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HYDROLOGIC YEAR 2017

HYDROLOGY MONITORING REPORT

Elk River

Freshwater Creek

Bear Creek

January 2018

PROJECT TITLE:

ELK RIVER WATERSHED WASTE DISCHARGE PERMIT R1-2014-0004 (HRC, 2004a)

FRESHWATER CREEK WATERSHED WASTE DISCHARGE PERMIT R1-2006-0041 (HRC, 2004b)

HY 2017 ANNUAL TURBIDITY TREND STATION DATA SUBMITTAL AND SUMMARY REPORT

ORGANIZATION IMPLEMENTING THE PROJECT:

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HYDROLOGY TEAM LEADER FOR THIS PROJECT

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Sal Chinnici

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Suspended sediment concentration (SSC) and streamflow were measured at eight (8) hydrologic monitoring stations in the Elk River watershed, nine (9) locations in the Freshwater Creek watershed, and one (1) location in the lower Eel River watershed (Table 1). This network is in place to monitor sediment and streamflow conditions in each watershed.

The following data were collected at each monitoring station during the water year (October 1 – September 30):

1. 15-minute electronic recording of turbidity, water depth, water temperature

2. Water samples. 100-500 mL water samples are pumped by ISCO auto-samplers during storm events or collected manually by periodic depth-integrated sampling and grab sampling. These samples are analyzed for SSC, turbidity, and/or both.

3. Manual measurement of streamflow area and velocity using wading and non-wading techniques used to calculate discharge

The above datasets were used to produce the following derived products:

- 15-minute SSC record

- Annual suspended sediment load

Data collected and produced through this monitoring network support the following goals:

- Assess SSC and turbidity response to management techniques and natural disturbances on an annual and stormflow basis.

- Assess how management practices applied in each watershed through the NCRWQCB permits and Humboldt Redwood Company's (HRC) Habitat Conservation Plan and Company policies affect trends in SSC and turbidity.

Each year, raw and processed data are submitted to the North Coast Regional Water Quality Control Board per requirements of the Watershed Waste Discharge Permit for Elk River (R1-2016-0004) and Freshwater Creek (R1-2006-0041). This report supports the data submission for hydrologic year 2016 reporting data collected from October 1, 2016 to May 15, 2017.

Table 1: HRC hydrologic monitoring stations for the 2017 hydrologic year

Watershed	**Station Number**	**Station Location**	**Basin Area (km^2)**
Elk River	509	Mainstem Elk River	111.83
	510	South Fork Elk River	50.34
	511	North Fork Elk River	56.91
	517	Bridge Creek	5.75
	522	Corrigan Creek	4.31
	532	North Fork Elk River	35.08
	683	West Branch Railroad Gulch	1.48
	684	East Branch Railroad Gulch	1.28
Freshwater	500	Beck's Tributary	2.17
	502	Mid-Freshwater Creek	17.13
	504	Cloney Gulch	12.04
	505	Graham Gulch	6.16
	506	South Fork Freshwater Creek	8.19
	523	Lower Freshwater Creek	22.83
	526	Upper Freshwater Creek	5.12
	527	McCready Gulch	4.71
	528	Little Freshwater Creek	12
Lower Eel	533	Bear Creek	20.95

2. METHODS

2.1 Site operations

2.1.1 Instrumentation

All hydrology monitoring stations are equipped with the following instrumentation:

- Automatic pump sampler (ISCO by Teledyne Technologies, Inc.)
- Turbidimeter (DTS-12 by FTS)
- Pressure transducer (Druck by GE) or a gas bubbler system
- Datalogger (WaterLOG by YSI)

Table 2 through Table 4 provide complete details regarding field and lab infrastructure.

Table 2: Standard Watershed Operating Protocols describing field and laboratory methods used in hydrology station monitoring.

SOP	Title	Current version	Description
SOP-01 (HRC, 2004c)	Hydrologic Site Selection, Monumenting and Documentation	2.3	Establishing and documenting a permanent monitoring station.
SOP-02 (HRC, 2004d)	Gaging Streams for Estimating Discharge	3	Installing a staff plate, measuring streamflow, constructing a stage-discharge rating curve.
SOP-03 (HRC, 2004e)	Instrumentation Methodology	1.2	Turbidimeters, water samplers, pressure transducers, and rain gauge manuals
SOP-04 (HRC, 2004f)	Water Quality Grab Sampling and Field Turbidity Measurement	2.1	Depth-integrated sampling methods and portable turbidimeter manual
SOP-05 (HRC, 2006)	Laboratory analysis of suspended sediment using electronic data collection methods	4.3	Turbidity and sediment concentration laboratory measurement.
SOP-19 (HRC, 2004g)	Establishing and maintaining the physical infrastructure of a hydrologic monitoring station	1.1	Hydrologic monitoring station set-up.

Table 3: Equipment used in the field and laboratory for hydrologic monitoring and inspection schedule.

