

Lower Mill Creek Surface Water & Groundwater Interactions Report for Water Years 2018 – 2020

**Trout Unlimited
June 2021**



1. Introduction

The Mill Creek Watershed located in the Russian River basin and is tributary to Dry Creek. It drains an approximately 24 square mile basin with headwaters near Venado, CA, and a confluence with Dry Creek near Healdsburg, CA (Figure 1). The Mill Creek Watershed is an important watershed within the Russian River basin for coho recovery, NMFS's CCC Coho Recovery Plan identifies Mill Creek as a Core Area for Coho protection and restoration (NMFS, 2012).

In 2009 the Russian River Coho Water Resources Partnership (Coho Partnership) was established to implement the National Fish and Wildlife Foundation (NFWF) Keystone Initiative Business Plan for coho salmon in the Russian River. Mill Creek was chosen as a focal watershed because it provided the critical intersection of feasibility of salmon restoration, degree of impairment of stream by diminished flows, landowner interest in collaboration, importance to coho salmon, range of land and water uses with the potential to demonstrate a variety of solutions, and federal and state recovery plan prioritization (Russian River Water Resources Coho Partnership, 2015). Trout Unlimited (TU) and formerly CEMAR has been monitoring streamflow conditions in the upper reaches of the Mill Creek watershed since 2010 as part of the Coho Partnership.

California Sea Grant's (CSG) Russian River Coho Salmon Monitoring Program conducts on going monitoring of salmonid populations in tributaries to the lower Russian River and has been monitoring salmonid populations in the Mill Creek watershed as part of the Coho Partnership. CSG biologists maintain Passive Integrated Transponder (PIT) tag antennas in the Mill Creek watershed to track the movement of PIT-tagged program coho at all life stages, as well as a downstream migrant smolt trap on the lower reach of Mill Creek. Additional CSG fish monitoring activities in the Mill Creek watershed include spawner surveys, snorkel surveys and wetted habitat surveys. CSG's surveys reported that the majority of coho salmon and steelhead trout spawn in the

lower reach of Mill Creek. While the ecological importance of this lower reach is understood, TU's gage network did not cover this area and the reach's hydrologic character was not well understood.

In 2017 the Sonoma Resource Conservation District (SRCD), TU and O'Connor Environmental, Inc. (OEI) received a grant from the Wildlife Conservation Board (WCB) to investigate streamflow conditions in the lower reach of Mill Creek, and to develop a comprehensive integrated hydrologic model of the Mill Creek watershed. The surface water/groundwater monitoring study in the lower reach of Mill Creek involves groundwater and surface water data collection to investigate the relationship between surface flow and groundwater conditions to determine whether streamflow enhancement projects can increase streamflow to benefit habitat for over-summering juvenile salmonids in this reach. Figure 2 shows the location of the groundwater and surface water gages in the lower reach of Mill Creek in relationship to TU's existing gage network in the upper portion of the watershed. This report describes the results of TU's three years of monitoring.

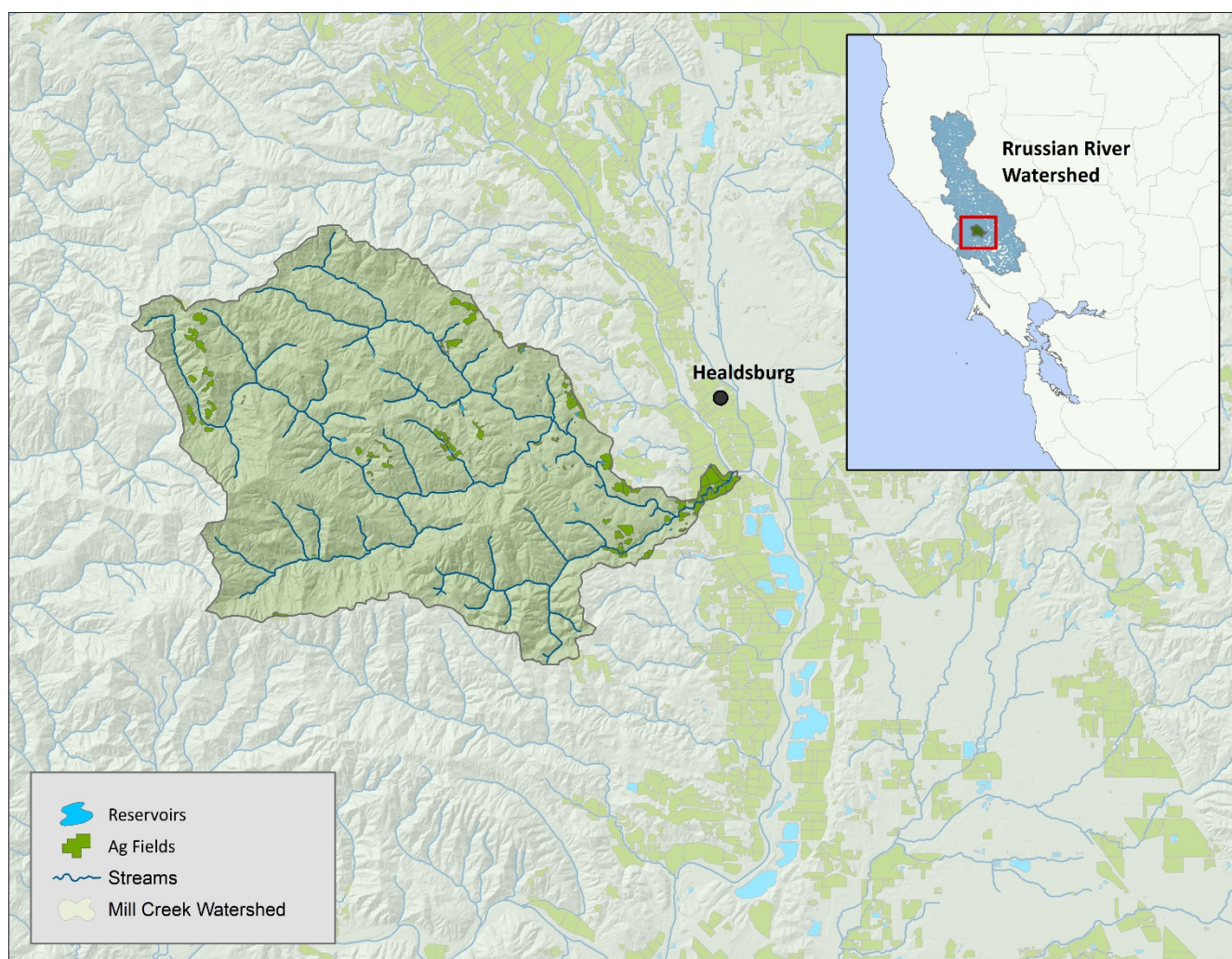


Figure 1. Location of the Mill Creek watershed in the Russian River, Ca.

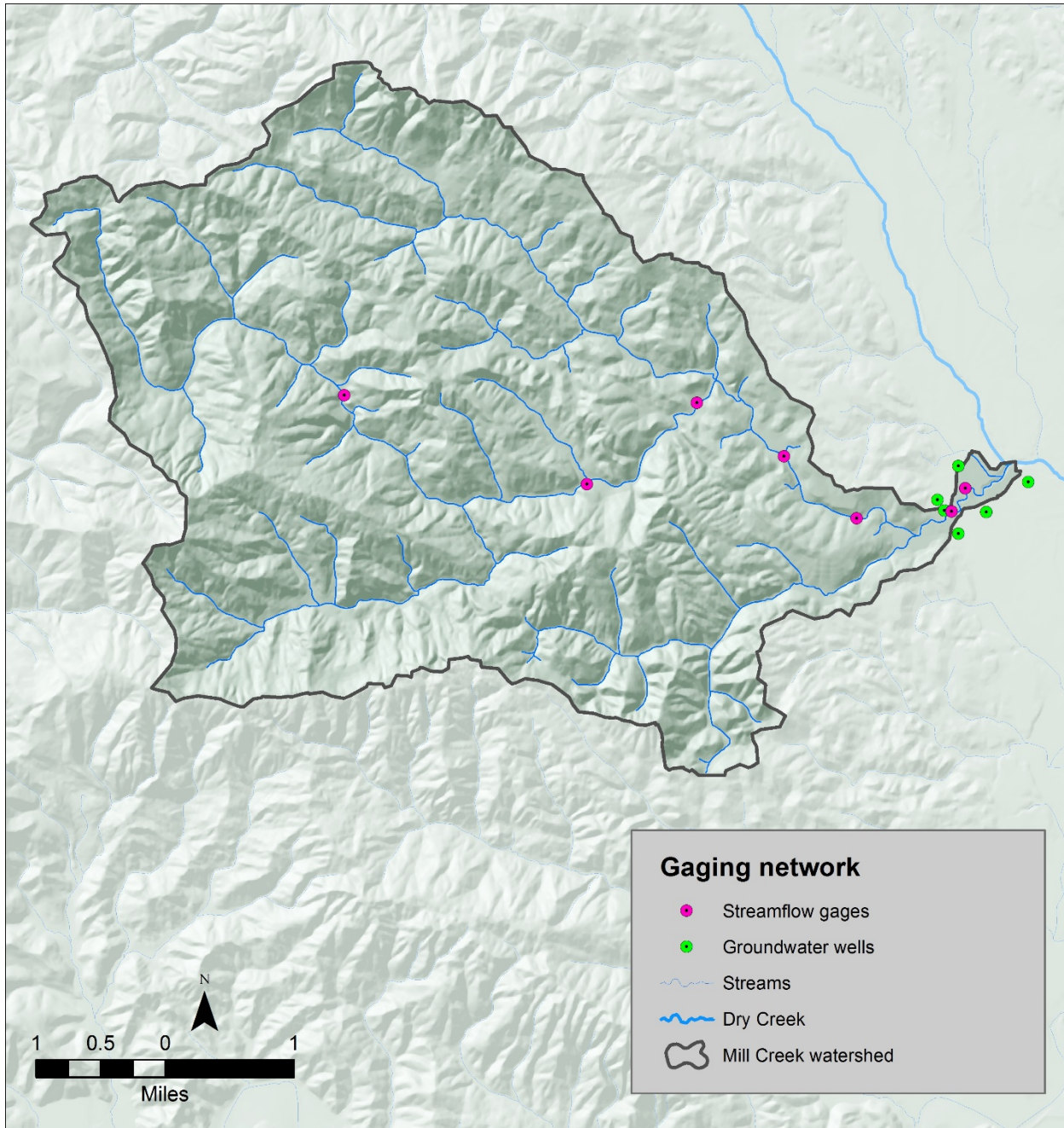


Figure 2. TU's streamflow and groundwater gage network in the Mill Creek watershed, red box indicates monitoring sites for this study.



