FINAL

FARR WEST
ENGINEERING

TECHNICAL MEMORANDUM

SQUAW VALLEY PUBLIC SERVICE DISTRICT

REDUNDANT WATER SUPPLY – PREFERRED ALTERNATIVE EVALUATION PROJECT

Prepared For: Mike Geary, P.E.
General Manager

Prepared By: Dave Hunt, P.E.
Farr West Engineering

Date: February 24, 2015

Subject: **Phase II Evaluation of Water Supply Source(s) Identified in Gap Analysis**

1.0 BACKGROUND

The primary purpose of the District's Redundant Water Supply – Preferred Alternative Evaluation Project (Project) is to evaluate the various water supply and transmission alternatives and identify a preferred water supply project for the District. To satisfy this purpose, the scope of work for the Project includes three distinct phases:

- Phase I – Water Supply Feasibility Summary and Gap Analysis,
- Phase II - Evaluation of Water Supply Source(s) Identified in Gap Analysis, and
- Phase III – Preferred Alternative Evaluation.

The District recently completed Phase I – Water Supply Feasibility Summary and Gap Analysis (November 6, 2014) (attached in Appendix A). The purpose of Phase I was to review and summarize the water supply investigations that have been performed by the District in past evaluations of local water sources. This memorandum summarized this work and presented the key findings as to which water supply alternatives were considered to be infeasible and why. Methods used to define supplemental and redundant water supply needs were also defined under Phase I. Finally, Phase I also identified gaps in evaluations of other potential local water sources as well.

The scope of Phase II - Evaluation of Water Supply Source(s) Identified in the Gap Analysis, includes a feasibility level evaluation of potential water sources in or near the Olympic Valley (Valley). The potential water supply sources identified in Phase I included:

- North Fork Squaw Creek,
- South Fork Squaw Creek,
- North Flank Horizontal Wells,
- South Flank Horizontal Wells,
- Squaw Creek Surface Water Storage,
- Wastewater treatment/reuse, and
- Alpine Springs County Water District.

Phase III – Preferred Alternative Evaluation will evaluate the feasible water supply options and develop a preferred alternative and project description. As it is currently written, this phase would include updating the 2009 Alternative/Supplemental Water Supply and Enhanced Utilities Feasibility Study, and performing a detailed ranking and evaluation of supply and transmission alternatives. In the end, a preferred water supply project and its associated components would be recommended and a detailed project description would be prepared. This would put the District in position to move forward with the environmental permitting process and design.

If any of the potentially available water sources in or near the valley appear feasible, Phase III of this project will be redefined to further explore these options. If these near valley water sources are shown to be infeasible, then the District will pursue Phase III as planned and define a preferred water supply project alternative from the Martis Valley.

2.0 ESTIMATE OF REDUNDANT WATER SUPPLY QUANTITY

This section presents a summary of the District's existing water demands as well an estimate of buildout water demands based on projected development. These demands define the District's redundant water supply need, and thus the amount of infrastructure necessary to provide an adequate redundant water supply.

The District has put a tremendous amount of effort in the recent past evaluating existing water demand patterns, as well as future water demands associated with projected development. These efforts have been well documented in the July 3, 2014 Village at Squaw Valley Specific Plan Water Supply Assessment (WSA), and the on-going Village at Squaw Valley Specific Plan (VSVSP) Water System Capacity Analysis. The District's water demands are made up of existing customers and future projected development including the VSVSP, vacant single family residential, and demands associated with the 1983 Squaw Valley General Plan and Land Use Ordinance.

Redundant water supply needs were defined in the Phase I Water Supply Feasibility Summary and Gap Analysis (November 6, 2014) as being the quantity of water necessary to maintain indoor water use patterns for all water customers. Indoor water use patterns are defined as water demands seen in the fall, winter, and early spring months where no outside irrigation is seen (November-April). This level of water supply will allow the District to mitigate drought impacts and emergency situations to their primary water supply with minimal impact to customers, while providing the minimum water demand to meet standards of public health and safety. Table 1 shows the District's existing and projected buildout water demands by month in both gallons per minute (gpm) and gallons per day (GPD. Table 2 provides a summary of the redundant water supply quantity based on these demands.

Table 1 – SVPSD Existing and Projected Buildout Water Demands

	Existing ADD, gpm	Existing ADD, GPD	Buildout ADD, gpm	Buildout ADD, GPD
January	200	288,000	523	754,000
February	214	308,000	566	815,000
March	200	288,000	572	823,000
April	164	235,000	433	623,000
May	215	310,000	458	659,000
June	336	484,000	614	884,000
July	446	643,000	940	1,354,000
August	439	632,000	867	1,248,000
September	341	491,000	648	933,000
October	202	291,000	463	666,000
November	120	172,000	292	420,000
December	188	271,000	506	729,000

Table 2 – Redundant Water Quantity Summary

Existing Demands	Buildout Demands
172,000 - 308,000 GPD	420,000 - 823,000 GPD
120-214 gpm	292 - 572 gpm
16-28 acre-feet/month	39-76 acre-feet/month

3.0 EVALUATION OF POTENTIAL NEAR VALLEY WATER SOURCES

3.1 North and South Forks of Squaw Creek

The North and South Forks of Squaw Creek represent potentially available water supply from fractured bedrock wells. The North Fork of Squaw Creek (Shirley Canyon) has the least amount of information available for groundwater source development. No evaluations have been performed in this area on behalf of the District or for any development project. Water supplies in the South Fork include wells owned and operated by the Squaw Valley Resort (SVR) for both snowmaking and potable water use. A discussion of the SVR wells is presented in this section. Also presented in this section is a discussion of the geology and hydrogeology of the Squaw Creek watershed.

3.1.1 Geology and Hydrogeology

Farr West Engineering (Farr West) subcontracted with Todd Groundwater to prepare a feasibility analysis of potentially available water supplies from mountain wells in the Squaw Creek watershed (Todd Groundwater, November 24, 2014). The complete evaluation is included as Appendix B of this memorandum. The evaluation summarizes the geology of the Squaw Creek watershed as being made up of igneous materials (rock) and that all groundwater production in these materials comes from fractures in the bedrock.

From a hydrogeologic standpoint, Todd Groundwater indicated that "the occurrence and flow of groundwater is significantly different in fractured bedrock conditions than in unconsolidated sediments in the Valley". The key difference being that groundwater from bedrock wells occurs in fractures while groundwater production from the Valley aquifer is seen in porous sand and gravel materials. Essentially, the potential available water and capacity of a bedrock well is highly dependent on the number and size of fractures encountered in a well. Also, the production from bedrock groundwater wells can also be limited by the duration of pumping (number of hours per day) based on the quantity of water within the fractures. SVR has seen pumping durations between 10-20 hours per day, with diminished production capacity seen in below average precipitation years.

SVR has undertaken a number of prior attempts to identify additional production wells within the South Fork of Squaw Creek. These efforts have included geologic research and hydrogeologic modeling and have resulted in little success. SVR has also drilled test wells that have resulted in finding no water at all, to wells with production volumes under 50 gpm. These wells have also exhibited poor water quality, which for a potable supply, would require treatment. The cost of these unsuccessful test wells has been in the range of $40,000-$100,000.

3.1.2 South Fork of Squaw Creek

The District and Farr West met with SVR staff on November 7, 2014 to discuss their water supplies within the South Fork of Squaw Creek. The agenda included:

- Existing SVR wells – locations and use,
- Available excess capacity to serve as a redundant water supply for the District,
- Data on existing SVR wells, including capacity, lithology, production, water quality,
- SVR plans for future water supply wells on the upper mountain, and
- District ability to explore water supplies on the South Fork.

SVR operates three upper mountain snowmaking wells which can operate from 10 to 20 hours per day, depending on conditions. It has been noted that frequent and long duration pumping of these wells has resulted in dewatering the fractures and well shut down. When all three wells are operating, they produce at a rate of approximately 325 gpm.

SVR also operates four potable water supply wells serving the High Camp and Gold Coast facilities. SVR indicated that production from these potable water supply wells decreases sharply during critically dry years. For instance, in the 2014 ski season, these wells were challenged to produce 7,000 GPD.

In their feasibility analysis, Todd Groundwater estimated the water supply production from new wells in the Squaw Creek watershed. Based on the production information provided by SVR and an operating period during critically dry years of 8 to 12 hours per day, a combined daily production of 23,300 to 34,400 GPD per well is considered representative of the existing mountain water supply wells. As presented in Section 2, the District's existing water demands vary from 172,000 to 308,000 GPD for indoor water use. At 308,000 GPD and the daily production rates identified above, 9-13 production wells would be required to meet this existing demand. Based on a buildout water demand projection of up to 823,000 GPD for indoor water use, 24-32 production wells would be required to meet this demand.

In summary, the SVR has indicated that they do not have excess capacity in their existing snowmaking and potable water supply wells to provide the District with a reliable redundant water supply. Also, any further water supply exploration/development on the South Fork will be used to satisfy the SVR snowmaking needs.

3.1.3 North Fork of Squaw Creek

The North Fork of Squaw Creek, commonly referred to as Shirley Canyon lies mostly on United States Forest Service (USFS) land. The North Fork has minimal information available for groundwater source development. No evaluations have been performed in this area on behalf of the District or for any development project.

In their feasibility analysis, Todd Groundwater indicated that Shirley Canyon is mapped as having similar surficial geology to the area of the SVR wells. This implies that wells drilled in the Shirley Canyon area may be similar to the existing wells in the South Fork. Further, the SVR has made repeated efforts to identify additional water supply wells on the South Fork. Most of these have resulted in dry and/or very low producing wells, some with poor water quality. Based on this, Todd Groundwater's assumptions were that multiple attempts would be needed to locate viable groundwater supplies in Shirley Canyon.

The estimated number of production wells required to meet the District's existing and projected redundant water supply needs is the same as presented in Section 3.1.2. Based on this, it is unlikely that the number of new bedrock wells required to meet the redundant water supply demands can be constructed in the Shirley Canyon area.

This conclusion if further supported by past water supply studies presented in the Phase I memorandum. Specifically, the Technical Memorandum of Squaw Valley Groundwater Background Data (Kleinfelder, 2000) reported that attempts to exploit fracture flow throughout the bedrock areas of the Squaw Creek watershed have shown limited success, stating that exploration of bedrock targets in the past have not located sufficient productive capacity to justify the construction of production wells. Further, Kleinfelder's 1996 Limited Phase 1 Groundwater Resource Feasibility Investigation, Squaw Valley West End investigated sources within the lower elevations of the Squaw Creek Watershed, including the Shirley Canyon area adjacent to the Olympic Valley Inn (OVI). This investigation resulted in drilling an exploratory bedrock well behind the OVI which was plugged and abandoned immediately after drilling. Kleinfelder selected this site based on a known predominant fracture in the bedrock that appeared to intersect this well site.

3.2 North and South Flanks

The North and South flanks of the Olympic Valley represent potentially available water supply from fractured bedrock horizontal wells. These areas have been explored for groundwater development since the late 1980's. These exploratory programs were detailed in the Phase I memo and are further summarized below. Both the District and the Squaw Valley Mutual Water Company (SVMWC) have active horizontal groundwater supply sources; the District on the South flank above the RSC, and the SVMWC on the North flank adjacent to their water storage tank. There is also an existing horizontal well adjacent to Hidden Lake that feeds the lake.

3.2.1 Previous Water Supply Investigations

The development of horizontal wells on the North Flank has been undertaken throughout the years. Along with the existing SVMWC and Hidden Lake horizontal wells, previous attempts have been made to develop horizontal wells along the North Flank. The SVMWC drilled a second well adjacent to the existing well which is currently inactive. The District also drilled a horizontal well just to the northwest of the existing West Tank in the late 1980's. This well produced very little quantity and was eventually abandoned due to surface water intrusion. A second horizontal well was proposed in this area, but was never drilled.

Also, Squaw Valley Associates drilled and tested a vertical exploratory boring in 2006/2007 near the ridge line between the Valley and Silver Creek (north of the Hidden Lake area). The Silver Creek Ridge Well was airlift tested at 66 gpm, and was estimated to produce up to 450 gpm by the hydrogeologist. It was noted, however, that the sustainable yield of this well would be limited by the fracture feeding the well. This well also produced poor water quality, exceeding drinking water standards for manganese, hardness, and total dissolved solids. This well is currently inactive and not equipped for production.

The South Flank has also been the subject to a number of hydrogeologic investigations and horizontal well attempts. Along with the existing District horizontal Wells #1 and #2, the RSC drilled the Golf Course horizontal well in the late 1990's. The RSC well is said to produce up to 30 gpm.

3.2.2 Existing Horizontal Well Capacities

Table 3 provides the historic production capacities of the District's two horizontal wells and the SVMWC horizontal well. This data represents monthly average production from 2000-2012.

Horizontal wells are similar to vertical bedrock wells in that water supply occurs in fractures in the bedrock. Essentially, the potential available water and capacity of a bedrock well is highly dependent on the number and size of fractures encountered in a well. Horizontal and vertical bedrock wells differ in the fact that horizontal wells flow by gravity and produce water constantly, and thus are not limited by pumping duration.

The historic production of the SVMWC horizontal well is consistent from month to month and year to year, having produced an average of approximately 14 million gallons per year since 2000. The SVMWC well has a constant flow into the storage tank and therefore represents the maximum production capacity of the well. The average flow rate has ranged from 24-30 gpm, or 35,000-43,000 GPD.

The District's horizontal wells operate on a demand basis; that is they flow into the distribution system based on water levels in the East Tank. When demands are low, the wells operate intermittently. When demands are high during the summer months, the wells flow nearly full time into the distribution system. Therefore, the production for June-September represents the maximum capacity of the wells. Based on this, the maximum capacity of the wells has ranged from 20-32 gpm, or 28,000-45,000 GPD.

Table 3 – Horizontal Production Well Capacity for the District and SVMWC

	SVPSD		SVMWC	
	GPD	gpm	GPD	gpm
January	16,000	11	38,000	26
February	16,000	11	40,000	28
March	17,000	12	43,000	30
April	24,000	16	43,000	30
May	36,000	25	42,000	29
June	45,000	32	37,000	25
July	40,000	28	37,000	26
August	38,000	26	34,000	23
September	28,000	20	38,000	26
October	20,000	14	35,000	24
November	15,000	10	35,000	24
December	16,000	11	38,000	26

3.2.3 Horizontal Well Development Feasibility

The historic production rates for the existing horizontal wells operated by the District and the SVMWC are discussed above. Production rates have ranged from 28,000-45,000 GPD.

As presented in Section 2, the District's existing water demands vary from 172,000 to 308,000 GPD for indoor water use. At 308,000 GPD and the daily production rates identified above, 7-11 horizontal wells would be required to meet this existing demand. Based on a buildout water demand projection of up to 823,000 GPD for indoor water use, 18-30 horizontal wells would be required to meet this demand.

Based on previous hydrogeologic investigations and the historic production rates from existing horizontal wells, it appears unlikely that the number of new wells required to meet the redundant water supply demands can be constructed along the North and South flanks of the Valley.

3.3 Squaw Creek Surface Water Storage

Surface water storage evaluations on Squaw Creek date back to the early 1990s as a water quality control measure, and more recently as a potential creek/aquifer management tool.

Between 1993 and 2003 the SVR prepared a preliminary engineering report and design for construction of a weir structure and dam just downstream of the confluence of the North and South forks of Squaw Creek. The project included:

- Construct a dam and weir structure downstream of the confluence with an approximate volume of 15-20 acre-feet,
- Install two large culverts under Squaw Creek to accommodate flood flows,
- Construct a low flow bypass stream, and
- Raise the level of Squaw Creek nearly up to the roadway elevation and create a meandering stream in place of the existing trapezoidal channel.

The purpose of this surface water impoundment was as a water quality/sediment mitigation measure based on development of the ski area. This included controlling the fine sediment on the South Fork resulting from ski slope development. The Lahontan Regional Water Quality Control Board (Lahontan) reviewed the SVR design and passed negative judgment. Lahontan expressed concerns about the culverts getting clogged as well as having inadequate capacity to pass the 100-year flood. They also brought up the concern that of the large sediment from the North Fork was removed at the pond, the hydrology would create an un-natural circumstance and potentially more erosion of larger particles would occur downstream (SVR Mike Livak). SVRs Enhancement and Reconstruction of a Portion of Squaw Creek was never constructed.

Recently, the District's *Olympic Valley Creek / Aquifer Interaction Study* (Hydrometrics November, 2014) provided recommendations for general water management strategies in the Valley which included potentially modifying the Squaw Creek trapezoidal channel to include an inflatable dam near or beneath Papoose Bridge. The trapezoidal channel drains the shallow aquifer in the western Valley. The study indicated that reducing this drainage would allow more water to be stored in the aquifer for late summer and fall use. A shallow lake, with a volume of approximately 6-7 acre-feet, would form behind an inflatable dam and reduce the amount of discharge from the aquifer into the trapezoidal channel. The water behind the dam could be released slowly in mid-summer to provide additional flows through the meadow portion of Squaw Creek.

