Walla Walla Basin Watershed Council

OWEB-Funded Streamflow Monitoring in the Walla Walla Basin

2019 Water Year

FINAL REPORT

Submitted: February

In cooperation with:

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Introduction

Overview

Since 2002, the Walla Walla Basin Watershed Council (WWBWC) has collected flow data throughout the Walla Walla River Valley and currently monitors 20 sites in Oregon on the Walla Walla River, its tributaries, springs, small order streams, and irrigation ditches. Thirteen near real-time gauge stations transmit data that are 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 aquifer recharge projects

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 from its headwaters in the Blue Mountains into the Walla Walla Valley and then spreads out 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 documented for several decades and has led to substantial investment by local, state, and federal entities in artificial aquifer recharge projects designed to restore historic floodplain functions, including restoring spring and creek flows and providing for agricultural needs.

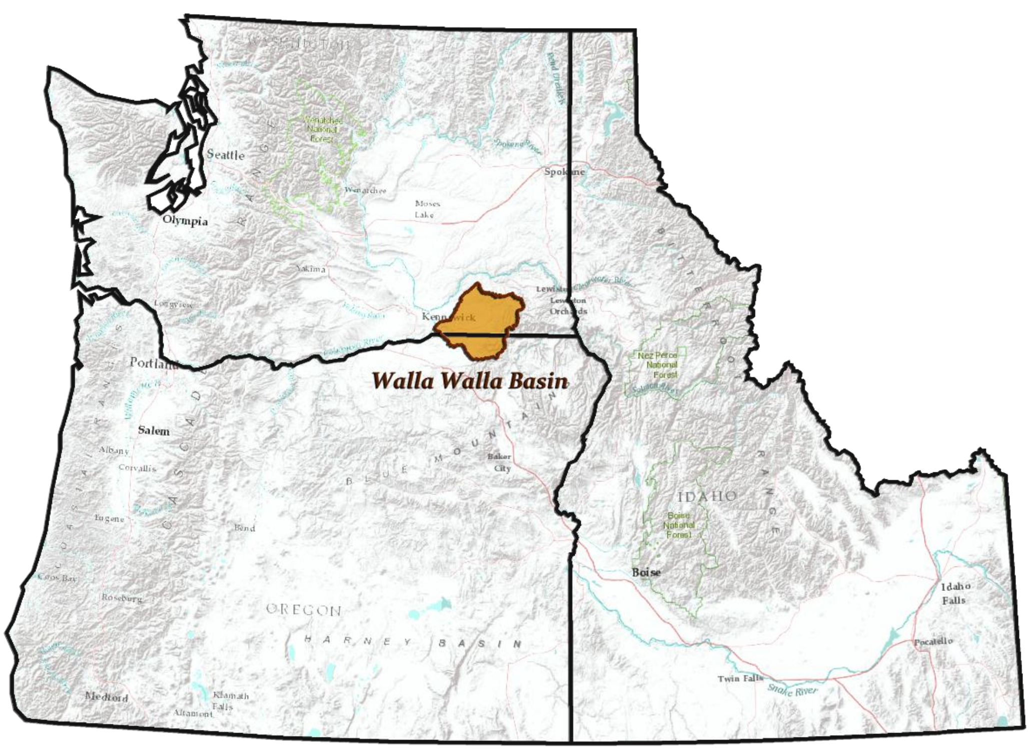

Figure 1. The Walla Walla Basin, a bi-state watershed.

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 sites under the current OWEB Hydro Monitoring Grant 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.

