

## TECHNICAL MEMORANDUM

Date:	12/1/2023
To:	Rob Swartz, Santa Margarita Groundwater Agency (SMGWA)
From:	Kiernan Kelty and Chris Hammersmark, cbec eco engineering (cbec)
Subject:	SMGWA Streamflow Monitoring, Dry Season 2023

### 1 INTRODUCTION

As part of the Santa Margarita Groundwater Agency's Groundwater Sustainability Plan (GSP), surface flow monitoring during the dry season (May – October) has been an ongoing effort since 2017. The primary goals of the monitoring effort have been characterizing the surface-groundwater exchange within the Santa Margarita Groundwater Basin during the dry season and identifying any potential adverse impacts on the beneficial users of the surface water (Neill, C., et al., 2022). Historically, surface flow, stage, water temperature, and specific conductance have been the metrics used to quantify potential impacts for SMGWA's gage network.

### 2 METHODS

#### 2.1 Gaging Sites

Five active gage sites are currently used within the dry season monitoring network for SMGWA (Figure 1). Four gage sites (San Lorenzo River Upstream of Love Creek, Newell Creek upstream of the San Lorenzo River, Zayante Creek at Woodwardia Weir, and Bean Creek at Mt. Hermon Camp) were actively managed and maintained by cbec eco engineering for the 2023 dry season. Bean Creek downstream of Mackenzie Creek gage site (Figure 1) is operated year-round and maintained/reported on by Balance Hydrologics, Inc. cbec eco engineering provided observed calibration measurements of surface flow, stage, water temperature, and specific conductance for the site during the 2023 dry season for the Bean Creek site.

In preparation for the 2023 dry season monitoring, cbec, with the help of SMGWA staff, identified that the infrastructure and gages for the historical gage sites at Newell Creek upstream of the San Lorenzo River and Bean Creek at Mt. Hermon Camp were lost during the 2022-2023 wet season. New gage sites were established in general vicinity of their historical locations for the 2023 monitoring period. Historical gage sites and infrastructure were used for the other gage locations.

## 2.2 Measurements and Analysis

Gages were deployed on May 15th, 2023, and visited monthly for inspection and repair. Gage data logs were also downloaded during monthly visits with corresponding calibration measurements of surface flow, stage, water temperature, and specific conductance also collected. SMGWA gages were retrieved on November 1st, 2023, concluding the 2023 monitoring period. Calibration measurements of stage and flow were used to develop site specific rating curves for the gage sites maintained and operated by cbec. The rating curves were utilized to translate the gages' stage records into an estimated flow times series for each respective site.

## 3 RESULTS

Calibration measurements for the monitoring network are detailed in Tables 1–5. Gage time series of surface flow, water temperature, and specific conductance, for the four gage sites managed by cbec, are shown in Figures 2 through 9 with a summary of 2023 dry season results provided in the following section.

### 3.1 Monitoring Summary

The initial surface flows for the 2023 dry season (Figures 2-9) were significantly higher than previous observations during the 2021 and 2020 dry seasons (Neill, C., et al., 2022, Neill, C., et al., 2021) and remained higher for the remainder of the monitoring period. Generally, each of the gage sites displayed a typical downtrend in surface flow magnitude throughout the dry season except for Newell Creek upstream of the San Lorenzo River (Figure 3) that is influenced by upstream managed releases from Loch Lomond Reservoir. For the Newell Creek gage location, surface flow values are estimated from 5/25/2023 14:30 – 6/16/2023 17:30 were due to stage values being outside of the max observed stage (2.86 ft) and thus requiring an extrapolation of the developed rating curve for the site (Figure 3). Bean Creek at Mt. Hermon Camp also had a slight increase in surface flows later in the dry season (Figure 5), likely from a minor rain event that began on 9/13/2023 (0.04 in Ben Lomond rain gage, California Department of Forestry and Fire Protection). There also is a data gap from 6/2/2023 7:30 – 6/16/2023 16:00 at this gage site due to gage failure. The gage was replaced with a backup gage on 6/16/2023.

Water surface temperatures generally began at 15 °C for all gage sites before increasing to their respective peaks during July - August of the monitoring period (Figures 2 - 9). The seven day forward rolling average for all gages sites stayed below the 20 °C threshold established by Don Alley for steelhead rearing in the San Lorenzo River system (D. Alley 2015).

Previously during the 2021 dry season, the San Lorenzo River above Love Creek gage site exceeding the 20°C threshold for 39 days total while all other sites stayed below it (Neill, C., et al., 2022). Additional water temperature measurements during the 2023 dry season were proposed for the site to further investigate the cause of the elevated water temperatures during 2021. It was speculated the gage sites' exposed location would have a greater amount of solar radiation than other shaded gage sites and could lead to increased observed water temperatures that are a local artifact rather than a system-wide description. Supplementary water temperature readings upstream of the gage site underneath the HWY 9 bridge were recommended to further investigate the driver(s) of the elevated water temperatures. Depth-varying water temperature measurements at the gage site was also suggested to determine if temperature stratification within the water column was occurring during low flow conditions.

Site visits during the 2023 monitoring period identified the water column to be fully mixed at the gage site and unlikely to have temperature stratification. Spot measurements of water temperature at various depths at the site verified the assumption. Additionally, a second water temperature measurement (20.73 °C) was taken under the HWY 9 bridge during the site visit on 7/19/2023 when highest water temperature observation (20.50 °C) was made for the 2023 dry season. The measurements showed marginal difference, indicating gage measurements were accurate for the larger system rather than a local artifact. No further measurements were taken under the HWY 9 bridge for the remainder of the monitoring period.

Specific conductance was consistently measured via gage timeseries at the Newell Creek upstream of the San Lorenzo River and Zayante Creek at Woodwardia Weir gage sites for the 2023 dry season (Figures 7 & 8). Surface water inflow from a culvert was identified immediately upstream of the Zayante Creek at Woodwardia Weir gage site. Additional conductivity measurements were taken at the gage site and the main channel to understand the influence of the culvert inflows. Measurements found the inflows lowered conductivity measurements at the gage site compared to the main channel (Table 3) with the largest differences occurring during the start of the dry season. The discrepancy suggests the gage record may underreport conductivity values for the 2023 dry season. Figure 8 displays the measured specific conductance at the gage site.

The Bean Creek at Mt. Hermon Camp gage location also has specific conductivity recordings for the 2023 dry season until 6/2/2023 when it failed (Figure 9). SMGWA staff directed cbec to replace the gage with the backup logger from the Zayante Creek gage site on 6/16/2023. The replacement gage was incapable of recording conductance, so no further time series exist past 6/2/2023 for the site. cbec staff were also instructed to deploy a gage incapable of recording conductance at the San Lorenzo upstream Love Creek gage site due to gage shortages at the start of the 2023 monitoring period (Figure 6). Observation measurements were still taken during site visits for the 2023 dry season (Table 1 & Figure 6). Generally, specific conductance measurements for all gage sites were lowest at the start and increased throughout the dry season with minor fluctuations.

