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TO JENÉE COLTON, KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS

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SUBJECT WESTERN WASHINGTON CATCH BASIN STUDY – FINAL PROGRAM DESIGN, IMPLEMENTATION, AND COST ANALYSIS TECHNICAL MEMORANDUM

INTRODUCTION

This memorandum summarizes lessons learned and transferable cost-efficiencies in the design and implementation of the inspection and maintenance programs based on information provided by the permittees. The 2017 survey soliciting information from all Phase I and II Western Washington municipal permittees and Washington Department of Transportation (WSDOT) regarding catch basin (CB) inspection and maintenance effectiveness was summarized in the Final Survey Results Technical Memorandum by Osborn Consulting from July 26, 2017. The survey was prepared and distributed to jurisdictions by the project team and Technical Advisory Committee (TAC). Additional follow-up interviews were conducted with selected permittees based on the information received in the survey.

This memorandum includes a review and evaluation of the various inspection and maintenance schedules and protocols used by selected jurisdictions. Cost efficiencies learned from the experience of individual jurisdictions are also summarized based on interviews and information provided. Various cost-saving approaches described by the permittees are presented in a qualitative summary.

This project is funded through the Stormwater Action Monitoring Program (SAM) as part of the Effectiveness Studies Component (S8.C). The municipal NPDES Stormwater permit in Washington State requires permittees to inspect and maintain catch basins under their jurisdiction on a regular basis. For Phase I permittees, the default inspection frequency is annual. For Phase II permittees, the frequency ranges from two to five years. Since the permit allows for an alternative schedule with demonstration that maintenance is needed less frequently, this study aims to extract important information related to the cleaning threshold that would help permittees direct limited inspection and maintenance resources to provide the greatest environmental benefit. Therefore, this study was designed to evaluate the existing records for CB inspection and maintenance to identify correlating factors that could be used to predict CB maintenance needs and to examine the program designs among Western Washington jurisdictions to identify cost efficiencies in program implementation.

PROGRAM DESIGN

Washington's Phase I and Phase II Municipal Stormwater Permits (permits) require inspection and regular maintenance of catch basins and inlets owned or operated by permittees. The default requirements for Phase I permittees include inspecting all catch basins annually (S5.C.9.d), while for Phase II permittees in Western Washington it includes inspecting all catch basins once no later than August 1, 2017 (except the City of Aberdeen, which has an extended deadline of June 30, 2018) and every two years thereafter (S5.C.5.d).

The permittees also have options to implement alternative schedules, which include: (1) establishing a less frequent schedule based on documented evidence; (2) identifying circuits and inspecting 25 percent of the catch basins within each circuit; or (3) cleaning the whole system, including all pipes, ditches, catch basins, and inlets within a circuit once during the five-year permit term, where the circuit drains to a single discharge point.

In the survey conducted in 2017, the first question addressed the permit schedule choices by jurisdictions. The question and responses are summarized below.

Question 1: Which permit schedule for routine CB inspection and maintenance is used by your jurisdiction? Check all that apply.

Inspection schedules vary between Phase I and Phase II permittees, and jurisdictions can select from multiple permit schedules choices for their catch basin program.

Phase I permittees can choose from one or more of the following programs:

- Standard approach – to inspect all CBs and inlet annually.
- Alternative 1 – to inspect all CBs more or less frequently than annually to meet maintenance standards based on at least two years of CB inspection records.
- Alternative 2 – to inspect all CBs annually on a "circuit basis," whereby 25-percent of CBs and inlets within each circuit are inspected to identify maintenance needs.
- Alternative 3 – to clean all pipes, ditches, CBs, and inlets within a circuit once during the permit term.

Phase II permittees can choose from one or more of the following programs:

- Standard approach – to inspect all CBs and inlets once by 8/1/17 and subsequently every two years thereafter.
- Alternative 1 – to inspect all CBs more or less frequently than every two years to meet maintenance standards based on at least four years of CB inspection records.
- Alternative 2 – inspect all CBs once by 8/1/17 and every two years thereafter on a "circuit basis," whereby 25-percent of CBs and inlets within each circuit are inspected to identify maintenance needs.
- Alternative 3 – clean all pipes, ditches, CBs, and inlets within a circuit once during the permit term.

Distributions of catch basin inspection schedules are presented in **Figure 1**. Of the 54 survey respondents, about 70 percent of jurisdictions used the standard approach. Approximately 17 percent of the jurisdictions used either Alternative 2 or Alternative 3, and only 9 percent of jurisdictions used Alternative 1 for routine catch basin inspection and maintenance. Several jurisdictions selected multiple schedules as they use different schedules for specific parts of their system.

