Soquel Creek
Streamflow Monitoring Report
October 2020 – June 2022

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Trout Unlimited
By: Mia van Docto, Krysia Skorko and Tony Vojtech

1. Introduction

The Soquel Creek Watershed drains a basin approximately 42 mi^2 and empties into Monterey Bay between the cities of Santa Cruz and Watsonville, on the Central Coast of California (Figure 1). In 2017, the Resource Conservation District of Santa Cruz County (RCDSC) and Trout Unlimited (TU) received a grant from the Wildlife Conservation Board (WCB) to assess streamflow conditions in the Soquel Creek watershed and opportunities to improve summer streamflow for juvenile salmonids. As part of that grant, RCDSC and TU designed a gage network to better understand streamflow conditions in the upper portion of the watershed. When the grant funding for the gage network ended in 2020, the Santa Cruz Mid-County Groundwater Agency contract TU to continue operation of the gage network through June 2022. This report describes the data generated by the 4 streamflow gages in this study from WY2020-WY2022, and includes summaries of streamflow values for WYs 2021 – 2022.

Figure 1. Location of Soquel Creek watersheds.

2. Study Area and Methods

2.1 Watershed Characteristics

The upper Soquel Creek watershed is dominated by mixed conifer forests, comprised mainly of coastal redwood, tan oak, madrone and Douglas fir (RCDSCC 2019). Most of the study area is within unincorporated Santa Cruz County. Land use includes rural residential development, parks and recreation, mining, and timber harvesting. Roughly 25% of the headwaters of the Soquel Creek Watershed are State-protected lands (RCDSCC 2019). Logging has been conducted in the middle and upper watershed since the mid-nineteenth century (RCDSCC 2003). The focus area of this study is the upper portion of the watershed, starting at the lowest study gage above the confluence with Bates Creek.

2.2 Rainfall

The Soquel creek watershed has a Mediterranean climate like most of coastal California, with warm dry summers and cool wet winters. The Parameter-elevation Regression on Independent Slopes Model (PRISM), a precipitation model developed at Oregon State University, indicates that average precipitation throughout the watershed is extremely variable, with the lower portion receiving only slightly more than half the annual precipitation of upper region. PRISM data show 30 to 40 inches of rainfall in the lower half of the watershed annually, and more than 40 inches (and up to 60 inches across the northeast corner of the watershed) in the upper portion (Figure 2).