## 4 REFERENCES

- Alley, D., 2015, Fishery implications of water-temperature data collected in the San Lorenzo River system in 2014: Consulting report to the San Lorenzo Valley Water District, June 2015, 74p.
- Neill, C., Hecht, B., Goodwin, E., and Parke, J. 2021, Water Year, 2020, Santa Margarita Basin Streamflow Monitoring and Accretion Assessment, Dry Season of 2020, consulting report 220237, 19p. plus figures, tables and forms.
- Neill, C., Parke, J., Hecht, B., Goodwin, E., 2022, Water Year, 2021, Santa Margarita Basin Streamflow Monitoring and Accretion Assessment, Dry Season of 2021, consulting report 221237, 18p. plus figures, tables and forms.

## 5 Tables

**Table 1. Station Log, San Lorenzo River upstream of Love Creek, County of Santa Cruz, California, dry season 2023**

*Data is preliminary, subject to revision*

Date/Time	Observed Stage	Measured Flow	Water Temperature	Electric Conductance	Specific Conductance at 25°C	Field Notes
	(ft)	(cfs)	(°C)	( $\mu S$ )	( $\mu S$ )	(-)
5/15/2023 17:45	2.90	56.96	17.23	313.18	368.50	Gage housing is close to full submergence. Water column is fully mixed. Visible inflow downstream of the gage site from Love Creek. Water is clear.
6/16/2023 18:15	1.80	32.32	18.20	346.70	399.23	Water column is fully mixed. Visible inflow downstream of the gage site from Love Creek. Water is clear.
7/19/2023 16:30	1.36	17.69	20.50 (g) 20.73 (brg)	374.77	410.17	Water column is fully mixed. Visible inflow downstream of the gage site from Love Creek. Water is clear.
8/9/2023 17:00	-	-	-	-	-	Gage housing inspected and cleared of sediment/debris. Water is clear.
8/14/2023 9:45	1.25	12.45	18.60	374.67	422.70	Water column is fully mixed. Visible inflow downstream of the gage site from Love Creek. Water is clear.
9/19/2023 8:45	1.16	10.31	16.10	340.60	412.70	Water column is fully mixed. Visible inflow downstream of the gage site from Love Creek. Water is clear.
11/1/2023 9:30	1.12	7.85	9.00	285.50	414.77	Water column is fully mixed. Visible inflow downstream of the gage site from Love Creek. Water is clear.

**Observed Stage:** Water level noted on staff plate. **Electric Conductance:** electrical conductance of 1 cubic centimeter ( $cm^3$ ) of a solution at field temperature. **Specific Conductance:** electrical conductance of 1 cubic centimeter ( $cm^3$ ) of a solution at 25°C. **(g):** measured at gage site. **(brg):** measured underneath the HWY 9 bridge upstream of gage site.

*Data is preliminary, subject to revision***Table 2. Station Log, Newell Creek upstream of the San Lorenzo River, County of Santa Cruz, California, dry season 2023**

Date/Time	Observed Stage	Measured Flow	Water Temperature	Electric Conductance	Specific Conductance at 25°C	Field Notes
	(ft)	(cfs)	(°C)	( $\mu S$ )	( $\mu S$ )	(-)
5/15/2023 16:10	2.86	2.53	16.40	237.43	284.63	Water is clear, waterfowl and aquatic activity at the gage site.
6/16/2023 16:45	2.86	2.99	15.50	245.63	302.43	Water is clear, waterfowl and aquatic activity at the gage site.
7/19/2023 14:30	2.84	2.22	16.23	253.03	302.80	Water is clear, agal build up on channel substrate. Waterfowl and aquatic activity at the gage site.
8/14/2023 12:15	2.82	1.78	16.40	250.90	300.10	Water is clear, agal build up on channel substrate. Waterfowl and aquatic activity at the gage site.
9/19/2023 10:30	2.80	1.99	14.00	242.03	306.83	Water is clear, agal build up on channel substrate. Waterfowl and aquatic activity at the gage site.
11/1/2023 11:15	2.80	1.94	9.83	222.63	311.83	Water is clear, agal build up on channel substrate. Waterfowl and aquatic activity at the gage site.

**Observed Stage:** Water level noted on staff plate. **Electric Conductance:** electrical conductance of 1 cubic centimeter ( $cm^3$ ) of a solution at field temperature. **Specific Conductance:** electrical conductance of 1 cubic centimeter ( $cm^3$ ) of a solution at 25°C.

**Table 3. Station Log, Zayante Creek at Woodwardia Weir, County of Santa Cruz, California, dry season 2023**

*Data is preliminary, subject to revision*

Date/Time	Observed Stage	Measured Flow	Water Temperature	Electric Conductance	Specific Conductance at 25°C	Field Notes
	(ft)	(cfs)	(°C)	( $\mu$ S)	( $\mu$ S)	(-)
5/15/2023 14:10	0.90	15.45	15.33	- (g) 362.15 (m) 362.15 (a)	337.63 (g) 442.80 (m) 397.73 (a)	Water is clear, there inflow from a culvert US of the gage site influencing measured conductance. Measurements taken at gage site (g) and main channel (m). Average of all data (a) provided.
6/16/2023 14:15	0.81	8.89	16.23	327.80 (g) 377.23 (m) 352.52 (a)	396.90 (g) 457.73 (m) 427.32 (a)	Water is clear, there inflow from a culvert US of the gage site influencing measured conductance. Measurements taken at gage site (g) and main channel (m). Average of all data (a) provided.
7/19/2023 12:15	0.72	6.08	16.80	363.20 (g) 389.00 (m) 376.10 (a)	430.63 (g) 462.10 (m) 446.37 (a)	Water is clear, there inflow from a culvert US of the gage site influencing measured conductance. Measurements taken at gage site (g) and main channel (m). Average of all data (a) provided.
8/14/2023 17:00	0.68	4.21	19.00	357.47 (g) 386.70 (m) 372.08 (a)	409.37 (g) 437.57 (m) 428.40 (a)	Water is clear, there inflow from a culvert US of the gage site influencing measured conductance. Measurements taken at gage site (g) and main channel (m). Average of all data (a) provided.
9/19/2023 15:30	0.66	3.54	16.57	350.63 (g) 355.23 (m) 352.93 (a)	413.77 (g) 428.40 (m) 421.08 (a)	Water is clear, there inflow from a culvert US of the gage site influencing measured conductance. Measurements taken at gage site (g) and main channel (m). Average of all data (a) provided.
11/1/2023 13:30	0.65	3.38	9.07	290.40 (g) 291.33 (m) 290.87 (a)	417.17 (g) 420.63 (m) 418.90 (a)	Water is clear, there inflow from a culvert US of the gage site influencing measured conductance. Measurements taken at gage site (g) and main channel (m). Average of all data (a) provided.

