Technical Memorandum

To: Mr. Bill Johnson
SkyPark at Santa's Village

From: Thomas Harder, P.G., C.HG.
Thomas Harder & Co.

Date: 23-Dec-15

Re: Hydrogeologic Evaluation of the Proposed SkyPark at Santa's Village, San Bernardino County, California

1.0 Background

1.1 Background

This technical memorandum (TM) summarizes an evaluation of potential impacts to water resources associated with planned groundwater pumping for the proposed SkyPark at Santa's Village (the Project) in San Bernardino County, California (see Figures 1 and 2). The Project property is approximately 153 acres and is located along Highway 18 in the San Bernardino Mountains. As outlined in the San Bernardino County Land Use Services Department's Notice of Preparation (2015), the Project site includes the redevelopment and re-use of the existing, but closed, Santa's Village attraction. The Project would include the development of a mixed-use adventure park including outdoor activities (e.g. mountain bike park, zipline, etc.), retail shops, winter attractions (e.g. ice rink, sledding.), and others. As proposed, the Project will use two existing wells on the property to meet on-site domestic and irrigation water demands.

To meet requirements of the California Environmental Quality Act, the Project is required to complete an Environmental Impact Report (EIR) which will, among other things, address the Project's impact on water resources. This TM provides:

- A description of the hydrogeological setting of the Project.
- A description of the wells planned for use to supply water.
- A description of available water supply.
- An evaluation of potential Project impacts to water resources.

1.2 Purpose and Scope of Work

The purpose of this work is to prepare a description of the hydrogeologic setting of the Project and compare anticipated water demand with existing reports on the available groundwater resources. These findings will be incorporated into the EIR. The scope of work to address the objective included:

- Obtaining and reviewing existing geological, hydrological, and hydrogeological data.
- Completing a hydrogeological description of the Project including well locations, groundwater occurrence and flow, groundwater level changes over time, and typical groundwater production rates, as available.
- A comparison of anticipated water demand with available groundwater resources.
- An evaluation of potential impacts of Project pumping on existing wells in the area.
- Conclusions on whether the Project will substantially deplete groundwater supplies.
- Conclusions on whether the Project will have sufficient water supplies available to serve the Project from existing resources.

1.3 Data Sources

The various types of data used for this analysis included existing reports, well completion data, downhole video log summaries, topographic maps, and well location maps. Specific reports and data included:

- San Bernardino County Land Use Services Department (SBCLUSD), 2015. Notice of Preparation of a Draft Environmental Impact Report.
- Geoscience Support Services, Inc., 2005. Geohydrologic Evaluation of the Maximum Perennial Yield of the Ground Water Basin in the Lake Arrowhead Area.
- Unpublished water demand estimates provided by SkyPark at Santa's Village.
- Morton, D.M. and Miller, F.K., 2006. Geologic Map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California. U.S. Geological Survey Open-File Report 2006-1217.
- Independent Geo-Environmental Consultants, 2000. Engineering Geologic Evaluation, Santa's Village, 28950 Highway 18, Sky Forest, California.
- United States Department of Agriculture, 2015. Detail Plans for Water & Sediment Control Basin and Lined Waterway for SkyPark Santa's Village LLC. Natural Resources Conservation Service.
- Pacific Surveys, 2014. Downhole Video Survey Reports (Attachments A and B).

- Water Well Drillers Report (i.e. Driller's Log), 1991. Fire Ring Well (Attachment C)

A complete list of data, publications, and reports relied on for the generation of this TM are listed in References (Section 6).

2.0 Physical Setting

2.1 Hydrology

The Project straddles the boundary between the Upper Santa Ana River watershed and the Upper Mojave River watershed (see Figure 3). Surface runoff in the Upper Santa Ana River watershed travels south and west via the Santa Ana River to the Pacific Ocean. Surface water in the Upper Mojave River watershed drains north to the Mojave River. The Project wells are located within the Hook's Creek subunit of the Upper Mojave River watershed, as described in Geoscience (2005).

The primary surface water feature in the Project Area is Hooks Creek (see Figure 3). Hooks Creek is a perennial stream (flowing year-round) that begins in Hencks Meadow (USGS, 1996). Before Santa's Village was constructed in 1955, Hooks Creek was mapped as intermittent in the Hencks Meadow area and perennial downstream of Hencks Meadow (USGS, 1953). Hooks Creek drains into Little Bear Creek approximately two miles northeast of the Project.

There are no known active or inactive stream gages on Hooks Creek (USGS, 2015). Accordingly, the surface flow of the creek is unknown. Area-weighted average annual precipitation in the subunit is 36.5 inches/year, which is equivalent to approximately 3,585 acre-ft/yr of annual precipitation over the entire 1,195-acre subunit (Geoscience, 2005). Average annual surface runoff in Hook's Creek Subunit has been estimated by Geoscience (2005) to be approximately 960 acre-ft/yr. It is assumed for this analysis that this is approximately equivalent to the long-term average annual flow in Hooks Creek.

Hencks Meadow is a natural, narrow meadow located in the Project Area (USGS, 1953). A small, man-made pond was constructed at the downgradient end of the meadow (see Figure 3). Debris exists in the meadow from when it was used as a storage site for wood material infested by bark beetles (SBCLUSD, 2015). There are plans to make improvements to Hencks Meadow including removal of the debris and wood. The plans also include the construction of three interconnected sediment settling basins that will collect storm flows for the purpose of improving water quality. The basins will discharge overflows to the next downstream basin, as applicable, and ultimately to the existing pond and Hooks Creek.