2. Study Site and Methods

Site Characteristics

The lower portion of Mill Creek flows out of a confined bedrock canyon into a broad alluvial valley before joining Dry Creek, which then flows into the Russian River. The reach is highly incised and disconnected from its floodplain. The surrounding floodplain is primarily used for vineyards and small-scale agriculture. Due to the permeable nature of the underlying alluvial sediments in this reach, surface flows can be absorbed into the channel bed and underlying aquifers, causing the lower reaches of the channel to dry out in the summer months.

Rainfall

The climate patterns of the Mill Creek watershed are characteristically Mediterranean: summers are warm and dry, and winters are wet and cool. Precipitation occurs almost exclusively as rainfall and mostly during the winter season. The Mill Creek watershed receives 49 inches of rainfall in an average year, with up to 54 inches occurring at higher elevations in the upper portion of the watershed and around 40 inches occurring at lower elevations (Figure 3), including the area that comprises Lower Mill Creek (Russian River Water Resources Coho Partnership, 2015).

Rainfall data collected over a 79-year period recorded at the nearest city, Healdsburg, CA (approximately 1 mile from the Mill Creek watershed), show that 90 percent of the average annual rainfall occurs during the wet half of the year November through April; less than 2 percent of the average annual rainfall occurs from June through September (Figure 4). While the total amount of rainfall may be variable from one year to the next, the seasonality of precipitation is consistent among all years.

These long-term records indicate that rainfall can be variable from one year to the next. Over the 79-year period 1941 to 2020, annual rainfall has varied from as low as 16 inches to as much as 83 inches, with

extended periods of low and of high rainfall throughout the historical record (Figure 5). Most notably, the drought of 2012-2015 represents one of two periods of below-average rainfall for four or more consecutive years: the other was 1989-1992. All three years of the study period (2018 – 2020) experienced below-average rainfall (Figure 6).

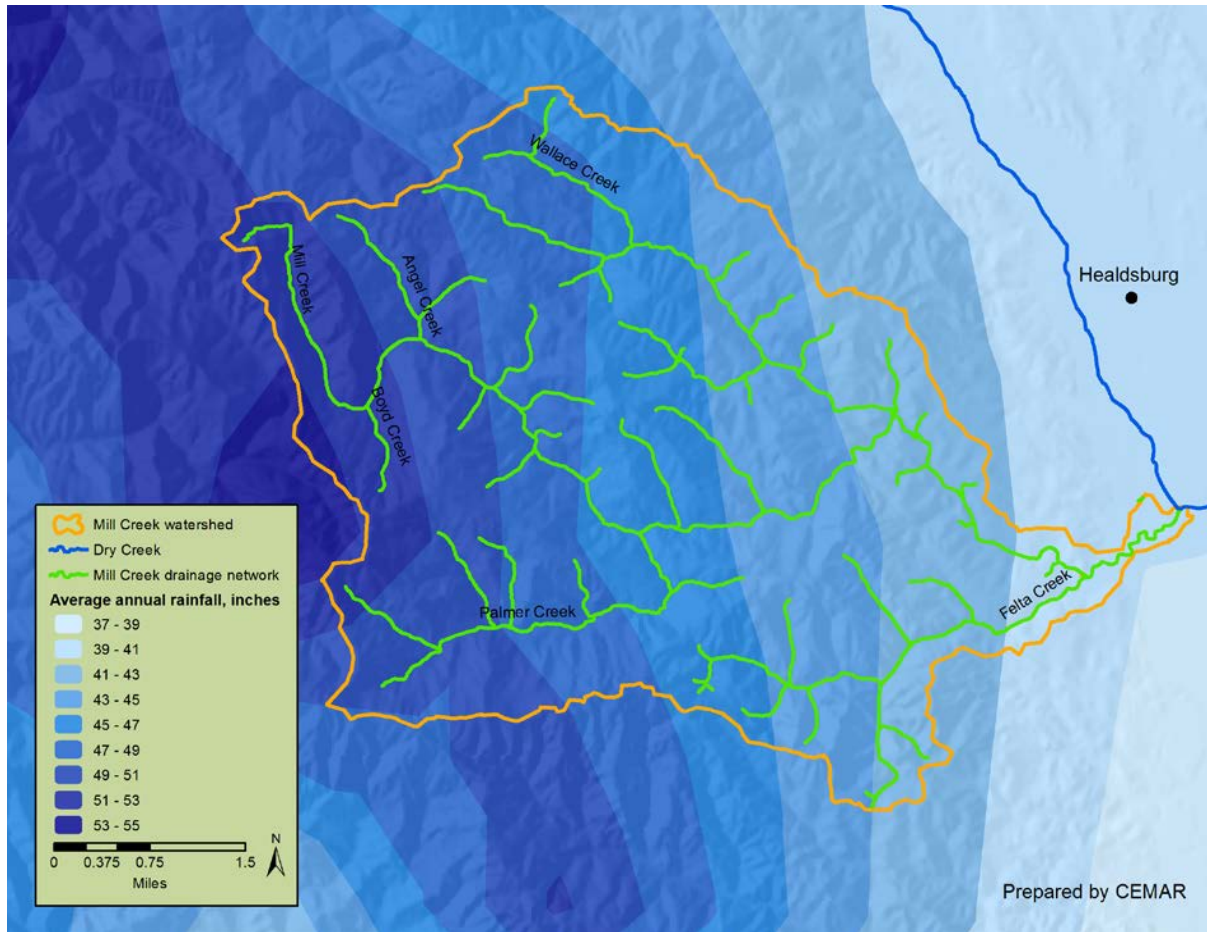


Figure 3. Average annual rainfall over the Mill Creek watershed.

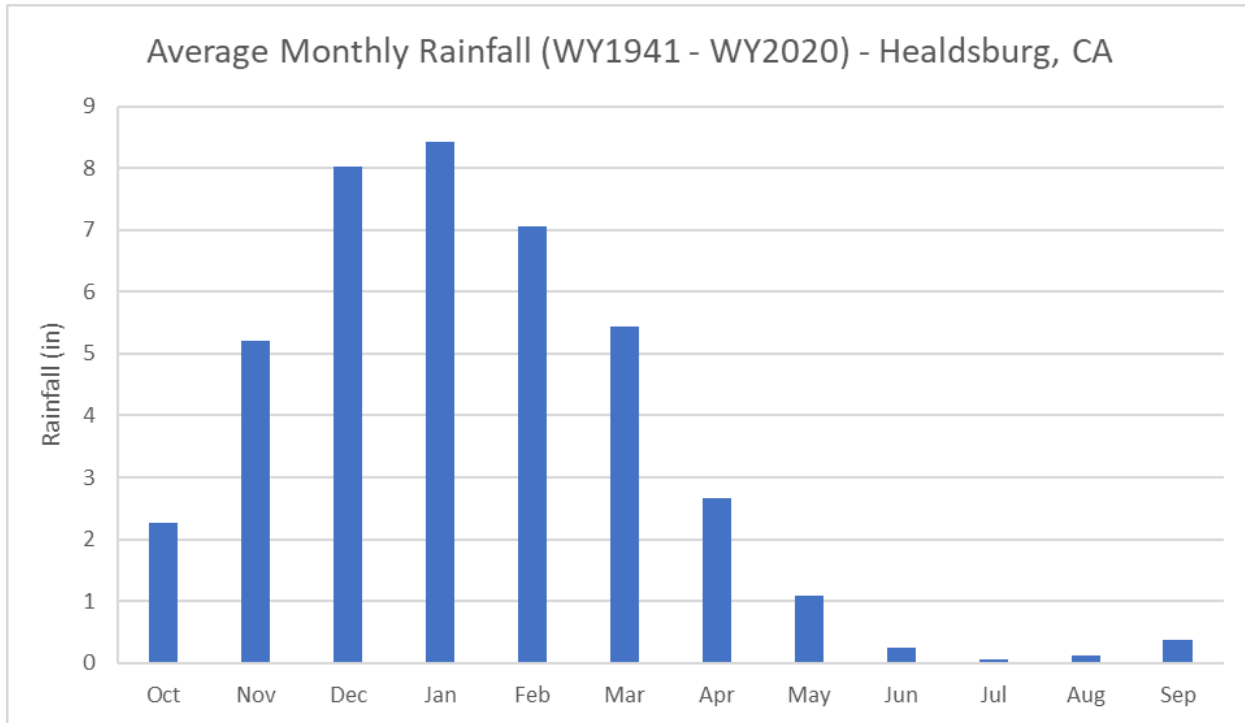


Figure 4. Average monthly rainfall in inches over the period of record (WY1941 – WY2020) recorded at the NCDC Station (USC00043875) in Healdsburg, CA.

