFICATION

All engineering information, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by an LFR Inc. California Professional Engineer.

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1.0 INTRODUCTION

LFR Inc. (LFR) has prepared this report to summarize the results of site-specific investigations characterizing groundwater recharge potential at a proposed commercial development site located in the southeastern portion of the City of Scotts Valley at the intersection of La Madrona Drive and Silverwood Drive (the "Site") in Scotts Valley, California (see Figure 1). The proposed commercial development footprint at the Site is 10.5 acres (see Figure 2).

This report summarizes the results of the following activities:

- Site background documentation research and review
- Supplemental site geotechnical investigation including cone penetrometer testing (CPT) and a limited site survey
- Evaluation of geotechnical soil borings, CPT data and laboratory testing
- Development of a site conceptual recharge model and site-specific water balance for existing conditions

This report describes site-specific conditions (hydrogeology and surface soil characteristics) with respect to estimated groundwater recharge potential at the Site.

Utilizing readily available information, a preliminary site-specific screening-level investigation was conducted that involved consideration of the following environmental topics and constraints for the proposed 10.5-acre development footprint:

- Site description
- Summary of site hydrogeology and conceptual recharge model
- Depth to groundwater (based on field observations and published data)
- Site soil characteristics (hydrologic soil group and saturated hydraulic conductivity)
- Existing site vegetation
- Depth, extent and slope of bedrock based on results of geotechnical borings and CPT investigation
- Buried utilities

2.0 SITE DESCRIPTION/BACKGROUND AND RESULTS OF FIELD SURVEYS

Site Description

The proposed Site is located in the southeastern corner of the City of Scotts Valley corporate city limits; however, the Site lies outside (south) of the Scotts Valley Water District (SVWD) jurisdictional boundary. The Site is situated on the southeastern edge of an area generally mapped as the Santa Margarita Groundwater Basin within the South Scotts Valley Subbasin (see SVWD exhibits in Appendix A).

Scotts Valley is situated on the southwestern slope of the central Santa Cruz Mountains in Santa Cruz County. The relief in the Scotts Valley area is moderately rugged, with elevations ranging from less than 300 feet along the San Lorenzo River to over 1,800 feet on Ben Lomond Mountain. Within Scotts Valley, which is situated along Carbonera Creek, ground surface elevations range from about 440 feet along Carbonera Creek to over 800 feet on the ridges north of the city, and over 1,000 feet on the ridges east of the city (USGS, 1998).

Scotts Valley has warm summers and mild winters. In inland areas that have a sunny exposure, the mean maximum daily temperature is often more than 80 degrees. Precipitation varies across Santa Cruz County primarily due to the orographic effects of topography. Precipitation is heaviest in the mountains, such as Ben Lomond Mountain, where seasonal precipitation totals average 60 inches, while mean annual precipitation along the coast is approximately 30 inches. The average annual rainfall for the Scotts Valley area is estimated at 42.8 inches (SVWD, 2006). The bulk of the total precipitation falls during the winter rainy season, which typically extends from November through March. Temperatures normally reach their summer peak in July. Monthly evapotranspiration (ET) rates are also highest in July. Local precipitation and evapotranspiration data for the water balance computations were obtained from the CIMIS #104 De Laveaga/Santa Cruz Weather Station (18-year precipitation and evapotranspiration record) [see Appendix E].

The proposed Site is located within the Carbonera Creek watershed, a tributary to the San Lorenzo River. Carbonera Creek originates in the rugged Santa Cruz Mountains and flows in a generally southwesterly direction through the Scotts Valley area. After Carbonera Creek discharges to the San Lorenzo River, the latter empties into the Pacific Ocean at Monterey Bay at Santa Cruz. The perennial Carbonera Creek watershed area is approximately 7.4 square miles; the West Branch of Carbonera Creek is 1.4 miles in length and passes under Vine Hill Road, Scotts Valley Drive and the State Route 17 Interchange through a series of box culverts before flowing south toward Santa Cruz (east of the Site).

