

Surface Water Discharge Measurements Tech Memo 09-23-2020 to 12-21-2020

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Project: Eel River Groundwater Assessment

Client: Humboldt County, GHD

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Summary

Thomas Gast & Associates Environmental Consultants (TGAEC) collected streamflow and stage measurements at three locations in 2020 in the Eel River Basin. Streamflow was measured manually and with the Acoustic Doppler Current Profiler (ADCP) during three monitoring events. Level loggers were installed to collect continuous stage data at two of the three locations (R-2 and R-5). SHN maintains a level logger at a third site (R-3). This task will support development of the water budget and calibration of the surface water portion of the hydrologic model.

The locations of the streamflow measurements were chosen to best inform the hydrologic modeling. The primary interest will be summer/fall low flow period and transition to the winter wet season. The measurements occurred during the late summer/fall of 2020. Additional loggers and calibration flows will be installed and conducted in 2021. Water level transducers and barometer loggers installed for the 2020 measurement season will remain in operation for the wet season and summer/fall of 2021. Temperature and conductivity are important water quality parameters. Temperature was recorded by the level loggers and TGAEC collected conductivity data at the discharge sites. Conductivity and water temperature can help determine areas of GW inflow to the surface water. This technical memorandum details the measurements and presents the rating curves for the sites R-2 and R-5.

A site reconnaissance trip was conducted by Thomas Gast, Jason Buck (SHN), and Mindi Curran (SHN) on September 9, 2020 during which the calibration flow discharge sites and level logger sites were established.

Monitoring Locations

Level Loggers and Discharge Sites

River stage was continuously monitored throughout the 2020 low flow season using three water level data loggers (Table 1; Figure 1). These devices are combination pressure transducer-data logger. R-3 was installed in 2017 and is maintained by SHN. Two additional HOBO U20-I4 water level loggers and one barometric pressure recorder were installed by TGAEC on the east bank, downstream of the existing device. The barometric pressure recorder provides the necessary compensation data to accurately calculate the depth of water above the in-stream level loggers.

Each of the installed devices continuously measures water level and water temperature at 15-minute intervals. The barometric pressure logger continuously measures atmospheric pressure and air temperature at 15-minute intervals.



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At the time of installation, elevation surveys were conducted to measure the relative elevations of water level loggers, water surfaces, and stage of zero flow (SZF) at each monitoring location, and all associated benchmarks. Subsequently, a CRTN-corrected GNSS Survey Antenna was used to collect true elevations. To ensure the accuracy of stage data, TGAEC downloaded data from R-1 and R-2 and performed elevation surveys of the water surface during each flow measurement site visit.

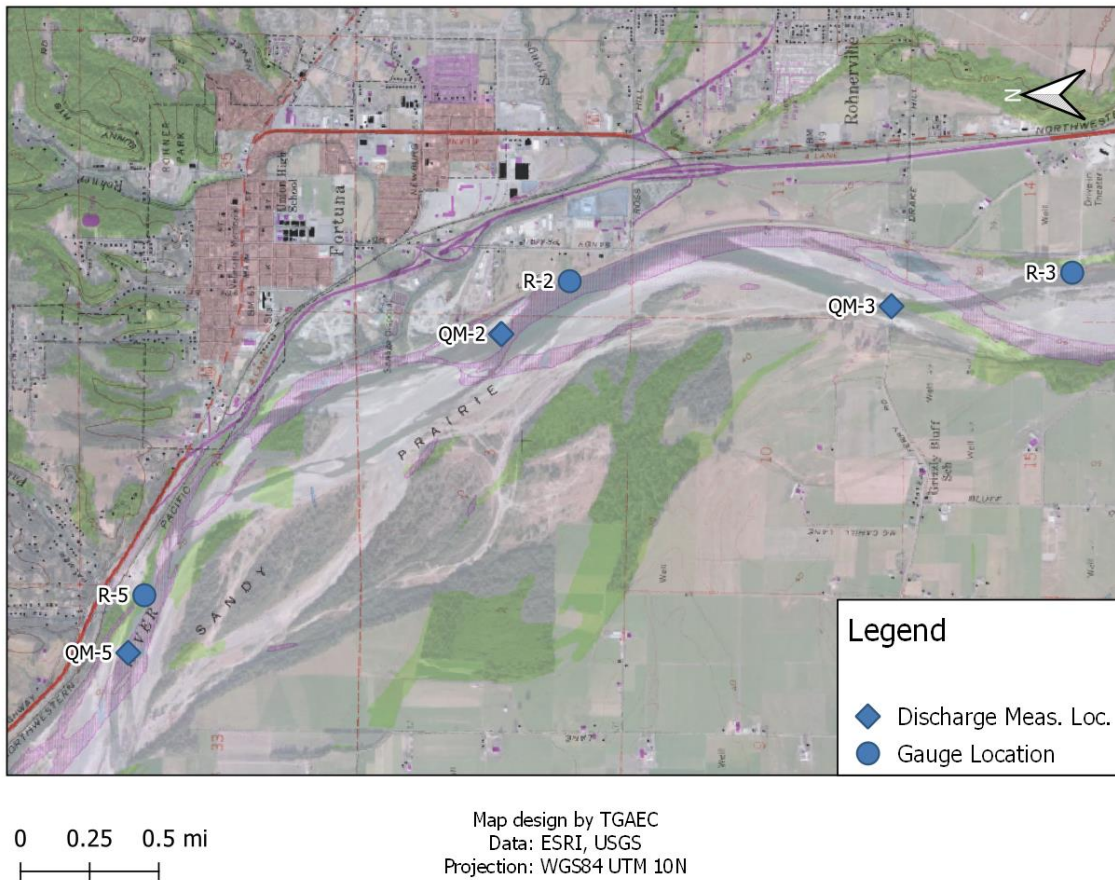


Figure 1. Location map of stream gauges and discharge measurements. Basemap imagery is not representative of streamflow conditions at the time of survey.

Results

Detailed reports of each calibration flow are included in the Attachments. Water quality parameters (temperature, dissolve oxygen, and conductivity) are reported in those field reports.

Calibration Flows

The low and middle calibration flows were measured with calibrated USGS cup style mini or AA current meters. The high flow was measured with a manned vessel and the ADCP. The calibration flows along with concurrent USGS gage readings are tabulated in Table 1. Note that during changing flows that there will be a time difference between the times a flow pulse reaches each location. This is particularly pertinent for the high flow measurement when a sharp flow pulse occurred in the Van Duzen River. The high calibration measurements were taken near the peak of the pulse at those sites; however, the flow was receding at the USGS gage at the same time. The Van Duzen River was disconnected on the surface at the confluence during the low calibration flow.

Table 1. Calibration flows and USGS Gage readings from the same time. Note that flows were changing during the middle and high flows and that there is travel time for water to reach each location.

<i>Discharge Measurement Locations</i>	<i>Time</i>	<i>Measured Discharge (cfs)</i>	<i>USGS Scotia Discharge (cfs)</i> 11477000	<i>USGS Van Duzen Discharge (cfs)</i> 11478500	<i>Sum USGS (cfs)</i>
Low Flow 9/23/2020					
QM-5	12:50	39.4	60.9	6.75	67.65
QM -2	16:20	33.1	60.9	6.75	67.65
Low Flow 9/25/2020					
QM -3	14:20	38.5	60.9	7.21	68.11
Middle Flow 11/16/2020					
QM -5	8:37	139.9	149	32.8	181.8
QM -2	10:37	144.2	147	31.7	178.7
QM -3	14:00	153.4	159	31.7	190.7
High Flow 12/14/2020					
QM -5	11:38	1235.47	623	501	1124
QM -2	12:52	1563.2	650	458	1108
QM -3	13:11	1596.97	657	453	1110

Surveyed Elevations

RTK Survey

TGAEC completed a survey of benchmarks and water surface elevations at each of the gauging sites (Table 2). Each point was measured using a Hemisphere S321 RTK GNSS antenna connected to the California Real Time Network (CRTN), utilizing station P160 at Hydesville. Data for each position was collected using the average value of 300 points recorded over a 5-minute period.



