SANTA MARGARITA BASIN STREAMFLOW MONITORING AND ACCRETION ASSESSMENT, DRY SEASON OF 2020

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County of Santa Cruz, Environmental Health Services

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1. INTRODUCTION

1.1 Background

Under the Sustainable Ground Water Management Act (SGMA) government and water agencies are required to develop and implement Groundwater Sustainability Plans (GSPs) to sustainably manage groundwater. One of the six sustainability indicators that must be evaluated within the GSP is the potential depletion of interconnected surface water that has significant and unreasonable adverse impacts on beneficial users of the surface water. As part of the Santa Margarita Groundwater Agency's (SMGWA) GSP process hydrologic monitoring and studies are on-going to evaluate the connection between surface water and groundwater within the basin. These studies include streamflow gaging, as part of the Santa Margarita monitoring network, and accretion studies. In addition to these studies providing an understanding of aquifer dynamics and surface-groundwater exchange, they also serve as the quantitative baseline against which the recharge and other management efforts described in the GSP can be assessed in future 5-year assessments.

The agencies sponsoring the overall investigation are the Santa Margarita Groundwater Agency, County of Santa Cruz Division of Environmental Health, the San Lorenzo Valley Water District, the Scotts Valley Water District, and the City of Santa Cruz.

1.2 Streamflow Gaging

Balance has operated streamflow gages for the County of Santa Cruz since 2017 to establish an understanding of the hydrologic conditions within the Santa Margarita basin. As part of the on-going GSP process, the monitoring network was adapted during water year 2020 to include five gaging locations. Three of the gages, including Zayante Creek at Woodwardia Weir, Bean Creek at Mount Hermon Camp, and Newell Creek upstream of the San Lorenzo River have been monitored previously (**Figure 1**). A new gage on the San Lorenzo River upstream of Love Creek, was installed in June 2020 (**Figure 1**). The fifth gage is planned for Bean Creek downstream of Mackenzie Creek and will be installed during water year 2021.

During water year 2020 the stream gages were operated seasonally from June to just after the first rain to focus on the drier summer and early fall months. This monitoring season is critical for understanding low-flow conditions when groundwater contributions to surface flow are the most important for maintaining flows and temperature for aquatic species, as well as for other beneficial uses.

Each streamflow gage was instrumented with a pressure transducer, which measures depth, specific conductance, and temperature and takes a reading every 15-minutes. The transducers are housed in a stilling well located within a pool, somewhat out of the main flow path, but not isolated from the stream flow. A staff plate was established and nearby locations for calibration flow measurements were determined. A barometric sensor was installed in the Basin to compensate for barometric pressure (gets subtracted from the pressure transducer record).

Regular (approximately monthly) visits were performed from June to November to measure flow, collect specific conductance measurements, make observations, and maintain the gages. High-water marks were also noted to inform the gaging record, and to assess whether waves of water and debris released during rupture of small (or big ones for that matter) logjams may have affected the channel. Details of the individual measurements made during each routine visit are chronicled in **Tables 1-4**.

We have attempted to make our measurements as compatible as possible with the formal methods used by the state and federal agencies. Traditionally, these have been published as the manuals of the Federal Interagency Sedimentation Program (FISP), which is a compilation of methods from the individual agencies, traditionally updated at intervals of about 5 to 10- years.

1.3 Accretion Study Design

In 2017 Balance Hydrologics began evaluating interconnected surface water by conducting annual late-season stream observation walks ("accretion runs"), where flow and specific conductance were measured with high precision at select locations along the San Lorenzo River and its tributaries.[1] The accretion runs also include habitat-oriented measurements of localized changes in water temperature, whether stratification of temperature may be present in deep pools, and the presence and height of recent high-water marks, all of which also inform our assessments of surface/groundwater exchange. Additionally, measurements of nitrate and sometimes other major ions or forms or organic carbon (c.f., Richardson and others, 2020) are also included in some of the 'runs'. Accretion studies tell where the aquifer is adding flow to the stream, and where the stream is replenishing the aquifer. Carefully conducted

1 This work grew out of detailed hydrologic studies conducted for the San Lorenzo Valley Water District during two very dry summers (2014 and 2015), coupled with the effects of a recovery year (2016), and the recommendations of the technical advisory committee reviewing that work.

accretion studies are perhaps the best way of quantifying an understanding of aquifer dynamics and surface-groundwater exchange.

1.3.1 Accretion Flow Measurements

During the summer and Fall of 2020, two separate accretion runs were conducted (July and September) at the same locations as in 2018 and 2019 (**Figure 1a and 1b**). Sites along the San Lorenzo River were measured from upstream of downtown Boulder Creek to below the USGS gage at Big Trees. Much of the emphasis was on areas within the outcrop of the Santa Margarita sandstone, which contributes water to the river and its tributaries, most notably from Love Creek to downstream of the USGS Big Trees gage beneath the Henry Cowell State Park entrance road. As part of the on-going GSP processes, sites along Zayante, Lompico and Bean Creeks were added to the accretion runs in the summer of 2019 and 2020, with most of the additional sites along Bean Creek and its tributaries.

Flow measurements were typically taken upstream of a tributary and on the tributary. The two measurements were then added together to calculate the amount of flow in the channel downstream of the tributary. Measurements were collected over one to three days to minimize variability associated with the strings of days of warm or foggy weather which are a hallmark of the San Lorenzo Valley summers.

1.3.2 Accretion Water Quality Sampling

On July 14, 2020 water quality samples were collected throughout the Santa Margarita Basin at similar locations as the accretion flow measurements by Balance staff. Samples were sent to the County of Santa Cruz Water Quality lab for analysis of nitrate (as N) and phosphate (as P). Water quality data are collected as part of this study because they can be used to the infer the paths followed by recharging waters and characterize where these groundwaters "come from" --which aquifer(s) and/or watershed uses have been influencing the waters emanating from groundwater into the river system.

While the focus of the accretion studies is firmly on the paths followed by groundwater on its way to the streams as well as in evaluating where and for how long these waters are stored in the aquifer, the water quality data also have meaning for managing the resources considered in the GSP. The California Water Resources Control Board Division of Water Quality and the EPA define the maximum concentration allowed in sources for community drinking water for 10.0 N-mg/L. Nitrate in 'pristine' groundwater is

considered by the State to be less than 2 mg-N/L[2] ; in fact, stream nitrate values below 0.11 mg/L-N (0.50 mg/L NO_3)are usually found in the pristine 'parkland' aquatic environments of the central Santa Cruz Mountains.[3]

The sources of nitrogen above these levels in the San Lorenzo River system are well known, in general terms, much of the nitrate-nitrogen traces to septic tanks and other onsite wastewater disposal treatments units widely dispersed throughout the watershed. The nitrogen disproportionately reaches the water table beneath areas of coarse-grained Zayante soils developed from the Santa Margarita formation. While there are other significant sources such as stables, urban runoff, fertilization and even from some areas of native vegetation, septic systems, which allow percolation of effluent more rapid than the soils can treat (Ricker and others,1976 and 1979; Hecht and others, 1991) allow nitrate to move rapidly to the water table, and thence to the stream system. The effluent richer in nitrate can migrate more rapidly through the sandstones than through alluvium, granitic, or shaley rock units before reaching the water table (Johnson and others, 1982), where it can seep out into the river and the main tributary creeks (Hecht and others, 1991; Ricker and others, 1994). Thus, it has been known for 30 years or more that nitrate is one marker, or tracer, of water entering the river system selectively from the Santa Margarita aquifer. The Santa Margarita is, of course, not the only aquifer through which nitrate reaches the river. Nonetheless, establishing a quantitative base for where, when, and how much nitrate emanates from this formation is an important way of denoting – and monitoring – where and how much water may enter the river through this source at present, and how management of the aquifer may change where and when nitrogen enters the river system.

Conversely, solutes (or 'salts') are largely naturally occurring, dissolved from the aquifer materials, or from the original formations waters (largely sea water) in which the local sedimentary aquifers were deposited. Groundwater transports such salts to the stream system, where we measure them as specific conductance, from which we can infer the paths and storage locations through the aquifer systems based on years of prior studies, our own and others. It is the paths and storage that are primary importance in gathering the specific conductance data. With important exceptions, salts (or specific conductance) are generally not limiting for most beneficial uses in the San Lorenzo Valley and the Santa Margarita Groundwater Basin.

[2] https://www.waterboards.ca.gov/gama/docs/coc_nitrate.pdf
[3] Nitrate values given as mg/L nitrate to conform with State Board nomenclature as above. All subsequent values in this report are expressed as mg/L-N. 1.0 mg/L-N = 4.4 mg/L-NO_3

Phosphates inform both about role and effects of waste management, and of remobilized naturally-occurring phosphorus (see Ricker, 1979). Both are significant sources of the generally low concentrations of phosphatic compounds found in the Santa Margarita Groundwater Basin. Other hydrogeologic information is usually required to infer the degree to which wastes or naturally-occurring sedimentary units are its source(s). Irrespective of origin, phosphate can contribute to algal growth and can biostimulate many aquatic organisms, contributing to water-quality and -management issues, including those affecting fish and other stream biota, and can lead locally to the need for water treatment before domestic consumption. Hence, phosphates are tracked both to serve as groundwater tracers and to guide water management.

1.3.3 Stream Walks

In addition to accretion sampling, Balance conducted two stream walks to document stream conditions along two reaches of Bean Creek; Bean Creek from Lucinda St. upstream to Morgan's Run near the middle of the Bean Creek watershed and Bean Creek from Mount Hermon Camp to Mount Hermon Road. in its lowermost reaches.

On July 8, 2020 Chelsea Neill (Balance), Alex Johanson (Watershed Steward) and Maya Vavra (Watershed Steward) walked the section of Bean Creek from Lucinda St. upstream to Morgan's Run, to document the extent of the dry reach and to look for remaining pools. This reach is difficult to access from the road network, calling for a broadened instream canvass. They repeated the initial walk on October 15, 2019 by Chelsea Neill (Balance), Kristen Kittleson (County of Santa Cruz), Alex Johanson (Watershed Steward) and Maya Vavra (Watershed Steward). It has been noted that this reach, beginning about a mile downstream of Mackenzie Creek, typically goes dry in the summer as it has done at least since the 1960s, although the extents of the dry reaches seem to vary from year to year (Kennedy Jenks, 2015; John Ricker, pers. comm., 2020).

On October 12, 2020 Balance staff Jason Parke and Emma Goodwin walked the section of Bean Creek from Mount Hermon Camp to Mount Hermon Road. The reach downstream from the confluence with Ruins Creek, in particular, is the primary gaining reach within the Santa Margarita Basin and is characterized by areas where the stream has cut through the Santa Margarita sandstone and into the top of underlying Monterey shale, such that springs emanating from the base of the Santa Margarita sands into the streambed and along the sides of the stream are contributing

groundwater discharge. The goal of the stream walk was to document the locations, approximate flows, and general water quality of numerous seeps and springs contributing groundwater from the Santa Margarita formation.

1.3.4 Cool Pools

Rearing fish often use deep, thermally stratified pools as habitat during the summer months. Groundwater upwelling through these pools is one means by which "cool pools" develop, and a potential path through which aquifer-stream linkage sustains aquatic habitat. Our practice during accretion surveys is to note the location of deep pools, and to try to measure the water temperature and specific conductance at the surface and at depth near the center of the pool with hand meters to quantify the degree and extent of thermal stratification.

While such pools have been historically noted at a number of locations (Don Alley, pers. comm. 2019) particularly in the San Lorenzo River main stem, Boulder Creek, and the lower reaches of Bean Creek, none were identified during our stream walks. It is likely that high-recurrence storms during the winters of water years 2017 and 2019 may have led to episodic sedimentation of these pools.[4] An important, long stratified pool in lower Boulder Creek has been reported in our recent work (Hecht and others, 2018) and previously by others, but this creek segment was not part of the dry season 2020 measurements.

1.3.5 Methods Integration

Accretion has been used in many locations to assess where and how much water is gained or lost in stream networks. The usual method is what is commonly called a "seepage run", making streamflow measurements at a number of sites along a stream on a given day.[5]

[4] Elevated bed sedimentation is likely to persist in the San Lorenzo River itself due to heightened delivery of coarser sands and gravels following the CZU fire. Work in the upper Carmel River following the 1977 Marble-Cone burn showed that deep pools were last of all habitat elements to recover following the post-fire sediment pulse in similar soils (Hecht, 1981); Richmond (2009) found that deep pools were the first element in these same pools that was lost after a much below-average rainfall season following the 2008 Indians fire. Hence, it may well be several years before the "swimming holes" that are part of the San Lorenzo River lore recover to depths more typical of the memories of the past.

[5] Synoptic surveys is a similar term, but these may involve measuring additional metrics, such as bed conditions or field water-quality indicators. See Rosenberry and LaBaugh, 2008; Magirl and others, 2009.

Methods used in this report build on this framework in several fundamental ways:

1. Streamflow measurements were made at 'double precision', including much denser measurement of each part of the channel, typically with 30 or more 'verticals'.
2. The spatial density of measurements was substantially greater than during conventional 'seepage runs', up to 3 or 4 measurements per mile of channel where flows appeared to be changing rapidly with distance downstream.
3. Concurrent measurement of salinity (as conductance) and streamflow were made, and samples were collected for nitrate and phosphate analysis by a state-certified laboratory.
4. Water temperature was tracked at each site, tributary, or at locations considered important by the field teams.
5. The location and degree of stratification of cool pools is a component of the analysis.

The accretion surveys have additional purposes of describing likely habitat conditions which vary with the extent of stream losses or gains, and of concurrently relating these changes to aquifer conditions and to land uses. The terms "accretion survey" or "accretion runs" is an appropriate way to describe the different nature and precision of work done, in contrast to "seepage run".

2. RESULTS

2.1 Conditions During Water Year 2020

2.1.1 Precipitation

Water year 2020 can be characterized as a dry year, with below-average annual precipitation, which resulted in lower-than-average flows (**Figure 2**). The San Lorenzo Valley Water District rain gage in Boulder Creek received 21.40 inches of rain (approximately 42% of the long-term average) and the CDEC rain gage in Santa Cruz (CRZ) received 18.94 inches of rain (approximately 66% of the long-term average) (see **Figure 1** for gage locations). The resulting runoff from the San Lorenzo River was approximately 35% of the long-term average, as measured at the USGS Big Trees stream gage (**Figure 2**).

2.1.2 CZU Lightning Complex Fire

The CZU lightening Complex Fire began on August 16, 2020 after a thunderstorm produced widespread lightning throughout the Bay Area. The fire began as several small fires within the Santa Cruz Mountains, which expanded and merged with changes in wind. The fire destroyed 1,490 buildings within the communities of Boulder Creek, Bonny Doon, Swanton, and Last Chance. The fire burned 86,509 acres and was reported as contained on September 22, 2020. While the burn area was mostly outside of the Santa Margarita Basin boundary, the western portion of the San Lorenzo River watershed did burn, thus potentially directly impacting the San Lorenzo River (**Figure 1**).

2.1.3 Other Noteworthy Antecedent Conditions

During 2017 and 2019, two very significant storms affected these watersheds. Runoff crested each year at about 30,000 cubic feet per second, among the five highest values recorded during the 80-year-plus history of the San Lorenzo River at Big Trees gage (**Figure 2**). These storms introduced considerable coarse-grained sediment into the channels, which remain locally aggraded.

2.2 Streamflow Gaging

Plots of 15-minute flows and mean daily values for gaged seasonal flows for San Lorenzo River above Love Creek, Newell, Zayante, and Bean Creeks, are shown on **Figures 3 – 6**. Water temperature and precipitation were also plotted to compare natural fluctuations in gages. Plots of specific conductance and temperature for each gage are shown in

Figures 7 -10. Measurements and observations for each gage are shown in **Tables 1 – 4** and a summary of daily mean flow for each gage are shown in **Forms 1 – 4**.

2.2.1 San Lorenzo River Upstream of Love Creek

The seasonal baseflow recession at the San Lorenzo River upstream of Love Creek gage ranged from about 6.5 cfs down to about 2.5 cfs prior to the first rain in November (**Figure 3**). The small spike in flow on August 21, 2020 is due to the San Lorenzo Valley Water District releasing water from tanks during the fire due to VOC contamination. There was also a slight rise in baseflow during the period of the fire, which could be due to lack of upstream diversions, as well as atmospheric conditions, or to increases in flows associated with reduced evapotranspiration following burning of the vegetation.

2.2.2 Newell Creek Upstream of San Lorenzo River

The seasonal baseflow recession at the Newell Creek upstream of the San Lorenzo River gage was consistent at about 1.5 cfs from June through November, which is consistent with observed flow recessions during previous years (**Figure 4**). This site is downstream of the Loch Lomond Reservoir and is highly regulated. During the period of the CZU the flow increased up to 5 cfs, which is likely due to changes in activity and releases from Loch Lomond. The City regularly releases 1.0 cfs from Loch Lomond to promote aquatic habitat in Newell Creek and the river.

2.2.3 Zayante Creek at Woodwardia Weir

The seasonal baseflow recession at Zayante Creek at Woodwardia Weir ranged from about 3 cfs in June down to just over 1 cfs in November 2020 (**Figure 5**). This baseflow is lower than was observed during water 2017 and water year 2019, which were both above average years, and comparable to water year 2018, which was a dry year.

2.2.4 Bean Creek at Mount Hermon Camp

The seasonal baseflow recession at Bean Creek at Mount Hermon Camp was consistently around 2.5 to 2 cfs from June until the first runoff-producing rain in November (**Figure 6**). Similar to the San Lorenzo River, there was a slight rise in baseflow (about 0.5 – 1 cfs) during the CZU fire, which could be due to changes in atmospheric conditions, or possible increases in groundwater flow while the surrounding and upstream areas were evacuated. In previous years there has typically been more of a recession during this period. The consistent baseflow reflects the steady inflow from groundwater during a dry year.

2.2.5 Temperature Monitoring

Detailed temperature monitoring and reporting has been conducted within the San Lorenzo River watershed by Don Alley in previous years. Within Don Alley's reports are a discussion of stream temperature tolerances and thresholds in relation to coho and steelhead lifecycle, which establish a 20° C general 7-day forward rolling average temperature guideline for evaluating steelhead life cycle (Alley, 2015). Stream temperature, including the 7-day forward rolling average, is plotted on **Figures 3-10** for each gage. None of the sites exceeded the 20° C general 7-day forward rolling average temperature guideline, except for the San Lorenzo River upstream of Love Creek gage, which exceeded the guideline during the period of the CZU fire.

2.3 Accretion Study

2.3.1 Accretion Flow

The accretion of flow showed a similar trend between the July and September 2020 sampling events, with a higher baseflow in July as expected earlier in the summer recession (**Figures 11-14**). The profile of accretion flow can be seen for the San Lorenzo River and Bean Creek during both events in **Figures 11 and 12,** respectively. The input of groundwater can be readily seen in each data set as a break in slope from horizontal of each line. If there were no groundwater interaction, then the flow would remain constant between tributaries assuming no diversions or losses to evapotranspiration. An up-trending slope from each set of points signifies accretion of flow apart from the tributary ('gaining reach'), likewise a down-trending slope indicates a flow loss in between each tributary ('losing reach'). The results can also be seen in map view for the July and September sampling events in **Figures 13 and 14**, respectively. Details of each measurement are shown in **Tables 5 and 6**, for the July and September events, respectively.

Notable reaches which show an increase in flow include:

- San Lorenzo River downstream of Love Creek to upstream of Newell Creek (0.21 cfs in July; 0.28 cfs in September)
- San Lorenzo River downstream of Newell Creek to upstream of Fall Creek (1.09 cfs in July; 0.27 cfs in September)
- Bean Creek downstream of Ruins Creek to upstream of Lockhart Gulch (0.21 cfs in July; 0.08 cfs in September)

- Bean Creek downstream of Lockhart Gulch to Mount Hermon Road (1.03 cfs in July; 1.22 cfs in September)
- Bean Creek at Mount Hermon Road to Mount Hermon Camp (0.5 cfs in July; 0.58 cfs in September)

These observations are consistent with previous findings, where the greatest inflow along the San Lorenzo River has been noted from downstream of Love Creek to upstream of Eagle Creek (Parke and Hecht, 2018, Parke and Hecht, 2020a). Similarly, the reach along Bean Creek from downstream of Ruins Creek to the confluence with Zayante has been noted as being the primary gaining reach within the Santa Margarita Basin. It is also the focus of one of the stream walks conducted during the season and is described in **Section 2.3.3**.

Notable reaches which show a decrease in flow include:

1. Bean Creek downstream of Redwood Camp to upstream of Mackenzie Creek (-0.17 cfs July)

The upper Bean Creek watershed and its tributaries are typically losing reaches that recharge the groundwater (California DWR (1958; 1966)). The extent of the dry reach was documented in a stream walk in July (See **Section 2.2.3**). In September 2020, the upstream extent of the dry reach between Redwood Camp and Mackenzie Creek is unknown.

In addition to measuring flow, measurements of specific conductance were taken at each site (**Figures 15 and16; Tables 5 and 6**).

Within the Zayante and Bean Creek watershed the specific conductance values tend to decrease from upstream to downstream, with the tributaries having lower specific conductance values than the main channel (**Figure 16**). This is a very unusual condition and has been commented upon many times since first being identified in the 1960s (c.f., Department of Water Resources, 1966). Specific conductance is an indication of salt content, which is easily measured in the field. The upstream parts of the Zayante and Bean Creek subwatersheds are underlain by formations that contain groundwater that is naturally saltier than parts of the basin south of the Zayante fault. The larger streams, which drain watersheds on both sides of the fault, carry the higher salt content from north of the fault, and then progressively are diluted by the fresher groundwater emanating from the Santa Margarita formation and other sandstones south of the

Zayante fault. Locally, increases in salt content can be imparted by passage through some of the marine shales that also outcrop, such as the Monterey formation. Differences in specific conductance between Ruins Creek and Lockhart Gulch are probably ascribable to the greater proportionate outcrop area of the Monterey shales in the latter watershed. Hence, the salt content of the streams can provide information on where waters originate in the San Lorenzo Valley, even at a fairly subtle level.

Similarly, the specific conductance tends to be lower in the tributaries to the San Lorenzo River compared to the mainstem (**Figure 15**), at least downstream to the vicinity of Felton. The specific conductance of Eagle Creek is notably low due to the influence of several springs emanating from the Santa Margarita sands along Eagle Creek (Parke and Hecht, 2020 b).

2.3.2 Accretion Water Quality

On July 14, 2020 water quality samples were collected throughout the Santa Margarita Basin at similar locations as the accretion flow measurements by Balance staff (**Figure 1, 1a, and 1b**). The results and additional observations are shown in **Table 7**, **Figure 17** shows a map of nitrate levels, and **Figures 18 and 19** show profiles of nitrate levels along the San Lorenzo River and Bean Creek, respectively.

As in previous years, the 2020 field work shows that considerable nitrate enters the river during a representative summer day as it flows downstream (**Figures 17 – 19; Table 7**). Along the San Lorenzo River concentrations increase through reaches where the Santa Margarita aquifer contributes directly to the river, from Love Creek at Ben Lomond downstream to Eagle Creek. And on Zayante Creek, discharge from the Santa Margarita raises nitrate levels from the Zayante Store (just upstream of the Santa Margarita outcrop) to Graham Hill Road, just above its confluence with the San Lorenzo River. Bean Creek also shows consistent downstream increases in reaches where it is incised through the Santa Margarita.

In general, nitrate levels on the San Lorenzo River on July 14, 2020 appeared to increase in the downstream direction from around 0.1 N-mg/L to 0.68 N-mg/L downstream of Newell Creek (**Figure 18**). This same pattern has been observed during previous water quality sampling events (Parke and Hecht, 2020 a).

The Newell Creek concentration just upstream of the confluence of the San Lorenzo River was 0.89 N-mg/L. On September 18, 2017 nitrate at this location was 1.56 (N-mg/L)

and 1.0 N-mg/L on June 16, 2019 . These higher concentrations are likely observed in part due to a relict plume from the former Ben Lomond Landfill, closed and converted to a transfer station about 20 years ago.