The currently undeveloped Site maintains an overall surface gradient typically ranging from approximately 10 to 15%; the Site slopes to the east and exhibits semi-complex micro-topography at smaller scales including a mixture of various shallow soil pockets and depressions. The Site is mostly pasture supporting a mixture of grasses, forbs and shrubs with some woodland areas along the western margin of the Site. There are no well-defined natural or artificial watercourses draining the Site other than very gentle grassy swales. Roadways and parking areas surround the north, south and east edges of the property.

Some of the existing pockets and surface depressions collect rainwater during the winter, supporting percolation of rainfall through site soil surface. During the early portion of the rainy season ponded water is adsorbed by the on-site soils following each storm series. Towards the latter part of the rainy season the underlying soils can become variably saturated and the on-site depressions begin to hold water on the surface for increased durations.

Based on site soil characteristics the local watershed response to rainfall was assumed to result in generation of surface runoff only during extreme precipitation events. During infrequent heavy rainfall (events with rainfall intensities exceeding 1 inch per hour) it is expected that overland surface runoff would occur. It is likely that during these instances the site soils exhibit classic Hortonian overland runoff as rainfall intensities exceed minimum soil infiltration rates.

Summary of Site Hydrogeology and Conceptual Recharge Model

The Santa Margarita Groundwater Basin is formed by the sedimentary sequence found within the Scotts Valley Syncline. The basin forms a roughly triangular area that is bounded by the two regional faults, the Ben Lomond Fault to the west and the Zayante Fault to the north. In the southeast, the location of the proposed Site, the basin is bounded by granitic crystalline rock, which rises steeply in this area. Where the granite rises closer to the ground surface especially along the southeastern side of Scotts Valley marks the southeastern edge of the Santa Margarita Groundwater Basin and aquifer.

The SVWD developed a series of hydrogeologic cross-sections to evaluate the geologic correlations within the Santa Margarita Groundwater Basin (see SVWD exhibits in Appendix A). These cross-sections in combination with field data collected at the Site between 2001 and 2008 provide support for the development of a site conceptual hydrogeologic model by improving the understanding of the underlying geology, groundwater, and interaction between groundwater and surface water based on data available to date.

The proposed Site has been previously identified on the boundary of an area preliminarily mapped as a potential groundwater recharge zone for the Santa Margarita Sandstone aquifer (SVWD, 2001). The Site is also mapped as a potential groundwater recharge area by Santa Cruz County. However, site-specific geotechnical data collected during previous and current investigations show that site soils are underlain by a local Andesite/Diorite/Granite restrictive bedrock layer sloping to the east (see Appendices C and D). Based on the SVWD hydrogeologic cross-sections, soil borings and cone penetration testing (CPT), this paralithic bedrock layer has been confirmed to be generally continuous throughout the Site, sloping to the east toward Carbonera Creek (see Figure 3). This bedrock boundary is a barrier to actual groundwater recharge to recognized water bearing formations/aquifers and production wells located to the north and west of the Site (see Appendix A).

Potential groundwater recharge at the Site is defined as the entry of water to the saturated zone at or below the water table. When characterizing groundwater recharge, a distinction between potential and actual recharge needs to be made. Potential recharge is soil-water that percolates below the root zone, whereas actual recharge is soil-water that reaches the aquifer. Potential recharge water will be typically stored in the vadose zone at negative pressures and is not generally available for extraction (well production). In addition, water stored in the vadose zone may still be lost later by an increase in vegetation rooting depth, capillary rise, or upward vapor transport. Conversely, actual recharge is the amount of water that in fact reaches a water bearing aquifer, and can be pumped. Based on site-specific geology, this study considers potential groundwater recharge at the Site as deep drainage with contributions to the local subsoil saturated zones with a hydraulic gradient to the east toward Carbonera Creek.

