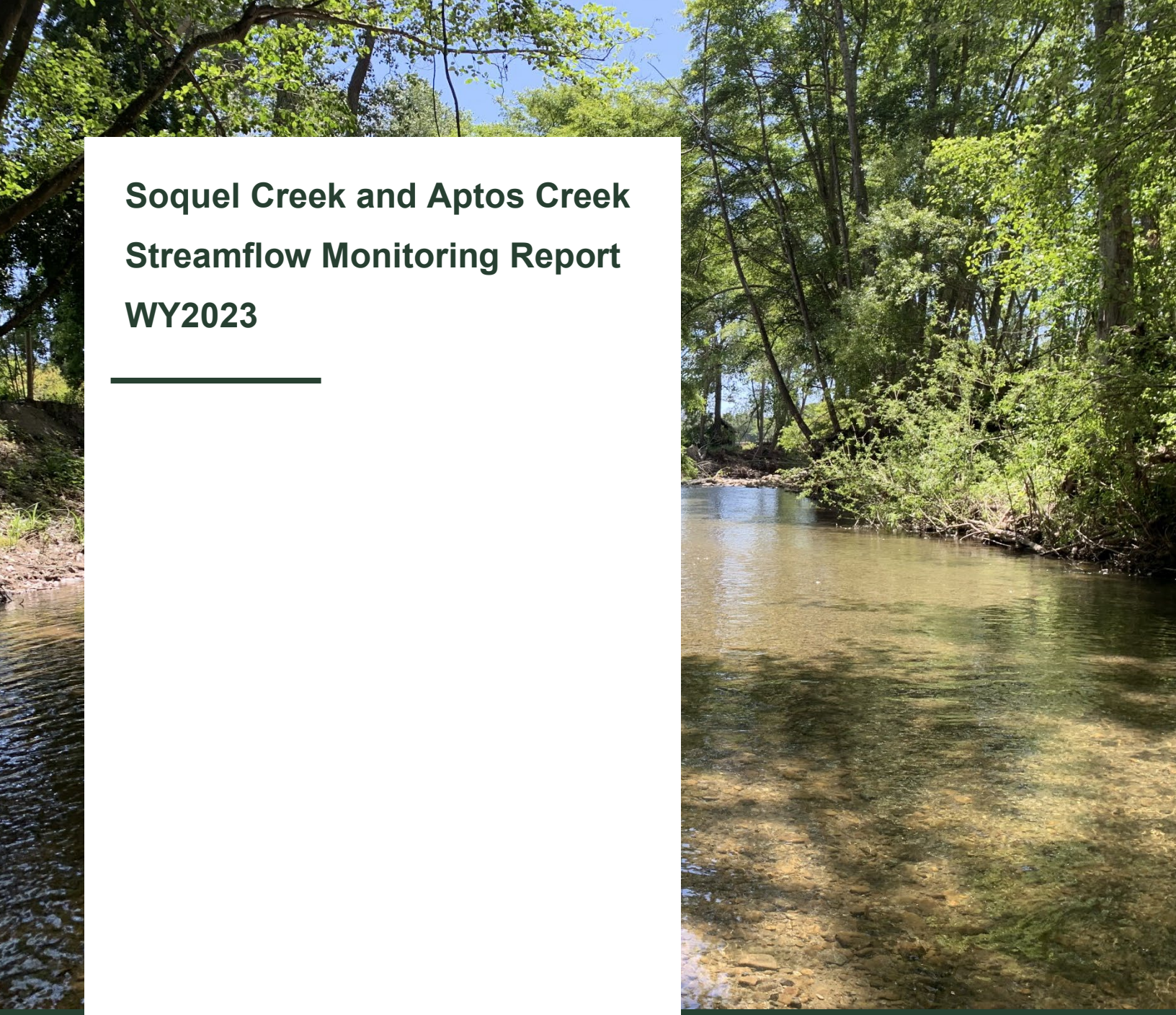

Soquel Creek and Aptos Creek Streamflow Monitoring Report WY2023

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1. Introduction

In 2022, Trout Unlimited (TU) was awarded a 3-year contract from the Santa Cruz Mid-County Groundwater Agency (MGA) to perform dry season (May through October) streamflow and year-round groundwater monitoring in the Santa Cruz Mid-County Groundwater Basin (Basin). The monitoring will inform evaluations of sustainable groundwater management as part of the MGA's 2019 Groundwater Sustainability Plan (GSP). The MGA GSP seeks to avoid undesirable results for five sustainability indicators: groundwater level declines, groundwater storage reductions, interconnected surface water depletion, seawater intrusion, and water quality degradation. The TU monitoring effort will primarily help assess interconnected surface water depletion while contributing to a larger data collection effort by MGA in assessing long-term groundwater levels. In WY2023, TU monitored stream conditions at 6 priority locations in the Basin. This report provides the results of the first year of streamflow monitoring. Funding for this project has been provided in part from the Budget Act of 2021 and through an agreement with the State Department of Water Resources.

2. Study Area

Watershed Characteristics

The Soquel Creek and Aptos Creek watersheds are coastal drainages 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. Soquel Creek drains approximately 42 sq. miles, and Aptos Creek drains approximately 25 sq miles. Land use in Soquel Creek 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). Land use in the Aptos Creek Watershed includes more than 50% forested and state park lands; other land uses include urban and rural residential. There is both historical and modern-day logging on these lands (SCC Environmental Health Dept). Both creeks provide important coho salmon and steelhead trout habitat (RCDSCC 2019).

Rainfall

The Soquel Creek and Aptos Creek watersheds have 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 an average

30 to 40 inches of rainfall annually, and rainfall averages of up to 60 inches in the higher elevation portions of the watersheds. Figure 1 shows rainfall data collected beginning in 1951 from National Climate Data Center (NCDC) station in nearby Santa Cruz, CA (NCDC USC00047916, hereafter, Santa Cruz station). 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. The data show that the long-term annual average rainfall here is 29.8 inches. Rainfall in WY2023 was 46.1 inches, well above the long-term average.

