Water Quality and Streamflow Monitoring of San Francisquito and Los Trancos Creeks at Piers Lane, and Bear Creek at Sand Hill Road, Water Year 2009, Long-term Monitoring and Assessment Program San Mateo and Santa Clara Counties, California

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SUMMARY AND CONCLUSIONS

San Francisquito Creek is currently listed by the California State Water Resources Control Board as being impaired by sediment and by the organophosphate pesticide, diazinon. Water quality in the creek is of particular concern because the creek is habitat for steelhead trout, a federally-listed threatened species. This study reports results of water year 2009 stream gaging and water quality sampling conducted as part of the Long-Term Monitoring and Assessment Program (LTMAP), a surface-water monitoring program sponsored by Stanford University and the City of Palo Alto. Water year 2009 was the eighth year of monitoring at the Los Trancos Creek and San Francisquito Creek stations at Piers Lane, and the sixth year of monitoring at the Bear Creek at Sand Hill Road station. Due to budget constraints, only flow and sediment were monitored at Bear Creek beginning in water year 2007, and at the Piers Lane stations beginning in water year 2008. Measurements and observations at all three stations are continuing during water year 2010, though on a limited scale.

Since fall 2001, Balance Hydrologics, Inc. has operated for LTMAP two automated water-quality sampling stations on San Francisquito Creek and Los Trancos Creek at Piers Lane, just above their confluence. In fall 2003, Kinnetic Labs (Santa Cruz) installed another automated sampling station, located on Bear Creek at Sand Hill Road, along the northern border of the Jasper Ridge Biological Preserve. The station, which is now also operated by Balance Hydrologics, is configured similarly to the other stations with a datalogger, several probes, and a programmable pumping unit. As in previous years, the electronic records were combined with manual measurements to create flow records for each stream. Measurements of temperature, specific conductance, dissolved oxygen and pH were made manually. Suspended-sediment samples were collected as grab samples during and between storms and used to estimate annual suspended-sediment yields. Our conclusions are presented below, together with citations to the relevant text subsections, tables and figures:

1. Rainfall and streamflow totals for water year 2009 were below average. Rainfall at the Bear Creek station was approximately 83 to 93 percent of the long-term average. Due to gauge malfunctions, the rainfall record at Piers Lane was based on correlation to nearby rainfall stations, and was estimated at 83 to 92 percent of the long-term average. Peak streamflow was slightly above average; based on USGS provisional streamflow data for San Francisquito Creek, the peak flow for the year

corresponds to about a 2.8-year recurrence-interval flood, equivalent to a 36 percent chance of being exceeded in any year. *(Sections 4.1 to 4.3; Table 4; Figures 2 to 5)*

2. Specific conductance values *(Section 6.1; Tables 1 to 3; Figures 8 to 10)* and pH values (*Section 6.3; Tables 1 to 3; Figure 14*) in all three streams were within the range of previous sampling results during water year 2009.

3. Dissolved oxygen concentrations *(Section 6.4; Tables 1 to 3; Figures 15 to 17)* were occasionally low – particularly in San Francisquito Creek in late summer or fall – a condition which may prove limiting for certain biota. This is consistent with previous years.

4. Dry-season water temperatures remained below lethal levels and below temperatures recorded in 2006 and other years, despite low baseflows and discontinuous pools in some upstream reaches. Low baseflows have a higher potential for high stream temperatures and, therefore, a greater impact on steelhead and other aquatic biota, especially if pools become discontinuous *(Sections 4.4 and 6.2; Tables 1 to 3; Figures 11 to 13).*

5. Fluctuations in flow and specific conductance during baseflow periods were most noticeable at the Bear Creek station, but also propagated downstream to San Francisquito Creek at Piers Lane. In addition, our records show multiple and various types of flow alterations in Los Trancos Creek. Upstream diversions and other flow alterations may affect baseflows and, therefore, aquatic habitat. Besides the volumetric changes to flow, water quality may also be altered by the apparent additions to creek flow *(Sections 4.4; Figures 3, 6, and 11 to 13).*

6. Even though water year 2009 was dry in terms of total flow, peak flows were moderately large. Therefore, roughly average or slightly below average amounts of sediment were discharged *(Section 6.5.3; Table 4; Figures 18 and 19).*

1. INTRODUCTION

This report presents the results of surface-water monitoring in the San Francisquito Creek watershed by Balance Hydrologics, Inc. ("Balance"), on behalf of the Stanford University Utilities Division, Jasper Ridge Biological Preserve, Stanford Real Estate Office, SLAC National Accelerator Laboratory (all, "Stanford") and the City of Palo Alto. Stanford is a participant in the San Francisquito Watershed Council, which is managing the Long-Term Monitoring and Assessment Program (LTMAP). The LTMAP was originally created by a subcommittee of the San Francisquito Creek Coordinated Resource Management and Planning (CRMP) Steering Committee, the group now known as the San Francisquito Watershed Council. The LTMAP was established primarily to monitor and assess current (i.e., baseline) conditions, analyze trends, and evaluate watershed management. Three LTMAP stations in the lower San Francisquito Creek watershed have been monitored since fall 2001 (water year 2002[1]); monitoring at a fourth station higher in the watershed began in fall 2003 (water year 2004).

The San Francisquito Creek watershed is located on the San Francisco Peninsula, and includes the northwestern portion of Santa Clara County and the southeastern portion of San Mateo County (Figure 1). Los Trancos Creek and (below their confluence) San Francisquito Creek form the boundary between the two counties. The watershed encompasses approximately 45 square miles, of which about 37 square miles lie upstream from the two Piers Lane stations, and includes a wide diversity of urbanized, rural and natural habitats. The 11.7-square mile Bear Creek sub-watershed encompasses the northwestern headwaters of San Francisquito Creek, covering approximately 25 percent of its watershed. Los Trancos Creek has a sub-watershed area of 7.8 square miles.

The first three LTMAP automated sampling stations were installed in fall 2001. The City of Palo Alto Regional Water Quality Control Plant staff are operating the lowermost station on San Francisquito Creek at Newell Road, a short distance upstream of Highway 101 and near the head of tidewater. Balance staff are operating the other two stations, on San Francisquito Creek and Los Trancos Creek at Piers Lane, a short distance downstream (north) of Interstate 280 and immediately upstream of the confluence of the two creeks. A fourth LTMAP station was

[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 2007 (WY2007) began on Oct. 1, 2006 and concluded on September 30, 2007.

installed on Bear Creek at Sand Hill Road in fall 2003, reoccupying a site previously gaged by Balance staff. This station, which is also operated by Balance, is about 2.5 miles upstream from Piers Lane.

Data and findings from the initial two years of monitoring the Piers Lane stations are presented in the prior annual monitoring reports (Owens and others, 2003; Owens and others, 2004). To better integrate findings from the three stations currently monitored by Balance staff, results were summarized in a single report beginning with water year 2004, the third year of monitoring the two Piers Lane stations and the initial year of monitoring the Bear Creek at Sand Hill Road station (Owens and others, 2005) and continuing in water year 2005 (Owens and others, 2006), water year 2006 (Owens and others, 2007), water year 2007 (Owens and others, 2008) and water year 2008 (Owens and others, 2009). This report similarly presents results of water year 2009 monitoring at all three stations operated by Balance. Measurements and observations will continue at all three stations during water year 2010, though on a limited scale.

2. BACKGROUND

Surface-water monitoring for this project is being implemented to assess known and potential pollutant concentrations as part of the Long-Term Monitoring and Assessment Program (LTMAP). The LTMAP was originally created by a subcommittee of the San Francisquito Creek Coordinated Resource Management and Planning (CRMP) Steering Committee, the group now known as the San Francisquito Watershed Council. The goals of the LTMAP are to provide a comprehensive framework for organizing and coordinating monitoring and assessment activities in the San Francisquito Creek watershed.

As part of the LTMAP, surface water data are being collected for use in describing constituents which might adversely affect water quality in the watershed, under storm runoff and low-flow conditions, in major part as they affect the full range of steelhead life stages. To assist the LTMAP in one of its objectives, Balance was asked to:

1. Identify which contaminants or sets of contaminants are present in San Francisquito Creek, Los Trancos Creek and Bear Creek, and to prioritize analyses for more detailed study in future years;
2. Assess if a relationship exists between the presence, absence or concentration of contaminants and streamflow; and
3. Evaluate the amount of suspended sediment and bedload being transported by the three streams and compare them to results from other locations in the watershed also monitored during this water year for other projects.

2.1 Local Influences on Water Quality

Restoration of habitat for steelhead -- a federally-listed threatened species greatly valued by the watershed community at large -- in the San Francisquito Creek drainage has been the focus of substantial efforts over the past ten years. Technical professionals and knowledgeable residents with experience in these streams suspect that water quality may be a significant constraint to the size and robustness of the steelhead population in San Francisquito Creek and its tributaries. Steelhead are anadromous[2] salmonids which spawn and rear throughout the free-flowing

[2] Migrates downstream to the ocean as a juvenile and returns upstream to fresh water to spawn.

headwaters of the San Francisquito Creek watershed. Water-quality impairment may likely affect other sensitive local species or possibly other beneficial uses as well.

The principal sources of potential concern include:

- horses and perhaps other livestock, particularly those boarded on land adjacent to the stream channels of San Francisquito Creek and its tributaries and/or using the stream or riparian buffer areas;
- septic systems, or other on-site wastewater-treatment units;
- urban runoff, including road and highway surface runoff, which may contribute nutrients and other constituents, such as heavy metals;
- pulses of water which have been repeatedly observed and documented in the streams at low flow, that may originate from human-managed sources, perhaps from flushing of swimming pools and other chlorinated ponds; and
- common garden, orchard and lawn or turf chemicals (i.e., fertilizers, pesticides).

Urban runoff and animal wastes from horses and other domesticated species, when washed into the creeks of the watershed, may be acutely toxic to steelhead and other fish or aquatic species. Chronic toxicity and/or indirect effects of these loadings may also counteract sustained regional efforts to improve and restore populations of steelhead. Each of the other sources listed above can also have chronic or acute toxicity.

The quantity of baseflow is also an important factor in maintaining habitat quality. Too little water in the creeks during the spring and summer can impede out-migration of year-old fish and affect summer survival of newly hatched "young-of-the-year" as well as year-old juveniles. Insufficient baseflow also magnifies the effects of introduced pollutants by reducing the amount of dilution available to decrease pollutant concentrations and at very low flows can lead to impaired conditions such as local increases in temperature or decreases in dissolved oxygen.

2.2 Related Water Quality Studies in the Watershed

We know of only one recent sub-watershed-scale investigation of water quality. As part of a grant from the Packard Foundation, the San Francisquito Watershed Council asked Balance to conduct a three-year water quality study in the Bear Creek portion of the larger watershed during water years 2000 through 2002. Balance has reported the results of the first two years of monitoring (Owens and others, 2001; 2002). Both published and unpublished data from the Bear Creek study are used in this report as a basis for comparison. The Bear Creek watershed encompasses the northwestern headwaters of San Francisquito Creek, as shown in Figure 1. Thus, water-quality problems in the Bear Creek watershed can directly affect nearly all other spawning and rearing areas in the San Francisquito Creek watershed. Conversely, measures which control causes of toxicity to fish in the Bear Creek system will benefit nearly the entire local steelhead population, as well as other species in the San Francisquito Creek watershed. Knowledge of natural and anthropogenic factors affecting water quality in Bear Creek can help in planning and assessing water quality elsewhere in the watershed.

3. STATION LOCATIONS

3.1 Bear Creek Sub-watershed Station

The Bear Creek at Sand Hill Road station (designated as BCSH) is located on the northern border of the Jasper Ridge Biological Preserve (Figure 1), approximately 2.5 miles upstream of the San Francisquito Creek at Piers Lane station. Balance has periodically monitored streamflow and water-quality constituents at this site, which receives flows from almost one-half of the San Francisquito Creek watershed above Piers Lane, since the spring of 1997. Prior to the current study, the most complete sets of data were compiled during water years 2000 to 2002, when this station was one of eight stations in the watershed regularly monitored on behalf of the San Francisquito Watershed Council (see Section 2.2 above). Balance continued to operate the gaging station during water year 2003 but only minimal water quality measurements were made that year.

Through the combined efforts of Stanford Management Co., SLAC National Accelerator Laboratory, and the Jasper Ridge Biological Preserve, this location became the fourth station in the LTMAP monitoring network. In fall 2003 (water year 2004), Kinnetic Laboratories, Inc. (Santa Cruz) installed new monitoring equipment on the left bank of Bear Creek, about 200 feet downstream from Sand Hill Road and only a short distance from the previous gaging location. The instream portion of this installation was severely damaged by the storm that began on Dec. 31, 2005. Temporary probes were installed one week later and permanent replacement of the instream components occurred in May 2006, with the assistance of Kinnetic Laboratories, Inc.

The station is equipped with a tipping-bucket rain gauge, a streamside staff plate, a datalogger and automated sampler pumping unit housed within an enclosure, and several water-quality probes. Water level, water temperature, specific conductance (an index of salinity), dissolved oxygen, and pH are continuously monitored. Water levels are measured using pressure transducers. Manual measurements of water levels at a staff plate, streamflow and water quality parameters are made at regular intervals to calibrate the electronic record. The station is connected to a land-line telephone so that real-time data can be monitored over the Internet. The automated sampler is designed to collect aliquots over a specified period into a composite sample bottle kept chilled in an ice bath. Following sampling events, sub-samples of the mixed composite sample are poured into prepared sample bottles for laboratory analysis of individual constituents.

From water year 2004 to water year 2006, monitoring at the Bear Creek station followed the originally envisioned sampling sequence. Beginning in water year 2007, budget constraints necessitated limiting the water quality monitoring component of the LTMAP program to collection of sediment, specific conductance and temperature data, supplemented with periodic manual measurements of dissolved oxygen and pH.

3.2 Piers Lane Stations

The other two LTMAP stations discussed in this report[3] are located on Los Trancos Creek and San Francisquito Creek, just upstream from their confluence, where Piers Lane crosses both creeks (Figure 1). The stations are within 100 yards of each other and only a short distance downstream (north) of Interstate 280. The stations were installed in fall 2001 by staff of Kinnetic Laboratories, Inc. and Larry Walker Associates (Davis) under contract to the City of Palo Alto. The station on San Francisquito Creek is equipped with a tipping-bucket rain gauge. From installation through fall 2005, water levels at both stations were measured by an ultrasonic sonar transponder mounted on the bridge above the creek at each site. Following failure of the transponder at the San Francisquito Creek station in November 2005, Balance installed a set of temporary probes and worked with City of Palo Alto Regional Water Quality Control Plant and Stanford staff to develop a repair plan that would also address maintenance problems at both Piers Lane stations, as detailed in previous monitoring reports. To improve reliability, a datalogger and pressure transducers were installed at the San Francisquito Creek station in February 2006, and the specific conductance probe was replaced with one of a different brand. Both stations remain powered by batteries, but solar panels were installed at each site to reduce or eliminate intermittent problems with battery failure that have resulted in occasional loss of monitoring data. The cable to the rain gauge was sheathed in conduit and buried to reduce chances of rodent damage. Sampling tubes at both stations were replaced and a second conduit was installed between the enclosures and the streams to carry the probe cables and reduce constriction in the original conduits. Otherwise, each station is equipped with the same instrumentation described above for the Bear Creek station and is monitored using the same

[3] The fourth LTMAP station, on San Francisquito Creek at Newell Road, a short distance upstream of Highway 101, has been operated by staff of the City of Palo Alto Regional Water Quality Control Plant since it was installed in fall 2001. Monitoring at this site is coordinated with activities at the upstream stations but results are interpreted by City staff and reported under separate cover.

protocols. Cell phone telemetry was attempted in the past but found to drain the batteries too quickly to make the data available in real-time.[4]

Balance initiated operation of the newly-installed Piers Lane stations, designated as San Francisquito Creek at Piers Lane (SFPL) and Los Trancos Creek at Piers Lane (LTPL), at the start of water year 2002. For a number of reasons detailed in the initial monitoring report (Owens and others, 2003), only a limited number of water-quality samples were collected during the first year of operation. From water year 2003 to water year 2007, monitoring at the Piers Lane stations more closely followed the originally envisioned sampling sequence. Beginning in water year 2008, budget constraints necessitated limiting the water quality monitoring component of the LTMAP program to collection of sediment, specific conductance and temperature data, supplemented with periodic manual measurements of dissolved oxygen and pH.

3.3 Other Stations in the Watershed

As part of a series of cooperating projects, Balance also monitored a number of locations in the San Francisquito Creek watershed upstream of Piers Lane during water year 2009 (Figure 1). The main focus was on monitoring streamflow and sediment discharge. Data from some of these other stations are used in this report for comparison to the data collected at the Piers Lane stations. Comparison of flow records among stations helps to verify the gaging data and describe and document differences in hydrologic responses to rainfall. These differences are proving larger than expected, such as very low baseflows on West Union Creek, or flashy storm peaks on Dry Creek, and may prove in and of themselves to be of significance to stream management, including steelhead restoration. Selected stations are described below.

3.3.1 Los Trancos Creek at Arastradero Road

Balance operates another station on Los Trancos Creek (LTAA) about 1.8 miles upstream of Piers Lane on behalf of Stanford University Utilities Division. This upstream station has been in operation since November 1994. Suspended-sediment and bedload discharge are also collected at this site. The watershed area upstream of this station is 5.3 square miles.

[4] Connection to a land-line telephone would decrease obstacles to real-time data availability but is reportedly not feasible at this time.

3.3.2 Searsville sub-watershed stations

Balance operated gages at Searsville Dam and upstream from Searsville Lake on Corte Madera Creek at Westridge Drive during water year 2009. Data collection from the Searsville sub-watershed stations focuses on sediment transport. Searsville and Corte Madera Creek flow data were considered during data analysis and in this report where such comparisons were useful.

3.3.3 U.S. Geological Survey station on San Francisquito Creek

USGS stream gage #1164500 (San Francisquito Creek at Stanford University) is located approximately 0.5 miles downstream from Piers Lane. This station was originally established in 1931 and has maintained a continuous record of flow since 1954. USGS staff regularly collected suspended-sediment (but not bedload sediment) data at this station from the mid-1960s to early 1970s (Brown and Jackson, 1973).

4. HYDROLOGIC SUMMARY, WATER YEAR 2009

Observations and measurements from our water year 2009 site visits are documented in Table 1 (Bear Creek), Table 2 (Los Trancos Creek) and Table 3 (San Francisquito Creek). Annual hydrologic summaries for each of the three creeks are presented in Forms 1 to 3. Table 4 is a hydrologic summary for all three creeks over the period of record. For Bear Creek, the summary includes gaging results from the earlier three-year water quality study (water years 2000 to 2002).

Daily flow hydrographs for the three creeks are plotted on the same graph in Figure 2, and for individual creeks in Figures 3 to 5. Figure 6 shows the unit flow hydrograph for each creek. "Unit flow", calculated by dividing the daily mean flow by the watershed area, allows comparison of the response to rainfall among different watersheds. In general, the magnitude of streamflow is governed by the size of the watershed, so that a larger watershed produces higher flows. However, differences among streams in wet- and dry-season baseflows also reflect variations in the geology, topography and management of diversions within their watersheds.

4.1 Narrative Summary

In general, water year 2009 was a below-average year in terms of total rainfall (Figure 7) and total flow, but peak flows (Figure 2) were at or slightly above normal. The water year began with very low baseflows in fall 2008 due to below-average rainfall the previous year. Light rains fell during November, and December of 2008, but baseflows remained low until a series of small storms in early February. The two largest events of the season were strong storms on February 15 and March 3, 2009. The rain on February 22 and 23 produced significantly larger flow peaks in some parts of the watershed than others (Figure 6). Several moderate late-season rains occurred on March 22 and between May 1 to 5, 2009.

On Bear Creek (Figure 3), the peak flow rate was about 590 cubic feet per second (cfs) on February 15, 2009 at 22:15. On San Francisquito Creek at Piers Lane (Figure 4), the highest peak flow rate was 1,730 cfs on February 15, 2009 at 22:15. On Los Trancos Creek at Piers Lane (Figure 5), the highest peak flow rate was 320 cfs on February 15, 2009 at 20:30.

As observed in water years 2007 and 2008, recessional flows during spring 2009 occurred earlier than usual and summer baseflows in all three streams were lower than in most previous years.

4.2 Precipitation

Estimates of long-term average annual rainfall or mean annual precipitation (MAP) may vary depending upon the source of the data. For sites around San Francisco Bay, we often use isohyetal maps by Rantz (1971) and/or Nahn and Saah (1988)[5]. Estimates of MAP for the Bear Creek site vary from 26 inches (Rantz, 1971) to 29 inches (Nahn and Saah, 1988). During water year 2009, our Bear Creek rain gauge recorded 24.16 inches (Figure 7), or approximately 83 to 93 percent of the above estimates of long-term MAP for the Bear Creek location.

Estimates of MAP for the Piers Lane site vary from 18.5 inches (Rantz, 1971) to 22 inches (Nahn and Saah, 1988). Because the Piers Lane tipping-bucket rain gauge did not function well this year (see Section 5.2); we estimated water year 2009 rainfall at Piers Lane by scaling the rainfall record from a nearby station in Los Altos Hills, operated by the California Department of Forestry (station ID: "LSA"), to the Piers Lane site. The scaling was based on the percentage of the MAP values calculated by Rantz and by Nahn and Saah for the Los Altos Hills station and three other nearby rainfall gauges. Water year 2009 rainfall at these four stations averaged 83 to 92 percent of MAP. Based on this analysis, we estimate that rainfall at Piers Lane during water year 2009 was likely between 17.0 and 18.3 inches. This range is shown in Figure 7 for the scaled data.

According to California Data Exchange Center (CDEC) records, water year 2009 rainfall at precipitation stations in the larger San Francisco Bay region ranged from 82 to 106 percent of long-term average values. At the two index precipitation stations in the region that we have referenced in previous years, water year 2009 precipitation at Mount Hamilton was 106 percent of the long-term average values, while rainfall at the San Francisco Airport was 92 percent of

[5] While these two isohyetal reference maps for mean annual precipitation are in agreement for most zones of the San Francisco Bay region, they differ by up to 4 inches in some portions of the San Francisquito Creek watershed. After checking the periods of data on which the maps were based, we concluded that this difference is not due to changes in precipitation during the time periods used to compile each map, but rather seems to be due to incorporation of additional rainfall stations when producing the newer (Nahn and Saah, 1988) map. We have chosen to provide values from both references as a way to bound the true long-term value of MAP at these sites, and thereby highlight the uncertainty in estimating the significance of rainfall for any particular year. This uncertainty stems partially from the actual spatial variability of rainfall patterns, and partially from choices made when evaluating the available data.

the long-term average. These rainfall totals are consistent with our flow totals, which indicate that water year 2009 was wetter than water year 2008, but still somewhat drier than average. Given two previous dry years in water years 2007 and 2008, even an average amount of rainfall in water year 2009 would probably have yielded below average total flow.

