Appendix F.

Implementation of Continuous Suspended Sediment Monitoring in the Santa Clara River at the Freeman Diversion

Freeman Diversion

Multiple Species Habitat Conservation Plan

Prepared by:

United Water Conservation District

"Conserving Water Since 1927"

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IMPLEMENTATION OF CONTINUOUS SUSPENDED SEDIMENT MONITORING IN THE SANTA CLARA RIVER AT THE FREEMAN DIVERSION HEADWORKS

TECHNICAL MEMORANDUM

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To: Murray McEachron, Senior Hydrologist

Date: August 14, 2019

Introduction

Suspended sediment concentrations in the Santa Clara River are highly variable, ranging from less than 10 mg/L total suspended solids (TSS) during summer baseflow periods, to greater than 10,000 mg/L during peak flows, at the Freeman Diversion facility. Measurement of suspended sediment concentrations at the Freeman Diversion facility is important for quantification of diverted sediment loads as well as for making operational decisions related to halting and resuming diversions ("turning out" and "turning in").

Currently, turnout decisions are partially based on so-called "cone tests", which measure the volume of sediment deposition from a water sample from the Santa Clara River in a sedimentation cone for a given timeframe and after addition of coagulant. However, cone tests are not a standard method, are subject to operator error, and can't provide continuous measurements. Therefore, the feasibility of using optical sensors for measuring suspended sediment concentrations was investigated.

Years ago a continuous optical turbidity sensor (Hach Solitax SC) was installed behind the trash rack at the Freeman headworks. The sensor reports TSS concentrations based on a theoretical conversion calculation. The sensor is serviced quarterly by a Hach technician, including a calibration for turbidity. However, the sensor has frequently reported erroneous data (e.g., constant concentrations during the receding limb), and has not been calibrated using laboratory analysis for TSS.

In December of 2019, the sensor wiper cleaning frequency was increased from once every hour to once every five minutes during storm events, in order to reduce fouling of the sensor at high sediment concentrations and the resulting erroneous readings. Also, the accuracy of the continuous optical sensor measurements were determined by comparing to concentrations obtained from grab samples, collected between 2016 and 2019. Grab samples were analyzed for TSS concentrations by FGL Laboratories, and for turbidity by United staff using a Hach 2100P Portable Turbidimeter.

Results

Figure 1A demonstrates a typical pattern of TSS concentrations during storm events, as reported by the optical sensor prior to 2019. Reported sediment concentrations frequently exhibited step changes, rather than smooth patterns as expected. After increasing the sensor wiper cleaning frequency in 2019, reported sediment concentrations appeared more realistic, in that changes were more gradual (Figure 1B).

Measurements by the optical sensor correlate well with measurements by grab sampling and laboratory analysis, for TSS and turbidity (Figure 2). TSS concentrations measured by the optical sensor were generally slightly higher than those measured by grab sampling. While the exact reason for this discrepancy was not determined, it could be caused by the sampling effects due to slightly different sampling locations, depths and volumes between methods, or by the difference in measurement method (optical vs. gravimetric). Regardless of the cause, the good correlation between the two measurement methods allows for calculation of sediment loads and operation of the Freeman Diversion based on measurements by the optical sensor. An operational rule for turning out has not been defined yet, but based on operations during the 2018-2019 season, it should at minimum include a TSS concentration threshold (e.g. between 5,000 and 20,000 mg/l) in combination with information regarding river flow (magnitude, rising or falling).

