Streamflow Monitoring in the Walla Walla Basin

2020-2021 Water Year

FINAL REPORT

Submitted: February 2022

In Cooperation with:

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Abstract

This project has 24 existing surface water monitoring locations in the Oregon portion of the Walla Walla basin in Umatilla County near Milton-Freewater. The project collects streamflow data in the Walla Walla River, its tributaries, and its distributaries. Data are needed to guide current planning efforts aimed to address the Basin's inadequate water supply to meet the needs of aquatic life and agricultural and municipal uses. The data collected are helping guide the Walla Walla Water 2050 planning process, the Walla Walla Basin Integrated Flow Enhancement Study, the USGS basin-wide Surface and Groundwater Study, and have been incorporated into both Oregon and Washington state databases. Data collection and sharing allows basin stakeholders to adaptively manage projects, design better projects, and create enhanced outcomes. The Walla Walla Basin Watershed Council uses similar guidelines that the United States Geological Survey and other state agencies use for surface water monitoring and base our standard operating procedures on their guidelines.

Introduction

Overview

Since 2002, the Walla Walla Basin Watershed Council (WWBWC) has collected flow data throughout the Walla Walla River Valley and currently monitors 24 sites in Oregon on the Walla Walla River, its tributaries, springs, small order streams, and irrigation ditches. Twelve near real-time gauge stations transmit data published hourly on our website at www.wwbwc.org for use by basin partners, state and federal entities, and the public. Seven stand-alone monitoring sites are instrumented with data loggers we download quarterly for data processing and online publishing.

The primary objectives of WWBWC's streamflow monitoring are to:

- Inform water and fisheries management decisions
- Provide data for surface water/groundwater modeling projects
- Monitor the effectiveness of projects implemented by the WWBWC

Streamflow Monitoring Area

The Walla Walla basin covers an area of approximately 1,760 square miles. It lies on the western side of the Blue Mountains, about 70 miles west of where the border between Oregon and Washington meets the Idaho border (Figure 1). The Walla Walla River flows westerly from its headwaters in the Blue Mountains into the Walla Walla Valley. The river then heads north with a large portion of the flow being diverted into a distributary network that delivers winter and spring flows across the valley floor. Historically, these distributary channels provided off-channel habitat for fish and other wildlife and also allowed for a significant amount of water to seep into the soil and recharge the valley's unconfined shallow alluvial aquifer system. The decline of the shallow aquifer has been document for several decades and has led to substantial investment by local, state, and federal entities in artificial aquifer recharge projects designed to restore historic function and provide for agricultural needs.

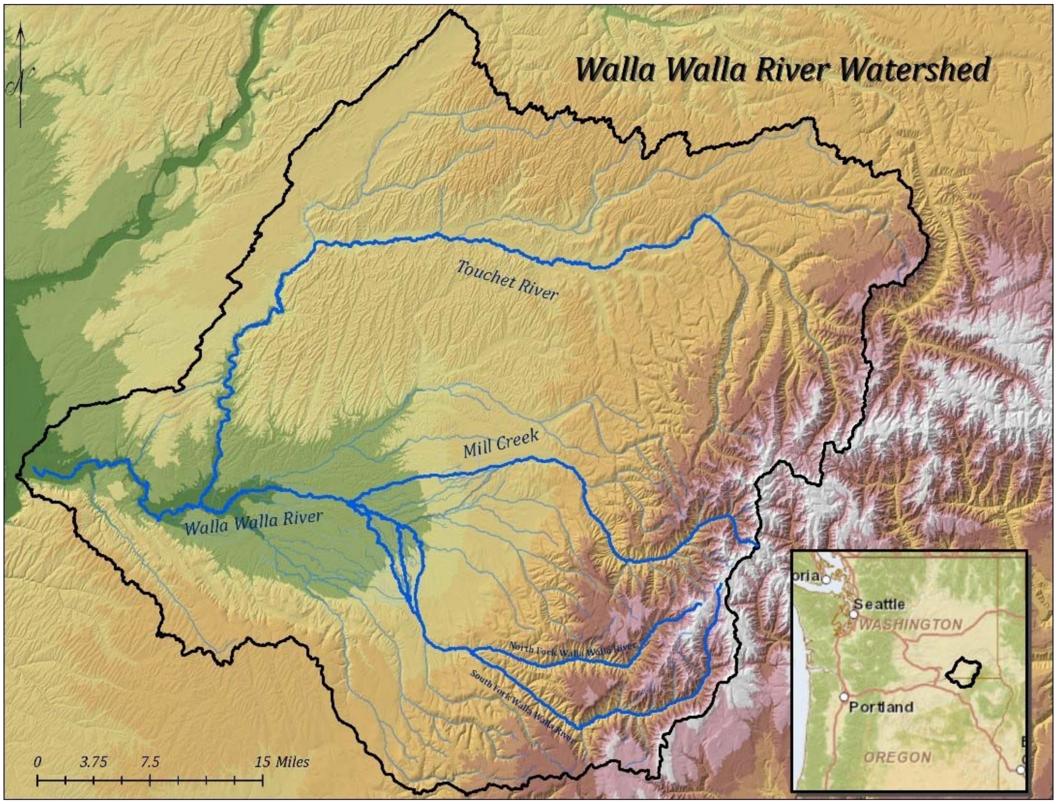

Figure 1. The Walla Walla Basin, a bi-state watershed

Flow monitoring sites are divided into six different regions of the watershed (Figure 2):

1. Walla Walla River
2. Little Walla Walla River system, including its associated irrigation canals
3. Mud Creek system
4. Pine Creek and the Hudson Bay District Improvement Company irrigation system
5. Mill Creek system
6. Touchet River system

The number of currently operating sites in each region is shown in Table 1. Monitoring site locations were developed in coordination with Oregon Water Resources Department, local irrigation districts, and other basin partners. Please see Figure 3 for a map of monitoring locations.

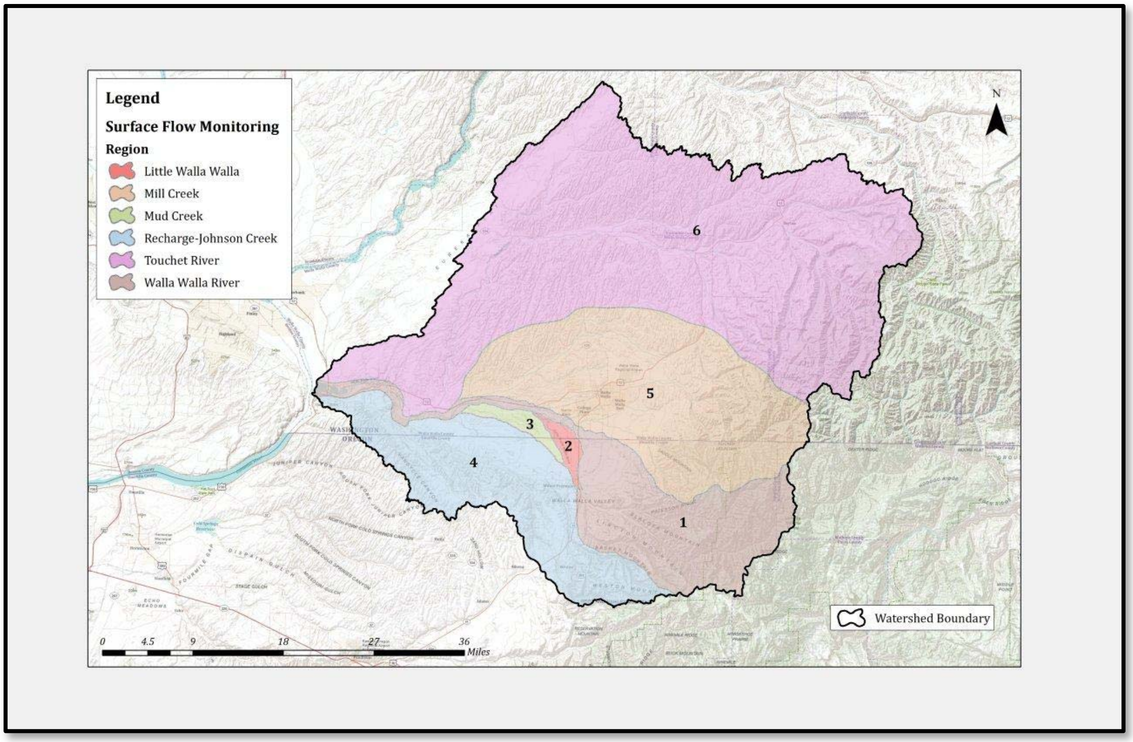

Figure 2. WWBWC Streamflow monitoring sites are organized according to the regions depicted above.