Depth to Groundwater

Local groundwater encountered at the Site is considered to be ‘perched’ due to the underlying restrictive bedrock layer (Treadwell & Rollo, 2001). The USDA Natural Resources Conservation Service (NRCS) soil survey reports the depth to groundwater for the Site as typically greater than 6.2 feet and reports an associated restrictive layer of paralithic bedrock. Site-specific piezometer measurements in Spring 2001 (05/01/01) and Spring 2008 (05/15/08) show that the local perched groundwater has been encountered on the Site at an average depth of approximately 10.4 feet below ground surface (see Table 1). The perched groundwater on the Site is not considered a source of direct recharge to water bearing portions of the Santa Margarita Sandstone aquifer (see Figure 3 and Appendix A showing the SVWD geologic cross-section of the Scotts Valley Area - northwest to southeast). It has been previously concluded that recharge of residential runoff in southeast Scotts Valley would not benefit the SVWD or the Scotts Valley Santa Margarita groundwater basin (SVWD, 1989). It is possible that during wet periods the local perched groundwater observed at the Site provides a seasonal flux of water toward the alluvium deposit located along Carbonera Creek east of the Site. However, this alluvium is not considered a significant water producer in the Scotts Valley area because of its limited saturated thickness and lateral extent and due to the fact that no production wells have been established in the area (see Appendix A).

Site Soil Characteristics

Site-specific factors that control infiltration rate include soil properties associated with hydraulic conductivity and available water capacity (AWC). These soil characteristics include soil texture, structure, composition, and degree of compaction, all of which influence soil matric forces and pore space distribution. Additionally, antecedent water content, type of vegetative or other ground cover, slope, rainfall intensity and movement and entrapment of soil air are important factors that also affect infiltration rates. Hydraulic conductivity is of critical importance to infiltration rate since it expresses how easily water flows through soil and is a measure of the soil's resistance to flow; saturated hydraulic conductivity is used as the primary parameter for most infiltration models.

Direct field observations and geotechnical soil borings at the Site in the spring/summer of 2001 and 2008 indicate that the Site is overlain by permeable alluvium typically characterized as sandy loam ranging from clayey sand to sandy clay. Based on the geotechnical investigations, the vast majority of soil sampled at the Site is classified as clayey sand (SC). The USDA NRCS Soil Survey maps the majority of the Site as the Pfeiffer soil series (sandy loam) with reported soil permeabilities ranging from approximately 2 to 6 inches per hour (see Appendix B). The site soils are classified by the NRCS as Hydrologic Soil Group 'B' soils. Hydrologic Soil Group 'B' soils are characterized as having moderate infiltration rates when thoroughly wetted and consist of moderately well to well drained soils with moderately fine to moderately coarse textures.

Hydraulic conductivity values were derived from the site-specific CPT data using the Elsworth Method, a correlation between material properties, the resistance to the advancement of the cone, and the excess pore pressures generated during the advancement of the cone to the material hydraulic conductivity (Elsworth and Lee, 2007). The Elsworth Method results compare favorably with the number derived from the Hazen formula for hydraulic conductivity of sands ($K = 100 * D_{10}^2$, D_{10} in cm and K in cm/s) using the sieve analysis from the 2001 Treadwell & Rollo report ($K = 100 * 0.018\ cm^2 = 0.032$ cm/second) and the values provided by the USDA NRCS (0.003 cm/second) [see Appendix D]. The NRCS values are for the upper strata of soils which are more clayey than the deeper soils and hence would be expected to have a lower hydraulic conductivity. Clayey sand in the upper portion of the vadose zone at the Site likely has hydraulic conductivities in the 0.0001 cm/second range. Overall estimates of saturated hydraulic conductivity for the site soils based on reported values, soil particle size analysis and based on CPT pore dissipation tests range from 0.0001 cm/second to 0.015 cm/second with an average approximate saturated hydraulic conductivity of 0.0076 cm/second.

Estimated soil porosity for clayey sand ranges from 0.23 to 0.47 with an average porosity of 0.35 (Selby, 1993). Estimated available water capacity (AWC) based on reported NRCS data, ranges from 0.07 to 0.10 inches per inch with an average AWC of 0.09 inches per inch of soil in the rooting zone (see Appendix B). This generally corresponds to the reported average AWC for clayey sand soils cited in the NRCS Technical Bulletin - sandy clay loam at various soil moisture conditions (www.wy.nrcs.usda.gov/technical/sandyclayloam.html).