Instrument	**Model/ Manufacturer**	**Instrument Range/Accuracy**	**Inspection Frequency**	**Inspection Type**	**Inspector**
Datalogger	Waterlogger by YSI	NA	Weekly	Check data download	Field crew
Field Turbidimeter	DTS-12 by FTS	Range: 0-1600 NTU Zero offset: ±0.2 NTU Accuracy: ±2% 0 to 500, ±4% 501-1600; Temp: ±0.20 C	Weekly	Proper operation	Field crew
Water Sampler	ISCO 6100/6712 by Teledyne	NA	Weekly	Proper operation	Field crew
Pressure Transducer	Druck 1830/8388 by GE	Range: 75 mbar to 60 bar; Accuracy: ±0.1%	Weekly	Check data download	Field crew
Flow Meter	Flo-Mate by Marsh-McBirney	Range: -0.15 – 6 m/s Zero Stability: ± 0.15 m/s Accuracy: ±2% reading + zero stability	Each use	Proper operation	Field crew
Lab Turbidimeter	HACH 2100N	Range: 0-4000 NTU; Accuracy: ¡100 NTU ±2%, 100-4000 NTU ±5%	Daily when used	Calibration, proper operation	Lab Leader
Analytical Balance	APX-100 by Denver Instruments	Range: 0.0001 to 100.0 g; Accuracy: ± 0.0001 g	Daily when used	Standard weights	Lab Leader
Top Loading Balance	XP-3000	Range: 0.1 to 1000.0 grams; Accuracy: ±0.1 g	Daily when used	Standard weights	Lab Leader
Lab Oven	Quincy Lab	Accuracy: 1C	Each use	Proper operation	Lab Leader
Vacuum Filtration	NA	NA	Each use	Proper operation	Lab Leader

Table 4: Instrument deployment at HRC hydrologic monitoring stations during the 2017 hydrologic year.

Station	Stream Name	Turbidimeter	Turbidimeter range (NTU)	Water level	Data recorder	High streamflow sampling method
509	Mainstem Elk River	DTS-12	0-1,600	Gas Bubbler	Water Logger	Bridge
510	South Fork Elk River	DTS-12	0-1,600	Druck	Water Logger	Cable system
511	North Fork Elk River	DTS-12	0-1,600	Druck	Water Logger	Cable system
522	Corrigan Creek	DTS-12	0-1,600	Druck	Water Logger	Cable system
532	North Fork Elk River	DTS-12	0-1,600	Druck	Water Logger	Bridge
517	Bridge Creek	DTS-12	0-1,600	Druck	Water Logger	Platform
683	West Branch Railroad Gulch	DTS-12	0-1,600	Druck	Water Logger	Platform
684	East Branch Railroad Gulch	DTS-12	0-1,600	Druck	Water Logger	Platform
188	South Fork Elk River	DTS-12	0-1,600	Druck	Water Logger	Bridge
523	Lower Freshwater Creek	DTS-12	0-1,600	Druck	Water Logger	Cable system
502	Mid-Freshwater Creek	DTS-12	0-1,600	Druck	Water Logger	Cable system
526	Upper Freshwater Creek	DTS-12	0-1,600	Druck	Water Logger	Temporary platform
527	McCready Gulch	DTS-12	0-1,600	Druck	Water Logger	Temporary platform
504	Cloney Gulch	DTS-12	0-1,600	Druck	Water Logger	Cable system
505	Graham Gulch	DTS-12	0-1,600	Druck	Water Logger	None
506	South Fork Freshwater Creek	DTS-12	0-1,600	Druck	Water Logger	Temporary platform
528	Little Freshwater Creek	DTS-12	0-1,600	Druck	Water Logger	Cable system
500	Beck's Tributary	DTS-12	0-1,600	Druck	Water Logger	Temporary platform
530	Bear Creek	DTS-12	0-1,600	Druck	Water Logger	Bridge

2.2 Data collection

1. 15-minute electronic recording of turbidity, water depth, water temperature

   Turbidity, measured in nephelometric turbidity units (NTU), is recorded with the turbidimeter suspended in the stream at approximately 6/10 water depth. Measurement ranges are listed for each turbidimeter in Table 3. Instruments are secured to a boom arm that may be raised or lowered within the water column as water stage changes.

   Water depth is measured using pressure transducers/gas bubblers which are mounted to the streambed. HRC has devised an apparatus at each site that firmly holds the instrument in place and allows the operator to return the device to the same position after servicing.

   Water temperature (°C) is measured within the water column at the same location as turbidity.

2. 100-500 mL water samples pumped by ISCO auto-samplers

   Each datalogger contains a program that triggers the ISCO to begin sampling based on a specified sustained rise in stage. The program runs in two segments ('A' and 'B') that fill bottles based on a set time interval. The objective is to sample on both the rising and falling limbs of storm hydrographs in sufficient detail to record and SSC hysteresis. Hysteresis is defined here as a different sediment concentration at a given stage on the falling limb as compared to the same stage on the rising limb. Samples are collected within one week following sampling and submitted to the HRC laboratory. Samples are identified by the hydrologist and sent to the lab for turbidity and SSC analysis. During laboratory processing turbidity is measured with a HACH 2100N bench turbidimeter (range of measurement = 0-2000 NTU) and SSC is determined through vacuum filtration.

   Depth-integrated point samples are collected across the range of flows and submitted for lab analyses of turbidity and SSC. These samples are used to validate ISCO samples that are collected at a single point in the water column. Grab samples are also collected and submitted for lab analysis in order to compare with the turbidimeter data for calibration of the field and lab turbidity instruments.

3. Manual measurement of streamflow area and velocity using wading and non-wading techniques used to calculate discharge

   Discharge is calculated by the velocity-area technique for a range of flows. Low flow velocities are measured with a wading rod and high flow velocities are measured using a variety of cableway and platform techniques (Table 3). High flows that exceed bankfull stage are less common and are generally under-represented in the measured data at nearly all the sampling sites. High flows are estimated by extrapolating rating curves beyond the range of empirical data, which introduces a degree of uncertainty into high flow discharge estimates.