2.2 Geology

Within the Project, the San Bernardino Mountains consist primarily of Cretaceous (146 to 66 million years ago) granitic rocks with isolated recent surficial deposits (Morton and Miller, 2006; see Figure 4). Two granitic rock units have been mapped: mixed granitic rocks of Heaps Peak and monzogranite of City Creek. The Project's wells are located on, and completed within, these two granitic rock units.

Surficial deposits within the Project property were identified and described by Independent Geo-Environmental Consultants (2000) and, though not shown by Morton and Miller (2006), are located within the valley areas and lower flanks of the hills. Surficial deposits were described as alluvium and slopewash soils composed of soft sand, silt, and clay mixed with organic detritus.

One fault has been mapped across the northern portion of the Project (see Figure 4; Morton and Miller, 2006). Faults mapped in the southern San Bernardino Mountains have been mapped as relatively steeply north dipping reverse faults. The impact of the fault in the Project Area on groundwater flow is not known.

2.3 Hydrogeology

Groundwater in the Project Area occurs in the complex rock fractures that are recharged through percolation of precipitation and surface runoff. Groundwater discharge principally occurs as underflow outflow and groundwater discharge to surface water (i.e. springs) with lesser amounts of pumping from wells. The majority of precipitation in the Project Area is lost to evapotranspiration and surface runoff before deep percolation to the fractured rock aquifer.

Depth to groundwater measured in August 2014 was 19 ft below ground surface (ft bgs) in the Fire Ring Well and 5 ft bgs in the Meadow Well (see Figure 2, Attachments A and B). A log book from the previous property owners recorded the depth to water in 1997 as 5 ft bgs in the Meadow Well (SkyPark, 2015). It is assumed that groundwater flow follows the topography. Therefore, in the Hooks Creek subunit, groundwater is assumed to flow towards Hooks Creek and then to the northeast in the same direction as surface water flow.

Instantaneous pumping rates in the two proposed Project wells are generally low, consistent with a fractured, granitic bedrock aquifer. Pumping tests in the Fire Ring Well and the Meadow Well were conducted at 48 gallons per minute (gpm) and 30 gpm, respectively. After five hours of pumping, the depth to groundwater in the Fire Ring Well was 220 feet below ground surface (ft bgs), representing 200 ft of drawdown. Drawdown data from the Meadow Well pumping test is not available. These pumping rates are consistent with those of similarly constructed wells in Grass Valley (see Figure 1) which have maximum discharge rates ranging from 15 to 150 gpm (Geoscience, 2007).

Geoscience (2005) provided estimates of maximum perennial yield of each hydrologic subunit in the Lake Arrowhead area using three methods: the watershed hydrologic model (with high and low estimates), weighted average precipitation (with high and low estimates), and the Crippen method (modified). Estimates of the maximum perennial yield of the Hooks Creek Subunit, in which the Project wells are located in (see Figure 3), ranged from 120 to 300 acre-ft/yr with an average of 226 acre-ft/yr. For the purposes of this work, it is assumed that deep infiltration of

surface water within the Hooks Creek Subunit that encompasses the Project wells results in groundwater recharge to the underlying bedrock aquifer system that is available for production.

3.0 Water Supply Facilities

The Project will utilize two existing wells, the Fire Ring Well and the Meadow Well (see Figure 2), to meet the water demand of the Project. The Fire Ring Well was drilled in 1991 to a depth of 414 ft below ground surface (see Attachment C). The well was completed with a 6-inch diameter conductor casing to 52 ft bgs and is an open hole, 6 inches in diameter, to the total depth (see Attachments A and C). The Fire Ring Well will provide water for domestic use and decorative landscaping. The well is anticipated to provide 4,800,000 gallons per year (14.7 acre-ft/year; unpublished data from SkyPark, 2015).

The Meadow Well will be used for decorative landscaping, supplemental water supply for the existing small pond, an orchard, and construction water. The Meadow Well was constructed sometime before 1955 when it began operation for Santa's Village. The well has a 35 ft conductor casing and is an open hole to a depth of 96 ft (see Attachment C). The anticipated water demand for the Meadow Well is 1,000,000 gallons per year (3.1 acre-ft/yr; unpublished data from SkyPark, 2015).

Under normal operating conditions, the Project will rely on the two existing Project wells with an expected total water demand of 5,800,000 gallons per year or 17.8 acre-ft per year. However, the Project does have a connection to the local water purveyor, Skyforest Mutual Water Company (SFMWC; see Figure 1), which can be used in emergencies. SFMWC is a member of Crestline-Lake Arrowhead Water Agency (CLAWA), a water wholesaler delivering imported California State Water Project water to the Crestline/Lake Arrowhead area (CLAWA, 2011).

4.0 Available Groundwater Resources

4.1 Available Groundwater Resources

Anticipated available groundwater resources in the Hooks Creek Subunit has been defined using the term maximum perennial yield which is:

> *The maximum quantity of ground water perennially available if all possible methods and sources are developed for recharging the basin. This quantity depends on the amount of water economically, legally, and politically available to the organization or agency managing the basin (Todd, 1980).*

As stated earlier, the perennial yield of the Hooks Creek Subunit ranges from 120 to 300 acre-ft/yr with an average of 226 acre-ft/yr.