**Observed Stage:** Water level noted on staff plate. **Electric Conductance:** electrical conductance of 1 cubic centimeter ( $\text{cm}^3$ ) of a solution at field temperature. **Specific Conductance:** electrical conductance of 1 cubic centimeter ( $\text{cm}^3$ ) of a solution at 25°C. **(g).** measured at gage site. **(m).** measured in main channel. **(a).** average of all measured data.

*Data is preliminary, subject to revision***Table 4. Station Log, Bean Creek at Mount Hermon Camp,  
County of Santa Cruz, California, dry season 2023**

Date/Time	Observed Stage	Measured Flow	Water Temperature	Electric Conductance	Specific Conductance at 25°C	Field Notes
	(ft)	(cfs)	(°C)	( $\mu S$ )	( $\mu S$ )	(-)
5/15/2023 12:00	2.05	8.34	14.60	335.93	412.87	Water is clear, no debris present.
6/16/2023 11:45	1.94	5.92	14.97	362.30	450.93	Water is clear, no debris present.
7/19/2023 10:15	1.85	4.34	15.30	350.93	433.70	Water is clear, no debris present.
8/14/2023 20:45	1.82	3.58	17.83	354.17	411.03	Water is clear, no debris present.
9/19/2023 17:30	1.81	3.22	16.63	348.20	416.07	Water is clear, no debris present.
11/1/2023 15:15	1.79	2.96	11.10	312.13	427.90	Water is clear, no debris present.

**Observed Stage:** Water level noted on staff plate. **Electric Conductance:** electrical conductance of 1 cubic centimeter ( $cm^3$ ) of a solution at field temperature. **Specific Conductance:** electrical conductance of 1 cubic centimeter ( $cm^3$ ) of a solution at 25°C.

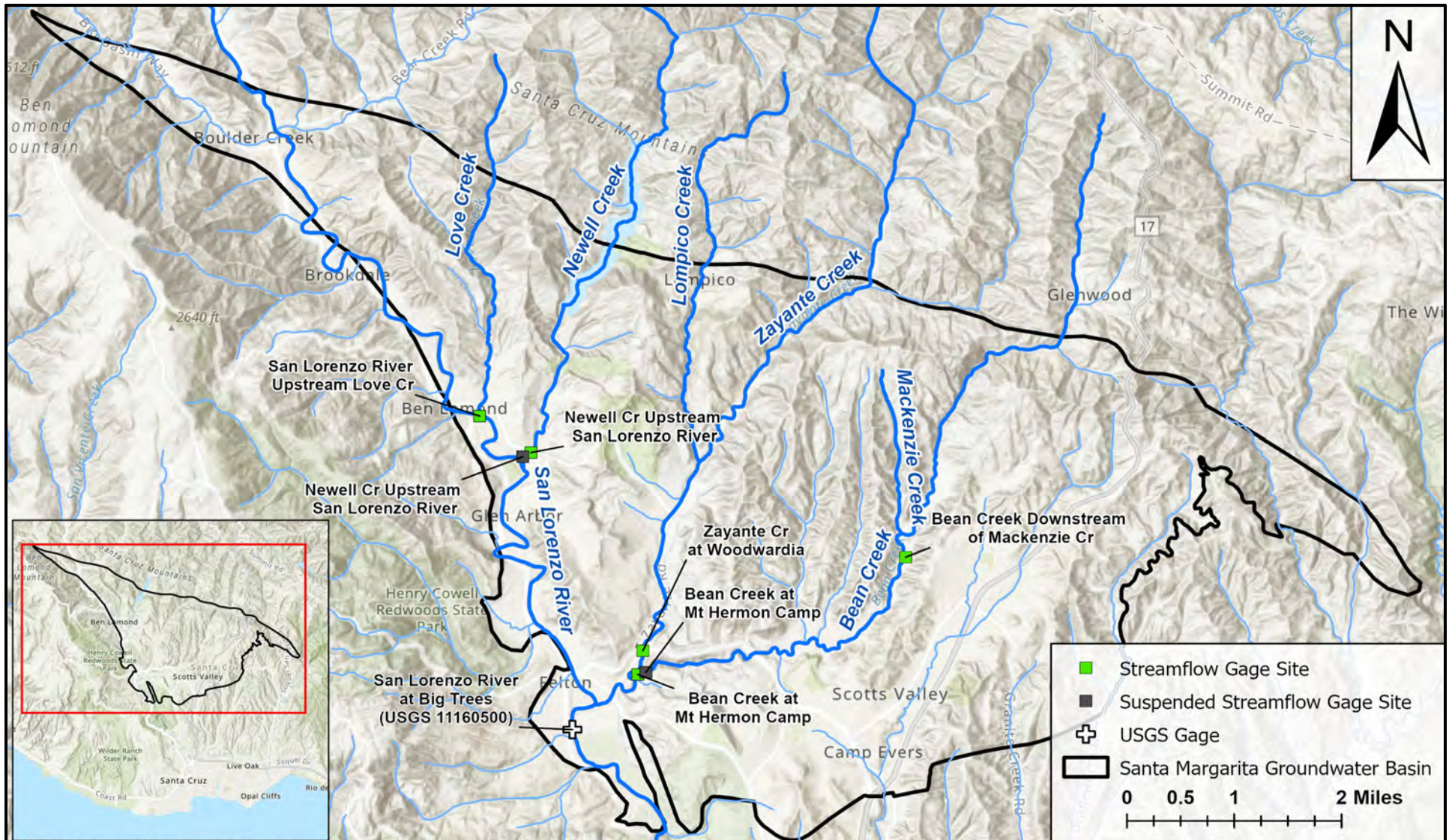
**Table 5. Station Log, Bean Creek downstream of Mackenzie Creek, County of Santa Cruz, California, dry season 2023**

*Data is preliminary, subject to revision*

Date/Time	Observed Stage	Measured Flow	Water Temperature	Electric Conductance	Specific Conductance at 25°C	Field Notes
	(ft)	(cfs)	(°C)	(µS)	(µS)	(-)
5/15/2023 19:35	2.09	2.05	15.50	490.05	596.60	Water is clear, no debris present.
6/16/2023 19:45	1.99	1.00	16.30	448.97	538.33	Water is clear, no debris present.
7/19/2023 17:45	1.86	0.41	19.10	501.67	565.97	Water is clear, no debris present.
8/14/2023 18:30	1.78	0.11	17.30	471.07	552.67	Water is clear, no debris present.
9/19/2023 12:00	-	-	-	-	-	Stream is dry. No measurements taken.
11/1/2023 14:15	-	-	-	-	-	Stream is dry. No measurements taken.