4.3 Return Period of Peak Flows

Flows were moderately large on both February 15 and March 3, 2009. Even though we do not have a sufficient period of record to calculate the return period of water year 2009 peak flows at the stations monitored for this project, we can characterize the peak flows at the USGS gaging station on San Francisquito Creek (USGS number 11164500). The estimated peak flow for this station for water year 2009 is 2,210 cfs, which corresponds to a 2.8-year return period (36 percent chance of being exceeded in any year), based on the annual-peak series. This is somewhat higher than the median peak flow of 1,330 cfs, which can be taken to approximate the 2-year return period (50 percent chance of being exceeded in any year).

4.4 Unexplained Flow Surges

During November 2008 we noted several moderate flow spikes in Los Trancos Creek. We alerted Stanford staff and were told that the extra flow was due to permitted releases from construction activities at Felt Lake.

In addition to the flow surges mentioned above, we continued to note significant abrupt changes in flow (mainly *dips* in flow) at the Bear Creek station that could be due to diversions. These changes are qualitatively consistent with operation of upstream diversions by California Water Service Company [6]. Other diversions occur in the watershed, either directly from the channel or indirectly through ground water pumping.

We have previously noted spikes of high temperature and/or high salinity at all three of the monitoring stations.

[6] Personal communication from Darin Duncan, California Water Service Co. to Marty Laporte, Stanford University, Utilities Division, May 26, 2006.

4.5 Creating a Record of Streamflow

We develop a record of streamflow in two steps. First, a record of water levels is compiled from the recorded electronic data and calibrated with field observations. Flow rates are then computed from the water levels using empirical equations developed specifically for each site from field measurements.

4.5.1 Developing a record of water levels

The monitoring equipment at the Bear Creek at Sand Hill Road station and the San Francisquito Creek at Piers Lane station includes two pressure transducers, which measure water levels in the creek at 15-minute intervals, and a Campbell Scientific CR10X datalogger to record the water-level data. The Los Trancos Creek at Piers Lane station is equipped with an ultrasonic sonar transponder connected to an American Sigma 950 flow meter and datalogger. Field measurements and observations at each station are used to calibrate the electronic record. Observations during site visits include: water level (or gage height) at the staff plate, high water marks, the presence of twig and leaf dams which may temporarily raise or lower water levels, signs of sedimentation or scour, and the specific conductance and temperature of the water (Tables 1 to 3).

During this year, as is typically done, we applied multiple stage shifts to the electronic water-level record to account for intermittent sedimentation, leaf dams and algae growth that affect the water-level elevation at the monitoring locations. We found that observed high-water marks corresponded well (usually within 0.2 to 0.3 feet) with the recorded water-level peaks, providing additional confidence in the stage record.

4.5.2 Computing flows

Based on our periodic site visits, staff plate readings, and flow measurements (Tables 1 to 3), we create an empirical stage-to-discharge relationship ("stage-discharge rating curve") for each gage. This rating curve is then applied to the electronic record of water levels measured by the pressure transducers (at BCSH and SFPL) and the sonar transponder (at LTPL).

At low flows, the sonar transponder values have a large amount of variation, up to about 0.3 feet per day. We consider most of this variation to be "noise" in the instrument reading that does not reflect actual changes in water levels, although a lower-amplitude (0.02-foot) diurnal pattern of water-level change is typically observed during low-flow periods. The flow record becomes particularly "noisy" at the 15-minute level of detail, which is why we present the data in daily form. Daily mean flow values appear to be fairly accurate because daily averaging removes most of the noise.

As with all other gaging of natural streams, some uncertainty remains (especially at high and low flows) in spite of efforts to be as precise as possible. Due to safety concerns and site limitations, we do not have manual stream flow measurements at the peak flow levels. The high end of the stage-discharge rating curves are defined by peak-flow estimates from water year 2006, based on standard indirect peak-flow measurements made by cross-sectional and longitudinal surveys of high-water marks (Owens and others, 2007).

5. WATER QUALITY SAMPLING APPROACH

Larry Walker Associates developed the water-quality monitoring plan for the two LTMAP stations at Piers Lane while under contract to the City of Palo Alto (LWA, 2001). Their Draft Surface Water Quality Monitoring Plan 2001/02, available from the City of Palo Alto, provides a complete description of the methods and protocols used in this study. Because the Bear Creek at Sand Hill Road stream gage is also part of the LTMAP study, the same protocols were used there as at the Piers Lane stations and results can be compared. Interested readers are referred to the water-quality monitoring plan for additional detail.

The LTMAP monitoring program is designed to measure field parameters on each sampling visit. Sediment sampling occurs from fall through spring, when flows are sufficiently elevated to transport sediment. Due to budget constraints, only flow and sediment were monitored at Bear Creek beginning in water year 2007, and at the Piers Lane stations beginning in water year 2008. Results of sampling for chemical constituents, collected four to five times annually in prior years, may be found in our previous monitoring reports.

5.1 Field Measurements and Laboratory Analyses

The current focus of the study is on characterizing water quality in the two streams during both baseflow and storm periods, particularly with regard to flow and sediment transport, as variables potentially affecting fisheries and aquatic habitat conditions.

<u>Field Measurements</u>

- streamflow (cubic feet per second, or cfs)
- specific conductance (microsiemens, or µs @ 25°C)
- water temperature (°C)
- dissolved oxygen (mg/L)
- pH
- qualitative remarks, for example, odors, color, clarity, (if noticeable), and anomalies

<u>Laboratory Analyses</u>

- total suspended solids
- bedload sediment

5.2 Exceptions and Deviations from Proposed Methods

Deviations almost inevitably occur in hydrologic studies, usually at very high or low flows, such as the responses necessary when a tree falls or other changes in the channel at the sampling location are encountered. Although no water-quality sampling was performed at the Bear Creek or Piers Lane stations in water year 2009, deviations related to the condition of the monitoring equipment at all stations are listed below.

During the eighth year of monitoring Los Trancos Creek and San Francisquito Creek at Piers Lane, we were unable to complete the following items as they were initially outlined in the project proposal:

- Maintenance of the original pH and dissolved oxygen probes at both Piers Lane stations remains problematic, so these probes continue to perform poorly and the only available data on these parameters are from hand-held meters.
- Performance of both the original specific conductance probe and the additional probe installed in March 2007 at the Los Trancos Creek station is erratic (Figure 8). A “loaner” probe was installed prior to the start of Water Year 2009 and will remain in place through the close of water year 2010.
- The replacement specific conductance probe installed at the San Francisquito Creek station in February 2006 was producing erratic data. We have since discovered (November 2009) that the datalogger programming was at fault, causing erroneous readings when conductivity was elevated. The “loaner” probe installed in February 2009 will remain in place until we confirm that the other probe works with the revised datalogger program.

During the sixth year of monitoring at the Bear Creek at Sand Hill Road station, we were unable to complete the following items as they were initially outlined in the project proposal:

- The datalogger module which failed in late May 2008 and was replaced with a “loaner” unit about two weeks later was repaired by the manufacturer and reinstalled by Balance staff in February 2009.
- Maintenance of the pH probe remains problematic, so this probe continues to perform poorly and the only available data on this parameter is from hand-held meters.

Recommendations for improving the monitoring program during water year 2010 and subsequent years are presented briefly in Chapter 7 below.

6. RESULTS AND DISCUSSION OF WATER QUALITY SAMPLING

This chapter includes a discussion of findings by individual constituent or constituent group. Results of manual measurements of specific conductance, temperature, pH, and dissolved oxygen are included in Tables 1 to 3. Results of suspended-sediment sampling during and between storms, used to estimate annual suspended-sediment yields, are presented in Table 5 (Bear Creek) and Table 6 (San Francisquito Creek and Los Trancos Creek). All laboratory reports are collected in Appendix A.

6.1 Specific Conductance

Specific conductance values during water year 2009 were within the range of previous sampling results and are generally within the expected range for the San Francisquito watershed.

Specific conductance, a widely used index for salinity or total dissolved solids (TDS), was measured in the field and recorded at field temperatures, then later converted to an equivalent value at 25°C according to the accepted relationship between specific conductance and temperature. The expected range of specific conductance in the San Francisquito Creek watershed is from about 100 to 2,000 µs (all values are normalized to 25°C). The lowest levels occur during storms, when flows are diluted with rain and fresh runoff. The highest levels are typically observed in early fall, when flows are lowest, prior to the onset of seasonal rains.

During water year 2009, specific conductance ranged from about 100 to 800 µs (values from Figure 9) in Bear Creek (Table 1; Figure 9) and from about 200 to 1,500 µs (values from Figure 10) in San Francisquito Creek (Table 3; Figure 10). Based solely on manual measurements, observed specific conductance ranged from about 180 to 2,000 µs in Los Trancos Creek (Table 2, Figure 8). As was observed in previous water years, specific conductance was again typically lowest in Bear Creek and highest in Los Trancos Creek. Specific conductance levels in all three streams were at the higher end of the range in summer of 2009, as would be expected during the third year of below-average rainfall.

6.2 Water Temperature

Water temperatures during water year 2009 were within the range of previous measurements.

6.2.1 Water temperature affects fish

Water temperature strongly affects steelhead habitat. Although steelhead can withstand high water temperatures of 29˚C for a short period of time, and 25˚C for longer periods, they have progressively-increasing difficulty extracting dissolved oxygen from water at temperatures above 21˚C (Lang and others, 1998) and require a larger food source to sustain their elevated metabolism (Smith, pers. comm.). Therefore, water temperatures of 21˚C and below are considered to provide adequate summer habitat, and values chronically above 25˚C are likely not viable for the local steelhead population.

6.2.2 Temperature monitoring probes

Each of the three stations includes one or two in-stream probes that continuously record water temperatures. Manual temperature measurements during water year 2009 site visits followed the same seasonal pattern and values recorded by the in-stream probes (Figures 11 to 13). Water temperatures in Bear Creek and Los Trancos Creek were within the reported acceptable range for steelhead habitat during water year 2009. In San Francisquito Creek, maximum water temperatures occasionally exceeded the 21˚C threshold between late June and early September.

6.2.3 Temperature differences between creeks

As observed in the seven previous years (water years 2002 to 2008), water temperatures in San Francisquito Creek (Figure 11) were slightly warmer than in Los Trancos Creek during the dry season (Figure 12). Dry-season temperatures in Bear Creek (Figure 13) were similar to Los Trancos Creek and cooler than in San Francisquito Creek.

6.3 pH

In most instances, pH values during water year 2009 were within the range of previous measurements. This parameter is not considered to be a management concern.

As stated above in Section 5.3, the pH probes at all three stations were non-functional in water year 2009, so this parameter was measured occasionally using hand-held meters. pH measurements ranged from 7.2 to 8.6 in Bear Creek (Table 1, Figure 14), from 7.0 to 8.3 in Los Trancos Creek (Table 2, Figure 14), and from 7.2 to 8.4 in San Francisquito Creek (Table 3, Figure 14). pH values were generally similar to measurements from previous years. Although based on a limited set of measurements, this year, pH was not consistently higher in Los

Trancos Creek than in San Francisquito Creek, as observed in previous years. pH in Bear Creek did not have a consistent pattern compared to the other two streams.

We note that fisheries biologists familiar with the northern Santa Cruz Mountains and San Francisco Peninsula streams have found that pH is very rarely a limiting factor in regards to steelhead habitat, so long as there is flow moving from pool to pool.

6.4 Dissolved Oxygen

Dissolved oxygen concentrations were occasionally low during late summer and fall, which may be limiting for biota.

As stated above in Section 5.3, the dissolved oxygen probes at the Los Trancos Creek and San Francisquito Creek stations were essentially non-functional in water year 2009 and the dissolved oxygen probe at the Bear Creek station was clogged for part of the year, so this parameter was measured only occasionally using hand-held meters. Based on the limited set of measurements, dissolved oxygen concentrations varied between 64 and 100 percent of saturation in Bear Creek (Table 1, Figure 15), between 65 and 100 percent of saturation in Los Trancos Creek (Table 2, Figure 16), and between 46 and 100 percent of saturation in San Francisquito Creek (Table 3, Figure 17). As reported in previous years, dissolved oxygen concentrations were typically highest in Los Trancos Creek, and higher in Bear Creek than in San Francisquito Creek.

As noted in our water year 2003 report (Owens and others, 2004), manual measurements of dissolved oxygen can vary considerably depending upon where in the creek the probe is placed, with values ranging from about 15 to 60 percent saturation at locations as little as one foot apart. This situation is particularly common in the fall, when the streams are full of dead leaves. Based on our monitoring data to date, we expect dissolved oxygen concentrations in all three creeks to range from 10 to 14 mg/L (90 to 100 percent saturation) during the winter and especially at high flows, when turbulence and cold ambient water temperatures promote oxygen saturation. Dissolved oxygen concentrations become more limiting for fish as streamflows decrease and temperatures rise in spring and summer. The lowest concentrations tend to occur in the fall months (c.f., Table 1), at the start of the next water year but before rains raise water levels and high flows flush accumulations of rotting leaves downstream.

6.5 Sediment

Even though water year 2009 was dry in terms of total flow, the peak flows were moderately large (approximately 2.8-year return period). Therefore, roughly average or slightly below-average amounts of sediment were discharged. Sediment concentrations during water year 2009 were within the range of previous sampling results.

San Francisquito Creek is listed by the State Water Resources Control Board as impaired due to sediment loading. All creeks carry some sediment; problems can arise when creeks carry too much sediment. Biologically, too much fine sediment can reduce oxygen circulation to buried eggs, abrade fish gills, fill hiding and resting niches and impede post-storm feeding. Too much coarse sediment affects bed conditions in a number of ways that can constrain steelhead habitat, including filling pools and undercut banks, creating ‘soft’ beds that are prone to scour, and forming mid-channel bars that divert flows into the banks, inducing bank erosion. Excess coarse sediment can also settle out at low-gradient locations, reducing pool depths and decreasing the flood capacity of the channel.

Monitoring sediment concentrations and rates of sediment transport is important as a way of evaluating the amount of sediment being carried by the creek, to assess the mobility of spawning gravels and document changes that may signal improving or worsening conditions. Previous Balance reports have documented rates of sediment transported in various watersheds upstream from Piers Lane (c.f., Balance Hydrologics, 1996; Owens and others, 2001; Owens and Hecht, 2002), as well as the role of Searsville Lake in trapping sediment and the contributions from different geologic formations. Staff of the U.S. Geological Survey previously made measurements of suspended sediment at the long-term gage at the golf course (Brown and Jackson, 1973). In this watershed, we have observed a number of sources, both natural (e.g., bank failure, landslides) and human-caused or human-exacerbated (e.g., failure of culvert outfalls, construction erosion control measures, bank protection). Detailing these sources, however, is beyond the scope of this report.

Following convention, we distinguish two types of sediment in transport, each of which is measured during storms using specific types of samplers and sampling methods. Suspended sediment is supported by the turbulence of the water and is transported at a velocity approaching the mean velocity of flow. In the San Francisquito Creek watershed, as elsewhere in the Santa Cruz Mountains, suspended sediment consists primarily of fine sands, silts, and clays. Bedload sediment is supported by the bed of the stream; it rolls and saltates along the bed, commonly within the lowermost 3 inches of the water column. Movement can be either continuous or intermittent, but is generally much slower than the mean velocity of the stream. At the Piers Lane stations and in the Bear Creek watershed, bedload consists primarily of coarse sands and gravels, but will also include cobbles at extreme high flows. Total sediment discharge is the sum of bedload-sediment and suspended-sediment discharges.

6.5.1 Suspended sediment

Suspended-sediment samples were collected from all three stations throughout the water year at various dates and levels of flow (Table 4) using standard methods and equipment adopted by the Federal Interagency Sedimentation Project (FISP: see Hecht, 1983). All grab samples were analyzed by Soil Control Laboratories of Watsonville, California, a state-certified laboratory. No suspended-sediment samples were collected when stream waters were visibly clear. From past experience, we have found that samples collected when the streams are clear produce no useful information because they test below the analytical reporting limit.

By multiplying the reported suspended-sediment concentrations by the streamflow at the time the sample was taken, concentrations (mg/L) were converted into an instantaneous suspended-sediment "load" (tons/day), as shown in Tables 5 and 6. We then plotted sediment load as a function of streamflow to create suspended-sediment rating curves describing the general trend of the data points for each creek (Figures 18 and 19). We also applied the suspended-sediment rating curves to the records of streamflow (at 15-minute intervals) to calculate a total annual suspended-sediment load for each creek (Forms 4 to 6). Interpretation of suspended-sediment rates and total loads is discussed in Section 6.5.3 below.

6.5.2 Bedload sediment

The *Draft Surface Water Quality Monitoring Plan 2001/02* (LWA, 2001) does not include consideration or protocols for measurements of bedload-sediment transport. At all three LTMAP gaging stations discussed in this report, the threshold for significant bedload transport occurs at flow depths and velocities that border on being too deep to sample safely by wading. No bedload samples were collected during water year 2009, yet bedload monitoring is one effective way of characterizing bed conditions for anadromy (Hecht and Enkeboll, 1981; Roques and Angelo, 2004; Hecht and Owens, 2006). If studying how bed conditions constrain anadromous fish populations in the Santa Cruz Mountains becomes an objective of this program, then a greater emphasis can be placed on collecting bedload sediment samples.

Although we have only a limited number of bedload-sediment measurements on Bear Creek and on Los Trancos Creek at Piers Lane, as compared to the number of suspended-sediment samples, we have constructed bedload rating curves for those stations (Figures 18 and 19). Bedload samples are converted to a discharge rate (in units of tons per day) and then plotted as a function of flow. As expected, sediment discharge increases as flow increases. We also applied the bedload rating curve to the record of streamflow (at 15-minute intervals) to calculate annual bedload totals for Bear Creek (Form 4 and Table 4) and Los Trancos Creek (Form 5 and Table 4). Interpretation of bedload-sediment rates and total loads for these two stations is discussed in Section 6.5.3 below.

6.5.3 Sediment discussion

Suspended-sediment rating curves for San Francisquito, Los Trancos, and Bear Creeks were adjusted slightly from the previous year based on the collected samples. The San Francisquito Creek sediment rating curve was adjusted slightly downward, while the Los Trancos and Bear Creek sediment rating curves were adjusted slightly upward.

Comparison of the suspended-sediment rating curves for the Los Trancos Creek and San Francisquito Creek at Piers Lane stations (Figure 18) with the rating curve for the Bear Creek station (Figure 19) shows that Los Trancos Creek generally carries higher suspended-sediment loads at a given flow than San Francisquito Creek or Bear Creek. Higher rates of transport in *tributary* streams at a given flow is a typical condition and nearly universal throughout the Bay Area (c.f., Hecht, 1983), since tributary watersheds tend to be steeper and more subject to erosion due to higher flow velocities. In addition, suspended-sediment concentrations in San Francisquito Creek are diluted by outflows from Searsville Lake, which traps a large proportion of the sediment load from tributary streams higher in the watershed. We compared the sediment rating curve for Bear Creek to rating curves of other creeks that we monitor in the watershed, and found that sediment-discharge rates (as a function of flow) for Bear Creek are lower than rates for Corte Madera or Los Trancos Creeks.

It is important to note that storm flow in San Francisquito Creek is typically at twice the rate of flow in Bear Creek[7], and usually five or more times greater than flow in Los Trancos Creek (Figure 2), so San Francisquito Creek still transports more total sediment load. This is evident in the annual sediment summaries (Forms 4 to 6), which show that the calculated total suspended-sediment load in San Francisquito Creek was approximately 4,500 tons in water year 2009, compared to about 2,100 tons in Bear Creek and 3,300 tons in Los Trancos Creek. The suspended-sediment total for San Francisquito Creek seems to us to be a little high (alternately, the Bear Creek total could be too low): we calculated the suspended-sediment total flowing out of Searsville Lake to be approximately 800 tons, and the San Francisquito total should be a little larger than the summation of the Searsville and Bear Creek totals.

Sediment discharge rates at each of the stations show a strong dependence on flow at the time of the measurement; when flow is higher, the creeks carry more sediment. Therefore, sediment totals for each stream also vary from year to year depending on the amount of rainfall and the size of the largest flood peak (Table 4). This concept of “episodicity” is useful for interpreting the sediment measurements within the context of the inter-annual variability in climate conditions. Rather than trying to calculate an average sediment discharge per year, we acknowledge that there will be large year-to-year variability in sediment discharge.

[7] The relationship between flow at the Bear Creek at Sand Hill Road station and flow at San Francisquito Creek at Piers Lane varies seasonally with the amount of outflow from Searsville Lake. Typically, differences in flow between the two sites are smaller at the start of the wet season, when the water level in the lake is below the spillway. Later in the wet season, differences are greater once the lake begins to spill freely.

7. FUTURE MONITORING AND RECOMMENDATIONS

The following recommendations are offered for consideration by the LTMAP working group based on our experience and observations since inception of monitoring:

1. We plan to monitor flow and sediment transport over a range of events during water year 2010, but will not sample chemical constituents at any of the three sites. At the Bear Creek at Sand Hill Road station, the gaging program will be maintained at a minimal (baseline) level that will still provide valuable data on streamflows, and sediment grab samples will be collected in conjunction with sampling at other local project sites.

2. Balance has been and is working with Stanford University and Regional Water Quality Control Board staff to develop useful metrics to evaluate sediment conditions in the creeks of the San Francisquito watershed. This effort could potentially enhance the current LTMAP monitoring program through application of new tools and a wider range of monitoring methods focused on sediment conditions as they relate to stream biota and habitat.

3. The problem with the specific conductance probes at the San Francisquito Creek station has been solved by reprogramming the datalogger. Both the Los Trancos Creek and San Francisquito Creek at Piers Lane stations are using "loaner" specific-conductance probes that will remain in place through the close of water year 2010.

8. LIMITATIONS

Analyses and information included in this report are intended for use at the watershed scale and for the planning and long-term monitoring purposes described above. 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. Balance Hydrologics, Inc. should be consulted prior to applying the contents of this report to evaluating water supply or any out-of-stream uses not specifically cited in this report.

Readers who have additional pertinent information, who observed changed conditions, or who may note material errors should contact us with their findings at the earliest possible date, so that timely changes may be made.

