Ananda Village
Water Supply Assessment

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Introduction

The California Water Code §10910 requires that large projects supplied by a Public Water System prepare a Water Supply Assessment. The Ananda Water System, with fewer than 200 service connections, does not meet the criteria for a Public Water System (over 3000 service connections) and the development proposed in Ananda's Comprehensive Master Plan (CMP) update (addition of 100 dwellings) is well below the project size threshold (addition of 500 dwellings or equivalent) and thus is not required to prepare a Water Supply Assessment. Much of what would be required in a Water Supply Assessment has been included in the Source Capacity Planning Study (Water Study) and the Well Capacity Analysis (see CMP Submittal Narrative, Appendix 3A[1]). However, in order to facilitate environmental review for the CMP, Ananda has followed the guidelines of a Water Supply Assessment to present here information pertinent to CEQA review of the CMP.[2]

A. Documenting Supply

The Ananda Water System is supplied exclusively by groundwater pumped from wells on the Ananda Village property. Future development will also be supplied from groundwater. Ananda Village is not served by any water wholesalers and does not anticipate receiving water from any outside sources. The Ananda Water System is not included in any State, County, or Urban Water Management Plans.

Ananda Village does have surface water rights, licensed and permitted with the California Water Resources Board, for the storage of 72.5 acre-feet of water in 7 reservoirs, of which 44.3 acre-feet can be withdrawn annually. This water is used for agricultural irrigation, fire suppression, and recreation. Ananda Village straddles a hydrologic divide and there are no other storage rights upstream of Ananda's catchment area.

Characterization of Groundwater Basin

Ananda Village is located on the San Juan Ridge between the Middle and South forks of the Yuba River in the foothills of the Sierra Nevada Mountains. Elevations on the 700-acre Village property range from 1600 feet, where the property touches the Middle Yuba, to over 2900 feet elevation at the high point. Groundwater is pumped from fractured bedrock underlying the development. The project area is not part of an adjudicated groundwater basin and is not part of any groundwater basin identified by the California Department of Water Resources or covered under the Sustainable Groundwater Management Act of 2014[3]. Current California Law places no restrictions on groundwater pumping in the project area.

The fractured bedrock provides groundwater to accumulate and flow in a locale based on fracture geometry and fracture interconnection, not a porous medium of gravels, sands and silts.

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[1] The Well Capacity Evaluation Report prepared by HydroSolutions of California is included as Appendix 1 of The Source Capacity Planning Study by Sauers Engineering.

[2] California Department of Water Resources, 2003, Guidebook for Implementation of Senate Bill 610 and Senate Bill 221, (http://www.water.ca.gov/pubs/use/sb_610_sb_221_guidebook/guidebook.pdf).

[3] http://www.water.ca.gov/groundwater/index.cfm

Groundwater beneath the Ananda Village is defined as water accessible to a groundwater well. Groundwater is recharged from precipitation, percolates into the subsurface and flows into a system of interconnected fractures in the underlying bedrock. The extent of the connectivity of the fractures and hydraulic barriers determines the boundaries of the aquifer. The San Juan Ridge in the vicinity of Ananda Village is bounded by deep river canyons of the Middle and South forks of the Yuba River. There is no evidence that groundwater flowing into or out of the project area across these divides is occurring. Identifying specific groundwater flow paths in the fractured bedrock of the San Juan Ridge is much more difficult to characterize than, for example, the alluvial basins of the Central Valley. Detailed quantification of the area's hydrology would be extremely difficult and unjustifiably expensive and still incorporates a high level of uncertainty.

To evaluate the groundwater aquifer in the project vicinity, a conceptual model was created, incorporating field observations and available information on lithology, hydrology, topography, climate, vegetation cover, and land use. The intent in developing this conceptual model was to establish a general understanding of the way that water is recharged, stored, and discharged. The resulting characterization allows the groundwater use proposed by the project to be examined in the context of the existing conceptual hydrologic flow paths, and an evaluation made as to expected impacts on the environment and existing water wells.

Lithic Zones

Underlying Ananda Village are four lithic zones. Jurrassic era granodiorite, part of the large igneous intrusion known as the Yuba Rivers pluton, underlies the northern and western portions of the Village and extends westward down the Ridge. To the north and east of the Village is an area of Mesozoic era metasedimentary rock. A relatively narrow finger of Jurrasic era Diorite bisects the Village from the south, ending at the junction of the metasedimentary rock and the granodiorite. To the southeast the Village is touched by Eocene era auriferous gravels that follow the ancient gold-bearing river beds that first brought Europeans to the San Juan Ridge during the California gold rush. Exhibit 1 shows a detail of the lithic zones in relation to Ananda Village boundaries. This map was developed from a variety of sources including field observations, well driller reports from the area, and published geologic maps. A portion of the Chico quadrangle map of the Geologic Map of California, which shows a much larger area, is included in the Well Capacity Evaluation Report (Appendix 3A, Figure 3).