4.2 Current Groundwater Production

Current municipal groundwater production in the Lake Arrowhead area is from LACSD and SFMWC. LACSD operates five wells in Grass Valley, located three miles northwest of the Project and outside the Hooks Creek Subunit. LACSD does not have municipal wells in the Hooks Creek Subunit. Private domestic pumping within the Hooks Creek Subunit is assumed to be negligible. Outside of, but adjacent to, the Hooks Creek Subunit, the SFMWC owns several wells located west of the Project. SFMWC supplies water to approximately 150 connections in the community of Skyforest (SFMWC, 2015a). Groundwater production varies with precipitation patterns (SFMWC, 2015a), but total production in 2014 was 7.3 acre-ft (SFMWC, 2015b).

5.0 Conclusions and Recommendations

Based on a review of available data the Project's expected water demand (17.8 acre-ft/yr) is below the low end of the range of estimated perennial yield (120 acre-ft/yr) of the Hooks Creek Subunit. Further, as current private groundwater production in the Hooks Creek Subunit is assumed to be minimal, groundwater pumping by the Project will not result in a cumulative depletion of groundwater resources. Accordingly, the Project will not substantially deplete available groundwater supplies.

Comparison of proposed Project groundwater pumping (17.8 acre-ft/yr) with the combination of perennial yield and surface runoff estimated by Geoscience (2005; 120 acre-ft/yr plus 960 acre-ft/yr or 1,080 acre-ft/yr) shows that Project pumping could, on a long-term basis, reduce surface water flow in the Hook's Creek by approximately 1.6 percent based on the assumption that the surface water and groundwater systems in Hooks Creek Subunit are in hydraulic continuity. On a short-term basis, the relative impact, if any, of groundwater pumping on surface water flow would be less during wet periods and more during dry periods.

The impact of proposed groundwater pumping on groundwater levels in existing wells is not expected to be significant. Well to well pumping interference in fractured rock aquifers depends on the fracture system being interconnected, which is unlikely given that the nearest well (owned by SFMWC) is approximately 1,500 ft away. Further, the nearest wells are in a different watershed and likely produce water from a different aquifer system.

Although the Project is not anticipated to significantly deplete available groundwater supplies, it is recommended to develop a groundwater and surface water monitoring plan as part of the Project. This plan would include:

- Installation of a stream gage on Hooks Creek at a location downstream of the Project boundary.
- Baseline monitoring of groundwater levels and Hooks Creek streamflow rates before the Project is constructed. Groundwater monitoring is recommended to be conducted on monthly basis. Stream gage measurements can be collected continuously using recording equipment that is downloaded quarterly.
- On-going monitoring of groundwater levels and Hooks Creek streamflow rates to provide the data necessary to assess the role of Project pumping on changes in stream flow rates (if any).

6.0 References

California Department of Water Resources, 1991. Water Well Drillers Report (Fire Ring Well). January 15, 1992.

Crestline-Lake Arrowhead Water Agency, 2011. 2010 Urban Water Management Plan. August 2011.

Geoscience Support Services, Inc., 2005. Geohydrologic Evaluation of the Maximum Perennial Yield of the Ground Water Basin in the Lake Arrowhead Area. January 4, 2005.

Geoscience Support Services, Inc., 2007. Evaluation of Potential Near-Term Ground Water Production Well Sites. April 24, 2007.

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Morton, D.M. and Miller, F.K., 2006. *Geologic Map of the San Bernardino and Santa Ana 30' x 60' quadrangles, California*. U.S. Geological Survey Open-File Report 2006-1217.

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Pacific Surveys, 2014. Video Survey Report, Well 6 (Fire Ring Well). August 4, 2014.

San Bernardino County Land Use Services Department (SBCLUSD), 2015. Notice of Preparation of a Draft Environmental Impact Report. August 26, 2015.

Skyforest Mutual Water Company, 2015a. Personal Communication with Todd Pahl, December 7, 2015.

Skyforest Mutual Water Company, 2015b. Unpublished Annual Water Extraction – 2014.

SkyPark at Santa's Village, 2015. Personal Communication with Bill Johnson, December 8, 2015.

Todd, D.K., 1980. Groundwater Hydrology. Second Edition, John Wiley & Sons.

United States Department of Agriculture, 2015. Detail Plans for Water & Sediment Control Basin and Lined Waterway for SkyPark Santa's Village LLC. Natural Resources Conservation Service. October 14, 2015.

United States Geological Survey, 1953. *Harrison Mountain Quadrangle, California-San Bernardino Co., 7.5 Minute Series (Topographic).*

United States Geological Survey, 1996. *Harrison Mountain Quadrangle, California-San Bernardino Co., 7.5 Minute Series (Topographic).*

