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Documenting Progress Report for Effectiveness Monitoring of the South 356th Street Retrofit and Expansion Project, Federal Way, WA (Deliverable D2.2)

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Summary of Activities

In the second half of 2015, King County continued to make progress monitoring the effectiveness of stormwater controls at the South 356th Street Retrofit and Expansion Project in Federal Way, WA. The objectives for this period were to 1) finish installing flow meters at all seven sampling locations and depth loggers in the two bioretention facilities, 2) collect initial flow and depth data to ensure meters are working, 3) develop a plan for pacing the autosamplers based on the initial flow and depth data, and 4) finalize the QAPP for water quality sampling. We accomplished all of the objectives except for finalizing the QAPP. The revised QAPP is going through the last internal review at King County and will be submitted to Ecology by February 12.

After some initial delays, all of the facilities were functioning by October 2015. These include the new combined detention and stormwater treatment wetland ("new CDSTW") that had been offline until grasses became established on the slopes, and the east bioretention facility that had had half of the underdrain replaced to improve infiltration. By October 2015, all facilities were receiving stormwater runoff and both bioretention facilities were draining. There have also been no more signs of vandalism or stolen property since the shed was stolen from the creek site in the spring. Most of the activities during Q3 and Q4 involved collecting initial flow data, recognizing problems with the flow data, trouble shooting the problems, and resolving them. These activities are summarized below.

Collecting initial flow data and identifying problems

King County completed the initial installation of the flow meters at all seven locations in Q3 and early Q4. Some flow meters were recording data and the data appeared to be reasonable based on field validation measurements, but meters at other locations were either not recording data properly, not transmitting the data reliably or the data did not appear to reflect the actual flow. An example includes measurements at the outlets of the bioretention facilities, EBO and WBO. Initial flow rates indicated the discharge coming from both bioretention facilities was much greater than expected based on the measured inflows. It was unclear if there were groundwater or

other sources of water to the bioretention facilities, problems with the outflow meters, problems with the inflow meters, or all of the above.

Trouble shooting the problems

KCEL field staff focused on identifying the cause(s) of each problem and fixing them. Flow meters were checked in the field, the variables used to calculate flow (size and slope of pipe) were checked on the engineer's drawings and verified in the field when necessary, and flow rates were recalculated as needed. For example, at EBO, one problem with the initial flow data was that the slope used to calculate flow in the old pipe that the bioretention drained to was incorrect. It turned out the "as-built" drawings from the old RDF done in 1997 were incorrect and the slope of a pipe needed to be measured. Another problem was that there was more flow than expected at EBO because inflows to the bioretention facilities needed to be diverted (through a bypass pipe that led to the initial location of the EBO) when large flows were forecasted. This was resolved by changing the location of the EBO so that it is now "upstream" of that bypass pipe. Finally, it appears an AVM flow meter functions better at the new location than the original bubbler flow meter. Flow data from the new EBO location are now reliable and accurately reflect the discharge from the east bioretention facility. There is no evidence that there is groundwater or any other source of water influencing flow measurements at the new EBO location.

Flow data at the WBO were unreliable initially because there were obstructions in the pipe and the water in the catch basin was backing up. By early January 2016, the problems were resolved by removing rocks in the pipe that were obstructing flow, replacing the bubbler meter with an AVM meter, and positioning the AVM meter far enough in the pipe to avoid the backed-up water in the catch basin.

Using flow and depth data to inform autosampler pacing guidelines

Preliminary data from the two inlets to the bioretention facilities indicate it will be challenging to pace sampling at these locations. Stormwater runoff from the basin flows along S. 356th Street in an open ditch, and infiltration appears to affect the rising and falling limbs in that both are more abrupt than what you would expect to see if flows were piped. For instance, there was no inflow reaching the bioretention facilities for most small storms (<0.2 in/24 hrs). When there was a moderate storm with at least ~0.2 inches of rain, inflows to the bioretention facilities were relatively brief. For example, on October 30, about 0.19 inches of rain had fallen by 5:00 am and most of that had fallen in the last three hours. By 6:00 am, 0.27 inches had fallen and the storm had ended. Flows into the bioretention facilities started at 5:00 am and had ended by 7:45 am (Figure 1).