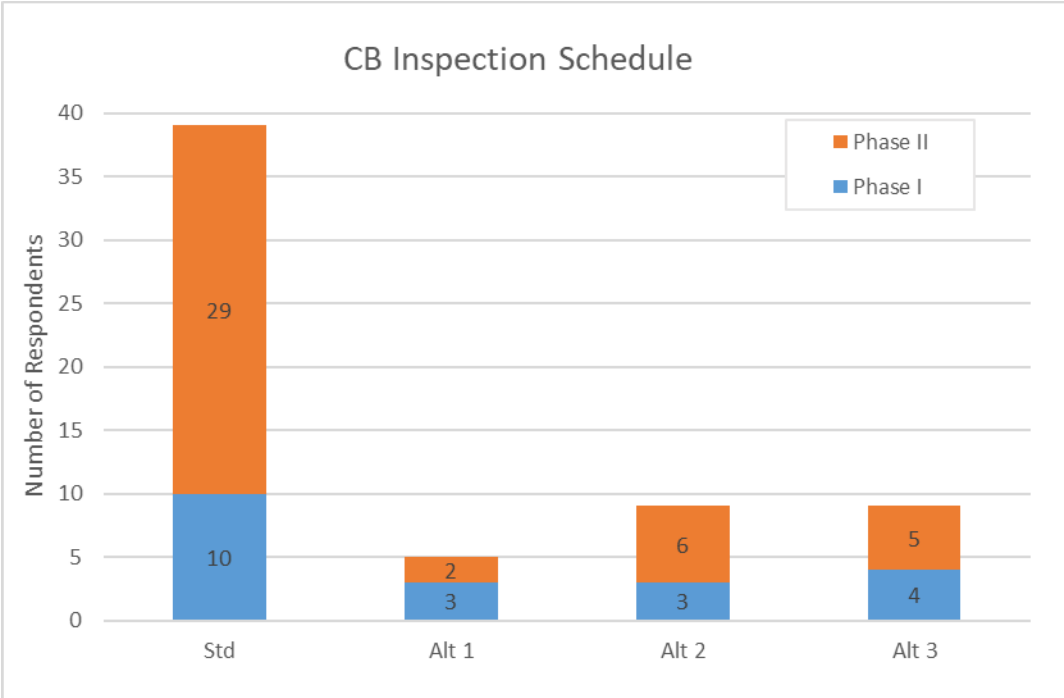


Figure 1: Catch Basin Inspection Schedule

Circuit-Based and Less Frequent Schedule Options

Some jurisdictions have observed variations in sediment accumulation that may be based on drivers such as traffic volumes, land use, topography, street maintenance practices. The less frequent schedule (Alternative 1) allows permittees to have a reduced inspection schedule based on documented evidence from twice the length of the proposed schedule. The circuit inspection alternative schedule (Alternative 2) allows permittees to target inspection of certain catch basins within areas that either drain to a single point or that have similar rates of accumulation and similar maintenance needs.

The permits define a circuit as "a portion of a MS4 discharging to a single point or serving a discrete area determined by traffic volumes, land use, topography, or the configuration of the MS4." Permittees using the circuit inspection approach have to inspect a minimum of 25 percent of catch basins within a circuit annually or biannually according to phase, including the catch basin immediately upstream of any system outfall (within their jurisdiction). This results in a much smaller burden for inspections for permittees for circuits with little sediment accumulation.

However, the circuit-based option has been poorly understood by jurisdictions and interpretations of how to implement it are highly variable among the members of the TAC for this project. In addition, TAC members and the project team were uncertain of how less frequent inspection schedules could be proposed. No examples of less frequent Phase I or II municipal permit CB inspection schedules were available from The Washington State Department of Ecology (Ecology). However, Ecology provided further clarification on the inspection and maintenance options for permittees in a publication titled "Catch Basin Inspection Alternatives for Phase I and II Municipal Stormwater Permittees." This resource is included in **Attachment A**. The Ecology publication describes how the documentation for a less frequent schedule needs to include inspection data for a period that is double in length to the time period of alternative frequency. Ecology also provided a list of jurisdictions with alternative schedules (**Attachment A2**) and an example of a support document presenting a less frequent inspection schedule used for private catch basins by the City of Seattle (**Attachment A3**).

The Ecology publication also explains that circuit inspections need to target at least 25 percent of the system and include a few quality control samples outside of the circuit. The inspections need to also incorporate the most downstream catch basin before an outfall. When none of the 25 percent inspected catch basins are found to need maintenance, the inspections can end. If all of the catch basins inspected are found to be needing maintenance, then the entire circuit needs to be inspected. When only a portion of the 25 percent inspected catch basins are found to require maintenance, the circuit may need more evaluation. The publication describes a possible approach implemented by Pierce County where the catch basins are inspected beginning with the most downstream catch basin in the circuit; inspections proceed upstream until three upgradient catch basins in every applicable direction are found that do not trigger maintenance per the standards, or until all catch basins in the circuit are inspected.

Attachments A4 through **A6** also include additional inspection resources about alternative schedules implementation from Ecology, Federal Way, and Pierce County.

Supplemental Interviews Summary

After reviewing the survey results, the TAC and project team recognized a need to better understand how jurisdictions are implementing CB inspection and cleaning programs and how they calculate program costs. Follow-up interviews were also needed to solicit information on cost savings experienced from changes in program design and management. Therefore, follow-up interviews were conducted with select jurisdictions. The questions for the follow-up interviews were developed in collaboration with the King County Project Manager and are outlined below.