2.3 Data processing

2.3.1 Stage-discharge relationships

Stage-discharge relationships are essential in estimating discharge (a complicated task) from more frequent stage readings (a simple task, often automated). In stable, well defined channels, discharge can be predicted from stage measurements based on a power relationship. Stage-discharge relationships for our hydrology monitoring sites are updated on a yearly basis to reflect channel changes that often occur. Channel changes are tracked by yearly cross-section topographic surveys. It is common for some scour or aggradation to occur within the discharge cross-section at most sites since they are not controlled by weirs or flumes. Stations were originally selected to minimize change through the local reach. Most sites are sufficiently stable to allow the use of the same rating curve for multiple years. A few stations have been very unstable requiring considerable measurement each year, most notably in Railroad Gulch and Bear Creek.

Many monitoring sites require multiple rating equations for different flow ranges. An example stage-discharge relationship is show in Figure 1. Rating equations are then used to calculate discharge on the same 15-minute interval during which river stage is recorded.

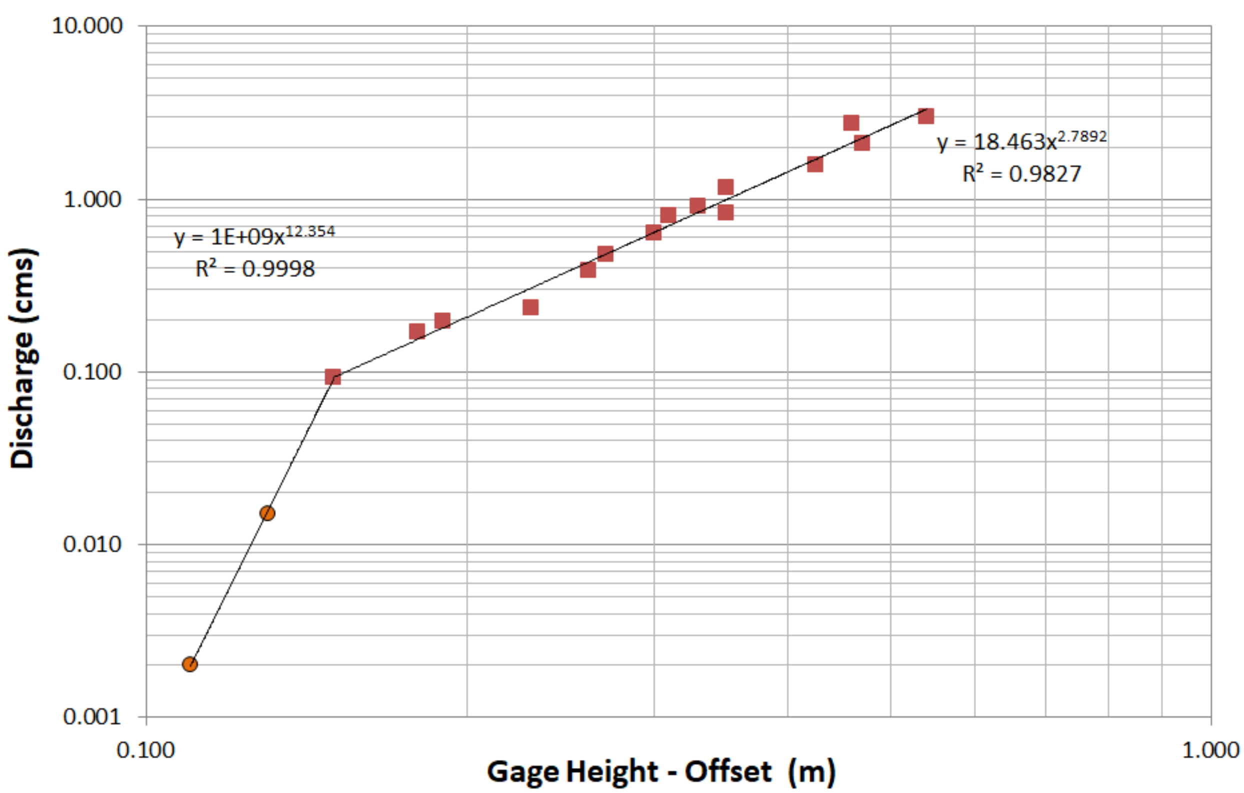

Figure 1: Stage discharge relationship for Graham Gulch (site 505), a tributary to Freshwater Creek. The offset, estimated for the point of zero flow, is 0.04m.

2.3.2 Data validation and correction

Validation and correction of 15-minute measurement records are conducted using TTS Adjuster software (Lewis) to produce continuous, 15-minute, monitoring records for water year. The corrected data file contains codes for stage and turbidity data records to indicate which, if any, correction methods were applied in the TTS Adjuster program (Table 5). QAQC procedures remove outliers or spikes that appear to be anomalies of the data collection process. Missing data are filled using a variety of techniques at the discretion of the data processor. Data may be filled from physically measured data, interpolated between recorded data, or reconstructed from another site best matched to that site. Figure 5 provides an example of raw and corrected continuous data from a hydrology monitoring station using TTS Adjuster software.

Table 5: Stage and turbidity codes that document edits made to hydrology data in the TTS Adjuster program.

