Perazzo Meadows Restoration
Hydrologic Monitoring Data Report
Upper and Middle Perazzo Meadows
Water Year 2010

Sierra County, California

Report prepared for:

Truckee River Watershed Council

Prepared by:

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December 2010

A report prepared for:

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Upper and Middle Perazzo Meadows, Water Year 2010
Sierra County, California

Project Assignment: 209116

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1. PROJECT PURPOSE AND INTRODUCTION

The Truckee River Watershed Council (TRWC) has requested that Balance Hydrologics, Inc. (Balance) monitor groundwater conditions and streamflow at Perazzo Meadows. The purpose of the monitoring program is to evaluate pre- and post-restoration conditions, as part of the Perazzo Meadows Restoration project.

This report summarizes groundwater conditions in Upper and Middle Perazzo Meadows and streamflow in the Little Truckee River at the downstream end of Middle Perazzo Meadow during water year 2010[1]. Documentation of streamflow, groundwater levels, and their interactions are important for the following reasons:

- Streamflow is the basic influence affecting fish habitat and populations;
- Little is known about shallow groundwater fluctuation and the amount that can be retained in restored meadows;
- Limited documentation is available regarding the effect of meadow restoration on peak flows and mid- to late-summer baseflow;
- Streamflow measurements and records on the Little Truckee River can be used to estimates flows in other nearby Truckee River tributaries and regional streams;
- Observed conditions and restoration performance criteria need to be placed in context of long-term variability in order to make reliable comparisons to other systems and other years, (e.g. are initial post-project conditions representative of extreme drought or above-average precipitation); and
- A continuous record of streamflow and groundwater levels allows for an evaluation of the restoration program in terms of geomorphic and vegetation changes that accompany trends in streamflow and groundwater levels for which the project was designed.

[1] Most hydrologic and geomorphic monitoring occurs for a period defined as a water year, which begins on October 1 and ends on September 30 of the named year. For example, water year 2001 (WY2001) began on October 1, 2000, and concluded on September 30, 2001.

This data report summarizes our work at Perazzo Meadows during water year 2010. The report:

- Briefly describes what measurements were made, and where;
- Summarizes the results of these measurements;
- Reports daily streamflows in the Little Truckee River during the study period;
- Reports daily groundwater levels for select areas of the meadows;
- Compares annual peak streamflow to estimated peaks in prior years; and
- Compares groundwater level fluctuations in a restored meadow to those in an unrestored meadow.

Gage maintenance and data collection is continuing during water year 2011. Comparison of year-to-year hydrologic variation will be provided in the Water Year 2011 Monitoring Report for this project.

1.2 Acknowledgments

Funding for this project is from the California State Water Resources Control Board (from the American Reinvestment and Recovery Act), awarded to the TRWC. Work was carried out in coordination with the TRWC and the U.S. Forest Service, and individuals from those organizations were instrumental in helping to develop the monitoring program. Beth Christman of the TRWC conducted monthly field monitoring and data collection, and Randy Westmoreland of the Forest Service provided insight regarding the monitoring program approach.

2. SITE DESCRIPTION

2.1 Perazzo Meadows

Perazzo Meadows is located in the Little Truckee Watershed, part of the Truckee River Watershed, about 15 miles northwest of the Town of Truckee in Sierra County, California . The Meadows are accessed from Jackson Meadows Road to the north and Heness Pass Road to the south (Figure 1). The watershed consists of three significant tributaries: the Little Truckee River (termed Lacey Creek upstream of Weber Lake), Perazzo Creek, and Cold Stream. The series of meadows is divided into an Upper, Middle, and Lower Meadow, separated by small canyons and volcanic bedrock outcrops. This monitoring program focuses on the Upper and Middle Meadows only.

The sub-alpine meadows are located in a glacially-formed basin, now filled with alluvial silt, sand, and gravel. The watershed reflects many of the geologic events that have shaped the Central Sierra: the hillsides north and south of the meadows consist of andesitic breccia, mudflow deposits, and welded tuff, while the headwaters of Perazzo Creek are located in meta-sedimentary rocks. A veneer of glacial till and moraines are also present throughout the margins of the valley. A number of terraces are present within the alluvium of the valley floor, most notably on the south side of the Middle Meadow at an elevation approximately 30-feet above the Middle Meadow. Remnant terraces are also present on the northeast side of the Upper Meadow, approximately 2- to 3-feet higher than the meadow surface. The banks of Perazzo Creek and the Little Truckee River are typically composed of sand and silty sand overlying gravel and cobble.

Hydrology in the watershed is influenced by California's Mediterranean climate and sub-alpine elevation. At roughly 6500 feet above sea level, most of the annual precipitation falls as snow, with occasional summer thunderstorms. Annual peak flows tend to occur during spring snowmelt, but periodic rain-on-snow events account for the highest flows. A number of small perennial streams are supported by springs emanating from the adjacent hillsides, especially on the south side of the valley, creating saturated wet meadow areas.

2.2 Restoration Activities

Prior to restoration, the channel followed a meandering course through the meadow, and flow was largely contained in one single-thread channel in most locations. Over the past two summers (2009 and 2010), the U.S. Forest Service has employed a 'plug and pond' restoration

approach to block the channel with the aim of spreading water across the valley floor to reoccupy multiple relic channels that have been abandoned. Figure 2 shows post-project conditions in the Middle Meadow and Figure 3 is an oblique aerial photo showing post-project conditions in the Upper Meadow.

2.3 Hydrologic Monitoring Approach and Methods

The TRWC authorized Balance to establish and maintain a hydrologic monitoring program beginning in Summer 2009, just prior to implementation of restoration activities in the Upper Watershed. Shortly after receiving authorization, Balance staff installed a network of eleven shallow monitoring wells ('piezometers') in the Upper and Middle Meadows, supplementing four monitoring wells that had been previously installed by the Forest Service. Wells were installed in the Upper Meadow on August 21, 2009, and the Middle Meadow on August 27, 2009. On September 23, 2009, several piezometers were instrumented with water level recorders, programmed to measure and record water levels every 15 minutes. In order to relate changes in water surface elevations in the channel to groundwater level fluctuations, several staff plates were installed in the main stream channel.

On September 25, 2009, a streamflow gaging station was installed on the Little Truckee River at the downstream end of the Middle Meadow in order to relate changes in groundwater storage to streamflow emanating from the meadows, with a continuous recorder installed on October 1, 2009. The gage was removed temporarily due to restoration activities. The continuous recorder and staff plate were removed from the channel on September 23, 2010, and re-installed in the reconfigured channel on September 29, 2010.

Monitoring station locations are shown in Figures 4 and 5.

2.3.1 Groundwater monitoring

Piezometers were designed with the aim of measuring seasonal water-table fluctuations, and ranged in depth from 4.10 to 8.00 feet below the meadow surface. Piezometer locations were chosen to represent a range of geomorphic and hydrologic conditions, including spring-fed areas with perennial saturation (e.g. Piezometers 09-02, 09-06), upland surfaces (e.g. 09-05, FS-14), and areas adjacent to the main channel (e.g. 09-03, 09-09), as shown in Figures 4 and 5.

Campbell well points were used to construct the screened interval of each piezometer, with a nominal diameter of 1¼ -inches, and connected via galvanized steel couplers to 1¼ -inch

galvanized steel pipe. The well points were driven by hand with a fencepost pounder until refusal, presumably in gravels or perhaps clayey silt at depth. In order to evaluate potential vertical hydraulic gradients, a reflection of the upward or downward movement of shallow groundwater, the piezometers were designed to only be screened in the bottom 24 inches. When present, vertical hydraulic gradients at each well provide an indication of the shallow groundwater flow direction, either downward from the surface into the ground, or upward from the ground to the surface.

Piezometers were monitored by TRWC and Balance staff beginning in September 2009. Monitoring consists of measuring the depth to water with an electronic water-level sounder and measuring the specific conductance and temperature of the groundwater. Specific conductance measures the ability of water to conduct electricity, and indicates the concentration of total dissolved salts in the water. Snow and rain have a very low specific conductance, (approaching zero) and groundwater is considerably higher; as water passes over and through the ground, salts are dissolved and the specific conductance increased. Higher specific conductance, therefore, indicates longer residence times in the ground, or transmittal through salt-bearing geologic formations, and can be used to distinguish groundwater sources.

The piezometers were occasionally bailed after depth to water measurements were taken to 'flush' the piezometer and allow the water level equilibrate with the surrounding soil. The specific conductance and temperature, thus, remained representative of groundwater conditions. TRWC or Balance staff performed these activities approximately monthly during the dry season.

2.3.2 Streamflow gaging

Balance stream-gaging practices follow procedures used by the USGS, as outlined by Carter and Davidian (1968).

Based on our periodic site visits, staff plate readings, and flow measurements at the Little Truckee River gage (see Table 1), we created an empirical stage-to-discharge relationship, also referred to as a stage-discharge "rating curve." We then used this rating curve to convert the datalogger record of stage to flow. During the monitoring period, as is typically done, we applied multiple stage shifts to account for local scour and fill, and the effects of leaf and debris dams during low flows. Large peak flows (greater than 400 cfs) were estimated based on a conventional extension of the pre- and post-event stage-discharge rating curve(s), as based on

indirect peak flow estimates inferred from high water marks. As with all open-channel gaging of natural streams, some degree of uncertainty remains (especially at high flows) in spite of efforts to be as precise as possible, as discussed in more detail by Rantz (1982).

Most of our results are presented as daily mean flow values, averaged from data collected and calculated every 15 minutes. The more detailed 15-minute streamflow record is available as an electronic attachment to this report.

2.3.2.1 Description of the streamflow gaging station

The streamgage is located on the right bank of the Little Truckee River where the channel exits the Middle Meadow and enters a straight narrow reach. The gaging site was chosen due to relatively shallow depths to bedrock, as indicated by the high concentration of large angular boulders with uniform lithology. The gaging site has been designated as 'LTPM' (Little Truckee at Perazzo Meadows) according to Balance gaging station naming conventions. The watershed of 32.7 square miles receives an average of 47.4 inches of precipitation, as estimated from precipitation data recorded from 1979 to the present at Independence Lake (SNOTEL site 541).

On September 23, 2010, the gaging station was disturbed while the restoration project was being completed. The staff plate and continuous water level recorders were removed temporarily, then re-installed in the reconfigured channel several days later, approximately 30 feet downstream. Figure 6 is a photo of the gaged reach before and after being re-located.

2.4 Comparisons to Other Watersheds

The calculated streamflow record was compared to Sagehen Creek, a streamflow gaging station operated by the U.S. Geological Survey (USGS station 10343500), about 7 miles to the southeast. The Sagehen Creek station has a watershed area of 10.5 square miles, compared to 32.7 square miles at the Little Truckee River at Perazzo Meadows gage. Sagehen Creek is also more distant from Sierra Crest than the Little Truckee River headwaters, with differing geology and soils, but still provides a basic check on the magnitude and timing of streamflow variations on the Little Truckee gage.

3. HYDROLOGIC OBSERVATIONS AND DISCUSSION

During the summers of 2009 and 2010, 'plug and pond' activities took place from upstream to downstream, with an initial plug constructed at the upstream end of the meadow, effectively damming the channel until a pond was formed and overflowed onto the floodplain, into remnant channels, or into the channel downstream. Plug and pond restoration in the Upper Meadow began in early later August, 2009 and continued through September. During the peak snowmelt period in early June 2010, the three uppermost newly constructed plugs were breached and eroded. Beginning in August, 2010, those plugs were repaired concurrently with plug and pond activities in the Middle Meadow. The Middle Meadow restoration was completed on September 30, 2010.

3.1 Water Year 2010 Hydrology

Precipitation in Water Year 2010 was near average, with 48.9 inches recorded at Independence Lake, approximately 4 miles south of the project site. Precipitation was spread fairly evenly over winter, with the exception of a relatively early rain storm occurring on October 13, 2009 causing a spike in streamflow and groundwater levels (Figures 7 through 9). The spring was unusually cold, with several late-season snowstorms followed by an early June heat wave which caused a relatively rapid increase in snowmelt and streamflow.

Continuous water-level records were collected in the Upper Meadow in Piezometers 09-01, 09-04, and FS-15. In the Middle Meadow, continuous water level records were collected in Piezometers 09-06, 09-07, 09-09, and 09-11. Hand measurements and hydrologic observations were made approximately monthly in all other piezometers. Measured groundwater levels are presented graphically in Figure 7. We collected a continuous record of water level (stage) at the Truckee River gaging station for the study period.[2] Daily mean stage is presented in Figure 8, and daily mean streamflow is presented in Form 1 and Figure 9.

Figure 10 is a comparison of flow on Sagehen Creek to flow on the Little Truckee River at Middle Perazzo Meadow. We used this information to validate the Little Truckee record. In

[2] An exception is 5 days between September 23 and September 29, 2010, when data collection was interrupted due to removal and relocation of the gage. Data collection resumed on September 29, 2010, but streamflow calculations for the final 3 days of the water years are pending development of a new rating curve at this station.

general, the streamflow peaks were consistent. One peak did occur on the Little Truckee River in response to the rains of January 19 through January 26 but caused only a minor increase in flow on Sagehen Creek. This storm produced 7.1 inches of precipitation at the Independence Lake gage, followed by very cold temperatures. From this information, we conclude that the record of flow at the Little Truckee River gage is valid based on a) the timing and magnitude of the flow peaks, b) general patterns of flow recession, and c) response to precipitation. We do, howver, but we do consider the data for very cold periods to have a greater degree of uncertainty, due to the build-up of ice and snow at the gage.