9. ACKNOWLEDGEMENTS

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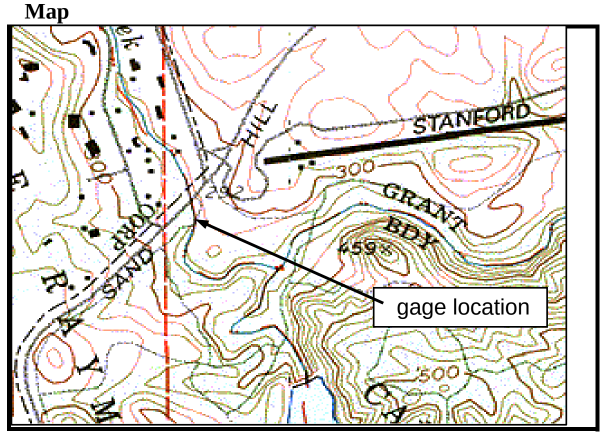
FORMS

Water Year:	**2009**		
Stream:	Bear Creek		
Station:	at Sand Hill Road	**BCSH**	
County:	San Mateo County, CA		

Form 1. Annual Hydrologic Record

Map



Station Location / Watershed Descriptors

Latitude: 37 24' 40", Longitude: 122 14' 28" Jasper Ridge Biological Preserve, Stanford, CA. Gage is installed on left bank, about 200 feet downstream from Sand Hill Rd. Staff-plate pool is eroded into hard sandstone; underflow is thought to be minimal. Land use includes forested open space, and suburban uses in valleys. Drainage area above gage is 11.7 sq. mile

Mean annual flow (MAF)

MAF for the period of record (2000 - 2009) is 7.04 cubic feet per second (cfs)
Mean Daily Flow for WY2009 = 3.58 cfs.; WY2008 = 3.36 cfs.; 2007 = 1.75 cfs.

Peak Flows

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
2/13/09	5:30	3.24	97	2/22/09	23:30	3.31	99
2/15/09	**22:15**	**6.32**	**586**	2/24/09	3:15	3.21	89
2/16/09	9:15	5.07	338	3/2/09	14:30	3.44	114
2/17/09	12:30	3.36	105	3/3/09	11:00	4.38	229
				3/5/09	7:30	3.03	72

The peak for the period of record (Oct. 1999 to Sept. 2009) was 3,800 cfs on Dec. 31, 2005

Period of Record

Station operated May to Nov. 1997, and October 1999 to present.
Flow, sediment transport, water quality, and specific conductance measured periodically. Gaging sponsored by Jasper Ridge Biological Preserve and Stanford Linear Accelerator Center.

WY 2009 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.27	8.27	0.31	0.55	0.97	6.94	1.64	1.94	0.69	0.39	0.24	0.32
2	0.28	2.88	0.36	0.72	0.94	52.39	1.57	2.39	0.75	0.36	0.27	0.28
3	0.30	1.70	0.47	0.69	0.84	88.54	1.49	2.09	0.72	0.31	0.29	0.08
4	1.07	0.68	0.50	0.60	0.75	52.96	1.43	1.74	0.73	0.33	0.29	0.08
5	0.34	0.26	0.46	0.58	0.90	35.77	1.35	3.16	0.69	0.35	0.19	0.30
6	0.34	0.20	0.45	0.57	1.15	19.42	1.27	2.28	0.69	0.38	0.22	0.03
7	0.32	0.20	0.46	0.58	1.13	10.67	1.60	2.00	0.76	0.40	0.19	0.02
8	0.27	0.33	0.44	0.55	1.43	10.66	1.48	1.61	0.71	0.32	0.34	0.03
9	0.16	0.48	0.49	0.57	2.56	7.17	1.44	1.51	0.63	0.33	0.27	0.50
10	0.19	0.28	0.42	0.54	1.02	6.77	1.49	1.31	0.64	0.33	0.26	0.63
11	0.24	0.23	0.46	0.52	2.61	5.85	1.30	1.16	0.71	0.43	0.16	0.38
12	0.26	0.20	0.44	0.60	2.56	5.06	1.20	1.12	0.70	0.45	0.13	0.46
13	0.24	0.21	0.38	0.56	23.24	4.55	1.11	1.12	0.72	0.36	0.18	0.62
14	0.29	0.20	1.05	0.54	9.38	4.21	1.23	1.06	0.73	0.21	0.05	0.98
15	0.23	0.19	2.76	0.54	209.04	3.95	1.39	1.01	0.69	0.22	0.12	0.47
16	0.24	0.18	1.19	0.53	199.26	3.30	1.22	0.99	0.63	0.25	0.23	0.08
17	0.19	0.19	0.58	0.49	65.88	2.49	1.04	0.88	0.64	0.22	0.21	0.29
18	0.19	0.19	0.46	0.47	20.26	2.27	1.01	0.81	0.54	0.14	0.10	0.27
19	0.25	0.19	1.48	0.47	8.60	2.27	0.92	0.75	0.43	0.17	0.25	0.12
20	0.29	0.20	0.61	0.46	4.10	2.18	0.85	0.73	0.36	0.20	0.18	0.10
21	0.22	0.18	2.18	0.48	2.25	2.49	0.83	0.82	0.42	0.05	0.18	0.02
22	0.20	0.19	3.03	2.56	31.28	11.86	0.82	0.77	0.40	0.10	0.15	0.02
23	0.23	0.21	1.08	2.56	71.12	3.33	0.88	0.82	0.38	0.16	0.30	0.03
24	0.25	0.23	0.69	1.68	48.52	2.33	0.84	0.92	0.37	0.16	0.35	0.03
25	0.20	0.27	10.63	1.17	15.68	2.25	0.89	0.96	0.36	0.08	0.26	0.14
26	0.20	0.35	1.61	1.15	11.67	2.09	0.93	0.90	0.31	0.17	0.41	0.17
27	0.27	0.37	0.80	1.04	6.46	2.10	0.96	0.87	0.36	0.19	0.35	0.08
28	0.31	0.34	0.67	1.02	4.33	2.06	1.07	0.86	0.43	0.14	0.24	0.05
29	0.36	0.29	0.61	1.02		1.98	1.19	0.81	0.45	0.27	0.15	0.06
30	0.39	0.27	0.61	1.05		1.88	1.23	0.75	0.30	0.28	0.25	0.06
31	0.66		0.58	0.98		1.76		0.72		0.25	0.43	
MEAN	0.30	0.66	1.17	0.83	26.71	11.66	1.19	1.25	0.56	0.26	0.23	0.22
MAX. DAY	1.07	8.27	10.63	2.56	209.04	88.54	1.64	3.16	0.76	0.45	0.43	0.98
MIN. DAY	0.16	0.18	0.31	0.46	0.75	1.76	0.82	0.72	0.30	0.05	0.05	0.02
cfs days	9.2	19.9	36.2	25.9	747.9	361.5	35.7	38.9	16.9	8.0	7.2	6.7
ac-ft	18.3	39.6	71.9	51.3	1483.5	717.1	70.7	77.1	33.6	15.9	14.4	13.3

Monitor's Comments

1. We collected a continuous stage record from October 1, 2008 to September 30, 2009.
2. Diversions upstream of the gaging location affect flow in the creek. Occasional flow alterations (both additions and subtractions) were recorded.
3. Multiple stage shifts were applied to the rating equation. Stage shifts adjust for local scour and fill in addition to water-level changes due to algal growth or dams caused by accumulation of fallen leaves and branches
4. Daily values with more than 2 to 3 significant figures result from electronic calculations, no additional precision is implied.

Water Year 2009 Totals:		
Mean daily flow	**3.60**	(cfs)
Max. daily flow	**209**	(cfs)
Min. daily flow	**0.02**	(cfs)
Annual total	**1,314**	(cfs-days)
Annual total	**2,607**	(ac-ft)

Balance Hydrologics, Inc. 800 Bancroft Way, Suite 101, Berkeley, CA 94710 (510) 704-1000; www.balancehydro.com

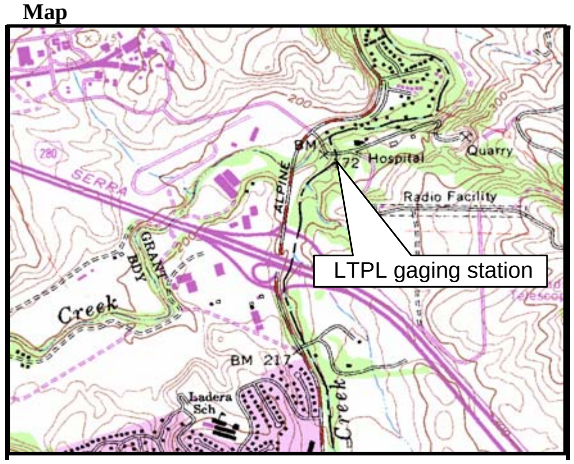
Water Year:	**2009**	
Stream:	Los Trancos Creek	
Station:	Piers Lane	**LTPL**
County:	San Mateo County, CA	

Form 2. Annual Hydrologic Record

Station Location / Watershed Descriptors

Latitude: 37° 24' 48" N, Longitude: 122° 11' 29" W, in San Mateo County, CA. The gaging station is located under Piers Lane bridge at Los Trancos Creek. Land use includes open space, sports fields, small commercial areas, and low-density residential. There is a water diversion about 1.8 miles upstream. Los Trancos Creek watershed area above gaging station = 7.8 square miles .

Map



Mean annual flow (MAF)

MAF for the period of record (2003-2009) is 3.09 cubic feet per second (cfs)
Mean Daily Flow for WY 2009 = 2.02 cfs.; 2008 = 1.80 cfs.; 2007 = 0.75 cfs.; 2006 = 7.09 cfs.

Peak Flows

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
2/15/09	**20:30**	**5.64**	**319**	3/2/09	13:30	2.45	46
2/16/09	9:00	4.42	198	3/3/09	11:15	5.39	291
2/17/09	9:15	2.66	77	3/5/09	5:45	2.28	47

The peaks (for the period of record Oct. 2002 to Sept. 2008) was 640 cfs on Dec. 16, '02 and Dec. 31, '06.

Period of Record

Equipment installed October 2001. Periodic site visits to measure flow, make observations, and collect water quality samples have been made since Feburary 2002. Gaging sponsored by Stanford University Utilities Division.

WY 2009 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.03	2.67	0.29	0.47	0.49	4.60	0.58	1.54	0.60	0.19	0.07	0.04
2	0.03	1.69	0.34	0.48	0.44	16.92	0.60	1.46	0.42	0.19	0.07	0.03
3	0.04	0.20	0.20	0.42	0.46	102.29	0.57	1.53	0.47	0.19	0.07	0.03
4	0.10	0.08	0.21	0.32	0.46	43.84	0.52	1.23	0.41	0.19	0.07	0.03
5	0.03	4.27	0.18	0.46	0.70	18.30	0.51	2.42	0.43	0.18	0.07	0.03
6	0.03	0.89	0.20	0.46	1.27	8.56	0.48	1.23	0.47	0.19	0.08	0.04
7	0.02	0.11	0.22	0.43	0.74	5.83	0.70	0.96	0.53	0.21	0.07	0.03
8	0.02	0.09	0.22	0.44	0.90	5.14	0.31	0.89	0.47	0.19	0.06	0.03
9	0.03	0.07	0.20	0.39	1.38	4.63	0.57	0.81	0.39	0.18	0.06	0.03
10	0.03	0.19	0.18	0.33	0.64	4.15	0.53	0.82	0.39	0.19	0.05	0.03
11	0.03	0.70	0.19	0.35	2.33	3.96	0.42	0.73	0.44	0.19	0.05	0.03
12	0.03	0.79	0.22	0.33	1.95	3.76	0.39	0.66	0.44	0.20	0.05	0.04
13	0.03	0.29	0.22	0.28	7.01	3.61	0.45	0.68	0.47	0.18	0.05	0.05
14	0.03	0.09	0.61	0.28	2.61	3.75	0.47	0.63	0.42	0.15	0.04	0.07
15	0.02	0.10	2.43	0.27	127.22	3.86	0.54	0.61	0.39	0.13	0.04	0.04
16	0.02	0.11	1.58	0.25	86.54	3.69	0.47	0.58	0.38	0.16	0.04	0.04
17	0.02	0.69	0.40	0.26	40.81	3.53	0.56	0.53	0.39	0.15	0.04	0.05
18	0.02	0.33	0.37	0.26	14.22	3.31	0.90	0.54	0.45	0.13	0.04	0.04
19	0.03	0.16	1.65	0.26	5.34	3.22	0.76	0.56	0.35	0.14	0.05	0.04
20	0.03	0.20	0.49	0.28	4.34	3.08	0.70	0.49	0.41	0.12	0.04	0.04
21	0.02	0.18	1.72	0.81	3.77	3.56	0.64	0.48	0.44	0.13	0.04	0.04
22	0.03	0.15	2.73	3.67	7.20	5.54	0.58	0.47	0.43	0.13	0.04	0.05
23	0.03	0.16	0.49	2.39	8.22	3.38	0.66	0.46	0.37	0.13	0.04	0.05
24	0.03	0.17	0.56	1.11	6.44	3.08	0.67	0.51	0.34	0.13	0.04	0.05
25	0.03	0.41	3.84	0.95	4.42	2.95	0.68	0.54	0.34	0.13	0.04	0.05
26	0.03	0.85	0.45	0.67	4.54	2.05	0.72	0.61	0.30	0.13	0.04	0.05
27	0.03	0.60	0.34	0.59	3.66	0.78	0.81	0.55	0.34	0.14	0.04	0.04
28	0.03	0.47	0.51	0.58	3.47	0.73	0.78	0.47	0.24	0.12	0.03	0.03
29	0.04	0.44	0.52	0.56		0.70	0.70	0.43	0.22	0.07	0.04	0.05
30	0.05	0.40	0.48	0.50		0.66	0.88	0.54	0.20	0.07	0.03	0.05
31	0.06		0.49	0.51		0.63		0.58		0.07	0.04	
MEAN	0.03	0.59	0.73	0.62	12.20	8.84	0.60	0.79	0.40	0.15	0.05	0.04
MAX. DAY	0.10	4.27	3.84	3.67	127.22	102.29	0.90	2.42	0.60	0.21	0.08	0.07
MIN. DAY	0.02	0.07	0.18	0.25	0.44	0.63	0.31	0.43	0.20	0.07	0.03	0.03
cfs days	1.0	17.6	22.5	19.4	341.6	274.1	18.1	24.6	11.9	4.7	1.5	1.2
ac-ft	2.0	34.8	44.7	38.4	677.5	543.7	36.0	48.7	23.7	9.4	3.0	2.4

Monitor's Comments

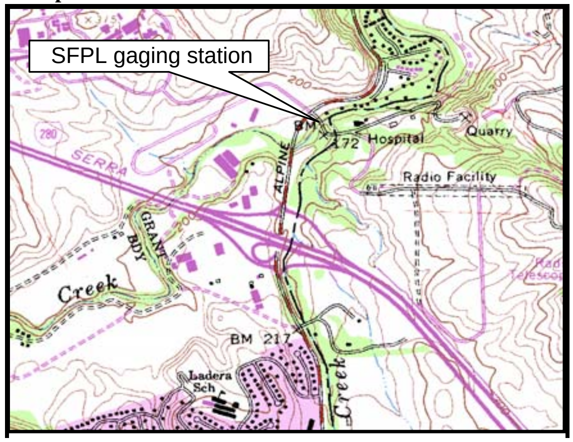
1. We collected a continuous record for the entire water year.
2. Multiple stage shifts were applied to the rating equation; stage shifts adjust for local scour or fill and leaf debris build-up.
3. The upper portion of the rating curve is based on several high-flow estimates. (Calculated using the "slope-area" method.)
4. Daily values with more than 2 to 3 significant figures result from electronic calculations; no additional precision is implied.
5. There is a surface-water diversion and fish ladder, about 1.8 miles upstream of this station, which may divert water out of Los Trancos Creek during the period from December 1 to May 1.

Water Year 2009 Totals:		
Mean daily flow	**2.02**	(cfs)
Max. daily flow	**127**	(cfs)
Min. daily flow	**0.02**	(cfs)
Annual total	**738**	(cfs-days)
Annual total	**1,464**	(ac-ft)

Water Year:	**2009**		
Stream:	San Francisquito Creek		
Station:	Piers Lane	**SFPL**	
County:	San Mateo County, CA		

Form 3. Annual Hydrologic Record

Map



Station Location / Watershed Descriptors

Latitude: 37° 24' 48" N, Longitude: 122° 11' 29" W in San Mateo County, CA. The gaging station is located directly under Piers Lane bridge at San Francisquito Creek, immediately upstream of its confluence with Los Trancos Creek. Land use includes open space, low-density residential, and some commercial uses. The watershed area above gaging station = 29.9 square miles.

Mean Annual Flow

Mean annual flow for the period of record is (2002-2009) is 17.9 cfs.
Mean daily flow for water year 2008 was 10.43 cfs; 2007 was 4.88 cfs; water year 2006 was 40.09 cfs

Selected Peak Flows

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
11/1/08	22:30	4.75	44	2/23/09	1:15	5.50	128
2/13/09	7:45	5.28	95	3/2/09	18:15	5.83	191
2/15/09	**23:15**	**9.11**	**1,733**	3/3/09	12:30	7.04	637
2/16/09	10:30	7.42	821	3/5/09	9:45	5.58	140
2/17/09	14:15	5.94	211	3/22/09	5:30	4.90	54

The peak for the period of record (October 2002 to Sept. 2009) was 4,300 cfs on Dec. 31, 2005

Period of Record

Equipment installed October 2001. Periodic site visits to measure flow, make observations, and collect water quality samples have been made since Feburary 2002. Gaging sponsored by Stanford University Utilities Division.

WY 2009 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.09	9.46	0.37	0.90	0.89	15.81	3.07	1.70	0.86	0.39	0.15	0.01
2	0.15	7.39	0.41	0.90	0.85	96.55	2.82	2.81	0.90	0.37	0.13	0.01
3	0.15	1.48	0.39	1.09	0.82	282.33	2.68	2.53	0.96	0.36	0.12	0.01
4	1.05	1.77	0.39	0.92	0.81	162.00	2.50	3.22	0.84	0.33	0.11	0.00
5	0.79	0.43	0.40	0.91	0.99	99.42	2.29	6.81	0.78	0.29	0.14	0.00
6	0.48	0.33	0.39	0.93	1.66	56.21	2.15	6.37	0.75	0.27	0.15	0.01
7	0.47	0.28	0.38	0.90	1.68	33.95	2.68	4.27	0.78	0.26	0.11	0.01
8	0.43	0.35	0.42	0.90	1.18	27.53	3.25	2.96	0.76	0.26	0.07	0.00
9	0.40	0.46	0.40	0.83	3.88	20.32	2.66	2.28	0.72	0.25	0.07	0.01
10	0.31	0.40	0.45	0.81	1.37	16.53	2.52	1.95	0.71	0.22	0.09	0.01
11	0.25	0.32	0.42	0.81	3.76	13.35	2.08	1.68	0.75	0.25	0.11	0.01
12	0.22	0.31	0.48	0.81	3.62	11.10	1.91	1.51	0.71	0.30	0.12	0.06
13	0.21	0.29	0.48	0.88	31.37	9.91	1.82	1.48	0.74	0.30	0.08	0.09
14	0.22	0.30	0.71	0.79	25.44	8.94	1.68	1.42	0.74	0.29	0.04	0.26
15	0.22	0.29	5.39	0.77	525.59	8.59	2.45	1.41	0.69	0.24	0.02	0.33
16	0.21	0.27	3.00	0.76	602.70	8.72	2.84	1.38	0.67	0.21	0.02	0.24
17	0.21	0.28	1.40	0.74	156.26	7.74	2.64	1.47	0.65	0.24	0.01	0.16
18	0.23	0.28	0.88	0.72	61.41	6.25	2.65	1.28	0.71	0.24	0.02	0.09
19	0.26	0.30	2.86	0.72	27.15	5.91	1.78	1.15	0.62	0.23	0.02	0.04
20	0.25	0.31	1.55	0.71	14.84	5.34	1.51	0.99	0.54	0.18	0.02	0.05
21	0.25	0.30	1.63	0.85	8.84	5.00	1.35	0.97	0.49	0.23	0.03	0.07
22	0.26	0.29	6.90	7.33	39.12	31.37	1.35	0.98	0.51	0.20	0.06	0.05
23	0.27	0.29	2.15	4.16	107.91	11.71	1.25	0.93	0.50	0.14	0.05	0.03
24	0.26	0.30	1.43	2.77	91.41	6.80	1.14	0.96	0.50	0.16	0.02	0.02
25	0.23	0.32	14.41	1.31	36.15	5.86	1.13	0.99	0.50	0.17	0.01	0.01
26	0.23	0.64	3.18	1.08	30.06	5.43	1.22	1.00	0.46	0.18	0.01	0.01
27	0.23	0.53	1.48	1.00	19.60	5.07	1.38	1.02	0.47	0.12	0.01	0.01
28	0.27	0.43	1.19	0.94	12.88	4.71	1.45	1.04	0.49	0.15	0.01	0.00
29	0.34	0.40	1.05	0.93		4.07	1.33	1.03	0.48	0.16	0.01	0.00
30	0.26	0.37	0.99	0.95		3.51	1.39	0.97	0.48	0.12	0.01	0.00
31	0.48		0.97	0.93		3.07		0.93		0.15	0.01	
MEAN	0.31	0.97	1.82	1.26	64.72	31.71	2.03	1.92	0.66	0.23	0.06	0.05
MAX. DAY	1.05	9.46	14.41	7.33	602.70	282.33	3.25	6.81	0.96	0.39	0.15	0.33
MIN. DAY	0.09	0.27	0.37	0.71	0.81	3.07	1.13	0.93	0.46	0.12	0.01	0.00
cfs days	10	29	57	39	1812	983	61	59	20	7	2	2
ac-ft	19	58	112	78	3595	1950	121	118	39	14	4	3

Monitor's Comments

1. We collected a continuous record for the entire water year.
2. Multiple stage shifts were applied to the rating equation; stage shifts adjust for local scour or fill.
3. Daily values with more than 2 to 3 significant figures result from electronic calculations; no additional precision is implied.
4. Flow is regulated by multiple diversions and an upstream reservoir (Searsville Lake), plus possible return flows from applied imported water.