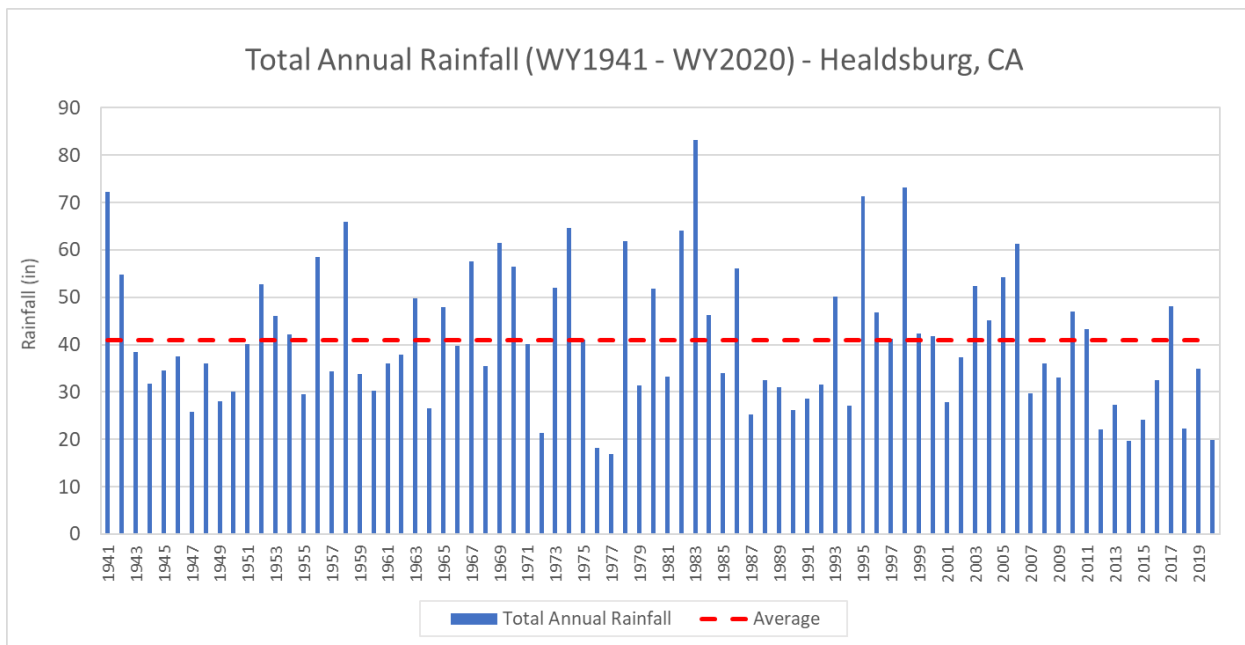


Figure 5. Total annual rainfall compared to the long-term average (40.95) in inches over the period of record (WY1941 – WY2020) recorded at the NCDC Station (USC00043875) in Healdsburg, CA.

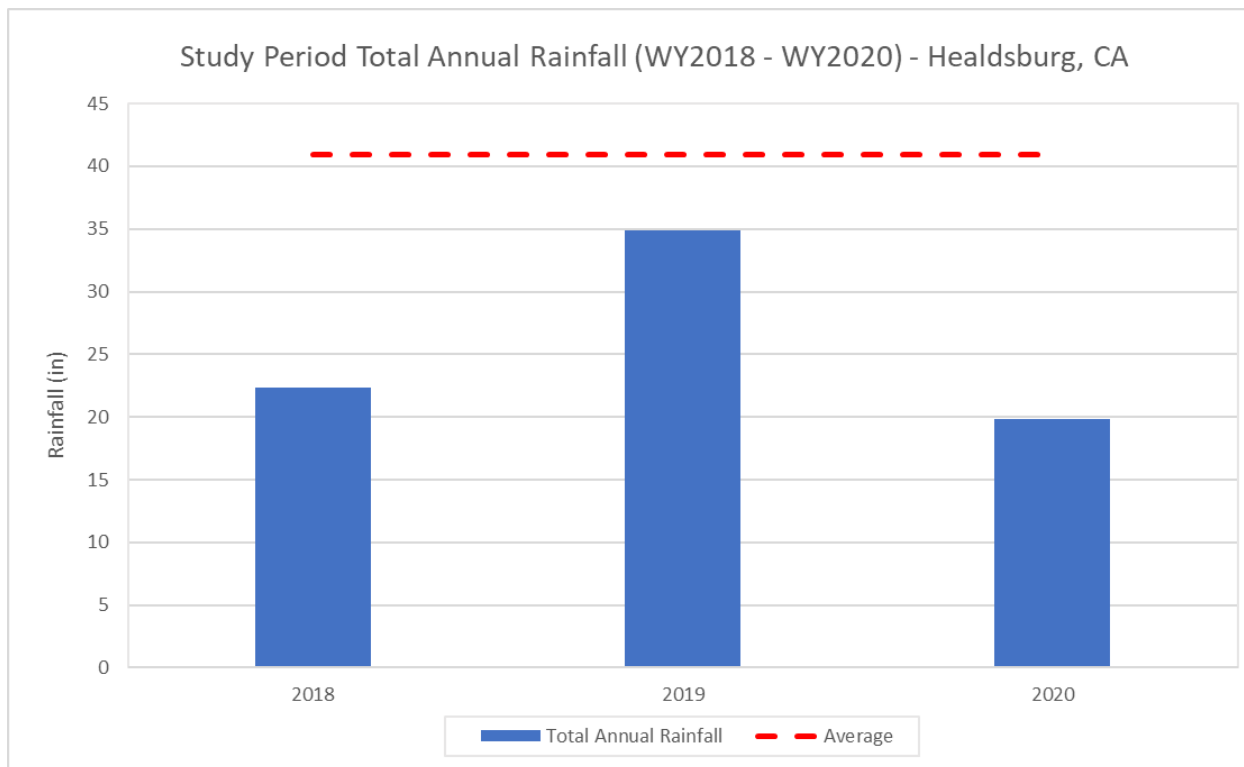


Figure 6. Total annual rainfall for the study period (WY2018 - WY2020) compared to the long-term average in inches recorded at the NCDC Station (USC00043875) in Healdsburg, CA.

Methods

The objectives of the study described in this report are to monitor the streamflow, stage, and groundwater levels in the lower reaches of Mill Creek over the three year study period, identify if water storage and conservation projects can add enough surface flow and groundwater to the system to improve the dry conditions frequently observed here. We aim to improve our understanding of surface-groundwater interactions in the reach and use the results to help resource managers understand if projects that increase streamflow conditions can be developed.

To monitor surface and groundwater in Lower Mill Creek, TU installed two surface water gages in the channel (Figure 7) in spring of 2018; the upstream gage (LM02, Lower Mill near the Tipi) is about 0.3 km upstream of the downstream gage (LM03, Lower Mill near Bramkampos Road). A gage collecting continuous 15-min level data was also installed in one of the wells (LM01, Unused Well 1), which is located adjacent to the channel, slightly upstream of the LM02 gage.

A total of 11 area wells were monitored by TU and SRCD staff starting in the spring through fall of 2018; monitoring continued through the fall of 2020 (Figure 7). Data from 8 of these wells will be discussed in this report.

To analyze the interaction between surface water and groundwater, data from wells and surface water gages that lie roughly in transects perpendicular to the down-valley slope were compared to each other; data from each transect will be discussed in section 4. Figure 8 shows transects 1-4, which were used for this comparison.