Tables 1 and 2 are observer's logs for groundwater and surface water monitoring stations.

3.2 Streamflow

3.2.1 Daily mean streamflow

Continuous streamflow gaging commenced on October 1, 2009 as restoration activities were being completed. Prior to the October 13 rainstorm, baseflow was fairly steady at approximately 1.7 to 2.1 cfs (Form 1, Figure 9).

During Summer 2010, baseflow receded fairly uniformly until restoration activities began in the Middle Meadow, apparently around August 14. Based on the streamflow record, flow appeared to decline as upstream plugs were constructed in the channel. When plugs were constructed upstream of the confluence with Cold Stream, a major perennial tributary, the flow decline was much less than the decline observed when plugs were constructed downstream of the confluence later in the season. Additional water was then captured from Cold Stream, causing flows to decline to less than 0.1 cfs (44 gallons per minute).

3.2.1.2 Basic estimate of increased water storage in the Middle Meadow

By extending the baseflow recession curve through the restoration period, we have developed a rough estimate of the volume of water stored in constructed ponds and meadow soils. We extended the recession curve from the period prior to restoration activities, to October 1, 2010, assuming a baseflow of 2 cfs on October 1, as observed in water year 2009. Two cfs is considered to be a conservatively low assumption given that a) precipitation was less in water year than water year 2010, b) the unusually late spring in water year 2010 likely extended the baseflow recession period, and c) streamflow was measured at 3.0 cfs on October 20, 2010, after meadow restoration was completed. Furthermore, since stream gaging was interrupted on

September 23, no calculations were made during the final days of construction, thereby omitting several days of calculated net flow deficit.

Based on this method of calculating storage, approximately 110 acre-feet of water were stored in the meadow between August 12 and September 23 as plugs were constructed. This is a preliminary estimate, and as stream gaging and monitoring continues, this estimate can be refined.

3.2.2 Peak streamflow

A peak stage of 8.59 was recorded on June 7, 2010. Based on high water marks and indirect flow calculations, we estimate this peak to have been approximately 1,050 cfs. High water marks and water surface observations in the middle meadow indicate that this peak overtopped the banks in the lower Middle Meadow, prior to restoration. As part of a geomorphic assessment in 2008, Swanson Hydrology and Geomorphology developed a flood frequency curve for Sagehen Creek and scaled this curve based on the ratio between watershed sizes. Based on this method, the water year 2010 peak streamflow is calculated to have been an approximately 5- to 10-year event. It is important to note, however, that watershed scaling is not necessarily a reliable predictor of past peak flows on the Little Truckee River at Perazzo Meadows. For example, in water year 2010, peak streamflow on Sagehen Creek was recorded at 64 cfs, compared to 1,050 cfs on the Little Truckee River, a ratio of .06, compared to the watershed size ratio of 0.32. This is likely due to higher precipitation and increased snow loading in the Little Truckee Watershed, which reaches higher elevations along the Sierra Crest. Watershed scaling is probably the best available tool to estimate peak flows in the Little Truckee River at this time; as peak streamflow information is collected on both streams in the future, adjustments may be made on the basis of peak flow correlation methods.

3.3 Groundwater

Piezometers were monitored beginning in July, 2009, continuing through the present, where shown in Figures 4 and 5. Groundwater characteristics were monitored to identify groundwater recharge and discharge areas, as well as response to plug and pond restoration techniques. Groundwater field observations are presented in Table 2, including depth to groundwater, specific conductance, color, odor, and qualitative observations. Specific conductance in groundwater over the course of the monitoring period is shown in Figure 11.

3.3.1 Pre-restoration groundwater conditions

Limited information is available regarding pre-project groundwater levels in the Upper Meadow because most piezometers were installed only days before restoration activities began. During piezometer installation and prior to restoration, observed groundwater levels ranged from 2.6 (in 09-02) to 6.2 (in 09-03) feet below the ground surface (bgs).

Conditions in the Middle Meadow are representative of un-restored meadow functioning under the same hydrologic conditions. Prior to the October 13 storm, groundwater levels ranged from 2.4 to 3.6 feet bgs. Groundwater response to the rainstorm was variable across the Middle Meadow. In the upper portion of the meadow, groundwater levels rose and fell rather abruptly, returning to levels slightly (0.03 to 0.04 feet) higher than pre-storm levels. In the southeast portion of the Middle Meadow, below the confluence with Cold Stream, the response was similar; the net increase in water table conditions about the same, but the recession after the storm was more extended, presumably due to contributions from Cold Stream and springs associated with the Cold Stream alluvial fan (Figures 5 and 12).

The northeast portion of the Middle Meadow, as represented by Piezometer 09-11, appears to be somewhat unique when compared to data from other piezometers (Figure 7). Groundwater response to storm and snowmelt events is limited. Rather, the water table rises and falls seasonally, regardless of short-duration events, suggesting the area is supplied by a deeper source of groundwater that supports a local hydraulic floor. Specific conductance values are relatively high in this area too, another indication of a deeper groundwater source.

3.3.2 Groundwater conditions during and after restoration

3.3.2.1 Groundwater response in the Upper Meadow

Figure 12 shows the observed groundwater conditions in both meadows during Upper Meadow restoration in Fall 2009. Datalogger-equipped piezometers in the Upper Meadow show an initial response to restoration activities, with groundwater levels slowly increasing by approximately 1 foot until the significant rainstorm of October 13, 2009. Shortly after restoration of the Upper Meadow, groundwater in areas near the existing channel or new channels rose anywhere from 1.5 feet (in Piezometers 09-01 and 09-02) to 6.5 higher (09-03) from pre-construction and pre-storm levels, and remained fairly high (Table 2, Figure 12).

In upland areas, as represented by Piezometers 09-05 and 09-14, we observed virtually no long-term increase in shallow groundwater levels until the snowmelt period, when soil saturation

was more or less widespread. Furthermore, the upland terrace where Piezometer 09-05 is located appears to be somewhat hydrologically disconnected from shallow groundwater conditions in the rest of the meadow, as indicated by relatively high specific conductance values (on the order of 500 μmhos/cm during the summer and fall).

3.3.2.2 Groundwater response in the Middle Meadow

As described in Section 3.3.1, no changes in Middle Meadow groundwater conditions were detected in response to restoration of the Upper Meadow.

Figure 13 shows observed groundwater conditions in both meadows during late Summer 2010, when plugs were being repaired in the Upper Meadow and plug and pond construction was taking place in the Middle Meadow. Groundwater levels increased throughout the meadow, with limited responses in areas already supported by elevated groundwater conditions. In these spring-supported areas, groundwater conditions increased by 0.1 to 0.25 feet. In other areas, such as the northwestern and north-central portion of the Middle Meadow, more substantial increases were observed, ranging from 1 to 3 feet.

It is interesting to note that in some cases, groundwater conditions fell by 0.5 to 0.75 feet and recovered over the course of 10 to 20 days during restoration, as the river was temporarily dewatered when water was being dammed upstream.

4. SUMMARY AND CONCLUSIONS

Plug and Pond restoration activities appeared to result in an overall increase in groundwater level at Upper and Middle Perazzo Meadows, but the increase varied spatially and temporally. In areas already supported by shallow groundwater conditions and/or at distant upland areas with perhaps disconnected subsurface geology, the increase was only a few tenths of a foot. In other areas, up to a 6-foot increase in groundwater condition was observed.

Stream gaging took place during water year 2010 where the Little Truckee River flows out of Middle Perazzo Meadow. The validated streamflow record indicated a decrease in streamflow associated with the upstream impounding of water in ponds and meadow soils. Preliminary calculations estimated the net streamflow deficit to be on the order of 110 acre-feet, providing an initial estimate of the minimum water volume stored in the Middle Meadow as a result of restoration activities.

Balance is continuing stream gaging and groundwater monitoring at Perazzo Meadows during water year 2011. To better evaluate the timing and magnitude of water storage in the restored meadows, several additional stream gages have been installed in major tributaries to the meadow, as well as on the Middle Truckee River between the Upper and Lower Meadows. Additional data collected during water year 2011 will assist with expanding the preliminary interpretations of data collected during water year 2010, gain a better understanding of how individual storms and episodic events affect the reconfigured meadow systems, and help infer how the particular hydrologic conditions we monitor compare to the long-term record from the Sagehen Creek station.

5. LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice existing in Northern California at the time the investigation was performed. No other warranties, expressed or implied, are made. It should be recognized that interpretation and evaluation of streamflow records and of subsurface conditions is a difficult and inexact art. Judgment leading to conclusions and recommendations presented above were based on existing information and personnel communications which in total represent an incomplete picture of the site. More extensive studies, including those recommended above, can reduce some of the uncertainties associated with this study.

Balance Hydrologics has prepared this report for the TRWC's exclusive use on this particular groundwater and surface water monitoring study. Analyses and information included in this report are intended for use at the watershed scale. Analyses of channels and other water bodies, rocks, earth properties, topography and/or environmental processes are generalized to be useful at the scale of a watershed, both spatially and temporally. Information and interpretations presented in this report should not be applied to specific projects or sites without the expressed written permission of the authors, nor should they be used beyond the particular area to which we have applied them.

This study was conducted to monitor work done by others. Our conclusions and any implied or inferred recommendations are based on a limited range of surface water and groundwater data in a region of relatively complex geology. They are limited to restoration evaluation purposes and should not be used for design or site-specific work. If readers are aware of additional data, observations, conditions, or forthcoming changes to the bases of our decisions, please contact us or the Truckee River Watershed Council at the first opportunity, such that this report may be promptly revised.

6. REFERENCES

Carter, R.W., and Davidian, J., 1968, General procedures for gaging streams, Techniques of Water Resources Investigations of the United State Geological Survey, Chapter A6, Book 3, 13 p. + figures

Rantz, 1982, Measurement and computation of streamflow, U.S. Geological Survey Water-Supply Paper 2175, 284 p.

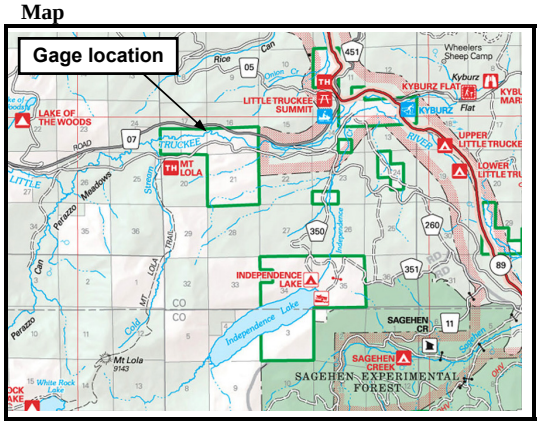
Swanson Hydrology and Geomorphology, 2008, Perazzo Meadows Geomorphic Assessment: consulting report prepared for the Truckee River Watershed C ouncil, 53 p. + appendices.

FORMS

Form 1. Annual Hydrologic Record

Water Year:	**2010**
Stream:	**Little Truckee River**
Station:	**at Middle Perazzo Meadow outlet**
County, State:	**Sierra County, California**

Map



Station Location / Watershed Descriptors

Latitude: 39.494833°N, Longitude: 120.335146°W. The gage is on the right bank, approximately 100 feet downstream of an S curve in the channel as it exits the meadow
Drainage Area = 32.7 sq. mi.

Mean Daily Flow

Mean Daily Flow (MDQ) during the monitoring period, October 1, 2009 to September 22, 2010 is approximately 80.3 cfs.

Peak Flows

Date	Time	Stage (feet)	Discharge (cfs)	Date	Time	Stage (feet)	Discharge (cfs)
10/13/09	20:15	4.72	37	5/21/10	0:30	7.00	464
1/23/10	22:45	4.87	48	**6/6/10**	**22:45**	**8.59**	**1052**
3/31/10	10:30	6.51	339	6/15/10	20:30	7.24	534
5/5/10	18:30	6.42	318	6/30/10	11:00	6.73	391
5/9/10	0:00	6.42	320				

Note: Indirect methods were used to develop an estimate for the annual peak flow.

Period of Record

Staff plate installed 9/23/10. Datalogger installed on October 1, 2009.