The highest concentration of nitrate during water year 2020 was found in Ferndell Creek at 1.99 N-mg/L. This is much higher than the concentration during water year 2019 (0.54 N-mg/L), but similar to the concentration during water year 2017 (2.26 N-mg/L). Ferndell Creek receives groundwater drainage from a dense cluster of on-site waste disposal systems, which likely contributes to the elevated nitrate levels.

2.3.3 Stream Walks

On July 8, 2020, the reach along Bean Creek was dry for about 0.50 miles with very few isolated pools (**Figure 13**). The downstream most point where the creek goes dry (approximately 1 mile downstream of Mackenzie Creek) is the same point where the creek was dry in October 2019. We did not walk the dry reach again in September to document the extent, but we assume that the downstream point was similar to July as flow was observed in September at Green Valley Road, just downstream of that point. The upstream extent in September, which is between Mackenzie Creek and Redwood Camp, is unknown.

On October 12, 2020 Balance staff Jason Parke and Emma Goodwin walked the section of Bean Creek from Mount Hermon Camp to Mount Hermon Road and documented numerous seeps and springs along the reach (**Figure 20**). Flow measurements were taken at three locations along Bean Creek: at Mount Hermon Camp, approximately halfway through the reach, and at Mount Hermon Road. Measurements, where possible, or estimates of inflow from seeps and springs were made, along with specific conductance readings; these are documented in **Table 8**. There was approximately a 0.41 cfs increase in flow along Bean Creek from Mount Hermon Road to Mount Hermon Camp, with most of the additional flow contributions coming from the upstream half of the reach (**Figure 20**). Much of the inflow is discharge from Redwood Spring, as well as other springs and seeps in the compound landslide area south of the creek along the Bean Creek fault. A smaller contribution from beneath the ridge north of Bean Creek probably enters the creek, although a substantial part of such flows likely is now directed to pond storage and to Zayante Creek through interception of pre-quarrying flow lines in the Olympia Quarry pit. Previous studies have shown that diurnal fluctuations at both gages can be as much as 0.5 cfs, with little difference between hot days and foggy days; this suggests that much

of the flow entering Bean Creek in the intervening reach is fairly deep, unaffected by daily differences in the weather over the course of an individual season (Parke and Hecht, 2018; Parke and Hecht, 2020a; Neill and Hecht, 2020). Speculatively, it may be that much of the inflow to Bean Creek in this reach moves within slide masses and along glide planes and fractures within the Monterey shale commonly found at their bases.

3. PRELIMINARY CONCLUSIONS

1. Water year 2020 was the third year of accretion measurements along the San Lorenzo River and the second year of measurements along Zayante and Bean Creeks. One of the purposes of this study is to document conditions, such that future changes in flow may be distinguishable as conditions evolve in the Santa Margarita groundwater basin in response to water management, climate change, and other trends. The data collected during water year 2020 establishes baseline surface water conditions during a dry year.

2. Streams flowing through the Santa Margarita formation in the San Lorenzo Valley all share common traits of elevated baseflows, low solute loads (measured as specific conductance), and elevated nitrate loads. This can be seen in the San Lorenzo River, Zayante Creek and Bean Creek as they pass through the portions of the watershed influenced by the Santa Margarita formation.

3. The results of the accretion sampling are consistent with previously reported ideas about the surface water groundwater interaction along Bean Creek, where segments of the upper Bean Creek watershed appear to be losing flow to groundwater and lower Bean Creek, which appears to gain discharge from groundwater.

4. The stream walks along Bean Creek were important to document the extent of the dry reach and to document the location and influence of groundwater from seeps and springs along the lower reach.

5. As has been noted in previous water quality sampling, nitrate levels along the San Lorenzo River tend to increase with distance downstream from Love Creek, the upstream-most point where the Santa Margarita aquifer contributes significantly to the San Lorenzo River.

6. During the CZU fire there was a slight increase in baseflow at the gages, which is likely due to changes in atmospheric conditions, as well as changes in diversion or groundwater pumping management. Increased summer flows from burned areas within the watershed might be anticipated, but the gaging array was not configured in a way that such changes could be measured.

7. Temperature monitoring at the gages showed that none of the sites exceeded the 20°C general 7-day forward rolling average temperature guideline for steelhead lifecycle, except for the San Lorenzo River upstream of Love Creek gage, which exceeded the guideline during the period of the CZU fire.

4. ACKNOWLEDGMENTS

The data presented in this memo represents a coordinated effort amongst the staffs of Balance Hydrologics and the Santa Cruz County Health Department, including its laboratory. We are grateful for the cooperation and sharing of data between the Santa Margarita Groundwater Agency, County of Santa Cruz Environmental Health, the San Lorenzo Valley Water District, and the City of Santa Cruz. The San Lorenzo Valley Water District has contributed to the project by providing valuable supporting flow data from a number of year-round and seasonal flow gages throughout the San Lorenzo River as well as the western tributaries. The City of Santa Cruz has also aided this effort by providing flow data from the gage its staff maintains on Newell Creek downstream of Loch Lomond as well as supporting the real-time stream gage on the San Lorenzo River at Big Trees which is operated by the United States Geological Survey's (USGS) Water Resources Division.

We would like to thank Kristen Kittleson and the Watershed Stewards, Alex Johanson and Maya Vavra, for providing insight and participating in the Bean Creek dry reach walk.

Our colleagues, John Hardy and Denise Tu, assisted meaningfully in the data collection and compilation, including some very long field days.

Finally, John Ricker, recently retired Water Manager for the County, actively abetted the accretion studies with helpful comments and suggestions, data contributions, and locating older data which would otherwise have been overlooked.

5. LIMITATIONS

Hydrologic calculations of low flows in coastal California are very complex, often requiring consideration of many years of data collection. Our work conforms with the standard of care for such work in coastal northern California; no other warranties are stated or implied.

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FORMS

Form 1
Annual Hydrologic Record: San Lorenzo River
Estimated daily flow upstream of Love Creek
Dry Season 2020

Stream and Station

Dry Season:	**2020**
Stream:	San Lorenzo River
Station:	Upstream of Love Creek
County:	Santa Cruz County, CA

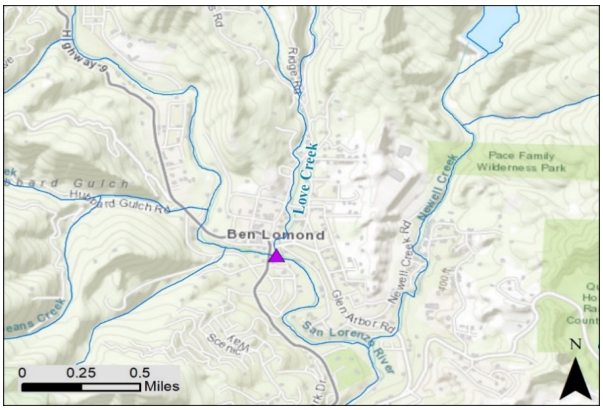
Station Location and Watershed

Latitude: 37° 5'16.83"N, Longitude: 122° 5'16.60"W (WGS84), Santa Cruz County, CA. Gage is located on the right bank approximately 150 ft downstream of the HWY 9 bridge in Ben Lomond and approximately 80 ft upstream of the confluence with Love Creek. The drainage area is approximately 57.9 square miles.

Period of Record

Gage installed on June 24, 2020. Gaging sponsored by Santa Cruz County Environmental Health and the Santa Margarita Groundwater Agency. Sensor removed temporarily for the wet season.

Station Location Map



Dry Season 2020 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN [4]	JUL	AUG [5]	SEPT [5]	OCT	NOV [6]
1										6.05	4.24	3.94	3.36	2.80
2										5.98	4.06	3.99	3.15	2.68
3										6.00	3.99	3.94	3.06	2.60
4										5.92	3.97	3.84	2.86	2.49
5										5.77	4.03	3.78	2.80	2.64
6										5.64	4.18	3.69	2.85	2.57
7										5.41	4.29	3.44	2.90	2.72
8										5.52	4.39	3.33	2.97	2.62
9										5.51	4.37	3.36	3.09	2.49
10										5.36	4.22	3.50	3.26	2.62
11										5.22	4.06	3.78	3.41	2.74
12										5.12	3.79	3.98	3.37	2.77
13										5.02	3.61	4.07	3.28	2.47
14										4.98	3.45	3.84	3.33	2.79
15										5.09	3.51	3.74	3.21	2.71
16										5.26	3.15	3.67	3.29	2.56
17										5.19	3.14	3.68	3.11	
18										5.18	3.06	3.70	2.96	
19										5.00	3.03	3.62	2.89	
20										4.91	2.94	3.72	2.86	
21										4.93	4.30	3.66	2.92	
22										4.88	3.37	3.56	2.95	
23										4.84	3.46	3.45	3.00	
24										4.89	3.84	3.41	3.09	
25									6.63	4.98	3.97	3.48	3.10	
26									6.54	4.83	4.06	3.55	3.04	
27									6.59	4.70	4.05	3.57	2.80	
28									6.58	4.56	4.00	3.61	2.71	
29									6.23	4.54	3.99	3.54	2.66	
30									6.23	4.42	3.94	3.41	2.66	
31									-	4.36	3.94	-	2.82	-
MEAN									6.47	5.16	3.82	3.66	3.02	2.64
MAX. DAY									6.63	6.05	4.39	4.07	3.41	2.80
MIN. DAY									6.23	4.36	2.94	3.33	2.66	2.47
cfs days									39	160	118	110	94	42
ac-ft									77	318	235	218	186	84
gallons									25,100,000	103,000,000	76,500,000	71,000,000	60,600,000	27,300,000

Daily mean flow is only reported seasonally from June 25, 2020 to November 16, 2020.

Monitors' Comments

1. Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.
2. Mean daily values are cumulated from 96 15-minute measurements of stage; several stage shifts have been applied to account for changes in bed conditions over the course of the monitoring program.
3. Diversion activities upstream may influence the gaged flow.
4. Stream gage was installed on 6/24/20. Totals for June are are partial, as they only include the last 6 days of the month.
5. The CZU fire began on 8/16/20 and was contained by 9/22/20. Minor changes in flow may have been indirectly caused by the fire or fire-fighting activities. See Figure 1 for burn area. SLVWD released water from tanks around 8/21/20, causing an increase in flow.
6. The first significant rain of water year 2021 occurred on 11/17/20. Data not reported past this date. Totals calculated for November are partial, as they do not include the last 14 days of the month.

Dry Season 2020 Totals

Seasonal totals calculated from 6/25/20 to 11/16/20

Mean seasonal flow	**3.88**	(cfs)
Max. seasonal flow	**6.63**	(cfs)
Min. seasonal flow	**2.47**	(cfs)
Seasonal total	**563**	(cfs-days)
Seasonal total volume	**1,117**	(ac-ft)
Seasonal total volume	**363,500,000**	(gallons)

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Form 2
Annual Hydrologic Record: Newell Creek
Estimated daily flow approx. 150 feet upstream of SLR
Dry Season 2020

Stream and Station

Dry Season:	**2020**
Stream:	Newell Creek
Station:	Newell Creek approx. 150 feet upstream of San Lorenzo River
County:	Santa Cruz County, CA

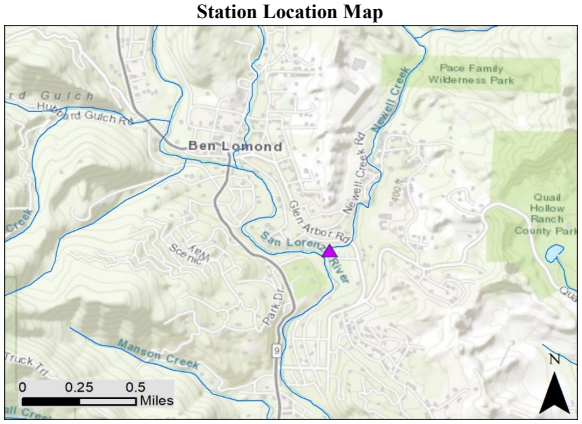
Station Location and Watershed

Coordinates: 37.08204, -122.07973 (WGS84), Santa Cruz County, CA. Gage is located approximately 150 feet upstream of the confluence with the San Lorenzo River. Drainage area is approximately 9.9 square miles. Land use in the watershed includes residential neighborhoods, Ben Lomond Transfer Station, Loch Lomond reservoir and recreation area. The City of Santa Cruz uses the reservoir as a water source and maintains bypass-flow of 1.00 cfs just downstream of the impoundment.

Period of Record

Gage installed on June 14, 2018. Gaging sponsored by Santa Cruz County Environmental Health and the Santa Margarita Groundwater Agency. Sensor removed temporarily for the wet season. Site very near a USGS gage operated from water years 1959 to 1962.

Station Location Map



Dry Season 2020 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG[5]	SEPT[5]	OCT	NOV[6]
1									1.60	1.64	1.53	2.57	1.49	1.35
2									1.58	1.66	1.51	2.78	1.51	1.33
3									1.58	1.61	1.55	2.78	1.51	1.32
4									1.60	1.62	1.56	2.78	1.48	1.35
5									1.65	1.57	1.60	2.74	1.48	1.41
6									1.69	1.70	1.53	2.74	1.51	1.40
7									1.70	1.68	1.52	2.75	1.53	1.44
8									1.68	1.62	1.50	2.88	1.52	1.40
9									1.65	1.53	1.50	2.97	1.51	1.28
10									1.61	1.54	1.47	3.54	1.52	1.28
11									1.62	1.51	1.49	4.47	1.53	1.35
12									1.66	1.50	1.61	4.37	1.54	1.36
13									1.68	1.59	1.03	4.43	1.47	1.35
14									1.64	1.59	0.93	3.29	1.49	1.40
15									1.67	1.59	1.41	2.73	1.47	1.36
16									1.70	1.54	1.62	2.64	1.46	1.36
17									1.65	1.56	1.64	2.72	1.44	
18									1.62	1.55	1.63	2.49	1.44	
19									1.65	1.54	1.61	1.55	1.49	
20									1.65	1.54	1.59	1.54	1.44	
21									1.61	1.54	1.58	1.52	1.38	
22									1.63	1.58	1.59	1.52	1.37	
23									1.62	1.56	2.68	1.49	1.38	
24									1.62	1.51	4.66	1.51	1.42	
25									1.63	1.54	4.79	1.53	1.43	
26									1.60	1.51	4.92	1.52	1.35	
27									1.61	1.56	3.40	1.51	1.30	
28									1.63	1.50	2.31	1.51	1.30	
29									1.61	1.51	2.26	1.52	1.28	
30									1.61	1.53	2.26	1.50	1.30	
31									-	1.58	2.26	-	1.37	-
MEAN									1.63	1.57	2.02	2.46	1.44	1.36
MAX. DAY									1.70	1.70	4.92	4.47	1.54	1.44
MIN. DAY									1.58	1.50	0.93	1.49	1.28	1.28
cfs days									49	49	63	74	45	22
ac-ft									97	96	124	147	89	43
gallons									31,700,000	31,400,000	40,400,000	47,800,000	28,900,000	14,100,000

Daily mean flow is only reported seasonally from July 1, 2020 to November 16, 2020.

Monitors' Comments

1. Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.
2. Mean daily values are cumulated from 96 15-minute measurements of stage; several stage shifts have been applied to account for changes in bed conditions over the course of the monitoring program.
3. Irregularities in flow over the dry season are likely attributed to activities at the upstream dam and other diversions or releases upstream of the gage.
4. Gage was destroyed over the winter of water year 2019. Gage was reinstalled on July 11, 2019.
5. The CZU fire began on 8/16/20 and was contained by 9/22/20. The fire did not burn the Newell watershed, but may have indirectly affected flows.
6. The first significant rain of water year 2021 occurred on 11/17/20. Data not reported past this date. Totals calculated for November are partial, as they do not include the last 14 days of the month.

Dry Season 2020 Totals

Seasonal totals calculated from 6/1/20 to 11/16/20

Mean seasonal flow	**1.78**	(cfs)
Max. seasonal flow	**4.92**	(cfs)
Min. seasonal flow	**0.93**	(cfs)
Seasonal total	**252**	(cfs-days)
Seasonal total volume	**499**	(ac-ft)
Seasonal total volume	**162,600,000**	(gallons)

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Stream and Station

Dry Season:	**2020**
Stream:	Zayante Creek
Station:	Zayante Creek at Woodwardia Weir
County:	Santa Cruz County, CA

Station Location and Watershed

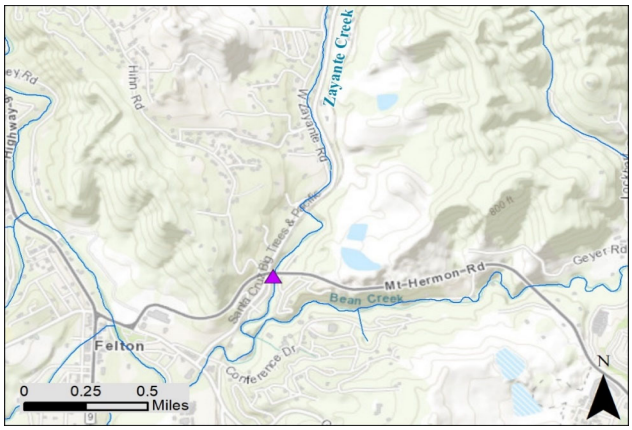
Latitude: 37° 03' 19.85" N, Longitude: 122° 03' 36.69" W (WGS84), Santa Cruz County, CA. Gage is located on the upstream side of the concrete weir just upstream of the Woodwardia Bridge 0.47 miles up E. Zayante Rd from the intersection with Graham Hill Rd. Site is almost directly under Mount Hermon bypass bridge. Land use is primarily rural residential. Drainage area is approximately 16.76 square miles.

Period of Record

Gage was operated from 10/2/08 to 10/22/10 by Balance Hydrologics and included estimation of suspended sediment loads using turbidity instrumentation during this time. Gage was seasonally reinstalled with the same datum from 7/14/17. Gaging sponsored by Santa Cruz County Environmental Health and the Santa Margarita Groundwater Agency. Previous measurements by H. Esmail. & Associates (1979-1981) and UCSC (1973).

Form 3
Annual Hydrologic Record: Zayante Creek
Estimated daily flow at Woodwardia Weir
Dry Season 2020

Station Location Map



Dry Season 2020 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG [4]	SEPT [4]	OCT	NOV [6]
1									3.09	2.28	1.82	1.91	1.57	1.27
2									2.97	2.38	1.79	1.95	1.53	1.24
3									2.82	2.27	1.74	1.90	1.49	1.24
4									2.84	2.15	1.79	1.83	1.39	1.18
5									2.95	2.05	1.85	1.80	1.57	1.18
6									3.01	2.06	1.84	1.76	1.51	1.25
7									2.98	2.01	1.83	1.68	1.57	1.31
8									2.91	2.06	1.82	1.70	1.58	1.26
9									2.79	2.02	1.78	1.78	1.58	1.11
10									2.66	1.96	1.78	1.96	1.59	1.11
11									2.66	1.98	1.74	2.07	1.57	1.20
12									2.75	1.91	1.72	1.97	1.51	1.22
13									2.77	1.96	1.70	1.92	1.44	1.23
14									2.66	2.04	1.69	1.84	1.41	1.28
15									2.69	2.06	1.70	1.81	1.38	1.25
16									2.69	2.01	1.68	1.78	1.36	1.21
17									2.60	2.00	1.73	1.78	1.34	
18									2.57	1.96	1.75	1.78	1.35	
19									2.58	1.96	1.81	1.77	1.37	
20									2.61	1.97	1.77	1.79	1.38	
21									2.50	1.97	1.73	1.78	1.37	
22									2.51	2.06	1.81	1.74	1.40	
23									2.43	2.07	1.87	1.68	1.41	
24									2.39	1.99	1.94	1.66	1.45	
25									2.44	1.97	1.95	1.66	1.45	
26									2.30	1.92	2.01	1.61	1.37	
27									2.29	1.89	1.96	1.63	1.15	
28									2.29	1.84	1.95	1.77	1.16	
29									2.27	1.88	1.93	1.62	1.21	
30									2.22	1.84	1.98	1.58	1.24	
31									-	1.82	1.93	-	1.28	-
MEAN									2.64	2.01	1.82	1.78	1.42	1.22
MAX. DAY									3.09	2.38	2.01	2.07	1.59	1.31
MIN. DAY									2.22	1.82	1.68	1.58	1.15	1.11
cfs days									79	62	56	53	44	20
ac-ft									157	124	112	106	87	39
gallons									51,200,000	40,300,000	36,400,000	34,600,000	28,400,000	12,600,000

Daily mean flow is only reported seasonally from June 1, 2020 to November 16, 2020.

Monitors' Comments

1. Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.
2. Mean daily values are cumulated from 96 15-minute measurements of stage; several stage shifts have been applied to account for changes in bed conditions over the course of the monitoring program.
3. Flow measurement accuracy constrained by boulders in standard cross sections.
4. The CZU fire began on 8/16/20, and was contained by 9/22/20. The fire did not burn the Zayante watershed, but may have indirectly affected flows.
5. A near-perrenial spring emanates from the Santa Margarita formation on the eastern floodplain. We frequently record observations of this "Tsm spring"
6. The first significant rain of water year 2021 occurred on 11/17/20. Data not reported past this date. Totals calculated for November are partial, as they do not include the last 14 days of the month.

Dry Season 2020 Totals		
Seasonal totals calculated from 6/1/20 to 11/16/20		
Mean seasonal flow	**1.86**	(cfs)
Max. seasonal flow	**3.09**	(cfs)
Min. seasonal flow	**1.11**	(cfs)
Seasonal total	**236**	(cfs-days)
Seasonal total volume	**468**	(ac-ft)
Seasonal total volume	**152,300,000**	(gallons)

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Form 4
Annual Hydrologic Record: Bean Creek
Estimated daily flow above mouth at Mount Hermon Camp
Dry Season 2020

Stream and Station

Dry Season:	**2020**
Stream:	Bean Creek
Station:	Bean Creek above mouth at Mount Hermon Camp
County:	Santa Cruz County, CA

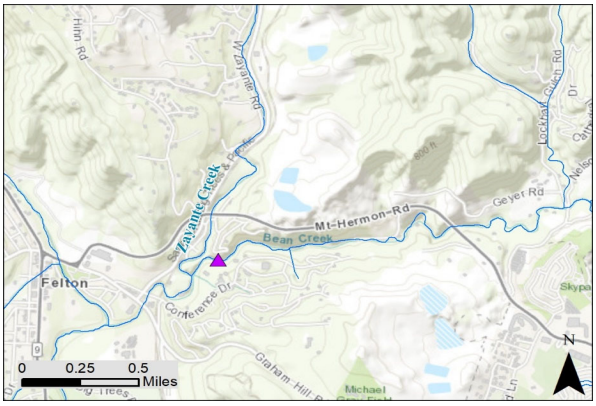
Station Location and Watershed

Latitude: 37.05246, Longitude: -122.05971 (WGS84), Santa Cruz County, CA. Gage is located approximately 80 feet upstream of the abandoned foot bridge on the right bank. Previously located (WY09-12) downstream of the current gage approximately 150 feet or about 70 feet downstream of the abandonded foot bridge on the left bank (facing downstream). Gage is upstream of the confluence of Ferndell Creek. Drainage area is approximately 9.64 square miles.

Period of Record

Seasonal gage was operated from 10/3/08 to 10/13/12 by Balance Hydrologics and included estimation of suspended sediment loads and turbidity using turbidity instrumentation. Gage reinstalled with a new datum 7/13/17 approx.150 ft upstream from the previous gage. Gaging sponsored by Santa Cruz County Environmental Health and the Santa Margarita Groundwater Agency. Flow and sediment also monitored in 1980 (Hecht and Enckeboll).

