

Risk Assessment for the Use of Water for Frost Protection
During the 2025 Frost Protection Season in the Russian River
Watershed, Sonoma County, CA

Prepared for:

North Coast Water Coalition 513 Center Street
Healdsburg, CA 95448

Prepared by:



O'Connell Environmental, Inc.

P.O. Box 794

Healdsburg, CA 95448

www.oe-i.com

A handwritten signature in blue ink that reads "Matt O'Connor".

Matthew O'Connor, PhD, CEG #2449 (Exp. Oct. 31, 2027)
President, O'Connell Environmental, Inc.



Cole Daly, BS
Environmental Scientist

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Appendix A: Detailed Stage Hydrograph Interpretations

1.0 Introduction

This risk assessment has been prepared in accordance with the State Water Resources Control Board's Russian River Frost Regulation (CCR Title 23, Division 3, Section 862). Beginning in 2015, this regulation required all vineyards with a Water Demand Management Plan (WDMP) to file an assessment of the risk of fish stranding and mortality posed by their instream diversions for vineyard frost protection. Frost protection can be a concentrated, high-intensity water use, and instream diversions to supply this water may cause sudden decreases in stream levels. Such declines in stage could adversely affect protected salmonid populations including coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*).

The purpose of this risk assessment is to evaluate whether instream diversions for frost protection by diverters and growers registered in the WDMP (enrollees) sponsored by the North Coast Water Coalition (NCWC) caused potentially harmful declines in stream levels in the Russian River and its tributaries in Sonoma County during the 2025 frost protection season. This report examined stream water level data (i.e. stream stage) from all portions of the Russian River watershed potentially affected by NCWC enrollees to assess risk posed to salmonids by water use for frost protection. The risk assessment also provides insight to increase the efficiency and effectiveness of monitoring efforts for future assessments.

In this risk assessment, stream stage was used as an indicator of the potential effects of frost protection on aquatic habitat. Data from 37 stream gages were used to evaluate the degree to which frost protection affected aquatic habitat during the 2025 season (March 15th – May 15th). These gages were operated by a variety of organizations including the North Coast Water Coalition (NCWC), U.S. Geological Survey (USGS), Sonoma Water (SW), U.S. Army Corps of Engineers (USACE), and Trout Unlimited (TU). In this report, the Russian River watershed within Sonoma County was divided into seven sub-regions to help focus the analysis of stage data and to determine whether and where water levels changed irregularly (a presumptive indicator of water diversion effects). The focus by sub-region, referred to herein as "Focus Areas", was also helpful when examining enrollee water use and whether stage changed on days when water was used for frost protection (Figure 1).

During the 2025 frost protection season, nighttime temperatures were below 40°F intermittently throughout the frost protection season and significant water use for frost protection occurred. Total reported water use by NCWC enrollees was 91.2 acre-feet. This is approximately 24% of the reported magnitude of water use in the 2024 season and approximately 8% of the reported magnitude of water use in the 2020 - 2023 seasons as shown in Table 2.

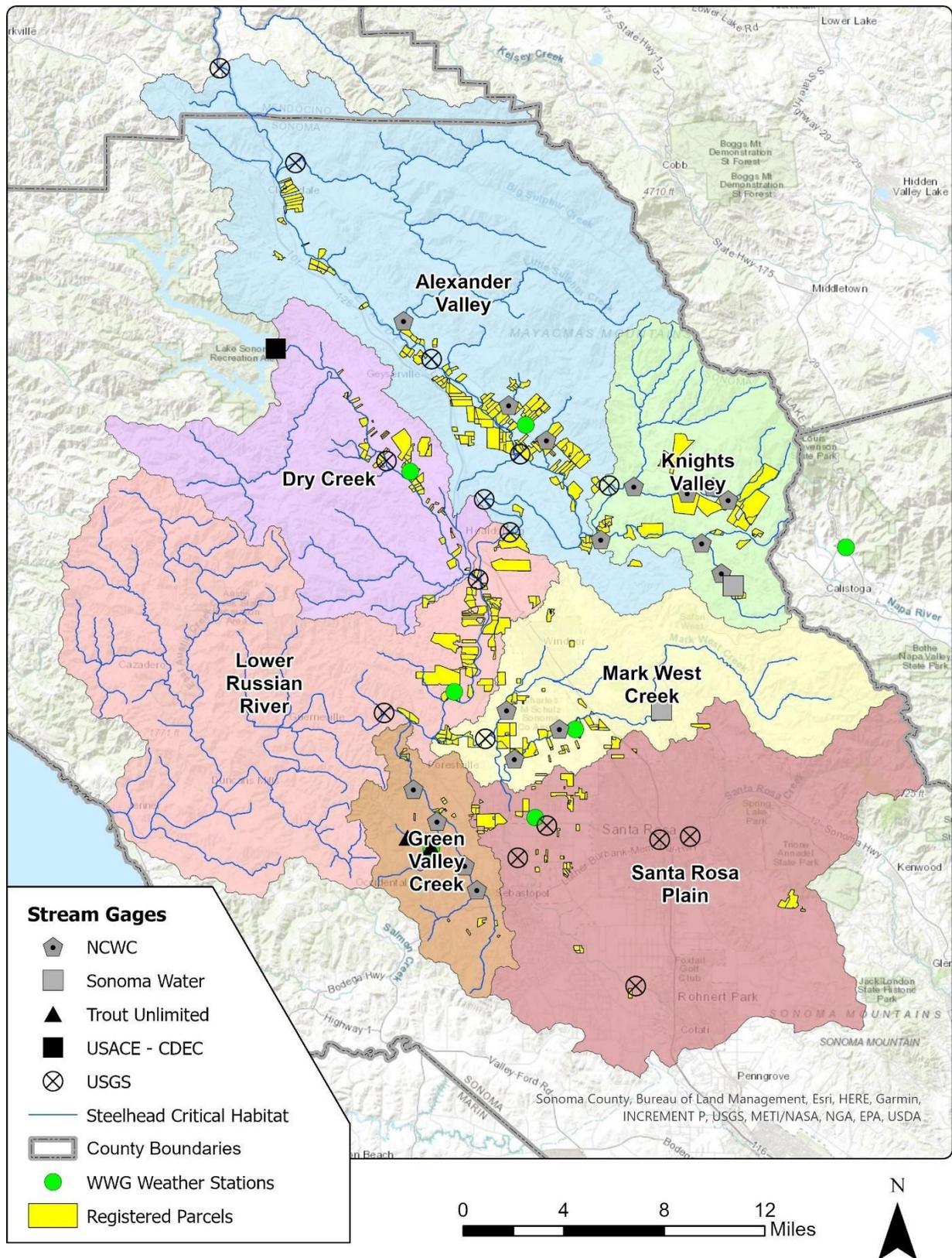


Figure 1: Location of study area, Focus Areas, parcels registered with the North Coast Watershed Coalition, and stream gages used in the 2025 Risk Assessment

2.0 Study Area

This risk assessment was performed for the portion of the Russian River and its tributaries located within Sonoma County. For the purposes of this analysis the study area was divided into seven Focus Areas based on geography and the locations of vineyards enrolled with the NCWC (Figure 1). Within the study area, primary species of concern were coho salmon (*O. kisutch*) and steelhead trout (*O. mykiss*). Based on the California Department of Fish and Wildlife's (CDFW) Anadromous Fish Distribution mapping, all Focus Areas except the Santa Rosa Plain contain significant coho salmon and steelhead trout habitat.

3.0 Methodology

The effects of instream diversions for frost protection on aquatic habitat were assessed by monitoring stage in streams potentially impacted by NCWC enrollees. As in prior assessments, stream stage time series data were analyzed for unusual changes believed to be indicative of diversions. Once identified, the timing and magnitude of these decreases were assessed using thresholds recommended by the National Marine Fisheries Service (NMFS) to determine if they posed a risk of fish stranding (Van Atta, 2016). The timing of these potential diversions was also cross-referenced with the timing of reported frost protection use and available climatic data to determine which were potentially associated with frost protection.

Potential diversions were identified by a visual review of individual stage records. This review identified all changes in stage that could not be readily explained by precipitation events or by natural diel (~24 hr cyclic) fluctuations in stage. Diel fluctuations are believed to be caused by variations in evapotranspiration rates throughout the day and typically cause stage to fluctuate over a range of a few hundredths to about one-tenth of a foot. These fluctuations occur in a regular 24-hour cycle and typically occur over several consecutive days of fair weather. Diel fluctuations were observed to some degree at most gages, typically increasing in magnitude later in the season and are most prevalent in smaller channels and alluvial settings.

Most potential diversions were recognized in the stage record (i.e. the stage hydrograph) as “U” or “V” shapes on the hydrograph indicative of a relatively abrupt decrease and subsequent increase in stage, typically with more rapid rates of change than diel fluctuations. These abrupt increases or decreases in stage were assumed to be caused by management or use of water. Other abrupt increases or decreases in stage (not associated with rainfall runoff events) were also common and some of these are thought to be indicative of changes in reservoir releases or diversions to storage. In some instances, only the abrupt increase in stage at the end of a diversion was observed with its beginning masked by natural decreases in stage occurring on the recession limb of a rainfall runoff hydrograph. In addition to these common hydrograph “signals”, all other hydrograph abnormalities (e.g., deviations from the recession limb), were considered potential diversions. Many diversion signals identified are subtle and we likely include many “false positive” diversions in the analysis. Additionally, due to relatively high flows in the Russian River watershed during the 2025 frost protection period, the higher magnitude of flow may have prevented identification of diversion signals in the hydrograph that might have been evident in lower flows. In addition, owing to rainfall runoff events during the 2025 frost season, there was more variation or “noise” in the hydrographs than is typical which potentially obscured some diversion signals, as well as rapid rise and fall in stage that may have been mistaken for diversion signals.

Once a potential diversion was identified, its magnitude and timing were analyzed to determine the risk of fish stranding that it posed. To avoid fish stranding, NMFS recommends limiting decreases in stage to

0.10 ft during daytime. At night, when fry occupy shallower waters along stream margins, very small decreases in stage may lead to stranding. Given the accuracy of stage measurements and natural fluctuations in stage, NMFS¹ recommends limiting nighttime decreases in stage to 0.02 ft. Using this guidance, all daytime diversions resulting in a 0.10 foot or greater decrease in stage were considered to pose a *substantial* risk of fish stranding. All nighttime diversions resulting in a 0.02 foot or greater decrease in stage were also considered to pose a *substantial* risk. Additionally, all daytime diversions resulting in a 0.02 to 0.09 foot decrease in stage were considered to pose a *potential* risk of fish stranding (Table 1). All diversions resulting in a less than 0.02 ft decrease in stage were considered to pose a *low* risk of fish stranding. Only those diversions which occurred concurrently with reported direct (instream) diversion were considered associated with frost protection. Given the general accuracy of hydrograph stage data, diversions causing decreases of less than 0.02 ft have not been identified in this report. When the beginning of a diversion could not be differentiated from the recession limb of a hydrograph and only the end was observable, this was also considered to pose a *low* risk of fish stranding because water levels are higher and naturally fluctuating as stream flow recedes from a prior peak in runoff.

Table 1: Primary criteria used to establish the fish stranding hazard posed by diversions.

	Substantial	Potential	Low
Daytime (6:00 AM - 6:00 PM)	Magnitude: ≥ 0.10 ft Ramping Rate: Any	Magnitude: ≥ 0.02 ft Ramping Rate: Any	Magnitude: < 0.02 ft Ramping Rate: Any
Nighttime (6:00 PM - 6:00 AM)	Magnitude: ≥ 0.02 ft Ramping Rate: Any	-	Magnitude: < 0.02 ft Ramping Rate: Any

The timing and duration of potential diversion signals were also analyzed to determine if they were associated with frost protection. This was achieved primarily by comparing the timing of potential diversions to the timing of reported frost protection use. If a potential diversion occurred within 24 hours before or after reported frost protection use, it was considered potentially associated with frost protection. This 48-hour period was chosen to account for instream diversions to storage that may occur before or after use but is somewhat arbitrary. If a diversion occurred within 24 hours of a night when the minimum temperature was less than 40°F but NCWC enrollees did not report using water for frost protection, it was considered unlikely to be associated with frost protection. Although 35°F is a commonly used threshold to identify frost events, the higher threshold 40°F was used to account for local variations in temperature not represented by the available sensor network. This temperature threshold makes it more likely that potential diversions would be associated with frost protection events.

Secondary factors such as the magnitude and duration of the change in stage as well as reported sources of water upstream used for frost protection were considered when determining if a diversion may have been associated with frost protection. It should be noted that water use within the Russian River

¹ Van Atta, A., 2016. Response to email with subject "Initial Water Demand Management Program for the Mendocino County Russian River Main Stem Diversers Pursuant to State Water Resources Control Board Regulation (California Code of Regulations Title 23 §862)". National Marine Fisheries Service.

watershed is complex and given the limited available data it was often not possible to definitively determine whether a diversion was associated with frost protection. If a conclusive factor could be determined, such as all upstream enrollees using groundwater, individual diversions were determined not to be associated with frost protection. This interpretation assumes that use of groundwater for frost protection would not produce an abrupt decrease in stream stage, not that use of groundwater for frost protection does not have the potential to affect in-stream flow. We believe that the hydrographic expression of groundwater pumping for short term frost protection would tend to be gradual, not abrupt as expected from a direct stream diversion. Different methods (e.g., hydrologic modeling) and more detailed data discussed below would be required to evaluate the effect of groundwater use on stream hydrographs. Typically, the interpretation that abrupt declines in stream stage (potential diversions) were likely the result of frost protection was based on timing: coincidence of diversion with reported frost protection.

Under the Russian River Frost Regulation, instream diversions are defined as direct diversions for immediate application, diversions to storage, or pumping from hydraulically connected (i.e., shallow riparian) wells. Data that might identify such hydraulically connected wells, such as well location, well depth, depth of perforated well casing, and pumping rates, and data on the timing of pumping are not provided by program enrollees. Hydrogeologic data describing the groundwater aquifers would also be of critical importance for evaluating the effects of groundwater pumping on stream stage during frost protection events. It is implicit in this risk analysis that in many cases use of wells for frost protection is unlikely to produce abrupt changes in stream stage that pose a threat of stranding to juvenile salmonids as identified by Van Atta (2016). It has been assumed that use of groundwater or water stored in reservoirs for frost protection has a relatively low risk of deleterious effects on fish compared to direct stream diversion. In this report, the term “diversion” generally refers to an observed change in stream stage judged likely to result from human intervention. The cause or purpose of such diversions is generally unknown, but we attempted to infer cause and purpose from circumstances and data as described above.

3.1 Stage Data

Stage time series (hydrographs) were analyzed for 37 stream gages within the study area (Figure 1). These gages are operated by several agencies including the U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (USACE), Sonoma Water (SW), NCWC and Trout Unlimited (TU). USGS operates gages along major rivers and creeks including the Russian River, Big Sulphur Creek, Maacama Creek, Dry Creek, Santa Rosa Creek, and Laguna de Santa Rosa. USGS gage records provide stream flow data as well as stage data. USACE operates gages recording releases from Warm Springs Dam to Dry Creek and Coyote Dam to the East Fork Russian River in Mendocino County. NCWC operates gages on smaller tributary streams near vineyards within the Alexander Valley, Knights Valley, Mark West Creek, and Green Valley Creek Focus Areas, including several locations formerly gaged by the National Marine Fisheries Service (NMFS) Gages operated by TU utilized in this analysis are in the Green Valley Creek Focus Area. SW operates several gages in watersheds burned by the 2017 Tubbs and Nunns Fires. Most gages used in the analysis have a precision of +/- 0.01 ft of stage and report on a 15-minute time step. This is sufficient to identify potentially harmful changes in stage. Sonoma Water gages report on a one-hour time step but remain useful for identifying larger diversions.

The network of gages used in the Sonoma County risk assessments has evolved since assessments began in 2015. Previous reports have identified high risk areas where additional gages were required as well as

low risk areas where the gaging network could be simplified. These refinements have established the current network which nevertheless could require future adjustments. No changes were made to the gage network for the 2025 Risk Assessment. Another recommendation from the 2020 Risk Assessment was to take measures improving the quality of stage records from NCWC gages. In past reports, records from several NCWC gages have been omitted due to unstable or “noisy” data. Corrective measures were successfully implemented in the 2021 frost protection season; since then, the equipment deployed (pressure transducers with data loggers) has functioned properly.

Four stage records utilized in previous risk assessments were not available in the 2025 study: The USGS gages on Dry Creek Near Geyserville, Russian River at Windsor, and Mark West Creek at Porter Creek Road did not report data during the 2025 Frost Protection season and access to the gage site at Bidwell Creek was lost in 2022 owing to change in ownership. Data was unavailable for the Abramson Creek on Guerneville Road gage. A total of 37 gage records were analyzed.

3.2 Frost Protection Data

Details of water use for frost protection during the 2025 season were reported by enrollees to the Sonoma County Farm Bureau which produced the data in a spreadsheet format delivered to NCWC’s consultant (OEI) in mid-July for analysis. Enrollees were provided with forms to report the days on which water was used for frost protection, as well as the volume used and the source of the water (e.g., direct diversions, surface storage, groundwater, etc.). This data was reported on a parcel basis.

During the 2025 frost protection season, enrollees reported using 91.2 acre-feet of water for frost protection. This is 7-24% of the reported water use during the 2020-2024 seasons and approximately 58% of the water use reported during the 2015-2018 period (Table 2). Similar to previous years, water use for frost protection in 2025 was concentrated in five Focus Areas: the Alexander Valley, Dry Creek Valley, the Lower Russian River, Mark West Creek, and the Santa Rosa Plain. This concentration is expected given that these Focus Areas also have the greatest vineyard acreages. Among all Focus Areas there was an average of 25-50% fewer days below the 40°F threshold for frost events in 2025 compared to 2024.

The number of frost protection reports received in the 2025 frost protection season declined by 24% or 125 parcels compared to 2024, a continuation of prior the prior 25% decline in parcels reporting from 2022 to 2023. Reporting declined primarily in the Green Valley/Atascadero and Mark West Creek Focus Areas with a 66% and 33% decline respectively. The Alexander Valley experienced a 6% decline in reporting while the Dry Creek Valley experienced a 22% decline. Nevertheless, water use in Dry Creek increased from 3% to 28% of the overall reported water usage for frost protection. Increases in storage and well water use for frost protection account for this change. Similar declines in reporting occurred in the Lower Russian River and Santa Rosa Plain, 27% and 28% respectively. Reporting increased in Knights Valley by 26%. This overall decrease in reporting parcels accompanied a 15% decline in reported frost protected acreage (Table 2).

Table 2: Reported 2025 frost protection water use (acre-feet) summarized by Focus Area.

Focus Area	Frost Protection Season										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Alexander Valley	79.4	5.4	15.5	26.0	-	191.7	163.0	264.3	130.1	49.4	16.5
Dry Creek Valley	10.8	0.5	0.5	24.2	-	78.0	48.3	55.0	40.4	10.4	25.8
Green Valley/Atascadero	43.9	7.9	3.7	12.3	-	126.5	49.3	107.7	56.9	39.2	1.6
Knights valley	11.0	74.9	31.8	26.1	-	72.0	26.3	139.0	32.5	15.0	3.0
Lower Russian River	-	2.8	1.5	31.9	-	199.2	129.3	118.8	175.9	58.8	11.9
Mark West Creek	35.0	32.6	0.2	15.7	-	272.1	265.9	224.5	237.3	127.2	11.3
Santa Rosa Plain	52.0	19.7	3.8	60.3	1.4	412.7	535.3	268.5	328.5	74.0	21.1
Total	232.1	143.8	57.0	196.5	1.4	1352.2	1217.5	1177.9	1001.6	374.1	91.2

Table 3: Historic annual reporting parcels by NCWC enrollees.

	Frost Protection Season									
	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Reporting Parcels	658	613	606	788	794	803	572	528	403	
Protected Area (ac.)	14,374	13,271	13,114	13,621	~13,000 ¹	13,684	13,414	11,944	10,115	

¹Total protected acreage not available for 2021 Frost Protection Season.

Almost all reported frost protection water use during the 2025 season occurred on parcels that obtain water from wells, surface storage, or a combination of the two. Together, these two sources supplied approximately 76.9 acre-feet (84%) of reported use (Table 4). Of these two sources, storage supplied the majority (38% of all reported use), with additional 27% of use attributed to storage and well. Enrolled parcels which reported direct diversions as one of their sources only account for 13.2 acre-feet (15%) of reported use. The low number of direct diversions for frost protection significantly limits the frequency of large nighttime diversions for frost protection. Diversions to fill reservoirs may also have caused decreases in stage, but such diversion may not be attributed to frost protection if they do not occur during frost protection events.

Table 4: Sources of water available for frost protection reported by NCWC enrollees in 2024.

Source	Alex. Valley	Dry Creek Valley	Green Valley Creek	Knights Valley	Lower Russian River	Mark West Creek	Santa Rosa Plain	Total
Storage and Well	1.8	24.2	0.0	0.5	0.6	0.0	0.0	27.0
Well	5.8	0.0	0.0	2.0	0.0	1.0	6.1	15.0
Storage	4.2	1.6	1.6	0.5	2.2	9.7	15.0	34.8
Recycled Water	0.5	0.0	0.0	0.0	0.0	0.6	0.0	1.1
Direct Diversion	4.1	0.0	0.0	0.0	9.1	0.0	0.0	15.0
Any Direct Diversion	4.1	0.0	0.0	0.0	9.1	0.0	0.0	13.2
No direct Diversion	16.5	25.8	1.6	3.0	2.8	11.3	21.1	78.0

3.3 Meteorological Data

Daily precipitation and temperature data were obtained from weather stations in each Focus Area. The Knights Valley/Maacama Creek Focus Area is an exception; climate data for this Focus Area was accessed from a station in Calistoga due to the lack of a complete dataset from any weather station in the Focus Area. All weather stations used were operated by the Western Weather Group (WWG), a private entity that manages weather stations and compiles historical weather and climate data for vineyard growers in Sonoma County and elsewhere. Stations measured a variety of meteorological parameters, including hourly temperature and precipitation data. These weather stations were used because they were located closer to registered parcels than many public weather stations. For Focus Areas containing multiple weather stations, sites most representative of valley bottom conditions were selected. However, minimum temperatures are heavily influenced by local topography and may vary significantly even within individual Focus Areas.

3.4 Other Data Sources

Additional water management records were accessed to identify likely causes of diversions. Reservoir release time series for Coyote Dam (Lake Mendocino) and Warm Springs Dams (Lake Sonoma) were accessed from the California Data Exchange Center (CDEC). The location of major surface water diversions both for frost protection and for other uses was accessed from the California State Water Resources Control Board's Electronic Water Rights Information Management System (eWRIMS). However, a review of individual water rights fillings would require significant additional effort and has not been conducted systematically for this Risk Assessment. Full utilization of the State Division of Water Rights databases may be helpful when attempting to investigate the relationship between diversions detected in this risk assessment and diversions that occur consistent with existing Water Rights.

4.0 Results

Potential diversions identified from stage records are summarized below for each Focus Area. The discussion for each Focus Area includes a brief description of observed diversions, the risk of fish stranding that they posed, and whether they were potentially associated with frost protection. Detailed hydrographs from each gage used in the analysis showing all identified potential diversions are provided in Appendix A.

4.1 Alexander Valley Focus Area

The Alexander Valley Focus Area consists of the Russian River and its tributaries upstream of Healdsburg and downstream of the USGS gage on the Russian River north of Cloverdale (Figure 2). Much of the floor of the Alexander Valley is cultivated vineyard. Most vineyards registered with the NCWC were in the southern half of the valley where several creeks draining the Mayacamas Mountains east of the valley flow across the valley floor before reaching the Russian River. The interior of the Mayacamas Mountains is drained by Big Sulphur Creek. Its watershed is largely undeveloped and does not contain vineyards registered with the NCWC. The Russian River and its tributaries in Alexander Valley are not identified as priority areas in the NOAA Coho Recovery Plan applicable for the Russian River.

Historically, frost protection water use within the Alexander Valley Focus Area has been higher than in other parts of the study area. During the 2025 frost protection season, reported use in the Alexander Valley Focus Area was 16.5 acre-feet, representing just the third highest water use among Focus Areas. This was lower than the average season between 2015-2018 and on par with the 2017 season (Table 2).

Of the reported use, 72% was supplied by wells or storage reservoirs. Parcels listing direct diversion as their water source reported using 4.1 acre-feet (Table 4). Storage reservoirs and direct diversions were the primary source of water on parcels away from the valley floor where the underlying geology does not favor high-capacity wells. Given their topographic position above the valley floor, these parcels were less likely to use water for frost protection (Figure 2).

4.1.1 Alexander Valley, Mainstem Russian River

Stage records were analyzed from five USGS stream gages along the mainstem of the Russian River in the Alexander Valley Focus Area (Figure 2). Reservoir release data from Coyote Dam to the Russian River north of Ukiah in Mendocino County were reviewed for potential impacts on streamflow. Reservoir releases decreased substantially on March 29th and between April 2nd and April 4th. Smaller-magnitude decreases were observed on March 17th, 26th, April 2nd, 4th, 6th, 8th, 14th, and May 2nd. Noticeable effects on streamflow were most notably observed in upstream Russian River gages on the night of March 29th-30th. Decreases in discharge from Coyote Dam that occurred on days with diversion signals were indicated in Table 5. These changes in reservoir release clearly affected stream stage at the Russian River at Cloverdale gage, Russian River at Geyserville gage, and at gages further downstream with diminishing clarity. The reservoir release events identified in Table 5 are indicated in the hydrograph for the Cloverdale gage (Figure A.1) and Geyserville gage (Figure A.2)) but are not carried through in Figures A.3 through A.5.

The stage record for the Russian River near Cloverdale gage, the upstream most gage analyzed, only showed changes in stage related to changes in reservoir release from Coyote Dam on Lake Mendocino in Mendocino County (Figure 2; Figure A.1). One of these dam release signals was observed in the stage record for the Russian River near Cloverdale and was observed again downstream at the Russian River at Geyserville and Jimtown gages (Table 5). It is possible that the reservoir release from Coyote Dam affected stream stage on other dates at Coyote Dam, however signals may be unidentifiable due to coinciding precipitation at the end of March and beginning of April. All diversions or diel fluctuations observed at the Russian River near Cloverdale Gage originated within Mendocino County and were not caused by instream diversions for frost protection by NCWC enrollees. Hydrographic evidence of potential diversions in the Cloverdale stage record do not appear to coincide with diversion signals at downstream gages and do not strongly suggest the transmission of significant stream stage declines from Mendocino County to the Alexander Valley.

Stage records at the Russian River at Geyserville gage displayed a moderate amount of noise, likely caused by wind, elevated flows, or other natural sources of flow turbulence that could affect stage data (Figure 3, A.2). A potential diversion signal was identified on March 20th of magnitude 0.05 feet at night and poses a substantial stranding risk. Upstream frost protection use via direct diversion was reported on March 18th and 19th during a cold period and may correspond with the diversion signal identified on the early morning of March 20th. Two other signals respective magnitudes of 0.2 feet and 0.06 feet occurred respectively on the night of March 30th and the day of April 8th – while the former poses a substantial stranding risk, both are likely responses from the Coyote Dam outflow drops on March 29th and April 8th.

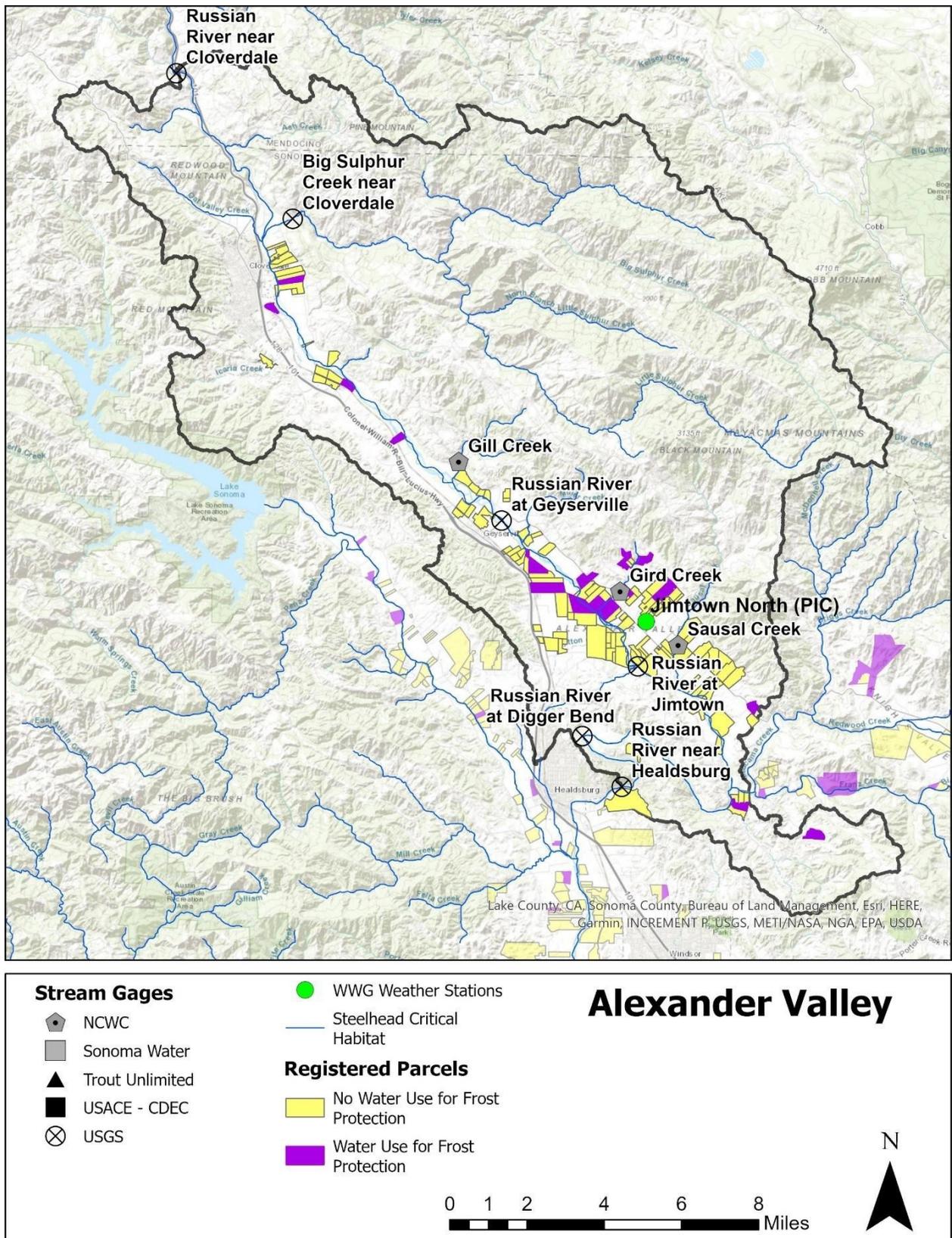


Figure 2: Stream gages and weather stations used in the Alexander Valley Focus Area.

Two potential diversions were identified in the stage record for the Russian River at Jintown Gage. An observed change in outflow from Lake Mendocino on March 29th can be indicated by a stage decrease of 0.06 feet on March 30th (Figure A.3). The observed change in outflow from Lake Mendocino on March 29th coincides with one observed signal on the day March 30th of magnitude 0.02 feet, but the earlier and separate signal for the given change can be observed more clearly during an earlier window and it is unlikely that dam release represents the potential diversion signal later on March 30th. A second diversion occurred during the day on April 20th and was .03 feet in magnitude, posing a potential fish stranding risk. No upstream frost protection was reported within 24 hours of these diversion signals. The stage record for this gage showed regular diel cycles of stage fluctuation throughout the frost protection season, increasing later in the season. Two potential diversion signals were identified on the stage record for Russian River at Digger Bend (Figure A.4) on March 28th and April 18th. Both occurred during the day with respective magnitudes of 0.05 and 0.04 feet, posing potential stranding risks. No upstream frost protection use was reported within 24 hours of these signals. No diversion signals were observed in the stage record for Russian River at Healdsburg (Figure A.5). Some noise and diel fluctuations were observed in these stage records, increasing later in the season.

Table 5: Potential diversions observed along the mainstem of the Russian River within the Alexander Valley during the 2025 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Russian River at Cloverdale	3/29/2025	0.17	night	substantial	no	Coyote Dam outflow drops 3/17, 3/26, 3/29, 4/2, 4/3, 4/4, 4/6, 4/8, 4/14, and 5/2
Russian River at Geyserville	3/20/2025	0.05	night	substantial	yes	
	3/30/2025	0.2	night	substantial	no	likely originated outside of study area
	4/8/2025	0.06	day	potential	no	likely originated outside of study area
Russian River at Jintown	3/30/2025	0.06	day	potential	no	likely originated outside of study area
	3/30/2025	0.02	day	potential	no	No reported direct diversion
	4/20/2025	0.03	day	potential	no	No reported direct diversion
Russian River at Digger Bend	3/28/2025	0.05	day	potential	no	No reported direct diversion
	4/18/2025	0.04	day	potential	no	No reported direct diversion
Russian River at Healdsburg						No diversions observed

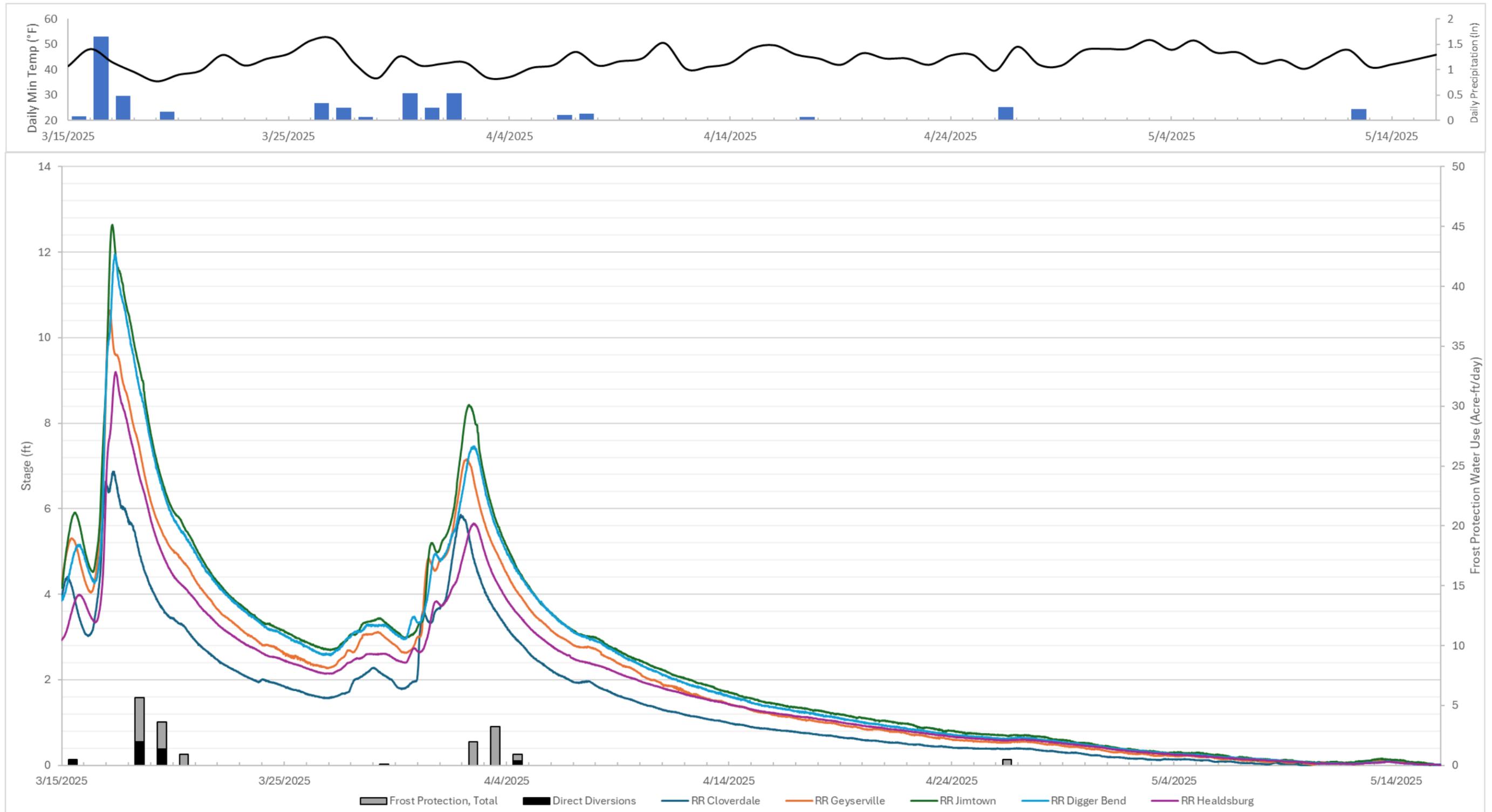


Figure 3: Hydrograph and hyetograph for gages along the mainstem Russian River within the Alexander Valley Focus Area. Daily precipitation and minimum temperature data are from the Alexander Valley (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area outside of the Big Sulphur, Gill, Gird, and Sausal Creek watersheds. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.1.2 Alexander Valley, Tributaries

Stage records were analyzed from four gages along tributaries to the Russian River in Alexander Valley. Stage data for Gird Creek are suspected to be errant owing to equipment problems and are not believed to be accurate. This equipment will be repaired or replaced. Sausal Creek stage data after approximately April 10 appear to be errant, but most likely reflect seasonal cessation of surface flow as observed in the stage data for Gill Creek. These gages are in alluvial reaches of Big Sulphur, Gill, Gird, and Sausal Creeks near their confluences with the Russian River (Figure 2). The Big Sulphur Creek gage is operated by USGS with no upstream enrollees; the data are reviewed to provide perspective on natural stage variation in the absence of frost protection (Figure A.6). Two NCWC gages on tributaries crossing the alluvium of Alexander Valley were installed in Gill Creek and Gird Creek. One diversion signal posing potential stranding risk was observed at Big Sulphur during the day of March 19th with a magnitude of 0.02 feet (Table 6). No diversion signals were observed for Gill, Gird, or Sausal Creek (Figures A.7 – A.9). The Gill Creek gage bottomed out at 0 feet during the day of April 12th, suggesting the time at which stage could no longer be measured by the pressure transducer (Figure A.7). Substantial daily oscillatory signals were observed on both the Gird and Sausal Creek gages (Figures A.8-A.9). For Gird Creek, these signals began on March 18th and persisted through May 15th and are represented by an amplitude ranging between 0.25 – 0.50 feet (Figure A.8). At Sausal Creek, signals appeared abruptly on April 9th and persisted through May 15th and are represented by amplitudes ranging between 0.30-0.60 feet (Figure A.9). It is likely that these daily oscillations are not representations of diel fluctuation due to their magnitude but rather an indication of the inability of the pressure transducer to accurately measure stage due to equipment malfunction or environmental change, e.g., seasonal dewatering of channel owing to declining water table.

