
WSDOT NPDES Municipal Stormwater Permit Embankment Hydrology Monitoring Final Report

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Prepared by

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Stormwater Monitoring Final Report

Embankment Hydrology Study

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1 Introduction

1.1 Permit Overview

On March 6, 2014, the Washington State Department of Ecology (Ecology) reissued a *National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge Municipal Stormwater General Permit* (Municipal Stormwater Permit) (Ecology 2014) to the Washington State Department of Transportation (WSDOT), effective April 5, 2014 to April 5, 2019. Under Special Condition S7 of the permit, WSDOT began a highway effectiveness study in 2017 that was approximately the same level of monitoring effort and cost as the previous vegetated filter strip study that concluded field data collection in July 2018.

This study, which fulfills part of the requirements of S7.D, collected hydrologic data from roadside embankments to assess infiltration levels. WSDOT planned to use this data to help validate an empirically optimized method for estimating saturated hydraulic conductivity (K_{sat}) developed by WSDOT's Geotechnical Office. WSDOT intends to use the validated K_{sat} estimation method to improve future best management practice designs and help evaluate the effectiveness of currently installed vegetated filter strip (VFS) best management practices. This work has continued under Section S7.C of the 2019 Municipal Stormwater Permit (Ecology 2019), reissued to WSDOT by Ecology on March 6, 2019. Findings from this study will inform revisions and updates to the *Highway Runoff Manual* (WSDOT 2014).

Under Special Condition S8.G of the 2019 Municipal Stormwater Permit, WSDOT must submit a final report that includes analysis of effectiveness data collected (Section 5.1) and an estimated cost of the effectiveness monitoring (Appendix A). The following report is meant to satisfy this reporting requirement and provides a summary of monitoring activities completed at embankment hydrology monitoring sites from October 1, 2017, through September 30, 2019 (water years 2018-19). The reporting of two years of data meets the requirements of the WSDOT Quality Assurance Project Plan.

2 Monitoring Program Implementation

2.1 Site Selection Strategy

The first step in selecting sites for embankment hydrology evaluation was a thorough review of the monitoring program's objectives. WSDOT used the program's objectives (defined in S7 of WSDOT's Municipal Stormwater Permit) to establish the number and types of sites needed for monitoring.

The following evaluation criteria helped ensure WSDOT selected the most appropriate sites:

- Property ownership.
- Site representativeness.
- Personnel safety.
- Site accessibility.
- Equipment security.
- Discharge measurement capability.
- Site design limitations.

2.1.1 *Property Ownership*

Initially, WSDOT only considered properties owned and operated by the agency during the site evaluation and selection process. Later, staff assessed county roads when state owned sites that met site selection criteria were difficult to locate. Eventually, WSDOT found two study sites that met selection criteria and that were on state owned property.

2.1.2 *Site Representativeness*

Screening criteria for representativeness meant study sites had to be typical of WSDOT highway conditions. The following factors were important in assessing study site locations:

- Long-Term Location – Based on information available during the site selection process, WSDOT avoided sites with plans for future development.
- Uniform Flow – Runoff flows need to be well mixed, but not turbulent. WSDOT did not select sites with slopes greater than 33 percent or slopes with abrupt grade changes.

2.1.3 *Personnel Safety*

For any WSDOT highway project, staff safety is a high priority. Staff avoided or minimized hazards whenever possible.

The following site attributes expose monitoring field teams to potentially unsafe conditions:

- Sites located along a highway shoulder.
- Sites that require traffic control.
- Sites with poor access.

To minimize the effects of these hazards, members of the field team had to be capable of performing all tasks required for monitoring water quantity data and be familiar with WSDOT's *Safety Procedures and Guidelines Manual* (WSDOT 2018a) and *Work Zone Traffic Control Guidelines* (WSDOT 2018b). Staff developed site-specific Health and Safety Plans for each monitoring site to minimize the effect of these hazards.

2.1.4 Site Accessibility

WSDOT selected monitoring sites to provide safe and feasible access. Highway shoulder width and site visibility from the roadway had to be sufficient to allow safe access for vehicles leaving and reentering the highway.

Due to the nature of highway embankment monitoring, locating sites away from the highway shoulder was not an option. To minimize exposure, field teams followed WSDOT safety guidelines and minimized time spent working along the highway.

To make sure personnel could quickly locate and access monitoring sites, staff developed site-specific Health and Safety Plans to include a description of parking and work zone safety procedures. Information in the Health and Safety Plans included lists of physical and biological hazards, standard emergency procedures, site maps, and driving directions.

2.1.5 Equipment Security

Selected sites had to provide adequate level space for monitoring station installation in areas that did not stand out visually. Staff installed data collection equipment in locked metal enclosures on concrete platforms to reduce the risk of tampering.

Locked metal enclosures provided a secure location as well as protection from wind, rain, and snowfall. Staff secured equipment outside of the enclosures (antenna, rain gage, solar panels) to a mast with chains and locks. Signs applied to the outside of the enclosures identified the monitoring stations as WSDOT property.

2.1.6 Discharge and Precipitation Measurement Capability

Staff selected monitoring sites in locations that allowed for accurate discharge measurement. In order to monitor sheet flow runoff from WSDOT highways, field personnel constructed conveyance systems to collect, direct, and measure stormwater runoff from sections of the roadway. Stormwater monitoring conveyance systems provided suitable water depth for measuring discharge during storm events.

Staff situated monitoring sites in locations that allowed for accurate precipitation monitoring. Requirements for accurate precipitation monitoring included adequate distance from biasing factors, such as trees, and the ability to mount rain gages high enough above the ground surface to avoid biases such as rain splashing from vehicle traffic.

2.1.7 Site Design Limitations

WSDOT had to establish monitoring stations to collect water quantity data from influent and effluent measurement locations. Personnel considered the following site design limitations when establishing monitoring stations for effectiveness evaluation:

- The physical space needed for monitoring infrastructure and data collection platform establishment.
- A monitoring site design that provided easy access for influent and effluent measuring.
- Monitoring equipment and site infrastructure installations that enabled accurate flow measurements and reduced the amount of maintenance required.

2.2 Resource and Logistical Constraints

To address logistical challenges and reduce mobilization costs, staff chose study sites close to the stormwater monitoring headquarters to reduce travel time and associated costs.

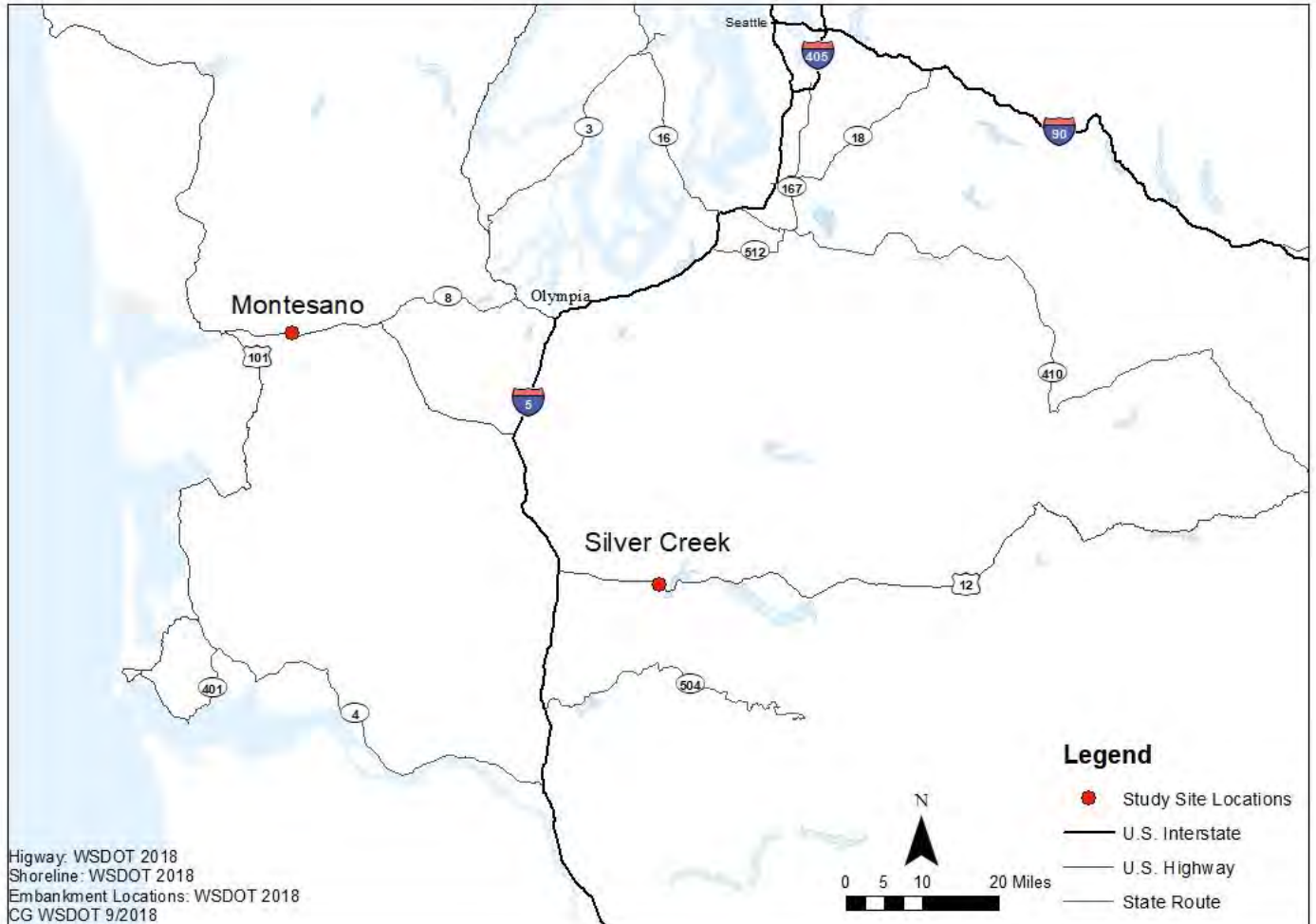


Figure 1. Embankment study sites.