Questions about the Program Schedule and Management:

- What drives the decision to pursue or not pursue circuit-based inspections?
- If using circuit-based inspections, what is your interpretation/decision tree of when failure in inspection of a catch basin happens?
- Does your jurisdiction have a combined inspection and cleaning program or are they separate events? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from doing a new method?
- Is inspection/maintenance done in-house or contracted out to consultant/contractor? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from changing your method?
- Are there any cost savings you have realized through other changes in your CB Inspection and cleaning program?

Questions about the Program Costs:

- What is the total number of CBs in your jurisdiction?
- What is the total cost of the CB maintenance program including inspections, cleaning, maintenance, sweeping etc.? OR, if not answerable, what activities are included in your maintenance cost total?
- What components are included in your costs for inspections and/or maintenance (e.g., data management, training, office staff, equipment the city owns, disposal fees, etc.)?

Questions about Best Management Practices (BMPs):

- Are there any BMPs you are currently implementing that target sediment removal before capture in CBs, such as street sweeping, wet vaults, socks/filters on CBs, curbs, impervious shoulders, etc.?
- Are there any lessons learned or cost savings from implementing them?

Jurisdictions selected for follow-up interviews were either (1) identified by the members of the TAC (Redmond, Pierce County, Seattle Public Utilities, Lakewood, and Thurston County), (2) included in the Catch Basin database (Everett, Kent, Kirkland, Tacoma, Tumwater, Washington State Department of Transportation, and King County), or (3) provided costs in their responses to the 2017 survey (Arlington, Battle Ground, Brier, Covington, Edgewood, Federal Way, Issaquah, Mercer Island, and Woodinville).

Information collected from the survey and follow-up interviews is summarized in the following sections organized by program implementation, transferable lessons learned, and program costs. **Table 1** provides an overview of program designs based on the interviews. The details from the follow-up interviews are included in **Attachment B** to the memorandum along with an exhibit showing the geographical distribution of the jurisdictions interviewed.

Table 1 – Interviews Summary

Jurisdiction	Phase	Program Implementation	Inspection and Cleaning Timing	Circuit-Based
WSDOT	Phase I and II	In house	Mixed Approach	No
Pierce County	Phase I	In house	Separated	No
SPU	Phase I	In house	Combined	No
Tacoma	Phase I	In house	Combined	Yes
King County WLRD	Phase I	In house	Combined	Partially
Redmond	Phase II	In house	Mixed Approach	Partially
Lakewood	Phase II	Contracted	Combined	No
Thurston County	Phase II	In house	Separated	No
Everett	Phase II	In house	Separated	No
Kent	Phase II	In house	Mixed Approach	No
Kirkland	Phase II	In house	Separated	No
Tumwater	Phase II	In house	Combined	No
Battle Ground	Phase II	In house	Separated	No
Brier	Phase II	In house	Combined	Partially
Covington	Phase II	Contracted	Combined	No
Edgewood	Phase II	Contracted	Separated	No
Federal Way	Phase II	In house	Separated	Yes
Mercer Island	Phase II	Contracted	Combined	No
Arlington	Phase II	In house	Combined	No
Issaquah	Phase II	In house	Separated	Yes

Program Implementation

Circuit-based inspection schedules.

Based on the survey results and interviews, only a few jurisdictions are implementing circuit-based inspections and a few are considering a circuit-based approach. The jurisdictions currently implementing circuit-based inspections include: King County, Tacoma, Federal Way, and Issaquah. The jurisdictions looking to start a circuit-based inspection schedule include Kent, Redmond, and Brier. Some of the reasons why jurisdictions have chosen not to pursue circuit-based inspections include:

- Jurisdictions do not have enough data about their system;
- Catch Basins are all off-line, making the circuit-based approach irrelevant (misunderstanding explained below).
- One jurisdiction found it more efficient to provide a higher level of service by visiting all catch basins and cleaning more often.
- Some jurisdictions were not familiar with the option of circuit-based inspections.

Defining a circuit with similar maintenance needs is critical for drawing conclusions about all catch basins in a system based on a sampling of catch basins. For well-defined circuits that include catch basins with similar sediment loads, sampling any 25 percent of the catch basins should be a representative sample to determine whether widespread maintenance within the circuit is needed. Therefore, circuits do not have to be on-line to allow for circuit approach. Off-line systems could still be inspected based on circuits, because they would have similar sediment loads in well-defined circuits. The most apparent pattern for jurisdictions that can pursue circuit-based inspection is the amount of data and operational knowledge about the stormwater conveyance system, which allows the jurisdiction to divide the geographical areas into circuits.

In-house vs. contracted out implementation strategies.