Table 2. Collected positional data from RTK survey

<i>Gauge Site</i>	<i>Meas.</i>	<i>Time</i>	<i>Latitude</i> ¹	<i>Longitude</i> ¹	<i>Elevation (m)</i> ²
R-2	BM1	13:15	40.58073892	-124.1567164	6.44
	BM3	13:07	40.58077255	-124.1565612	12.13
	WS ³	13:23	40.58067829	-124.1566954	5.37
R-3	BM	14:01	40.554774	-124.1553519	16.92
	WS ³	14:09	40.55545276	-124.1559563	7.05
R-5	BM2	10:36	40.60304516	-124.178862	4.66
	WS ³	10:50	40.60302669	-124.1788315	2.83

Notes: ¹ NAD83 horizontal datum, ² NAVD88 vertical datum, ³ water surface

Rating Curves

R-2

The rating equation for R-2 is Equation 1 and Figure 2, where Q is the discharge. The Stage is the water surface elevation (ft) corrected to true elevation and 17.082 is the true elevation of the stage of zero flow (SZF) in feet.

Equation 1. R-2 Rating Equation $Q = 507.124 * (Stage - 17.082)^{1.956}$

The standard error is 0.097% and R Squared is 1.0000.



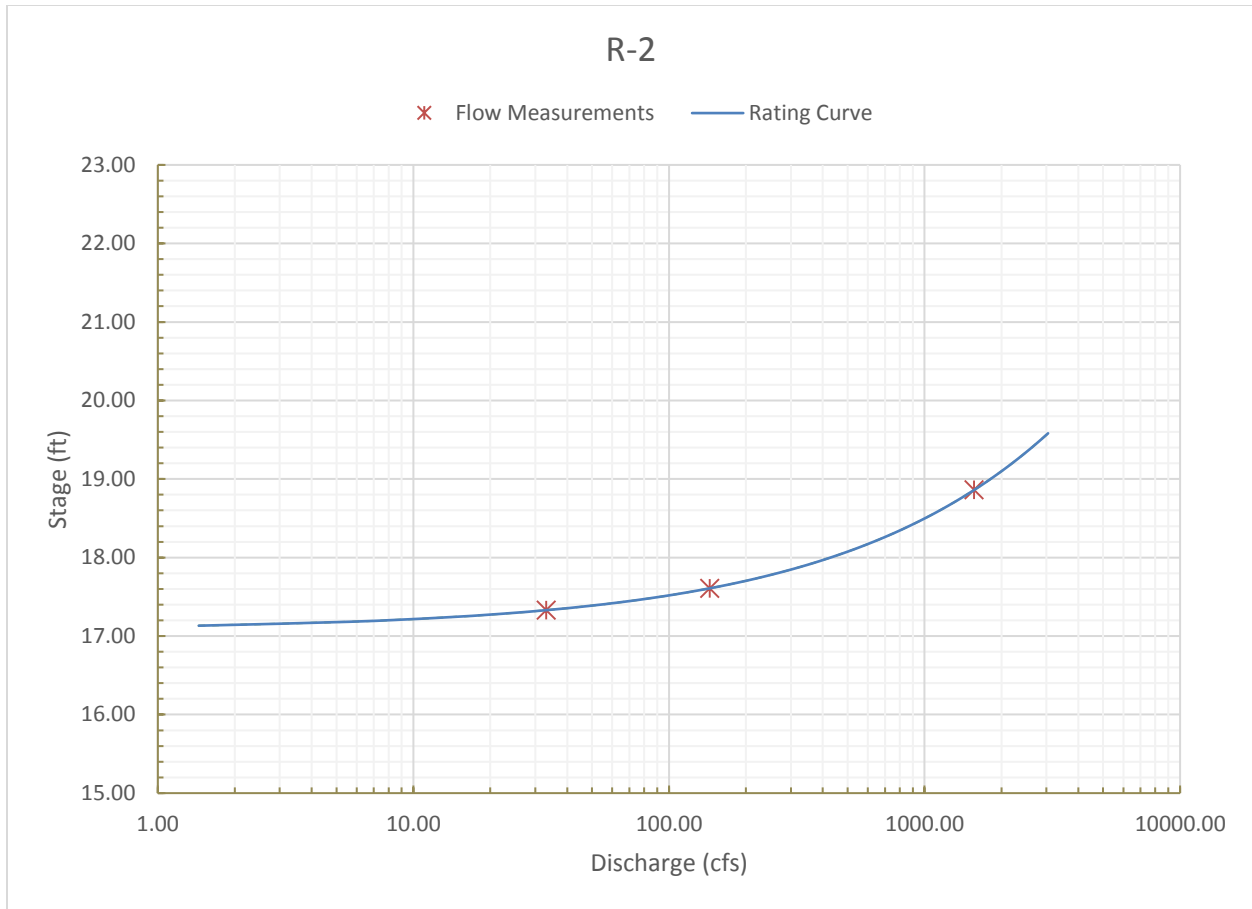


Figure 2. Rating curve for R-2.

The rating curve for R2 will be different above the highest measured flow since a side channel at the hydraulic control became active and will influence the SZF at higher discharge. Normal wintertime movement of the gravel in the channel will require recalibration of the stage/discharge relationship.

R-5

The rating equation for R-5 is Equation 2 and Figure 3, where Q is the discharge. The Stage is the water surface elevation (ft) corrected to true elevation and 8.482 is true elevation of the SZF in feet.

Equation 2. R-5 rating equation. $Q = 221.301 * (Stage - 8.482)^{2.277}$

The standard error is 0.002% and the R Squared is 1.0000.