Table 6: Potential diversions observed along selected tributaries to the Russian River within the Alexander Valley Focus Area during the 2025 frost protection season. NOTE: Sausal Creek stage data are believed to be accurate prior to about April 10; after that time, oscillations are likely caused by seasonal cessation of flow.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Big Sulphur Creek	3/19/2025	0.02	day	potential	no	No reported direct diversion
Gill Creek						No diversions observed, bottoms out April 12th
Gird Creek	3/18-5/15	0.25-0.50				Oscillations possibly due to equipment error
Sausal Creek	4/9-5/15	0.30-0.60				Oscillations possibly due to equipment error

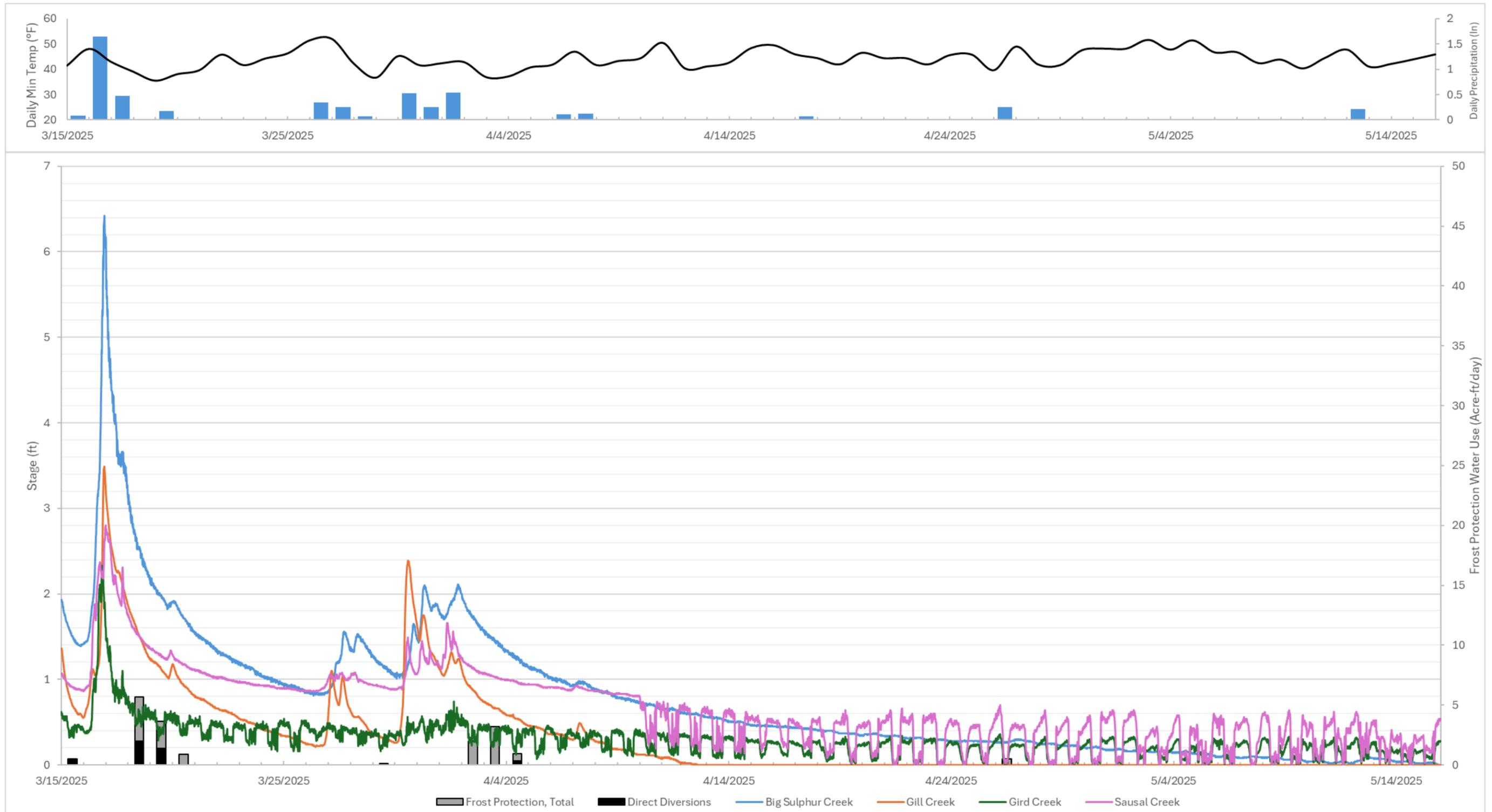


Figure 4: Hydrograph and hyetograph for gages along tributaries to the Russian River within the Alexander Valley Focus Area. Daily precipitation and minimum temperature data are from the Alexander Valley (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Gill, Gird, and Sausal Creek watersheds. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.2 Knights Valley Focus Area

The Knights Valley Focus Area is comprised of the Maacama Creek watershed. This watershed is naturally divided into northern and southern portions. The northern portion consists of the mainstem of Maacama Creek and Redwood Creek (Figure 5). The watershed drained by the main branch of Maacama Creek is mountainous and does not contain commercial vineyards. The Redwood Creek watershed along the bottom of Knights Valley has dense vineyard plantations. The southern half of the Focus Area is drained by Franz and Bidwell Creeks. The Franz and Bidwell Creek watersheds are relatively undeveloped for agriculture but contain two clusters of vineyards at their upstream and downstream ends. Bidwell Creek also drains vineyards in the southern portion of Knights Valley. Lower Maacama and Redwood Creeks are identified as high priority (Core) areas in the NOAA Coho Recovery Plan. Other portions of the watershed are identified as medium priority (Phase I Expansion).

The Knights Valley Focus Area has been one of the highest users of water for frost protection; however since 2020 this Focus Area has been among the lowest users. In 2025, reported frost protection use was 3.0 acre-feet, 20% of the 15.0 acre-feet reported in 2024 and just 9% of the 32.5 acre-feet reported in 2023. This was well below the range of frost protection use reported during the 2015 – 2019 seasons and the lowest of any Focus Area other than Green Valley/Atascadero in the 2025 season (Table 2). All water frost protection was sourced from wells or storage reservoirs (Table 4). Many of these reservoirs are located along or on tributaries to Redwood Creek.

4.2.1 Redwood and Upper Maacama Creeks

Stage records were analyzed from five gages along upper Maacama Creek and Redwood Creek: a USGS gage at Maacama Creek near Kellogg, and the NCWC gages along Redwood Creek and a major tributary. (Figure 5). Stage data for Redwood Creek at Treasury Winery are suspected to be errant owing to equipment problems and are not believed to be accurate. This equipment will be repaired or replaced.

Three diversion signals were observed in the stage record for Foote Creek, two of which pose substantial fish stranding risk (Figure A.10). The first diversion occurred from March 19th to March 24th with a magnitude of 0.29 feet and began at night (Table 7). This sudden decrease in stage followed by a sudden increase some days later may be attributed to a ‘fill and spill’ event. The second diversion was observed on April 4th during the night with a magnitude of 0.09 feet. A third diversion posing potential stranding risk occurred on March 26th during the day with a magnitude of 0.06 feet. None of these diversion signals were associated with frost protection reported by upstream users. Two diversions were observed in Redwood Creek (Figures A.12, A.13). At Redwood Creek at Highway 128 a diversion signal with a magnitude of 0.02 feet was observed on April 20th during the day. At Redwood Creek at Ferrari Winery a diversion signal with a magnitude of 0.07 feet was observed during the day (Table 7). Both signals pose potential fish stranding risk. No diversion signals were observed in the stage record for Redwood Creek at Treasury Winery (Figure A.11). No diversion signals were observed in the stage record for Maacama Creek (Figure A.14). All gages displayed diel fluctuations ranging from a maximum of 0.04-0.20 feet (Figure 6). These fluctuations generally become visible during the middle of April but vary by gage. The stage record of Redwood Creek at Treasury Winery exhibited the largest diel fluctuation with a maximum magnitude of 0.20 feet and was observable from the middle of April onwards. The stage record of Redwood Creek at Ferrari Creek exhibited the smallest diel fluctuation with a maximum magnitude of 0.04 feet and was observable from late April onwards.

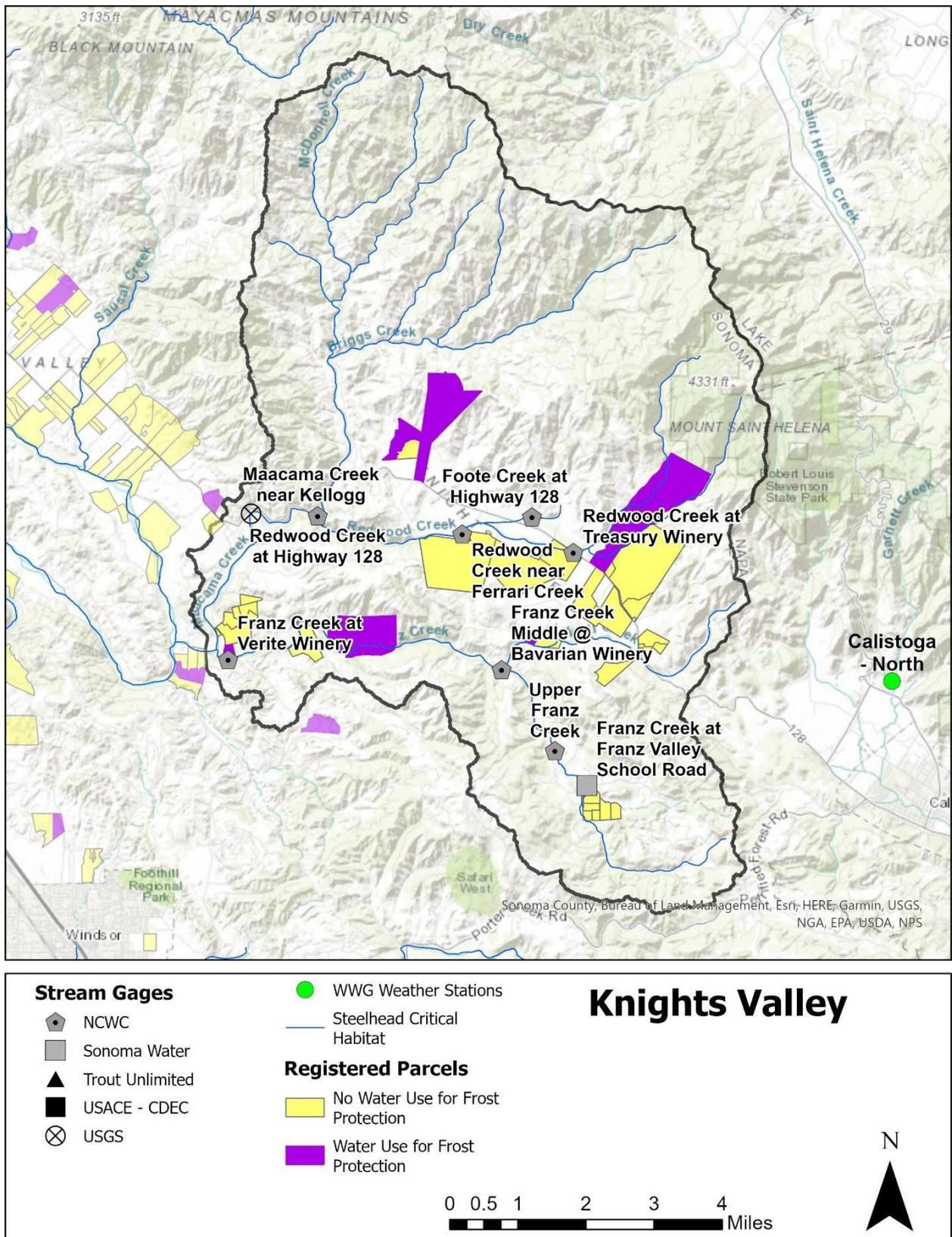


Figure 5: Stream gages and weather stations used in the Knights Valley Focus Area.

Table 7: Potential diversions observed along Redwood and Matanzas Creeks within the Knights Valley Focus Area during the 2025 frost protection season. NOTE: Stage data for Redwood Creek at Treasury Winery are believed to be inaccurate owing to equipment problems.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Foote Creek	3/19/2025	0.29		substantial	no	Reservoir fill+spill - stage drop of 0.29 feet on 3/19, stage increase of 0.12 feet on 3/24, daily variation of 0.1 feet max early April onwards
	3/26/2025	0.06	day	potential	no	No reported direct diversion.
	4/4/2025	0.09	night	substantial	no	No reported direct diversion
Redwood Creek at Treasury Winery						No diversions observed, daily variation of 0.26 feet max mid-April onwards
Redwood Creek at Hwy 128	4/20/2025	0.02	day	potential	no	No reported direct diversion, daily variation of 0.1 feet max mid-April onwards
Redwood Creek at Ferrari Winery	4/14/2025	0.07	day	potential	no	No reported direct diversion, daily variation of 0.04 feet max late-April onwards
Maacama Creek						No diversions observed, daily variation of 0.05 feet max late-April onwards

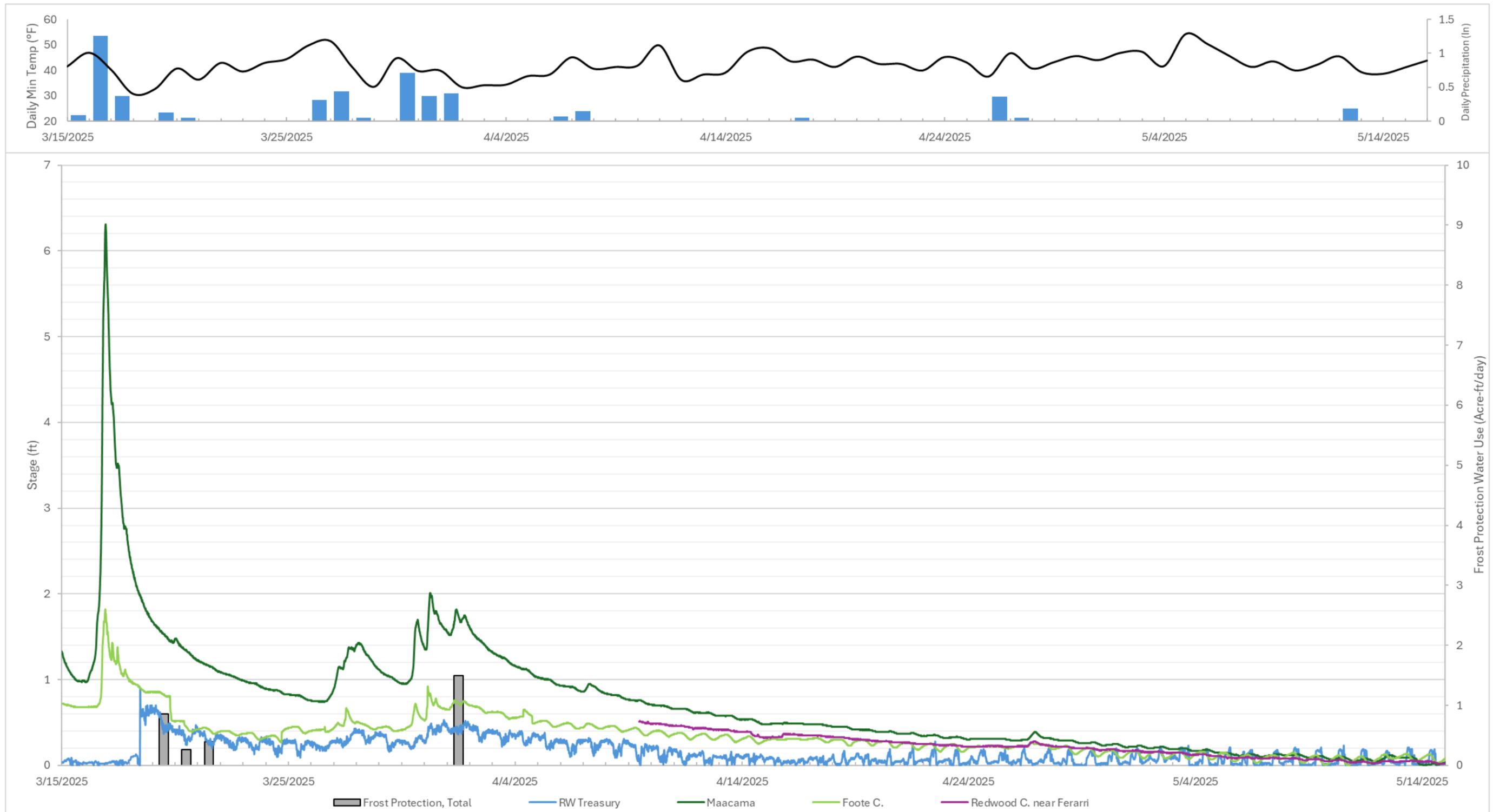


Figure 6: Hydrograph and hyetograph for gages along Redwood Creek and Maacama Creek within the Knights Valley Focus Area. Daily precipitation data and minimum temperature data are from the Calistoga North weather station. Frost protection use reflects volumes reported by NCWC enrollees in the Knights Valley Focus Area exclusive of the Franz Creek watershed. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.2.2 Franz Creek

Stage records were analyzed from four gages within the Franz Creek watershed. Three of these gages were operated by the NCWC and one was operated by Sonoma Water (Figure 5). The NCWC gage installed on Franz Creek at Bavarian Lion is downstream of the confluence of Bidwell Creek and Franz Creek and is expected to provide some ability to detect potential diversions in the Bidwell Creek watershed. Stage data for Upper Franz Creek are suspected to be errant owing to equipment problems and are not believed to be accurate. This equipment will be repaired or replaced.

No potential diversions were observed within the Franz Creek Watershed (Table 8; Figures A.15-A.18). The stage record for Upper Franz Creek displayed periodic spikes of maximum magnitude 0.25 feet between the middle of April through the end of the record (Figure 7, A.16). These spikes may be attributed to equipment error. Diel fluctuations of maximum magnitude 0.6 feet are visible in the stage record of Franz Creek Middle at Bavarian Winery from late-March onwards (Figure A.18).

Table 8: Potential diversions observed along Franz Creek within the Knights Valley Focus Area during the 2024 frost protection season. NOTE: Stage data for Upper Franz Creek are believed to be inaccurate owing to equipment problems.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Franz Creek at Franz Valley School Road						No diversions observed
Upper Franz Creek						Periodic spikes 0.25 feet max due to equipment error
Franz Creek at Verite Winery						No diversions observed
Franz Creek Middle at Bavarian Winery						No diversions observed, daily variation of 0.6 feet max late March onwards

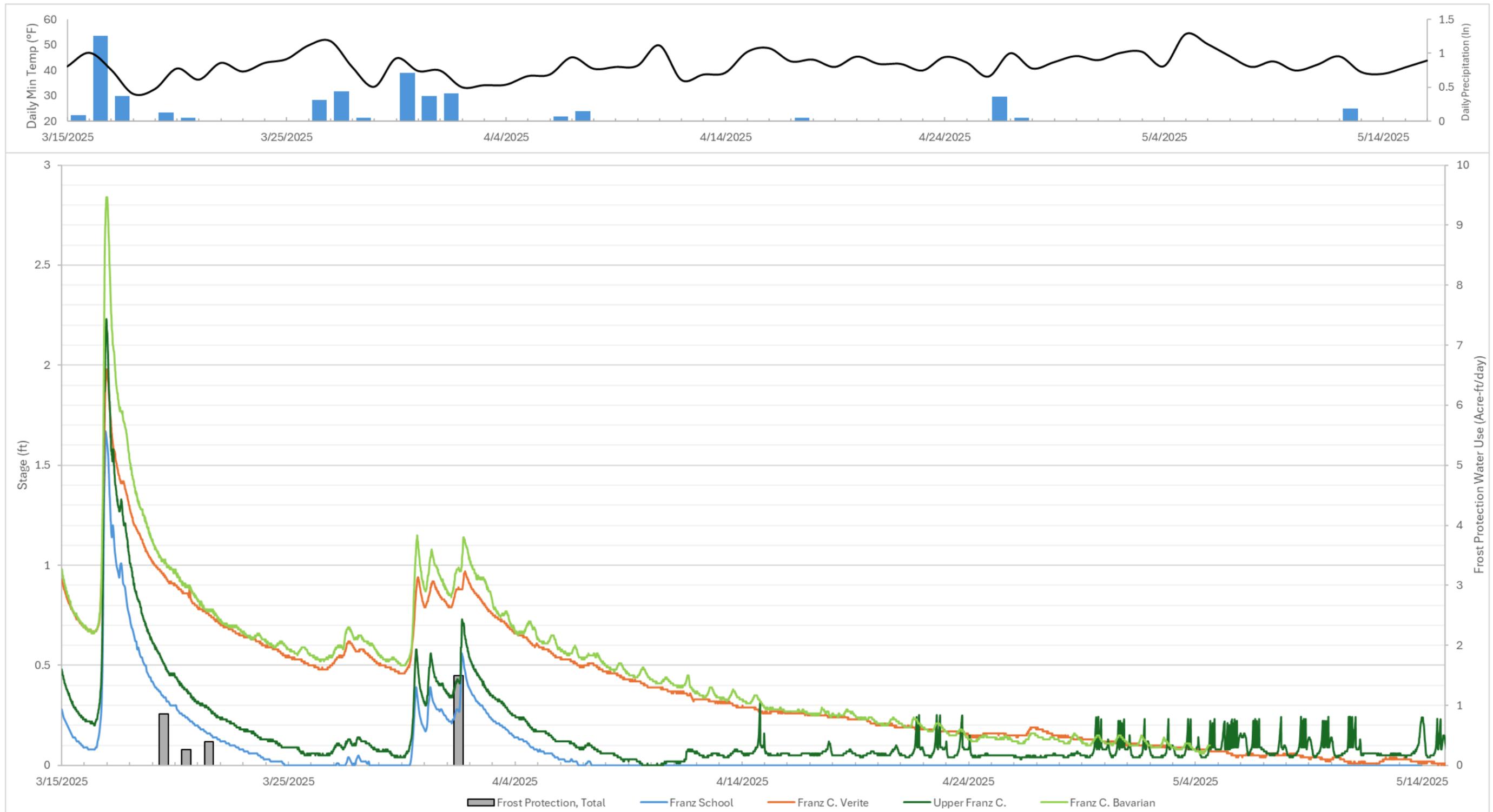


Figure 7: Hydrograph and hyetograph for gages along Franz Creek within the Knights Valley Focus Area. Daily precipitation and minimum temperature data are from the Knights Weather Station (KNY). Frost protection use reflects volumes reported by NCWC enrollees within the Franz Creek watershed. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.3 Dry Creek Focus Area

The Dry Creek Focus Area is defined as the Dry Creek watershed upstream of its confluence with the Russian River and downstream of Warm Springs Dam/Lake Sonoma (Figure 8). The valley bottom is densely planted with vineyards, many of which are registered with the NCWC. Flows within Dry Creek are controlled to a significant degree by the rate of release from Lake Sonoma. Managed releases result in higher spring and summer baseflow but smaller storm peaks. Releases from Lake Sonoma in the winter to manage the flood control pool are conducted at the direction of the US Army Corps of Engineers. The entire Dry Creek Focus Area except for the Pena Creek watershed is identified as a high priority (Core) area in the NOAA Coho Recovery Plan.

Historically the Dry Creek Focus Area has used less water for frost protection than other Focus Areas. However, during the 2025 frost protection season reported use was 25.8 acre-feet, comprising 28% of water used by registered parcels amongst all Focus Areas and more than any other individual Focus Area (Table 2). Parcels reporting storage and wells as their only source of water for frost protection accounted for 93.8% of proposed use. All the remaining water use was on parcels which reported surface storage as their only source of water. No frost protection water use came from parcels that reported direct diversions as one of their water sources. (Table 4).

Stage records were analyzed from two USGS gages covering Dry Creek below Warm Springs Dam (Table 9). No potential diversions were observed at the Dry Creek below Lambert Bridge gage or the Dry Creek at Mouth near Healdsburg gage (Table 9, Figure A.19 and A.20). Some large drops in stage correspond to changes in releases from Warm Springs Dam. These dam release signals were observed in stage records at both Dry Creek sites on March 28th, April 10th, 17th, 18th, 22nd, and 28th. A sudden increase of stage during the day of May 12th can be observed in both stage records – a larger magnitude increase of 0.2 feet is visible in the upstream record of Dry Creek at Lambert Bridge with a smaller magnitude increase of 0.11 feet apparent downstream in the record of Dry Creek Mouth. These sudden increases in stage may be attributed to return flow from a storage reservoir on Dry Creek upstream of both gages. Any other changes in stage in this record can be attributed to precipitation events.

Table 9: Potential diversions observed within the Dry Creek Focus Area during the 2025 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Dry Creek at Lambert Bridge	3/28/2025	1.0	day			Reservoir Release Change
	4/10/2025	0.55	day			Reservoir Release Change
	4/17/2025	0.14	day			Reservoir Release Change
	4/18/2025	0.13	day			Reservoir Release Change
	4/22/2025	0.17	day			Reservoir Release Change
	4/28/2025	0.08	day			Reservoir Release Change
	5/12/2025		day			Possible return flow, sudden stage increase of 0.2 feet
Dry Creek Mouth	3/28/2025	1.07	day			Reservoir Release Change
	4/10/2025	0.42	day			Reservoir Release Change
	4/17/2025	0.16	day			Reservoir Release Change
	4/18/2025	0.14	day			Reservoir Release Change
	4/22/2025	0.09	day			Reservoir Release Change
	4/28/2025	0.07	day			Reservoir Release Change
	5/12/2025		day			Possible return flow, sudden stage increase of 0.2 feet

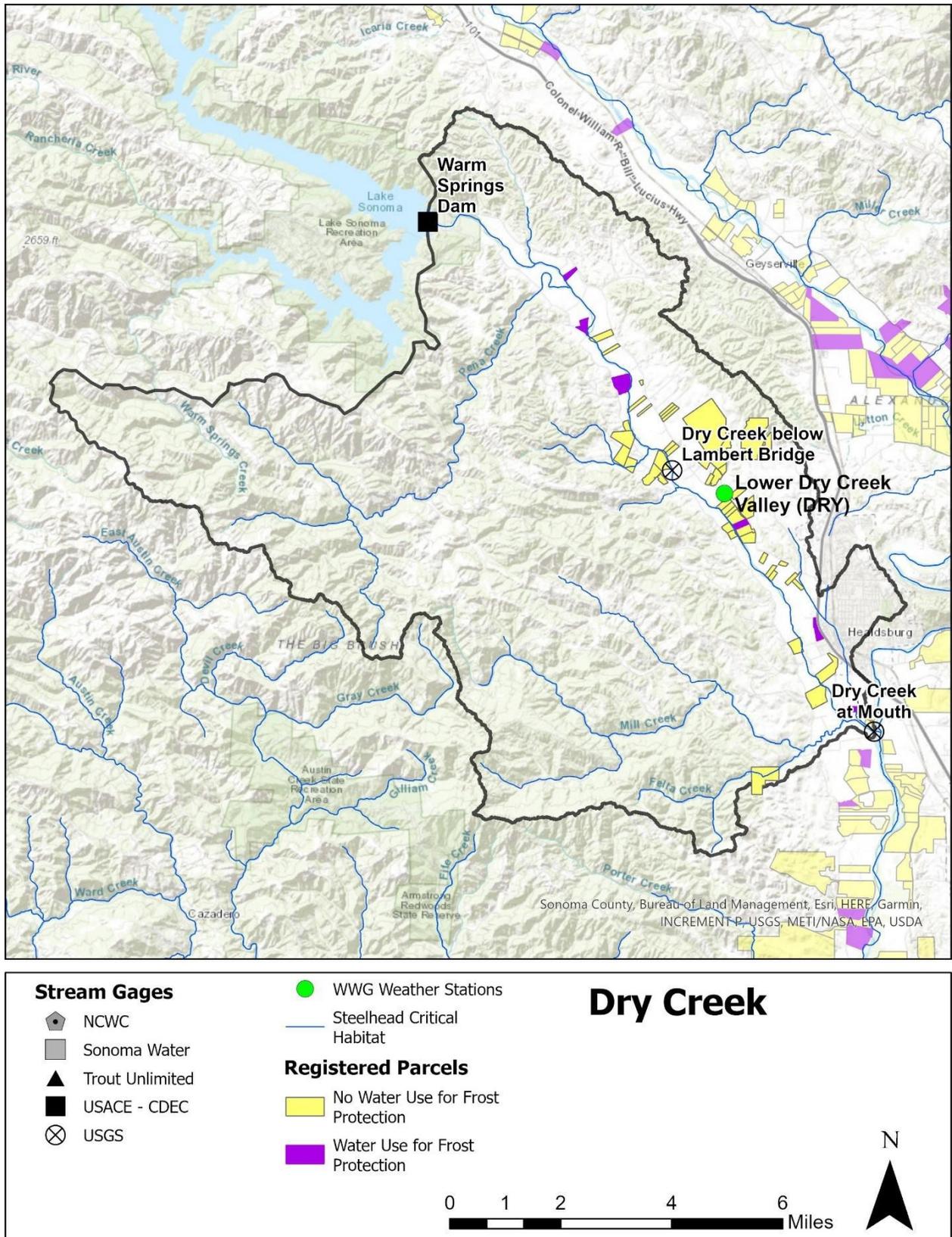


Figure 8: Stream gages and weather stations used in the Dry Creek Valley Focus Area.

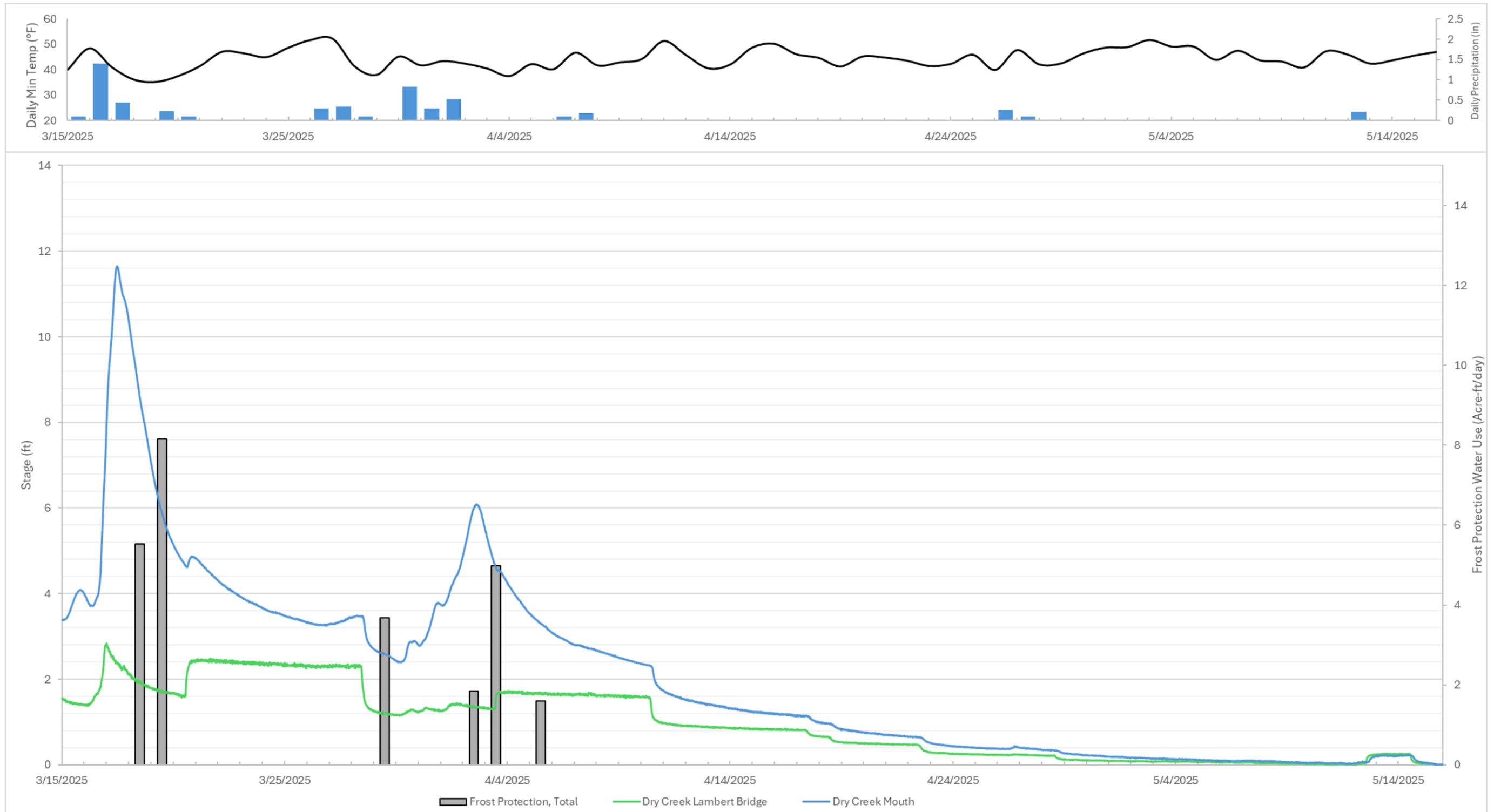


Figure 9: Hydrograph and hyetograph for gages along Dry Creek in the Dry Creek Focus Area. Daily precipitation and minimum temperature data are from the Lower Dry Creek Valley (DRY) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees in the Dry Creek Valley Focus Area. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.4 Mark West Creek Focus Area

The Mark West Creek Focus Area consists of the Mark West Creek watershed excluding the Laguna de Santa Rosa and Santa Rosa Creek watersheds which are included in the Santa Rosa Plain Focus Area (Figure 10). This Focus Area can be divided into upper and lower watersheds with significantly different topography and land use. The upper watershed is located in the Mayacamas Mountains, and land use is predominantly rural-residential or undeveloped. While there are several vineyards within the upper watershed, only one registered with the NCWC reported frost protection during the 2025 season. The lower watershed is located within the Santa Rosa Plain and includes Mark West, Windsor, and Pool Creeks. Land use within the lower watershed is a mixture of vineyards, suburban residential, and light industrial. Mark West Creek between its confluence with Porter creek and its confluence with the Laguna de Santa Rosa is identified as a high priority (Core) area in the NOAA Coho Recovery Plan. The Core Areas in the NOAA Recovery Plan have also been identified as critical habitat for aquatic species by the California Water Resources Control Board and is identified as a watershed of special concern with respect to groundwater use by County of Sonoma; of particular concern are over-wintering juvenile coho salmon.