2.3 Embankment Hydrology Monitoring Sites

WSDOT selected the two embankment study sites based on the general guidelines listed in Section 2.1 and more specific guidelines listed below. Additional site selection criteria for this study, accounting for characteristics of both monitoring locations, were:

Embankments:

1. Safely accessible for WSDOT staff and providing access not putting the traveling public at undue risk.
2. Within the WSDOT right-of-way.
3. Adjacent to and receiving stormwater sheet flow from a WSDOT roadway.
4. Exhibiting site characteristics, including shape, slope, soil composition, and soil compaction level, that were representative of current WSDOT specifications for roadway embankments.
5. At a location that regularly received enough precipitation and subsequent stormwater runoff to maintain a reasonable monitoring timeline.
6. Of a 3:1 (H:V) or 4:1 (H:V) slope and a height of at least 10 feet.¹

Highway Sections:

1. Straight for at least 200 feet to accommodate pipe collectors.
2. Less than five percent slope for consistent runoff.
3. Relatively flat so that runoff from adjacent areas did not run off into any of the study drainage areas.

Table 1. Embankment Study Site Location.

Site Name	State Route	Mile Post	Embankment Slope
Montesano	State Route 12	9	3:1 (H:V)
Silver Creek	State Route 12	80	4:1 (H:V)

¹ Horizontal to vertical or H:V.

2.4 Embankment Hydrology Monitoring Study Design

The embankment hydrology studies evaluated and compared highway runoff volumes at stormwater collectors (6-inch-diameter, high-density polyethylene pipes) installed at three different locations along the embankment; at the edge of pavement (EOP), 2 meters downslope from the pavement edge, and near the toe of embankments.

The edge of pavement collectors evaluated the amount of runoff before infiltration occurred. Stormwater collectors 2 meters downslope evaluated the amount of runoff that infiltrated within a limited space from the edge of pavement. This distance is consistent with past WSDOT studies that evaluated runoff at 2 meters and that were originally chosen largely because highways often have limited space to locate stormwater treatment along the road shoulder. The toe of slope collectors collected infiltrated water that reemerged from the subsurface of the roadway embankment slope.

Figures 2 and 3 show the catchment areas for the two monitoring sites.

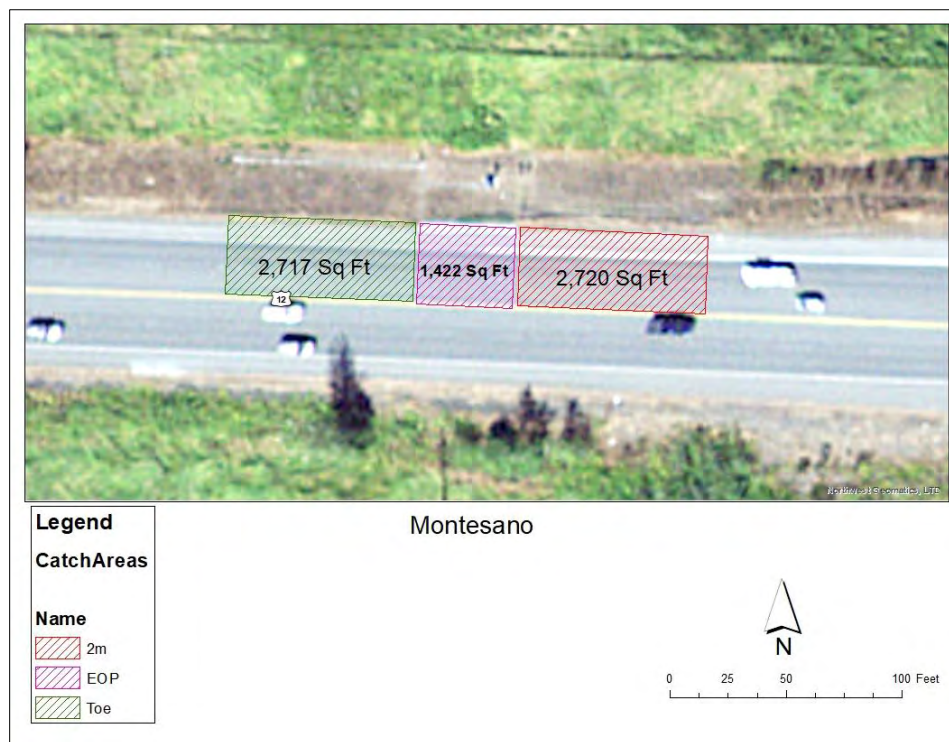


Figure 2. State Route 12 (SR 12) westbound at MP 9, Montesano, WA.

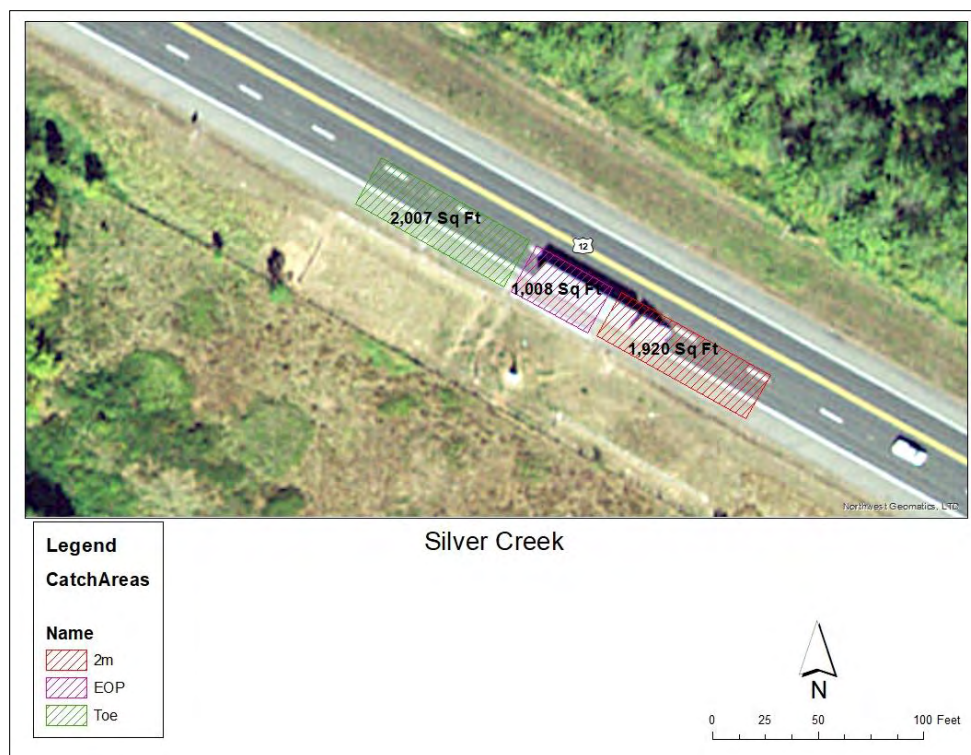


Figure 3. State Route 12 (SR 12) eastbound at MP 80, Silver Creek vicinity, WA.

2.4.1 Monitoring Site Set-Up and Measurement Design Details

WSDOT staff installed pipe collectors along the pavement at each monitoring site. Staff buried pipes and mortared them to the edge of the pavement. Collector pipes sloped slightly downhill to promote directional flow for measurement. Figure 4 shows the pavement edge collector pipe and highway shoulder in cross section.

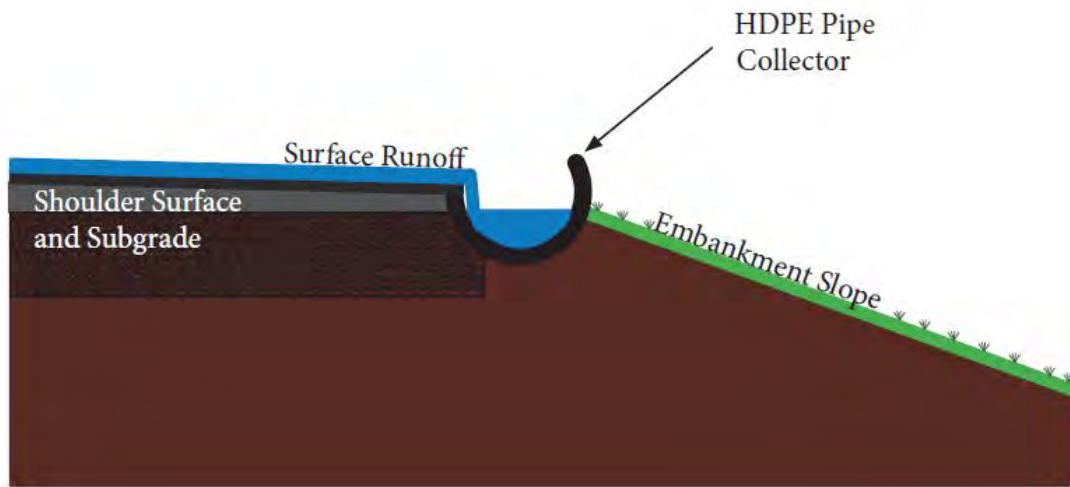


Figure 4. Cross Section of the pavement edge collector.

WSDOT recessed collector pipes, installed 2 meter downslope and at the toe of the highway embankment, into the surface of the soil and positioned them to collect surface runoff flowing from the edge of pavement over the surface of the embankment similar to the pavement edge collector. The 2 meter and toe of slope collectors were also sloped slightly to promote directional flow for measurement. Figure 5 shows a downslope collector in cross section.