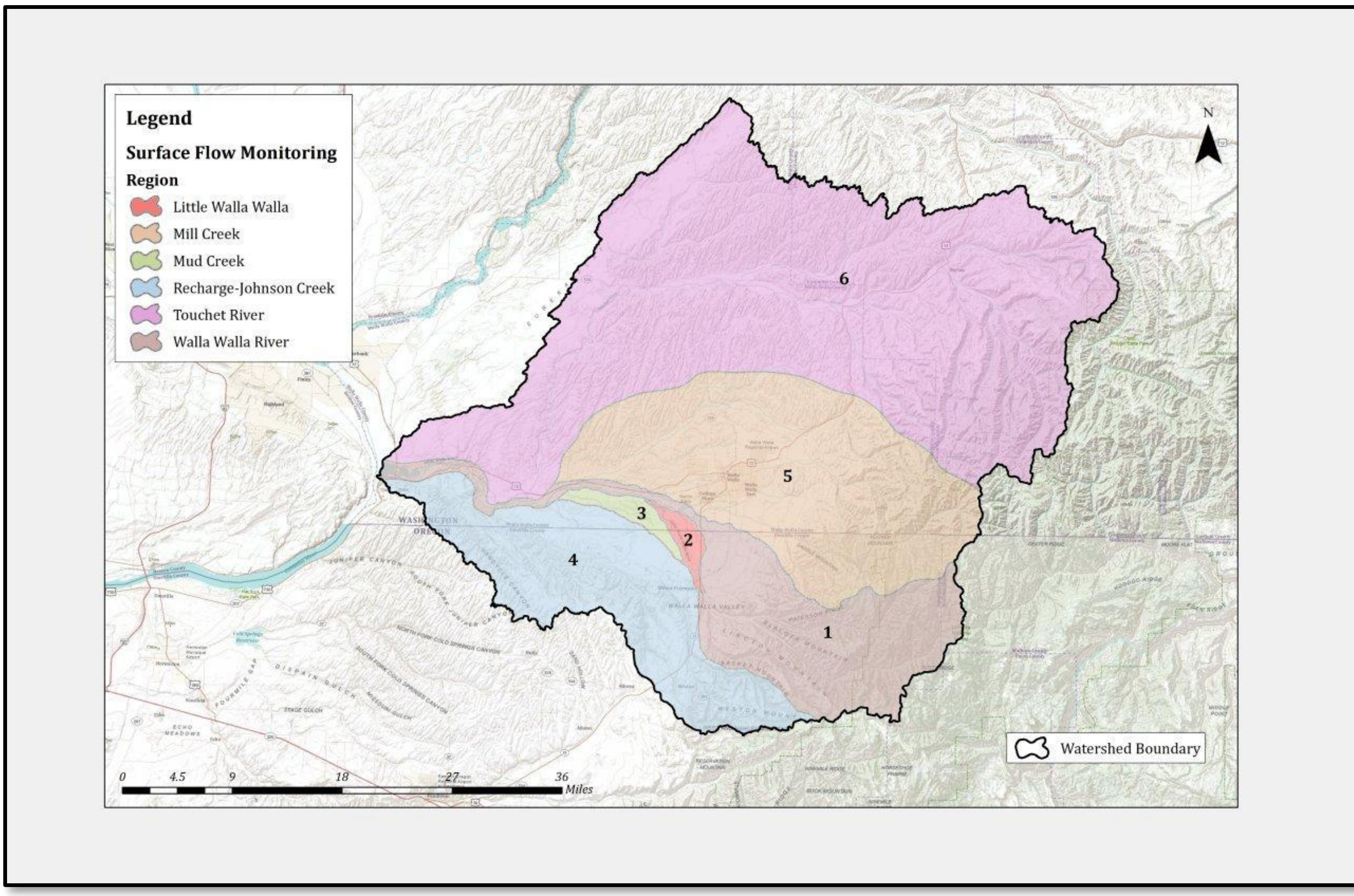

Figure 2. WWBWC Streamflow monitoring sites are organized according to the regions depicted above.

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

Region	# of Sites
1: Walla Walla River	6
2: Little Walla Walla River	10
3: Mud Creek/Fruitvale Irrigation System	1
4: Pine Creek/Hudson Bay Irrigation System	3
Total	20