Station Location Map



Dry Season 2020 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG [4]	SEPT [4]	OCT	NOV [5]
1									2.34	2.34	2.24	2.73	2.06	1.87
2									2.30	2.42	2.22	2.66	2.03	1.84
3									2.20	2.20	2.21	2.55	2.06	1.84
4									2.22	2.20	2.29	2.61	2.03	1.81
5									2.26	2.25	2.21	2.51	2.04	1.86
6									2.37	2.30	2.09	2.47	2.07	1.81
7									2.36	2.27	2.07	2.37	2.15	1.91
8									2.31	2.27	2.10	2.42	2.15	1.93
9									2.26	2.22	2.08	2.59	2.18	1.77
10									2.18	2.21	2.09	2.66	2.19	1.77
11									2.19	2.18	2.07	2.59	2.18	1.83
12									2.31	2.10	2.03	2.53	2.09	1.81
13									2.37	2.24	2.02	2.50	2.05	1.82
14									2.31	2.32	1.93	2.37	2.03	1.83
15									2.32	2.27	1.90	2.40	2.01	1.74
16									2.36	2.20	2.04	2.38	2.00	1.70
17									2.42	2.24	2.10	2.40	2.03	
18									2.51	2.25	2.07	2.31	2.05	
19									2.60	2.28	2.13	2.37	2.07	
20									2.58	2.23	2.15	2.39	2.03	
21									2.51	2.26	2.18	2.32	1.99	
22									2.47	2.34	2.23	2.31	2.02	
23									2.43	2.31	2.25	2.19	2.01	
24									2.41	2.20	2.31	2.09	2.07	
25									2.44	2.22	2.36	2.12	2.11	
26									2.33	2.18	2.60	2.11	2.10	
27									2.32	2.18	2.62	2.08	1.96	
28									2.28	2.18	2.63	2.13	1.98	
29									2.21	2.22	2.67	2.13	1.98	
30									2.19	2.22	2.81	2.09	2.00	
31										2.23	2.82	-	1.96	-
MEAN									2.34	2.24	2.24	2.38	2.05	1.82
MAX. DAY									2.60	2.42	2.82	2.73	2.19	1.93
MIN. DAY									2.18	2.10	1.90	2.08	1.96	1.70
cfs days									70	70	70	71	64	29
ac-ft									140	138	138	142	126	58
gallons									45,500,000	44,900,000	44,900,000	46,100,000	41,200,000	18,800,000

Daily mean flow is only reported seasonally from June 1, 2020 to November 16, 2020.

Monitors' Comments

1. Daily values with more than 2 to 3 significant figures result from electronic calculations. No additional precision is implied.
2. Mean daily values are cumulated from 96 15-minute measurements of stage; several stage shifts have been applied to account for changes in bed conditions over the course of the monitoring program.
3. Diversion activities upstream may influence the gaged flow.
4. The CZU fire began on 8/16/20 and was contained by 9/22/20. The fire did not burn the Bean Creek watershed, but may have indirectly affected flows.
5. The first significant rain of water year 2021 occurred on 11/17/20. Data not reported past this date. Totals calculated for November are partial, as they do not include the last 14 days of the month.

Dry Season 2020 Totals		
Seasonal totals calculated from 6/1/20 to 11/16/20		
Mean seasonal flow	**2.21**	(cfs)
Max. seasonal flow	**2.82**	(cfs)
Min. seasonal flow	**1.70**	(cfs)
Seasonal total	**374**	(cfs-days)
Seasonal total volume	**741**	(ac-ft)
Seasonal total volume	**241,400,000**	(gallons)

Balance Hydrologics, Inc. 224 Walnut Ave., Suite E, Santa Cruz, CA 95060 (831) 457-9900; fax: (831) 457-8800
Balance Hydrologics, Inc. 800 Bancroft Way, Suite 101, Berkeley, CA 94710 (510) 704-1000; fax: (510) 704-1001

TABLES

Table 1. Station Observer Log, San Lorenzo River upstream of Love Creek, County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
San Lorenzo River upstream of Love Creek														
6/24/2020 11:39	jh, cn	0.84	B	6.57	5.00	AA	g	19.5	406	454	-	~5.5' above wse	-	Installed gage on right bank about 80 ft upstream of Love Creek; water clear; cross section was good with laminar flow; gage was installed during measurement; leveloggers in stilling well at 11:50; stage remained at 0.84 ft
7/7/2020 8:30	cn	0.77	B	5.19	3.60	PY	p	17.7	404	470	-	-	-	Cross section pretty laminar with a few cobbles
7/14/2020 10:52	dt	0.73	B	-	1.80	vis	p	18.2	407	467	-	-	-	Collected water quality sample
7/17/2020 13:32	jh	0.75	B	5.35	5.70	AA	g	20.8	433	470	-	-	-	Water clear; moved cobbles/boulders to create measurement transect
8/12/2020 13:51	jh	0.67	B	3.92	3.80	AA	f	21.6	451	482	-	-	-	Water clear; replaced equipment with County owned equipment at 14:30
9/15/2020 16:39	jp	0.66	B	3.83	-	PY	g	17.7	347	403	-	-	-	-
10/21/2020 14:00	jp	0.61	B	2.84	-	PY	g	14.9	339	421	-	-	-	Visual estimate of flow in Love Cr 10-20 gpm, lowest I have seen it.
12/2/2020 14:16	jp	0.75	B	4.34	-	PY	g/f	6.0	301	472	-	~0.2 ft above WL	-	Love Creek visual estimate ~0.12 cfs
Love Creek upstream of San Lorenzo River (no gage)														
5/7/2020 11:37	dt	-	B	0.74	-	PY	g/f	12.8	314	410	-	-	-	Clear water, no odor; cross section located ~ 100 ft downstream of concrete culvert where left bank is rock retaiing wall and before the right bank becomes a concrete retaining wall; some turbulence in cross section
6/24/2020 12:00	cn, jh	-	B	-	0.25-0.30	VIS	p	16.4	361	432	-	-	-	-
7/7/2020 9:38	cn	-	B	0.19	0.25	PY	g	14.7	355	442	-	~1.5 ft above WSE	-	Water clear, laminar flow through section, water level did not change during measurement

Table 1. Station Observer Log, San Lorenzo River upstream of Love Creek, continued
County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
7/14/2020 12:21	dt	-	B	-	0.28	VIS	p	15.2	357	439	-	-	-	Collected water quality sample
8/12/2020 15:20	jh	-	B	-	0.10	VIS	p	-	-	-	-	-	-	Water clear; rock piles built at confluence with San Lorenzo River
9/15/2020 17:35	jp	-	B	0.08	<0.1	PY	-	16.7	381	452	-	-	-	-
10/21/2020 14:50	jp	-	B	-	0.03	VIS	f	14.4	362	468	-	-	-	Lowest flow I have seen at Love Cr.
12/2/2020 14:16	jp	-	B	-	0.12	VIS	p	-	-	-	-	-	-	-

Notes:

Stage: Water level observed at outside staff plate

Observers: (jp) Jason Parke, (dt) Denise Tu, (cn) Chelsea Neill, (jh) John Hardy

Hydrograph: Describes stream stage as rising (R), falling (F), 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. Extremely low flows are measured with a bucket+stop watch (B) If estimated, from rating curve (R) or visual (V).

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

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

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Table 2. Station Observer Log, Newell Creek, County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
Newell upstream of Rancho Rio Bridge (no gage)														
5/7/2020 12:41	dt	-	B	0.92	-	PY	g/f	13.2	305	394	-	~ 2 ft above WSE	-	Clear water, no odor; High-water marks are trash caught on rootwad upstream of cross section
6/17/2020 14:14	dt	-	B	0.71	-	PY	g/f	14.5	325	406	-	2 - 2.5 ft above WSE	-	Moved cross section measurement slightly upstream from the last location in May; High-water mark is an old shirt wrapped up on rootwad on the right bank; some turbulence through cross section especially along left bank.
7/7/2020 17:05	jp	-	B	0.81	-	PY	f	16.3	338	405	-	-	-	Uneven spins; diversion hose instream downstream of cross section
7/14/2020 12:05	jp	-	B	-	-	-	-	14.1	346	437	-	-	-	Collected water quality sample, can't estimate flow, no high-water mark, water clear with no odor
9/15/2020 13:42	jp	-	B	2.55	-	PY	g	16.5	347	415	-	0.1' above WL	-	Downstream diversions have a newly built pool, sand has aggraded downstream new pool structure
Newell gage 100 ft upstream of San Lorenzo River														
5/6/2020 12:20	jp, dt	2.68	B	-	-	-	-	-	-	-	-	-	-	-
5/7/2020 9:50	dt	2.68	B	1.59	-	PY	g	13.0	253	329	-	-	-	Clear water, no odor; cleared tree trimmings from creek yesterday, reach now clear of woody debris jams; High-water marks is downstream of gage leafy debris is built up against right bank rocks
6/17/2020 13:02	dt	2.68	B	1.38	-	PY	g	14.9	265	329	-	-	-	Clear water, no odor; stream clear of yard trimmings/debris; newly placed riprap along right bank downstream of gage, appears to be placed to discourage flow through side channel, this riprap may impact stage at higher flows.
7/7/2020 15:35	jp	2.71	B	1.93	-	PY	g	16.5	303	362	-	-	-	Repeat measurement on the upstream side of tape at the same section (one measurement 1.93 cfs, second was 1.96 cfs); no debris downstream of gaged pool; diversion hose at gaged pool
7/14/2020 11:39	jp	2.66	B	-	-	-	-	15.1	273	338	-	-	-	May be a low level high-water mark approximately 0.1 above water surface, diversion hose is still in gaged pool

Table 2. Station Observer Log, Newell Creek, continued
County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
8/12/2020 14:46	jp	2.66	B	1.35	-	PY	g	17.7	298	347	-	-	-	Minimal sand at the gaged reach, all gravel and cobble, some very fine; removed sensor and installed client owned sensors; diversion hose still in gage pool.
9/15/2020 15:41	jp	2.80	B	2.92	-	PY	g	16.0	317	383	-	-	-	There is another diversion hose (larger, 2 in, green) from the same house in the gage pool; flow is higher than usual
10/21/2020 15:45	jp	2.65	B	1.30	-	PY	g	14.2	260	328	-	-	-	Both diversion hoses have been removed from the gaged pool. No debris downstream in the gaged reach.
12/2/20 12:54	jp	2.68	B	1.33	-	PY	g	9.1	240	345	-	-	-	Cleaned some debris from upstream of gage at 12:56; single diversion hose in the gage pool.

Notes

Stage: Water level observed at outside staff plate

Observers: (jp) Jason Parke, (dt) Denise Tu

Hydrograph: Describes stream stage as rising (R), falling (F), 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. Extremely low flows are measured with a bucket+stop watch (B) If estimated, from rating curve (R) or visual (V).

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

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

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Table 3. Station Observer Log, Zayante Creek at Woodwardia Weir, County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
9/24/19 14:50	jp	0.63	B	2.80	-	PY	g	16.7	355	422	-	-	-	Downstream seems slighty backwatered but flowing good enough for a cross section; Tsm spring flow estimate is 1-2 gpm and 131 µmhos/cm @ 17.9 °C, 152 µmhos/cm @ 25 °C
11/1/19 11:45	jp	0.620	B	2.84	-	PY	g/f	8.0	286	423	-	-	-	Downstream looks backwatered; cleared some leaves from weir at 11:47; usual cross sections are too slow and deep or turbulent; went upstrem ~1000 feet. Tsm spring flow visual estimate = 0.3-0.5 gpm and 9.2 °C, 209 µmhos/cm @ 25 °C
5/6/20 13:45	jp, dt	0.680	B	4.01	-	PY	g	14.2	385	485	-	2.40	-	Tsm spring flow visual estimate is 2-3 gpm; clear water, no odor; cleaned stilling well of sand; downloaded gage, logger back in water at 15:23, stage = 0.68 ft
6/17/20 11:24	dt	0.640	B	2.44	-	PY	g/f	14.5	249	311	-	~ 1 - 1.5 ft above water surface	-	Tsm spring flow visual estimate is 4 gpm; some wood collecting within cross section, cleared before taking measurements; High-water marks are leafy debris caught on rocks mid channel downstream of cross section
7/7/20 12:55	dt	0.600	B	1.97	2.80	PY	g	15.7	385	469	-	-	-	Clear water, no odor; similar to conditions as last visit; Tsm spring = 201.9 µmhos/cm @ 14.9 °C, 250 µmhos/cm @ 25 °C
7/14/20 8:27	dt	0.600	B	-	2.43	vis	p	16.1	386	465	-	-	-	Collected water quality sample; Tsm spring= 142.5 µmhos/cm @ 14.5 °C, 178.3 µmhos/cm @ 25 °C
8/12/20 15:54	jp	0.570	B	1.72	-	PY	g/f	18.3	391	449	-	-	-	Tsm spring wet but not flowing; gage almost cut off from main channel by sed/sand bar right in front of gage; slow cross section but smooth spins on pygmy
9/17/20 13:00	dt	0.580	B	1.92	1.14	PY	f	15.8	347	421	-	-	-	Typical section too slow, moved downstream just above gage; moved boulders from section as much as possible, still turbulence through cross section
10/20/20 15:45	jp	0.560	B	1.40	-	PY	g	14.1	325	410	-	-	-	Slow spinning verticals but laminar flow and a very even/sandy bed. Tsm spring is just a trickle/drip.
12/2/20 10:15	jp	0.6	B	1.95	-	PY	-	6	273	429	-	-	-	Smooth bed, smooth spin verticals, deep but okay; Tsm spring is not flowing at all.

Notes:

Stage: Water level observed at outside staff plate

Observers: (jp) Jason Parke, (dt) Denise Tu, (cn) Chelsea Neill, (jh) John Hardy

Hydrograph: Describes stream stage as rising (R), falling (F), 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. Extremely low flows are measured with a bucket+stop watch (B) If estimated, from rating curve (R) or visual (V).

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

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

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Tsm = Spring located on the left bank just upstream of the weir, draining from the Santa Margarita Sandstone

Table 4. Station Observer Log, Bean Creek at Mount Hermon Camp, County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
Bean Cr at Mount Hermon Camp														
5/6/20 9:54	jp, dt	1.25	B	3.29	-	PY	g	12.7	365	477	-	6.0	previous winter	Minor debris downstream of gage; sand deposition at gage, dug out bottom of staff plate; 10:30 am clearing debris from downstream of gage; stage dropped to 1.24 ft at 10:30 after clearing debris; pool mostly scoured; high-water marks at old gage = 6.0 ft on staff plate
6/17/20 9:38	dt	1.20	B	2.37	-	PY	g	13.2	324.7	415.8	-	~ 2 ft above water surface	-	Clear water, no odor; high-water marks are wood debris on left bank upstream of gage
7/7/20 14:28	dt	1.19	B	-	1.96	PY	g/f	17.3	399.7	468.2	-	-	-	Clear water, no odor; 3 parties walked through cross section while measurement being taken; discarded measurement from work-up because not accurate, repeated measurement on 7/17
7/14/20 7:27	dt	1.19	B	-	2.15	VIS	p	15.0	376.3	465.3	-	-	-	Collected water quality sample
7/17/20 9:27	jh	1.19	B	2.51	2.31	AA	g	15.4	393.9	482.0	-	-	-	Water clear; did not see any channel spanning dams downstream of gage; had to walk a decent distance upstream to find a measurement transect; tributary ~100 ft upstream of measurement transect flowing (flow estimate ~0.2 cfs)
8/12/20 16:19	jh	1.17	B	2.13	2.16	AA	g	17.8	408.9	475.0	-	-	-	Water clear; family with young kids stacking rocks in pool downstream of gage; secured barologger to large stump uphill of old staff; stilling well extremely loose upon arrival; replaced equipment with County owned equipment; finished replacing probes and securing stilling well at 16:54; bring new hose clamp on next visit to replace rusted/malfunctioning top hose clamp on stilling well
9/17/20 7:41	dt	1.20	B	2.66	2.10	PY	g/f	14.4	368.5	461.9	-	-	-	Some turbulence through cross section; right bank edge is bedrock, left bank edge is built up rocks; clear water, no odor.
9/24/20 11:18	jp	1.18	B	2.37	-	PY	g	15.4	379.0	465.0	-	-	-	There is minimal debris in the riffle downstream, cross section is too deep and slow just 6ft downstream of staff, measured around 20ft downstream of gage. Stilling well is very loose and misplaced on staff plate; replaced hose clamp and adjusted the stilling well.
10/12/20 8:28	eg, jp	1.19	B	2.10	-	PY	g	12.6	355.0	466.0	-	-	-	First flow measurement during synoptic Bean Creek stream walk going to Mt Hermon Rd
12/1/20 10:15	jp	1.21	B	2.40	-	PY	e/g	7.7	261.0	389.9	-	-	-	Cleared debris from downstream riffle after measurement, stage dropped from 1.21 to 1.19; good laminar cross section.
12/15/20 10:39	jh	1.20	B	-	-	-	-	-	-	-	-	1.5	12/13/2020	Water clear; no signs of recreational dam building downstream of gage; downloaded baro

Table 4. Station Observer Log, Bean Creek at Mount Hermon Camp, continued
County of Santa Cruz, California, dry season 2020

Site Conditions				*Streamflow*				*Water Quality Observations*				*High-Water Marks*		*Remarks*
Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured Flow	Estimated Flow	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	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)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
Ferndell Cr (no gage)														
5/30/19 11:45	jp	-	B	0.36		PY	g	14.9	156	194	-	-	-	Water is clear
5/6/20 11:10	jp, dt	-	B	0.22		PY	f	14.7	160	199	-	-	-	Some crossing flow lines and turbulence; no odor or color; woody debris caught upstream along elevated pipe concrete piers
6/17/20 10:25	dt	-	B	0.30		PY	f	14.8	115	142	-	-	-	Clear water, no odor; wood jam starting to develop on upstream face of the concrete piers for elevated pipe (same as previous month); turbulent through cross section
7/7/20 15:41	dt	-	B	0.24	0.42	PY	f	15.8	177	209	-	-	-	Clear water, no odor; turbulence through cross section
7/14/20 7:39	dt	-	B	-	0.36	vis	p	14.7	166	207	-	-	-	Collected water quality sample
9/17/20 9:03	dt	-	B	0.24	0.27	PY	f	14.4	160	201	-	-	-	Clear water, no odor; turbulence through cross section

Notes:

Stage: Water level observed at outside staff plate

Observers: (jp) Jason Parke, (dt) Denise Tu, (cn) Chelsea Neill, (jh) John Hardy

Hydrograph: Describes stream stage as rising (R), falling (F), 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. Extremely low flows are measured with a bucket+stop watch (B) If estimated, from rating curve (R) or visual (V).

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

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

Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Table 5. Station observer log; July 2020 Accretion Survey of San Lorenzo River Watershed
County of Santa Cruz, California

Site Information					Streamflow				*Water Quality Observations*			*High-Water Marks*		*Remarks*
Stream, Site description	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	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)*	*umhos@25oC*	*(feet)*	*(mm/dd/yy)*	
SAN LORENZO RIVER														
Foreman Creek	7/7/20 18:48	cn	12.06	B	0.11	0.12	PY	f	14.9	132	164	-	-	Water clear, flow lower than last visit; moved some rocks in gage pool but did not change stage; bad section and had to start over; flow lines not totally parallel in new section.
Boulder Creek 1200 ft upstream of San Lorenzo River	7/7/20 17:47	cn	0.56	B	1.68	2.1	PY	g/f	17	215.1	254	-	-	Flow too low in first section, moved downstream and changed to PY meter; flow relatively even in section, but some boulders.
San Lorenzo River downstream of Boulder Creek	7/7/20 15:49	cn	-	B	3.6	2.25	AA	f	18.2	448.2	515	3-4 ft above WSE	previous winter	Water clear, boulders and cobbes in section caused uneven flow; HWM 3-4 ft above WS. Water level did not noticeably change during measurement; seep along right bank next to section (houses upslope)
Spring Creek Gulch at Irwin Way	7/7/20 15:07	cn	-	B	-	0.006	-	-	15.8	392	476	-	-	Earthy decay smell; bedrock substrate
Clear Creek downstream of HWY 9	7/7/20 12:53	cn	-	B	0.29	0.315	PY	e	15.2	176.5	217	-	-	Water clear, flow is very consistent through XS, water level did not change during measurement
San Lorenzo River downstream of Clear Creek	7/17/20 16:13	jh	-	B	4.62	4.8	AA	f	18.8	421.8	478	2-3 ft above WSE	previous winter	water clear; difficult to find measurement transect; large cobble/bouldder bottom through measurement reach; measurement transect velocities split by large boulder upstream
Seep at Larkspur St.	7/7/20 11:30	cn	-	B	-	0.007	Vis	p	15.1	552	680	-	-	Estimated flow from end of drain gutter
Alba Creek	7/7/20 11:03	cn	-	B	-	0.25	Vis	p	14	211.1	268	-	-	Water clear; cobbles at the mouth, downstream pool on SLR has a lot of sand covering cobbles and gravel
Marshall Creek	7/7/20 10:43	cn	-	B	-	0.35	Vis	p	13.7	217.8	278	-	-	Water clear
San Lorenzo River upstream of Love Creek	7/17/20 14:14	jh	0.75	B	5.35	5.7	AA	g	20.8	433	470	-	-	Water clear; moved cobbles/boulders to create transect
Love Creek upstream of San Lorenzo River	7/7/20 9:38	cn	-	B	0.19	0.25	PY	g	14.7	355.3	442	~1.5 ft above WSE	previous winter	Water clear, laminar flow through section, water level did not change during measurement
San Lorenzo River upstream of Newell Creek	7/7/20 14:57	jp	-	B	5.75	-	PY	g	21.4	439	472	-	-	Good cross section on San Lorenzo River upstream Newell; kids playing upstream and downstream of measurement; 100s of 2-3cm fish
Newell Creek at Rancho Rio	7/7/20 17:05	jp	-	B	0.81	-	PY	f	16.3	338	405	-	-	Uneven spins; diversion hose instream downstream of cross section
Newell Creek at Gage - upstream of San Lorenzo River	7/7/20 15:35	jp	2.71	B	1.93	-	PY	g	16.5	303	362	-	-	Repeat measurement on the upstream side of tape at the same section (one measurement 1.93 cfs, second was 1.96 cfs); no debris downstream of gaged pool; diversion hose at gaged pool
Manson Creek	7/7/20 14:18	jp	-	B	-	0.12	Vis	p	-	-	-	-	-	Visual estimate from bridge; dogs barking; no easy access
Fall Creek	7/7/20 12:12	jp	2.03	B	-	1.475	Vis	p	14.3	229	289	-	-	Gage upstream of v-notch stage is 4.76 at 12:16; Trib near Highschool/ church flow estimate is 0.15 to 0.1 cfs; gage us v-notch has some debris downstream of gaged run/pool - cleaned at 12:18; pool downstream fall creek partial shade; top of water 18.3 deg C, bottom 17.9-18 deg C.
San Lorenzo River downstream of Fall Creek	7/7/20 12:47	jp	-	B	10.27	-	PY	g	18.1	355	409	-	-	-
San Lorenzo River upstream of Bull Creek	7/7/20 11:00	jp	-	B	10.43	-	PY	g	17.1	346	408	-	-	-

Table 5. Station observer log; July 2020 Accretion Survey of San Lorenzo River Watershed, continued
County of Santa Cruz, California