Region	# of Sites
1: Walla Walla River	6
2: Little Walla Walla River/Walla Walla River Irrigation System	10
3: Mud Creek/Fruitvale Irrigation System	2
4: Pine Creek/Hudson Bay Irrigation System	6
Total	24

Table 1. Distribution of WWBWC's current Flow Monitoring Sites

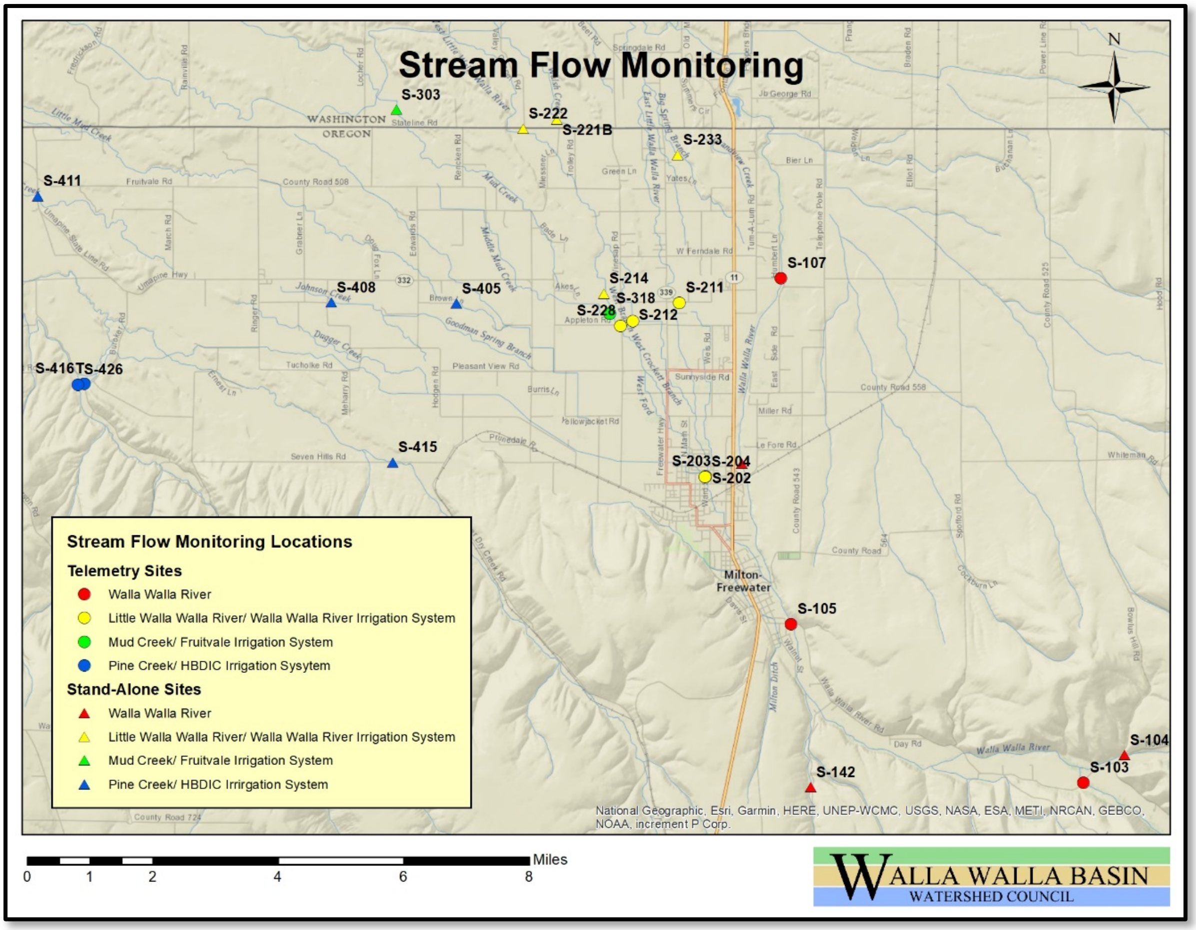

Figure 3. Map showing streamflow monitoring sites as of September 2021.

Methods

Our standard operating procedures are based on USGS, Washington, and Oregon state methods for streamflow monitoring. All flow monitoring activities were conducted according to WWBWC Monitoring Program Standard Operating Procedures[1], which were updated in 2018 to reflect industry standards and the current flow monitoring equipment available.

Near Real-Time Monitoring Sites

Since 2013, WWBWC has strategically installed real-time flow monitoring sites where hourly flow data can benefit the public, tribal, state, and federal agency staff and local resource managers. Figure 4 shows an example of a near real-time monitoring site. Twelve stream sites were monitored during the 2021 water year using near real-time telemetry equipment. WWBWC used electronic sensors and data loggers manufactured by Campbell Scientific, WaterLog, and In-Situ, Inc. to record gauge height at a programmed interval (typically every 15 minutes). These stage data

[1] Walla Walla Basin Watershed Council (2018). *WWBWC Standard Operating Procedures – Version 1.3.* http://wwbwc.org/images/Monitoring/SOP/WWBWC_SOP.pdf

were relayed to the WWBWC office using satellite or radio telemetry and then processed through customized rating equations (see details below) to produce discharge values that were published hourly online.

Monitoring staff visited the near real-time sites every two weeks to read the staff gauges and visually inspect equipment. Manual discharge measurements were taken approximately every six weeks using a SonTek FlowTracker Handheld Acoustic Doppler Velocimeter, Marsh-McBirney Flo-Mate 2000 flow meter, or Price AA current meter (Figure 5). Water temperature was measured using a calibrated NIST-traceable YSI 30 handheld meter (www.ysi.com).

Figure 4. At this near real-time monitoring site on the Walla Walla River (S-107), a cabled sensor, secured to a boulder in the channel, collects water level data. A communication cable transmits the information to a data logger and radio housed in the gauge box. Using radio telemetry, water level and temperature data are sent to the WWBWC office to be processed and published online.

Figure 5. Staff setting up a bridge board flow measurement on South Fork Walla Walla River (S-103) using a Price AA current meter and AquaCalc Pro Plus.

Stand-Alone Flow Monitoring Sites

Many of WWBWC's streamflow monitoring sites are stand-alone stations not equipped with telemetry capability. We visit these sites quarterly to take stage and discharge measurements and to download data. For the 202 monitoring period, these sites were equipped with Solinst or In-Situ, Inc pressure transducers programmed to log water level and temperature measurements at a set interval (typically every 15). Figure 6 shows an example of data logger deployment in a perforated PVC stilling well anchored to an ecology block in the Walla Walla River.

A monitoring technician visited each site every three months to read the staff gauge and take a manual discharge measurement. Also, during the quarterly visit, stage and water temperature data were downloaded from the logger, site maintenance was conducted (for example, weeds or other debris removed), the water temperature was measured, and photographs were taken.

Most of WWBWC's streamflow monitoring sites have been surveyed with survey-grade Magellan GPS units, providing accurate coordinates and elevations used for mapping and analysis.

Figure 6. At this stand-alone monitoring site on the West Little Walla Walla River (S-222), a staff gauge and perforated PVC stilling well enclose a suspended pressure transducer. These are the typical components installed at stand-alone monitoring sites that were visited quarterly for manual data download

Data Processing and Analysis

Data were processed using Aquatic Informatics AQUARIUS Time-Series software (www.aquaticinformatics.com). Water height recorded by data loggers was plotted with staff gauge readings. Offsets and drift corrections were applied as warranted. All data corrections were documented within the software and annually reviewed for approval. An explanation of data gaps can be found in Appendix A.

Customized stage-discharge relationship equations were developed using the AQUARIUS rating curve tool. The tool utilized a logarithmic plot of stage and discharge measurements to produce a rating equation describing the relationship (Figures 7-8). Based on that equation, a rating table was created to calculate discharge values for each datum in the logger file and produce a continuous discharge signal for the monitoring period (Figure 9). Rating curves were shifted to reflect channel changes caused by high water events and/or seasonal vegetation growth. Figure 8 displays Walla Walla River below Nursery Bridge flow data calculated by processing stage values through the rating curve equation created for that site (Figures 7-8). Discharge values higher than manual measurements were produced by the rating equation and were included in the graph but cannot be considered as accurate as those flows that lie within the boundaries of the points used to generate the curve. The manual flow measurements were plotted with the flow data in the output graphs so that a viewer can see which calculated flows are above those measurements.

For additional detail about data processing and analysis, see our 2018 SOP V1.3.