Fracture size, direction, and density tend to vary between lithic zones. The border or contact zones between different lithic zones can also be associated with changes in hydrology. The contact zone between the diorite and the metasedimentary that runs northwest to southeast on the eastern portion of the property offers potential for groundwater storage greater than what is found in zones of undifferentiated bedrock. Geohydrologist Don Moore, of Geoimagery, studied Ananda Village and postulated that the Village area offers groundwater potential that is somewhat unique for the foothills region. The central area of the Village lies within a topographic divide that forms a bowl or amphitheater. The well history and topography indicate much of the water is stored as perched water in the upper zones and on top of the underlying granitic rock. It is likely these upper zones may act as a small aquifer. Four out of the five wells comprising the Village water system (Exhibit 1) are located in this area, and the depth of water producing fractures, lithology encountered during drilling, and water quality are similar. These unique features could be indicative of a zone of greater water storage and greater isolation than is typical in the surrounding region.

Observation of the project topography through high resolution aerial photography revealed a possible lineation that connects the granite/metasedimentary contact zone to the auriferous gravels and sediments that were extensively mined in this area. These sand/gravel deposits offer the potential for significant water storage and transmission as compared with hard rock geology. Don Moore concluded, "The eastward dipping contact zone, the overlying porous gravel/sand formations on the subject property and possible underlying fracture zone offer potential for additional water storage on the property, off site water flowing to the property, and isolated zones of water recharge separate from the main valley." (See CMP Submittal Narrative, Appendix 3C, Test Well Locations, Ananda Village, Geoimagery, July 2008.)

Faulting

The directional trend of faulting along the western slope of the Sierra Nevada, in general, and the San Juan Ridge, in particular, is northwest to southeast. These major and minor faults impede and alter the east to west water flow that one would expect from the decline in elevation from the Sierra crest in the east to the Central Valley to the west. Aerial photography and analysis performed by geohydrologist Don Moore confirmed this general trend. (See CMP Submittal Narrative, Appendix 3C, Test Well Locations, Fig. 1) Ananda Village extends from the Middle Yuba River in the north almost to Blind Shady Creek in the south. This general orientation paralleling the fault lines indicates more of the land where one would expect greater connection is owned by Ananda rather than neighbors.

Topography

Topography is not a perfect indicator of subsurface hydrologic flows, as depth and direction of fractures can be independent of changes in surface elevations. However, in mountainous regions subsurface flows generally follow surface gradients, flowing in the direction of declining elevation. Ananda Village straddles a hydrologic divide between three basins (see Exhibit 1). From a point near the northwest boundary of the Village, the gradient is downward to the north toward the Middle Yuba River, downward to the south and east to Shady Creek, and downward to the west into the Clear Creek drainage. All the wells in the Ananda Water System are in the Shady Creek Drainage, and there are only two neighboring landowners (both of whom work in close cooperation with Ananda) upstream, as the hydrologic divide lies almost entirely within the Ananda Village boundary. No streams flow into Ananda Village from neighboring properties and there are no perennial watercourses on the property. The Middle fork of the Yuba River does touch the extreme northern boundary of the property, but the elevation difference between the riverbed and Ananda's wells make it unlikely that the river is a source of recharge to the local aquifer[4].

The landscape of Ananda Village can be characterized as relatively water abundant due to the many springs, seeps, and small ponds present on the property. Springs are present on the property because fractures that carry water intersect with the topography at discrete locations. This abundant fracture system at or near the ground surface can also act as discrete pathways for precipitation to enter the ground surface and accumulate in fracture zones that serve as the entry to the fractured aquifer systems beneath the property (See CMP Submittal Narrative, Appendix 3A, Water Study App. 1, Well Capacity Evaluation Report, Sections 3.1-3.4, pp. 8-13 for a more detailed discussion of site geology, storage, recharge, and discharge).

[4] River elevation is about 1600 feet above mean sea level while the deepest water-producing fracture in Ananda's wells is 2380 ft.

Soils

Ninety percent of the soils at Ananda Village fall into three soil classifications: Hoda Sandy Loam, Musick Sandy Loam, and Josephine Loam (see CMP Submittal Narrative, Exhibit K-2.) These soil classes are characterized by deep, well drained soils, with moderate, to moderately slow permeability[5]. Soil testing associated with the establishment of existing and future leach fields throughout the Village has shown sufficient percolation to allow for the establishment of standard leach fields in most areas of the Village (see CMP Submittal Narrative, Appendix 4, Engineered Septic and Soils Analysis for Ananda Village), indicative of soils that allow precipitation to percolate through to underlying bedrock. Even at full build-out the project area is over 70% open space, distributed between cropland, pasture, grasslands, and forest. In developed areas, runoff is channeled in to vegetated swales and ponds to retain and recharge the maximum amount of rainfall.