Site Information					Streamflow				*Water Quality Observations*			*High-Water Marks*		*Remarks*
Stream, Site description	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	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)*	*umhos@25oC*	*(feet)*	*(mm/dd/yy)*	
Bull Creek upstream of SLR	7/7/20 10:40	jp	-	B	0.13	0.3	PY	g	14.4	313.7	394	-	-	Shingle Mill Creek just downstream Big Trees gages flow estimate ~0.2 cfs; flowing ~20gpm into gaged pool, probably not affecting gage height; Shingle Mill SC 13.8C- 225, 25C - 286
San Lorenzo River at USGS Big Trees	7/7/20 10:10	jp	3.015	B	17.2	-	-	-	16	360	435	-	-	San Lorenzo River Big Trees water level just barely below bottom of staff plate; flow is mean daily flow reported by USGS
Eagle Creek us of San Lorenzo River	7/7/20 9:01	jp	0.425	B	0.51	0.35	PY	g	12.7	76.8	100	-	-	Sand has aggraded in gage pool
Eagle Creek at Graham Hill Rd	7/7/20 8:27	jp	0.425	B	0.005	0.045	PY/Vis	p	12.5	75.6	100	-	-	Flow going mostly under culvert at Graham Hill Rd; only one vertical to measure flow
ZAYANTE CREEK														
Zayante Creek at Zayante Store upstream of Lompico Creek	7/7/20 10:06	dt	5.73	B	0.84	0.84	PY	g	14	579	733	-	-	Channel spanning log jam/debris present just downstream of gage, cleared; right bank side slope tree trimming and clearing recently done by neighbors; clear water, no odor; took repeat measurement (one measurement 0.84 cfs, second measurement 0.86 cfs)
Lompico Creek at LCWD diversion below Mill Creek	7/7/20 8:40	dt	3.73	B	0.17	0.18	PY	g	12.9	259	337	6.7	-	Green algae growing in the pool at the gage; clear water, no odor; High-water mark is left bank debris wrapped against tree; some turbulence through cross-section
Lompico Creek 50 feet upstream of Zayante Creek	7/7/20 12:03	dt	-	B	0.31	0	PY	g	14.1	443	560	-	-	Clear water, no odor
Spring tribuatary into Zayante Creek at Woodwardia weir	7/7/20 12:55	dt	0.6	B	-	-	-	-	14.9	201.9	250	-	-	-
Zayante Creek at Woodwardia weir beneath Mt. Hermon Bypass	7/7/20 12:55	dt	0.6	B	1.97	2.80	PY	g	15.7	385	469	-	-	Clear water, no odor; similar to conditions as last visit
Zayante Creek at Graham Hill Road	7/7/20 16:15	dt	-	B	5.03	6.09	PY	g	17.8	402	466	-	-	Clear water, no odor
BEAN CREEK														
Bean Creek upstream of Glenwood Cutoff	7/7/20 19:00	jh	...	B	0.06	0.07	PY	f	14.6	667	832	-	-	Water clear; channel downstream of road crossing consists of long stagnant runs separated by short cobble riffles; orange/rust colored deposits on banks; slight sulfur odor; seep on downstream left bank ~100 ft downstream of culvert, 257.9 µmhos/cm @ 15.1 °C, 316 µmhos/cm @ 25 °C
Bean Creek at Redwood Camp	7/7/20 17:56	jh	...	B	0.30	0.25	PY	f	16.3	560	672	-	-	Water clear; Redwood Camp visitors created a cobble/boulder dam downstream of culvert pool
Bean Creek upstream of McKenzie Creek at Morgan's Run	7/7/20 16:18	jh	...	B	0.13	0.17	PY	e	17.9	567	657	-	-	Water clear; laminar flow through measurement transect; made duplicate measurement at this site (0.13 cfs)
Mackenzie Creek upstream of Morgan's Run near mouth	7/7/20 17:17	jh	...	B	0.005	0.01	PY	p/f	17.4	323	378	-	-	Water clear; very little flow; difficult to measure
Bean Creek at Green Valley Rd	7/7/20 13:45	jh	...	B	0.29	0.41	PY	g	15.3	471	577	-	-	Water clear; moved cobbles to create measurement transect; large pieces of concrete riprap in channel from adjacent property
Ruins Creek upstream of confluence with Bean Creek	7/7/20 14:44	jh	...	B	0.27	0.36	PY	f	15.8	389	472	-	-	Water clear; no odor; no apparent seeps/springs
Bean Creek upstream of Lockhart Gulch	7/7/20 10:53	jh	...	B	0.77	0.68	AA	f	14.2	432	545	-	-	Water clear; difficult to find suitable measurement transect; channel downstream of bridge at confluence with Lockhart Gulch is completely inundated with water cress for ~150 ft; no apparent seeps/springs

Table 5. Station observer log; July 2020 Accretion Survey of San Lorenzo River Watershed, continued
County of Santa Cruz, California

Site Information					Streamflow				*Water Quality Observations*			*High-Water Marks*		*Remarks*
Stream, Site description	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	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)*	*umhos@25oC*	*(feet)*	*(mm/dd/yy)*	
Lockhart Gulch upstream of confluence	7/7/20 12:01	jh	…	B	0.21	0.22	PY	g	14.8	386	480	-	-	Water clear; created measurement transect by removing cobbles at tail out of run; channel at confluence with Bean Creek is completely inundated with water cress
Unnamed left-bank tributary approximately 0.25 miles upstream from Mt. Hermon Rd	7/7/20 9:39	jh	…	B	…	0.02	vis	p	13.7	169	215	-	-	Water clear; tributary just above confluence with Bean Creek consists of stagnant runs and short flowing riffles; no apparent seeps/springs; poultry farm on downstream left bank is very loud; dead bird in water at confluence
Bean Creek at Mount Hermon Rd (former USGS site)	7/17/20 12:19	jh	1.06	B	2.01	2.10	AA	g	16.4	402	480	3.0	previous winter	Water clear; conditions similar to last visit; measured flow downstream of debris jam, as recommended by CN and BH
Bean Creek at Mount Hermon Camp near mouth	7/17/20 10:26	jh	1.19	B	2.51	2.31	AA	g	15.4	394	482	-	-	Water clear; did not see any channel spanning dams downstream of gage; had to walk a decent distance upstream to find a measurement transect; tributary about 100 ft upstream of measurement, estimated flow 0.2 cfs
Ferndell Creek just upstream of Bean Cr/Zayante confluence	7/7/20 15:41	dt	-	B	0.24	0.42	PY	f	15.8	177	209	-	-	Clear water, no odor; turbulence through XS

Notes:

Observer Key: cn = Chelsea Neill; jp = Jason Parke; dt = Denise Tu; jh = John Hardy

Stage: Water level observed at outside staff plate.

Hydrograph: Describes stream stage as rising (R), at peak (P), falling (F), steady (S), baseflow (B), diversion (D), not spilling (NS) or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or Pygmy (PY) bucket-wheel ("Price-type") current meter or 5 gallon bucket (bkt), plastic bag (bag), If estimated, from rating curve (R) or visual (V).

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

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

Table 6. Station observer log; September 2020 Accretion Survey of San Lorenzo River Watershed
County of Santa Cruz, California

Site Information					Streamflow				*Water Quality Observations*			*High-Water Marks*		*Remarks*
Stream, Site description	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	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)*	*umhos@25oC*	*(feet)*	*(mm/dd/yy)*	
SAN LORENZO RIVER														
Foreman Creek	9/15/20 14:00	jp	12.11	B	0.24	-	PY	g/f	15.6	157	191	-	-	Some gravel and cobble in gage pool - did not remove
Boulder Creek 1200 ft upstream of San Lorenzo River	9/16/20 13:11	jp	0.53	B	1.28	-	PY	g/f	15.7	195	237	-	-	Algae at 0.48 on staff plate; boulders and cobbles in cross section; no debris in downstream riffle/pool
San Lorenzo River downstream of Boulder Creek	9/16/20 11:55	jp	-	B	2.12	-	PY	g/f	16.1	383	462	-	-	Uneven cobble bed; substantially warmer than 9-15-20
Spring Creek Gulch at Irwin Way	9/16/20 12:36	jp	-	B	0.01	-	BAG	f/p	14.6	362	453	-	-	-
Clear Creek downstream of HWY 9	9/16/20 11:06	jp	-	B	0.57	-	PY	-	15.1	156	193	0.15' above WL	recent	Water turbulent, moved some cobbles around to get smooth velocity profile; water is clear
San Lorenzo River downstream of Clear Creek	9/16/20 9:40	jp	-	B	2.92	-	PY	f	14.2	341	414	-	-	San Lorenzo River cross section has a lot of boulders and some uneven spins on meter, clear and no odor
Seep at Larkspur St.	9/16/20 10:45	jp	-	B	0.008	-	BAG	f/p	14.2	534	673	-	-	Took 3 different measurements in ziploc bags, added them up.
Alba Creek	9/16/20 14:15	jp	-	dry	0.00	0.00	VIS	-	-	-	-	-	-	Creek appears dry from road
Marshall Creek	9/16/20 14:40	jp	-	B	0.15	0.15	PY	g	15.4	221	275	-	-	water is clear, no odor
San Lorenzo River upstream of Love Creek	9/16/20 16:39	jp	0.66	B	3.83	-	PY	g	17.7	347	403	-	-	-
Love Creek upstream of San Lorenzo River	9/15/20 17:35	jp	-	B	0.08	<0.1	PY	-	16.7	381	452	-	-	-
San Lorenzo River upstream of Newell Creek	9/15/20 14:40	jp	-	B	4.19	-	PY	g	17.5	341	398	-	-	Missing approximately 5 gpm in rocks in side channel, added to measurement
Newell Creek at Rancho Rio	9/15/20 13:42	jp	-	B	2.55	-	PY	g	16.5	347	415	0.1' above WL	recent	Downstream diversions have a newly built pool, sand has aggraded downstream of new pool structure
Newell Creek at Gage - upstream of San Lorenzo River	9/15/20 15:41	jp	2.8	B	2.92	-	PY	g	16	316.7	383	-	-	There is another diversion hose (larger, 2 in, green) from the same house in the gage pool; flow is higher than usual
Manson Creek	9/16/20 15:15	jp	-	B	-	0.07	VIS	p	-	-	-	-	-	-
San Lorenzo River upstream of Fall Creek	9/15/20 11:35	jp	-	B	7.39	-	PY	-	14.8	305	378	-	-	Missing 1-2 gpm in rocks, added to measurement
Fall Creek	9/15/20 0:00	jp	-	B	-	2.00	VIS	p	13.5	223	285	-	-	Turbulent cross section, used upstream v-notch to estimate flow; tributary to Fall Creek is appoximately 0.1 cfs
San Lorenzo River downstream of Fall Creek	9/15/20 10:18	jp	-	B	8.38	-	PY	g	14.6	298	372	-	-	Good cross section downstream Fall Ck; pool downstream of Fall Creek has tempurature at top 15.4 °C and bottom 15.2 °C
San Lorenzo RIver upstream of Bull Creek	9/15/20 9:00	jp	-	B	8.59	-	PY	-	14.3	298	375	-	-	Water level is around 0.17' below level from earlier in year at cross section; water clear, no visible high-water marks
Bull Creek upstream of San Lorenzo River	9/15/20 8:29	jp	-	B	0.16	0.2	PY	-	13.3	302.6	389	-	-	Water clear, no high-water marks
San Lorenzo River at USGS Big Trees	9/15/20 8:00	jp	-	B	14.8	-	-	-	14.4	314.8	394	-	-	Shingle Mill Creek is flowing approximately 30-40 gpm; flow is mean daily flow reported by USGS

Table 6. Station observer log; September 2020 Accretion Survey of San Lorenzo River Watershed, continued
County of Santa Cruz, California

Site Information					Streamflow				*Water Quality Observations*			*High-Water Marks*		*Remarks*
Stream, Site description	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	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)*	*umhos@25oC*	*(feet)*	*(mm/dd/yy)*	
Eagle Creek upstream of San Lorenzo River	9/16/20 8:36	jp	6.36	B	0.37	0.35	PY	g	12.4	58	76	-	-	Gaged pool has filled up with sand since last visit, minimal debris in pool outlet
Eagle Creek at Graham Hill Rd	9/16/20 8:01	jp	-	B	-	0.006	-	p	12.3	135	178	-	-	-
ZAYANTE CREEK														
Zayante Creek at Zayante Store upstream of Lompico Creek	9/17/20 10:25	dt	5.62	B	0.59	1.33	PY	g/f	14.9	608	753	-	-	Clear water, no odor
Lompico Creek at LCWD diversion below Mill Creek	9/17/20 9:45	dt	3.72	B	0.1	0.11	PY	f	14.05	326	412	-	-	Gage pool has stagnant water, film on water surface; otherwise water is clear and no odor.
Lompico Creek 50 feet upstream of Zayante Creek	9/17/20 11:56	dt	-	B	0.3	0.38	PY	g	14.9	508	629	-	-	Clear water, no odor; bedrock section above confluence
Spring tribuatary into Zayante Creek at Woodwardia weir	9/17/20 13:40	dt	0.58	B	-	<0.0022	VIS	p	17.4	143	166.6	-	-	Video in field photos to demostrate flow coming off seep
Zayante Creek at Woodwardia weir beneath Mt. Hermon Bypass	9/17/20 13:00	dt	0.58	B	1.92	1.14	PY	f	15.8	347	421	-	-	Typical cross section too slow, moved downstream just above gage; section cleared of boulders as much as possible, still some turbulence through cross section
Zayante Creek at Graham Hill Road	9/17/20 14:22	dt	-	B	4.40	3.65	PY	g	16	364	439	-	-	Clear water, no odor
BEAN CREEK														
Bean Creek upstream of Glenwood Cutoff	9/17/20 8:15	cn	-	B	-	0.01	VIS	p	14.5	638	803	-	-	Flow is very low; too low to measure, green algae on top of stangnant looking water just downstream of culvert
Bean Creek at Redwood Camp	9/17/20 8:56	cn	-	B	0.07	0.15	PY	g/f	14.9	550	681	-	-	Water clear, more flow than upstream at Glenwood, water level did not change during measurement, cobbles in cross section
Bean Creek upstream of McKenzie Creek at Morgan's Run	9/17/20 9:23	cn	-	dry	0.00	0.00	VIS	-	-	-	-	-	-	Creek is dry, no evidence of recent flow or moisture in channel
Mackenzie Creek upstream of Morgan's Run near mouth	9/18/20 9:23	cn	-	dry	0.00	0.00	VIS	-	-	-	-	-	-	Creek is dry, no evidence of recent flow or moisture in channel
Bean Creek at Green Valley Rd	9/17/20 11:30	cn	-	B	0.15	0.09	PY	g	14.6	340	424	-	-	Water clear, measured flow downstream of Green Valley Rd, water level did not change during measurement
Ruins Creek upstream of confluence with Bean Creek	9/17/20 10:50	cn	-	B	0.23	0.30	PY	g	14.2	373	470	-	-	Water clear, tree has fallen over Ruins Creek, cleared branches to take measurement, measurement was downstream of hydraulic drop and likely not impacted by branches in water, appears to be more flow from Ruins Creek than Bean Creek upstream of Ruins
Bean Creek upstream of Lockhart Gulch	9/17/20 13:16	cn	-	B	0.46	0.40	PY	e/g	15.9	443	536	-	-	Water clear, flow laminar through cross section, lots of water cress in channel at confluence with Lockhart Gulch backing up flow, took measurement upstream of road

Table 6. Station observer log; September 2020 Accretion Survey of San Lorenzo River Watershed, continued
County of Santa Cruz, California

Site Information					Streamflow				*Water Quality Observations*			*High-Water Marks*		*Remarks*
Stream, Site description	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	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)*	*umhos@25oC*	*(feet)*	*(mm/dd/yy)*	
Lockhart Gulch upstream of confluence	9/17/20 12:37	cn	-	B	0.12	0.20	PY	f	15.6	398	485	-	-	Water clear, water cress and algae at confluence with Bean Creek, cross section has some turbulence due to cobbles, water level did not change during measurement
Unnamed left-bank tributary approximately 0.25 miles upstream from Mt. Hermon Rd	9/17/20 15:37	cn	-	B	-	0.003	VIS	p	16.6	167	198	-	-	Very low flow, estimated at 1-2 gpm from tributary
Bean Creek at Mount Hermon Rd (former USGS site)	9/17/20 14:08	cn	1.08	B	1.80	1.90	PY	g/f	16.7	393	466	-	-	Water clear, some debris caught on fallen tree downstream of gage; measured flow downstream of debris at culvert
Bean Creek at Mount Hermon Camp near mouth	9/24/20 11:18	jp	1.18	B	2.37	-	PY	g	15.4	379	465	-	-	There is minimal debris in the riffle downstream, cross section is too deep and slow just 6ft downstream of staff plate, measured around 20ft downstream of gage.
Ferndell Creek just upstream of Bean Cr/Zayante confluence	9/17/20 9:03	dt	-	B	0.24	0.27	PY	f	14.4	160	201	-	-	Clear water, no odor; turbulence through cross section

Notes:

Observer Key: cn = Chelsea Neill; jp = Jason Parke; dt = Denise Tu; jh = John Hardy

Stage: Water level observed at outside staff plate.

Hydrograph: Describes stream stage as rising (R), at peak (P), falling (F), steady (S), baseflow (B), diversion (D), not spilling (NS) or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or Pygmy (PY) bucket-wheel ("Price-type") current meter or 5 gallon bucket (bkt), plastic bag (bag), If estimated, from rating curve (R) or visual (VIS).

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

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

Table 7. Station observer log and water quality results: July 14, 2020 Accretion Survey of San Lorenzo River Watershed County of Santa Cruz, California

Site Information						Streamflow			*Water Quality Observations*			*Water Quality Results*	
Stream, Site description	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	Nitrate as N	Ortho-phosphate as P
	(mm/dd/yr)		(feet)	*(R/F/S/B)*	*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*˚C*	*(µmhos/cm)*	*umhos@25oC*	*mg/L*	*mg/L*
SAN LORENZO RIVER													
Bear Creek at Old Bear Creek Rd	7/14/20 10:41	jh	-	B	-	0.4	VIS	p	16	528	638	0.01	0.12
San Lorenzo River upstream of Boulder Creek	7/14/20 11:02	jh	-	B	-	3	VIS	p	16.3	485	583	0.20	0.07
Boulder Creek upstream of San Lorenzo River	7/14/20 10:52	jh	-	B	-	2	VIS	p	15.2	210.7	259	0.31	0.05
San Lorenzo River downstream of Boulder Creek	7/14/20 10:57	jh	-	B	-	5	VIS	p	15.9	318.5	386	0.17	0.05
Spring Creek Gulch at Irwin Way	7/14/20 10:22	jh	-	B	-	0.01	VIS	p	14	389.8	494	0.28	0.3
Clear Creek downstream of HWY 9	7/14/20 11:12	dt	-	B	-	0.22	VIS	p	14.3	174.5	219	0.18	≤ 0.01
San Lorenzo River downstream of Clear Creek	7/14/20 10:57	dt	-	B	-	-	-	-	17.9	423.9	490	0.11	0.06
Seep at Larkspur St.	7/14/20 10:52	dt	-	B	-	0.006	VIS	p	-	-	-	0.40	0.13
San Lorenzo River upstream of Love Creek	7/14/20 10:52	dt	0.73	B	-	1.8	VIS	p	18.2	406.8	467	0.11	0.06
Love Creek upstream of San Lorenzo River	7/14/20 12:21	dt	-	B	-	0.28	VIS	p	15.2	356.5	439	0.12	0.2
San Lorenzo River upstream of Newell Creek	7/14/20 11:30	jp	-	B	-	-	-	-	18.4	402.5	461	0.41	0.08
Newell Creek at Rancho Rio	7/14/20 12:05	jp	-	B	-	-	-	-	14.1	346	437	0.13	0.04
Newell Creek at Gage - upstream of San Lorenzo River	7/14/20 11:39	jp	2.66	B	-	-	-	-	15.1	273	338	0.89	0.26
San Lorenzo River upstream Glen Arbor Bridge	7/14/20 11:08	jp	-	B	-	-	-	-	17.7	355	411	0.68	0.14
San Lorenzo River upstream Fall Creek	7/14/20 10:30	jp	-	B	-	-	-	-	18	364	420	0.57	0.14
Fall Creek upstream San Lorenzo River	7/14/20 10:33	jp	-	B	-	2-3	VIS	p	14	227	287	≤0.01	0.03

Table 7. Station observer log and water quality results: July 14, 2020 Accretion Survey of San Lorenzo River Watershed, continued
County of Santa Cruz, California

Site Information						Streamflow			*Water Quality Observations*			*Water Quality Results*	
Stream, Site description	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	Nitrate as N	Ortho-phosphate as P
	(mm/dd/yr)		(feet)	*(R/F/S/B)*	*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*˚C*	*(µmhos/cm)*	*umhos@25oC*	*mg/L*	*mg/L*
San Lorenzo River downstream of Fall Creek	7/14/20 10:20	jp	-	B	-	15-20	VIS	p	17.3	341	401	0.46	0.09
San Lorenzo River upstream of Bull Creek	7/14/20 9:40	jp	-	B	-	-	-	-	17.3	302	357	0.27	0.04
Bull Creek upstream of San Lorenzo River	7/14/20 9:33	jp	-	B	-	0.15	VIS	p	14.5	311	377	0.24	0.03
San Lorenzo River at USGS Big Trees	7/14/20 9:19	jp	<3.02	B	-	-	-	-	17.1	360	423	0.44	0.17
San Lorenzo River upstream Eagle Creek	7/14/20 8:46	jp	-	B	-	-	-	-	17.3	326	425	0.39	0.14
Eagle Creek upstream of San Lorenzo River	7/14/20 8:55	jp	6.37	B	-	0.3	VIS	p	13.6	63.4	93	0.26	0.07
ZAYANTE CREEK													
Zayante Creek at Zayante Store upstream of Lompico C	7/14/20 9:19	dt	5.68	B	-	0.66	VIS	p	15.2	617	759	0.07	0.08
Lompico Creek at LCWD diversion below Mill Cr.	7/14/20 9:00	dt	3.7	B	-	0.18	VIS	p	14.5	339	424	0.02	0.14
Lompico Creek 50 feet upstream of Zayante Creek	7/14/20 9:40	dt	-	B	-	0.26	VIS	p	14.5	480	601	0.22	0.13
Spring tribuatary into Zayante Creek at Woodwardia w	7/14/20 8:30	dt	-	B	-	0.002	VIS	p	14.5	142.5	178	0.41	0.03
Zayante Creek at Woodwardia weir beneath Mt. Herm	7/14/20 8:27	dt	0.6	B	-	2.43	VIS	p	16.1	386.2	465	0.38	0.25
Zayante Creek at Graham Hill Road	7/14/20 7:59	dt	-	B	-	3.3	VIS	p	15.3	349.2	428	0.47	0.28
BEAN CREEK													
Bean Creek upstream of McKenzie Creek at Morgan's Run	7/14/20 7:29	jh	-	B	-	0.25	VIS	p	15.4	190	232	≤ 0.01	0.08
Mackenzie Creek upstream of Morgan's Run near mouth	7/14/20 7:35	jh	-	B	-	0.007	VIS	p	14	294	372	0.02	0.28
Bean Creek at Green Valley Rd	7/14/20 8:01	jh	-	B	-	0.35	VIS	p	14.7	510	635	0.08	0.21

Table 7. Station observer log and water quality results: July 14, 2020 Accretion Survey of San Lorenzo River Watershed, continued
County of Santa Cruz, California

Site Information						Streamflow			*Water Quality Observations*			*Water Quality Results*	
Stream, Site description	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	Nitrate as N	Ortho-phosphate as P
	(mm/dd/yr)		(feet)	*(R/F/S/B)*	*(cfs)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*˚C*	*(µmhos/cm)*	*umhos@25oC*	*mg/L*	*mg/L*
Ruins Creek upstream of confluence with Bean Creek	7/14/20 8:11	jh	-	B	-	0.25	VIS	p	14	382	484	0.15	0.36
Bean Creek upstream of Lockhart Gulch	7/14/20 8:30	jh	-	B	-	0.70	VIS	p	14.4	441	553	0.19	0.32
Lockhart Gulch upstream of confluence	7/14/20 8:36	jh	-	B	-	0.20	VIS	p	14.4	393	493	0.35	0.3
Unnamed left-bank tributary approximately 0.25 miles upstream from Mt. Hermon Rd	7/14/20 9:20	jh	-	B	-	0.30	VIS	p	14.5	175	220	1.03	0.57
Seep upstream of Mount Hermon Rd (left bank)	7/14/20 9:33	jh	-	B	-	-	-	-	13.8	225	286	1.46	0.3
Bean Creek at Mount Hermon Rd (former USGS site)	7/14/20 9:04	jh	1.07	B	-	1.10	VIS	p	14.8	386	479	0.45	0.3
Bean Creek at Mount Hermon Camp near mouth	7/14/20 7:27	dt	1.19	B	-	2.15	VIS	p	15	376	465	0.43	0.28
Ferndell Creek just upstream of Bean Cr/Zayante confluence	7/14/20 7:39	dt	-	B	-	0.36	VIS	p	14.7	166	207	1.99	0.51

Notes:

Observer Key: cn = Chelsea Neill; jp = Jason Parke; dt = Denise Tu; jh = John Hardy

Stage: Water level observed at outside staff plate.