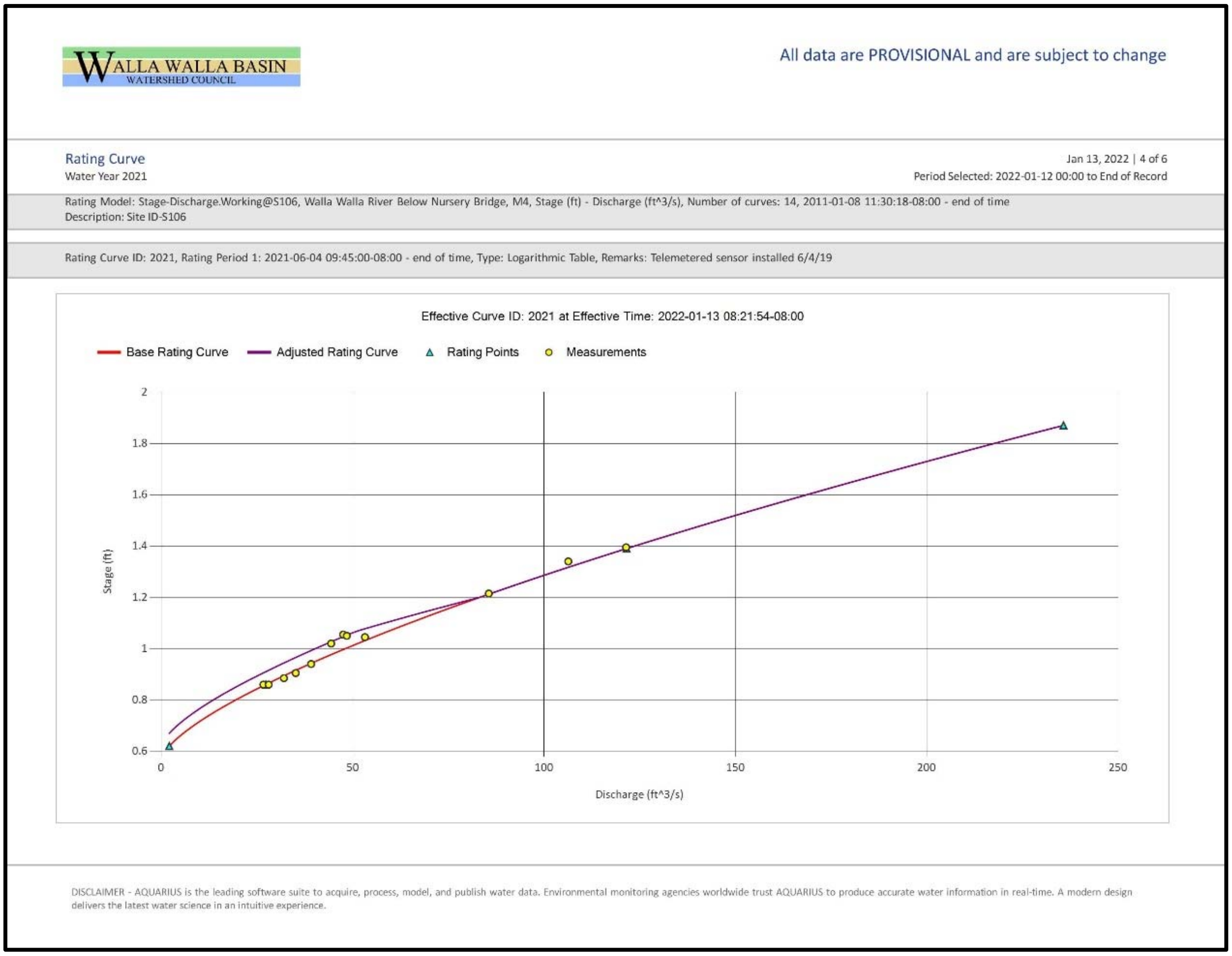

Figure 7. Rating Curve for the Walla Walla River below Nursery Bridge. Yellow dots represent manual discharge measurements. Blue triangles show rating points.

WALLA WALLA BASIN
WATERSHED COUNCIL

All data are PROVISIONAL and are subject to change

Rating Curve
Water Year 2021

Jan 13, 2022 | 5 of 6
Period Selected: 2022-01-12 00:00 to End of Record

Rating Model: Stage-Discharge.Working@S106, Walla Walla River Below Nursery Bridge, M4, Stage (ft) - Discharge (ft^3/s), Number of curves: 14, 2011-01-08 11:30:18-08:00 - end of time
Description: Site ID-S106

Rating Curve ID: 2021, Rating Period 1: 2021-06-04 09:45:00-08:00 - end of time, Type: Logarithmic Table, Remarks: Telemetered sensor installed 6/4/19

Base — Discharge (ft^3/s) — Effective Curve ID: 2021 at Effective Time: 2022-01-13 08:21:54-08:00

Stage (ft)	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.6			2.09	2.73	3.42	4.15	4.94	5.76	6.62	7.52
0.7	8.45	9.42	10.4	11.4	12.5	13.6	14.7	15.9	17.0	18.2
0.8	19.5	20.7	22.0	23.3	24.6	25.9	27.3	28.7	30.0	31.4
0.9	32.9	34.3	35.8	37.2	38.7	40.3	41.8	43.3	44.9	46.5
1	48.1	49.7	51.3	53.0	54.6	56.3	58.0	59.7	61.4	63.2
1.1	64.9	66.7	68.5	70.3	72.1	73.9	75.7	77.6	79.5	81.3
1.2	83.2	85.1	87.1	89.0	90.9	92.9	94.9	96.8	98.8	101
1.3	103	105	107	109	111	113	115	117	119	122
1.4	124	126	128	130	132	135	137	139	141	143
1.5	146	148	150	152	155	157	159	162	164	166
1.6	169	171	173	176	178	181	183	185	188	190
1.7	193	195	198	200	203	205	208	210	213	215
1.8	218	220	223	225	228	231	233	236		

Figure 8. Rating table for the Walla Walla River below Nursey Bridge.

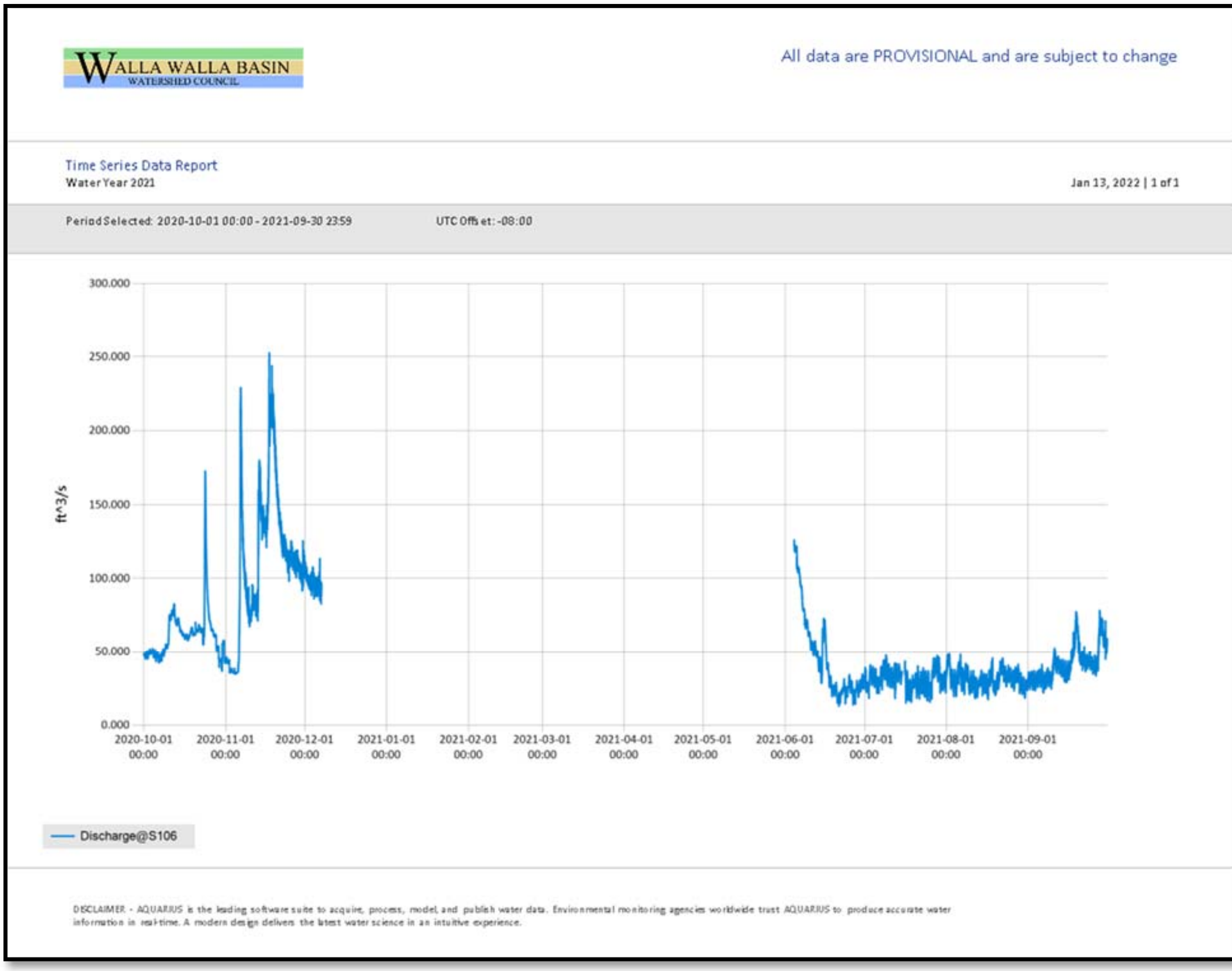

Figure 9. Walla Walla River below Nursey Bridge flow data computed by processing stage data through the rating curve shown in Figure 7.