Precipitation

Rainfall is typically abundant in the mid elevations of the Western slope of the Sierra Nevada, and Ananda Village averages about 54 inches of annual precipitation, the great majority as rain. During a dry year (10% probability of occurrence), rainfall is expected to be 33.3 inches. In a critical dry year (3% probability of occurrence), expected rainfall is 26 inches.[6]

Recharge

Based on the above characterization of the local aquifer, recharge was quantified by three different approaches: 1) Water Table Fluctuation Method, 2) Applied Hydrogeology of Fractured Rocks, and 3) Water Budget Method. Because a complete set of hydrology data is not available and its collection is not economically feasible for the project, the analysis is not a detailed model of site hydrology. Rather, recharge estimates are intended to serve as a basis for comparing the magnitudes of projected water use by Ananda Village to groundwater recharged from rainfall on the Ananda Village property. Specific values used in the calculation of recharge were chosen to understate the amount of recharge to the underlying fractured rock aquifer.

Groundwater recharge estimates from the three methods described above are as follows:

Table 1
Annual Recharge to Groundwater In Acre-Feet

WTF Method	444
Applied Hydrogeology	160-479
Water Budget	579

The Village is characterized by many springs and seeps, which suggests the land is more water abundant than many other areas of the Sierra region. Hydrologic analysis conducted for the nearby San Juan Ridge Mine assumed recharge to bedrock was 15% of precipitation.[7] These factors, combined with consistency with the other methods, supports using the upper range value for the Applied Hydrology Method. (For details on recharge methods and calculations see CMP Submittal Narrative, Appendix 3A, Water Study App. 1, Well Capacity Evaluation Report, Section 3.5 pp. 13-17).

[5] (soilseries.sc.egov.usda.gov)

[6] Precipitation data is for water years 1914-2014, as recorded in Grass Valley, CA, as reported by the Western Regional Climate Center. Grass Valley is at a similar elevation to Ananda Village, about 2500 ft. and is located 10 miles south of Ananda Village.

[7] "Bedrock Hydrology – San Juan Ridge Mine – East Workings", HSI, 1983.

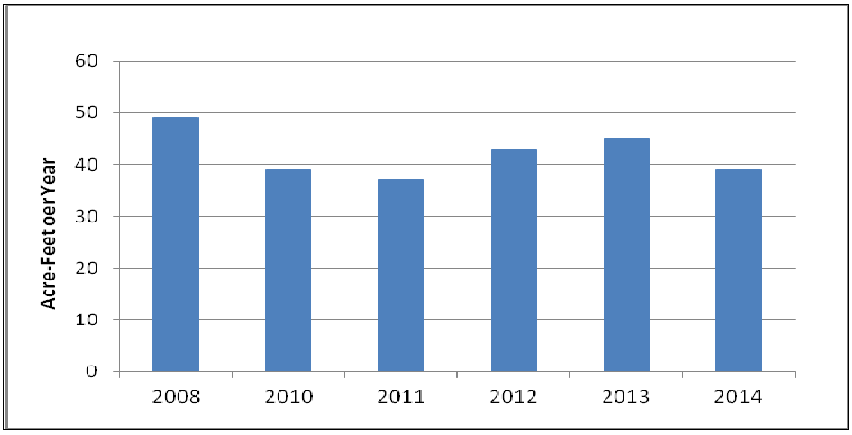
Dry Year Supply

Ananda Village will rely on the same groundwater sources during dry years as during wet years. Groundwater tends to show less fluctuation between wet and dry years than surface water supplies. Historical records of Ananda Water System show that water quality at Ananda's wells has remained consistent in wet and dry years. Water levels in the wells fluctuate seasonally and show some variation between wet and dry years, but have remained in a consistent range over the years. Recharge from precipitation would be less during dry years but underground storage buffers annual differences in recharge. The value of ΔH used in the calculation of recharge in the WTF Method was estimated during the 2007 water year. Rainfall during this year corresponded to the expected dry year rainfall of 33.3 inches discussed above (See CMP Submittal Narrative, Appendix 3A, Water Study App. 1, Well Capacity Evaluation Report, Figure 4). No data is available to estimate recharge in a critical dry year using this method. The other two methods assume recharge to be proportional to rainfall. Using these methods results in 245-357 acre-feet recharged on the property in a dry year and 191-279 acre-feet in a critical dry year[8].

Current Supply

Ananda Water System pumped an average of 40.5 acre-feet annually during the last five years[9] (see Figure 1). Water was supplied primarily from two wells: Dairy (A4) and St Francis (A2), although water was supplied to the system by four wells (A1-4) in total. Turtle well (A5) is not currently connected to the Ananda Water System[10]. Exhibit 1 shows well locations. (For more details on information summarized in this section see CMP Submittal Narrative, Appendix 3A, Water Study, Sec. 2-3, pp. 3-7; and Water Study App. 1, Well Capacity Evaluation, Sections 5-6, pp. 19-33)

Figure 1
Ananda Village Annual Groundwater Pumping
Water System and Irrigation Wells



[8] Assuming a recharge value toward the upper end of the estimated range (75% interval) the Applied Hydrogeology results in an expected recharge of 245 AF in a dry year and 191 AF in a critical dry year. The Water Budget Method results in an expected recharge of 357 AF in a dry year and 279 AF in a critical dry year.