Historically, water use for frost protection within the Mark West Creek focus area has been moderate. Since the 2020 frost protection season, this Focus Area has been among the highest users of water for frost protection by a large margin. However, in the 2025 season frost protection use returned to a proportionately moderate percentage of that used amongst all Focus Areas. During the 2025 season, enrollees in the Mark West Creek Focus Area used 11.3 acre-feet of water for frost protection, an amount only greater than that used in the Green Valley Creek and Knights Valley Focus Areas (Table 2). Water use during this period constituted only 9% of that used during the 2024 frost protection period and roughly 5% of the average water use from 2020-2024. Approximately 86% of the reported water use for frost protection amongst registered parcels in this Focus Area was supplied from storage reservoirs (Table 4); many vineyards have large off-channel storage reservoirs. 10.7 acre-feet or 95% of reported water use came from storage reservoirs or wells. The remaining 0.6 acre-feet came from parcels which reported recycled water as their water source.

Stage records were analyzed from five gages: one in the upper watershed and four in the lower watershed (Figures 10, 11). The upper watershed gage is operated by Sonoma Water and data from these gages are not expected to reveal diversions signals associated with frost protection. The observations from these upper watershed gages are illustrative of stage fluctuations likely to occur in the absence of diversions for frost protection.

One significant drop in stage was identified in the Mark West at Michelle Way gage (Figure A.21). This signal was observed during the night on April 5th and had a magnitude of 0.14 feet. This corresponds to a substantial fish stranding risk but is not associated with any reported frost protection. A sudden and short-lived spike of 0.34 feet can be observed in the stage record on April 23rd; with no corresponding precipitation during this period, this spike may be attributed to equipment maintenance or a local release of stored water. A sustained stage of 2.42 feet between March 16th and March 18th can be observed in the stage record for Mark West Creek at Laughlin Road (Figure A.22). This 'flat-line' may represent the peak stage for which the pressure transducer is calibrated to measure. Diel fluctuations of maximum magnitude 0.1 feet can be observed from early April onwards. No diversion signals were observed at the Mark West at Saralee Vineyard gage, though diel fluctuations of maximum magnitude 0.05 feet can be observed from mid-April onwards (Figure A.23). A diversion signal of magnitude 0.08 feet can be observed

on the stage record for Mark West Creek at Mirabel Way during the night of May 5th (Figure A.24). This corresponds to a substantial fish stranding risk but is not associated with any reported frost protection. No diversions were identified within the stage record for Windsor Creek at Mark West Station Road (Figure A.25).

Table 10: Potential diversions observed within the Mark West Creek Focus Area during the 2025 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Mark West Creek at Michelle Way	4/5/2025	0.14	night	substantial	no	No reported direct diversion
	4/23/2025					Sudden, short duration increase in stage 0.34 feet - possibly due to equipment error or landslide
Mark West Creek at Laughlin Road	3/16/2025					Sustained stage flatline at 2.42 feet - possible equipment limitation. Daily variation of max 0.1 feet early April onwards
Mark West Creek at Saralee Vineyards						No diversions observed. Daily variation of max 0.05 feet mid-April onwards
Mark West Creek at Mirabel Way	5/5/2025	0.08	night	substantial	no	No reported direct diversion
Windsor Creek						No diversions observed

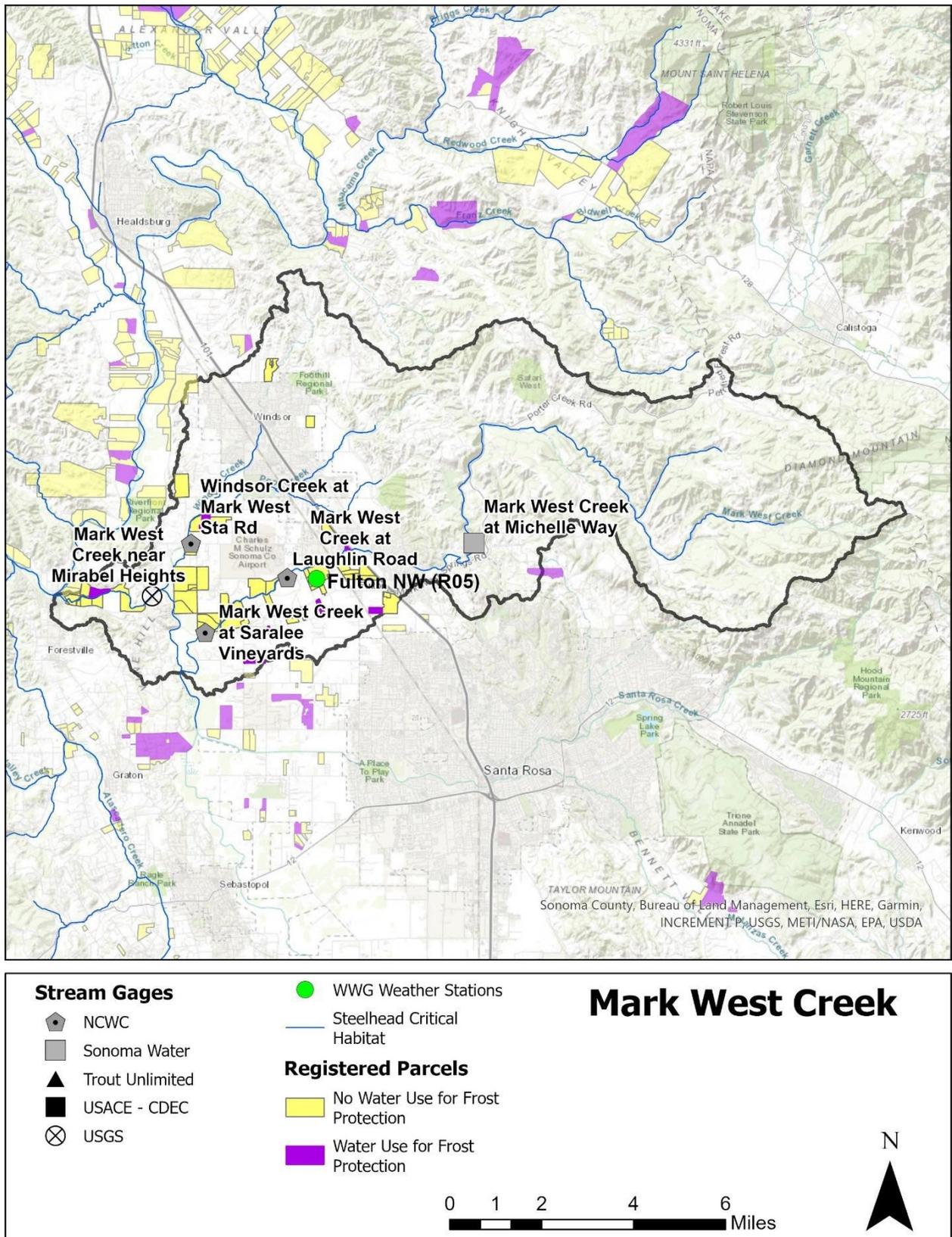


Figure 10: Stream gages and weather stations used in the Mark West Creek Focus Area.

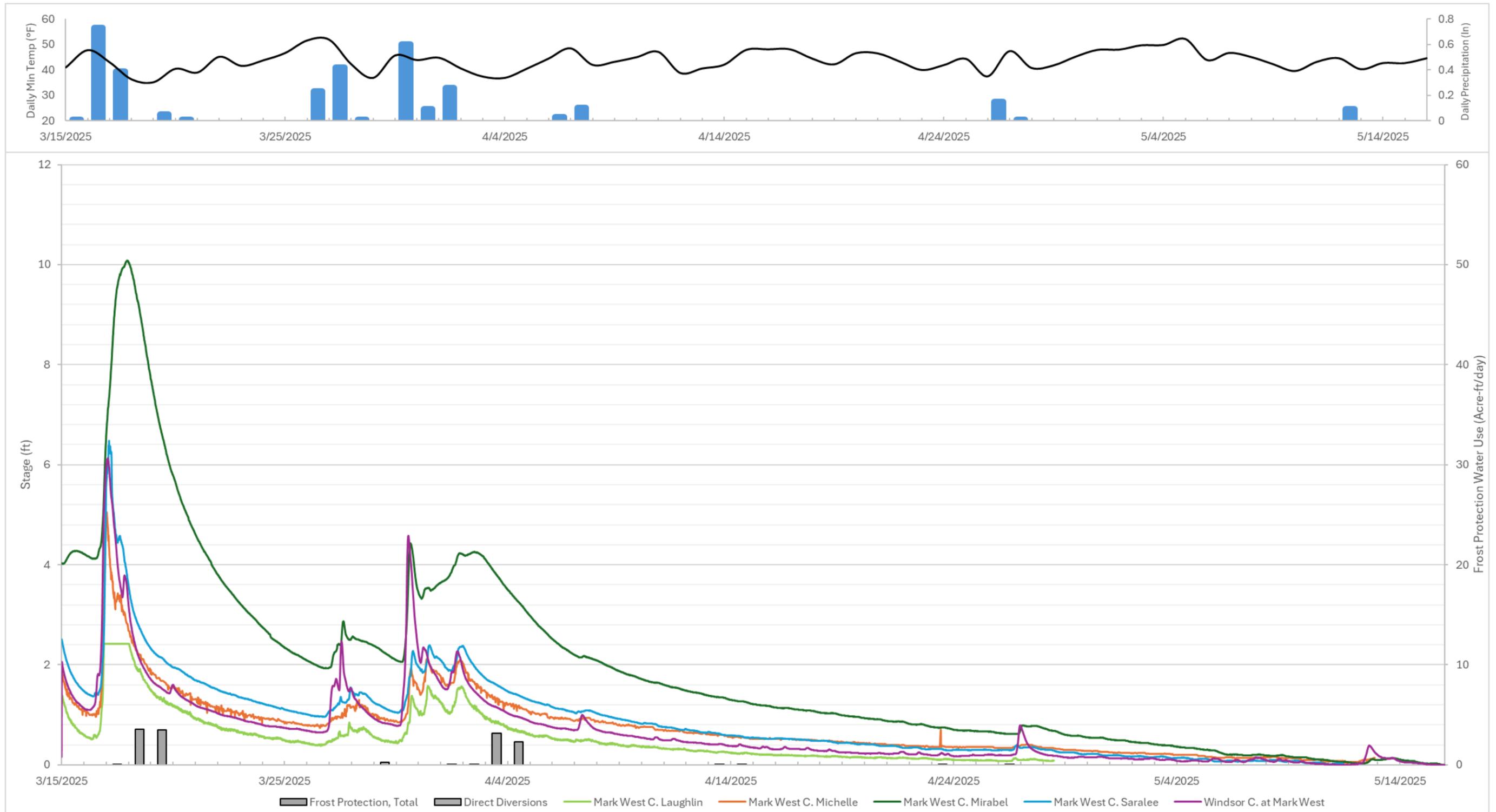


Figure 11: Hydrograph and hyetograph for gages along Mark West and Windsor Creeks within the Mark West Creek Focus Area. Daily precipitation and minimum temperature data are from the Fulton NW (R05) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees in the Mark West Creek Focus Area. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.5 Santa Rosa Plain Focus Area

The Santa Rosa Plain Focus Area consists of the Santa Rosa Creek and Laguna de Santa Rosa watersheds (Figure 12). Within the Santa Rosa Plain, land use is a mixture of urban, rural-residential, and varied agricultural lands including vineyards and pasture. Agricultural lands are typically located along the western side of the plain while urban areas are located along the eastern side. Also included in the Santa Rosa Plain Focus Area is Bennett Valley, southeast of Santa Rosa. This valley contains vineyards, rural-residential properties, and large amounts of open space. It is situated in the volcanic uplands above the Matanzas Creek Reservoir. This Focus Area contains minimal mapped steelhead habitat and is identified as a medium and low priority (Expansion Phases I & II) area in the NOAA Coho Recovery Plan for the Russian River.

Historically, the Santa Rosa Plain Focus Area has been among the highest users of water for frost protection in the study area. This was particularly true for high-use seasons such as 2020 and 2021. During the 2025 season, water use in the Santa Rosa Plain Focus Area was 21.1 acre-feet, the highest of any Focus Area with the exception of Dry Creek but less than 10% of the reported use from 2020-2023 and 29% of reported use in 2024 (Table 2). The alluvium underlying the Santa Rosa Plain is a productive aquifer and most vineyards historically report wells as a source of water for frost protection. However, during the 2025 frost protection season approximately 71% reported storage reservoirs as their only source of water while just 29% reported using wells. Many vineyards also use water from off-channel reservoirs. All reported frost protection use came from one of these two sources. No parcels reporting direct diversions as a water source also reported using water for frost protection (Table 4).

Data from one gage added to the network in this Focus Area for the 2024 frost protection season on Abramson Creek at Guerneville Road was unavailable for the 2025 frost protection season. Given the very limited extent of enrollees in the Santa Rosa Creek watershed and the density of urbanized landscape in the watershed it may be more fruitful to investigate potential for monitoring other streams in this Focus Area in the future.

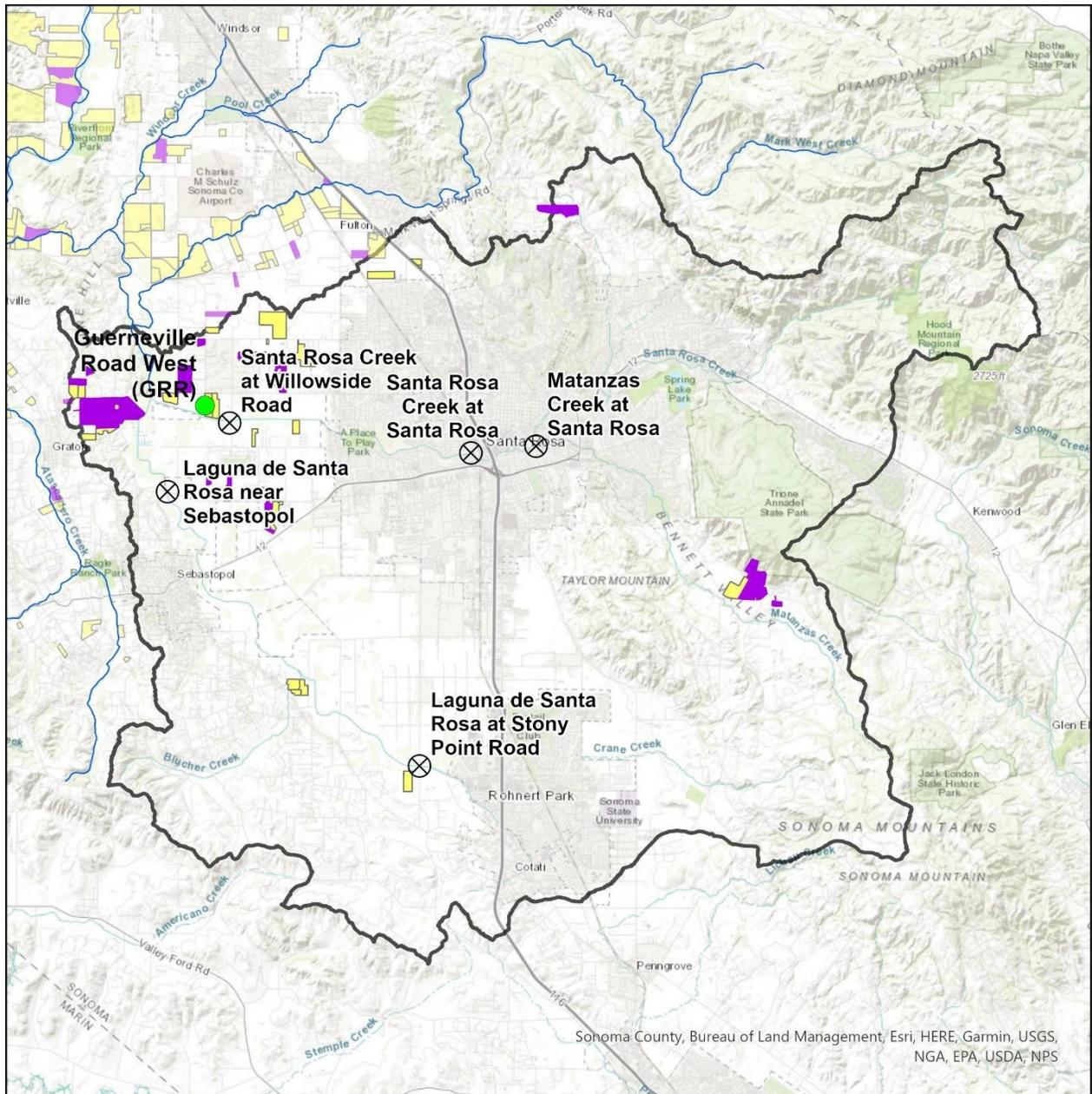
4.5.1 Santa Rosa and Matanzas Creeks

Stage records were analyzed from three USGS gages along Santa Rosa and Matanzas Creeks (Figures A.26, A.27, and A.28). Previously, data from a fourth gage, the Matanzas Creek at Bennett Valley Road gage operated by Sonoma Water, has also been analyzed (Figure 12). However, the stage appeared to be below the detection limit of the sensor throughout the majority of the frost protection season and no observations could be made from this record.

The stage records of Matanzas Creek at Santa Rosa and Santa Rosa Creek at Santa Rosa show the influence of flood control reservoir management causing the drops in stage observed on March 20th, 28th, and April 4th (Figure A.26, A.27). Three diversion signals were observed in the stage record for Matanzas at Santa Rosa (Table 11, Figure A.26). All three signals occurred during the day with magnitudes of 0.02 feet from mid-late April and are not associated with frost protection use; no direct diversions were reported for this Focus Area. No potential diversion signals were identified in the stage record of Santa Rosa Creek at Willowside Road (Table 11, Figure A.28). Diel fluctuations of maximum magnitude 0.10 feet could be observed from early April onwards.

Table 11: Potential diversions observed along Santa Rosa and Matanzas Creeks within the Santa Rosa Plain Focus Area during the 2025 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Matanzas Creek at Santa Rosa	3/20/2025					Reservoir Release Change
	3/28/2025					Reservoir Release Change
	4/4/2026					Reservoir Release Change
	4/18/2025	0.02	day	potential	no	
	4/24/2025	0.02	day	potential	no	
Santa Rosa Creek at Santa Rosa	4/25/2025	0.02	day	potential	no	
	3/20/2025					Reservoir Release Change
	3/28/2025					Reservoir Release Change
Santa Rosa Creek at Willowside Road	4/4/2025					Reservoir Release Change
						No diversions observed. Daily variation of max 0.10 feet early April onwards



Stream Gages

- NCWC
- Sonoma Water
- Trout Unlimited
- USACE - CDEC
- USGS

Registered Parcels

- No Water Use for Frost Protection
- Water Use for Frost Protection

Santa Rosa Plain

WWG Weather Stations

Steelhead Critical Habitat

0 1 2 4 6 Miles

Figure 12: Stream gages and weather stations used in the Santa Rosa Plain Focus Area.

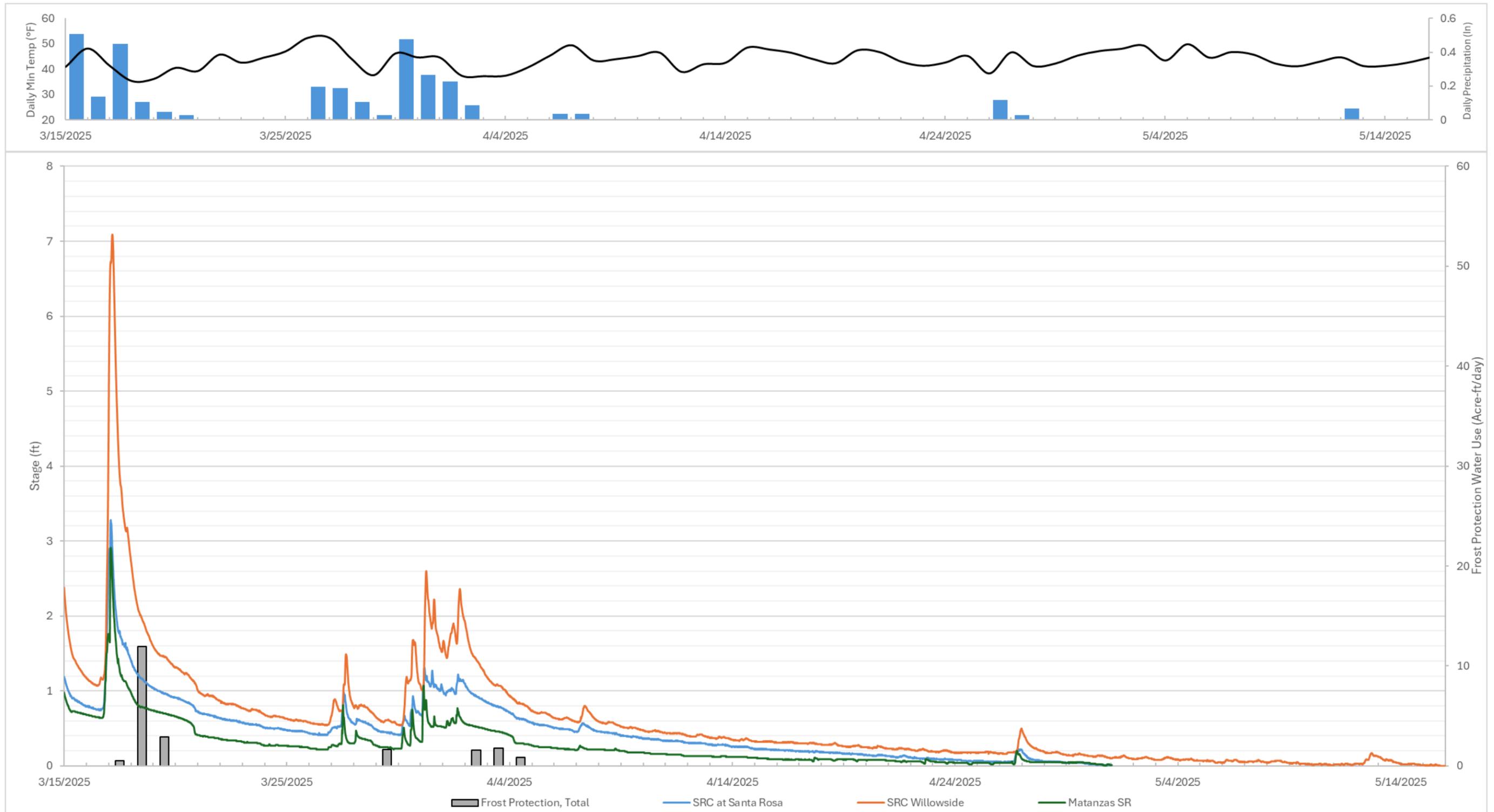


Figure 13: Hydrograph and hyetograph for gages along Santa Rosa and Matanzas Creeks within the Santa Rosa Plain Focus Area. Daily precipitation and minimum temperature data are from the Guerneville Road West (GRR) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees in the Santa Rosa Creek watershed. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.5.2 Laguna de Santa Rosa

Stage records were analyzed from two USGS gages along the Laguna de Santa Rosa. No potential diversion signals were identified in either gage. The Laguna De Santa Rosa at Sebastopol and Laguna De Santa Rosa at Stony Point Road stage records exhibit diel fluctuations of maximum 0.05 feet from early April onward, as well as relatively steady responses to precipitation (Figures A.29, A.30). However, both exhibited no clear diversion signals and there were no reported diversions for frost protection. All variation in both gages on the Laguna De Santa Rosa can be attributed to natural variations in precipitation or wind.

Table 12: Potential diversions observed along the Laguna de Santa Rosa within the Santa Rosa Plain Focus Area during the 2025 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Laguna de Santa Rosa at Stony Point Road						No diversions observed. Daily variation of max 0.05 feet early April onwards
Laguna de Santa Rosa at Sebastopol						No diversions observed. Daily variation of max 0.05 feet early April onwards

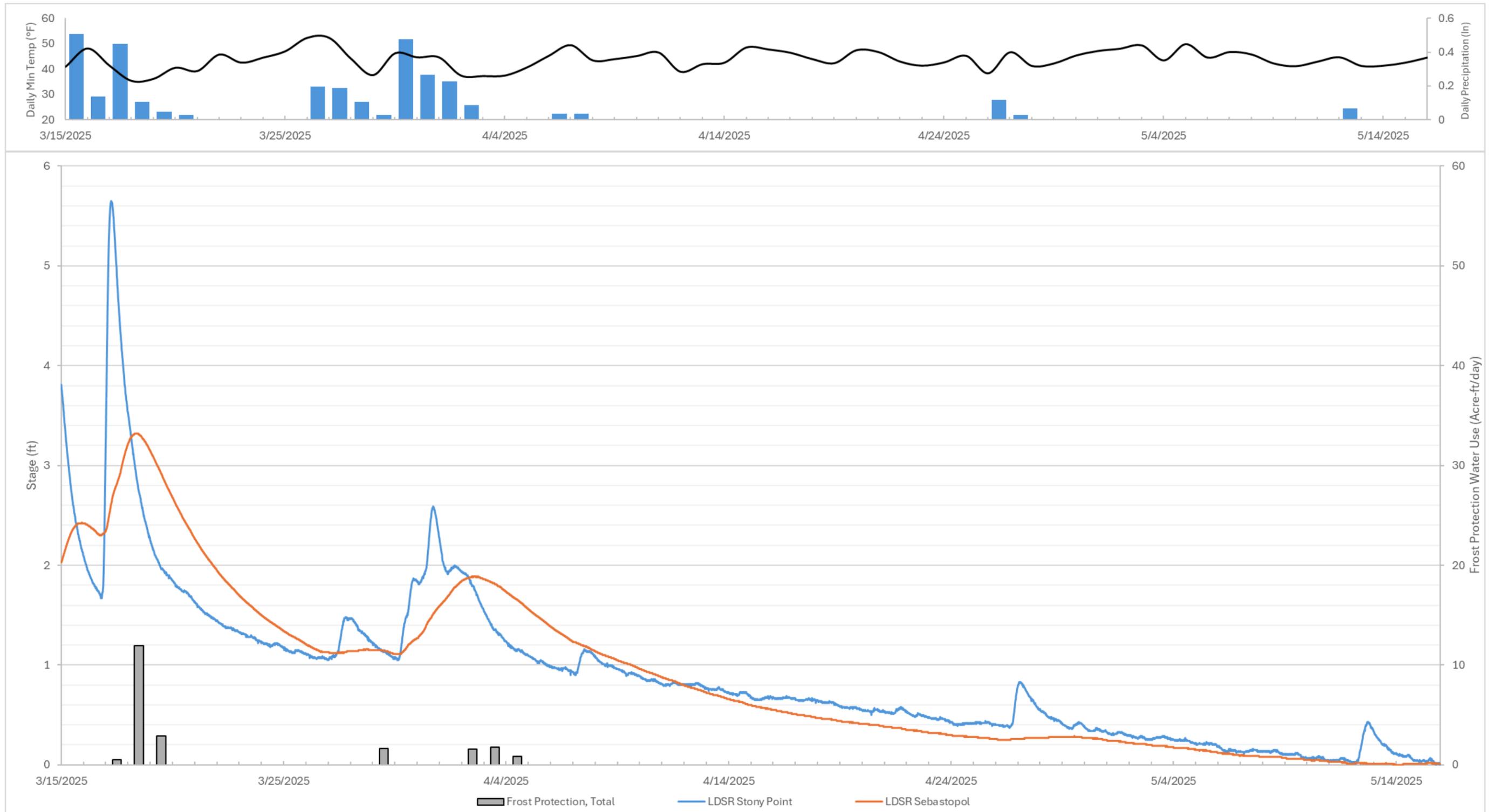


Figure 14: Hydrograph and hyetograph for gages along the Laguna de Santa Rosa within the Santa Rosa Plain Focus Area. Daily precipitation and minimum temperature data are from the Guerneville Road West (GRR) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees in the Laguna de Santa Rosa watershed. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.6 Green Valley Creek Focus Area

The Green Valley Creek Focus Area consists of the Green Valley and Atascadero Creek watersheds upstream of their confluence with the Russian River (Figure 15). Much of the Atascadero and lower Green Valley Creek watersheds are substantially developed for agriculture. Vineyards and orchards are interspersed with rural-residential properties and small urban areas including Forestville and Graton. The upper Green Valley Creek watershed is a mixture of open pasture and coniferous forest and for the most part does not contain commercial vineyards. Vineyards enrolled with the NCWC are concentrated along the valley bottoms of lower Green Valley, Purrington, and Atascadero Creeks. The Green Valley and Purrington Creek watersheds have been identified as high priority (Core) areas in the NOAA Coho Recovery Plan while the Atascadero Creek watershed is identified as medium to low priority areas. The Core Areas in the NOAA Recovery Plan have also been identified as critical habitat for aquatic species by the California Water Resources Control Board and is identified as a watershed of special concern with respect to groundwater use by County of Sonoma; of particular concern are over-wintering juvenile coho salmon.

Vineyards in the Green Valley Focus Area have historically used less water for frost protection than in other Focus Areas. This trend has amplified for the 2025 frost protection season where enrollees reported using only 1.6 acre-feet of water for frost protection, approximately 4% of reported usage in 2024 (Table 2). No enrollees reported direct diversion as a water source in the Green Valley Creek Focus Area and 100% reported their water source as storage reservoirs (Table 4). As no parcels reported direct diversions as a water source, none of the diversion signals identified in the Green Valley Creek Focus Area are believed to be directly associated with frost protection. Nevertheless, the Green Valley Creek Focus Area has historically had some of the highest counts of identified diversion signals.

4.6.1 Green Valley and Purrington Creeks

Stage data were analyzed for two NCWC gages and two Trout Unlimited gages along Purrington and Green Valley Creeks (Figures 15, 16). Records from the upstream most gage, Green Valley Creek at Bones Road, show one diversion signal with a magnitude of 0.04 feet during the day on May 11th, representing a potential stranding risk (Figure 16; Figure A.31). Five diversion signals were observed in the Purrington Creek stage record (Figure A.32). Three of these diversions occurred on April 23rd, 24th, and 25th during the night and all were 0.03 feet in magnitude, posing substantial fish stranding risks (Figure A.32). These diversions were observed downstream on the same dates on the Upper Green Valley Creek at Green Valley Road gage at 0.03-0.04 feet in magnitude and pose the same substantial stranding risks (A.33). While these signals could also be identified on the Green Valley at Thomas Creek Ranch gage, they were all of 0.01 feet in magnitude and thus pose only potential stranding risks (Figure A.34). Because these three signals were not observable on the stage record for Green Valley Creek at Bones Road, the diversion likely occurred in Purrington Creek upstream of the Purrington Creek gage.

Two other signals were observed in the stage record for Purrington Creek. These diversion signals were both 0.02 feet in magnitude, occurred during the day on both April 8th and May 14th, and pose potential stranding risks (Figure A.32). Flattened peaks were observed in the Green Valley Creek at Thomas Creek Ranch hydrograph during precipitation events on March 16th and 30th. In both instances the maximum observed stage was exactly 2.392 feet which was maintained for an extended period during which peaks were observed in other gage records in the region. As such we believe this to be a pressure transducer recording the peak value of its range rather than any evidence of diversion. One final signal was identified

on the stage record for Green Valley Creek at Thomas Creek Ranch. A sudden increase in stage of magnitude 0.20 feet can be observed on the late afternoon of May 5th, followed by an equal decrease on the morning of May 6th (Figure A.34). This stage increase lasts approximately 14 hours and may represent a possible return flow from an off-channel storage reservoir.

Historically, the Green Valley Creek Focus Area has been among those with the greatest number of observed diversion signals, especially considering the relatively low number of enrollees reporting direct diversion as a water source. In 2025, there were substantially fewer diversion signals in the stream stage data, continuing a trend first observed in 2023. It is possible additional precipitation later in the season reduced the demand for in-stream diversions for frost protection and other water users.

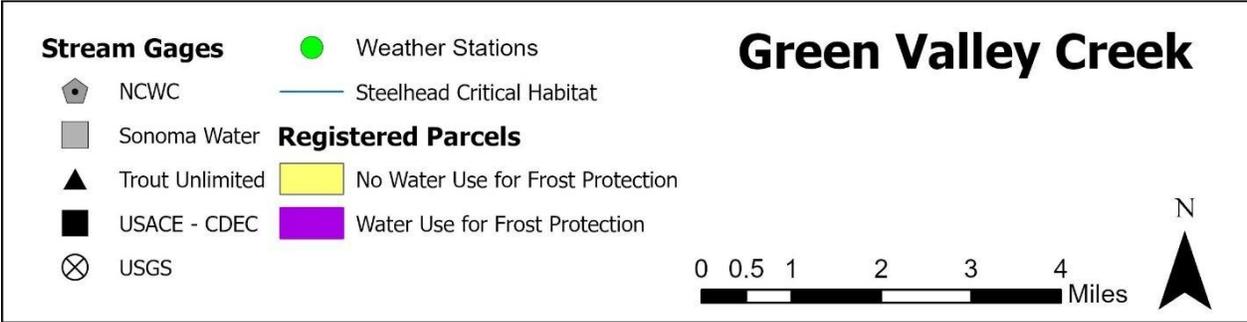
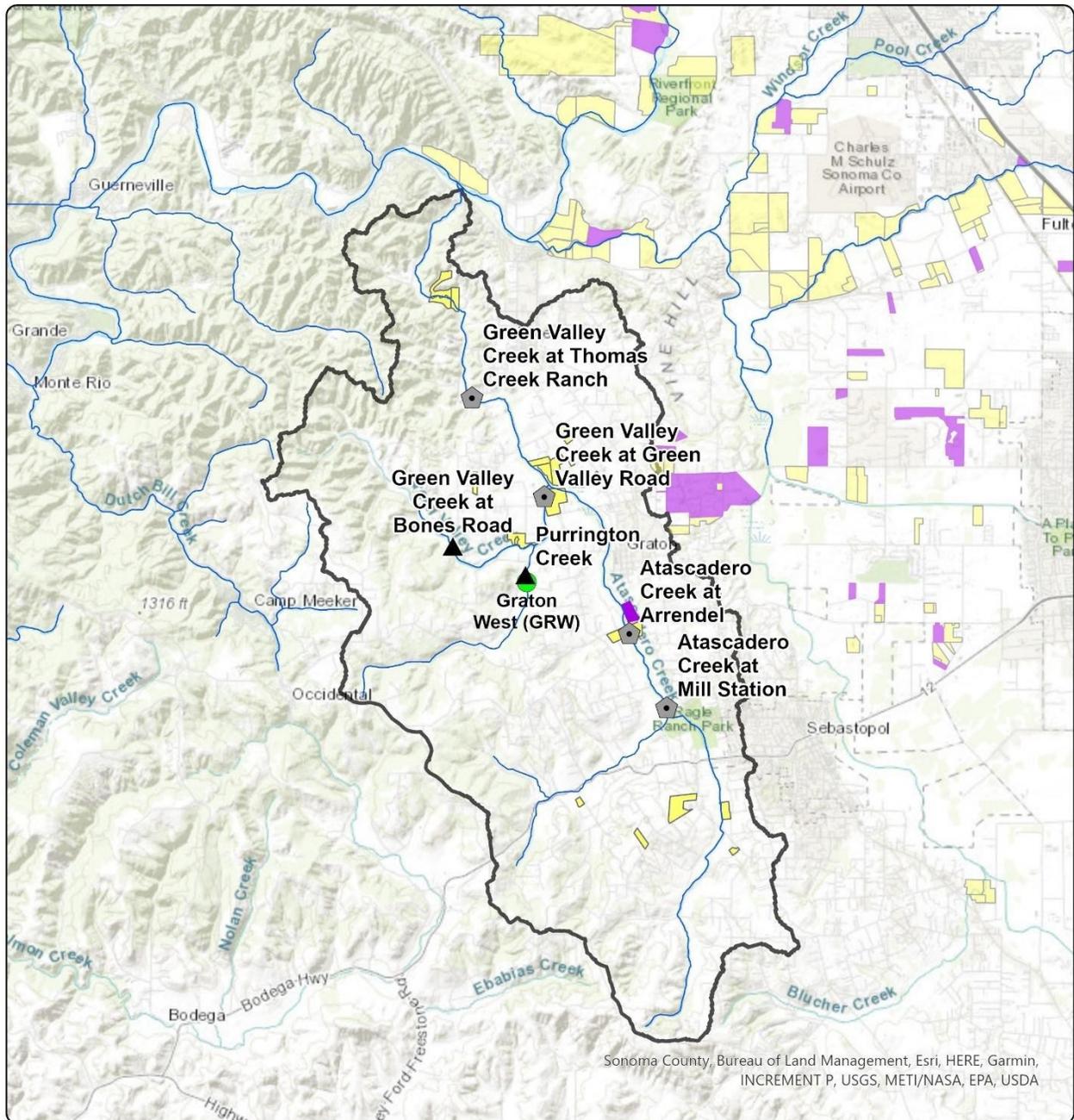


Figure 15: Stream gages and weather stations used in the Green Valley/Atascadero Creek Focus Area.