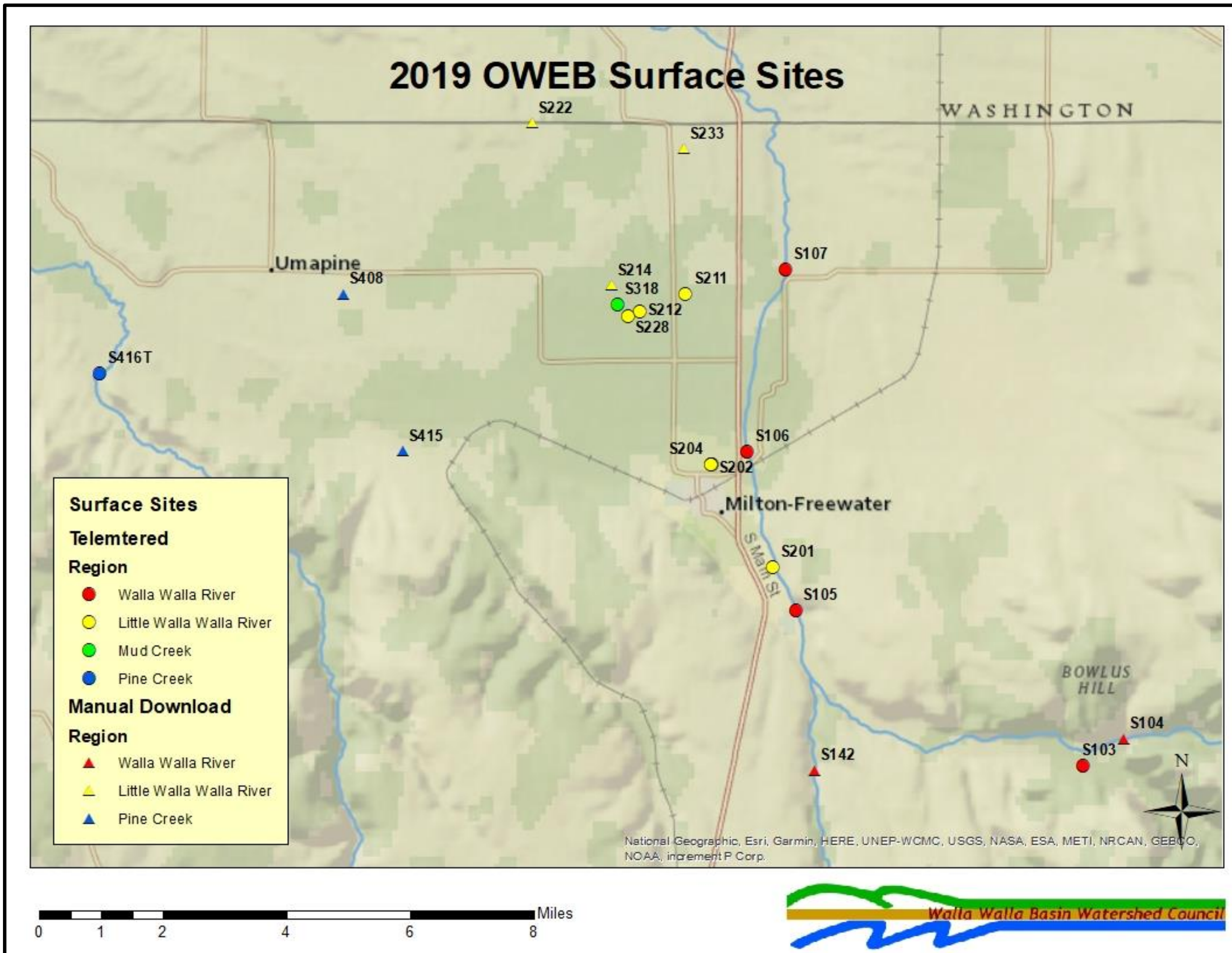

Figure 3. Map showing OWEB-funded streamflow monitoring sites as of October 2019.

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 worked to strategically install 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. During the 2019 water year, 13 stream sites were monitored 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 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 twice a month to read the staff gauges and visually inspect equipment. Manual discharge measurements were taken approximately every 6 weeks using either a SonTek FlowTracker Handheld Acoustic Doppler Velocimeter (Figure 5), Marsh-McBirney Flo-Mate 2000 flow meter, or Price AA current meter. Water temperature was measured using a calibrated NIST traceable YSI 30 handheld meter (www.ysi.com).

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

Figure 4. At this near real-time monitoring site on the Walla Walla River (S-106), a cabled sensor secured to a T-post and staff gauge in the channel collects water level data. A communication cable transmits the information to a data logger and radio housed on the streambank. 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 flow measurement on Pine Creek (S-416T) using a FlowTracker2 acoustic Doppler velocimeter.

Stand-Alone Flow Monitoring Sites

Many of WWBWC's streamflow monitoring sites are stand-alone stations we visit quarterly to take stage and discharge measurements and to download data. For the 2019 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 or 30 minutes). 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.

Every three months, a monitoring technician visited each site 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 conducted (for example, weeds or other debris removed), water temperature was measured, and photographs were taken.

Fifteen stand-alone monitoring sites were decommissioned in 2019, concluding a 10+ year monitoring period for many of them. A list of decommissioned sites can be found in Appendix B.

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. Coordinates and elevations for the newest sites in the network were recorded with a handheld GPS unit (Garmin eTrex) and will be properly surveyed as time allows.

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 with a suspended pressure transducer. Typical equipment 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 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.

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Rating Curve

2018-2019 Water Year

Label: Working
Description: Site ID-S106
Curve on: January 17, 2020 Curve Start Date: June 4, 2019 Location: Walla Walla River Below Nursery Bridge, M4

Stage (ft)	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	1.23	1.31
0.80	1.40	1.50	1.60	1.71	1.82	1.94	2.07	2.20	2.33	2.48
0.90	2.63	2.79	2.95	3.12	3.30	3.49	3.69	3.90	4.11	4.34
1.00	4.57	4.81	5.07	5.33	5.61	5.89	6.19	6.50	6.82	7.16
1.10	7.50	7.86	8.24	8.62	9.03	9.44	9.87	10.32	10.78	11.26
1.20	11.76	12.27	12.80	13.35	13.91	14.50	15.10	15.72	16.37	17.03
1.30	17.72	18.43	19.16	19.91	20.69	21.49	22.31	23.16	24.03	24.93
1.40	25.86	26.81	27.79	28.80	29.84	30.90	32.00	33.13	34.29	35.48
1.50	36.70	37.95	39.24	40.57	41.93	43.32	44.75	46.22	47.73	49.27
1.60	50.85	52.48	54.14	55.85	57.59	59.39	61.22	63.10	65.02	66.99
1.70	69.01	71.07	73.19	75.35	77.56	79.83	82.14	84.51	86.93	89.41
1.80	91.94	94.53	97.18	99.88	102.64	105.47	108.35	111.30	114.31	117.38
1.90	120.52	123.72	126.99	130.33	133.74	137.22	140.76	144.39	148.08	151.85
2.00	155.69	159.61	163.61	167.69	171.84	176.08	180.40	184.80	189.29	193.86
2.10	198.52	203.27	208.11	213.04	218.06	223.17	228.38	233.68	239.08	244.57
2.20	250.17	255.87	261.67	267.57	273.58	279.69	285.91	292.24	298.68	305.24
2.30	311.90	318.68	325.57	332.59	339.72	346.97	354.34	361.84	369.46	377.21
2.40	385.09	393.09	401.23	409.50	417.90	426.44	433.89			