[9] The Water Study was prepared before 2014 data was available and the 5-year average of 43 acre-feet used in that study was calculated from data from 2008, and 2010-2013. 2009 is excluded due to a lack of summertime data because of a meter failure.

[10] In addition to the demand of the users connected to the Ananda Water System, an additional one to two acre-feet of water was supplied for irrigation from wells A5, B4, and B5. This additional water supplied from wells not permitted as part of the Ananda Water System is included in the yearly pumping total.

Ananda Village began working with HydroSolutions of California in 2006 to put in place a comprehensive groundwater monitoring program. Pressure transducers and automatic data loggers were installed in the system's production wells, allowing the recording of depth-to-water measurements at intervals of 45 minutes or less. Depth-to-water measurements are continuous and ongoing. Additionally a 10-day pump test, supervised by HSCI in accordance with State Waterworks Standards, was conducted for each of the five Class II wells located within the project area. Adjacent potable water wells were monitored during the tests and showed no evidence of connectivity between the five wells during the duration of the tests. Sustained yield for each well was determined by analyzing the 10-day pump test data, including step draw down tests and recovery time, along with well-specific data, including pumping history (more than 10 years) and hydrographs (1-9 year duration). Sustained yields for each well are shown in Table 2 below:

Table 2
Sustained Yields for Ananda Class II Wells

Well Name	Sustained Yield (gpm)
Dairy	40
St Francis	14
Ballpark	44
Turtle	7
Badrinath	11
Total	**116**

The first four wells listed above show similar characteristics, including water quality and recovery time after pumping. Dairy and St. Francis wells have long pumping histories, and the sustained capacity reflects that record. Ballpark well exhibited a relatively higher specific capacity during the pump test than the other tested water wells. This observation, combined with the absence of significant seasonal variation in static water levels, indicates a healthy aquifer condition and a strong well. The modest drawdown during the pump test and the very rapid recovery time of the Turtle well creates a well capacity that can be close to the 10-day pumping rate. The minimal drawdown and slow recovery observed during the pump test of Badrinath well indicate a significant underground storage capacity but a slow recharge rate. This well can make a significant contribution to meeting summer peak demand but will need a long recovery time.

Transmissivity (T) was calculated for four out of the five wells from the residual drawdown plot of recovery data using the Cooper Jacob methodology. Transmissivity for the four wells were typical of a healthy fractured rock aquifer, ranging from 990 to 654 gpd/ft (132 to 87 sf/day).Transmissivity could not be calculated for the Badrinath well.
The San Juan Ridge in the vicinity of Ananda Village is characterized by low-density development with parcels zoned Agriculture or Forestland. Most of the parcels that are developed with residential dwellings draw their water from wells on the parcel. The greatest concentration of developed parcels is to the northwest and southeast. Directly to the west and south are larger

parcels, some of which are not developed. Residential development in the area has not been constrained by water availability[11].

B. Water Demand

Because the Ananda Village water system has been in existence for over 40 years, demand analysis relies on historical data rather than on engineering generalities. Water usage is metered both at the wells and at the point of use. Residential and non-residential meters are read bimonthly and all users are charged based on usage. For the purpose of tracking Village water use over time, Ananda divides use into four categories: (1) residential; (2) non-residential indoor; (3) non-residential outdoor; and (4) large residential and agricultural irrigation. Demand has been fairly stable over the last decade and future use was projected for each of the categories based on the average of the highest 5 years of demand. These categories were chosen because growth rates in each category over the life of the project are distinct, and a different method of projecting future demand was used for each. A detailed discussion of current and future demand is provided in the Water Study, Sections 3 and 4, pp. 6-11.

Table 3 shows projected water system demand divided into three phases.

Table 3
Baseline and Projected Seasonal Water Demand[1]

	Baseline[2] 86 Units	Phase 1 123 Units	Phase 2 159 Units	Phase 3 195 Units
	AF	AF	AF	AF
November-January	4.0	5.5	7.1	8.6
January-March	3.4	4.6	6.1	7.4
March-May	4.9	7.1	8.9	10.7
May-July	9.2	12.6	16.0	19.6
July-September	12.0	16.3	20.6	24.9
September-November	7.7	10.4	13.2	16.0
ANNUAL TOTALS (Acre-feet)	41.1	56.5	71.8	87.2

[1]Values are shown Acre-Feet (AF) for the period. Table derived from Water Study, Table 4-4.
[2] Baseline is average of 2008 and 2010-2013.

Each phase represents 5-10 years of growth. Project build-out is anticipated to take several decades. Thus, projected demand at project build-out would be a conservative projection of project needs 20 years from now. Projections are for annual water demand across all classes of service connections for the water system. In addition to demand from users connected to the

[11]Peter's Drilling owner, Greg Peters , drawing on decades of experience drilling in Nevada County, including on the San Juan Ridge, stated that in more than 99% of the parcels he has drilled on, including small parcels less than an acre in size, viable water-producing wells were located. (Presentation to symposium on 2014 drought, sponsored by Nevada County Relators Association, June 2014, and personal communication with Stephen Baker).