Table 13: Potential diversions observed on Green Valley and Purrington Creeks in the Green Valley Creek Focus Area during the 2025 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Green Valley Creek at Bones Road	5/11/2025	0.04	day	potential	no	No reported direct diversion
Purrington Creek	4/8/2025	0.02	day	potential	no	No reported direct diversion
	4/23/2025	0.03	night	substantial	no	No reported direct diversion
	4/24/2025	0.03	night	substantial	no	No reported direct diversion
	4/25/2025	0.03	night	substantial	no	No reported direct diversion
	5/14/2025	0.02	day	potential	no	No reported direct diversion
Green Valley Creek (Upper) at Green Valley Road	4/23/2025	0.04	night	substantial	no	No reported direct diversion
	4/24/2025	0.03	night	substantial	no	No reported direct diversion
	4/25/2025	0.04	night	substantial	no	No reported direct diversion
Green Valley Creek at Thomas Creek Ranch	3/16/2025					Sustained stage flatline at 2.39 feet- possible equipment limitation
	3/30/2025					Sustained stage flatline at 2.39 feet- possible equipment limitation
	4/23/2025	0.01	night	potential	no	No reported direct diversion
	4/24/2025	0.01	night	potential	no	No reported direct diversion
	4/25/2025	0.01	night	potential	no	No reported direct diversion
	5/5/2025					Possible return flow - sudden sustained increase in stage mag 0.20 feet, drops back down after 14 hrs

4.6.2 Atascadero Creek

Stage data was analyzed from two NCWC gages in the Atascadero Creek watershed. These gages were located near “Arrendel” vineyard at Poplar Road and at Mill Station Road (Figure 15). No diversion signals were observed in either gage (Figure 17; Figure A.35 and A.36). Flattened peaks were observed in the Atascadero Creek at Arrendel Vineyard hydrograph during precipitation events on March 16th, 30th, and 31st (Figure A.35). In all instances the maximum observed stage was exactly 2.62 feet which was maintained for an extended period during which peaks were observed in other gage records in the region. As such we believe this to be a pressure transducer recording the peak value of its range rather than any evidence of diversion, similar to the behavior identified on Mark West at Laughlin Road and the Green Valley Creek at Thomas Creek Ranch stage records (Figure A.22, A.34). All other observed changes in the Atascadero Creek at Mill Station Road and at Arrendel Vineyard stage records were readily explained by observed precipitation or by diel fluctuations in stage.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Atascadero Creek at Arrendel						No diversions observed. Sustained stage flatline at 2.62 feet on 3/16, 3/30, and 3/31 - possible equipment limitation at Daily variation of max 0.08 feet early April onwards
Atascadero Creek at Mill Station Road						No diversions observed. Daily variation of max 0.10 feet early April onwards

Table 14: Potential diversions observed on Atascadero in the Green Valley Creek Focus Area during the 2025 frost protection season.

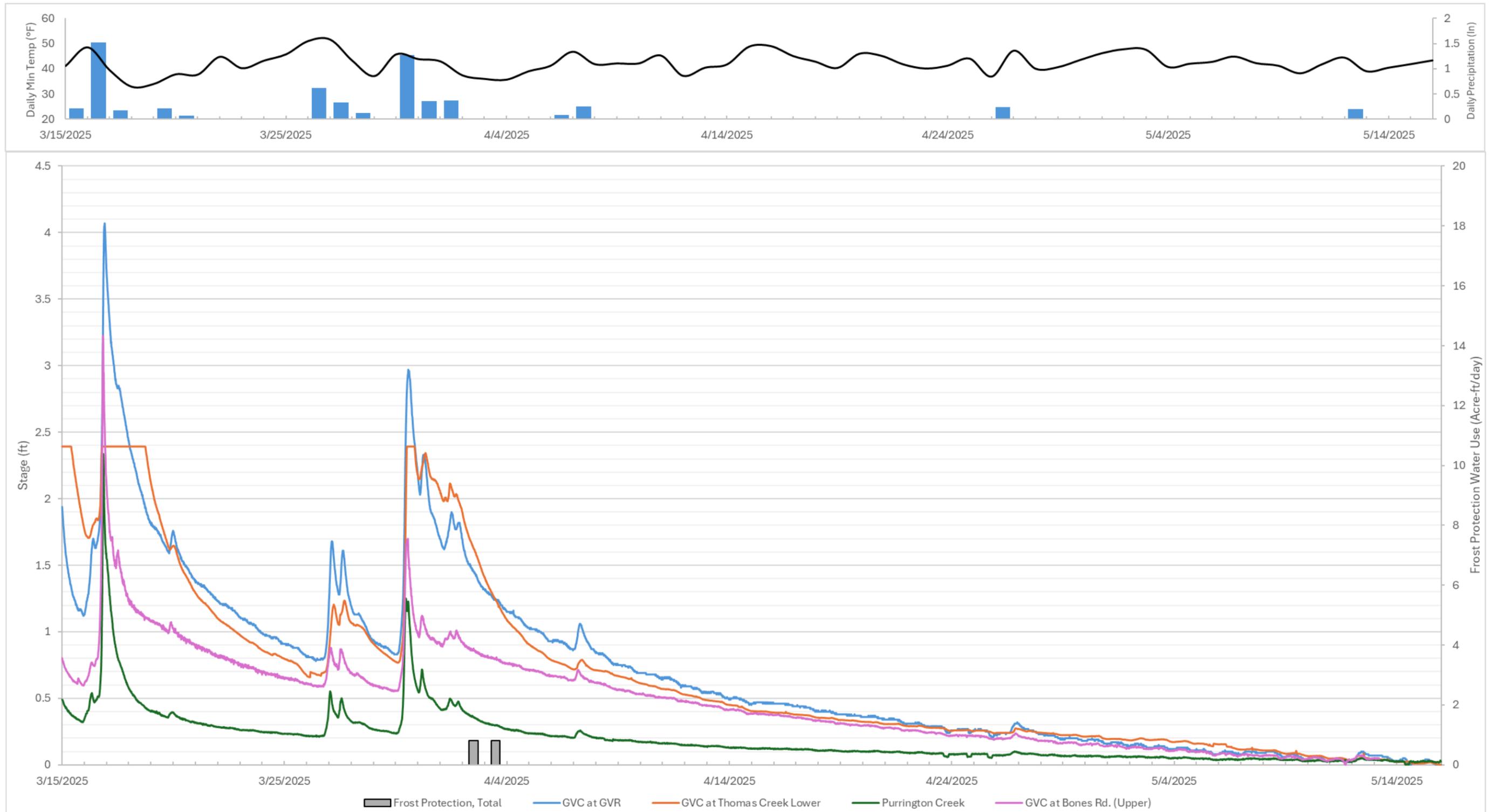


Figure 16: Hydrograph and hyetograph for gages along the Green Valley and Purrington Creeks within the Green Valley/Atascadero Creek Focus Area. Daily precipitation and minimum temperature data are from the Graton West (GRW) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees in the Green Valley/Atascadero Creek Focus Area exclusive of the Atascadero Creek watershed. Note that stage records have been adjusted vertically for the purposes of visual presentation.

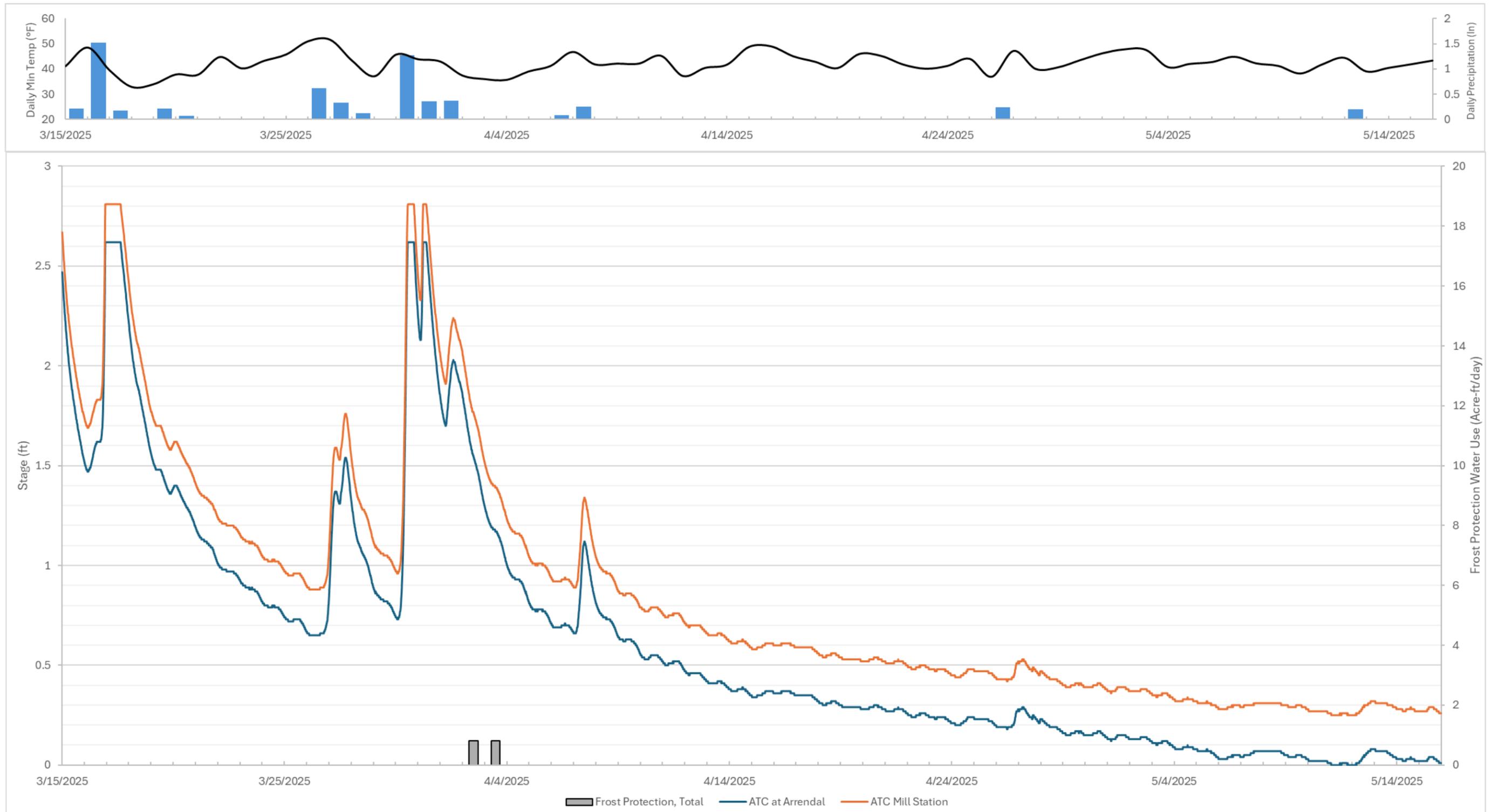


Figure 17: Hydrograph and hyetograph for gages along Atascadero Creek within the Green Valley/Atascadero Creek Focus Area. Daily precipitation and minimum temperature data are from the Graton West (GRW) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Atascadero Creek watershed. Note that stage records have been adjusted vertically for the purposes of visual presentation.

4.7 Lower Russian River Focus Area

The Lower Russian River Focus Area consists of the Russian River downstream of Healdsburg minus areas included in other Focus Areas (Figure 18). This Focus Area can be divided into two significantly different regions. The smaller, upper region consists of an alluvial valley bottom densely planted with vineyards. The larger, lower region is located within the coastal mountains. This lower region is largely forested except for small towns and a few vineyards along the banks of the Russian River. The Focus Area is listed as a low priority (Expansion Phase II) area in the NOAA Coho Recovery Plan for the Russian River.

Historically, water use for frost protection in the Lower Russian River Focus Area has been moderate compared to other Focus Areas. Like many other Focus Areas, water use was minimal during the 2015 – 2017 frost protections seasons and on the order of tens of acre-feet during the 2018 season. During the 2025 season, water use for frost protection was 11.9 acre-feet, the median value for all Focus Areas (Table 2). The alluvium along the Russian River is a productive aquifer and historically most vineyards report wells as a source of water for frost protection. However, this year direct diversion constituted 76% of all water used for frost protection. The remaining 24% use reported as storage or storage / well; many vineyards also used water from off-channel storage. One parcel accounts for the entirety of the 9.1 acre-feet of water use reporting direct diversions as a water source (Table 4). The Lower Russian River Focus Area was the only Focus Area reporting more than 25% of water use from direct diversions, but this use decreased roughly 52% from the 19.1 acre-feet of water used during the 2024 frost protection season.

Stage data from one USGS gage was analyzed in the Lower Russian River Focus Area (Figure 18). In previous risk assessments, data from the USGS’s Russian River Near Windsor Gage, was also analyzed. However, data was not available from the USGS and could not be analyzed.

No diversion signals were observed at the Russian River at Hacienda Bridge (Figure A.37). All changes in stage at this gage are likely the result of changes in dam release from Warm Springs Dam on Lake Sonoma and Coyote Dam on Lake Mendocino. Reservoir releases observed in stage records at upstream gages on Dry Creek and the Russian River are identifiable in the Russian River at Hacienda Bridge Gage with approximately a 12-hour delay from upstream gages. (Table 15).

Table 15: Potential diversions observed within the Lower Russian River Focus Area during the 2024 frost protection season.

Gage	Date	Change in Stage (ft)	Time of Day	Stranding Risk	Frost Protection?	Notes
Russian River at Hacienda Bridge						Coyote Dam outflow drops 3/17, 3/26, 3/29, 4/2, 4/3, 4/4, 4/6, 4/8, 4/14, and 5/2. Warm Springs Reservoir outflow drops 4/10, 4/17, 4/18, 4/22

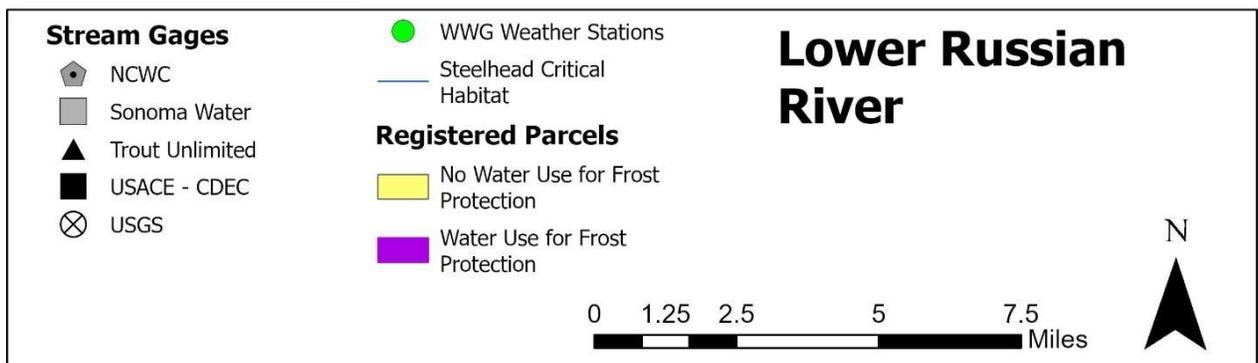
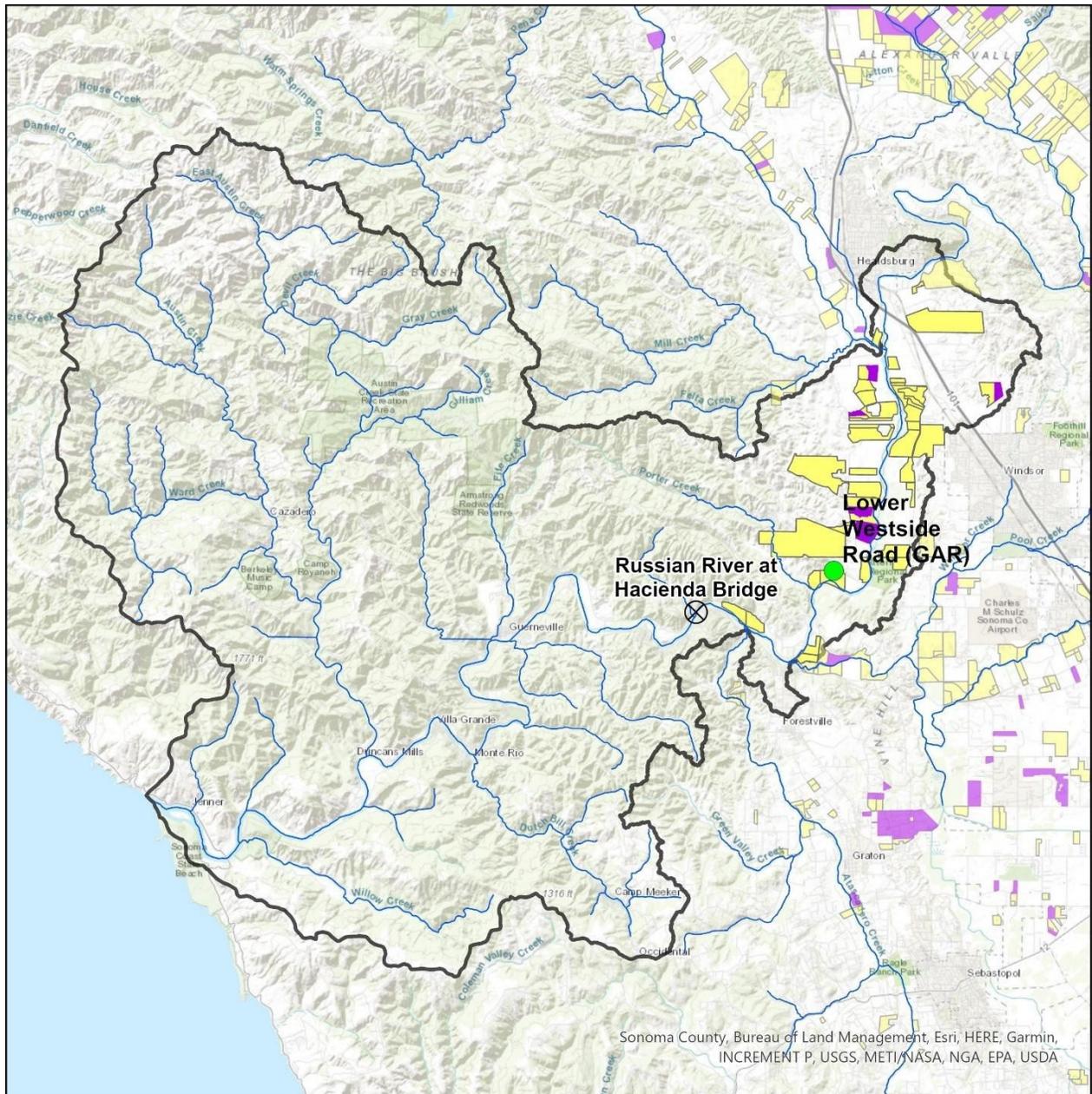


Figure 18: Stream gages and weather stations used in the Lower Russian River Focus Area.

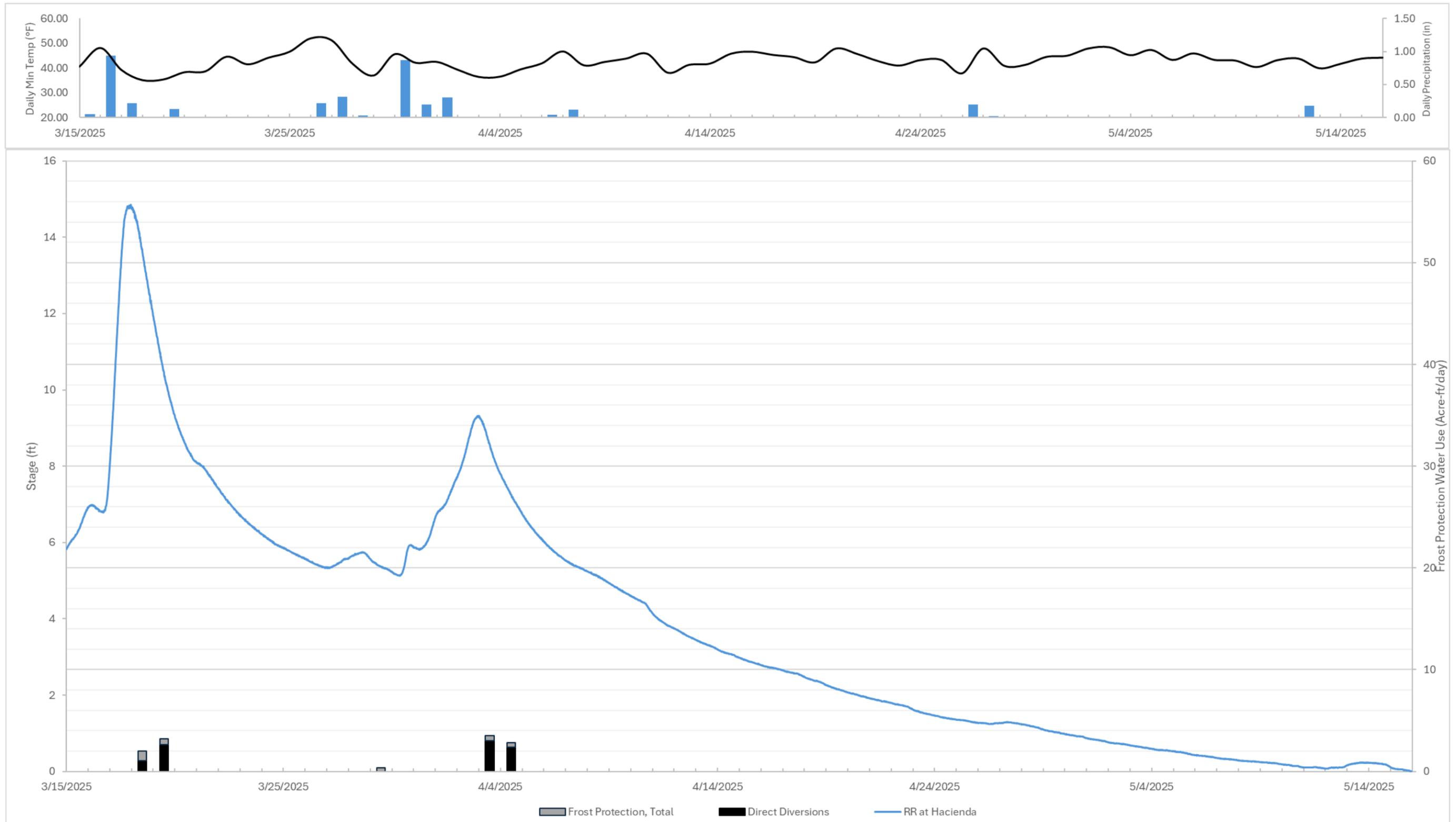


Figure 19: Hydrograph and hyetograph for gages in the Lower Russian River Focus Area. Daily precipitation and minimum temperature data are from the Lower Westside Road (GAR) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Lower Russian River Focus Area. Note that stage records have been adjusted vertically for the purposes of visual presentation.

5.0 Conclusions

The 2025 Risk Assessment analyzed stage data from the Russian River and its tributaries located within Sonoma County to assess the impact of instream diversions for frost protection on salmonid habitat. The fundamental methodology of this report follows that of the 2015 – 2024 Risk Assessments and includes cumulative changes in data sources and methodology recommended by these prior assessments.

5.1 Summary of 2025 Risk Assessment

Water use for frost protection during the 2025 season was relatively low compared to the period 2015-2019 and significantly lower than the period of 2020-2024 (Table 2). Water use in 2025 is most comparable to the 2016 and 2017 frost protection seasons. Reported water use during the 2025 season was 91.2 acre-feet, lower than any reported use since 2017 and approximately 9% of the average water use between 2020 and 2024 of 1,025 acre-feet (Table 2). Relatively low use in 2025 corresponds with relatively few frost control events in 2025. There has also been a 24% decline in the number of frost protection water use reports compared to 2024. This is believed to be related to numerous vineyard removals owing to contraction of the wine industry in the past two years and likely to continue in 2026.

Stage data were analyzed from 37 gages across the Russian River watershed within Sonoma County. From these data, 29 diversions could be identified, only one of which was determined to be potentially associated with frost protection. This signal was determined to pose a substantial fish stranding risk. Recall that the term “diversion” in this context simply refers to an anomaly in hydrographs of stream stage that appears to occur abruptly and as such is considered potential evidence of a management-related change in stream stage, including both increases and decrease in stage. (Table 16).

The number of diversions observed during the 2025 frost protection season was substantially smaller than the 2021 and 2022 frost protection seasons and somewhat smaller than the 2023 and 2024 seasons. Despite similar quantities of diversions observed between the 2023 and 2025 frost protection seasons, water use in 2025 was less than 10% of that used in 2023. The number of diversions was comparable to that over the period 2016-2018 when total water use for frost protection was on the same order of magnitude as in 2025; in 2019, water use for frost protection was effectively zero. In 2025, higher than average stream flow may have muted diversion signals that might have been detectable if stream flow was lower. In addition, relatively frequent precipitation events caused changes in stage that could resemble or conceal diversion signals. This implies that higher streamflow and frequent storm events may lower stranding risks associated with frost protection. It is also consistent with the limited use of direct diversion from streams to supply water for frost protection (see Section 3.2). Additionally, most enrollees use wells or stored water as their primary water source, reducing dependence on in-stream diversions.

As in previous years, some diversions identified as potentially associated with frost protection may be from other uses. It is relatively straightforward to infer whether a diversion is reasonably associated with frost protection based on time of day and timing of reported use. Diversions to storage that may be associated with frost protection but occur at times when frost protection is not occurring are not generally attributed to frost protection. Potential fish stranding risk associated with this type of diversion is potentially mitigated because the diversion would not be occurring during a frost event when there would be greater demand for water. Such diversions to storage would likely be conducted consistent with valid Water Rights.

Following a drop in the number of water use reports from 2023-2024 by about 8% after a steady increase from 2017 – 2022, the number of water use reports dropped a further 24% from 2024-2025. The total reporting acreage also decreased about 15% compared to 2024; reporting acreage has been consistent with small variations since 2018 (see Section 3.2, Table 3). It is possible that this decrease in reported and observed in-stream diversions is the result of an increase in usage of fans for frost protection causing a decrease in sprinkler and overall water use. However, current reporting does not provide a thorough dataset on fan usage for frost protection in Sonoma County. An overall decline in wine grape production in the region, including fallowing of some vineyards, is another likely source of declining reporting and use of water for frost protection. Further investigation may be warranted to better understand the reduction in the number of frost protection reports.

Table 16: Summary of identified diversions and fish stranding risk potentially attributable to frost protection water use during the 2025 frost protection season.

	Potential Diversions			Frost-Associated Diversions	
	Potential Diversions	Not Associated with Frost Protection	Potentially Associated with Frost Protection	with Potential Fish Stranding Risk [†]	with Substantial Fish Stranding Risk [†]
Alexander Valley*	8	7	1	0	1
Dry Creek Valley	0	0	0	0	0
Green Valley Creek	12	12	0	0	0
Knights Valley	4	4	0	0	0
Lower Russian River	0	0	0	0	0
Mark West Creek	2	2	0	0	0
Santa Rosa Plain	3	3	0	0	0
Total	29	28	1	0	1

**Includes potential diversions observed at the Russian River near Cloverdale gage which originated outside of Sonoma County, these diversions are considered not associated with frost protection*

† Includes only diversions potentially associated with frost protection use

Table 17: Diversions observed at gages for the 2017 – 2025 frost protection seasons excluding stage decreases definitively associated with reservoir operations. The count of diversions includes only instances where the start of a diversion was observed in the stage data and does not include diversions that caused observed stage to decrease by less than 0.02 feet.

Focus Area	Gage Location	Data Source	2017	2018	2019	2020	2021	2022	2023	2024	2025
Alexander Valley	Russian River near Cloverdale	USGS	0	0	0	10	39	31	1	4	0
	Russian River at Geyserville	USGS	0	2	0	4	14	19	0	1	3
	Russian River at Jimtown	USGS	0	3	0	1	3	1	2	2	3
	Russian River at Digger Bend	USGS	0	0	0	1	0	1	2	1	2
	Russian River near Healdsburg	USGS	0	1	0	0	0	0	0	1	0
	Gill Creek	NCWC	1	0	0	-	0	-	1	0	0
	Gird Creek	NCWC	0	-	3	-	0	-	0	3	0
	Big Sulphur Creek	NCWC	-	-	-	-	-	-	2	0	0
	Sausal Creek	NCWC	0	0	1	1	2	5	0	0	0
Dry Creek Valley	Dry Creek near Geyserville	USGS	0	0	1	4	1	2	-	-	-
	Dry Creek at Lambert Bridge	USGS	0	0	0	4	3	7	0	0	0
	Dry Creek at Mouth	USGS	0	0	1	-	1	6	0	0	0
Green Valley Creek	Green Valley Creek at Bones Road	Trout Unlimited	0	0	0	-	2	0	0	1	1
	Green Valley Creek at Green Valley Road	Trout Unlimited	-	-	-	4	28	14	2	3	3
	Purrington Creek	NCWC	-	0	0	-	20	16	2	0	5
	Green Valley C.at Thomas C. Ranch	NCWC	-	-	-	42	55	27	0	7	3
	Atascadero Creek at Arrendel Road	NCWC	-	-	-	0	0	0	0	0	0
	Atascadero Creek at Mill Station Road	NCWC	0	4	-	-	0	0	0	0	0
Knights Valley	Foote Creek	NCWC	1	4	2	1	0	6	4	3	2
	Redwood Creek at Treasury Vineyards	NCWC	10	4	0	-	1	0	0	0	0
	Redwood Creek above Ferrari Creek	NCWC	-	-	-	1	0	2	-	0	1
	Redwood Creek at Hwy 128	NCWC	1	8	-	-	2	0	0	0	1
	Maacama Creek near Kellogg	NCWC	0	0	0	2	1	3	3	0	0
	Franz Creek at Franz Valley School Rd	Sonoma Water	-	2	0	4	9	3	6	4	0
	Upper Franz Creek	NCWC	-	-	-	3	5	5	0	4	0
	Franz Creek Middle at Bavarian Winery	NCWC	-	-	-	-	-	-	-	0	0
	Bidwell Creek	NCWC	-	-	-	-	1	2	-	-	-
	Franz Creek at Verite Winery	NCWC	3	0	0	0	3	1	0	0	0
Lower Russian River	Russian River near Windsor	USGS	0	0	0	0	0	-	-	-	-
	Russian River at Hacienda Bridge	USGS	0	0	3	1	4	6	0	0	0
Mark West Creek	Mark West Creek at Porter Creek Road	Sonoma Water	-	0	0	-	1	3	0	-	-
	Mark West Creek at Michelle Way	Sonoma Water	-	0	0	0	1	2	1	1	1
	Mark West Creek at Laughlin Road	NCWC	0	11	5	3	4	3	1	3	0
	Mark West Creek at Saralee Vineyards	NCWC	-	-	0	1	0	1	0	0	0
	Mark West Creek near Mirabel Heights	NCWC	0	7	16	0	2	9	0	0	1
	Windsor Creek at Mark West Station	NCWC	-	-	-	-	-	-	1	13	0
Santa Rosa Plain	Matanzas Creek at Santa Rosa	Sonoma Water	4	1	8	1	0	0	6	6	3
	Santa Rosa Creek at Santa Rosa	USGS	2	4	3	0	3	1	0	1	0
	Santa Rosa Creek at Willowside Road	USGS	1	6	5	2	3	0	0	0	0
	Abramson Creek at Gurneville Road	NCWC	-	-	-	-	-	-	-	0	-
	Laguna de Santa Rosa at Stony Point Rd	USGS	0	0	1	3	8	0	0	0	0
	Laguna de Santa Rosa near Sebastopol	USGS	0	0	0	0	1	0	0	0	0
Total			23	57	49	93	217	176	34	58	29

5.2 Recommendations for Future Assessments

The 2025 Risk Assessment is the eleventh prepared pursuant to the State Water Resources Control Board's Russian River Frost Regulation. Successive reports have been improved based on recommendations regarding monitoring locations and methods and frost protection use reporting practices. This approach has produced an efficient monitoring program with consistent methods. Recommendations for future assessments include:

- Continue and expand best practices to maintain data quality from NCWC gages:
 - Continue to test, maintain and replace pressure transducers used to monitor stream stage as necessary to consistently and accurately collect stream stage data. Consider the historical stage records when installing pressure transducers such that peak flows can be adequately measured.
 - Consider adopting alternative installation practices to improve stability of stage records; this could include use of temporary stilling wells and/or modified location of equipment installations.
 - Consider adopting a supplemental quality assurance procedure where NCWC gage sites are revisited within two weeks of installation to review data and make adjustments to installation if needed.
 - Consider collecting stream discharge data at monitoring sites where feasible; include at least four stream discharge measurements so that a stage-discharge relationship can be determined.
 - Where stream discharge is measured, install a temporary staff plate to establish a water elevation datum and survey a local benchmark to facilitate consistent and comparable stream stage and discharge data year-to-year.
 - The suggested changes above might best be implemented beginning with a pilot program focusing on a few gage sites and extended or rotated in future years.
- Consider an internal audit of frost protection water use reporting data and enrollee information to better understand apparent changes in reporting and protected acreage observed in 2026; this is a practice to maintain accuracy of the data pertaining to use of water for frost protection.
- Continue to encourage NCWC enrollees to report the dates, times, and specific locations of diversions to storage for frost protection to better identify which diversions are associated with application of frost protection water; this reporting request was implemented in 2024 but provided little additional data. Encourage reporting of fan use for frost protection.
- Consider implementing a systematic review the public Water Rights database in the watersheds corresponding to Focus Areas analyzed in this report to identify points of diversion and diversion rates that may be active during the frost protection season. This would improve interpretation of the frost season stream stage data in that watersheds and stream reaches subject to diversions under existing Water Rights would be more definitively identified and considered.
- Review with State and Federal regulators the minimum change in stream stage considered to be a potential stranding risk for fish (currently 0.02 ft; Van Atta, 2016). This change in stage is at the practical detection limit for stream gaging equipment; it is very difficult to distinguish such small changes in stream stage that are theoretically indicative of water management activities including diversions from naturally occurring changes and/or background variation in stream stage.