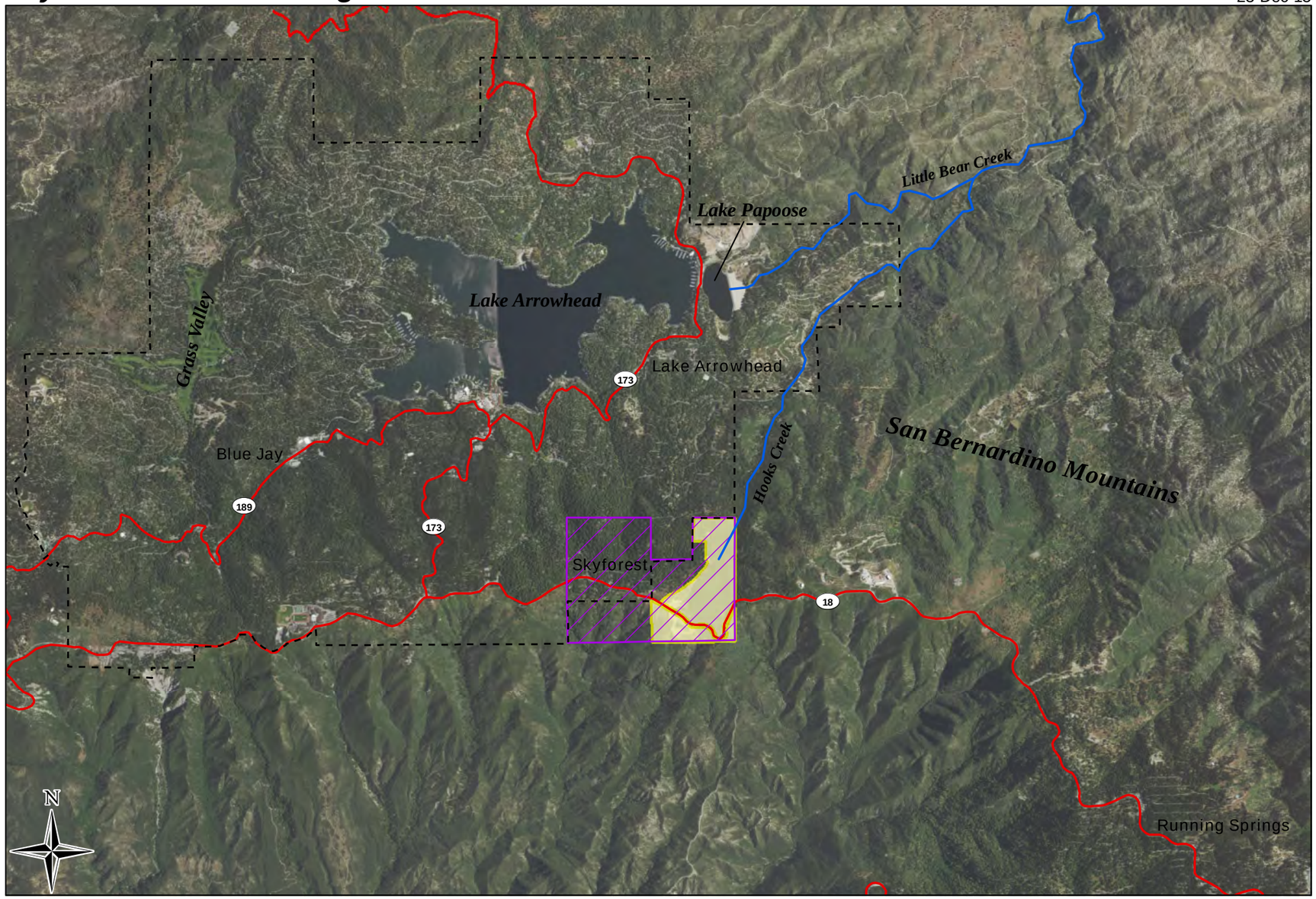
United States Geological Survey, 2015. National Water Information System: Mapper. Retrieved from http://maps.waterdata.usgs.gov/mapper/

Figures

Hydrogeologic Evaluation of the Proposed Sky Park at Santa's Village

Sky Park at Santa's Village

23-Dec-15



0 0.5 1 2 Miles

NAD 83 State Plane Zone 5, feet

Basemap Source: www.esri.com
Hooks Creek mappyed by USGS, 1996.

Map Features

- Project Area
- Skyforest Mutual Water Company Boundary
- Lake Arrowhead Community Services District Boundary
- Creek
- State Highway