Date Processed: January 17, 2020 11:01

AQUARIUS TIME-SERIES™ SOFTWARE

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

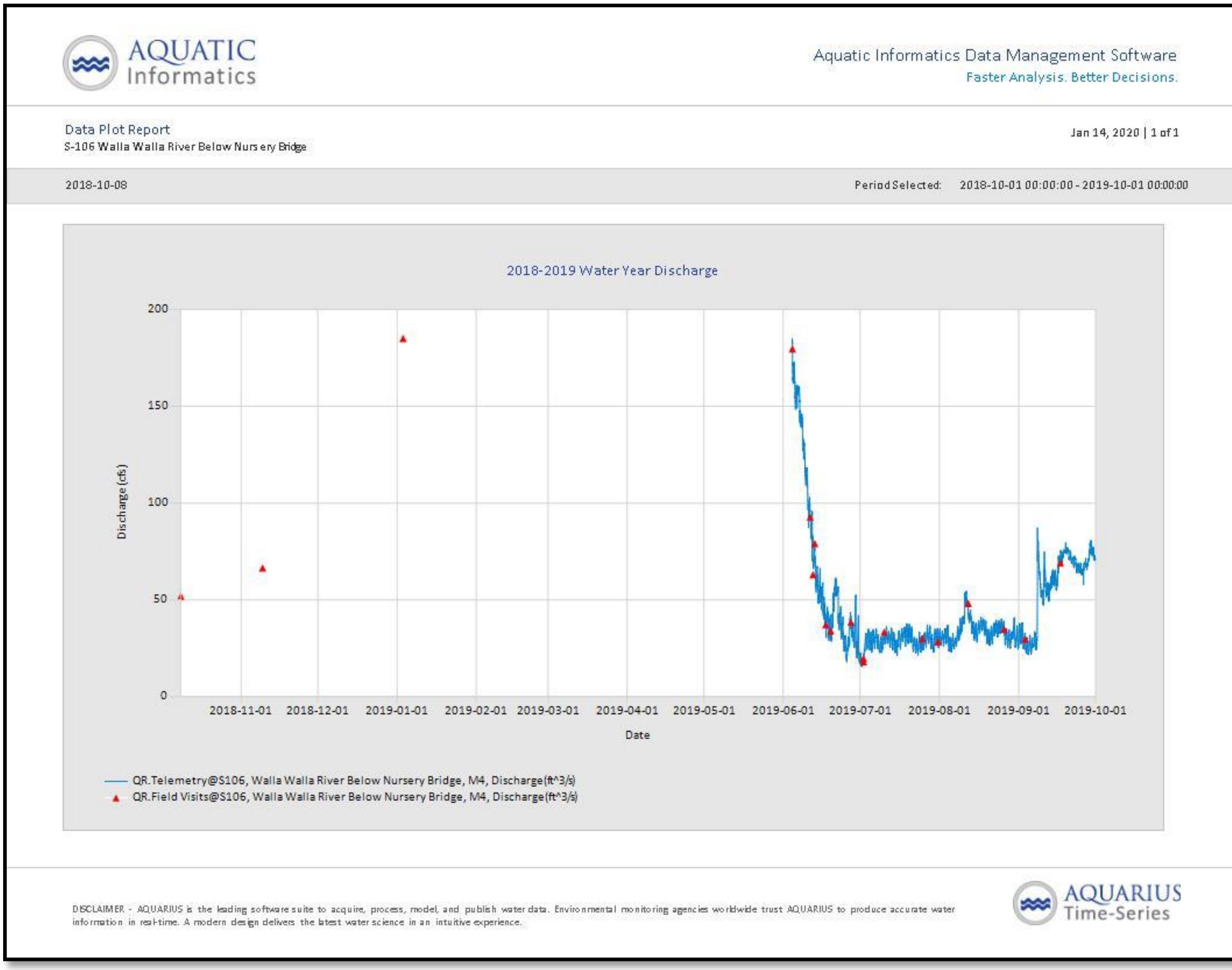

Figure 9. Walla Walla River below Nursey Bridge flow data computed by processing stage data through the rating table shown in Figure 7. This site was installed in June 2019

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.