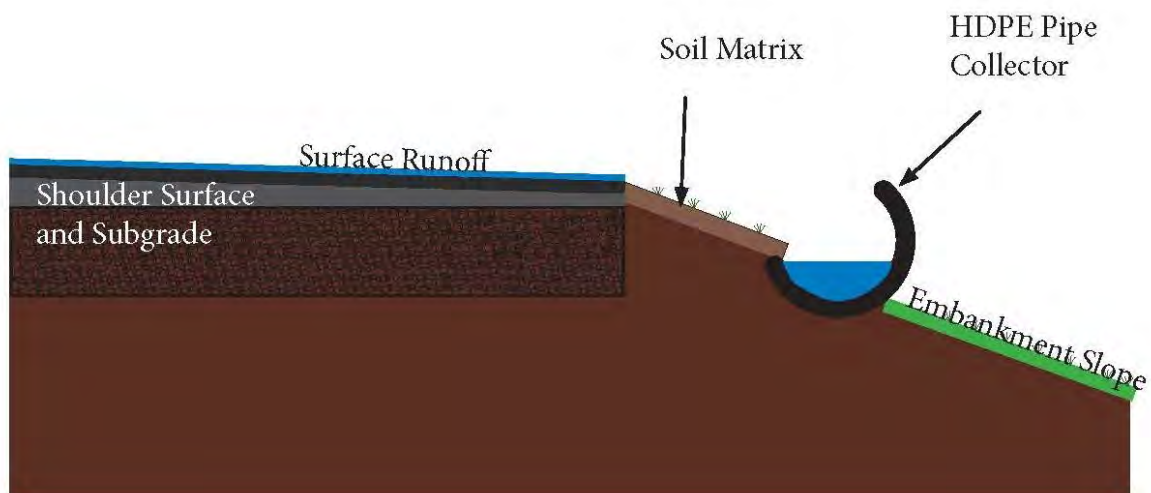


Figure 5. Cross section of the downslope collector.

Figure 6 shows a generalized drawing of an embankment hydrology-monitoring site. The diagram illustrates how collector positions accumulated sheet flow runoff from the surface of the highway and downslope over the surface of the embankment. WSDOT staff installed the data collection platform with rain gages, solar panel, transmitting antennae, Global Positioning System, and enclosures along the roadside embankment.

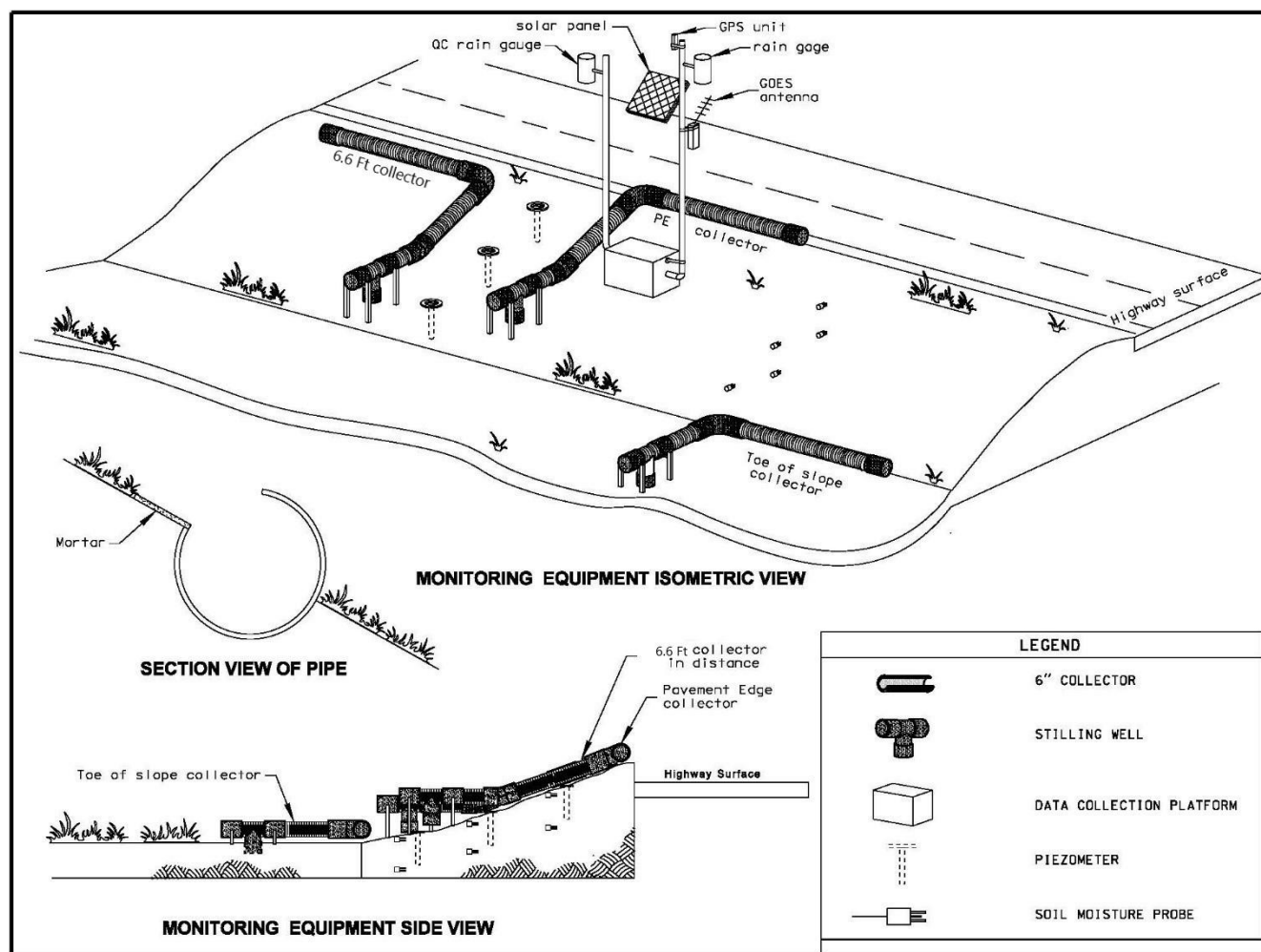


Figure 6. Generalized system design.

3 Measuring and Monitoring Procedures

3.1 Monitoring Stations

Monitoring stations at embankment hydrology monitoring sites typically included an equipment enclosure with lock, Global Positioning System, antenna, solar panel, and rain gage. Staff mounted the antenna, solar panel, and rain gage on a mast attached to the side of the equipment enclosure.

The equipment enclosure housed a data logger, stage measuring devices, and a 12-volt battery. The stage measuring equipment lines ran through conduit to a stilling well where pressure transducers recorded stage and temperature. The locked enclosure provided a secure location for equipment as well as protection from wind, rain, and snowfall.

3.1.1 *Precipitation Measurement*

At each monitoring station, WSDOT installed two pole-mounted, tipping-bucket rain gages. Staff utilized the second gage for quality control and as a backup in case the first gage failed. WSDOT installed rain gages, using National Weather Service criteria as guidance (NWS 2010), where no trees, buildings, overpasses, or other objects would obstruct or divert precipitation. Rain gages collected data every 15 minutes and stored the data in the logger's memory. WSDOT used these data, transmitted telemetrically to a WSDOT database, to track and record site-specific precipitation measurements.

3.1.2 *Temperature Measurement*

WSDOT used water temperature measurements at each of the embankment study sites to determine when to discontinue monitoring in the event of freezing or near freezing conditions. The data logger recorded temperature sensor data every 15 minutes and transmitted these records hourly to WSDOT's database.

3.2 Weather Tracking

WSDOT used weather information—from satellite imagery, prediction models, the National Oceanic and Atmospheric Administration, National Weather Service, and private forecasters—to forecast storm events on a daily basis. As candidate storms approached, staff tracked storms through radar observations and then evaluated station readiness using telemetered data.

3.3 Measuring Methods

WSDOT established embankment hydrology monitoring sites to measure stormwater runoff volumes. Table 2 lists parameter categories, measurement frequency, and methods.

Table 2. Measuring methods overview.

Parameter Category	Measurement Frequency	Measurement Method	Telemetered Data?
Rainfall	Continuous, year round	Rain gage	yes
Stage (flow)	Continuous, year round	Stage measuring device	yes
Temperature	Continuous, year round	Stage measuring device	yes

For further information regarding fieldwork activities for embankment hydrology evaluation, see the *Quality Assurance Project Plan for WSDOT Embankment Hydrology Monitoring* (WSDOT 2017).

3.4 Station Maintenance

WSDOT staff provided regular station maintenance on a three-week schedule. Monitoring staff performed a visual inspection of the monitoring site to identify possible damage to equipment and any new or unsafe conditions and checked equipment enclosures for signs of tampering or forced entry. Staff inspected and cleaned outlet pipes, pressure transducer stilling wells, and the conveyance system to ensure the monitoring station was in good condition prior to a sampled storm event. Field staff followed this inspection and cleaning procedure to ensure data collected from the system was unaffected by accumulated debris and sensor drift. In addition to the maintenance visits, staff typically visited sites twice weekly to reset pressure transducers to zero.

Following the *Standard Operating Procedure for Monitoring Station Maintenance* (WSDOT 2019), field staff conducted station checks that included inspections, testing, and replacement of worn or missing parts. Monitoring staff inspected internal wires and cables to evaluate wear and ensure cable connections to the data logger were in good condition. Staff checked station antennae declinations and bearings, and cleaned solar panels to remove accumulated debris. When servicing or calibrating of scientific equipment at monitoring stations was required, trained technicians followed manufacturers' specifications and conducted servicing and calibration of equipment on site or in a controlled environment, as appropriate.

3.5 Staff Roles and Responsibilities

WSDOT used Stormwater Monitoring Program staff in the Headquarters Environmental Services Office to implement its monitoring programs. Seven staff from the Headquarters Environmental Services Office played key roles in the stormwater hydrology monitoring strategy.

4 Quality Assurance and Quality Control

The *Quality Assurance Project Plan for WSDOT Embankment Hydrology Monitoring* (WSDOT 2017) includes a comprehensive description of quality assurance and quality control activities.

WSDOT implemented quality control procedures through all phases of data collection and analyses. Verification and validation of field-generated data occurred as part of data management activities. The quality of raw, unprocessed, and processed data was subject to review and management. This included the following areas of work:

1. Field quality control

- Implementation of standard operating procedures.
- Field instrument inspection, calibration, and maintenance.
- Stormwater conveyance systems inspection and maintenance.
- Collection of field notes and maintenance documentation.