WY 2010 Daily Mean Flow in cubic feet per second (cfs)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	1.7	3.9	5.2	9.4	17.1	15.8	46.3	113.1	384.0	258.3	15.2	2.5
2	1.7	3.8	5.1	8.7	14.9	10.8	55.5	122.1	463.4	198.2	14.3	2.7
3	1.7	3.8	4.9	8.1	13.3	15.8	120.5	147.1	698.7	171.8	13.4	2.0
4	2.0	3.6	4.3	8.2	11.8	17.6	45.1	243.9	916.5	149.9	12.7	1.9
5	2.1	3.4	5.7	8.0	10.9	12.8	82.9	304.1	809.9	140.8	11.6	1.9
6	2.1	3.6	5.9	8.1	11.2	10.7	33.0	281.0	888.3	126.0	10.8	1.8
7	2.0	3.9	7.0	7.8	11.2	10.9	34.6	256.3	813.1	125.1	10.5	1.9
8	1.9	4.0	8.8	7.7	10.7	14.1	32.6	288.6	631.2	138.1	10.3	2.5
9	1.9	3.5	7.8	8.0	10.5	14.6	33.5	296.5	589.1	130.5	9.9	2.8
10	1.9	3.2	6.5	8.2	10.5	13.6	35.6	243.2	539.1	108.5	9.4	2.0
11	1.8	3.3	5.7	7.8	9.8	15.6	37.3	189.2	404.0	92.2	8.6	1.2
12	1.8	4.3	5.4	10.9	9.4	12.8	39.4	162.1	366.3	79.4	8.4	1.1
13	12.7	4.4	6.9	16.3	10.8	13.5	36.9	176.4	373.9	97.4	7.9	1.1
14	14.5	4.1	7.8	15.7	12.2	16.2	35.6	213.1	382.8	89.8	7.3	0.4
15	11.9	3.9	7.3	13.4	9.2	18.9	36.7	273.1	429.8	68.2	6.7	0.5
16	8.7	3.8	7.4	12.3	10.4	16.9	43.6	360.5	409.8	60.4	6.3	0.4
17	7.0	3.8	8.8	9.4	13.3	13.1	52.5	411.9	322.1	54.7	6.0	0.1
18	5.9	4.4	8.3	10.6	15.8	14.4	63.2	362.1	353.8	48.9	5.7	0.1
19	6.2	4.3	8.2	11.5	15.5	16.0	81.2	353.4	316.2	50.7	4.7	0.1
20	6.1	4.4	7.2	13.3	12.1	15.6	117.8	426.2	310.6	48.1	3.4	0.1
21	5.7	4.8	9.0	33.2	10.7	16.0	111.3	396.6	293.6	39.8	2.8	0.3
22	5.2	5.3	10.4	45.7	18.8	17.7	113.8	304.6	273.1	34.6	3.3	0.2
23	4.7	6.2	9.2	46.1	13.3	19.6	95.1	233.8	296.7	30.8	3.6	nm
24	4.5	5.6	8.5	40.4	10.8	21.8	104.8	197.3	303.1	27.5	3.0	nm
25	4.3	4.8	9.2	35.1	17.6	24.3	126.0	202.0	292.9	25.7	2.5	nm
26	4.0	5.0	9.1	31.8	11.8	25.7	155.7	222.7	277.0	23.9	2.3	nm
27	4.2	4.9	8.5	32.6	14.7	23.5	194.8	213.6	303.3	21.9	2.2	nm
28	4.3	5.1	8.4	27.5	17.0	25.4	207.3	180.0	310.9	19.7	2.2	nc
29	3.9	5.2	7.9	24.0		33.3	161.5	169.5	271.8	18.5	3.2	nc
30	3.9	5.2	7.3	21.2		177.4	119.4	215.9	291.8	17.0	3.9	nc
31	3.9		9.7	19.8		200.3		289.9		15.6	2.8	
Monthly MEAN	4.7	4.3	7.5	18.1	12.7	28.2	81.8	253.2	443.9	81.0	--	--
MAX	14.5	6.2	10.4	46.1	18.8	200.3	207.3	426.2	916.5	258.3	--	--
MIN	1.7	3.2	4.3	7.7	9.2	10.7	32.6	113.1	271.8	15.6	--	--
cfs days	144.2	129.4	231.1	560.7	355.3	874.9	2453.7	7849.9	13316.7	2512.0	214.8	--
ac-ft	286.1	256.7	458.4	1112.2	704.8	1735.3	4866.9	15570.3	26413.7	4982.6	426.1	--

Monitor's Comments

1. Data collection was manual, continuous stage data was not collected. Therefore, calculationed values should be considered to be estimates.
2. Daily mean flow calculated all the 15-minute observations in one day.
3. Staff plate was removed temporarily on September 23, then reinstalled on September 29, 2010.
4. nm = not measured; nc = stage measured, but flow not yet calculated; -- = data not available
5. Gray values reflect inferred fouling of the gage by ice, a source of significant error.

Water Year 2010		
Mean Daily Flow	**80.3**	(cfs)
Max. Daily Flow	**916**	(cfs)
Min. Daily Flow	**1.7**	(cfs)
Total Flow	**56,813**	(ac-ft)

Balance Hydrologics, Inc., PO Box 1077, Truckee, CA, 96161 phone:(530) 550-9776; Berkeley (Main) Office: (510) 704-1000
www.balancehydro.com

TABLES

Table 1. Hydrologic monitoring observations: Surface water, Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Streamflow				Water Quality Observations				High-Water Marks		Remarks
Date/Time (mm/dd/yr)	Observer(s)	Stage (staff plate) (feet)	Hydrograph (R/F/S/B)	Ground Level (ft)	Measured Discharge (cfs)	Estimated Discharge (cfs)	Instrument Used (AA/PY)	Estimated Accuracy (e/g/f/p)	Water Temperature (oC)	Specific Conductance at field temp. (µmhos/cm)	Specific Conductance at 25C (at 25 oC)	Additional Samples	Estimated stage at staff plate (feet)	Inferred dates? (mm/dd/yr)	
LTPM - Little Truckee River at Middle Perazzo Meadow outflow															
WY2010															
9/25/09 16:00	ds	3.73			--	1.0	--	f	19.3	73	82	--	7.5	wy09	wp239; installed staff plate, many photos taken; HWM appears to be ~geomorphic bankfull
10/1/09 13:16	ds	3.75			1.7	--	py	--	--	--	--	--	--	--	installed levellogger
10/23/09 14:03	bc	3.96			--	1.0	--	--	10.4	61	84	--	--	--	
11/6/09 10:30	ds	3.90			3.2	--	py	--	--	--	--	--	--	--	some suds in water, light rain, ll appears to have slipped
12/3/09 14:00	ds	3.93			4.1	--	py	--	--	--	--	--	--	--	ice at staff plate and at edge of water at Qmeas station
5/14/09 12:30	ds	5.89			170.8	--	AA	f	--	--	--	--	--	--	
6/11/10 12:23	ds	6.69							--	--	--	--	8.1	--	
6/16/10 14:50	ds	6.67			389.5	--	AA	f	--	--	--	--	8.3	--	flagged HWMs along left bank
7/14/10 16:19	ds	5.19			80.9	--	AA	g	20.2	35	39	--	--	--	
7/19/10 7:30	bc	4.83							11.3	35	48	--	7.3	--	some foam - small amt
8/12/10 12:00	ds	4.12			7.7	--	AA	e	14.9	54	67	--	--	--	downloaded datalogger
8/23/10 0:00	bc	3.91							12.1	55	73	--	--	--	channel bed at 3.45; water cloudy
9/15/10 16:20	ds, jo	3.62			0.41	--	py	e	16.7	58	69	--	--	--	downloaded datalogger; surveyed HWMs; plug and pond construction upstream, water level slightly lower than normal judging by silt/algae on rocks
9/27/10 0:00	ds	--			--	.05-0.075	--	--	--	--	--	--	--	--	no staff plate present; gage pulled on 9/23; downloaded levellogger
9/28/10 0:00	ds	--			0.1	--	FLOAT		--	--	--	--	--	--	installed staff plate in new location
LTLL - Little Truckee River, Lower Middle Meadow															
8/21/09 0:00	ds,tb	--	--	--	--	1.10	--	f	15.1	60	74		--	--	near beaver dam, gravel bar
9/23/09 11:50	ds	--	--	--	--	1.60	--		11.7	59	79		--	--	
10/23/09 14:20	bc	4.65	--	--	--	1.00	--		10.2	56.9	79.3		--	--	water is slight brown in color
6/11/10 12:40	ds	6.88	--	--	--	--	--	--	--	--	--		7.7	--	overbank flow evident, at lowest elevation, estaimate 200' wide; small fish (2-3") in left bank swale
7/19/10 8:00	bc	5.20	--	--	--	--	--	--	11.4	35.2	47.5		7.5	--	water cloudy, some foam; beaver action
8/23/10 11:35	bc		--	--	--	--	--	--	11.2	51.9	70.5		7.5	--	water cloudy, lots of beaver activity
9/28/10 11:30	bc	6.95	--	--	--	--	--	--	11.5	61.3	82.8		--	--	now a pond; water clear, brown tint
LTUL - Little Truckee River at Upper Lower Meadow															
10/1/09 13:16	ds	1.58	--	--	--	--	--	--	--	--	--	--	--	--	installed staff plate and levellogger just upstream of major beaver dam, in ponded area
10/23/09 13:28	bc	1.81	--	--	--	--	--	--	10.9	61	84	--	2.12	--	bank is moist and slightly eroded; water clear
6/11/10 14:26	ds	2.96	--	--	--	--	--	--	9.3	24	34	--	3.6	--	water clear; evidence of overbank flow here
7/19/10 10:00	bc	1.26	--	--	--	--	--	--	14.8	36	45	--	--	--	eroding bank
8/23/10 12:50	bc	0.69	--	--	--	--	--	--	16.1	66	80	--	--	--	water murky, constructing taking place upstream, bed and
9/27/10 11:09	ds	2.91	--	--	--	--	--	--	--	--	--	--	--	--	
9/28/10 14:01	bc	2.90	--	3.5	--	--	--	--	13.4	97	125	--	--	--	now a pond; tea colored

Site Conditions					Streamflow				Water Quality Observations				High-Water Marks		Remarks
Date/Time (mm/dd/yr)	Observer(s)	Stage (staff plate) (feet)	Hydrograph (R/F/S/B)	Ground Level (ft)	Measured Discharge (cfs)	Estimated Discharge (cfs)	Instrument Used (AA/PY)	Estimated Accuracy (e/g/f/p)	Water Temperature (oC)	Specific Conductance at field temp. (µmhos/cm)	Specific Conductance at 25C (at 25 oC)	Additional Samples	Estimated stage at staff plate (feet)	Inferred dates? (mm/dd/yr)	
PCUM - Perazzo Creek at Upper Meadow, near FS-14															
7/19/09 0:00	ds,bc	--	--	--	--	0.80	--	--	15.0	39.2	48.0	--	--	--	
10/1/09 17:01	ds	0.97	--	--	--	--	--	--	--	--	--	--	--	--	installed staff plate
10/23/09 10:43	bc	3.20	--	--	--	0.00	--	--	7.1	50.7	77.0	--	--	--	water is flowing over meadow surface by ~1-inch
5/21/10 15:30	ds, rw	3.62	--	--	--	--	--	--	4.4	23.6	39.0	--	--	--	
6/12/10 14:30	bc	3.85	--	--	--	--	--	--	9.4	24.7	35.3	--	--	--	
7/19/10 14:45	bc	3.49	--	--	--	--	--	--	11.8	27.4	40.0	--	--	--	
8/23/10 14:15	bc	3.15	--	--	--	--	--	--	14.2	80.7	101.9	--	--	--	bank and meadow surface saturated; very low flow
9/28/10 16:20	bc	3.22	--	--	--	--	--	--	16.3	78.7	94.3	--	--	--	comorants present
PCLT - Perazzo Creek near confluence with the Little Truckee River															
7/19/09 0:00	ds,bc	--	--	--	--	--	--	--	16.7	45	54	--	--	--	
10/1/09 16:19	ds	0.73	--	--	--	--	--	--							installed staff plate; "PCLT" in field notes
10/23/09 11:41	bc	>3.33	--	--	--	--	~0	--	7.2	47	72	--	--	--	bed and banks are very wet; water is murky brown in color
6/12/10 14:00	bc	--	--	--	--	--	--	--	--	--	--	--	--	--	unable to locate staff plate, perhaps under water
7/19/10 10:45	bc	--	--	--	--	--	--	--	12.5	30	40	--	--	--	unable to locate staff plate, perhaps under water
8/23/10 15:25	bc	>3.33	--	--	--	--	--	--	16.6	63.6	75.9	--	--	--	lots of little fish; top of staff plate just poking out; water murky
LTLU - Little Truckee Lower Upper Meadow (new Channel btween 09-3 and FS-15)															
9/23/09 13:00	--	--	--	--	--	--	--	--	28.4	51	48	--	--	--	water stagnant
LTTR - Little Truckee Trib at Hennes Pass Rd.															
9/23/2009 10:45	ds	--	b	--	--	0.18	--	--	7.4	95	63	--	--	--	
6/11/10 15:00	ds	--	--	--	--	5.50	--	--	12.7	41	52	--	--	--	
9/28/10 13:35	bc	--	--		--	--	--	--	17.5	78.9	92.0	--	--	--	water clear

Notes:

1) ds is David Shaw (Balance); bc is Beth Christman (Truckee River Watershed Council); rw is Randy Westmoreland (USFS); tb is Travis Bagget (Balance); jo is Jonathan Owens (Balance)
2) Ground level may change due to erosion of the channel
3) Hydrograph abreviations, R=rising, F=falling, S=Steady, B=Baseflow