Thomas Harder & Co.
Groundwater Consulting

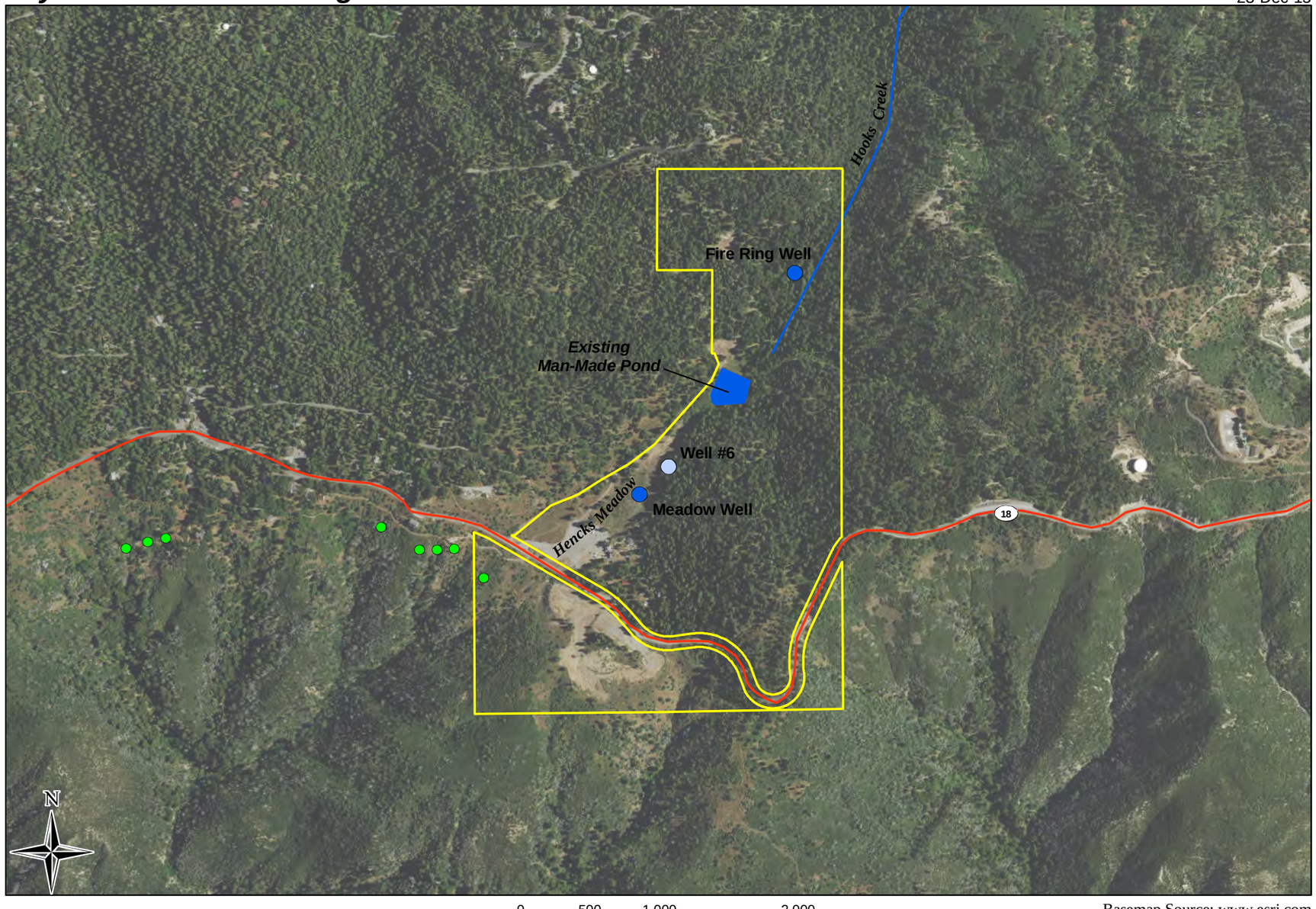
Area Map

Figure 1

Hydrogeologic Evaluation of the Proposed Sky Park at Santa's Village

Sky Park at Santa's Village

23-Dec-15



0 500 1,000 2,000 Feet

NAD 83 State Plane Zone 5, feet

Basemap Source: www.esri.com
Hooks Creek mappyed by USGS, 1996.

Map Features

- Proposed Project Pumping Well
- Inactive Well
- Skyforest Mutual Water Company Well (Status Unknown)
- Hooks Creek
- Existing Man-Made Pond
- Project Boundary
- Highway 18

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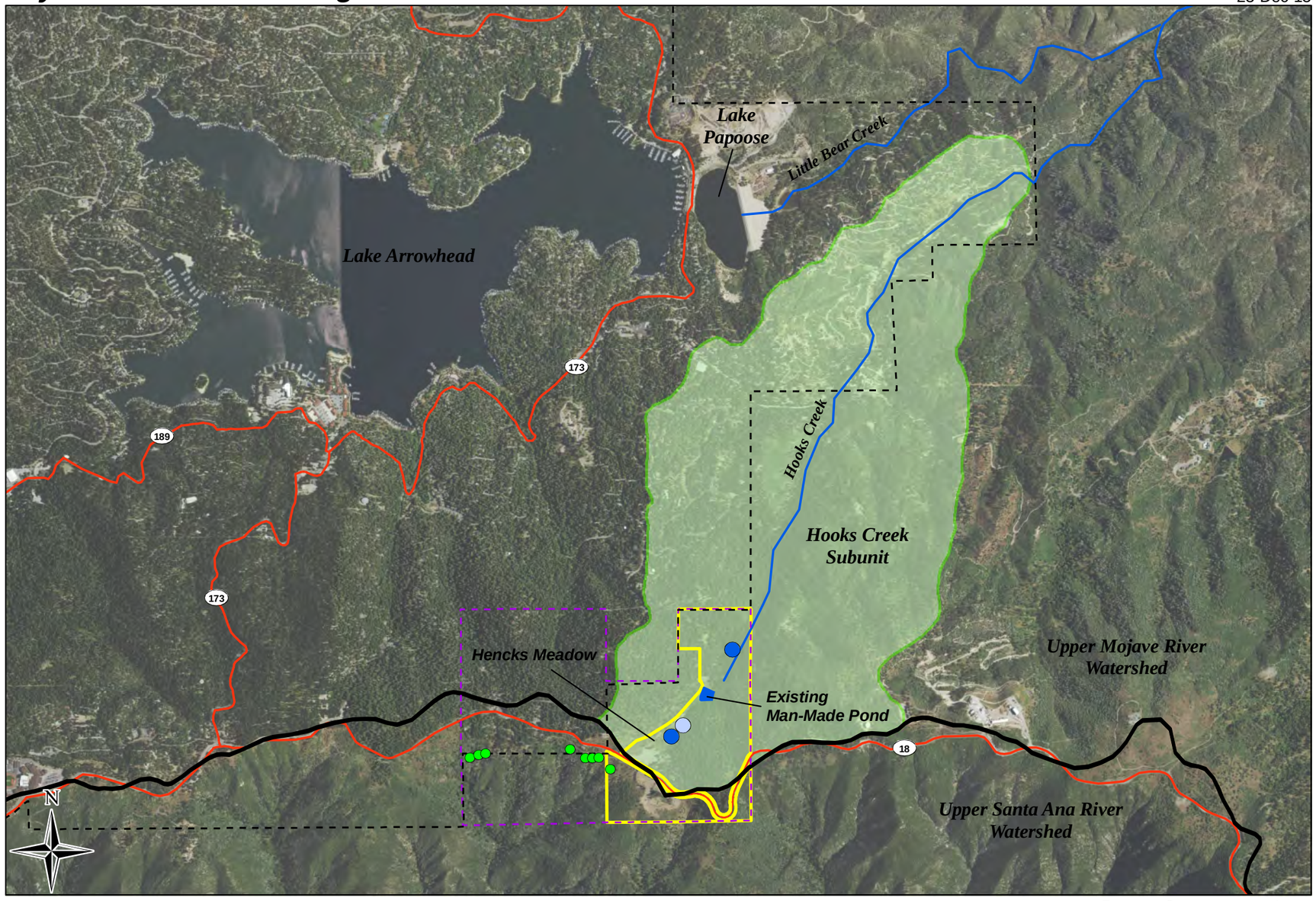
Project Area