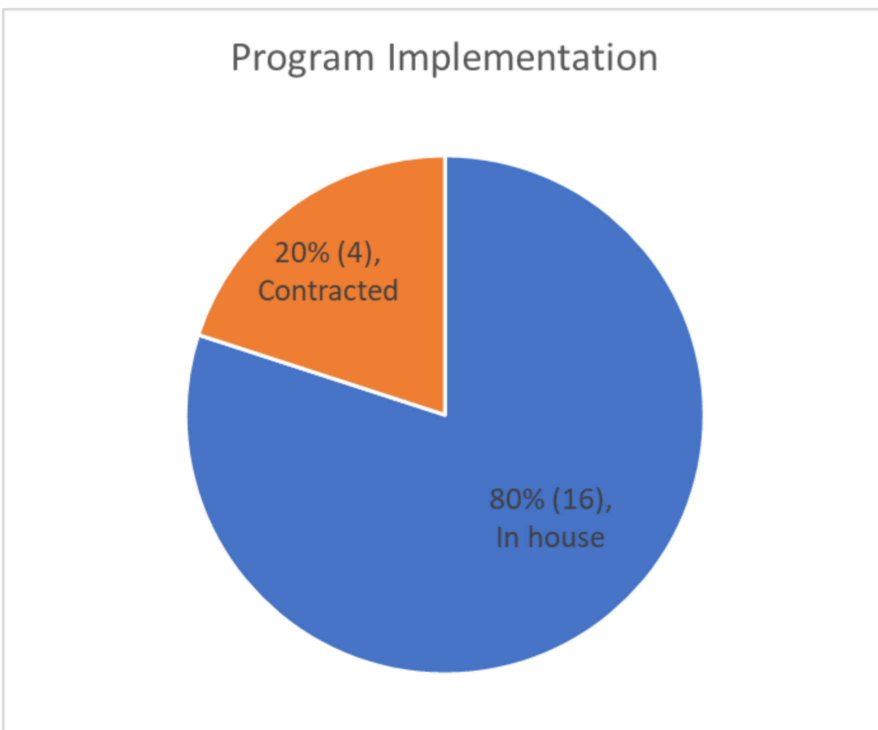


Figure 2: Program Implementation Distribution

Figure 2 above shows the breakdown of the program implementation strategies for the jurisdictions interviewed. Regarding the implementation strategies for inspection and cleaning activities, a high percentage of jurisdictions have the crew and equipment available and have always done the work in-house. Only four of the jurisdictions, representing 20 percent of those interviewed, are currently contracting out the inspection and maintenance activities. The jurisdictions contracting out this work include Lakewood, Covington, Edgewood, and Mercer Island.

Combined vs. separate inspection and cleaning activities.

Another question in the follow-up interviews focused on whether jurisdictions perform inspections separate from cleaning or if they combine them where the Vactor® truck is available at the time of inspection to perform any necessary cleaning. As shown on **Figure 3** below, the distribution is split with as many jurisdictions choosing to perform inspection and cleaning separately as choosing to do them together. A few jurisdictions apply a mixed approach where in some areas inspections and cleaning are combined (e.g., in high traffic areas that require traffic control plans or in areas with high sediment loads that, from experience, are known to need annual cleaning), and in other areas they first perform inspections and then send out the cleaning crew to the catch basins needing to be cleaned.

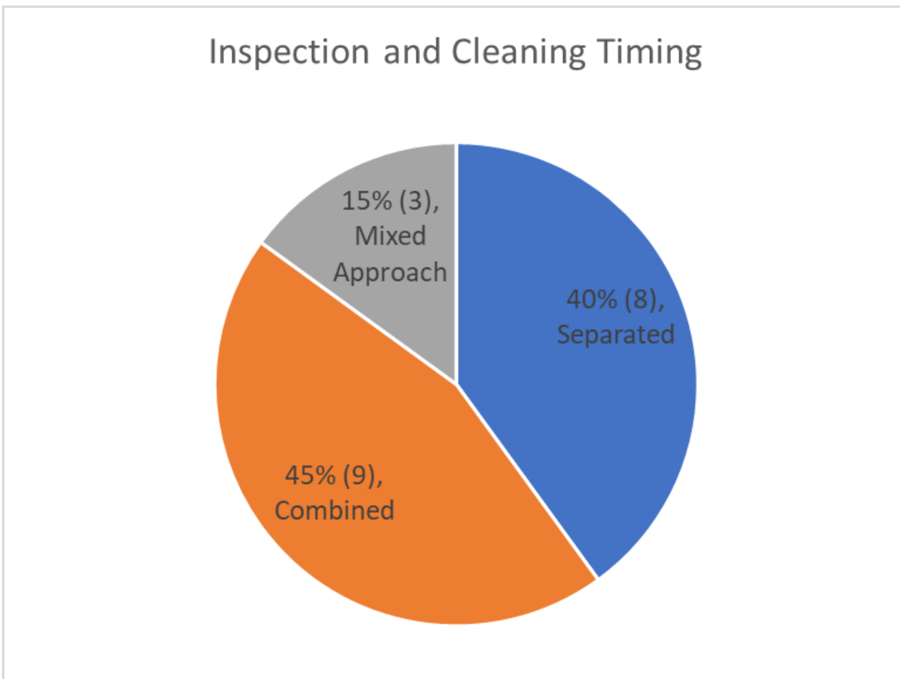


Figure 3: Inspection and Cleaning Timing

Transferable Lessons Learned

Several lessons learned from the survey and the follow-up interviews with jurisdictions have become apparent:

- Using updated data management tools for catch basin data built on digital databases has allowed jurisdictions to become more efficient, analyze trends, and define circuits. Some jurisdictions have implemented GIS-based tracking systems for crews in the field where they can mark inspection results, cleanings, and other issues with catch basins in real-time. Pierce County has realized 24-percent savings in their per catch basin cleaning and inspection costs after implementing an Asset Management System for catch basins. **Attachment A** includes more details about the Pierce County experience.
- Jurisdictions report that sweeping programs are one of the most cost-effective ways to keep streets and catch basins trash and sediment-free. Because street sweepers are much cheaper to operate than Vactor trucks, most of the jurisdictions have a sweeping program. However, none of the jurisdictions have quantified any cost savings realized by increased or targeted sweeping programs. Jurisdictions that experience relatively more snow in Western Washington have designed their sweeping program to remove sand from the roads after snow events and sweep arterials and areas with higher sediment accumulation on a more frequent basis. Some jurisdictions also try to optimize removal of leaves and debris according to the seasons and weather (i.e., deploy sweepers immediately after wind storms in the fall). These jurisdictions report heavier sediment loads in catch basins after heavy snow years that required increased sanding of the roads. A few jurisdictions are looking at using alternatives to sand, such as calcium magnesium acetate or various other salts.
- A few jurisdictions also report that having other BMPs that remove and/or accumulate sediment (i.e., wet vaults, stormwater treatment facilities) allows them to focus their sediment removal to fewer structures. These observations were qualitative; none of the jurisdictions measured reductions in sediment loads or maintenance required in the rest of the system.
- Many jurisdictions have reported that measuring the exact sediment depth has been difficult and inefficient when data for their system is incomplete (i.e., lacking total catch basin depth). While they can measure the depth to sediment, they do not know the total catch basin depth nor do they use a standard depth for sumps that would allow calculation of the sediment depth and the fill percentage. To make the process more efficient, a few jurisdictions are using a minimum of 12 inches clearance from the sediment surface to the invert of the lowest pipe instead of the 60 percent of the sump depth full. This results in fewer sediment accumulation records and more cleanings of catch basins. One jurisdiction reported that performing more cleanings of the catch basins and jetting of the pipes have significantly reduced their flooding events over roadways by 80 to 90 percent.

PROGRAM COSTS SUMMARY

One of the original goals of compiling catch basin inspection and cleaning cost information in this project was to examine how costs of inspection and/or cleaning may be lower depending on program implementation decisions (e.g., inspection schedule, combined/separate inspection, and cleaning). Comparing cost information submitted by jurisdictions has been challenging due to the high variability between jurisdictions' tracking systems. Each jurisdiction tracks their catch basin program in a unique way and includes expenses based on how their accounting system is setup. Generally, jurisdictions combine costs of inspection and cleaning activities in their accounting system, and therefore, a distinction between inspection costs and cleaning costs cannot be drawn. Many jurisdictions also include inspections for structural integrity and repairs to the catch basins in the same accounts that track catch basin inspections and cleanings for compliance with the permit. Some jurisdictions include equipment costs using an asset depreciation and recovery rate, and others do not include equipment costs. Overhead costs are recovered differently for each jurisdiction with some including program management, data management, office staff, or training activities and others including only some or none of the overhead activities. Disposal fees for solids have also been included in the costs of some jurisdictions, but others track the solids disposal separately when they manage sediment decant facilities or participate in other sediment management programs. The lack of uniformity in tracking costs does not allow for an accurate comparison between jurisdictions.

Attachment C includes the information received from jurisdictions in a summarized format. Box and whisker plots show the cost data distribution. The key to understanding the plots is provided in **Figure 4** below. The upper and lower quartiles are shown by the box, and the average is shown with an "X" in the middle of the box. The median is shown as a line across the box. The whiskers on the box show the range of values and outliers with values more than 1.5 times the quartiles are portrayed by the points above and below the extreme value. This plot helps extract any similarities or differences within data of the same kind where it can be divided into different bins.