**Observed Stage:** Water level noted on staff plate. **Electric Conductance:** electrical conductance of 1 cubic centimeter (cm<sup>3</sup>) of a solution at field temperature. **Specific Conductance:** electrical conductance of 1 cubic centimeter (cm<sup>3</sup>) of a solution at 25°C.





Notes: The historical gage sites and infrastructure for Newell Creek Upstream of the San Lorenzo River and Bean Creek at Mt Hermon Camp were lost during the winter storms of 2022/2023. New gage sites were identified for the 2023 dry season.



SMGWA Dry Season Stream Flow Monitoring, Water Year 2023

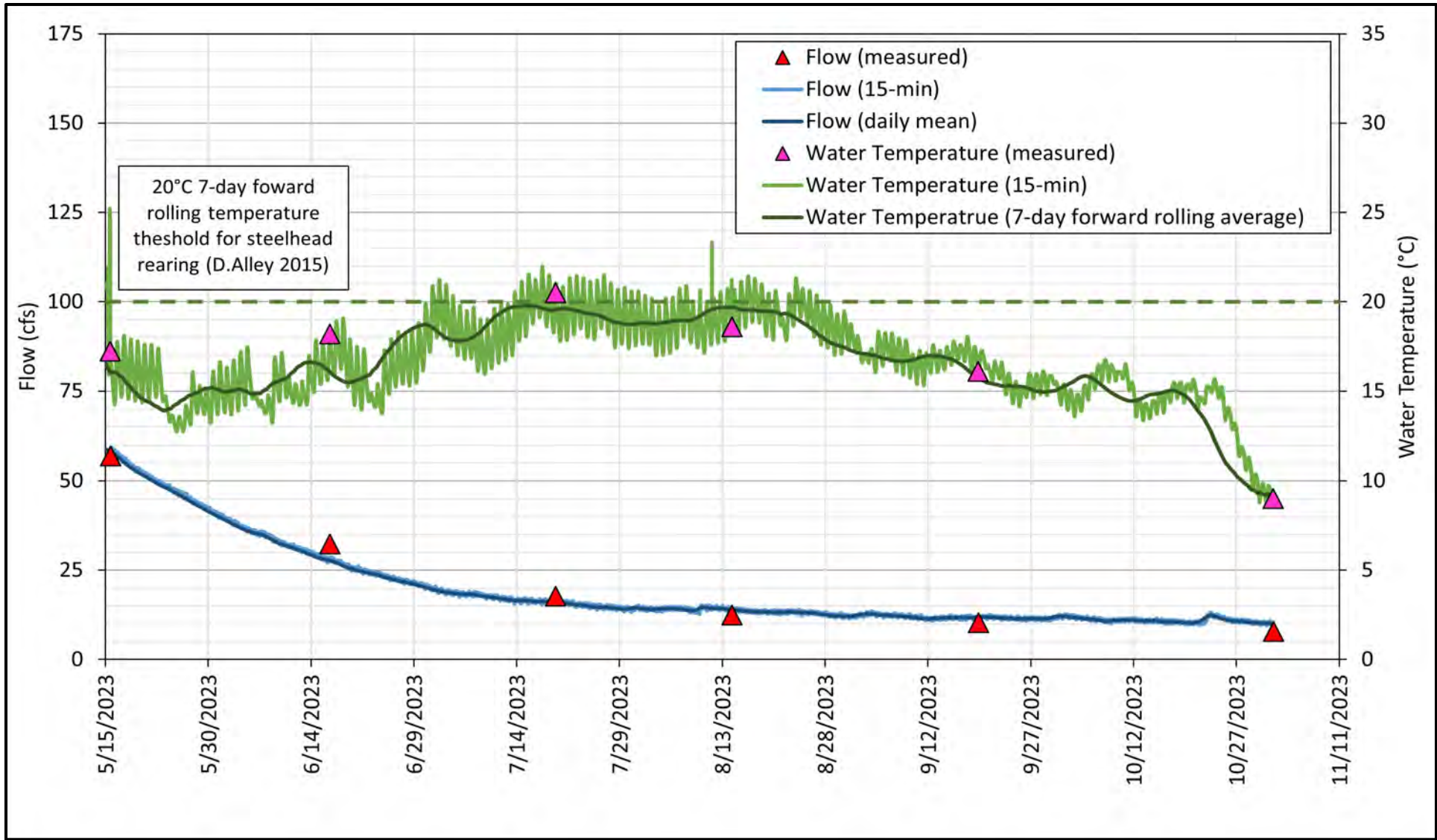
**Santa Margarita Groundwater Agency Streamflow Monitoring Sites**