Figure 2

Sky Park at Santa's Village

23-Dec-15



0 0.5 1 2 Miles

NAD 83 State Plane Zone 5, feet

Basemap Source: www.esri.com
Hooks Creek mappyed by USGS, 1996.

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Hydrogeologic Evaluation of the Proposed Sky Park at Santa's Village

Map Features

- Watershed Boundary
- Hooks Creek Hydrologic Subunit (Geoscience, 2005)
- Proposed Project Pumping Well
- Inactive Well
- Skyforest Mutual Water Company Well (Status Unknown)
- Existing Man-Made Pond
- Project Boundary
- Lake Arrowhead Community Services District Boundary
- Skyforest Mutual Water Company Boundary
- Creek
- State Highway

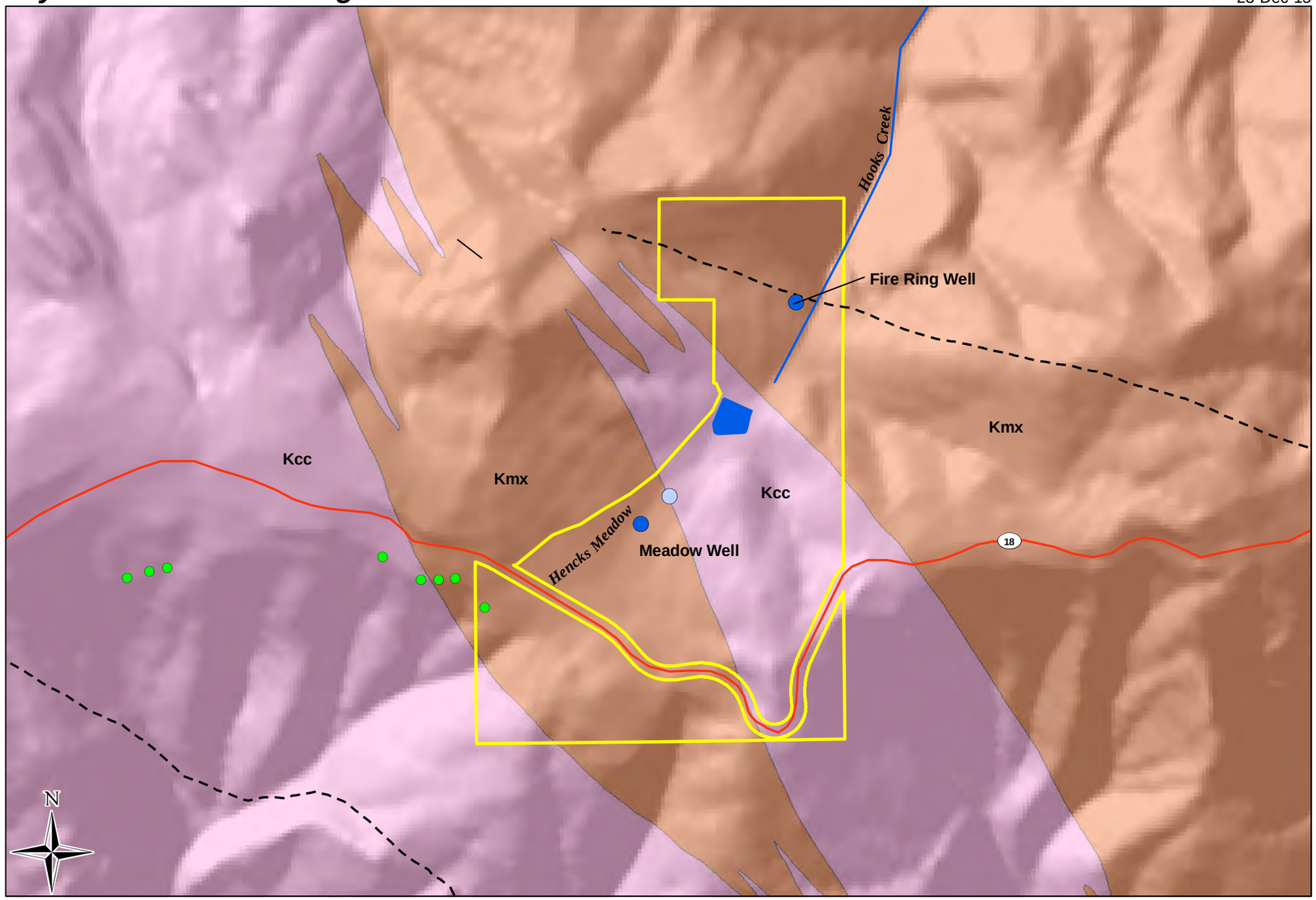
Hydrologic Features

Figure 3

Hydrogeologic Evaluation of the Proposed Sky Park at Santa's Village

Sky Park at Santa's Village

23-Dec-15



0 500 1,000 2,000 Feet

NAD 83 State Plane Zone 5, feet

Geology from Morton and Miller, 2006
Hooks Creek mapped by USGS, 1996

Map Features

- Proposed Project Pumping Well
- Inactive Well
- Skyforest Mutual Water Company Well (Status Unknown)
- Monzogranite of City Creek
- Mixed granitic rocks of Heaps Peak
- Fault (approximately located)
- Hooks Creek
- Existing Man-Made Pond
- Project Boundary
- Highway 18

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Geology Map

Figure 4

Appendix A

Video Survey Report

Fire Ring Well