Site Vegetation

The Site is composed mostly of pasture and scrubland supporting a mixture of grasses, forbs and shrubs with some woodland areas along the western margin of the Site. The annual grassland habitat type is found on the lower slopes of the Site, including native and non-native species of annual grasses and shrubs. Non-native plant species found on the Site includes Bermuda grass (*Cynodon dactylon*), Italian ryegrass (*Lolium multiflorum*), and French broom (*Genista monspessulana*). Native plant species observed includes California poppy (*Eschscholzia californica*), purple needlegrass (*Nassella pulchra*), and California brome (*Bromus carinatus*). Along the western margin of the Site, the mixed forest habitat type is found almost exclusively on areas with steeper slopes (generally upgradient of the proposed development area), with the exception of two large coast live oaks (*Quercus agrifolia*) and a small stand of Coastal redwoods (*Sequoia sempervirens*) (EIP Associates, 2003).

Depth, Extent and Slope of Bedrock

The Site is located on the southeast flank of a roughly elliptical knob (USGS 7.5 minute series topographic map, Felton, Ca 1991). The long axis of the knob is oriented northwest-southeast and is approximately 2,500 feet long. The short axis of the knob is oriented northeast-southwest and is approximately 2,000 feet long. The change in elevation of the knob is approximately 240 feet (from 600 to 840 feet above mean sea level). The southern end of the Site is located at the southeast end of the long axis of the knob. Bedrock encountered generally follows the surface contours; the bedrock falls off to the southeast at a gradient of approximately 10%. The northern portion of the Site is located along the eastern side of the knob with bedrock falling off to the east-northeast at a gradient of approximately 10 to 12%.

Extensive geotechnical site explorations have been conducted at the Site: 7 hollow stem auger borings by Treadwell & Rollo (2001); 8 Cone Penetration Test (CPT) probes by LFR (2008) and 27 hollow stem auger borings by Kleinfelder (2008) [see Appendices C and D]. The geotechnical investigations encountered bedrock and/or drilling refusal in soil borings at an average depth of 11.3 feet below the ground surface. The deepest soil is located at the western side of the Site (uphill). The soils generally become thinner toward the lower elevations at the Site. However, a stem auger boring near the western boundary of the Site shows only three feet of soil above rock. This may represent a point along a bedrock promontory that follows the surface topography or it may be a large boulder (eratic) within the soil matrix. The general extent and slope of the bedrock layer is depicted in Figure 3.

Buried Utilities

Prior to approval of the eight CPT boring locations the Site was surveyed for existing utilities by Cruz Brothers Locators, Inc. on May 15, 2008. An inductive sweep for ‘hot’ electrical and communication lines was conducted, and a sweep for metal utilities/obstructions was conducted. The results of the survey concluded that no existing subsurface utilities were encountered on the Site. However, the survey specifically focused on a ten foot radius surrounding each of the eight CPT boring locations.

3.0 SOIL MOISTURE BALANCE METHODOLOGY AND RESULTS

Daily site soil moisture budget computations utilized a hydrologic soil moisture mass balance model that was originally developed for watershed-scale soil moisture accounting (Dunne and Leopold 1979; Hillel, 1998). The model treats evapotranspiration loss as a function of the soil moisture content and accumulated potential water loss which measures the extent of drying in the rooting zone. In moderate Mediterranean climates such as the Scotts Valley area, water availability during the dry season is typically low and this becomes a critical factor in assessing the potential for saturated soil conditions and surface ponding.

The depth of the rooting zone in site soils was conservatively assumed at 36 inches, equivalent to the total depth of the 'A' soil horizon reported for the Site by NRCS. For the estimated available water capacity for the site soils (0.09 in./in.), the total available water capacity of the rooting zone was computed at 3.24 inches (0.09 in./in. x 36 in.) [see Appendix B]. Applying a shorter rooting depth to the AWC value for the site soils would result in a lower capacity.