Code	**Definition**
-1	Unedited, unapproved
0	Raw data, accepted as good
1	Raw data, accepted but questionable
2	Bad data, replaced with NA
3	Constant shift was applied
4	Variable (linear) shift was applied
5	Interpolated (linearly)
6	Reconstructed from another site
7	Free-hand reconstruction
8	Y-proportional shift was applied
9	Replaced with lab-measured value

2.3.3 Stage validation and correction

Site specific correlations are developed between pairs of instrument recorded water depth and observed stage (recorded by observers at the staff plates). 15-minute water depths are then adjusted to water stage that correlates to staff plate readings prior to data correction in TTS adjuster. The number of water depth pairs ranged from 35 to 101 and varied based on the frequency of site visits. An example correlation is shown for monitoring site 509 in Figure 2.

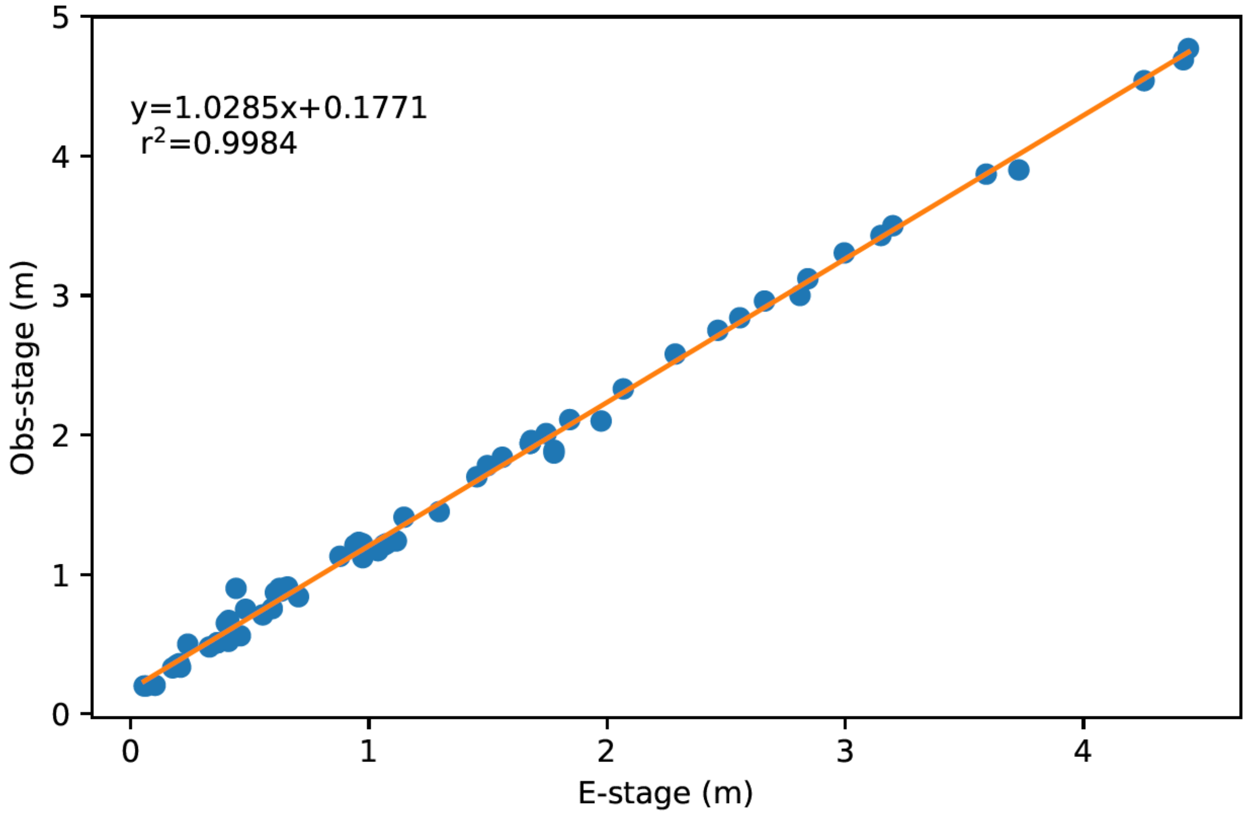

Figure 2: Example relationship between 15-minute stage (E-stage) and observed stage, Main stem Elk River (site 509)

2.3.4 Turbidity validation and correction

Field turbidity is used to model continuous SSC at each monitoring site. Field turbidimeters are calibrated to 1,600 NTU (Figure 3). Turbidity peaks are replaced with lab turbidity values when field turbidity exceeds 1,600 NTU. Relationships are established between field and lab turbidity, but are often complicated by grain size distributions and settling that introduce error in lab turbidity measurements. Field-lab turbidity regressions are still used to reconstruct turbidity peaks when stream turbidity exceeds the limit of field turbidimeters. An example field-lab turbidity relationship is shown in Figure 2. Field turbidity is corrected and validated in TTS adjuster, using the same QAQC codes that are used for stage corrections.