Pacific Surveys

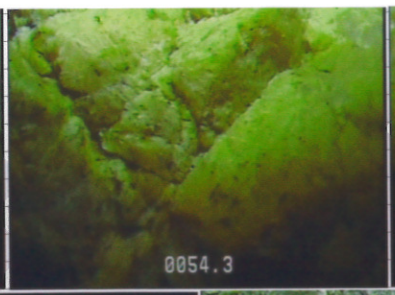
a full service geophysical well logging company

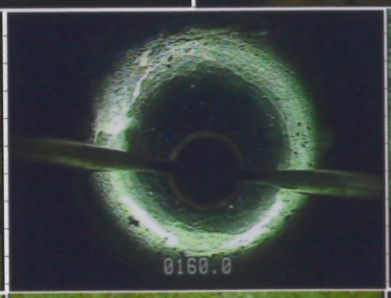
Video Survey Report

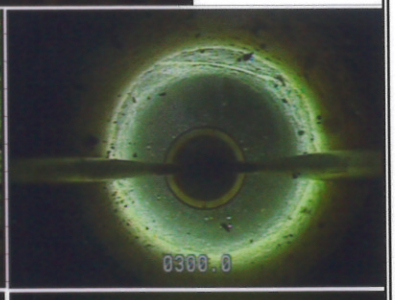
Company:	Harich Enterprises	**Date:**	04-Aug-14
Well:	Well 6	**Run No.**	One **Truck** PS-6
Field:	Skyforest	**Job Ticket:**	18613
State:	California	**Total Depth:**	410 ft
		Water Level:	19 ft SWL
Location:	Santa's Village	**Oil on Water:**	No **Amount:** 0 ft
	GPS N34o14.304' W117o09.905'	**Operator:**	Nelson
Zero Datum:	Top of CSG **Tool Zero:**		Side-Scan **Dead Space** 2.00 ft
Reason for Survey:	General Inspection	**Guides Set @**	5.00 in

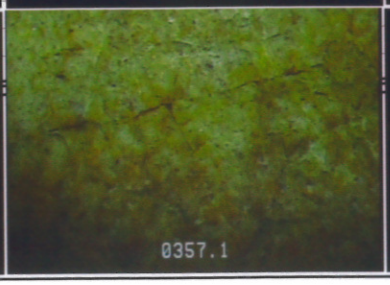
Depth	Observations
0.0 ft	Start survey at top of survey.
18.6 ft	SWL; water clear, visibility good.
52.8 ft	Casing ends Open hole.
54.3 ft	Fractured zone.
92.4 ft	Fractured zone.
97.9 ft	Fractured zone with small break out.
160.0 ft	High-angle fractures.
216.2 ft	High-angle fractures.
300.0 ft	Suspended particles in water column.
311.4 ft	Fractured zone.
357.1 ft	Fractured zone.
385.0 ft	Water column becomes cloudy.
409.5 ft	Fill; end survey.

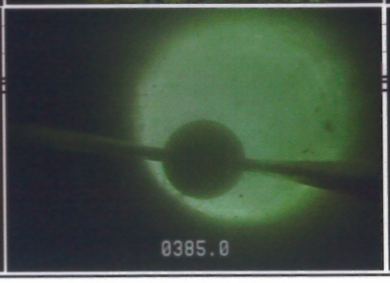
Perforation:	**From Survey**
Open Hole	N/A
Casing Size	**From Survey**
6.00 in	0.00 ft to 52.80ft
Open Hole	52.80 ft to 409.50ft
CSG Material	PVC
Screen Material	Open Hole