Hydrograph: Describes stream stage as rising (R), at peak (P), falling (F), steady (S), baseflow (B), diversion (D), not spilling (NS) or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or Pygmy (PY) bucket-wheel ("Price-type") current meter or 5 gallon bucket (bkt), plastic bag (bag), If estimated, from rating curve (R) or visual (VIS).

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

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

Table 8. Station observer log; October 12, 2020 Bean Creek walk from Mount Hermon Camp gage to Mount Hermon Road Gage
County of Santa Cruz, California

Site Information						**Streamflow**						*Water Quality Observations*			*Remarks*
Stream, Site description, Waypoint	Description (seep, spring, trib, wet banks, Bean Ck, etc)	Date/Time (mm/dd/yr)	Observer(s)	Stage (staff plate) (feet)	Hydrograph (R/F/S/B)	Measured discharge (cfs)	Measured discharge (gpm)	Estimated Discharge (cfs)	Estimated Discharge (gpm)	Instrument Used (AA/PY)	Estimated Accuracy (e/g/f/p)	Water Temperature ˚C	Specific Conductance at field temp. (µmhos/cm)	Specific Conductance at 25C umhos@25oC	
Bean Ck at Mount Hermon Rd, WP 831	Bean Ck	10/12/20 13:30	eg, jp	1.12	B	1.69	759	-	-	PY	g	15.4	380	466	Left debris downstream of gage in place during Q measurement; end of stream walk from Mount Hermon Camp; whole stream walk was in the channel; cleared large tree limb out of channel downstream of gage after measurement
WP 830	Spring/seep	10/12/20 13:05	eg, jp	-	B	-	-	0.0006	0.25	-	-	-	-	-	Seep just upstream of other streams, more wet banks upstream for 50 yds.
WP 829	Spring	10/12/20 13:00	eg, jp	-	B	0.01	4.85			graduated cylinder	-	14.4	202	254	20-30 feet upstream of WP 830, maybe same source
WP 828	Spring	10/12/20 12:50	eg, jp	-	B	0.012	5.44	0.0078	3.5	graduated cylinder	-	14	209	265	Falling down bedrock face; likely same source as WP 827
WP 827	Spring	10/12/20 12:40	eg, jp	-	B	0.0008	0.36	0.0022	1	graduated cylinder	-	14.7	251	313	Many more larger springs upstream
WP 826	Seep/spring	10/12/20 12:30	eg, jp	-	B	0.0009	0.42	-	1 to 3	graduated cylinder	-	14.8	213	264	Measurable spring coming down from concrete face/bedrock; still monterey formation?; upstream edge of temporary dam
WP 825	Wet banks/seep	10/12/20 12:25	eg, jp	-	B	-	-	-	-	-	-	-	-	-	Wet seeping bedrock faces, not measureable
WP 824	Seep/spring	10/12/20 12:20	eg, jp	-	B	0.0002	0.10	-	-	graduated cylinder	-	14.8	191	237	Seep on left bank at old diversion box/structure; hard to measure, seeping down/dripping in many spots, looks like somewhat modern diversion pipe/modern electrical; at old temporary dam, may be diversion structure on other side of stream too; SCT of stream is 362 at 14C and 459 at 25C
WP 823	Seep/spring	10/12/20 12:10	eg, jp	-	B	0.0006	0.29	-	-	graduated cylinder	-	13.4	192	246	Spring on right bank, looks like it gets runoff also at high flow because significant erosion into concrete/bedrock; at old dam site- large concrete structures eroded at upstream edge of pool, upstream of spring
WP 822	Seep/spring	10/12/20 12:00	eg, jp	-	B	0.004	1.92	0.0033	1.5	graduated cylinder	-	13.2	120	155	Water seeping down tall right bank, bedrock exposed faces; tripled measurement because unmeasureable sheet flow
WP 821	Diversion pipe from house	10/12/20 11:55	eg, jp	-	B	-	-	-	-	-	-	-	-	-	Diversion pipe coming down from house; 1" PVC, not running
WP 820	Seep	10/12/20 11:50	eg, jp	-	B	-	-	-	-	-	-	-	-	-	Not measurable flow at seep on left bank, wet
WP 819	Seep	10/12/20 11:45	eg, jp	-	B	-	-	0.001	0.5	-	-	-	-	-	Can hear trickle, cannot see through dense vegetation, maybe 0.5 gpm, slow seep through sand/loose bank
WP 818	PVC over channel	10/12/20 11:40	eg, jp	-	B	-	-	-	-	-	-	-	-	-	White PVC pipe spanning channel 20 ft up, looks like it is not in operation
WP 817	Wet banks	10/12/20 11:35	eg, jp	-	B	-	-	-	-	-	-	-	-	-	Wet banks right bank side, some seeps that are dry now
WP 816	Spring	10/12/20 11:30	eg, jp	-	B	0.001	0.55			graduated cylinder		14.6	143	179	Large tree spanning channel just upstream of measurement spot; also a seep/spring coming down from left bank approximately
Bean Ck at halfway point, WP 816	Bean Ck	10/12/20 10:58	eg, jp	-	B	2.03	451	1.9	853	PY	g	13	367	477	0.25 gpm; just 10 ft upstream of measurement location; pipe where it is dripping from
WP 815	Dip Slope	10/12/20 10:55	eg, jp	-	B	-	-	-	-	-	-	-	-	-	Dipslope into leftbank of channel; steep runoff likely from left bank took meas in Bean Creek just upstream
WP 814	Septic seep	10/12/20 10:45	eg, jp	-	B	-	-	-	-	-	-	13	900	1184	Septic seep, left bank, strong sulfur odor

Table 8. Station observer log; October 12, 2020 Bean Creek walk from Mount Hermon Camp gage to Mount Hermon Road Gage, continued
County of Santa Cruz, California

Site Information						**Streamflow**						*Water Quality Observations*			*Remarks*
Stream, Site description, Waypoint	Description (seep, spring, trib, wet banks, Bean Ck, etc)	Date/Time	Observer(s)	Stage (staff plate)	Hydrograph	Measured discharge	Measured discharge	Estimated Discharge	Estimated Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Specific Conductance at field temp.	Specific Conductance at 25C	
		(mm/dd/yr)		(feet)	*(R/F/S/B)*	*(cfs)*	*(gpm)*	*(cfs)*	*(gpm)*	*(AA/PY)*	*(e/g/f/p)*	*˚C*	*(µmhos/cm)*	*umhos@25oC*	
Redwood Spring Tributary, WP 813	Spring/Trib	10/12/20 10:30	eg, jp	-	B	0.13	59.5	0.15	67	PY	f/p	13.6	174	222	Very steppy, not many places to measure, measured with PY at base/confluence; sand bar forming at confluence with Bean Creek
WP 812	Spring/seep	10/12/20 10:15	eg, jp	-	B	0.003	1.27	0.005	2.25	graduated cylinder	-	13.8	210	268	Seep out of right bank, measured at main point of flow; hearing other trickles downstream
WP 811	Seep	10/12/20 10:00	eg, jp	-	B	-	-	0.0001	0.04	-	-	-	-	-	Another wet bank/unmeasurable seep
WP 810	Seep	10/12/20 9:55	eg, jp	-	B	0.0002	0.09	-	-	graduated cylinder	-	11.7	288	386	Seep down vertical rightbank, similar to other wet banks downstream, but more flow
WP 809	Wet banks	10/12/20 9:45	eg, jp	-	B	-	-	-	-	-	-	-	-	-	Wet banks, seep out of vertical bedrock bank
WP 808	Septic seep	10/12/20 9:30	eg, jp	-	B	-	-	-	-	-	-	11.6	14650	19367	Seep through bedrock bank, likely septic, green and brown algae growing all over rocks; just dripping, trickle; SCT in stream is 361 at 12.4C and 476 at 25C
WP 807	Spring	10/12/20 9:16	eg, jp	-	B	0.07	32.4	0.18	81	PY	-	14	160	202.7	Flowing with small waterfall upstream; 800 ft upstream of gage
Bean Ck at Mount Hermon Camp, WP 806	Bean Ck	10/12/20 8:28	eg, jp	1.19	B	2.10	943	-	-	PY	g	12.6	355	466	First flow measurement synoptic stream walk going to Mt Hermon Rd

Notes:

Observer Key: cn = Chelsea Neill; jp = Jason Parke; dt = Denise Tu; jh = John Hardy; eg = Emma Goodwin

Stage: Water level observed at outside staff plate.

Hydrograph: Describes stream stage as rising (R), at peak (P), falling (F), steady (S), baseflow (B), diversion (D), not spilling (NS) or uncertain (U).

Instrument: If measured, typically made using a standard (AA) or Pygmy (PY) bucket-wheel ("Price-type") current meter or 5 gallon bucket (bkt), plastic bag (bag), If estimated, from rating curve (R) or visual (VIS).

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

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

FIGURES

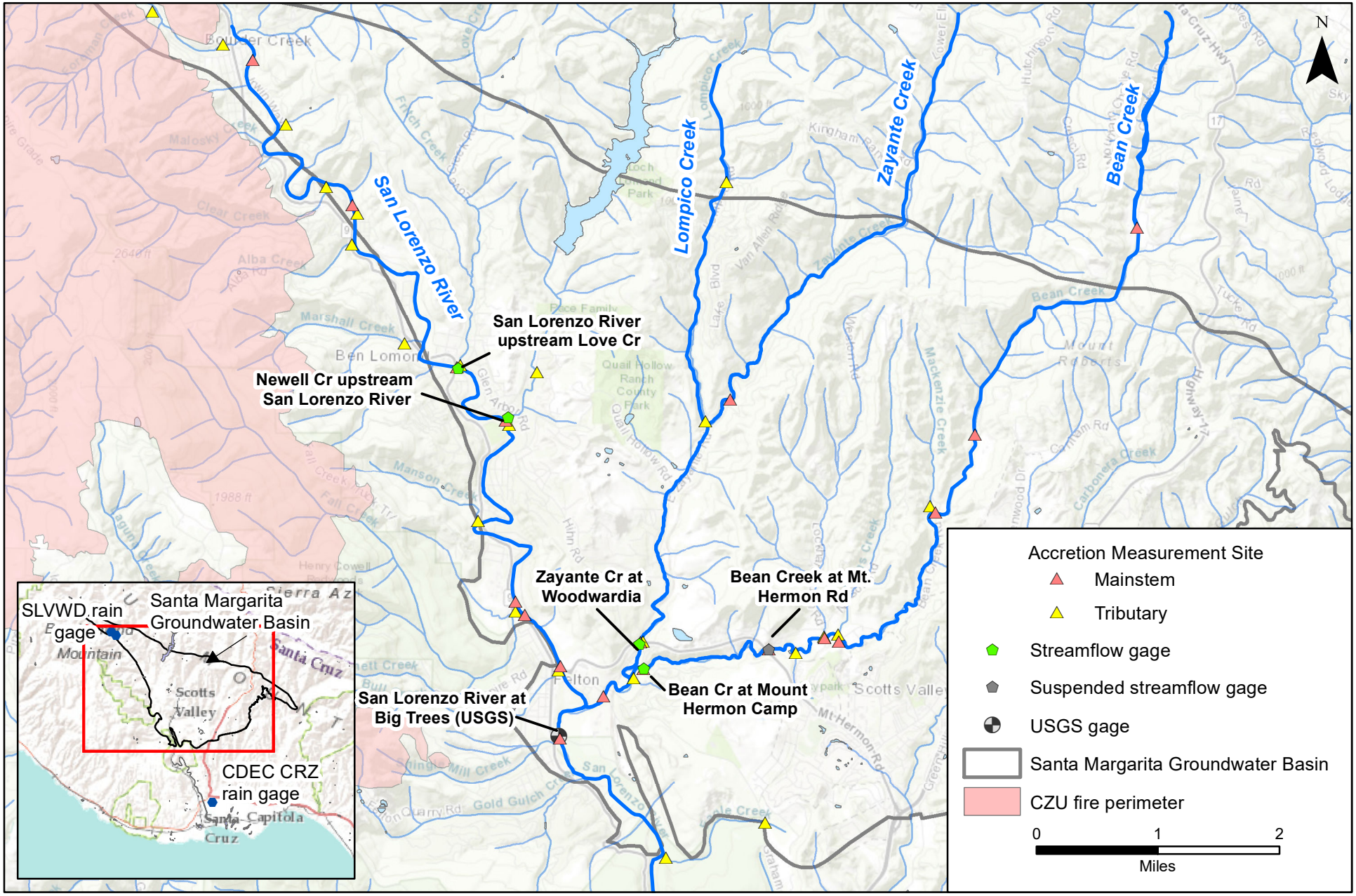


Figure 1. Santa Margarita Basin streamflow monitoring sites dry season 2020, Santa Cruz County, California
See Figures 1a and 1b for more detail on accretion measurement sites

Balance Hydrologics

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Basemap: ESRI 2021

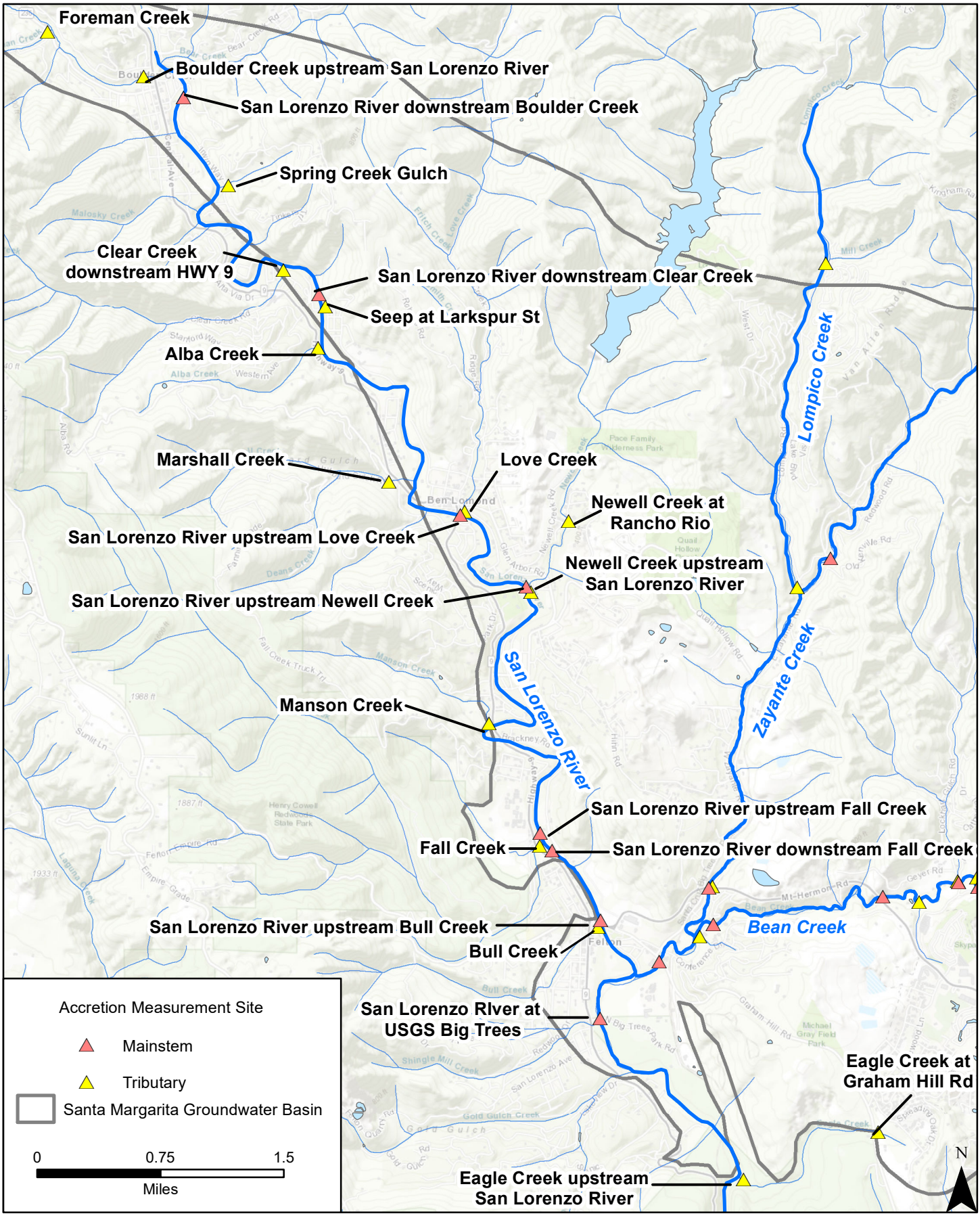

Figure 1a. San Lorenzo River accretion study reach, dry season 2020, Santa Cruz County, California

Balance Hydrologics

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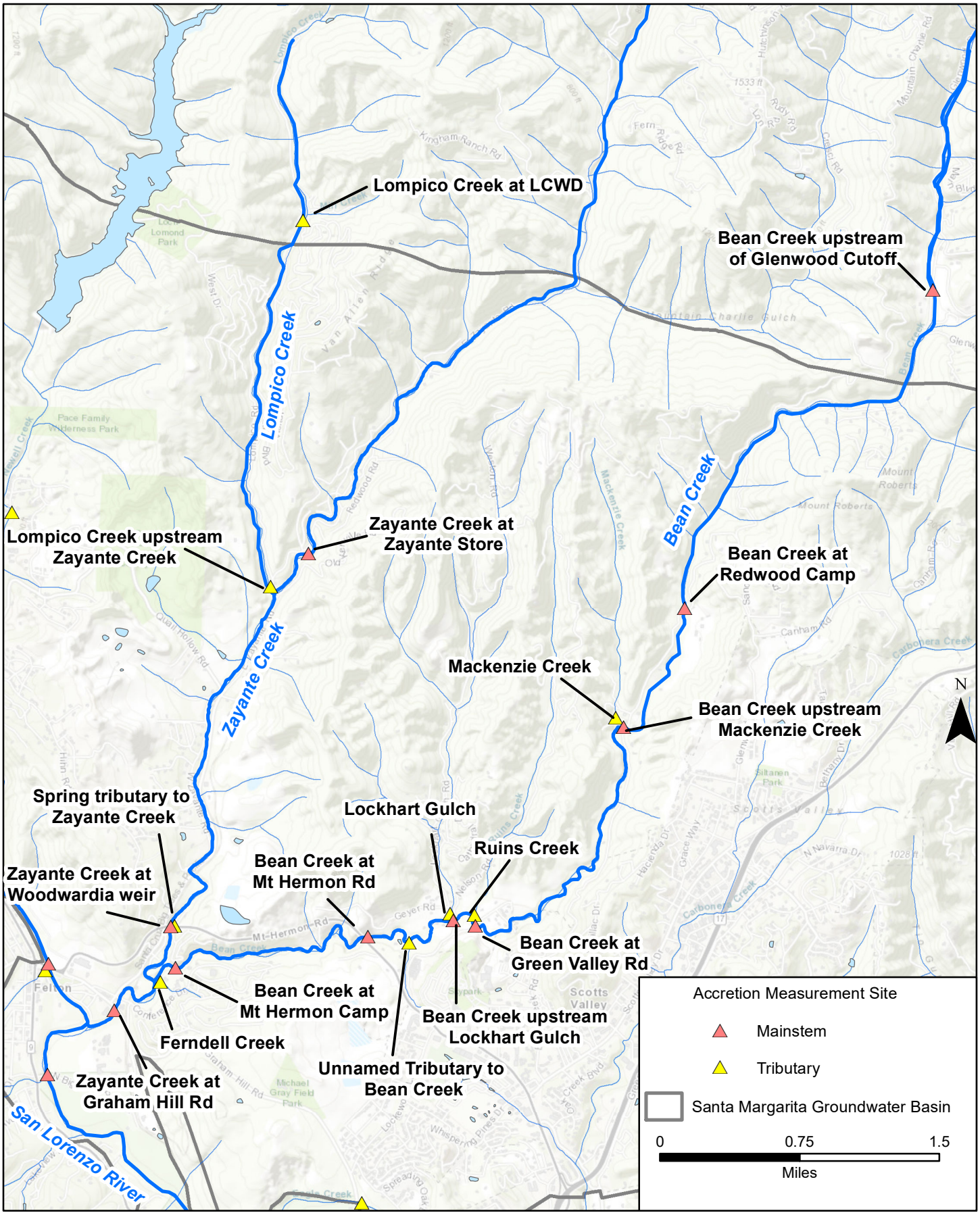

Balance Hydrologics

Figure 1b. Zayante, Bean, and Lompico Creeks study reaches, dry season 2020, Santa Cruz County, California