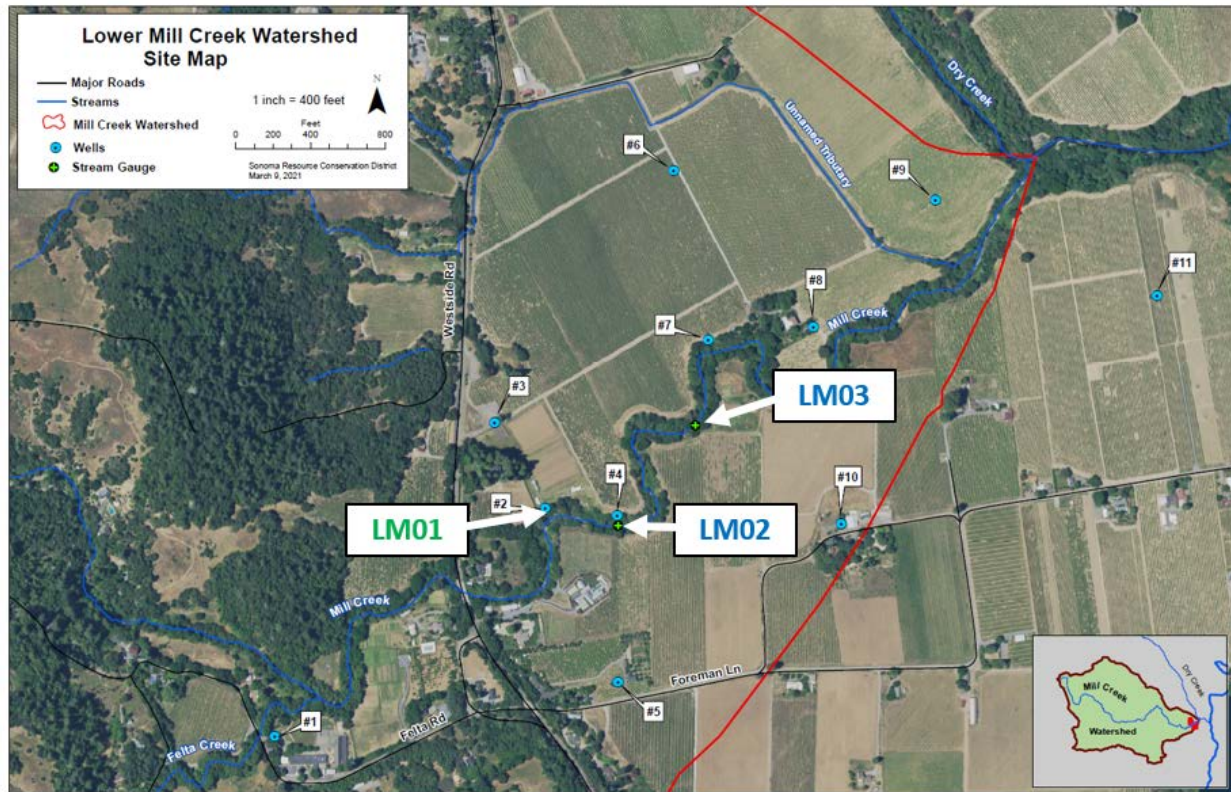


Figure 7. Lower Mill Creek watershed site map, with surface water gages LM02 and LM03 (blue callouts), continuous groundwater gage LM01 (green callout), and area wells from which monthly level measurements were taken (black callouts).

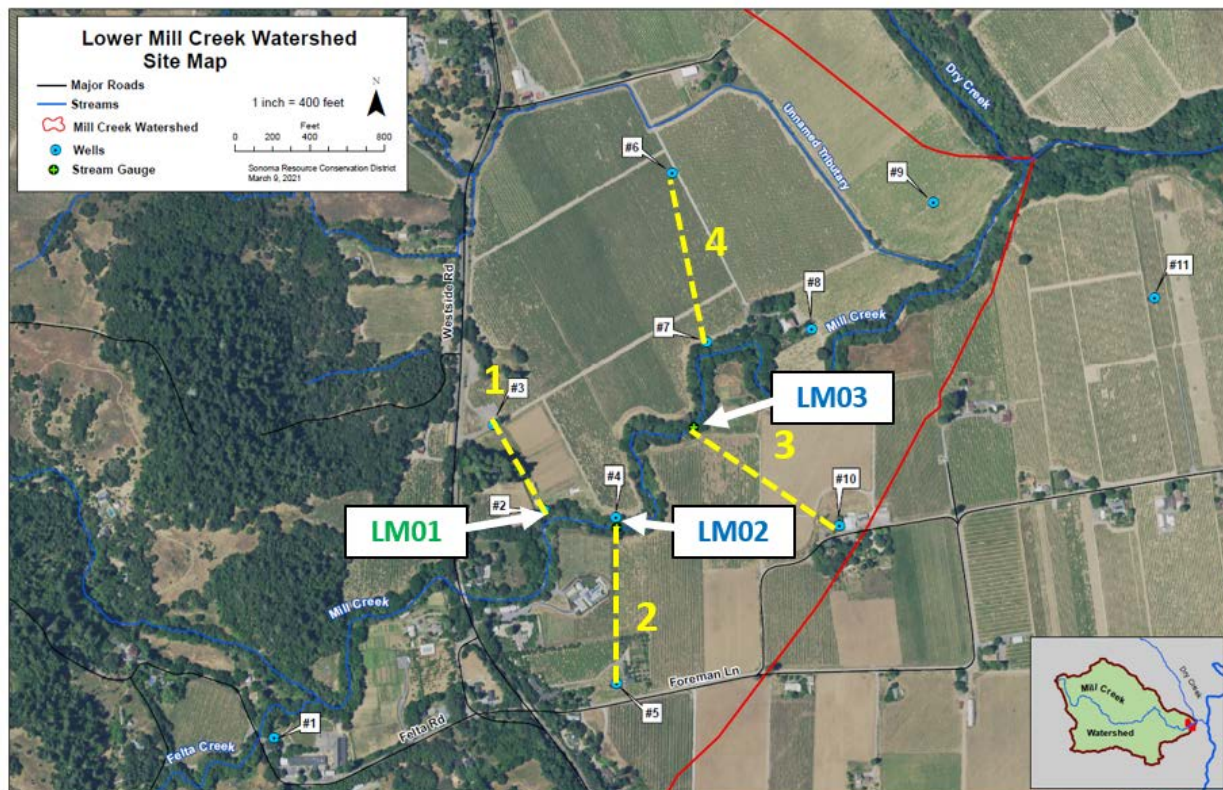
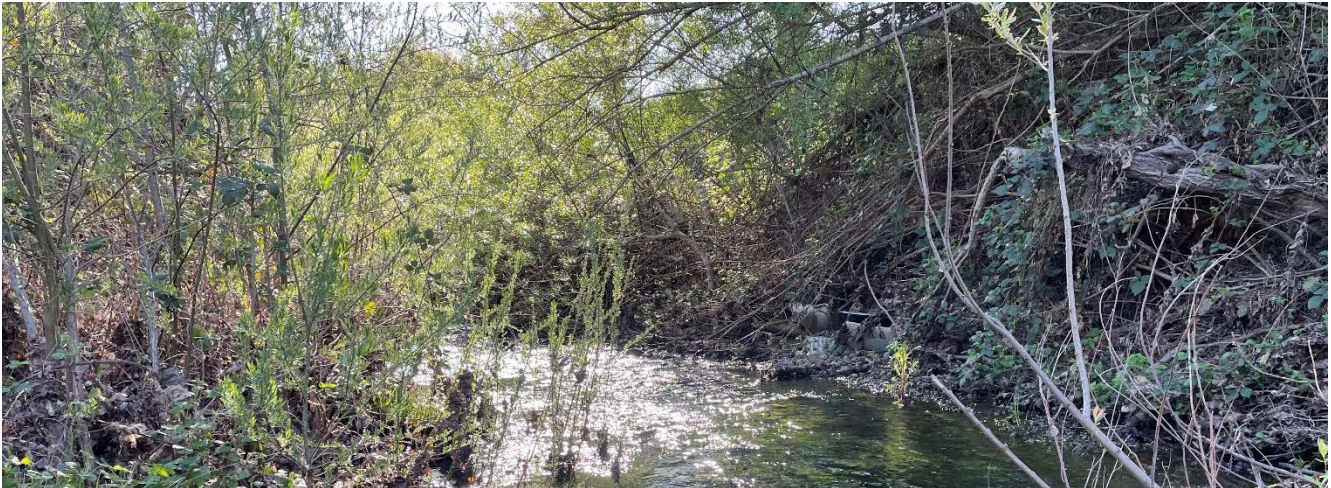


Figure 8. Transects for comparison of surface and groundwater data, Lower Mill Creek.



3. Results

3.1 Continuous stage data

Figure 9 displays the stage data collected in 15-minute increments for the two surface water gages (LM02 and LM03) and the continuous groundwater well gage (LM01) collected over the entire study period. All stage data has been converted from an arbitrary datum to feet above mean sea level using data from a TU total station survey, which was conducted in July 2018. Slight elevation adjustments (approximately less than 1 ft) were made during gage repairs in the spring of 2019 and 2020; adjustments were then made to the stage data to provide continuous stage records. The upstream surface water gage (LM02) and groundwater gage (LM01) were installed in late March 2018. The downstream surface water gage (LM03) was installed in late April 2018, after the last spring storm of the season.

At the time of installation, the data show that groundwater was higher than the adjacent surface water, although some of this elevation difference is likely due to the well's location (about 400 ft upstream of the surface water gage). A few days after installation, the last major rain event of the season occurred, and a spike in stage was observed both in the surface and groundwater, a result expected from a well located adjacent to the channel. Following the storm, water levels receded at both gages, with groundwater higher than and feeding the surface water through June 2018. In late June, the drop in groundwater levels accelerated, and within a few weeks dropped to the same level as the surface water. On July 17, flow in the stream reached 0 ft³/sec, though the channel held water in disconnected pools for a few days to weeks after. Groundwater continued to drop sharply until early October, when levels stabilized at about 75 ft above MSL – roughly 12 ft below where they had been in the spring, and approximately 10 feet below the channel flow line. The downstream surface water gage (LM03) was installed in late April 2018, after the last spring storm of the season. Flow slowly receded through spring and early summer, reaching 0 ft³/sec on July 18, 2018. Water in the gage pool here remained for a few weeks after the channel disconnected. The gage pool dried out on August 30, 2018, coinciding with a second steep drop in groundwater levels observed at the LM01 groundwater gage.

In the beginning of water year 2019, the level was at a low point from the previous dry water year (2018), levelling out at about 75 feet above MSL. LM02 and LM03 were dry early in the water year. The LM03 gage was washed out during large winter storms, and data from early June onward is displayed here. Groundwater level began to rise with the onset of winter storms in late November 2018. Following this rise, the channel re-wetted and inundated the gage pool at LM02, and from late December onward, both surface and groundwater levels rose and fell with the numerous winter storms that occurred. The largest storm was in late February 2019 – both ground and surface water level rose over 17 feet during this event. Water levels slowly receded during the dry season. Streamflow remained connected at LM02 until in mid-September, and remained connected until mid-October at LM03. Water was observed to be held in pools at LM03 throughout the dry season. Due to the wetter year, groundwater levels did not drop as steeply as was observed in the fall of 2018.