The daily soil moisture budget model was developed using locally available California Irrigation Management Information System (CIMIS) published daily precipitation and ET data for a ten year period (1998-2007). Two specific years were selected to represent the range of rainfall and ET conditions that could be expected at the Site. The data for an above-average rainfall year (1998, 51.6 inches) and a dry rainfall year (2002, 22.2 inches) were used to characterize the potentially wide precipitation range that could be expected to occur on the Site. The mean annual rainfall for the Scotts Valley area is 42.8 inches (SVWD, 2006). Inflow to the soil profile was limited to actual daily records of direct rainfall during these previous years. Outflow from the profile occurred in the form of estimated evapotranspiration or drainage; excess soil moisture within the upper, modeled portion of the soil profile was temporarily stored or allocated to deep drainage to the lower portion of the soil profile (see Figure 4).

ET rates were estimated using values obtained from CIMIS Daily Average Reference Evapotranspiration Rates for the Scotts Valley area (CIMIS Station No. 104). Consumptive use coefficient values for the local plant community were simulated based on published consumptive use values for typical upland grass and shrub species found on the Site.

Based on a starting soil moisture value set at the available water capacity of 3.24 inches on January 1, for an average year the soil moisture budget indicates that saturated soil conditions would typically occur from January through April.

Daily Root Zone Soil Water Balance Methodology

When infiltrating water exceeds the storage capacity of the soil root zone the excess water tends to move downward through the lower soil profile. This deep drainage contributes to potential groundwater recharge. The soil water mass balance concept is used to estimate water available for plants and potential water drainage below the root zone. The basic concept is a statement of the principle of conservation of mass. It can be represented by the following general equation:

Infiltration – Evapotranspiration – Increase in Storage = Drainage

Where Infiltration represents the amount of water entering the soil surface from rainfall or irrigation, Evapotranspiration represents the amount of water leaving the soil by surface evaporation or through plants growing in the soil, Drainage represents the amount of water moving below the root zone, and Storage represents the amount of water stored in the soil root zone.

In this model the water balance is calculated on a daily basis using actual historical daily rainfall and evapotranspiration data and site specific soil infiltration and vegetation parameters. Potential evapotranspiration amounts calculated from historical weather data along with time-dependent vegetation coefficients are used to estimate evapotranspiration. The soils water-holding capacity and known storage amount on a specific date are used to characterize the water stored in the soil. If the amount of water entering the soil on a particular day can be stored in the root zone, the drainage amount is zero for that day. If the infiltration exceeds the storage capacity of the soil the excess is lost as drainage below the root zone.

The daily soil water balance model simplifies soil water dynamics by treating infiltration, evapotranspiration storage, and drainage processes as essentially instantaneous processes. This may lead to slight underestimates in soil water storage in the root zone. Another simplification in this model is the assumption that all rainfall enters the soil; runoff has been assumed to be negligible as the infiltration capacity of the site soil is large relative to typical rainfall intensities.

Model Description

Root zone water balance during a specified period of time may be expressed as (Hillel, 1998):

$$\Delta S + \Delta V = P + I + U - (R + D + E + Tr) \qquad [1]$$

Where ΔS is the change in root-zone soil-moisture storage, ΔV is the amount of water incorporated in vegetative biomass, P is the amount of precipitation, I is the amount of additional irrigation water applied, U is the amount of water moved upward into the root zone by capillary flow, R is the amount of runoff per unit area, D is the amount of downward drainage out of the root zone, E is the amount of evaporation from the soil surface, and Tr is the amount of water transpired by plants.

When the infiltration capacity of a soil system is large relative to rainfall intensities, surface runoff will be negligible. If the depth-to-groundwater is greater than several feet, the upward capillary flow into the root zone will also be negligible. Neglecting surface runoff, upward movement of water from below the root zone, and the amount of water incorporated in vegetative biomass, the root-zone water balance in a soil system can be expressed as:

$$\Delta S = P + I - (D + ET) \qquad [2]$$

Where, ET is based on published CIMIS values for the location of interest, a dimensionless crop factor or crop coefficient reflecting the relative evapotranspiration of the vegetation of interest to that of the published CIMIS reference value, and a dimensionless soil factor reflecting the fraction of water holding capacity that is readily available to the evapotranspiration process.