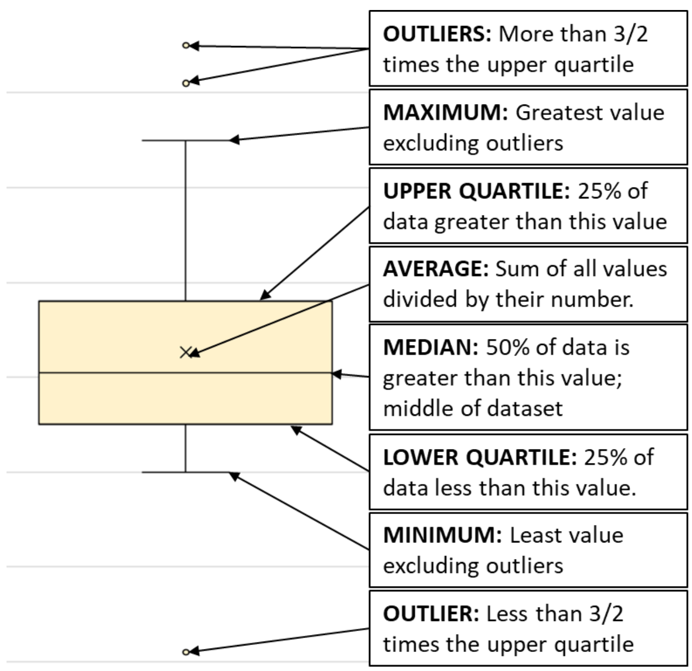


Figure 4: Box and Whisker Plot Key

Figure 5 below shows the distribution of cost data per catch basin in a box and whisker plot. The jurisdictions were separated into categories by size; small (less than 2,000 catch basins), medium (2,000 to 10,000 catch basins) and large (more than 10,000 catch basins); to try to illuminate any trends. Eight jurisdictions had more than 10,000 catch basins: City of Everett, City of Federal Way, City of Kent, City of Kirkland, City of Tacoma, Seattle Public Utilities, Pierce County, and WSDOT. These eight large jurisdictions contributed 43 cost data points between 2008 and 2015. Seven jurisdictions had between 2,000 and 10,000 catch basins: City of Arlington, City of Covington, City of Issaquah, City of Lakewood, City of Mercer Island, Port of Seattle, and Thurston County. These seven medium jurisdictions contributed 32 cost data points between 2008 and 2015. Four jurisdictions had less than 2,000 catch basins: City of Battle Ground, City of Brier, City of Edgewood, and City of Poulsbo. These four small jurisdictions contributed 28 cost data points between 2008 and 2015.

The distributions were similar between the different categories, but inconsistent cost tracking created wide variations in general, including some significant outliers. For example, the overall average cost per catch basin reported by jurisdictions was around $45, but the median value was only around $25. The minimum cost per catch basin reported was around $0.23 and the maximum was around $290. There is similarity in the average and median across the bins compared to the average. Counterintuitive to the paradigm of economies of scale, the large jurisdiction category shows the highest average, median, and outliers.