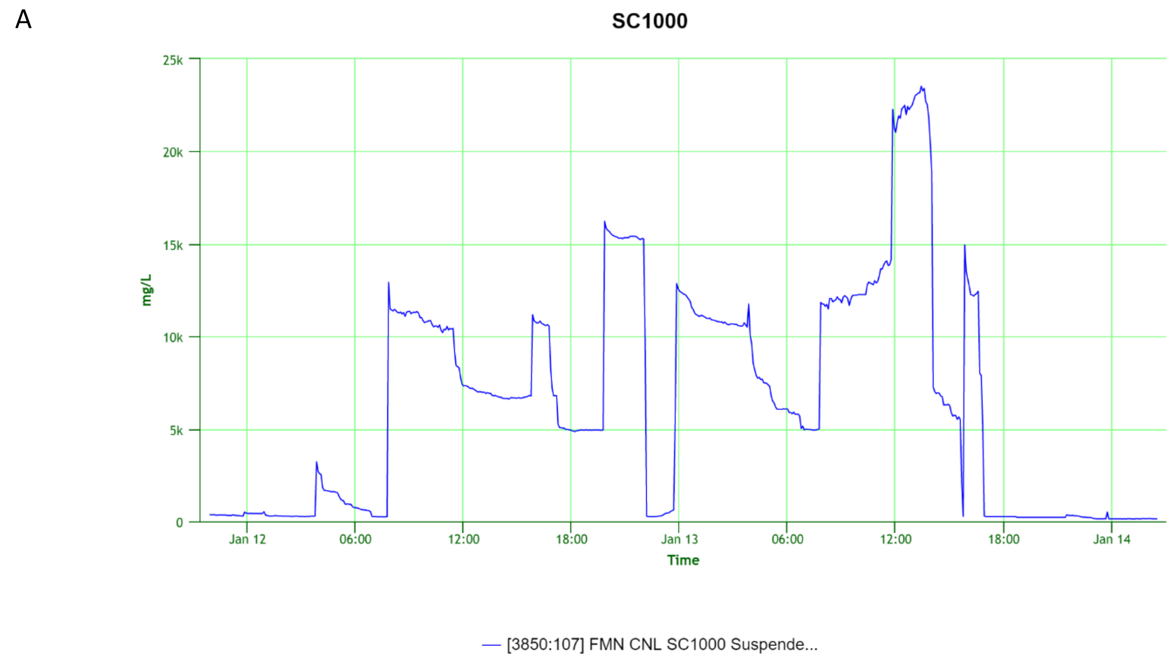
For calculating suspended sediment concentrations and loads, the regression equation shown in Figure 2A can be used. Note that the equation may be updated in the future as more sampling data become available. TSS concentrations measured by the optical sensor could also be used to calculate turbidity based on the equation in Figure 2B, however, this is generally less useful compared to calculating TSS.

Figure 3 illustrates that the optical sensor worked satisfactorily during the 2018-2019 season. Little downtime was experienced, and the TSS concentrations based on grab samples were very close to those reported by the optical sensor.

Conclusions

Continuous measurement of TSS in the Santa Clara River at the Freeman Diversion headworks is feasible using an optical TSS sensor. Sensor measurements are reliable and sufficiently accurate to be incorporated in operational rules for turning out, and for estimating TSS concentrations and loads in the Santa Clara River.