Ananda Community Water System, water pumped from irrigation wells (wells not sealed to a depth suitable for permitting in the Community Water System) was estimated to increase from current levels of 1-2 acre-feet per year to a maximum of 5 acre-feet at build-out. Thus, total projected demand at build-out would be 92 acre-feet.

Comparison of Demand Projections with Other Projects

Ananda Village is a single-owner community where residents work together toward the common goal of sustainably managing Village resources. Water is treated as a scarce and precious resource, and residents cooperatively manage water supply. Historically, per capita water use has been significantly below State and County averages. Homes are small, individual landscaping is modest, lawns are discouraged, and a tiered water rate structure encourages conservation. Projected residential water use per household is significantly below California and Nevada County averages. Residential water use per dwelling unit (du) in 2010 (a dry year), including vegetable gardens and landscaping, was 217 gpd/du. In 2011 (a wet year) residential water use at Ananda Village dropped to 196 gpd/du. A residential unit in a typical subdivision uses 450 gpd/du and design standards can be twice this amount[12]. NID the local water supplier for Nevada County, reports that average household water use among its customers is about 400gpd/du[13]. A detailed study of residential water use in California sponsored by the California Water Resources Control Board, estimated that the average California household used 360 gpd[14].

Dry Year Demand

Ananda Village residents work closely together with water system staff and Village management to conserve water during drought years. Ananda Village has all the components in place to effectively reduce demand in a drought, including: well monitoring, end use demand metering, a licensed water system staff to provide technical expertise, effective leadership and organization through a Village staff and elected Village Council, well-developed means of Village-wide communication, and most importantly, a spirit of cooperation among community residents , who participate in the cooperative ownership and governance of the development.

The drought of 2014 is a good example of the ability of the community to cooperate to reduce water consumption. After 3 dry years and in response to the Governor's call for state-wide conservation, the Ananda Village Council adopted a goal of 20% reduction in residential and non-residential water use. The Village planning and water system staffs worked with residents to develop a plan to conserve water in homes, businesses, and gardens. Each month, water users were given personalized feedback on their water use (gallons per day per person), with comparisons to other Village users. Conservation tips were published in the weekly Village newsletter and two community meetings were held, where residents shared information on conservation efforts, and information was shared about the state and regional context of the drought. Village staff worked closely with large irrigators, providing them weekly reports on current and past year's water use in the form of tables and graphs.

Peak conservation occurred between mid-July and mid-August, when water demand was 26% less than average use between 2006 and 2013, and was 31% less than demand during the same period

[12] Hydrologic Investigation Report for Standing Rock Ranch Subdivision, Holdridge and Kull, June 2013

[13] http://nidwater.com/water-service/treated-water

[14] California Single-Family Water Use Efficiency Study, Aquacraft Water Engineering and Management et. al., sponsored by California Department of Water Resources, June 2011

in 2013. Overall, Ananda Water System users were able to conserve 20.3% from mid-March to mid-October compared to the previous year's use. CMP Submittal Narrative, Appendix 3D, Ananda Village 2014 Water Conservation and Groundwater Management, summarizes the program and the results of the conservation efforts. The experience of 2014 shows that dry year demand can be reduced for the Ananda Village Water System. In a critical dry year (3% likelihood of occurrence) even greater reductions could be achieved, especially by further reduction in irrigation. It is projected that demand could be reduced by 25-35%.

C. Sufficiency of Supply

Projected recharge over the 706 acres of Ananda Village is significantly higher than the projected annual water demand of 92 acre-feet per year. Annual recharge volumes estimated through three different methods are 5-6 times higher than total demand at build-out, see Table 1 above.

Wastewater disposal for the project is and will continue to be through on-site leach fields. Most of the water used in buildings enters the septic system and is recharged back into the ground. These septic returns at full build-out are estimated to be 38 acre-feet annually, effectively reducing the net water withdrawal associated with the project from 92 acre-feet per year to 54 acre-feet. Taking expected septic returns into account results in normal-year recharge that is 8-11 times greater than net annual demand at build-out. (See CMP Submittal Narrative, Appendix 3A, Water Study App. 1, Well Capacity Evaluation Report, Section 3.6, pp. 16-17.)

Sustainable yield of the five Class II wells permitted and or tested for inclusion in the water system is estimated to be 116 gpm. The projected annual potable system demand of 87 acre-feet represents 47% of sustained yield. Demand is not spread evenly throughout the year, with demand in the peak summer period 3 times higher than average winter demand. The highest daily demand (Maximum Day Demand, or MDD) has been 25-35% higher than average peak period demand. Ananda may need to make adjustments to meet MDD in Phase III of build-out. These adjustments may include shifting irrigation demand to existing Class I wells, proving the capability of the Badrinath Well (A1) to provide more water for the peak than its current rating of 11 gpm, or developing new sources of supply, (see CMP Submittal Narrative, Appendix 3A, Water Study, Section 6.5-6.7, pp. 20-21.)