At the beginning of water year 2020, in October 2019, stage at all three gages was at its dry season low. Streamflow had disconnected at LM02 in mid-September 2019, and at LM03 in mid-October. Groundwater levels at LM01 reached their lowest levels in late November 2019 at about 83 ft above MSL. The upstream LM02 gage pool dried in late October 2019, whereas the downstream LM03 gage pool retained water through the 2019 dry season. Stage began rising at all sites in late November with the arrival of the first storms of the year. Both surface and groundwater stage rose and fell in response to rain events. Stage at all three sites reached a peak on December 7, 2019, during the largest storm of the year. During this storm as well as during the smaller peaks, surface water at LM02 exceeded the level of groundwater at LM01. At all other times, the groundwater level exceeds the surface water level. It should be noted that LM01 is slightly upstream of LM02, and a slightly higher elevation is expected.

The last peak of the rainy season occurred on January 21, 2020, and after this storm stage at all three sites slowly receded. Flow in the channel disconnected on June 22, 2020. Water in the gage pools remained for a few weeks after disconnection. The LM02 gage pool dried out on July 11, 2020, and the LM03 gage pool dried out on August 4, 2020. The pools drying coincided with a steep drop in groundwater levels observed at the LM01 groundwater gage. From August through mid-November 2020, groundwater levels dropped to a low point of 68.5 ft above MSL.

Water year 2020 was the driest year during the study period, with flow disconnecting in mid-June upstream and mid-July downstream, compared to mid-July in water year 2018, and Mid-September through mid-October in 2019. Water year 2018 was also a dry year, and similar to water year 2020, groundwater levels dropped rapidly after the channel dried, but did not reach as low of a level as in water year 2020. Water year 2019 was the wettest year in our study, and the spring recession and channel disconnection came later, and pools in the downstream reach held water year-round. This led to a slower drop in groundwater levels, and as a result levels dropped only slightly before rising again in winter 2020. Winter 2020 had many fewer storms compared to 2019. The early spring recession and channel drying coincided with groundwater levels dropping to the lowest level in our records in late fall 2020.

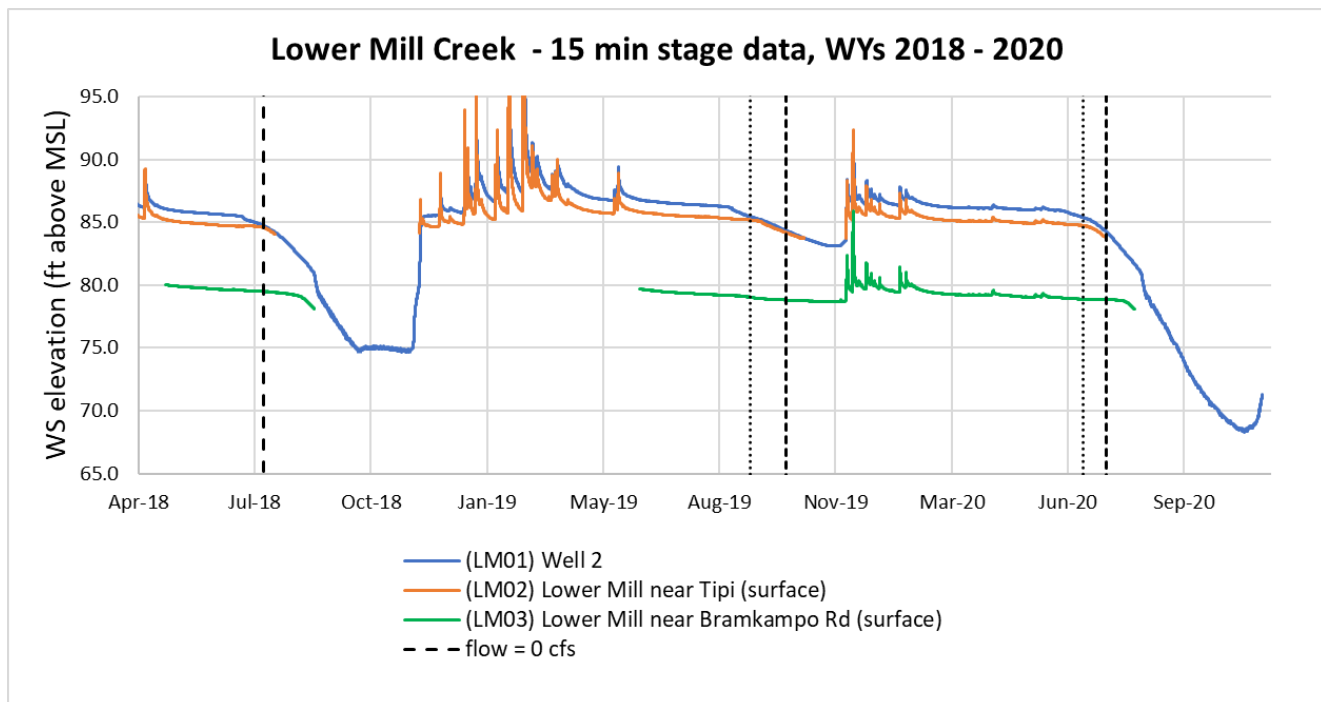


Figure 9. Water surface elevation (ft above MSL) for two surface water gages and one continuous groundwater gage, Lower Mill Creek, WY2020.

3.2 Surface and groundwater level in Transects 1-4

This section compares surface water data and groundwater data in the four transects roughly perpendicular to the down-valley slope. In figures 10-15, solid lines represent continuous data, points along the lines represent monthly manual measurements, and dotted lines connect monthly measurements in the absence of continuous data.

Upstream Sites – Transects 1 and 2

Transect 1. Transect 1 compares the continuous groundwater gage, LM01, in Well 2 to Well 3 monthly measurements. LM01 is adjacent to the channel, while Well 3 is further out on the floodplain. Figure 10 compares these wells over the course of the 2018 – 2020 study period. Well 3 was observed to have higher levels than Well 2 during the spring of 2018, and during the winter and spring of 2019. It was only during 2020 that the near-channel well lost water to the floodplain well year-round, with the exception of late October.

Transect 2. Transect 2 is comprised of data from the furthest upstream surface water gage (LM02), Well 4, which is close to the gage on the channel bank, and Well 5, which is further out on the floodplain. Figure 11 shows surface and groundwater levels in transect 2 for the duration of the 2018 – 2020 study period. This shows that groundwater levels are consistently lower than surface water levels. In the largest storm of the study, in late February 2019, both groundwater and surface water levels rose considerably, but groundwater was still lower than surface water. The lowest groundwater levels recorded were in the fall of 2018, however, sparse data from fall of 2020 likely misses another deep drop in groundwater levels.

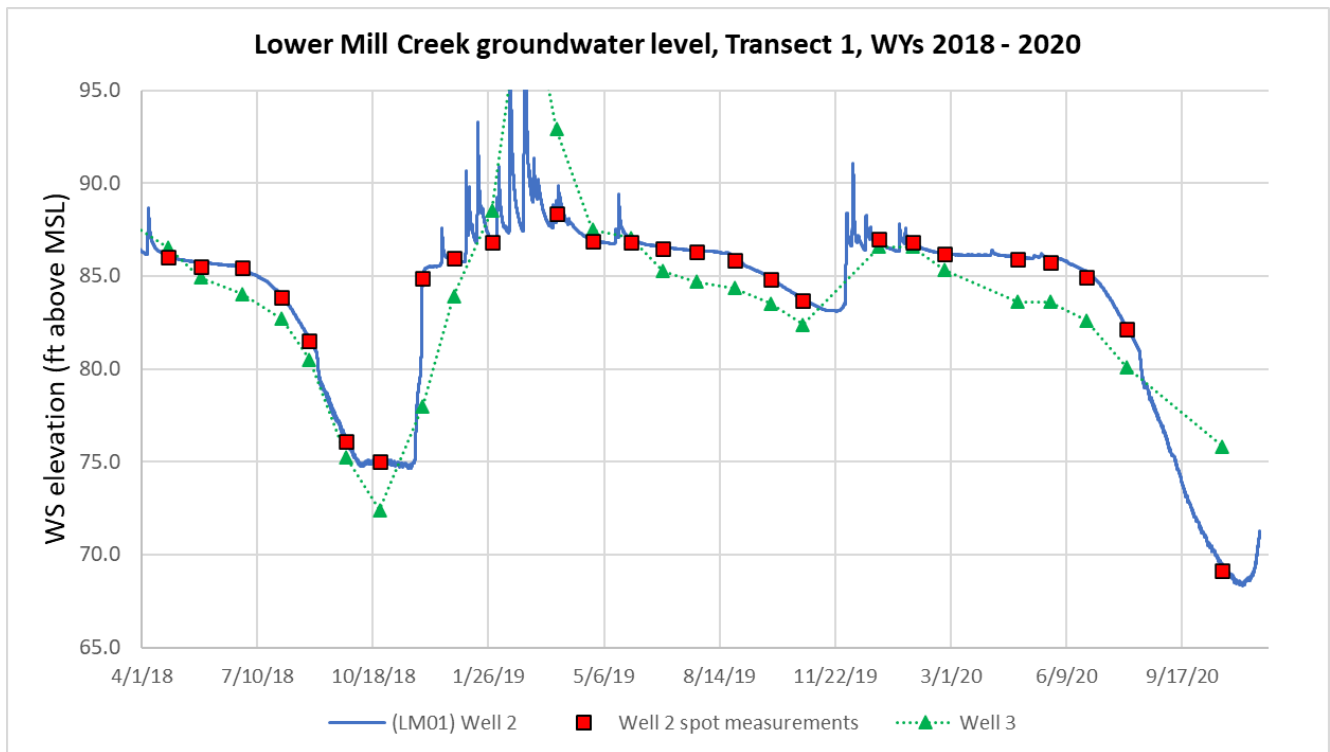


Figure 10. Water surface elevation (ft above MSL), Transect 1, Lower Mill Creek, WY2018 - WY2020.