2. Data management

- Hydrology and precipitation data validation including:
 - Checking for concurrence between primary and secondary pressure transducers.
 - Checking for consistency and similarity between site rain gage measurements.
 - Examining hydrology and precipitation data compared to historical and expected patterns at the site.
 - Verifying that no equipment malfunctions biased the data.
 - Verifying that conveyance systems operated accurately.
 - Checking field notes to ensure no outside factors biased the data.
 - Verifying that precipitation and runoff patterns make logical sense. For example, an extended delay in runoff at the highway edge, which normally takes little time, might indicate problems with the equipment or site performance.
- Field data verification.
- Correction of data gaps, anomalies, and use qualification for precipitation and hydrology data.
- Self-assessment and review of project processes.

Failure to meet the hydrology and precipitation data validation criteria listed above could prompt a rejection or flagging (J flag) of hydrology data collected during a storm. WSDOT Embankment Study QAPP (Section 12-2 Data Validation) contains specific information regarding the data validation process. At a minimum, problems identified by WSDOT staff during data validation prompted corrective actions by WSDOT staff in the field, with equipment, or data management activities.

5 Monitoring Results

5.1 Embankment Hydrology Monitoring

WSDOT initiated hydrological and meteorological data collection at the embankment monitoring sites in 2017. A total of 357 storms passed hydrology data validation at the two monitoring study sites from October 2017, through September 2019 (water years 2018 and 2019). The 357 storms accounted for approximately 81 percent of total storms that occurred.

In accordance with the research proposal, the stormwater monitoring program partnered on this research project with the WSDOT Geotechnical Office as part of a larger research goal of validating an empirically optimized method for estimating saturated hydraulic conductivity (K_{sat}). The Geotechnical Office is currently using the data collected by the stormwater monitoring program for their modeling portion of the research project. Appendix B contains the rainfall/runoff data and the continuous soil moisture data is available upon request.

5.2 Measurement Logistics and Challenges

WSDOT field staff attempted to measure highway runoff from all storms at both sites, however several challenges prevented staff from successfully doing so. The major cause of rejected data was pressure transducer (PT) failure. Staff attempted to validate hydrology data weekly so that anomalies in PT readings could be identified quickly, and field teams would be notified to replace PTs that were not reading correctly.

Another challenge encountered was PT readings trending negative as water evaporated from the collection systems or leaks appeared around weir gaskets. Because of this trend, it was important to reset and calibrate PTs on a regular basis to ensure that PTs were ready to record flow measurements as soon as runoff reached the equipment. Staff typically visited sites twice weekly to reset the PTs to the point of zero flow.

WSDOT staff also found collecting flow data from smaller storms (0.08-inch or less) to be problematic. Since data loggers only calculate flow when PT data is positive, negative readings meant that small flow events were not enough to raise PT levels to zero. Staff attempted to reset PTs to zero within 18 hours prior to the start of runoff to avoid this problem.

WSDOT discovered a possible issue with pipe collector installation at both sites in October 2018. Staff deemed the problem at Silver Creek negligible, so no correction was made. Field team staff made corrections to the collector systems at Montesano before beginning data collection in water year 19. As the water year progressed, staff compared Montesano WY18 to WY19 records and found no unexpected or abnormal patterns in the data.

5.3 Lessons Learned

WSDOT staff evaluated the effectiveness of monitoring practices during the project. Staff observations helped refine existing monitoring methods and procedures. These changes improved the accuracy and efficiency of data collection and made more effective use of staff time and resources.

1. **Targeting storms:** Staff set PTs to zero within 18 hours of a forecasted storm. Staff tracked storm forecasts and PT levels daily.
2. **Hydrology validation:** WSDOT applied a stringent hydrology validation process to ensure that collected data was valid and scientifically credible. After review of completed hydrology validation, staff identified improvements in storm targeting procedures to allow for greater data collection success. Staff downloaded the full data set from the data loggers at the beginning of each week so that hydrology validation could occur weekly, and identification of system issues occurred close to real time.
3. **Cross training of staff:** Cross training was an important factor for the program considering the limited number of staff. Having more staff trained to track instrument settings improved data quality. Having more staff available to conduct site visits also improved chances for successful data collection.
4. **Conduct frequent site storm event observations:** WSDOT discovered several issues at the embankment study sites when observing sites during storm events. One example is the discovery of a vegetated berm that directed water away from an edge of pavement collector. Direct observation during storms was critical to assess the operational performance of the monitoring equipment and observe site hydrological processes only present during rain events.

Glossary

Data collection platform – A collection of instruments or sensors that operate and report to a central data logger. WSDOT houses data collection platforms in a central location or “platform” at the monitoring site.

Global Positioning System – A satellite navigation system used to determine ground position and velocity (location, speed, and direction).

National Pollutant Discharge and Elimination System (NPDES) – The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the state from point sources. The Washington State Department of Ecology (Ecology 2014) administers these permits referred to as NPDES permits and, in Washington State.

Pavement edge collector – A 6-inch high-density polyethylene pipe or similar device installed to collect runoff from an impervious roadway. Pavement edge collectors also act as conveyance systems for stormwater from the road surface to pass through a flow measurement device and allow for composite sample collection.

Quality Assurance Project Plan – A document that describes the objectives of a monitoring project and the processes and activities necessary to develop data that will support those objectives (Ecology 2004).

Stormwater – That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a stormwater drainage system into a defined surface water body or a constructed infiltration facility (WSDOT 2014).

Stilling well – A well or chamber that is connected to the main flow channel by a small inlet used to house a pressure transducer.

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Acronyms and Abbreviations

Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
H:V	Horizontal to Vertical
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
PT	pressure transducer
WSDOT	Washington State Department of Transportation
WY	water year
EOP	Edge of pavement

Appendix A: Monitoring Costs

The following describes program implementation, labor, equipment, and materials costs for embankment hydrology monitoring. Table A-1 provides an equipment cost estimate, and Table A-2 presents a monitoring cost summary.

Program Implementation Costs

Costs associated with planning and implementing the embankment hydrology monitoring study include:

Planning

- Background research (e.g., previous, similar studies).
- Develop the site selection strategy.
- Field reconnaissance for final site selection.
- Develop the project scope and sampling designs.
- Develop the monitoring Quality Assurance Project Plan.

Implementation

- Equipment and supplies (purchase, installation, maintenance, and replacement).
- Database development and implementation.
- Training.
- Logistics (e.g., pre-storm preparation).
- Data verification and validation (data quality assurance and quality control).
- Data management.
- Data analysis and reporting.

Labor Costs

Seven staff from the department's Environmental Services Office played key roles in implementing the embankment hydrology monitoring study. These staff include:

- Monitoring Program Coordinator (position transitioned to Stormwater Monitoring and Research Program Manager in 2019).
- Monitoring Field Lead.
- Data Management and Reporting Lead.
- Monitoring and Research Analyst Lead
- Monitoring Specialists (three positions).

Equipment and Materials

The following monitoring program start-up costs were excluded from this cost summary if expended to support all of the WSDOT's ongoing stormwater monitoring programs and not specific to this study:

- staff time spent conducting initial monitoring program planning.
- vehicle purchases.
- hydrology databases (license, and maintenance fees).
- equipment storage and staging facilities.
- tools for station construction, installation, and site maintenance.
- initial purchase of equipment (e.g., automatic samplers, data loggers, pressure transducers, connecting cables, and solar panels).

Monitoring Cost Summary

Table A-1 provides an estimate of the equipment costs and an anticipated equipment replacement schedule. The estimate includes costs for four monitoring installations, two at each site.

Table A-2 provides an estimate of WSDOT's labor, equipment, construction, and hydrology validation costs for the embankment hydrology monitoring study.

Table A-1 Equipment and materials costs.

Equipment	Units	Cost/Unit (\$)	Total (\$)
Data loggers w/GOES ^[1]	2	5,180	10,360
GOES antenna	2	500	1,000
Enclosure	2	1,700	3,400
Pressure transducer	12	1,300	15,600
Rain gages	4	815	3,260
Iridium modem ^[2]	2	2,240	4,480
GPS antenna	2	100	200
6-inch weir	6	230	1,380
Solar power installation	4	1,200	4,800
120aH starved electrolyte battery	6	630	3,780
Data logger upgrade			37,000
Total			85,260

[1] Geostationary Operational Environmental Satellites (GOES) relay data from WSDOT monitoring stations to public servers where the department accesses the information through an approved National Environmental Satellite, Data, and Information Service Internet connection.

[2] Two-way remote communication system.

Table A-2 Monitoring labor, equipment, materials, and laboratory costs.

Category	Monitoring Program Costs (\$ estimate)
State-force labor costs	
Site selection	5,000
Site construction and equipment installation	99,020
QAPP development	15,000
Data management and verification	5,000
Data analysis and reporting	15,000
Site decommissioning	3,000
Geotechnical evaluation	67,300
Equipment purchase	85,260
Total	294,580