Specific conductance: Measured in micromhos/cm in field using a YSI30 hand-held meter; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer 09-1 - Head of Upper Meadow									
Total Depth	5.34 *ft bgs*								
Depth to bottom =	8.30 *ft btoc*								
Total Stickup =	2.96 *ft above gs*								
Elevation =	6567.5 *ft*								
8/21/09 0:00	ds,bc	6.75	3.79	6563.7					piezometer installed; DTW does not necessarily reflect static water level
9/23/2009 17:16	ds	7.1	4.14	6563.3	8.8	66	97		stratified: 122uS at top (82@9.4)
10/23/2009 9:43	bc	4.64	1.68	6565.8	7.9	73	108	n	labelled top of casing
12/4/2009 12:39	bc	4.60	1.64	6565.8	4.3	62	102	n	water clear, no odor
5/21/2010 16:00	ds,rw	3.04	0.08	6567.4	2.8	31	55		DTSW=2.83 (several inches deep and flowing), SCTsw=20@2.9C, 35@25
7/19/2010 13:45	bc	3.64	0.68	6566.8	11.0	47	65	n	ground is wet
8/23/2010 16:40	bc	4.78	1.82	6565.7	12.5	68	90	y	water clear
9/28/2010 15:40	bc	4.98	2.02	6565.5	11.0	90	124	n	water clear, no odor
11/2/2010 9:50	ds	3.89	0.93		6.1	75	116	n	not stratified; flowing water in depression just NW of piezo; main channel is now SE of piezo, ponds and plugs in original channel; sfc water SCT = 50@25; downloaded datalogger
				6566.6					
Piezometer 09-2 - East side of Upper Meadow									
Total Depth	4.24 *ft bgs*								
Depth to bottom =	6.00 *ft btoc*								
Total Stickup =	1.76 *ft above gs*								
Elevation =	6556.8 *ft*								
8/21/09 0:00	ds, bc	4.34	2.58	6554.3					piezometer installed; DTW does necessarily reflect static water level
9/23/2009 15:51	ds	4.02	2.26	6554.6	8.0	105	157		wp230
10/23/2009 10:03	bc	2.43	0.67	6556.2	5.8	107	168	n	
12/4/2009 11:45	bc	2.26	0.50	6556.3	2.8	112	194	n	water clear, no odor
5/21/2010 13:30	ds, rw	2.06	0.30	6556.5	4.4	24	40		
6/12/2010 14:10	bc	2.26	0.50	6556.3	6.9	33	50		
7/19/2010 12:15	bc	2.72	0.96	6555.9	8.3	53	74	n	
8/23/2010 15:00	bc	2.97	1.21	6555.6	6.6	98	150	y	water clear, no odor
9/28/2010 16:05	bc	2.68	0.92	6555.9	6.3	114	176	n	water clear, no odor
11/2/2010 10:20	ds	2.31	0.55	6556.3	3.9	110	184	n	gradual increase in SC with depth, SC=225 at bottom of piezo

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer 09-3 - Lower Upper Meadow, near confluence Upper Truckee / Perazzo Cr									
Total Depth	8.00 *ft bgs*								
Depth to bottom =	10.10 *ft btoc*								
Total Stickup =	2.10 *ft above gs*								
Ground Elevation =	6544.2 *ft*								
8/21/09 0:00	ds,bc	8.33	6.23	6538.0					piezometer installed; DTW does necessarily reflect static water level
9/23/2009 12:50									piezo is filled with sediment to depth 3.52 below toc; adjacent to constr. Access road
10/23/2009 11:25	bc	1.7	-0.40	6544.6	7.5	77	117	n	water ponded on ground surface
12/4/2009 11:04	bc								water ponded on surface and frozen solid
5/21/2010 14:30	ds, rw	0.93	-1.17	6545.4	2.1	83	142	n	water flowing at sfc, SCT(sw) = 18@3C, 31@25; depth to SW = 1.16
6/12/2010 15:30	bc								unable to access due to high water
7/19/2010 10:40	bc	1.15	-0.95	6545.2	12.7	101	132	n	water ponded at sfc
8/23/2010 14:00	bc	1.49	-0.61	6544.8	12.2	102	136	y	water ponded at sfc; water clear, no odor
9/28/2010 15:00	bc	1.89	-0.21	6544.4	10.3	122	170	n	water ponded at sfc; water clear, no odor
11/2/2010 12:48	ds	1.59	-0.51	6544.7	40.7	114	182	n	waetr ponded at sfc, slightly lower elevation (by 0.10') than groundwater impling downward hydraulic gradient; sfc water SC=64@25
Piezometer 09-4 - North Side lower upper meadow, adjacent to volcanic bedrock outcrop									
Total Depth	7.34 *ft bgs*								
Depth to bottom =	10.10 *ft btoc*								
Total Stickup =	2.76 *ft above gs*								
Elevation =	6546.2 *ft*								
8/21/09 0:00	ds,bc	6.92	4.16	6542.0					piezometer installed; DTW does necessarily reflect static water level
9/23/2009 14:59	ds	7.43	4.67	6541.5	8.7	69	101		wp228; installed levelogger
10/23/2009 12:02	bc	3.18	0.42	6545.7	7.1	99	150		
12/4/2009 10:32	bc	3.18	0.42	6545.7	1.7	68	122		
5/21/2010 17:25	ds, rw	2.23	-0.53	6546.7	3.7	56	95		SCTsfc=23@4.9C, 38@25
6/12/2010 16:00	bc								unable to access due to deep water and channels at well
7/19/2010 13:15	bc	2.85	0.09	6546.1	11.6	67	90	n	ground saturated but no standing water
8/23/2010 17:15	bc				12.0	65	87	y	water clear, no odor
9/28/2010 16:50	bc	3.26	0.50	6545.7	9.4	79	113	n	water clear, no odor
11/2/2010 12:10	ds	2.65	-0.11	6546.3	6.8	64	99	n	not stratified; surface water is 76@25

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer 09-5 - North side, lower upper meadow, upland terrace									
Total Depth	5.26 *ft bgs*								
Depth to bottom =	10.01 *ft btoc*								
Total Stickup =	4.75 *ft above gs*								
Elevation =	6553.8 *ft*								
8/21/09 0:00	ds,bc	dry							piezometer installed
9/23/2009 14:46	ds	9.78	5.03	6548.8	11.2	145	197	y	wp227; very little water in bottom of well.
10/23/2009 12:12	bc	9.65	4.90	6548.9	9.3	362	517	n	murky brown color, water level near bottom of well
12/4/2009 10:18	bc	8.91	4.16	6549.6	6.8	298	459	n	water clear, no odor; capped
6/12/2010 15:45	bc	4.77	0.02	6553.8	9.2	174	250	n	
7/19/2010 13:05	bc	5.80	1.05	6552.7	10.6	171	237	n	
8/23/2010 17:00	bc	7.87	3.12	6550.7	10.1	194	270	y	water clear, no odor
9/28/2010 16:40	bc	8.62	3.87	6549.9	9.9	280	393	n	water clear, no odor
11/2/2010 11:58	ds	6.18	1.43	6552.4	7.3	96	145		stratified: 374@25 at depth
Piezometer 09-6 - S Side Middle Meadow, just east of willow line of Cold Creek									
Total Depth	5.35 *ft bgs*								
Depth to bottom =	8.60 *ft btoc*								
Total Stickup =	3.25 *ft above gs*								
Elevation =	6492.6 *ft*								
8/27/09 0:00	ds, tb	4.23	0.98	6491.7					piezometer installed; water level not static, but fairly stable
9/23/2009 10:35	ds	4.01	0.76	6553.0	9.3	95	137	y	replaced SCT meter battery just prior to measurement; installed levelloger after bailing well
10/1/2009 9:30	ds,bc	4.00	0.75	6553.0	7.3	82	124	n	downloaded levelogger
10/23/2009 12:58	bc	3.69	0.44	6553.3	6.4	82	127	n	water clear, no odor
12/4/2009 13:56	bc	3.83	0.58	6553.2	2.8	79	137	n	water clear, no odor
6/11/2010 15:00	ds	3.28	0.03	6553.8	4.6	98	160	n	stratified; SCT at water table = 94.4@9.3degC, 135@25; downloaded DL; saturated at sfc
7/19/2010 9:24	bc	3.47	0.22	6553.6	10.4	116	161	n	
8/23/2010 12:35	bc	4.21	0.96	6552.8	8.3	100	148	y	water clear, no odor; cap replaced with loose oversized cap
9/28/2010 13:45	bc	3.71	0.46	6553.3	6.4	86	133	n	water clear, no odor
11/2/2010 13:43	ds	3.41	0.16	6553.6	5.2	83	131	n	stratified: 88@25 in upper portion of well; water ponded in nearby depressions, evidence of surface flow in willows; downloaded datalogger

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer 09-7 - S Side lower middle meadow									
Total Depth	6.26 *ft bgs*								
Depth to bottom =	10.00 *ft btoc*								
Total Stickup =	3.74 *ft above gs*								
Elevation =	6472.7 *ft*								
8/27/09 0:00	ds, tb	7.19	3.45	6469.3	11.2	101	139		coupler driven onto pipe, could not remove, no cap installed
9/23/2009 11:16	ds	7.01	3.27	6469.5	9.7	102	72	y	SC rises slightly after purcging, ~10uS; water slightly turbid after bailing
10/1/2009 11:55	ds,bc	6.97	3.23	6469.5	9.5	81	115		downloaded levellogger; measurement from top of inside casing, not coupling
10/23/2009 14:30	bc	6.50	2.76	6470.0	8.1	73	107		water clear in color, no odor
12/5/2009 10:44	bc	6.38	2.64	6470.1	4.5	68	113	n	water clear, no odor; no cap installed; bird droppings
6/11/2010 16:00	ds	4.23	0.49	6472.3	8.5	95	142	n	temperature stratified, 4.1degC at bottom of well; downloaded DL
7/19/2010 8:13	bc	5.96	2.22	6470.5	8.3	96	142	n	no cap
8/23/2010 11:20	bc	6.59	2.85	6469.9	8.9	92	133	y	water clear, no odor, replaced cap
9/28/2010 0:00									unable to located piezo
11/3/2010 16:23	ds		0.36	6472.4	6.6	119	183		well stickup is broken off, replaced; downloaded and removed datalogger to avoid damage.
Piezometer 09-8 - Upper end middle meadow, north side									
Total Depth	4.80 *ft bgs*								
Depth to bottom =	9.75 *ft btoc*								
Total Stickup =	4.95 *ft above gs*								
Elevation =	6497.4 *ft*								
8/27/09 0:00	ds,tb	8.53	3.58	6493.8					piezometer installed; not static, fairly steady
9/23/2009 16:05	ds	8.42	3.47	6493.9	10.6	115	160	y	wp238; no stratification
10/1/2009 9:01	ds,bc	8.41	3.46	6493.9	10.4	97	135	n	
10/23/2009 13:20	bc	7.96	3.01	6494.4	9.4	104	149	n	water clear; no odor
12/4/2009 13:29	bc	7.82	2.87	6494.5	6.6	93	144	n	water clear no odor; capped
6/12/2010 16:30	bc	5.14	0.19	6497.2	9.7	149	209	n	
7/19/2010 9:45	bc	7.52	2.57	6494.8	9.4	117	167	n	
8/23/2010 13:00	bc	7.03	2.08	6495.3	10.7	101	140	y	water muddy at bottom, next to active construction
9/28/2010 14:15	bc	5.50	0.55	6496.8	10.2	98	134	n	water clear, no odor
11/2/2010 14:54	ds	4.97	0.02	6497.4	8.6	140	206		not stratified; no evidence of overland flow at this location

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer 09-9 - Upper end middle meadow, north side near lone double pine in meadow									
Total Depth	4.34 *ft bgs*								
Depth to bottom =	5.97 *ft btoc*								
Total Stickup =	1.63 *ft above gs*								
Elevation =	6493.2 *ft*								
8/29/09 0:00	ds,tb	4.04	2.42	6490.8	13.6	90	116	n	piezometer installed; water level not static
9/23/2009 18:00	ds				11.7	162	216		stratified: 147uS at top (111@12.3); installed levellogger
10/1/2009 8:48	ds,bc	3.87	2.25	6491.0	11.1	88	123	n	changed levellogger id to "09-9"; downloaded data
10/23/2009 13:12	bc	3.36	1.74	6491.5	9.4	102	145	n	water clear, no odor
12/4/2009 13:22	bc	3.20	1.58	6491.7	4.7	88	143	n	water clear, no odor
6/11/2010 14:07	ds				9.4	76	108	n	
7/19/2010 9:40	bc	3.50	1.88	6491.4	11.8	121	162	n	
8/23/2010 13:15	bc	4.47	1.16	6492.1	12.4	94	124	y	water clear, no odor
9/27/2010 11:00	ds	2.29	-1.02	6494.3	10.7	103	142	n	downloaded levellogger
9/28/2010 14:10	bc	2.38	-0.93	6494.2	11.2	101	137	n	water clear, no odor
11/2/2010 14:27	ds	1.92	-1.39	6494.6	7.1	100	150	n	not stratified, downloaded datalogger, HWM is 0.55' above ground surface
Piezometer 09-10 - Lower Middle Meadow, S side, opposite and corral									
Total Depth	6.70 *ft bgs*								
Depth to bottom =	10.01 *ft btoc*								
Total Stickup =	3.31 *ft above gs*								
Elevation =	6477.1 *ft*								
8/29/09 0:00	ds,tb	5.76	2.45	6474.7	13.2	127	165	n	piezometer installed; water level not static
9/23/2009 12:35	ds	5.21	1.90	6475.2	9.0	120	174	y	
10/1/2009 11:04	ds,bc	5.11	1.80	6475.3	9.2	103	148	y	
10/23/2009 14:47	bc	4.38	1.07	6476.1	7.4	102	154	n	water clear, no odor
12/5/2009 10:13	bc	4.40	1.09	6476.1	2.6	91	158	n	water clear, no odor
6/11/2010 13:35	ds	3.85	0.54	6476.6	9.5	102	144	n	temp stratified; 5.3 degC at depth
7/19/2010 8:30	bc	5.00	1.69	6475.5	11.4	101	136	n	
8/23/2010 10:55	bc	5.80	2.49	6474.7	10.4	91	126	y	water clear, no odor
9/28/2010 12:00	bc								destroyed by cows
11/3/2010 16:00	ds		0.55	6476.6	7.9	75	111	n	well is destroyed, DTW reading is in remnant hole, was able to replace stickup, but well is filled with gravel; need to replace.