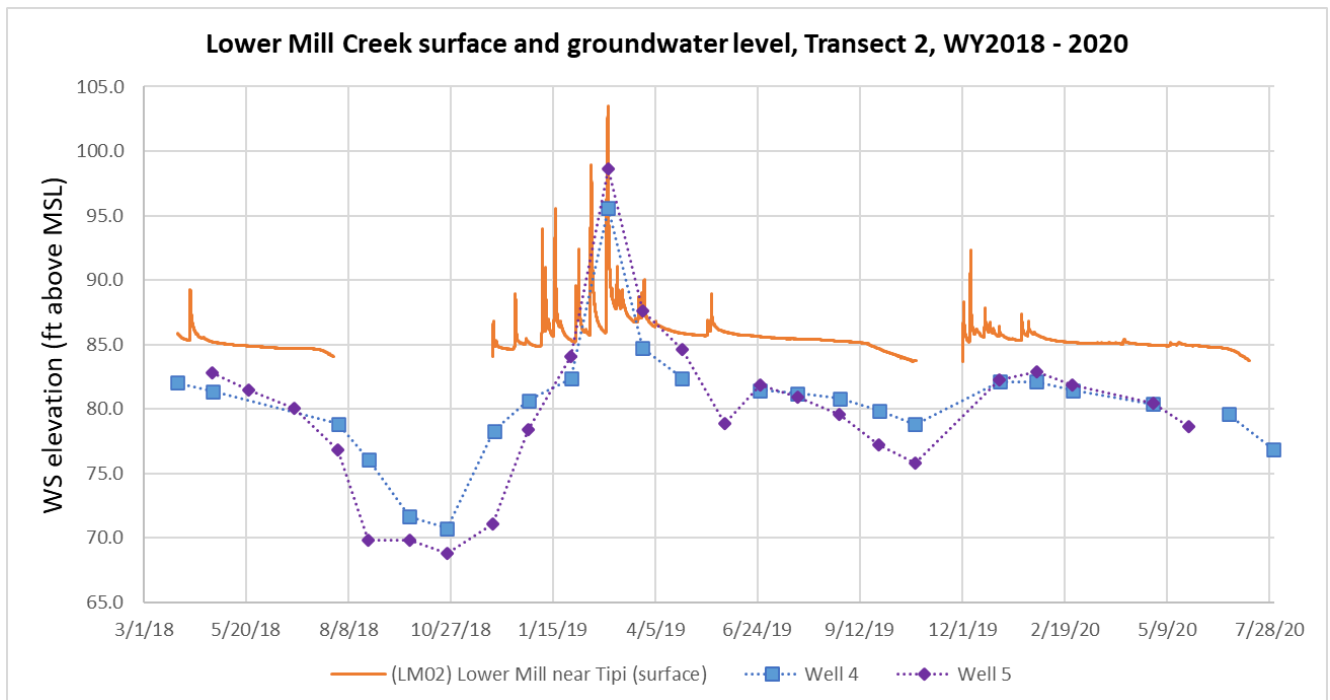


Figure 11. Water surface elevation (ft above MSL), Transect 2, Lower Mill Creek, WY2018 - WY2020.

Upstream site summary

Figure 12 shows the data from the upstream sites, Transect 1 and Transect 2, plotted together for the entire study period. This plot shows that through the years, a similar pattern emerges, with groundwater and surface water at Transect 1 remaining within 1-3 feet of each other, but consistent disconnection of about 3-5 feet between surface and groundwater at Transect 2 sites.

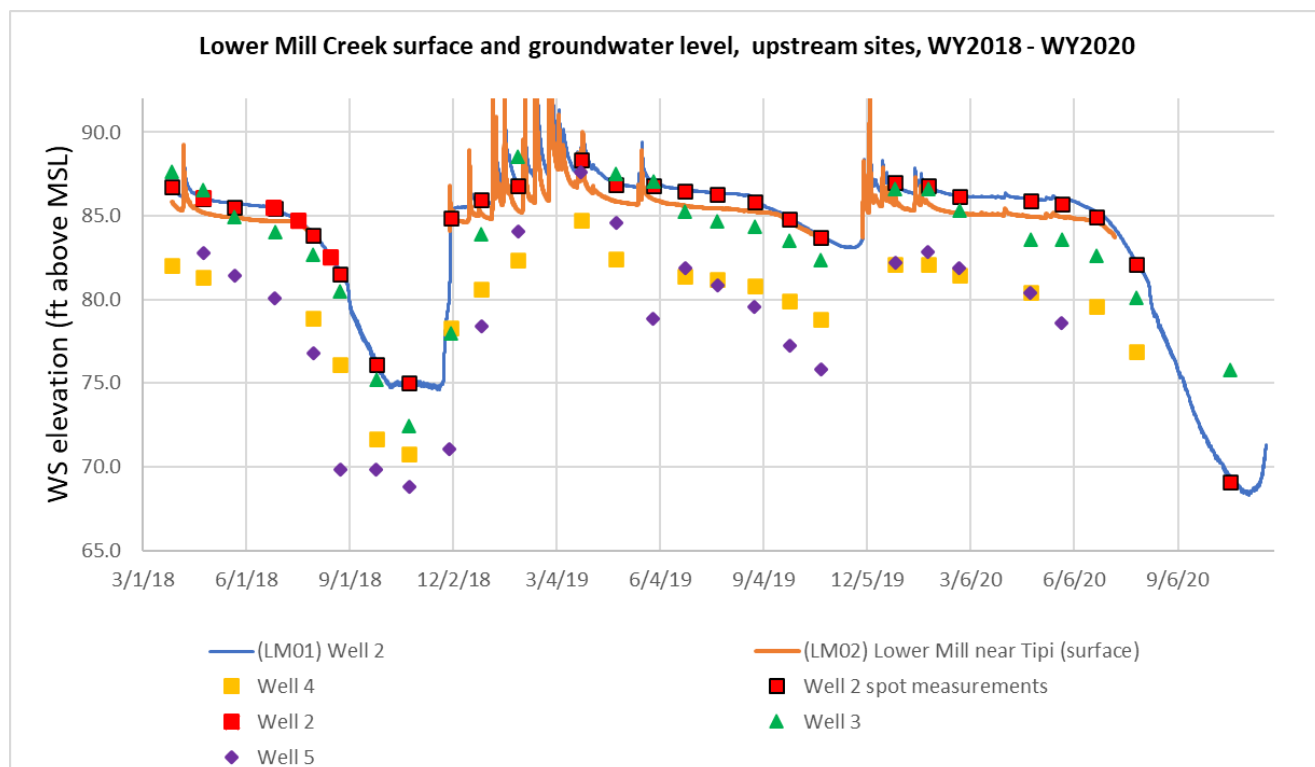


Figure 12. Water surface elevation (ft above MSL), Transects 1 and 2, Lower Mill Creek, WY2018 - WY2020.

Downstream Sites – Transects 3 and 4

Transect 3. Figure 13 shows data from Transect 3 throughout the 2018 – 2020 study period, which includes the downstream surface water gage (LM03), and Well 10, which is a floodplain well (see figure 8). Adjusted elevation data from the upstream LM02 gage is shown as reference during a gage gap due to washout. The data show that while the groundwater at Well 10 rose in response to the largest storm of the study (February 2019), groundwater levels are consistently perched about 15 feet below surface water in this reach.

Transect 4. Figure 14 shows data from Transect 4 throughout the 2018 – 2020 study period, which is comprised of a cross section between two groundwater wells – the near-channel Well 7, and the floodplain Well 6 (see figure 8). At these wells, the water level out on the floodplain was consistently higher than the water level adjacent to the channel. This far down the watershed, it is possible that the floodplain aquifer is under the influence of inputs from Dry Creek.