Project No. 23-1013

Created By: KMK

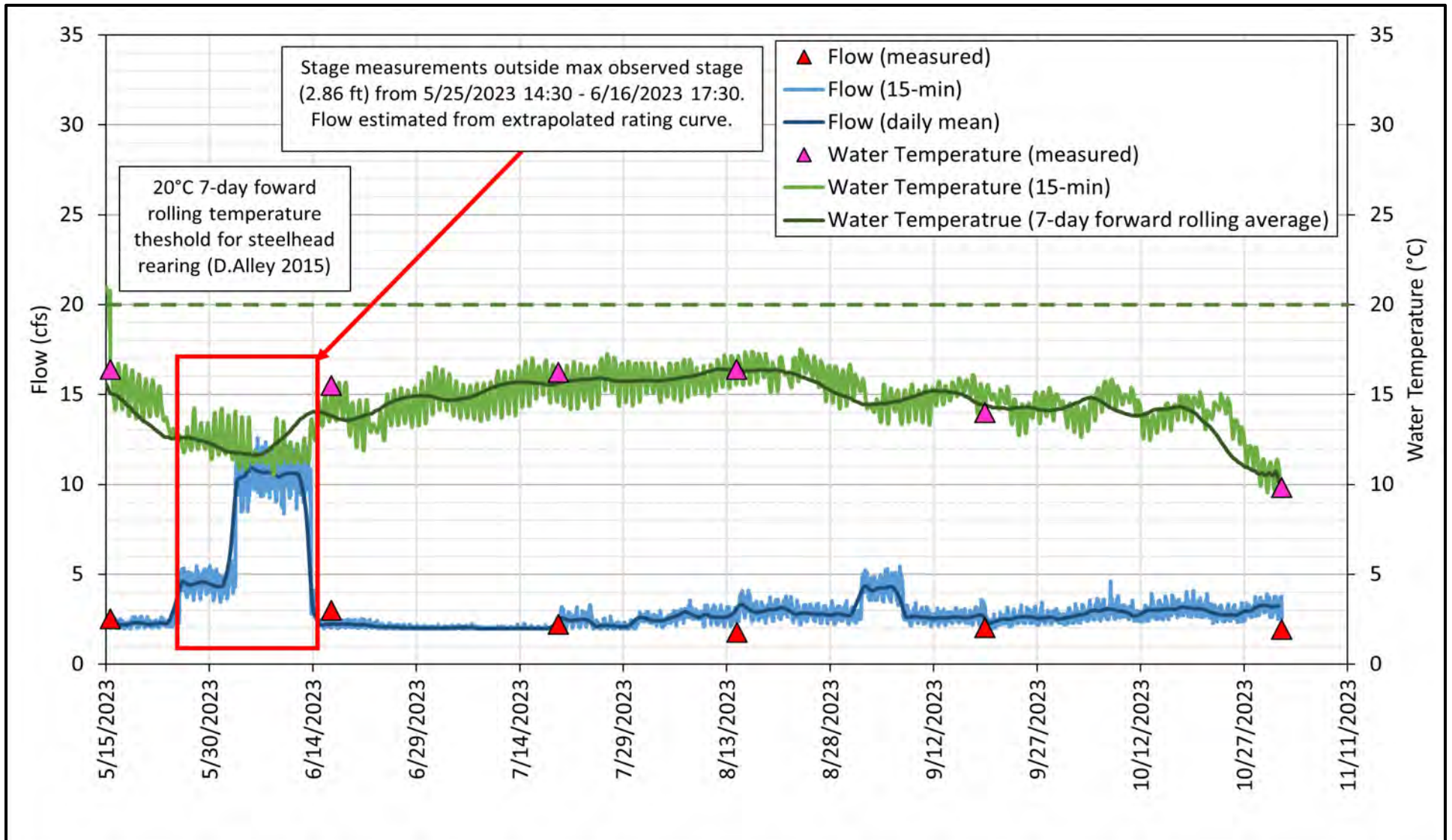
Figure 1





Notes:





Notes:



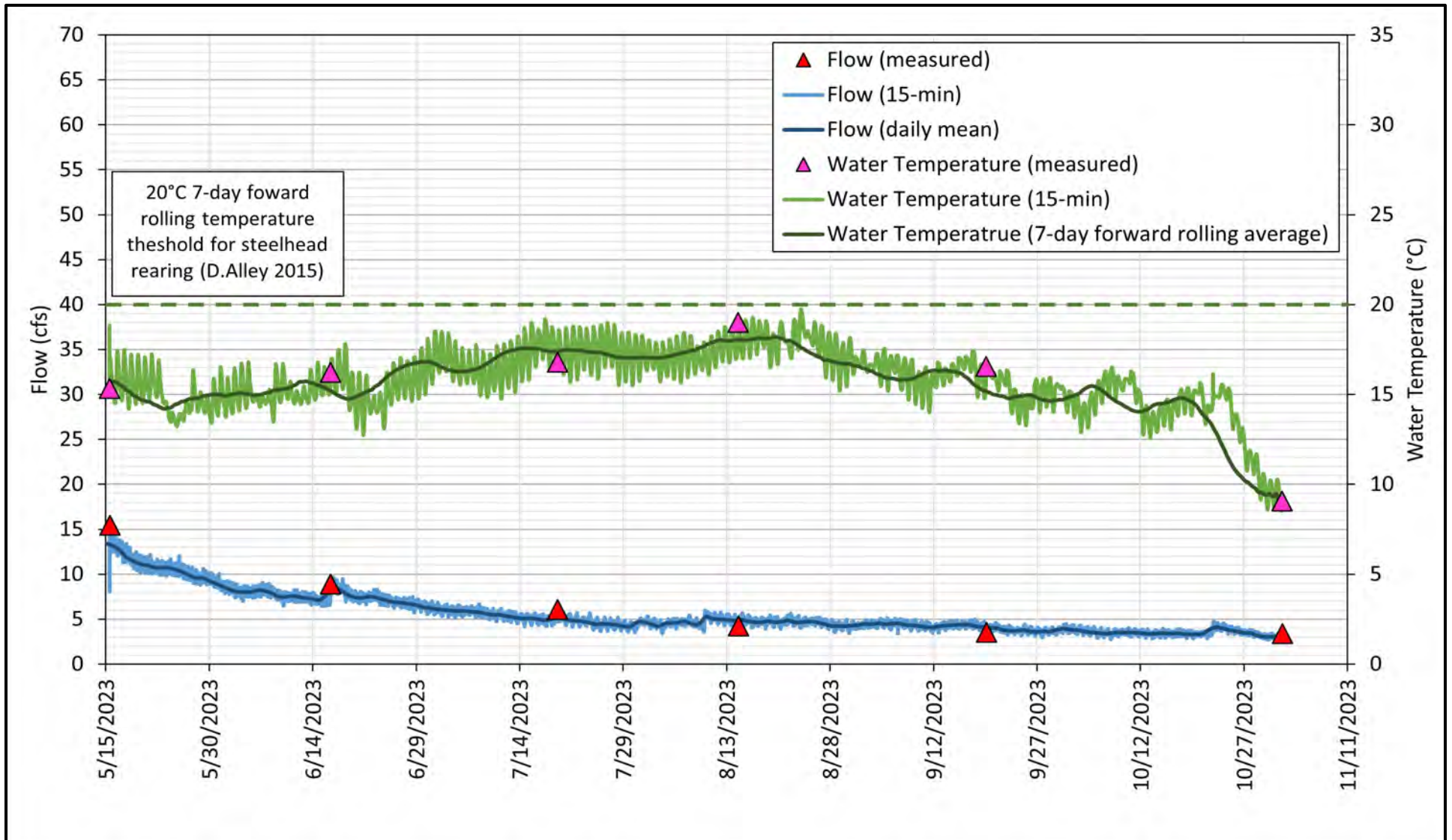
SMGWA Dry Season Stream Flow Monitoring, Water Year 2023

Flow and Water Temperature at Newell Creek Upstream of the San Lorenzo River

Project No. 23-1013

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Figure 3



Notes:



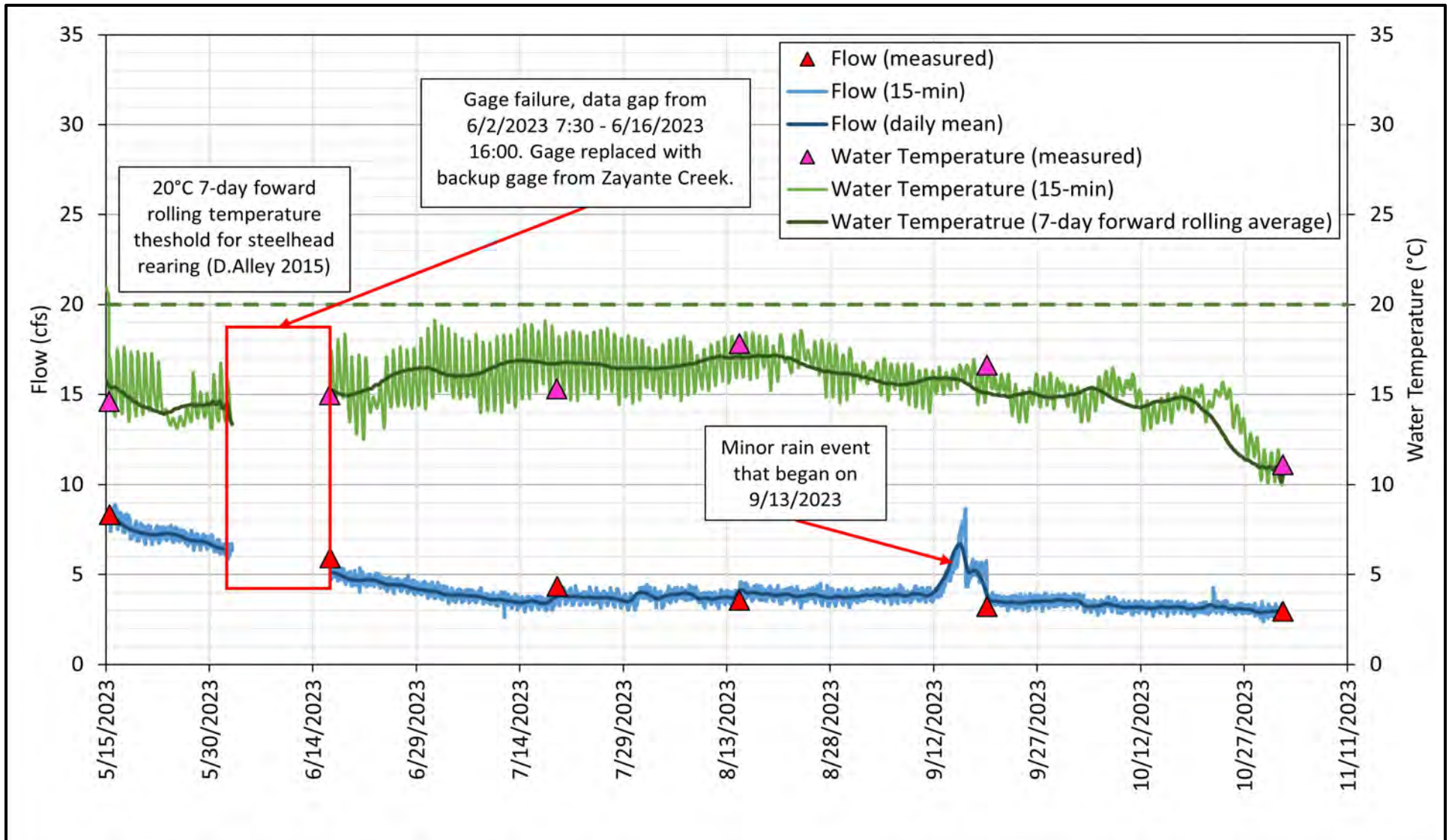
SMGWA Dry Season Stream Flow Monitoring, Water Year 2023  
 Flow and Water Temperature at Zayante Creek at Woodwardia Weir