APPENDIX A

DETAILED STAGE TIMESERIES

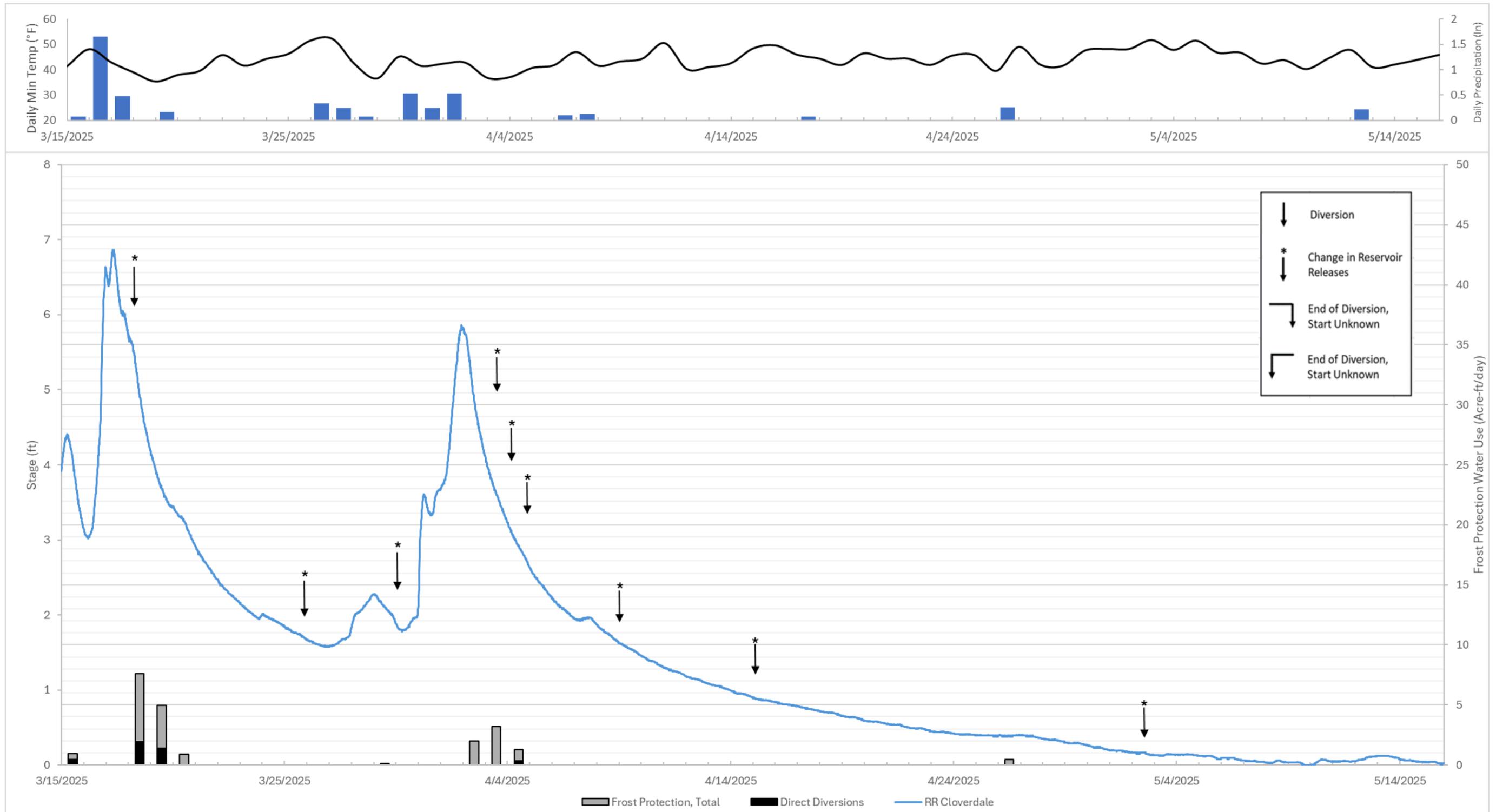


Figure A.1: Detailed hydrograph for the Russian River near Cloverdale gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

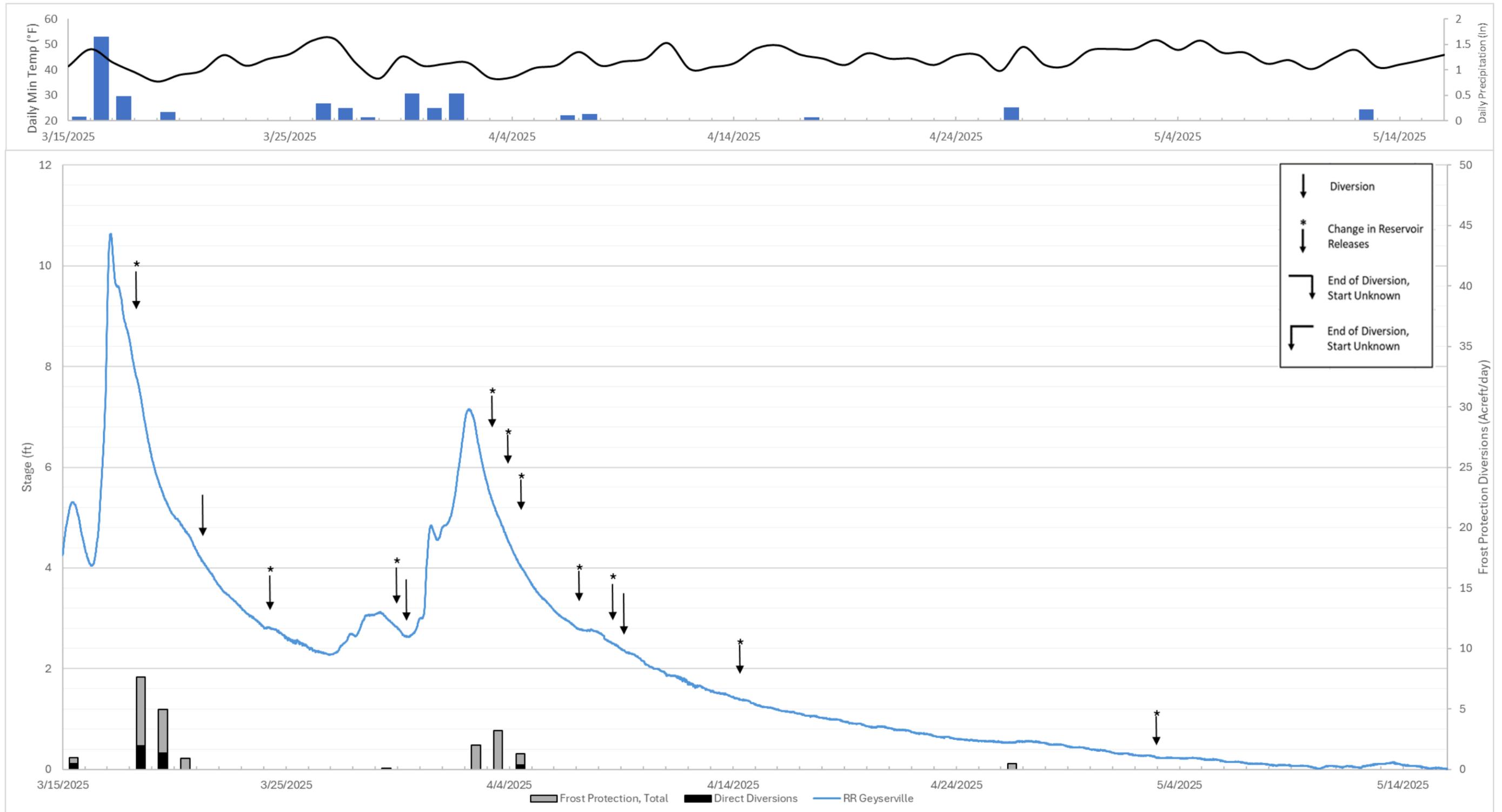


Figure A.2: Detailed hydrograph for the Russian River at Geyserville gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

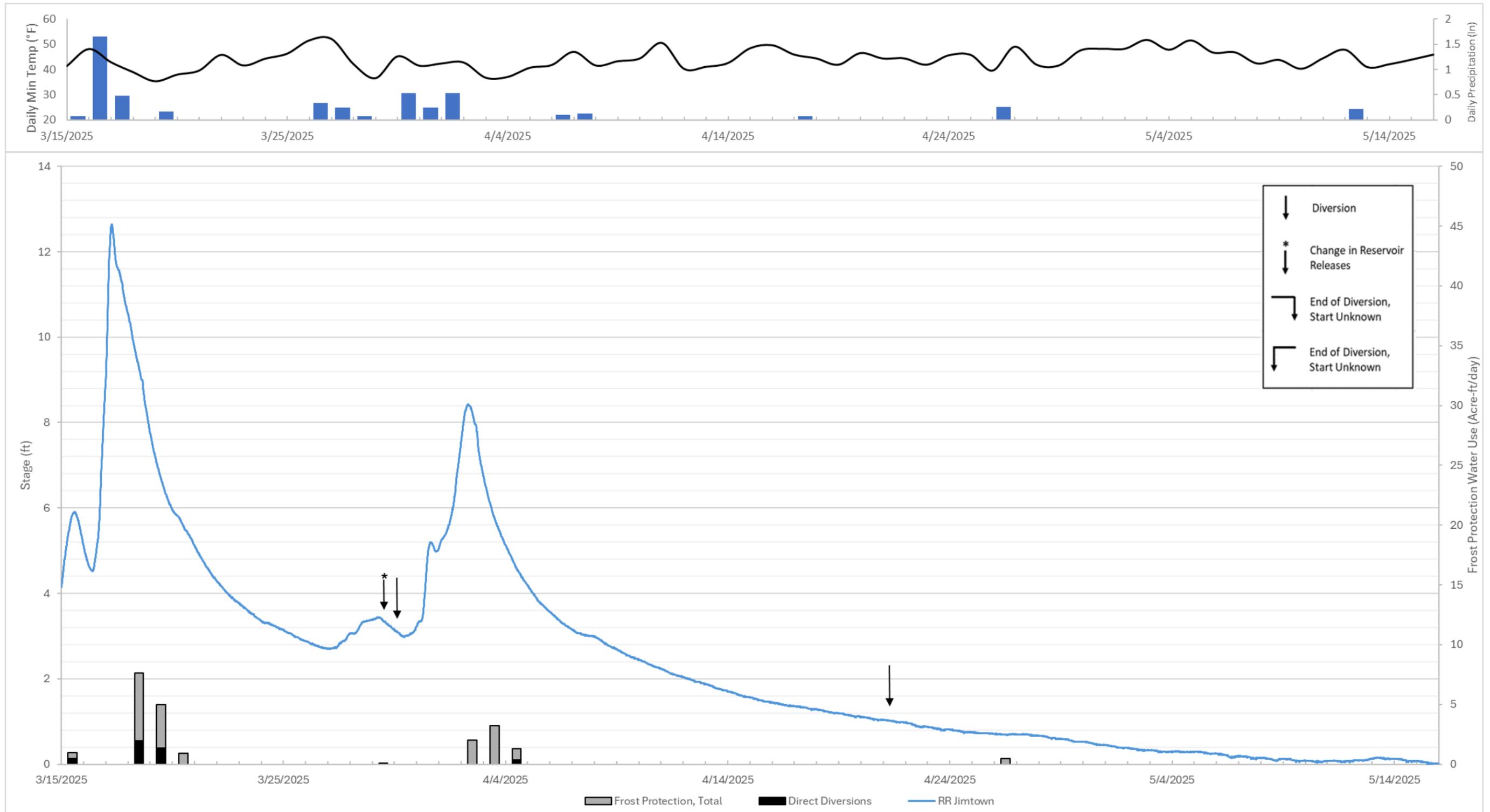


Figure A.3: Detailed hydrograph for the Russian River at Jimtown showing identified diversions. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

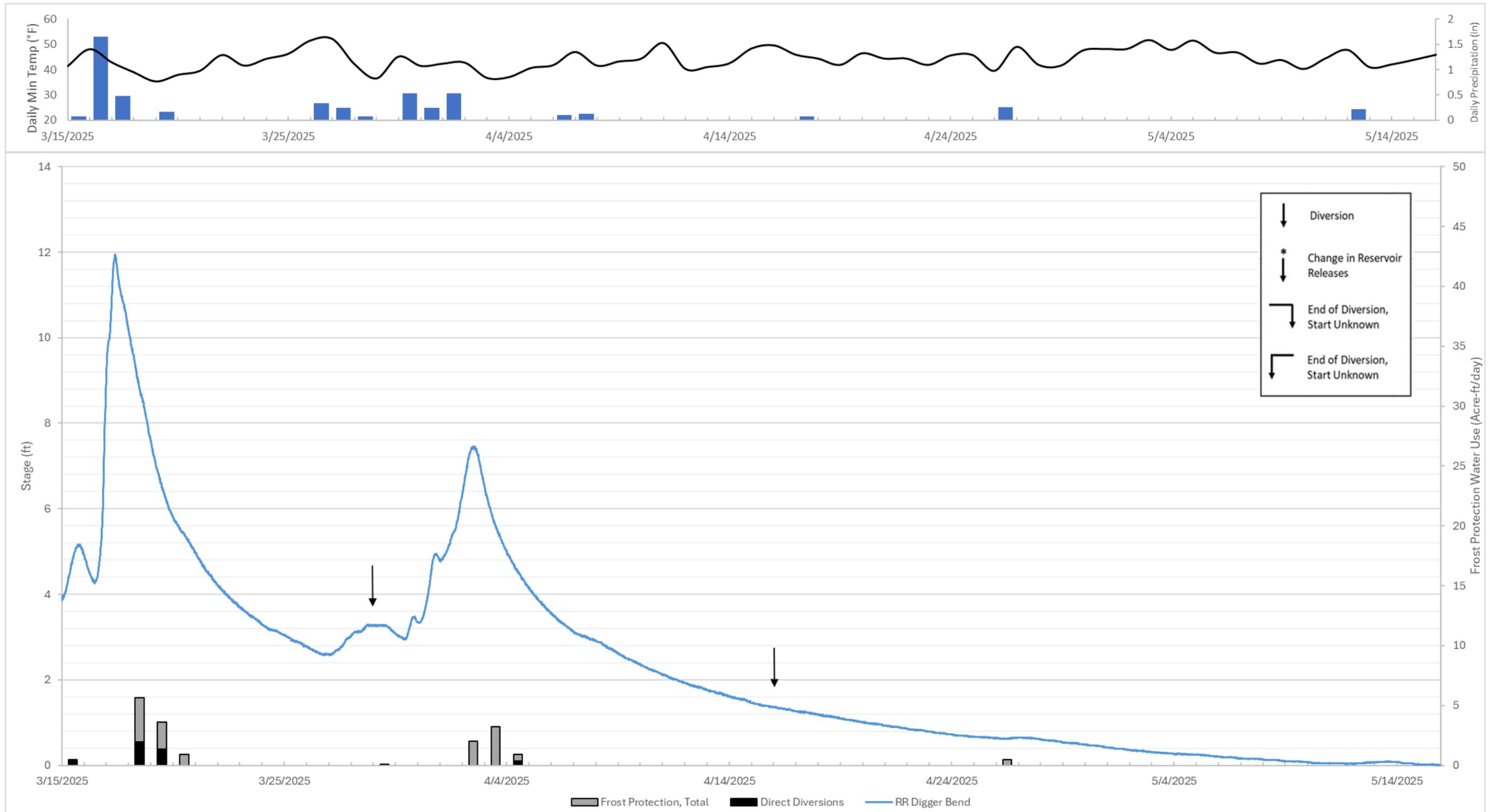


Figure A.4: Detailed hydrograph for the Russian River at Digger Bend gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

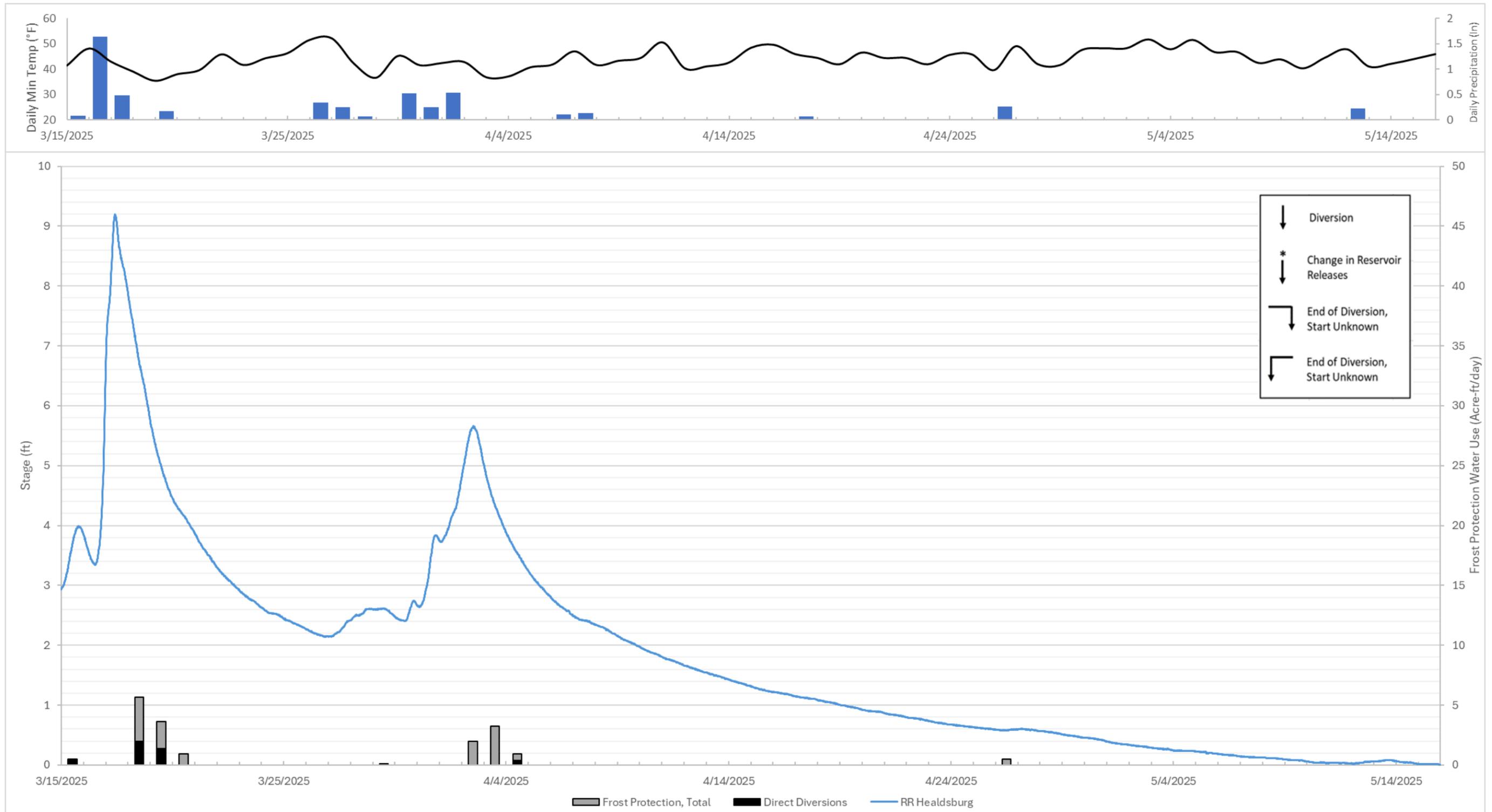


Figure A.5: Detailed hydrograph for the Russian River near Healdsburg showing identified diversions. Daily precipitation data and minimum temperature data is from the Jintown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

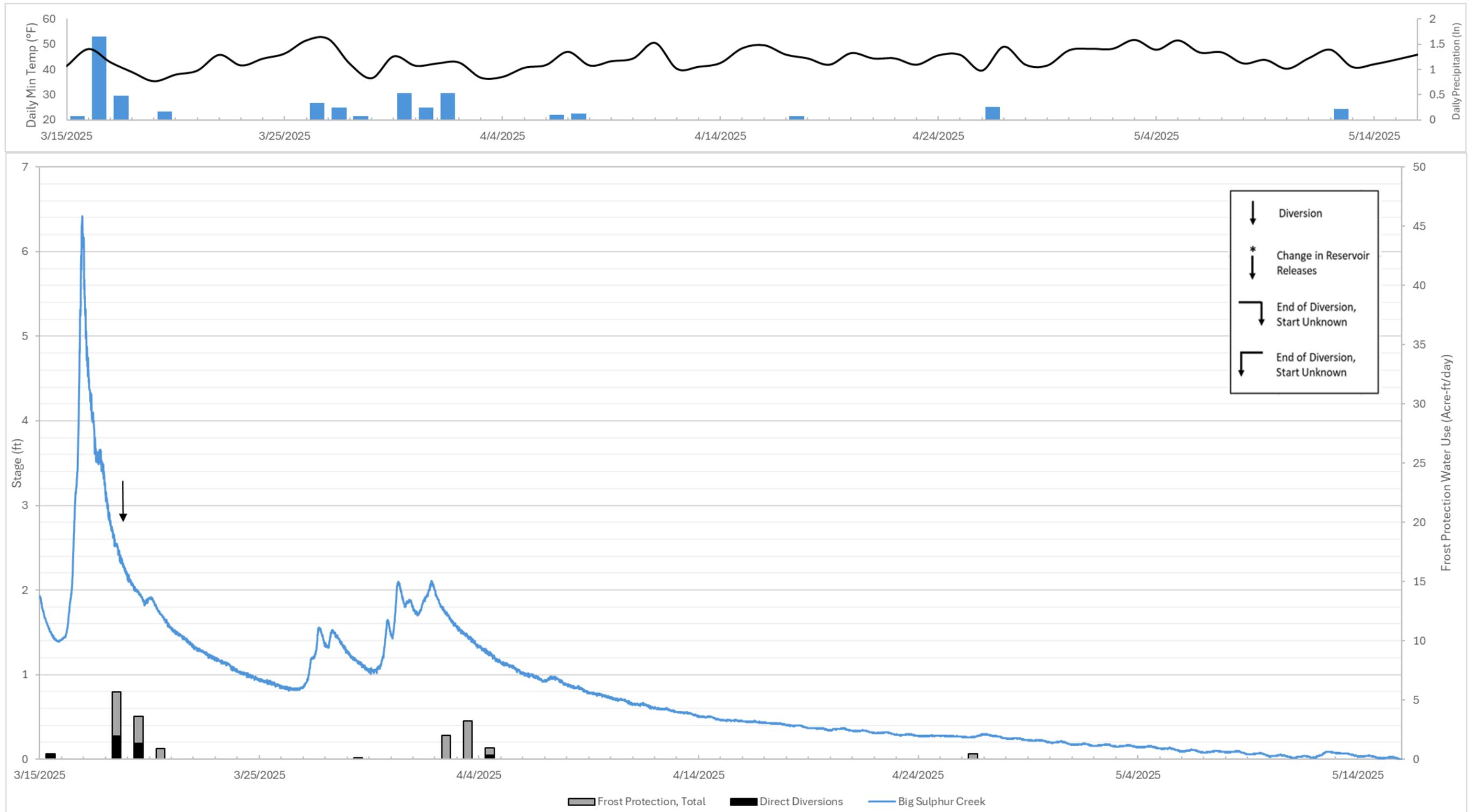


Figure A.6: Detailed hydrograph for the Big Sulphur Creek gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

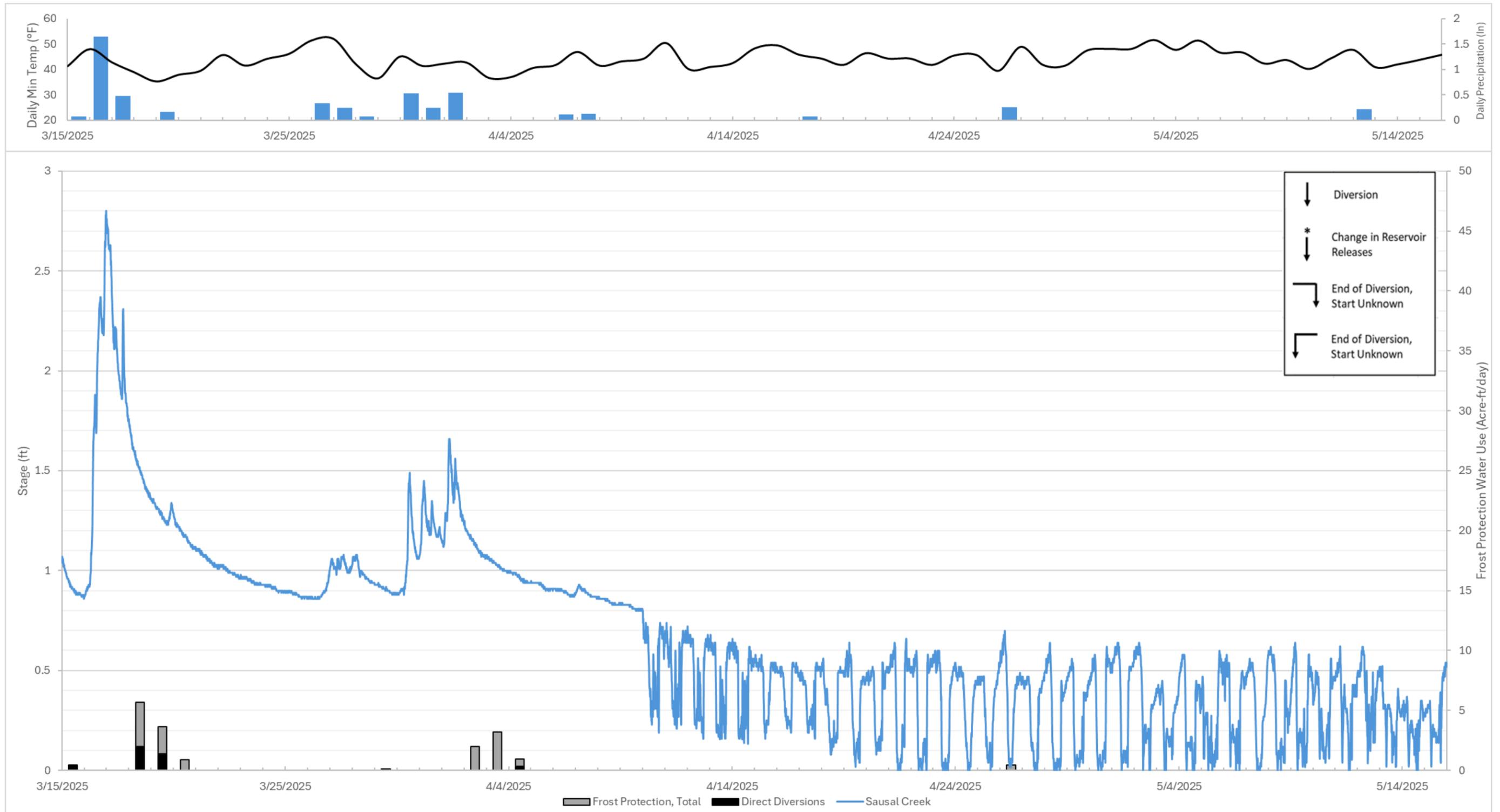


Figure A.7: Detailed hydrograph for the Sausal Creek gage. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

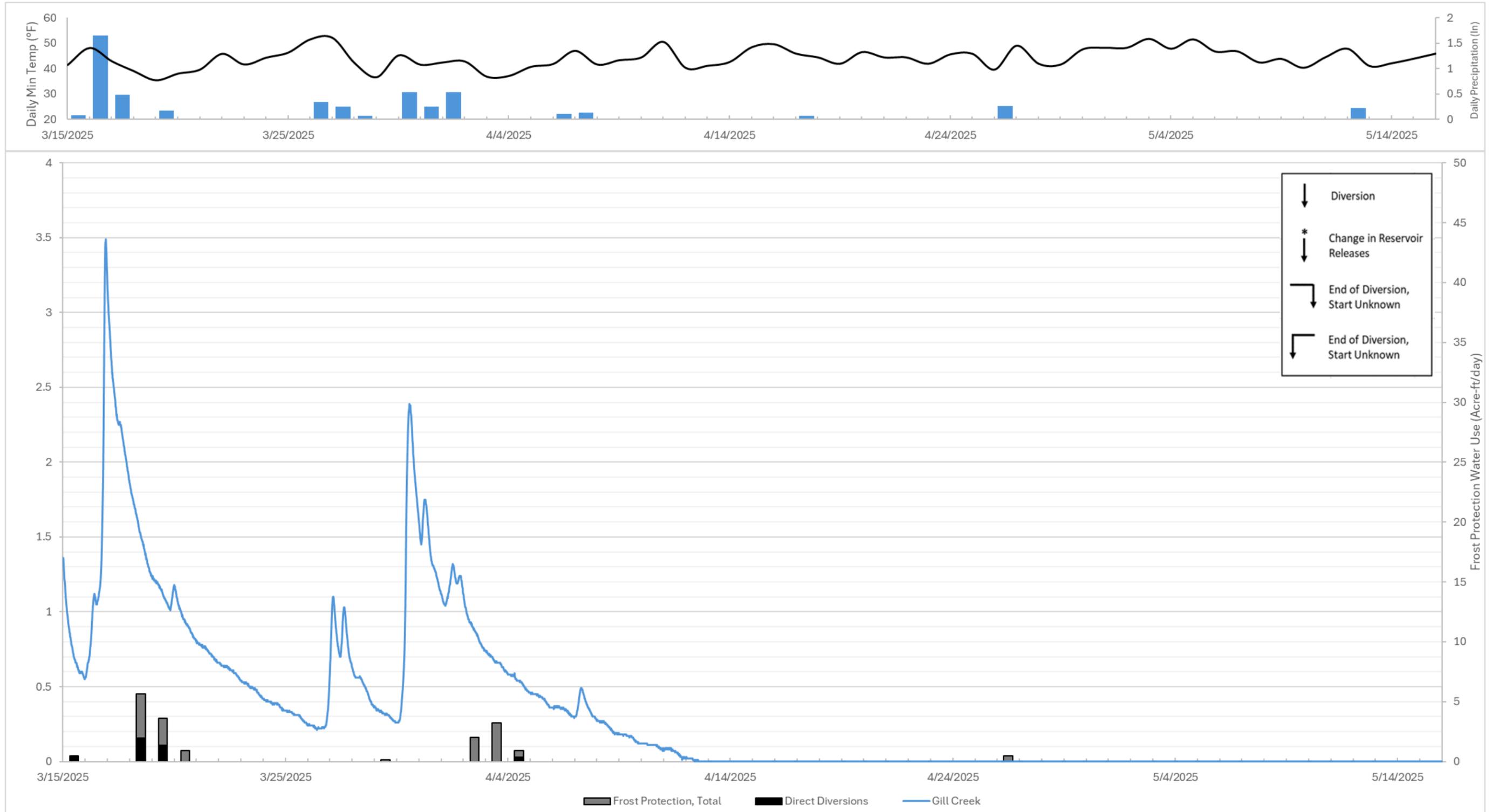


Figure A.8: Detailed hydrograph for the Gill Creek gage. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

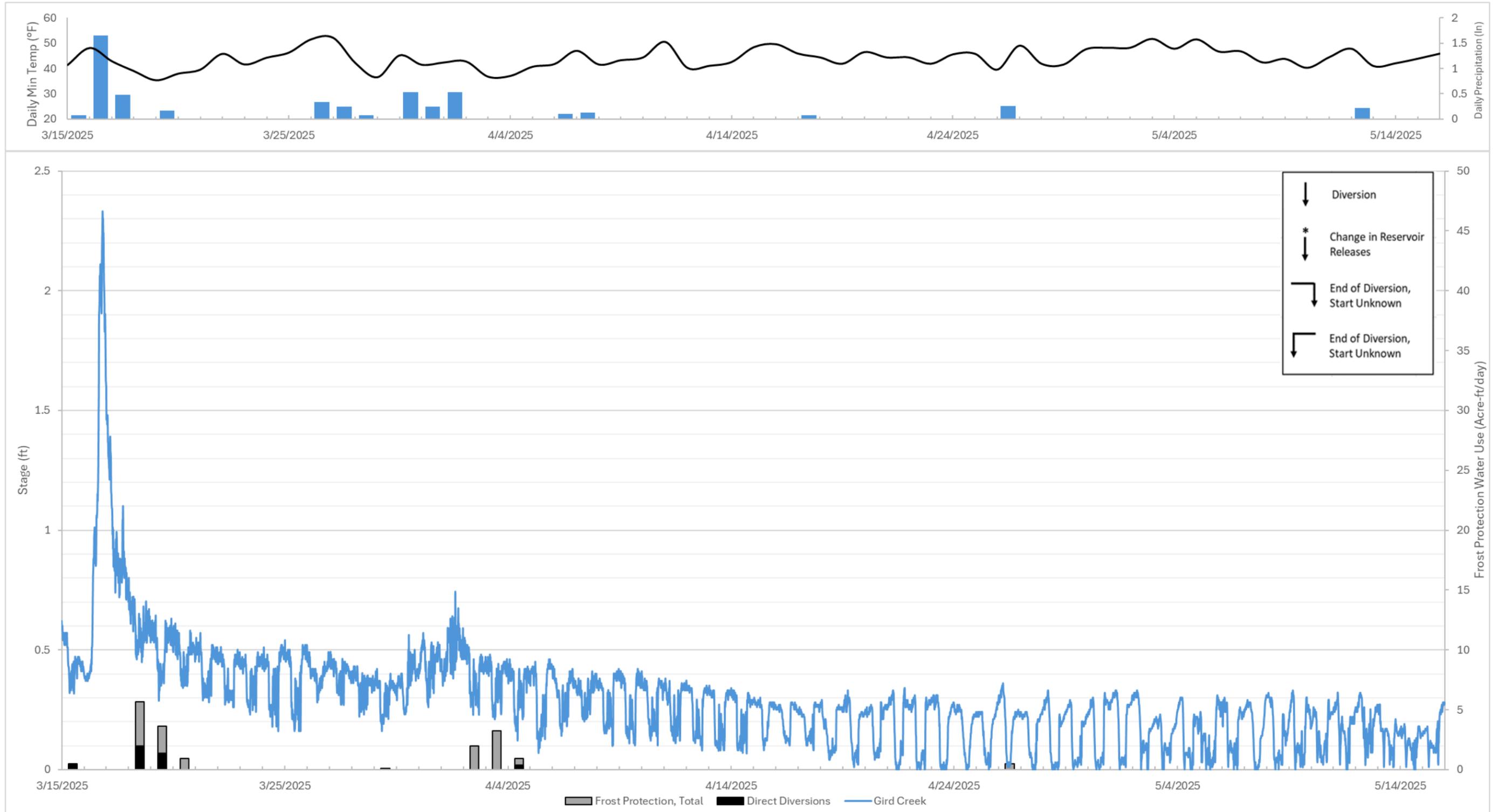


Figure A.9: Detailed hydrograph for the Gird Creek gage. Daily precipitation data and minimum temperature data is from the Jimtown North (PIC) Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Alexander Valley Focus Area.