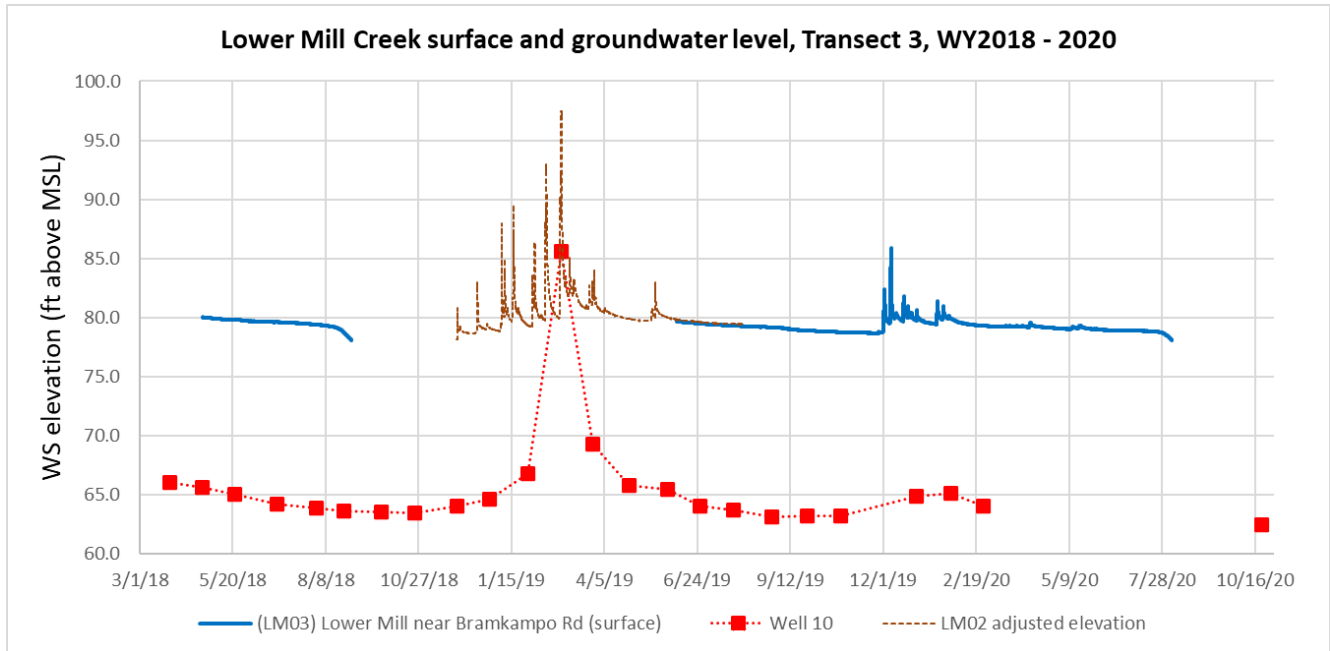


Figure 13. Water surface elevation (ft above MSL), Transect 3, Lower Mill Creek, WY2018 - WY2020.

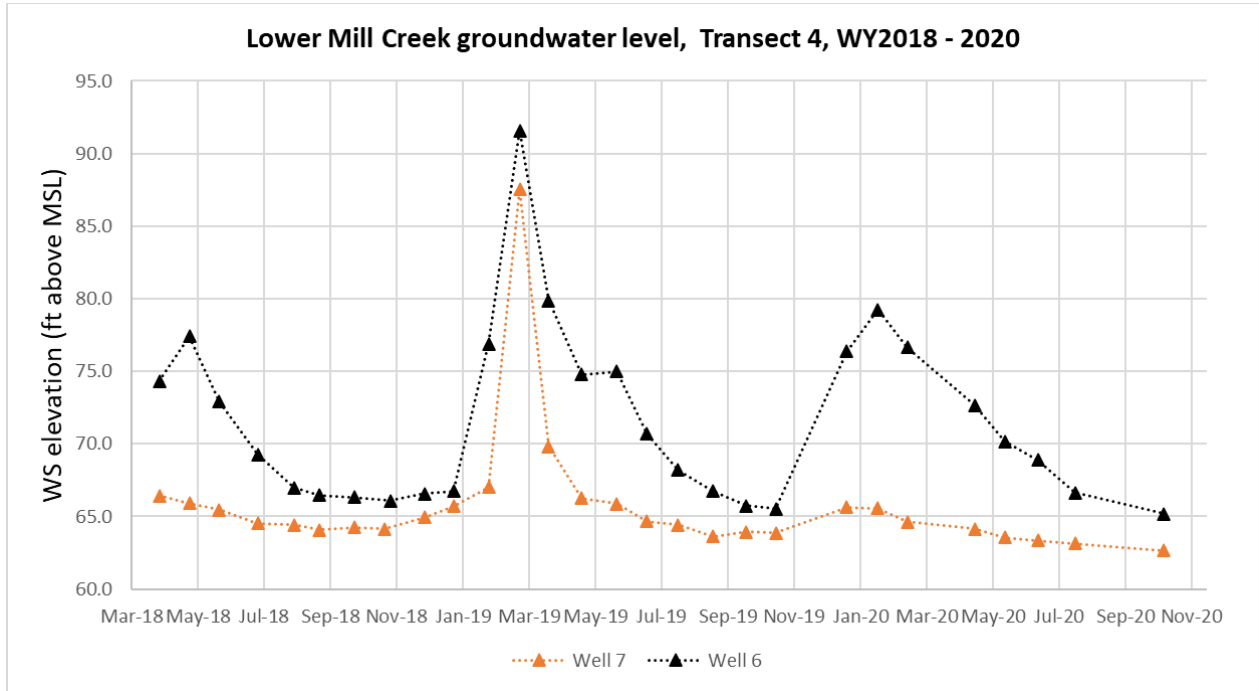


Figure 14. Water surface elevation (ft above MSL), Transect 4, Lower Mill Creek, WY2018 - WY2020.

Downstream site summary

Figure 15 shows the data from the upstream sites, Transect 3 and Transect 4, plotted together for the entire study period. These data show that throughout the year, groundwater levels were considerably lower than the level of the surface water. The surface water table is perched approximately 15 feet above the groundwater table at all times. The exception is Well 6, which is likely influenced by Dry Creek. Levels here approach the same level as the surface water during the winter months.

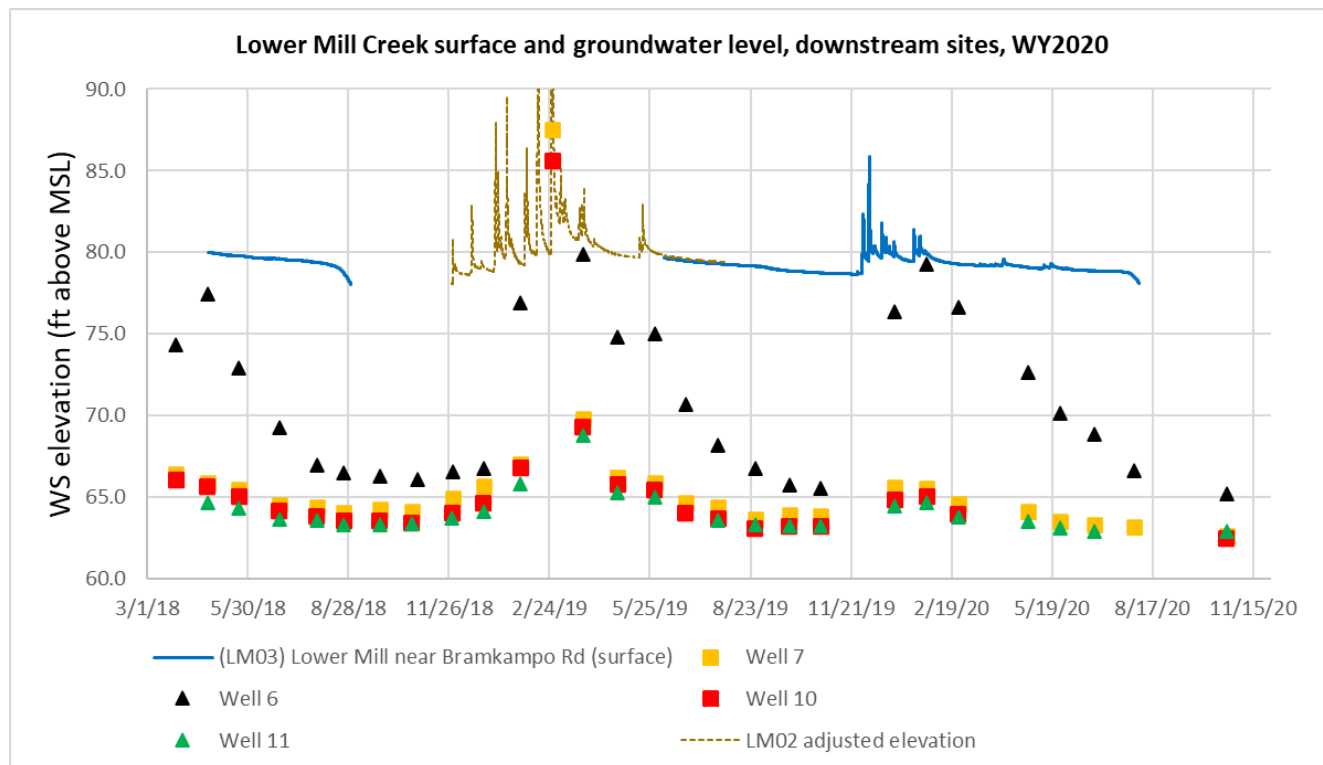


Figure 15. Water surface elevation (ft above MSL), Transects 3 and 4, Lower Mill Creek, WY2018 - WY2020.

3.4 Streamflow

Streamflow monitoring at the surface water gages began in spring each year and continued until the channel dried out. A comparison of streamflow conditions from water year 2108 through water year 2020 is shown in Figures 16 and 17. Low streamflows in 2020 reflect the fact that 2020 was the driest year in our study period. In water year 2018, flows in early May were at about 6 ft³/sec. In water year 2019, the wettest year of the study, flows were above 10 ft³/sec at this time. In early May of 2020, flows at the same sites were about 0.8-1 ft³/sec. Despite some small spring peaks in 2020, flows were generally lower than all other years, and dried out the earliest. Water year 2018, the next driest in our study, had slightly higher flows through the year, and flows persisted about 1-3 weeks longer than in 2020. Despite being a drier than average year, streamflows in 2019 were considerably higher than those observed in both 2018 and 2020. Flows in this year did not disconnect until the fall, and some pools in the lower reaches were wet year-round.