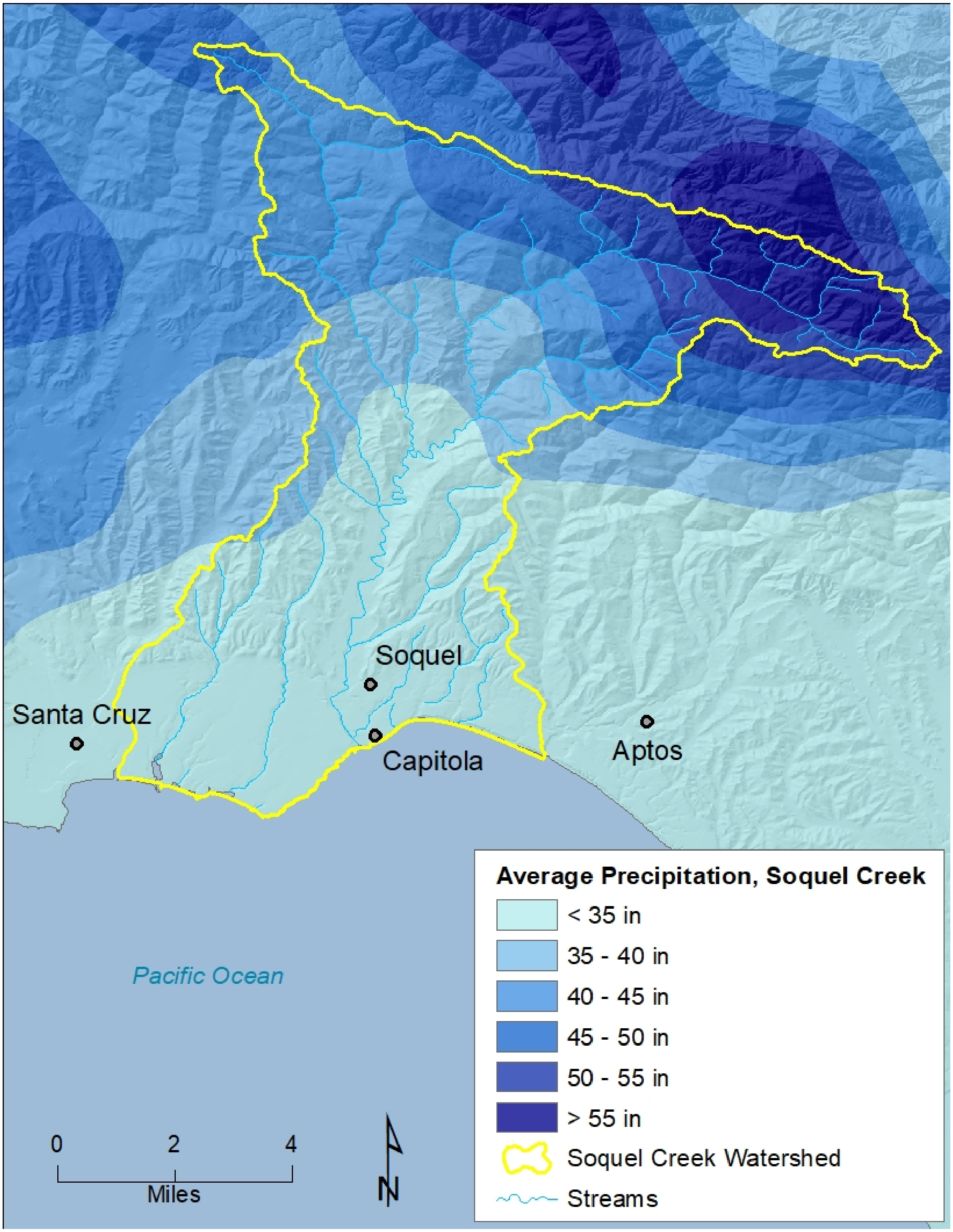


Figure 2. Average annual precipitation (inches) in the Soquel Creek watershed.

In the Soquel watershed, like similar systems, streamflow begins to recede at the end of the rainy season, usually in late spring and early summer. It is therefore important to analyze the timing and amount of rainfall in the watershed, as those factors can greatly influence summer flow conditions. Above-average rainfall and late-season rain events in the spring can increase summer baseflows and contribute to stream channels staying connected longer into the dry season.

Annual rainfall totals in this watershed are extremely variable. According to data collected beginning in 1951 from National Climate Data Center (NCDC) station in nearby Santa Cruz, CA (NCDC USC00047916, hereafter, Santa Cruz station), average rainfall is 29.6 inches, with significant variation between years (Figure 3). The study has included two years of below-average rainfall. The Santa Cruz station is located in the eastern portion of the city of Santa Cruz near the border with the town of Soquel, at an approximate elevation of 100 feet. Elevations in the watershed range from sea level to approximately 2,000 feet, so the Santa Cruz station rainfall data is likely representative of the rainfall occurring in the lower portion of this watershed. Rainfall in complex terrain such as the Soquel creek watershed can be highly spatially variable, and direct rain gage measurement in the area represents a single point measurement (the Santa Cruz station). The exact values across the watershed may not be represented by the Santa Cruz station, but we believe the overall patterns are representative and are relevant to the streamflow conditions we have monitored during the study.