In this model, root zone water balance is calculated on a daily basis. The following equation is used for daily water balance computation:

$$S_i = S_{i-1} + P_i + I_i - (D_i + ET_i) \qquad [3]$$

Where, S_i and S_{i-1} are amounts of water stored in the root zone at the end of day i and day i-1, respectively. P_i, I_i, D_i, and ET_i represent precipitation, irrigation, drainage, and evapotranspiration amounts on day i. The water storage amounts must be greater than or equal to zero and less than or equal to the maximum amount of water that can be stored in the root zone, S_{max}.

The ability of a soil to conduct water is reduced as the soil dries out. At some point, the soil can no longer provide water to the plant roots at a rate sufficient to maintain plant turgor (wilting point). If we let S_{wilt} represent the amount of water in the root zone when the soil dries out, the amount of water available for plant use on day i, AW_i, is given by:

$$AW_i = S_i - S_{wilt} \qquad [4]$$

Combining equations 3 and 4 and treating the infiltration, storage, and drainage as essentially instantaneous processes, the available water on day i, AW_i, is calculated using the equation:

$$AW_i = \begin{cases} AW_{i-1} + P_i + I_i - ET_i & if: AW_i \le AW_{\max} \\ AW_{\max} & Otherwise \end{cases} \quad [5]$$

and the drainage amount on day i, D_i can be calculated from the equation:

$$D_i = \begin{cases} 0 & if: AW_i < AW_{\max} \\ P_i + I_i - ET_i - (AW_{\max} - AW_{i-1}) & Otherwise \end{cases} \quad [6]$$

Where, AW_{max} is the available water holding capacity.

The daily soil moisture balance model includes the following assumptions and simplifications:

1. The model simplifies soil water dynamics; it treats the infiltration, storage, and drainage processes as essentially instantaneous processes.

2. All rainfall and irrigation water enters the soil; runoff is considered negligible.

3. No water is carried upward into the root zone from the below.

4. Water intercepted by the vegetative biomass is insignificant.

Discussion of Soil Water Balance Results

The daily soil water balance model is based on the examined range of historical daily precipitation and ET data (1998-2007). The results indicate that infiltration/percolation of rainfall into the upper soil surface (root-zone) typically occurs on a regular basis during the wet season (October through April) and can subsequently result in drainage to the lower subsoil portions of the soil profile (see Figure 4). The soil water balance results show the high variability in potential soil saturation and associated drainage that occurs from year to year. Focused evaluations of an above-average rainfall year (1998) and a relatively dry year (2002) are summarized in Table 2 and in Figures 5 - 10. The comprehensive set of detailed soil water balance daily data and graphical results are presented in Appendix E.

The 1998 soil water balance model results show what can be expected during an above average rainfall year at the proposed Site. The total rainfall in 1998 was 51.6 inches compared to the average annual rainfall of 42.8 inches (approximately 121% of average). The soil water balance results for 1998 show that daily drainage from the root-zone occurred on a relatively frequent basis during the wet season (October through April) and yielded a total annual cumulative drainage of 35.92 inches (see Figures 5 – 7).

The 2002 soil water balance model results show what can be expected during a relatively dry rainfall year. The total rainfall in 2002 was 22.2 inches compared to the average annual rainfall of 42.8 inches (approximately 52% of average). The results for 2002 show that daily drainage from the root-zone occurred much less frequently and yielded a total annual cumulative drainage of 7.06 inches (see Figures 8 – 10).

By applying the average site soil porosity of 0.35 an estimate of the total potential subsoil water storage volume was determined for the 10.5-acre proposed development footprint. Based on the site CPT data the total subsoil volume (below the root-zone and above bedrock) is estimated at approximately 3,243,000 cubic feet; therefore, the total subsoil pore volume is approximately 1,135,000 cubic feet (see Appendix D).

As summarized previously, the 1998 soil water balance yields a total annual cumulative drainage of 35.92 inches; this is equivalent to a total drainage water volume of approximately 1,369,000 cubic feet over the 10.5-acre development area. Therefore, during a moderately wet year (1998) it is expected that the subsoil will become saturated and the potential translocation of excess soil water (approximately 234,000 cubic feet) will be contributed to subsoil areas immediately down-gradient and east of the Site (see Figures 3 and 4). Conversely, during a dry year (2002) it is expected that site subsoil will only become partially saturated (due to a total drainage water volume of approximately 269,000 cubic feet) and translocation of excess soil water to subsoil areas immediately down-gradient of the Site will not occur or will be relatively insignificant. In both the wet and dry year cases the vast majority of total soil water is stored within the local site subsoil supporting the localized perched groundwater conditions observed on the Site.