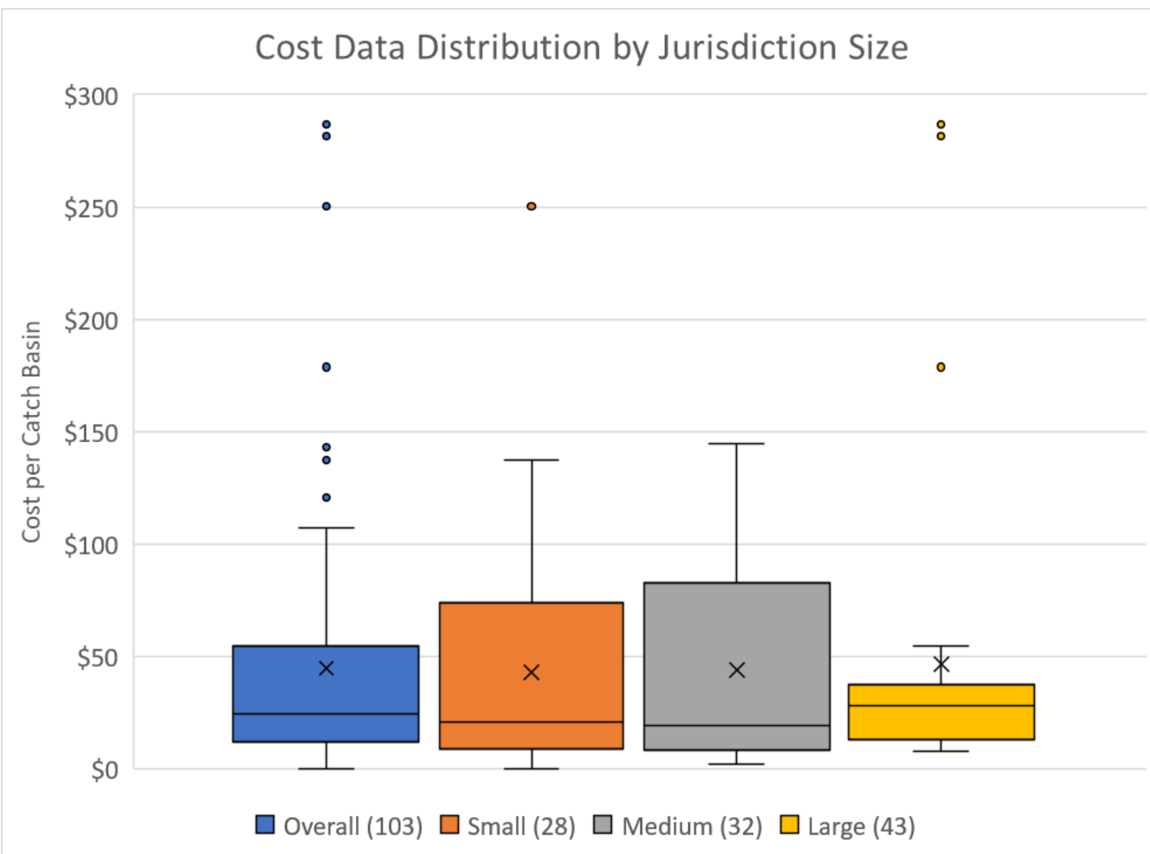


Figure 5: Costs by Permittee Size Distribution

Figure 6 below shows a breakdown of the cost data distribution by permittee phase. Large jurisdictions are typically Phase I permittees and, when the same data set was broken down in two bins by Phase I and Phase II permittees, the cost difference becomes more apparent. Phase I jurisdictions included are Port of Seattle, Seattle Public Utilities, Pierce County and WSDOT. WSDOT has a general NPDES permit that covers both Phase I and Phase II jurisdiction due state-wide distribution, but for the intent of this comparison, it was bundled together with the Phase I jurisdictions. The Phase I jurisdictions contributed only 28 cost data points, while Phase II jurisdictions contributed 75 cost data points. The Phase I cost average and median is showing at a much higher level than Phase II permittees. Additionally, all the outliers in the data appear in the Phase II bin.

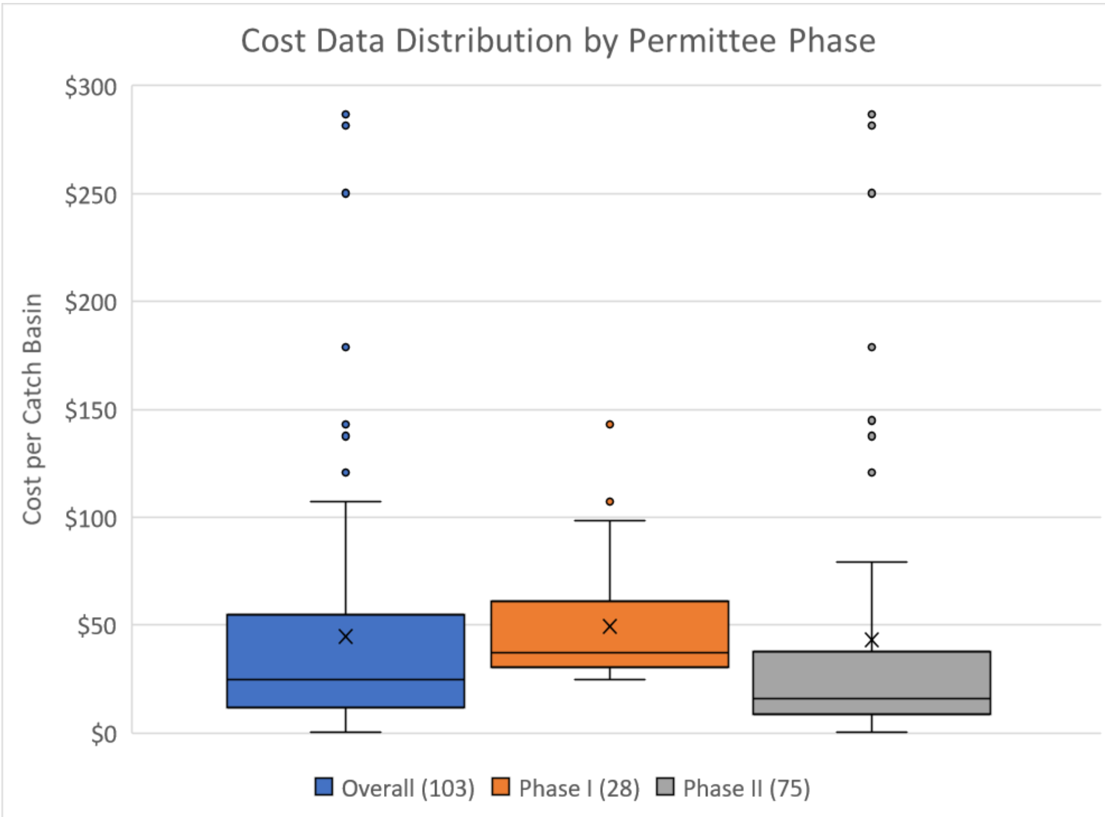


Figure 6: Costs Data Distribution by Permittee Phase

In summary, the lack of consistency in the cost tracking by jurisdiction results in data that do not allow for a lot of meaningful analysis into the reasons for the cost differences and similarities.