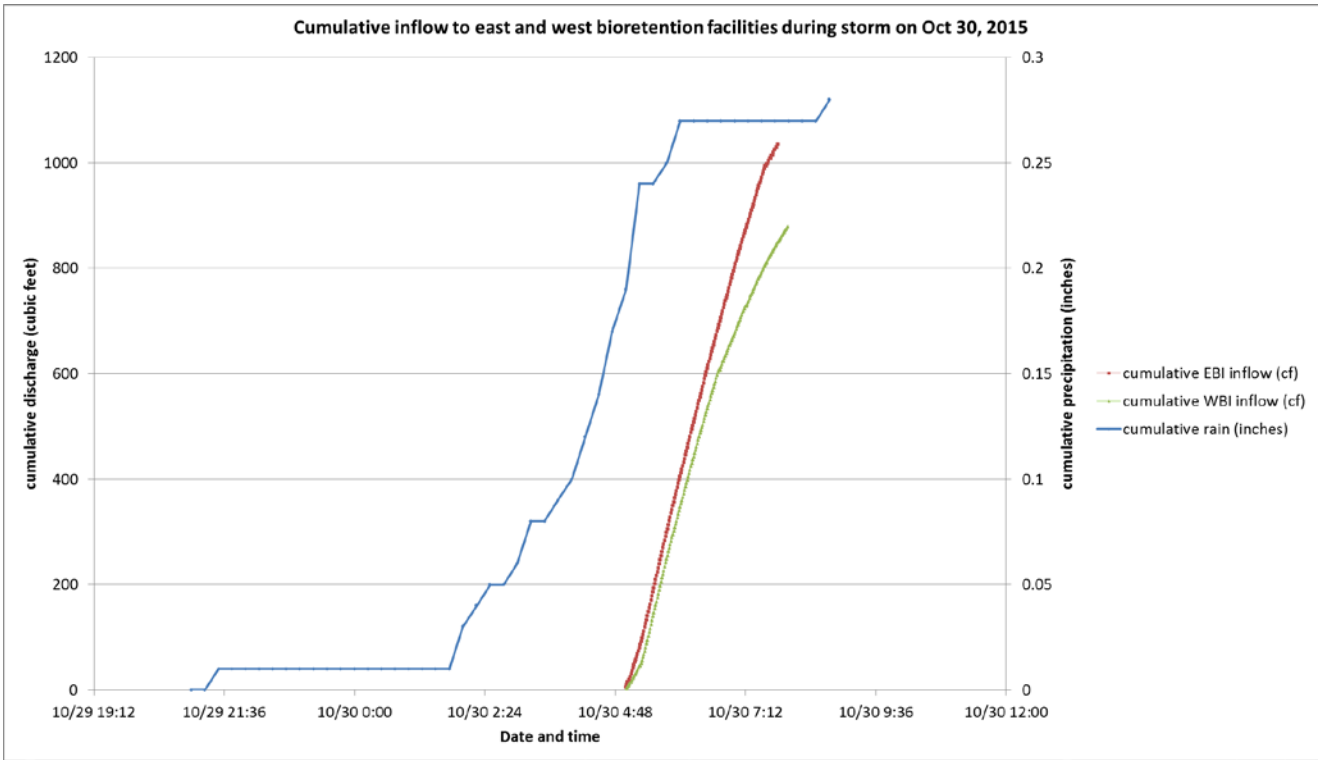

Figure 1. Cumulative stormwater inflow to east (EBI) and west (WBI) bioretention facilities at the S. 356th Street Regional Detention Facility on October 30, 2015.

Another challenge may be assessing flow control and sampling during large storms. When large storms (>1.0 in/24hrs) were predicted, Federal Way's engineer, Fei Tang, diverted flows from the bioretention facilities to prevent overflows that would potentially flood the surrounding streets. We will continue to assess how the bioretention facilities respond to large storms and adapt the criteria for diverting flows accordingly.

Depth loggers were deployed in the two bioretention facilities in September 2015, and while problems with the outflow data were being resolved, depth data were used to help understand flow dynamics within the bioretention facilities. For instance, the depth loggers confirmed that during several large storms (before flows were diverted) the west bioretention facility filled and overflowed into the new CDSTW (Figure 2). Depth loggers were also useful in documenting the slow drainage rate of outflow from the west compared to the east bioretention facility (Figures 2 and 3).