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer 09-11 - N Side lower middle meadow, just N USFS boundary									
Total Depth	7.17 *ft bgs*								
Depth to bottom =	10.00 *ft btoc*								
Total Stickup =	2.83 *ft above gs*								
Elevation =	6474.7 *ft*								
8/29/09 0:00	ds,tb	9.88	7.05	6467.7	11.9	199	267		piezometer installed, water level not static, still rising
9/23/2009 12:00	ds	5.16	2.33	6472.4	10.8	111	151	y	
10/1/2009 11:26	ds,bc	5.01	2.18	6472.5	10.5	116	160		no stratification
10/23/2009 15:03	bc	3.98	1.15	6473.6	8.7	103	150	n	water clear, no odor
12/5/2009 10:28	bc	3.23	0.40	6474.3	2.6	81	141	n	
6/11/2010 12:52	ds	2.38	-0.45	6475.2	19.5	140	157	n	water ponded in depressions; downloaded DL; red-tail hawk; stratified: 131@4.9; 211@25 at depth; depth to SW from TOC = 2.65, suggests upward vertical hydraulic gradient
7/19/2010 7:50	bc	3.92	1.09	6473.6	12.8	178	137	n	
8/23/2010 10:35	bc	5.15	2.32	6472.4	11.6	148	198	y	water clear, 'oily' odor
9/28/2010 12:10	bc	4.85	2.02	6472.7	9.6	157	223	n	water clear, no odor
11/3/2010 15:15	ds	2.92	0.09	6474.6	9.1	154	223	n	ground is moist; no evidence of overland flow; water is flowing swale ~400' N of piezo, SC=164@25, appears to be spring fed from base of N hillside alluvial fan
Piezometer FS-12 - West (left) side Upper Meadow									
Total Depth	4.43 *ft bgs*								
Depth to bottom =	8.10 *ft btoc*								
Total Stickup1 =	3.67 *ft above gs*								
Total Stickup2 =	3.58 *ft above gs*								
Elevation =	6553.8 *ft*								
7/19/09 0:00	ds	7.14	3.47	6550.3	9.5	102	145	n	
9/23/2009 16:19	ds	5.3	1.63	6552.1	9.9	90	122	n	stratified: 49 uS/cm at top (37@10.8)
10/23/2009 10:22	bc	6.98			7..6	85	127	n	stinky; well seems disturbed and data point is an outlier, omitted from the record
12/4/2009 12:18	bc	5.60	1.93	6551.8	4.7	36	59	n	water clear, no odor
5/21/2010 15:30	ds, rw	7.77	4.10	6549.7					SCT reading Lerr
6/12/2010 0:00	bc								unable to remove cap
7/19/2010 11:55	bc								unable to remove cap
8/23/2010 15:35	bc	4.54	0.96	6552.8	12.2	59	78	y	water light brown; cut cap off well, new stickup = 43" (see 'Total Stickup2)
9/28/2010 15:50	bc	4.32	0.74	6553.0	9.7	64	90	n	water clear, no odor
11/2/2010 11:17	ds	3.96	0.38	6553.4	6.5	62	40		stratified: 112@25 in bottom 1-2" of well; 78@25 in adjacent pond

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer FS-13 - East (right) side Upper Meadow									
Total Depth	4.10 *ft bgs*								
Depth to bottom =	7.35 *ft btoc*								
Total Stickup =	3.25 *ft above gs*								
Elevation =	6555.2 *ft*								
7/19/09 0:00	ds	5.69	2.44	6552.8	8.4	102	145	n	stratified: 75 uS/cm at top of water table
9/23/2009 16:04	ds	4.88	1.63	6553.6	8.2	104	152	y	stratified: 62 uS/cm at top of water table; installed levellogger programmed for 09-03
10/23/2009 10:14	bc	3.09	-0.16	6555.4	6.5	41	63	n	labeled well; standing water at base of well
12/4/2009 12:09	bc								frozen
5/21/2010 14:20	ds, rw	7.49	4.24	6551.0	4.4	24	39		1" water on sfc, SCTsfc same as piezo; checked meas several times.
6/12/2010 14:40	bc	3.59	0.34	6554.9	7.0	26	38	n	water ponded on sfc
6/16/2010 12:30	ds	2.53	-0.72	6556.0				n	water flowing at sfc; downloaded LL
7/19/2010 11:55	bc	2.66	-0.59	6555.8	11.7	30	46	n	water ponded on sfc
8/23/2010 15:45	bc	3.54	0.29	6555.0	15.4	177	216	y	ground wet, no standing water; water brown, no odor
9/28/2010 15:55	bc	3.48	0.23	6555.0	10.8	151	207	n	water clear, no odor
11/2/2010 11:00	ds	3.00	-0.25	6555.5	4.1	40	67	y	conductance same as sfc water ponded at base of well 0-3" deep; downloaded datalogger
Piezometer FS-14 - West (left) side Upper Meadow, upstream bedrock reach, on upland terrace									
Total Depth	5.28 *ft bgs*								
Depth to bottom =	8.08 *ft btoc*								
Total Stickup =	2.80 *ft above gs*								
Elevation =	6553.8 *ft*								
7/19/09 0:00	ds	7.64	4.84	6549.0	9.5	471	671	n	
9/23/2009 16:33	ds	7.05	4.25	6549.6	9.6	413	580	y	stratified: 412 uS at bottom (413@9.6); smells bad, like feces or rotting flesh; no levelogger installed
10/23/2009 10:37	bc	4.50			8.3	41	60	n	water clear, no odor; data point is an outlier, omitted from the record
12/4/2009 11:21	bc	7.93	5.13	6548.7	4.5	63	104	n	water clear, no odor, no cap
6/12/2010 15:00	bc	7.02	4.22	6549.6	6.5	23	36		no cap
7/19/2010 11:40	bc	4.33	1.53	6552.3	10.7	36	50	n	no cap
8/23/2010 15:15	bc	4.7	1.90	6551.9	11.8	59	79	y	water clear, no odor, replaced cap
9/28/2010 15:55	bc	3.48	0.68	6553.2	10.8	151	207	y	water clear, no odor
11/2/2010 10:45	ds	4.31	1.51	6552.3	7.6	68	102		terrace is now surrounded by remnant channels with flowing sw; terrace sfc appears to be 2-4' higher than meadow/floodplain; this piezo probably better reflects changes from surface flow and restoration activities than other gw-influenced areas.

Table 2. Hydrologic monitoring observations: Shallow groundwater
Perazzo Meadows Restoration, Sierra County, California

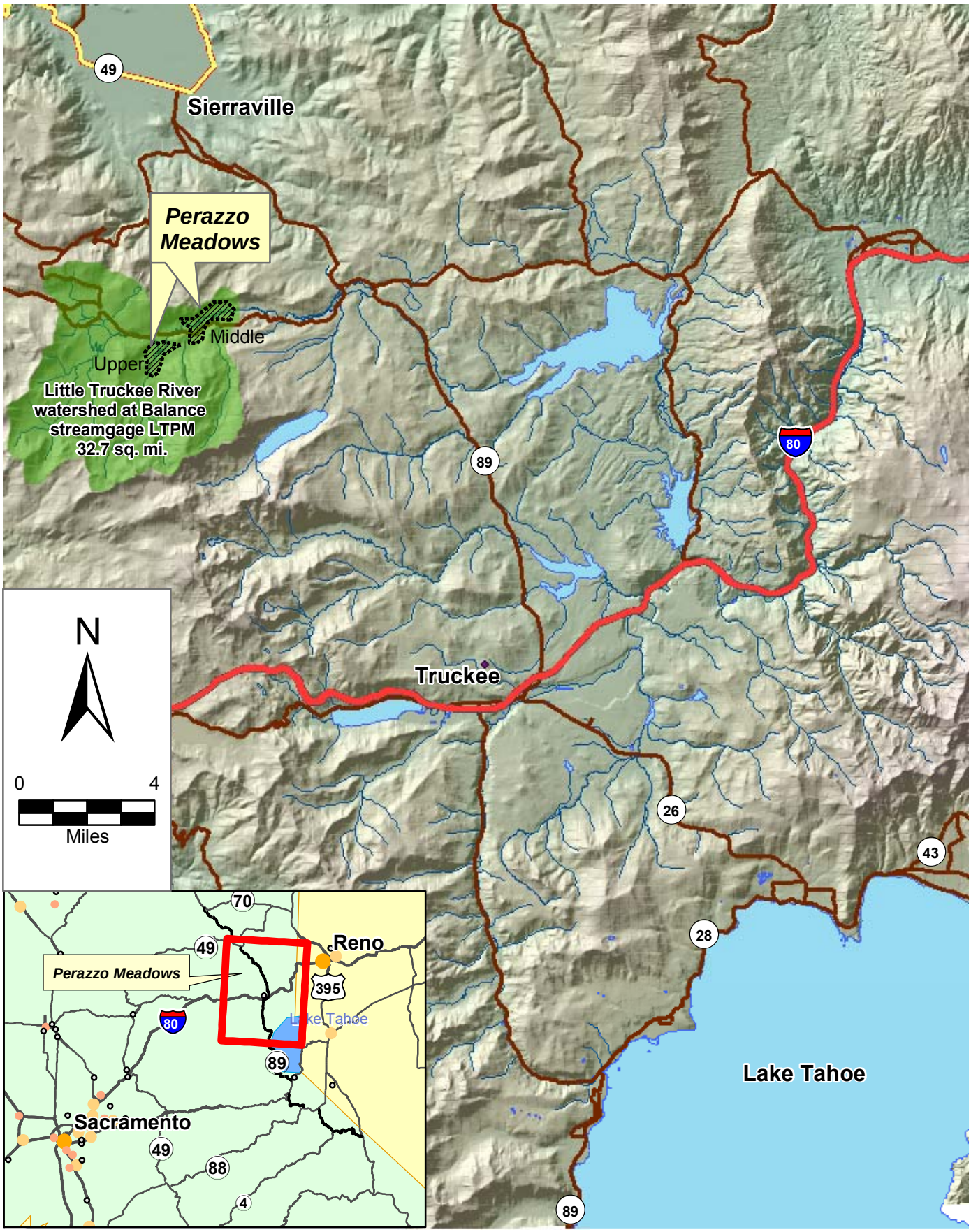
Site Conditions					Water Quality Observations				Remarks
Date/Time	Observer	Top-of-casing to water (ft)	Depth to water (ft, bgs)	Water Surface Elevation NGVD/NAVD)	Temperature (°C)	Specific Conductance (at field temp.) (µS/cm)	Specific Conductance (at 25 °C)	Bailed?	
Piezometer FS-15 - Upper Meadow, Immediately downstream of bedrock reach									
Total Depth	5.52 *ft bgs*								
Depth to bottom =	7.72 *ft btoc*								
Total Stickup =	2.20 *ft above gs*								
Elevation =	6548.3 *ft*								
7/19/09 0:00	ds								not measured (locking cap)
9/23/2009 15:20	ds	7.58	5.38	6542.9					wp229 unable to get SC reading due to mud at bottom; equipped with FS water level recorder
10/23/2009 11:04	bc	4.04	1.84	6546.5	9.6	54	79		water clear, no odor; added label
12/4/2009 10:47	bc	3.88	1.68	6546.6	6.7	53	83	n	water clear, no odor;
6/12/2010 15:15	bc	3.74	1.54	6546.8	4.7	43	70	n	
7/19/2010 11:07	bc	3.93	1.73	6546.6	9.9	53	74	n	
8/23/2010 14:30	bc	4.13	1.33	6547.0	14.6	59	73	y	clear on top, brown on bottom, no odor
9/28/2010 15:10	bc	4.05	1.25	6547.0	12.7	63	83	n	water clear, no odor

Notes:
1) ds is David Shaw (Balance); bc is Beth Christman (Truckee River Watershed Council); rw is Randy Westmoreland (USFS); tb is Travis Bagget (Balance)
2) NR is not recorded, -- is not applicable
3) Water surface elevationsare based on ground surface elevations indicated on digital elevation models (DEM) provided by the USFS
4) btoc=below top of casing; bgs=below ground surface

Specific conductance: Measured in micromhos/cm in field using a YSI30 hand-held meter; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance

Wellhead elevation information derived from LiDAR-based topographic mapping.