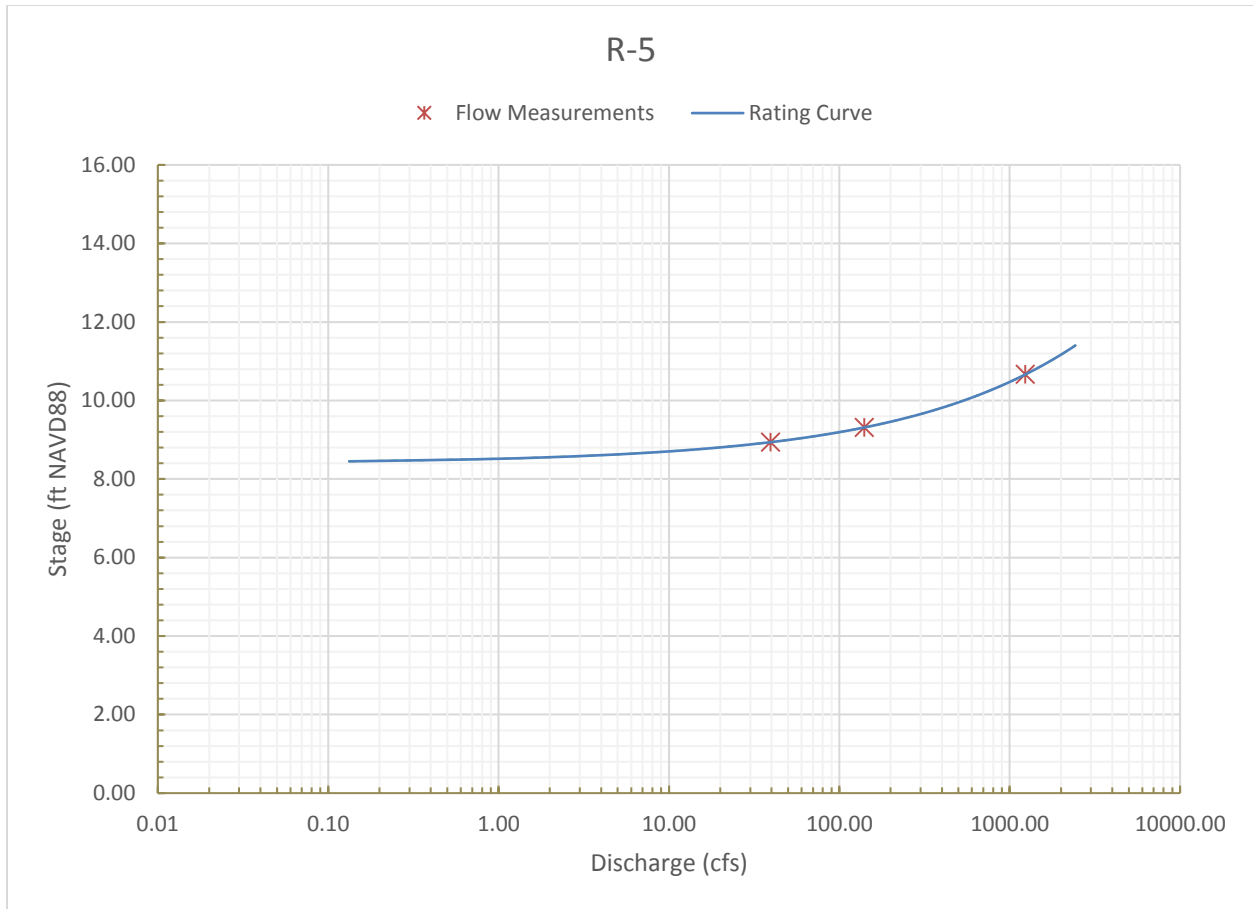


Figure 3. Rating curve for R-5.

The rating curve for R-5 will be better than R-2 at higher flows since there is no opportunity for a side channel to form in the control. The useful high range of this rating curve will be approximately 2.5 times the high calibration flow (approximately 3000 cfs). Normal wintertime movement of the gravel in the channel will require recalibration of the stage/discharge relationship.

Attachment A: Excel file of R-5 Stage and Discharge

Attachment B: Excel file of R-2 Stage and Discharge

Attachment C: Excel file comparing R-2 and R-5

Attachment D: Field Reports of Calibration Flows

**Raw data (Attachments A, B, and C) are available on the Humboldt County Groundwater website:
<https://humboldt.gov.org/2820/Eel-River-Valley-Groundwater-Basin-Resou>**



Surface Water Measurements – Field Report 09-23-2020/09-25-2020

Memo # and Date: 09/28/2020

Project: Eel River Groundwater Assessment

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Summary

Dates: 23 September 2020 and 25 September 2020

Personnel: Tom Gast and Edward Davis

Objectives:

- Installation of two HOBO pressure transducer/data loggers in Eel River
- Installation of one HOBO pressure transducer/data logger as barometer
- Level survey of pressure transducer/data loggers, water surface elevations, and associated benchmarks
- Streamflow measurement at each measurement site
- Conductivity measurements at each measurement site

Gauge Installations

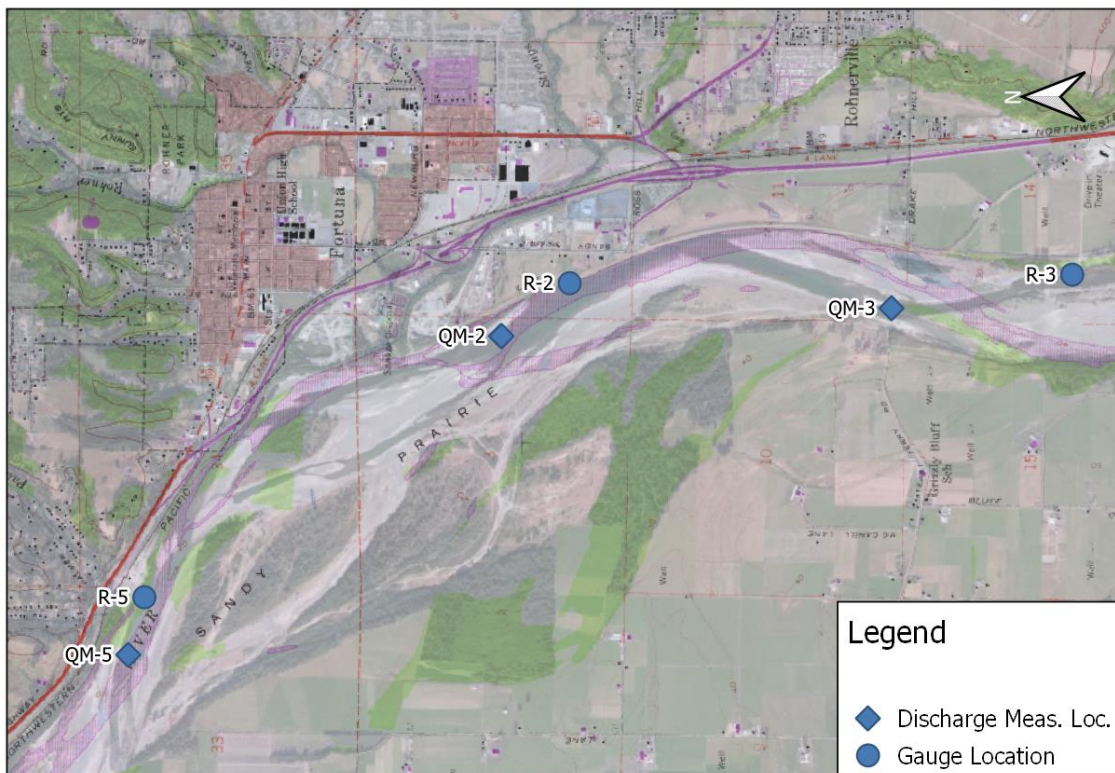


Figure 1. Location map of stream gauges and discharge measurements. Basemap imagery not representative of streamflow conditions at time of survey.

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Two HOBO pressure transducer/data loggers were installed in the Eel River at two gauging sites, R-5 and R-2 (Figure 1; Table 1). The locations of the loggers were determined at a previous site reconnaissance visit on 9 September 2020.

Table 1. Approximate coordinates of gauge installations

Gauge	Latitude	Longitude
R-5	40.6030000	-124.1786917
R-2	40.5807694	-124.1568222

R-5

R-5 is located on the north bank of the river and is accessed through the former gravel plant at the Palmer Boulevard exit on Highway 101 (Figure 3). The device is housed in a PVC housing anchored to a concrete slab with concrete anchor bolts and is camouflaged with paint and vegetation to deter opportunistic vandalism. Three benchmarks were established in this location: a blaze orange spot on a rip-rap slab, the upstream top concrete anchor bolt, and a nail in the base of an alder tree upslope from the gauge.