Although potentially beneficial to Squaw Creek and the Olympic Valley aquifer for the reasons stated, neither of the Squaw Creek surface water storage concepts provide a complete redundant water supply for the District.

A true redundant water supply would include surface water storage as a raw water supply to a surface water treatment facility. Section 2 defined the District's approximate redundant water supply need by month. As Squaw Creek does not flow year round in most locations, a surface water storage quantity in excess of 200-250 acre-feet would be required to provide water supply in the dry summer months.

3.4 Wastewater Treatment/Reuse

Currently, the District is responsible for managing their sewer collection system, while the Tahoe Truckee Sanitation Agency (TTSA) provides wastewater treatment for the District, as well as a number of other municipalities throughout the region. Domestic wastewater treatment and reuse in the Valley represents a potential for decreased groundwater pumping in both the West and East aquifers. This treated wastewater is a non-potable water supply and would be used only for irrigation and snowmaking; specifically by the RSC and the SVR. Although this would offset aquifer pumping overall, it does not bring new water into the Valley and is therefore not a redundant water supply.

The benefits of implementing such a strategy would include potentially reduced groundwater pumping in the West aquifer by the SVR. This is applicable in the fall months, October-December, when the aquifer levels may be low and before the first winter storms begin to recharge the aquifer. The East aquifer would see reduced pumping from the RSCs 18 series wells that currently provide water for golf course irrigation and snowmaking.

There are also a number of restrictions associated with wastewater treatment and reuse in the Valley. Implementing wastewater treatment in the Valley would require the District to construct and operate an advanced tertiary wastewater treatment plant that would meet the regulatory discharge requirements of Lahontan. The plant would include storage for flow equalization and treatment capacity to satisfy the District's wastewater flows. The District recently completed a capacity analysis of the sewer collection system which projected estimated wastewater flows at the buildout level of development in the Valley (VSVSP Sewer Capacity Analysis, November 17, 2014). The analysis showed existing average dry weather sewer flows to be approximately 650,000 GPD, with a peak wet weather flow of just over 2 million gallons per day (MGD). Projected sewer flows were estimated to include an average dry weather flow of 1.4 MGD and a peak wet weather flow of 4.3 MGD.

Also, the timing of the irrigation and snowmaking demands versus wastewater generation would require significant effluent storage. Based on monthly snowmaking and irrigation water demands presented in the WSA and historic District wastewater flows, more than 20 million gallons of storage capacity would be required to balance supply and demand. In years of above normal and early precipitation, snowmaking demands would likely decrease, creating the need for additional storage.

Finally, there would likely be issues associated with water rights and compliance with the Truckee River Operating Agreement which would need to be addressed during the planning and preliminary design of the facilities.

3.5 Alpine Springs County Water District (ASCWD)

The District and Farr West met with ASCWD staff in Alpine Meadows on November 18, 2014 to discuss their ability to support the District with a redundant water supply. The agenda included a discussion of:

- Existing ASCWD water sources and demands,
- Available excess capacity to serve as a redundant water supply for the District,
- ASCWD plans for future water supplies, and
- ASCWD need for additional water supply.

The discussion centered around the ASCWD recent master planning efforts and capital improvement program (Proposed Alpine Sierra Development Water & Sewer Feasibility Evaluation, Stantec, August 26, 2013). This evaluation recommended a number of water system improvements needed to address system deficiencies and improve overall system reliability, service pressures, and fire flows. The evaluation noted that water system improvements are required to satisfy MDD criteria in each pressure zone of the water system. These improvements include re-drilling the existing AME Well to ensure there is adequate production capacity to meet California Waterworks Standards.

Based on this discussion and understanding of ASCWDs capital improvement needs, the ASCWD does not have excess source capacity to provide the District with a redundant water supply, either now or into the future.

4.0 SUMMARY AND CONCLUSIONS

This memorandum provided a feasibility level evaluation of potential water sources in or near the Valley as identified in the Phase I - Water Supply Feasibility Summary and Gap Analysis. A summary of the evaluation of each potential water source is shown below.

4.1 South Fork Squaw Creek

The District and Farr West met with SVR staff on November 7, 2014 to discuss their water supplies within the South Fork of Squaw Creek and ability to support the District with a redundant water supply. The SVR operates a combined 7 snowmaking and potable water supply wells on the upper mountain. All of these wells are completed in fractured bedrock. The 3 snowmaking wells produce an average of approximately 325 gpm, in total, but with pumping durations ranging from 10-20 hours, depending on conditions. The potable water supply wells serving the High Camp and Gold Coast facilities produce much less than the snowmaking wells. These wells were challenged to produce 7,000 GPD in the 2014 ski season.

Todd Groundwater prepared a feasibility analysis of potentially available water supplies from mountain wells and estimated a daily production rate of between 23,300 to 34,400 GPD per well as representative for wells drilled in bedrock on the upper mountain. Based on the District's existing and projected water demands for their redundant water supply need for indoor water use, it is estimated that 24-32 production wells would be required.

The SVR has undertaken a number of prior attempts, including exploratory well drilling, to identify additional production wells within the South Fork of Squaw Creek. These efforts have resulted in very little success, with exploratory borings producing very low flow rates and in some cases dry holes.

Finally, the SVR has indicated that they do not have excess capacity in their existing snowmaking and potable water supply wells to provide the District with a reliable redundant water supply. Also, any further water supply exploration/development on the South Fork will be used to satisfy the SVR snowmaking needs.

4.2 North Fork Squaw Creek

The North Fork of Squaw Creek, commonly referred to as Shirley Canyon lies mostly on USFS land. No hydrogeologic evaluations have been performed in this area on behalf of the District or for any development project.

In their feasibility analysis, Todd Groundwater indicated that Shirley Canyon is mapped as having similar surficial geology to the area of the SVR wells. This implies that wells drilled in the Shirley Canyon area may be similar to the existing wells in the South Fork. Further, the SVR has made repeated efforts to identify additional water supply wells on the South Fork. Most of these have resulted in dry and/or very low producing wells, some with poor water quality. Based on this, Todd Groundwater's assumptions were that multiple attempts would be needed to locate viable groundwater supplies in Shirley Canyon.

Based on the District's existing and projected redundant water supply needs, and the estimated daily production rate for bedrock wells in the Squaw Creek watershed, it is estimated that 24-32 production wells would be required.

Further evaluation, if any, of water supply from the North Fork would be performed in Phase III. This would include development of an exploratory well drilling program, as well as a comprehensive feasibility evaluation including transmission alternatives, infrastructure needs (power, access, etc.), land availability, and defining environmental constraints and the permitting process. If this evaluation was favorable, then a project description would be developed to support moving forward with the CEQA/NEPA processes, planning, permitting, and preliminary design of the water supply project.

4.3 North and South Flanks

The North and South flanks of the Olympic Valley represent potentially available water supply from fractured bedrock horizontal wells. These areas have been explored previously for groundwater development, and both the District and the SVMWC have operational horizontal wells on the South and North flanks, respectively. Historic production capacities of the horizontal wells range from 24-30 gpm, or 35,000-43,000 GPD. Based on these production rates, 18-30 horizontal wells would be required to meet the District's projected buildout redundant water supply demand.

Further evaluation, if any, of water supply from the North and South flanks would be performed in Phase III. This would include development of an exploratory well drilling program, as well as a comprehensive feasibility evaluation including transmission alternatives, land availability, and defining environmental constraints and the permitting process. If this evaluation was favorable, then a project description would be developed to support moving forward with the CEQA/NEPA processes, planning, permitting, and preliminary design of the water supply project.

4.4 Squaw Creek Surface Water Storage

In the 1990s, Squaw Creek surface water storage was evaluated by the SVR to mitigate water quality/sediment related issues associated with development of the ski slopes. This project included construction of a dam and weir structure at the confluence of the North and South Forks of Squaw Creek as well as creation of a meandering stream in place of the existing trapezoidal channel. This project was never constructed.

Recently, The District's creek/aquifer interaction study recommended potentially modifying the trapezoidal channel to include an inflatable dam near the Papoose Bridge. The purpose of this creek modification would be for general water management, reducing the amount of discharge from the aquifer into the trapezoidal channel thus allowing more water to be stored in the aquifer for late summer and fall use.

Although potentially beneficial to Squaw Creek and the Olympic Valley aquifer for the reasons stated, neither of the Squaw Creek surface water storage concepts provide a complete redundant water supply for the District.

4.5 Wastewater Treatment and Reuse

Domestic wastewater treatment and reuse in the Valley represents a potential for decreased groundwater pumping in both the West and East aquifers. This treated wastewater is a non-potable water supply and would be used only for irrigation and snowmaking; specifically by the RSC and the SVR. Although this would offset aquifer pumping overall, it does not bring new water into the Valley and is therefore not a redundant water supply.

4.6 Alpine Springs County Water District (ASCWD)

The District and Farr West met with ASCWD staff on November 18, 2014 to discuss their ability to support the District with a redundant water supply.

Based on this discussion and understanding of ASCWDs capital improvement needs, the ASCWD does not have excess source capacity to provide the District with a redundant water supply, either now or into the future.

Appendix A

Redundant Water Supply
Preferred Alternative Evaluation Project

Phase I Water Supply Feasibility Summary and Gap Analysis

FINAL

FARR WEST
ENGINEERING

TECHNICAL MEMORANDUM

SQUAW VALLEY PUBLIC SERVICE DISTRICT

REDUNDANT WATER SUPPLY – PREFERRED ALTERNATIVE EVALUATION PROJECT

Prepared For:	Mike Geary, PE General Manager
Prepared By:	Dave Hunt, PE Farr West Engineering
Date:	November 6, 2014
Subject:	**Phase I Water Supply Feasibility Summary and Gap Analysis**

REGISTERED PROFESSIONAL ENGINEER DAVID T. HUNT C71254 EXP. 12-31-2015 CIVIL STATE OF CALIFORNIA 11/6/14

PHASE I PURPOSE

In the District's 5-Year Strategic Work Plan, a top priority was identified as developing a feasibility study of water supply options that addresses available water supplies from within the Olympic Valley watershed, as well as address potentially available water supplies that can be imported from outside the watershed.

To that end, this *Water Supply Feasibility Summary and Gap Analysis* memorandum includes a summary of current and past studies prepared by the District and others evaluating alternative/additional water supplies. The Phase I investigation identifies gaps in evaluations of other potential local water sources as well. These gaps will be addressed and further evaluated in Phase II of the project. Also presented are the methods used to define the supplemental and redundant water supply needs to meet the current and anticipated future water supply needs of the District. These definitions will allow the District to quantify the redundant and supplemental water supply needs.

BACKGROUND

Since the first wells were drilled to provide water supply for the 1960 Winter Olympics, the Squaw Valley Public Service District (District), as well as developers and individuals in the area, have dedicated an enormous amount of resources studying water supply options and the available water supply in and around the Olympic Valley.

The need for a redundant and supplemental water supply has long been established as a primary goal in the District's Strategic Plans. The need has been defined in a number of studies prepared on behalf of the District. The 2003 *Groundwater Utilization and Feasibility Study Update* identified the need to develop additional water supply from outside the Valley, indicating that the groundwater wells recommended in the study would ultimately develop the full sustainable yield of the basin. In 2005 the *Groundwater Management Support Activities - Groundwater Characterization Report* summarized that the District does not have ready access to an alternative water supply that would be necessary to provide a redundant water supply during a drought emergency or contamination of the Olympic Valley aquifer. It was concluded that the District should undertake further water supply contingency planning. Finally, a peer review of the 2005 study by Richard Slade & Associates recommended that the District should avoid placing new or additional wells within the existing well field for a number of reasons. This included providing more reliability and flexibility to the water system in case of an emergency and/or drought; diversifying the water supply source to allow for necessary system redundancy in the case of groundwater contamination in the existing well field; and potentially reducing the impact of groundwater pumping on Squaw Creek.

Moving forward with the evaluation of additional water supply, in September 2009, the District completed the *Squaw Valley Public Service District - Alternative/Supplemental Water Supply and Enhanced Utilities Feasibility Study*. The purpose of this study was to investigate the feasibility of importing water supplies from outside District boundaries as a redundant and supplemental and/or alternative water supply for the Valley's current and future water supply customers and assess potential project "fatal flaws" of each supply option. The study concluded that a project that imported water from Martis Valley was feasible based on the following scenarios:

- Available water supply from the Martis Valley aquifer,
- Desire of local water purveyors to work with the District on the project,
- Potential transmission main corridors within the Highway 89 corridor and USFS rights of way,
- No major environmental fatal flaws, and
- Interest from natural gas and communications providers to partner with the District to create a utility corridor to provide these services to the Valley and others along the alignment.

PROJECT PURPOSE

The primary purpose of the District's *Redundant Water Supply – Preferred Alternative Evaluation Project* is to evaluate the various water supply and transmission alternatives and identify a preferred water supply project for the District. To satisfy this purpose, the scope of work for the *Redundant Water Supply – Preferred Alternative Evaluation Project* includes three distinct phases:

- Phase I – Water Supply Feasibility Summary and Gap Analysis,
- Phase II - Evaluation of Water Supply Source(s) Identified in Gap Analysis, and
- Phase III – Preferred Alternative Evaluation.

The purpose of Phase I – Water Supply Feasibility Summary and Gap Analysis is presented above.

Phase II – Evaluation of Water Supply Source(s) Identified in the Gap Analysis, will include a feasibility level evaluation of any potential, local sources of water supply identified in the Phase I Gap Analysis. This phase includes a literature level hydrogeologic feasibility evaluation of additional potential water sources in or near the Valley. If any of the potentially available water sources in or near the valley appear feasible, Phase III of this project will be redefined to further explore these options. If these near valley water sources are shown to be infeasible, then the District will pursue Phase III as planned and define a preferred water supply project alternative from the Martis Valley.

Phase III – The Preferred Alternative Evaluation will evaluate feasible water supply options and develop a preferred alternative and project description. As it is currently written, this phase would include updating the 2009 *Alternative/Supplemental Water Supply and Enhanced Utilities Feasibility Study*, and performing a detailed ranking and evaluation of supply and transmission alternatives. In the end, a preferred water supply project and its associated components would be recommended and a detailed project description would be prepared. This would put the District in position to move forward with the environmental permitting process and project design.

If further analysis of in or near valley water sources is shown to be feasible, they would be further evaluated in Phase III and incorporated into the overall alternatives evaluation. The scope of Phase III would be modified as necessary to accomplish this.

GOALS AND OBJECTIVES

The overall project goals are:

- Define a water supply project that would reduce pumping demands on the Olympic Valley aquifer;
- Identify a reliable water supply of sufficient quantity and adequate quality to serve the existing and future water supply needs based on projected water demands associated with the 1983 Squaw Valley General Plan & Land Use Ordinance; and
- Provide a secondary source of water supply for Olympic Valley to allow for reliable quantity and quality that is geographically diverse from the aquifer currently used as the primary source of potable water, and to provide redundancy for improved emergency preparedness.

Specific objectives of the project include:

- Summarize previous water supply studies; identify data gaps and update, as necessary;
- Quantify existing and future water demand scenarios and establish supplemental and redundant water supply needs to meet the anticipated future water supply needs of the District;
- Evaluate the availability of groundwater from other areas within the Olympic Valley, including the upper mountain watershed and horizontal wells;
- Verify the availability of groundwater available in the Martis Valley as a supply for the Olympic Valley;
- Evaluate water supply and transmission alternatives and identify a preferred water supply project;
- Define the environmental constraints and permitting process for the water supply project; and
- Develop a project description that would be used to support moving forward with the CEQA and NEPA processes, public outreach program, planning, permitting, and preliminary design of the water supply project.

LITERATURE REVIEW

Previous/Current Water Supply Studies Summary

The District and others expended an enormous amount of resources over the past 60 years assessing the Olympic Valley aquifer and its ability to meet current and estimated future water demands within the Valley. Studies prepared by or on behalf of the District include, but are not limited to:

- Squaw Valley Groundwater Development & Utilization Feasibility Study and associated update;
- Olympic Valley Groundwater Management Plan and associated updates;
- Aquifer Storage and Recovery Study;
- Water Treatment Plant Siting and Process Evaluation;
- Alternative/Supplemental Water Supply and Enhanced Utilities Feasibility Study;
- Creek/Aquifer Interaction Study; and
- Water Supply Assessment for the proposed Village at Squaw Valley Specific Plan (VSVSP) development.