Water Year 2009 Totals:		
Mean daily flow	**8.44**	(cfs)
Max. daily flow	**603**	(cfs)
Min. daily flow	**0.00**	(cfs)
Annual total	**3,081**	(cfs-days)
Annual total	**6,111**	(ac-ft)

Form 4. Annual sediment-discharge record, Bear Creek at Sand Hill Road, water year 2009

Water Year : **2009**
Stream: Bear Creek
Station: at Sand Hill Road **BCSH**
County: San Mateo County, CA

Total annual sediment discharge
(suspended- plus bedload-sediment discharge)
WY 2009: 2,176 ***tons***

WY 2009 Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	2.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.2	0.0	0.0	0.0	46.7	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.1	0.0	0.0	0.0	133.3	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	35.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	17.3	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.1	1.4	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.0	14.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	1.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.1	0.0	1150.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	526.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	56.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	5.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.2	0.1	27.2	2.8	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.1	62.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.0	36.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	2.4	0.0	3.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.0	1.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	**Qss**
31	0.0		0.0	0.0		0.0		0.0		0.0	0.0		**Annual**
TOTAL	0	3	3	0	1887	247	0	0	0	0	0	0	**2,141**
Max.day	0	3	2	0	1151	133	0	0	0	0	0	0	**1,151**

WY 2009 Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	18.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	**Qbed**
31	0.0		0.0	0.0		0.0		0.0		0.0	0.0		**Annual**
TOTAL	0	0	0	0	30	4	0	0	0	0	0	0	**34**
Max.day	0	0	0	0	18	2	0	0	0	0	0	0	**18**

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Multiple sediment-discharge rating curves were used for different periods of the year and ranges of flow.
Daily values with more than 2 signifiant figures result from electronic calculations. No additional precision is implied.

Balance Hydrologics, Inc. 800 Bancroft Way, Suite 101, Berkeley, CA 94710 (510) 704-1000; www.balancehydro.com

Form 5. Annual sediment-discharge record, Los Trancos Creek at Piers Lane, water year 2009

Water Year: **2009**
Stream: Los Trancos
Station: at Piers Lane **LTPL**
County: San Mateo County, CA

Total annual sediment discharge
(suspended- plus bedload-sediment discharge)
WY 2008: 3,415 *tons*

Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.8	0.0	0.0	0.0	1.1	0.0	0.1	0.0	0.0	0.0	0.0	
2	0.0	0.4	0.0	0.0	0.0	20.4	0.0	0.1	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	831	0.0	0.4	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	146.3	0.0	0.1	0.0	0.0	0.0	0.0	
5	0.0	1.8	0.0	0.0	0.0	20.4	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.1	0.0	0.0	0.1	3.8	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.1	1.3	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.1	0.0	0.0	0.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.1	0.0	0.0	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.0	4.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.1	0.0	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.4	0.0	1527	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.2	0.0	546	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.1	0.0	0.0	97.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	12.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.2	0.0	1.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.4	0.1	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.6	1.0	3.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.3	3.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.1	2.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	1.3	0.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	**Qss**
31	0.0		0.0	0.0		0.0		0.0		0.0	0.0		**Annual**
TOTAL	0.0	3.5	3.2	1.8	2204	1038	0.6	1.2	0.2	0.0	0.0	0.0	**3,253**
Max.day	0.0	1.8	1.3	1.0	1527	831	0.0	0.4	0.0	0.0	0.0	0.0	**1,527**

Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	42	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.0	0.0	76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	**Qbed**
31	0.0		0.0	0.0		0.0		0.0		0.0	0.0		**Annual**
TOTAL	0.0	0.2	0.2	0.1	110.2	51.9	0.0	0.1	0.0	0.0	0.0	0.0	**163**
Max.day	0.0	0.1	0.1	0.0	76.3	41.5	0.0	0.0	0.0	0.0	0.0	0.0	**76**

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Daily values with more than 2 significant figures result from electronic calculations. No additional precision is implied.

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Form 6. Annual sediment-discharge record, San Francisquito Creek at Piers Lane, water year 2009

Water Year:	**2009**	
Stream:	San Francisquito Creek	
Station:	at Piers Lane	**SFPL**
County:	San Mateo County, CA	

Daily Suspended-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	Qss Annual
1	0.0	0.9	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	0.3	0.0	0.0	0.0	43.3	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	0.0	0.0	0.0	0.0	359.9	0.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	0.0	0.0	0.0	102.7	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	34.1	0.0	0.2	0.0	0.0	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	10.8	0.0	0.1	0.0	0.0	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.1	0.0	0.0	0.0	0.0	
8	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	
9	0.0	0.0	0.0	0.0	0.1	1.4	0.0	0.0	0.0	0.0	0.0	0.0	
10	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.0	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	
13	0.0	0.0	0.0	0.0	4.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.0	2.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
15	0.0	0.0	0.1	0.0	2218.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
16	0.0	0.0	0.0	0.0	1511.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
17	0.0	0.0	0.0	0.0	82.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
18	0.0	0.0	0.0	0.0	13.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	0.0	0.0	0.0	2.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
20	0.0	0.0	0.0	0.0	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
21	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	0.0	0.2	0.2	8.5	3.7	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.0	0.0	0.0	0.1	38.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	0.0	29.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	
25	0.0	0.0	1.2	0.0	4.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
26	0.0	0.0	0.0	0.0	3.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
27	0.0	0.0	0.0	0.0	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	0.0	0.0	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	
29	0.0	0.0	0.0	0.0		0.1	0.0	0.0	0.0	0.0	0.0	0.0	
30	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
31	0.0		0.0	0.0		0.0		0.0		0.0	0.0		
TOTAL	0.0	1.3	1.7	0.4	3923.3	567.9	0.5	0.6	0.0	0.0	0.0	0.0	**4,496**
Max.day	0.0	0.9	1.2	0.2	2218.3	359.9	0.0	0.2	0.0	0.0	0.0	0.0	**2,218**

Daily Bedload-Sediment Discharge *(tons)*

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	Qbed Annual
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12						Daily bedload discharge							
13						was not calculated for WY2009							
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													
TOTAL	...	...	...	...	...	...	...	...	...	...	...	...	...
Max.day	...	...	...	...	...	...	...	...	...	...	...	...	...

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Daily values with more than 2 significant figures result from electronic calculations. No additional precision is implied.

Balance Hydrologics, Inc. 800 Bancroft Way, Suite 101, Berkeley, CA 94710 (510) 704-1000; fax: (510) 704-1001

TABLES

Table 1. Station Observer Log: Bear Creek at Sand Hill Road, water year 2009

Site Conditions				Streamflow				Water Quality Observations							High-Water Marks		Remarks
Date/Time	Observer	Stage	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	pH	Dissolved Oxygen	Dissolved Oxygen	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		(feet)	'R/F/S/B)	(cfs)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(pH)	(mg/L)	(% sat.)	(Qbed, etc.)	(feet)	(mm/dd/yr)	
9/26/08 11:10	jo	1.508	B	0.09	…	PY	f	…	…	…	…	…	…	…	…	…	water surprisingly very turbid and brown, walked upstream but under and above bridge water was clear
10/24/08 13:33	tb, jm	…	…	…	0.15	…	…	16.9	785	660	…	…	…	…	…	…	calibrated the rain tipping gauge, clipped some brush near solar panel
12/2/08 12:40	jo	1.57	B	0.28	0.3	PY	f	10.9	429	584	…	…	…	…	2.2-2.4	10/31/2008	water clear, leaf dams present but pushed to side, gates opened, brown algae on rock
12/12/08 13:52	tb	1.545	B	0.40	0.5	PY	g	7.2	421	638	8.6	9.8	81%	…	…	…	cleaned loose sand out of probe head
2/3/09 12:00	tb, nn	1.59	B	0.79	…	PY	g, e	6.9	425	650	8.0	11.9	98%	…	2.1-2.6	Late Jan-09	Replaced datalogger, cleaned probes.
2/15/09 15:03	jo	3.40	R	…	120	visual	p	9.1	194	278	…	…	…	2 Qss	3.7	today	water turbid and light brown; just a few floating sticks, waded 3/4 across
2/16/09 12:00	jo	4.1	F	…	250	visual	p	9.05	126	181	…	…	…	Qss	6.1, 4.6	overnight and this AM	water higher than yesterday and too deep to wade
3/3/09 14:05	bdb, tb	3.2	U	…	150	visual	p	11.3	156	211	…	…	…	Qss	4.2, 5.2		water very turbid and brown
3/17/09 15:20	jo	1.87	F, B	3.57	…	PY	g, e	13.0	486	631	…	10.8	100%	…	…	…	water clear, fine silt and algae on bed
4/28/09 11:45	tb	1.625	B	1.07	…	PY	g, e	10.7	357	491	7.9	10.8	98%	…	…	…	troubleshooting of modem, grasses growing in controling riffle
5/13/09 11:50	tb	1.61	B	…	…	…	…	…	…	…	…	…	…	…	…	…	on site to trouble-shoot modem.
6/17/09 11:45	tb	1.53	B	0.60	0.3	PY	g, f	15.4	481	589	7.8	7.4	74%	…	…	…	10-20 2" fish in gage pool, controling riffle has grasses along the right bank that are larger and more full than last visit.
7/28/09 13:00	tb	0.15	B	0.11	…	PY	g, f	18.3	564	646	…	6.9	76%	…	…	…	Water clear, many fish in gage pool, grasses at control riffle continue to fill in.
9/16/09 11:30	jo	0.145	B	0.11	…	PY	g	15.7	423	513	7.2	6.3	64%	…	…	…	brown slime of algae and silt on rocks, many 3/4" fish, water clear.

Notes:

Obs Key: jo is Jonathan Owens, tb is Travis Baggett, bdb is Bonnie deBerry, jm is Jennie Munster, nn is Nathan Nuefeld

Stage: Water level observed at outside staff plate

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B), or diversion underway (D)

Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve(R), visual (V), or float test

Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy given

High-water mark (HWM): Measured or estimated at location of the staff plate

Table 2. Station observer log: Los Trancos Creek at Piers Lane, water year 2009

Site Conditions				*Streamflow*				*Water Quality Observations*								*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	pH	Dissolved Oxygen	Dissolved Oxygen	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(R/F/S/B/P)*	*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(°C)*	*(µmhos/cm)*	*(at 25 °C)*	*(pH)*	*(mg/L)*	*(% sat.)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
9/24/08 15:57	tb	0.58	B	…	0.05	visual	p	17.0	1649	1950	8.3	6.9	72%	…	…	…	Probes appear in good condition but could not check the pressure transducers because the stilling well is filled with sediment.
10/24/08 8:58	tb, jm	0.60	B	…	0.02	visual	p	11.3	1465	1985	8.2	7.1	67%	…	…	…	thorough cleaning of all probes and the stilling well; a leaf dam is present at the control riffle for the gauge pool.
11/13/08 13:10	jo	1.16	U	…	0.4-0.5	visual	p	…	…	…	…	…	…	…	…	…	onsite to download LTPL, water is slightly turbid and greenish, JO talked to Alan Launer who said, "Releases are permited from Felt Lake."
12/12/08 11:30	tb	0.65	B	0.164	0.20	PY	g	8.8	685	992	8.2	10.4	89%	…	…	…	Possibly more gravel in the gauge pool; 10 or more 1-2" fish in downstream pool.
1/6/09 14:32	tb, jm	0.74	B	…	0.34	visual		10.0	99.1	1390	8.0	11.3	100%		1.50		water clear, high water mark of 1.5 feet as evidenced from packed leaves on staff plate
2/3/09 15:50	tb, nn	0.76	B	0.426	…	PY	g	10.5	983	1360	7.8	10.8	98%	…	1.30	late Jan09	many leaves and tree debris still in pools and along banks
2/15/09 15:25	jo	3.80	U	…	160	visual	p	9.1	188	270	…	…	…	Qss (2)	none obvious		water is dark brown, many floating sticks
2/16/09 12:50	jo	gone	U	…	80	visual	p	9.4	170	281	…	…	…	Qss	3' above present WL	last 24 hours	staff plate has washed away again; stage looks ~ 0.5' below prior day's observation
3/3/09 11:55	tb, bdb	gone	R	…	30	visual	p	10.6	123.8	171	7.0	11.7	105%	Qss	1 to 2' above present WL	w/in last week and within last month	Water is brown and turbid, very turbulent and unable to do a float test because floats sink and reappear elsewhere.
3/17/09 11:28	jo	1.15	F/B	3.57	4.00	PY	g	11.8	612	818	…	9.7	91%	…	5.6'	2/1/09	Cows grazing near creek and have crossed the creek, water clear, upper staff plate found 50' d/s, some mosquitoes present.
4/28/09 13:45	tb	0.86	B	0.762	…	PY	g	11.7	806	1080	7.1	9.3	95%	…	…	…	many leaves and tree debris in pools and along banks
6/17/09 12:45	tb	0.76	B	0.464	0.25	PY	f	16.7	1038	1221	7.9	6.9	71%	…	…	…	Many 0-3" fish spotted, water clear.
7/28/09 14:45	tb	0.58	B	0.055	0.08	PY	g, f	18.9	1519	1720	…	6.3	69%	…	…	…	Many 0-3" fish spotted, water clear flows are very low, cleared large leaf dam.
9/16/09 15:30	jo	0.50	B	0.038	…	PY	f	18.2	1726	1984	7.4	6.0	65%	…	…	…	flow is low, water is clear, many leaves and bark in creek, many 3" fish in pool d/s of bridge.

Observer Key: jo= Jonathan Owens; nn = Nathan Neufeld; tb = Travis Baggett; jm = Jennie Munster; bdb = Bonnie deBerry

Stage: Water level observed at outside staff plate

Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), baseflow (B), uncertain (U), or peak (P).

Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual estimate (visual) or float test (float.)

Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) = +/- > 9%

High-water mark (HWM): Measured or estimated at location of the staff plate

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, WQ = composite water quality sampling, WQgrab = grab samples (typically ammonia or mercury.)

Table 3. Station observer log: San Francisquito Creek at Piers Lane, water year 2009

Site Conditions				Streamflow				Water Quality Observations							High-Water Marks		Remarks
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	pH	Dissolved Oxygen	Dissolved Oxygen	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		(feet)	(R/F/S/B)	(cfs)	(cfs)	(AA/PY)	(e/g/f/p)	(°C)	(µmhos/cm)	(us@25°C)	(pH)	(mg/L)	(% sat.)	(Qbed, etc.)	(feet)	(mm/dd/yr)	
10/24/08 10:18	tb, jm	3.35	B	…	0.20	visual	p	10.9	983	1345	8.4	5.0	46%	…	…	…	cleaned stilling well and staff plate and probes; all were in good shape before cleaning; calibrated rain gage with
12/12/08 12:45	tb	3.43	B	0.414	…	PY	g	7.1	674	1025	8.4	9.6	80%	…	…	…	second pool upstream of gauge is covered with leaves, many leaves among rocks.
1/6/09 15:00	tb, jm	3.46	B	…	…	…	…	…	…	…	…	…	…	…	3.52	1/3/09	water clear
2/3/09 17:15	tb, nn	3.44	B	0.877	…	PY	g/f	8.1	650	950	7.7	11.8	101%	…	4.30	1/22/09	strong smell of paint thinner; though no sheen, foaming or odd color of water
2/15/09 15:35	jo	6.00	R	…	…	…	…	9.2	332	475	…	…	…	Qss (x2)	…	…	highest water of year; some floating wood; water light brown in color
2/16/09 13:01	jo	7.10	F	…	…	…	…	9.0	182	262	…	…	…	Qss	9.20	2/15/09	slight smell of dirt; a few floating items in stream; rain has slowed
3/3/09 12:17	tb, bdb	6.95	P	…	…	…	…	11.0	197	269	7.5	10.3	93%	Qss	8.00	2/16/09	…
3/17/09 13:00	jo	3.98	F	8.01	…	PY	f	12.2	570	753	…	9.7	88%	…	9.70	2/15/09	water murky (~1' visibility); rocks covered in algae; specific conductance probe was above water level; re-
4/28/09 14:40	tb	3.54	B	1.506	…	PY	g	12.8	720	940	7.6	9.1	85%	…	…	…	moss on large cobbles at section where flow was measured; at least one 2-inch fish in gage pool
6/17/09 13:00	tb	3.42	B	0.559	…	PY	f	17.2	812	956	7.2	5.8	60%	…	…	…	many spotted fish from 0-4"; water clear, greenish.
7/28/09 15:15	tb	3.38	B	…	0.16	V	p	19.8	1008	1277	…	6.2	70%	…	…	…	several four-inch fish in gage pool; many one-inch fish throughout creek; water clear
9/16/09 14:20	jo	3.38	B	0.228	…	PY	f	16.7	1259	1496	7.5	5.0	54%	…	…	…	water clear until disturbed; many small fish; light oily sheen on water surface

Observer Key: jo= Jonathan Owens; nn = Nathan Neufeld; tb = Travis Baggett; jm = Jennie Munster; bdb = Bonnie deBerry

Stage: Water level observed at outside staff plate

Hydrograph: Describes stream stage as rising (R), falling (F), peak (P), steady (S), baseflow (B), or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual estimate (visual) or float test (float.)

Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) = +/- > 9%

High-water mark (HWM): Measured or estimated at location of the staff plate

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, WQ = composite water quality sampling, WQgrab = grab samples (typically ammonia or mercury.)

Table 4. Hydrologic summary for the period of record, Bear Creek at Sand Hill Road, Los Trancos and San Francisquito Creeks at Piers Lane

	Annual Flow [4]				Sediment Discharge [4]				Peak Flow			Rainfall [7]		
Water Year [1]	Mean Daily Flow	Maximum Daily Mean Flow	Minimum Daily Mean Flow	Total Flow Volume	Suspended Sediment	% suspended	Bedload Sediment	% bedload	Peak Flow	Peak Stage [5]	Date Time	Annual total rainfall	Percent of long-term average, Rantz	Percent of long-term average, Nahn & Saah
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(tons)*		*(tons)*		*(cfs)*	*(ft)*	*(24-hr)*	*(in)*	*(%)*	*(%)*
Bear Creek at Sand Hill Road [2, 6]														
2000	10.65	684	0.01	7,728	24,426	93%	1,778	7%	2,050	8.81	2/13/00 20:45	…	…	…
2001	3.71	113	0.01	2,689	681	87%	98	13%	353	4.26	1/25/01 16:45	…	…	…
2002	5.12	189	0.01	3,704	1,681	91%	171	9%	733	5.78	12/2/01 7:45	…	…	…
2003	6.86	434	0.01	4,965	11,258	94%	762	6%	2,231	9.29	12/16/02 5:45	…	…	…
2004	5.87	282	0.01	4,260	5,624	91%	555	9%	1,186	7.28	1/1/04 12:15	20.5	79%	71%
2005	10.77	257	0.01	8,113	2,460	96%	98	4%	487	5.35	12/30/04 21:30	36.8	142%	127%
2006	18.33	849	0.01	13,269	11,693	96%	468	4%	3,800	10.70	12/31/05 7:00	36.7	141%	127%
2007	1.75	72	0.01	1,269	133	96%	5	4%	197	4.02	2/26/07 23:30	16.7	64%	58%
2008	3.36	241	0.01	2,442	1,127	96%	45	4%	862	7.29	1/4/08 14:45	21.3	82%	73%
2009	3.60	209	0.02	2,607	2,141	98%	34	2%	586	6.32	2/15/09 22:15	24.2	93%	83%
Los Trancos Creek at Piers Lane [3]														
2003	2.67	123	0.01	1,934	2,494	…	…	…	649	7.58	12/16/02 6:30	…	…	…
2004	2.70	136	0.02	1,461	2,991	…	…	…	582	5.47	2/25/04 11:00	…	…	…
2005	3.56	67	0.02	2,575	1,424	94%	85	6%	357	4.33	2/18/05 6:00	…	…	…
2006	7.09	190	0.13	5,137	4,328	91%	433	9%	640	7.80	12/31/05 8:15	…	…	…
2007	0.75	11	0.01	540	37	90%	4	10%	44	2.32	12/12/06 9:15	…	…	…
2008	1.80	125	0.02	1,307	1,436	91%	144	9%	316	5.64	1/25/08 18:30	…	…	…
2009	2.02	127	0.02	1,464	3,253	95%	163	5%	319	5.64	2/15/09 20:30	…	…	…
San Francisquito Creek at Piers Lane [3]														
2003	15.40	782	0.09	11,146	10,097	…	…	…	2,706	12.46	12/16/02 6:30	26.8	145%	122%
2004	11.02	453	0.12	8,002	6,910	…	…	…	1,474	9.67	1/1/04 13:15	…	…	…
2005	24.35	509	0.05	17,627	9,463	…	…	…	749	7.77	2/15/05 21:00	21.9	118%	100%
2006	40.09	1,704	0.39	29,027	34,217	…	…	…	4,300	12.98	12/31/05 8:15	26.0	141%	118%
2007	4.88	213	0.01	3,533	674	…	…	…	436	6.46	2/27/07 0:45	10.9	59%	50%
2008	10.43	551	0.01	7,574	7,323	…	…	…	1,621	8.86	1/25/08 21:30	17.0	92%	77%
2009	8.44	603	<0.01	6,111	4,496	…	…	…	1,733	9.11	2/15/09 23:15	*17.6* [8]	*92%*	*83%*

Notes:

General: Values displaying more than 2 or 3 significant figures are the result of electronic calculations; no additional precision is implied.

1) Hydrologic monitoring is conducted by "water years", rather than calendar years, to encompass whole rainfall seasons. Water year 2009 (WY2009) extends from October 1, 2008 through September 30, 2009.

2) The period of record for the Bear Creek at Sand Hill Road station is October 12, 1999 to September 30, 2009.

3) The period of record for the Piers Lane stations is October 2002 to September 2009; the partial record from the initial season (WY2002) of monitoring is not shown.

4) Daily flow values were computed from instantaneous flow calculated at 15-minute intervals. Sediment-discharge values were calculated with a sediment rating curve specific to the data available at the time, and then totalled from calculations at 15-minute intervals. "Maximum daily mean flow" is the highest daily mean flow of the year.

5) Stage is the staff plate reading; the staff plate is set at an arbitrary datum and does not represent the absolute depth of water in the creek.

6) In water year 2006, Bear Creek peak flow (12/31/2005) was estimated using the slope-area method from surveyed high-water marks. Because the gaging equipment was destroyed in the high flows, daily mean flow on that day was calculated from the 15-minute flow record synthesized by correlation with other creeks. Peak flows at the two Piers Lane stations (12/31/2005) were calculated using the slope-area method and surveyed high-water marks (the equipment at Piers Lane was not damaged).

7) The long term average of total annual rainfall is derived from Rantz, 1971 and from Nahn and Saah, 1988. See section 4.2 of the text for explanation.