Table 2. Level survey at R-5

Date: 9/23/2020		Level: TG			
Units: meters		Rod: ED			
STA	BS	FS	HI	EL	Note
BM3	0.091		100.091	100.000	Nail in tree
BM2		1.614		98.477	Spot on concrete slab
BM1		3.090		97.001	Upstream top anchor bolt
PT Bolt		3.918		96.173	
WSEL		3.580		96.511	
Level Loop					
BM2	0.403		98.880	98.477	
BM1		1.879		97.001	
Closure error (m)				0.000	

R-2

R-2 is located on the east bank of the river and is accessed from the Fortuna Riverwalk trail (Figure 8). The device is housed in a PVC housing secured to two tee posts with an additional tee post used as a horizontal reinforcement and is camouflaged with paint and hidden in vegetation to deter vandalism. The pressure transducer/data logger used for barometric



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compensation is located in an alder tree near R-2, above the high-water mark. Three benchmarks were established in this location: the top of the tee-post holding the data logger housing, a blaze orange spot on a rip-rap boulder, and a blaze orange spot on a boulder upslope from the gauge.

Table 3. Level survey at R-2

Date: 9/23/2020			Level: TG		
Units: meters			Rod: ED		
STA	BS	FS	HI	EL	Note
BM1	6.018		106.018	100.000	Boulder spot
BM2		6.022		99.996	Top of fence post
BM3		0.329		105.689	Boulder
PT Bolt		7.400		98.618	
WSEL		7.162		98.856	
Level Loop					
BM3	0.393		106.082	105.689	
BM1		6.071		100.011	
		Closure error (m)		0.011	

Relative elevations of the pressure transducers, water surfaces, and benchmarks were measured using an auto-level and stadia survey (Table 3; Table 2). Future surveying with an RTK device will provide real elevations.

Discharge Measurements

Two discharge measurements were made on 23 September 2020: one below the R-5 gauge at QM-5 (Table 5; Figure 7) and one below the R-2 gauge at QM-2 (Table 6; Figure 12). The measurement at QM-3 (below R-3) was made on 25 September 2020 (Table 7; Figure 13). QM-3 was accessed via East Ferry Road in Fortuna. Velocities at QM-5 and QM-3 were made using a Gurley Mini-type current meter, and velocities at QM-2 were made using a Price AA-type current meter. All velocity calculations were made using the USGS standard rating equations.

River stage was stable for the duration of all three flow measurements. The streamflow measurement at QM-3 was made at a split channel and discharge was calculated as the sum of the flow in the main channel and the flow in side channel.

On 23 September, the streamflow at QM-5 was 39.42 cfs—6.33 cfs more than at QM-2, which had a streamflow of 33.09 cfs. On 25 September, streamflow at QM-3 was 38.50 cfs.



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The nearest USGS stream gage (11477000) is located in Scotia, approximately 7.7 river miles upstream of R-3. On 23 September, the gage reported a discharge of 60.9 cfs (Figure 2). A rain event occurred on 24 September and a CoCoRaHS station located in Fortuna (CA-HM-94) recorded 0.19 in of rainfall. The Scotia gauge did not report a significant increase in streamflow resulting from this event. On 25 September, the Scotia gage reported a streamflow of 60.9 cfs at the time we made a measurement at QM-3.

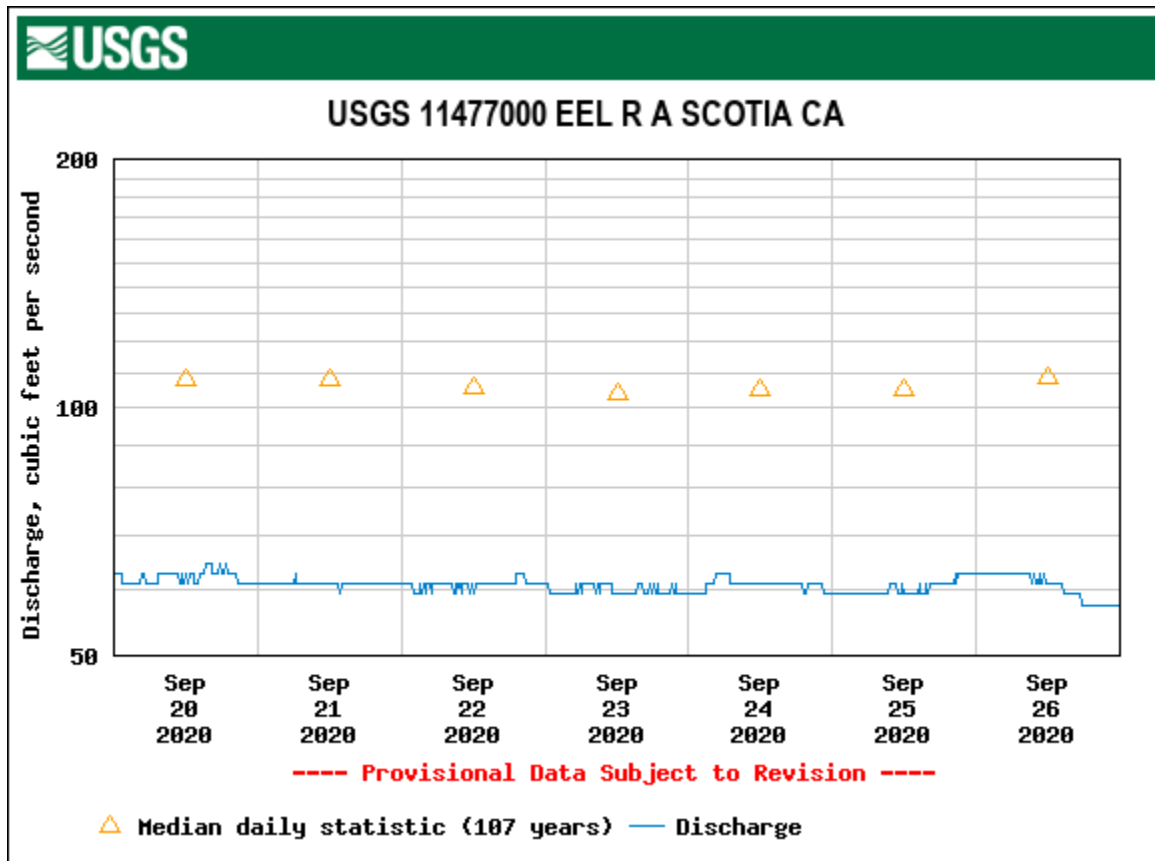


Figure 2. USGS hydrograph for Eel River at Scotia; 20 Sep 2020 – 26 Sep 2020

The most recent field measurement made by USGS at the Scotia gage was on 16 September 2020. Technicians measured a discharge of 57.1 cfs at a stage height of 8.01 ft and rated the quality of the measurement “fair.” Using the current stage-discharge rating, a stage height of 8.01 ft is equivalent to a discharge of 60.9 cfs.

Conductivity Measurements

Water quality measurements, including conductivity, were made at each site on 25 September (Table 4) using a YSI 2030 Pro handheld water quality meter. No significant differences were observed in conductivity between sites. The dissolved oxygen sensor was calibrated twice. The high DO was likely due to algal growth in the river and sunshine. R-5 and R-3 were sampled in

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moving water, while R-2 was in still water at the logger which explains the difference in water temperature.

Table 4. Water quality measurements by site

Parameter	R-5	R-2	R-3
Time	11:00	12:55	14:30
Temperature (deg. C)	21.4	24.2	22.0
Dissolved O2 (mg/L)	11.50	11.91	10.76
Dissolved O2 (% sat.)	130.2	142.1	123.0
Conductivity ($\mu\text{S}/\text{cm}$)	253.9	255.7	252.5
Specific Cond. ($\mu\text{S}/\text{cm}$)	272.6	259.5	268.0

Site Photos

R-5



Figure 3. Gauge in housing at R-5. Additional vegetation was added later for increased camouflage.

