CATCH BASIN STUDY DATA ANALYSIS PLAN 12/20/17

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The following summarizes the data analysis plan for the Catch Basin Inspection and Maintenance Effectiveness Project. Development of this plan has required substantial, iterative, preliminary analysis. The plan summarizes the catch basin metrics that will be used, definitions for two different data quality tiers, data normalization methods, the specific analytical questions of focus and the resulting study questions that can be answered. Due to labor intensive data preparation and data availability, the study questions have been modified from the original proposal and analyses will be more limited.

Catch Basin Data Metrics

Some catch basin (CB) records include measured sump depths while others do not. Where sump depths are provided, accumulation rates can be calculated as inches per day based on inspection results. When sump depths are not provided, a time to failure can be calculated.

Potential Correlating Factors

The project team has examined the usability of the available CB data to run correlations with independent variables such as land use, % impervious surface, and road size. Unfortunately, without drainage basins delineated, we can't assign values for these variables to individual catch basins. In addition, data screening steps to establish data quality and methods for data normalization have been time consuming. For these reasons, data analysis will not include correlations to independent variables.

Two Analytical Tiers

Data anomalies were identified and sometimes affected substantial volumes of data. Thus, assumptions were implemented to allow use of these data. Because of the tenuous nature of some assumptions, it was decided we would analyze two tiers of CB data (a High Confidence Tier and Low Confidence Tier). High Confidence Tier assumptions are meant to eliminate high uncertainty assumptions so that data quality is higher than the Low Confidence Tier. The Low Confidence Tier is meant to be more inclusive of data quantity but sacrifices some confidence, having greater uncertainty associated with the CB data. See attachment for assumptions made for each tier.

Data normalization

Pitt and Bissonnette (1985) normalized the CB sediment volumes to catchment size (liters/hectare) to account for differences in runoff received. This normalization assumes a relationship between runoff volume and CB sump fill rate. Because drainage catchment sizes are not available for normalizing CB accumulation rates to land area, we will normalize accumulation rates to precipitation. Precip-normalized accumulation rates will be calculated where possible, (i.e. KC, Everett, Tacoma) as well as precip-normalized times to failure for all 6 permittees (Seattle, Everett, Tacoma, King County, Kent, WSDOT). Use of precipitation to normalize accumulation rates is supported by preliminary calculations (See Figure 1: precip-normalized accumulate rates by time since last activity) showing a remarkable unity of data (>18,000 records) from 3 permittees. Note: some negative accumulation rates are seen because this graph displays accumulation rates between inspections as well as from cleaning to inspection. If a CB is full, sediment loss from the sump might have been measured.

Although there are not precipitation gages co-located with the catch basins in the database, there are gages in the general areas where catch basin records were provided. Initial precip-normalization was done coarsely as a count of rain days by dividing the total inches accumulated by the number of rain days since last activity (i.e., inspection or cleaning). Rain days were assigned as 1 or 0 based on having greater or less than 0.05" rain in a 24-hour period (i.e. total daily rainfall). Then, rain days were summed to determine the total number of rain days in the period between inspections and between last cleaning and inspections. Rainfall data were downloaded for one or more gages in a city or county (averages were calculated when >1 gage readily available). Precip data for WSDOT records were obtained from County gages for Whatcom, Thurston, Skagit, and Kitsap Counties and used along with Everett, Tacoma and Seatac gage data. WSDOT records where no county gage data were found were excluded from the normalized data calculation (we have relatively few WSDOT records for these areas).

Table 1 Rainfall data sources

Permittee	Gages	# gages used
Seattle	Average of Seattle gages	15
King County	Seatac Airport	1
Kent	Seatac Airport	1
Everett	Avg of Everett gages	3
Tacoma	Avg of Tacoma gages	2
WSDOT	By County for King (Seatac), Snohomish (Everett), Skagit (1), Pierce (Tacoma), Thurston (4), Kitsap (3), and Whatcom (1).	15