Many private parties and developers have presented their conclusions to water supply development in the Valley as well. A number of water supply evaluations were performed for the Resort at Squaw Creek, Masa Ti, and Sena at the east end of the Valley.

For the purposes of clarity, the Squaw Creek tributary watershed was divided in five areas (Figure 1):

- West Aquifer
- East Aquifer
- North Fork Squaw Creek
- South Fork Squaw Creek
- North Flank
- South Flank

Groundwater investigations performed in each area are summarized in this section. Groundwater supplies for the District were also investigated outside of the Squaw Creek watershed; namely the Tahoe Forest Tract subdivision (Cinder Cone) and the side drainages to the Truckee River along Highway 89.

This section identifies the studies that evaluated additional water supply sources for the District and summarizes the key reports and their findings. More than 50 reports were reviewed under this task. Appendix A provides a summary table of many of these reports. Figures 2 through 4 highlight the approximate locations of the wells identified in the reports. Only production wells for domestic and irrigation/snowmaking and test wells are shown on the figures. There are numerous other monitoring well installations Valley wide, which include more than 30 monitoring wells in the East Meadow, in addition to contamination site monitoring wells throughout the West Aquifer.

West Aquifer

The West Aquifer has long been recognized as the main well field for potable water supply, producing sufficient water quality and quantity for the District and the Squaw Valley Mutual Water Company (SVMWC). For the purposes of this summary, the West Aquifer is defined essentially by eastern edge of the ski resort's parking lot. The District currently supplies potable water to their customers through the existing Wells 1R, 2R, 3, and 5R. The SVMWC has two active production wells in the West Aquifer, SVMWC #1 and #2. There are also a number of snowmaking and irrigation wells, including the Squaw Valley Resort's Squaw Kids and Cushing Wells and the Plumpjack irrigation well.

This area has been the subject of a tremendous amount of hydrogeologic investigation, beginning with Gasch & Associates 1973 *Squaw Valley Geophysical Investigation*, and continuing on to more recent studies including the *Olympic Valley Creek/Aquifer Interaction Study – Phases I and II* (Reference 39) and the *Village at Squaw Valley Specific Plan Water Supply Assessment* (Reference 40).

The 2012 *Independent Analysis of Groundwater Supply, Olympic Valley Groundwater Basin* (Reference 38) prepared by Todd Engineers, provides a comprehensive chronological summary of groundwater development and investigations in the Olympic Valley. For that purpose, the Todd Engineers summary is attached as Appendix B to this memorandum. This section provides further discussion on Olympic Valley groundwater investigations in the West Aquifer.

The majority of the groundwater development and investigation work has been performed as a result of large development proposals, namely the Resort at Squaw Creek (RSC), the Intrawest Village project, and the recently proposed Village at Squaw Valley Specific Plan Project.

The 1985 Cook & Associates *Summary of Squaw Valley Water Resources and Potential Impacts of Proposed Development* (Reference 1) provided a summary of the current state of knowledge regarding the hydrogeologic characteristics of Squaw Valley with an emphasis on the impacts of the proposed RSC. Although the report generally agreed that there is enough groundwater to meet project demands, it was concluded that new water sources should be located outside of the existing parking lot/production well area. Moving forward with water supply investigations for the RSC, Kleinfelder performed a number of investigations, including both monitoring well drilling and exploratory well drilling projects. Although a majority of that work was performed in the East Aquifer, investigations in the West Aquifer included the 1989 *Resort at Squaw Creek Wells 4 and 6* series of memorandums (Reference 4) and the 1990 *Summary of Irrigation and Municipal Well Installation and Aquifer Testing in Squaw Valley* (Reference 5). Wells 4R and 6 were drilled in 1989 for potential municipal water supply for the RSC (the original Well 4 was drilled in 1958 for the Winter Olympics and later abandoned). Aquifer testing and analysis provided conservative estimates of well yield of 600 gpm for Well 4R and 250 gpm for Well 6, but with significant drawdown associated with each of these flow rates. Well 4R was eventually abandoned by the District in 1991 due to excessive sanding. Further investigation was completed for this well by ECO:LOGIC in 2001 in the *Well No. 4 Replacement Project Phase 1 – Feasibility Study* (Reference 14), also known as the Well 4RII study. The purpose of this study was to assess the feasibility of constructing a new Well 4 within the existing easement. The results indicated that it was technically feasible to drill 4RII, but the risks and costs were high.

Numeric groundwater modeling of the Olympic Valley basin began in 2001 as described in the *Groundwater Model Report for the Groundwater Development and Utilization Feasibility Study* (Reference 15). This initial groundwater model was developed to provide a tool for estimating the effects on the aquifer of various pumping and recharge scenarios. The model has been updated a number of times since then with current data. The *Update of Squaw Valley Groundwater Model and 2001 Pumping Analysis* (Reference 16) updated the original model with the incorporation of the 2001 dry year conditions, as well as attempting to estimate the effects of snowmaking on the aquifer. The conclusion of this work was that water levels in Well 2 fall below critical water levels and that transferring pumping from Well 2 to Wells 1 and 5 would reduce the impact. This modeling effort also provided the first indication that snowmaking pumping can have an impact on water levels in the District production wells, although the impact was not quantified.

The 2003 *SVPSD Groundwater Development and Utilization Feasibility Study* (Reference 20) was a comprehensive look at water supply development needs for the District to meet water demands associated with the 1983 Squaw Valley General Plan and Land Use Ordinance. The results of this analysis predicted that the District would need 4 to 6 new wells to satisfy buildout water demands. Using the groundwater model to estimate the sustainable yield of the aquifer, the study recommended 6 new well sites, of which 2 would be sited in the West Aquifer (the remaining wells were recommended in the East Aquifer). All of the wells would require treatment for iron, manganese, and potentially arsenic. This was the first indication that water supply outside of the West Aquifer would be necessary to meet future water demands. Further, the recommended wells would develop the full sustainable yield of the basin and any additional water supply would need to come from outside the Olympic Valley aquifer.

In 2003, Derrik Williams prepared the *Plumpjack Squaw Valley Aquifer Test Simulation* (Reference 22) for the purpose of incorporating the Plumpjack well aquifer tests into the groundwater model, and assess the ability for the Plumpjack well to not only supply the resort, but also Intrawest Phases III and IV. The results indicated that the well could only be operated to supply the resort water demands without having a negative effect on the District's Well 2.

Another groundwater model update was prepared in 2004 and discussed in the *Squaw Valley 2004 Model Update – Updated Sustainable Yield Analysis* (Reference 25). This effort included updating the model with new and current data, and indicated the maximum sustainable yield during two consecutive dry years for three pumping scenarios, including existing wells, existing wells plus the new wells recommended in the 2003 study (Reference 20), and existing wells plus the new wells with the Well 2 screen lowered by 15 feet. The results showed 976 acre feet annually (AFA), 1,091 AFA, and 1,300 AFA respectively for the three scenarios. The 2005 *Groundwater Management Support Activities – Groundwater Characterization Report* (Reference 26) again updated the sustainable yield and indicated a reduction in sustainable yield for the first two scenarios to 870 AFA and 1,010 AFA respectively. In 2005 West Yost also prepared the *Results of Hydrogeologic Peer Review of May 2005* Report (Reference 29) which recommended that new or additional wells in the future should be constructed in different portions of the Valley and should avoid being placed within the existing West Aquifer well field. The reasons stated were that this would provide more flexibility and reliability to the District's water system in case of emergency and that spreading out wells allows the District to be less vulnerable to possible groundwater contamination as well as reducing potential pumping impacts on Squaw Creek.

The most recent groundwater model updates were recently completed as part of the *Olympic Valley Creek/Aquifer Interaction Study – Phases I and II* (Reference 39). This was a multi-year groundwater study directed at improving and quantifying the understanding of interactions between Squaw Creek and the Aquifer. The study also provides groundwater pumping strategies aimed at diminishing the groundwater pumping impacts on Squaw Creek. Phase I of this study included installation of monitoring wells and data collection equipment (permanent and temporary data loggers, temperature probes, and piezometer installation). Phase I also included an aquifer test on the District's existing Well 2. Phase II included updating the groundwater model with current data, including water temperature and water level data, aquifer test data from Well 2, and extending the model period to include the period 1992-2011. Phase II also included an examination of groundwater inflow to Squaw Creek using radon and other tracers (Lawrence Livermore National Laboratory). The data suggested a close hydrologic connection between Squaw Creek and groundwater, including the fact that pumping municipal wells may deplete creek flow by capturing water from the creek and that the trapezoidal channel dewaters part of the aquifer, leading to less water available for municipal users. The Phase II report cited a number of conclusions:

- Additional pumping from the East Aquifer will have a greater environmental impact on Squaw Creek and should not be considered for a long term water supply source,
- The bulk of groundwater recharge to the Olympic Valley aquifer originates from just above the Valley floor (average around 6,300 feet elevation);
- Pumping rates are a small percentage of stream flows in spring and early summer, but significant in mid to late summer;
- Fast transit times in the aquifer imply that wells are highly vulnerable to contamination, and therefore source water protection is vital;
- Groundwater pumping strategies should include moving pumping around during the year (i.e. pumping from sources further from the creek in late summer); and
- Because the reduction in creek flows is only a small percentage of pumping from any one well, pumping is only a significant influence on the creek during low flow times.

On behalf of the developer, Todd Engineers drilled and tested three wells in locations shown on Figure 3. This water supply investigation was completed to support the Village at Squaw Valley Specific Plan (VSVSP) Project. The work was reported in the *Independent Analysis of Groundwater Supply Olympic Valley Groundwater Basin* (Reference 38) prepared by Todd Engineers on behalf of the developer. The purpose of this work was to provide a compilation of all available relevant information on groundwater resources in the valley, as well as provide an independent evaluation of the existing groundwater model and assessment of well field configurations to support the Village at Squaw Valley project. This peer review concluded that the current groundwater model, updated as part of the *Olympic Valley Creek/Aquifer Interaction Study,* is a reasonable representation of the groundwater basin and can be used to evaluate potential groundwater development and management scenarios and to assess theoretical well field configurations.

As required by California Water Code Section 10910, a water supply assessment (WSA) was prepared for the proposed Village at Squaw Valley Specific Plan Project (Project). The purpose of the *Village at Squaw Valley Specific Plan Water Supply Assessment* (Reference 40) was to evaluate the water demands of the Project, to assess available water supplies, and to determine if sufficient water is available to meet existing and planned future demands, including the Project, during normal, dry, and multiple dry water years. The groundwater model updated as part of the *Olympic Valley Creek/Aquifer Interaction Study* was used to assess the water supply sufficiency. Todd Engineers developed a number of well field scenarios in the West aquifer that were modeled to ascertain available water supply. The WSA estimated current water demand for the entire Olympic Valley to be 842 acre-feet annually (AFA); for the Project to be 234 AFA; and for the entire Valley in year 2040 to be 1,205 AFA. The criteria used to evaluate the sufficiency of supply was based on an average saturated thickness of the aquifer greater than 65%. The simulated thickness of the expanded well field showed the average saturated thickness at any individual well never fell below 65%. It was concluded that there is sufficient water supply to meet the projected 2040 Project and non-project water demands during normal, single, and multiple dry years with an adequate margin of safety. The conclusions also stated that any additional water demands beyond the 2040 projections would need to be reevaluated using the specific demand schedule and proposed water supply system at the time that such development is proposed.

In the spring of 2015, the District plans to further update the groundwater model with data from 2012 through 2014 to update and amend the WSA for the Project. The proposed groundwater model update will include impacts from the current historical drought.

East Aquifer

The East Aquifer has also been the subject of a large number of evaluations and exploratory drilling programs. The East Aquifer is defined by wells east of the edge of the ski area parking lot. Although the East Aquifer is historically understood to be the meadow area, for the purpose of this summary, it includes the eastern area within the Olympic Valley groundwater basin, as designated by the California Department of Water Resources' Bulletin 118, as shown on Figure 1. The East Aquifer is currently home to active snowmaking and irrigation wells for the RSC including 18-1, 18-2, 18-3R. The RSC also owns additional wells in the area including the 4th Fairway well and the Perini well, which are planned to be used for the RSC Phase 2. There are a few other active private wells in the East Aquifer, including the Poulsen Well, the 7-11 Well and Woody's Well. There are also a couple of abandoned production wells; the Winding Creek Well and the Old Realty Well. The East Aquifer also has numerous monitoring wells drilled back in the 90's in support of the RSC development.

Within the Meadow area, other wells have included Winding Creek well (abandoned), Poulsen Well, the Old Realty well (abandoned). Outside of the meadow area, water supply investigations have included the Masa Ti and Sena exploratory wells. There are also two active private wells outside of the meadow area; the 7-11 and Woody's wells located adjacent to Highway 89.

Water supply investigations in the East Aquifer began in the late 1980s as a result of the proposed RSC development. The 1987 *Potential Impacts of the Resort at Squaw Creek on the Groundwater Resources in Squaw Valley* (Reference 2) was commissioned to review potential impacts of the RSC on groundwater quality and quantity. The conclusion at that time indicated that there was more than adequate water to meet the demands of the project and that the amount of water required by the project would not significantly impact the groundwater resource in the Valley. Also in 1987, the *Basin Water Quality Investigation, Resort at Squaw Creek* report (Reference 3) was prepared to identify pre-project conditions in the Valley. As part of this project, 35 borings were drilled in the meadow area (not shown on Figure 2) and completed as monitoring wells. The conclusions from this work indicated that there was no interaction between pumping in the meadow and pumping in the West Aquifer.

In 1999, two new test wells were installed and three other existing test wells were tested. This work was presented in the *Report of Field Activities – SVPSD Water Resources Assessment Project* (Reference 11). Test well T1 (also known as the IDW well), and test boring T2 were drilled. T2 was abandoned and not tested. Eight-hour step tests were performed on the Condo Well, Hoffman Well, and 4th Fairway Well along with the T1 well. Test well T1 was the only well that met water quality standards for iron and manganese.

In 2000, three more test wells were installed in the East Aquifer, T3, T4 and T5. The work was summarized in the *Technical Data for The Resort at Squaw Creek Test Wells 3, 4, and 5* report (Reference 13). There were no pumping tests performed on these test wells; only hydraulic slug testing. None of these wells met water quality standards for iron, manganese, or total dissolved solids.

The *2003 Groundwater Development & Utilization Feasibility Study* (Reference 20) recommended groundwater well development to satisfy the estimated buildout water demands. This included developing 18-2, 18-3, Well 4RII, 4th Fairway Well, Condo Well, Stables Well, and 2 new wells in the West Aquifer for this purpose. The wells would require treatment, and a 2 million gallon per day water treatment plant was recommended for the 1810 Squaw Valley Road property.

With the proposed RSC Phase II project, a new set of hydrogeologic investigations were commissioned. In 2005 the *Installation and Testing of Well 18-3R Resort at Squaw Creek* (Reference 28) provided results of an assessment of water supply options, drilling and testing of well 18-3R, and recommendations for further work associated with water supply development for the RSC Phase II. The results of this investigation indicated that well 18-3R should be able to produce 150 gpm continuously and provide the necessary water supply for the project. The results also referenced that pumping 18-3R does show an impact on the discharge rate of the spring (Upwelling) located north of the well. The development agreement between the District and the RSC owner provided that well 18-3R would be dedicated to the District for potable water supply, and that 18-1 and 18-2, along with the RSC Irrigation Well (Perini Well) and the 4th Fairway Well, would be used to provide irrigation and snowmaking water for the area. Further work performed on behalf of the RSC Phase II proposed development included the *Resort at Squaw Creek Phase II Development Water Supply Modeling* (Reference 31) and the *Resort at Squaw Creek Phase II Development Revised Water Supply Modeling* (Reference 32). The initial investigation was undertaken to address potential impacts of pumping well 18-3R, as well as the planned replacement irrigation/snowmaking wells 18-1 and 18-2. The results concluded that additional pumping of the 18 series wells will have an insignificant impact on the District's West Aquifer production wells and a small impact on the SVMWC wells. The work also highlighted the impacts of pumping on Squaw Creek. The follow up modeling was completed using the locations proposed for six snowmaking and irrigation wells. These are shown as RSC Phase 2 Test Wells on Figure 4. The results of the modeling were similar to the previous modeling effort. The modeling results for both investigations did indicate that there would be increased upwelling flows during mid-summer and mid-winter due to decreased pumping rate of 18-3R and decreased upwelling flows in late winter and early spring due to pumping of 18-3R to satisfy potable water demands. Previously, well 18-3 was operated at a rate of 225 gpm to satisfy irrigation and snow making demands in mid-summer and mid-winter, and not operated in the later winter and early spring shoulder months.