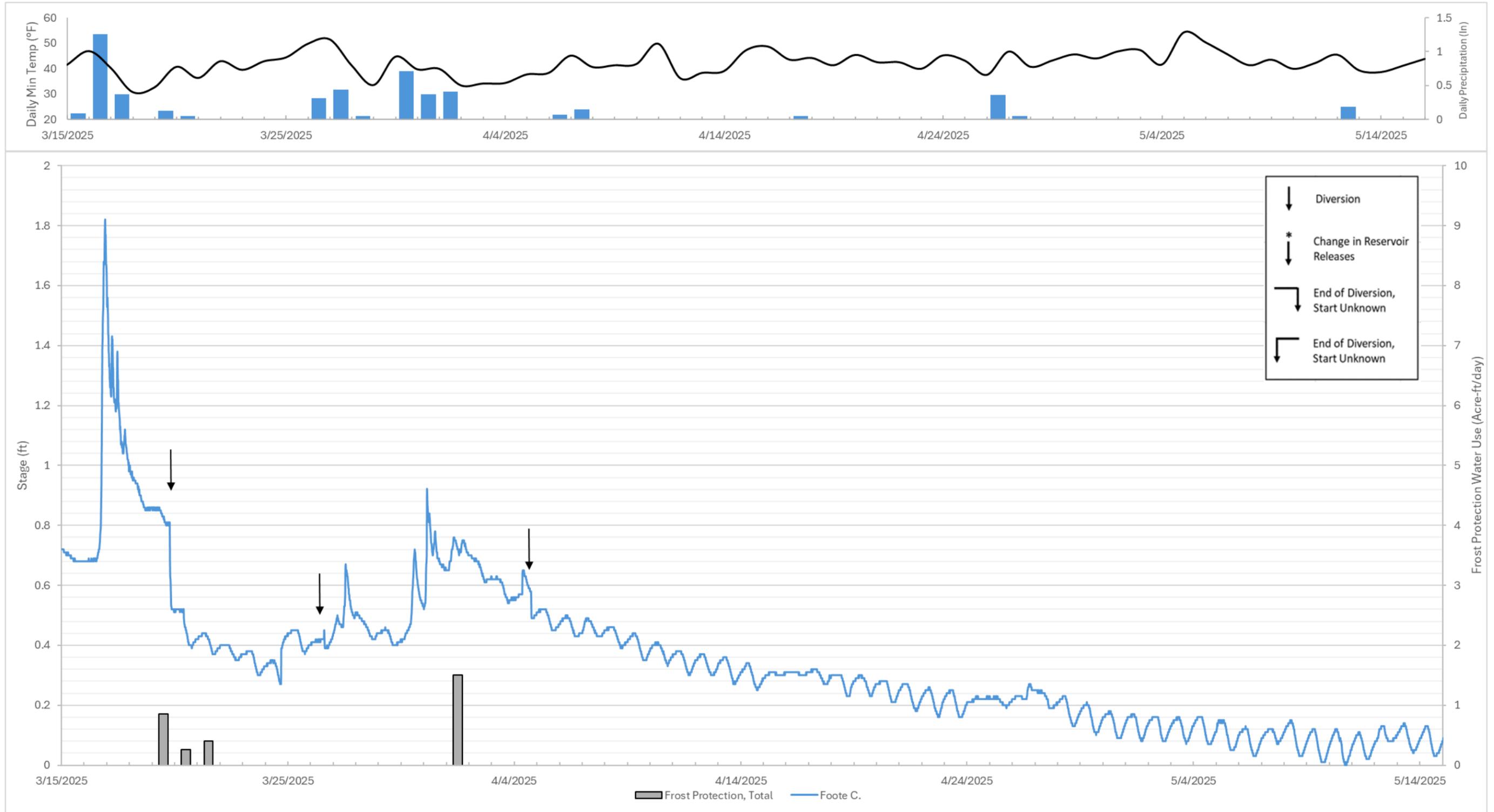


Figure A.10: Detailed hydrograph for the Foote Creek at Highway 128 gage showing identified diversions. Daily precipitation and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

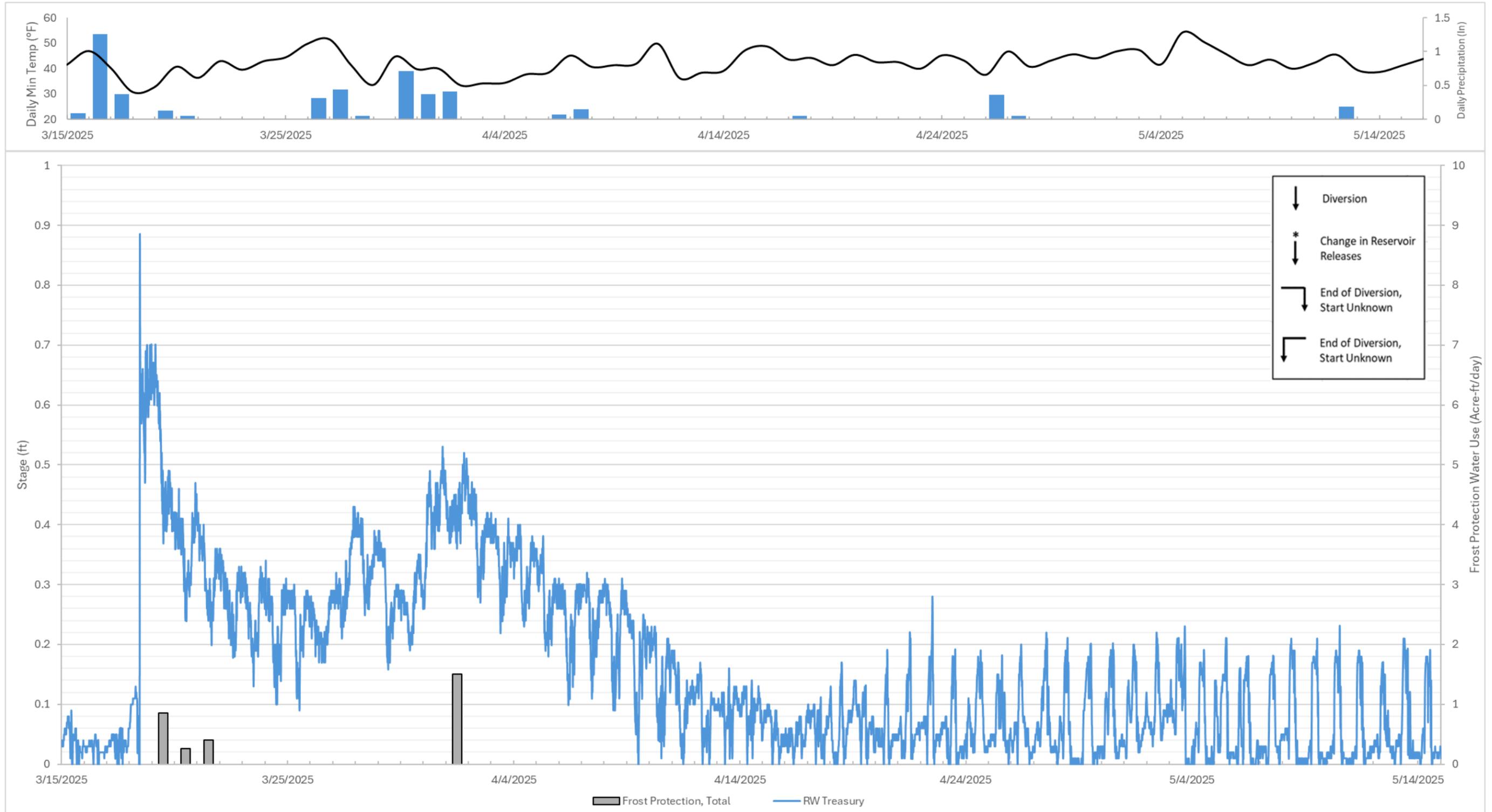


Figure A.11: Detailed hydrograph for the Redwood Creek near Treasury Vineyards gage showing identified diversions. Daily precipitation and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

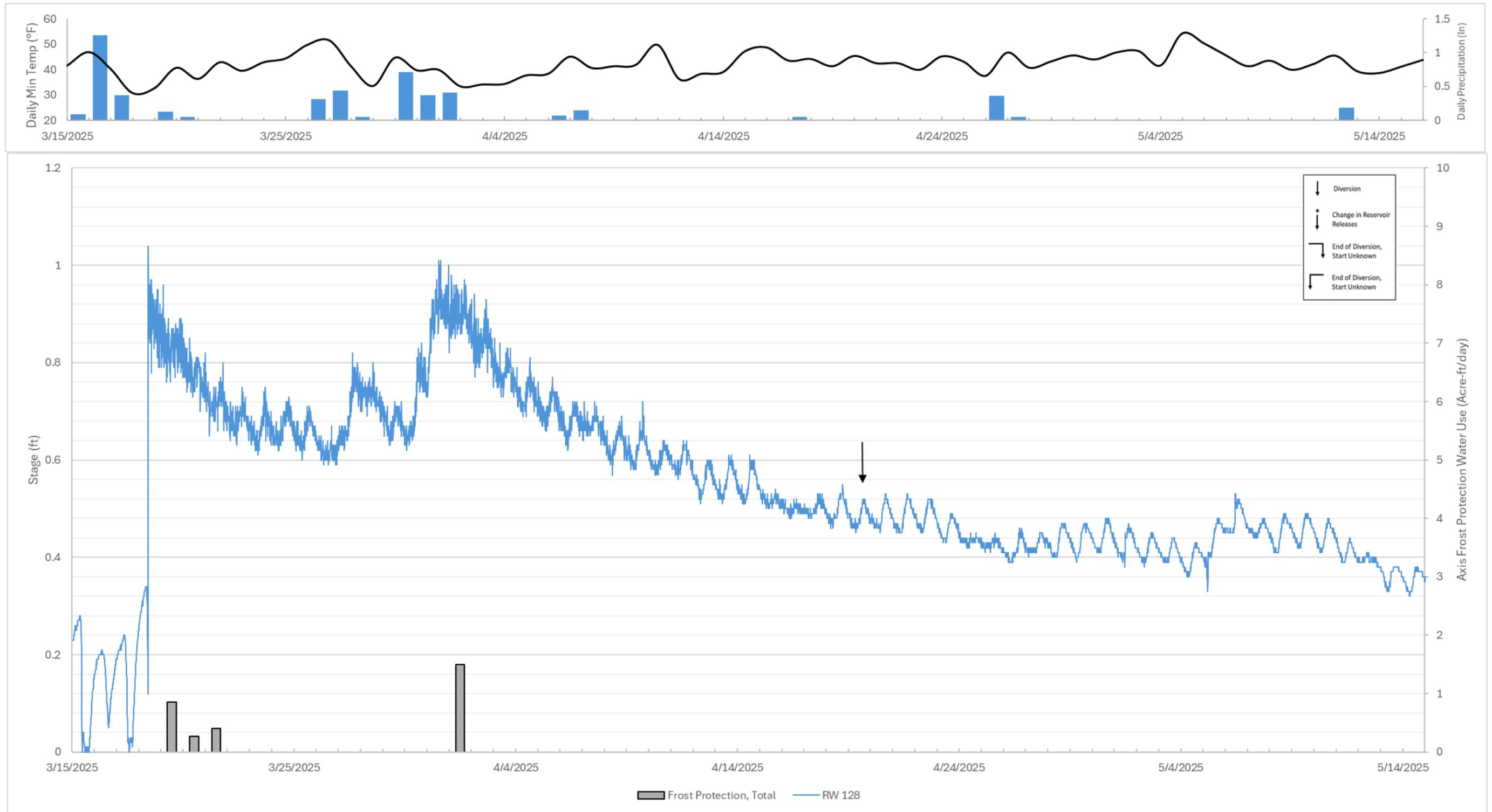


Figure A.12: Detailed hydrograph for the Redwood Creek at Highway 128 gage showing identified diversions. Daily precipitation and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

2025 Frost Protection Risk Assessment for the Russian River Drainage in Sonoma County – Appendix A

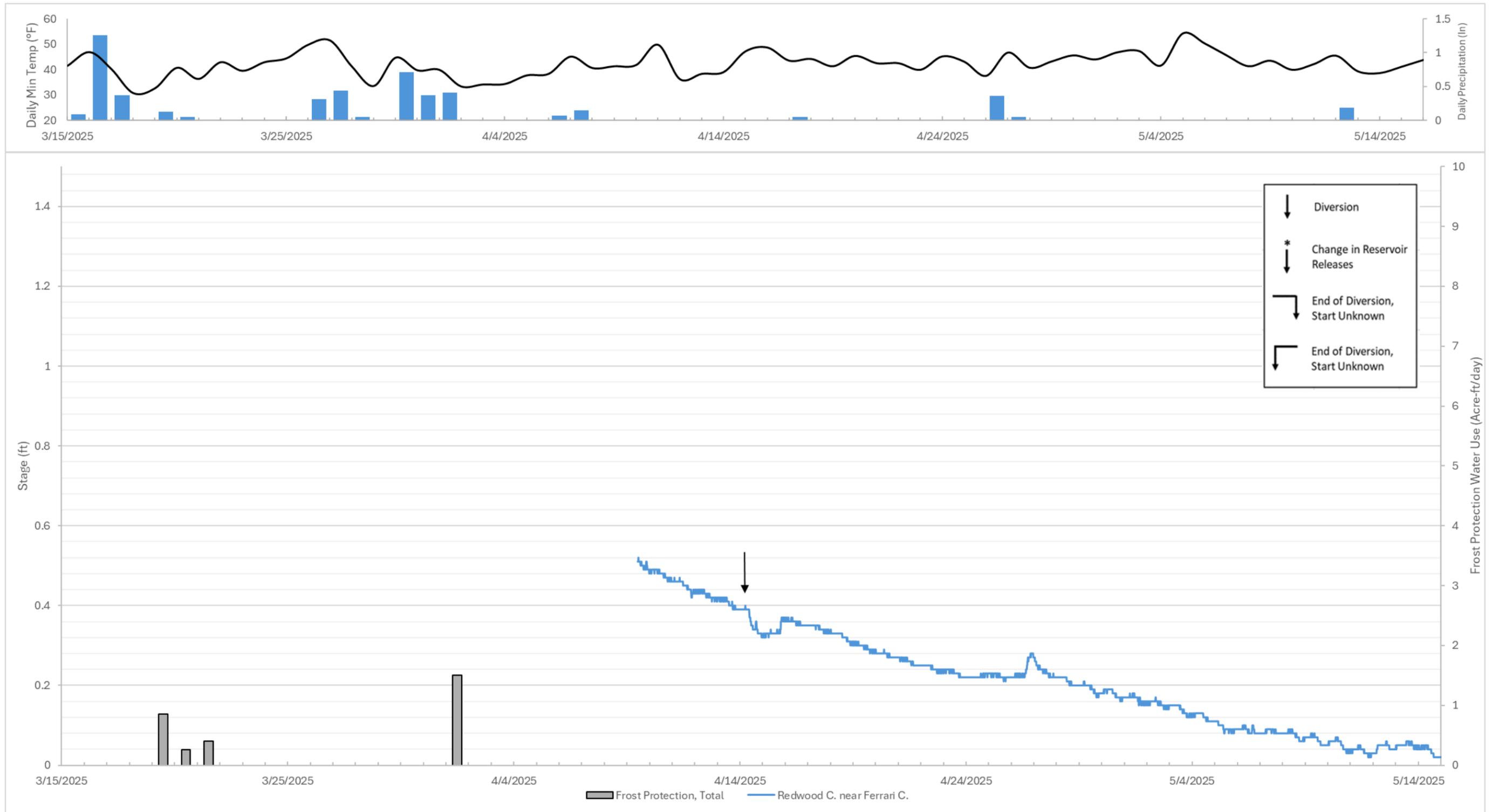


Figure A.13 Detailed hydrograph for the Redwood Creek at Ferrari Winery gage showing identified diversions. Daily precipitation and minimum temperature data is from the Calistoga North Weather Station. Frost Protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

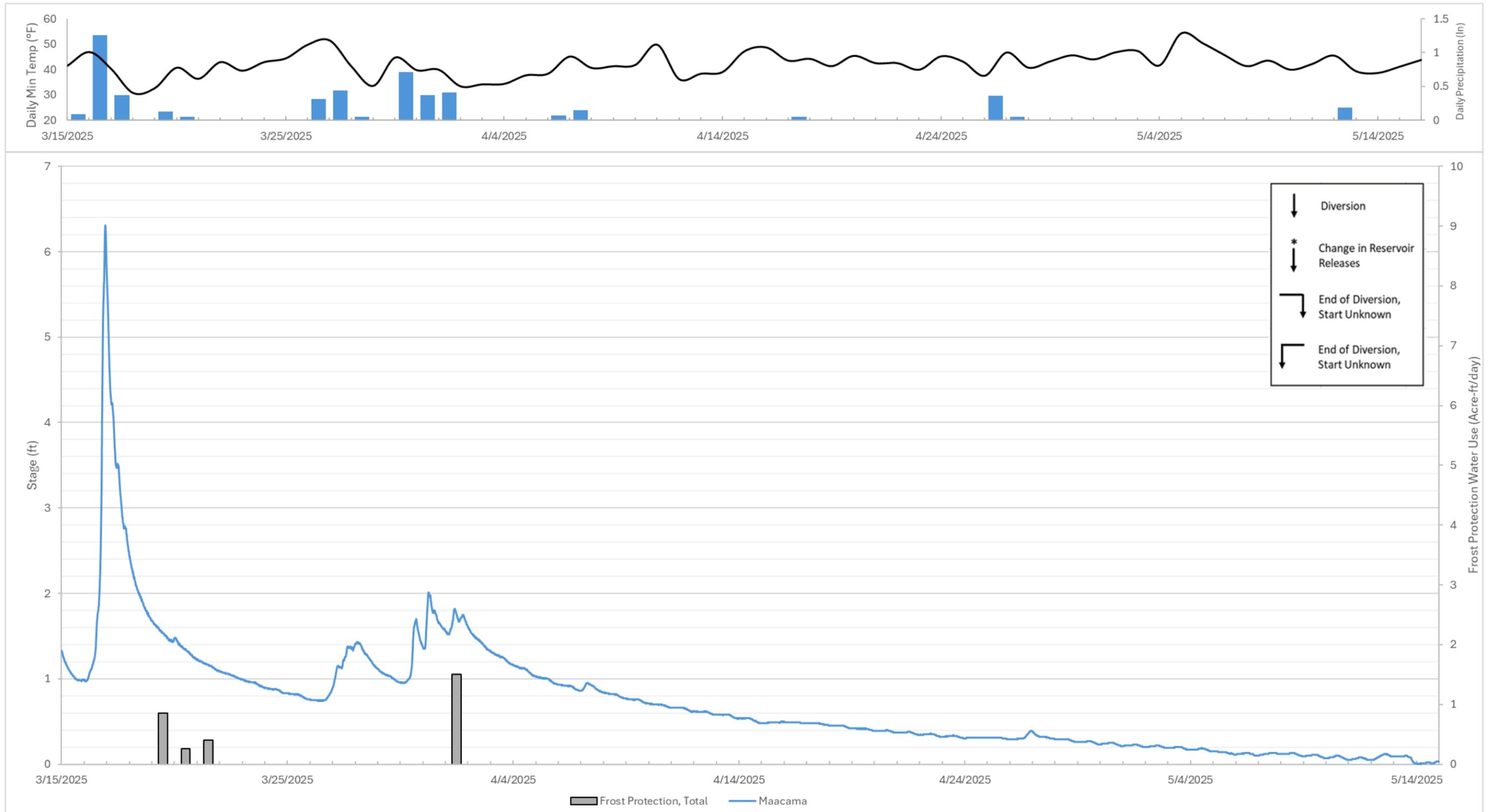


Figure A.14: Detailed hydrograph for the Maacama Creek near Kellogg gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

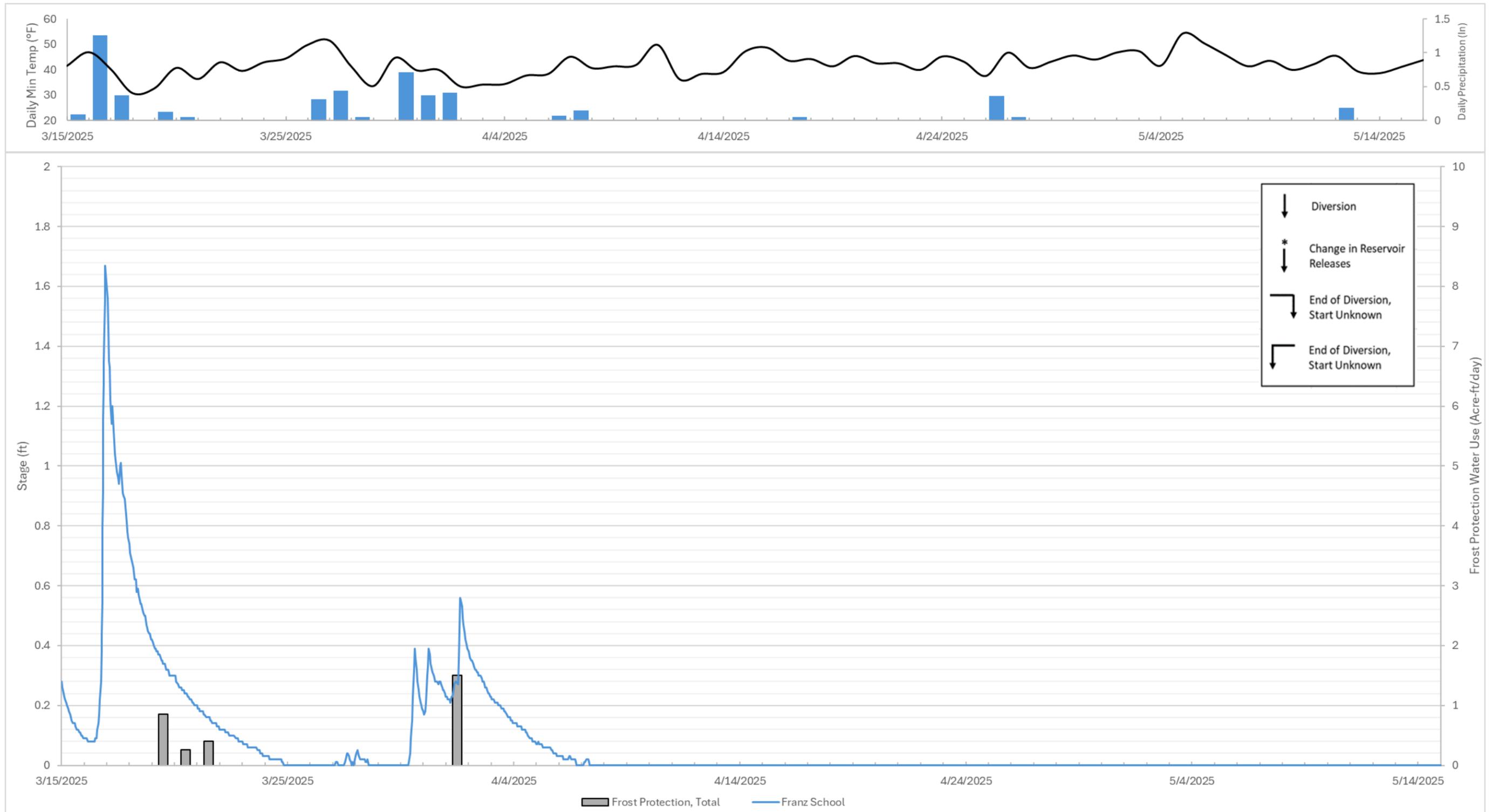


Figure A.15: Detailed hydrograph for the Franz Creek at Franz Valley School Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

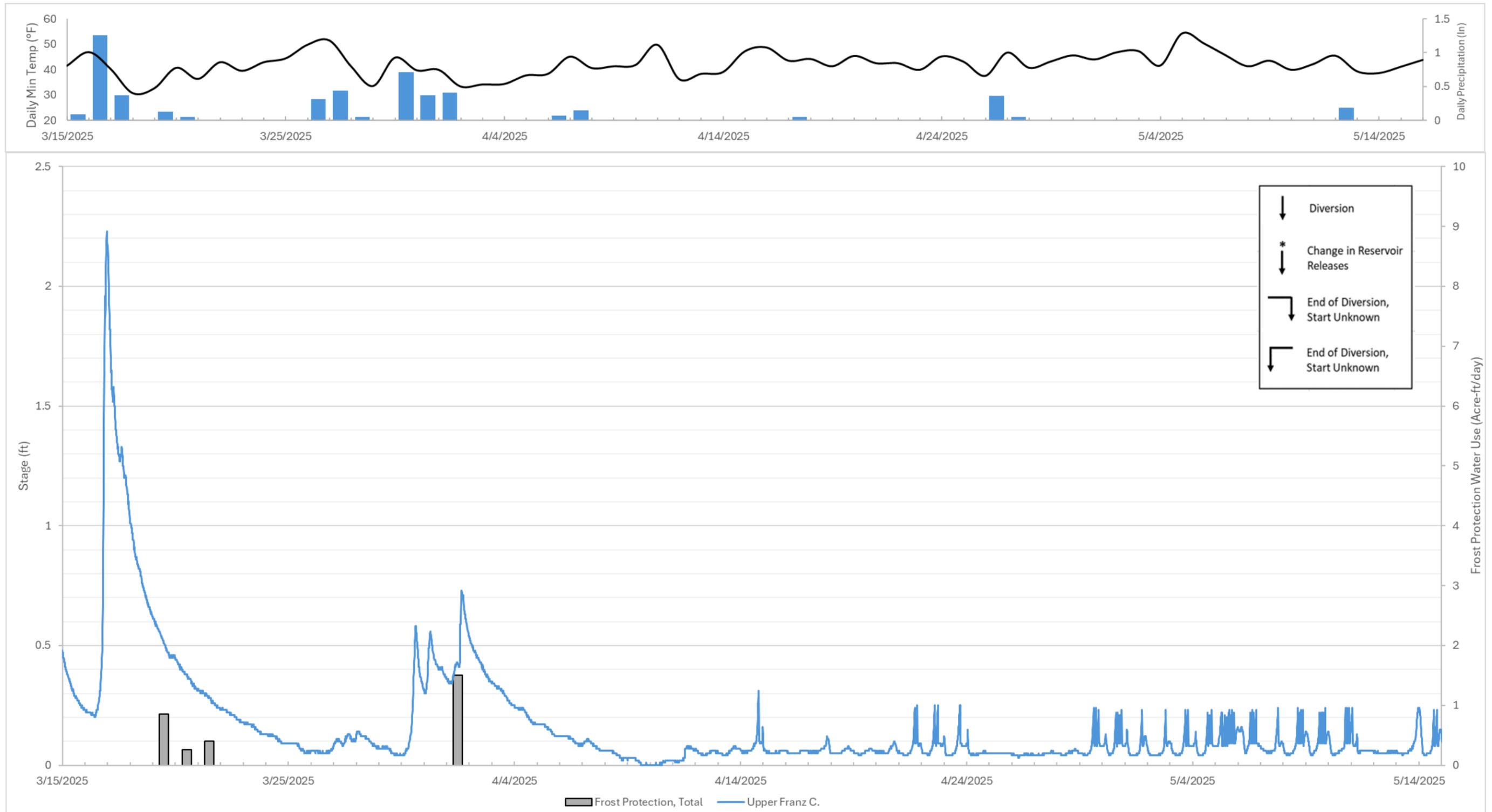


Figure A.16: Detailed hydrograph for the Upper Franz Creek gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

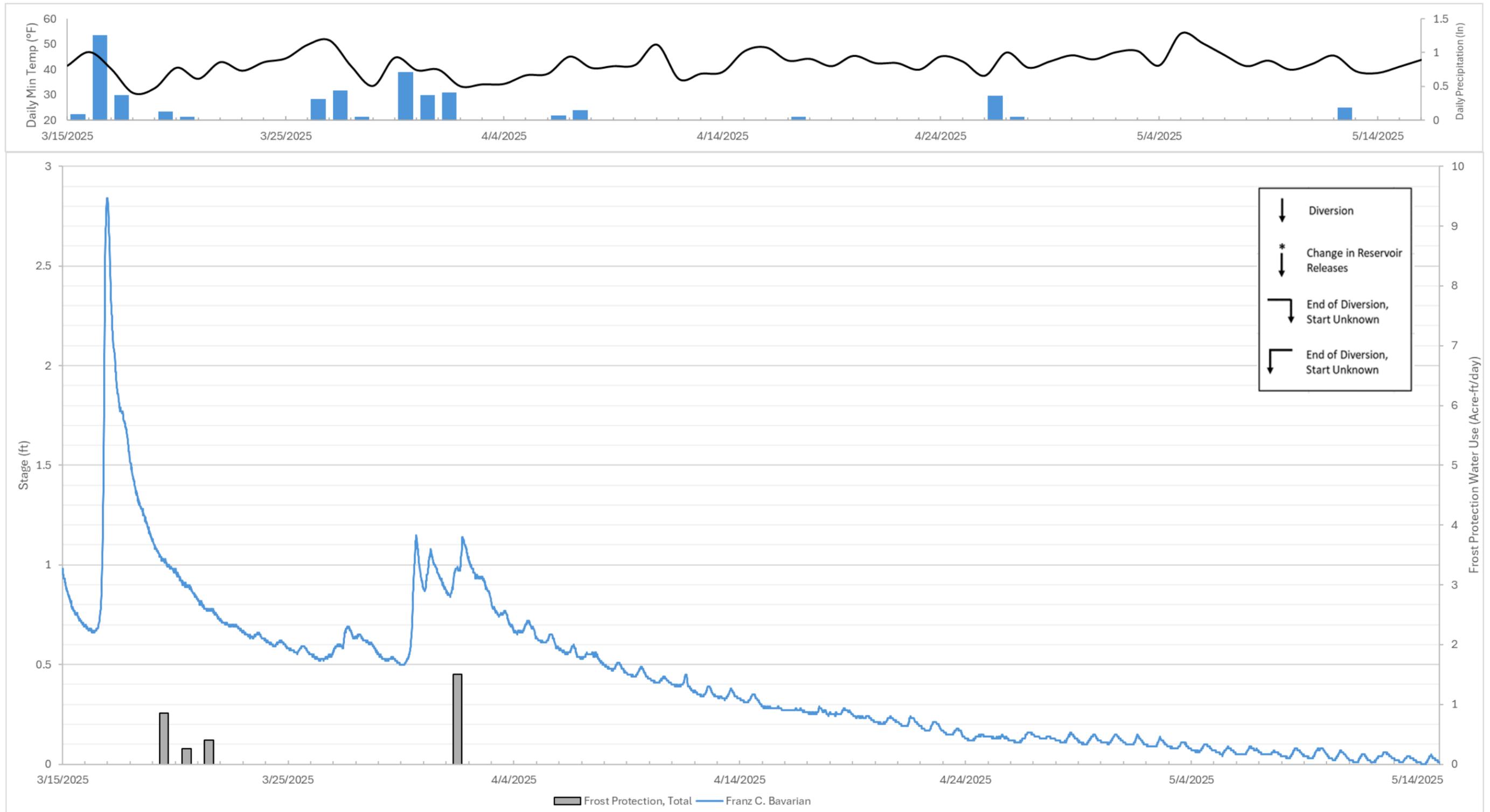


Figure A.17: Detailed hydrograph for the Franz Creek Middle at Bavarian Lion gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley Focus Area.

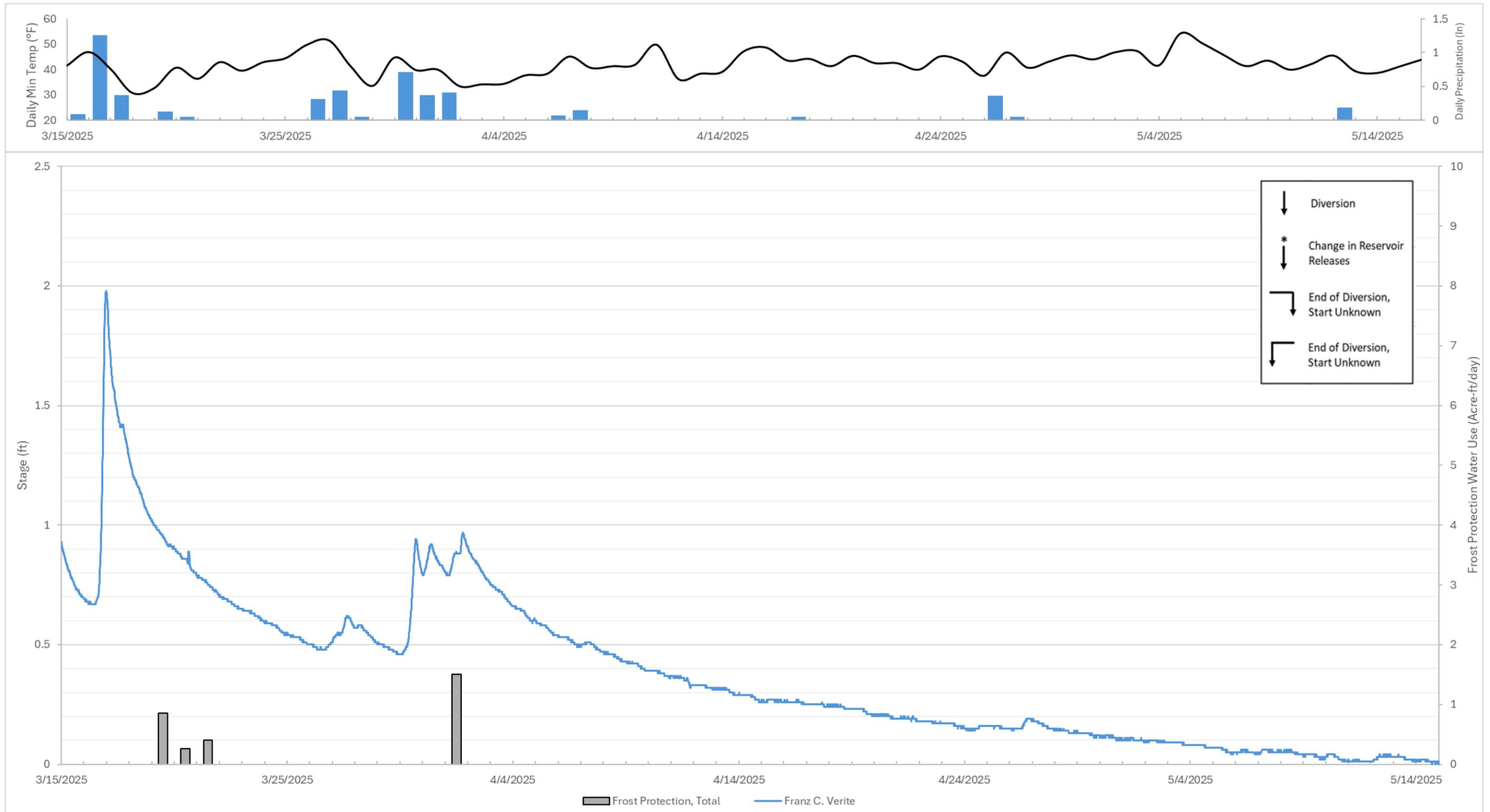


Figure A.18: Detailed hydrograph for the Franz Creek at Verite Winery gage showing identified diversions. Daily precipitation data and minimum temperature data is from the Calistoga North Weather Station. Frost protection use reflects volumes reported by NCWC enrollees within the Knights Valley watershed.

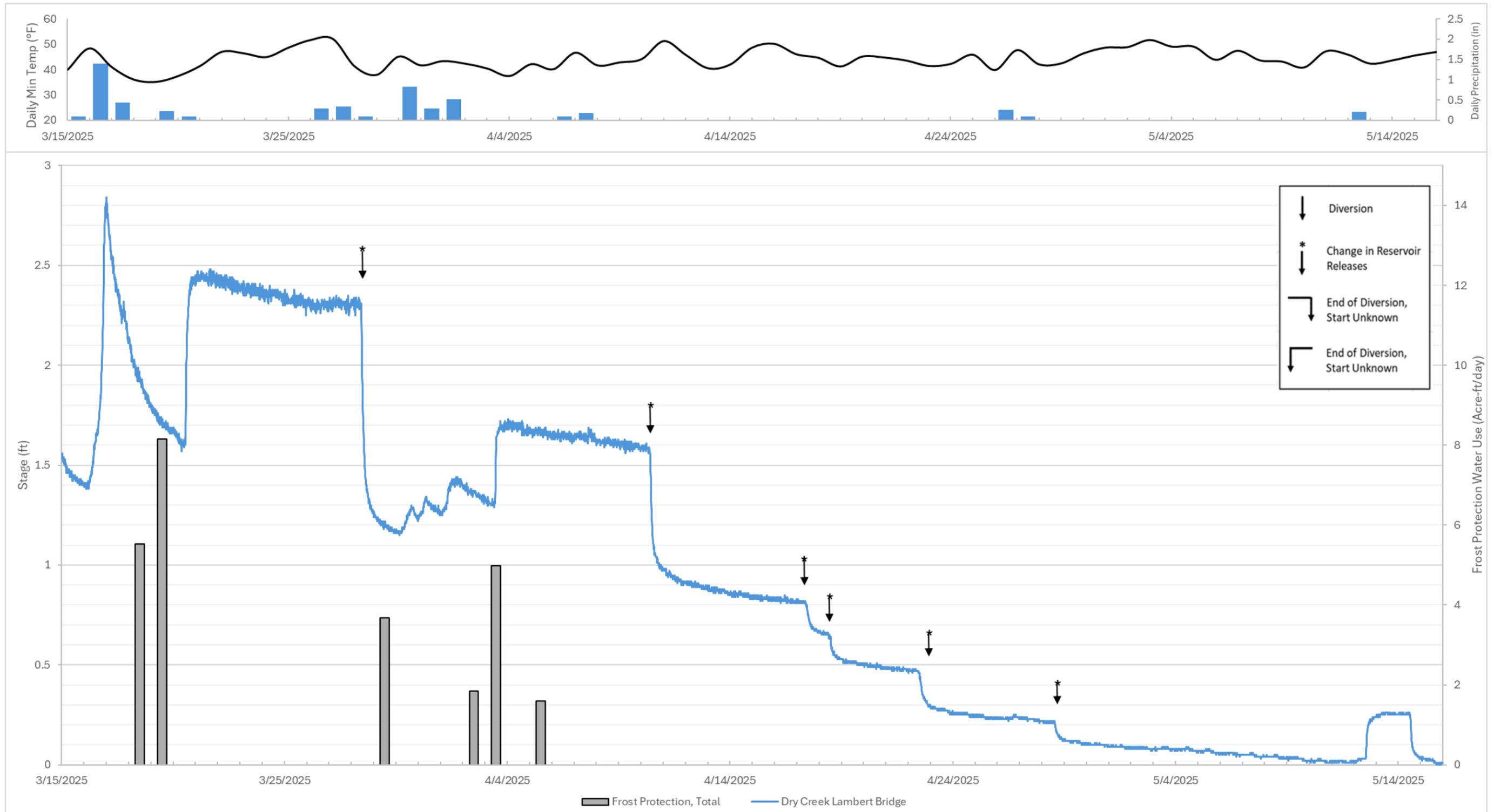


Figure A.19: Detailed hydrograph for the Dry Creek below Lambert Bridge gage showing identified diversions. Daily precipitation and minimum temperature data is from the Lower Dry Creek Valley (DRY) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Dry Creek Valley Focus Area.