FIGURES



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209116 location.mxd

Figure 1. Location of Perazzo Meadows, Sierra County, California

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Figure 2. Middle Perazzo Meadow, post-restoration
Sierra County, California

209116 Figure 2 Middle Meadow

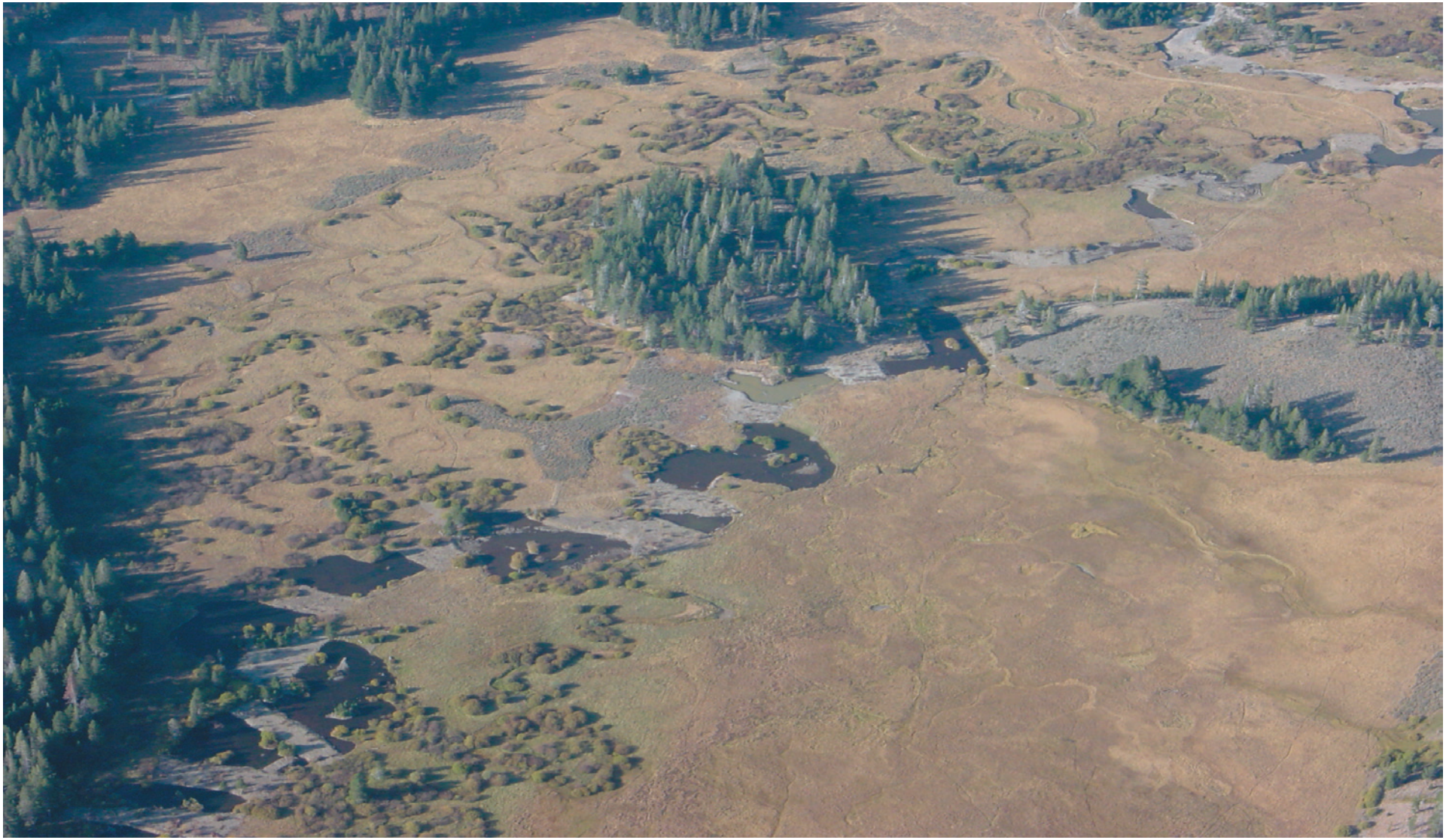

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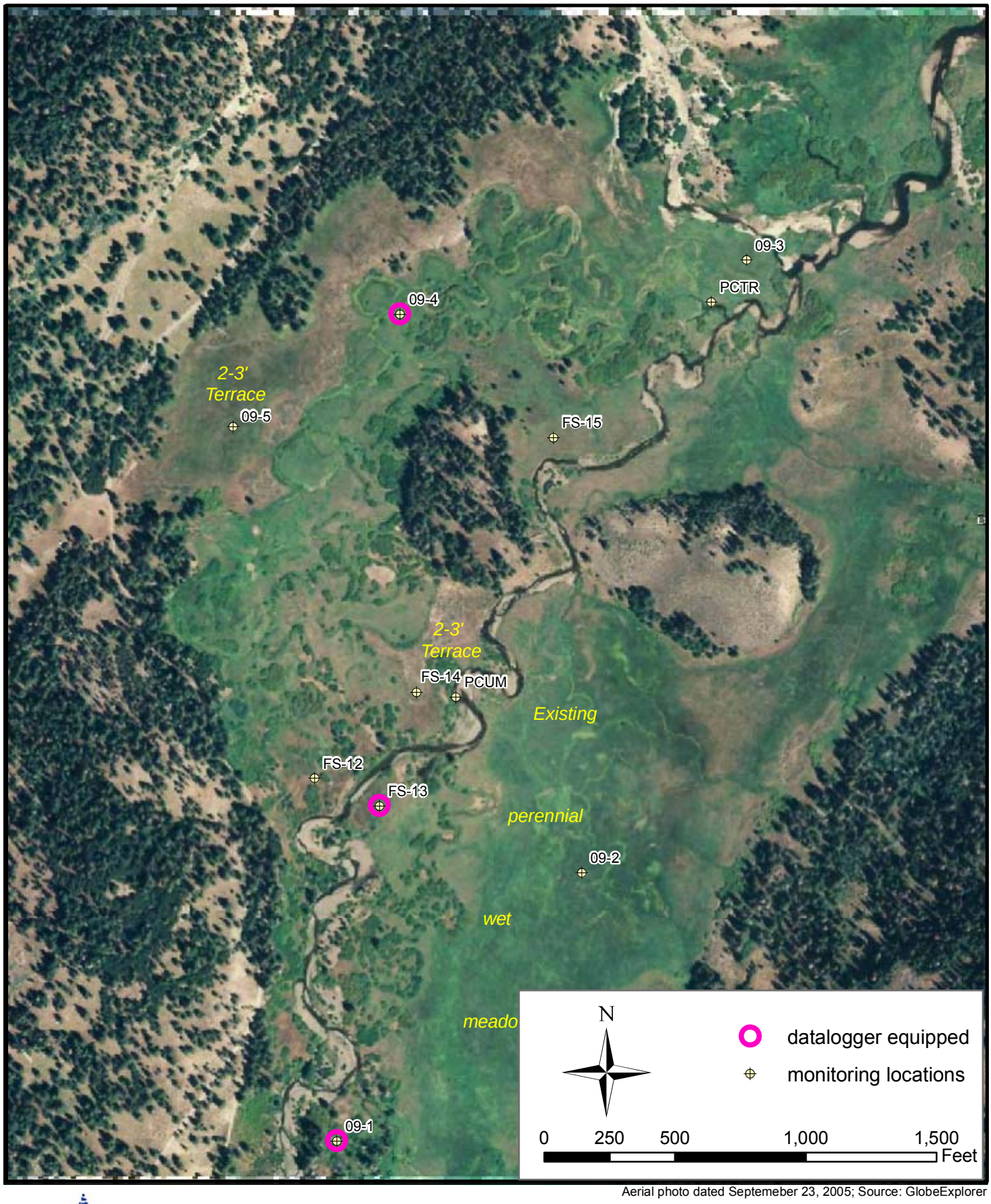
Figure 3. Oblique aerial photograph of Upper Perazzo Meadow, post-restoration, Sierra County, California

209116 Figure 2 Upper Meadow.indd



Aerial photo dated Septemeber 23, 2005; Source: GlobeExplorer

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Figure 4. Location of groundwater and surface water monitoring stations Upper Perazzo Meadow, Sierra County, California

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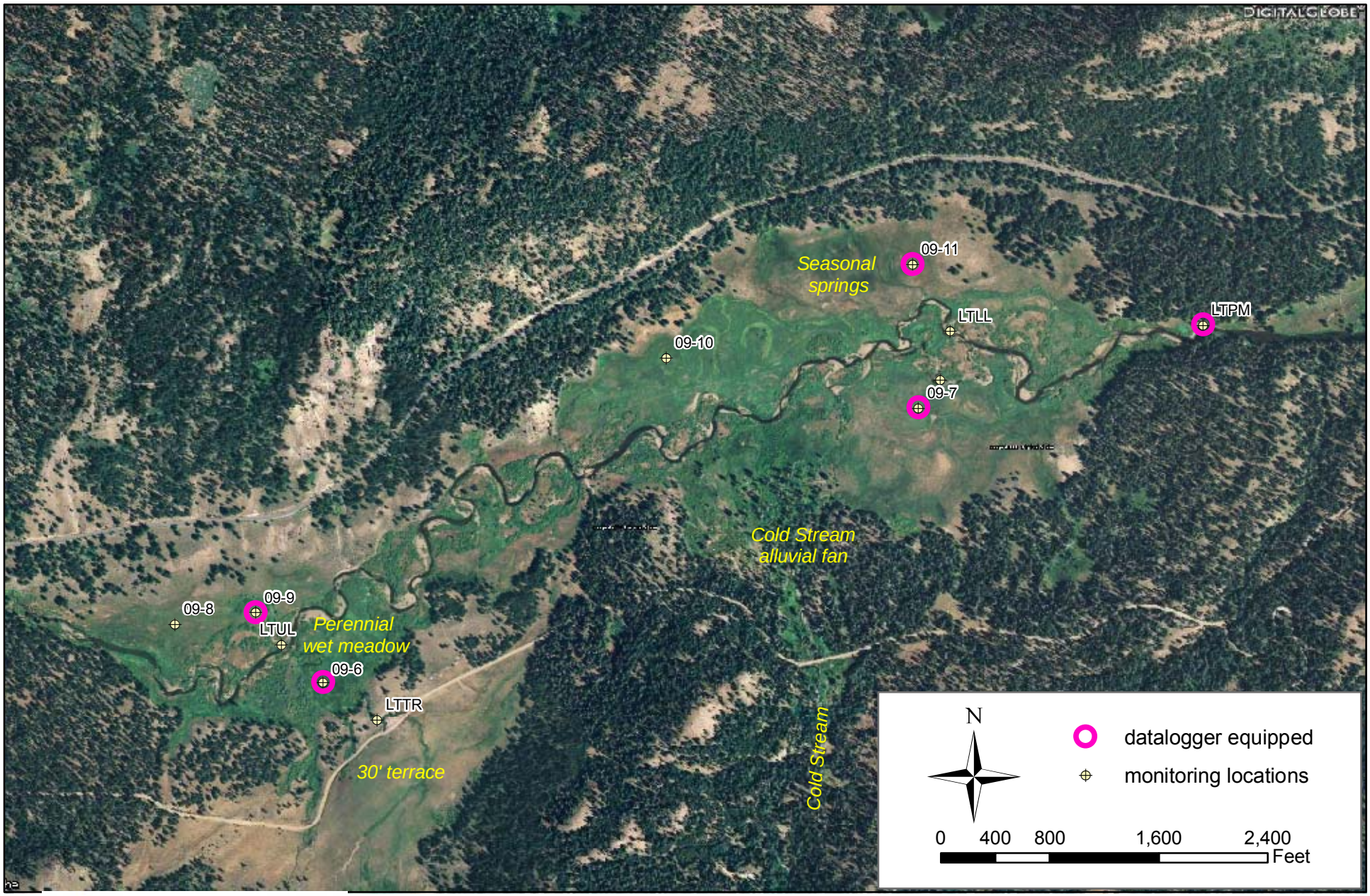

Aerial photo dated Septemeber 23, 2005; Source: GlobeExplorer

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Figure 5. Location of groundwater and surface water monitoring stations Middle Perazzo Meadow, Sierra County, California

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Pror to restoration and relocation

After restoration and gage relocation

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Figure 6. Little Truckee River at the Middle Perazzo Meadow outflow (Balance stream gaging station LTPM) Sierra County, California