Proposed development on the east end of the Valley also prompted hydrogeologic investigations outside of the meadow area for the Masa Ti and Sena projects. In support of the Masa Ti development, Layne GeoSciences drilled two test wells, Masa Ti TH1 and TH2, as shown on Figure 4. The 2002 *Exploratory Test Hole Results for New Water Supply Well Masa Ti* report (Reference 19) concluded that these test holes should not be considered as viable sources of water for the project. Additional test wells were installed in 2007 to support the Sena at Squaw Valley project. Four exploration holes were completed and discussed in the *Results of Exploration Drilling and Aquifer Testing SENA at Squaw Condominium Project* report (Reference 35). Three of these test wells were completed and very short duration aquifer tests were performed. The report concluded that properly constructed wells at these locations appear capable of producing a total of 143 gpm for approximately 30 days. It was noted that the short duration aquifer tests hold a high degree of uncertainty. Also, the water quality indicated that all three test wells had issues with high iron, manganese, and antimony. A peer review of this work performed by ECO:LOGIC in the *Review of Kleinfelder SENA Exploratory Wells Report* (Reference 36) highlighted that the method used by Kleinfelder to approximate well yields was not adequate due to the complicated nature of the aquifer conditions in the area. It was also concluded that the report did not provide the comprehensive assessment of reliable long term yield of the wells that the District required to commit to serving a project of that size.

Finally, the District undertook a water supply investigation project to determine the feasibility for aquifer storage and recovery (ASR) in the East Aquifer. The *ASR Project* (Reference 27) was a multi-phased project completed between 2005 and 2007. The purpose was to investigate the feasibility of storing drinking water pumped from the West Aquifer during the winter months and recovery of this water for potable water supply in the summer months. Phase 1 of the project included identifying and briefly describing the key issues and hurdles associated with the concept of ASR. Phase 2 included a hydrogeologic investigation and identification of an ASR test well site. The ASR test well, shown on Figure 4, was drilled in 2007. The conclusion from the test well phase was that ASR was not feasible based on the geology in the Valley.

North Flank

The development of horizontal wells on the North Flank has been undertaken throughout the years. There were a few attempts at drilling and developing horizontal well supplies, including the currently active SVMWC horizontal well and a well adjacent to Hidden Lake that feeds the lake. The SVMWC horizontal well is located to the northwest of the water storage tank and has consistently produced between 23-28 gpm over the years. Water quality for this well meets all drinking water requirements. Flow rate and water quality data are not known for the Hidden Lake well. The SVMWC drilled another horizontal well in the same area which is currently inactive.

The District drilled a horizontal well just to the northwest of the existing 1.1 million gallon water storage tank in the late 80s. This well produced very little quantity and was eventually abandoned due to surface water intrusion. A second horizontal well was proposed in this area but was not drilled.

Finally, a series of three reports were prepared for the drilling and development of Squaw Valley Associates' Silver Creek Ridge Well. The *Silver Creek Ridge Well* reports (Reference 32) summarize an electrical resistivity groundwater investigation to help identify moisture-bearing zones, drilling and testing of an exploratory boring, and recommendations for repairing the collapse of the exploratory well. The location of the test well is shown on Figures 2 and 4 (Russell Poulsen Test Well). An exploratory boring was drilled to a depth of 640 feet below ground surface and airlift tested at an average flow rate of 66 gpm. The analysis indicated a potential to produce upwards of 450 gpm based on the limited testing, but warned that this would be sustainable only if the fracture feeding the well was sustainable. The water quality analysis indicated elevated levels of manganese (190 μg/L) and sulfate (940 mg/L), as well as high TDS (1,200 mg/L) and hardness (840 mg/L). A video survey was performed on the well in 2007 and showed that the borehole had collapsed. The hydrogeologist for Squaw Valley Associates recommended enlarging the collapsed borehole to a depth of 600 feet to accommodate an 8 inch well casing and construct the well to municipal standards. The reports also concluded that there may be a use for the well even though the well produced poor water quality.

South Flank

The South Flank has been the subject to a number of hydrogeologic investigations and horizontal well attempts. The 1991 *Phase I Water Resources Investigation Feasibility Study for Installation of Horizontal Wells at the Resort at Squaw Creek* (Reference 6) assessed the feasibility of developing horizontal wells, and recommended drilling locations for four horizontal test wells, K1-K4 as shown on Figure 2. Ultimately, only one of those wells was drilled, the Golf Course Horizontal Well, which included an array of test wells south of the No. 4 fairway (see Reference 10). This well, located adjacent to the RSC's 4th Fairway Well, is an active well and is said to produce up to 30 gpm.

William Nork's 1992 *Well Construction and Testing Summary for the SVCWD Horizontal Test Well* (Reference 7) identified four potential horizontal well sites on the South Flank. These included the existing District horizontal wells # 1 and #2, and site H3. One of these four sites was drilled in the summer of 1992 and based on aquifer testing, was rated to yield approximately 15 gpm of good water quality. A second investigation by Nork in 1993, *Drilling and Completion of Horizontal Wells for SVCWD* (Reference 8), included drilling three new wells and cleaning out the well drilled in 1992 to its total depth of 135 feet. H-1a and H-1b (drilled in the same location but at different angles into the mountain) are now the existing District horizontal wells #1, and H-2 is District horizontal well #2. Location H-3 showed an initial flow of only 4 gpm and was not tested for long term yield at the time. Together, District horizontal wells #1 and #2 historically produce between 10-25 gpm of good quality water.

The 1998 *Horizontal Well Installation Report* (Reference 10) provided a summary of the installation of test wells for the RSC. Two wells were drilled adjacent to each other, Golf Course Horizontal Well, as shown on Figure 2. At the time of installation, B-1 flowed freely at 60 gpm and B-2 at 30 gpm. Testing performed on these wells by the District in 1999 indicated that the average flow from these wells was about 30% of what was anticipated or approximately 30 gpm. The water quality from these wells appeared to meet state and federal drinking water standards at the time.

North & South Forks Squaw Creek

The North Fork of Squaw Creek (Shirley Canyon) has the least amount of information available for groundwater source development. No evaluations have been performed in this area on behalf of the District or for any development project.

The Squaw Valley Ski Corporation does have a number of snowmaking wells drilled in fractured rock in the South Fork area. There is no formal literature describing the lithology, long term performance or water quality of these wells. The 1996 *Limited Phase I Groundwater Resource Feasibility Investigation, Squaw Valley West End* (Reference 9) indicated that there are approximately 8 wells installed in the bedrock in the High Camp Regions. The capacity of the wells is unknown, but it was reported that the largest production was less than 35 gpm based on air lift tests. There are apparently horizontal wells installed west of Gold Coast, but no production data was provided. Water quality was also not mentioned in the report. The 2000 *Technical Memorandum of Squaw Valley Groundwater Background Data* (Reference 12) confirmed the sustained rate of the High Camp area wells at less than 35 gpm, while also reporting that attempts to exploit fracture flow throughout the area have shown limited success. Exploration of bedrock targets in the past has not located sufficient productive capacity to justify the construction of production wells.

Kleinfelder's *Limited Phase 1 Groundwater Resource Feasibility Investigation, Squaw Valley West End* (Reference 9) also investigated the location of specific areas within the lower elevations of the north and south forks for future test wells. The report identified four vertical and two horizontal test well sites, of which all were located in granitic bedrock. The recommendations included drilling a vertical well, V-1, and a horizontal well located on the northwest flank of KT-22. Of the six wells, only V-1, located behind the Olympic Valley Inn, was drilled. This well was plugged and abandoned immediately after drilling.

This area will be further evaluated for potential water supply in Phase II of the project.

Areas Outside the Squaw Creek Tributary Watershed

In the 2003 *Groundwater Development & Utilization Feasibility Study Update,* the potential for water supply from the Truckee River concordant with the Truckee River Operating Agreement (TROA) was evaluated. The District filed a water rights application with the State Water Resources Control Board in 2003 for 1,600 gpm maximum diversion rate and an annual total diversion of 920 acre feet. The raw surface water would need to be treated at a surface water treatment plant. The risks associated with this water supply option included the possibility that surface water may not be available in every year, specifically drought years, thus making this water supply option undependable as a sustainable option. The 2003 study eliminated this option from consideration as an alternative for this reason.

A component of the *2009 Alternative/Supplemental Water Supply and Enhanced Utilities Feasibility Study* (Reference 37) included the review of potential well sites along the side drainages of the Truckee River in the Highway 89 corridor between Truckee and Squaw Valley. The side drainages evaluated included Silver Creek, Deer Creek, Pole Creek, Deep Creek, and Cabin Creek. Based on the geology, observations, and known groundwater quality issues associated with this area, the study concluded that none of the drainages investigated appeared to be particularly favorable for production of groundwater of sufficient quantity and quality to serve the District. All of the sites have relatively thin alluvial aquifers underlain at a shallow depth by volcanic bedrock which likely have either low permeability and/or poor water quality.

In 2004 the *Draft Tahoe Truckee Forest Tract Groundwater Evaluation* (Reference 24) evaluated the available groundwater at Cinder Cone springs as a source of domestic water supply for residences in the Tahoe Forest Tract. The evaluation concluded that water supply from this area is unlikely for a number of reasons. This included difficulty in drilling site access and drilling conditions, permitting and TROA implications, land ownership, public perception, and the low anticipated potential for adequate water quantity. The *2003 Groundwater Development & Utilization Feasibility Study Update* (Reference 20) also investigated the Cinder Cone area. The springs were eliminated as a potential source of new water for the District. It was thought that the springs would not have the capacity to provide a reliable, long term water supply. The report also referenced the potential difficulty in permitting with the California Department of Health Services due to the previous use of the area as a percolation basin for primary treated wastewater effluent.

Redundant and Supplemental Water Supply Needs

The District has a responsibility to provide a safe and reliable water supply to not only existing customers, but future customers as well. While it is Placer County's responsibility to establish general planning strategies and approve or deny development projects for Olympic Valley, the responsibility of water supply lies solely in the hands of the District. The District continues to proceed in a diligent manner to identify needed water supply to provide necessary system redundancy and potentially meet increasing demands brought on by development. Although, for new development, it is the developer's responsibility to provide sufficient water supply for their project.

The California Water Code requires water systems, as part of their Urban Water Management Plan, to include in their long term planning provisions for water supply redundancy. The Safe Drinking Water Act requires water systems to address emergency water supplies through the 2002 Bioterrorism Act, establishing methods and means to provide alternative supplies of drinking water in the event of contamination of a public water system. The Bioterrorism Act requires community water systems serving more than 3,000 persons to prepare an Emergency Response Plan with eight (8) core elements; core element five (5) is an identification of alternate sources of water.

In response to the Village at Squaw Valley Specific Plan, the District prepared the WSA required of the proposed project. The WSA is a vital planning tool for the District that evaluates not only historical, current and proposed water use patterns, but also predicts future water demands for the next 25 years. The WSA includes an in-depth, scientifically-backed assessment of the sufficiency of water supply from the current and proposed wells in the West Aquifer, which is defined using the recently updated groundwater model.

Now, more accurate estimates of the maximum sustainable water supply available from the West Aquifer as well as more accurate projections of the Valley's ultimate water demand associated with land use planning identified in Placer County's 1983 *Squaw Valley General Plan & Land Use Ordinance* (General Plan) are possible. This information is essential to the short and long term water supply planning for the District.

With this information, the District is better equipped to define both their *redundant* and *supplemental* water supply needs. These definitions quantify the water supply needed to achieve the District's long-term goals and fulfill its duty and responsibility to supply water to its existing customers and future customers.

Redundant Water Supply Needs

Current water supply planning in the Valley is directed at identifying new water sources to serve proposed development. The focus of new source development lies within the West Aquifer and is aimed at maximizing the yield from the aquifer. All water supplies but the District's horizontal well comes from the West Aquifer, and the District does not have a redundant source of supply in the case of failure of the West Aquifer due to drought or contamination. *Therefore, a redundant water supply source is necessary to address this situation.*

By definition, redundancy is the duplication of critical components or functions of a system with the intention of increasing reliability of the system, usually in the form of a backup or fail-safe. California Waterworks Standards, Chapter 15 Section 64544(c) requires that water systems using only groundwater as a source must be capable of meeting the maximum day demands of the system with the highest capacity source off line. This achieves *well field redundancy* and the District meets this regulatory requirement. *Well field redundancy* assumes no failure of the source, which in this case is the Olympic Valley Aquifer. *Supply source redundancy*, on the other hand, does consider the loss of the primary aquifer due to drought or contamination. To provide *supply source redundancy*, the District must look outside the Olympic Valley Aquifer to provide a safe and reliable water supply in the event of failure of the primary aquifer.

The District's *redundant water supply* will be defined as the quantity of water necessary to maintain indoor water use patterns for its customers. Based on existing water demands and projected water demands for the Project and non-project development (General Plan buildout), this amounts to an average daily water demand in the range of 300-575 gpm, depending on the month of use. This does not include irrigation for District customers or domestic and snowmaking/irrigation demands met with supply from the SVMWC, Squaw Valley Resort or the RSC. This methodology is consistent with that developed for the Reno/Sparks area. The Truckee Meadows Water Authority 2010-2030 Water Resource Plan adopted the policy that they maintain, as a minimum, the ability to meet daily indoor water use with their wells if their primary surface water source is lost due to a water supply emergency on the Truckee River. This level of water resource planning will allow the District to mitigate drought impacts and emergency situations to their primary water supply with minimal impact to customers.

Supplemental Water Supply Needs

Upon completion of the amendment to the WSA and some additional groundwater modeling, the maximum amount of water that can sustainably be produced from the West Aquifer (from existing and planned wells) will be well understood. With this maximum water supply quantity, the District will be able to calculate the amount of additional water supply needed, if at all, to satisfy the ultimate water demands projected at General Plan Buildout. The *supplemental water supply* need is the difference between maximum water supply and ultimate water demands projected at General Plan Buildout. The supplemental water supply will be quantified as part of Phase III of this project.

CONCLUSIONS

The District and others have expended an enormous amount of resources over the past 60 years assessing water resources in Olympic Valley and their ability to meet current and estimated future water demands within the Valley. Based on the literature review presented in this report, and an understanding of the current state of proposed development within the Valley, the following conclusions are presented regarding redundant and supplemental future water supplies for the District.

For the West Aquifer, it is assumed new water sources identified for the Village at Squaw Valley Specific Plan project will develop the majority of the groundwater yield. As part of the WSA, the developer has proposed additional wells in the West Aquifer that would be used to satisfy the Project, as well as the 25-year forecasted water demands presented in the WSA. Although the WSA concluded that there is sufficient supply to meet the 1,205 acre-feet annual demand projected in year 2040, *maximum* supply or sustainable yield from the West Aquifer was not modeled or estimated. Additional modeling will be performed that will provide an estimate of the maximum water supply available from the well field proposed in the West Aquifer, which can be used to define and quantify the District's supplemental water supply needs. It is further assumed that any additional groundwater available from the West Aquifer, by definition, does not support the District's redundant water supply needs since it does not provide *supply source redundancy* as discussed above.

The East Aquifer has been studied extensively, mostly with respect to providing potable, as well as irrigation and snowmaking water supply for the RSC. The current development agreement for the RSC provides that Well 18-3R will provide potable water supply to the RSC Phase II, and snowmaking and irrigation supply will be provided by a combination of wells 18-1 and 18-2, 4th Fairway Well, and the Perini Well. The recently completed *Olympic Valley Creek/Aquifer Interaction Study* concluded that additional pumping from the East Aquifer will have a much greater environmental impact on Squaw Creek. The study indicated that the East Aquifer is not a viable long term water supply based on these impacts. So, it is concluded that no new groundwater development, outside of the existing planned RSC water supply will be pursued in the East Aquifer. Also, based on the results of exploratory drilling for the Sena and Masa Ti projects, groundwater development in the East Aquifer, outside of the Meadow area, does not produce the quality or quantity necessary to provide additional water supply. The East Aquifer, like the West Aquifer, together the Olympic Valley Aquifer, does not support the District's redundant water supply needs since it too does not provide *supply source redundancy*.

The North and South Flank have the potential for more small capacity horizontal wells, but developing the number of wells necessary to meet the redundant/supplemental water supply needs may be impractical. Historically, horizontal wells drilled on the North and South Flanks produce very low flows (e.g., 25 gpm, plus or minus 10 gpm). The redundant water supply need for the District is estimated to be 300-575 gpm; requiring in excess of 20 fractured bedrock wells to satisfy the water demands.

The North and South Forks of Squaw Creek have not been extensively investigated for water supply. Squaw Valley Ski Holdings has a number of wells drilled in bedrock on the South Fork to support their snowmaking needs as well as providing potable water supply to the Gold Coast and High Camp areas. Very limited data is available to assess water quantity and quality in this area. There has not been any formal hydrogeologic investigation performed on the North Fork of Squaw Creek (Shirley Canyon).