Appendix B: Monitoring Data

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
10/1/2017	Montesano	0.08	0:45	110.8		1:00	27.4		1:15	0		Null
10/1/2017	SilverCreek	0.41	9:10	2341.6		9:45	1389.8		9:45	1344.4		9:45
10/2/2017	SilverCreek	0.08	6:20	1627.8		11:55	606.9		11:55	502.3		11:55
10/7/2017	SilverCreek	0.1	12:15	505.02		13:25	249.8		12:35	310.5		14:40
10/8/2017	Montesano	0.05	2:00	358.8		4:55	27.4		3:00	0		Null
10/12/2017	Montesano	0.1	17:45	1173.4		23:55	441		23:55	127.8		23:55
10/12/2017	SilverCreek	0.6	2:10	2826		5:05	1928		5:05	1773		5:05
10/13/2017	Montesano	0.58	23:30 10/12	1033.8		5:25	444		5:25	291.6		4:50
10/13/2017	SilverCreek	0.06	11:40	570.8		14:30	331.4		14:30	327.5		14:30
10/17/2017	Montesano	0.4	17:10	1266		22:55	486.4		22:55	253.8		22:55
10/18/2017	SilverCreek	0.14	17:15	545.8		18:00	103.4		6:00	77.7		17:05
10/20/2017	Montesano	3.05	6:35	9132.6		9:50	2505.5		9:50	2475.5		9:50
10/20/2017	SilverCreek	2.13	7:40	9071.4		11:05	1413.6		8:05	1512.7		8:25
10/22/2017	Montesano	3.38	9:10	8384.8		15:05	1923.8		10:15	2208.1		14:45
10/22/2017	SilverCreek	4.1	9:45	10411.4		15:45	2510.5		13:05	2763.4		10:05
11/2/2017	Montesano	0.48	6:00	2195.2	J	6:00	129		6:00	70.4		2:05
11/3/2017	SilverCreek	0.54	3:45	2266.66		0:55	1115.7		23:20 11/2	1899.2		4:55
11/4/2017	SilverCreek	0.15	22:15	699.8		22:35	124.1		22:50	281.8		19:15
11/6/2017	Montesano	0.7	18:45	4224.32		21:25	103.9		16:55	34.3		17:05
11/6/2017	SilverCreek	0.76	19:15	4336.6		20:00	973.2		19:40	1112.3		19:50
11/9/2017	SilverCreek	0.33	5:15	1278.72		5:30	238.41		5:25	194		0:40
11/10/2017	SilverCreek	0.17	23:55 11/09	567.8		0:05	88.4		22:50 11/09	54.7		21:30 11/9
11/11/2017	SilverCreek	0.09	23:35 11/10	339.62		23:25 11/10	0		Null	0		Null
11/12/2017	SilverCreek	0.08	21:05 11/11	20.84		21:25 11/11	22.8		20:50 11/11	22.12		20:55 11/11
11/12/2017	SilverCreek	0.06	20:40	93		19:25	0		Null	0		Null
11/14/2017	Montesano	3.88	9:00	11191.68		11:30	933.5		5:10	2011.6		12:25
11/14/2017	SilverCreek	0.61	9:20	2800.64		6:20	326.67		3:15	127.27		1:25
11/15/2017	Montesano	2.14	20:00	5926.16		20:45	426.7		13:50	1183.9		20:00
11/16/2017	SilverCreek	0.7	23:50 11/15	2097.04		0:10	473.03		19:00 11/15	187.28		15:00 11/15
11/16/2017	SilverCreek	0.39	22:05	1623.32		22:05	260.96		16:20	22.59		13:15
11/17/2017	SilverCreek	0.54	14:55	2164.82		15:00	470.16		13:25	34.99		13:10
11/18/2017	Montesano	1.27	9:36	5280.2		21:40	174.3		15:25	307.6		16:25
11/20/2017	Montesano	2	14:30	4500.2		16:55	396		14:30	842.8		15:15
11/20/2017	SilverCreek	1.53	18:15	5978.7		19:45	1197.49		16:30	1263.28		20:50
11/22/2017	SilverCreek	0.75	3:00	3543.72		3:55	584.42		1:20	255.35		1:15

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
11/24/2017	SilverCreek	1.17	5:10	3424.58		5:45	1028.27		5:25	630.14		5:10
11/25/2017	Montesano	0.14	2:00	461.8		6:35	37.4		3:45	145		7:30
11/26/2017	SilverCreek	0.19	3:00	793.02		3:25	72.54		2:15	72.54		2:15
11/27/2017	Montesano	1.9	8:30	4569.48		9:15	470.7		0:00	1162.3		0:25
11/27/2017	SilverCreek	0.65	4:10	2140.1		4:10	203.56		2:40	153.12		2:40
11/29/2017	Montesano	0.5	2:00	850		2:55	704	J	3:45	443.9		4:05
11/29/2017	SilverCreek	0.64	23:40 11/28	2665.66		1:05	814.09		22:30 11/28	936.63	J	23:35 @ 11/28
11/30/2017	Montesano	0.05	19:45	38.6		19:50	22.1		20:00	37.7		22:15
11/30/2017	Montesano	0.3	19:15	789.8		18:30	445.4	J	19:15	446.7		18:35
12/1/2017	SilverCreek	0.14	23:55 11/30	1108.8		0:50	40.19		22:50 11/30	409.33	J	0:30
12/2/2017	Montesano	0.7	2:30	995.4		2:45	456.7	J	2:00	491.7		5:10
12/2/2017	SilverCreek	0.19	13:05	2345.62	J	13:55	78.2		8:50	622	J	0:00
12/3/2017	Montesano	0.7	2:30	1405.6		2:40	619.1		3:00	258.7		2:50
12/3/2017	SilverCreek	0.65	9:25	4155.52		7:30	489.52		5:05	1397.33		6:05
12/18/2017	Montesano	1	12:00	7353.4	J	18:40	1679.9		15:00	1856.8		15:10
12/20/2017	Montesano	2.6	6:15	6830.8		8:55	1548.5		8:10	2345.8		11:35
12/20/2017	SilverCreek	2.02	9:55	9542.38		11:50	3875.38	J	10:40	3071.89		10:15
12/23/2017	Montesano	0.3	1:30	2333.4	J	5:00	133.4		22:55 12/22	226.3		23:25 @ 12/22
12/23/2017	SilverCreek	0.58	6:25	4606.94		6:45	675.33		6:35	1311.27		7:20
12/28/2017	SilverCreek	0.19	4:55	1824.3		5:20	608.67		7:55	45.06		3:15
12/30/2017	Montesano	3.6	10:15	11048.8		17:00	2644.8		13:55	1344.8		8:10
12/30/2017	SilverCreek	2.69	10:30	10649.88		10:30	3621.76		6:10	4948.63		6:35
1/4/2018	Montesano	1.53	13:20	3229.59	J	14:15	821.68		13:20	966.1		13:20
1/5/2018	Montesano	0.8	16:30	4132.6		17:00	1493.6	J	18:00	650.6		17:30
1/6/2018	SilverCreek	0.62	19:15	4112.46		19:45	1106.1	J	19:15	1134.95		19:50
1/6/2018	SilverCreek	0.09	8:10	599.06		9:40	29.08	J	4:45	8.38		5:35
1/6/2018	SilverCreek	0.06	15:50	244.62		16:50	3.43	J	15:50	87.09		17:00
1/8/2018	Montesano	0.68	12:00	3932		11:00	1212.96	J	9:30	413.12		8:00
1/9/2018	Montesano	0.09	13:00	700.2		15:15	101.78	J	13:15	113.92		13:20
1/9/2018	SilverCreek	0.59	16:45	4334.84		17:50	798.52		16:15	1178.42		18:30
1/10/2018	SilverCreek	0.05	21:00	295.48		23:25	0		null	34.27		21:45
1/11/2018	SilverCreek	0.09	4:00	654.9		4:00	41.92		2:30	149.11		4:30
1/12/2018	Montesano	2.64	19:15	9886.24		20:30	2510.37		19:50	1478.99		19:25
1/12/2018	SilverCreek	0.9	5:50	3996.38		5:55	1092.11		0:20	1549.64	J	2:55
1/13/2018	Montesano	0.26	16:30	2036.3		18:20	265.73		13:45	6.85		15:50

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
1/13/2018	SilverCreek	0.06	12:05	234.16		12:45	0	J	null	266.12		16:05
1/18/2018	Montesano	0.75	2:05	1171.74		4:05	243.7		0:15	209.45		0:50
1/18/2018	SilverCreek	0.26	3:00	1001.44		3:40	183.22		1:55	346.56		4:25
1/18/2018	Montesano	0.48	11:05	1040.36		13:00	274.23		11:25	233.03		11:25
1/18/2018	SilverCreek	0.42	13:00	1115.5		13:30	356.03		13:10	374.97		13:45
1/19/2018	SilverCreek	0.05	19:15 1/18	704.32		23:40 1/18	43.3		19:50	13.16		19:25
1/19/2018	SilverCreek	0.24	2:30	749.46		7:15	189.87		3:05	110.72		2:55
1/20/2018	Montesano	0.94	16:00	5094.04		18:00	558.04		13:05	409.93		10:30
1/20/2018	SilverCreek	0.09	18:35	353.88		19:20	25.65		14:25	46.72		14:40
1/22/2018	Montesano	0.93	22:55 1/21	3505.24		23:40 1/21	417.94		23:00 1/21	392.16		23:10 1/21
1/22/2018	SilverCreek	0.08	0:05	197.14		0:15	16.22		20:55 1/21	0	J	Null
1/22/2018	Montesano	0.45	17:10	1892.58		18:45	154.33		16:05	97.61		9:35
1/24/2018	Montesano	2.14	14:05	5438.86		15:10	1273.79		8:15	1145.57	J	13:00
1/25/2018	Montesano	0.23	6:40	1347.38		7:50	100.64		1:15	11.34	J	1:20
1/25/2018	SilverCreek	1.26	3:20	7025.12		3:40	1918.83		3:50	3283.23	J	9:00
1/25/2018	Montesano	0.27	18:25	1487.44		19:20	87.79		14:45	11.34	J	1:20
1/26/2018	Montesano	0.29	12:15	1429.8		13:25	132.08		6:25	10.28	J	1:00
1/26/2018	SilverCreek	0.41	5:30	1594.04		5:45	541.92		5:50	266.91		5:35
1/27/2018	SilverCreek	0.38	15:15	1956.42		15:40	215.58		15:40	49.54		8:15
1/28/2018	Montesano	0.31	16:25	983.84		18:05	54.79		10:25	0	J	null
1/28/2018	SilverCreek	0.09	9:35	270.48		9:55	3.4	J	7:25	0	J	null
1/30/2018	SilverCreek	1.28	14:45	4315.66		16:45	1909.27		18:55	3024.56	J	20:30
1/30/2018	Montesano	0.1	14:10	333.18		15:00	13.61		14:00	0	J	null
2/2/2018	Montesano	1.39	11:35	8587.78		14:20	593.45		7:20	45.5		1:55
2/2/2018	SilverCreek	0.82	10:35	2837.62		11:00	820.24		5:40	1130		9:05
2/3/2018	SilverCreek	0.08	20:00 2/2	186.32		20:30 2/2	47.46		20:10 2/2	6.85		20:00 2/2
2/3/2018	SilverCreek	0.11	14:45	460.66		14:55	19.55		10:05	0	J	null
2/8/2018	SilverCreek	0.06	18:20	453.06		20:20	270.9	J	20:50	187.25		20:40
2/14/2018	Montesano	0.63	12:15	2411.1		17:00	437.98		12:40	787.69		17:00
2/16/2018	SilverCreek	0.11	23:20 11/15	420		0:00	170	J	0:05	94.47	J	23:45 2/15
2/17/2018	Montesano	0.66	2:50	5309.04	J	4:35	368.47		16:30 2/16	1627.76	J	4:35
2/18/2018	Montesano	1.25	6:45	4511.74	J	7:20	645.21		22:20 2/17	1072	J	23:45 2/17
2/18/2018	SilverCreek	0.62	21:40 2/17	2677.96	J	22:15 2/17	1009.28	J	22:20 2/17	543.58		20:00 2/17
2/19/2018	SilverCreek	0.4	1:05	814.62	J	0:55	567.7		1:00	436.71		2:00
2/28/2018	Montesano	0.23	23:45 2/27	1308.56		0:30	277.1	J	20:35	194.74		21:00