Data from monitoring sites equipped with flumes and weirs were analyzed using equations or tables provided by the engineers who designed the structures. Occasionally, sites with engineered structures were also rated using the rating curve method described above (i.e., for a damaged weir that no longer conforms to its once-engineered characteristics).

At sites instrumented with non-vented pressure transducers, water level data were corrected to account for atmospheric pressure. Using AQUARIUS Time-Series, barometric pressure collected by one of the transducers located throughout the valley (Figure 10) was subtracted from stage data to produce a corrected signal showing water levels without the influence of atmospheric pressure.

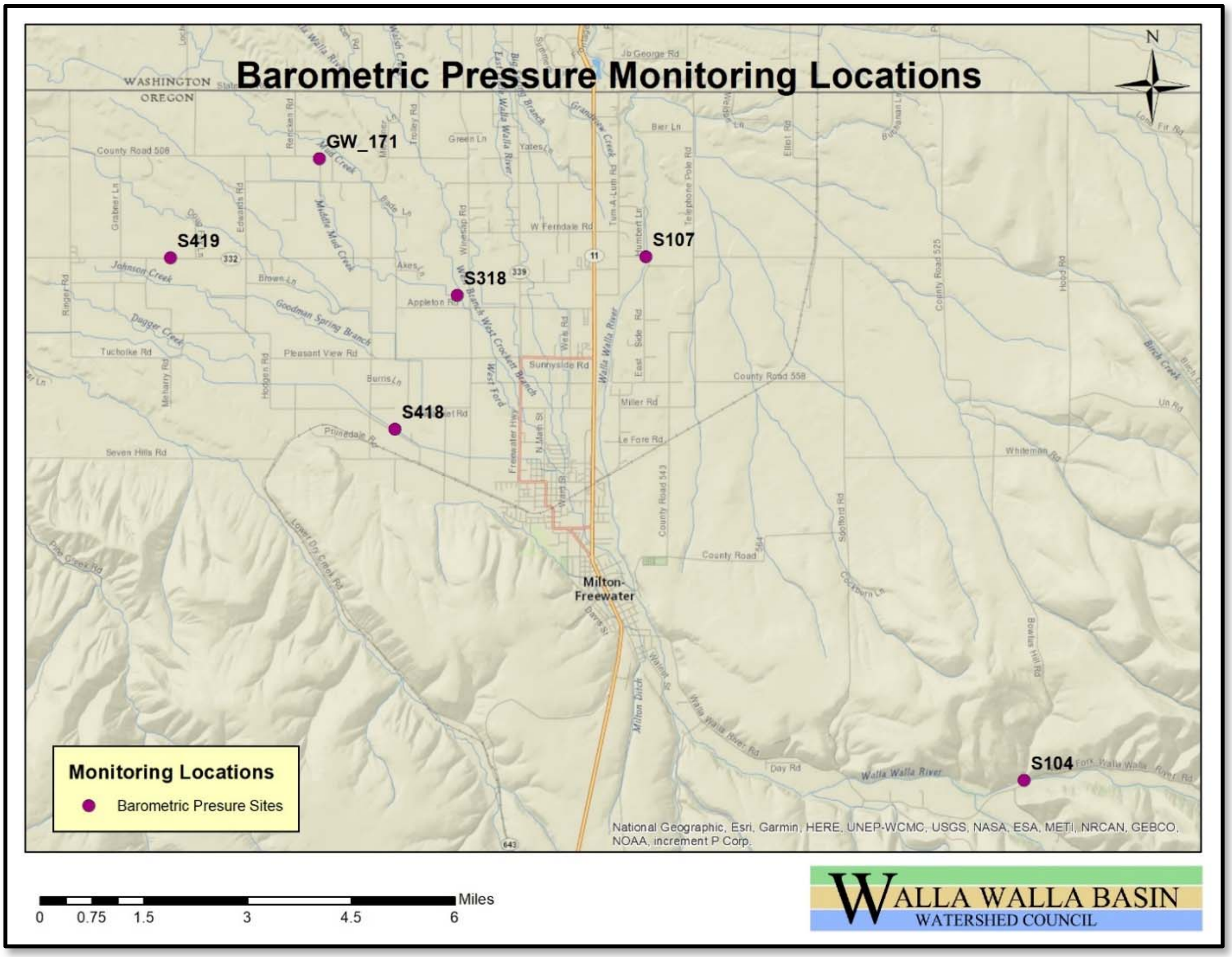

Figure 10. Map showing barometric pressure transducer locations in the Walla Walla Basin.

An essential part of our quality assurance plan is data grading and approval. We graded data in AQUARIUS based on a scale from "Excellent" to "Unusable," which also includes grades such as "Estimated Good," "Dry," "Flooded," and "Undefined." Below is an overview of our grading procedure:

- Water level data imported from data loggers received an "estimated" grade (typically "Estimated Very Good" unless degraded conditions such as seasonal vegetation exist) until our yearly review and approval of data.
- Manual staff gauge readings were graded based on site conditions. When the gauge could be easily read, the data point was rated "Excellent" or "Very Good." If water turbulence or other conditions made accurate reading difficult, the data point was rated "Good," "Fair," "Poor," or "Unusable."
- Manual discharge measurements taken with the FlowTracker ADV were graded based on the instrument's built-in quality control report as well as professional judgment. Based on the "percent overall uncertainty" in the report, we graded the measurement as follows:
  - o Overall uncertainty <2%, grade = Excellent
  - o Overall uncertainty 2-5%, grade = Very Good
  - o Overall uncertainty 5-10%, grade = Good

- Overall uncertainty 10-20%, grade = Fair
- Overall uncertainty >20%, grade = Poor

- Manual discharge measurements taken with the MarshMcBirney Flo-Mate were graded based on measurement conditions.
- Flow data processed through the rating curve were graded based on the quality of stage data in addition to the fit of the curve and site conditions.

Results

Walla Walla River Summer Base Flows

Summertime base flows in the Walla Walla River are supplied, in large part, by basalt groundwater spring inputs in the upper watershed. The South Fork Walla Walla River (S-103) produces most Walla Walla River base flows, contributing between 95 to 108 cfs during August and September, with the lowest daily mean flow of 96.84 cfs occurring on 08/12/2021 (Figure 11). Summer low flows in 2021 were similar to the lows documented in 2018 and 2019 but about two cfs lower than the summers of 2016, 2017, and 2020 (figure 12). Table 2 shows the lowest daily mean flow values with corresponding dates at the South Fork Walla Walla River gauge site during the last six summers.

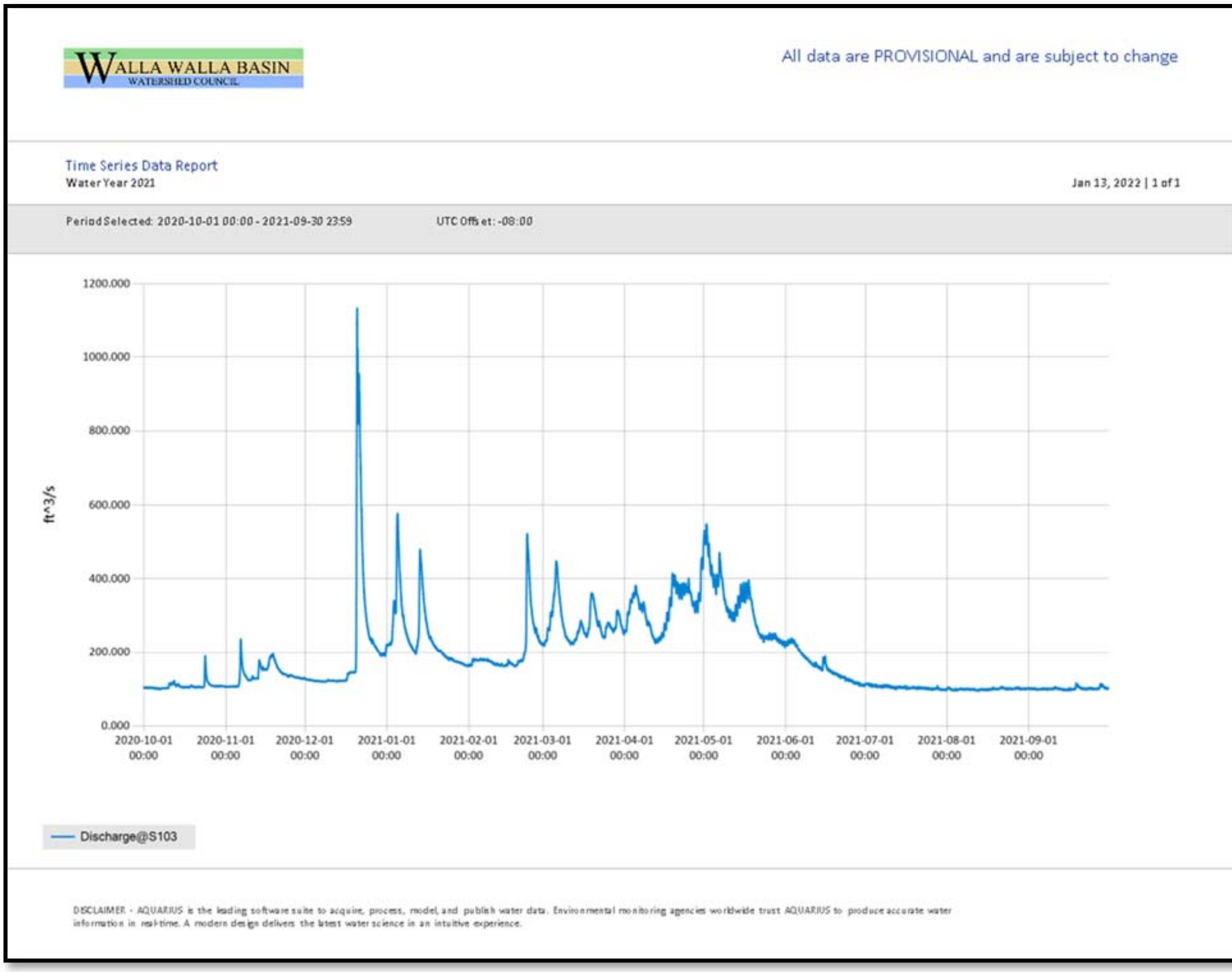

Figure 11. South Fork Walla Walla River near Confluence (S-103) 2021 Water Year Discharge.