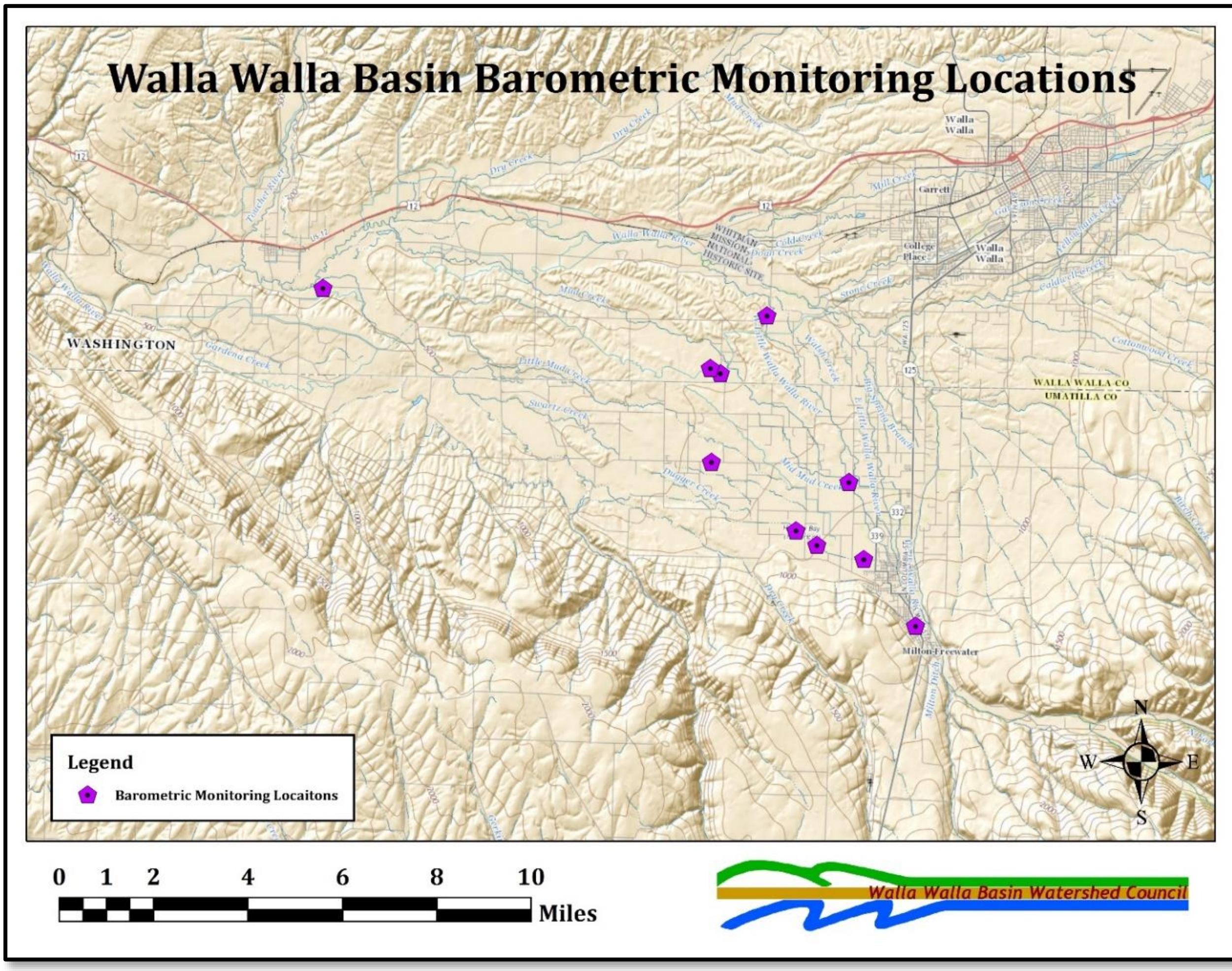

Figure 10. Map showing barometric pressure transducer locations in the Walla Walla Basin.

An important 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:
  - Overall uncertainty <2%, grade = Excellent
  - Overall uncertainty 2-5%, grade = Very Good
  - 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 and Discussion

Flow and temperature data for our current and historic monitoring sites are available at the Surface Water Monitoring page of our website (www.wwbwc.org). Near real-time sites are updated hourly, and stand-alone sites are updated quarterly.

North and South Forks of the Walla Walla River

The South Fork produces the majority of Walla Walla River flows. During the 2019 water year, flows at our South Fork gauge were similar to 2018 (Figures 11 and 12) with summertime base flows just below 100 cfs and winter flows fluctuating around 200 cfs. Peaks ranged from 450 to 850 cfs. Our equipment was damaged during the peak flows in April so we didn't capture the highest peak.

At our seasonal North Fork flow gauge base flows were similar to previous years, dropping to about 5 cfs in August and beginning to increase again in September (Figure 13).