A



B

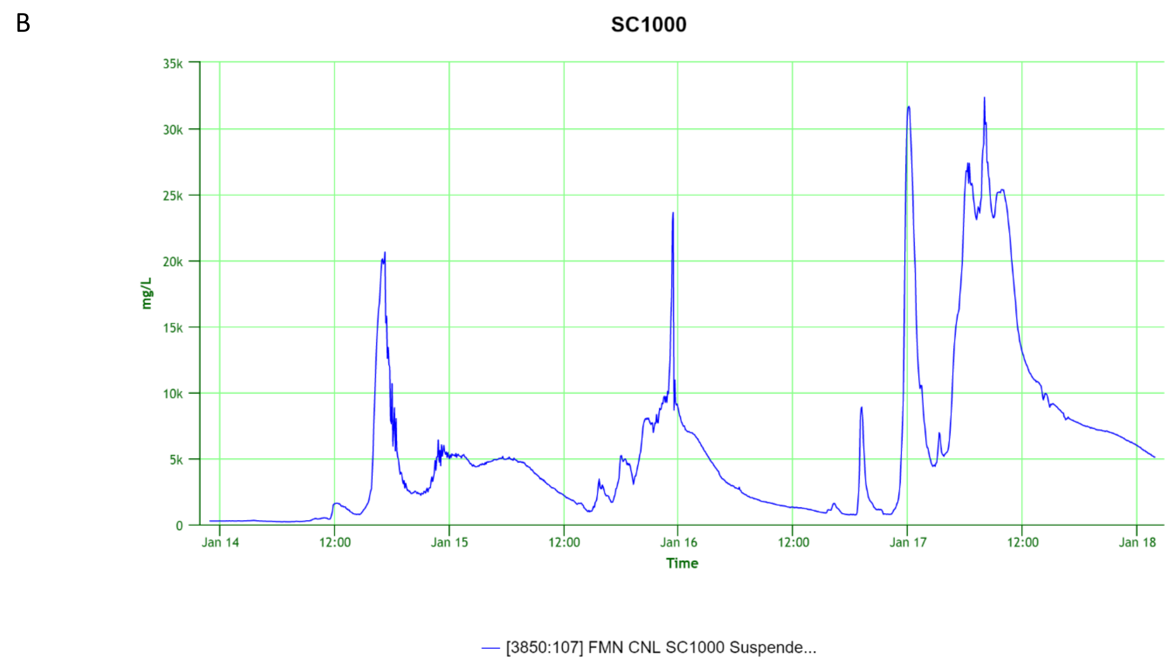
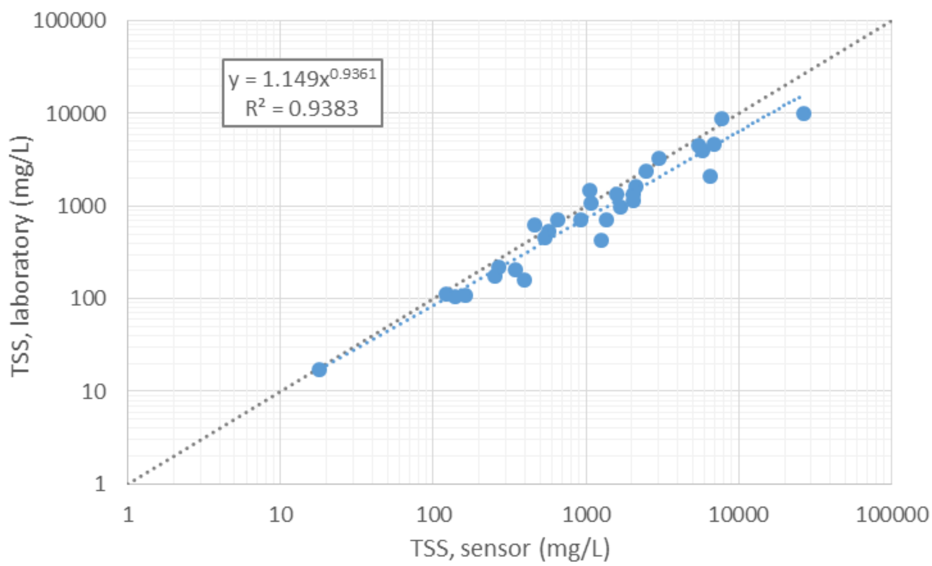


Figure 1. Examples of TSS concentrations reported during storm events by the continuous optical sensor with a one-hour wiper frequency (A) and a five-minute wiper frequency (B).