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Figure 4. BM1 at R-5: upstream (left) anchor bolt



Figure 5. BM2 at R-5: blaze spot on concrete rip-rap

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Figure 6. BM3 at R-5: nail in base of alder



Figure 7. Streamflow measurement at QM-5

R-2



Figure 8. Gauge in housing at R-2

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Figure 9. Barometric pressure data logger installed in alder tree



Figure 10. BM2 at R-2: blaze spot on boulder



Figure 11. BM3 at R-2: blaze spot on boulder

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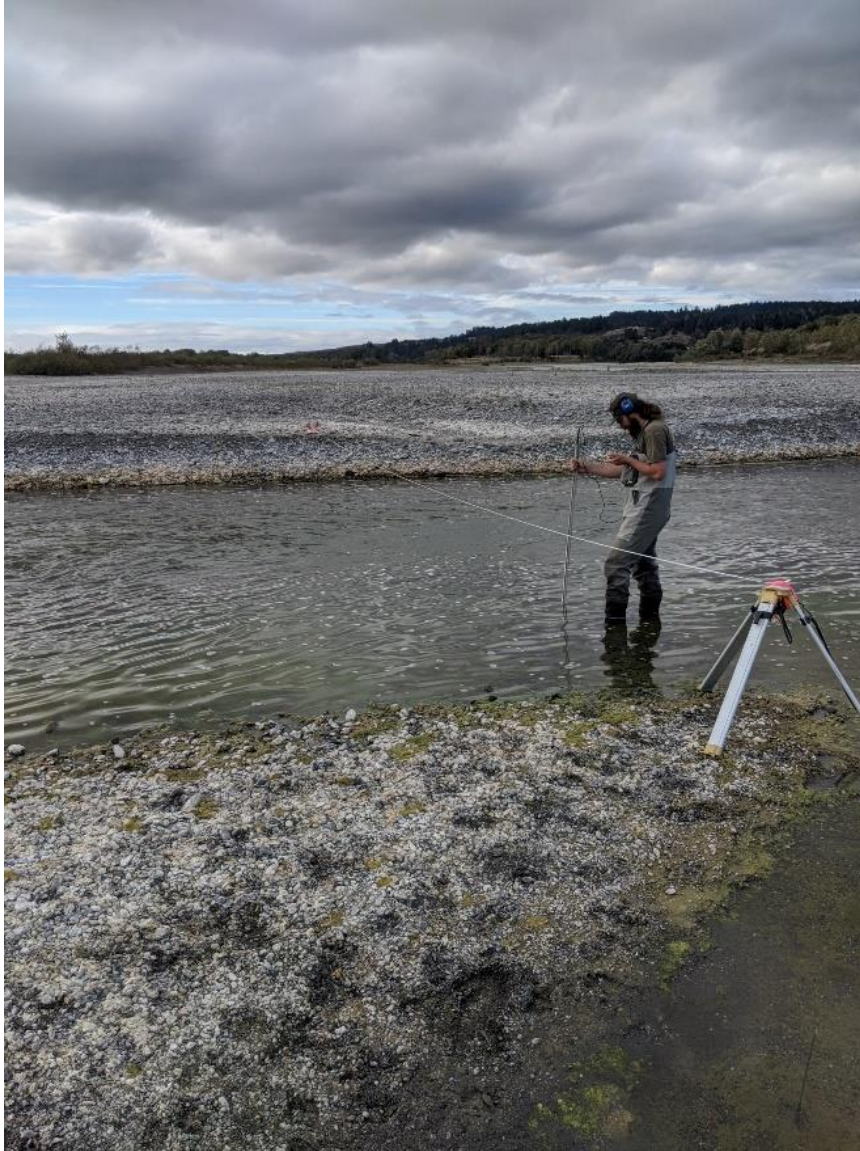


Figure 12. Streamflow measurement at QM-2



R-3



Figure 13. Streamflow measurement at QM-3

Appendix 1

Discharge Measurements

Table 5. Discharge measurement and calculation for R-5

Station	Depth (ft)	Rev.	Time (s)	Velocity (ft/s)	Cell Width (ft)	Q (cfs)
6	WE					
7	0.2	9	43.28	0.231	2.5	0.115
11	0.3	14	41.6	0.354	4	0.425
15	0.35	24	41.47	0.587	4	0.822
19	0.6	34	41.41	0.820	3	1.476
21	0.6	34	40.5	0.837	2	1.005
23	0.65	47	40.72	1.140	2	1.482
25	0.95	47	41.37	1.122	2	2.132
27	1	44	40.47	1.075	2	2.151
29	0.9	49	41.31	1.170	2	2.107
31	0.8	46	40.97	1.110	2	1.775
33	0.8	36	40.63	0.882	2	1.411
35	0.7	36	41.38	0.867	3	1.820
39	0.8	21	41.43	0.518	4	1.658
43	0.65	26	41.38	0.635	4	1.650
47	0.5	33	41.03	0.804	4	1.607
51	0.6	26	41.19	0.637	4	1.530
55	0.75	25	41.31	0.612	4	1.837
59	0.65	37	40.94	0.899	4	2.338
63	0.65	42	42.5	0.980	4	2.549
67	0.65	29	40.63	0.717	4	1.863
71	0.7	32	41.19	0.777	4	2.177
75	0.5	25	42.13	0.601	4	1.202
79	0.5	22	43.57	0.516	4	1.032
83	0.4	24	43.19	0.565	4	0.904
87	0.45	16	40.88	0.407	4	0.733
91	0.3	9	43.5	0.230	4	0.276
95	0.3	11	43.85	0.272	4	0.327
99	0.2	19	48.38	0.408	4	0.327
103	0.2	10	45.72	0.241	4	0.193
107	0.15	20	41.29	0.496	4	0.298
111	0.15	14	43.78	0.338	4	0.203
115	we					
Total Q						39.424



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Table 6. Discharge measurement and calculation for R-2

Station	Depth (ft)	Rev.	Time (s)	Velocity (ft/s)	Cell Width (ft)	Q (cfs)
2	WE					
4	0.2	1.25	43.06	0.082	2	0.033
6	0.4	0.5	40	0.045	2	0.036
8	0.7	1.25	41.24	0.085	2	0.118
10	0.9	1	41.59	0.071	2	0.127
12	1.1	1	40.9	0.072	2	0.158
14	1.3	5	45.8	0.258	1.5	0.504
15	1.4	7	43.06	0.376	1	0.527
16	1.5	13	42.85	0.687	1	1.030
17	1.5	22	41.34	1.191	1	1.787
18	1.6	30	41.3	1.619	1	2.591
19	1.6	35	40.84	1.907	0.75	2.289
19.5	1.7	33	41.5	1.771	0.5	1.505
20	1.8	37	41.16	2.000	0.5	1.800
20.5	1.8	37	41.06	2.005	0.5	1.804
21	1.8	32	41.3	1.726	0.75	2.330
22	1.8	23	40.59	1.267	1	2.281
23	1.8	20	42.44	1.057	1	1.902
24	1.8	20	42.87	1.046	1	1.884
25	1.7	20	41.47	1.081	1	1.838
26	1.55	21	42.06	1.119	1	1.734
27	1.55	20	42.37	1.059	1	1.641
28	1.45	18	40.69	0.993	1	1.440
29	1.3	18	43	0.941	1	1.223
30	1.2	18	42.53	0.951	1	1.141
31	1.1	11	44.19	0.567	1	0.623
32	0.9	8	41.7	0.441	1	0.397
33	0.6	8	48.1	0.385	1	0.231
34	0.4	4	40.88	0.234	1.25	0.117
35.5	WE					
Total Q						33.090



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Table 7. Discharge measurement and calculation for R-3

Station	Depth (ft)	Rev.	Time (s)	Velocity (ft/s)	Cell Width (ft)	Q (cfs)
Main Channel						
4.5	WE					
6	0.4	2	43.28	0.076	1.75	0.053
8	0.7	11	41.72	0.284	2	0.398
10	1	10	41.75	0.261	2	0.522
12	1.1	11	43.57	0.274	2	0.602
14	1.15	18	42.5	0.438	2	1.007
16	1.25	17	42.13	0.419	2	1.047
18	1.3	21	41.97	0.512	2	1.331
20	1.45	19	42.7	0.459	2	1.330
22	1.5	21	41.44	0.518	2	1.554
24	1.5	23	41.8	0.560	2	1.679
26	1.6	25	42.13	0.601	2	1.924
28	1.6	24	40.4	0.602	2	1.926
30	1.6	28	42.4	0.665	2	2.129
32	1.7	27	42.15	0.646	2	2.198
34	1.7	27	42.38	0.643	2	2.186
36	1.65	30	40.6	0.741	2	2.445
38	1.6	32	42.15	0.760	2	2.433
40	1.6	29	43.25	0.675	2	2.161
42	1.55	28	40.97	0.688	2	2.131
44	1.6	23	42.97	0.545	2	1.745
46	1.6	23	42	0.557	2	1.783
48	1.5	16	43.02	0.388	2	1.165
50	0.85	11	42.3	0.281	3	0.716
54	0.7	8	44.97	0.202	4	0.566
58	0.6	7	43.05	0.187	4	0.450
62	0.9	2.5	45.09	0.084	4	0.304
66	0.85	0.75	41.87	0.048	4	0.165
70	0.3	0.75	41.87	0.048	4	0.058
74	0.85	0.75	41.87	0.048	5	0.206
80	0.8	0.75	41.87	0.048	6	0.232
86	0.5	0.01	40	0.031	7	0.110
94	0.4	5	44.59	0.139	5	0.278
96	0.5	12	41.38	0.310	2	0.310
98	0.3	13	41.19	0.334	2	0.201
100	0.4	4	43.6	0.119	2	0.095



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102	0.45	3	48.65	0.090	2	0.081
104	0.5	5	52.75	0.122	1.625	0.099
105.25	WE					
				Main Channel Q		37.619
Side Channel						
5.25						
6	0.4	15	41.12	0.38	0.875	0.134
7	0.4	27	40.69	0.67	1	0.267
8	0.4	21	40.46	0.53	1	0.212
9	0.3	18	40.89	0.45	1	0.136
10	0.25	7	43.09	0.19	1	0.047
11	0.2	17	40.6	0.43	1	0.087
12	WE					
				Side Channel Q		0.882
Total Q (cfs)						38.501



Surface Water Measurements – Field Report 11/16/2020

Memo # and Date: 12/4/2020

Project: Eel River Groundwater Assessment

Client: Humboldt County, GHD

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Summary

Dates: 16 November 2020

Personnel: Tom Gast and Edward Davis

Objectives:

- Streamflow measurement at each measurement site
- Conductivity measurements at each measurement site
- RTK survey of benchmarks and water surface elevations
- Download data loggers at R-5 and R-2

Discharge Measurements

Discharge measurements were made below each gauging location on 16 November 2020 (Table 1; Figures 3, 4, 6). Velocities were measured using a Price AA-type current meter and the USGS standard rating equation. River stage at each location was stable for the duration of the measurement, but the stage in Eel River rose slowly throughout the day.

Table 1. Eel River discharge on 16 November 2020

<i>Gauge Site</i>	<i>Time</i>	<i>Measured Discharge (cfs)</i>	<i>USGS Scotia Discharge (cfs)</i>
R-5	8:37	139.9	149
R-2	10:37	144.2	147
R-3	14:00	153.4	159

The nearest USGS stream gage (11477000) is located in Scotia, approximately 7.7 river miles upstream of R-3 (Figure 1). Measured discharge at R-2 and R-3 do not vary greatly from the reported values from the Scotia gauge (Table 1). Discharge at R-5 varied by a greater amount (9.1 cfs), but this may be explained by its greater distance from the USGS gauge.



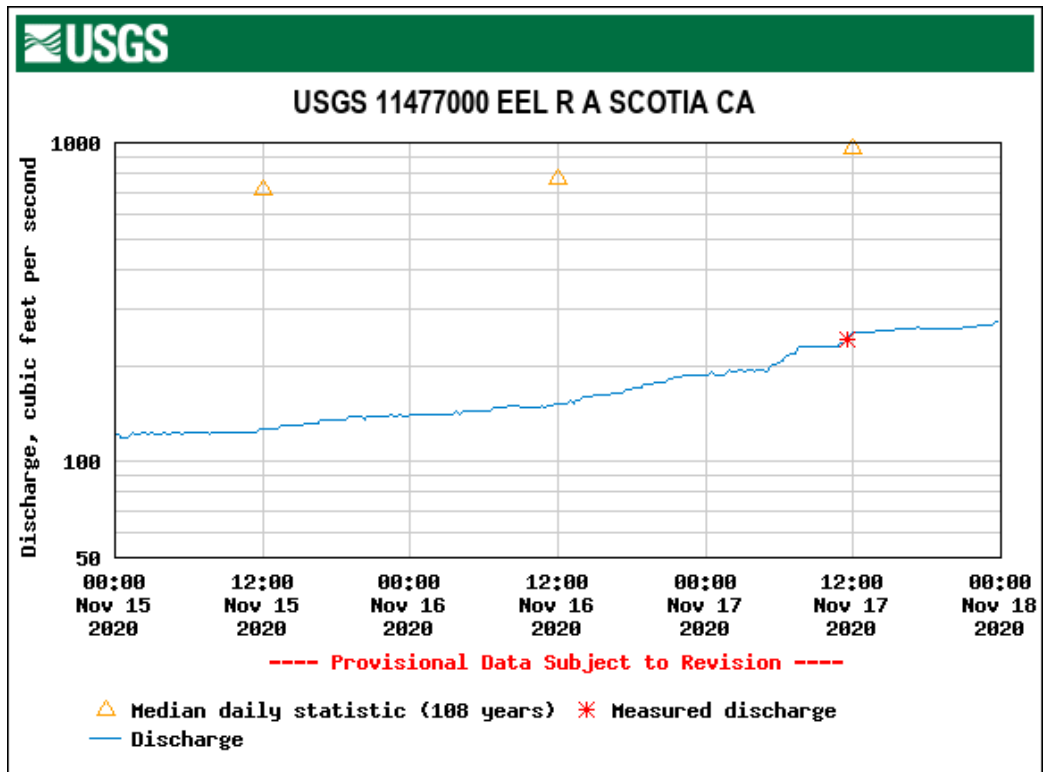


Figure 1. USGS hydrograph for Eel River at Scotia; 15 Nov 2020 – 17 Nov 2020

Conductivity Measurements

Water quality measurements, including conductivity, were made at each site on 16 November (Table 2) using a YSI 2030 Pro handheld water quality meter. No significant differences were observed in conductivity between sites. The dissolved oxygen sensor was calibrated prior to measurement. The high DO was likely due to algal growth in the river and sunshine. All water quality data was collected in fast moving water.