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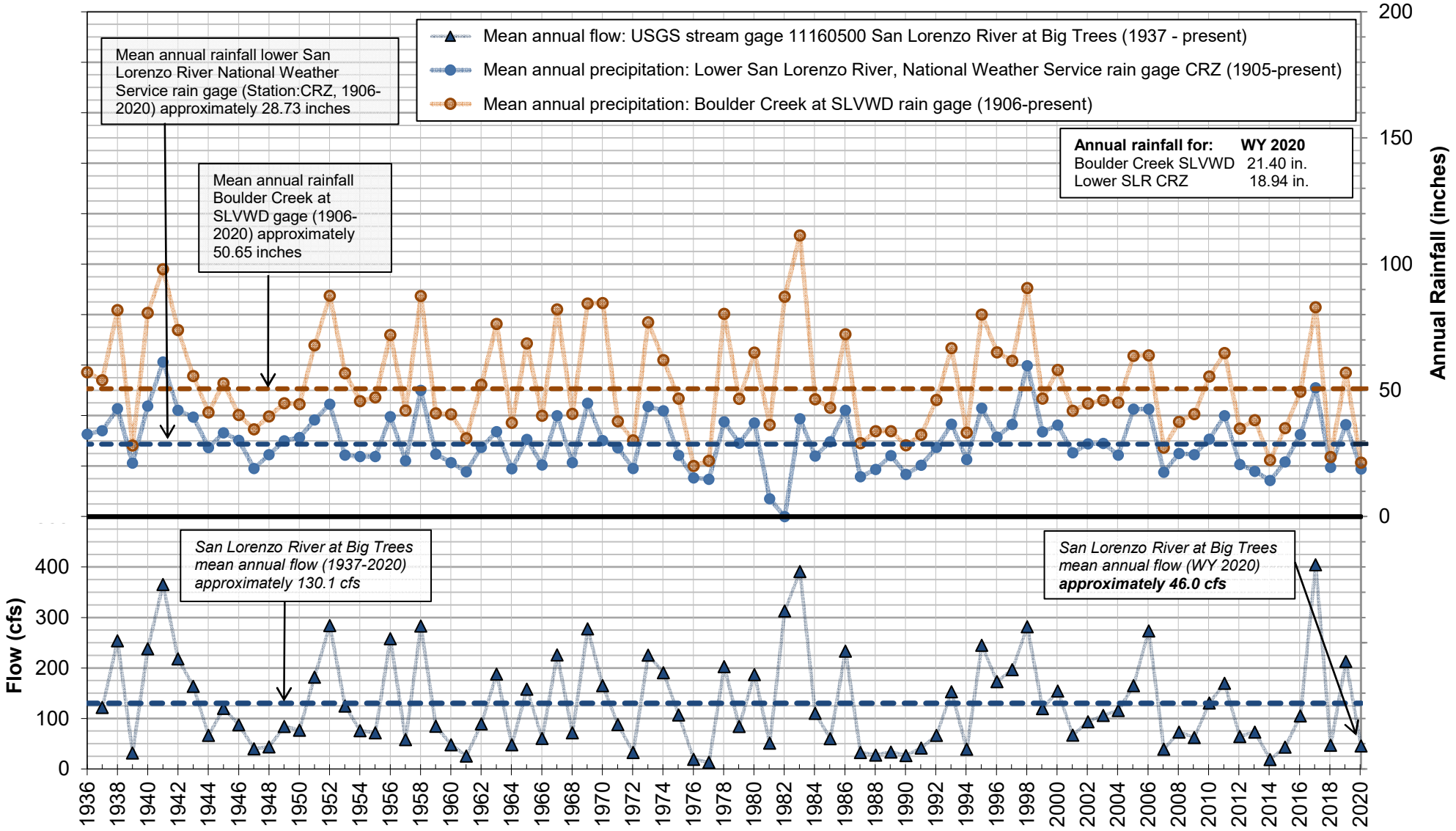
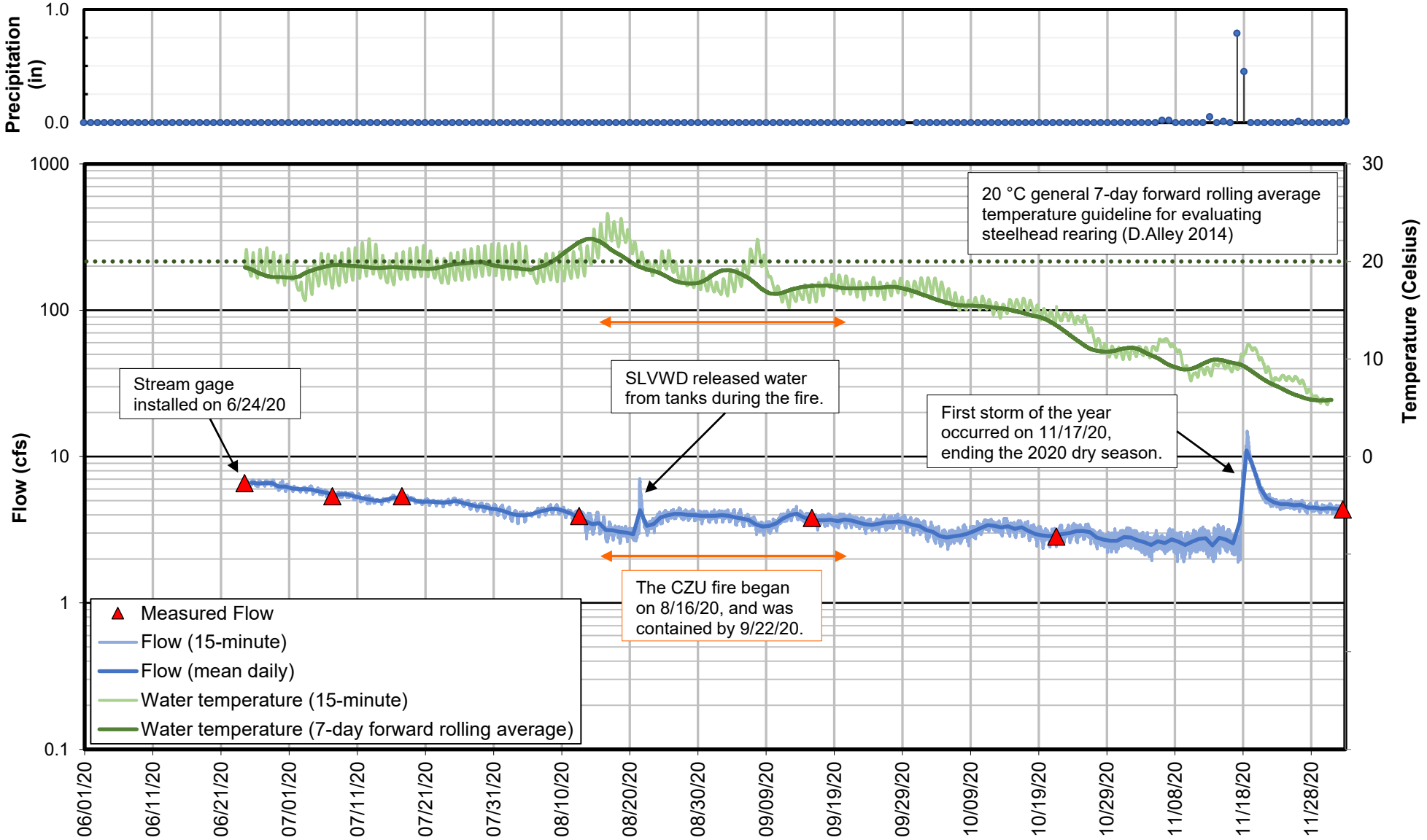
Basemap: ESRI2021



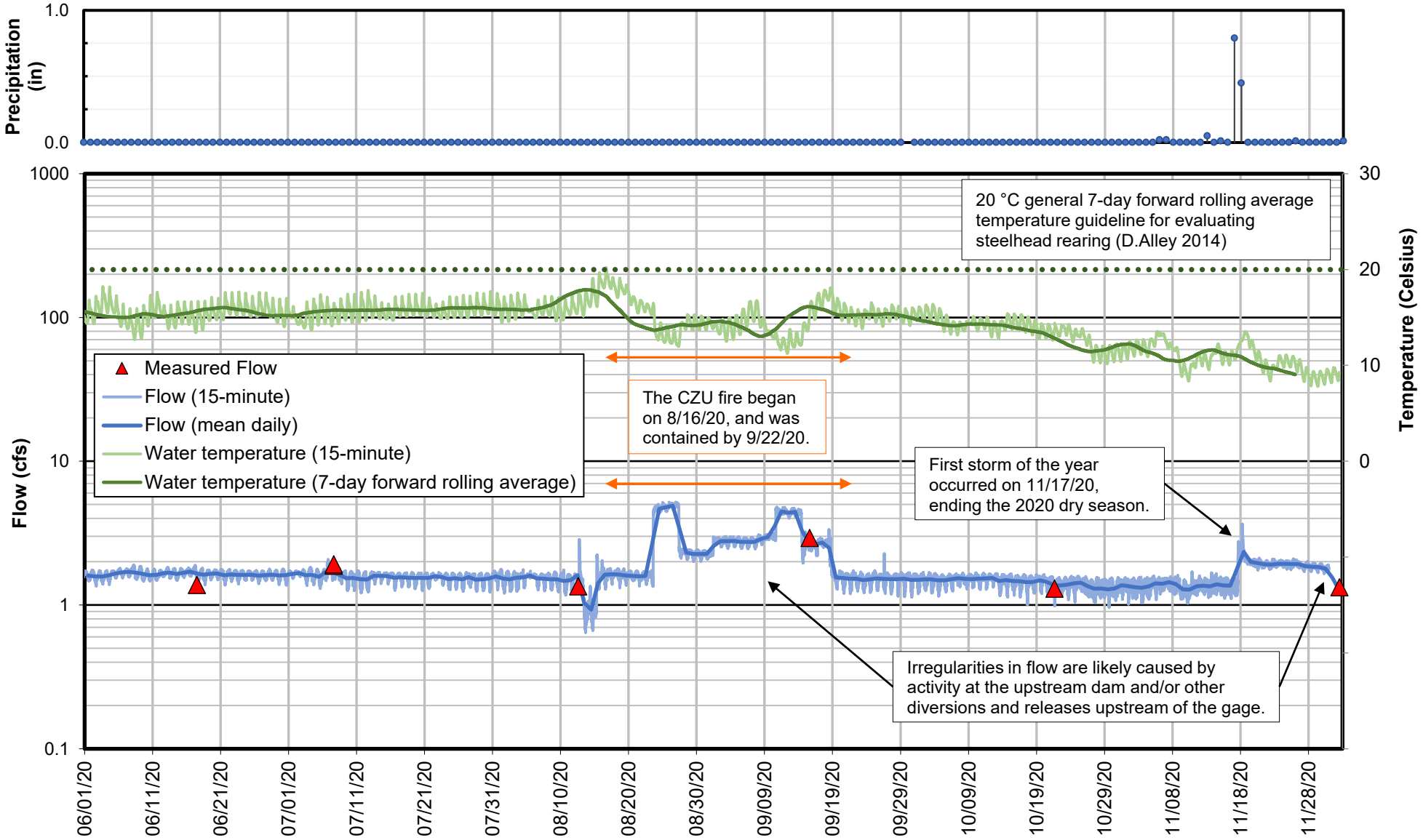
Balance Hydrologics

Figure 2. **Comparison of historic annual rainfall in San Lorenzo Basin to annual streamflow at USGS Gage 11160500, San Lorenzo River at Big Trees, Santa Cruz County, CA**



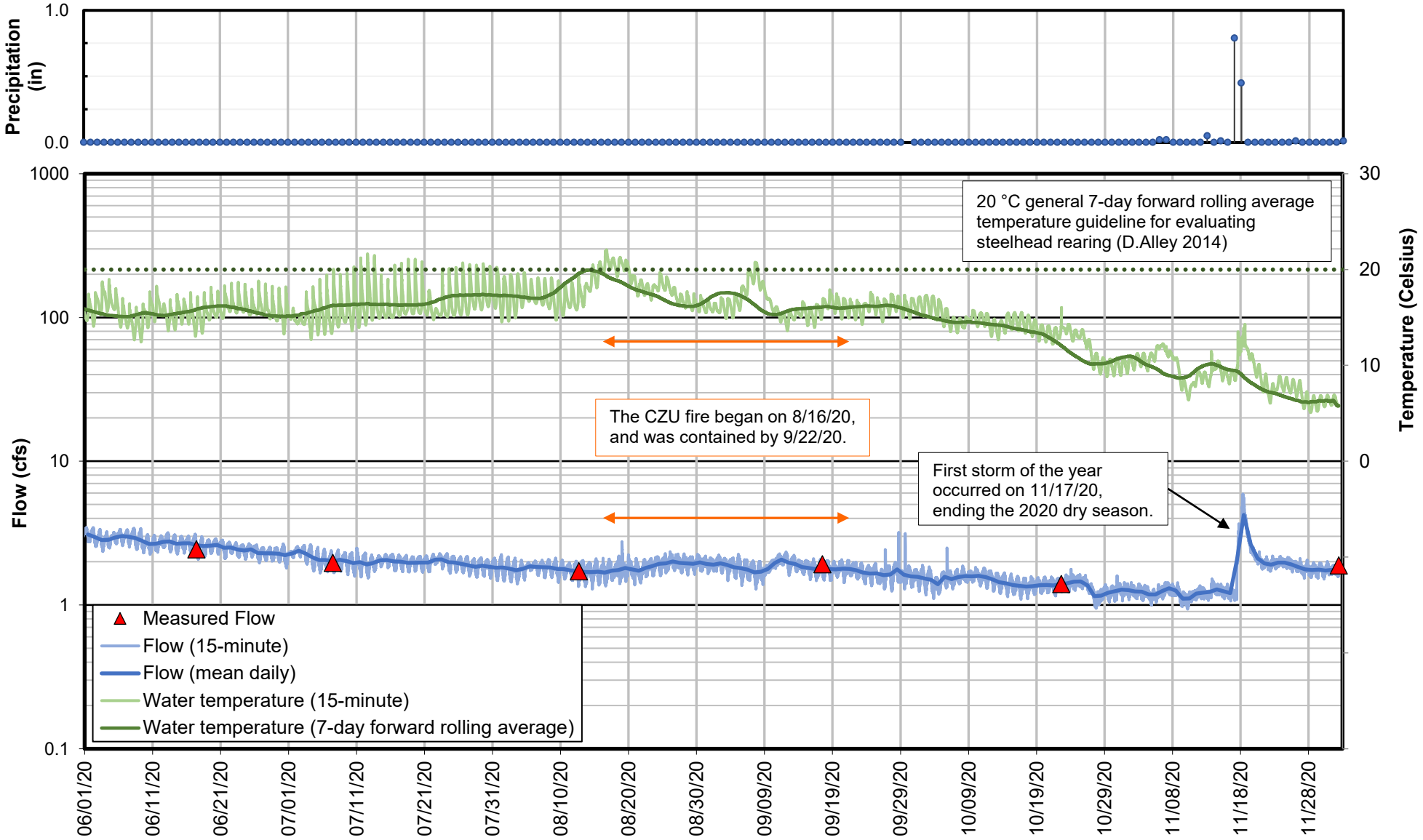
Balance Hydrologics

Figure 3. **Flow and temperature at San Lorenzo River upstream of Love Creek, dry season 2020, Santa Cruz County, CA** Precipitation data from SLVWD downtown Boulder Creek gage



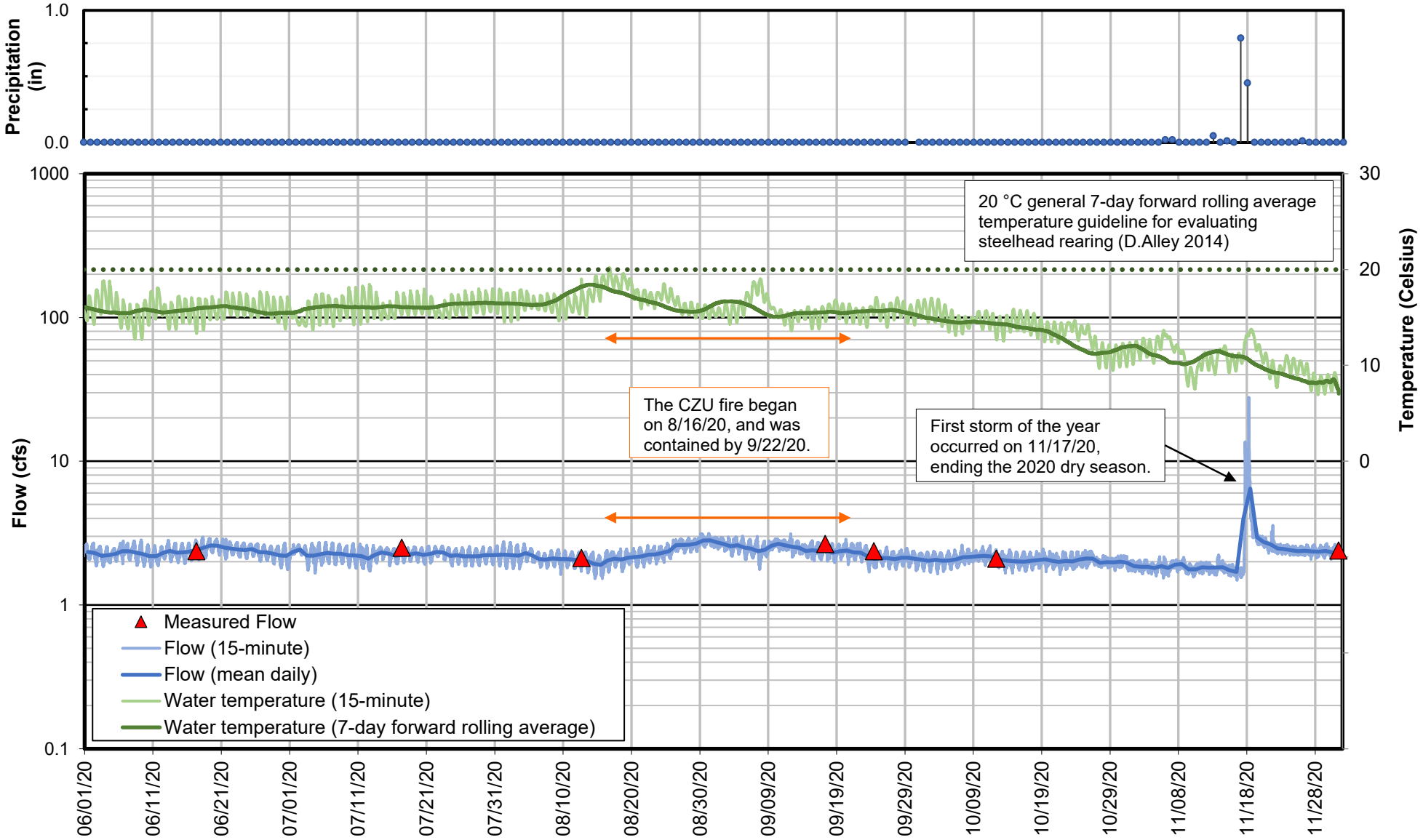
Balance Hydrologics

Figure 4. **Flow and temperature at Newell Creek approximately 120 ft upstream of the San Lorenzo River, dry season 2020, Santa Cruz County, CA.** Precipitation data from SLVWD downtown Boulder Creek gage.



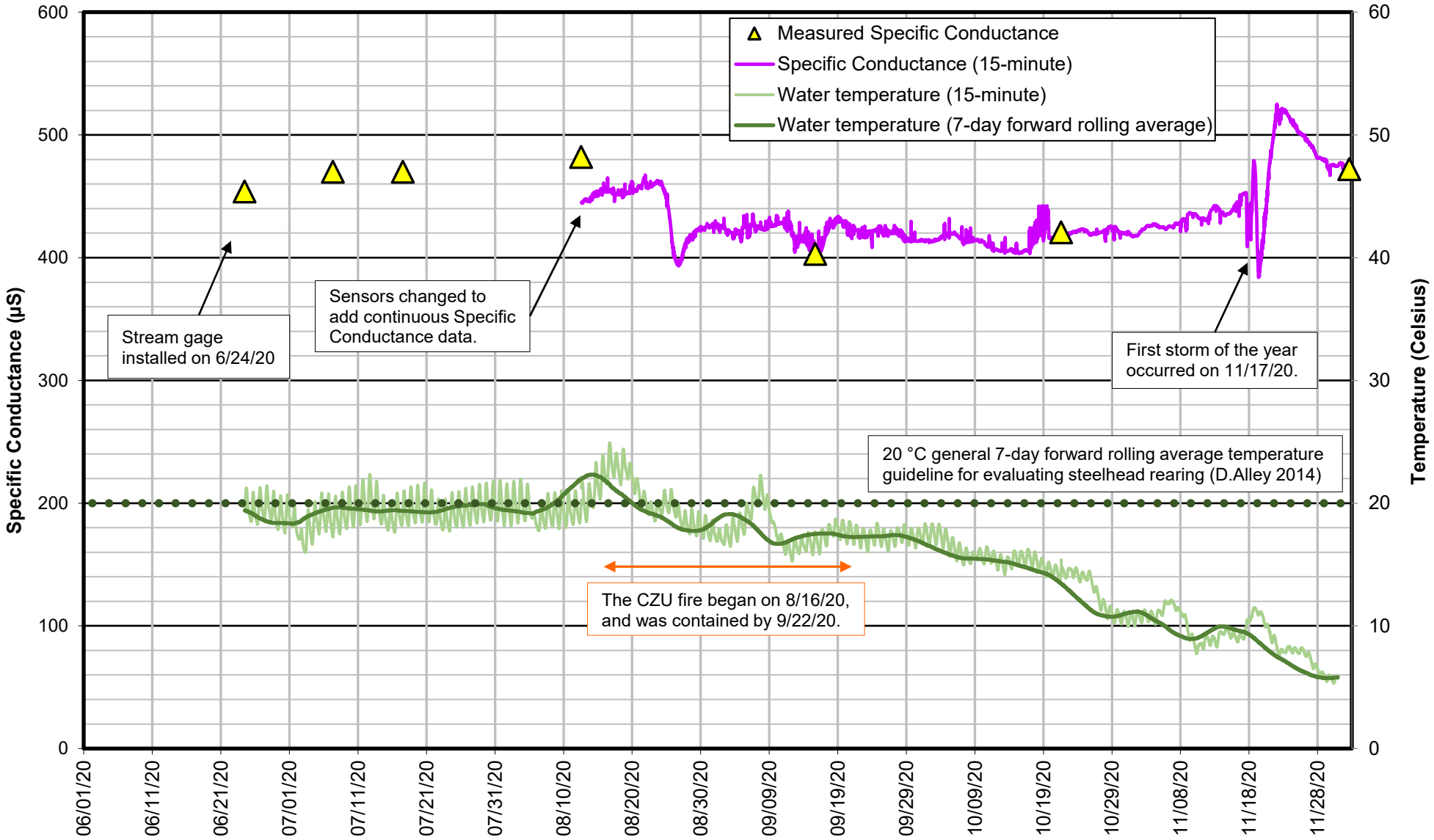
Balance Hydrologics

Figure 5. **Flow and temperature at Zayante Creek at Woodwardia, dry season 2020, Santa Cruz County, CA.** Precipitation data from SLVWD downtown Boulder Creek gage.



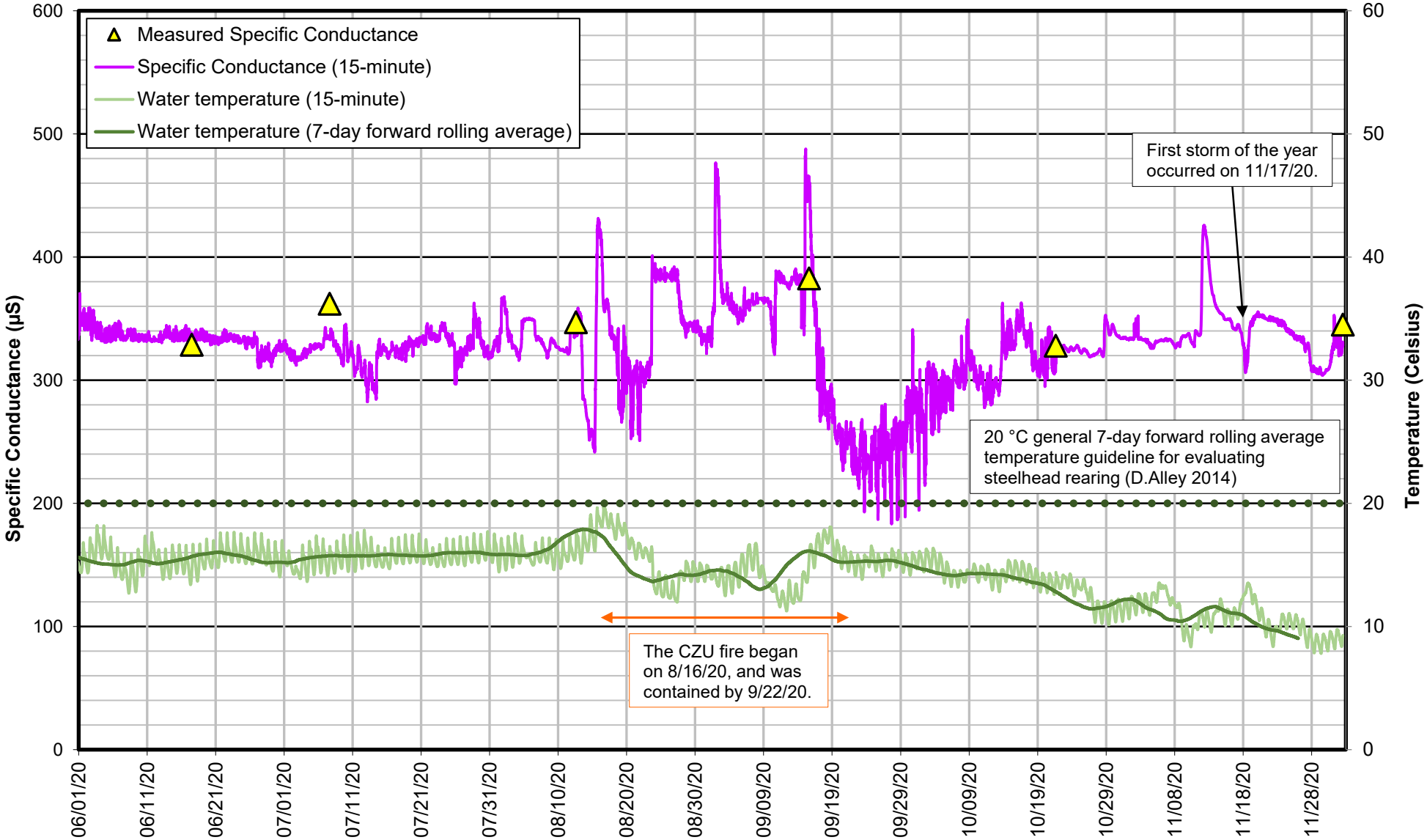
Balance Hydrologics

Figure 6. **Flow and temperature at lower Bean Creek above mouth at Mt. Hermon Camp, dry season 2020, Santa Cruz County, CA** Precipitation data from SLVWD downtown Boulder Creek gage.