A



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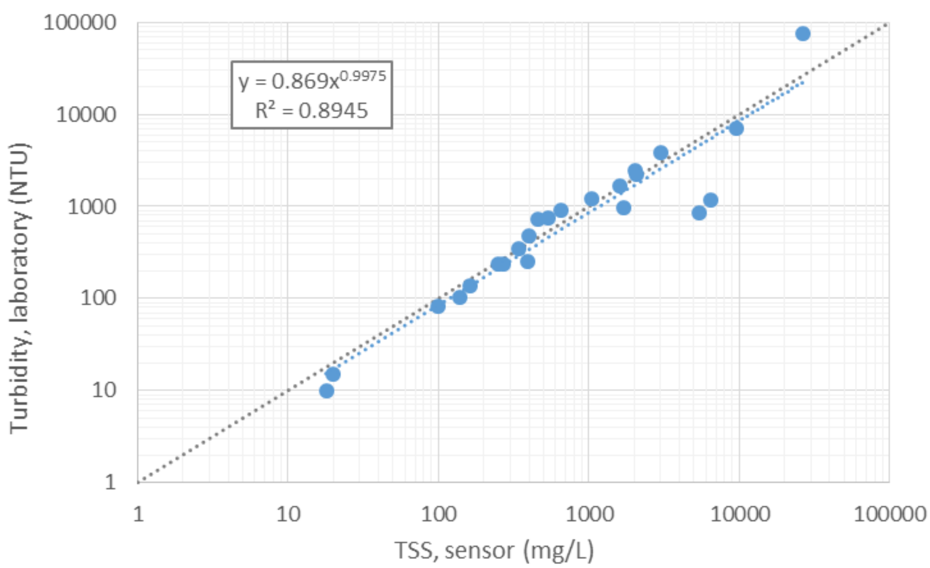

Figure 2. Correlation of measurements by the continuous optical TSS sensor and laboratory measurements of TSS (A) and turbidity (B). Regression curves are indicated by the blue line.

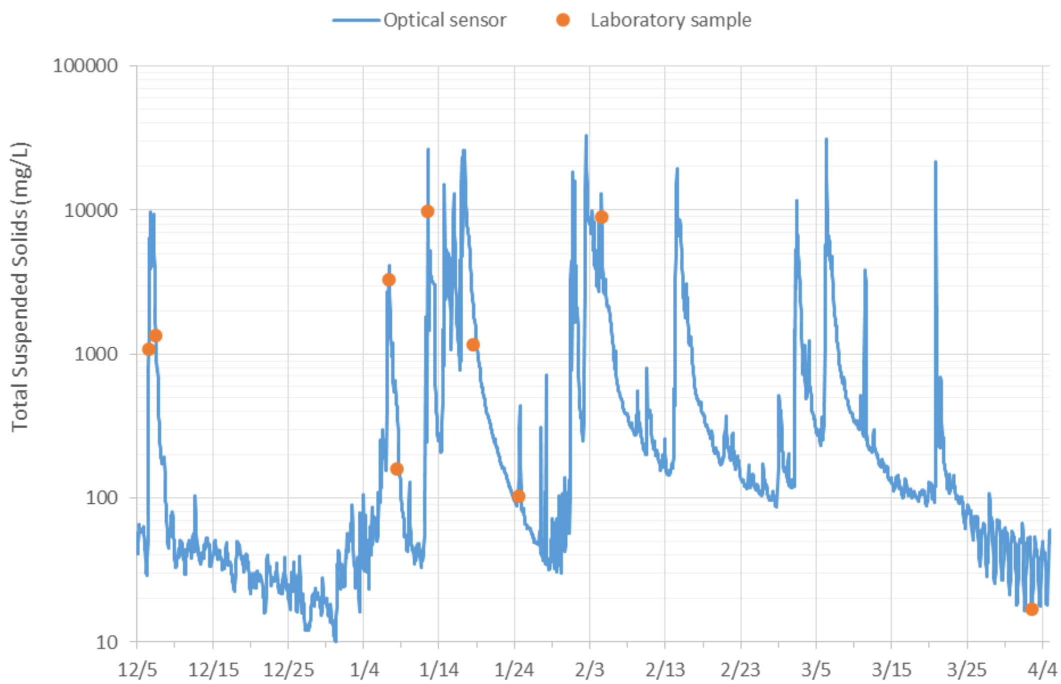

Figure 3. Comparison of TSS concentrations reported by the continuous optical sensor and measurements by grab samples for the 2018-2019 season.