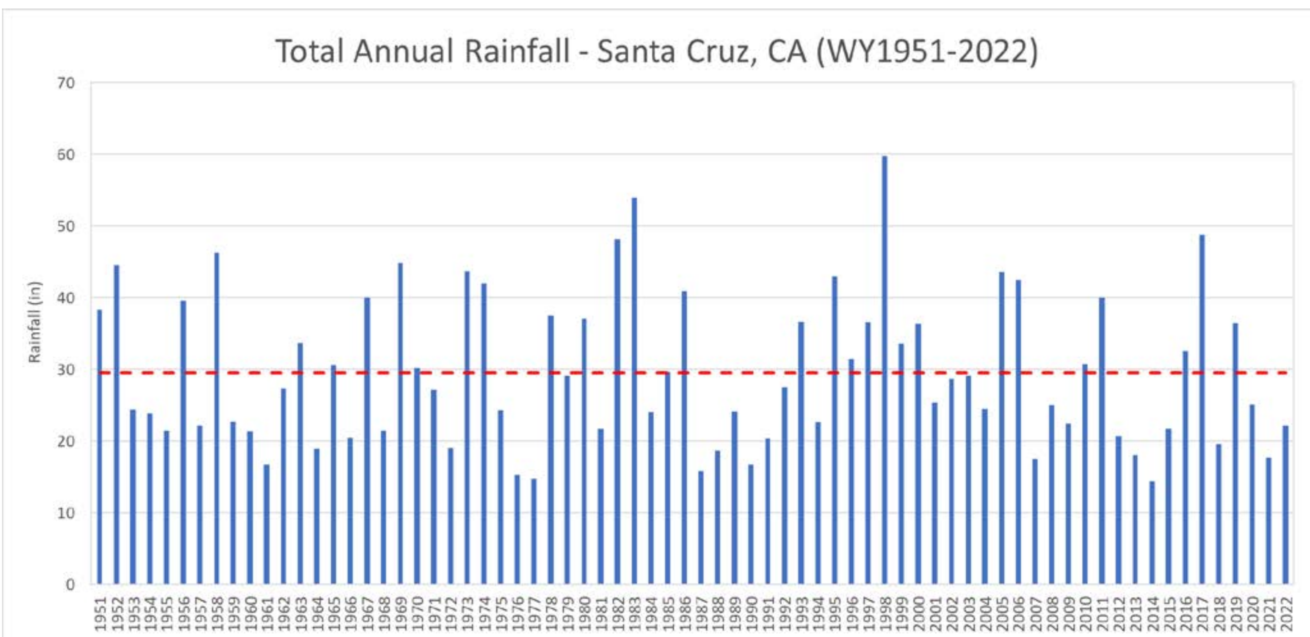


Figure 3 Annual precipitation (inches) during the period of record, WY1951-2022, collected at the NCDC Santa Cruz Station (USC00047916). The red dashed line represents the average annual rainfall (29.6 in) collected at the station.

In addition to the magnitude, the timing of rainfall also impacts summer baseflow conditions in the Soquel creek watershed (Figure 4). In WY2020, rainfall was low overall and spread throughout the winter season, with over half occurring in November and December. WY2021 was dry year, with 52% of the total annual rainfall occurring in January, and below average rainfall throughout the entire spring season. The largest storm of WY2021 occurred in late January; other notable storms took place in mid-December and mid-March. WY2022 was another dry year with 80% of the total annual rainfall occurring in October through December. The largest storm of WY2022 was a multi-day storm that took place in mid-December, and the second largest storm was in late October 2021. Conditions in January – March 2022 were exceptionally dry for the region, and only 8% of the total annual rainfall occurred during those months.