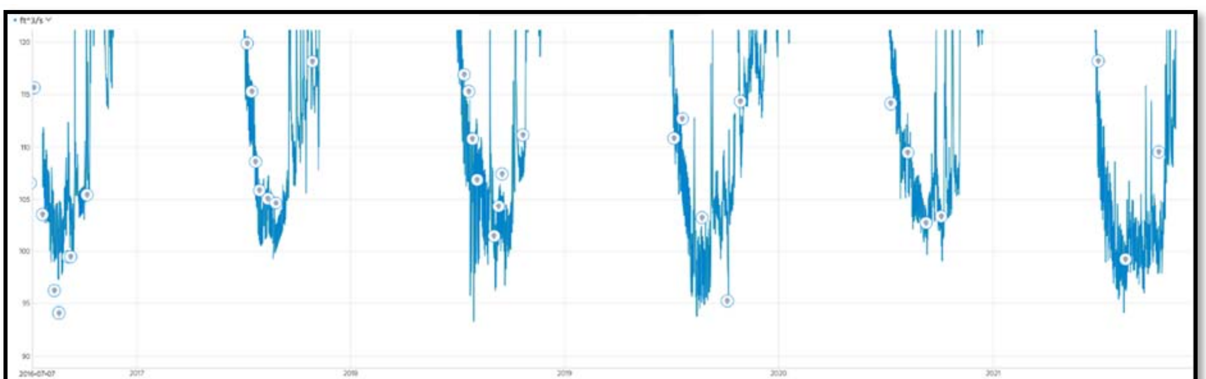

Figure 12. South Fork Walla Walla River near Confluence (S-103) low flow summer months during water years 2016-2021.

S-103 Lowest Daily Mean Flows		
Water Year	**Date**	**Flow**
2016	8/21/2016	100.14 cfs
2017	8/29/2017	101.09 cfs
2018	9/5/2018	98.71 cfs
2019	8/15/2019	96.27 cfs
2020	9/10/2020	101.37 cfs
2021	8/12/2021	96.84 cfs

Table 2. Lowest daily mean flows in the South Fork Walla Walla River near Confluence (S-103) during water years 2016-2021.

The North Fork Walla Walla River (S-104) produced 4 to 9 cfs during the low flow season during August and September (Figure 13).

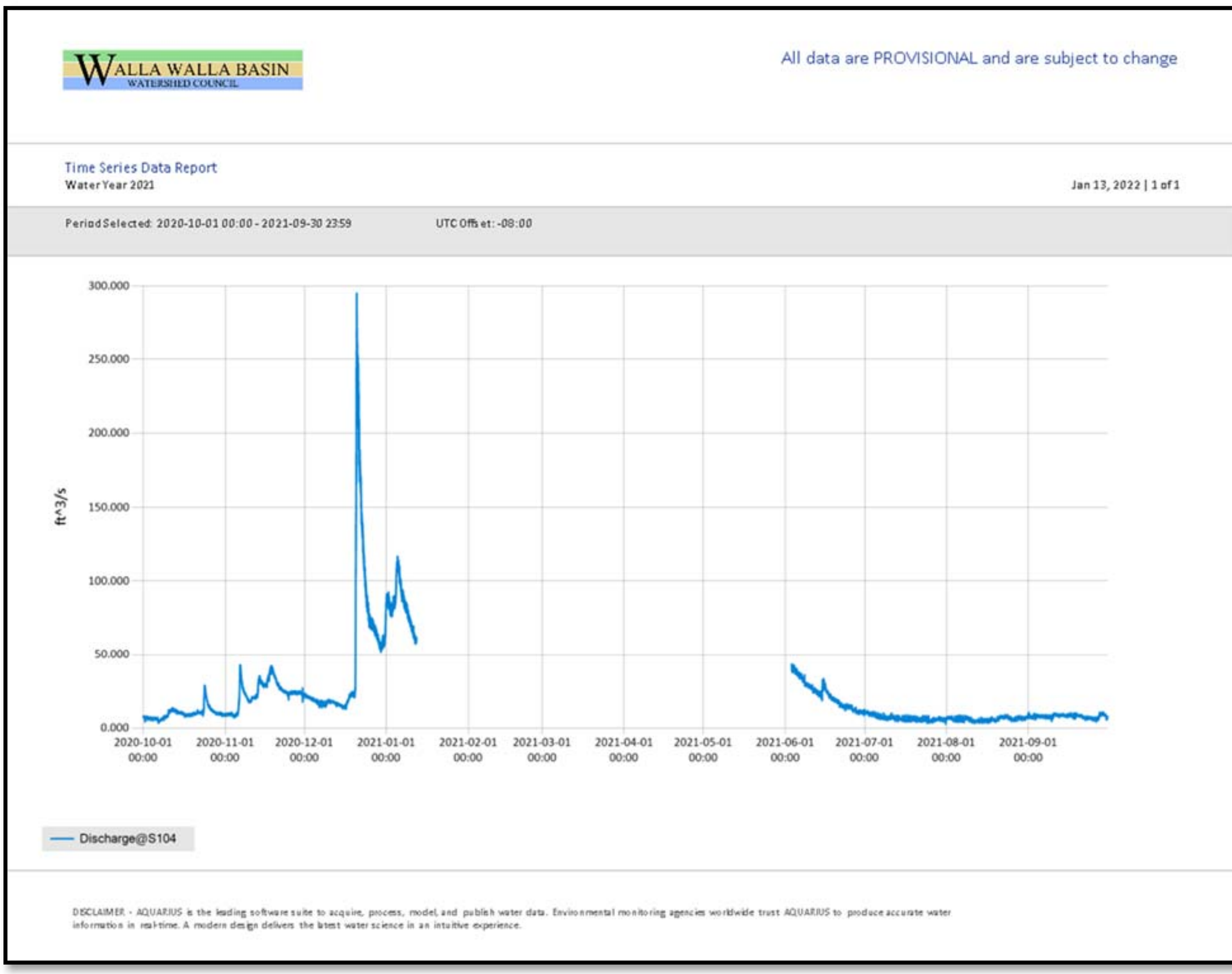

Figure 13. North Fork Walla Walla River near Confluence (S-104) 2021 Water Year Discharge. The gauge was removed during the winter months.

Downstream of the North and South Fork confluence, the Walla Walla River at Milton-Freewater (S-105) had daily mean base flows ranging from 98 to 115 during August and September, with the lowest daily mean flow of 96.92 cfs occurring on 08/16/2021 (Figure 14). Summer low flows in 2021 were in the median compared to previous years (Figure 15). Table 3 shows the lowest daily mean flow values with corresponding dates at the Milton-Freewater gauge site during the last seven summers.