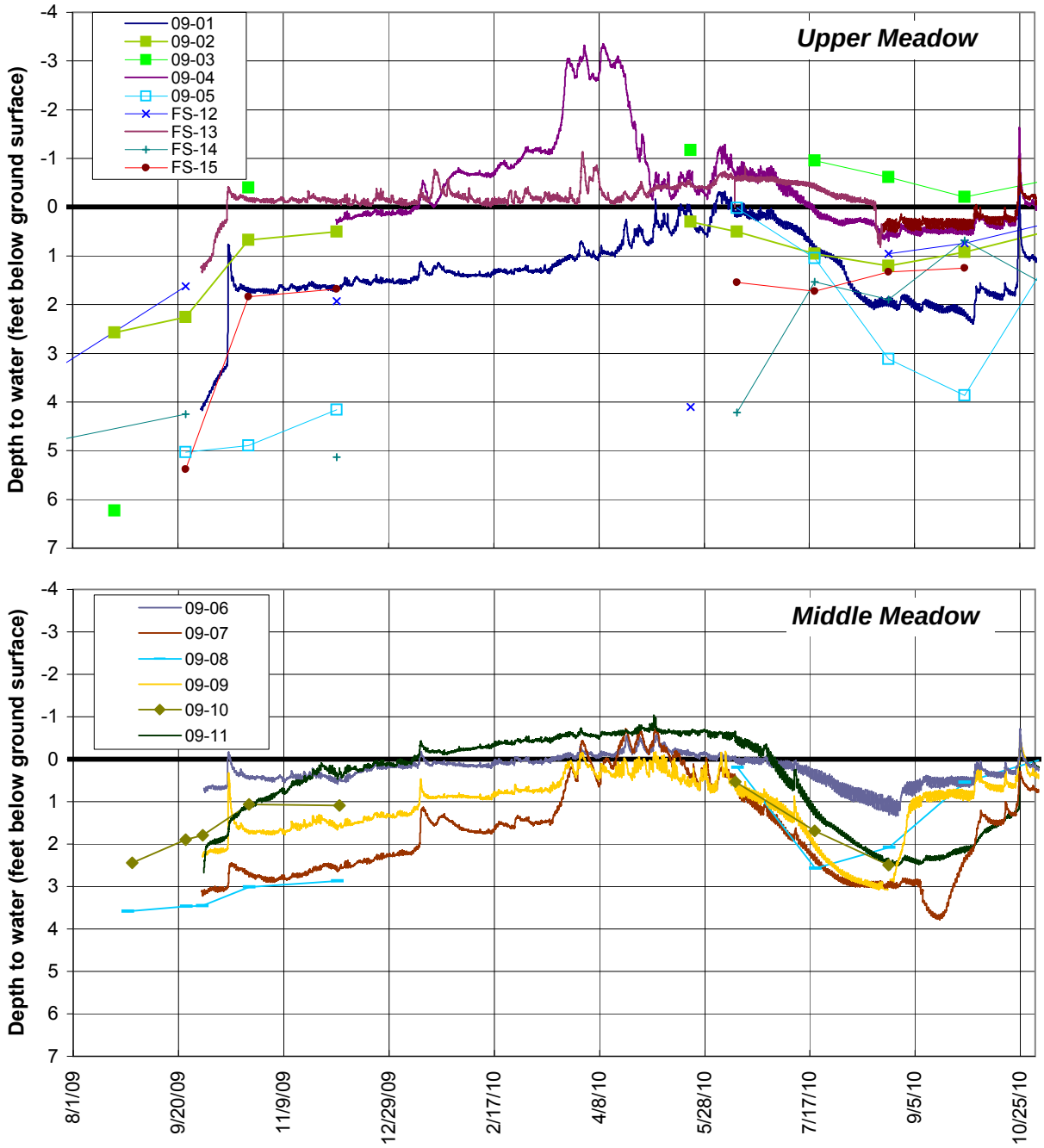

Figure 7. Depth to groundwater over the monitoring period, Upper and Middle Perazzo Meadows, Sierra County, California

See Figures 4 and 5 for piezometer locations.

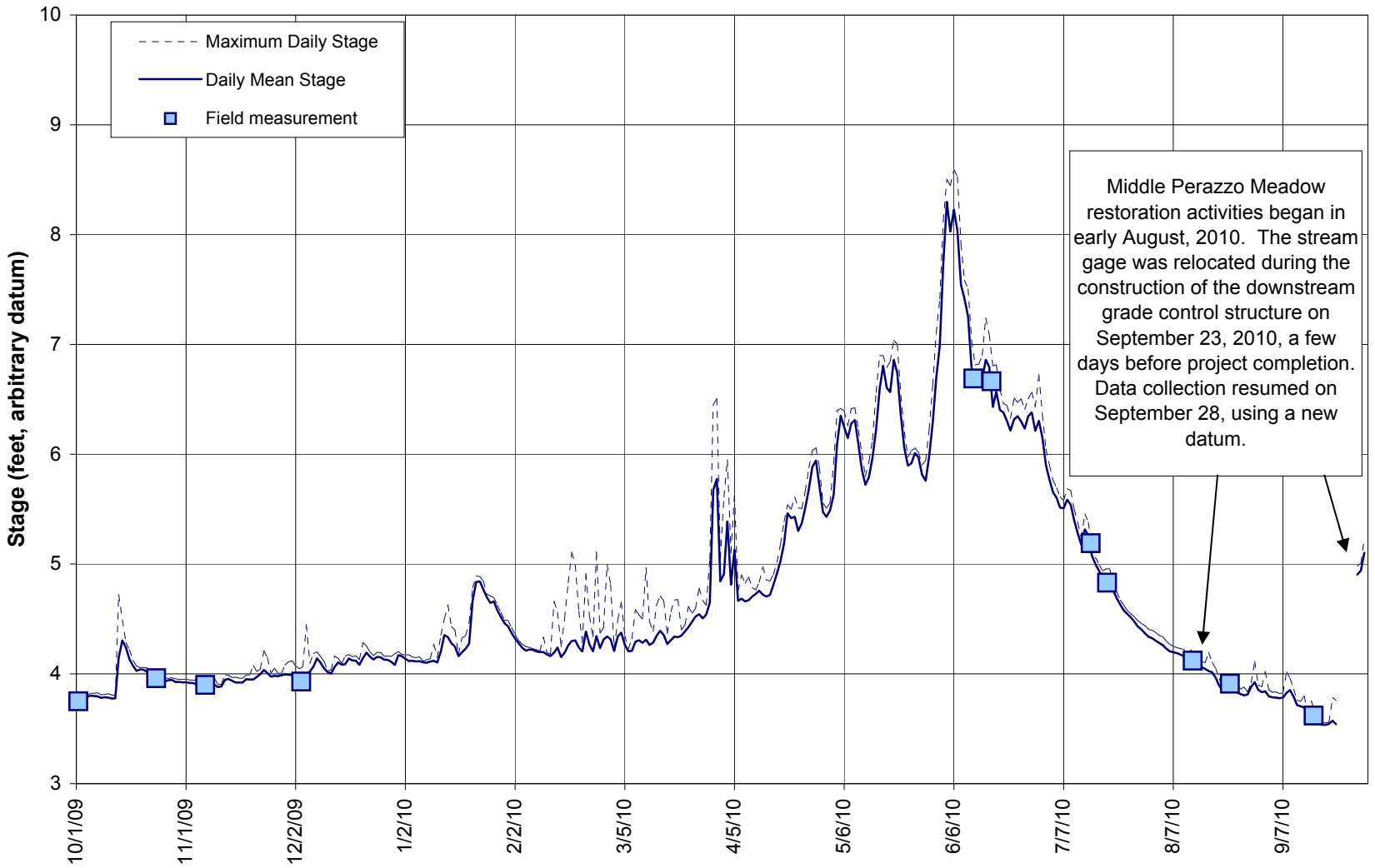

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Figure 8. Daily mean and maximum stage on the Little Truckee River at Middle Perazzo Meadow, water year 2010, Sierra County, California

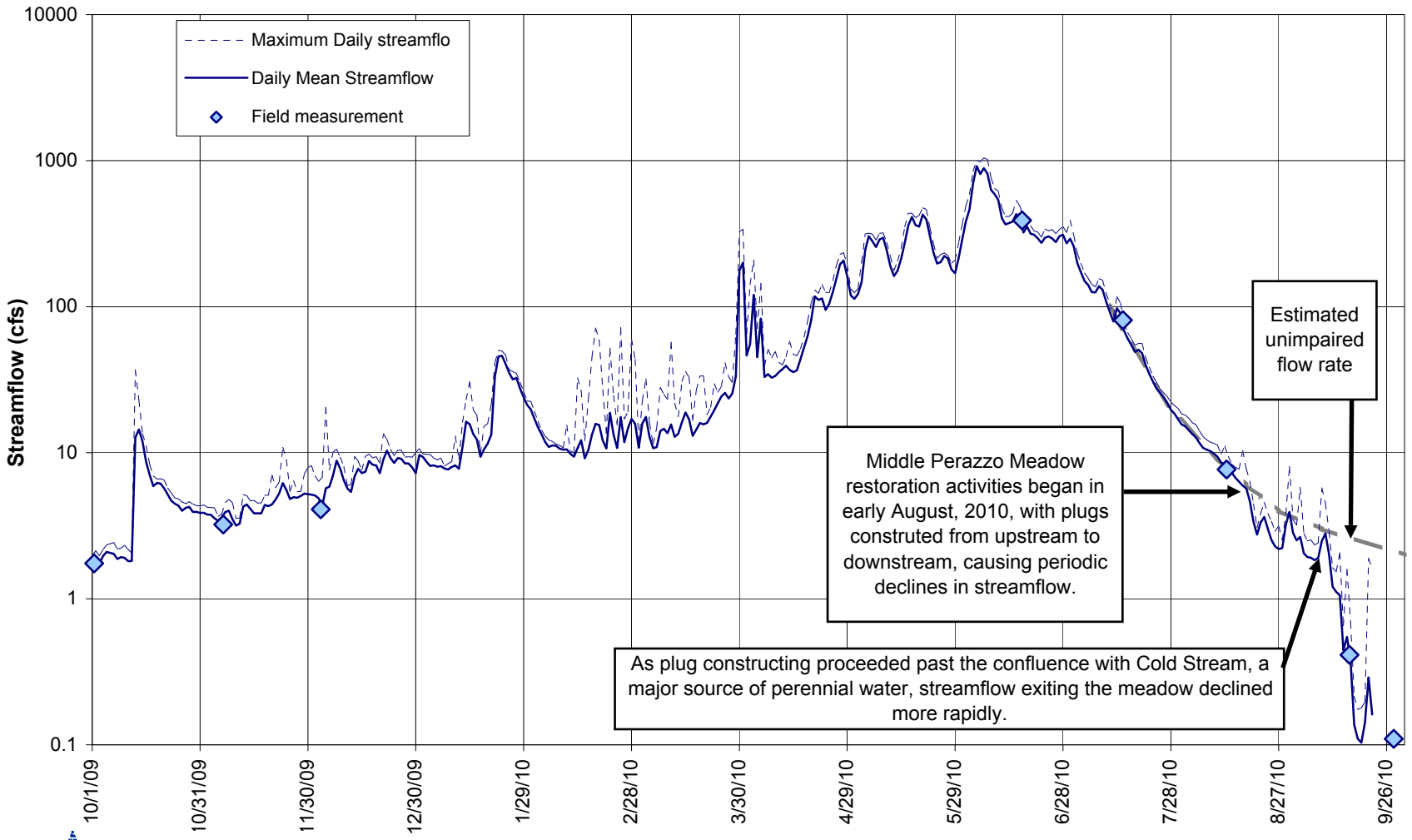

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Figure 9. Daily mean and maximum streamflow on the Little Truckee River at Middle Perazzo Meadow, water year 2010, Sierra County, California

By comparing an estimated 'unimpaired flow rate' to the measured flow rate, the volume of water retained in the meadow due to plug and pond restoration activities is estimated to be at least 110 ac-ft. Gaging was discontinued approximately 7 days before restoration was completed. Shortly after restoration was completed, baseflow recovered to approximately 3.0 cfs.

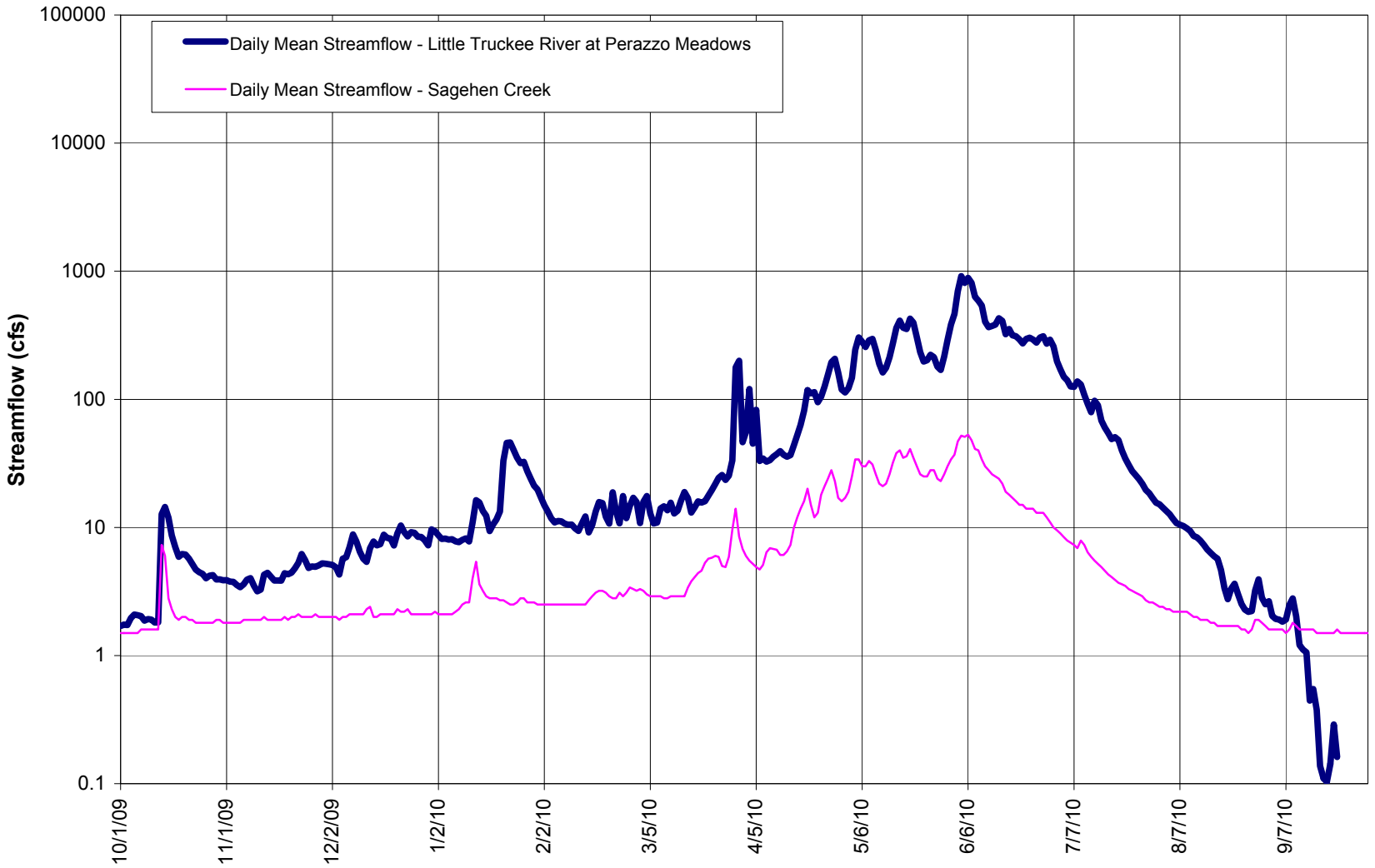

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Figure 10. Comparison of daily mean streamflow on the Little Truckee River at Middle Perazzo Meadow and Sagehen Creek, water year 2010.