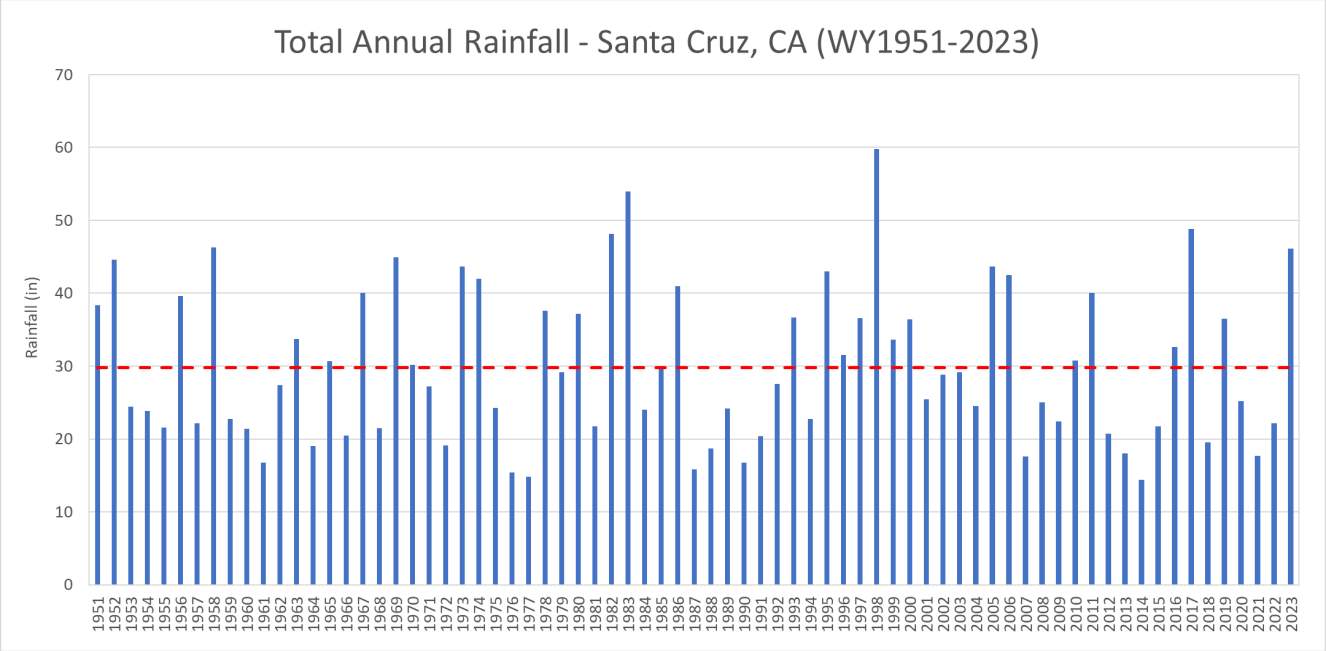

Figure 1. Annual precipitation (inches) during the period of record, WY1951-2023, collected at the NCDC Santa Cruz Station (USC00047916). The red dashed line represents the average annual rainfall (29.8 in) collected at the station.

Monitoring Sites

Figure 2 shows the locations of the gages on Soquel Creek and Aptos Creek. Soquel Creek has four gages in both the upper and lower reaches of the watershed. Soquel Creek at the Quarry (Sq04) is the uppermost gage, just downstream of the confluence with Hinckley Creek. Next downstream is East Branch Soquel above West Branch (Sq01). Next downstream is the Soquel at Mountain Elementary gage (Sq06). Furthest downstream is the Soquel at Cherryvale gage (Sq05), which is upstream of the confluence with Bates Creek. The two gages on Aptos Creek are in the lower portion of the watershed; Aptos at County Park (Ap01) is upstream of Highway 1 and Aptos below Highway 1 (Ap02) is downstream.

