memo

Project Name |	Weather Station Monitoring Program	**Date** |	1/03/2019
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Mike Majeski		
Regarding |	2018 Weather Station QA/QC Summary		

Background

The Weather Station Monitoring Program was initiated in the spring of 2011. Each season the weather station is installed on top of the vegetated berm at the Stillwater Public Works Facility and collects the following data: precipitation, air temperature, relative humidity, solar radiation, wind speed, gust speed, and wind direction. The weather station is programmed to collect data on a 15 minute interval and is operated from spring through fall of each season. This information is being collected to support a variety of District projects and programs including hydrologic and hydraulic model upgrades and calibration, thermal modeling efforts, and other watershed projects. The weather station data is routinely shared with the Washington Conservation District and University of Minnesota (Bill Herb). During the course of the 2018 monitoring season, the weather station data was evaluated for quality assurance purposes by comparing data on a monthly basis to local weather stations. This memorandum summarizes the results of this quality assurance/quality control (QA/QC) process.

QA/QC Summary

The Brown's Creek weather station was installed at the Stillwater Public Works Facility (latitude: 45°03'49.86", longitude: 92°51'21.05") on April 10, 2018 and was removed on October 31, 2018. For quality assurance and quality control of the dataset, 9 individual time periods were analyzed by comparing the data to the nearest weather stations reporting similar data parameters. A review of weather station locations provided by WeatherUnderground.com indicated a personal weather station located 0.37 miles southeast (KMNSTILL 8) and another station located 0.72 miles northeast (KMNSTILL36) of the Brown's Creek weather station. These two weather stations were chosen for comparison because they were the nearest weather stations reporting hourly temperature, relative humidity, precipitation, and wind speed data. The addition of a second weather station was incorporated into the memo this year to provide additional data comparison when data gaps were encountered.

Beginning in April, individual time periods in each month were compared to the personal weather stations for the same time period. For example, the time period selected in April was April 19 at 4:30 for the Brown's Creek station, April 19 at 4:30 for the KMNSTILL36 station, and April 19 at 4:29 for the KMNSTILL8 station. It should be noted that the weather stations did not report at the exact same time, resulting in slightly different timestamps for data comparison. In addition, time periods were selected at different times of the day (early morning, late morning, early afternoon, evening, and night) to compare the data against temperature, relative humidity, and solar radiation extremes. Nine time periods were analyzed from April-October (Table 1).

Table 1. Comparison of Weather Station Data for the 2018 Monitoring Season

Weather Station	Date/ Time	Temp (°F)	RH (%)	Solar Radiation (w/m2)	Wind Speed (mph)	Gust Speed (mph)	24 hr Precip (in)
Brown's Creek	4/19/2018 4:30	17.4	80.9	0.6	0.0	0.0	0.00
KMNSTILL36	4/19/2018 4:30	21.7	81.0	N/A	0.0	N/A	0.00
KMNSTILL8	4/19/2018 4:29	21.4	75.0	0.0	0.0	0.0	0.00
Brown's Creek	5/10/2018 8:30	46.1	61.9	414.4	5.6	12.4	0.00
KMNSTILL36	5/10/2018 8:28	47.5	59.0	N/A	8.0	N/A	0.00
KMNSTILL8	5/10/2018 8:30	46.9	66.0	410.0	4.0	7.0	0.00
Brown's Creek	5/28/2018 15:00	100.2	41.6	789.4	0.0	4.5	0.00
KMNSTILL36	5/28/2018	Station not reporting on this date					
KMNSTILL8	5/28/2018 15:02	96.8	41.0	810.0	0.0	0.0	0.00
Brown's Creek	6/17/2018 11:00	88.7	68.4	772.0	1.1	7.9	0.39
KMNSTILL36	6/17/2018 10:59	90.6	61.0	N/A	2.0	N/A	0.60
KMNSTILL8	6/17/2018 10:59	84.9	35.0	788.0	0.0	1.0	0.36
Brown's Creek	7/12/2018 18:00	68.2	95.7	0.6	0.0	6.8	2.81
KMNSTILL36	7/12/2018 17:59	70.0	93.0	N/A	1.0	N/A	3.72
KMNSTILL8	7/12/2018 17:59	74.0	23.0	0.0	0.0	2.0	0.75
Brown's Creek	8/20/2018 12:15	76.3	80.8	171.9	0.0	3.4	0.22
KMNSTILL36	8/20/2018 12:19	78.3	73.0	N/A	2.0	N/A	0.24
KMNSTILL8	8/20/2018 12:14	76.8	30.0	125.0	0.0	0.0	0.13
Brown's Creek	9/11/2018 14:45	82.0	54.4	639.4	2.3	19.2	0.00
KMNSTILL36	9/11/2018 14:44	85.3	50.0	N/A	4.0	N/A	0.00
KMNSTILL8	9/11/2018 14:44	80.5	57.0	686.0	3.0	6.0	0.00
Brown's Creek	10/2/2018 23:15	51.9	99.0	0.6	0.0	4.5	0.02
KMNSTILL36	10/2/2018 23:13	51.9	96.0	N/A	2.0	N/A	0.02
KMNSTILL8	10/2/2018 23:14	53.5	0.0	0.0	0.0	2.0	0.01
Brown's Creek	10/24/18 19:45	38.7	76.9	0.6	0.0	0.0	0.00
KMNSTILL36	10/24/18 19:43	40.7	73.0	N/A	0.0	N/A	0.00
KMNSTILL8	10/24/18 19:44	42.7	65.0	0.0	0.0	0.0	0.00