Investigations were performed for water supplies outside of the Olympic Valley watershed. The Cinder Cone springs were investigated as a potential water supply for the Tahoe Forest Tract. These investigations show very limited potential for water supply in this area. As part of the *2009 Supplemental Water Supply and Enhanced Utilities Feasibility Study* (Reference 37), the District investigated water supply options on the Truckee River side drainages as well as water supply from the Martis Valley. The Truckee River side drainages showed no reasonable promise of an adequate supply of water quantity and quality. The water supply from Martis Valley is a feasible option and will be subject to further investigation as part of this project.

DATA GAPS

Phase II of this project includes a feasibility level evaluation of water supply options near the Olympic Valley. Based on the conclusions of this Phase I Technical Memorandum, additional investigations recommended include:

- North Fork Squaw Creek
- South Fork Squaw Creek
- North Flank Horizontal Wells
- South Flank Horizontal Wells
- Squaw Creek Surface Water Storage
- Wastewater recycling/reuse
- Alpine Springs County Water District

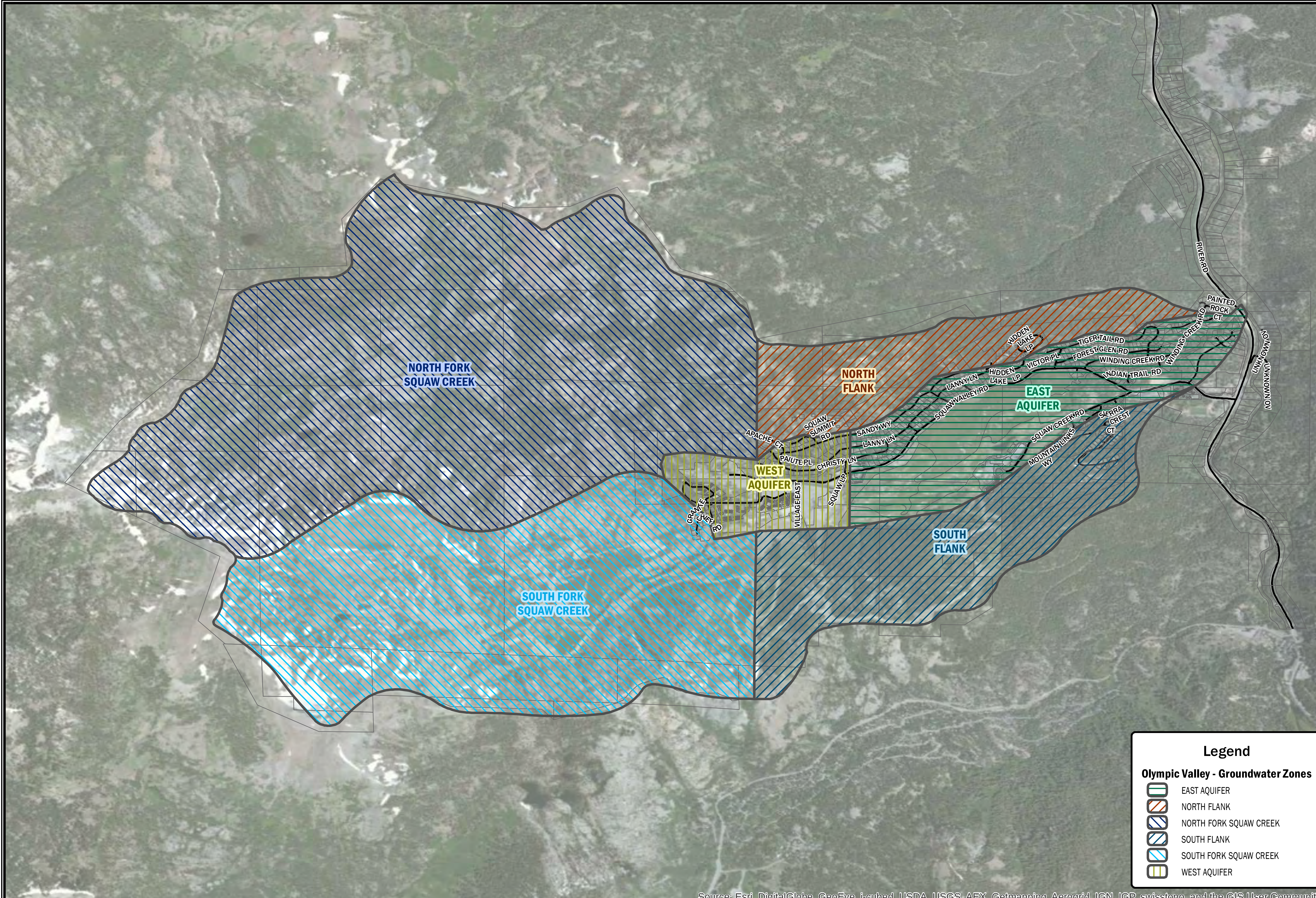
As discussed previously, there is not a great amount of available data regarding groundwater development in the North and South Forks of Squaw Creek area. It is recommended that a feasibility level hydrogeologic investigation be performed for these areas to assess the potential for groundwater development. The scope of this investigation would include evaluating existing mountain wells and geology of the target areas, as well as an assessment of the feasibility of well development from bedrock wells in the area. This investigation will also provide valuable insight into the potential for further horizontal bedrock well development along the North and South Flanks of the Valley.

Phase II would also include an assessment of the potential for an intertie with the Alpine Springs County Water District. The District will meet with Alpine Springs to determine if they have excess water supply that may be used to meet the District's redundant and supplemental water supply needs.

Finally, Phase II will include an evaluation of surface water storage, as well as the potential for wastewater treatment and reuse in the Valley. There are previous preliminary designs for the construction of a surface water impoundment at the confluence of the North and South forks of Squaw Creek. Phase II will include a review of these documents as well as discussions with regulatory agencies as to the ability to permit such a project. The discussion with the regulatory agencies will also include the applicability of treating wastewater within the Valley and permitting, design, and construction of a wastewater reuse system.

If any of these water supply options shows promise, they will be further evaluated in Phase III of the project.

Figures



FARR WEST ENGINEERING

5442 Longley Lane
Reno, NV 89511
(775) 851-4788
www.farrwestengineering.com

Redundant Water Supply - Preferred Alternative Evaluation
Phase 1 - Water Supply Feasibility Summary & Gap Analysis
Figure 1 - Squaw Creek Tributary Water Shed Areas

N

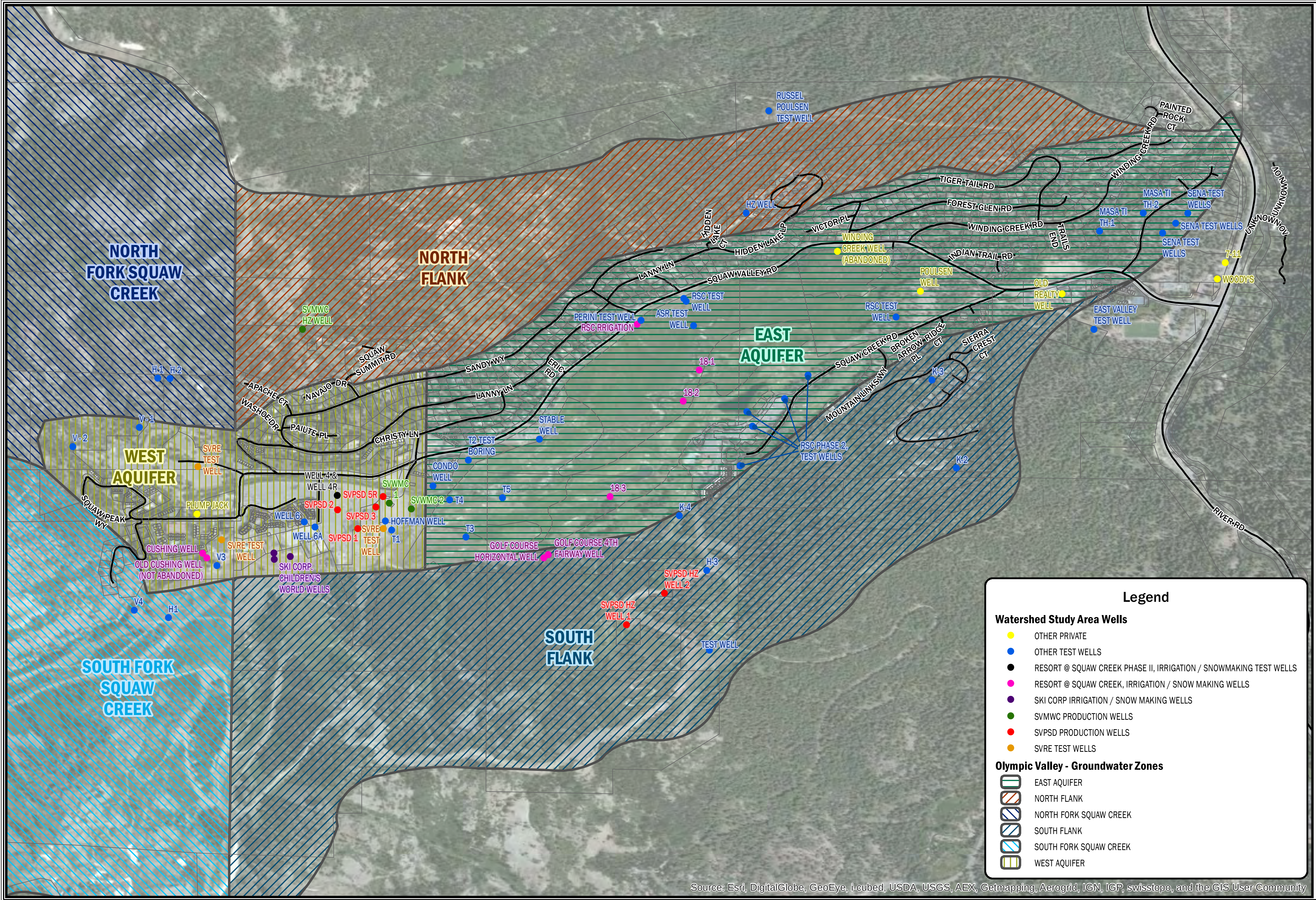
1 " = 2,500 '

The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

Q:\client\squaw\map\Figure1_SquawCreekTributaryWatershedAreas_11X17.mxd, Editor: mforrest, Printed: 2/18/2014

FARR WEST ENGINEERING
5442 Longley Lane
Reno, NV 89511
(775) 851-4788
www.farrwestengineering.com

Redundant Water Supply - Preferred Alternative Evaluation
Phase 1 - Water Supply Feasibility Summary & Gap Analysis
Figure 2 - Valley Wide Well Locations

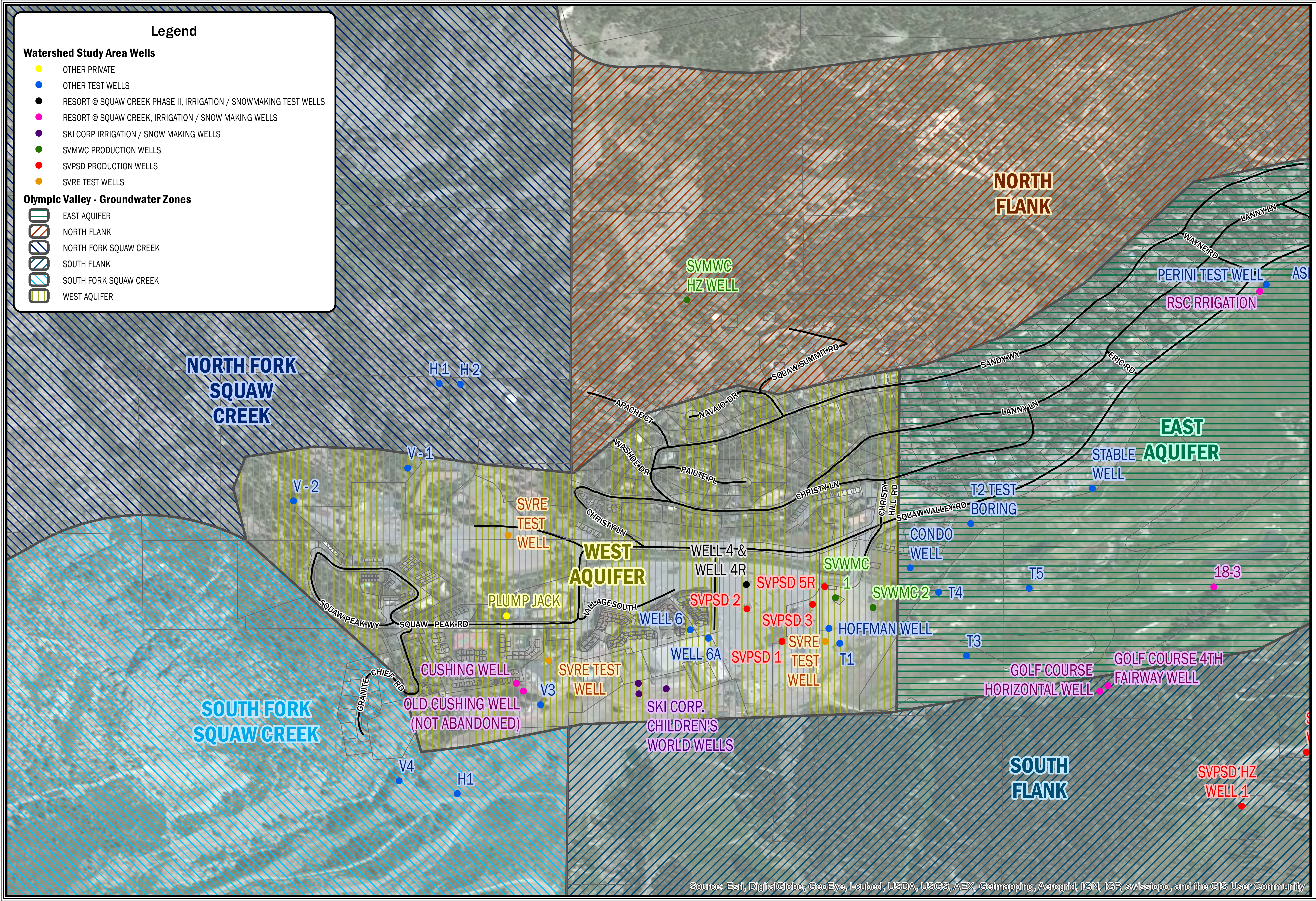


N

1 " = 1,200 '

The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

Q:\client\squaw\map\Figure2_ValleyWideWellLocations_11X17.mxd, Editor: mforrest, Printed: 2/18/2014



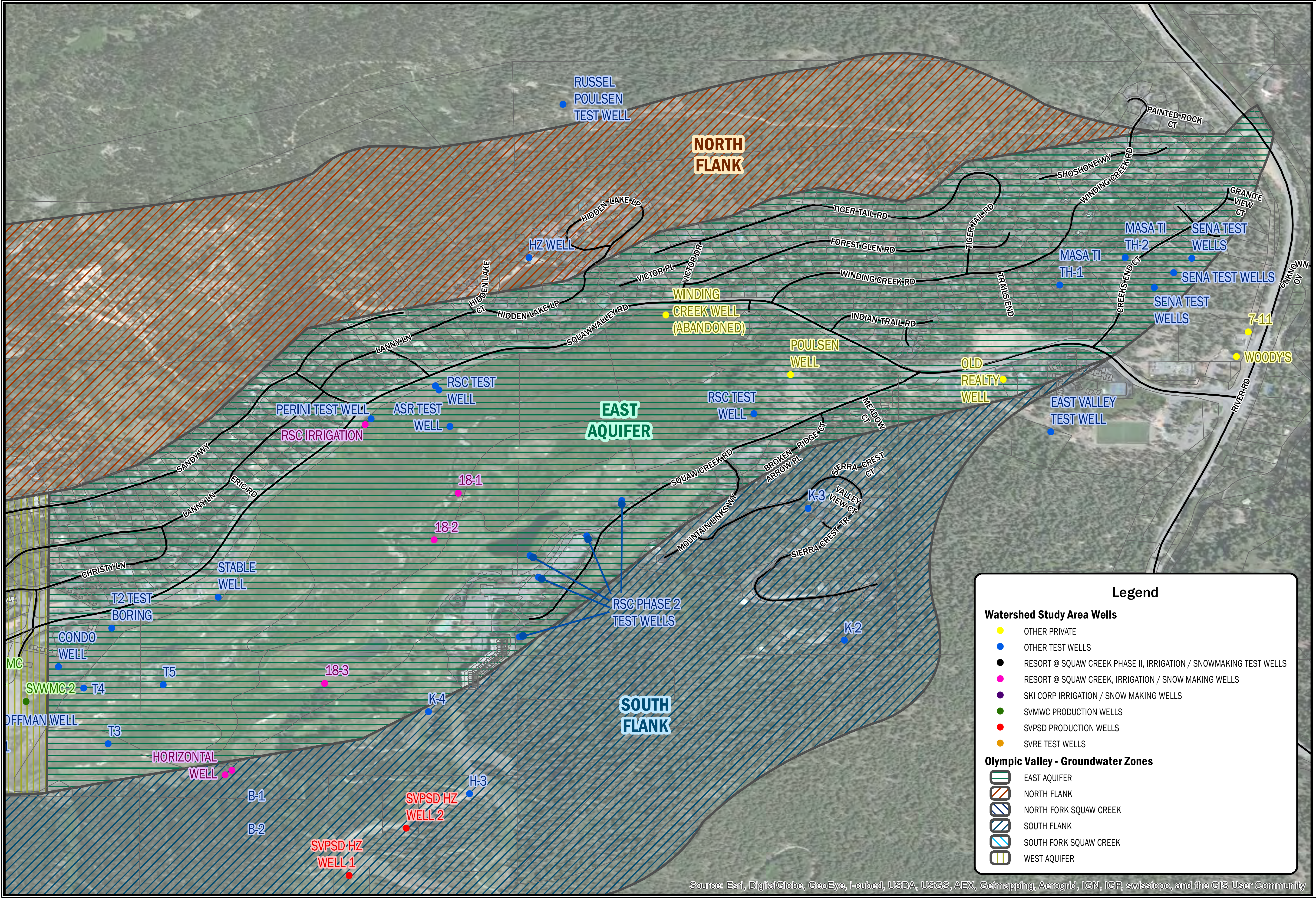
FARR WEST ENGINEERING
5442 Longley Lane
Reno, NV 89511
(775) 851-4788
www.farrwestengineering.com