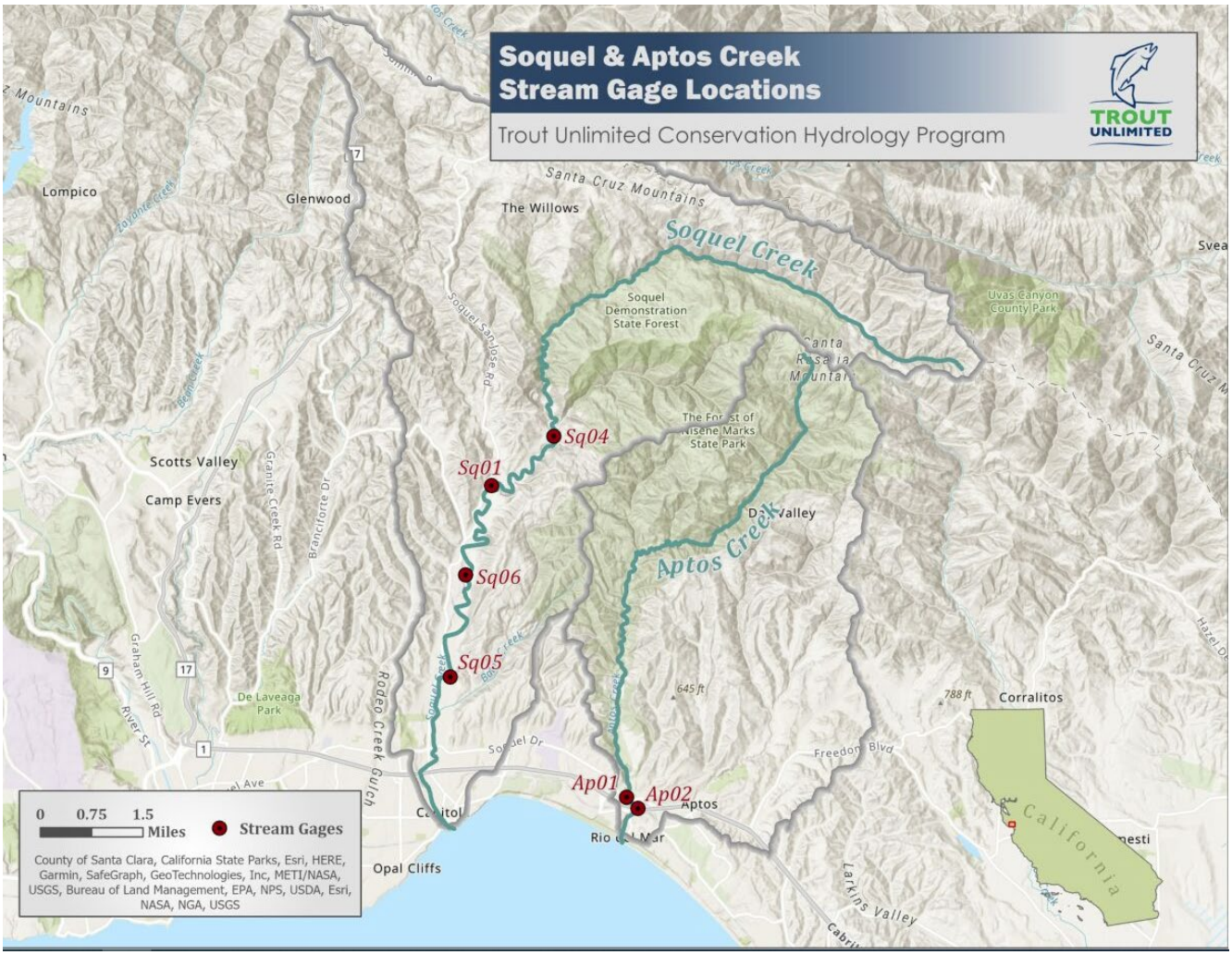

Figure 2. Location of Soquel Creek and Aptos Creek streamflow gages.

3. Streamflow and Conductivity Conditions

Streamflow

TU began monitoring at the gage network in May of 2023. 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). Staff plate readings were used 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 and to tie data in to surveyed benchmarked. Using measured streamflow values, rating curves were developed to correlate streamflow with stage at each site. Manual measurements of temperature and conductivity were collected using a handheld YSI probe.

Figure 3 shows 15-minute streamflow at the four Soquel Creek gages from May through October 2023. In early May, streamflow was highest at site Sq05 (Soquel at Cherryvale), the lowest gage in the watershed, at around 35 ft^3/sec. Flows at the next gage downstream (Sq06, Soquel at Mountain Elementary) were nearly as high, with flows approximately 31 ft^3/sec. Flows in the upper portions of the watershed were lower; flows at Sq01 (East Branch Soquel above West Branch) were approximately 22 ft^3/sec, and the highest gage in the watershed (Sq04, Soquel Creek at the Quarry), had the lowest flows of approximately 17 ft^3/sec. Flows receded quickly through May and early June, rising slightly in late June due to early summer rain events, and receded to baseflow in late August, September and October. The lower portion of the watershed consistently gained flow

from the upper portion, and baseflows remain higher at the lower gage (Sq05, Sq06) than at the upper watershed gages. The lower watershed gages show a higher level of variability and daily fluctuations.

Figure 4 shows 15-minute streamflow at the two Aptos Creek gages from May through October 2023. Because of its smaller watershed size, flows are lower than in Soquel Creek. Flow at the upstream site (Ap01) starts out slightly higher than at the downstream site (Ap02) in May, at approximately 9 and 7 ft^3/sec, respectively. This relationship reverses briefly in late June and early July, but by the time the sites recede to baseflow in early September, flows are still slightly higher at the upstream site. These gages are low in the watershed, and similar to the gages in lower Soquel Creek, show high variability and daily fluctuations.