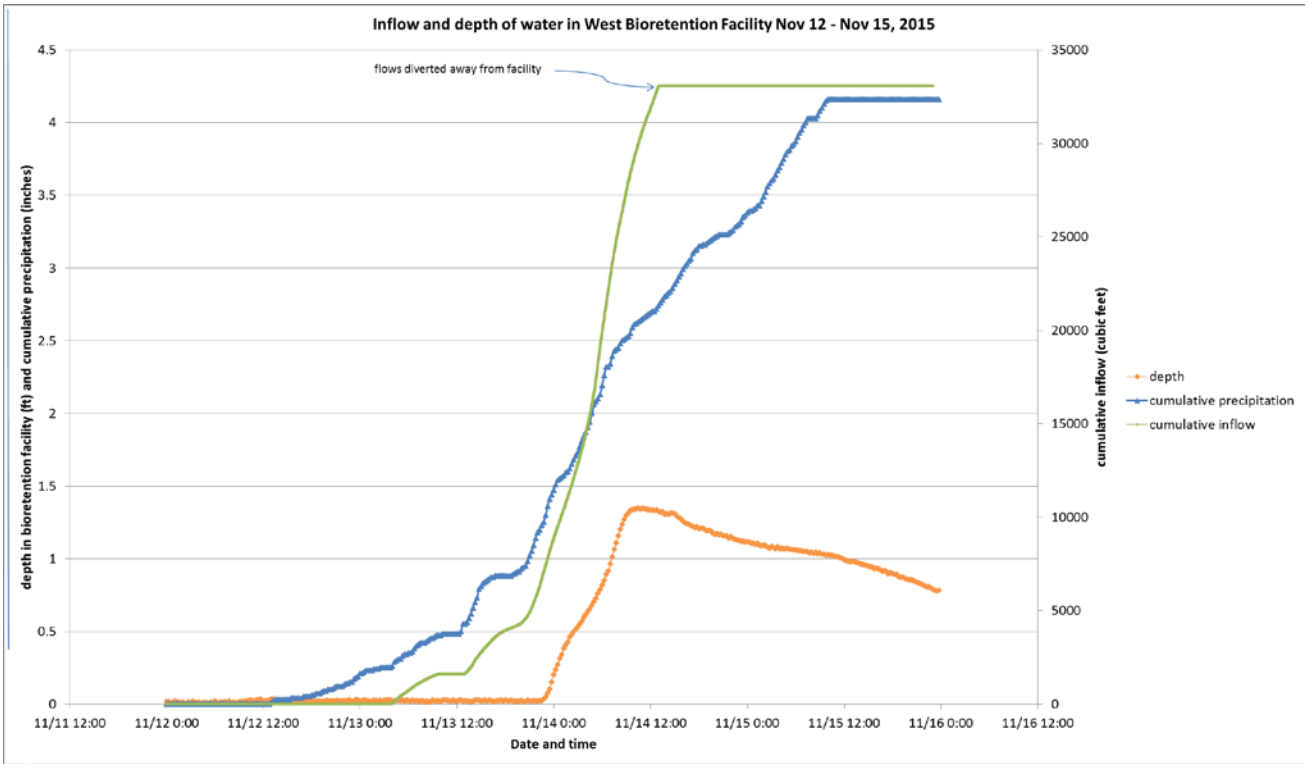

Figure 2. Cumulative inflow of stormwater runoff to the west bioretention facility along with cumulative precipitation during a storm that started on Nov 12, 2015. Note that there was overflow of the west bioretention facility after ~2.5 inches of rain had fallen and the water depth (orange line) in the facility had reached 1.3 feet. Inflows were diverted approximately 4 hours after the facility had filled, and only then did the water depth in the facility begin to decline steadily. It took nearly four days for the facility to drain completely.