Sagehen Creek data provided by the USGS for station 10343500.

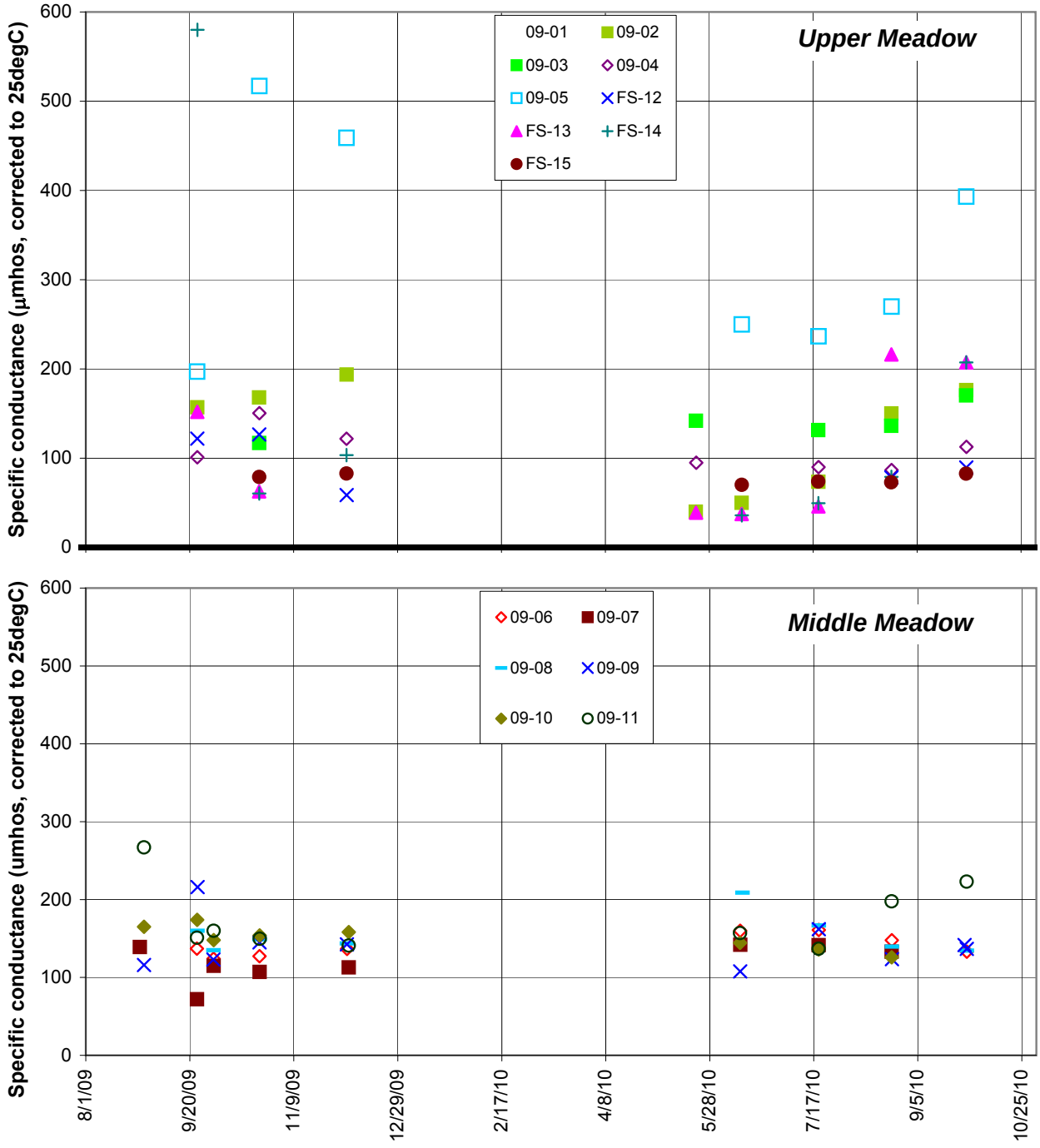

Figure 11. Specific conductance of groundwater, Upper and Middle Perazzo Meadows, Sierra County, California

See Figures 4 and 5 for piezometer locations.

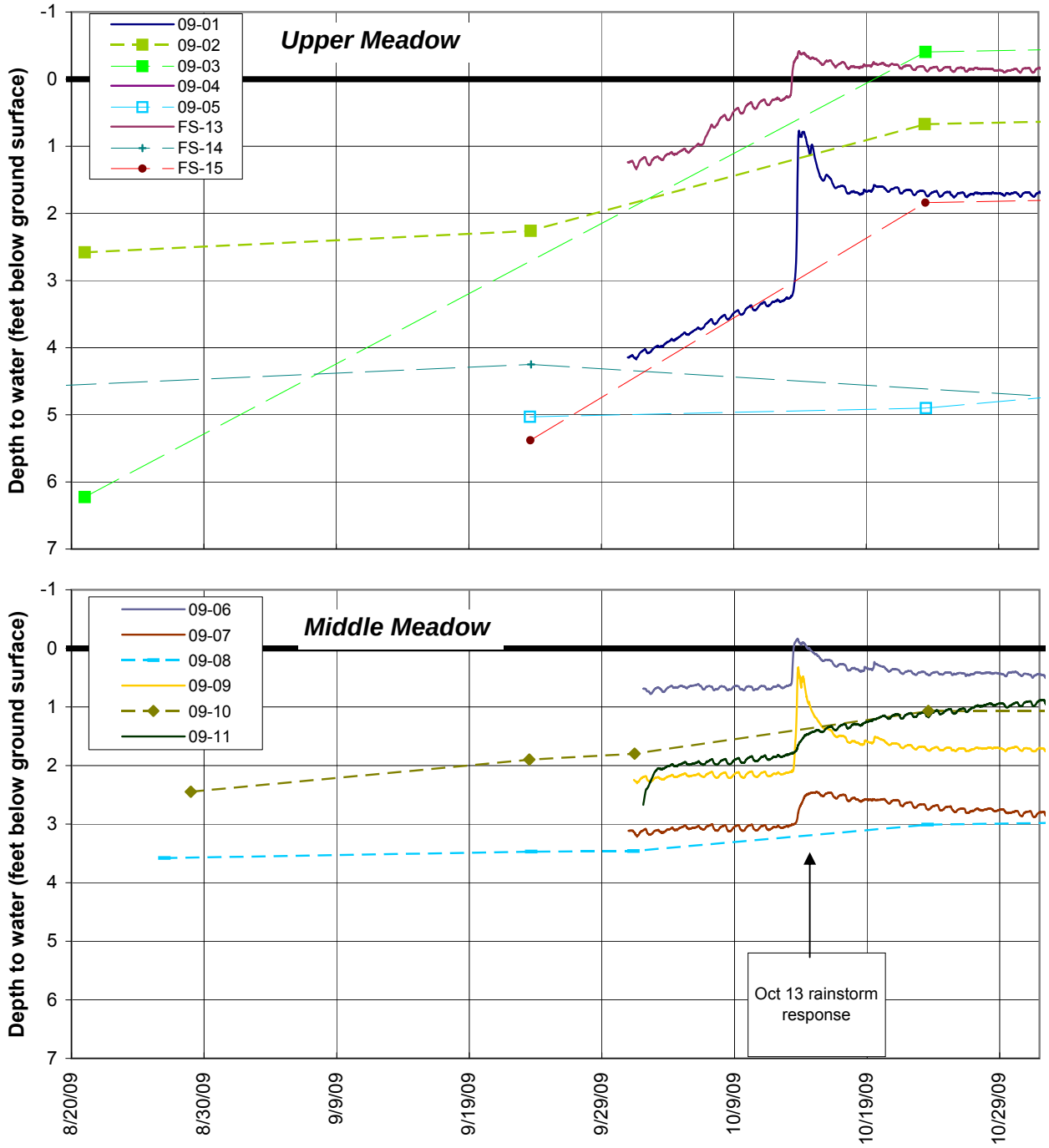

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Figure 12. Depth to groundwater before and after restoration in Upper Perazzo Meadow, Sierra County, California

See Figures 4 and 5 for piezometer locations.

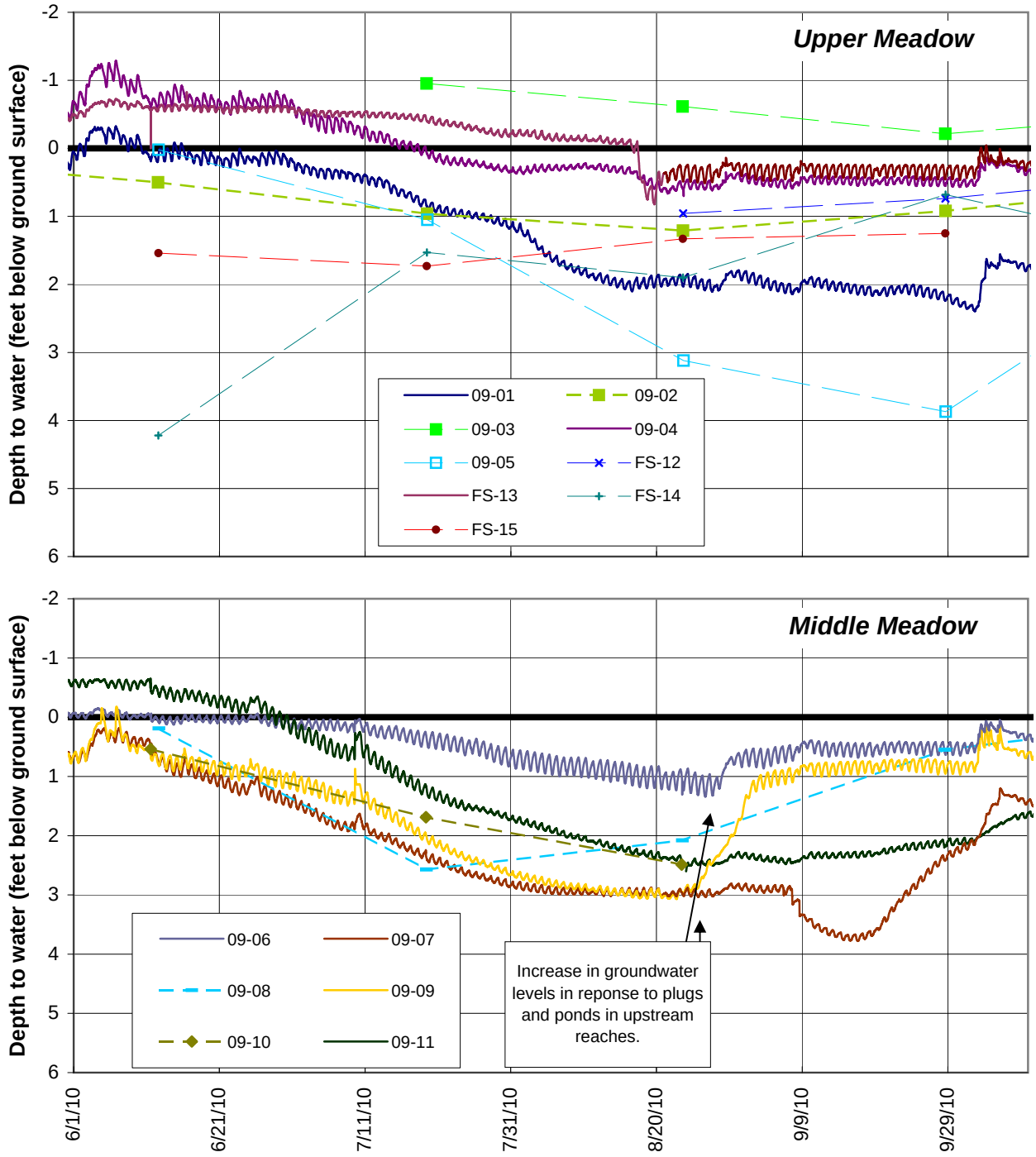

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Figure 13. Depth to groundwater before and after restoration of Middle Perazzo Meadow, Sierra County, California

See Figures 4 and 5 for piezometer locations.