8) Water year 2009 rainfall at SFPL is scaled from a CDF rain gauge in Los Altos Hills; the scaling is based on the percentage of normal for several nearby rain gauges.

Table 5. Measurements and calculations of sediment transport, Bear Creek at Sand Hill Road, water year 2009

	Field Observations [1]					Sediment Transport				
Sample Date:Time	Observer(s)	Stage	Stream Condition	Streamflow Discharge	Streamflow Value Source	Bedload Discharge	Bedload Discharge	Suspended Sediment Concentration	Suspended Sediment Discharge	Turbidity
		(ft)	*R,F,B,U*	*(cfs)*	*M,R,E*	*(lb/sec)*	*(tons/day)*	*(mg/l)*	*(tons/day)*	*(ntu)*
Bear Creek at Sand Hill Road										
2/15/09 14:55	jo	3.42	R	113	R	…	…	295	90	210
2/15/09 15:00	jo	3.42	R	116	R	…	…	236.0	74	200
2/16/09 12:05	jo	4.45	F	240	R	…	…	336	217	230
3/3/2009 14:00	tb	3.54	F	125	R	…	…	205	69	190

Notes and explanations

1) Observer Key: jo = Jonathan Owens; tb = Travis Baggett
Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain
Streamflow discharge is the measured or estimated instantaneous flow at the time that sediment was sampled. The value is usually taken from the datalogger record and typically differs from the mean flow for the day.
Streamflow Value Source: M = measured; R = rating curve; E = estimated; Streamflow for composite samples is mean flow for the sampling period.

2) Active Bed Width is estimated by the field observer as the width through which significant amounts of bedload are being transported.
Sampler Width and Type: 0.25 = 3-inch Helley Smith; 0.50 = 6-inch Helley Smith

3) Values for sediment discharge showing more than two to three digits are the result of calculations; increased precision is not implied.
Bedload Discharge (lbs/sec) = [active bed width (ft) * sample dry weight (gm) * 0.002205 (lbs)]/ [sampler width (ft) * sampling time (sec)]
Bedload Discharge (tons/day) = [active bed width (ft) * sample dry weight (gm) * 86,400 (sec)]/ [sampler width (ft) * sampling time (sec) * 907,200 (gm)]
If the creek is visibly clear, then suspended sediment samples are not collected because concentrations would likely be below the detection limit.

Table 6. Measurements and calculation of suspended sediment:
San Francisquito and Los Trancos Creeks at Piers Lane, water year 2009

Field observations					*Bedload Sampling Details*						*Bedload Discharge*		*Suspended sediment*		
Date and Time	Observer	Stage	Stream Condition	Discharge	**Active Bed Width**	**Sampler Width**	**No. of Verts.**	**Time/Vert.**	**Total Time**	**Sample Dry Weight**	**Bedload-Sediment Discharge Rate**	**Bedload-Sediment Discharge Rate**	Total Suspended Solids	Suspended Sediment discharge	Turbidity
		(feet)	*(R, F, B)*	*(cfs)*	*(ft)*	*(ft)*		*(sec)*	*(sec)*	*(gm)*	*(lb/sec)*	*(tons/day)*	*(mg/L)*	*(tons/day)*	*(NTU)*
San Francisquito Creek at Piers Lane															
2/15/2009 15:43	jo	6.00	R	284	…	…	…	…	…	…	…	…	319	244	170
2/15/2009 15:45	jo	6.00	R	287	…	…	…	…	…	…	…	…	279	216	170
2/16/2009 13:05	jo	7.10	F	650	…	…	…	…	…	…	…	…	493	864	280
3/3/2009 12:24	tb, bdb	6.95	F	623	…	…	…	…	…	…	…	…	909	1528	420
Los Trancos Creek at Piers Lane															
2/15/2009 15:25	jo	4.40	R	180	…	…	…	…	…	…	…	…	3100	1505	970
2/15/2009 15:30	jo	4.40	R	196	…	…	…	…	…	…	…	…	4050	2141	920
2/16/2009 12:55	jo	3.02	F	87	…	…	…	…	…	…	…	…	1030	242	480
3/3/2009 12:00	tb, bdb	4.64	F	216	…	…	…	…	…	…	…	…	5040	2934	1300

Notes:

Observer Key: jo= Jonathan Owens; tb = Travis Baggett; bdb = Bonnie deBerry

Streamflow discharge is the measured or estimated instantaneous flow when sediment was sampled, usually from the datalogger record, and usually differs from the mean flow for the day.

Stream Condition: R = rising, F = falling, B = baseflow, P = peak, U = uncertain

Values for sediment discharge having more than two to three digits displayed are the result of calculations; increased precision is not implied.

If the creek is visibly clear, then suspended sediment samples are not collected because concentrations would likely be below the detection limit.

Bedload Discharge (lbs/sec) = [active bed width (ft) * sample dry weight (gm) * 0.002205 (lbs)]/ [sampler width (ft) * sampling time (sec)]

Bedload Discharge (tons/day) = [active bed width (ft) * sample dry weight (gm) * 86,400 (sec)]/ [sampler width (ft) * sampling time (sec) * 907,200 (gm)]

FIGURES

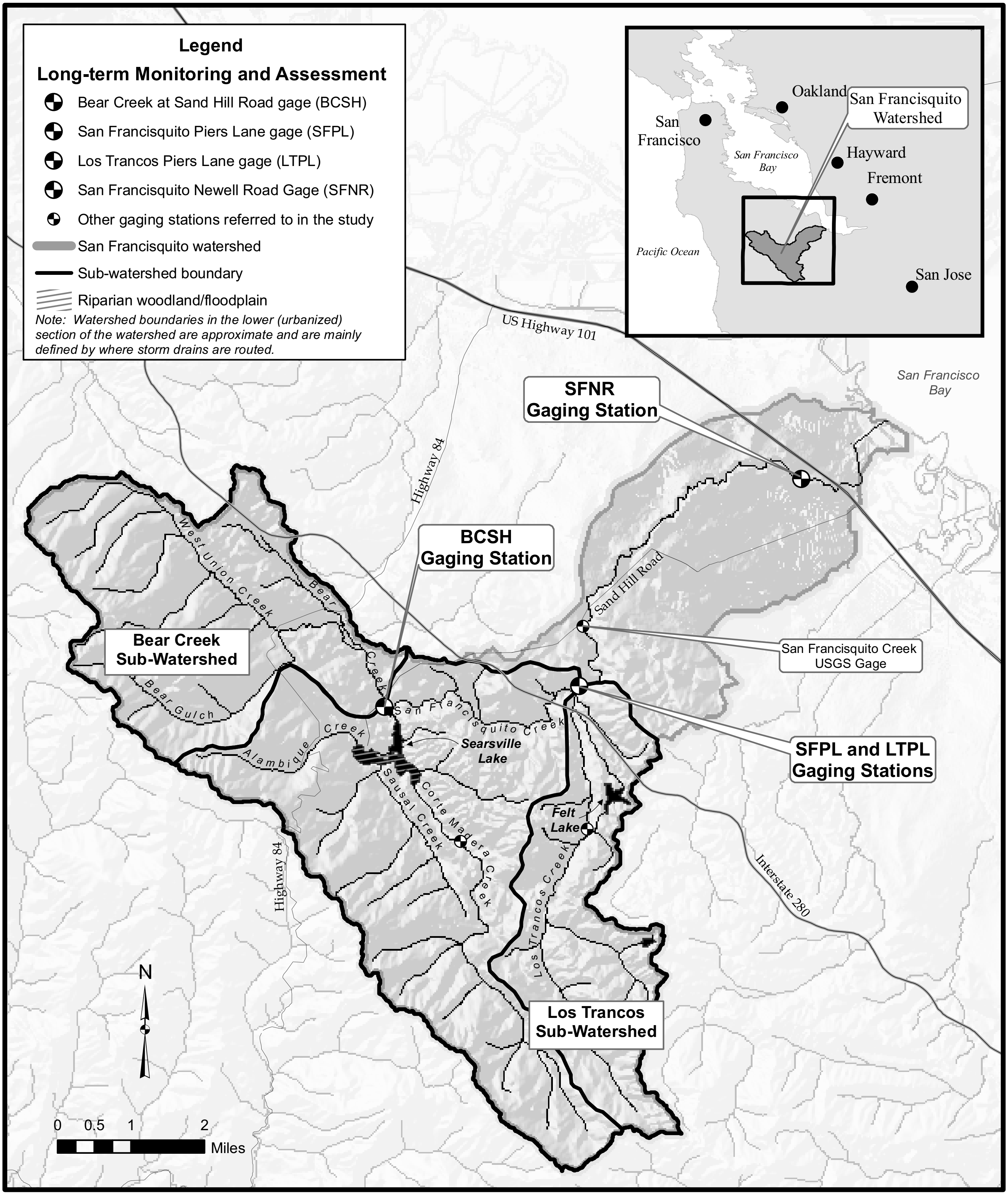

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Figure 1. Stream monitoring location in the San Francisquito watershed
The Piers Lane stations are located just above the confluence of San Francisquito and Los Trancos Creeks. The Bear Creek station is located downstream of Sand Hill Road.

W:\Projects\202018\202018_Figure1_extended.mxd

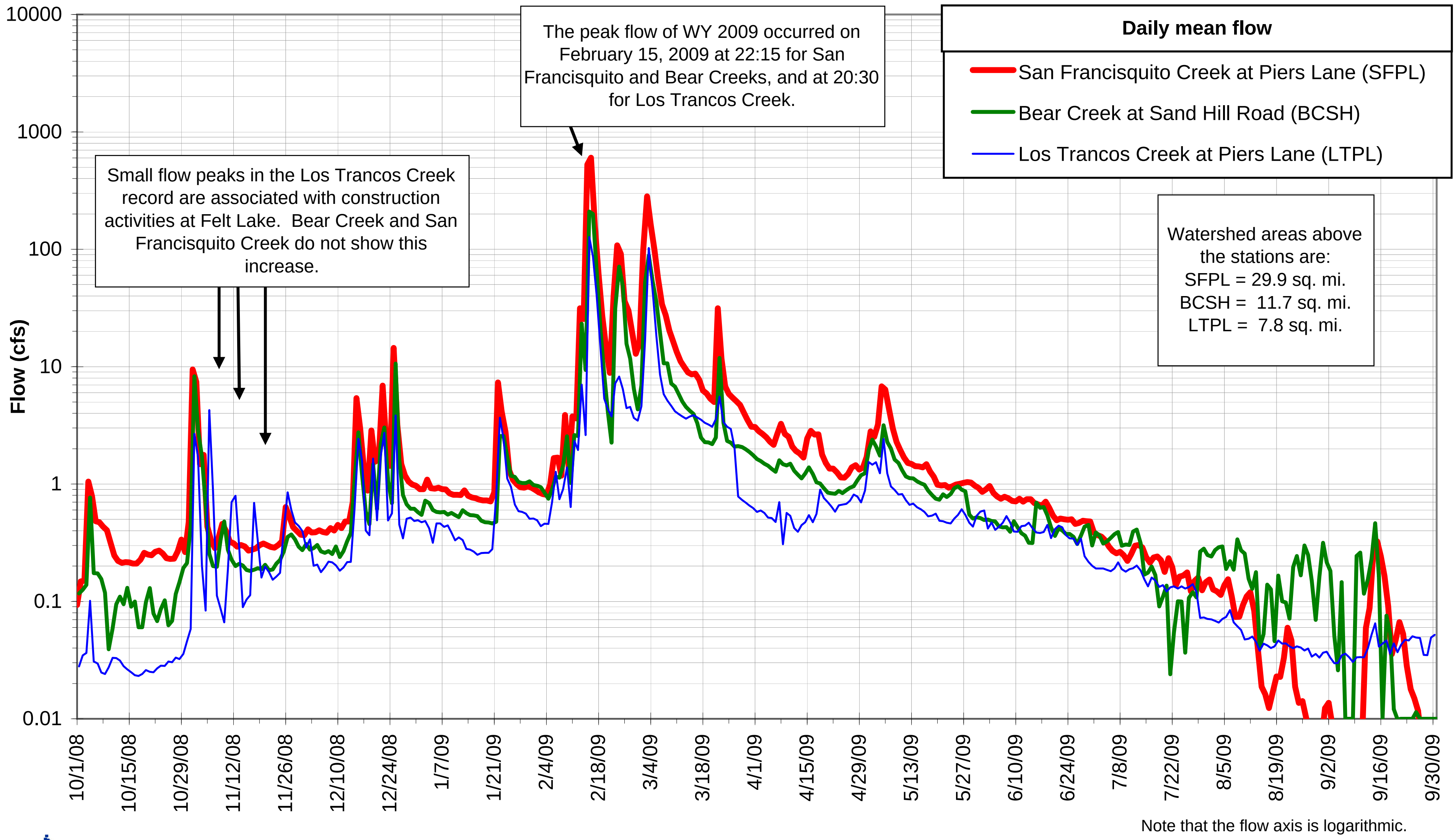

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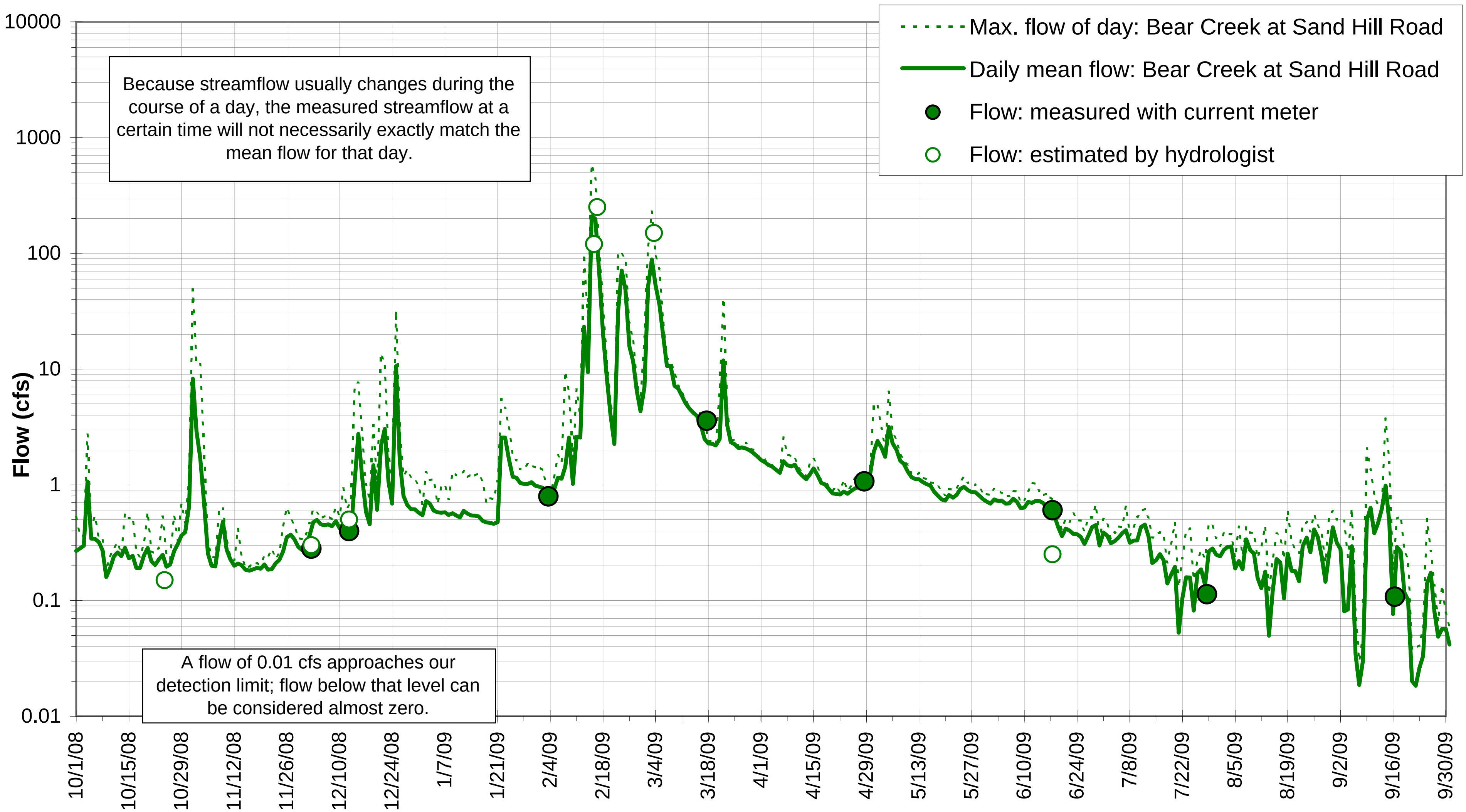
Figure 2. Daily flow hydrographs for San Francisquito, Los Trancos and Bear Creeks, water year 2009. Flow in San Francisquito Creek is generally greater than flow in Bear Creek or Los Trancos Creek, as would be expected from its larger drainage area. Note that the peak 15-minute flow (Feb. 15) does not necessarily correspond to the highest daily mean flow (Feb. 16).



Note that the flow axis is logarithmic.

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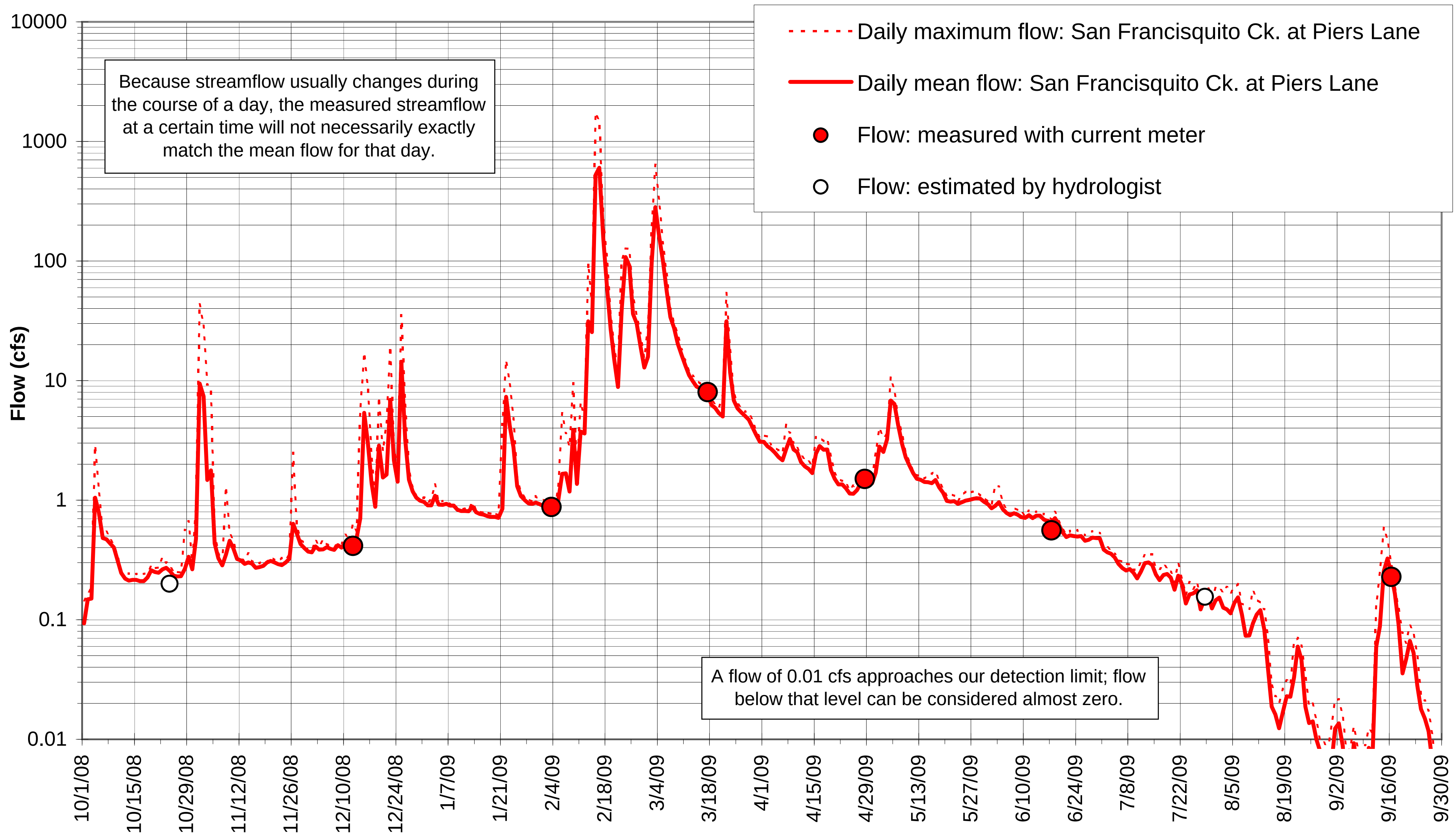
Figure 3. **Daily flow hydrograph for Bear Creek at Sand Hill Road, water year 2009.** Some flow regulation occurs upstream of this station which sometimes causes irregular flow patterns. The peak flow of the water year was approximately 590 cfs on February 15, 2009 at 22:15.



Note that the flow axis is logarithmic.