Sufficiency of Supply in Dry years

Water supply to the project is sufficient for dry years (10% probability) and critically dry years (3% probability). As discussed above, dry year demand is projected to be 20% below normal year demand because of system-wide conservation efforts, similar to what were implemented in 2014. In critical dry years, a 25% reduction is projected. Dry year demand at build-out thus will be 74 acre-feet in a dry year and 69 acre-feet in a critical dry year. As discussed above, in the Dry Year Supply Section, it is estimated that 245-357 acre-feet are recharged on the property in a dry year and 191-279 acre-feet in a critical dry year. Recharge is thus 3-5 times more than projected demand in a dry year and 3-4 times in a critical dry year. Assuming the same rate of septic system returns as discussed above, 30 acre-feet would be recharged to groundwater, effectively reducing the net water withdrawal associated with the project from 74 acre-feet per year to 44 acre-feet in a dry year, and 69 acre-feet per year to 39 acre-feet in a critical dry year.[15] Thus, taking septic returns into

[15] The greater conservation in critical dry years compared to dry years will come from reductions in irrigation, not indoor use, and thus septic recharge for both demand scenarios is estimated to be 20% below the 38 AF estimated for septic recharge in a normal year, or 30 AF.

account, recharge in a dry year can be expected to be 6-8 times higher than demand and 5-7 times higher in a critical dry year.

Water system records show that the wells that currently supply the Ananda Water System have remained viable through drought periods. Although water levels are somewhat lower in dry years than in normal years, long-term well capacity and water quality were not adversely affected by continued consistent pumping during drought years. Ananda Village resiliency has increased even more due to adjustments that are made in the well field as a whole. Adjusting pumping schedules and pumping rates redistributes the stress in the aquifer resulting in less overall drawdown.

Impact on Other Users of the Aquifer

Parcels adjacent to Ananda Village are supplied by groundwater wells. Ananda's wells are clustered in the center of the development and tend to be well buffered to neighboring parcels. The main production wells located in the central bowl of Ananda (St. Francis, Ballpark, Dairy, and Turtle wells, A2-A5) are all at least 1600 feet away from the closest neighboring well. The Badrinath well (A1) is closer to the Village boundary and there are five neighboring wells within a quarter of a mile. The closest well is 720 feet to the northwest of the Badrinath well. There are a total of 25 neighboring wells within a half mile of an Ananda Water System well, see Exhibit 1.

Characterizing the connectivity between wells in a fractured rock environment is extremely difficult. Of primary importance is whether the proposed withdrawal of groundwater from Ananda Village is likely to have a detrimental impact on the regional hydrologic system in general, and wells of neighboring properties in particular. As discussed above, expected recharge over the 706-acre project area substantially exceeds projected withdrawals, indicating that the project is generally in balance with the area's water resources.

Analysis undertaken for the Well Capacity Evaluation Report (See CMP Submittal Narrative, Appendix 3A, Water Study App. 1) indicates that the radius of influence of the Ananda wells is not likely to extend outside of the Ananda Village Boundary. Potential impacts on neighbors are further reduced by the well field pumping limits that Ananda has placed into their operational program. Shallow-most productive fractures will not be dewatered. This goal allows continued flow of groundwater to other water users.

The following sections examine several factors that can influence the potential for connectivity between wells. It is helpful to consider these factors, in addition to estimates of recharge and proposed well operation, when analyzing potential effects of project pumping.

Lithic Zones

Fracture patterns within lithic zones tend to be similar in structure than across lithic zones. Contacts between lithic zones can serve as areas of aquifer storage and advective flow. Ananda Water System wells all occur in the Jdi zone. There are only three neighboring wells within a half mile that are in the same lithic zone.

Faulting

The general direction of faulting on the San Juan Ridge is NW to SE. Ananda Village boundaries run longer in the north south direction (1.8 miles) than in the east west direction (0.85 miles). This means there are fewer neighbors along the direction of predominant faulting than if the property ran more in an east west direction.

Topography and Hydrologic Divides

Ananda's wells are located at the top of a hydrologic basin, as discussed above. Within this hydrologic basin there are eight neighboring wells within a half mile of Ananda's wells. Seven of the eight wells are to the southeast, at a lower elevation. Because the water-producing fractures in Ananda's wells are relatively shallow, it is likely that these fractures are at a higher elevation than the water-producing fractures in lower-elevation neighboring wells. This was confirmed for three of these wells for which drillers reports were available to Ananda. Therefore, Ananda's wells would likely be affected by over pumping before the neighboring wells. Ananda will manage its pumping to prevent dewatering of productive fractures in its wells. This should protect the health of the aquifer in general and the wells down gradient in particular.