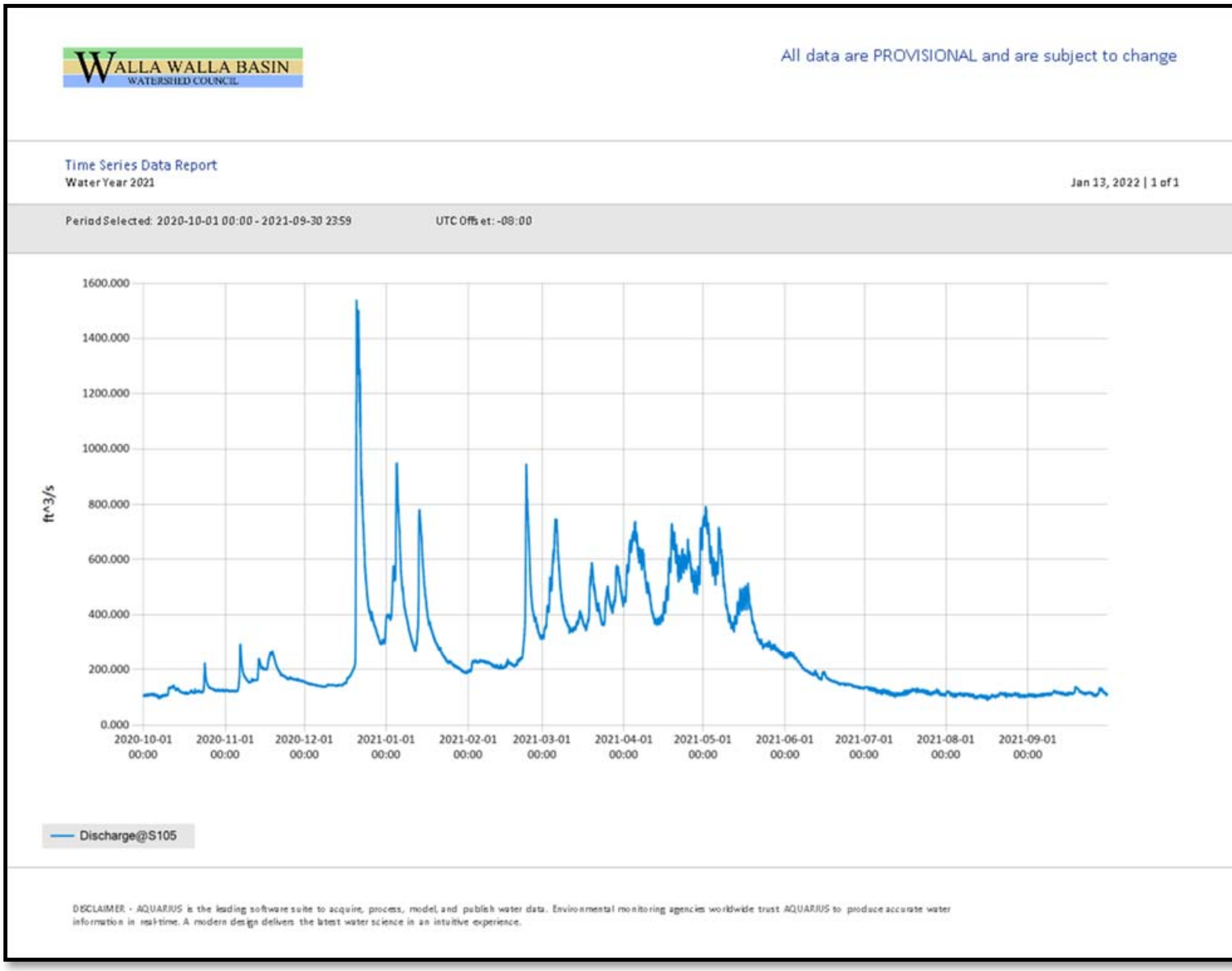

Figure 14. Walla Walla River at Milton-Freewater (S-105) 2021 Water Year Discharge.

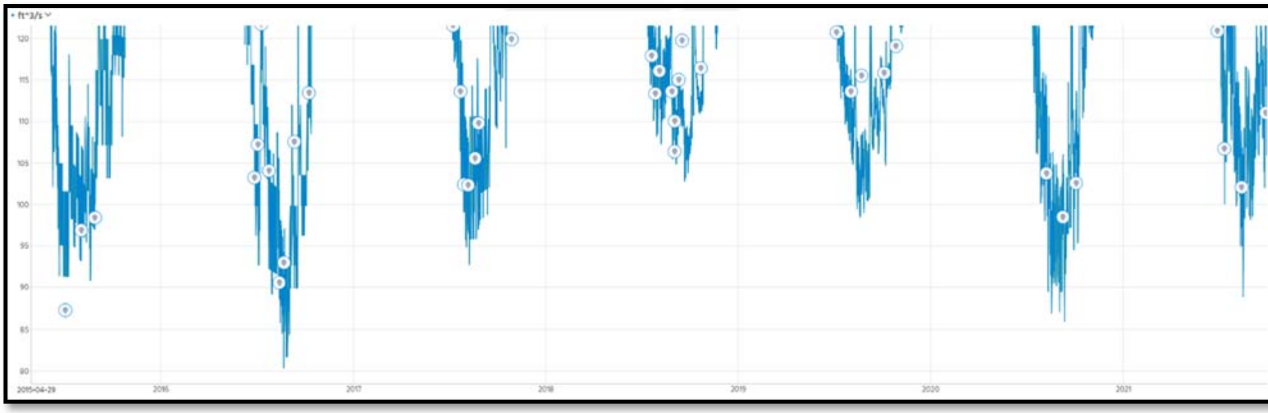

Figure 15. Walla Walla River at Milton-Freewater (S-105) low flow summer months during water years 2015-2021.

S-105 Lowest Daily Mean Flows		
Water Year	**Date**	**Flow**
2015	7/8/2015	99.46 cfs
2016	8/28/2016	87.00 cfs
2017	8/9/2017	98.58 cfs
2018	9/29/2018	106.28 cfs
2019	8/22/2019	101.52 cfs
2020	9/12/2020	91.27 cfs
2021	8/16/2021	96.92 cfs

Table 16. Lowest daily mean flows in the Walla Walla River at Milton-Freewater (S-105) during water years 2015-2021.

Walla Walla River Bypass Flows in Milton-Freewater

The M4 flow gauge records water levels below Nursery Bridge, tracking conserved Walla Walla River water left instream after the primary Milton-Freewater irrigation diversions. Due to extensive irrigation efficiency projects and the collaboration of local water users, over a quarter of available summertime, Walla Walla River water has been permanently conserved as instream water rights. In 2020, June flows dropped from 120 cfs to 20 cfs, while July-September flows fluctuated from 20-40 cfs (Figure 9).

About 2.4 miles downstream of Nursery Bridge, the Walla Walla River below Tum-A-Lum Bridge (S-107) had daily mean base flows ranging from 8 to 18 during July, August, and September, with the lowest daily mean flow of 7.55 cfs occurring on 06/21/2021 (Figure 16).

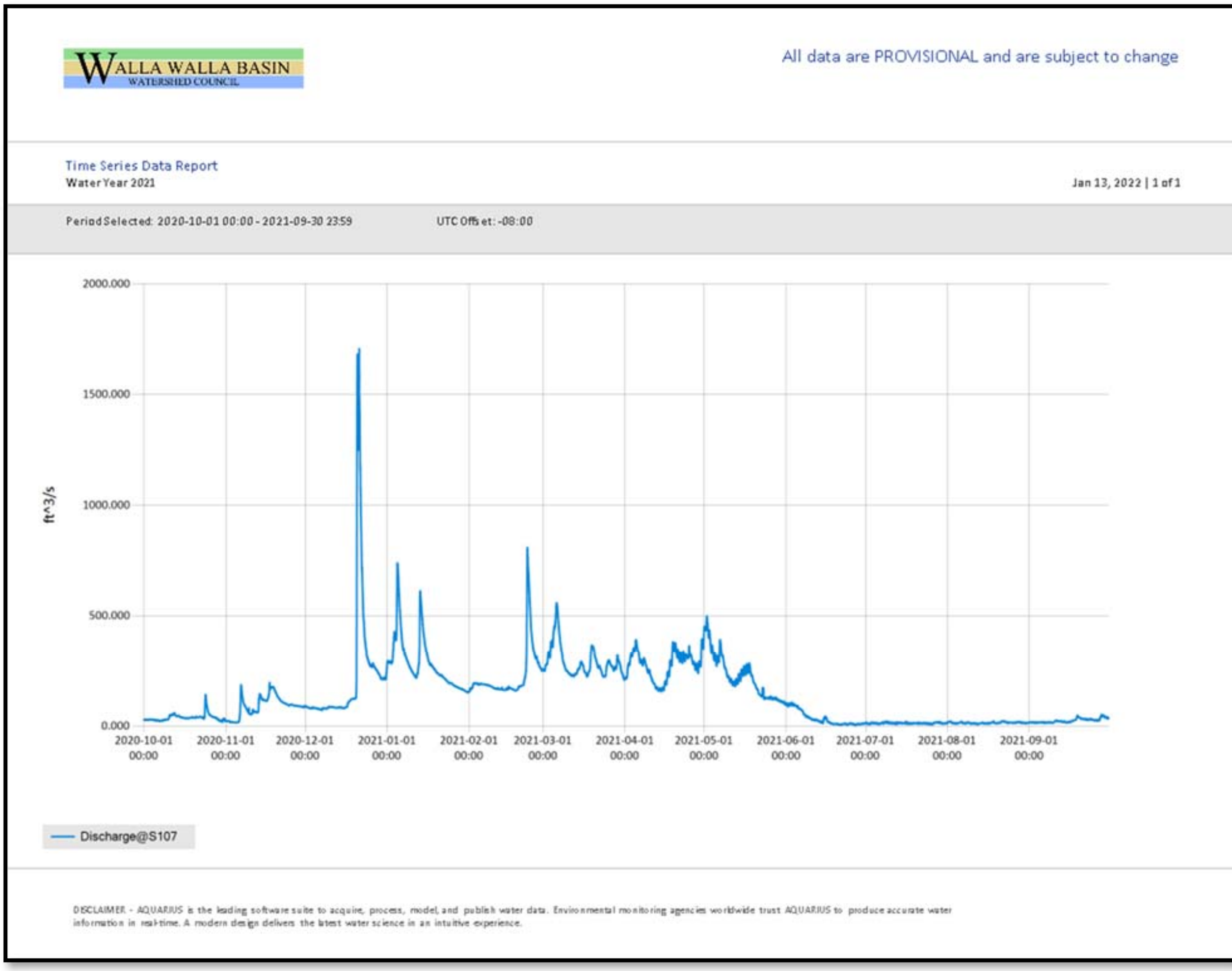

Figure 17. Walla Walla River below Tum-A-Lum Bridge (S-107) 2021 Water Year Discharge.