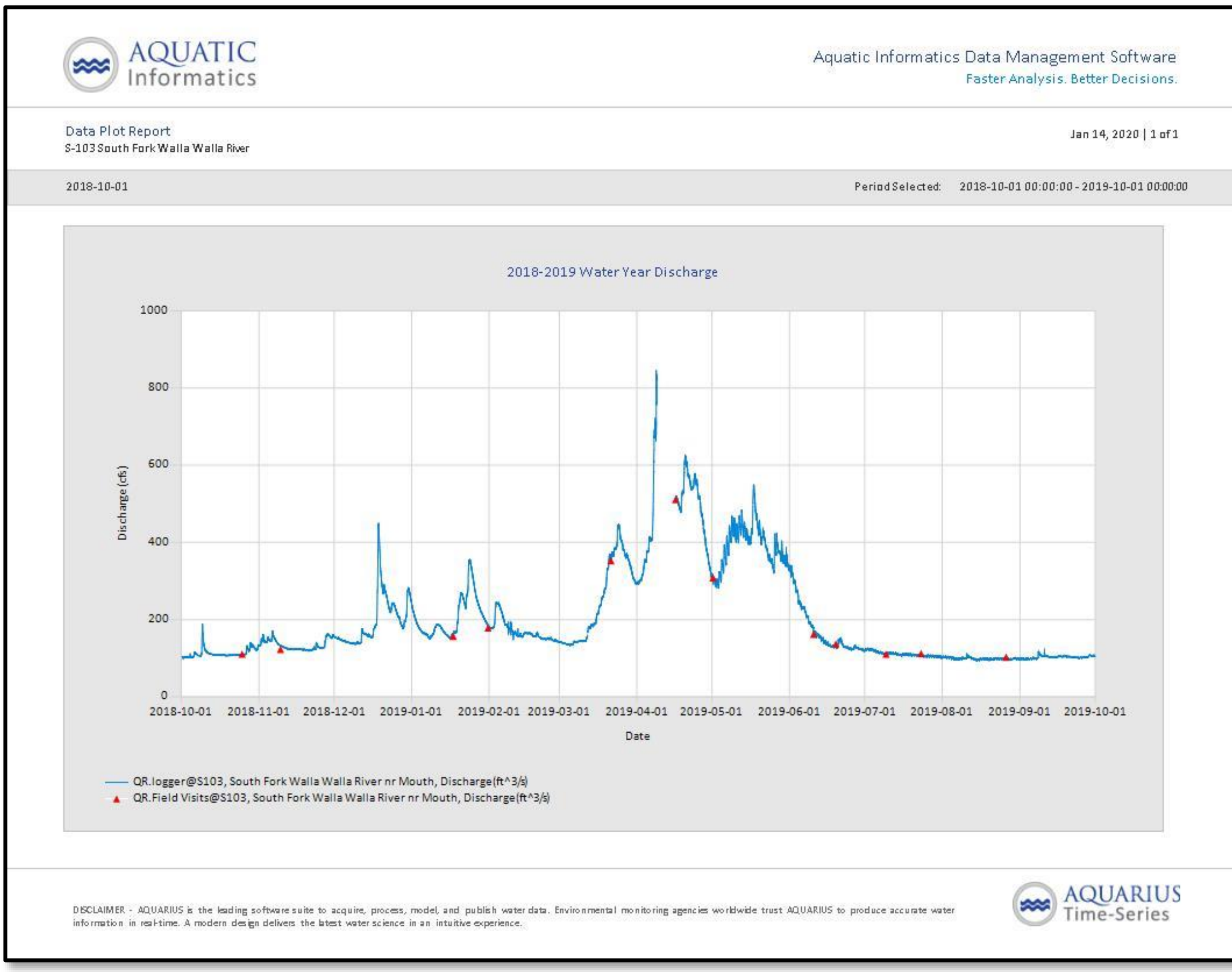

Figure 11. South Fork Walla Walla River 2018-2019 Water Year Discharge.