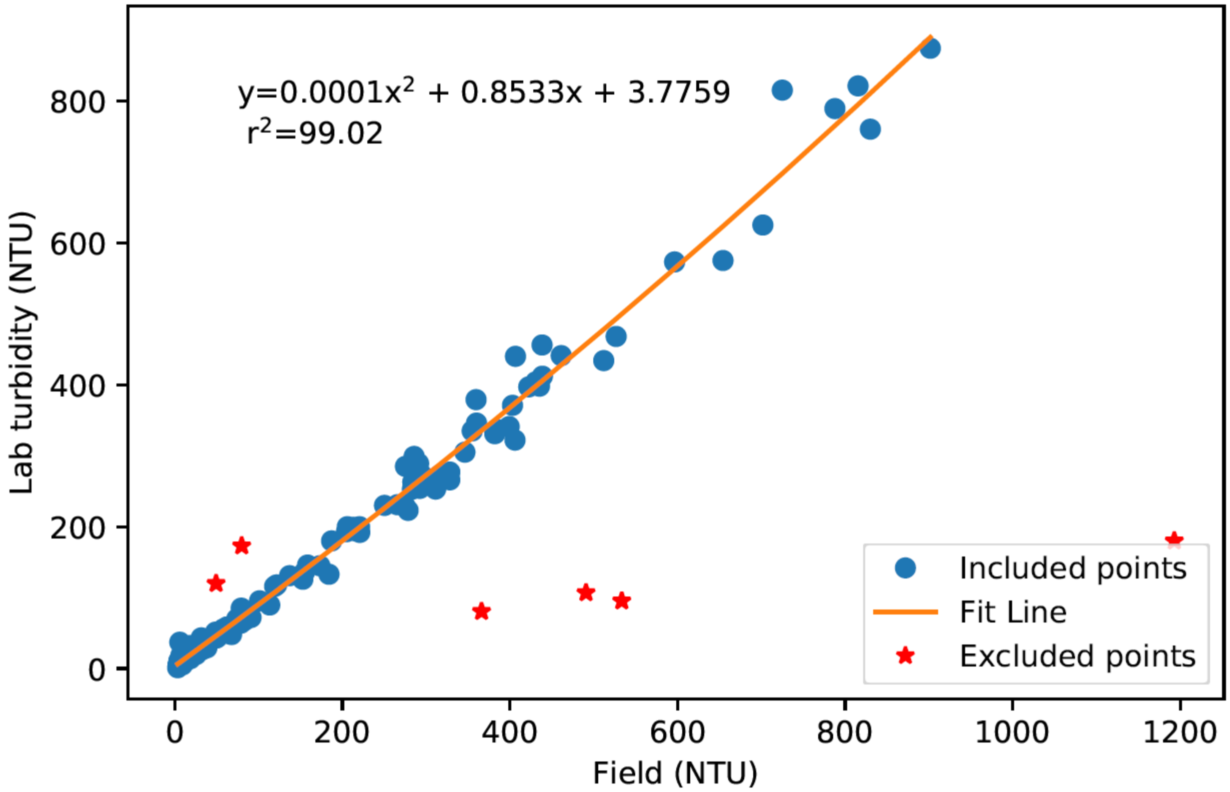

Figure 3: Example Field turbidity (NTU) vs. laboratory turbidity (NTU) for the Main stem Elk River (Site 509).

Once all data correction and validation within TTS Adjuster is complete, discharge values are calculated for every 15-minute stage measurement (using the stage-discharge relationships described above) and the corrected data file is saved. A graphical example of the corrected data file is shown in Figure 4.

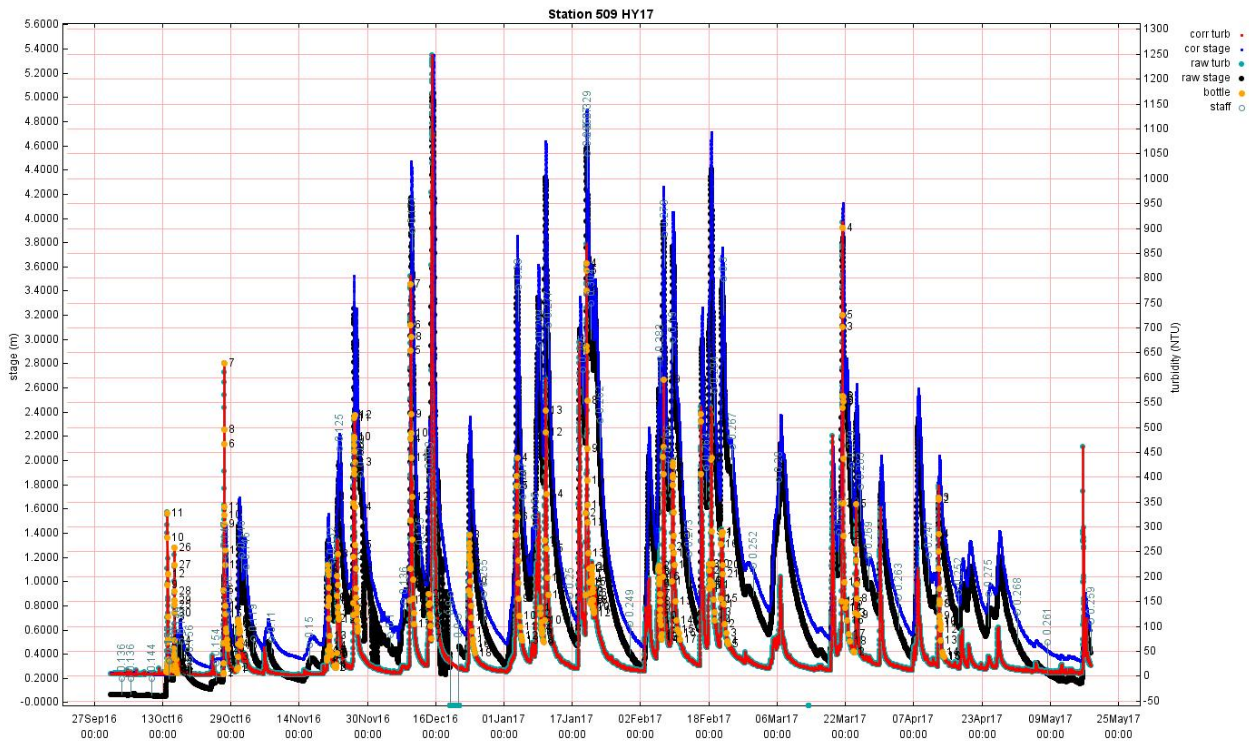

Figure 4: Example corrected hydrologic data measured at South Fork Elk River (Station 510), WY 2016.