Significant deviations in values between the three weather stations occurred with the relative humidity, wind gust speed, and precipitation data. It should be noted that the Brown's Creek weather station was upgraded in the spring of 2016 with a new anemometer, wind direction sensor, and data logger. The relative humidity sensor was replaced in 2014. In addition, EOR calibrated the precipitation logger to a one-inch equivalent rain event prior to installing the weather station in April. Based on comparison between the three weather stations, it appears station KMNSTILL8 had a faulty or obstructed relative humidly sensor during the months of June, July, August, and October. During those months, the relative humidity values from both the Brown's

Creek and KMNSTILL36 stations were reporting similar values. All other KMNSTILL8 relative humidity values for the remainder of the season were similar to the Brown's Creek and KMNSTILL36 weather stations. Differences in wind gust could be influenced by differences in measuring equipment, location, age of the anemometer, logging rate and time, and landscape obstructions such as buildings, trees, and topography. Differences in precipitation can be influenced by tree and buildings obstructions, clogging of the precipitation funnel, and differences in rainfall intensity and duration between weather stations. Since the Brown's Creek weather station precipitation logger was calibrated prior to installation in 2018, it is assumed the recorded data was accurate throughout the monitoring season. It is unknown if obstructions or clogs occurred at the KMNSTILL8 and KMNSTILL36 weather stations, or if they were recently calibrated.

Conclusion

With the upgrades to the Brown's Creek weather station, the District can expect several years of good operating performance from the weather station. The pyranometer (solar radiation sensor) was inspected in 2018 and was determined to be in good condition based on an assessment of the filter window and color. The filter window should be white at all times; if the filter window begins to fade to a dull yellow color or darker, the sensor will need to be replaced. No sensors need to be replaced at this time.

Recommendations

In early spring of 2016, Stillwater Public Works staff cut down the box elder trees that were growing along the berm where the weather station is located. Unfortunately, sucker growth has occurred around each cut stump, and it is unlikely that any herbicide was applied to the stumps when the trees were cut. The suckers have now grown to over 10 feet in height and will need to be removed before the weather station is re-installed in March/April of 2019. EOR will contact Stillwater Public Works again to inquire if they can conduct the cutting and herbicide application before the weather station is re-installed. The cost to coordinate this effort easily fits within the existing 2018 Weather Station Program budget, so no action item is needed at this time. If Stillwater Public Works Staff are unable to perform this work, EOR will cut the trees and coordinate with Tara Kelly with the Washington Conservation District to apply herbicide to the cut stumps.

2019 Scope of Services

The following scope identifies the costs associated with the collection and review of weather station data for the 2019 monitoring season (March to November). This scope includes the cost to prepare a memo describing the quality control used to evaluate data integrity and to forward the data to the Washington Conservation District, University of Minnesota, and other entities as requested.

Task	Hours	Estimated Cost
Equipment Prep and Installation of Weather Station	5	$595.00
Monthly Download of Data	7	$833.00

End of Season Equipment Removal	4	$476.00
Data Storage, Quality Control memo, and Distribution to the WCD	9	$1,071.00
Expenses	N/A	$100.00
TOTALS	**25**	**$3,075.00**

Action Item

1. Authorize EOR to implement the weather station monitoring program in the spring of 2019 per the costs identified in this scope. This work will be completed by December 31, 2019.