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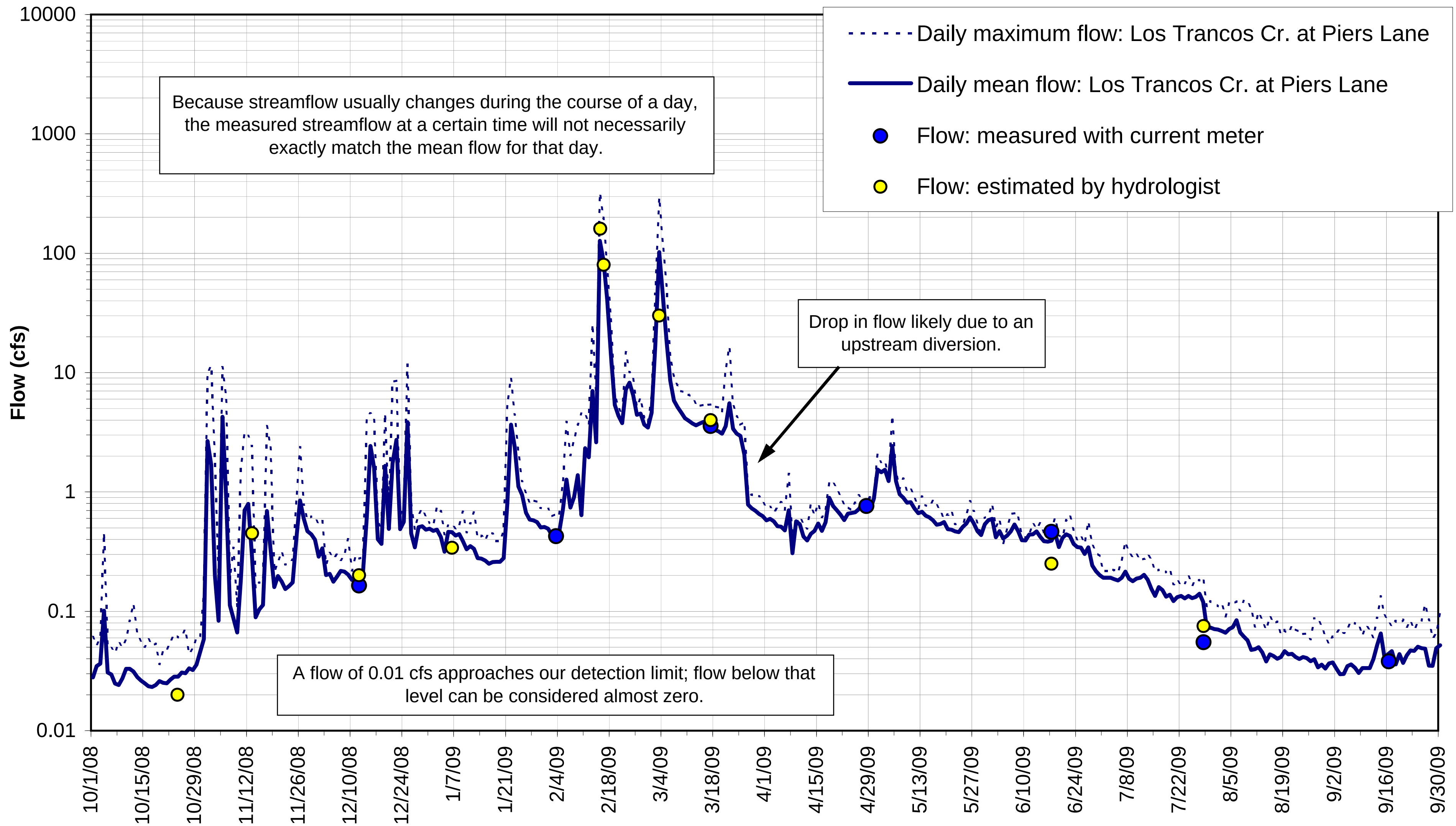
Figure 4. Daily flow hydrograph for San Franscisquito Creek at Piers Lane, water year 2009.
The peak flow of the season (1,730 cfs) occurred on February 15, 2009 at 22:15.



Note that the flow axis is logarithmic.

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Figure 5. Daily flow hydrograph for Los Trancos Creek at Piers Lane, water year 2009. Baseflow was low at both the beginning and end of the water year, reflecting the below average rainfall during water years 2008 and 2009. The flow in Los Trancos Creek is effected by diversions to and releases from Felt Lake. The peak flow of the season (320 cfs) occurred on February 15, 2009 at 20:30.

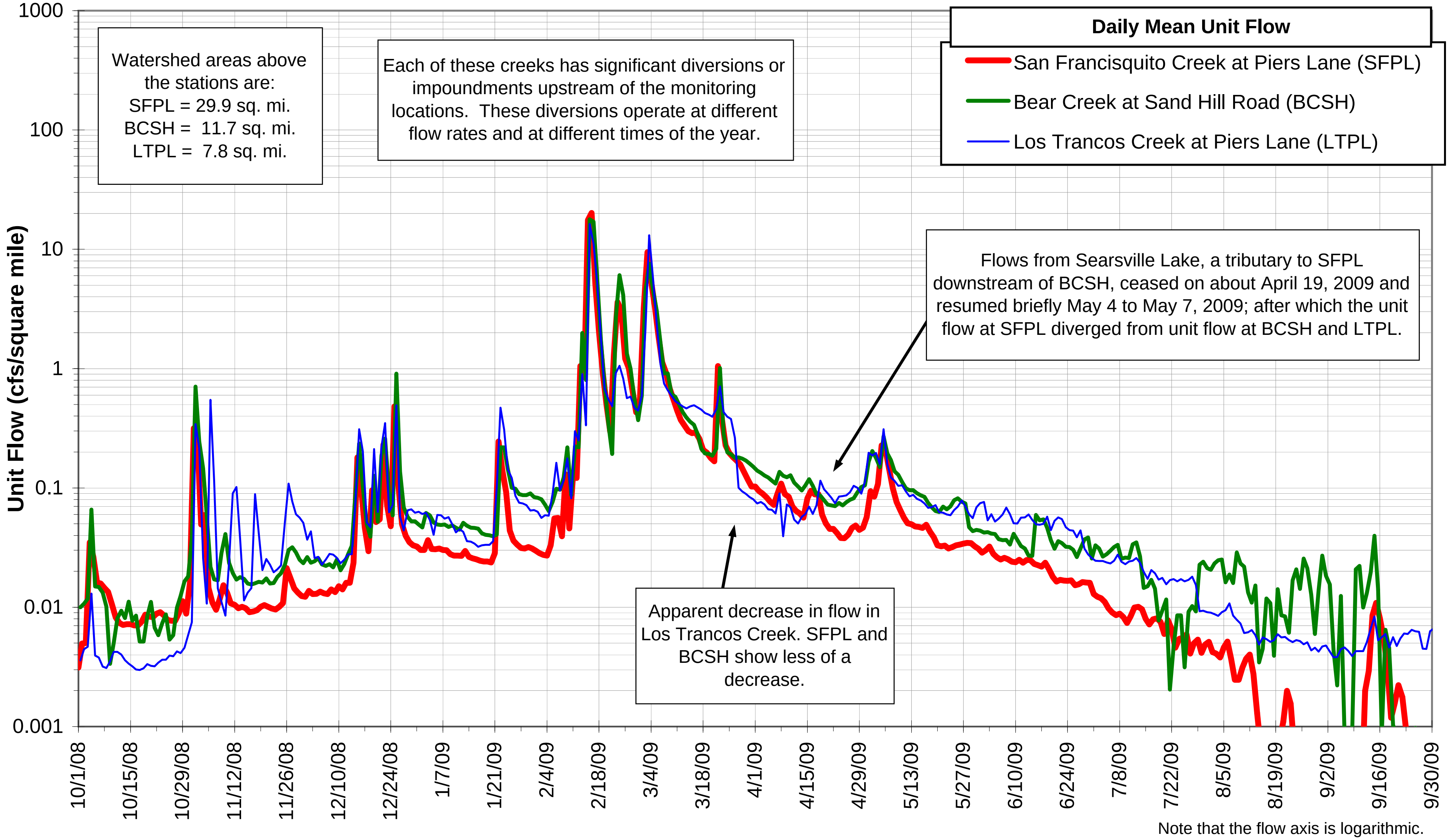

Figure 6. Unit flow hydrographs for San Francisquito, Los Trancos and Bear Creeks, water year 2009. Unit flow is calculated by normalizing flow by watershed area. In many cases, lower flows in one creek as compared to the other creeks may be due to diversions, but flows can also be influenced by geology, topography and weather patterns.

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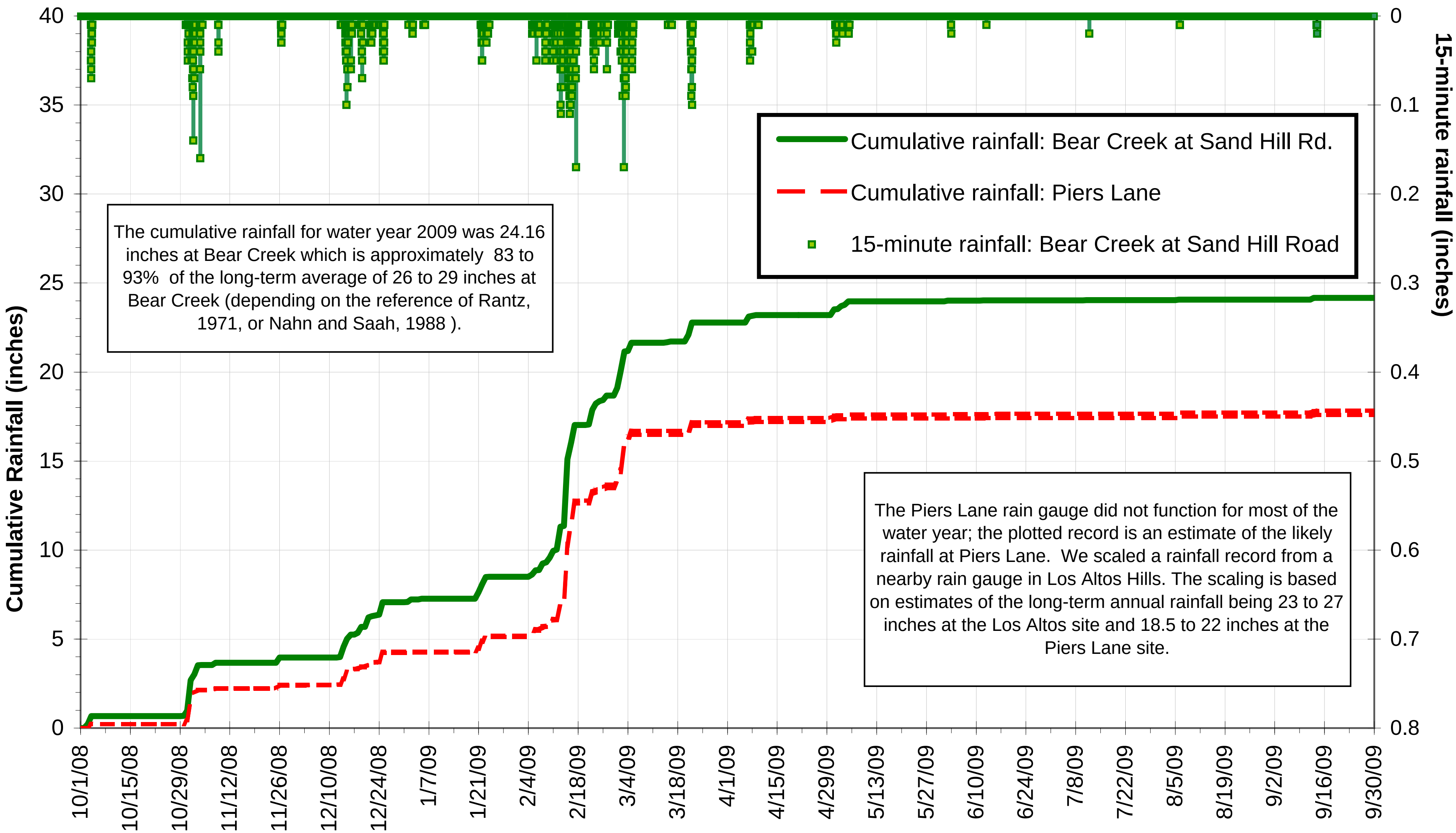

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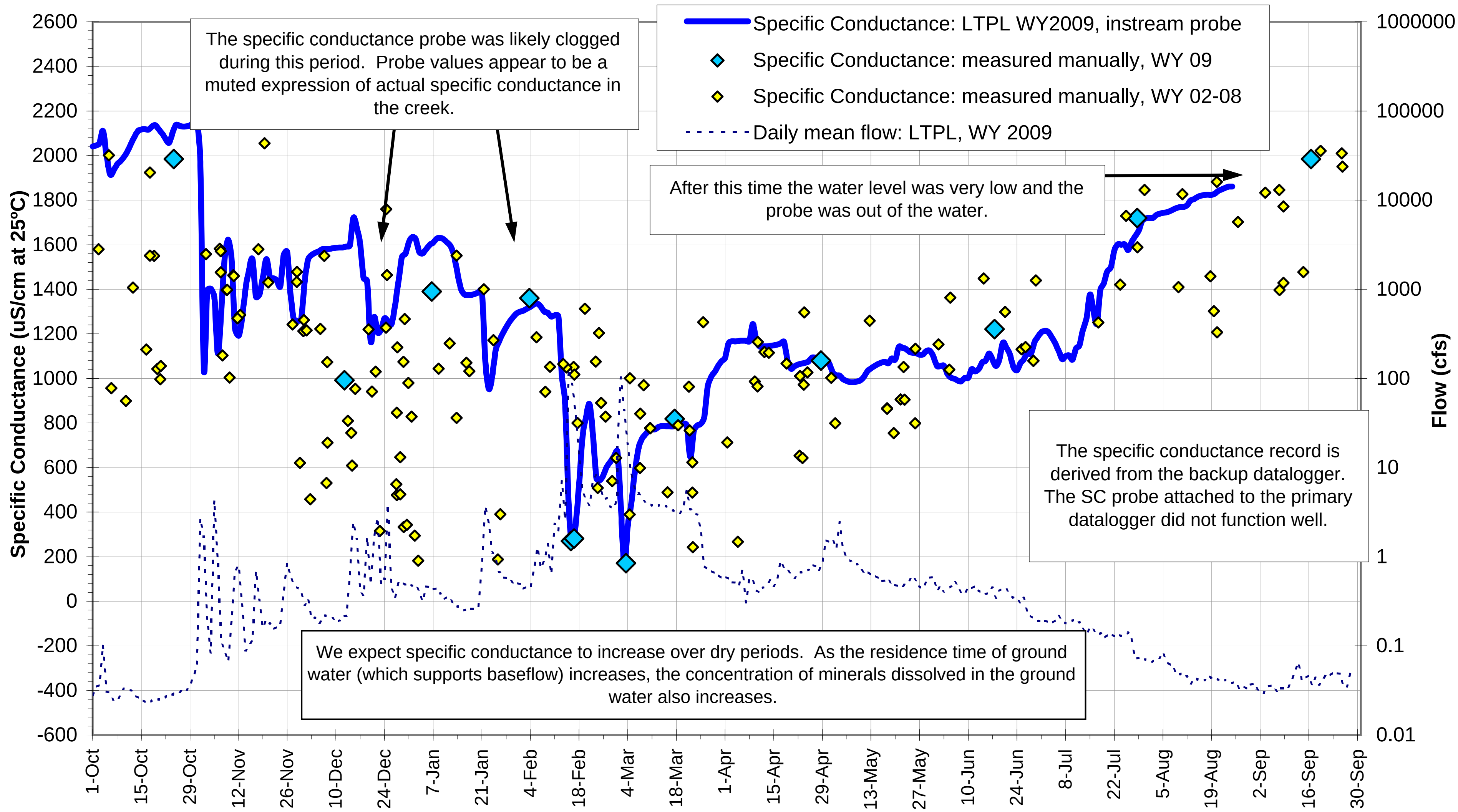
Figure 7. Cumulative 15-minute precipitation record at Bear Creek at Sand Hill Road, and San Francisquito Creek at Piers Lane, water year 2009. Total rainfall for water year 2009 was 82 to 93 percent of the long-term mean annual precipitation (MAP); for a more complete discussion of varying estimates of MAP see Section 4.2 in the report text.



Note: 1) the flow axis is logarithmic, and 2) the date axis does not include the year because multiple years of data are shown.

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Figure 8. Specific conductance measurements, Los Trancos Creek at Piers Lane, water years 2002 to 2009. Specific conductance of baseflow during water year 2009 is near the high end of previous measurements; this would be expected during a dry period when more of the baseflow is derived from groundwater with a long flow path.

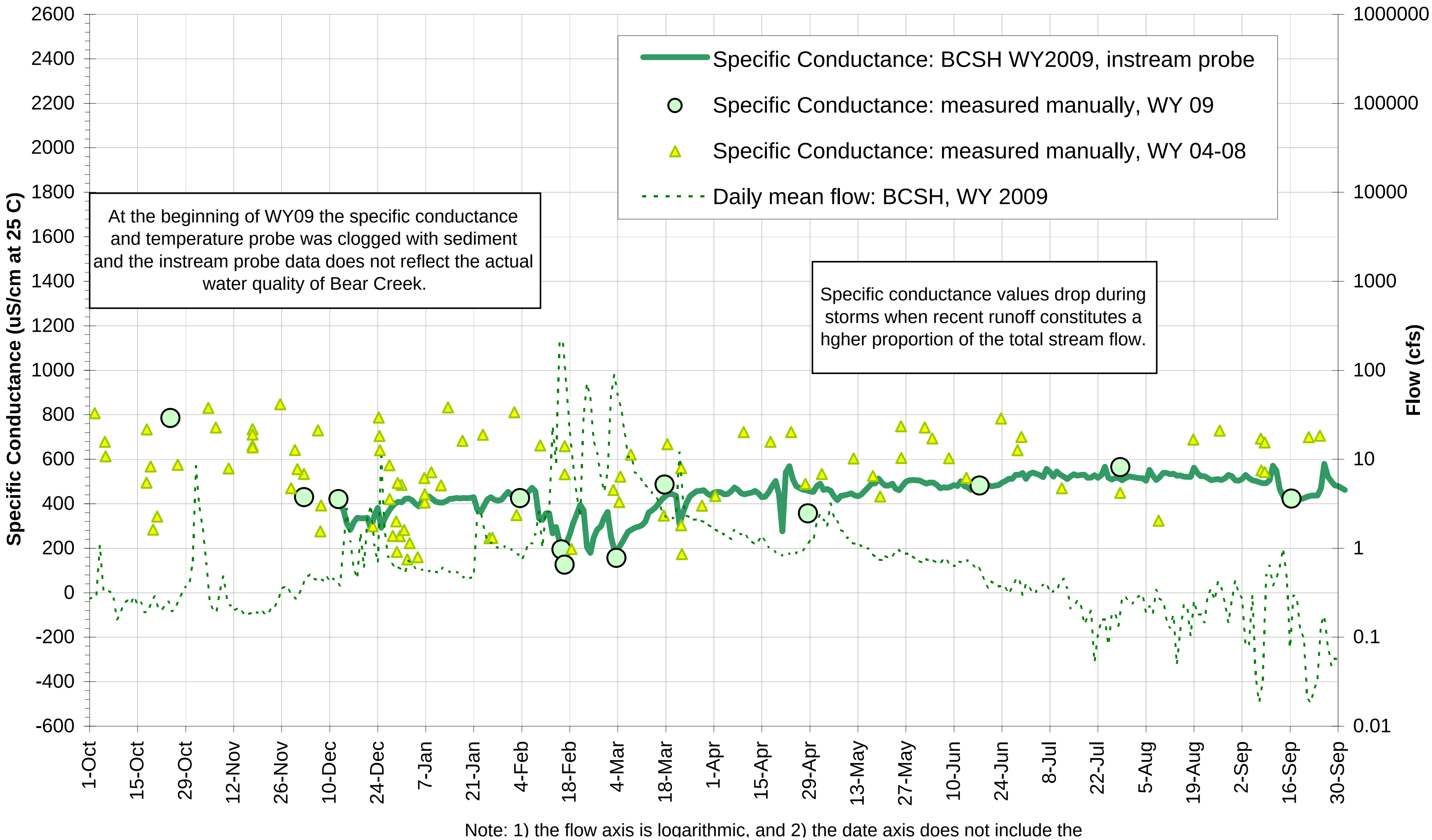

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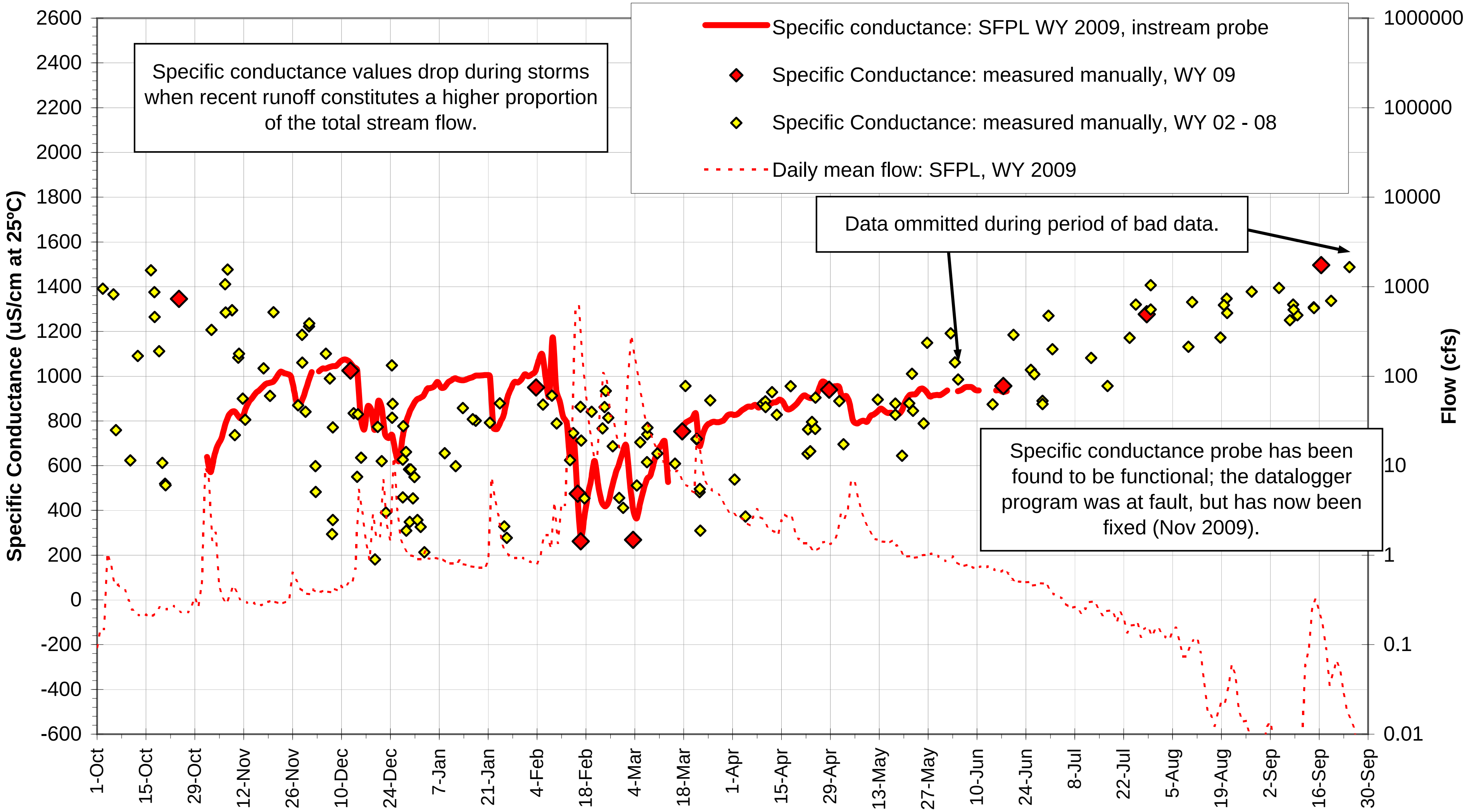
Figure 9. Specific conductance measurements, Bear Creek at Sand Hill Road, water years 2004 to 2009. Specific conductance measurements are generally similar for all years, with lower values during storms. The water year 2009 flow record is plotted for reference.