2.3.5 SSC modeling using R software packages

Continuous suspended sediment concentrations are calculated from composited field turbidity/SSC relationships using R software packages developed by Jack Lewis. All discrete SSC measurements (i.e. pumped samples, ISO samples, and grab samples) are combined for this analysis. See Figure 5 for a graphical example. For some monitoring sites, SSC is modeled after combing all turbidity/SSC pairs throughout the water year. This is done in cases where there is not much inter-storm variability between turbidity and SSC relationships. When there is such inter-storm variability, SSC is modeled on a storm event basis. These decisions are described in individual data files and are made on a site-by-site basis depending on the trends observed in the data. Sediment mass is calculated for each 15-minute interval using the appropriate 15-minute discharge. Total annual suspended sediment yield is then derived by accumulating the sediment mass throughout the measurement record. Sediment loads reported here are computed for generally the same interval of time for all stations, and start and end dates are included for each calculation.

Additional details regarding HRC's methods for site installation, equipment, field measurements of sediment and streamflow, and sediment laboratory processing are provided as Standard Watershed Operating Protocols (SOP's) listed in Table 2.

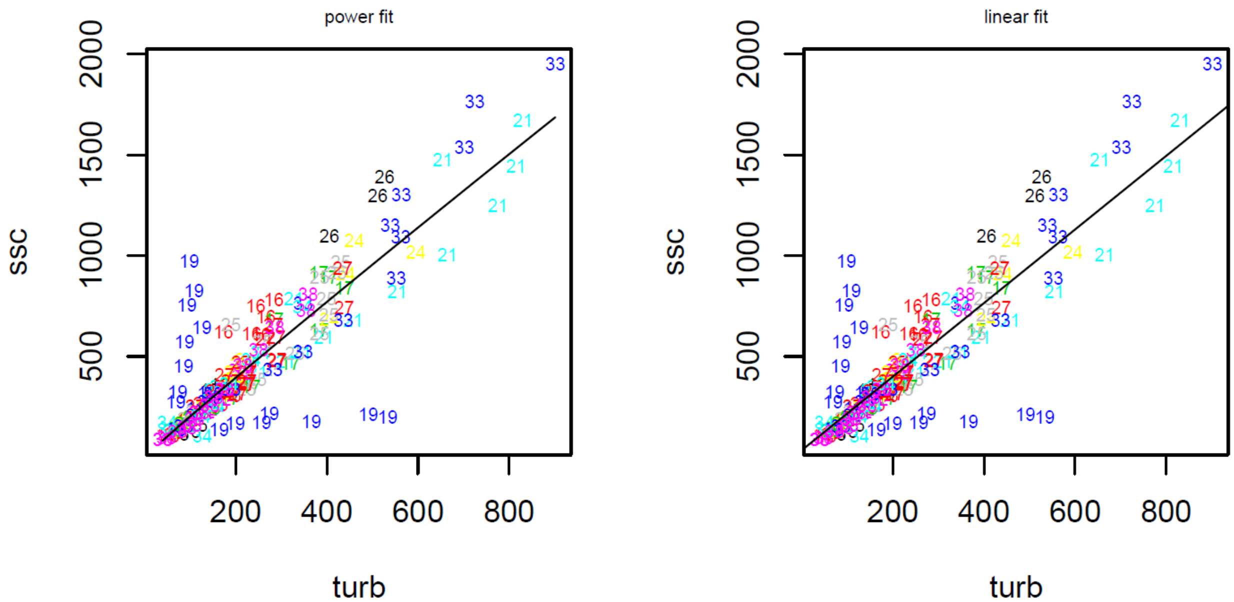

Figure 5: Example field turbidity (NTU) vs. SSC (mg/L) relationships at Mainstem Elk River (site 509). Numbers indicate groups of samples (or data dumps) collected during distinct storm events throughout the water year. For this site, storm-based turbidity-SSC relationships were used instead of the full year relationships shown above.

2.4 Sources of error

2.4.1 Rating curves

I continued, to the extent possible, the process my predecessor used to create rating curves. Total sediment loads were calculated as the product of suspended sediment concentrations and discharge, estimated at 15-minute intervals based on models derived from measured data. High discharges, if estimated from rating curve extrapolation, included more uncertainty than lower discharges, and that error was propagated through to sediment load estimates during the highest flows. Therefore, differences in high flow estimates due to rating curve creation could have large impacts on sediment yields, even in situations where small or no changes in actual sediment concentrations occurred.

For each monitoring site the file titled “###stage.pdf,” within the “flow_ssc_turb_duration_data_plots” folder, includes an indication of the highest discharge measurement that was included in that site’s rating curve. In WY2017, the percentage of time that flows exceeded those values was exceedingly small (¡1%) for all sites except Mid-Freshwater Creek (site 502), which was 4%. For flows that fall within the well constrained rating curves (the majority of flows), the uncertainty in estimated discharge values is likely below ±5% (Whiting, 2016). For flows above the highest measured discharge, uncertainty may be greater. 95% confidence intervals (CI) are reported for peak flows, but are based on the measured points used to construct the high end of the rating curve; therefore the actual 95% CI for peak flows may be greater. HRC is in the process of improving high flow discharge estimates by comparing rating curve extrapolations to additional indirect measurement techniques.