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3/1/2018	Montesano	0.53	7:30	2566.39		11:25	750.13		10:05	521.1		8:45
3/1/2018	SilverCreek	0.15	23:30 2/18	1797.34		0:55	313.81		1:05	104.7		0:05
3/2/2018	Montesano	0.12	7:40	745.1	J	8:55	240.06		10:45	290.22		11:00
3/5/2018	Montesano	0.11	22:35 3/4	504.16		0:25	126.71		2:50	0		null
3/5/2018	Montesano	0.11	7:45	312.04		9:30	85.54		8:50	56.38		8:30
3/8/2018	Montesano	0.08	7:25	364.6		8:50	221.68		10:30	0		null
3/9/2018	Montesano	0.93	11:20	4379.54		9:20	541.28		21:05 3/8	880.2		8:20
3/14/2018	SilverCreek	0.57	16:05	1445.18		16:20	596.21		17:35	339.39		16:00
3/22/2018	Montesano	0.42	16:40	3115.1		16:40	670.02		17:50	768.7		18:45
3/23/2018	Montesano	0.16	15:45	1696.08		17:50	150.69		16:10	478.48		17:45
3/23/2018	SilverCreek	0.85	23:50 3/22	4057.14		3/22/2019 23:15	2199.3	J	23:40 3/22	1721		1:55
3/23/2018	SilverCreek	0.14	17:05	747.22		17:50	505.64	J	18:35	410.23		19:20
3/24/2018	Montesano	0.09	0:40	399.12		1:25	66.71		0:15	53.52		22:00 3/23
3/24/2018	SilverCreek	0.22	8:40	1727.16		10:05	858.86	J	10:50	625.27		10:50
3/27/2018	Montesano	0.33	0:50	247.26		4:25	285.18		1:25	309.41		2:45
3/28/2018	SilverCreek	0.51	2:40	4057.3	J	3:10	2055	J	3:20	1240.94	J	5:10
4/2/2018	Montesano	0.3	21:45 4/1	1668.76		23:30 4/1	387.12		22:40 4/1	321.68		22:45 4/1
4/2/2018	SilverCreek	0.24	23:45 4/1	2751.36	J	0:50	1081.73	J	1:05	1027.25	J	1:10
4/4/2018	SilverCreek	0.11	12:05	637.16		14:05	205.4		13:30	136.4		11:55
4/5/2018	Montesano	0.58	23:30 4/4	3302.82		1:10	358.86	J	22:05 4/4	323.73	J	22:25 4/4
4/5/2018	SilverCreek	0.23	21:15	981.02		22:10	311.1		21:50	289.08	J	22:05
4/6/2018	Montesano	0.77	7:10	3688.56		8:55	500.17		6:10	469.82		6:25
4/6/2018	SilverCreek	0.4	3:05	1869.08		3:25	581.57		3:20	542.37		3:55
4/9/2018	Montesano	3.04	4:10	9968.48		4:40	2098.79	J	23:30 4/8	1582.52		2:15
4/9/2018	SilverCreek	1.48	21:10 4/9	5412.98		21:30 4/9	1798.18		21:15 4/9	3430.03	J	1:05
4/10/2018	Montesano	0.21	16:10	697.94		17:40	101.12	J	16:30	83.3		16:40
4/11/2018	Montesano	0.09	11:15	586.9		12:30	0		Null	0		Null
4/11/2018	SilverCreek	0.15	19:00 4/10	578.58		19:25 4/10	127.25		19:20 4/10	159.12		19:40 4/10
4/12/2018	Montesano	0.23	7:40	1885.54		7:55	3.43		0:55	30.84		22:40 4/11
4/12/2018	SilverCreek	0.63	9:55	1819.82		6:30	714.96		6:20	531.86		6:25
4/12/2018	Montesano	0.29	19:25	1828.08		20:15	108.72		18:00	27.42		15:45
4/13/2018	SilverCreek	0.09	20:50 4/12	269.98		20:50 4/12	38.53	J	17:40 4/12	10.28		17:30 4/12
4/14/2018	Montesano	4.01	6:20	10540.22		7:20	2545.76	J	6:05	1135.8		1:15
4/14/2018	SilverCreek	1.85	14:05	7751.14		14:05	2584.33	J	10:45	5064.93	J	17:45
4/17/2018	Montesano	0.12	6:50	304.54		7:10	29.29		3:50	0		Null

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
4/17/2018	SilverCreek	0.84	21:05	2032.92		20:50 4/16	1114.25		21:20 4/16	1967.39		1:55
4/21/2018	Montesano	0.17	8:05	547.8		11:35	78.81		8:25	71.82		9:35
4/21/2018	SilverCreek	0.09	11:30	294.39		11:30	24.67		11:10	100.27		11:55
4/28/2018	Montesano	0.12	4:30	559.42		6:15	150.73		6:30	128.14		7:35
4/28/2018	SilverCreek	0.32	3:35	1507.92		4:40	650		4:00	478.01		4:20
4/28/2018	Montesano	0.17	17:55	563.81		18:45	40.72		16:45	106.94		18:20
4/29/2018	SilverCreek	0.16	22:55 4/28	472.95		23:20 4/28	302		0:15	82.07	J	23:05 4/28
5/9/2018	Montesano	0.06	0:55	178.55		1:40	11.3		1:15	0		Null
5/10/2018	Montesano	0.17	12:15	580.89		12:15	42.77		12:25	130.01	J	12:55
6/9/2018	Montesano	0.59	3:25	2071.52		5:20	287.82		3:05	357.39	J	3:45
6/11/2018	Montesano	0.72	2:40	1104.05		3:35	224.87		0:15	216.46		0:45
6/14/2018	SilverCreek	0.09	22:40	106.03		22:05	7.91		22:05	6.85		21:15
6/16/2018	Montesano	0.2	11:10	426.03		13:15	58.92		11:35	44.46	J	11:45
6/25/2018	SilverCreek	0.15	11:05	820	J	11:05	306.78	J	12:25	282.46		11:05
7/7/2018	Montesano	0.09	13:40	423.69		14:35	75.39		14:00	0		Null
8/12/2018	Montesano	0.34	3:25	1041.99		4:05	167.84		20:09	317.36		7:30
8/12/2018	SilverCreek	0.09	21:10 8/11	253.66		21:10 8/11	185.75		20:55 8/11	248.63	J	22:55 8/11
8/27/2018	SilverCreek	0.62	9:00	2896.4		9:00	873.05		9:25	1677.38	J	14:00
9/8/2018	Montesano	0.05	14:30	161.45		14:30	17.33		14:50	0	J	Null
9/10/2018	Montesano	0.24	5:35	860.62		7:25	87.72		4:10	81.24		4:15
9/10/2018	SilverCreek	0.49	13:10	1642.99		13:25	466.21		13:45	929	J	18:30
9/11/2018	Montesano	0.06	20:30	131.96		21:10 9/10	0	J	Null	0	J	Null
9/11/2018	SilverCreek	0.14	0:45	301.23		23:20	94.03		23:25	929		4:40
9/12/2018	Montesano	0.27	22:05 9/11	913.71		22:55 9/11	94.12		22:35 9/11	100.97		0:05
9/12/2018	SilverCreek	0.07	10:15	214.59		10:45	290.5		13:25	247.99		14:00
9/13/2018	Montesano	1.08	2:45	1733.59	J	4:40	188.61		2:50	1498.52		2:40
9/13/2018	SilverCreek	0.56	22:55 9/12	550.67		23:20 9/12	273.92		0:05	148.02		23:20 9/12
9/16/2018	Montesano	0.84	14:15	3278.49		15:30	993.39		15:25	553.29		14:05
9/17/2018	Montesano	0.18	20:35 9/16	435.17		21:20 9/16	126.1		21:30 9/16	145.89		21:30 9/16
9/22/2018	SilverCreek	0.05	18:45	69.82		14:20	99.57		15:50	287.66	J	19:05
9/23/2018	Montesano	0.4	21:25 9/22	2189.63		22:00	115.45		17:50	59.75		21:35
9/23/2018	SilverCreek	0.21	21:00	250.03		21:20	104.09		21:25	140.57		22:30
9/30/2018	Montesano	0.06	7:20	167.93		7:20	26.1		6:00	0	J	Null
9/30/2018	SilverCreek	0.08	3:15	189.54		2:45	172.93	J	5:00	167.06		4:55
10/1/2018	Montesano	0.07	2:35	133.45		22:35 9/30	22.89		22:10 9/30	0	J	Null