Walla Walla River Tributaries

The tributaries of the Walla Walla River we monitor are Couse Creek at River Mile 1.1 (S-142), Dry Creek at Seven Hills Road (S-415), and Pine Creek at Schubert Road (S-416T). These seasonal streams are typically dry during the summer months. Tributaries also experienced high flows events in the 2021 water year. Couse Creek peaked at just over 120 cfs (Figure 17). The peaks at Dry Creek at Seven Hills Road and Pine Creek at Schubert Road was just over 250 cfs and 140 cfs, respectively (Figures 18 and 19), although the high peak for Dry Creek is a modeled prediction because the highest manual discharge measurement for the 2021 water year is 91 cfs.

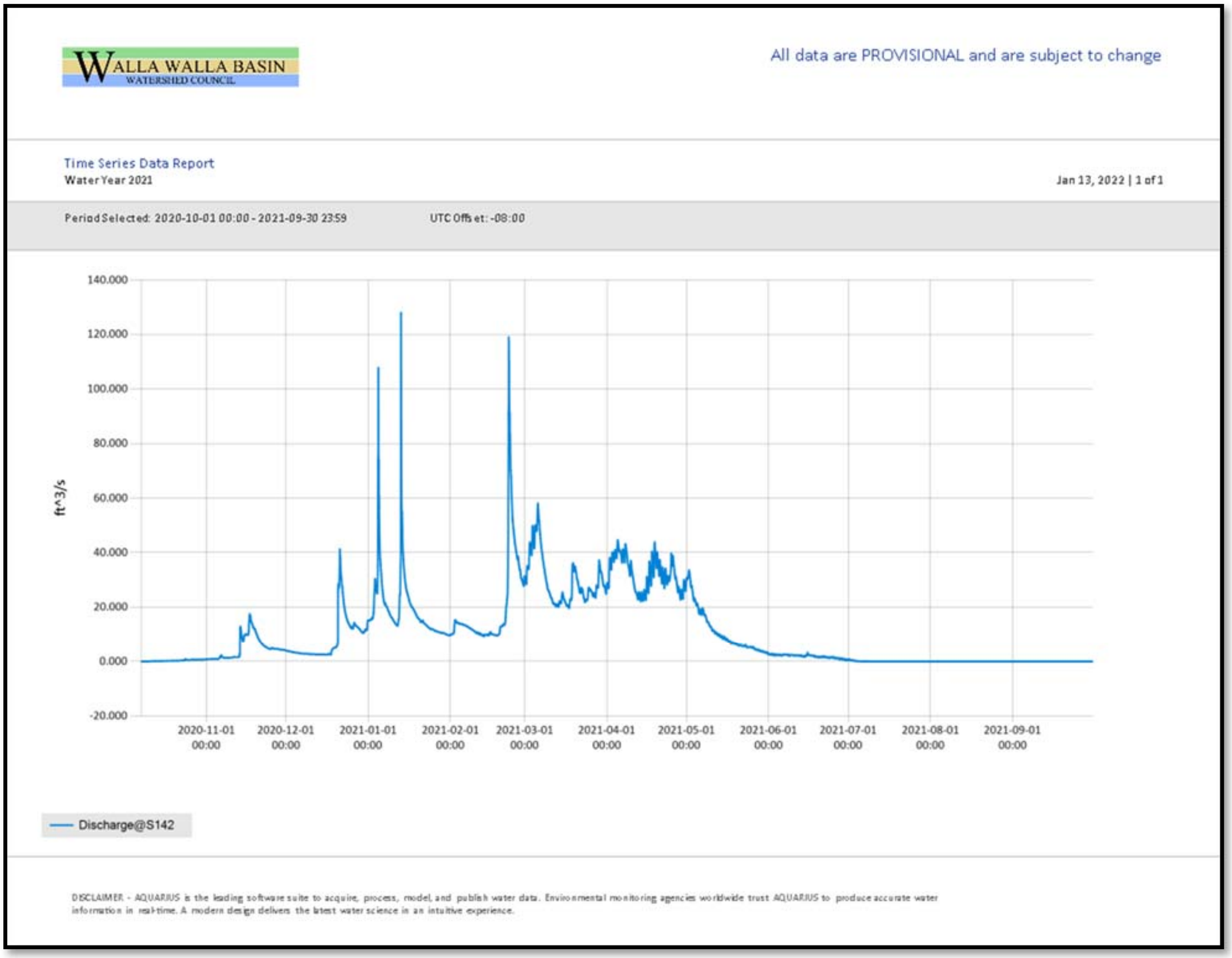

Figure 18. Couse Creek at River Mile 1.1 (S-142) 2021 Water Year Discharge.

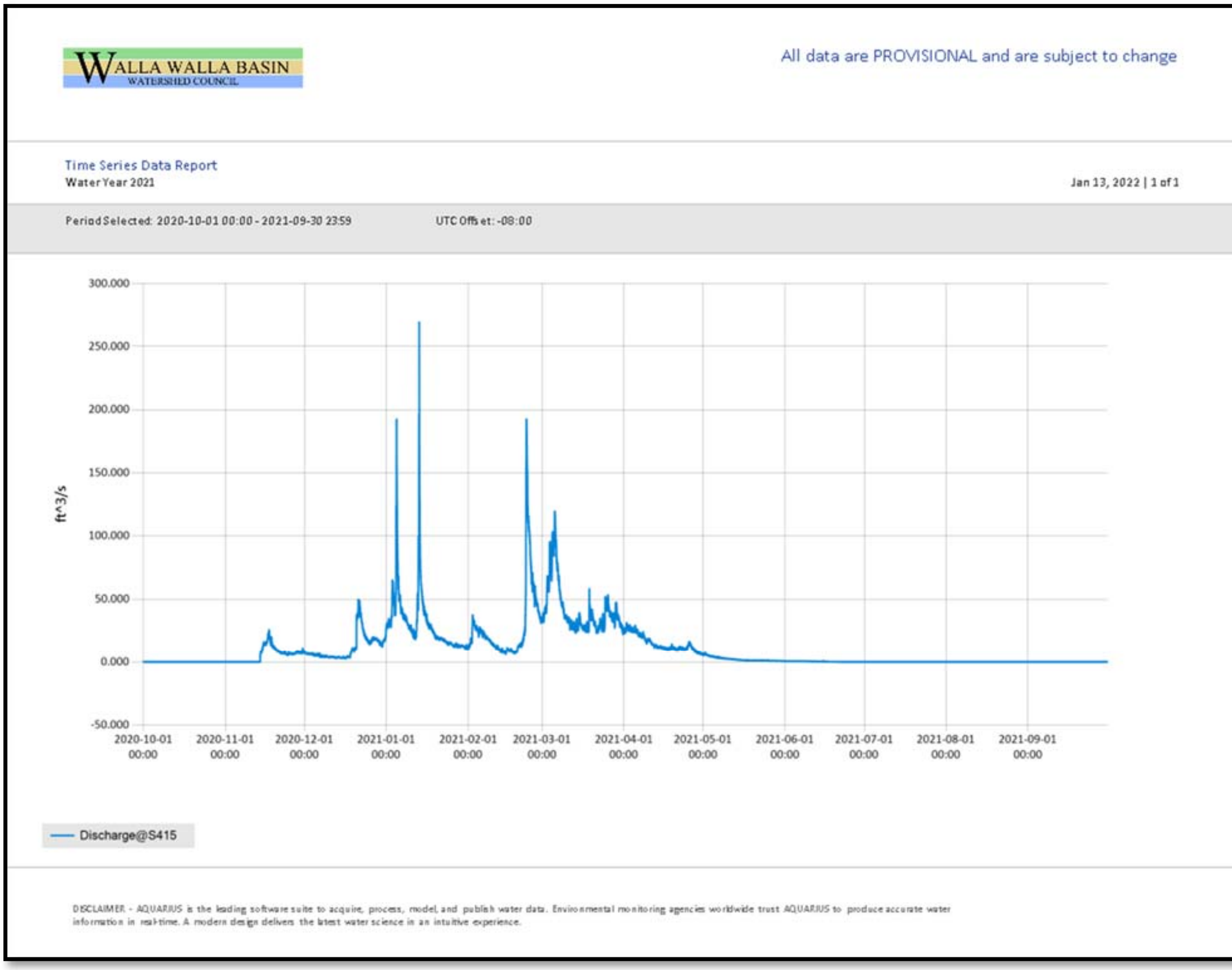

Figure 19. Dry Creek at Seven Hills Road (S-415) 2021 Water Year Discharge.