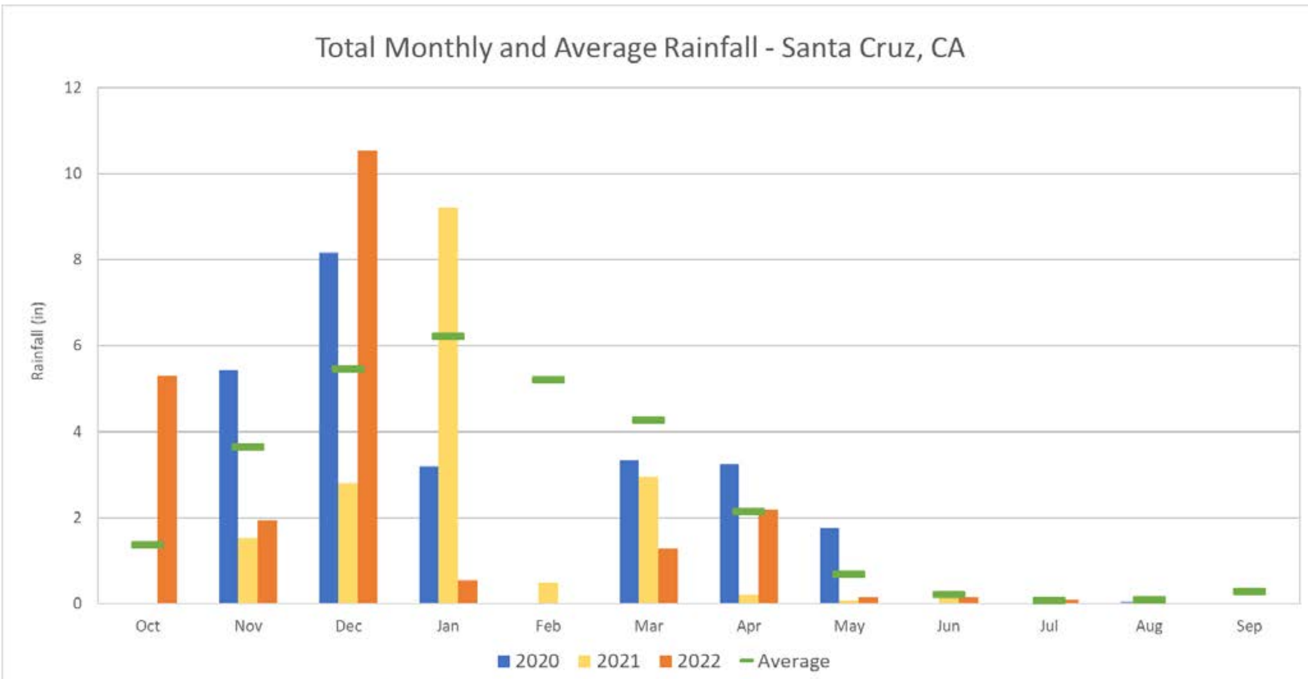
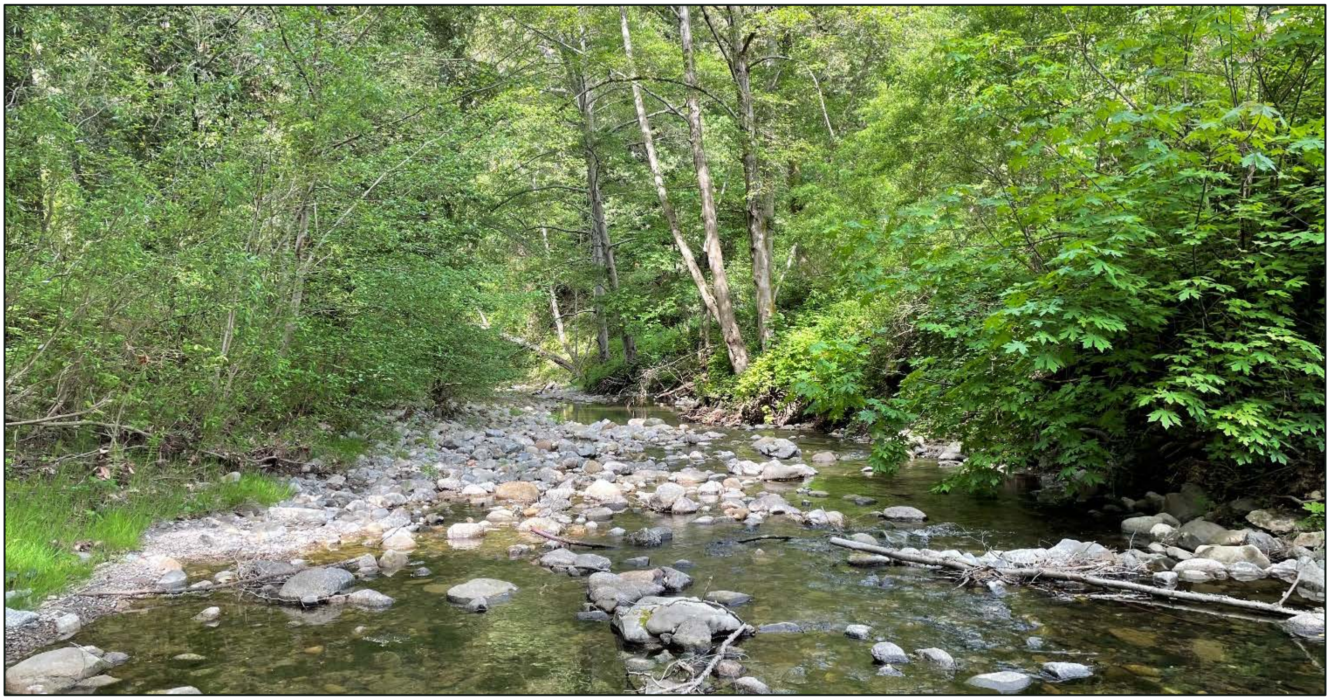