Redundant Water Supply - Preffered Alternative Evaluation
Phase 1 - Water Supply Feasibility Summary & Gap Analysis
Figure 3 - West Aquifer Well Locations

N
1 " = 700 '

The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

Q:\client\squaw\map\Figure3_WestAquiferWellLocations_11X17.mxd, Editor: mforrest, Printed: 2/18/2014



FARR WEST ENGINEERING
5442 Longley Lane
Reno, NV 89511
(775) 851-4788
www.farrwestengineering.com

Redundant Water Supply - Preferred Alternative Evaluation
Phase 1 - Water Supply Feasibility Summary & Gap Analysis
Figure 4 - East Aquifer Well Locations

N

1 " = 800 '

Q:\client\squaw\map\Figure4_EastAquiferWellLocations_11X17.mxd, Editor: mforrest, Printed: 2/18/2014

Appendix A

Literature Review Summary Table

Squaw Valley Redundant Water Supply - Preferred Alternative Evaluation
Phase 1 Water Supply Feasibility Summary and Gap Analysis
Appendix A - Literature Review Summary

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
1	Summary of Squaw Valley Water Resources and Potential Impacts of Proposed Development	West Aquifer East Aquifer	Cook & Associates	1985	Summary of current state of knowledge regarding hydrogeologic characteristics of Squaw Valley with emphasis on potential impacts of proposed Resort at Squaw Creek.	1. Harrison's estimate of available capacity = 4,284 AFA. 2. Maximum annual demand = 2,500 AFA. 3. Generally agreed that there is enough groundwater to meet the projected BO water demands. 4. CH2MHILL aquifer test on SVMWC well estimated that a properly designed and constructed well could achieve 1,000 gpm. - Applicability to the aquifer as a whole is limited. 5. New wells should be located outside of the "A" zone. 6. Based on Water Supply Master Plan for the Resort at Squaw Creek Project, new water sources will need to be exploited: - most obvious is the aquifer underlying the meadow. - Other sources are 2 springs on the hillside above the development.	New water sources should be located outside of the "A" zone (which is where all existing supply wells are located).
2	Potential Impacts of the Resort at Squaw Creek on the Groundwater Resources in Squaw Valley	West Aquifer East Aquifer	McLaren Environmental	1987	Review potential impacts of Resort at Squaw Creek on groundwater quality and quantity.	1. Quantity of recoverable groundwater at least 4,000 AFA, based on Gasch and Associates. 2. Fertilizer nitrogen contamination should not be an issue due to low application rate.	1. More than adequate water to meet the needs of the project. 2. Amount of water required by the proposed development will not be a significant drain on the groundwater resource in Squaw Valley.
3	Basin Water Quality Investigation, Resort at Squaw Creek	East Aquifer	Kleinfelder	1987	Identify project pre-conditions in the Valley with respect to groundwater quality and quantity.	1. Geophysical investigation by Gasch in 1973; recoverable groundwater storage 5,150 AFA. 2. 35 borings drilled in project area; all completed as monitoring wells in 1985-86.	No interaction between meadow pumping and parking lot pumping.
4	Resort at Squaw Creek Wells 4 and 6 (Various memos 1989)	West Aquifer	Perini	1989	Design and development of Wells 4 and 6.	1. Well 4 re-drill to 74 feet, requested sanitary seal variance to 35'. 2. Well 6 new well drilled to 63 feet, requested sanitary seal variance to 25'.	See Report Number 5 below.
5	Summary of Irrigation and Municipal Well Installation and Aquifer Testing in Squaw Valley	West Aquifer East Aquifer	Kleinfelder	1990	Summary of well installation and testing of 7 wells.	1. 7 wells drilled 1989-1990 for irrigation and municipal for Resort at Squaw Creek. 2. 18-1 and 18-2 irrigation 3. SVPSD #4 and #6 for municipal 4. SVMWC Pilot #1 and #2	1. Pumping tests: - 18-1 no aquifer test, 20 gpm - 18-2 designed for pumping rate of 200 gpm - Well 4 - 600 gpm (7.5 days for drawdown to reach pump level) - Well 6 - 250 gpm (1.5 days of drawdown to pump level) - SVMWC Pilot #2 - 500 gpm, high Fe and Mn

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
6	Phase I Water Resources Investigation Feasibility Study for Installation of Horizontal Wells at the Resort at Squaw Creek	South Flank	Kleinfelder	1991	Assess the feasibility of developing additional horizontal wells for the Resort at Squaw Creek.	1. Recommended 4 sites (K-1 through K-4 on map). 2. Recommendations to drill array of test wells south of No. 4 fairway; seek access for well arrays at sites 2 and 3.	Recommended drilling of horizontal test wells on South flank
7	Well Construction and Testing Summary for the SVCWD Horizontal Test Well	South Flank	William Nork	1992	Identified 4 potential horizontal well sites on South Flank.	1. Horizontal test well drilled, 6,700' elevation (just above Site 4 identified in Kleinfelder report). 2. Completed September 1992 to 110 ft. 3. SVMWC horizontal well on the North Flank of Valley; Alpine Spring horizontal well to the south. 4. Groundwater flow is clearly dominated by fracture flow and the aquifer is compartmentalized.	Well rated to yield 15 gpm for sustained use.
8	Drilling and Completion of Horizontal Wells for SVCWD	South Flank	William Nork	1993	1. H-1 drilled previously was cleaned up and completed to 135'. 2. Three more horizontal wells drilled in Sept/Oct 1993 (all on same access road as previous well).	1. H-1b won't operate unless H-1a is shut off. 2. H-2 encountered hydrothermally altered andesitic rocks, was not tested for long term yield. 3. H-3 flow measured at approximately 4 gpm, not tested for long term yield. 4. H-2 and H-3 encountered more groundwater volume when they were being drilled than when they were allowed to flow on their own (attributed to relatively low piezometric head as compared to the elevation of the boreholes. 5. If drilled at lower elevation, may encounter more groundwater, but would preclude from gravity flow into East Tank.	1. Not enough head to produce. 2. Can increase head by drilling at lower elevations, but this would preclude gravity draining to East Tank.
9	Limited Phase I Groundwater Resource Feasibility Investigation, Squaw Valley West End	West Aquifer N. and S. Fork Squaw Creek	Kleinfelder	1996	1. Assess general hydrogeologic characteristics. 2. Assess feasibility for developing groundwater supply. 3. Locate specific areas for future test well.	1. Identified 4 vertical and 2 horizontal well sites (all 6 well sites were located in granitic terrain): - All located on Ski Corp property - HZ-1 located on Northwest Flank of KT-22 2. August 14, 1996 site visit with Jesse and Rick (SVPSD) and Tom Kelly of Ski Corp: - Approximately 8 wells installed in bedrock in High Camp region (largest production <35 gpm during air lift tests). - Ski Corp provided well construction and production information on the High Camp area wells, approximately 8 wells. - Newport Well, Riviera Well, Siberia Well, horizontal wells. - Horizontal wells west of Gold Coast, no production data.	1. Recommended drilling V1. 2. H1 better than H2.

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
10	Horizontal Well Installation Report	South Flank	Kleinfelder	1998	Summary of installation of horizontal wells.	1. SVPSD drilled 2 horizontal wells; B-1 and B-2 (at the K-1 site recommended in reference 7). 2. NO long term yield results. 3. At the time of installation, B-1 flowed free at 60 gpm and B-2 at 30 gpm. 4. Follow up memos on discharging horizontal well flows: A. LRWQCB Memo 8/28/98 - Discharge horizontal well flow via temporary above ground pipeline to wetland. - Initial concern was TDS levels to Squaw Creek - District proposed to reduce TDS loading by reducing flows from continual to 72-hour test conducted monthly over the test period B. SVPSD Memo to LRWACB 11/1/1999 - Average flow from GC horizontal well 35 gpm. - Amount of water produced by GC horizontal well is about 30 % of what was anticipated. - Request continuous flow test for 1 year.	Wells should be flowed monthly over a year long period and run continuously for 24 hours for testing.
11	Report of Field Activities - SVPSD Water Resources Assessment Project	East Aquifer	Kleinfelder	1999	1. Update well performance and water quality data from previously drilled wells. 2. Explore untested sites for water production potential.	1. Installed 2 test wells: - IWD well (112') developed for 8 hours at 20 gpm. - Test Boring #2 (northeast of Condo Well), 66', abandoned 2. Tested 3 other wells; 4th Fairway Well and Hoffman Well, 8 hour step tests: - Condo step test (106') 104 gpm, 154 gpm, 195 gpm, and 284 gpm. - Hoffman step test (126') 18 gpm, 39 gpm, 58 gpm, and 89 gpm. - 4th Fairway step test (87') 50-70 gpm. 3. IWD well only well that passed Fe, Mn, and As.	1. Condo test well - encrustation of well screen has resulted in up to a 37% decline in well capacity. 2. Hoffman Well - low well efficiency caused by encrusted perforations. 3. 4th Fairway Well - well efficiency of approx. 75%
12	Technical Memorandum of Squaw Valley Groundwater Background Data	West Aquifer East Aquifer South Flank	Kleinfelder	2000	1. Summary of background data relating to SVPSD Water Resources Assessment Project. 2. Hydrogeology, water quality, well construction, and aquifer parameters. 3. Includes summary tables of Olympic Valley wells.	1. 2 types of groundwater regimes: - Fracture flow. - Primary flow in glacial and fluvial deposits. 2. Approximately 10 wells located in High Camp Area yield water at sustained rate of <35 gpm. 3. Data gaps and exploration targets: - No data on High Camp wells. - Attempts have been made to exploit fracture flow at several locations with limited success. - Recent exploration of alluvium and bedrock targets in the northwest and southeast ends of the Valley have not located sufficient productive capacity to justify construction of production wells. - Northern margin characterized by high Fe and Mn.	1. Moderate quantities of good water quality horizontal wells on flanks of south Valley side slopes. 2. Most promising target for future wells in the West-Central Valley floor area. Eastern extension of present well field located down gradient from the existing well field on the south side of Squaw Creek on golf course property.
13	Technical Data for The Resort at Squaw Creek Test Wells 3, 4, and 5	East Aquifer	Kleinfelder	2000	Discussion of The Resort at Squaw Creek Test Wells 3, 4, and 5.	1. Test Wells 3, 4, and 5 installed at the Resort at Squaw Creek in March 2000. 2. Hydraulic slug testing, no pumping. 3. None of the wells meet Fe, Mn, or TDS standards.	1. T-3 drawdown steadily increasing at end of pumping. 2. T-4 drawdown approaches steady state 3. T-5 drawdown approaches steady state

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
14	Well No. 4 Replacement Project Phase 1 - Feasibility Study	West Aquifer	ECO:LOGIC	2001	Assess feasibility of constructing Well 4 within the existing easement.	1. August 1989 Perini Resorts drilled Well 4R. 2. Well 4R domestic supply for the Resort at Squaw Creek. 3. Well 4R began sanding in 1991 and was abandoned. 4. Estimated new Well 4RII could produce 215 gpm on average.	1. Technically feasible to drill Well 4RII. 2. Recommended drilling program includes exploratory drilling followed by production well.
15	Groundwater Model Report for Groundwater Development and Utilization Feasibility Study	West Aquifer East Aquifer	Derrik Williams	2001	Discuss development of Groundwater Model for GW Development & Utilization Feasibility Study.	1. Groundwater Model incorporates all available hydrogeologic data for the Basin. 2. Model successfully simulates water level fluctuations in production and monitoring wells and reasonably simulates Squaw Creek flows.	1. Best tool for estimating effects on various pumping and recharge scenarios. 2. Continued model updates will occur over time with the availability of new data.
16	Update of Squaw Valley Groundwater Model and 2001 Pumping Analysis	West Aquifer East Aquifer	West Yost	2001	1. Update Groundwater Model with dry year 2001 conditions. 2. Analyze alternative pumping scenarios. 3. Estimate effect of snowmaking.	1. Model remains an accurate predictor of water levels. 2. Water levels in SVPSD Well 2 fall below critical water levels; adjust Well 2 pumping. 3. Transfer pumping from Well 2 to Well 5 and Well 1. 4. Snowmaking pumping can have an impact on water levels in the District production wells.	Water levels in Well 2 fall below critical water levels; adjust Well 2 pumping to reduce impact
17	Squaw Valley Watershed Sanitary Survey	West Aquifer East Aquifer	West Yost	2001	1. Support the Source Water Assessment. 2. Obtain initial information on existing contaminant sources. 3. Identify development and activities on the watershed that may contribute contaminants.	Identification of potential contaminant sources such as Village and Heavy Commercial area, ski area maintenance activities, stables, LUST sites, wastewater collection and transmission, etc.	
18	Squaw Valley Source Water Assessment	West Aquifer East Aquifer South Flank North Flank	West Yost	2001	1. Delineation of protection area boundaries for potable water supply wells. 2. Inventory of contaminants of concern. 3. Vulnerability assessment. 4. Public education and outreach.	1. Minimum components of contingency planning outlined. 2. Assessment of the ability of the water system to function with the loss of the largest water supply	1. Development of a plan for alternate water supplies: - Expand existing sources - Identify potential interties with other public water systems. - Develop new sources. - Install treatment on poor water quality sources. 2. Development of a Spill/Incident Response Plan.
19	Exploratory Test Hole Results for New Water Supply Well MASA TI	East Aquifer	Layne GeoSciences	2002	Drilled 2 test holes to determine the feasibility of constructing a water well for Phase II of Masa Ti on Squaw Creek development	1. Test Hole #1 was drilled to 197 ft; bucket test yielded 2 gpm for 5-6 minutes; high TDS; no borehole geophysical logging or water quality analysis due to no sustainable groundwater flow. 2. Test Hole #2 drilled to 217 ft; bucket test yielded 4 gpm for 4-5 minutes; high TDS; no borehole geophysical logging or water quality analysis due to no sustainable groundwater flow.	Test Holes #1 and #2 should not be considered as viable sources of water for the project

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
20	SVPSD Groundwater Development & Utilization Feasibility Study	West Aquifer East Aquifer North Flank South Flank Truckee River Cinder Cone Alpine CWD	West Yost	2003	1. District is proceeding in a diligent manner to identify needed water supply and treatment facilities to meet increasing demands. 2. Thorough evaluation of surface and groundwater resources in the Valley: - Siting and drilling of new test holes. - Water resources management plan. - Groundwater Model and sustainable yield estimate. - Identification of new well sites. 3. Developed Source Water Assessment and Watershed Sanitary Survey.	1. Estimate of buildout water demands: - SVPSD 1,628 AFA (total with SVMWC and Resort at Squaw Creek snow = 2,091 AFA) - Estimate based on future development limited to 80% of GP. 2. Water production needs - District will need 4 to 6 new wells in the 250-400 gpm range to satisfy build-out water demands. 3. Sustainable yield analysis: A. Maximum pumping of existing wells - 706 AFA. B. Existing plus new wells: - 18-2 and 18-3, Well 4RII, 4th Fairway Well, Condo and Stables Wells, 2 wells in western portion of Basin. - SVPSD 1,091 AFA (total with SVMWC and snow making = 1,524 AFA). 4. Alternative water supplies evaluation: - Additional wells in Squaw Valley (Well 4RII, Condo Well, 4th Fairway Well, 18-2 and 18-3, New Wells 1 and 2 in west parking area). - Springs east of Truckee River (Cinder Cone area). - Truckee River wells (not firm water supply during drought years). - Alpine Springs CWD. 5. Water treatment plant evaluation (treat additional wells at 1810 property)	1. District needs an additional 1,600 gpm to meet buildout water demands 2. The new groundwater wells recommended develops the full sustainable yield of the basin - Any additional supply beyond this would need to come from outside of the Valley
21	Overview of the Squaw Valley Aquifer Evaluation	West Aquifer East Aquifer	SVPSD	2003	Summarize aquifer planning and evaluation efforts	1. Completed Development and Utilization Feasibility Study: - Assessed available hydrogeologic data and collected new data. - Performed watershed sanitary survey and source water assessment. - Future water demand estimates based on GP buildout. - Developed numerical Groundwater Model. - Evaluated water supply alternatives. 2. Ongoing Activities: - Stream monitoring of Squaw Creek. - Groundwater monitoring. - Stream/aquifer interaction study. - Estimate of sustainable yield. - Groundwater management plan.	No conclusions
22	Plumpjack Squaw Valley Aquifer Test Simulation	West Aquifer	Derrik Williams	2003	1. Incorporate Plumpjack well aquifer test results into Groundwater Model. 2. Assessed water supply for Resort only. Resort plus Intrawest III and IV and maximum pumping.	1. Well maintained average pumping rate of 142 gpm during aquifer test. 2. Test results cannot be used to estimate creek/aquifer interactions. 3. Would have little impact on hydrocarbon plume and Squaw Creek flows.	Plumpjack Well can be operated to supply resort only without having negative effect on Well 2. Could supply more demand but needs to be operated in coordination with other District wells.