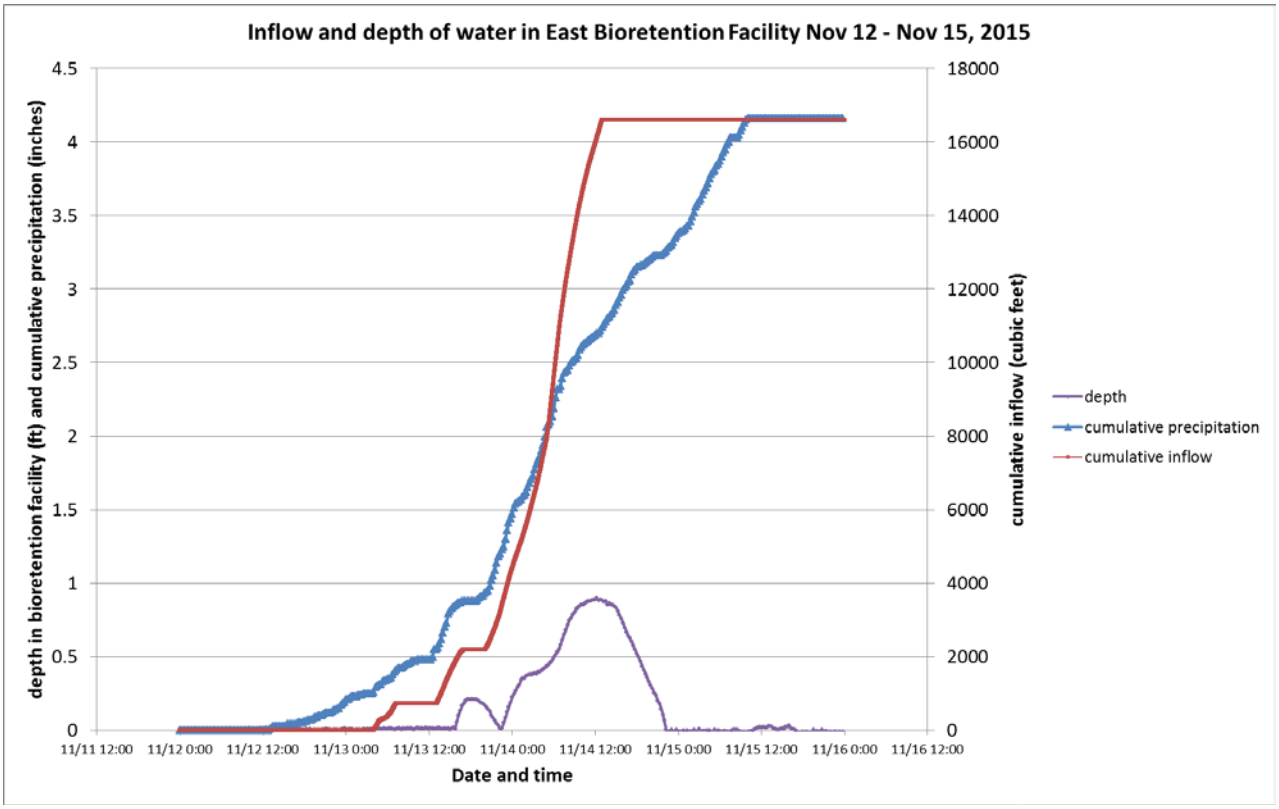

Figure 3. Cumulative inflow of stormwater runoff to the east bioretention facility along with cumulative precipitation during a storm that started on Nov 12, 2015. Note that there was no overflow of the facility (overflow depth is 1.2 feet), and it drained within ~9 hours after the inflows were diverted away from the facility.

<u>General observations about flow through the facilities thus far:</u>

- Storms with <0.2 inches result in increased flows to the wetlands but are unlikely to result in inflows to the bioretention facilities.
- The west bioretention facility is more likely to overflow and drains more slowly than the east bioretention facility.
- Inflows to the bioretention facilities appear to be 3-5% of the total flows to the S. 356th Street RDF

<u>Progress on QAPP</u>

Revisions to the QAPP include a clearer description of the two combined detention and stormwater treatment wetlands (CDSTWs) that are part of the overall facility. These had been incorrectly referred to as wetponds in the Draft QAPP. Although the original CDSTW or "old CDSTW" and the "new CDSTW" were not built exactly to Ecology's guidelines, they were both designed to provide detention and treatment and they both meet many of the specifications for combined detention and stormwater treatment wetlands according to King County and Federal Way engineers. Specifications related to the design and function of the two CDSTWs are included in the revised QAPP.

Activity Log

The following activities and site visits were logged by Jeff Droker, Houston Flores and Kate Macneale.