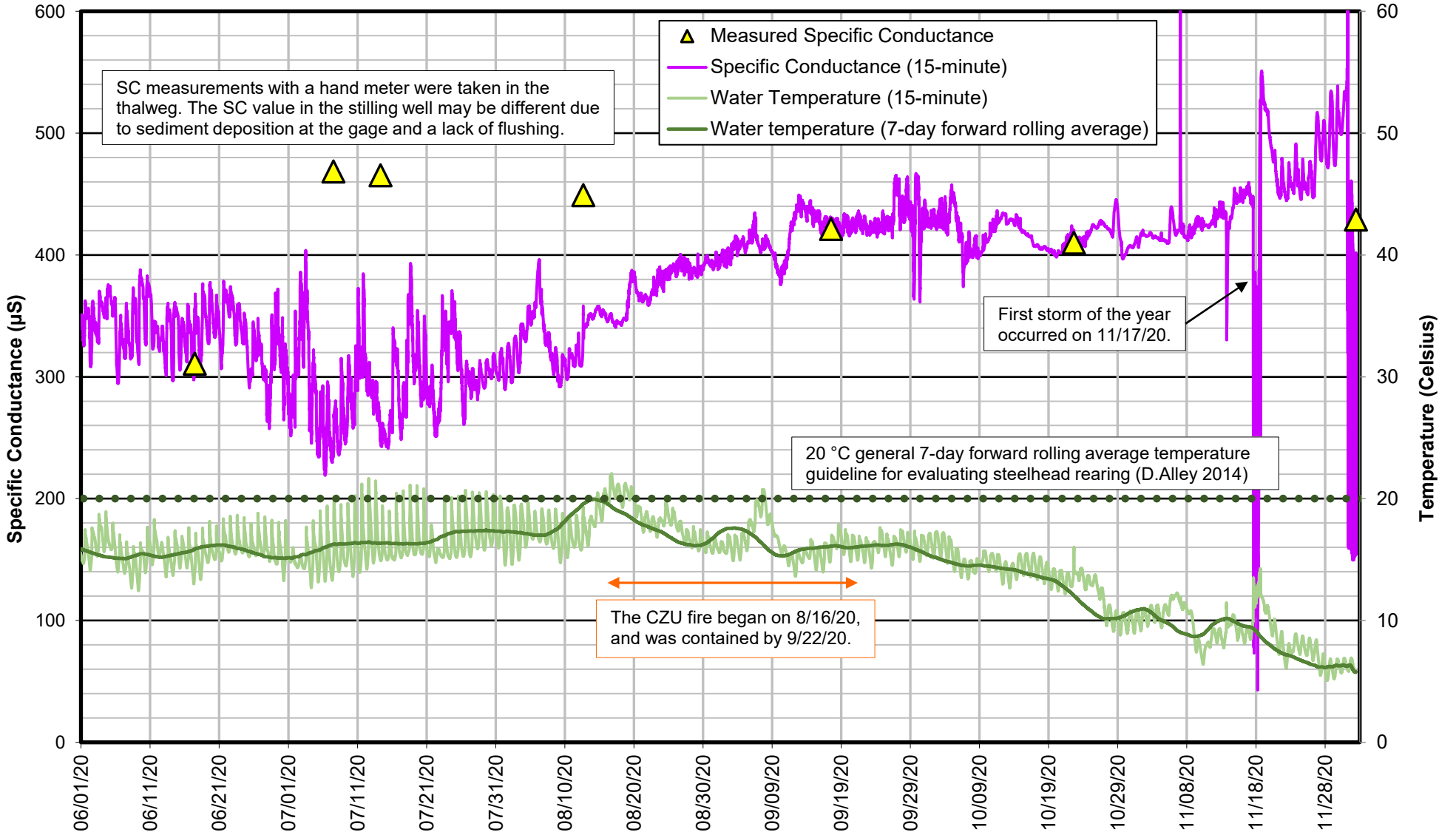
Balance Hydrologics

Figure 7. Specific Conductance and temperature at San Lorenzo River upstream of Love Creek, dry season 2020, Santa Cruz County, CA



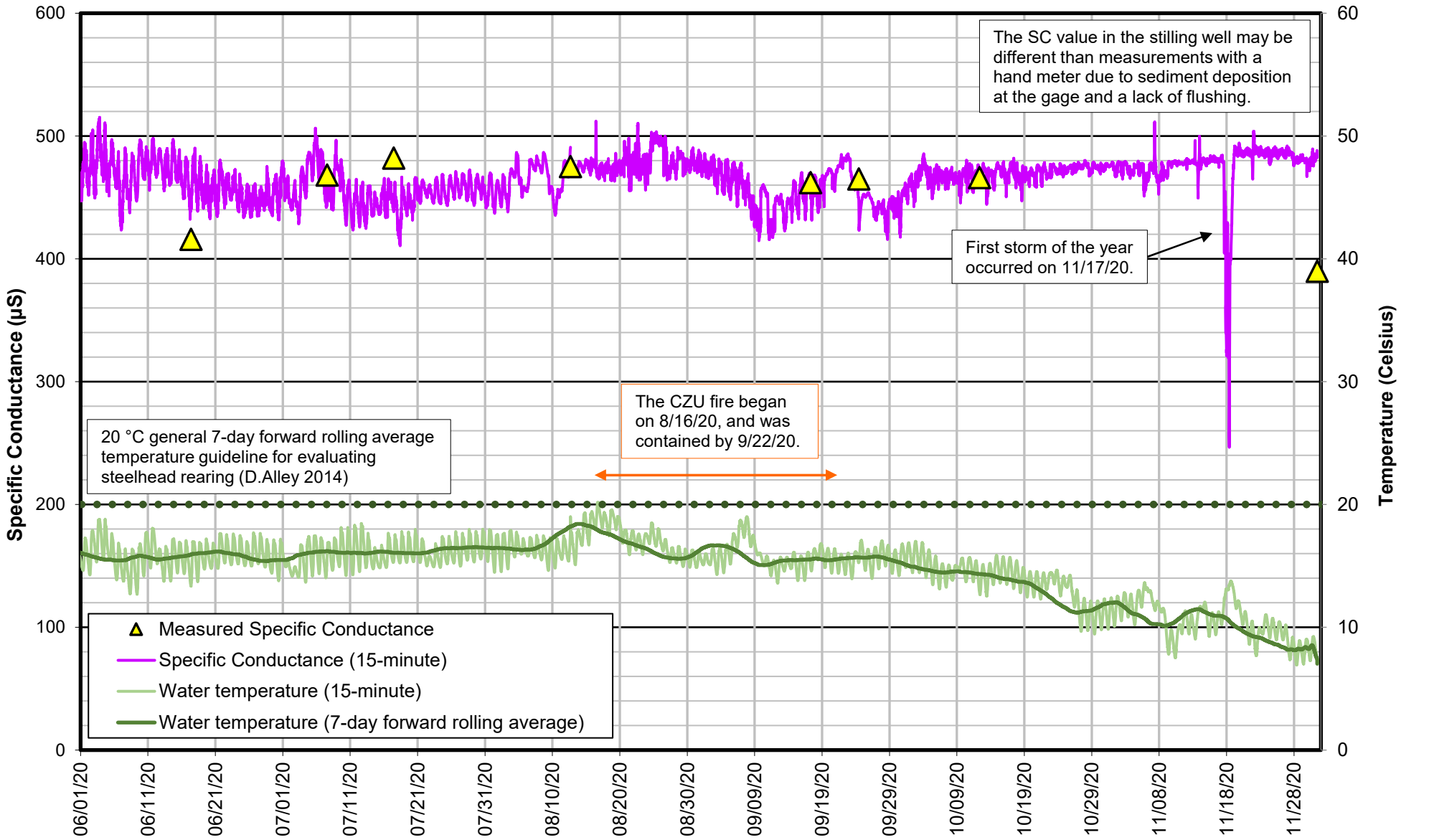
Balance Hydrologics

Figure 8. **Specific Conductance and temperature at Newell Creek approximately 120 ft upstream of the San Lorenzo River, dry season 2020, Santa Cruz County, CA.**



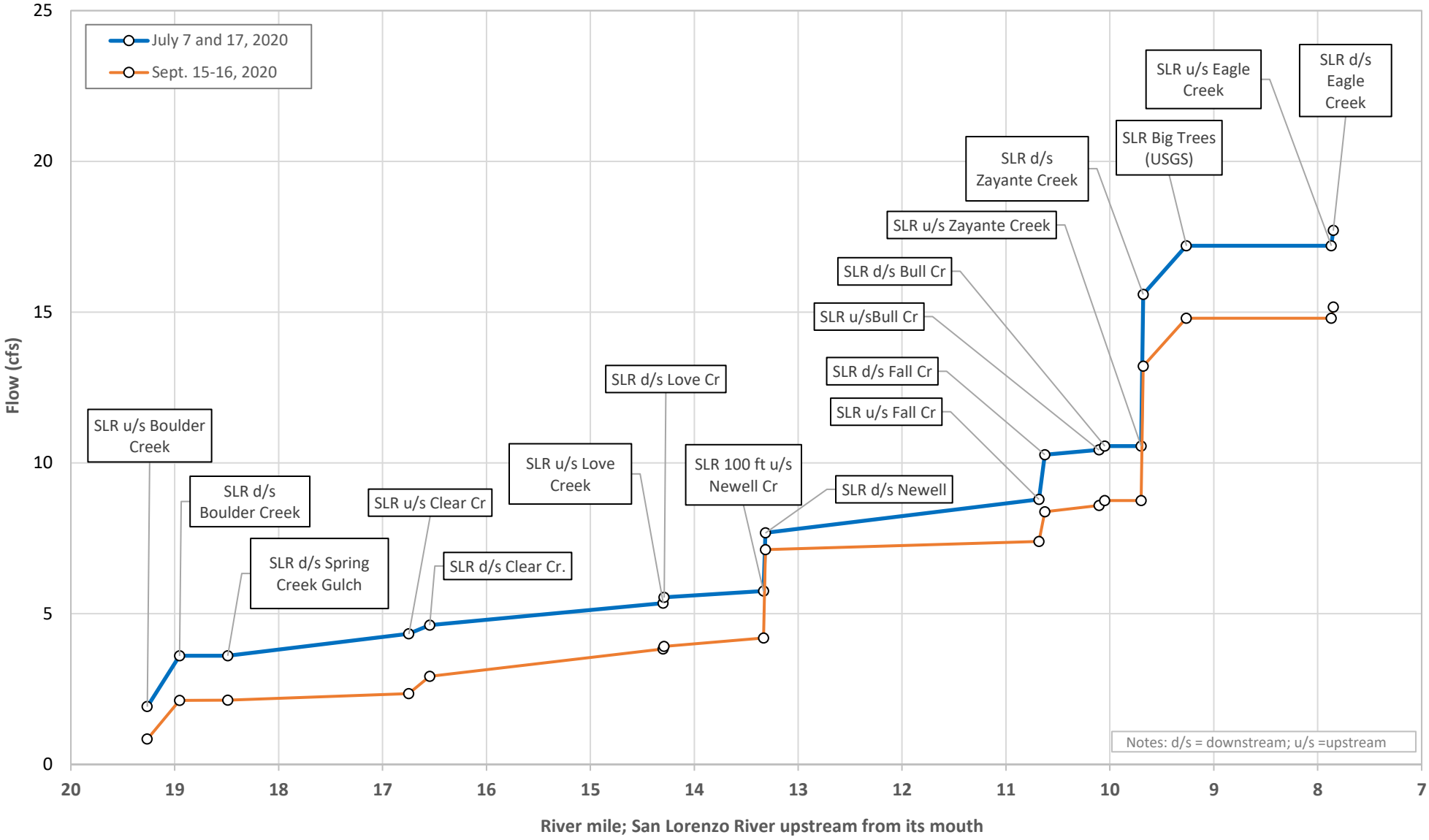
Balance Hydrologics

Figure 9. Specific Conductance and temperature at Zayante Creek at Woodwardia, dry season 2020, Santa Cruz County, CA.



Balance Hydrologics

Figure 10. Specific Conductance and temperature at lower Bean Creek above mouth at Mt. Hermon Camp, dry season 2020, Santa Cruz County, CA Precipitation data from SLVWD downtown Boulder Creek gage.



Balance Hydrologics

Figure 11. **San Lorenzo River mainstem downstream changes in flow, dry season 2020 Santa Cruz County, CA**

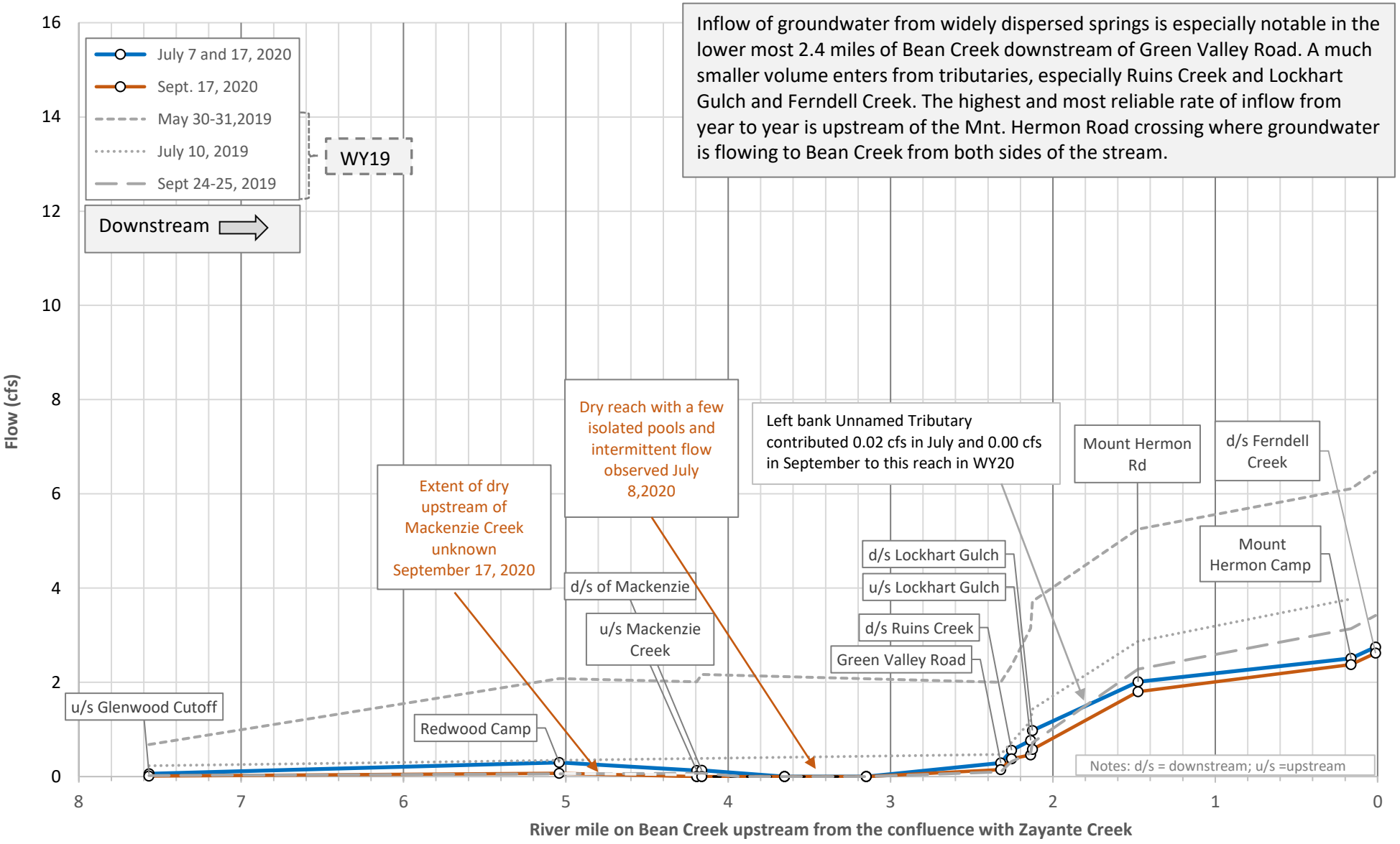


Figure 12. **Downstream changes of flow in Bean Creek over the WY 2020 dry season and comparison with the dry season changes during WY 2019, a substantially wetter year. Santa Cruz County, CA** The reach between Mackenzie Creek and Green Valley Road has been observed to go dry mid-summer.

Balance Hydrologics

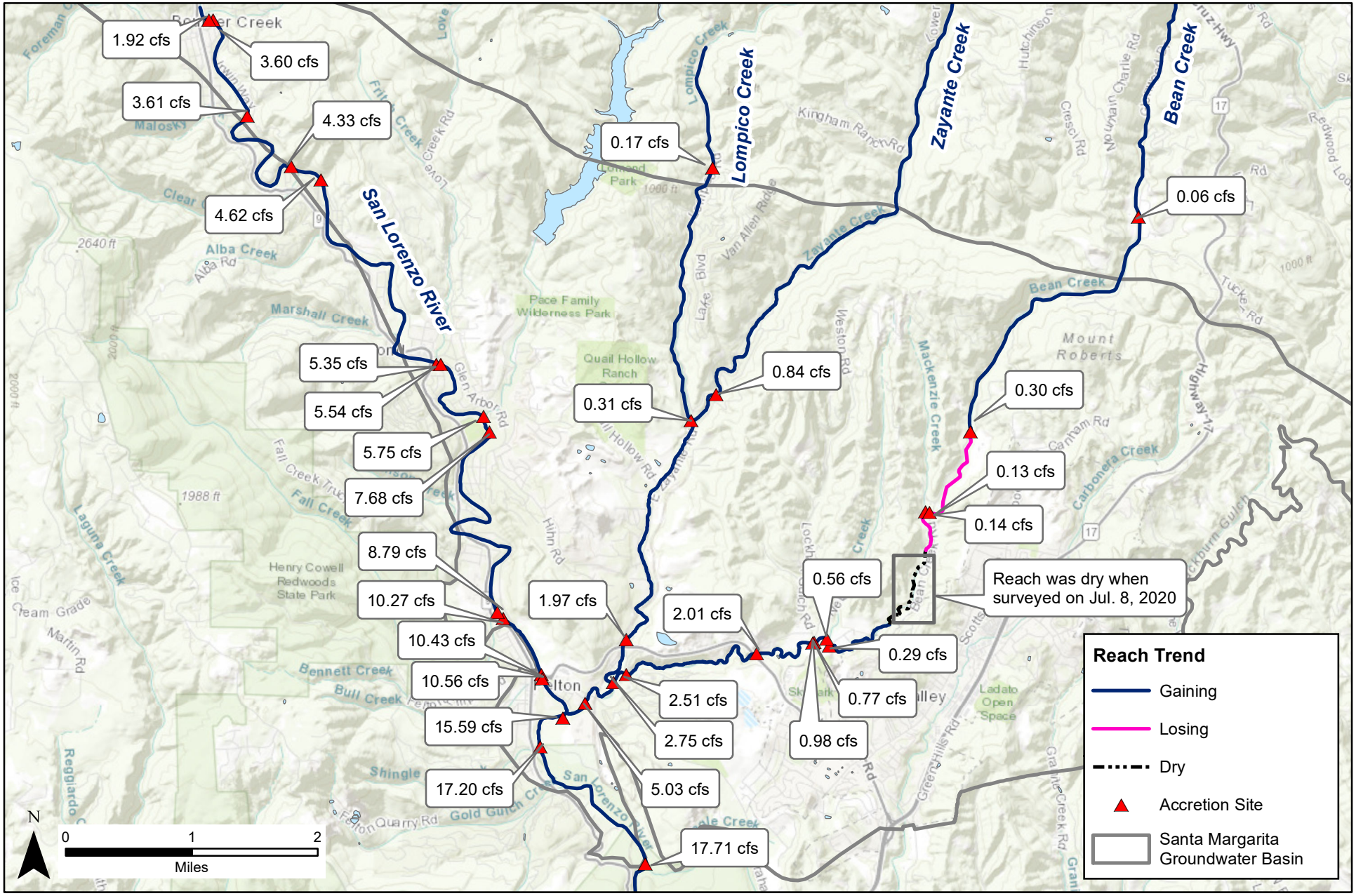


Figure 13. Results of San Lorenzo River, Zayante, Bean, and Lompico Creeks mainstem accretion measurements, July 2020, Santa Cruz County, California

Balance Hydrologics

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Basemap: ESRI 2021

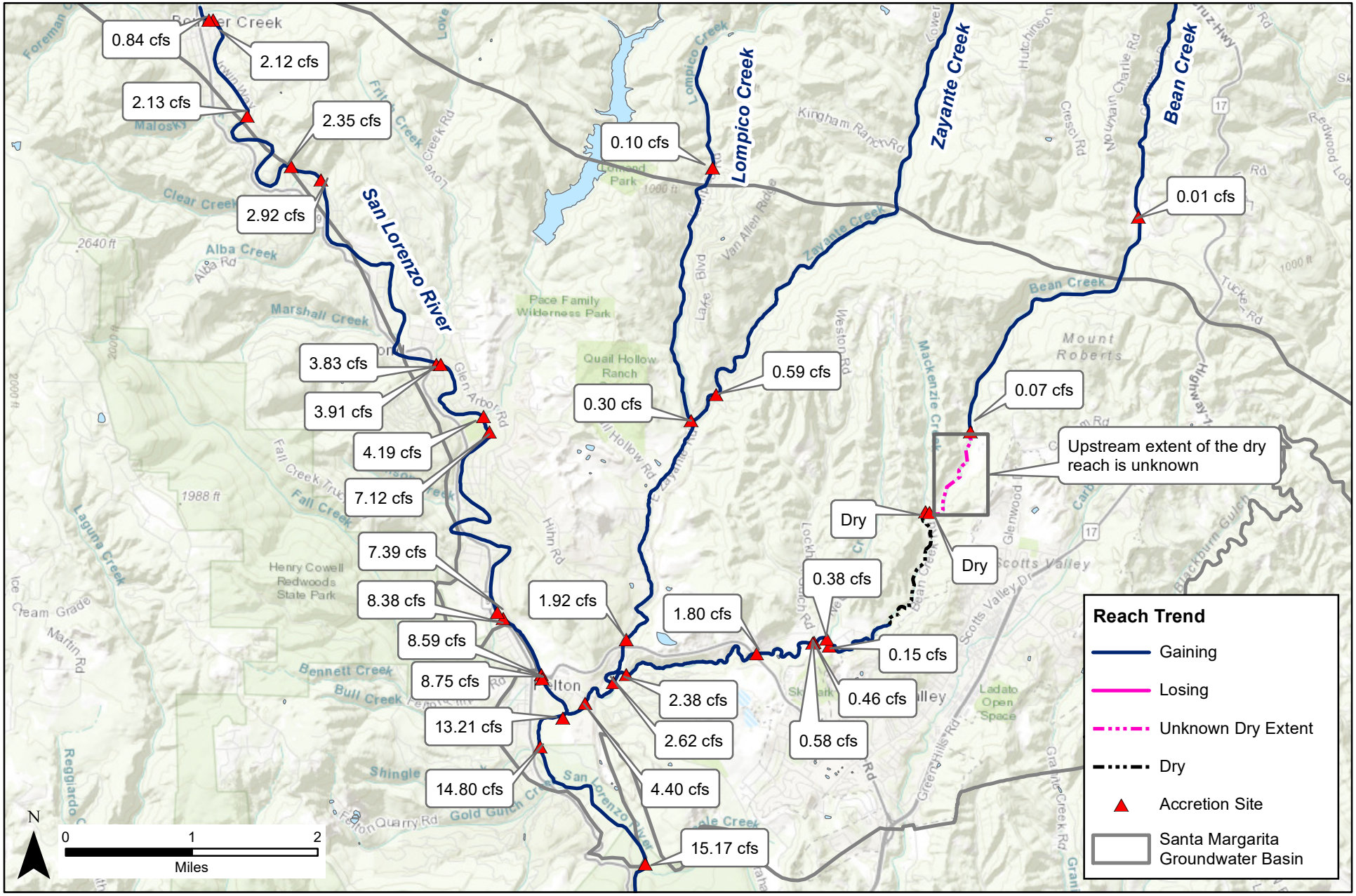

Figure 14. Results of San Lorenzo River, Zayante, Bean, and Lompico Creeks mainstem accretion measurements, September 2020, Santa Cruz County, California