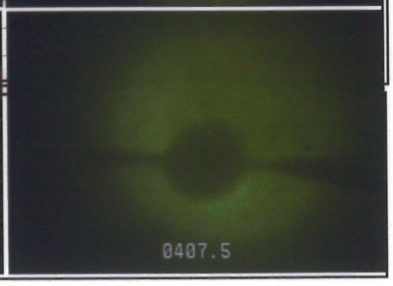












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Appendix B

Video Survey Report

Meadow Well

Pacific Surveys

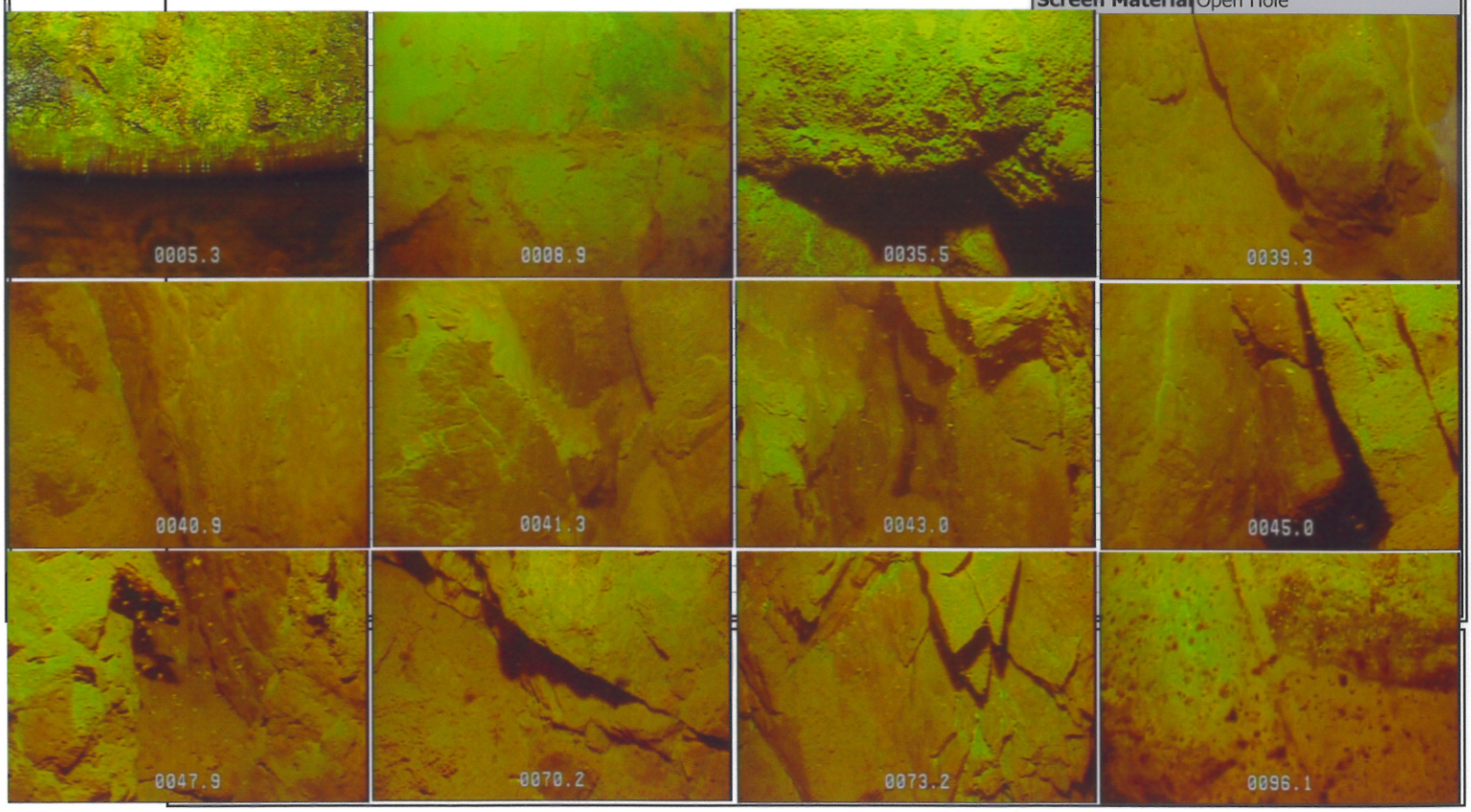
a full service geophysical well logging company

Video Survey Report

Company:	Harich Enterprises	**Date:**	04-Aug-14		
Well:	Meadow well 1	**Run No.**	One	**Truck**	PS-6
Field:	Skyforest	**Job Ticket:**	18613		
State:	California	**Total Depth:**	96 ft		
		Water Level:	5 ft	SWL	
Location:	Santa's Village	**Oil on Water:**	No	**Amount:**	0 ft
	GPS N34o14.023' W117o10.163'	**Operator:**	Nelson		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	2.00 ft
Reason for Survey:	General Inspection	**Guides Set @**	7.00 in		

Depth	Observations
0.0 ft	Start survey at top of survey.
5.3 ft	SWL; water cloudy, visibility poor.
8.9 ft	Heavy scale on casing.
35.5 ft	End of casing open hole.
39.3 ft	Fractured zone.
40.9 ft	Fractured zone with possible water production zone.
43.0 ft	Fractured zone with possible water production zone.
45.0 ft	Large fractured with possible water production zone.
47.9 ft	Break out fractured zone.
70.2 ft	Fractured zone.
73.2 ft	Large break out.
96.1 ft	Fill; end survey.

Perforation:	**From Survey**
Open Hole	N/A
Casing Size	**From Survey**
8.00 in	0.00 ft to 35.50ft
Open Hole	35.50 ft to 96.10ft
CSG Material	PVC
Screen Material	Open Hole



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