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
23	Groundwater Management Support Activities Final Report	West Aquifer East Aquifer	West Yost	2004	Describes activities performed by the SVPSD to support the development of a Groundwater Management Plan.	1. Install groundwater level monitoring equipment. 2. Install stream gauges on East and West Fork and east end of Valley on Squaw Creek. Perform stream monitoring. 3. Update Groundwater Model: - Refine hydrogeologic cross sections and update data with stream gauge data. - Evaluate groundwater basing using updated model. 4. Education and public outreach.	
24	Tahoe Truckee Forest Tract Groundwater Evaluation Draft	Cinder Cone	ECO:LOGIC	2004	Evaluate groundwater (Cinder Cone Springs) as a source of domestic water supply for residences in the area referred to as the Tahoe Truckee Forest Tract.	1. In the 70's, Cinder Cone Area as a percolation basin for primary treated effluent. 2. Springs were eliminated as a potential source of new water for the SVPSD as part of the 2003 GDUFS Update. They didn't think the springs could deliver a reliable supply of water and didn't thing DOHS would permit the springs as a water source without treatment. 3. Identified potential well sites (2 vertical, 1 horizontal, and inclined well) west of Highway 89.	1. Difficulty in site access, permitting, drilling conditions, low anticipated potential for yield, TROA implications, proximity, to Truckee River, land ownership (USFS), perception of water supply in previous wastewater discharge area, water rights issues. 2. No appetite from Board to evaluate further based on conclusions
25	Squaw Valley 2004 Model Update - Updated Sustainable Yield Analysis	West Aquifer East Aquifer	Derrik Williams	2004	1. Updated sustainable yield analysis. 2. Modified Groundwater Model with new data.	1. Sustainable yield existing wells - 706 AFA, two consecutive dry years, Well 2 is the controlling factor. 2. Maximum pumping existing wells plus new wells - 1,352 AFA: - 261 AFA reserved for Resort at Squaw Creek. - 1091 AFA available for potable. 3. Maximum pumping existing plus new wells (Well 2 screened 15' lower) - 1,560 AFA: - 261 AFA for Resort at Squaw Creek. - 1,300 AFA for potable.	See findings
26	Groundwater Management Support Activities - Groundwater Characterization Report	West Aquifer East Aquifer	West Yost	2005	1. Evaluate historical water level and water quality data. 2. Collect and analyze samples of surface water and groundwater for temporal (spring/fall) evaluation. 3. Install test well to assess interaction between upper and lower aquifer zones. 4. Collect additional year of stream gauge data. 5. Update Groundwater Model and sustainable yield estimates.	1. Sustainable yield existing wells - 870 AFA, two consecutive dry years: - Well 2 is the controlling factor. - 261 AFA reserved for Resort at Squaw Creek. - 605 AFA available for potable. 2. Maximum pumping existing wells plus new wells - 1,010 AFA: - 261 AFA reserved for Resort at Squaw Creek. - 750 AFA available for potable. 3. Maximum pumping existing plus new wells (Well 2 screened 15' lower) - 1,560 AFA: - 261 AFA for Resort at Squaw Creek. - 1,300 AFA for potable. - Identical to 2004 sustainable yield update.	1. With this data, the District is ready to develop a Groundwater Management Plan. 2. District does not have ready access to an alternative water supply that could supplement groundwater in drought emergency. District should undertake further drought contingency planning.

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
27	ASR Project	East Aquifer	ASR Systems	2005	Storage of drinking water during winter months and recovery for potable use during summer months.	1. Phase 1 Report - Identify and briefly describe key issues and hurdles. 2. Phase 2 Hydrogeologic Information Review (3/2005): - Review available information to support development of an ASR program in Squaw Valley. - Identified test ASR well site. - ASR Systems believes that a reasonable probability exists for ASR success in Squaw Valley. 3. Phase 3 Additional Data Collection Results (11/2007): - Drill test ASR Well in October 2007.	Supplemental data collection program produced the final conclusion that ASR not feasible in the Valley based on geology.
28	Installation and Testing of Well 18-3R Resort at Squaw Creek	East Aquifer	Amec	2005	Results of assessment of water supply options, drilling and testing of Well 18-3R, and recommendations for further work associated with water supply development for Resort at Squaw Creek Phase II.	1. Resort at Squaw Creek Phase II has a water demand of 53.3 gpm on ADD and 106 gpm MDD. 2. 18-3R was installed June 2005 (E:L inspected the well installation for the District). Well was drilled to meet DOHS requirements. 3. Water resources considered for Phase II: - ASR, water treatment plant, Truckee River water, exploration on Resort at Squaw Creek property. - Considered upland drilling (i.e., horizontal type wells). Risk of not getting water quality considered too significant.	1. Well 18-3R should be able to continuously produce 150 gpm. - Pumping 18-3R does show an impact on the discharge rate of the spring (upwelling) located north of the well. - Pumping in excess of 175 gpm not recommended. 2. Water quality - Mn elevated, but continued pumping and testing brought levels below the MCL of 0.05 mg/L.
29	Results of Hydrogeologic Peer Review of May 2005 Report	West Aquifer East Aquifer	West Yost	2005	Hydrogeologic peer review of groundwater management support activities.	1. New or additional wells in the future should be constructed in different portions of the valley and should avoid being placed within the existing well field on the west side: - Provides more reliability and flexibility to the water system in case of emergency, pipeline breaks, etc. - Spreading out wells allows wells to be less vulnerable to possible groundwater contamination. - Less potential to impact creek. 2. Additional wells outside of the west end would likely require treatment for Fe, Mn, and As.	See findings
30	SVPSD Water Treatment Plant Preliminary Design Project	West Aquifer East Aquifer	ECO:LOGIC	2005	1. Identify and describe design criteria used to evaluate, rank, and select preferred treatment plant process and site combination. 2. Identify preferred treatment process and site combination	1. Wells to supply treatment plant include those identified in 2003 Capacity and Utilization Feasibility Study. 2. Looked at the following sites: County Park site, West Tank, 1810 property, Tiger Tail, Stable Well, Creek Side Estates, Well 18-3R.	Preferred alternative was greensand filtration at County Park site.

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
31	Resort at Squaw Creek Phase II Development Water Supply Modeling	East Aquifer	Hydrometrics	2006	1. Address potential impacts of pumping wells 18-3R, as well as planned replacement wells 18-1 and 18-2 for snow making and irrigation. 2. Update Groundwater Model with 18-3R data and assess impacts of pumping.	1. Pumping Well 18-3R reduces flow from upwelling. Flow which would otherwise contribute to flow in Squaw Creek. 2. Cumulative impacts of continuous pumping of Well 18-3R versus seasonal pumping to meet irrigation and snow making demands.	1. Additional pumping of 18 series wells will have insignificant impact on District wells. Small increase in water level in late summer/early fall due to shifting pumping further east to Wells 18-1 and 18-2. 2. Additional pumping of 18 series wells will have small impact on SVMWC wells. 3. Squaw Creek flows are both reduced and increased: - Increased upwelling flows during mid-summer and mid-winter due to the decreased pumping rate of Well 18-3R from 225 gpm to 150 gpm. - Decreased upwelling flows in late winter/early spring due to pumping of Well 18-3R to meet potable demands. Previously, Well 18-3 was not operated during these times. - During mid-summer, pumping at 18-2 is mostly creek water (very uncertain due to a lack of stream flow data).
32	Silver Creek Ridge Well	North Flank	Gasch, Luhdorff & Scalmanini	2006/2007	1. Electrical resistivity groundwater investigation to help identify moisture-bearing zones and assist in placement of exploratory wells 2. Drilling and testing of exploratory boring for Squaw Valley Associates on the ridge line north of Squaw Valley 3. Recommendations for repairing exiting collapsed borehole and completing as a municipal well	1. Electrical resistivity study indicated potential deep drill targets for a sustainable water source. 2. Test Hole No. 1 was drilled and tested in October 2006. 3. The test hole was drilled to 640 feet bgs and airlift tested at an average discharge rate of 66 gpm. 4. The analysis indicated a potential to produce upwards of 450 gpm based on the limited testing, but warned that this would only be sustainable if the fracture feeding the well was sustainable. 5. Water quality analysis indicated elevated levels of manganese (190 ug/L and sulfate (940 mg/L). Water quality also indicated brackish water with a TDS of 1,200 mg/L and a hardness of 840 mg/L. 6. Video survey performed in 2007 showed the borehole had collapsed. 7. Recommended ODEX drilling method (air rotary) for enlarging collapsed borehole to a depth of 600 feet to accommodate 8-inch casing and constructed to municipal well standards.	1. Recommendation included enlarging the existing borehole and constructing the well to municipal standards. 2. Indicated that Squaw Valley Associates may have options for the use of the water even with the poor water quality.

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
33	Resort at Squaw Creek Phase II Development Revised Water Supply Modeling	West Aquifer East Aquifer	Hydrometrics	2007	Update Groundwater Model analysis with proposed vertical and horizontal wells at the Resort at Squaw Creek	1. Resort at Squaw Creek proposed pumping plan includes 6 locations for snowmaking and irrigation water. Existing 4th Fairway Well and proposed vertical and horizontal wells near resort. Resort plans to use horizontal collector well as lead extraction point. 2. Resort at Squaw Creek Revised Pumping Plan: - Well 18-3R dedicated to District for Phase II potable supply. - Reduced irrigation demand equal to estimated summer Phase II development demand. New effect is no increase in water usage between May and October. 3. Modeling also looked at redistributing pumping from SVPSD Well 5 to 18-3R and Well 18-3R to Well 1. Goal is to impart positive impact on Creek (Well 5 is closest to Creek).	1. Insignificant impact on SVPSD wells. 2. Small impact on SVMWC wells. Increase water levels in late summer/early fall due to reduced pumping of Well 18-3R. 3. Squaw Creek flows are both reduced and increased: - Increased upwelling flows during mid-summer and mid-winter due to the decreased pumping rate of Well 18-3R from 225 gpm to 150 gpm. - Decreased upwelling flows in late winter/early spring due to pumping of Well 18-3R to meet potable demands. Previously, Well 18-3 was not operated during these times. - Increase summer Creek flows due to moving pumping from Well 18-1 and 18-2 further away from Creek.
34	Olympic Valley Groundwater Management Plan	West Aquifer East Aquifer	Hydrometrics	2007	1. SB1938 requires any public agency seeking State funds to prepare and implement a Groundwater Management Plan. 2. Olympic Valley GMP satisfies multiple objectives: A. Building on and formalizing groundwater management activities. B. Framework for implementing future groundwater management activities. 3. Groundwater management activities (such as minimizing impacts on Squaw Creek) are accomplished through cooperative management by all Valley groundwater users.	1. 2 water suppliers: SVPSD and SVMWC. 2. Other pumpers include Resort at Squaw Creek (irrigation and snowmaking), Plumpjack Squaw Valley Inn, Gladys Poulsen. Squaw Valley Ski Corp claims to pump for irrigation. 3. SVPSD has instituted water conservation measures: A. Implement Maximum Applied Water Allowance (MAWA). B. Tiered rate structure. C. Drought response plan. 4. Resort at Squaw Creek has offered to reduce water use as part of their Phase II Project where there will be no net increase in water demand. Irrigation demands will go down to make up for the domestic use at the Resort. 5. GMP objectives: A. Estimate, verify, and regularly update the sustainable pumping rates. B. Increase conservation efforts. C. Modify pumping locations and schedules.	See findings
35	Results of Exploration Drilling and Aquifer Testing SENA at Squaw Condominium Project	East Aquifer	Kleinfelder	2007	Drilled 4 exploration holes and perform short duration aquifer tests to determine feasibility of constructing water wells for the SENA project.	1. Four exploration holes were drilled; 3 were completed and 7 short-duration aquifer tests were performed. 2. 4 hour pumping tests were performed (very short duration) which provided capacities ranging from 20-75 gpm sustainable for 30 days (estimate). 3. Drilling appears to indicate permeable aquifer. 4. Short duration tests carry a high degree of uncertainty. 5. Poor water quality; manganese, iron, and antimony.	1. Properly constructed wells at these locations appear capable of producing a total of 143 gpm for approximately 30 days; based on short duration 4 hour tests. 2. High degree of uncertainty with short duration tests. 3. Water quality issues with manganese, iron, and antimony.

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
36	Review of Kleinfelder SENA Exploratory Wells Report	East Aquifer	ECO:LOGIC	2008	Review 2007 exploratory well drilling report prepared by Kleinfelder for SENA wells	1. The method used by Kleinfelder to approximate well yields is not adequate due to the complicated nature of the aquifer conditions in this area. 2. Long term pumping test necessary, one that allows drawdown and recovery data to be simulated and compared to the observed responses in the wells. 3. The conclusion of 143 gpm did not take into account interference between wells; and the data clearly showed interference between the wells even in the short duration testing; thus significantly decreasing the long term yield of wells in this area.	1. Kleinfelder investigation only indicates that there is some undetermined amount of groundwater available and acknowledged that extrapolating 4 hour pumping tests into the future carries a large amount of uncertainty. 2. The report did not provide the comprehensive assessment of the reliable long term yield of the wells that the District requires to commit to serving a project of this size.
37	Supplemental Water Supply and Enhanced Utilities Feasibility Study	Martis Valley Truckee River side drainages	ECO:LOGIC	2009	Feasibility level study of importing water supplies outside of the District's boundary as a supplemental and/or alternative water supply to meet current and future water supply needs	1. Future buildout water demands based on 2003 Study of 1,628 AFA, District requires additional 1,210 AFA and 1,951 gpm for MDD. 2. Based on available literature it appears Martis Valley has adequate groundwater resources to meet District demands 3. Truckee River side drainages - Based on geology, observations and know water quality issues, none of the drainages appear to be favorable. 4. District has right to Martis Valley groundwater. 5. Export water supply options include obtaining water from TDPUD, PCWA or NCSD; or Developing new water source in Martis Valley 6. Transmission main alternatives - Highway 89 and USFS corridors 7. Joint trench partners - natural gas and fiber, Placer County bike trail. 8. Environmental analysis - no fatal permitting flaws. 9. Estimated cost - Highway 89 $27.5 million, USFS $33 million	1. Analysis indicated that the Martis Valley has sufficient groundwater resources and the District has the right to the water. 2. No environmental fatal flaws.
38	Independent Analysis of Groundwater Supply Olympic Valley Groundwater Basin	West Aquifer East Aquifer	Todd Engineers	2012	1. Compilation of all available relevant information on GW resources in the Valley 2. Independent evaluation of existing GW model and assessment of well field configurations to support SVRE Village development	1. Chronological summary of GW supply and investigations 2. Analyze well field and pumping scenarios to satisfy project and District water demands. 3. Drilled and tested 3 wells (KSL 1, 2, and 4).	1. Overall, the current GW model is a reasonable representation of the GW basin and can be used to assess theoretical well field configurations. 2. GW must be managed in concert with surface water 3. GW model provides an accurate representation of the GW system and is a reasonable tool for evaluating potential GW development and management scenarios. 4. GW model can be used for the WSA