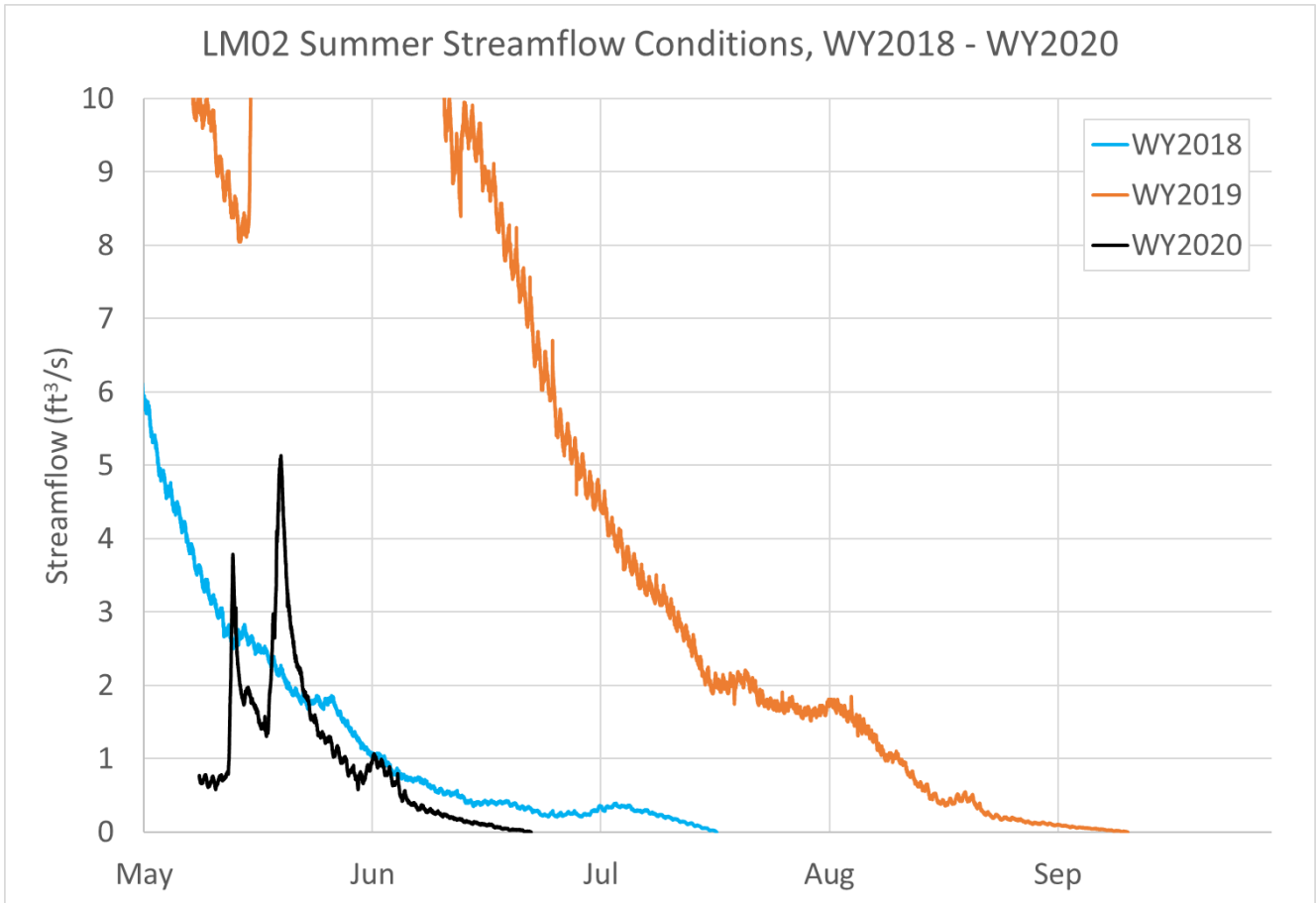


Figure 16. Summer streamflow conditions at LM02 (ft³/sec³), WY2018 – WY2020.

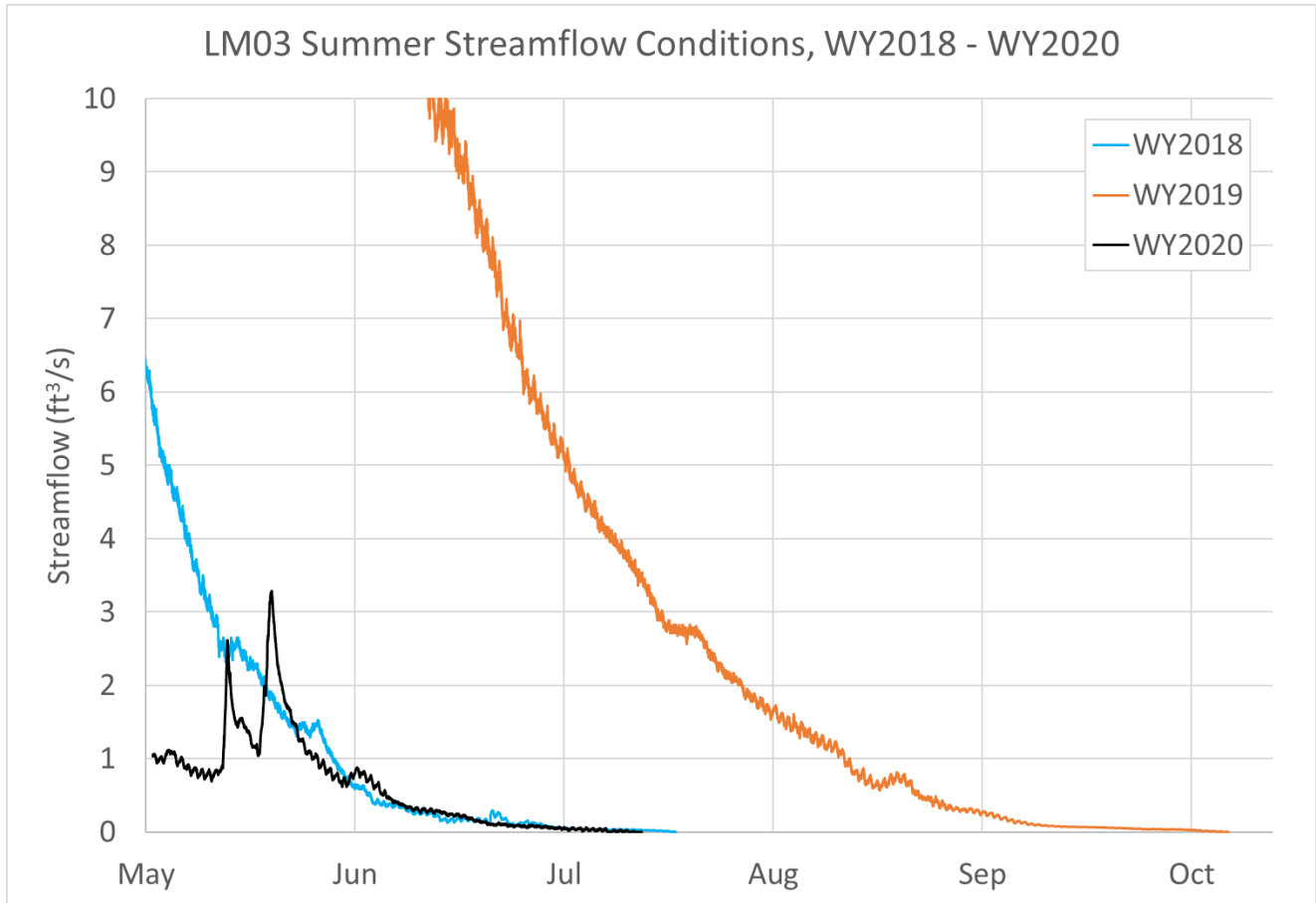


Figure 17. Summer streamflow conditions at LM02 (ft/sec³), WY2018 – WY2020.



4. Discussion and Conclusions

Data collected in water years 2018 – 2020 show that the Lower Mill Creek channel was perched above the groundwater table throughout the entire study period (April 2018 through November 2020) in both the upper and lower transects and is consistently losing water to the alluvial aquifer. Water year 2020 was the driest in our 3-year study period. In previous years, floodplain groundwater levels in upstream Transect 1 were slightly above the near-channel levels early in the spring. However, in 2020 the near-channel wells lost water to the floodplain year-round. Similar to 2018, the second driest year of the study, groundwater levels were observed to drop steeply after the channel dried in mid-summer. By mid-November, the level at LM01 was the lowest in the three-year study period, at about 68 feet above MSL.

Water year 2020 was also observed to have the lowest streamflow levels of the three-year study period. Flows dried out in mid-June upstream and mid-July downstream. In the next driest year, water year 2018, flows in early May were at about 6 ft³/sec, whereas in early May of 2020, flows at the same sites were about 0.8-1 ft³/sec. Despite being a drier than average year, streamflows in 2019 were improved over what was observed in both 2018 and 2020. Flows in this year did not disconnect until the fall, and some pools in the lower reaches were wet year-round. This gives some hope that in a wet year, the reach could maintain pools for over-summer juvenile rearing, and that smolts outmigrating in May or June may reach Dry Creek. However, as seen in 2018 and 2020, data from our study show there is little hope for these outcomes in drier years.

The data generated during this study period were collected in three dry years: 2018, and 2020, which is the fourth driest year in the long-term records. 2019 was a dry but closer to average year. Data from our study provide insights to groundwater and surface water interactions in these dry conditions. Future years of monitoring in different hydrologic conditions will provide more insights to the hydrological character of the Lower Mill Creek reach.

References

National Marine Fisheries Service. (2012). Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.

Russian River Coho Water Resources Partnership, 2015, Mill Creek Streamflow Improvement Plan. Russian River Coho Water Resource Partnership, Santa Rosa, California.