Date	KC staff	Activities
7/21/15	JD	Batteries changed; recalibrated flow meter at WBO
8/3/15	JD, DH	Batteries changed; Checked settings at WBI/WBO
8/6/15	JD, DM	Tested expansion band at WPCEBO; installed 6712 autosampler at WPCEBO; installed 6712 autosampler at NWH
8/19/15	JD	Checked and replaced batteries; checked on flow condition
8/31/15	JD	Uploaded data at WBI and WBO; replaced batteries
9/8/2015	JD, ALI	Checked batteries; trouble shooting challenge of installing meter at NWH
9/9/2015	JD, ALI	Installed meter at NWH
9/16/2015	JD, HF	Checked batteries; adjusting/fixing expansion band at EBI; testing modems
9/17/2015	JD, HF, AW, KM	Installed shed on grating at WPCI; modified shed for security, secured Isco in shed; installed temporary expansion band and AVM in EBI; Installed depth loggers in EB and WB (and additional logger deployed for barometric compensation)
10/1/2015	JD, HF	Downloaded data from WBI, EBI; checked batteries; checked meter programs
10/6/2015	JD, HF, JDD, DH	Confined space entry at WPCI, attached AVM, attached sample line, and rotohammered band into place; changed expansion band at EBI for better fit; checked batteries
10/12/2015	HF	Replaced battery at WPCI (unclear why other battery failed and data lost); checked other batteries
10/13/2015	HF, BB	Reconfigured modem at EBI (and unfortunately lost data)
10/21/2015	JD, HF	Downloaded data from all locations and checked batteries
10/22/2015	JD, DH	Changed batteries at 6 of the 7 locations
10/28/2015	JD, HF	Downloaded data from WBI, EBI and WPCI; Installed sampling lines for WBI, EBI and both field reps; checked all batteries
11/3/2015	HF, SH	Exchanged batteries at WPCI, WBO, NWH; programmed all modems; changed time (for daylight savings time); cleared gravel out from around AVM at NWH; recalibrated WBO
11/10/2015	JD	Troubling shooting problems with a couple of modems; checked batteries
11/16/2015	JD	Checked batteries and replaced several; downloaded data from WPCI, WPCEBO, WBI, WBO, EBI, EBO
11/18/2015	JD	Downloaded data from NWH, WPCI
11/19/2015	JD	Trouble shooting problem with cables for the field reps
11/20/2015	KM	Checked on pool depths, flows and equipment
11/23/2015	JD, HF	Checked and changed batteries; additional trouble shooting for field

Date	KC staff	Activities
		rep sample lines; installed and adjusted sampling lines at EBO, WPCEBO; WBO
12/3/2015	JD, HF	Replaced batteries; FREP communication cable connected to WBI – programmed both autosamplers to communicate with each other
12/15/2015	HF	Replaced batteries; downloaded data
12/21/2015	KM	Downloaded data from depth loggers
12/23/2015	JD, HF	Prepared for alterations to EBO/WBO
12/30/2015	JD, HF	Trouble shooting at WBO; installed AVM meter at WBO (along with the existing bubbler there)

Photos of inflows, sampling locations and field activities

Stormwater runoff flowing towards bioretention facilities on December 21, 2015 (photo taken looking upstream and east on S. 356th Street).

Stormwater runoff flowing towards bioretention facilities on December 21, 2015 (photo taken looking downstream). The east bioretention facility can be seen in the background.

Inflow sampling locations for the east (left) and west (right) bioretention facilities on November 20, 2015.

Inflow sampling locations for the east (left) and west (right) bioretention facilities on December 21, 2015.

The west bioretention facility on September 17, 2015. The facility was dry throughout.

The west bioretention facility on November 20, 2015. It had rained 1.3 inches three days before this photo and there was standing water remaining in the eastern half (where it is not underdrained, seen in photo) but none in the western half (that is underdrained, not seen in photo).

The west bioretention facility on December 21, 2015. The submerged depth logger is attached to the white stake.

Jeff Droker (King County) standing near sampling location and the autosampler at the west bioretention outlet (WBO).

Grate over catch basin that WBO drains to, and the shed that contains autosampler for WBO. The black pipe protects the sample tubing that runs from the WBO to the autosampler.

The depth logger in the east bioretention facility when it was installed on September 17, 2015.

The east bioretention facility on December 21, 2015 (looking west).

The small pipe was the initial sampling location for the east bioretention outlet. This location was moved in early January 2016 to a connector pipe upstream of this location. The new location is not influenced by flows diverted from the bioretention facilities (which can happen during large storms) and it receives only water flowing from the east bioretention facility.

The new sampling location for the outlet of the east bioretention facility (EBO) is accessed through the grate at the far end of the black pipe.

Autosampler and shed set up to sample the inflow to the “old” combined detention and stormwater treatment wetland (WCI).

The new combined detention and stormwater treatment wetland on November 20, 2015.

The old combined detention and stormwater treatment wetland in September 2015.

Outflow control structure in the old combined detention and stormwater treatment wetland in September 2015.

The sampling location for the outlet of the RDF (WCEBO). Flow through this pipe includes outflow from the two wetlands, outflow (and any overflow) from the east bioretention facility, and any flows that were diverted from the bioretention facilities (in the case of large storms). This pipe flows under the road and discharges to the creek.

Autosamplers in shed that sample the WCEBO and EBO.

Autosampler set up to sample at site on the North Fork of West Hylebos Creek (NWH) (photo taken September 17, 2015).

North Fork of West Hylebos Creek, just upstream of the flow control structure and culvert under S. 359th Street (photo taken September 17, 2015).