Water Chemistry

The four wells in the Village Center basin (A-2 through A-5) are similar in water chemistry with low iron and manganese. Anecdotal evidence suggests that the majority of neighboring wells to the north and east in the MS and Tg lithic zones exhibit different chemistry. This is suggestive of different groundwater sources. Again, anecdotal evidence concerning wells in the granitic lithic zones (Jdi , Jg) show significant variations in water quality even among wells in close proximity. The Badrinath well (A1) is higher in iron and was age dated as quite a bit older than the water in the Dairy Well (A4). It also seems to be different in iron, pH, and manganese compared to the wells in close proximity on neighboring parcels 61-240-15, and 61-240-27. Water chemistry in area wells has not been studied sufficiently to draw conclusions, but observed variability is indicative of a variety of different recharge pathways among wells.

Water Levels

Ananda's wells are closer to each other than to neighboring wells. Examination of depth-to-water measurements taken during all five of the 10-day pump tests showed no evidence that 10 days of continuous pumping affected any of the other wells in the system. During the pump tests, the wells were pumped at rates significantly above the sustained well yields set in the Well Capacity Report, and in normal operation, wells would never be pumped at this rate for such a long period. Instead, Ananda is proposing to manage pumping in all of its potable system wells to prevent dewatering of the water producing fractures, thus maintaining the dynamic equilibrium of the regional aquifer. This will protect the health of both Ananda's wells and neighboring wells (see, CMP Submittal Narrative, Water Study, Section 6.4, Adaptive Groundwater Management, pp. 17-19.) This strategy has already been successfully maintained during dry years and normal precipitation years.

Groundwater Management and Monitoring

Ananda has developed a comprehensive groundwater monitoring plan. All wells in use in the potable system will have equipment to automatically record depth-to-water. Quantity of water pumped is continuously metered and recorded daily. End-use will also be metered at all service connections. Development will be slow, over several decades, and during this time, data will be collected from all the wells. A baseline of seasonal depths, water quality, recharge rates, and well flows will be established for each well. Ananda will adjust pumping rates and spread demand among the system wells so that water producing fractures are not dewatered in any of the wells. The management goal is to maintain pumped water levels above the shallow most fracture. The practice of not dewatering fractures will insure that the aquifer system is maintained in a dynamic equilibrium, thus protecting the health of Ananda wells and neighboring wells. Change in water quality, water level recovery rates, or pump flow will also be used as triggers for shifting supply source, or managing demand until the affected well stabilizes within the pre-defined safe range.

Future development will occur slowly, probably over several decades. The capacity and organization to manage water supplies exists at Ananda Village and has a record of effectiveness. Ananda has a number of alternatives to maintain balance between demand and supply and thereby insure aquifer health for all users including:

- Reducing demand on the potable system by shifting some irrigation demand to existing irrigation wells
- Shifting supply among wells that have different characteristics and vulnerabilities
- Developing new sources of supply
- Managing development to reduce demand in the long-term
- Managing demand through operational and behavioral changes to meet short-term supply fluctuations (drought contingency plan)

(See CMP Submittal Narrative, Appendix 3A, Water Study, Section 6.4-6.9 pp. 17-23.)

D. Conclusion

There is a certain degree of hydrologic uncertainty inherent in fractured rock systems. However, there is a preponderance of evidence to suggest that water resources for this project are adequate to meet projected demand without significant effect on the aquifer system.

- Expected recharge over the project area substantially exceeds projected net withdrawals by Ananda Village, even in drought years.
- Groundwater pumping at Ananda Village is both reasonable in use and beneficial to the property. This criterion is valid for all property owners exercising their California overlying groundwater right.
- Ananda Village's large area and location at the top of a hydrologic divide, abundant water evidenced by seeps and springs, and location at the intersection of lithic zones, are indicative of minimal likelihood of adverse impact to overall health of the aquifer, based on projected usage.
- Ananda's wells are in closer proximity to each other than to neighboring wells and are more similar in many of the characteristics discussed above.
- Ten-day pump tests of the wells showed no interference between Ananda's wells, which suggest unlikely impact to neighboring wells.
- Development will occur slowly, and there is a monitoring system in place to help insure sustainability of groundwater withdrawals.
- Ananda Village has all the components in place to effectively manage its water resources and to reduce demand in a drought, including: well monitoring, end use demand metering, a licensed water system staff to provide technical expertise, effective leadership and organization through a Village staff and elected Village Council, well-developed means of Village-wide communication, and most importantly, a spirit of cooperation among community residents , who participate in the cooperative ownership and governance of the development.