Balance Hydrologics

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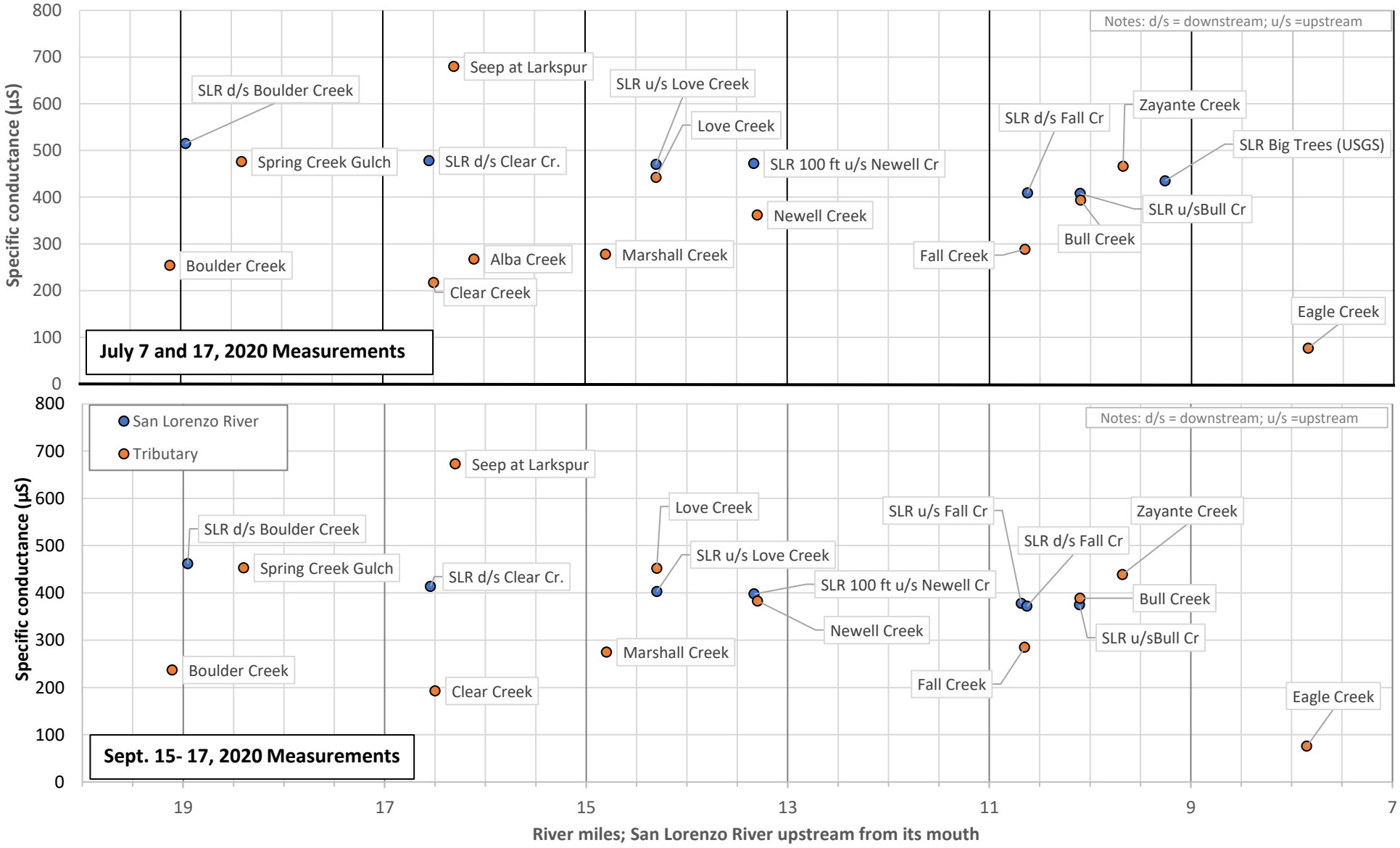


Figure 15. San Lorenzo River specific conductance measurements, dry season 2020, Santa Cruz County, CA

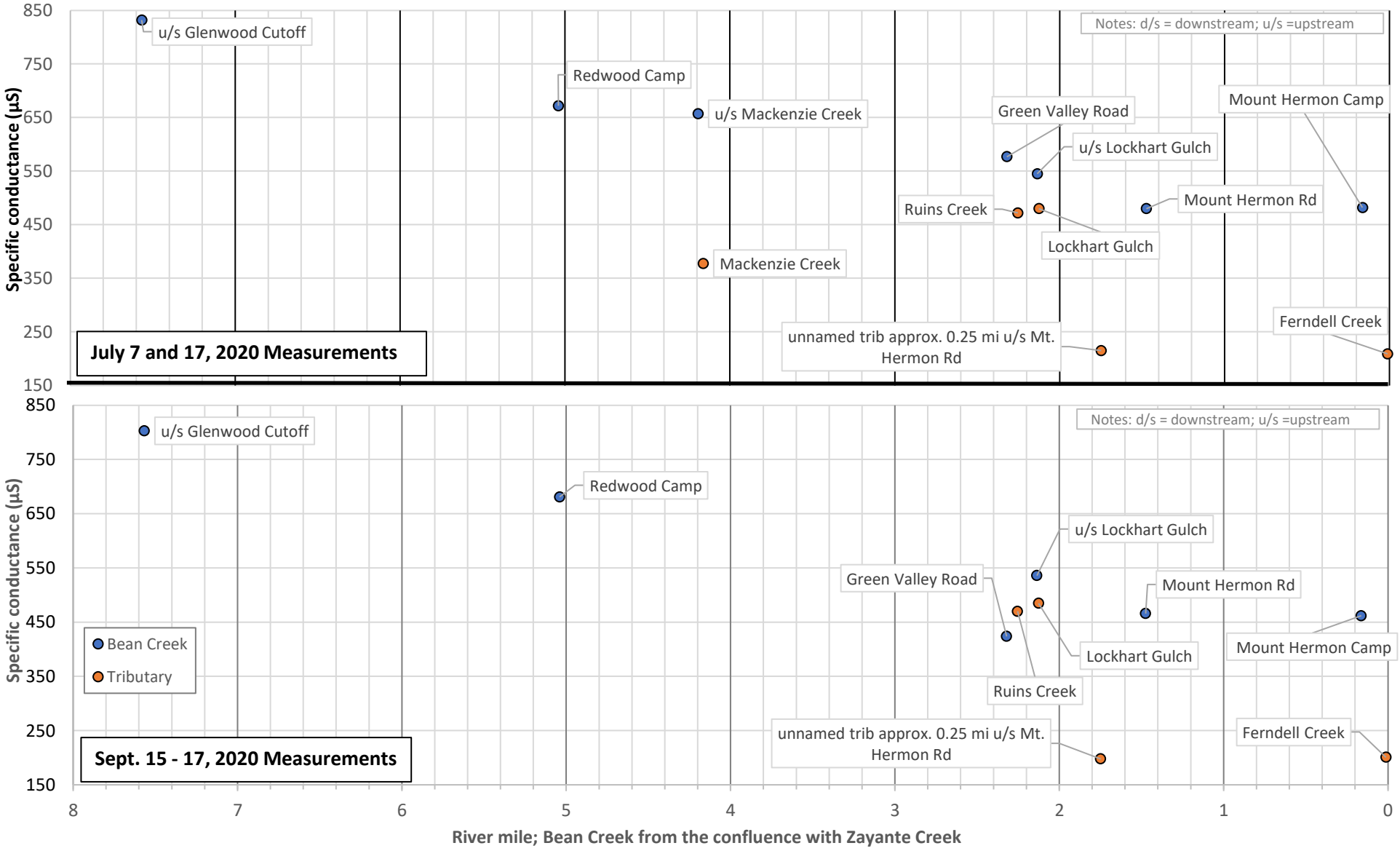


Figure 16. **Bean Creek specific conductance measurements dry season 2020, Santa Cruz County, CA**

Balance Hydrologics

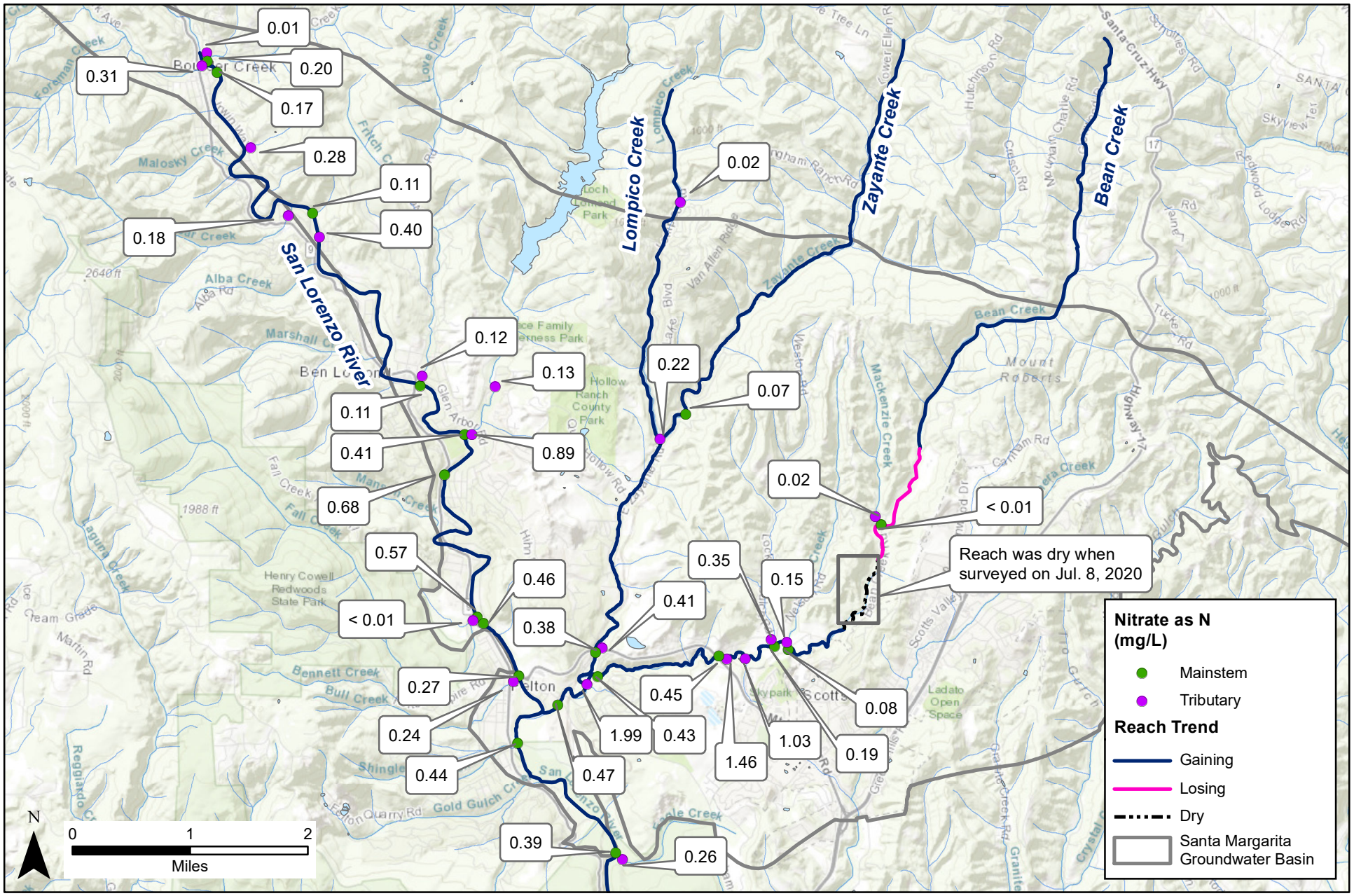


Figure 17. Nitrate as N results from water quality sampling, July 2020, Santa Cruz County, California

Balance Hydrologics

J:\Projects\220237 Santa Margarita Year 20\220237 Water Quality July 2020.mxd

Basemap: ESRI 2021

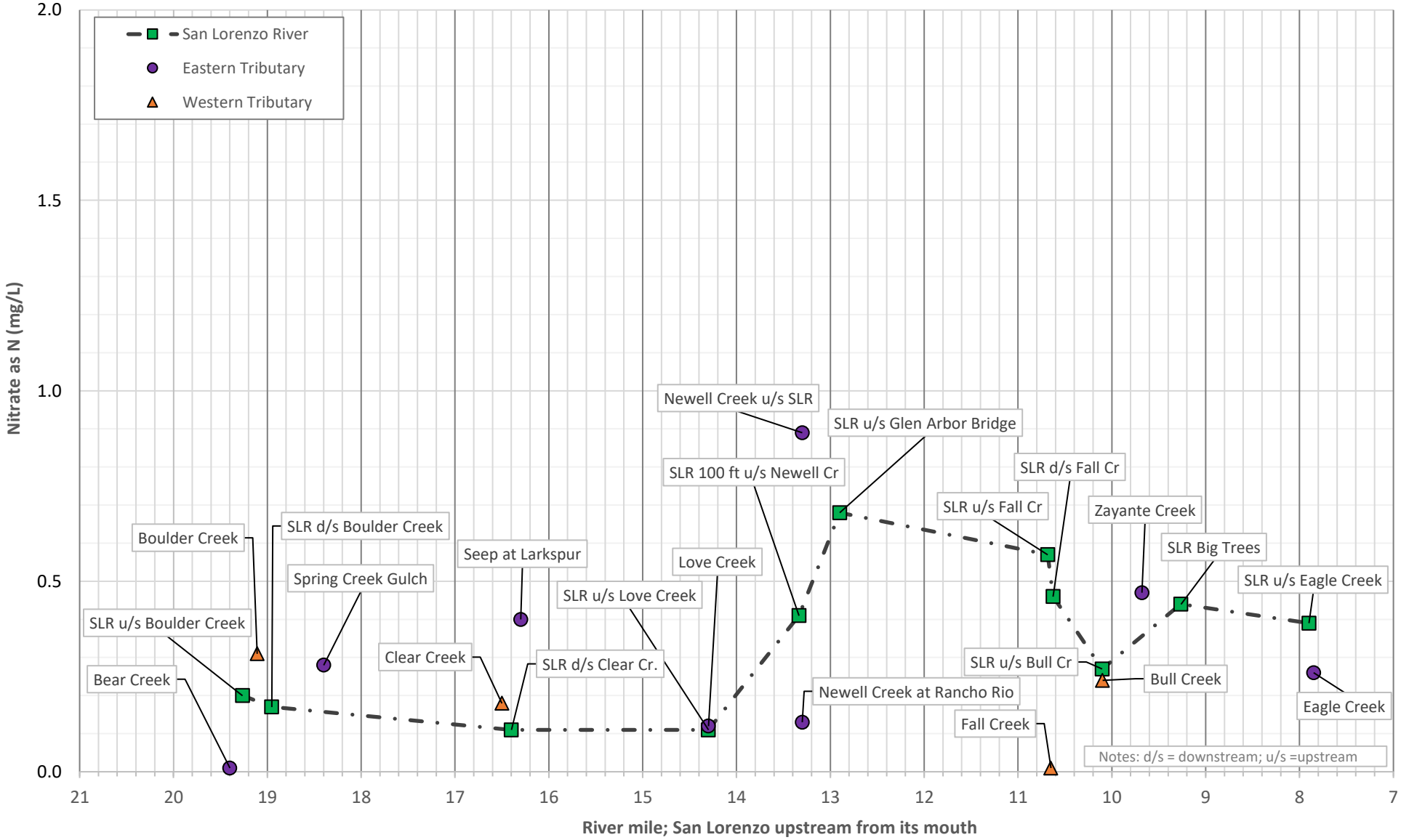
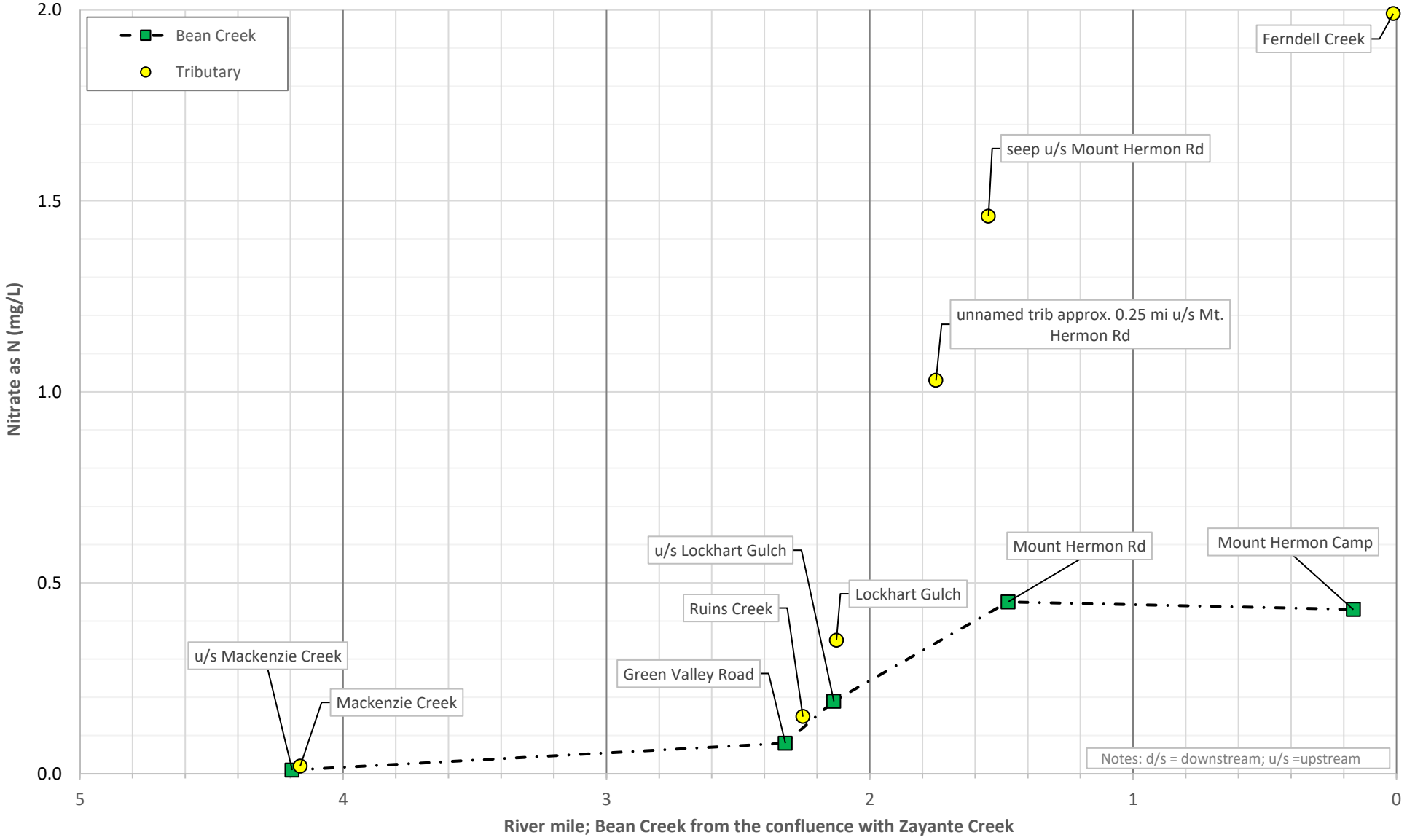


Figure 18. San Lorenzo River Nitrate as N from samples taken July 14, 2020, Santa Cruz County, CA

Balance Hydrologics



Balance Hydrologics

Figure 19. Bean Creek Nitrate as N from samples taken July 14, 2020, Santa Cruz County, CA

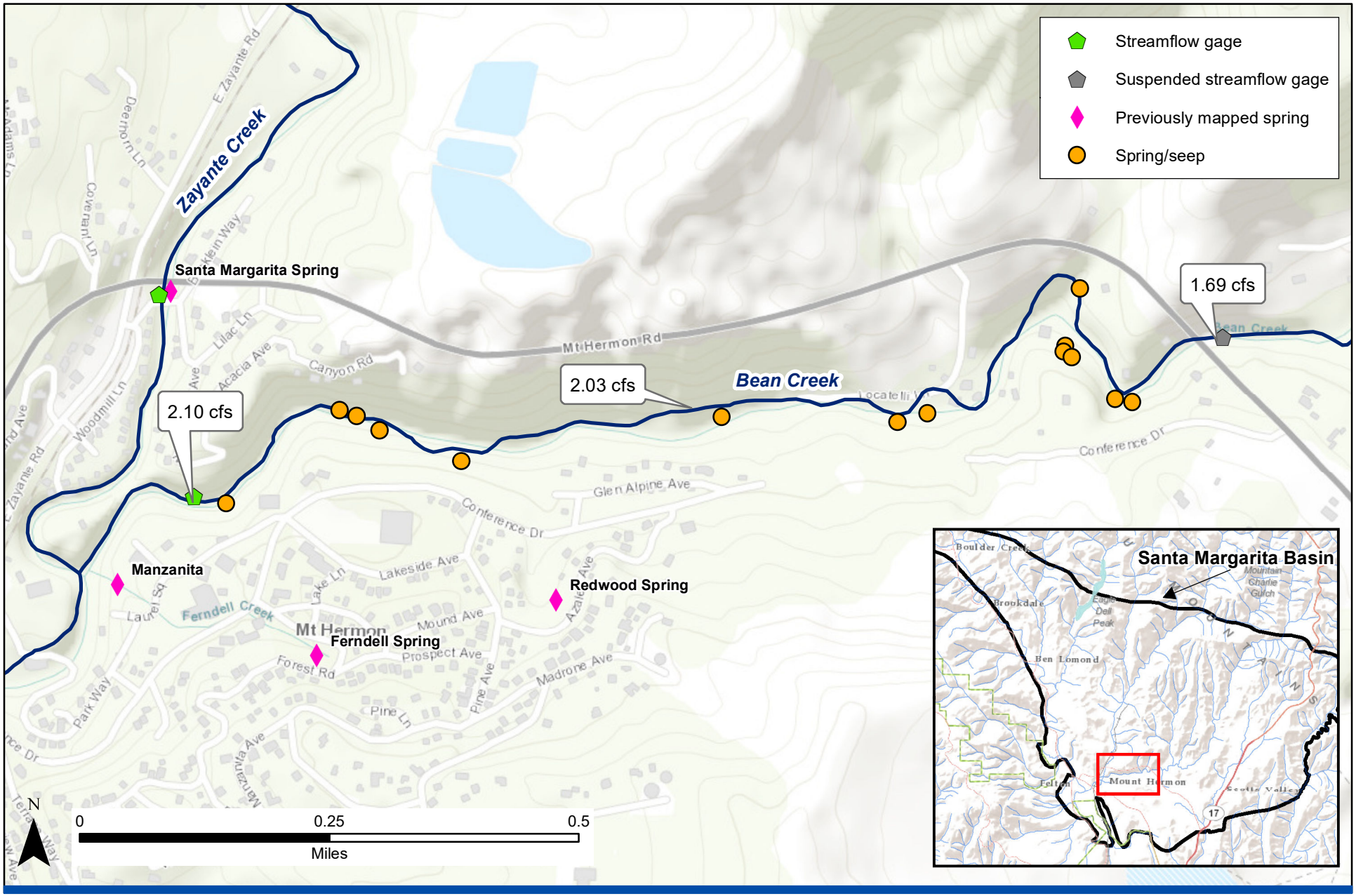


Figure 20. Accretion from springs and seeps mapped along Bean Creek October 12, 2020, Santa Cruz County, California

Streamflow was measured at three locations along Bean Creek. Measured flow is shown in text boxes.

Balance Hydrologics

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Basemap: ESRI 2021