Date	Site	Rain Total (Inches)	Time of Final Rain Increase	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase
10/2/2018	Montesano	0.07	7:50	316		9:50	30.04		8:15	181.63		12:25
10/2/2018	SilverCreek	0.05	6:00	69.51		6:15	20.17		6:15	0	J	Null
10/6/2018	Montesano	0.86	3:30	3044.69		6:20	557.75	J	3:00	509.55		2:25
10/6/2018	SilverCreek	0.81	8:40	2577.89		7:20	876.7		5:55	1531.56	J	11:25
10/8/2018	Montesano	0.44	5:05	2730.1	J	4:10	434.17		2:00	657.13		5:25
10/10/2018	Montesano	0.2	5:50	682.86		7:35	125.85		6:25	47.38		5:20
10/24/2018	SilverCreek	0.08	1:35	193.61		1:50	108.7		2:30	193.6		4:35
10/25/2018	Montesano	0.06	6:25	308.95		8:50	6.9		6:20	0		Null
10/26/2018	Montesano	1.5	14:55	5175.65		15:36	1286.01		15:45	1076.63		15:40
10/26/2018	SilverCreek	0.95	18:20	3567.24		18:00	383.58		17:50	562.55		18:05
10/28/2018	SilverCreek	1.26	10:50	2556.38		11:05	589.38		10:35	820.84		11:40
10/29/2018	Montesano	2.29	0:00	2878.87		0:00	856.65		22:55 10/28	782.61		22:55 10/28
10/29/2018	Montesano	0.25	8:55	758.32		9:55	105.83		8:55	63.54		8:50
10/30/2018	Montesano	0.09	14:10	244.64		14:10	21.6		14:20	24		17:50
10/31/2018	SilverCreek	0.27	12:05	1811.76		14:20	780.36	J	17:05	480.07	J	17:05
11/1/2018	Montesano	0.39	16:40	2260.01		17:25	95.98		15:45	54.83		15:20
11/2/2018	Montesano	0.55	13:00	1588.5		13:50	176.29		11:40	132.06		11:35
11/2/2018	SilverCreek	0.54	15:05	1939.16		16:35	482.34		15:30	165.01		15:05
11/4/2018	Montesano	1.52	11:30	4060.66		12:55	584.64		11:40	438.18		11:35
11/4/2018	SilverCreek	0.42	16:55	1963.19		17:05	544.24		14:45	134.17		13:15
11/5/2018	Montesano	0.04	11:15	1201.03		16:00	149.44		14:25	211.53		14:40
11/6/2018	Montesano	0.08	4:55	355.56		6:00	0		Null			Null
11/14/2018	Montesano	0.21	16:30	591.29		18:20	77.96		16:35	77.88		16:55
11/15/2018	SilverCreek	0.19	19:55 11/14	805.63		21:00 11/14	112.67		19:50 11/14	186.18		20:10 11/14
11/16/2018	SilverCreek	0.1	16:30	916.36		19:20	11.34		13:30	159.13		16:10
11/21/2018	Montesano	0.19	15:55	1264.7		18:15	409.2		17:25	395		17:50
11/22/2018	Montesano	0.61	9:05	1719.4		10:05	513.49		10:05	528.5		10:00
11/22/2018	SilverCreek	0.36	11:40	1411.96		14:00	402.58		12:45	610.1		16:00
11/23/2018	Montesano	1.21	19:05	4580		20:50	1569.16		22:00	1254.98		17:10
11/23/2018	SilverCreek	0.17	3:40	1048.03		4:40	378.83		19:55	175.16		23:20 11/22
11/24/2018	Montesano	0.14	7:45	1175.42		7:45	249.57		9:25	431.84		8:30
11/24/2018	SilverCreek	0.51	22:30 11/23	3306.44		23:50 11/23	531.95		23:05 11/23	384.11		23:40 11/23
11/27/2018	SilverCreek	0.1	23:05 11/26	537.79		23:55 11/26	0		Null	34.27		0:30
11/27/2018	SilverCreek	0.47	14:55	2099.03		16:35	328.12		14:25	410.8		14:10
11/28/2019	Montesano	4.44	0:55	8100.59		2:15	2551.77		1:35	2569.33		1:10
11/28/2018	Montesano	0.35	16:25	1072.71		17:35	398.12		20:30	83.09		14:45

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
11/28/2018	SilverCreek	0.29	11:45	1562.81		12:50	236.36		6:35	167.81		6:55
11/29/2018	Montesano	0.17	3:25	1070.69		5:30	332.68	J	4:30	118.66		3:15
11/29/2018	SilverCreek	0.17	3:25	1272.83		4:35	87.87		23:25 11/28	26.1		23:45 11/28
12/1/2018	Montesano	0.79	7:30	3216.2	J	8:35	536.7		7:50	448.11		7:25
12/1/2018	SilverCreek	0.24	1:15	630.98		3:05	255.51		4:35	143.3		2:00
12/8/2018	Montesano	0.08	11:05	603.81		9:35	5.33		9:10	89.1		9:30
12/10/2018	SilverCreek	0.79	11:40	3577.67		12:05	1240.85		13:15	822.92		10:05
12/10/2018	Montesano	0.91	16:50	4479.35		18:35	16.25		9:36	10:33		17:05
12/11/2018	SilverCreek	0.19	12:50	1020.56		15:00	283.31		13:20	143.25		13:05
12/12/2018	Montesano	2.28	7:25	5261.4		9:50	478		16:25	1138.44		17:05
12/12/2018	SilverCreek	1.13	9:05	2992.44		9:15	1402.02		10:05	1775.07		9:35
12/13/2018	SilverCreek	0.17	7:45	1026.28		8:25	337.98		9:40	205.93		9:50
12/14/2018	Montesano	1.8	22:45 12/13	5749.4		0:40	792.39		22:10 12/13	893.76		14:40 12/13
12/15/2018	Montesano	0.27	8:35	1428.04		10:20	110.63		8:35	6.85		1:15
12/15/2018	SilverCreek	0.23	6:50	917.81		7:15	164.81		7:15	148.27		7:25
12/16/2018	SilverCreek	0.05	11:10	121.79		12:10	0		Null	11.34		11:35
12/17/2018	Montesano	0.84	3:00	4054.71		6:05	648.26		2:45	870.76		5:10
12/17/2018	SilverCreek	0.1	0:00	526.44		1:00	50.03		23:15 12/16	75.63		0:30
12/18/2018	Montesano	1.79	14:30	3961.53		16:25	1044.49		14:45	879.83		13:40
12/18/2018	SilverCreek	1.57	19:45	5630.73		20:00	1996.17		19:40	2512.07	J	23:55
12/19/2018	Montesano	0.2	9:35	717.97		9:40	169.71		9:20	85.96		7:45
12/19/2018	SilverCreek	0.15	9:35	313.25		8:30	122.99		8:35	62.71		8:20
12/20/2018	Montesano	0.58	20:25	2253.26		21:00	416.12		21:30	233.95		17:30
12/21/2018	Montesano	0.17	5:45	819.7	J	5:45	150.64		3:15	58.8		2:30
12/21/2018	Montesano	0.13	16:30	1179.61	J	17:15	100.14		12:05	0		Null
12/21/2018	SilverCreek	0.18	3:05	851.99		4:15	139.8		2:45	114.53		3:05
12/22/2018	Montesano	0.06	11:35	380.76		13:50	34.27		11:45	0		Null
12/23/2018	Montesano	1.17	16:10	3167.12		16:00	702.9		16:25	328.17		11:35
12/23/2018	SilverCreek	0.72	14:45	2941.8		16:35	607.38		12:15	344.74		9:10
12/24/2018	Montesano	0.4	5:45	1422.8		6:40	165.19		3:50	68.53		3:05
12/24/2018	SilverCreek	0.61	6:25	2134.4		6:15	662.46		6:10	1056.1	J	11:35
12/27/2018	Montesano	0.44	0:20	1886.62		0:40	345.06		0:10	109.3		0:00
12/30/2018	Montesano	2.8	11:25	10666.73		13:00	2701.6		14:25	2609.57		10:55
12/30/2018	SilverCreek	0.71	10:05	2326.93		11:50	950.76		10:55	1052.87		10:50
12/31/2018	SilverCreek	0.16	0:35	306.24	J	0:15	130.01	J	0:25	99.28		0:40

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
1/3/2019	SilverCreek	0.17	16:40	515.06	J	17:05	385.01	J	18:50	323.59		17:30
1/4/2019	SilverCreek	0.21	14:45	759.78		14:55	351.48		15:05	510.76	J	15:20
1/6/2019	Montesano	0.74	13:35	2648.91	J	13:35	374.37		11:20	443.06		11:20
1/7/2019	Montesano	0.48	10:40	2816.78	J	12:20	386		9:05	399.27		11:15
1/7/2019	Montesano	0.08	15:25	588.12		15:25	30.59		15:55	34.27		6:00
1/7/2019	SilverCreek	0.26	4:40	516.06		4:10	65.04	J	5:40	540.68		8:10
1/9/2019	Montesano	0.53	13:05	4251.93		14:15	609.12		13:30	240.17		9:05
1/10/2019	Montesano	0.63	16:10	3740.33		17:10	473.13		16:30	393.33		12:10
1/17/2019	Montesano	0.74	0:00	1017.19		9:00	147.85		7:05	126.25		7:00
1/17/2019	SilverCreek	0.21	7:40	1451.97		9:55	213.47		8:00	210.48		8:15
1/18/2019	Montesano	1	16:55	2745.51		17:25	833.9		15:25	872.67		14:50
1/18/2019	SilverCreek	0.05	6:45	393.58		8:45	49.18		7:40	27.16		7:15
1/18/2019	SilverCreek	0.06	15:30	522.27		17:35	131.02		17:25	5.12		15:45
1/19/2019	Montesano	1.46	8:50	2627.6		8:40	918.11		8:40	924.88		8:40
1/19/2019	SilverCreek	0.78	11:00	3744.4		13:30	1226.71		11:30	711.19		9:55
1/20/2019	Montesano	0.24	0:15	601.75		1:20	192.65		0:45	157.51		0:35
1/22/2019	Montesano	2.12	16:25	5144.93		17:15	1317		17:00	1560.6		19:45
1/23/2019	SilverCreek	0.55	6:45	3182.71		8:15	713.66		7:15	390.93		6:45
1/24/2019	SilverCreek	0.22	7:10	1431.46		9:25	251		7:50	112.01		7:15
2/2/2019	Montesano	0.67	6:10	3467.57		7:55	703.6		7:50	286.75		2:00
2/23/2019	Montesano	0.44	0:21	1567.54	J	1:15	463.28	J	0:50	457.59	J	0:45
2/23/2019	SilverCreek	0.19	3:25	1692.86		4:25	227.63		1:50	86.91		1:05
2/24/2019	Montesano	0.31	0:05	586.96	J	1:35	187.71	J	1:05	160.42	J	0:05
3/8/2019	Montesano	0.4	20:50	761.86		0:15	239.29		21:35	248.54		22:35
3/12/2019	Montesano	0.78	9:05	2014.15	J	10:15	473.54		9:10	451.42		10:00
3/12/2019	SilverCreek	0.78	12:45	2601.03		12:45	1263.13		15:10	918.58		13:30
3/23/2019	Montesano	0.06	23:15	231.14	J	1:30	51.36		0:30	0		Null
3/26/2019	Montesano	0.31	12:35	1372.44		12:45	193.4		9:15	114.15		4:00
3/26/2019	SilverCreek	0.39	8:45	1887.86		9:10	370.31		9:25	296.77		9:00
3/28/2019	SilverCreek	0.18	4:40	578.72		5:25	73.9		4:50	77.93		4:55
4/3/2019	Montesano	0.15	18:50	818.3		19:40	20.56		19:00	0		Null
4/3/2019	SilverCreek	0.18	17:25	540.42	J	18:55	192.83		19:45	116.16		18:00
4/5/2019	Montesano	0.25	15:00	595.01		1:30	83.86		11:25	74.36		20:40 4/5
4/6/2019	Montesano	0.41	1:30	1134.13		1:30	245.85		1:35	214.25		1:30
4/6/2019	Montesano	0.41	19:00	858.83		20:15	198.71		19:00	156.9		16:25