Ananda Planned Development

Water Supply Assessment
Lithic Zones, Hydrologic Divide

Scale: 1"= 1200'

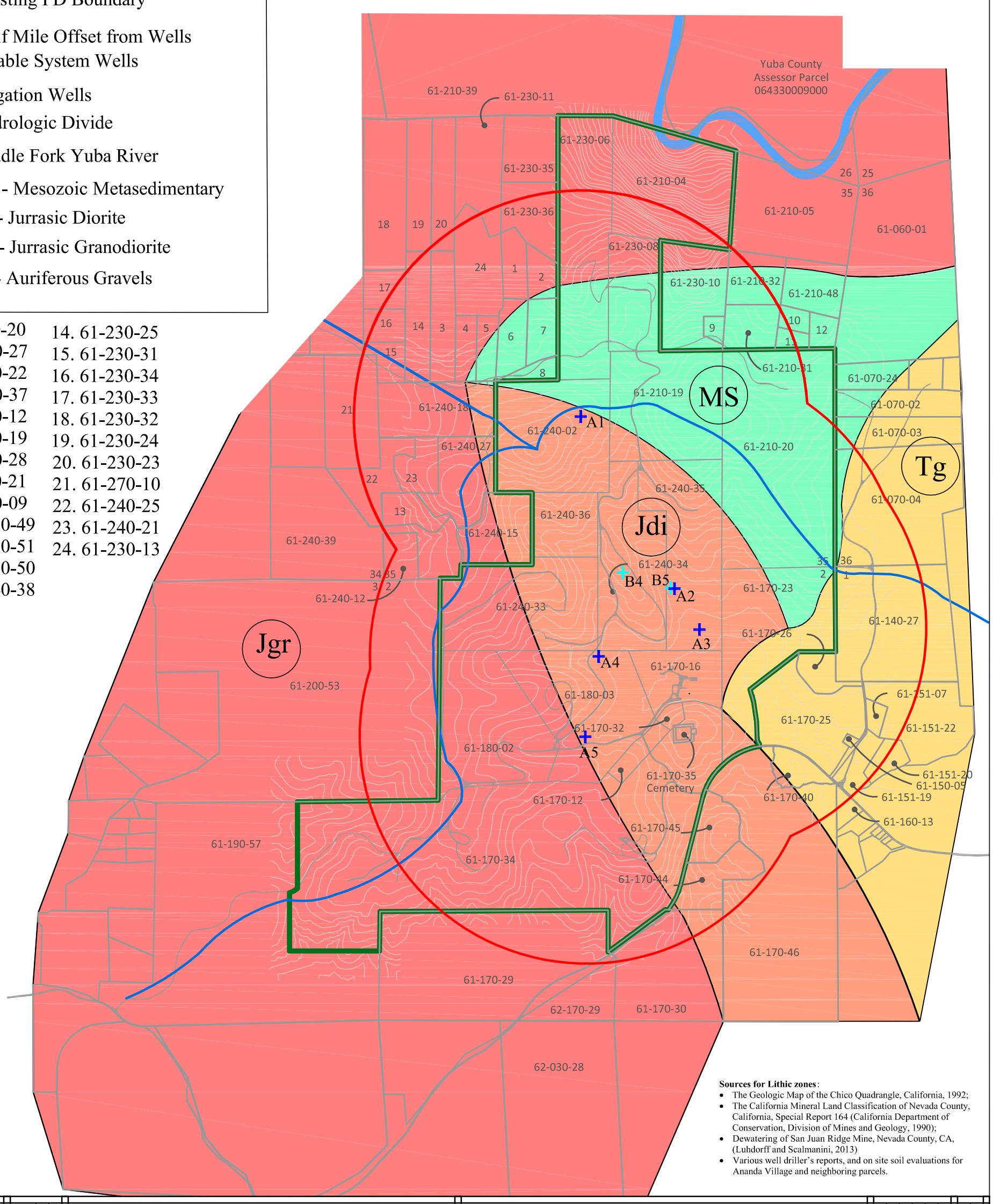
0' 1200' 2400' 3600'

N

Legend

- Existing PD Boundary
- Half Mile Offset from Wells
- Potable System Wells
- Irrigation Wells
- Hydrologic Divide
- Middle Fork Yuba River
- MS - Mesozoic Metasedimentary
- Jdi - Jurrasic Diorite
- Jgr - Jurrasic Granodiorite
- Tg - Auriferous Gravels

1. 61-230-20
2. 61-230-27
3. 61-230-22
4. 61-230-37
5. 61-230-12
6. 61-230-19
7. 61-230-28
8. 61-230-21
9. 61-230-09
10. 61-210-49
11. 61-210-51
12. 61-210-50
13. 61-240-38
14. 61-230-25
15. 61-230-31
16. 61-230-34
17. 61-230-33
18. 61-230-32
19. 61-230-24
20. 61-230-23
21. 61-270-10
22. 61-240-25
23. 61-240-21
24. 61-230-13



Sources for Lithic zones:

- The Geologic Map of the Chico Quadrangle, California, 1992;
- The California Mineral Land Classification of Nevada County, California, Special Report 164 (California Department of Conservation, Division of Mines and Geology, 1990);
- Dewatering of San Juan Ridge Mine, Nevada County, CA, (Luhdorff and Scalmanini, 2013)
- Various well driller's reports, and on site soil evaluations for Ananda Village and neighboring parcels.

Ex. 1

Sheet 1 of 1

Date: 12-26-14

Drawn By: GB

Checked By: PG

Lithic Zones, Hydrologic Divide

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Revisions		
No.	Date	By
1	12/26/14	PG

Project: Ananda PD