Figure 4. Monthly precipitation totals (inches) in the Soquel creek watershed during the period WY2020-WY2022, and monthly averages for the period of record (WY1951-WY2020) collected at the NCDC Santa Cruz Station (USC00047916).

2.3 Methods

In 2017 TU installed four gages in the Soquel Creek watershed (Figure 5). Each streamflow gage was operated following United States Geological Survey (USGS) standard procedures, as described in Rantz (1982). Streamflow measurements were collected approximately monthly using a Flow Tracker 2, following USGS protocols for measuring streamflow velocity (Turnipseed and Sauer, 2010). Using measured streamflow values, rating curves were developed to correlate streamflow with stage at each site. High flows were estimated using watershed scaling based on flows at the USGS gage (USGS 11160000 Soquel C A Soquel CA). In addition, we installed staff plates to detect pressure transducer drift and other factors that may cause phase shifts (i.e., changes in the relationship between stage and streamflow) over the course of the project.

Figure 5. Gage locations in the Soquel Creek watershed, with project gages in orange and the USGS gage in blue.



3. Streamflow Conditions

TU monitored streamflow conditions at four streamflow gaging stations in the Soquel Creek watershed: (Sq01) Soquel Creek above the West Branch, (Sq02) West Branch Soquel Creek, (Sq03) Soquel Creek above Bates Creek, (Sq04) Soquel Creek at the Quarry (Figure 5).

Figure 6 shows data from the gage (Sq04) Soquel Creek at the Quarry, for October 2021 through early June 2022. This gage is one of three gages on mainstem Soquel Creek, and is the gage located furthest upstream in the network. In October 2021, flows were at a low summer baseflow of approximately 0.7 ft^3/sec. Starting in November 2021, flows began to rise and fall with winter rainstorms, with the first flows rising above 10 ft^3/sec. The highest flows of the season were in late January and early February. Between storms, winter base flows ranged between about 2 and 3.5 ft^3/sec. The last larger winter storm of the season was in late March; following this storm flows gradually receded, reaching a summer baseflow of approximately 1.0 ft^3/sec in early July 2021. Flows dropped to the lowest of the season in early October 2021, with flows falling below 0.5 ft^3/sec.

Flows rose from their dry season lows in response to the late October 2021 storm, then fell to a winter baseflow of about 1.2 ft^3/sec. Flows rose and remained elevated during the December 2021 storms, receded in early winter, and rose again during larger late spring storms that occurred in March and April 2022. In early June 2022, the end of the data period, flows at this site were approximately 1.5 ft^3/sec.