4.0 CONCLUSION

The potential for deep drainage at the Site is characterized by the results of the soil water balance presented above. However, when characterizing groundwater recharge, a distinction between potential recharge and actual recharge needs to be made. This study considers deep drainage (potential recharge) as soil-water that percolates below the root zone. The distinction is that actual recharge is soil-water that replenishes aquifer storage. Potential recharge water is typically stored in the vadose zone at negative pressures (suctions) and is not generally available for exploitation. Conversely, actual recharge is the amount of water that in fact reaches a water bearing aquifer that can be pumped. Based on the site-specific geology and soil conditions, the potential recharge occurring at the proposed Site consists solely of deep drainage that contributes to saturation of local subsoil zones with a hydraulic gradient to the east toward Carbonera Creek. The observed perched groundwater on the Site is not considered a source of direct actual recharge to water bearing portions of the Santa Margarita Sandstone aquifer (see Figure 3 and Appendix A showing a geologic cross-section of the Scotts Valley Area - northwest to southeast).

It has been previously concluded that recharge of runoff from development parcels in southeast Scotts Valley would not benefit the SVWD or the Scotts Valley Santa

Margarita groundwater basin (SVWD, 1989). Local groundwater is perched at the Site because underlying highly impervious bedrock formations prevent further infiltration/recharge. The proposed Site has been previously characterized as a groundwater discharge zone as opposed to an effective area of actual groundwater recharge (EIP Associates, 2004). It is likely that during very wet years the local perched groundwater and saturated subsoil at the Site provides a seasonal flux of water to down gradient soils and springs draining toward the alluvium deposit located along Carbonera Creek east of the Site. However, this alluvium is not considered a significant water producer in the Scotts Valley area because of its limited saturated thickness and lateral extent and due to the fact that no production wells have been established in the area (see Appendix A).

While the Site is mapped on the edge of a Primary Groundwater Recharge (PGR) area, as classified by the Santa Cruz County GIS, this definition has a very limited technical basis. The mapping is primarily used for preliminary zoning/development determinations and is helpful as initial screening criteria in hydrologic evaluations. PGR areas are defined as areas where potentially high permeability soils (as mapped by the USDA) overlying outcrops of geologic units (as mapped by the USGS) that act as significant aquifers. Other factors such as slope, site-specific geologic data, vegetation type, or whether streams crossing the units were gaining or losing were not incorporated into the mapping. The original data was hand traced from the original USDA and USGS maps onto 7.5 minute quadrangle maps. These 7.5 minute quadrangle maps were in turn hand digitized to create the GIS layer. The hand work introduced a level of inaccuracy into the final product (pers. comm. Santa Cruz County, 2008).

The Santa Cruz County GIS update occurred when the original USDA and USGS digital data were acquired. The new polygons were created by the superposition of these two layers on one another. The PGR mapping is not considered entirely accurate; there are errors in the original USDA and USGS mapping as well as registration problems with data from the original base maps projected onto a common set of contours. The County has indicated that this mapping is only a best approximation of where groundwater may be recharged. That is why the County allows parcel owners to submit hydrologic reports contesting the designation if they feel their properties were mistakenly included in PGR areas (pers. comm. Santa Cruz County, 2008).

In conclusion, the results of this site-specific groundwater recharge investigation indicate that deep drainage from the soil root-zone to lower portions of the soil profile is a common occurrence at the Site. However, geotechnical data collected during previous and current site investigations show that site soils are underlain by a local Quartz Diorite restrictive bedrock layer. Based on local hydrogeologic cross-sections, soil borings and CPT data this paralithic bedrock layer has been confirmed to be sloping to the east toward Carbonera Creek. This bedrock boundary provides an impediment for actual groundwater recharge to recognized water bearing formations/aquifers and production wells located to the north and west of the Site.

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