Analysis of data from Sq05, Sq06, Ap01 and Ap02 at a daily time step show that the sensors picked up fluctuations in stage that do not match typical diurnal patterns. This variability could be caused by sensor sensitivity limitations and the locations of the gages. Due to nature of the reach conditions TU had to work with, these gages are in pools with higher near-bed velocity gradients than the upper watershed gage pools (Sq01 and Sq04). The reaches' more turbulent nature causes water levels to vary more frequently, resulting in slightly noisier data.

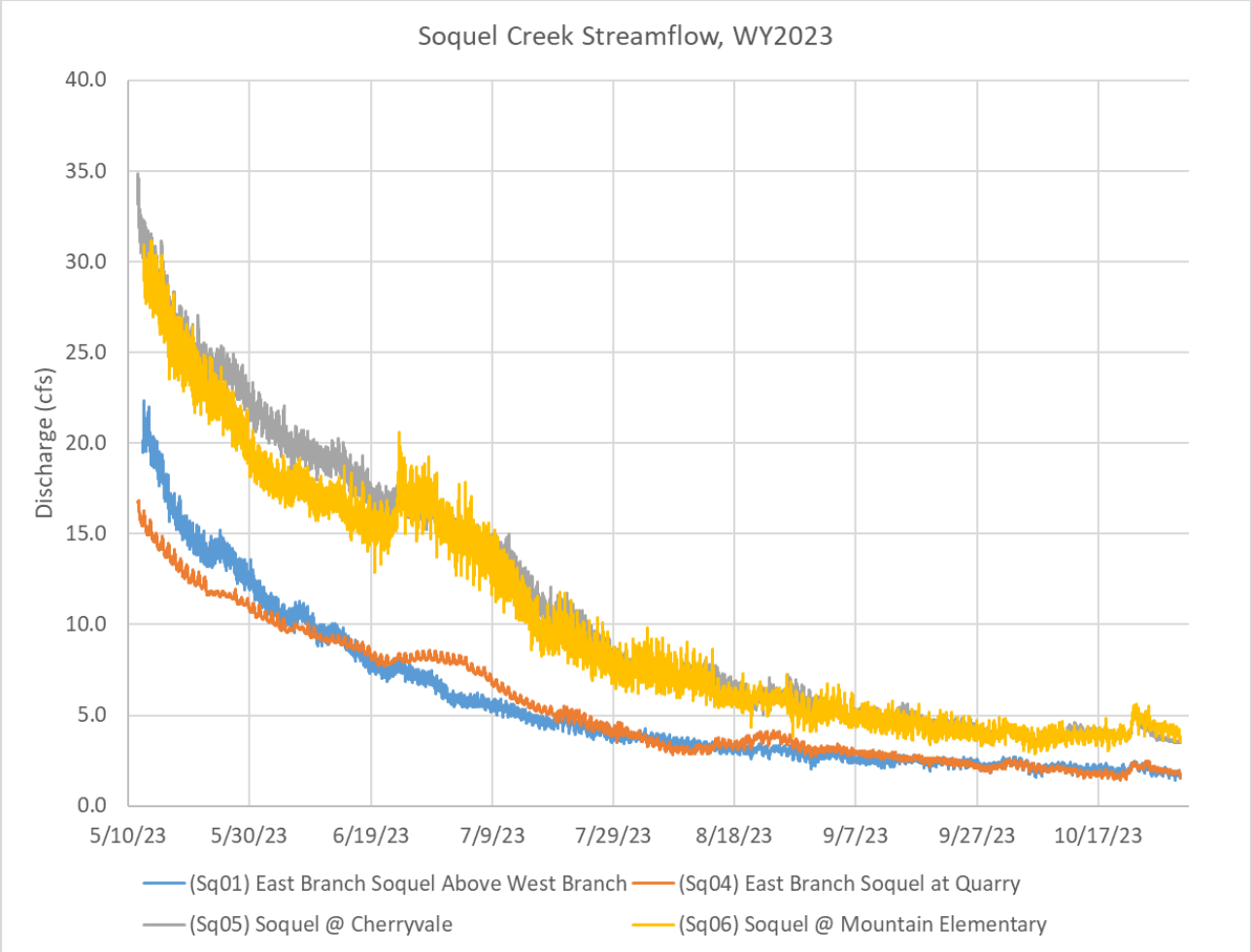

Figure 3. Streamflow conditions in Soquel Creek, at all gage sites in WY2023.

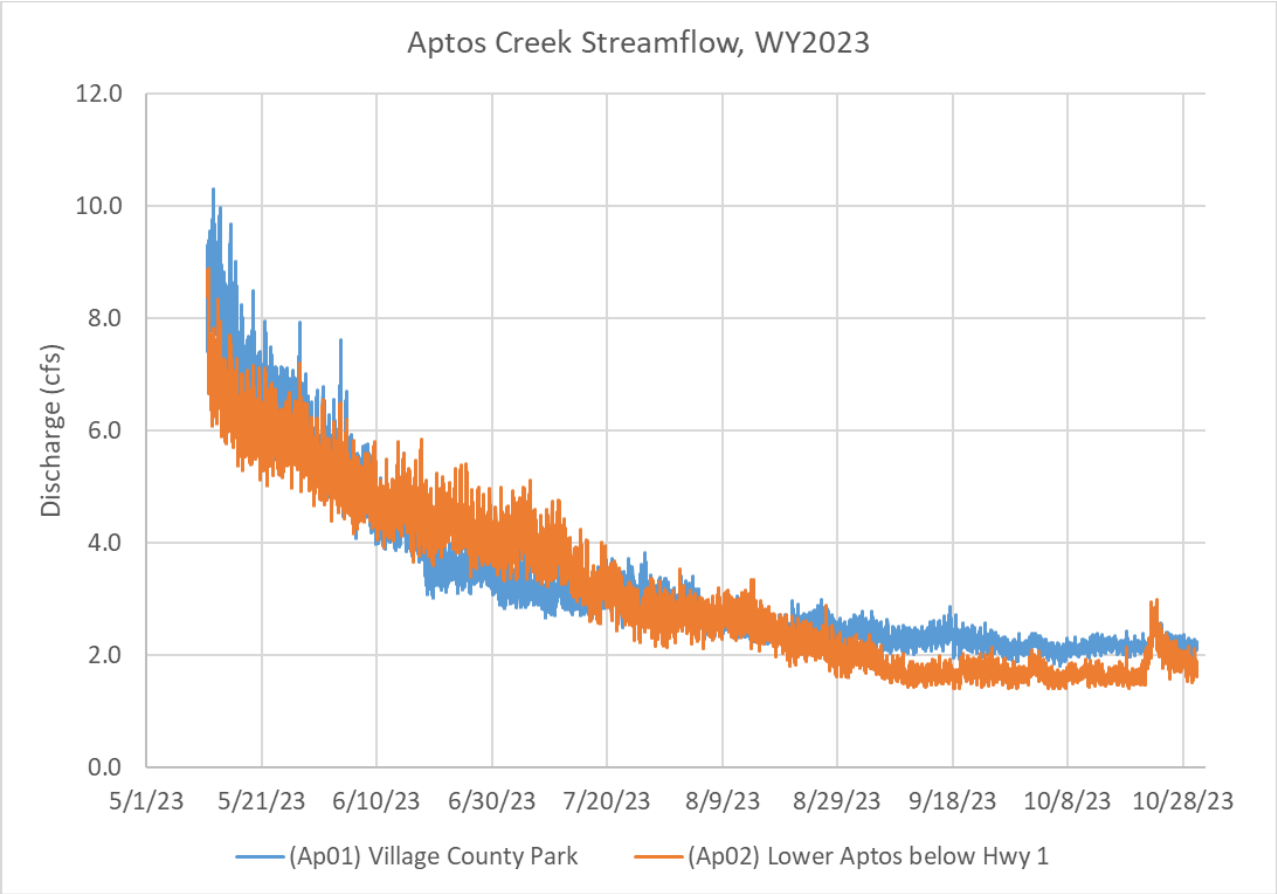

Figure 4. Streamflow conditions at Aptos Creek, WY2023.