Project No. 23-1013

Created By: KMK

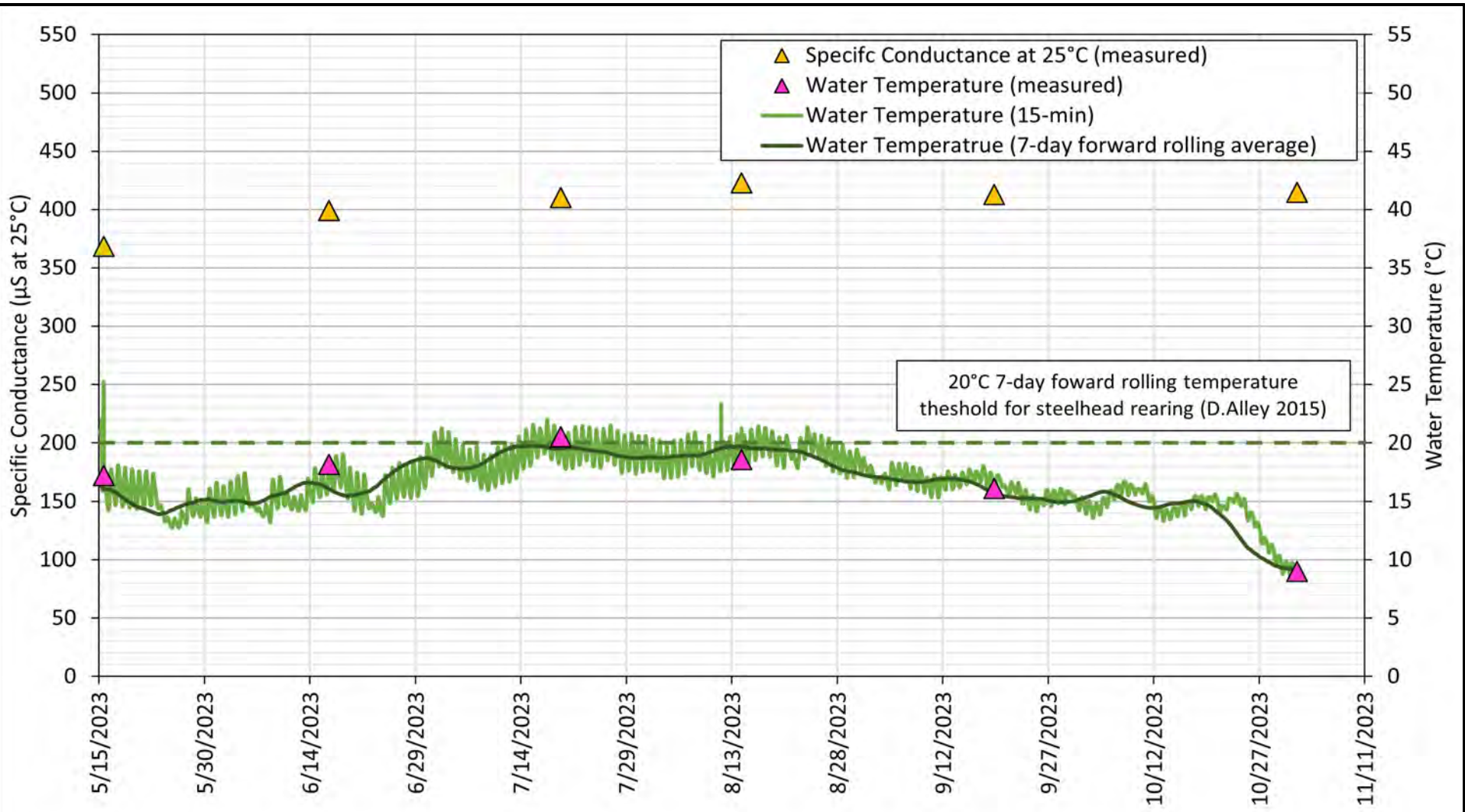
Figure 4





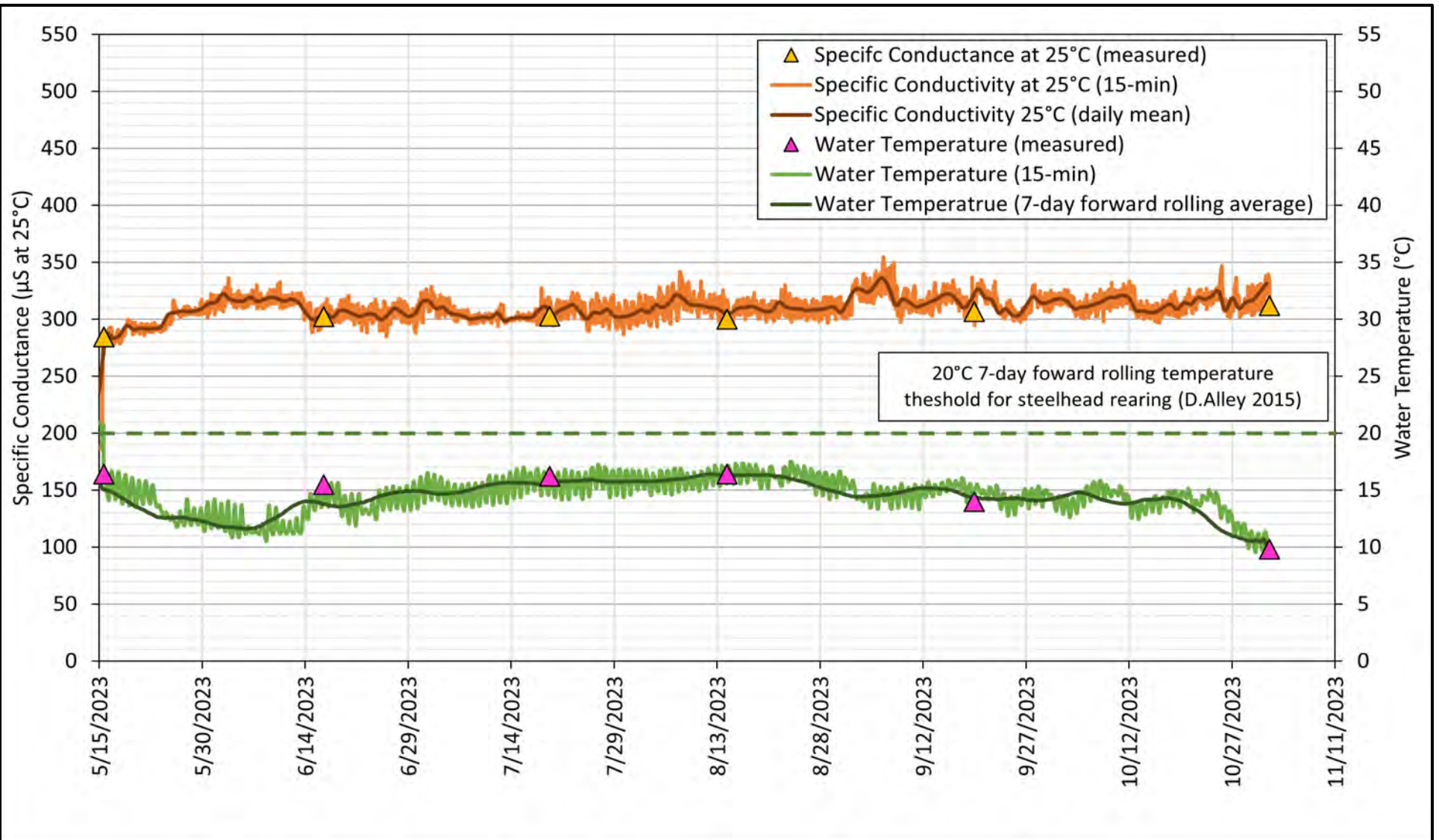
Notes:





Notes: Deployed gage was only capable of recording pressure and water temperature. No specific conductance time series was recorded at the site. Specific conductance field measurements were taken during site visits.





Notes:



SMGWA Dry Season Stream Flow Monitoring, Water Year 2023

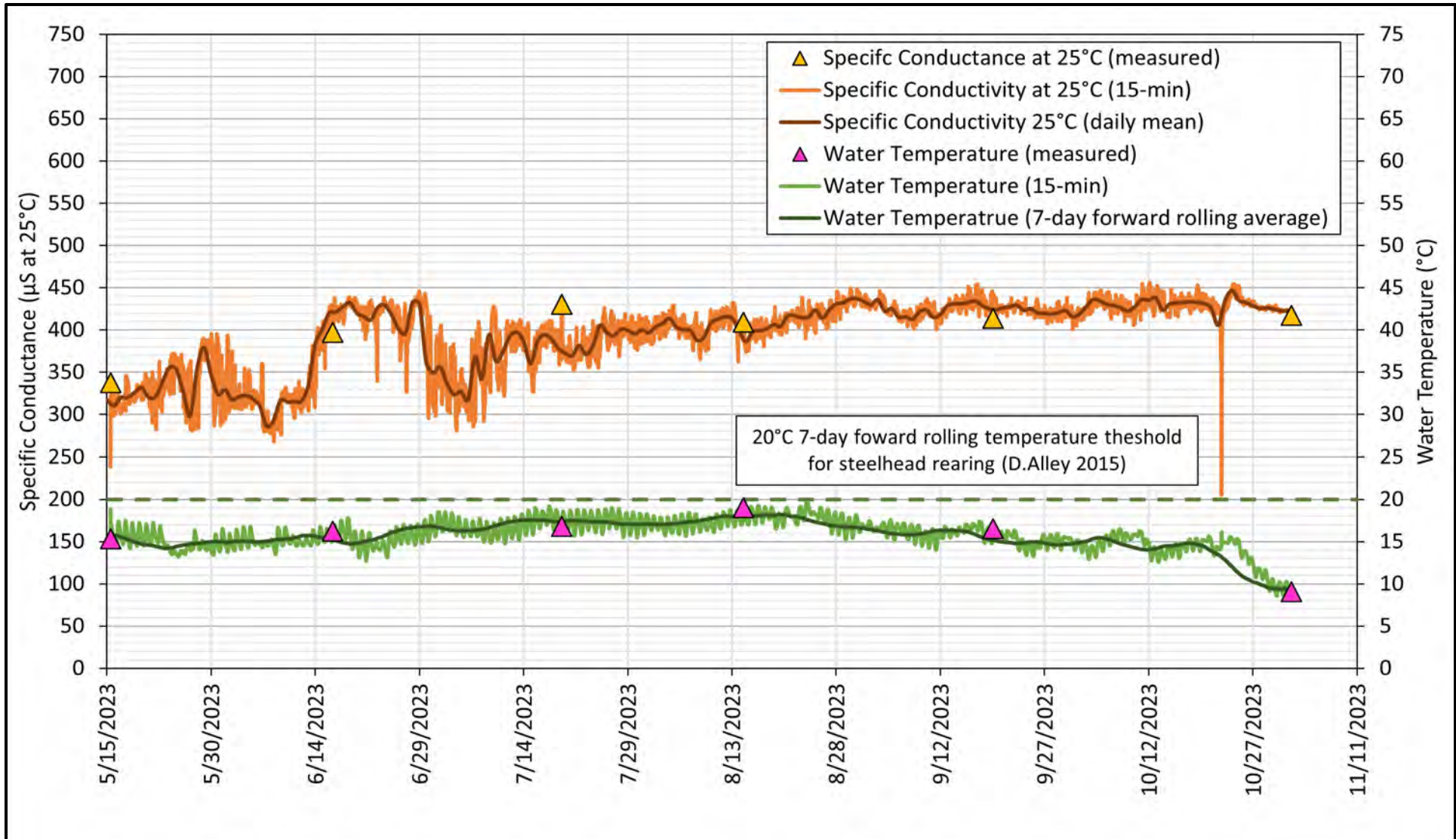
Specific Conductance and Water Temperature at Newell Creek Upstream of the San Lorenzo River

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Figure 7





Notes: Measured Specific Conductance recorded at the gage site. Refer to Table 3.



SMGWA Dry Season Stream Flow Monitoring, Water Year 2023

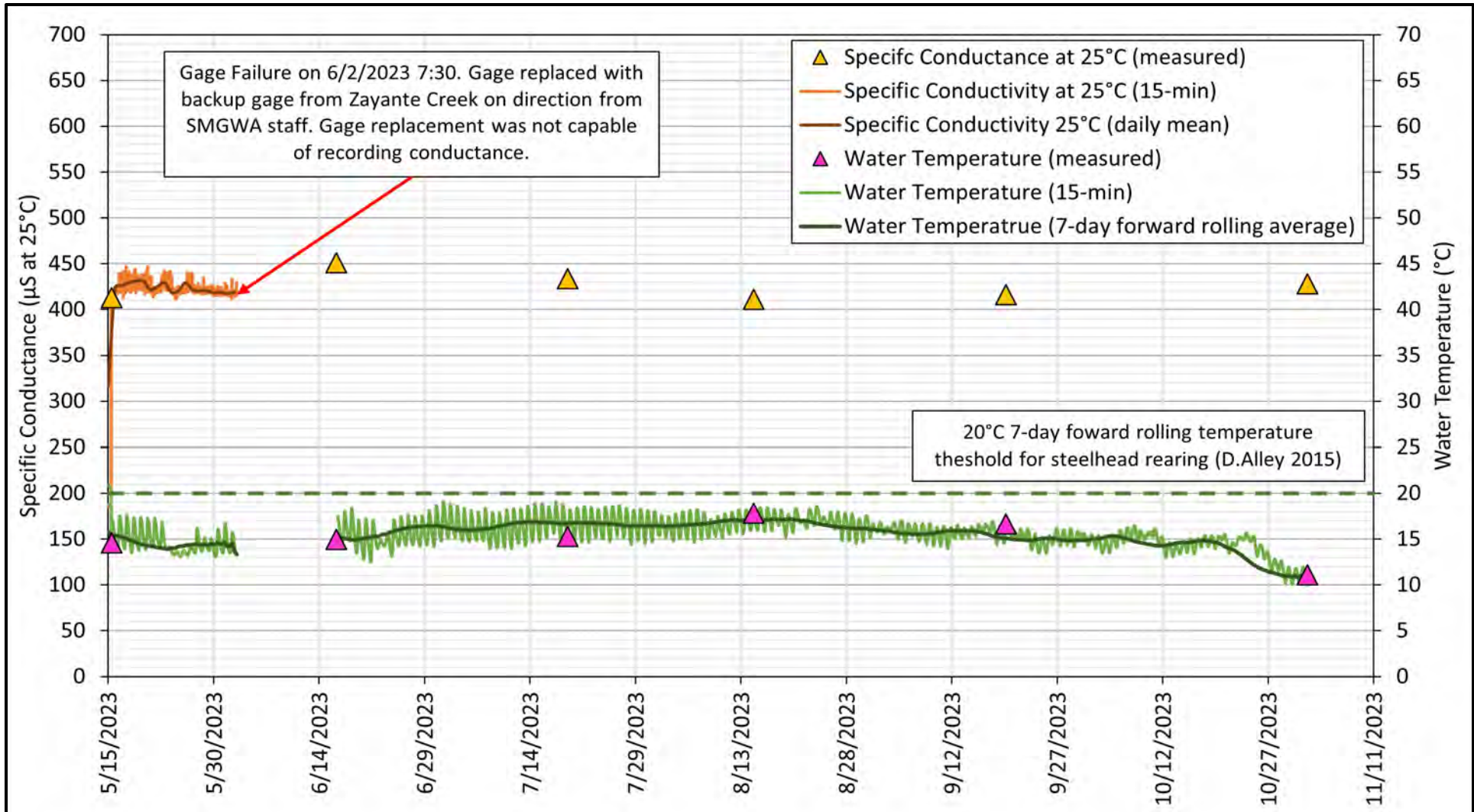
Specific Conductance and Water Temperature at Zayante Creek at Woodwardia Weir

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Figure 8





Notes:

