Annual Report for Monitoring of Suspended Sediment Concentrations and Turbidity During the 2024 Water Year in McCloud Creek, Humboldt County, California

Pursuant to:
Monitoring and Reporting Program (MRP)
Order No. R1-2020-0001

Submitted:
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Prepared By:

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1.0 Introduction

Elk River is listed as an impaired water body under Section 303(d) of the Federal Clean Water Act (USEPA, 1999) due to high instream sediment loads and associated adverse impacts to the beneficial uses of water. In response to this, the North Coast Regional Water Quality Control Board (NCRWQCB) developed a Total Maximum Daily Load (TMDL) for sediment in Elk River. In May 2016 the NCRWQCB adopted the Action Plan for the Upper Elk River Sediment TMDL as an amendment to the Water Quality Control Plan for the North Coast. The TMDL Action Plan was approved by the State Water Resources Control Board in August 2017, the Office of Administrative Law in March 2018, and the US Environmental Protection Agency in April 2018.

To address the Elk River sediment impairment, the NCRWQCB has adopted and revised multiple Waste Discharge Requirements (WDRs) with Green Diamond Resource Company (GDRCo) over the years. These Orders have included Monitoring and Reporting Programs (MRPs), that include the monitoring activities that GDRCo has been conducting in Elk River beginning in 2006. The current Order (R1-2020-0001) supersedes those portions of GDRCo's Forest Management WDR (Order R1-2012-0087) that apply to certain activities conducted by GDRCo on our timberlands in the Upper Elk River Watershed.

As part of the MRP in Order No. R1-2020-0001, GDRCo has agreed to continue to conduct water-quality trend monitoring in McCloud Creek, a tributary of SF Elk River. Using Turbidity Threshold Sampling (TTS), GDRCo measured stage, water velocity, turbidity and suspended sediment concentrations in McCloud Creek during the 2024 water year (WY). This annual report covers the period from October 1, 2023 to July 1, 2024, during which TTS monitoring occurred.

2.0 Data Collection and Analysis Activities

Data collection and analysis have been conducted as outlined in the MRP (Order No. R1-2020-0001), Standard Operating Procedures, and the Turbidity Threshold Sampling Quality Assurance Project Plan for McCloud Creek. See this document for further details on the monitoring parameters, protocols, and frequencies.

2.1 Station Installation and/or Adjustments

Equipment was installed on September 22, 2023 at the McCloud Creek TTS station for the 2024 WY. The surface hydrology was disconnected at this time and the monitoring unit was an isolated pool. The station was turned online beginning September 28th when continuous flow was observed, at which time stage and turbidity were monitored and the station remained online for the remainder of the water year.

2.2 Continuous Measurement Station

The 2024 WY concluded the 18th year of monitoring at the McCloud Creek TTS station. The TTS station was established in McCloud Creek in 2007 on BLM property, approximately 400 feet upstream from the confluence with SF Elk River (Figure 1). The watershed area above the McCloud TTS monitoring site is approximately 1,482 acres (6.0 km^2). The specifications for the construction and operation of the TTS station are based on procedures developed by the United States Forest Service Redwood Science Laboratory (Lewis and Eads, 2008). The station automatically records stage height and turbidity at 10-minute intervals and collects and stores automated grab samples of creek water, which are later transported to the lab and analyzed to quantify turbidity and suspended sediment concentration. Table 1 displays all the parameters and frequency of measurements collected at the McCloud Creek TTS station.

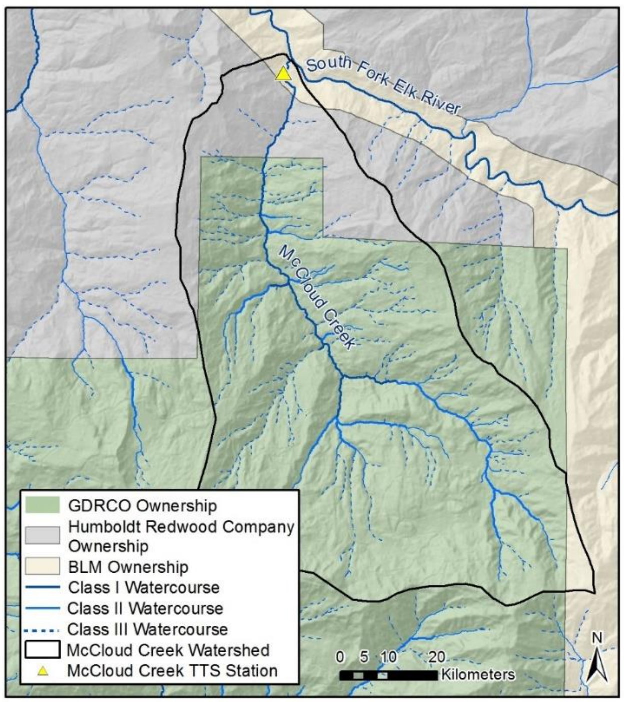

Figure 1. Location of the McCloud Creek TTS station and the extent of the watershed being monitored.

Table 1. McCloud Creek TTS station parameters and specifications.

Parameter	Units	Sampling Method	Sampling Frequency
Turbidity	FNU	DTS-12 (turbidimeter, *in situ* measurement)	Continuous (10-minute interval)
Turbidity	NTRU	Manual grab sample, ISCO water sampler	When FNU $\geq$ 30 during visit
Suspended sediment	mg/L	Manual grab sample, ISCO water sampler	When FNU $\geq$ 30 during visit
Suspended sediment	mg/L	Automated grab sample, ISCO water sampler	Event driven, based on turbidity thresholds
Discharge	CFS	Direct measurement	Weekly[1] and as needed for stage-discharge relationship
Stage	ft	Druck (pressure transducer, *in situ* measurement)	Continuous (10-minute interval)
Stage	ft	Stage plate	Weekly and when present for stream flow measurements

[1] May vary due to low-flow conditions where velocity is below minimum required for current meters.

2.2.1 Field Visits – Summary of Logs

A total of 53 field visits (about one or more times a week) were conducted during the 2024 WY. Visits were conducted to exchange sample bottles and batteries, download data, take streamflow measurements, or perform other storm-related maintenance activities. A summary of the activities conducted during the 2024 WY is provided in Table 2.

Table 2. Summary of field activities at the McCloud Creek TTS station during the 2024 WY. *Type: SI = Site installation, MO = Monitoring (flow measurements, and grab samples), MA = Maintenance (sensor cleanings and site adjustments), G/C = grab and control sample collected.

Date	Type*	Comments
9/22/2023	SI	Monitoring equipment installed, station offline due to hydrologically disconnected monitoring unit
9/28/2023	SI, MO	Station online for stage and turbidity, monitoring unit hydrologically connected
10/2/2023	MO	Discharge not measured, G/C
10/10/2023	MO/MA	Discharge not measured, adjusted DTS
10/17/2023	MO/MA	Measured discharge, Desiccant change, High-water stage plate adjustment
10/27/2023	MO	Measured discharge
10/31/2023	MO/MA	Adjusted DTS, Re-calculated stage offset.
11/6/2023	MO/MA	Measured discharge, G/C, raised DTS
11/9/2023	MO/MA	Measured discharge, adjusted DTS
11/14/2023	MO/MA	Measured discharge, lowered DTS, Desiccant change
11/22/2023	MO/MA	Measured discharge, lowered DTS
12/1/2023	MO/MA	Measured discharge
12/4/2023	MO/MA	Measured discharge, G/C, adjusted DTS
12/7/2023	MO/MA	Measured discharge, G/C, adjusted DTS
12/13/2023	MO/MA	Measured discharge, adjusted DTS, Desiccant change
12/19/2023	MO/MA	Measured discharge, G/C, adjusted DTS
12/21/2023	MO/MA	G/C, adjusted DTS
12/28/2023	MO/MA	Measured discharge, adjusted DTS
1/3/2024	MO/MA	Measured discharge, adjusted DTS
1/9/2024	MO/MA	Measured discharge, adjusted DTS
1/11/2024	MO/MA	Measured discharge, adjusted DTS
1/13/2024	MO/MA	Measured discharge, adjusted DTS
1/17/2024	MO/MA	Measured discharge, adjusted DTS, G/C, adjusted DRUCK
1/22/2024	MO/MA	Measured discharge, adjusted DTS, Desiccant change
1/30/2024	MO	Measured discharge
2/1/2024	MO	Measured discharge
2/7/2024	MO	Measured discharge
2/15/2024	MO/MA	Measured discharge, adjusted DTS, Desiccant change
2/20/2024	MO/MA	Measured discharge, replaced wiper on DTS
3/1/2024	MO/MA	Adjusted DTS, G/C
3/5/2024	MO/MA	Measured discharge, G/C, adjusted DTS
3/7/2024	MO/MA	Measured discharge, G/C, adjusted DTS
3/12/2024	MO/MA	Measured discharge, adjusted DTS, replaced ISCO pump tubing
3/20/2024	MO/MA	Measured discharge, adjusted ISCO tubing
3/25/2024	MO/MA	Measured discharge, adjusted DTS, Desiccant change
3/26/2024	MO, MA	Did not measure discharge, adjusted DTS
3/29/2024	MO, MA	Measured discharge, adjusted DTS
4/4/2024	MO, MA	Measured discharge, adjusted DTS
4/9/2024	MO	Measured discharge
4/17/2024	MO	Measured discharge
4/23/2024	MO/MA	Measured discharge, Desiccant change
4/30/2024	MO	Measured discharge
5/7/2024	MO	Measured discharge
5/15/2024	MO/MA	Measured discharge, adjusted DTS
5/22/2024	MO	Measured discharge
5/29/2024	MO	Measured discharge
6/5/2024	MO	Measured discharge
6/12/2024	MO/MA	Measured discharge, desiccant change
6/17/2024	MO	Measured discharge
6/26/2024	MO	Measured discharge
7/2/2024	MO	Site Uninstall, monitoring equipment removed for cleaning and calibration. End of 2024 water year.

2.2.2 Site Observations

A summary of site observations was compiled for the 2024 WY (Table 3). These site visit observations included notable items relating to the station status and site conditions. Observations for this WY included station status, hydrologic conditions and discharge measurement quality.

Table 3. Summary of station observations collected at the McCloud Creek TTS station during the 2024 WY.

Start Date	End Date	Comment	Initials
09/22/23	09/28/23	Monitoring unit is an isolated pool and hydrologically disconnected. Station offline.	RCH/MRR
09/28/23	07/02/24	Monitoring unit hydrologically connected after rainfall event. Station is fully online for stage and turbidity	MRR
10/31/23	11/06/23	Station is hydrologically connected but streamflow is too low to obtain a discharge measurement.	ERM
11/09/23		Discharge measurement had two verticals >10% of total flow; graded as fair data in TTS.	SRB
11/14/23		Discharge had two verticals >10% of total flow: graded as poor data in TTS.	ERM
11/22/23		Discharge had four verticals >10% of total flow: graded as poor data in TTS.	ERM
12/04/23		Discharge measurement had one vertical >10% of total flow; graded as good data in TTS.	SRB
12/07/23		Discharge measurement had one vertical >10% of total flow; graded as good data in TTS.	SRB
01/03/24		Discharge measurements had two verticals >10% of total flow: graded as good data in TTS.	ERM
01/13/24		Measured discharge using highwater cables twice.	ERM
01/22/24		Datalogger pelican case desiccant requires replacement.	MRR
01/22/24		Discharge measurement had one vertical >10% of total flow; graded as good data in TTS.	MRR
01/30/24		Discharge measured approximately (6 feet) downstream of normal cross-section due to log washing down and being deposited on right bank causing water in our low water cross section to go around and under log.	ERM
01/30/24		Discharge measurement had one vertical >10% of total flow; graded as good data in TTS.	ERM
02/15/24		Datalogger pelican case desiccant requires replacement.	RCH
03/05/24		Discharge measurement had 4 verticals >10% of total flow; graded as fair data in TTS.	SRB
03/25/24		Discharge measurement had one verticals >10% of total flow; graded as good data in TTS. Only measured 16 verticals due to time.	ERM
03/26/24		Triggered a manual sample using the flag #3 for DD#30.	MRR
04/09/24		Discharge measurement had 4 verticals >10% of total flow; graded as fair data in TTS.	SRB
04/17/24		Discharge measurement had 3 verticals >10% of total flow; graded as fair data in TTS.	RCH
04/23/24		Datalogger pelican case desiccant requires replacement.	RCH
04/23/24		Discharge measurement had 3 verticals >10% of total flow; graded as fair data in TTS.	RCH
04/30/24		Discharge measurement had 1 vertical >10% of total flow; graded as good data in TTS.	RCH
05/15/24		Discharge measurement had 3 verticals >10% of total flow; graded as fair data in TTS.	RCH
05/22/24		Discharge measurement had 4 verticals >10% of total flow; graded as fair data in TTS.	RCH
05/29/24		Discharge measurement had all verticals with low velocity (<0.25 cfs), graded as fair.	MRR
06/05/24		Discharge measurement had 4 verticals >10% of total flow; graded as fair data in TTS.	RCH
06/12/24		Discharge measurement had 3 verticals >10% of total flow; graded as fair data in TTS.	RCH
06/12/24		Datalogger pelican case desiccant requires replacement.	RCH
06/17/24		Discharge measurement had 4 verticals >10% of total flow; graded as poor data in TTS.	RCH
06/26/24		Discharge measurement had 5 verticals >10% of total flow; graded as poor data in TTS.	SRB
07/02/24		Monitoring equipment removed from station. Station offline.	RCH/SRB

2.2.3 Data Download Summary

The data stored on the data logger at the TTS station was downloaded to a field tablet at least weekly when the station was online. The files were then transferred to the GDRCo server and compiled into a proprietary SQL database. Editing and analysis were performed using this database, Aquatic Informatics' AQUARIUS Time-Series© (Aquarius, 2024), and Microsoft Excel. The output data file for this report is labeled as "Appendix_A_MC2_All_Data_WY2024.xlsx" and was submitted with this annual report in accordance with the NCRWQCB 2014 electronic document submission guidelines (Appendix A).

2.2.3.1 Continuous Stage

A Druck pressure transducer (Druck Inc.) was used to measure continuous stage height (feet) at 10-minute intervals throughout the 2024 WY (Figure 2). Stage plate observation (accuracy +/- 0.02 feet) was used to validate the stage readings during each site visit. Where recorded stage values were erroneous or missing due to stage drift, stage offset, or equipment failure, values were estimated using time-interpolated drift corrections, offset corrections, or interpolated using adjacent valid data in AQUARIUS. The type of estimates used for missing or erroneous data was noted and can be found in the 'Data Management' tab of the electronic data file (Appendix A).

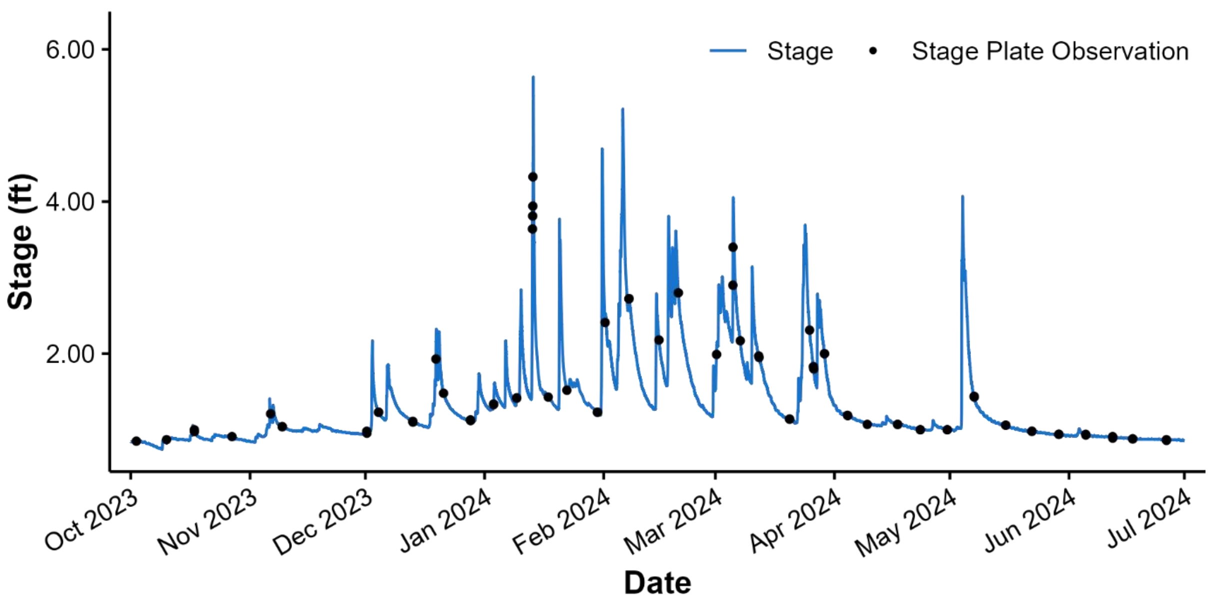

Figure 2. Continuous time-series of stage collected by the instream Druck pressure transducer sensor and stage plate observations at the McCloud Creek TTS station during the 2024 WY.

2.2.3.2 Stage-Discharge Relationship

During the 2024 WY, GDRCo personnel collected 43 water velocity measurements using USGS Price AA or pygmy current meter. Using Aquatic Informatics' Rating Review Tool (Aquarius, 2024), coincidental stages were taken with discharge measurements and plotted to create a rating curve for the 2024 WY (Figure 3). Two effective rating periods were used during the 2024 water year due to fill changes to the channel control of the monitoring unit resulting from the January 13th storm event. Prior to this major storm event, the same relationship had been used since the beginning of WY 2022 given that there were no major physical changes to the channel control of the monitoring unit during that time. Nine shifts were applied to the base ratings during the 2024 WY due to physical changes of the section control in the monitoring unit.

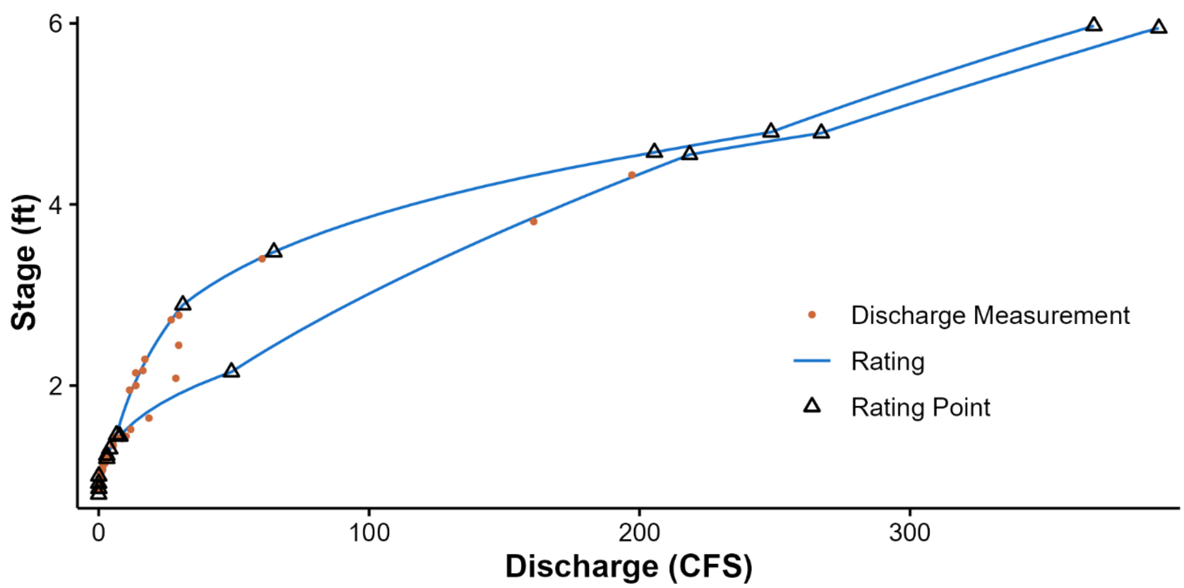

Figure 3. Discharge-stage ratings including the associated rating points and measurements used for the 2024 WY. Note: shifts are not shown.

2.2.3.3 Continuous Discharge

Continuous discharge for the 2024 WY (Figure 4) was derived using two discharge-stage rating models and the continuous stage time series data in Aquarius. The estimated peak discharge for McCloud Creek during the 2024 WY occurred on January 13th and was about 357 CFS (stage = 5.64 ft). The extrapolated discharge values that exceed the range of empirical values have a high uncertainty given the lack of discharge measurements for stages greater than 4.3 ft (200 CFS) for the first rating period, and greater than 3.4 ft (60 CFS) for the second rating period. Despite this limitation, 98.8% of the stage measurements recorded during the 2024 WY were within the range of measured discharges in the rating periods. A general rule of thumb is to not estimate over two times the max measured discharge stage value as it becomes exceedingly difficult to estimate as this is where floodplain controls take effect.

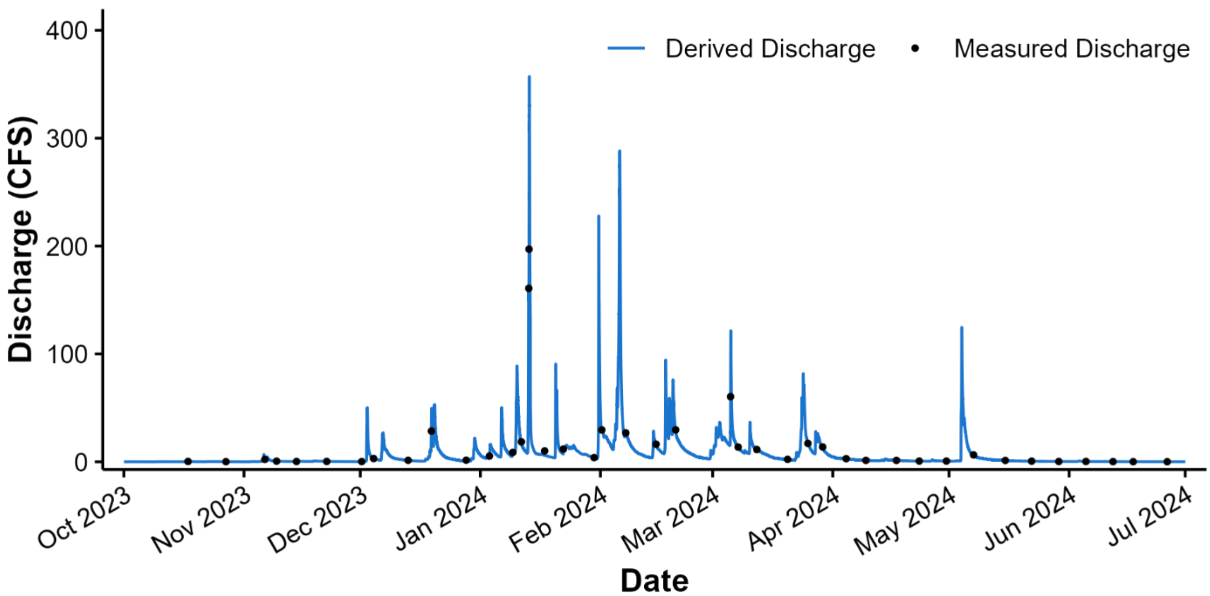

Figure 4. Continuous estimated discharge and measured discharge at the McCloud Creek TTS station during the 2024 WY.

2.2.3.4 Turbidity

Turbidity was measured simultaneously using two methodologies at the McCloud Creek TTS station during the 2024 WY. A DTS-12 turbidity sensor (Forest Technology Systems, LTD., Victoria, B.C., Canada) was used to measure water turbidity (Formazin Nephelometric Units [FNU]) in the field. Coincident water samples were collected using an ISCO 3700C water sampler (Teledyne ISCO, Lincoln, Nebraska) during each field visit and automatically based on established turbidity thresholds.

During the 2024 WY, 318 water samples were collected with the ISCO water sampler. Most of the water samples were collected by automated turbidity threshold sampling (n = 284) and the remainder were paired manual samples collected during site visits (n = 34 (17 pairs)). Low-level turbidity samples (FNU <30) comprised a disproportionate amount of the total samples collected. Overprocessing of these samples can lead to bias in the low end of the FNU-NTRU relationship. To reduce this bias, a systematic subsampling protocol was introduced to process 50% of the samples in the lab with low turbidities (FNU <30). Water samples were brought to the laboratory and a Hach 2100N turbidimeter (Hach Company, Loveland, Colorado) was used to measure turbidity (Nephelometric Turbidity-Ratio Units [NTRU]). A total of 164 water samples collected via automated turbidity threshold sampling and 25 collected via manual collection were processed for turbidity in lab.

A relationship between the lab and field turbidity measurements was established to develop a regression equation (Figure 5). This regression equation was then applied to lab sample turbidities to assist in reconstructing missing field turbidity, smoothing erratic values, or verifying turbidity spikes.

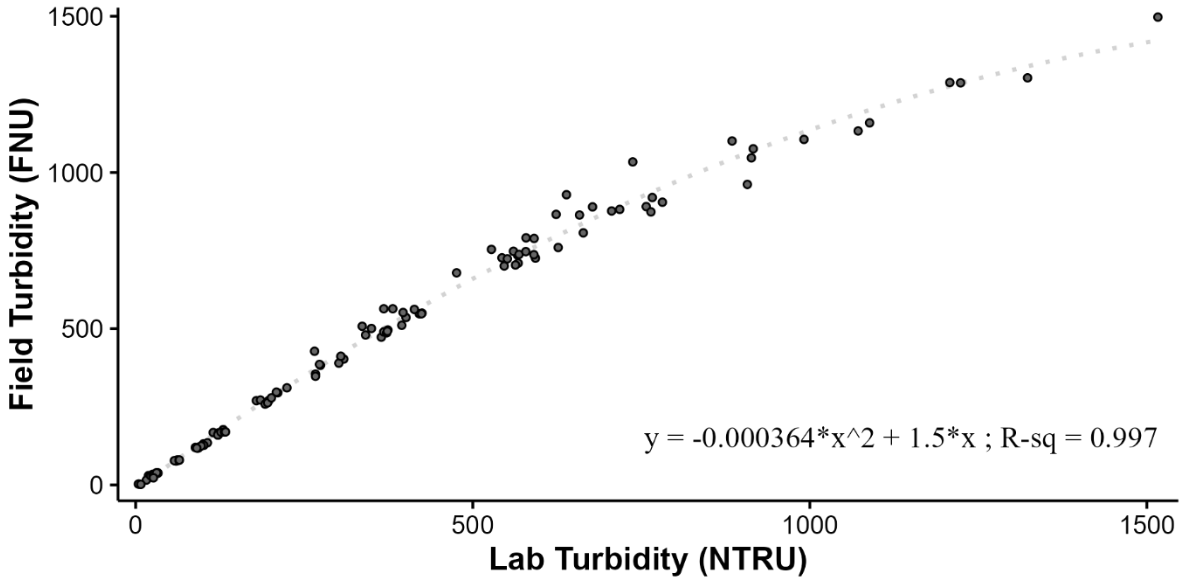

Figure 5. Relationship between coincident lab turbidity measurements (NTRU) and field turbidity measurements (FNU) collected at the McCloud Creek TTS station during the 2024 WY.

2.2.3.5 Continuous Turbidity

A DTS-12 sensor was used to measure continuous turbidity (FNU) at 10-minute intervals throughout the 2024 WY (Figure 6). Where turbidity values were missing or erroneous due to equipment failure or measurable range exceedance, values were estimated using stage-based regressions, values derived from grab samples (when possible), or interpolated using adjacent valid data. The type of estimates used for missing or erroneous data was noted and can be found in the 'Data Management' tab in the electronic data file (Appendix A).

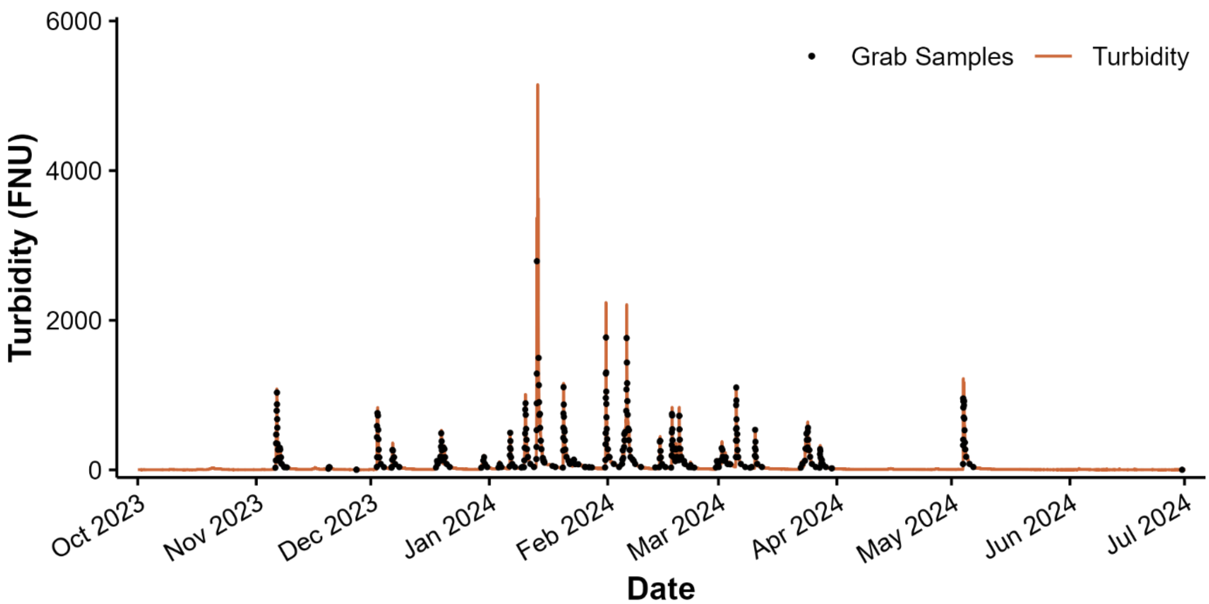

Figure 6. Continuous Time-Series of turbidity collected by the instream DTS-12 sensor and timing of turbidity threshold grab samples at the McCloud Creek TTS station during the 2024 WY.

2.2.3.6 Grab Sample Data Summary

A total of 318 water samples were collected (284 automated and 34 manual) during the 2024 WY. Paired manual grab samples were always taken if the station turbidity read 30 FNU or greater. These were collected using the ISCO sampler with a manual override and were primarily used as laboratory quality control samples. The collection times for automated (i.e., turbidity threshold) grab samples were compiled and overlaid on the continuous turbidity time series for the 2024 WY (Figure 6).

2.2.3.7 Comparative Analysis of Continuous Stage and Turbidity

A visual assessment comparing continuous stage and turbidity data was made to determine if there were any increases in continuous turbidity that were not associated with an increase in continuous stage. This would indicate additional sediment input into the system though such sources as localized landslides, nearby upstream tributaries, or roads for example. As expected, most increases in turbidity coincided with an increase in stage at the McCloud Creek TTS monitoring site for the 2024 WY, indicating that turbidity was primarily discharge driven (Figure 8). However, there was one turbidity event lasting about 3 hours that occurred on May 4, 2024. This event exhibited two pulses of a rapid rise in turbidity at initial rise in stage. Overall, the largest increase in turbidity coincided with the largest increase in stage and occurred on January 13th, 2024.

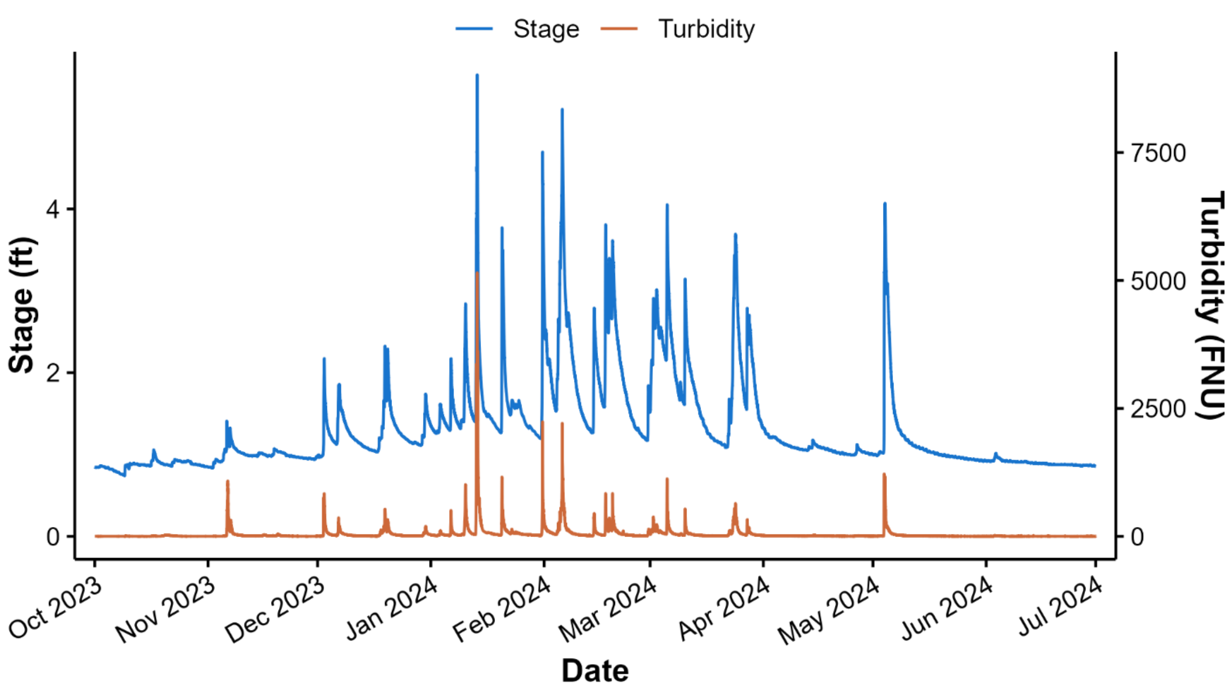

Figure 8. Continuous time-series of stage and turbidity at the McCloud Creek TTS station during the 2024 WY.

2.2.3.8 Suspended Sediment Concentration

The relationship between suspended sediment concentration (SSC, in mg/L) of the grab samples and the coincident field turbidity (FNU) for the entire 2024 WY is shown in Figure 9. There was a total of 277 automated samples processed for suspended sediment concentration during the 2024 WY. The initial assessment of this relationship is relatively simplistic, and a better fit of these data is possible through an assessment of storm-specific relationships.

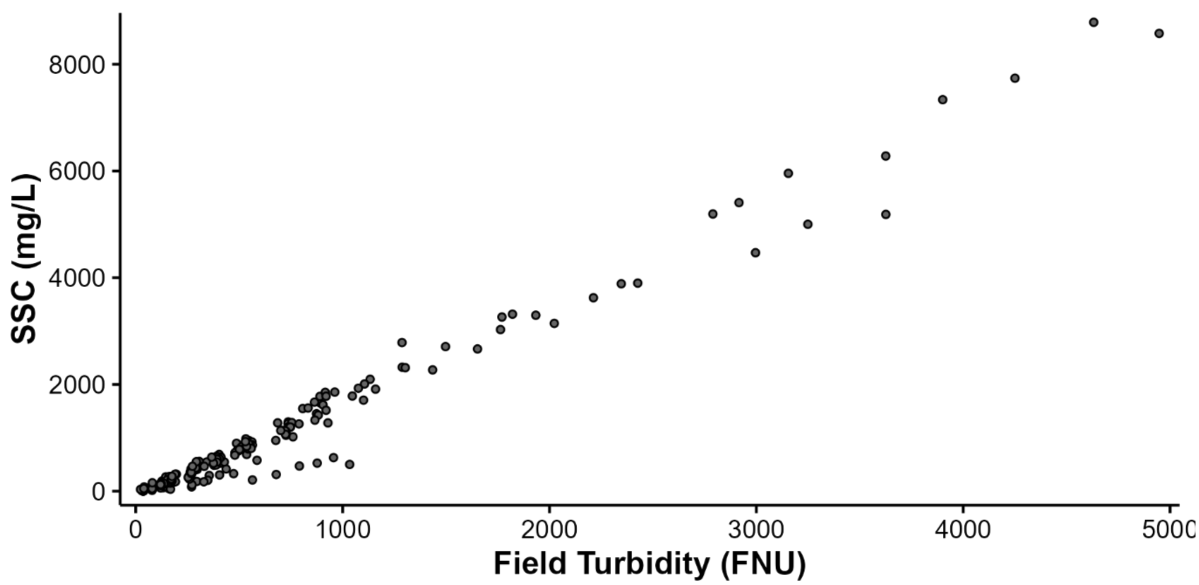

Figure 9. Relationship between turbidity and SSC for the McCloud Creek TTS station during the entire 2024 WY.

The relationship between SSC and turbidity can change over the course of the year either between or within storm events (Lewis, 1996). We analyzed individual storm events to establish stronger relationships, and if sample sized allowed, the relationships of individual rising and falling limbs of storms. SSC data was then paired with corresponding turbidity measurements using a set of procedures developed by Jack Lewis at Redwood Sciences Lab (Lewis, 2007) for use within R, a free statistical software package (R Core Team, 2024). This software allows for the construction of turbidity sediment rating curves where relationships between SSC and turbidity can be established on a storm-by-storm basis. Storm periods are defined for those rising and falling turbidities having at least four samples, sometimes separated further by rising and falling limbs if sample size allows. For those periods where the sample size was less than 4, they were combined with adjacent storm's samples. The best-fit relationship for each storm period was determined after reviewing graphics, R-squared values and residual standard error. The best-fit relationship is determined to be either linear, power or log-transformed variables. Once relationships are established, the software produces a derived SSC time-series data set using the turbidity time-series as the input (Figure 10). The derived SSC data set is then multiplied by the derived discharge data produced by a standard stage-discharge rating curve. The resulting data set gives instantaneous Suspended Sediment Load (iSSL) estimates for every 10-minute interval for the water year.

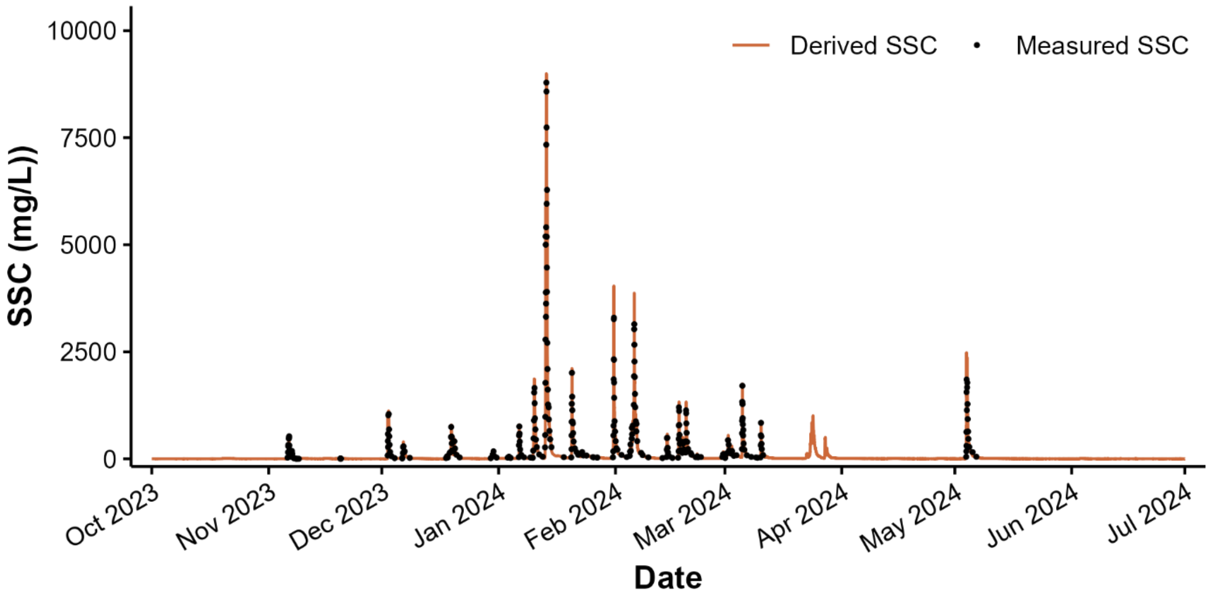

Figure 10. Derived Suspended Sediment Concentration (SSC) based on individual storm's best-fit relationships during the 2024 WY. Black points indicate the measured SSC of automated water samples.

2.2.3.9 Sediment Load and Yield

Sediment load was produced for the 2024 WY using a set of procedures developed by Jack Lewis at Redwood Sciences Lab (Lewis, 2007) for use within R, a statistical software package (R Core Team, 2024). Sediment Load (kg) was estimated for the entire water year based on derived continuous sediment concentrations (mg/l). For the 2024 WY there was a total of 25 periods for which relationships were established between turbidity and SSC, including 22 storms, an anomalous peak, and a fall and spring base relationship (Table 4). This annual sediment load was adjusted by watershed area upstream of the TTS monitoring site (6.0 km^2) producing sediment yield in metric tons per km^2 per year (metric tons/km^2/year). The estimated sediment load for the 2023 WY was 3264180 kg (3264 metric tons). The sediment load for storm 10 (January 13, 2024) comprised about 47% of the total annual sediment load and had a duration of about 1.7 days. The annual sediment yield for the 2024 WY was 542.85 metric tons/km^2/year. The median annual sediment yield for the entire monitoring period since the 2007 WY is 232.62 metric tons/km^2/year (Table 5). Annual sediment load and water yield for monitoring years 2007 through 2024 are strongly and positively correlated (ρ = 0.82, Figure 11).

Table 4. Summary of time periods and relationships used to estimate continuous suspended sediment concentration (mg/l) and sediment Loads (kg) for the 2024 WY. (A = ascending limb, D = descending limb, logxy = log-transformed turbidity and SSC, mvue = minimum-variance unbiased correction method, n = sample size, CV% = coefficient of variation). Note: the same samples and regression were used for each period with the same superscript on relationship type.

Period	Start	End	Relationship	n	Sediment Load (kg)	CV%	Percent Annual Sediment Load
Storm 1 (A)	11/6/2023 2:40	11/6/2023 10:10	logxy:mvue	5	888.918	2.04	<0.1%
Storm 1 (D)	11/6/2023 10:20	11/7/2023 1:50	power[1]	15	372.675	7.42	
Storm 2	11/7/2023 2:00	11/9/2023 0:20	power[1]		316.852	17.1	<0.1%
Storm 3	12/2/2023 13:30	12/4/2023 10:20	power	12	29184.397	4.2	0.9%
Storm 4	12/6/2023 10:10	12/8/2023 10:30	linear	9	8482.253	1.9	0.3%
Storm 5	12/19/2023 6:20	12/19/2023 22:10	linear[2]	11	17610.816	2.23	0.5%
Storm 6	12/19/2023 22:20	12/21/2023 15:30	linear[2]		22643.627	4.1	0.7%
Storm 7	12/29/2023 21:40	12/31/2023 11:20	power	5	3674.616	3.87	0.1%
Storm 8	1/6/2024 8:20	1/7/2024 17:20	linear	9	19787.511	5.08	0.6%
Storm 9	1/10/2024 1:20	1/12/2024 16:40	linear	13	125085.499	1.44	3.8%
Storm 10	1/13/2024 7:20	1/15/2024 0:30	linear	29	1526165.87	1.72	46.8%
Storm 11	1/20/2024 6:10	1/22/2024 2:40	power	15	77543.05	1.59	2.4%
Storm 12	1/31/2024 7:20	2/1/2024 9:30	power	15	250925.138	1.63	7.7%
Storm 13 (A)	2/5/2024 13:30	2/5/2024 23:10	linear	4	209571.93	3.05	17.6%
Storm 13 (D)	2/5/2024 23:20	2/6/2024 18:10	linear	10	364153.523	0.87	
Storm 14	2/14/2024 12:30	2/16/2024 2:20	power	8	10317.898	6.08	0.3%
Storm 15	2/17/2024 14:20	2/18/2024 15:50	power[3]	22	53245.516	1.01	1.6%
Storm 16	2/18/2024 16:00	2/19/2024 13:10	power[3]		22421.547	2.43	0.7%
Storm 17	2/19/2024 13:20	2/20/2024 6:20	power[3]		46549.006	1.14	1.4%
Storm 18 (A)	3/5/2024 13:10	3/5/2024 15:40	linear	5	22026.702	1.32	2.6%
Storm 18 (D)	3/5/2024 15:50	3/8/2024 0:10	linear	9	62255.57	1.45	
Storm 19	3/10/2024 10:40	3/11/2024 3:30	linear[4]	7	13793.614	7.03	0.4%
Storm 20	3/23/2024 14:20	3/27/2024 9:40	linear[4]		94175.943	5.87	2.9%
Storm 21	3/27/2024 9:50	3/29/2024 2:40	linear[4]		11861.875	25.9	0.4%
Anomalous peak	5/4/2024 0:10	5/4/2024 2:00	linear	4	144.319	5.88	<0.1%
Storm 22	5/4/2024 2:10	5/4/2024 20:30	power	10	120731.63	2.1	3.7%
Fall Base	10/1/2023 0:00	11/6/2023 2:30	Power	14	17.542	60.1	0.2%
	11/9/2023 0:30	12/2/2023 13:20			92.992	46.9	
	12/4/2023 10:30	12/6/2023 10:00			114.989	36.4	
	12/8/2023 10:40	12/19/2023 6:10			1786.711	11.6	
	12/21/2023 15:40	12/29/2023 21:30			502.854	37.4	
	12/31/2023 11:30	1/6/2024 8:10			1956.263	23.2	
	1/7/2024 17:30	1/10/2024 1:10			638.316	32.7	
	1/12/2024 16:50	1/13/2024 7:10			292.287	26.2	
Spring Base	1/15/2024 0:40	1/20/2024 6:00	Power	46	4842.212	3.9	4.4%
	1/22/2024 2:50	1/31/2024 7:10			9608.771	4.42	
	2/1/2024 9:40	2/5/2024 13:20			45098.705	1.63	
	2/6/2024 18:20	2/14/2024 12:20			19178.501	2.88	
	2/16/2024 2:30	2/17/2024 14:10			763.495	6.28	
	2/20/2024 6:30	3/5/2024 13:00			44450.695	2.62	
	3/8/2024 0:20	3/10/2024 10:30			1481.665	5.88	
	3/11/2024 3:40	3/23/2024 14:10			5183.287	5.1	
	3/29/2024 2:50	5/4/2024 0:00			1841.301	7.37	
	5/4/2024 20:40	6/30/2024 23:50			12399.135	2.85	
			Total:	277	3264180		

Table 5. Annual sediment yield (metric tons/km^2/year) estimates for the McCloud TTS monitoring site for water years 2007 through 2024. Sediment yield was determined using the watershed area above the monitoring site (6.0 km^2).

WY	Sediment Yield (metric tons/km^2/year)
2007	301.81
2008	210.11
2009	43.71
2010	149.81
2011	430.63
2012	537.07
2013	255.13
2014	26.81
2015	764.84
2016	608.23
2017	568.95
2018	78.68
2019	550.44
2020	44.30
2021	26.16
2022	17.47
2023	208.91
2024	542.85
Average:	298.11
Median:	232.62

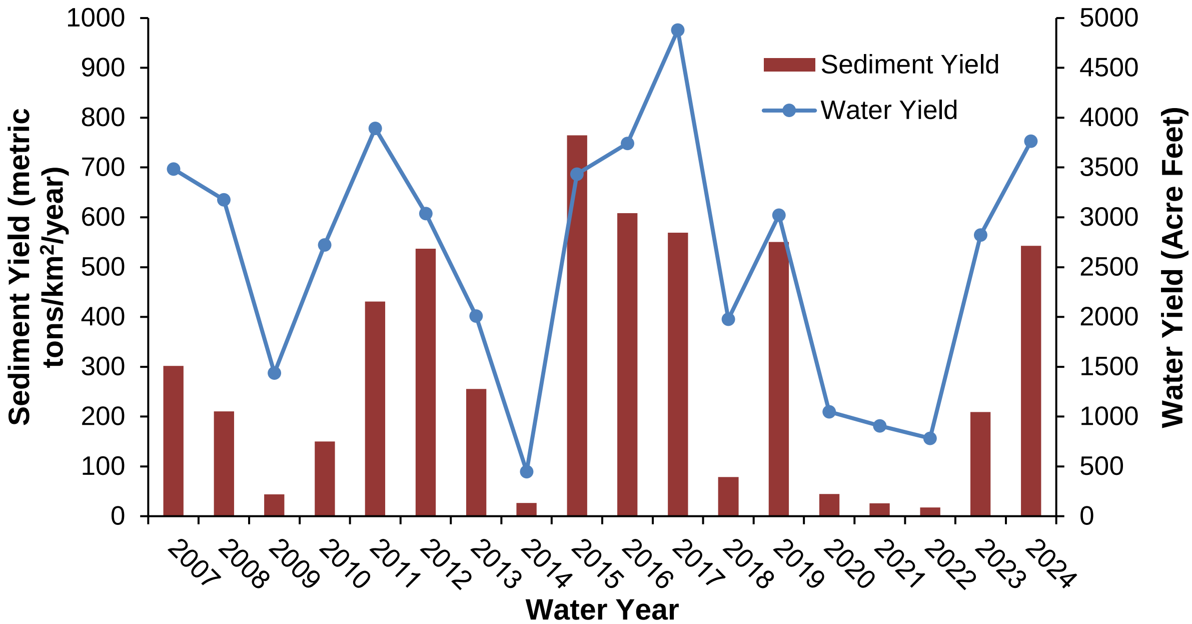

Figure 11. Annual sediment yield (metric tons/km^2) and water yield (Acre Feet) estimates for the McCloud TTS monitoring site for water years 2007 through 2024.

3.0 Summary of Field Problems Encountered and Resolutions

A summary of problems encountered and resolutions were compiled for the 2024 WY (Appendix B). Typical problems encountered included but were not limited to electronic stage offset adjustments, turbidimeter adjustments, stage plate observations, discharge measurement notes, and equipment maintenance.

4.0 Quality Assurance Summary

Special training is required for all GDRCo staff involved in the implementation of this project. During the 2024 WY, seven individuals participated in some part of the implementation of field and lab standard operating procedures. All personnel were trained prior to performing assigned work tasks and responsibilities.

The hydrology coordinator/lead was appointed by the GDRCo Aquatic Supervisor to perform the training and certification of the watershed staff during the 2024 WY (Table 7). Training was performed on all aspects of field work including cleaning and adjusting equipment, downloading of data, collecting grab samples, replacing ISCO bottles, and taking discharge measurements. Training in the laboratory included: preparing filters, taking turbidity measurements, filtering and weighing of suspended sediment, and recording data. Data management training included: data entry, QA/QC, and updating files. The chain-of-custody for all phases of project implementation was tracked.

Table 6. Summary of initial training dates for certifications completed by GDRCo staff involved in field and lab activities during the 2024 WY. Employees have annual refresher training before the beginning of each water year.

Personnel	Role	Field Methods Certification	Lab Certification	Data Management certification
Matt Nannizzi	Aquatic Biologist - Supervisor	10/1/2021	12/15/2011	10/21/2021
Melissa Reneski	Hydrology Coordinator	10/1/2015	10/1/2015	10/1/2015
Simon Boycott	Hydrology Techncian	11/15/2022	10/1/2022	10/1/2022
Reed Hamilton	Hydrology Technician	11/15/2022	10/1/2022	10/1/2022
Eli Martineau	Hydrology Technician	10/10/2022	12/14/2022	12/15/2022
Jordan Spence	Aquatics Technician	12/5/2022	NA	NA
Erin Philips	Aquatics Technician	NA	12/14/2023	NA

Among the turbidity samples collected and measured, 23 samples were excluded from the FNU-NTRU regression analysis due to unreliable field turbidity values. There were no outliers identified otherwise. Potential outliers are identified empirically by graphing lab vs turbidity values. Generally, there is a tight relationship ($R^2 > 95\%$) between the two measurements, so errors and outliers tend to stand out.

To evaluate the consistency of laboratory processing for turbidity and SSC, GDRCo performed a QA/QC test using paired grab and control water samples collected during site visits. Grabs are taken back to be immediately processed in the lab while controls are stored in a refrigerator until the end of the water year. Hydrochloric acid is added to each control sample that is placed in the refrigerator to help preserve it for later processing. At the end of the water year a random subsample of grabs and paired controls are processed for turbidity and SSC to assess lab repeatability. This subsample resulted in 7 of the 17 paired manual samples from McCloud to be selected. These samples were collected during routine site visits, using the ISCO pump sampler.

The relationships between the paired grab and control samples for turbidity and SSC were established (Figures 11 and 12, respectively) using data from 11 TTS sites that GDRCo operates, including the McCloud Creek station. The relationship for lab turbidity was linear and strong ($n = 26$, $R^2>0.99$); and produced no outlier data, indicating that the turbidity laboratory process produced nearly identical values between paired water samples. The 26 paired samples for SSC also produced a linear relationship (R^2= 0.97) and contained two outliers. One outlier pair, taken at Carson Creek TTS station, indicated that there was significant amount of sand (bedload) on the grab sample filter while the control sample did not have sand, which would result in the observed discrepancy in SSC. Another outlier grab and control pair, taken at Mainstem Ah Pah Creek TTS station, had a significant amount of organic debris on both grab and control samples possibly creating the discrepancy in SSC weights between the two samples.

All equipment was maintained and calibrated within the frequency defined in Section B6 of the Turbidity Threshold Sampling Quality Assurance Project Plan submitted by GDRCo. The DTS-12 sensors were calibrated by FTS in August 2023 prior to deployment. The Hach 2100N was calibrated every 3 months with Formazin StableCal® standards and weekly during the monitoring season using Gelex Secondary standards and receives yearly calibration and maintenance from HACH. The Druck pressure transducer was calibrated by the GDRCo watershed staff on in September, 2023 to ensure proper operation prior to deployment. Finally, current meters used during the monitoring season received calibration at least weekly.

At times there can be complications regarding the DTS-12 turbidity sensor, resulting in missing, or “noisy”, data. When this happened, the “cleaning” of the data was applied conservatively. In the case of missing data, values were generated using the methods described in Section 2.2.3.5 and are noted in the ‘Data Management’ tab in the electronic data file (Appendix A).

Two different approaches were used to address “noisy” turbidity data where there was no association with fluctuations in stage. If the turbidity recordings prompted an automated grab sample that verified there was no increase in SSC, that turbidity value was interpolated from adjacent values. If there was no associated grab sample, which can happen when the turbidity increases didn’t cross set thresholds, the value was left and no “cleaning” took place.

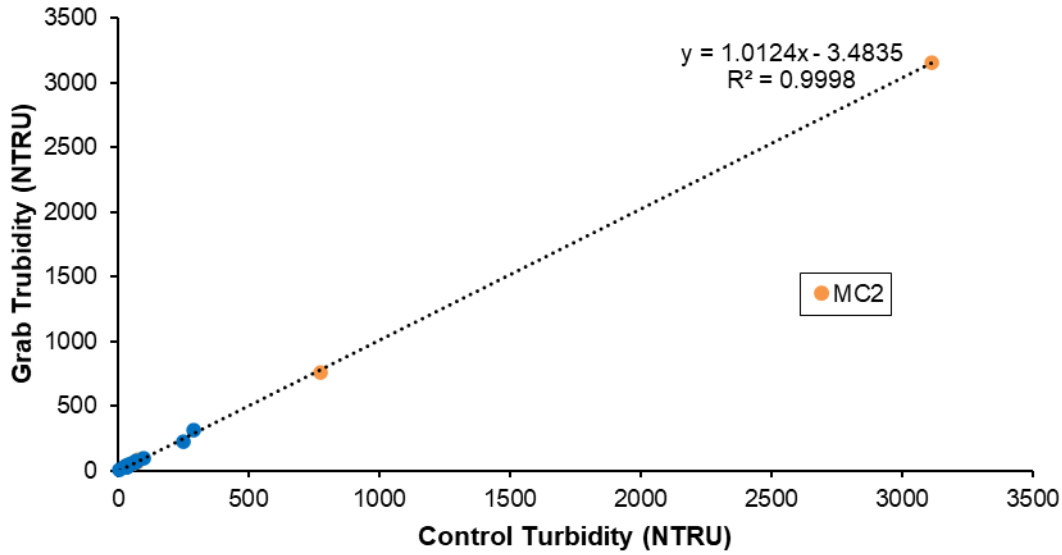

Figure 11. Relationship between lab turbidity (NTRU) of paired control and grab samples collected across 11 TTS sites during the 2024 WY, with those samples collected at the McCloud Creek TTS station indicated by orange points.

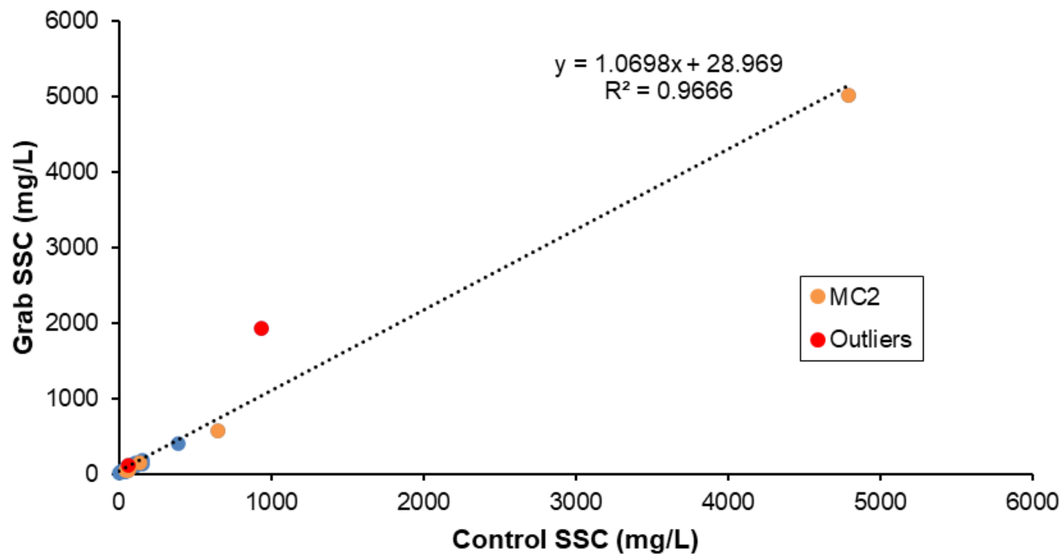

Figure 12. Relationship between suspended sediment concentration (SSC, mg/l) of paired control and grab samples collected across 11 sites during the 2024 WY, with those samples collected at the McCloud Creek TTS station indicated by orange points and outliers indicated by red points.

5.0 Other Problems Encountered

Previous to water year 2024, and the storm event observed on January 13, 2024, derived discharge values above the maximum measured stage of 2.12 ft were extrapolated using the Flow Transference Method (FTM; Cafferata et al., 2004) with discharge data from the South Fork Elk River provided by Humboldt Redwood Company. Prior to water year 2022, measuring a high-water discharge above this stage has been limited by technician's ability to cross the SF Elk River which is unsafe at higher flows. Since then, access to the station at higher stages has allowed technicians to access the site during large discharge events. Two discharge measurements were collected on January 13, 2024 during a large and rising streamflow allowing us to obtain the necessary data that has been needed to improve the discharge rating models for this site. This includes the current and previous effective periods and now allows for a more accurately estimated discharge for stage values up to 4.3'. Data above stage values of 4.3' should be used and viewed with caution without additional empirical support.

Given that the channel geometry at the monitoring site is substantially different above the range of empirical discharge measurements, and includes an overland flow channel control, we assume that the actual relationship is likely different than that predicted here for discharges above this range. Furthermore, large storm events are associated with higher sediment loads, and calculation of discharge and sediment load require extrapolation from relationships established at low to medium flow conditions, resulting in low confidence in the higher sediment load estimates. We will continue to prioritize obtaining discharge measurements for McCloud Creek at stages exceeding our current measurements to improve our discharge-stage ratings and thus the accuracy of suspended sediment load estimates.

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Appendix A

Electronic copy (file name = Appendix_A_MC2_All_Data_WY2024.xlsx) of data collected and data management notes for the McCloud TTS site during the 2024 WY. This file was submitted as an email attachment to the NCRQCB in accordance with the 2014 electronic document submission guidelines.

Appendix B

Summary of field problems encountered and resolutions at the McCloud Creek TTS station during the 2024 WY.

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
09/28/23	10/17/23	Station is hydrologically connected but streamflow is too low to obtain a discharge measurement.	Will monitor and measure discharge as streamflow increases.	10/17/23	MRR/RCH /ERM
10/10/23	10/10/23	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	10/10/23	MRR/ERM
10/13/23	10/13/23	Datalogger pelican case desiccant requires replacement.	Replaced datalogger pelican case desiccant.	10/13/23	RCH/ERM
10/27/23	10/27/23	E-stage does not match observed stage measurement, is off by +0.021	Will monitor and re-calculate stage offset if necessary	10/31/23	RCH
10/31/23	10/31/23	E-stage does not match observed stage measurement, is off by +0.022 for two weeks	Recalculated stage offset so that e-stage matches observed stage measurement	10/31/23	ERM
11/06/23	11/06/23	DTS is sitting too low in water column	Raised DTS so that sensor is at standard 6/10 depth	11/06/23	RCH
11/09/23	11/09/23	DTS is sitting too low in water column	Raised DTS so that sensor is at standard 6/10 depth	11/09/23	SRB
11/09/23	11/09/23	Slight amount of water (30-50 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-16. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	11/09/23	SRB
11/14/23	11/14/23	DTS is sitting to high in water column	Lowered DTS so that sensor is at standard 6/10 depth.	11/14/23	ERM
11/14/23	11/14/23	Datalogger pelican case desiccant requires replacement.	Replaced datalogger pelican case desiccant.	11/14/23	ERM
11/22/23	11/22/23	DTS is sitting too high in the water column for anticipated flows.	Lowered DTS so that sensor will be at standard 6/10 depth as stage drops.	11/22/23	ERM
11/22/23	11/22/23	Slight amount of water (10 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-4. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	11/22/23	ERM
12/01/23	12/01/23	DTS is sitting to low in water column	Raised DTS so that sensor is at standard 6/10 depth	12/01/23	RCH

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
12/01/23	12/01/23	Slight amount of water (20 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-2. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	12/01/23	RCH
12/04/23	12/04/23	DTS is sitting too low in water column	Raised DTS so that sensor is at standard 6/10 depth	12/04/23	SRB
12/04/23	12/04/23	DTS housing, stage plate, and druck have heavy debris.	Removed heavy debris away from DTS housing and from around stage plate and druck.	12/04/23	SRB
12/04/23	12/04/23	Decent amount of water (~50-100 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-4 and slots 10-12, but lower volumes observed in slots 5-9. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	12/04/23	SRB
12/07/23	12/07/23	DTS is sitting too low in water column.	Raised DTS so that sensor is at standard 6/10 depth	12/07/23	SRB
12/07/23	12/07/23	Slight amount of water (~30 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-9. Checked tube in ISCO distributor arm and length was appropriate, so must have been a head pressure issue. Tightened backstay and recalibrated ISCO at 8:59.	12/07/23	SRB
12/13/23	12/13/23	DTS is sitting to high in water column	Lowered DTS so that sensor is at standard 6/10 depth.	12/13/23	RCH
12/13/23	12/13/23	Datalogger pelican case desiccant requires replacement.	Replaced datalogger pelican case desiccant.	12/13/23	RCH
12/19/23	12/19/23	DTS is sitting too low in water column.	Raised DTS so that sensor is at standard 6/10 depth	12/19/23	SRB
12/19/23	12/19/23	Slight amount of water (~30 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-6. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	12/19/23	SRB
12/19/23	12/19/23	Debris present on DTS housing.	Removed debris away from DTS housing.	12/19/23	SRB
12/21/23	12/21/23	DTS is sitting to high in water column	Lowered DTS so that sensor is at standard 6/10 depth.	12/21/23	ERM

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
12/21/23	12/21/23	Slight amount of water (30 mL) observed in ISCO base	OK sample volumes observed in ISCO slots 1-9. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	12/21/23	ERM
12/28/23	12/28/23	DTS is sitting to high in water column	Lowered DTS so that sensor is at standard 6/10 depth.	12/28/23	RCH
01/03/24	01/03/24	DTS is sitting to low in water column	Raised DTS so that sensor is at standard 6/10 depth	01/03/24	ERM
01/03/24	01/03/24	Slight amount of water (10 mL) observed in ISCO base	OK sample volumes observed in ISCO slots 1-5. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	01/03/24	ERM
01/03/24	01/03/24	ISCO had no power upon arrival	Switched batteries and ISCO turned on displaying that the next bottle is bottle 6 which matched up with the next bottle on the datalogger. Indicating that no samples were missed. The old battery was taken back to the office for further evaluation.	01/03/24	ERM
01/09/24	01/09/24	Slight amount of water (40 mL) observed in ISCO base	OK sample volumes observed in ISCO slots 1-12. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	01/09/24	RCH
01/11/24	01/11/24	Slight amount of water (50 mL) observed in ISCO base	OK sample volumes observed in ISCO slots 1-15. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	01/11/24	RCH
01/13/24	01/13/24	DTS out of water on arrival	Lowered DTS into water to 6/10 depth; tightened backstay and added second backstay.	01/13/24	SRB
01/13/24	01/13/24	Slight amount of water (~50 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-7. Lower sample volumes in ISCO slots 8-11. Will monitor and adjust ISCO settings if necessary.	01/13/24	SRB
01/13/24	01/13/24	Field turbidity exceeded the calibration range of turbidimeter from 10:40 - 21:20.	Used laboratory turbidity measurements (NTRU) of samples to reconstruct field turbidity (FNU) time series data during this time.	02/26/24	MRR
01/17/24	01/17/24	DRUC has been put out of place from high flow event; therefore, E-stage was not accurate at this time	Re-secured and cleaned DRUC of sediment inside the housing. Followed by a re-calculation of the E-stage offset	01/17/24	ERM

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
01/17/24	01/17/24	DTS out of water on arrival	Lowered DTS into water to 6/10 depth	01/17/24	ERM
01/17/24	01/17/24	High amount of water ~400 mL in ISCO base	OK sample volumes in ISCO slots 1-18, Overfilled sample volumes in ISCO slots 19 and 20, Empty sample volumes in slots 21-24. Lowered DTS back into the water.	01/17/24	ERM
01/22/24	01/22/24	Slight amount of water in ISCO base ~50 mL	OK to low sample volumes in slots 1-19. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	01/22/24	MRR
01/22/24	01/22/24	DTS is sitting to low in water column	Raised DTS so that sensor is at standard 6/10 depth	01/22/24	MRR
01/22/24	01/22/24	Stage plate unable to be accurately read in fast flows (+/- 0.04').	Used e-stage value as observed stage measurement (for discharge measurement) due to difficulty reading stage plate.	01/22/24	MRR
01/30/24	01/30/24	Slight amount of water in ISCO base ~50 mL	OK sample volumes in slots 1-8. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	01/30/24	ERM
01/31/24	01/31/24	Field turbidity exceeded the calibration range of turbidimeter from 13:00 - 14:20.	Used laboratory turbidity measurements (NTRU) of samples to reconstruct field turbidity (FNU) time series data during this time.	02/26/24	MRR
02/05/24	02/06/24	Field turbidity exceeded the calibration range of turbidimeter from 2/5/2024 23:00 - 2/6/2024 00:20.	Used laboratory turbidity measurements (NTRU) of samples to reconstruct field turbidity (FNU) time series data during this time.	02/26/24	MRR
02/01/24	02/01/24	Moderate amount of water (100 mL) observed in ISCO base	OK sample volumes observed in ISCO slots 1-18. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	02/01/24	RCH
02/07/24	02/07/24	Organic debris observed to be built up around DTS housing upon arrival to the site sensor optics were not obscured and DTS still in water.	Removed debris that had been built up around DTS housing.	02/07/24	ERM
02/07/24	02/07/24	ISCO full upon arrival to site. Datalogger reads "Next bottle = 26". 2 missed samples.	Collected all samples and reset ISCO. Advanced data dump count. Both ISCO and datalogger read "Next Bottle = 1".	02/07/24	ERM
02/07/24	02/07/24	Slight amount of water (approximately 50 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-13 and 20-24. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	02/07/24	ERM

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
02/15/24	02/15/24	Slight amount of water (40 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-13. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	02/15/24	RCH
02/20/24	02/20/24	Slight organic debris observed to be built up around DTS housing upon arrival to the site sensor optics were not obscured and DTS still in water.	Removed debris that had been built up around DTS housing.	02/20/24	ERM
02/20/24	02/20/24	Wiper blade on DTS optics required replacement. Turbidity reading low at 0940 due to checking new wiper on DTS.	Attached wiper blade to DTS optics.	02/20/24	ERM
02/20/24	02/20/24	Slight amount of water (approximately 50 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-23. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	02/20/24	ERM
02/20/24	02/20/24	False trigger generated in ISCO slot 24 of DD #22 due to technician checking new DTS wiper.	Discarded sample. Changed data exception type to "NULL" in TTS.NET.	02/20/24	ERM
03/01/24	03/01/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	03/01/24	ERM
03/01/24	03/01/24	Slight amount of water (40 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-12. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	03/01/24	ERM
03/01/24	03/01/24	Low sample volume(s) observed in ISCO slot(s) 1-11 of DD #23.	Fixed undulation in ISCO tubing and grab and control volumes seemed higher as a result.	03/01/24	ERM
03/05/24	03/05/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	03/05/24	SRB
03/05/24	03/05/24	Slight amount of water (~50 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-13 and in manual Grab and Control samples of DD #24. Will monitor and adjust ISCO settings if necessary.	03/05/24	SRB
03/05/24	03/05/24	Stage plate unable to be accurately read in fast flows.	Used e-stage value as observed stage measurement due to difficulty reading stage plate.	03/05/24	SRB
03/07/24	03/07/24	DTS is sitting too high in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	03/07/24	SRB
03/07/24	03/07/24	Slight amount of water (approximately 30 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-9 and in manual Grab and Control samples of DD #25.	03/07/24	SRB

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
			Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.		
03/07/24	03/07/24	ISCO pump tubing requires replacement.	As I did not have extra tubing with me, I patched the split in the ISCO pump tubing with electrical tape and rotated it before resetting pump tubing counter. Tested with additional manual sample and obtained OK sample volume.	03/07/24	SRB
03/12/24	03/12/24	Slight amount of water (50 mL) observed in ISCO base.	Low sample volumes observed in ISCO slots 1-11. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	03/12/24	ERM
03/12/24	03/26/24	Empty sample observed in ISCO slot 1 of DD #27	ISCO was turned off due to issues collecting samples. Issued generic BID# 9999 and changed data exception type to "NULL" in TTS.NET.	03/26/24	RCH
03/25/24	03/25/24	DTS is sitting too low in the water column for anticipated flows.	Raised DTS so that sensor will be at standard 6/10 depth as stage rises.	03/25/24	ERM
03/25/24	03/25/24	Datalogger pelican case desiccant requires replacement.	Replaced datalogger pelican case desiccant.	03/25/24	ERM
03/25/24	03/25/24	Overfilled sample volume(s) observed in ISCO slot(s) 5 and 6 of DD #28.	Overfilled sample volumes related to ongoing ISCO pump tubing issue, assigned generic BID #9995-9994.	03/25/24	ERM
01/22/24	03/12/24	Low sample volumes observed in slots DD# 17 - 26 along with > 50 mL of water in ISCO base	Calibrated sample volumes in ISCO settings. Tested with additional manual sample and obtained OK sample volume prior to leaving site visit. Each successive site visit would have low sample volumes again and water int he ISCO base. Eventually discovered that internal pump tubing had a crack and thus inaccurate sample volumes and water in ISCO base resulted. Replaced cracked internal pump tubing, yet now water was not reaching liquid detector and thus not sampling.	03/12/24	MRR/ERM /SRB/RCH
03/07/24	03/12/24	ISCO pump tubing requires replacement.	Replaced ISCO pump tubing and reset pump tubing counter. Tested and discovered issue with water reaching the liquid detector.	03/12/24	SRB/ERM

Start Date	End Date	Comment	Resolution	Resolution Date	Initials
03/12/24	04/09/24	Empty samples observed in ISCO for DD#s 26 through 31 where a total of 36 automated ISCO samples were missed due to malfunctioning ISCO.	ISCO has ongoing issue with pump and/or head pressure. There appears to not be enough pressure to ensure that water reaches liquid detector and thus samples were not taken during these times. Tested different internal pump tubing, a new 3/8" ID vinyl tubing, new tubing coupler, lowered ISCO to reduce head pressure and nothing has solved the issue. Attempted to replace 3/8" ID vinyl tubing with 1/4" ID tubing to see if that will improve the pumping issue, but there was no change (04/04/24). Empty samples were Issued generic BID# 's and changed data exception type to "NULL" in TTS.NET. Final resolution was to swap out ISCO with new one. Connected new ISCO (SN: 204C01176) to 1/4 inch tubing at site and successfully took 2 samples. Switched 1/4 inch tubing with 3/8 inch tubing and connected new ISCO and recalibrated it. Site fully online and running again.	04/09/24	ERM/MRR /RCH/SRB
03/26/24	03/29/24	E-stage does not match observed stage measurement, is off by ~- 0.02'.	Will monitor and re-calculate stage offset if necessary.	03/29/24	MRR
03/26/24	03/26/24	DTS is sitting to low in water column for anticipated flows	Raised DTS so that sensor is at standard 6/10 depth for when stage rises	3/26/2024	MRR
03/29/24	03/29/24	DTS is sitting too high in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	03/29/24	RCH
05/07/24	05/07/24	Organic debris observed to be built up around DTS housing upon arrival to the site	Removed debris that had been built up around DTS housing.	05/07/24	SRB
05/15/24	05/15/24	DTS is sitting too high in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	05/15/24	RCH
06/05/24	06/12/24	E-stage does not match observed stage measurement, is off by - 0.019'-0.026'	Will monitor and re-calculate stage offset if necessary.	06/12/24	RCH