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
4/6/2019	SilverCreek	0.82	1:20	2931.19		1:10	657.39		1:25	1357.48		2:15
4/7/2019	Montesano	0.39	11:05	1760.15		14:15	334.08		10:50	331.45		11:20
4/7/2019	SilverCreek	0.18	20:25 4/6	326.84		20:30 4/6	184.56		20:40 4/6	266.62		22:00 4/6
4/7/2019	SilverCreek	0.64	13:35	2908.5		15:00	100.14		14:00	113.72		18:00
4/8/2019	SilverCreek	0.12	17:25	730.75		17:30	50397		13:45	0	J	Null
4/9/2019	Montesano	0.09	8:30	435.25		10:30	94.8		9:55	97.72		9:50
4/9/2019	SilverCreek	0.49	14:10	1713.67		14:45	357.33		12:15	543.23		13:45
4/11/2019	SilverCreek	1.45	17:00	6261.12		18:30	2145.68		16:30	2821.21		20:15
4/12/2019	Montesano	1	22:40 4/11	6738.44		0:55	963.29		22:50	1636.47		3:45
4/12/2019	SilverCreek	0.4	18:35	3768.69		20:10	606.37		14:00	75.38		11:20
4/14/2019	Montesano	0.42	23:00 4/13	2381.88		23:10 4/13	324.44		22:35 4/13	534.79		23:25 4/13
4/14/2019	Montesano	0.11	15:35	1200.15		15:00	104.13		11:25	290.06		16:20
4/14/2019	SilverCreek	0.32	18:55 4/13	986.38		20:10 4/13	399.13		19:15 4/13	182.29		19:05 4/13
4/14/2019	SilverCreek	0.13	5:00	608.26		5:30	90.97		1:20	89.9		2:00
4/15/2019	Montesano	0.17	2:15	1731.89		2:55	162.37		22:00 4/14	482.12		2:55
4/15/2019	SilverCreek	0.28	6:15	2047.44		7:55	425.28		6:40	582.53		7:45
4/16/2019	Montesano	0.11	4:10	892.31		6:00	6.85		0:30	260.79		7:45
4/17/2019	Montesano	0.29	14:10	2278		15:30	17.73		3:10	62.47		3:05
4/17/2019	SilverCreek	0.11	9:50	1465.65		11:25	525.48		11:55	463		12:10
4/18/2019	Montesano	0.06	13:50	368.24		15:50	0		Null	0		Null
4/20/2019	SilverCreek	0.08	22:45 4/19	219.3		20:00 4/19	0		Null	60.45		20:20
4/20/2019	SilverCreek	0.07	6:10	514.31		6:55	0		Null	0		Null
4/23/2019	Montesano	0.21	4:20	1587.11		6:05	358.35		2:55	232.01		5:20
4/23/2019	Montesano	0.07	15:15	534.64		17:15	61.69		15:10	65.11		15:45
4/23/2019	SilverCreek	0.33	6:45	2100.9	J	7:45	417.35		7:45	715.69		7:45
5/15/2019	Montesano	0.18	1:00	1795.99		2:15	92.54		1:10	334.69		3:45
5/16/2019	Montesano	0.05	4:05	1184		6:10	217.43		4:30	197.19		4:35
5/16/2019	Montesano	0.11	17:35	643.99	J	18:40	133.07		18:25	50.26	J	15:55
5/17/2019	SilverCreek	0.36	16:50	1647.19		18:00	389.06		17:35	1566.52		19:35
5/19/2019	Montesano	0.16	15:10	1230.65	J	16:55	278.46		16:10	133.42		17:20
5/21/2019	Montesano	0.59	7:55	1186.79	J	7:15	144.05		4:15	179.76		4:35
5/25/2019	SilverCreek	0.1	1:25	178.01		2:00	0		Null	26.87		20:50 5/24
5/26/2019	Montesano	0.07	0:25	212.41		0:50	37.7		0:35	0	J	Null
5/26/2019	SilverCreek	0.28	1:25	1352.71		2:15	0		Null	172.39		0:10
6/7/2019	Montesano	0.36	8:40	1158.23		12:35	137.67		4:55	54.41		4:55

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
6/7/2019	SilverCreek	0.07	21:50	114.73		22:10 6/6	46.01		22:25 6/6	0		Null
6/8/2019	Montesano	0.47	2:30	1330.9		1:10	299.87		3:15	165.75		3:00
6/8/2019	SilverCreek	1.11	6:15	2681.82		9:10	832.4		6:30	391.18		5:45
6/26/2019	SilverCreek	0.05	21:00 6/25	105.08		21:35 6/25	52.1		21:45 6/25	0		Null
6/27/2019	Montesano	0.15	4:05	179.94		4:40	72.13		4:40	50.36		4:20
6/27/2019	SilverCreek	0.08	11:55	1559.1		13:30	474.7		12:15	390.98		11:55
7/3/2019	SilverCreek	0.19	6:10	701.28	J	4:05	135.95		4:10	0		Null
7/11/2019	Montesano	0.77	19:25	3472.78		21:55	628.91		19:35	258.45		19:05
7/11/2019	SilverCreek	0.2	3:20	662.63		2:25	208.15		6:00	173.78		5:15
7/15/2019	SilverCreek	0.19	15:30	606.14		15:55	24.49		14:35	59.26		15:25
7/16/2019	SilverCreek	0.17	0:30	327.45	J	2:15	24.3		0:35	36.17		0:45
7/18/2019	Montesano	0.66	4:05	2059.01		4:55	282.3		4:40	385.52		4:05
7/18/2019	SilverCreek	0.15	6:30	494.94	J	6:50	14.98		4:20	111.24		5:30
7/27/2019	SilverCreek	0.9	14:20	483.46		16:15	93.09		14:35	0	J	Null
8/2/2019	Montesano	0.22	14:05	846.8		14:25	112.39		15:10	149.22		15:10
8/12/2019	Montesano	0.11	22:25 8/11	328.92		22:55 8/11	121.94		22:50 8/11	229.68	J	3:40
8/12/2019	SilverCreek	0.12	2:30	202.95		5:10	37.45		2:35	0	J	Null
8/22/2019	Montesano	0.63	21:00 8/21	1871.23	J	22:00 8/21	371.72	J	21:05 8/21	409.28	J	22:40 8/21
8/22/2019	SilverCreek	0.39	3:40	1396.68		6:15	253.53		3:10	152.41	J	2:45
8/30/2019	SilverCreek	0.61	4:15	1134.94		5:30	139.68		0:20	132.6		22:50 8/29
9/6/2019	SilverCreek	0.17	15:35	150.21		14:45	52.42		14:50	98.23		15:30
9/9/2019	Montesano	0.62	5:55	797.11		6:45	107.7		5:35	100.78		5:35
9/10/2019	Montesano	0.31	0:55	983.59		1:10	92.83		22:45 9/9	101.73		16:40 9/9
9/13/2019	Montesano	0.34	3:50	859.31		4:50	202.33		6:25	168.95		4:30
9/13/2019	SilverCreek	0.49	11:30	1345.2		12:55	124.09		7:30	475.36		12:50
9/15/2019	Montesano	0.45	14:05	2318.21		16:30	379.76		14:40	318.22		14:50
9/16/2019	Montesano	0.38	12:10	1537.82		14:20	248.45		13:05	229.46		13:10
9/16/2019	SilverCreek	0.91	22:55 9/15	2886.37	J	0:20	332.62		9/15/2019 18:30	569.17		19:25
9/17/2019	Montesano	0.16	7:05	971.85		7:20	117.67		4:10	216.65		7:00
9/17/2019	SilverCreek	0.14	21:20	751.81		19:35	49.59		16:45	250.82		19:35
9/18/2019	Montesano	0.62	3:25	2008.4		3:50	284.5		12:00	311.69		22:20 9/17
9/18/2019	SilverCreek	0.24	13:50	912.8		16:20	101.75		13:05	262.09		15:25
9/19/2019	Montesano	0.18	22:35 9/18	291.91		3:05	58.85		23:00 9/18	37.52		23:00 9/17
9/23/2019	Montesano	0.3	20:45 9/22	1325.6		21:25 9/22	372.46		21:30 9/22	160.5		21:20 9/22
9/23/2019	SilverCreek	0.64	5:20	2775.91		5:50	263.62		1:55	253.17		1:15

Date	Site	Rain Total (Inches)	Time of Final Rain Increase (UTC)	Edge Volume (Liters)	Flag	Time of Final Edge Increase (UTC)	2 Meter Volume (Liters)	Flag	Time of Final 2 m Increase (UTC)	Toe of Slope Volume (Liters)	Flag	Time of Final Toe Increase (UTC)
9/24/2019	Montesano	0.14	3:05	704.92		3:50	187.71		3:50	0		Null
9/26/2019	Montesano	0.27	14:35	989.61		16:20	171.28		15:15	139.26		15:25
9/26/2019	SilverCreek	0.15	18:15	851.98		20:05	27.42		17:50	349.4	J	21:40
9/28/2019	Montesano	0.07	8:10	459.21		11:45	67.51		9:15	10:25		8:10