202094 BCSH WY09 TB.xls, Fig 9 SC BCSH



Note: 1) the flow axis is logarithmic, and 2) the date axis does not include the year because multiple years of data are shown.

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Figure 10. Specific conductance measurements, San Francisquito Creek at Piers Lane, water years 2002 to 2009. Specific conductance measurements are generally similar for all years, with lower values during storms. This year, values were generally anear the high end of the range, except during the wet period in February and March, as expected during a dry period. The WY09 flow record is plotted for reference.

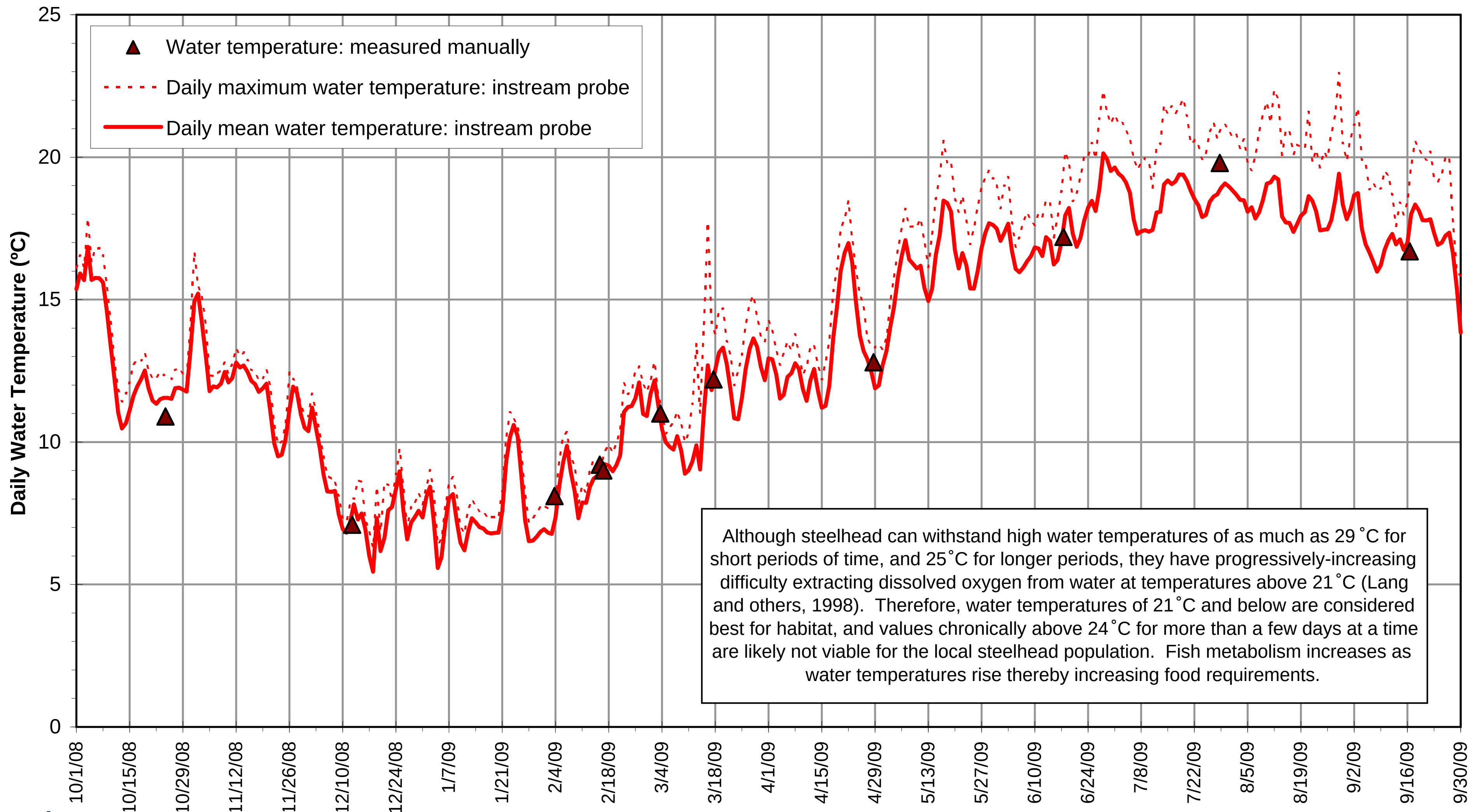

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Figure 11. Daily water temperature record for San Francisquito Creek at Piers Lane, water year 2009. Temperature patterns are similar at the San Francisquito Creek, Los Trancos Creek and Bear Creek stations. Water temperature generally seems to be slightly cooler in San Francisquito Creek than in Los Trancos Creek during the winter and warmer during the summer.

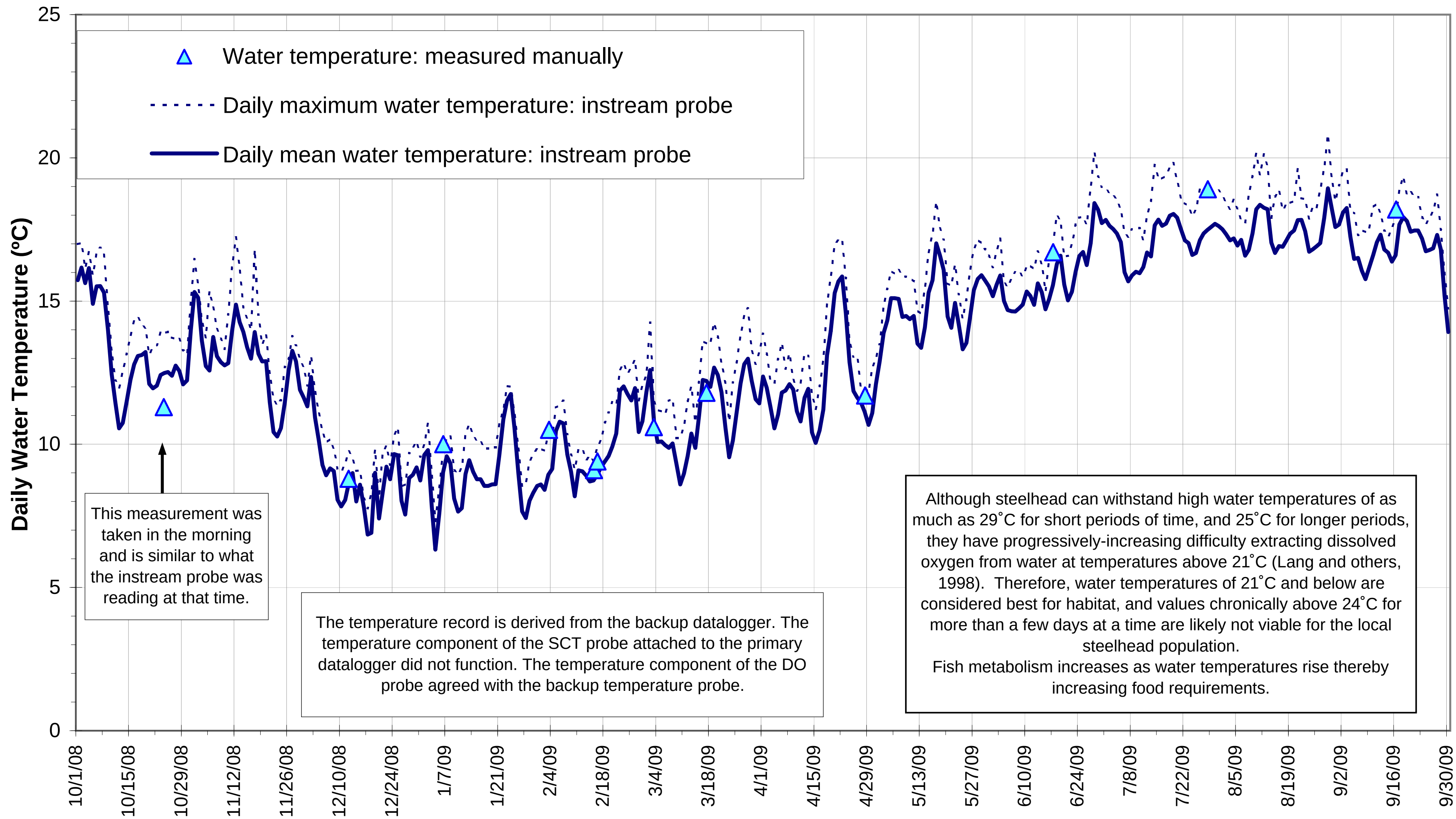

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Figure 12. Daily water temperature record for Los Trancos Creek at Piers Lane, water year 2009. Temperature patterns are similar at the San Francisquito Creek, Los Trancos Creek and Bear Creek stations. Water temperature generally seems to be slightly warmer in Los Trancos Creek than in San Francisquito Creek during the winter and cooler during the summer.

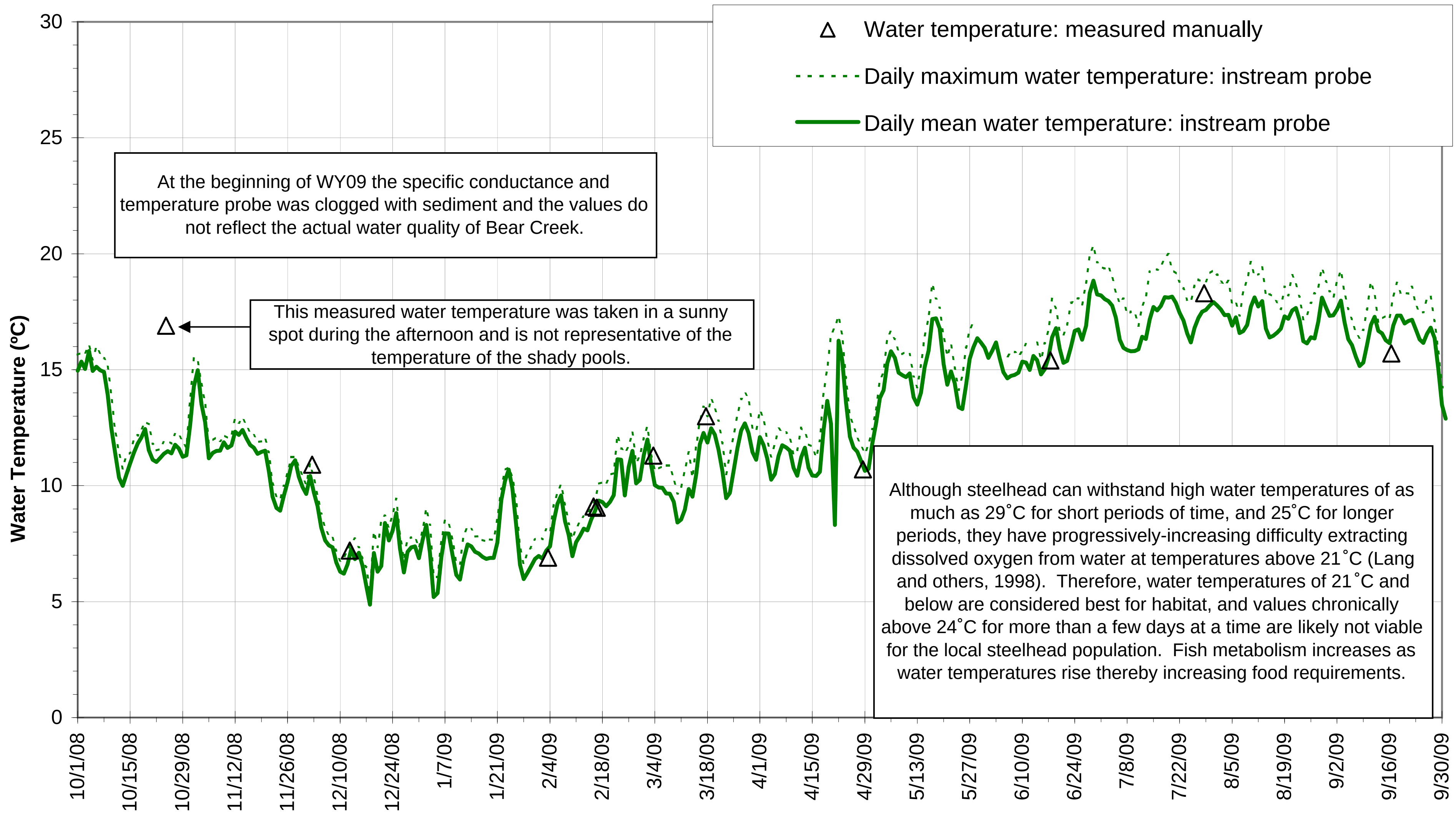

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Figure 13. Daily water temperature record for Bear Creek at Sand Hill Road, water year 2009. Temperature patterns at this station were similar to the downstream station, San Francisquito Creek at Piers Lane. Summer temperatures are lower at Bear Creek than either of the Piers Lane Stations.

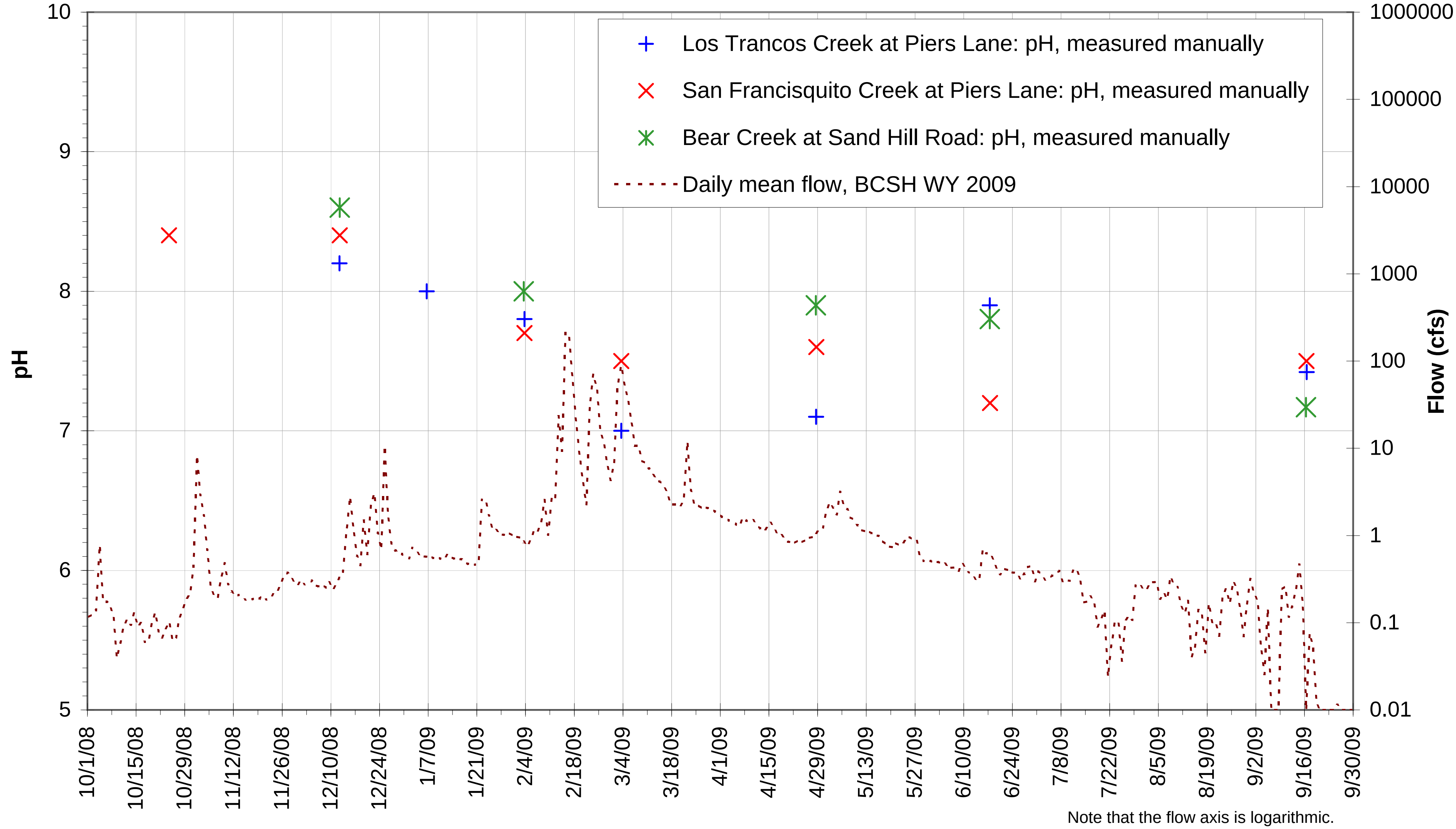

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Figure 14. pH measurements in San Francisquito Creek, Los Trancos Creek and Bear Creek, water year 2009. Field measurements were made with hand-held pH meters. The instream pH probes did not work properly at any of the three stations. The Bear Creek water year 2009 daily mean flow record is plotted for reference.

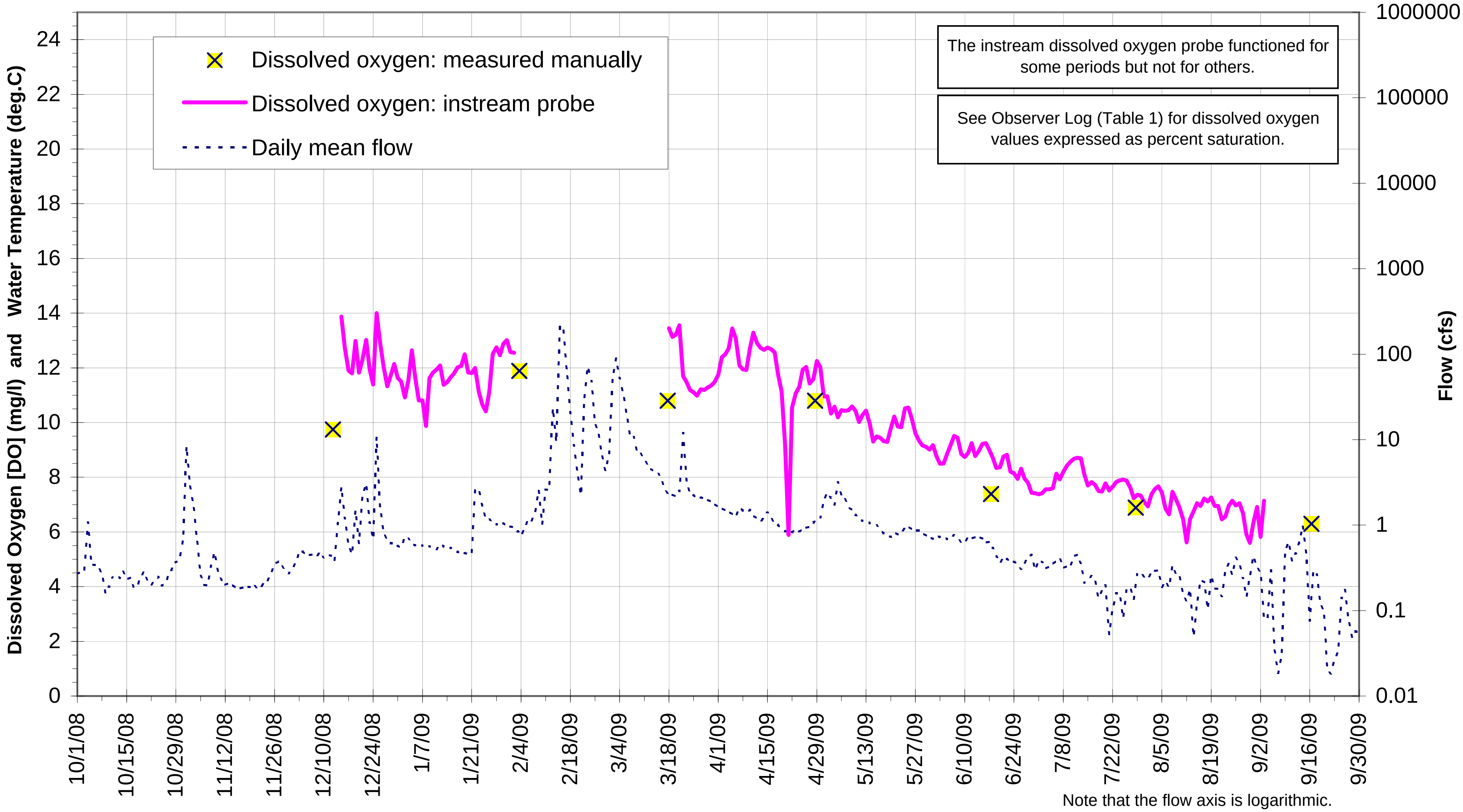

Figure 15. Dissolved oxygen concentrations in Bear Creek at Sand Hill Road, water year 2009. Field measurements and probe data indicate that dissolved oxygen concentrations are lower during late summer and fall low flows when water temperatures are higher, stream turbulence is lower, and products of decomposing leaves often create localized oxygen demand. The flow record is plotted for reference.