Specific Analytical Questions

Pitt and Bissonette (1984) is the only published study identified that estimates municipal catch basin accumulation rates in the Western Washington region. Pitt and Bissonnette (1984) found that stormwater runoff rates in the two Bellevue drainage basins (e.g. catchments) studied were well correlated with total precipitation. These authors also found that catch basin sediment volumes stabilized at around 60% in a time period of 13 – 20 months from cleaning. This study was used as the basis for the Ecology municipal catch basin maintenance standards. Ecology assumes that sediment depth is a general indication of sediment volume. We will use sediment depth as a proxy for sump volume and plot depths for all CBs against time-since-cleaning (in rain days) to determine the % sediment depth at which stabilization occurs (see example in Figure 2). This will test if the sediment threshold for this area is close to 60% (or something different) and identify if precip can be used to predict maintenance for CBs in Western Washington (and if so, what precip amount). If time and budget allows, total precipitation will be used instead of rain days. Because a subset of the CB database contains sump depth, we will be able to examine if accumulation rates differ by sump size (> or < 12" depth).

Plotting the distribution of time for CBs to reach the 60% threshold (i.e.”time-to-failure”) will describe how fast CBs in western Washington accumulate sediment on average and how wide-ranging the timespan is for the region (see Figure 3 for example distribution).

- What is the distribution of time-to-failure across jurisdictions? How similar/different are CBs? What is the average time-to-failure?
- Does % sediment depth (i.e. % Full) stabilize over time for CBs to around 60% or a different value?
- What is the relationship (slope, r^2) between accumulation rates and inspection time interval under High Confidence and Low Confidence tier assumptions?
- Does sump depth (> or < 12”) explain variability in accumulation rates?
- Compare circuit-based inspection schedule (Tacoma) accumulation rates to other non-circuit based CB rates. Are they different or similar?
- Identify CBs that are anomalous and behave differently from most as far as accumulation.

If budget allows, we will look into some or all of the following for central Everett where drainage basins are delineated:

Case study:

- Everett: Does Sump Type, % impervious surface, explain variability in accumulation rates?
- Are CBs with fastest/slowest accumulation rates associated with particular land use, road size, and drainage area?

<u>I&M study questions to be answered -</u>

What CBs are outliers for sediment accumulation compared to others and may warrant further investigation on unique influencing factors?

Does the CB I&M database indicate 60% sump fill is the correct threshold for maintenance or should this threshold perhaps be refined?

How many days pass before most CBs approach 60% full? What does this suggest about inspection frequency needs?

Can precipitation be used to predict catch basin maintenance needs?

Do sumps with <12” depth have different accumulation rates than those with > 12”?

Are most CBs inspected before they reach 60%?

Are accumulation rates significantly different for circuit-based inspections vs non-circuit based?

What key information is needed to enable a more quantitative analysis of CB accumulation rates?

Preliminary Results: Precip-normalized accumulation rates by time since last inspection (a few outliers fall above and below the shown y-axis interval; axis truncation provided for data visibility)