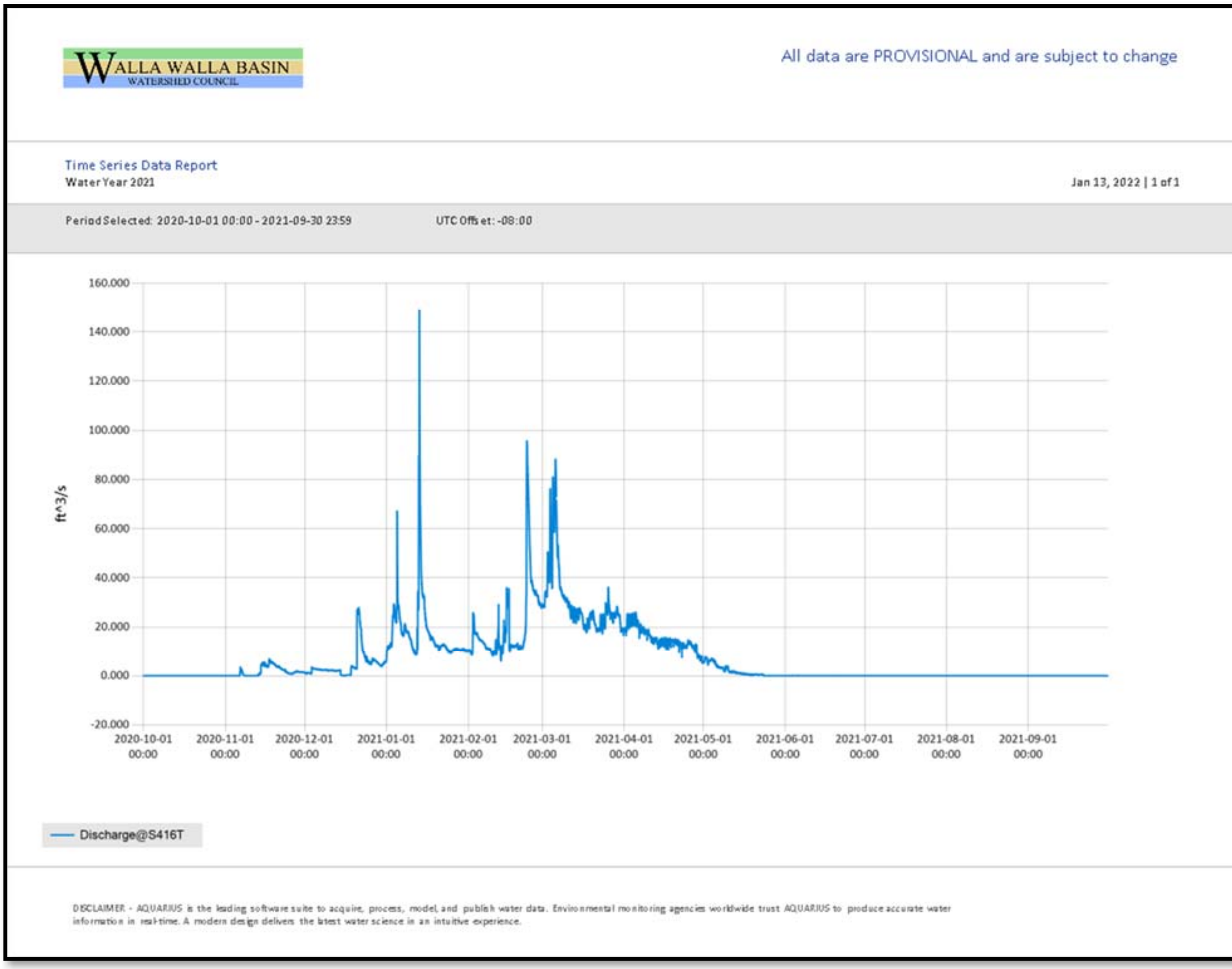

Figure 20. Pine Creek at Schubert Road (S-416T) 2021 Water Year Discharge.

High Flow Event

In the 2021 water year, the Walla Walla River didn't experience a high flow event as severe as previous years. The highest flow event occurred on 12/20/2020, with the peak reaching about 1,500 cfs at Milton-Freewater (S-105). Previous years had high flow events over 4,000 cfs in 2018 and 2019 and over 9,000 cfs in 2020. About 10 much smaller events occurred from January 2021 to May 2021, with ranges between 500 to 1,000 cfs at Milton-Freewater (S-105). The insignificant high flow event in the water year 2021 suggests the snow melted slower than in previous years, causing smaller and more frequent high flow events.

Drought Conditions in 2021

The water year 2021 was one of the hottest summers in the Walla Walla Basin, with the highest air temperature being 116 °C in Walla Walla, WA on 06/29/2021. More information on water and air temperature in 2021 can be found on the Water Temperature Report. Although the summer base flows for the Walla Walla River seem to be at the average we would expect, farmers in the basin had to irrigate their crops/livestock more frequently, relying on surface and groundwater to meet their irrigation needs. These frequent activities may negatively impact groundwater and spring performance, especially if drought conditions continue. Also, the drought conditions may have a delayed reaction to the base flows of the Walla Walla River since the river is fed by groundwater from the upper watershed. It is not known yet how long the groundwater that feeds the Walla Walla River has been in the ground.

Aquifer Recharge and Spring Performance Analysis

Fifteen recharge sites operated during the 2021 water year, infiltrating 8,248 acre-feet, including conveyance seepage losses through the irrigation ditches. This year was one of the highest aquifer recharge seasons in terms of most acre-feet put into the ground. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these sites.

Decommissioned Sites

At the beginning of October 2021, WWBWC decommissioned S-105, Walla Walla River at Milton-Freewater, OR. United States Geological Survey (USGS) obtained funding through the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) to gauge at that location. To provide continuity in the gauging record, the WWBWC continued monitoring to overlap the USGS gaging record at the site until the end of the water year.

Figure 21 Walla Walla River at S-105 looking river.

Discussion/Conclusion

During the 2021 water year, the Walla Walla Basin Watershed Council collected streamflow data from 24 surface water monitoring locations. Data were corrected using manual stage and discharge measurements and published on the WWBWC's website. The data is then used by resource managers, irrigators, federal and state agencies, and private landowners. Monitoring streamflow is essential to the Walla Walla Basin. It documents current conditions and describes trends to inform the development of projects to restore watershed function and increase in-stream flow.

Adaptive Management and Lessons Learned

The WWBWC's streamflow monitoring efforts continue to produce high-quality data utilized to:

- Inform water and fisheries management decisions
- Provide data for surface water/groundwater modeling projects
- Monitor the effectiveness of projects implemented by the WWBWC

Resource managers, irrigators, and other basin residents continue to rely on the availability of reliable streamflow data in the Walla Walla Valley. Without the support of the WWBWC's funding agencies, partners, and private landowners this project would not be possible. Their involvement and support are very much appreciated.

- Bonneville Power Administration
- Confederated Tribes of the Umatilla Indian Reservation
- Walla Walla River Irrigation District
- Fruitvale Water Users Association
- Hudson Bay District Improvement Company
- Oregon Watershed Enhancement Board
- Oregon Water Resources Department
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey

APPENDIX A

Data Sets

Flow and temperature data for our current and historic monitoring sites are available at the WWBWC website's Surface Water Monitoring page (http://wwbwc.org/monitoring/surfacewater.html). Near real-time sites are updated hourly, and stand-alone sites are updated quarterly.

Explanation of Data Gaps during the 2021 Water Year

Site ID	Site Name	Gap Dates	Explanation
S-104	North Fork Walla Walla River near Confluence	1/12/21 – 6/3/21	Seasonal gauge
S-106	Walla Walla River below Nursery Bridge	12/7/20 – 6/4/21 7/15/21 – 7/16/21	Seasonal gauge Battery failure
S-202	Crockett Ditch at the Frog	11/21/20 – 11/23/20 12/26/20 8/17/21 – 8/19/21 8/30/21 – 9/30/21	Ice formed Ice formed Program error Sensor failure
S-203	Ford Ditch at the Frog	7/8/21 – 9/30/21	Sensor failure
S-214	Ford Ditch/Mid-West Prong of the West Little Walla Walla River	1/26/21 – 4/1/21	Logger failure
S-221B	Walsh/Lewis Creek at Knopf Farm	10/1/20 – 1/8/21	Started collecting data on 1/8/21
S-303	Mud Creek at Stateline	10/1/20 – 1/8/21	Started collecting data on 1/8/21
S-411	Swartz Creek at Umapine Highway	10/1/20 – 1/8/21 1/15/21 – 2/8/21	Started collecting data on 1/8/21 Intermittent data loss from logger failure