Table 2. Water quality measurements by site

Parameter	R-5	R-2	R-3
Time	09:30	11:40	15:00
Temperature (deg. C)	13.2	14.0	14.2
Dissolved O2 (mg/L)	10.41	10.97	11.7
Dissolved O2 (% sat.)	99.3	106.4	114.1
Conductivity (µS/cm)	225.2	230.4	229.5
Specific Cond. (µS/cm)	290.7	291.1	289.1

RTK Survey

TGAEC completed a survey of benchmarks and water surface elevations at each of the gauging sites (Table 3). Each point was measured using a Hemisphere S321 RTK GNSS antenna connected to the California Real Time Network (CRTN), utilizing station P160 at Hydesville. Data for each position was collected using the average value of 300 points recorded over a 5-minute period.

Table 3. Collected positional data from RTK survey

<i>Gauge Site</i>	<i>Meas.</i>	<i>Time</i>	<i>Latitude</i> ¹	<i>Longitude</i> ¹	<i>Elevation (m)</i> ²
R-2	BM1	13:15	40.58073892	-124.1567164	6.839
	BM3	13:07	40.58077255	-124.1565612	12.529
	WS ³	13:23	40.58067829	-124.1566954	5.775
R-3	BM	14:01	40.554774	-124.1553519	17.318
	WS ³	14:09	40.55545276	-124.1559563	7.452
R-5	BM2	10:36	40.60304516	-124.178862	5.065
	WS ³	10:50	40.60302669	-124.1788315	3.236

Notes: ¹ NAD83 horizontal datum, ² NAVD88 vertical datum, ³ water surface

Preliminary Stage Data

RTK surveyed water surface elevations were paired with stage data downloaded from the installed HOBO data loggers to calculate a time series of water surface elevations at each gauging site. To compare values between sites, elevations were normalized by subtracting the minimum value at each gauge from all values at that gauge so that the minimum value is set to zero (Figure 2).

The river stage shows some diurnal variation, which is more pronounced prior to 15 October. Small diurnal variations are seen throughout the record—generally ± 1 cm each day. Over the entire record, the difference between the smallest and largest stage values is 9.7 cm at R-2 and 13.1 cm at R-5.

Values at R-5 were examined for potential tidal influence. Stage values from the USGS gauge at Fernbridge were converted to NAVD88 elevations and compared to water elevation values at R-5. During the king tides of 15-16 November 2020, river stage at Fernbridge remained approx. 0.75 meters below the elevations at R-5, suggesting that the gauging site is free of tidal influence.

Field Report – Eel River SW Measurements

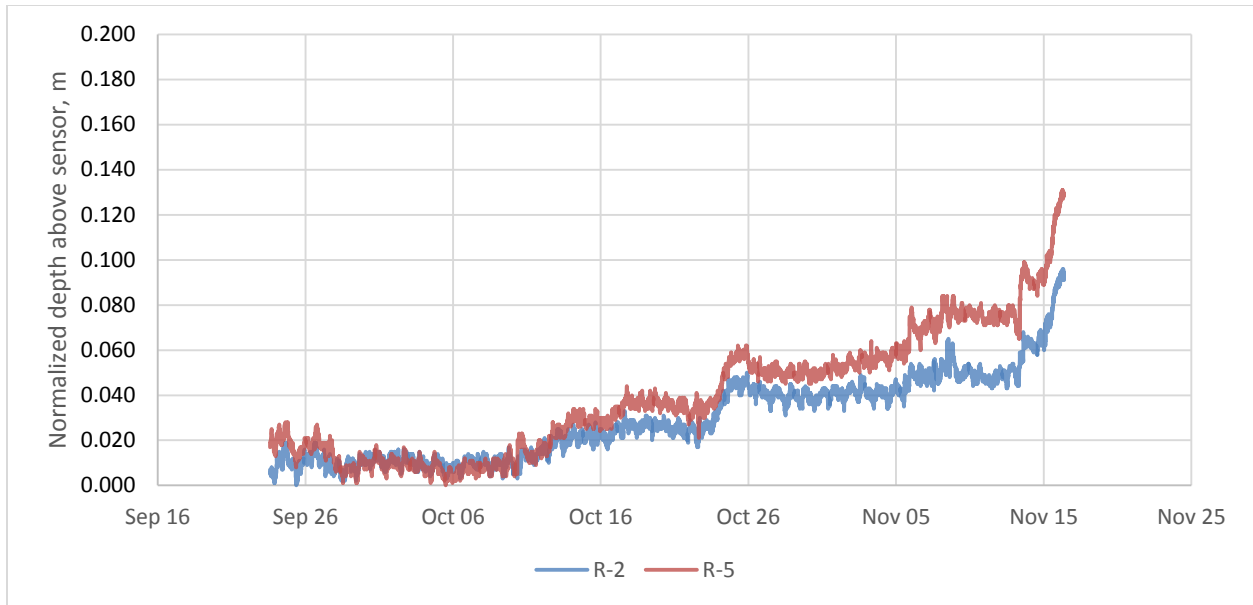


Figure 2. Normalized stage data at R-2 and R-5 from 23 Sep 2020 - 16 Nov 2020

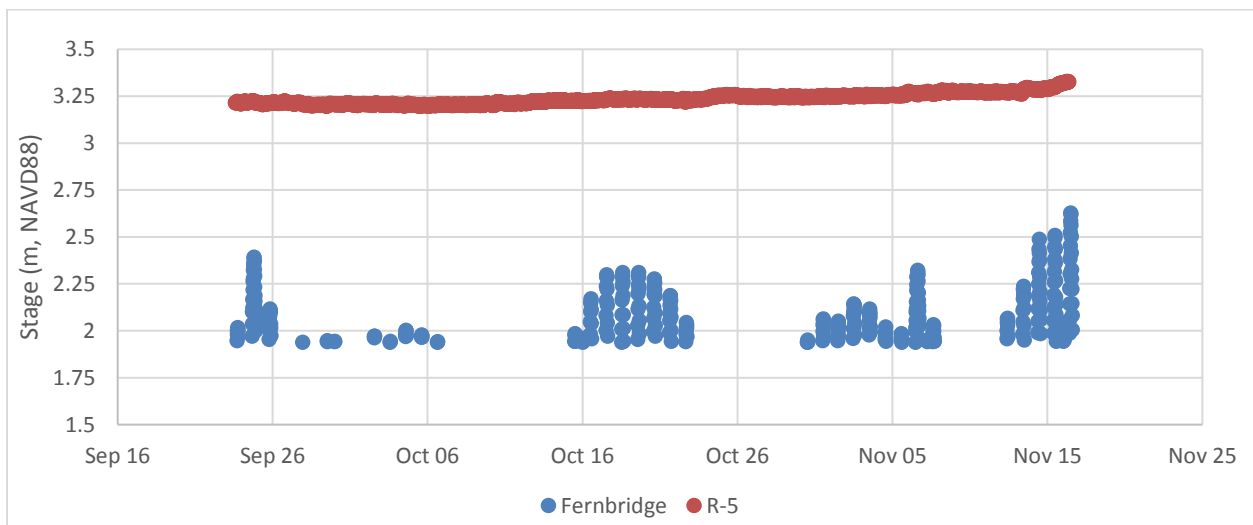


Figure 3. Stage data from Fernbridge (USGS 11479560) converted to NAVD88 elevations



Site Photos



Figure 4. Discharge measurement below R-5

Field Report – Eel River SW Measurements



Figure 5. Discharge measurement below R-2



Figure 6. RTK survey of water surface elevation at R-2

Field Report – Eel River SW Measurements



Figure 7. Discharge measurement below R-3

Surface Water Measurements – Field Report 12/14/2020

Memo # and Date: 12/16/2020

Project: Eel River Groundwater Assessment

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Summary

Dates: 16 December 2020

Personnel: Tom Gast and Edward Davis

Objectives:

- Streamflow measurement at each measurement site
- Conductivity measurements at each measurement site
- Download data loggers at R-5 and R-2

Discharge Measurements

Discharge measurements were made below each gauging location on 14 December 2020 (Table 1). Measurements were made with a TRDI RiverPro ADCP mounted to a boat. River stage was unstable and rose rapidly over the course of the day.