Report Number	Title	Water Resource Area	Author	Year	Purpose	Findings	Conclusions
39	Olympic Valley Creek/Aquifer Interaction Study - Phases I and II	West Aquifer East Aquifer	Hydrometrics	2014	1. Improve and quantify the understanding of interactions between Squaw Creek and the aquifer 2. Diminish GW pumping impacts on Squaw Creek 3. Increase GW storage in Olympic Valley 4. Develop groundwater pumping strategies	1. Phase 1 included instrumentation, testing and data collection - Monitoring well installation - Temperature probe and piezometer installation - Permanent and temporary data logger installation - Aquifer test on Well 2 2. Phase 2 included data analysis and updating GW model - Water temperature and water level data - Aquifer test data (2 tests on Well 2) - Analyze temperature and radon study - Update GW model 3. Groundwater model update - Model period extended to 1992-2011 4. Data suggest a close hydrologic connection between Squaw Creek and groundwater. - Pumping municipal wells may deplete creek flow by capturing water from the creek. - The trapezoidal channel dewaters part of the aquifer, leading to less water available for municipal users	1. Bulk of GW recharge originates from just above Valley floor (average around 6,300 feet elevation) 2. Pumping rates are a small percentage of stream flows in Spring/Early Summer but significant in mid to late summer 3. Fast transit times imply that wells are highly vulnerable to contamination (source water protection is important) 4. Move pumping during the year 5. Reduce pumping in the meadow (move pumping to west as possible). 6. Reduction in Squaw Creek flows is small percentage of pumping from any one well. 7. Pumping is only significant influence on Creek during low-flow times.
40	Village at Squaw Valley Specific Plan Water Supply Assessment	West Aquifer	Farr West, et. al.	2014	1. SB 610 water supply assessment for the proposed VSVSP Project. 2. Evaluate water demands including existing demands, VSVSP demands, and other potential development demands over 25 year period. 3. Assess available water supplies. 4. Determine if sufficient water is available to meet existing and planned future demands during normal, dry, and multiple dry year scenarios.	1. Existing average annual water demands from four primary producers (SVPSD, SVMWC, RSC, and SVR) of 842 AFY. 2. Future water demands, including existing, VSVSP, and non-project related growth estimated at 1,205 AFY. 3. Current groundwater model (Creak/Aquifer Interaction Study) used to assess water supply sufficiency with proposed well field configuration. 4. Criteria used to evaluate sufficiency of supply was saturated thickness of aquifer >65%. 5. Modeled scenarios included normal, single dry, and multiple dry year scenarios.	1. Proposed VSVSP project and non-project growth over 25 year period requires a total water supply of 1,205 AFY. 2. Simulated thickness of the expanded well field showed the average saturated thickness at any individual well never fell below 65%. 3. There is sufficient supply to meet the projected 2040 water demands in normal, single, and multiple dry years with an adequate margin of safety. 4. Any additional demands beyond those projected for 2040 would need to be reevaluated using the specific demand schedule and proposed water supply system at the time that such development is proposed.

Appendix B

Feasibility Analysis of Redundant Water Supply from Mountain Wells

Todd Groundwater

TODD GROUNDWATER

November 24, 2014

MEMORANDUM

To: David Hunt, PE; Farr West Engineering

From: Chad Taylor, PG, CHG; Senior Hydrogeologist

Re: Feasibility Analysis of Redundant Water Supply from Mountain Wells
Squaw Valley Public Services District, Squaw Valley, California

The Squaw Valley Public Service District (SVPSD) is in the process of updating their supplemental water supply analyses. As part of this update, SVPSD is evaluating the potential for the development of redundant water supplies from wells in the mountain areas surrounding the Olympic Valley Groundwater Basin (Basin, DWR 2003). This evaluation specifically focuses on the feasibility of developing water supply wells from the mountainous areas of the north and south forks of Squaw Creek (Figure 1). The south fork of Squaw Creek is within the Squaw Valley Ski Resort, and the north fork, sometimes referred to as Shirley Canyon, is on United States Forest Service (USFS) land. This memorandum presents an evaluation of existing mountain wells and the feasibility of providing redundant water supply to SVPSD from additional new mountain wells.

1. EXISTING MOUNTAIN WELLS

The Squaw Valley Ski Resort (Squaw Ski) currently operates a total of seven mountain wells within the ski resort. These wells serve water for snowmaking and potable water supply to the High Camp and Gold Coast resort facilities. Three existing wells serve snowmaking water uses and four serve potable demands. These are all fractured bedrock wells.

1.1 Existing Snowmaking Wells

The three existing snowmaking wells are reported to have a combined capacity of 325 gallons per minute (gpm). During the snowmaking season, these wells are reported to be able to operate for up to 20 hours per day (Livak 2014). However, during dry periods these wells cannot be pumped continuously for extended periods. Dry season use is reported to limit production from these wells to only 10 hours per day (Livak 2014). When these wells are in use for snowmaking, no excess water supply capacity is available, so the existing wells do not appear to be candidates for redundant supply to the SVPSD.

For the purpose of this redundant water supply feasibility assessment, these wells or wells like them are assumed to be able to produce for 8 to 12 hours per day to account for dry season conditions. The combined daily production from three wells operating under these conditions is between 156,000 and 234,000 gallons per day (gpd). This is equivalent to an average per-well rate of 52,000 to 78,000 gpd/well for the existing snowmaking wells or wells of similar production capacity.

1.2 Existing Potable Water Supply Wells

The four potable water supply wells that currently serve the High Camp and Gold Coast facilities have lower production capacities than the existing snowmaking wells. These potable wells are reported to be able to produce a combined 7,000 gpd during dry periods (Livak 2014). This is equivalent to an average per well production rate of 1,750 gpd/well. These wells do not currently have excess capacity; the High Camp and Gold Coast facilities currently use all of the available water (Livak 2014).

1.3 Average Existing Mountain Well Supply

There is some variability in the production capacity of the existing mountain wells. This type of production rate variability should be expected from bedrock wells in the area. As a result, the combined daily production rate of approximately 23,300 to 34,400 gpd/well is considered representative of the existing mountain water supply wells.

2. GEOLOGY AND HYDROGEOLOGY

The surficial geology of the Squaw Creek watershed area is shown in Figure 1. The mapped geology indicates that the existing wells are located in either intrusive or extrusive igneous materials. These include the extrusive late Miocene to Pliocene Squaw Peak volcanoclastics (Tsp) and basalts (Tsb) and the intrusive Cretaceous hornblende-biotite granodiorite (hbg). None of these rock types are expected to have any primary porosity, so all groundwater is expected to exist in fractures (secondary porosity). Of the mapped geologic units, the Cretaceous hornblende-biotite granodiorite (hbg) is the oldest, which means that it has likely been exposed to more of the tectonic forces that cause the faulting and fractures that result in secondary porosity. This generally results in the presence of potentially water-bearing fractures, which can in turn result in higher well capacities. Two of the three snowmaking wells are located in the hornblende-biotite granodiorite, which further indicates that higher well yields may be expected from wells in this material. However, the younger volcanic material likely overlies deeper hornblende-biotite granodiorite, so wells mapped in areas of Tsp and Tsb may also be completed in the underlying hornblende-biotite granodiorite. In addition, the third snowmaking well is located in the younger Squaw Peak volcanoclastics and some of the lower capacity potable wells are located in the hornblende-biotite granodiorite, so no strong correlation apparently exists between surficial geology and well capacity.

The Shirley Canyon area of the north fork of Squaw Creek area is mapped as exclusively hornblende-biotite granodiorite. This implies that wells drilled in the Shirley Canyon area may be similar to the existing wells in the South Fork of Squaw Creek. However, from a hydrogeologic standpoint, the occurrence and flow of groundwater is significantly different in fractured bedrock conditions than in unconsolidated sediments n Olympic Valley. The key difference in these bedrock areas is that groundwater primarily occurs in fractures in the rock, and not in porous sands and gravels. In this type of hydrogeologic environment, the presence of groundwater and potential capacity of a well is dependent not only on its geographic location and geology, but also on the number and size of fractures encountered when the well is drilled. As a result, there is no means of knowing if wells drilled in similar geologic and geographic conditions will have similar production capacities. No exploration drilling has ever occurred in the Shirley Canyon area, so no direct information is available regarding subsurface geology and hydrogeology. Further, Squaw Ski has expended significant resources in the past in attempting to expand on-mountain groundwater supply in the Gold Coast and High Camp areas. These efforts have included geologic research, hydrogeologic modeling, and even dowsing for well locations (Livak 2014). Many of these efforts resulted in expensive dry or very low producing or poor water quality wells. Therefore, it should be assumed that multiple attempts will be needed, and even where fractured bedrock groundwater is located, the capacity and water quality may be poor.

3. REDUNDANT WATER SUPPLY DEMAND

The future demands for water within the SVPSD service area have been identified by Farr West Engineering (Farr West 2014). These demands are summarized in Table 1. The future demands total over 297 million gallons per year, which is over 912 acre-feet per year (AFY). These demands equate to an average daily demand of over 814,000 gpd.

4. FEASIBILITY OF SUPPLY FROM MOUNTAIN WELLS

As noted above, seven wells currently are operated in the mountainous area of the South Fork of Squaw Creek. Yields of these wells indicate that successful new wells may be expected to produce an average of 23,300 to 34,400 gpd per well. At these production capacities, a redundant water supply would need to include 24 to 35 new wells to meet the average daily demands of over 814,000 gpd. Meeting the maximum average daily demand or peak day demand would require even more wells. The number of wells required to meet even average SVPSD daily redundant water supply demand is likely infeasible.

5. CONCLUSIONS

The information presented above indicates the following:

- Production capacity in existing mountain wells varies widely, ranging from approximately 1,750 to 78,000 gpd. However, the existing wells represent the range of production rates that should be expected from any new wells in the area of interest.
- No additional capacity is available from the existing mountain wells.
- The geology of the areas where the existing wells are located is similar, and no obvious correlation exists between surficial geology and well capacity.

- The Shirley Canyon area is mapped as having similar surficial geology to the area where the existing wells are located.
- No exploratory drilling has occurred in the Shirley Canyon area
- Squaw Ski has had difficulty in finding new bedrock wells of high capacity and water quality in the past.
- Supplying average daily demand from bedrock wells would require between 24 and 35 new wells, and meeting maximum average daily demand or peak demands would require significantly more wells.
- It is unlikely that the number of new bedrock wells required to meet the redundant water supply demands can be constructed in the areas of interest.

REFERENCES

Farr West Engineering, 2014, Redundant Water Supply – Preferred Alternative Evaluation Project, prepared for Squaw Valley Public Service District, November 6, 2014.

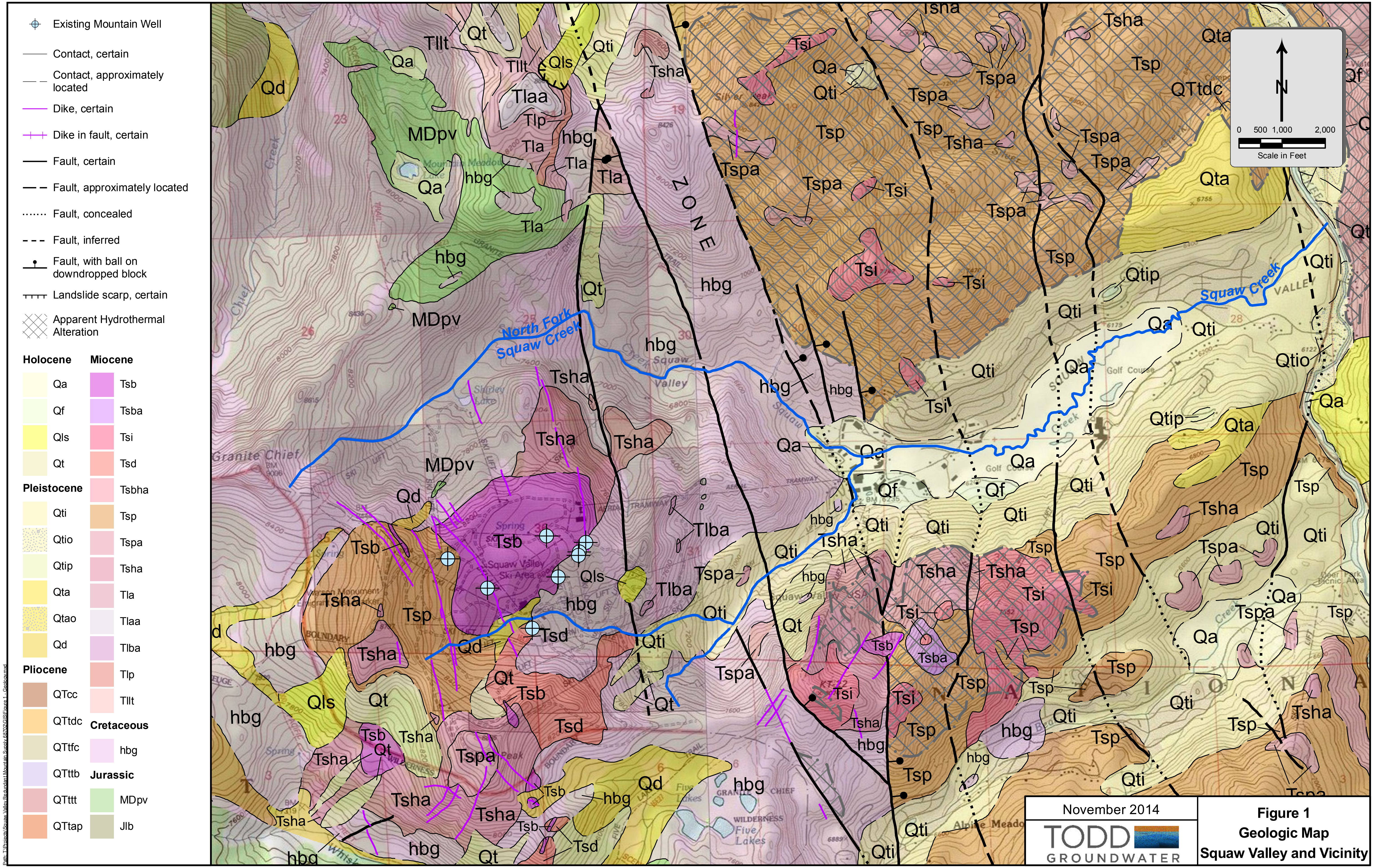
Livak, Mike, 2014, Personal Communication Regarding Existing Mountain Well Operation and Supply Capacity, November 11, 2014.

TABLES

Table 1: Redundant Water Supply Demands

Month	Number of Days	Average Existing SVPSD Use (gallons)	Estimated Additional Future SVPSD Demand (gallons)	Resort at Squaw Creek Phase 2 Potable Demand (gallons)	SVRE Project Estimated Demand (gallons)	Total Future SVPSD Water Demand (gallons)	Total Future Daily Demand (gallons per day)	Number of Wells Required Each Well Producing 23,300 gallons per day	Number of Wells Required Each Well Producing 34,400 gallons per day
January	31	8,645,350	6,356,058	1,250,000	6,353,646	22,605,054	729,195		
February	28	9,230,311	7,177,952	1,250,000	6,353,646	24,011,909	857,568		
March	31	8,634,702	7,431,389	1,300,000	6,353,646	23,719,737	765,153		
April	30	7,064,194	5,108,905	500,000	6,353,646	19,026,745	634,225		
May	31	9,297,070	4,138,406	800,000	6,353,646	20,589,122	664,165		
June	30	14,513,459	5,270,074	1,200,000	6,353,646	27,337,179	911,239		
July	31	19,286,405	10,525,609	1,400,000	6,353,646	37,565,660	1,211,795		
August	31	18,962,928	9,038,802	1,600,000	6,353,646	35,955,376	1,159,851		
September	30	14,742,878	6,437,216	1,200,000	6,353,646	28,733,740	957,791		
October	31	8,716,986	5,198,443	800,000	6,353,646	21,069,075	679,648		
November	30	5,172,618	3,045,669	600,000	6,353,646	15,171,933	505,731		
December	31	8,134,596	6,128,067	900,000	6,353,646	21,516,309	694,074		
Total	**365**	**132,401,497**	**75,856,590**	**12,800,000**	**76,243,752**	**297,301,839**	**NA**		
Average Daily Demand							**814,526**	**35**	**24**
Maximum Daily Demand							**1,211,795**	**52**	**35**
Peak Daily Demand (average daily demand x 2.5)							**2,036,314**	**87**	**59**

FIGURES



November 2014

Figure 1
Geologic Map
Squaw Valley and Vicinity