2.4.2 Suspended sediment sampling

The combination of substrate characteristics, common rainfall intensities, and small size of many of our monitoring basins often produces streamflow responses that rise and fall quickly during and after a rainfall event. Ideally, point suspended sediment samples would be collected at flow depths associated with the average suspended sediment load for a given channel, which changes as a function of flow depth and sediment size. The sampling infrastructure used at HRC monitoring sites allows for adjustment in the SSC input tube, but changes must be completed manually. In practice, the SSC input locations are adjusted as base flow rises throughout the winter season, but are rarely adjusted on a storm-event basis. At times during certain storms, the input tube may end up close enough to the river bed to collect bed load in addition to suspended sediment. Samples with obvious bedload are flagged during lab analysis and excluded from predictive sediment models. When samples are less obvious and not flagged, suspended sediment concentrations may be biased high. Suspended sediment concentrations may therefore over-predict total sediment yields. Sediment values are reported to no more than two significant figures to account for this uncertainty.

2.4.3 Proposal to end monitoring at Mid-Freshwater (site 502)

HRC would like to end monitoring indefinitely at the Mid-Freshwater site (502), beginning in WY2019. HRC will continue to collect data from site 502 for the remainder of WY2018. Site 523 would continue to operate downstream from 502 on the Upper Freshwater main stem, just before its confluence with the South Fork, and site 500 would continue to operate at the mouth of Beck's Tributary, which is the largest class I watercourse between site 502 and site 523. Logistically, site 502 is difficult to access and maintain, and it lies within the well-instrumented portion of the Upper Freshwater drainage. For these reasons, site 502 often receives lower priority during storm events than more critical monitoring stations. High flow discharges are also difficult to measure at 502, and in WY2017 a higher percentage of flows exceeded our highest measured discharge (4%), than at all other sites (¡1%). High flows at 502 have greater uncertainty, which is then propagated through to calculated sediment yields. The marginal added benefit of the site is outweighed by the cost in money and time needed to keep it operable. Site infrastructure will remain in place at 502 should HRC find reason to re-start monitoring in the future.

3. WY 2017 DATA SUMMARY

Suspended sediment yields and peak flows are summarized by site in Table 6

Table 6: Summary of annual sediment load and discharge from HRC hydrologic monitoring stations during hydrologic year 2017

Stn #	**Stn name**	**Watershed**	**Upstream drainage area** (km^2)	**Total suspended sediment yield** (Mg)	**Total suspended sediment yield** (Mg/km^2)	**Instantaneous Annual Peak Discharge** (cms) **(95% CI)**	**Instantaneous Annual Peak Discharge** (cms/km^2)
509	MS Elk River	Elk River	111.83	32000	290	74.5 (67.5-82.2)	0.67
510	Lower SF Elk	Elk River	50.34	17000	340	38.6 (32.1-46.5)	0.77
511	Lower NF Elk River	Elk River	56.91	17000	300	46.0 (32.5-65.0)	0.81
517	Bridge Ck	Elk River	5.75	550	96	4.2 (3.6-4.8)	0.73
522	Corrigan Ck	Elk River	4.31	680	160	4.5 (3.3-6.2)	1.04
532	Upper NF Elk River	Elk River	35.08	13000	360	54.6 (43.3-68.9)	1.56
683	WB Railroad Gulch	Elk River	1.48	1300	880	1.2 (0.9-1.6)	0.81
684	EB Railroad Gulch	Elk River	1.28	1700	1400	1.2 (0.8-1.8)	0.94
500	Beck's Tributary	Freshwater Ck	2.17	270	120	2.5 (2.0-3.3)	1.15
502	Mid Freshwater	Freshwater Ck	17.13	2500	140	17.4 (14.4-21.1)	1.02
504	Cloney Gulch	Freshwater Ck	12.04	1100	88	12.4 (9.4-16.3)	1.03
505	Graham Gulch	Freshwater Ck	6.16	1600	270	12.6 (8.7-18.3)	2.05
506	SF Freshwater	Freshwater Ck	8.19	1800	220	14.3 (11.5-17.7)	1.75
523	Lower Freshwater Ck	Freshwater Ck	22.83	5000	220	31.8 (26.6-37.9)	1.39
526	Upper Freshwater Ck	Freshwater Ck	5.12	330	64	2.9 (2.2-3.7)	0.57
527	McCready Gulch	Freshwater Ck	4.71	370	79	4.4 (3.7-5.3)	0.93
528	Little Freshwater Ck	Freshwater Ck	12	1900	160	15.0 (11.5-19.5)	1.25
530	Bear Ck	Lower Eel River	20.95	8900	420	32.1 (19.0-54.4)	1.53

Supporting data are filed by watershed and site as described below:

3.1 Each monitoring site contains the following folders:

1. "continuous_data_plots"

   (a) Full year, inter-storm and storm event folders, named by storm and regression model used in R software.

      i. "predData.csv" =15-minute date, turbidity and predicted SSC data

      ii. "sed.csv"= dump, bottle #, SSC, turbidity, and discharge for all SSC samples used to model SSC for that storm

      iii. "total.csv" = summary with storm start and end date/time, type of model, SSC predictor ("surr"), total sediment load (kg), number of SSC samples used to model SSC ("n"), r^2 for the model, and standard deviation.

      iv. "turbssc_logxy_fit.pdf" = plot of turb vs SSC correlation for the storm event

      v. "storm1701loxgxy.pdf" = SSC (estimated and samples), turbidity, and Q plots for the storm event

      vi. "###_dischargeSSCPlot.pdf" = discharge and 15 minute modeled SSC (15-minute SSC values are compiled from storm event models unless otherwise indicated).

      vii. "###_StageTurbPlot.pdf" = 15 minute stage and turbidity data with observed stage readings and lab samples included. NOTE: not all lab NTU samples were also run for SSC.