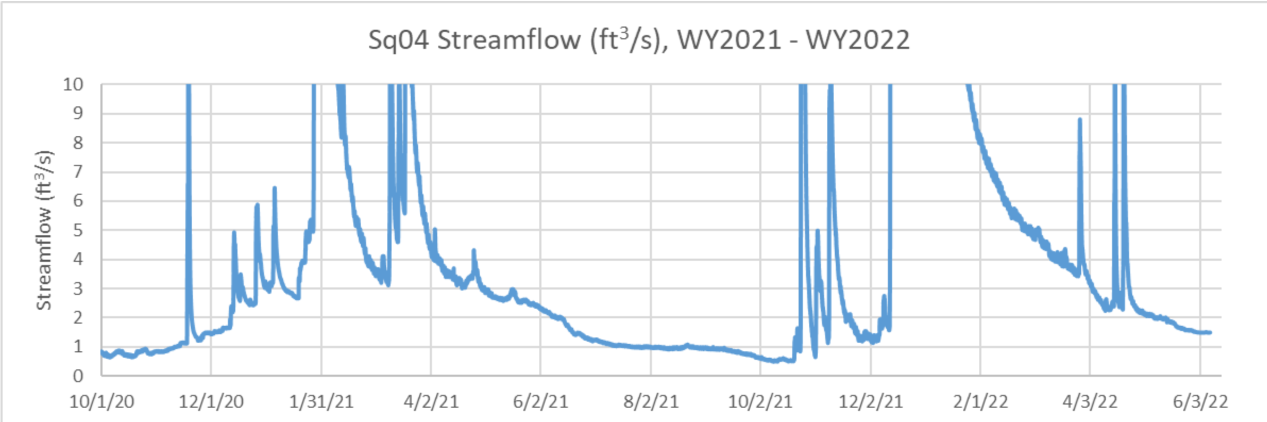


Figure 6. Streamflow conditions at (Sq04) Soquel Creek at the Quarry.

Figure 7 shows data from the gage (Sq01) Soquel Creek above the West Branch confluence, for October 2021 through early June 2022. This gage is the second gage downstream in the network of gages on mainstem Soquel Creek, located just upstream of the confluence with the West Branch of Soquel Creek. In October 2021, flows were at a low summer baseflow of approximately 0.6 ft^3/sec. Starting in November 2021, flows began to rise and fall with winter rainstorms, with the first flows rising to about 10 ft^3/sec. The highest flows of the season were in late January and early February. Between storms, winter base flows ranged between 0.5 and 3.5 ft^3/sec. The last larger winter storm of the season was in late March; following this storm flows gradually receded, reaching a low summer baseflow of approximately 0.1 ft^3/sec in early August. Flows approached disconnection in August, September, and early October, with flows dropping below 0.01 ft^3/sec during this time, the lowest dry season flows observed in the gage network.

Flows rose from their dry season lows in response to the late October 2021 storm, then fell to a winter baseflow of about 1 ft^3/sec. Flows rose and remained elevated during the December 2021 storms, receded in early winter, and rose again during the larger late spring storms that occurred in March and April 2022. In early June 2022, the end of the data period, flows at this site were 1.5 ft^3/sec.