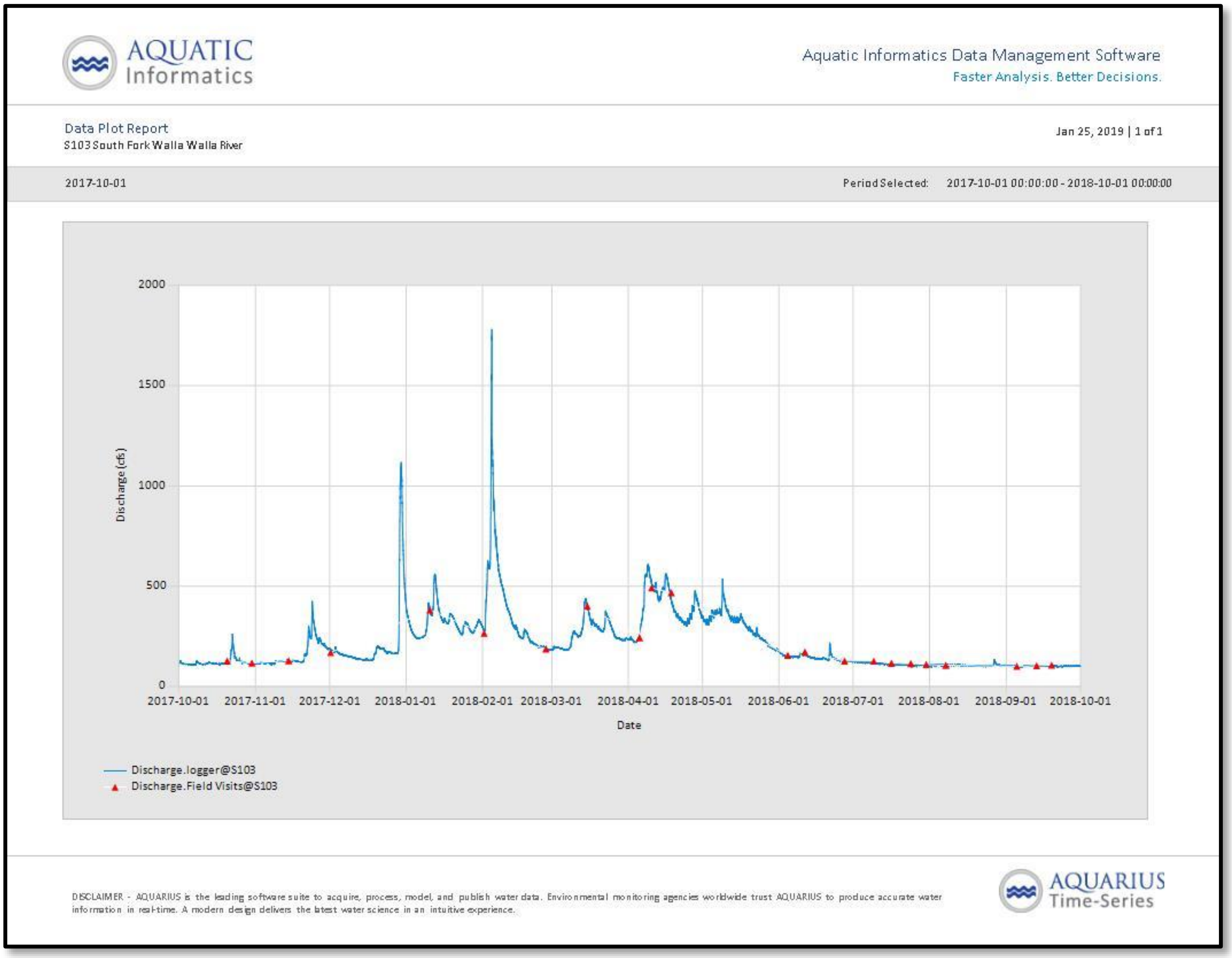

Figure 12. South Fork Walla Walla River 2017-2018 Water Year Discharge.

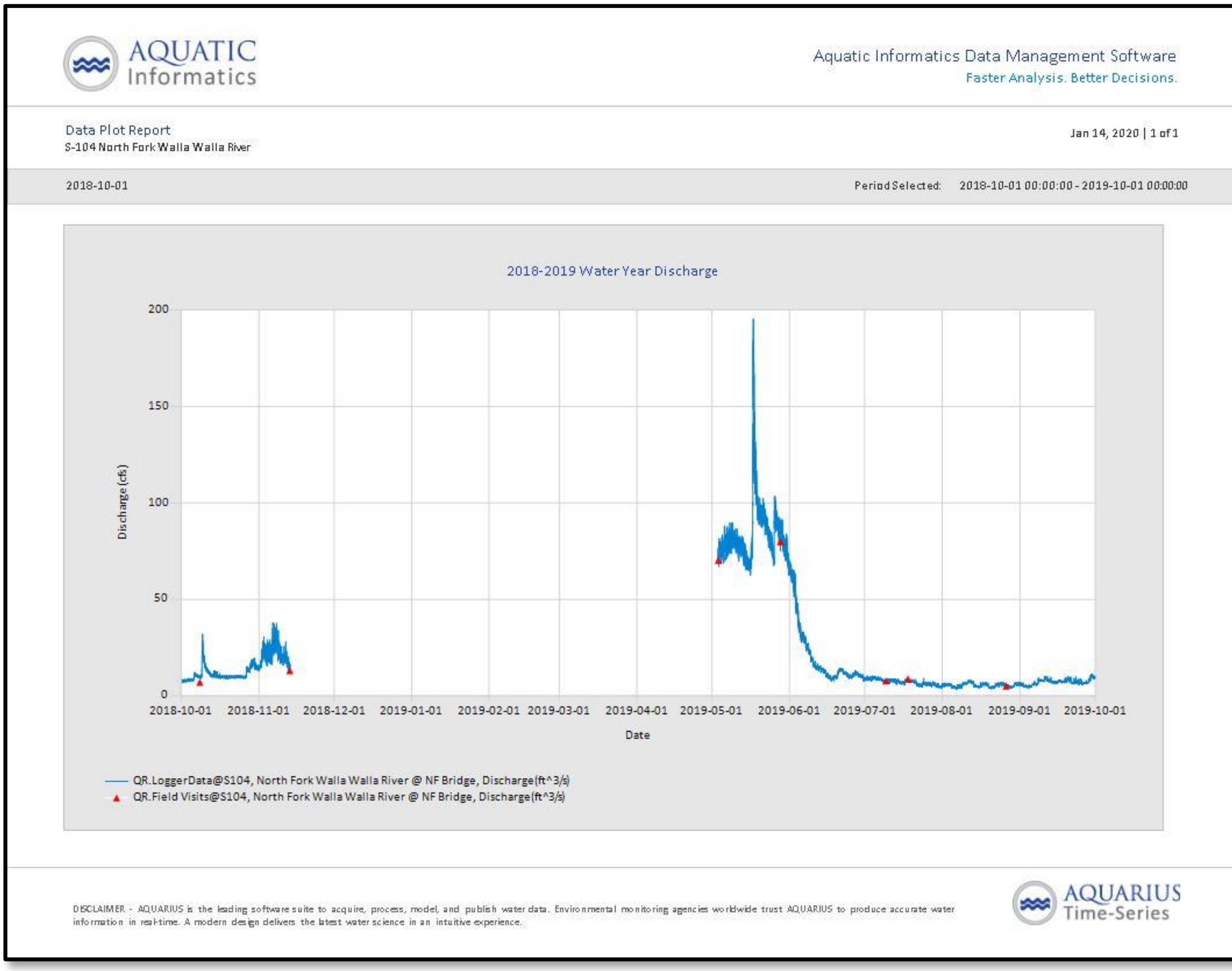

Figure 13. North Fork Walla Walla River 2018-2019 Water Year Discharge.