   (b) "###_SedimentSummary.csv" = comprehensive list of totals, with additional information, including:

      i. Storm sediment yields/area, predicted peak Q by storm, and estimated water volume by storm

   (c) "###_ContinuousData.csv" = 15-minute flow (discharge, cms), turbidity (ntu), and SSC (mg/L)

(d) "###_peakQ.csv" = peak discharge (cms/35.315) and associate date/time by storm

(e) "###_peakStage.csv" = peak stage (m) and associated date/time by storm

(f) "###_dischargeSSCPlot.pdf" = 15 minute discharge and SSC over the entire measurement period

(g) "###_stageTurbPlot.pdf" = 15 minute stage and turbidity over the entire measurement period

2. "field_lab_turbidity_relationship"

   (a) "###NTU_Data.csv" = data used in field/lab NTU regression

   (b) "###NTU_DataExcluded.csv" = data excluded from field/lab NTU regression

   (c) "###NTU_Stats.csv" = regression equation information

   (d) "###ntu.pdf"=field vs lab turbidity regression plot

3. "flow_ssc_turb_duration_data_plots"

   (a) "###Exceed.csv" = exceedance data files for flow (discharge), field turbidity, and stage.

      i. Counts are the number of 15-minute measurements in a given category. % of total time, total days, and total hours above each threshold are also included.

   (b) "###.pdf" = exceedance probability plots for flow, NTU and SSC (combined), field turbidity at index probabilities, and stage.

4. "instrument_observer_stage_relationship"

   (a) "###or_Data.csv" = data used in instrument/observer stage regression

   (b) "###or_DataExcluded.csv" = data excluded from instrument/observer stage regression

(c) "###or_Stats.csv" = regression equation information

(d) "###OR.pdf" = E-stage (instrument stage) vs. observer stage regression plot

5. "other_model_input_files"

(a) ".sdr" = stage discharge relationship file, used by TTS adjuster to calculate 15-minute discharge

(b) ".isc" = bottle dump, bottle number, and SSC (mg/L) value, used by TTS adjuster

(c) ".or" = date, time, observed stage (m) used by TTS adjuster

(d) "###_SSC.csv"= datetime and SSC (mg/L) values used by R software

6. "peak_flow_estimate_data"

(a) "Qmax##.csv" = estimate Q max with 95% CI (Clarke, 1999)

(b) "Qmax_data.csv" = rating data used to predict max Q

3.2 Each monitoring site contains the following files:

1. "###_Summary_Info.csv" = relevant station metrics and summary information on sediment load, yield, turbidity, discharge.

2. "Data_comments.csv" = notes from field techs and hydrologist on relevant observations, corrections, troubleshooting

3. "Station###RatingData##.xlsx" = workbook with stage discharge rating data. At a minimum, it includes tabs with all years rating data, rating data used for WY2017 discharge calculations and notes on developing/updating the WY2017 rating curves.

4. "###Streamflow_Stats.csv" = relevant streamflow statistics

5. "Station_###_cross_section_data.xls" = Excel workbook with cross section data. At the least, it includes worksheets with processed data, a summary table, a plot of area change, and a plot of cross sections for all years.

3.3 Additional data included:

1. "rainfall_eureka.csv" = rainfall recorded at the Eureka NWS station between 10/1/16 and 9/30/17
2. "storms17.csv" = storm event time periods used by R to calculate storm event sediment yields
3. Tom's Gulch survey data (included within the Elk River watershed folder)
   (a) "plots_allYears"
      i. "planformComparison.pdf"
      ii. "XS_thalweg_plot_allYears.pdf" = italicized numbers in the upper panel are reach slopes (%)
      iii. "XS1-4_plots_allYears.pdf" = 2016/2017 channel cross section overlay plots

   (b) "plots_change"
      i. "###absolute_area_chart.pdf" = changes in cross sectional area between 2016 and 2017

   (c) "summaryTables" = channel geometry statistics

   (d) "fullData_###.csv" = data files with residuals for each year

   (e) "reach_regressionSlope_stats.csv" = slope equations by reach and year

   (f) "statsSlopeComp.csv" = inter-year statistical comparison of reach slopes

REFERENCES

Clarke, R. T. 1999. Uncertainty in the estimation of mean annual flood due to rating-curve indefinition. 222(1):185–190.

HRC, 2004a. Report of waste discharge elk river.

HRC, 2004b. Report of waste discharge freshwater creek.

HRC, 2004c. SOP-01, site monumenting and documentation.

HRC, 2004d. SOP-02, gaging streams for estimating discharge.

HRC, 2004e. SOP-03, hydrologic station instrumentation methodology.

HRC, 2004f. SOP-04, water quality grab sampling for sediment and field turbidity measurement.

HRC, 2006. SOP-05, laboratory analysis of suspended sediment.

HRC, 2004g. SOP-19, physical infrastructure of a hydrologic station,.

Whiting, P. J. Flow measurement and characterization. In *Tools in Fluvial Geomorphology*. John Wiley & Sons, 2 edition, 2016.