Table 1. Eel River discharge on 14 December 2020

<i>Gauge Site</i>	<i>Time</i>	<i>Measured Discharge (cfs)</i>	<i>USGS Scotia Discharge (cfs)</i>	<i>USGS Van Duzen Discharge (cfs)</i>	<i>Sum USGS (cfs)</i>
R-5	11:38	1235.47	623	501	1124
R-2	12:52	1563.20	650	458	1108
R-3	13:11	1596.97	657	453	1110

The nearest USGS stream gage (11477000) is located in Scotia, approximately 7.7 river miles upstream of R-3 (Figure 1). Measured discharge at all 3 locations are greater than the sum of the reported discharge from USGS. The USGS stream gage on the Van Duzen River (11478500) is located upstream from Yager Creek, which may explain some of the difference in the measured and reported discharges (Figure 2).



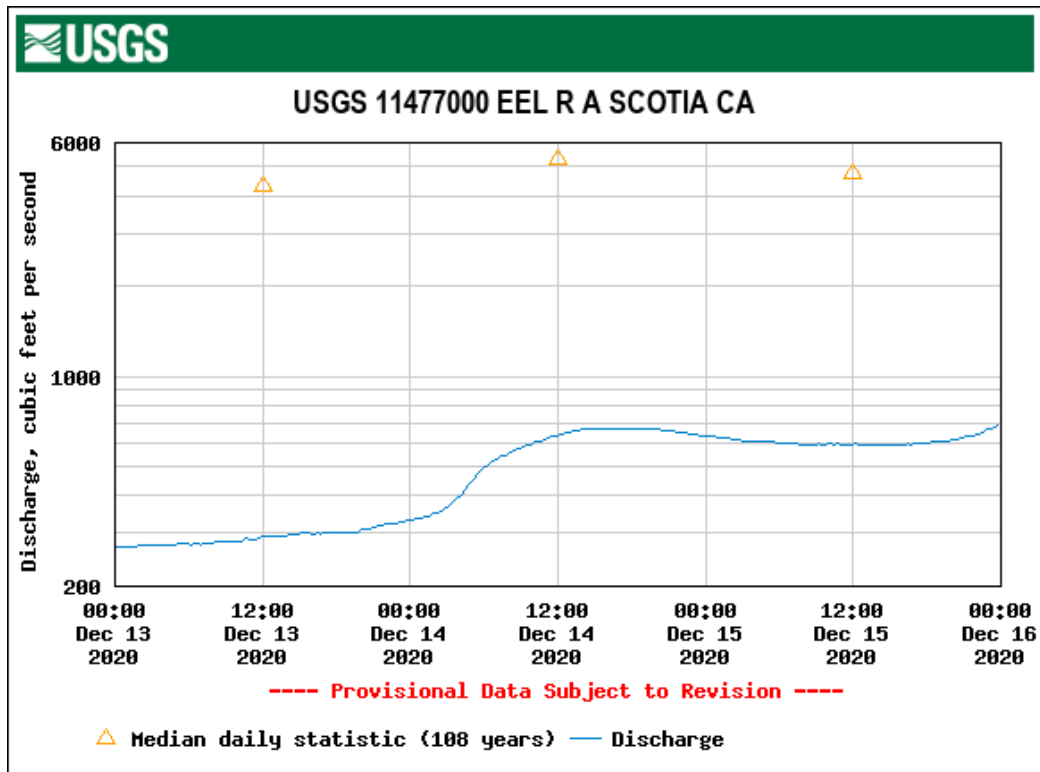


Figure 1. USGS hydrograph for Eel River at Scotia; 13 Dec 2020 – 16 Dec 2020

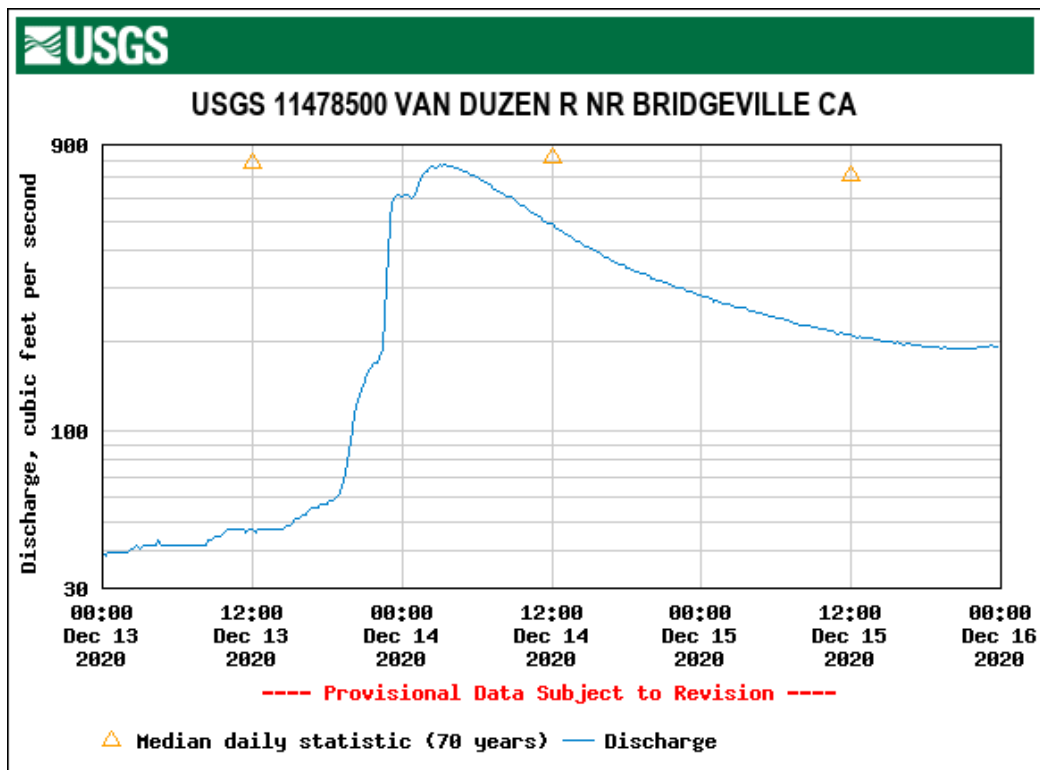


Figure 2. USGS hydrograph for Van Duzen River near Bridgeville; 13 Dec 2020 – 16 Dec 2020

Conductivity Measurements

Water quality measurements, including conductivity, were made at each site on 14 December (Table 2) using a YSI 2030 Pro handheld water quality meter. No significant differences were observed in conductivity between sites. The dissolved oxygen sensor was calibrated prior to measurement. The high DO was likely due to algal growth in the river and sunshine. All water quality data was collected in fast moving water.

Table 2. Water quality measurements by site

Parameter	R-5	R-2	R-3
Time	09:45	12:15	
Temperature (deg. C)	10.2	9.9	
Dissolved O2 (mg/L)	12.11	12.21	DATA
Dissolved O2 (% sat.)	107.9	107.9	MISSING
Conductivity ($\mu\text{S}/\text{cm}$)	212.2	198.1	
Specific Cond. ($\mu\text{S}/\text{cm}$)	296.0	278.6	