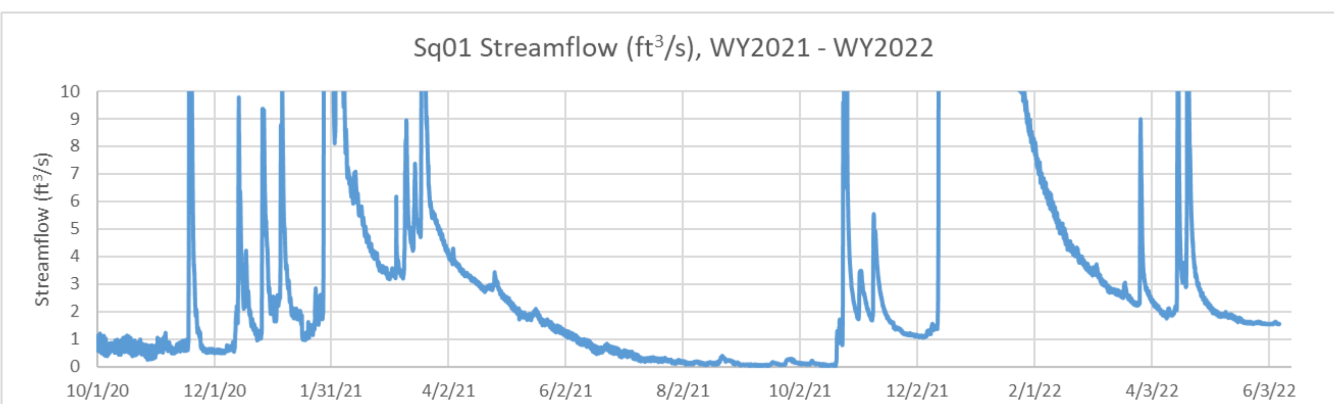


Figure 7. Streamflow conditions at (Sq01) Soquel Creek above the West Branch confluence.

Figure 8 shows data from the gage (Sq02) West Branch of Soquel Creek, for October 2021 through early June 2022. This gage is the sole gage located on the West Branch of Soquel Creek, and is located just upstream of the confluence with the mainstem of Soquel Creek. In October 2021, flows were at a summer baseflow of approximately 1 to 1.5 ft^3/sec. Starting in November 2021, flows responded to small early winter storms, but flows did not spike as high as in sites on the mainstem of Soquel Creek. As observed in the mainstem, the highest flows of the season were in late January and early February. Between storms, winter base flows ranged between 1.5 and 2 ft^3/sec. As flows receded following the last larger winter storm in late March, reaching a baseflow of 0.5 to 1.5 ft^3/sec. Flows in this branch of the watershed were lower than the mainstem during the winter, but maintained a higher summer baseflow than observed at the Sq01 gage, suggesting flows in this branch are less flashy than the mainstem.

Flows rose from their dry season lows in response to the late October 2021 storm, then fell to a winter baseflow of about 1.5 ft^3/sec. Flows rose and remained elevated during the December 2021 storms, receded in early winter, and rose again during the larger late spring storms that occurred in March and April 2022. In early June 2022, the end of the data period, flows at this site were 1.3 ft^3/sec, similar to those observed at upstream mainstem sites.

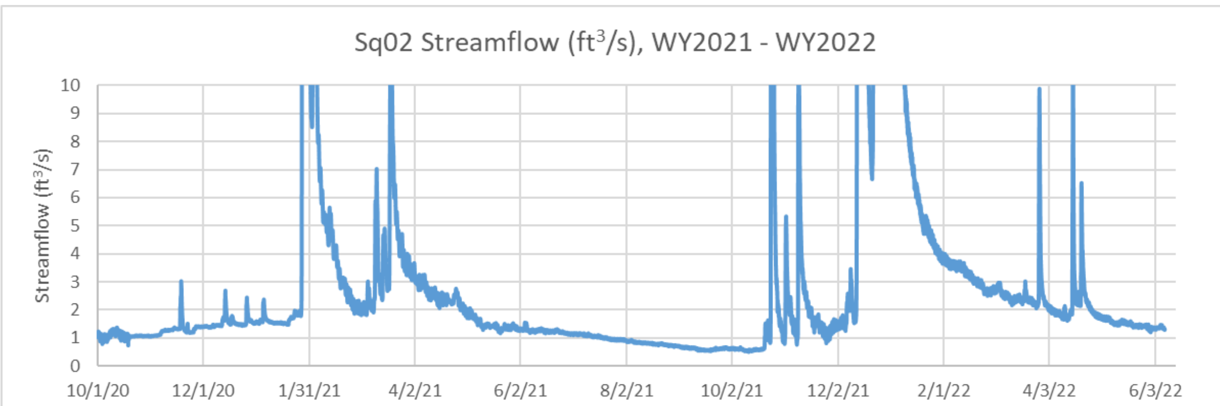


Figure 8. Streamflow conditions at (Sq02) West Branch of Soquel Creek.

Figure 9 shows data from the gage (Sq03) Soquel Creek above Bates Creek, for October 2021 through early June 2022. This gage is the furthest downstream in the network, located in the mainstem channel below the confluence of the West Branch, and just upstream of the confluence with Bates Creek. In October 2021, flows were the highest of any gage in the network, with summer baseflows of 2 ft^3/sec. Starting in November 2021, flows began to rise and fall with winter rainstorms. As seen at the gages upstream, the highest flows of the season were in late January and early February. Between storms, winter base flows ranged between about 4 and 7 ft^3/sec. The last larger winter storm of the season was in late March; following this storm flows receded steadily through the spring and early summer, eventually reaching a baseflow of 1.10.5 ft^3/sec. In early October 2021, flows briefly dropped below 0.5 ft^3/sec.

Flows rose from their dry season lows in response to the late October 2021 storm, then fell to a winter baseflow of about 3 ft^3/sec. Flows rose and remained elevated during the December 2021 storms, receded in early winter, and rose again during the larger late spring storms that occurred in March and April 2022. In early June 2022, the end of the data period, flows at this site were approximately 3 ft^3/sec, the highest flow observed at all gages in the network.

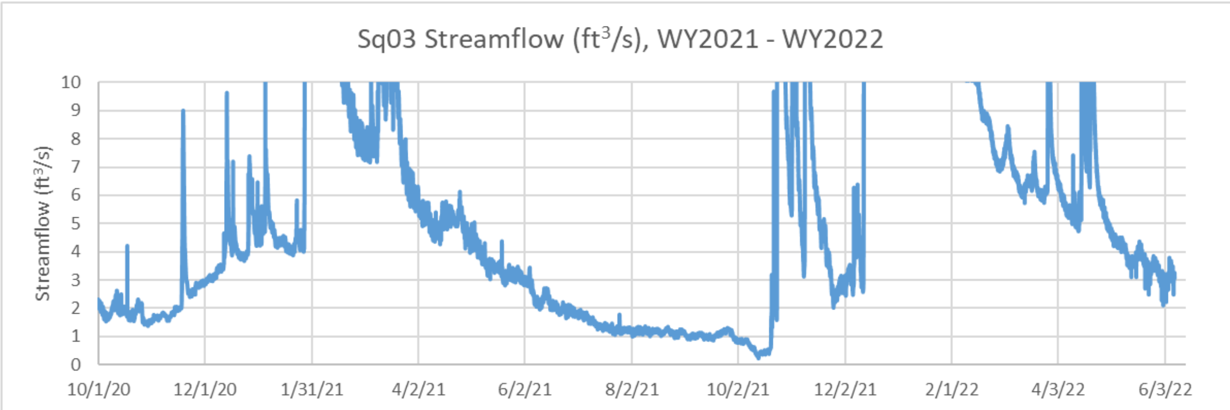


Figure 9. Streamflow conditions at (Sq03) Soquel Creek above Bates Creek.

4. Conclusion

The gage data presented in this report represent two dry years. Rainfall in WY2021 was 17.2 inches, 40% less than average and rainfall in WY2022 (thru August 2022) was 22.2 inches, approximately 25% less than average. Out of the four gage study sites, lowest summer baseflows observed at (So01) Soquel Creek above the Confluence with West Branch. Based on TU's human water demand analysis conducted as part of the WCB streamflow enhancement grant (RCDSCC 2019), the loss in flow at this site could be impacted by the residential houses upstream of the gage as well as potential near stream groundwater pumping. Gage site (Sqo3) Soquel Creek above Bates Creek consistently gained flow from its upper tributaries thought the year, with the highest flows in the network consistently observed. Streamflow at gage site (Sq02) West Branch Soquel Creek were lower than the mainstem during the winter but maintained a higher summer baseflow than observed at the nearby mainstem gage site (Sq01) Soquel Creek at the Quarry, suggesting flows in this branch are less flashy than the mainstem.

References

Rantz, S.E. and others. 1982. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. Geological Survey Water-Supply Paper 2175. Washington, D.C.: GPO.

Resource Conservation District of Santa Cruz County (RCDSCC). 2019. Soquel Creek Streamflow Assessment Study.

Resource Conservation District of Santa Cruz County (RCDSCC). 2003. Soquel Creek Watershed Assessment and Enhancement Plan.

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p. (Available at http://pubs.usgs.gov/tm/tm3-a8/.)