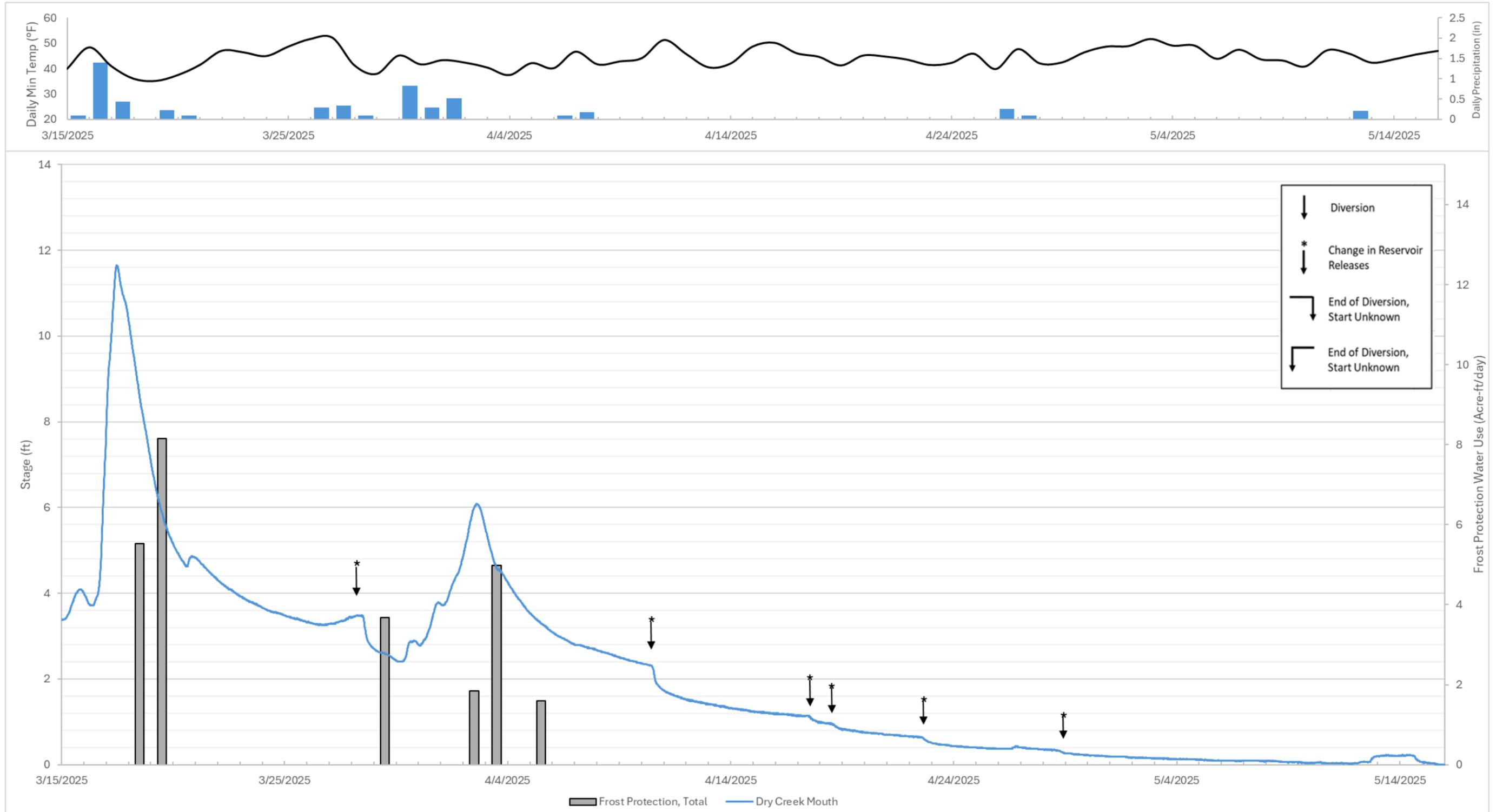


Figure A.20: Detailed hydrograph for the Dry Creek at Mouth near Healdsburg gage showing identified diversions. Daily precipitation and minimum temperature data is from the Lower Dry Creek Valley (DRY) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Dry Creek Valley Focus Area.

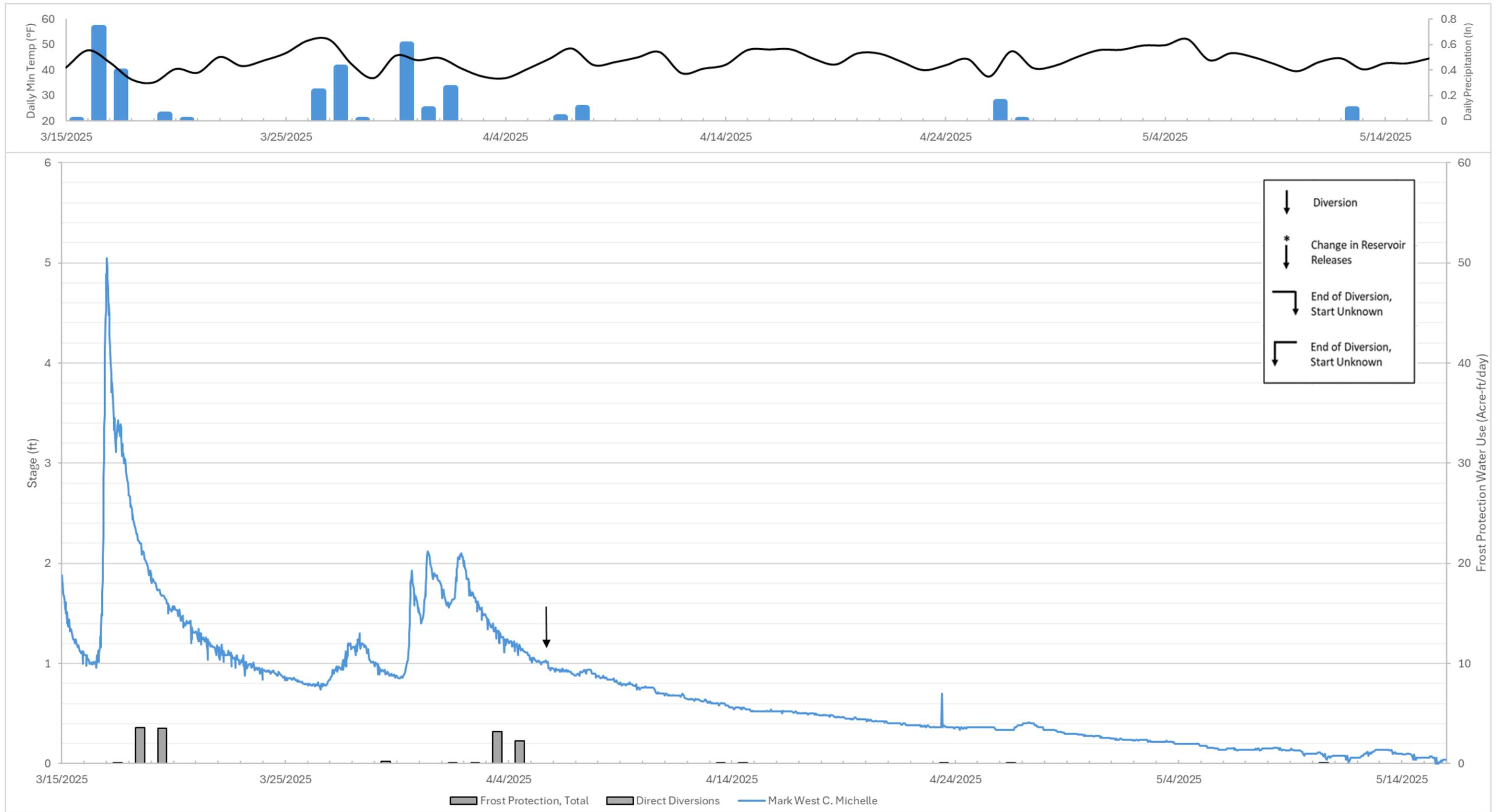


Figure A.21: Detailed hydrograph for the Mark West Creek at Michelle Way gage showing identified diversion signals. Daily precipitation and minimum temperature data is from the Fulton NW (R05) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Mark West Creek Focus Area. NO UPSTREAM FROST PROTECTION USERS AT THIS SITE.

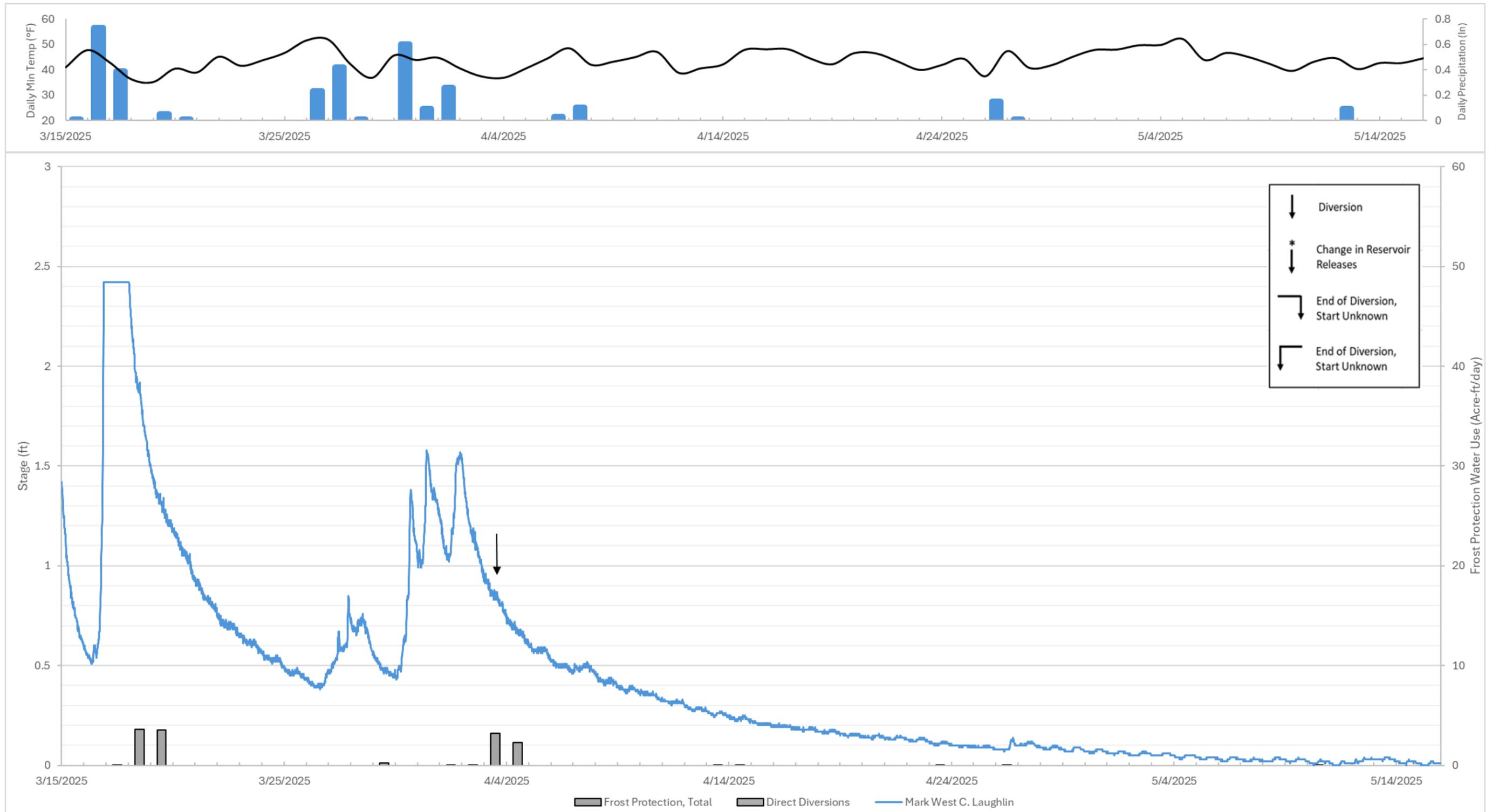


Figure A.22: Detailed hydrograph for the Mark West Creek at Laughlin Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Fulton NW (R05) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Mark West Creek Focus Area.

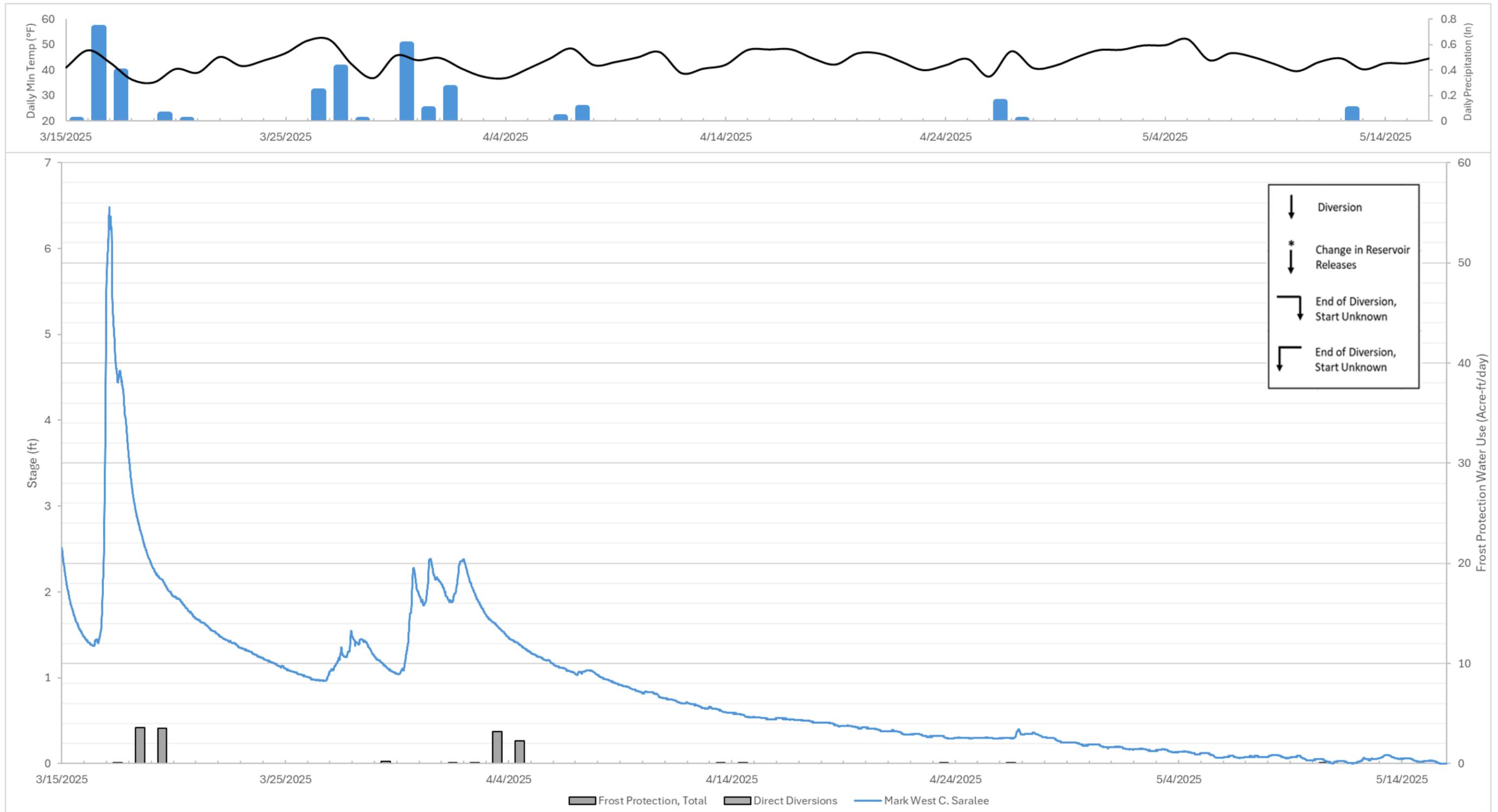


Figure A.23: Detailed hydrograph for the Mark West Creek at Saralee Vineyards gage showing identified diversions. Daily precipitation and minimum temperature data is from the Fulton NW (R05) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Mark West Creek Focus Area.

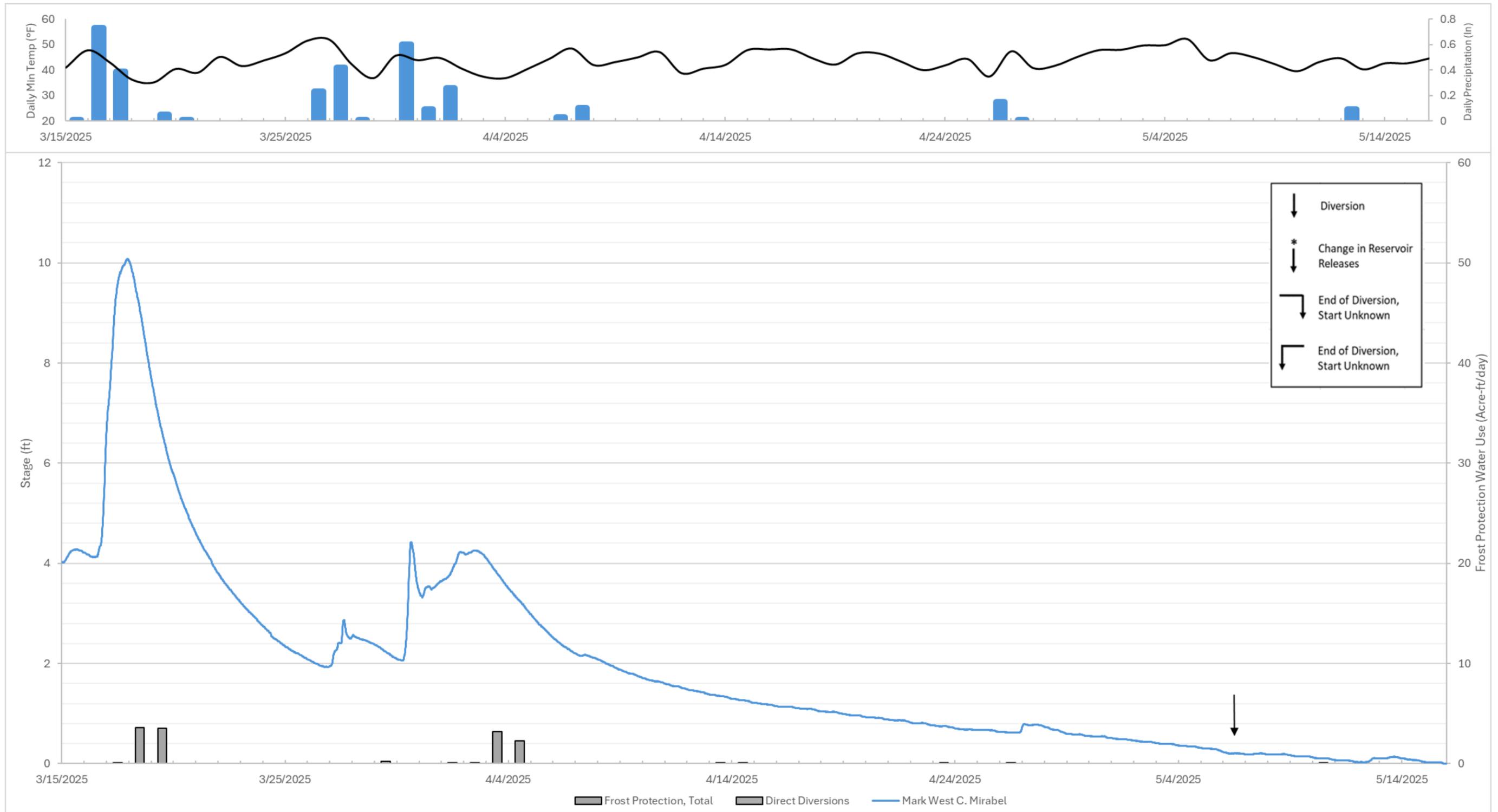


Figure A.24: Detailed hydrograph for the Mark West Creek at Mirabel Heights gage showing identified diversions. Daily precipitation and minimum temperature data is from the Fulton NW (R05) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Mark West Creek Focus Area.

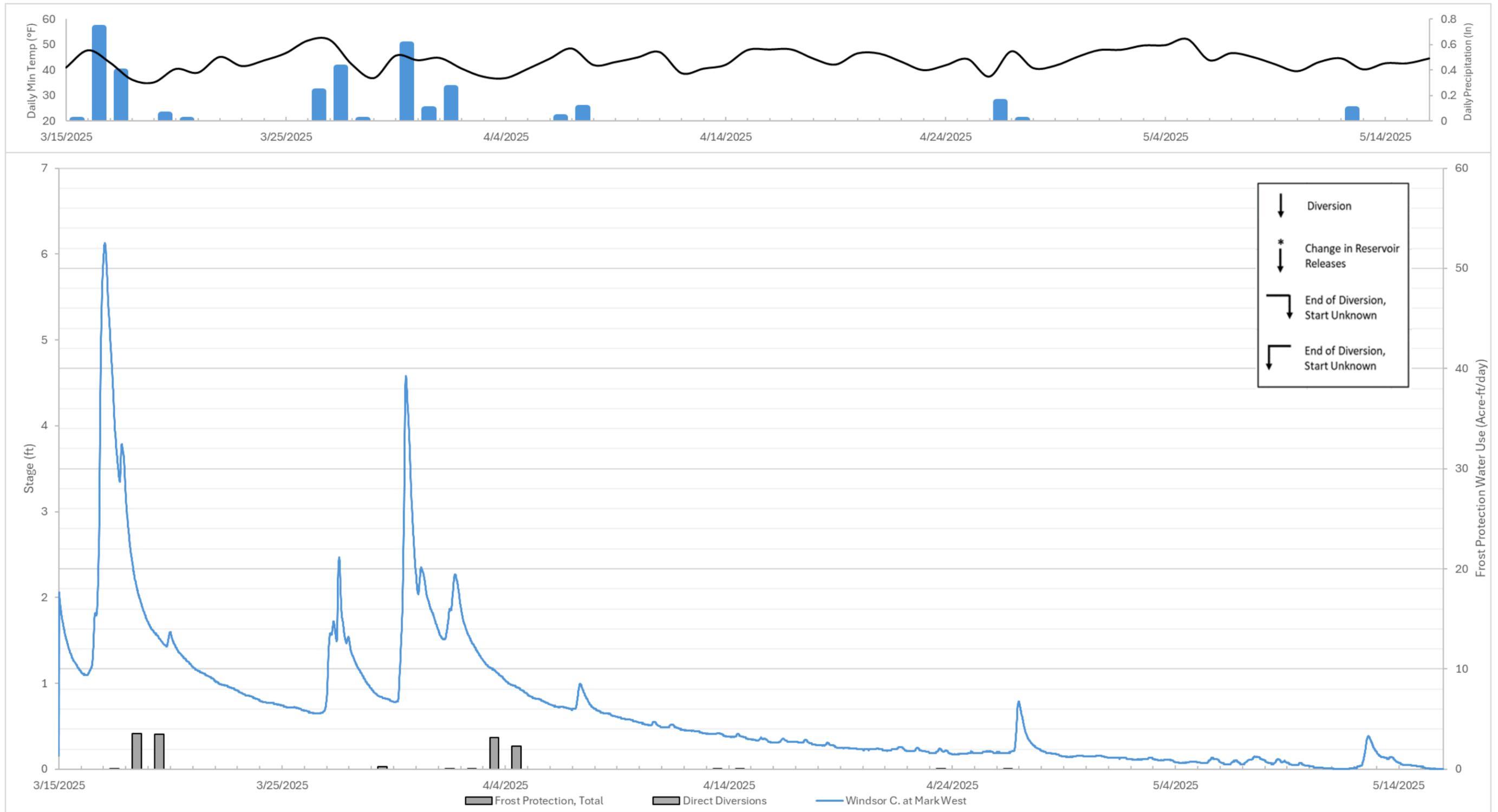


Figure A.25: Detailed hydrograph for the Windsor Creek at Mark West Station Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Fulton NW (R05) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Mark West Creek Focus Area.

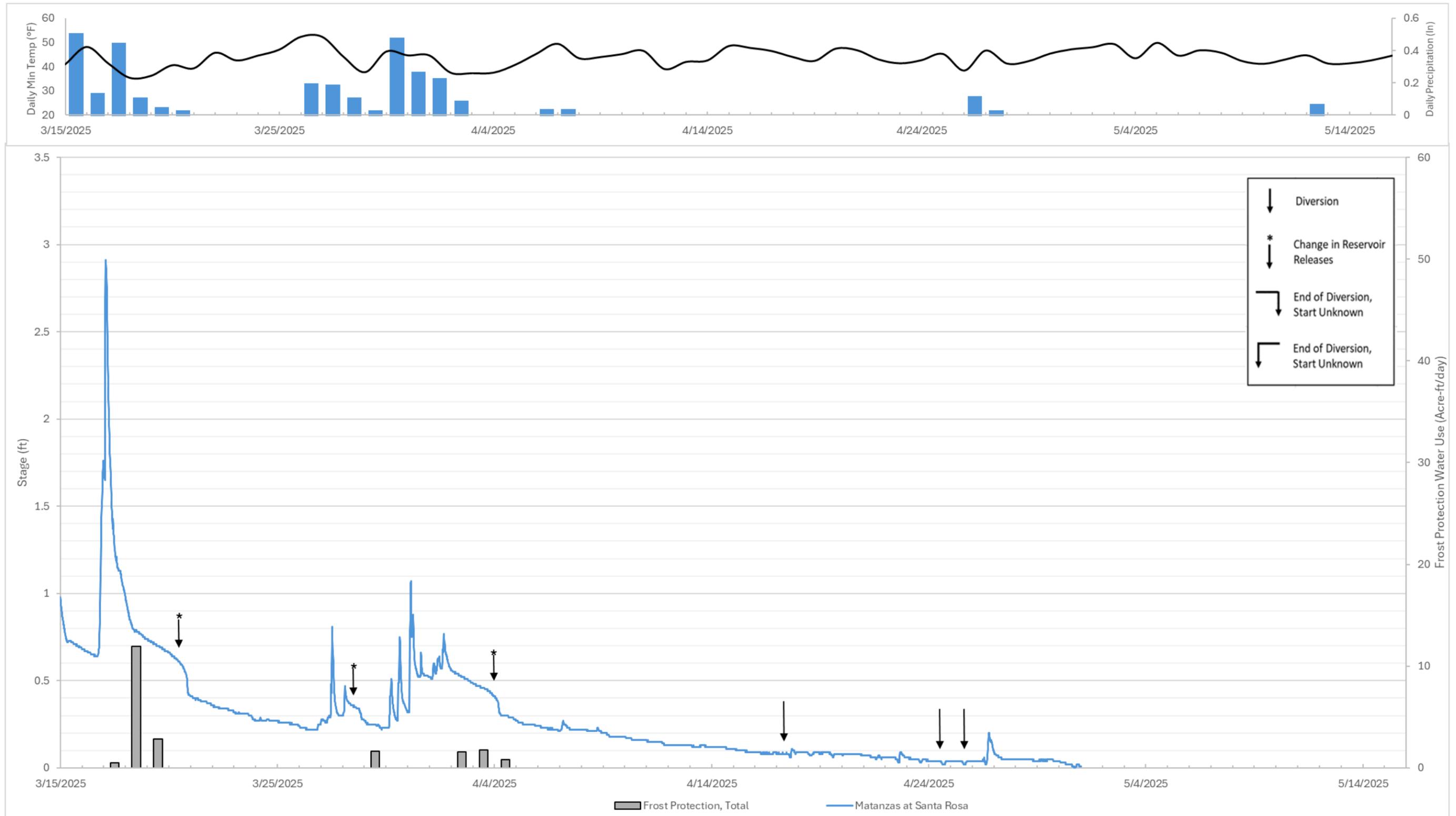


Figure A.26: Detailed hydrograph for the Matanzas Creek at Santa Rosa gage showing identified diversions. Daily precipitation and minimum temperature data is from the Guerneville Road West (GRR) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Santa Rosa Plain Focus Area.

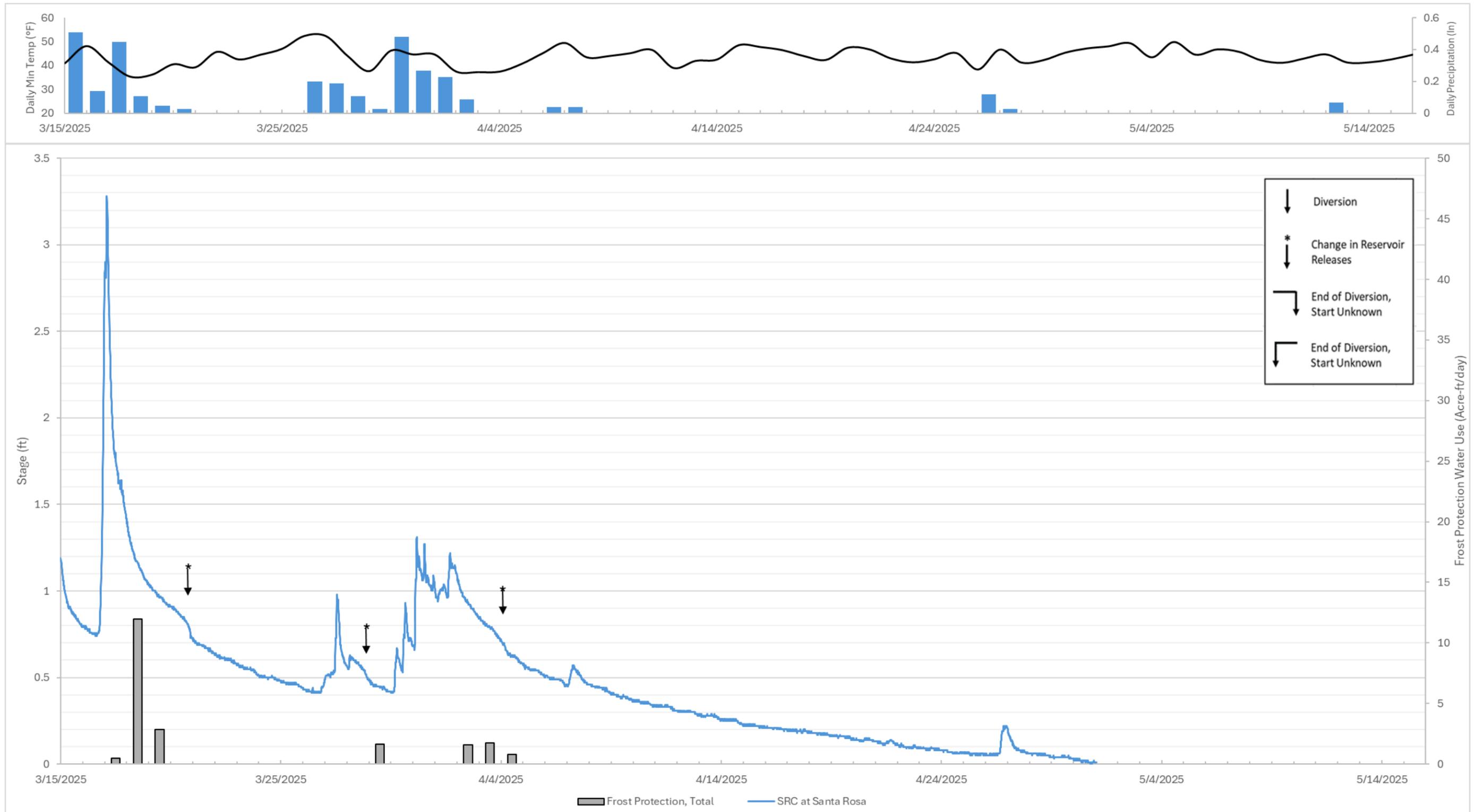


Figure A.27: Detailed hydrograph for the Santa Rosa Creek at Santa Rosa gage showing identified diversions. Daily precipitation and minimum temperature data is from the Guerneville Road West (GRR) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Santa Rosa Plain Focus Area excluding the Laguna de Santa Rosa.

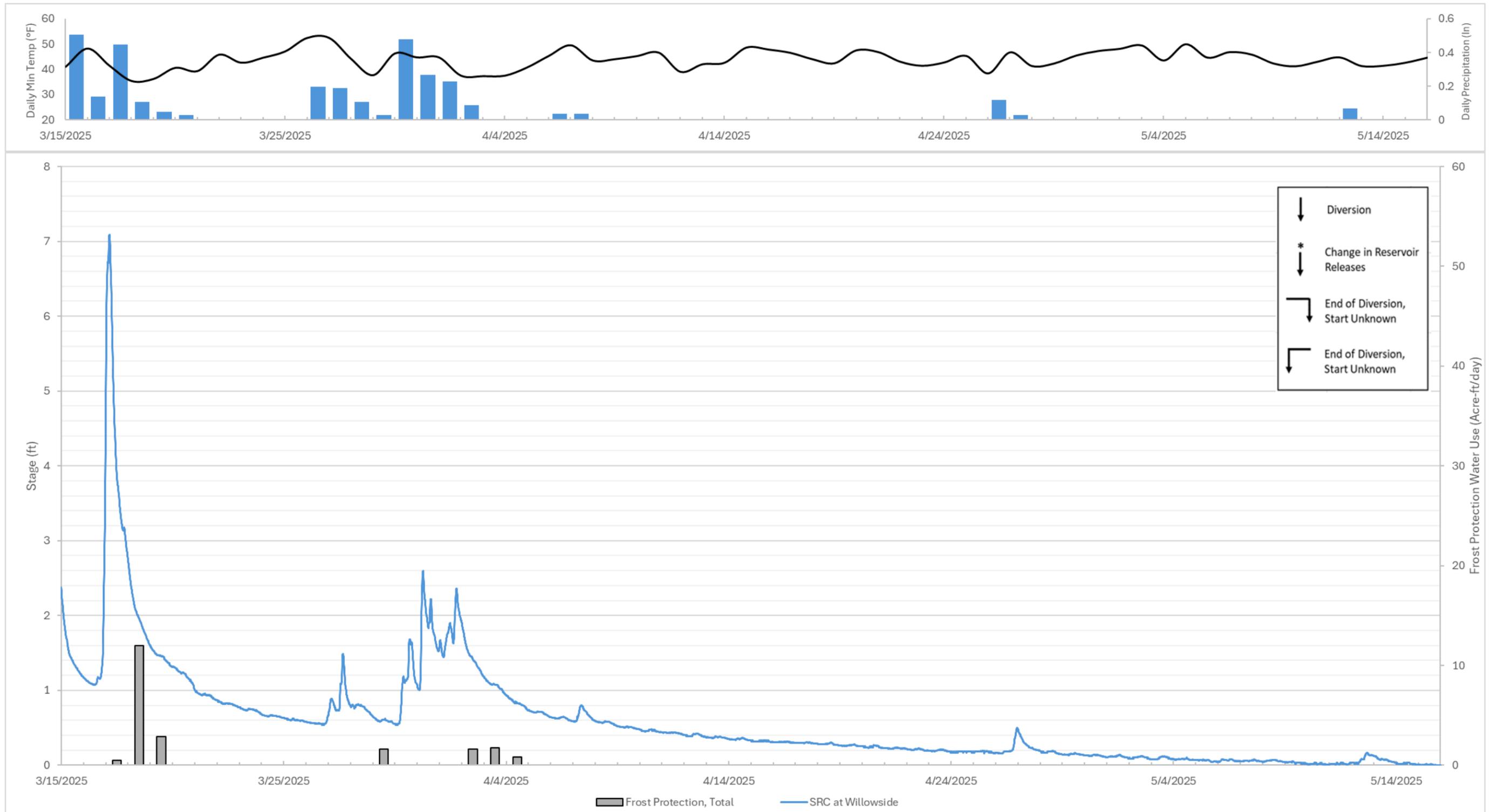


Figure A.28: Detailed hydrograph for the Santa Rosa Creek at Willowside Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Guerneville Road West (GRR) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Santa Rosa Plain Focus Area.