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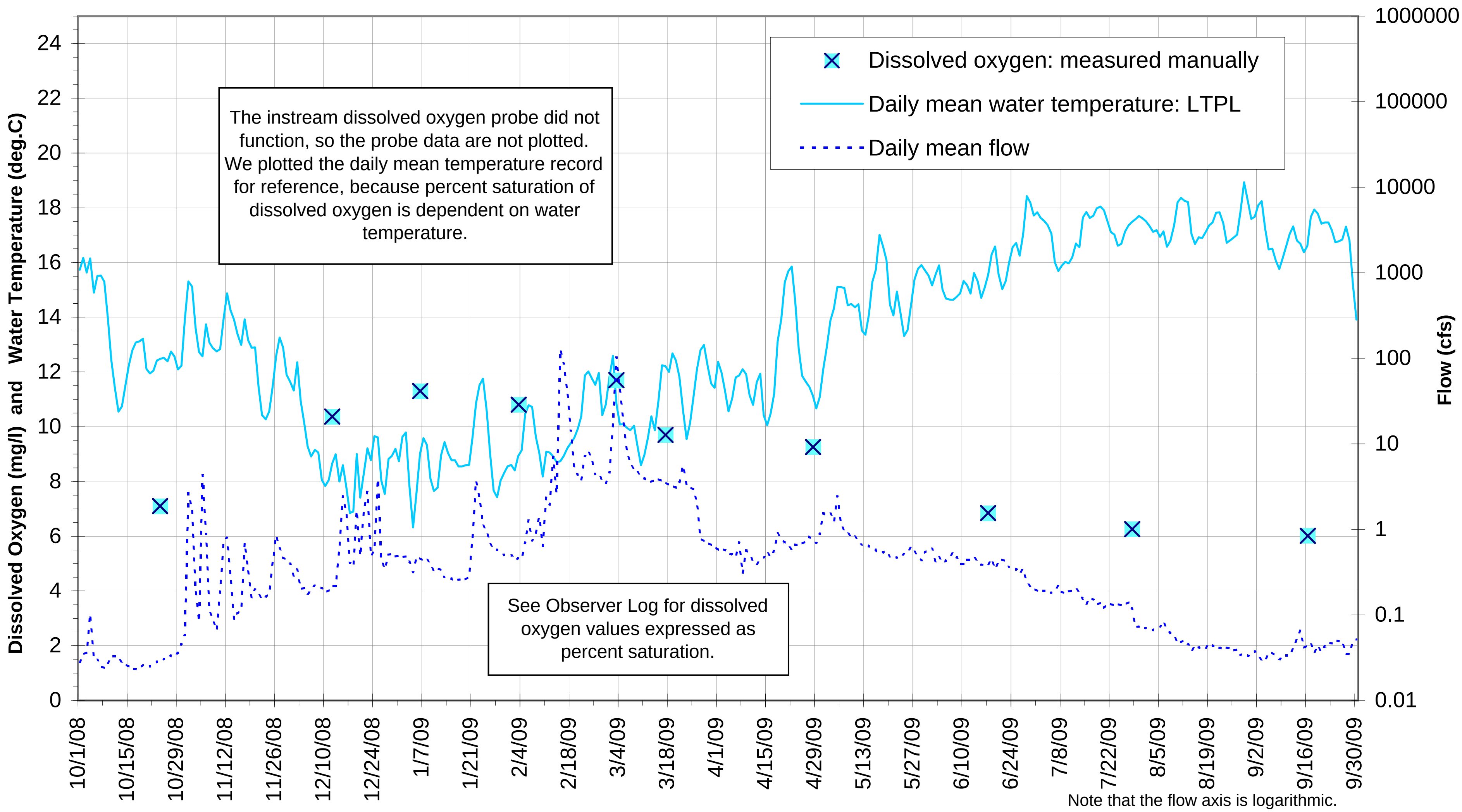

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Figure 16. Dissolved oxygen concentrations in Los Trancos Creek at Piers Lane, water year 2009. Dissolved oxygen levels in Los Trancos Creek are typically between 70% and 100% saturation. Field measurements by Balance staff indicate that dissolved oxygen concentrations are lower during late summer and fall low flows when water temperatures are higher, stream turbulence is lower, and products of decomposing leaves often create localized oxygen demand. The flow record is plotted for reference.

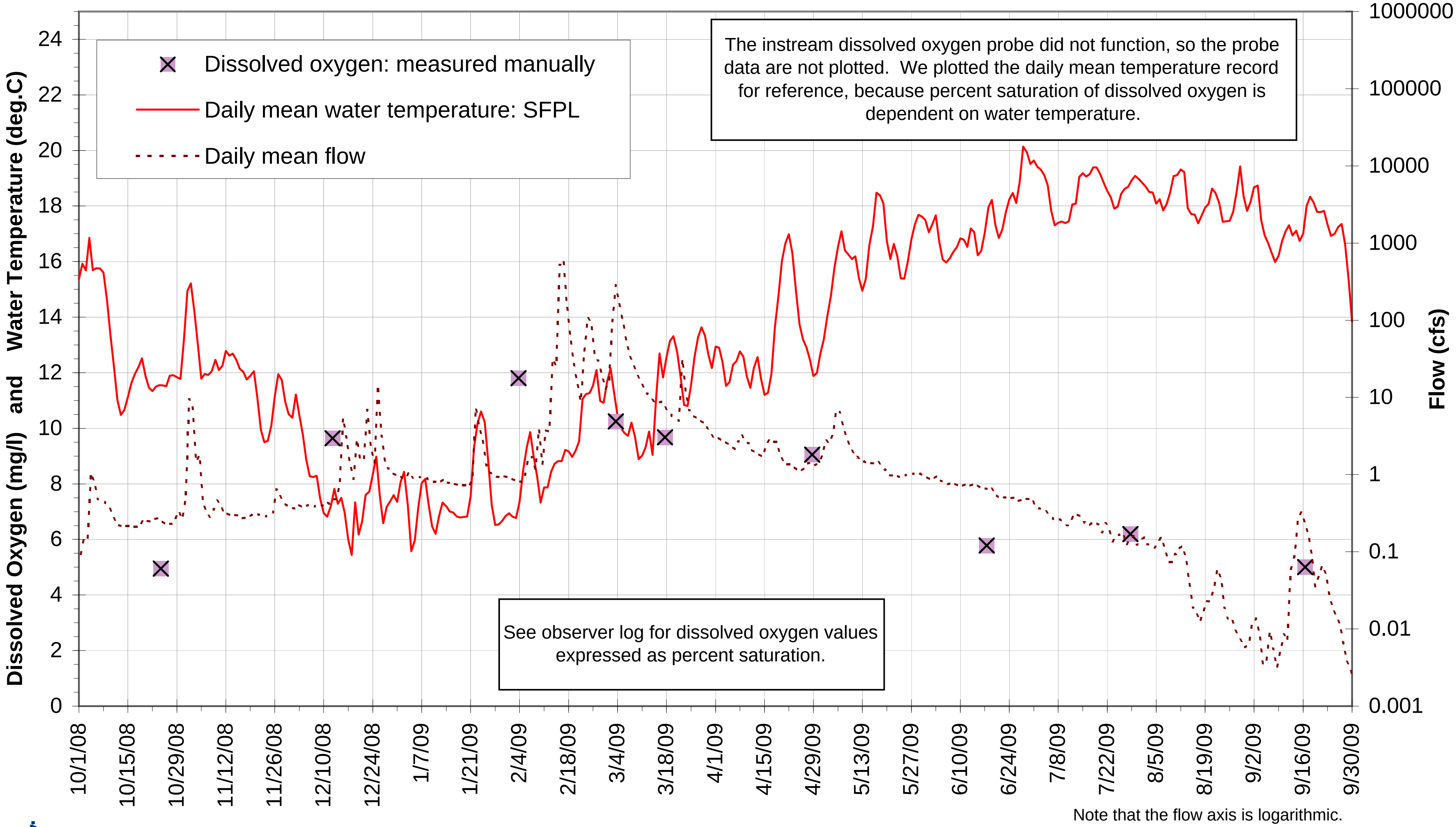

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Figure 17. Dissolved oxygen concentrations in San Francisquito Creek at Piers Lane, water year 2009. Field measurements by Balance staff indicate that dissolved oxygen concentrations are lower during late summer and fall low flows when water temperatures are higher, stream turbulence is lower, and products of decomposing leaves often create localized oxygen demand.

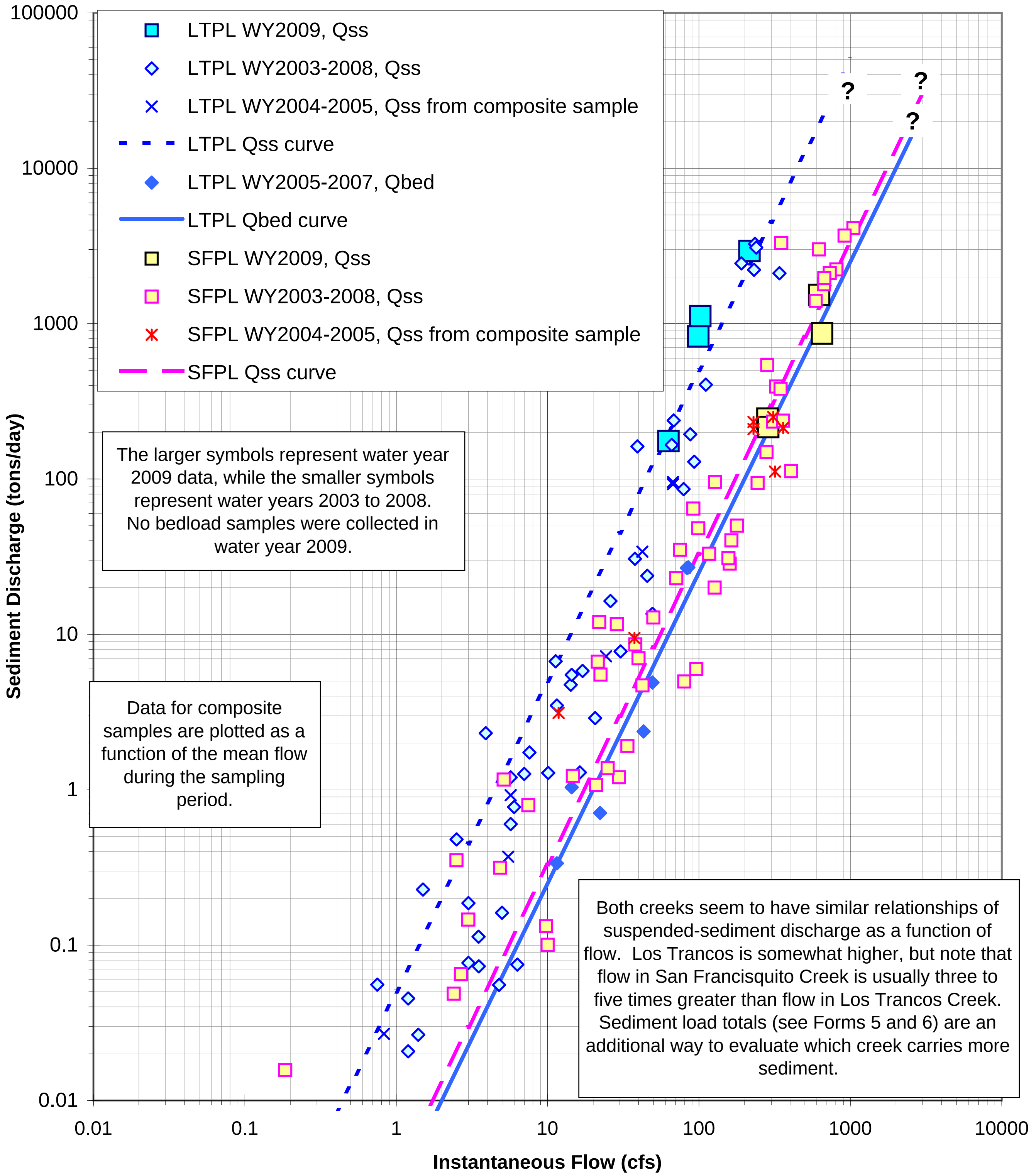

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Figure 18. Sediment measurements and rating curves for the Piers Lane stations. The samples collected this year show slightly different relationship from previous years, therefore we did change the sediment rating curves for water year 2009.

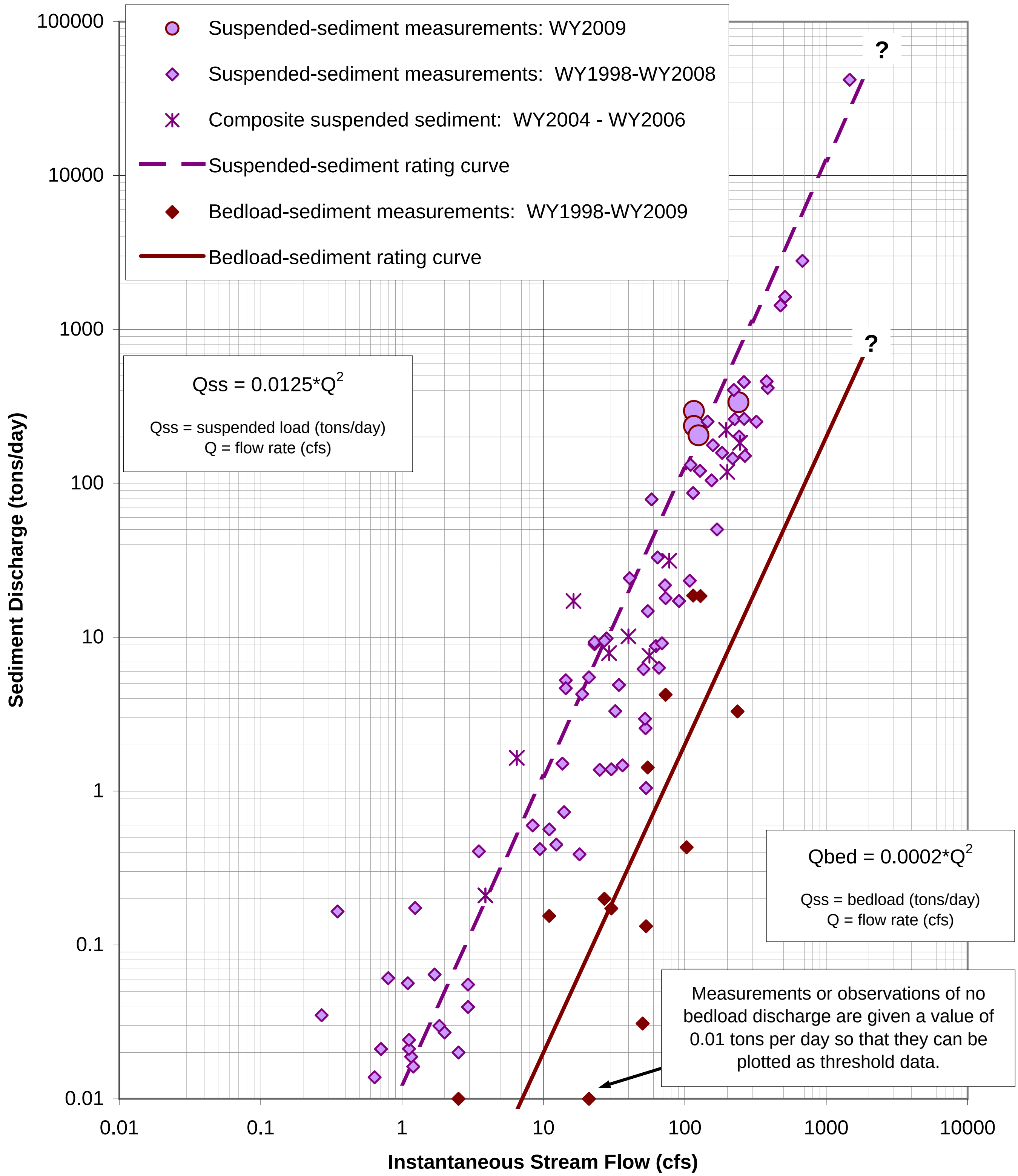

Figure 19. Sediment measurements and rating curves for Bear Creek at Sand hill Road, water years 1998-2009.
Suspended sediment as a function of flow is similar in water year 2009 to the previous year. No bedload discharge was measured in water year 2009.

APPENDICES

APPENDIX A

Laboratory Results (Piers Lane and Bear Creek stations)

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
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TEL: 831-724-5422
FAX: 831-724-3188

Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227

Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	BCSH 090215:1455, sampled 2/15/2009 2:55:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-07

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	210	NTU	0.10	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	295	mg/L	2.69	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	21.8	mg/L	2.69	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	273	mg/L	8.26	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	372	mL	0.00	ASTM D3977-97C	02/25/09	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

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Berkeley, CA 94710-2227

Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	BCSH 090215:1500, sampled 2/15/2009 3:00:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-08

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	200	NTU	0.10	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	236	mg/L	2.77	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	22.7	mg/L	2.77	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	214	mg/L	7.08	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	361	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	BCSH 090216:1205, sampled 2/16/2009 12:05:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-09

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	230	NTU	0.10	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	336	mg/L	2.51	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	94.9	mg/L	2.51	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	241	mg/L	8.58	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	398	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	LTPL 090215:1525, sampled 2/15/2009 3:25:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-11

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	970	NTU	1.0	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	3100	mg/L	2.77	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	1970	mg/L	2.77	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	1130	mg/L	29.2	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	361	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received: February 17, 2009
Project # / Name: Various / Various
Sample Identification: LTPL 090215:1526, sampled 2/15/2009 3:26:00PM
Sampler Name / Co.: Travis Baggett / Balance Hydrologics
Matrix: Water
Laboratory #: 9020400-12

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	920	NTU	1.0	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	4050	mg/L	2.64	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	2830	mg/L	2.64	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	1220	mg/L	35.0	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	379	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	LTPL 090216:1255, sampled 2/16/2009 12:55:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-13

	Results	**Units**	**RL**	**Analysis Method**	**Date Analyzed**	**Flags**
Turbidity	480	NTU	1.0	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	1030	mg/L	2.75	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	435	mg/L	2.75	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	592	mg/L	14.9	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	364	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	SFPL 090215:1530, sampled 2/15/2009 3:30:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-14

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	170	NTU	0.10	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	319	mg/L	2.80	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	57.5	mg/L	2.80	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	261	mg/L	10.1	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	357	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	SFPL 090215:1531, sampled 2/15/2009 3:31:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-15

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	170	NTU	0.10	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	279	mg/L	2.80	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	62.2	mg/L	2.80	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	217	mg/L	8.24	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	357	mL	0.00	ASTM D3977-97C	02/25/09	

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Work Order #: 9020400
Reporting Date: March 17, 2009

Date Received:	February 17, 2009
Project # / Name:	Various / Various
Sample Identification:	SFPL 090216:1305, sampled 2/16/2009 1:05:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9020400-16

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	280	NTU	1.0	EPA 180.1	02/18/09	
SSC - Total Particulate Solids	493	mg/L	2.72	ASTM D3977-97C	02/25/09	
SSC - Total Coarse Fraction (>63um)	171	mg/L	2.72	ASTM D3977-97C	02/25/09	
SSC - Total Fine Fraction (<63um)	322	mg/L	12.3	ASTM D3977-97C	02/25/09	
SSC - Total Vol. of Sample Analyzed	367	mL	0.00	ASTM D3977-97C	02/25/09	

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Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227

Work Order #: 9020400
Reporting Date: March 17, 2009

*** DEFAULT GENERAL METHOD *** - Quality Control

Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PB90323 - Default Prep GenChem											
Blank (PB90323-BLK1)					Prepared & Analyzed: 25-Feb-09						
SSC - Total Fine Fraction (<63um)	ND		1.00	mg/L							
Blank (PB90323-BLK2)					Prepared & Analyzed: 25-Feb-09						
SSC - Total Fine Fraction (<63um)	ND		1.00	mg/L							
Duplicate (PB90323-Dup1)		**Source: 9020400-02**			Prepared & Analyzed: 25-Feb-09						
SSC - Total Fine Fraction (<63um)	995		26.0	mg/L		922			7.62	20	
Duplicate (PB90323-Dup2)		**Source: 9020401-02**			Prepared & Analyzed: 25-Feb-09						
SSC - Total Fine Fraction (<63um)	512		13.0	mg/L		487			4.89	20	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

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Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227

Work Order #: 9020400
Reporting Date: March 17, 2009

Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PB90184 - Default Prep GenChem											
Blank (PB90184-BLK1)					Prepared & Analyzed: 18-Feb-09						
Turbidity	ND		0.10	NTU							
Duplicate (PB90184-Dup1)		**Source: 9020399-01**			Prepared & Analyzed: 18-Feb-09						
Turbidity	177.0		0.10	NTU		184.0			3.88	20	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

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Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227
Attn: Jonathan Owens

Work Order #: 9030577
Reporting Date: April 7, 2009

Date Received:	March 20, 2009
Project # / Name:	Various / Various
Sample Identification:	LTPL 090303:1156, sampled 3/3/2009 11:56:00AM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9030577-01

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	1300	NTU	1.0	EPA 180.1	03/20/09	
SSC - Total Particulate Solids	5040	mg/L	2.44	ASTM D3977-97C	03/09/09	
SSC - Total Coarse Fraction (>63um)	3350	mg/L	2.44	ASTM D3977-97C	03/09/09	
SSC - Total Fine Fraction (<63um)	1690	mg/L	28.5	ASTM D3977-97C	03/09/09	
SSC - Total Vol. of Sample Analyzed	410	mL	0.00	ASTM D3977-97C	03/09/09	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Mike Galloway

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227
Attn: Jonathan Owens

Work Order #: 9030577
Reporting Date: April 7, 2009

Date Received:	March 20, 2009
Project # / Name:	Various / Various
Sample Identification:	SFPL 090303:1205, sampled 3/3/2009 12:05:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9030577-02

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	420	NTU	1.0	EPA 180.1	03/20/09	
SSC - Total Particulate Solids	909	mg/L	2.70	ASTM D3977-97C	03/09/09	
SSC - Total Coarse Fraction (>63um)	246	mg/L	2.70	ASTM D3977-97C	03/09/09	
SSC - Total Fine Fraction (<63um)	663	mg/L	15.8	ASTM D3977-97C	03/09/09	
SSC - Total Vol. of Sample Analyzed	370	mL	0.00	ASTM D3977-97C	03/09/09	

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Berkeley, CA 94710-2227
Attn: Jonathan Owens

Work Order #: 9030577
Reporting Date: April 7, 2009

Date Received:	March 20, 2009
Project # / Name:	Various / Various
Sample Identification:	BCSH 090303:1405, sampled 3/3/2009 2:05:00PM
Sampler Name / Co.:	Travis Baggett / Balance Hydrologics
Matrix:	Water
Laboratory #:	9030577-06

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
Turbidity	190	NTU	0.10	EPA 180.1	03/20/09	
SSC - Total Particulate Solids	205	mg/L	3.19	ASTM D3977-97C	03/09/09	
SSC - Total Coarse Fraction (>63um)	28.0	mg/L	3.19	ASTM D3977-97C	03/09/09	
SSC - Total Fine Fraction (<63um)	177	mg/L	8.31	ASTM D3977-97C	03/09/09	
SSC - Total Vol. of Sample Analyzed	314	mL	0.00	ASTM D3977-97C	03/09/09	

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Work Order #: 9030577
Reporting Date: April 7, 2009

Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PC90224 - Default Prep GenChem											
Blank (PC90224-BLK1)					Prepared & Analyzed: 20-Mar-09						
Turbidity	ND		0.10	NTU							
Duplicate (PC90224-Dup1)		**Source: 9030570-01**			Prepared & Analyzed: 20-Mar-09						
Turbidity	1.030		0.10	NTU		0.9800			4.98	20	

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