Pine and Dry Creeks

Pine Creek and Dry Creek are tributaries that enter the valley from the south, seasonally delivering significant quantities of water from a higher gradient upland forest environment. The Schubert Road gauge tracks Pine Creek water entering the valley floor prior to its confluence with Dry Creek. This site is typically dry from June to December. Since the flow gauge was installed here in 2016, February and March flows during have varied from 10-20 cfs, with peaks ranging from 80-400 cfs.

Dry creek typically produces 10-40 cfs from January-June with peaks ranging from 100-225 cfs. The flow gauge at Seven Hills Road records Dry Creek water levels prior to its confluence with Pine Creek.

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 2019, June flows dropped from 180 cfs to 16 cfs while July and August flows consistently fluctuated from 22-40 cfs.

April Channel Changing Event

A spring freshet during the first week in April 2019 brought about channel changes evident at several gauging stations on the Walla Walla River. We were able to capture high flow measurements on the tail end of the event, increasing the accuracy of higher flow predictions of our rating curves.

Telemetry Site Installations or Upgrades.

During the 2019 water year, we upgraded one existing flow monitoring site on the Walla Walla River below Nursery Bridge, enabling the site to send data via the radio network. We also installed a flow monitoring site with telemetry equipment on the Walla Walla River at Tum-A-Lum Bridge. This site will help resource managers evaluate seepage losses in the highly modified reach between Nursery Bridge and Tum-A-Lum Bridge.

Walla Walla Basin Instream Flow Enhancement Study

The WWBWC, Walla Walla Watershed Management Partnership, Confederated Tribes of the Umatilla Indian Reservation, Washington's Office of Columbia River, the Bureau of Land Management and local stakeholders are conducting a Walla Walla Basin Instream Flow Enhancement Study, an effort to identify strategies to meet instream flow demands while addressing municipal and agricultural needs[2]. WWBWC flow data collected during the 2019 water year and prior were used to support the study.

Aquifer Recharge and Spring Performance Analysis

During the 2019 water year, fourteen recharge sites operated and recharging a total of 6,321 acre-feet including conveyance seepage losses on the irrigation ditches. The irrigation ditches were shut off for an extra month due to snow and freezing conditions, therefore less acre feet were put into the ground compared to last year. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these sites.

Summary and Acknowledgements

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 aquifer recharge projects

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 is very much appreciated.

- Bonneville Power Administration
- Confederated Tribes of the Umatilla Indian Reservation
- 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
- Walla Walla River Irrigation District

[2] http://wwbwc.org/assessment/57-wwflow.html

APPENDIX A

Explanation of Data Gaps during the 2019 Water Year

Site ID	Site Name	Gap Dates	Explanation
S-103	South Fork Walla Walla River	3/12/19 4/8/19 - 4/16/19	Battery Failure Damage to equipment during high flow event
S-104	North Fork Walla Walla River	11/13/18 - 5/3/19	Seasonal Gage
S-105	Walla Walla River at Milton-Freewater	12/4/18, 1/17/19	Battery Failure
S-106	Walla Walla River below Nursery Bridge	8/16/19	Battery Failure
S-203	Ford Ditch at Frog Diversion	11/10/18 - 11/15/18, 11/17/18 – 11/22/18, 11/24/18, 11/26/18, 12/4/18 – 12/11/18, 12/22/18, 12/25/18 – 12/26/18, 12/28/18, 12/31/18 – 1/2/19, 1/8/19 – 1/10/19, 1/16/19 – 1/17/19, 1/26/19 – 2/2/19, 2/4/19 – 3/19/19	Battery Failure
S-204	HBDIC at Frog Diversion	3/5/19 – 3/7/19, 3/14/19 – 3/19/19	Battery Failure
S-211	East Crockett End	2/4/19 – 2/12/19, 2/14/19 – 2/17/19, 2/21/19 – 2/22/19, 2/24/19 – 3/12/19	Battery Failure
S-228	Ford Ditch at Appleton and Winesap Road	7/31/19 – 8/1/19	
S-318	Fruitvale Ditch	1/14/19 – 1/16/19	Battery Failure
S-416T	Pine Creek at Schubert Road	10/29/18 – 10/31/18	Battery Failure

APPENDIX B

List of Surface Sites Decommissioned in 2019

Site ID	Site Name
S-210	East Crockett at Appleton Road
S-216	Downing Spring
S-218	Big Spring at Ballou Road
S-220	East Little Walla Walla River at Stateline
S-221	Walsh/Lewis Creek
S-235	Ferndale Spring
S-302	Crystal Spring
S-303	Mud Creek at Stateline
S-404	Dugger Creek
S-405	Little Mud Creek
S-407	Dugger Creek/HBDIC Ditch Split
S-411	Swartz Creek
S-413	HBDIC Ditch at Prock Lane
S-422	Richardz Ditch
S-423	Dugger Creek/HBDIC Ditch Split