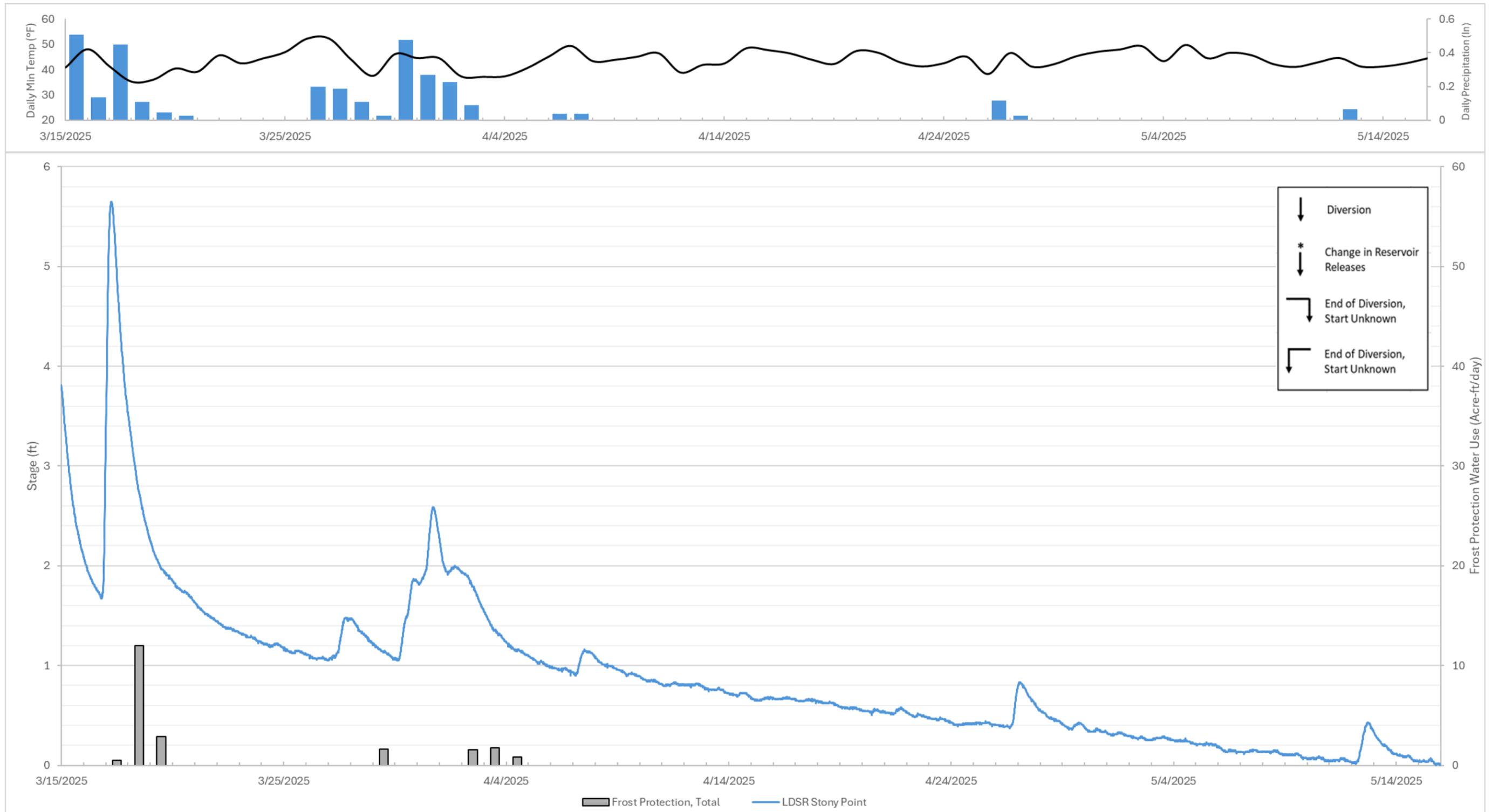


Figure A.29: Detailed hydrograph for the Laguna de Santa Rosa at Stony Point Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Guerneville Road West (GRR) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Santa Rosa Plain Focus Area.

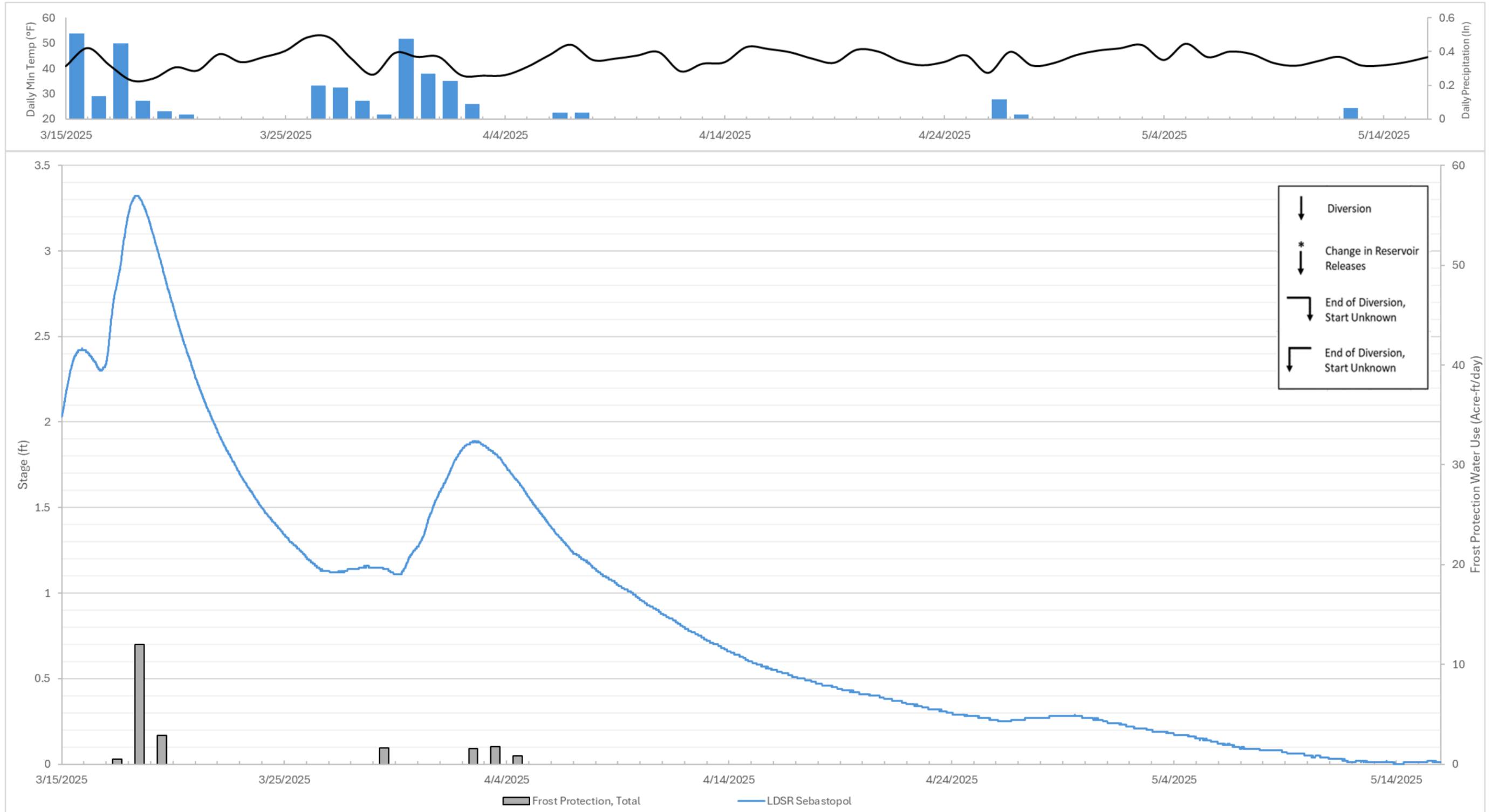


Figure A.30: Detailed hydrograph for the Laguna de Santa Rosa near Sebastopol gage showing identified diversions. Daily precipitation and minimum temperature data is from the Guerneville Road West (GRR) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Santa Rosa Plain Focus Area.

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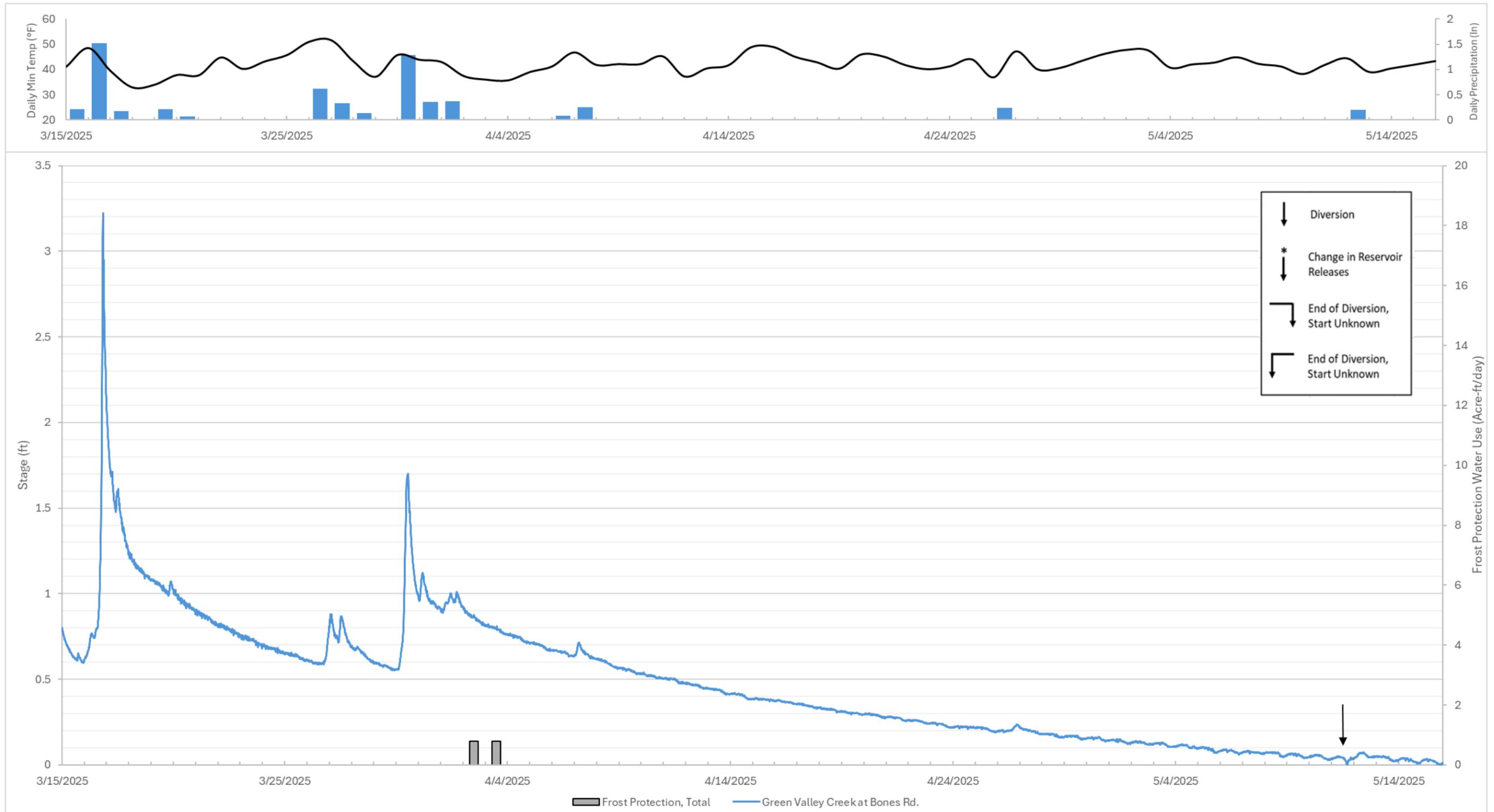


Figure A.31: Detailed hydrograph for the Green Valley Creek at Bones Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Graton West (GRW) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Green Valley/Atascadero Creek Focus Area.

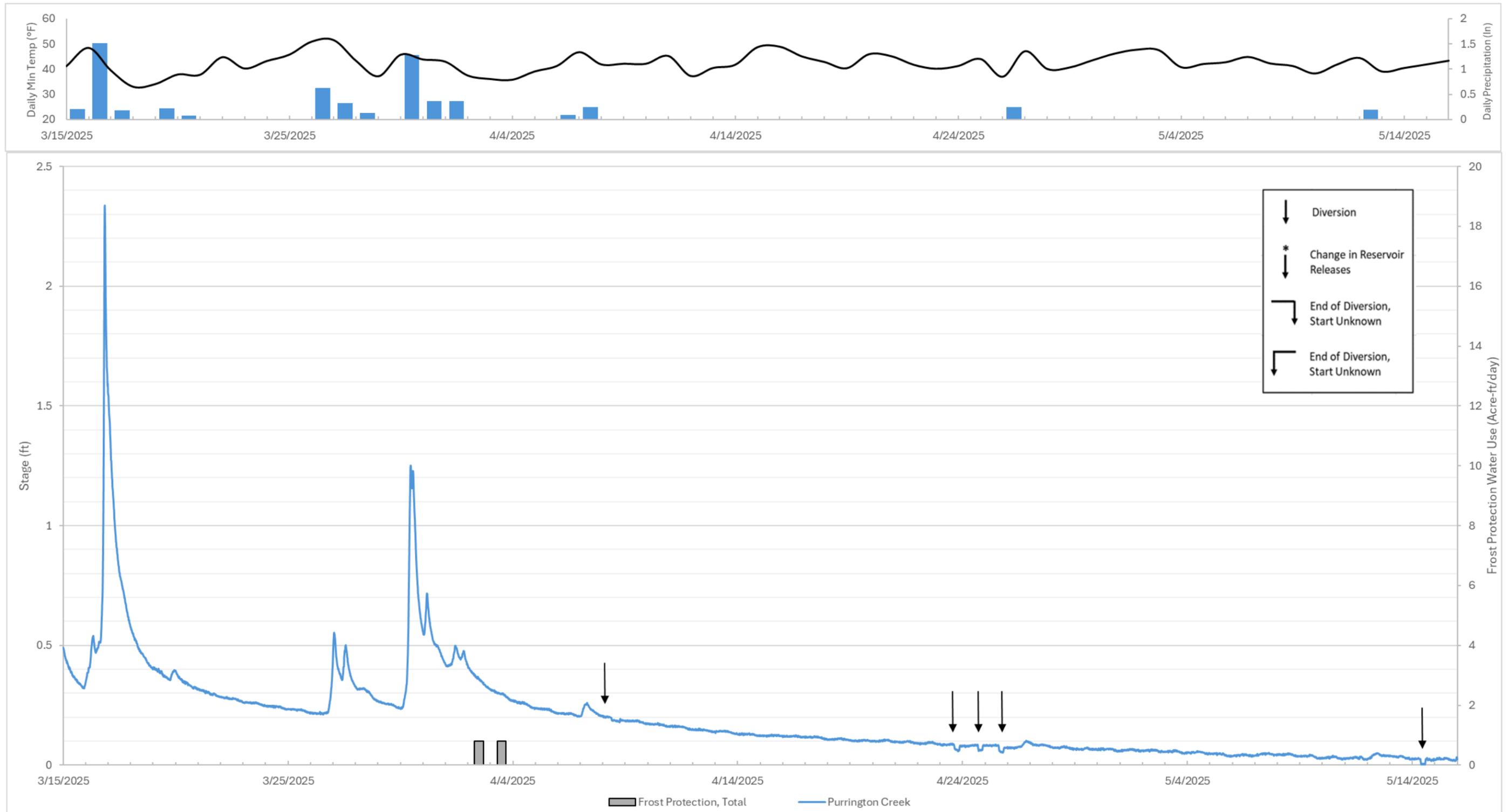


Figure A.32: Detailed hydrograph for the Purrington Creek gage showing identified diversions. Daily precipitation and minimum temperature data is from the Graton West (GRW) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Green Valley/Atascadero Creek Focus Area.

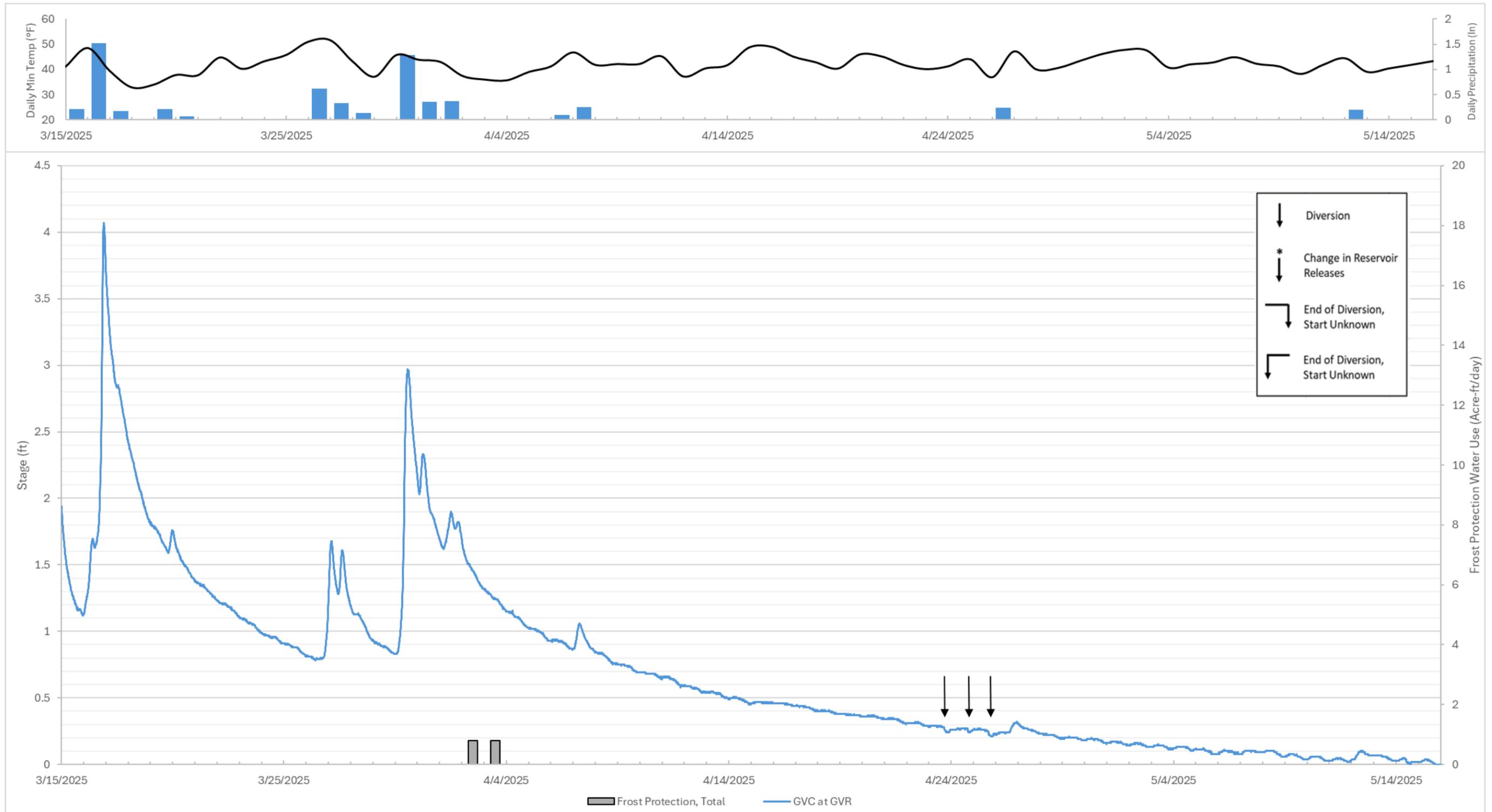


Figure A.33: Detailed hydrograph for the Green Valley Creek at Green Valley Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Graton West (GRW) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Green Valley/Atascadero Creek Focus Area.

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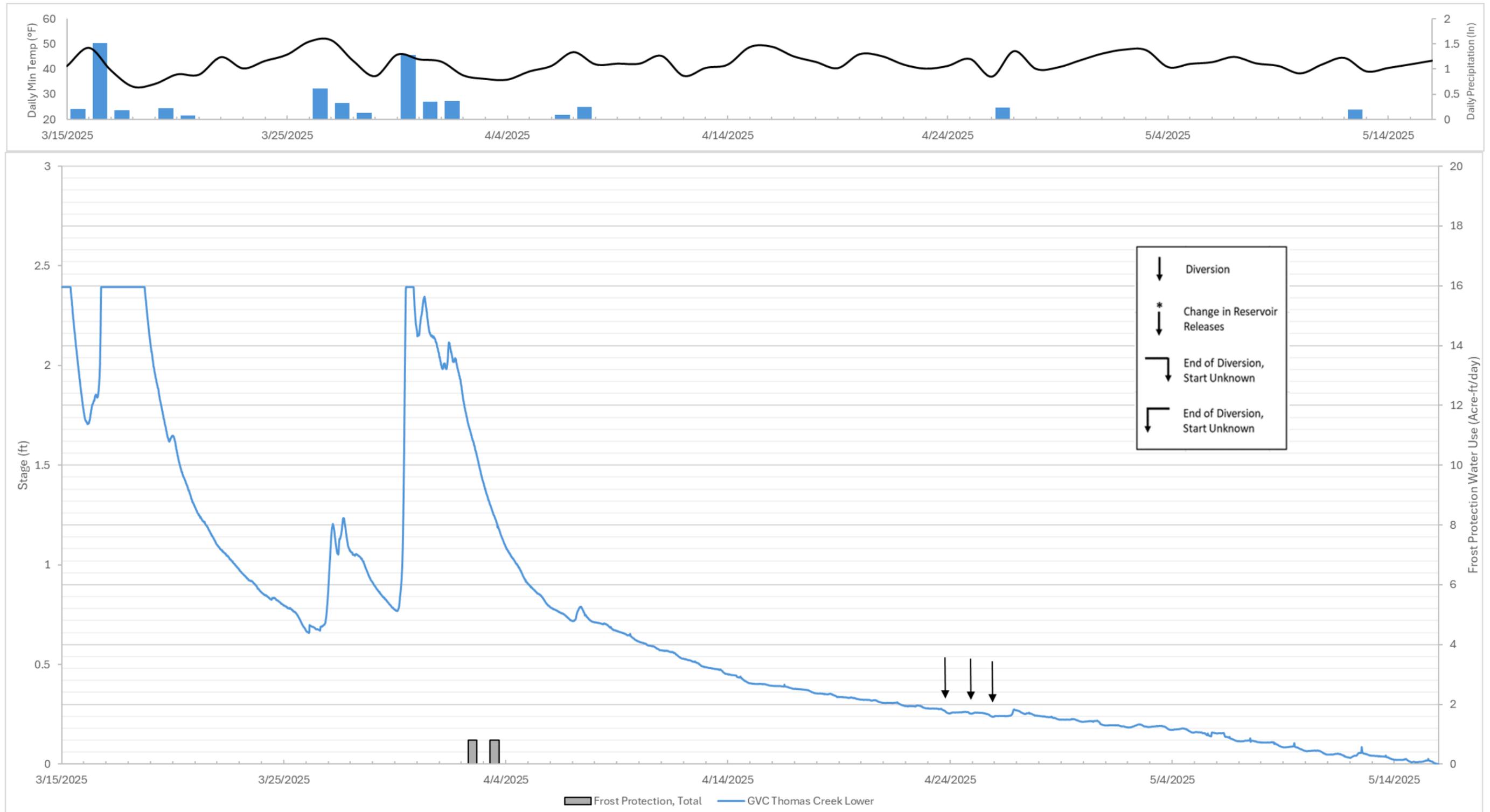


Figure A.34: Detailed hydrograph for the Green Valley Creek at Thomas Creek Ranch gage showing identified diversions. Daily precipitation and minimum temperature data is from the Graton West (GRW) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Green Valley/Atascadero Creek Focus Area.

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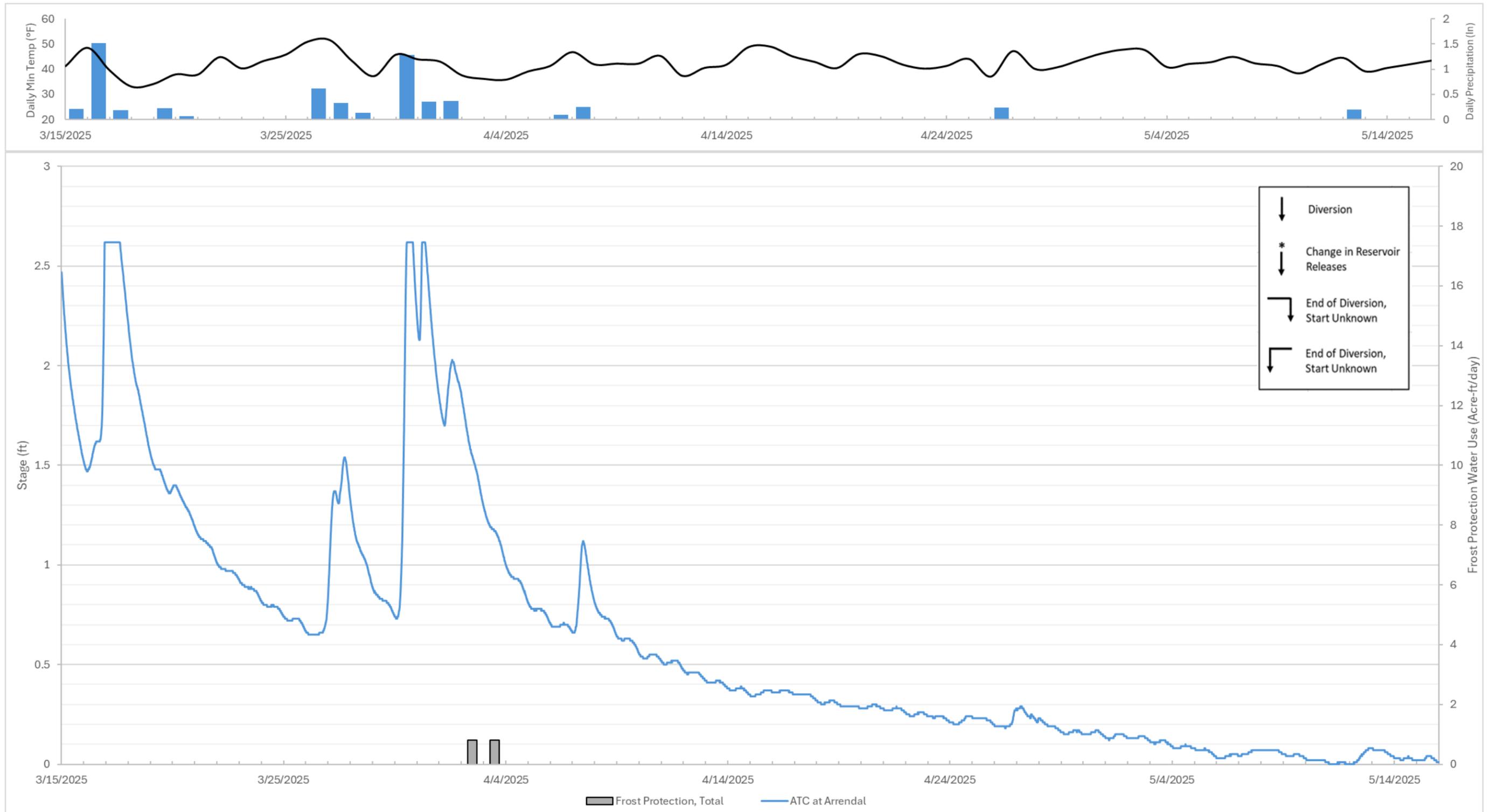


Figure A.35: Detailed hydrograph for the Atascadero Creek at Arrendel Vineyard gage showing identified diversions. Daily precipitation and minimum temperature data is from the Graton West (GRW) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Green Valley/Atascadero Creek Focus Area.

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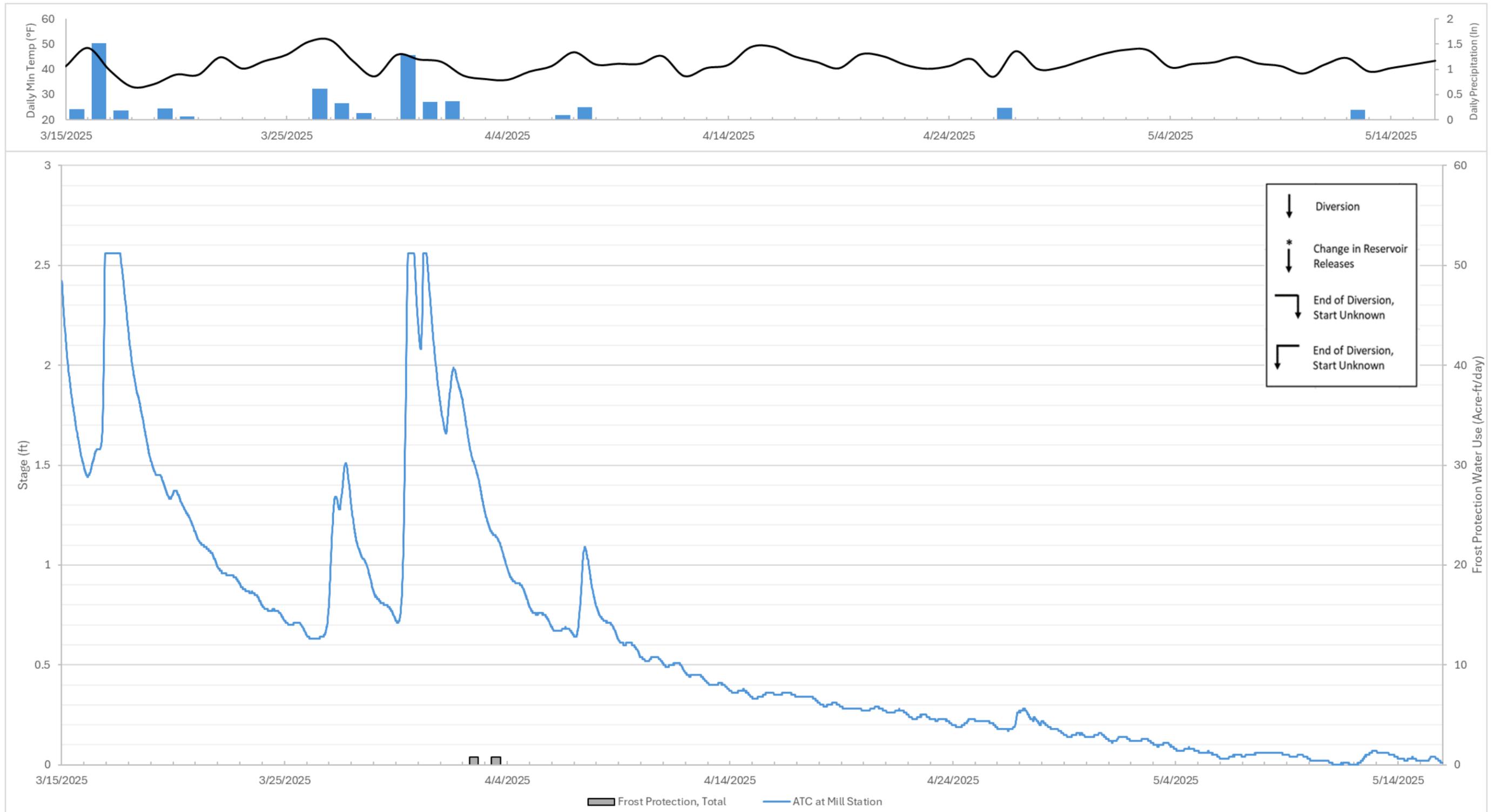


Figure A.36: Detailed hydrograph for the Atascadero Creek at Mill Station Road gage showing identified diversions. Daily precipitation and minimum temperature data is from the Graton West (GRW) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Green Valley/Atascadero Creek Focus Area.

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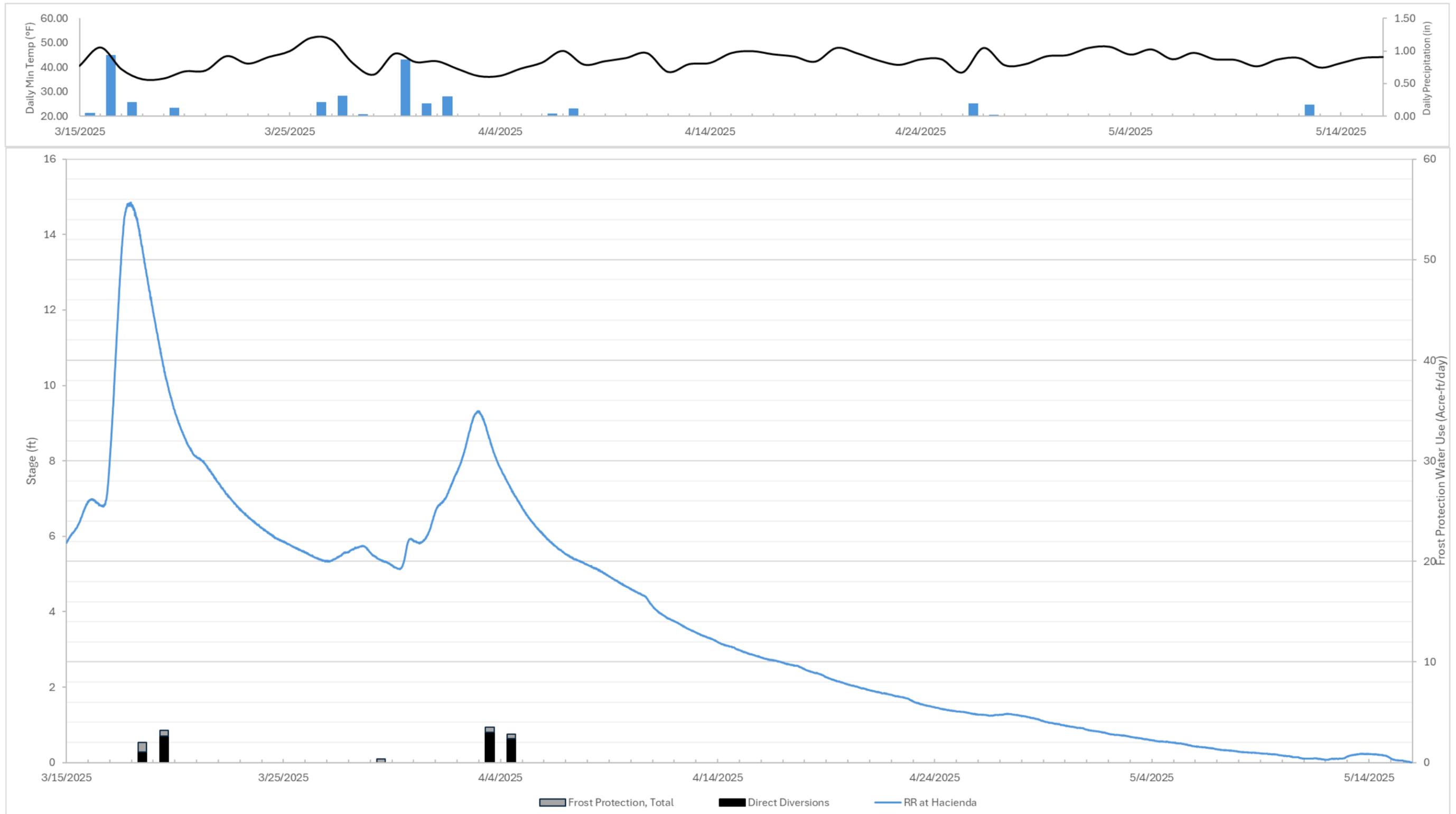


Figure A.37: Detailed hydrograph for the Russian River at Hacienda Bridge gage showing identified diversions. Daily precipitation and minimum temperature data is from the Lower Westside Road (GAR) weather station. Frost protection use reflects volumes reported by NCWC enrollees within the Lower Russian River Focus Area.