Conductivity

Manual field measurements of temperature, actual conductivity and specific conductivity at 25 degrees C were made in August and September of 2023, the results are shown in Table 1. Conductivity is a measure of the ability of water to pass an electrical current. Each body of water has a baseline conductivity that is considered to be its normal range, often dictated by local geology. It can be affected by rain, spring water inputs, minerals, tides and mixing zones and evaporation. The normal range for freshwater streams is between 100 and 2,000 µs/cm (SWRCB 2002). According to the EPA, because dissolved salts and other inorganic chemicals conduct electrical current, conductivity increases as salinity increases.

Comparison of the specific conductivity measurements in Table 1 shows that at each site, conductivity increased between August and September as streamflow decreased, but all measurements remained within the normal range for freshwater streams. Specific conductivity at the Aptos sites were similar to each other between sites. The highest conductivities in the Soquel watershed were observed in the upper reaches of the watershed, at the Soquel at the Quarry and EB Soquel above West Branch sites, with lower conductivities observed at the further downstream sites.

Site	Date/Time	Water Temperature (deg C)	Actual Conductivity at Field Temp (µs/cm)	Specific Conductivity at 25 deg C (µs/cm)
(Ap01) Village County Park	8/14/2023 10:52	16.8	706	837
(Ap01) Village County Park	9/13/2023 10:03	15.3	735	902
(Ap02) Lower Aptos below Hwy 1	8/14/2023 16:52	19.1	706	796
(Ap02) Lower Aptos below Hwy 1	9/13/2023 10:51	15.4	737	902
(Sq01) EB Soquel Above West Branch	8/14/2023 12:01	18.4	862	986
(Sq01) EB Soquel Above West Branch	9/13/2023 14:02	16.9	916	1084
(Sq04) East Branch Soquel at Quarry	8/14/2023 13:20	18.6	892	1016
(Sq04) East Branch Soquel at Quarry	9/13/2023 12:59	16.1	961	1158
(Sq05) Soquel @ Cherryvale	8/14/2023 16:00	26.4	761	741
(Sq05) Soquel @ Cherryvale	9/13/2023 11:59	16.6	783	933
(Sq06) Soquel @ Mountain Elementary	8/14/2023 14:34	21.1	757	818
(Sq06) Soquel @ Mountain Elementary	9/13/2023 14:56	18.5	790	902

Table 1. Temperature, actual conductivity and specific conductivity measurements, Soquel and Aptos Creeks, WY2023.

4. Conclusions

The gage data presented in this report represent a wetter than average year. Rainfall in WY2023 was 46.1 inches, more than 50% higher than average of 29.8 inches. All of the gage sites monitored remained flowing throughout the dry season, and specific conductivity remained relatively low. Out of the four gages on Soquel Creek, summer baseflows were highest in the lower portions of the watershed and lowest in the upper portions of the watershed. In Aptos Creek, the downstream gage generally had lower flows than the upstream gage. Flow in the lower portion of both watersheds show higher than expected daily fluctuation in streamflow that could not be explained by diurnal variability. Potential causes of the variability include sensor sensitivity limitations and the gages being in higher near-bed velocity gradient pools. If the MGA would like to try to reduce this variability, TU could try using a higher quality sensor at these sites in the future. This report represents the first full year of data collection at these gages. Streamflow will continue to be monitored and comparison of multiple years of gaging will provide further insights into streamflow dynamics.

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