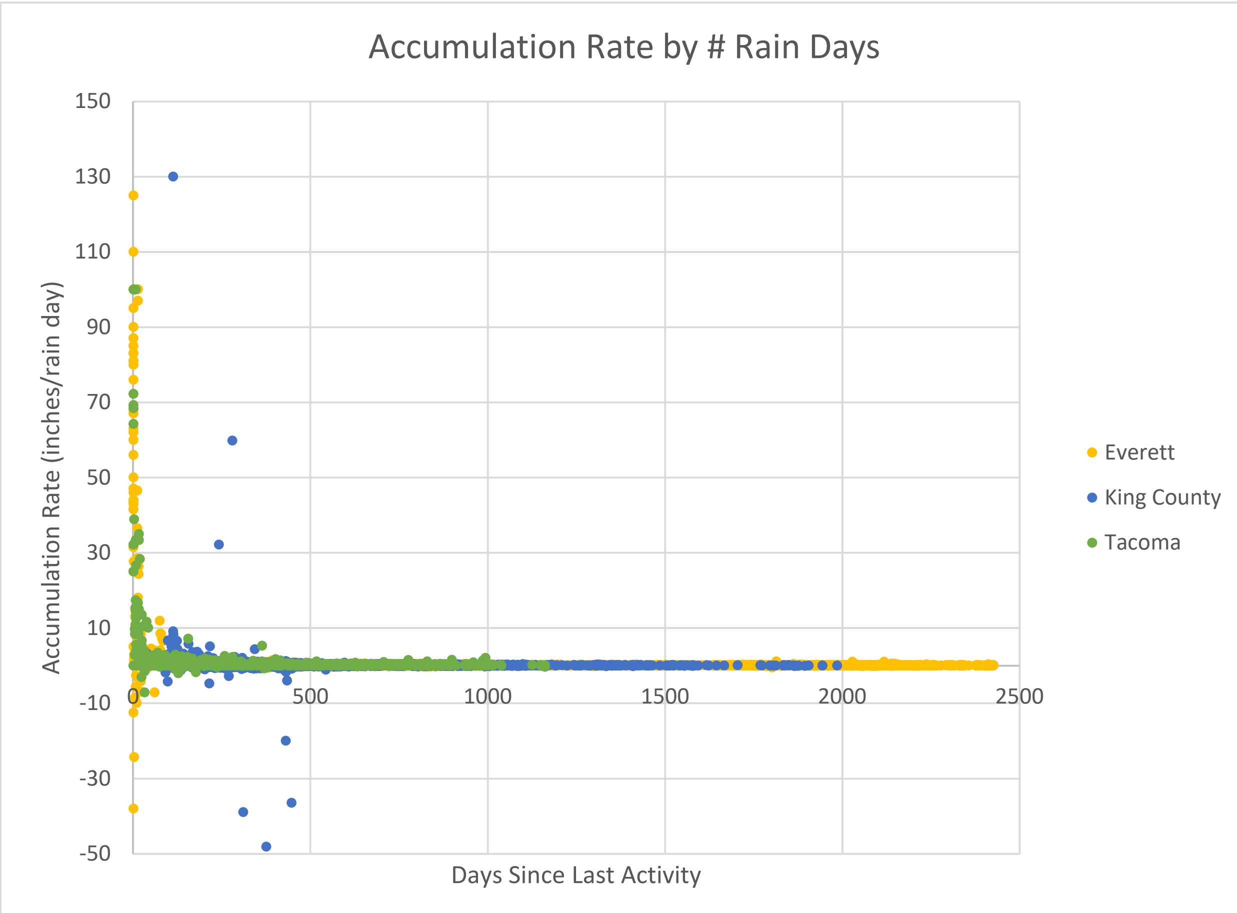

Figure 2 Theoretical example of CB sediment accumulation over time

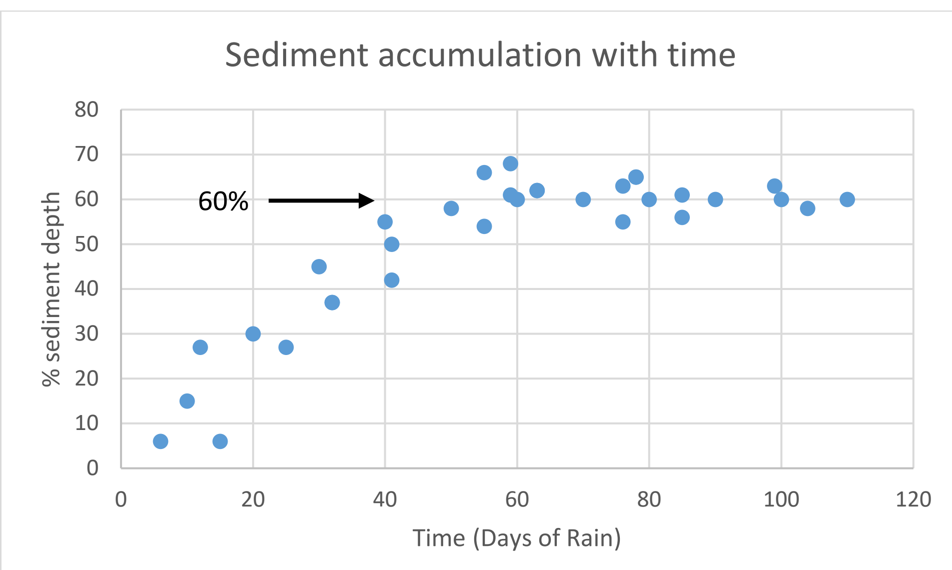

Figure 3. Theoretical example of CB time-to-failure