LIST OF ATTACHMENTS

ATTACHMENT A

INSPECTION RESOURCES

FOR ALTERNATIVE SCHEDULES

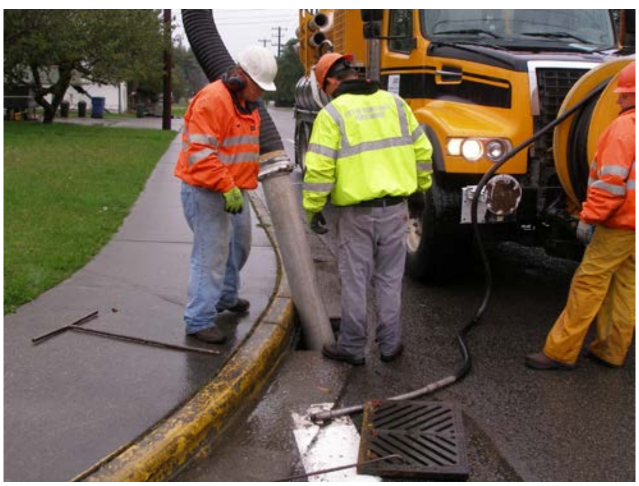
A Department of Ecology Report

Catch Basin Inspection Alternatives for Phase I and II Municipal Stormwater Permittees

Introduction

Washington's Phase I and Phase II Municipal Stormwater Permits (permits) require inspection and regular maintenance of catch basins and inlets[1] owned or operated by permittees. This focus sheet explains the catch basin inspection options in the permits and provides examples. This focus sheet will help permittees:

- Understand their catch basin inspection permit requirements.
- Review the four options each permittee has for implementing catch basin inspections.
- Select a catch basin inspection implementation approach (or approaches).



Vactor truck crew cleaning out a catch basin.

Benefits of catch basin inspection and maintenance

Catch basins have been in use nearly as long as modern storm drainage systems to prevent conveyance pipes from becoming clogged with debris and sediment. Catch basins act as the "first line of defense" by trapping and removing leafy debris, trash, and sediments from stormwater, thus preventing them from entering surface and ground water.

Several studies from around the country[2] have demonstrated the water quality benefits of regular catch basin maintenance. Kitsap County, a Western Washington Phase II permittee, reported removing 1,200 tons of material from catch basin sumps, vaults, stormwater ponds and streets in 2010. The majority, 962 tons, came from the catch basins and

[1] The term "catch basin" in this document also includes inlets.
[2] USEPA Catch Basin Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=77&minmeasure=5

vaults. Sediment sampling indicates that this equates to removing roughly 800 pounds of toxic metals (copper, lead, and zinc), nine pounds of polycyclic aromatic hydrocarbons (PAHs), and 290 gallons of oil[3]. This is just one year of maintenance from one of over 100 Washington State permittees.

To maintain proper catch basin functions, permittees need to regularly inspect catch basins and remove the buildup of materials when needed. Inspections also allow permittees to identify and address potential structural and functional issues early. This proactive effort helps prevent small problems from developing into costly, time-consuming repairs.

Catch basin inspection timelines

Washington State municipal stormwater permits establish timelines for catch basin inspection requirements. The default requirements are:

- *Phase I Permit* (S5.C.9.d): Inspect all catch basins annually.
- *Western Washington Phase II Permit* (S5.C.5.d): Inspect all catch basins once no later than August 1, 2017 (except City of Aberdeen by June 30, 2018) and every two years thereafter.
- *Eastern Washington Phase II Permit* (S5.B.6.a.ii (b)): Inspect all catch basins at least once by December 31, 2018, and every two years thereafter.

These inspection timelines (referred to as the standard approach in this document) may be adjusted using the alternatives discussed below.

Vactor truck crew cleaning out a catch basin.

Options for implementing catch basin inspection requirements

Given the wide variability in municipal separate storm sewer system (MS4) configurations and pollutant loading potential, each permit contains four options for inspecting catch basins and inlets:

1. A *standard approach* of inspecting all catch basins and inlets within the MS4 (frequency is set by permit—either annually or every two years).
2. Establishing a specific, *less frequent schedule* based on documented evidence.
3. Identifying *circuits* (see explanation of circuits on page 4) and inspecting 25 percent of the catch basins within each circuit (frequency set by permit—either annually or every two years).
4. Cleaning the *whole system*, including all pipes, ditches, catch basins, and inlets within a circuit once during the five-year permit term, where the circuit drains to a single discharge point.

Permittees may choose to implement one of the four inspection options for the entire MS4, or implement different options for different portions of the MS4. The permit does not require that

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[3] Kitsap County: www.kitsapgov.com/sswm/pdf/7007.pdf

Ecology 'approve' a permittee's switch to a less frequent or different inspection schedule or approach. Still, the permittee must be able to explain why a less frequent or different inspection schedule is appropriate in certain areas, and must document and report the change in the Annual Report.

Catch basin inspection for depth of sediment accumulation.

The following are detailed descriptions of the four catch basin inspection options:

1. Standard Approach

With this approach, permittees inspect all catch basins they own or operate according to default permit timelines (described above). Permittees maintain those found out of compliance with applicable maintenance standards.

2. Documentation of a Less Frequent Schedule

Under this option, permittees consult maintenance records or documented maintenance experience to determine a specific, less frequent inspection schedule that will reliably track the condition of the catch basin without exceeding the maintenance standards. For example, maintenance records may document that for a portion of the MS4, the rate of sediment accumulation is equivalent to 10% per year. At this rate of sediment accumulation, it would take six years to reach the sediment height of 60% full. If, for this community, the maintenance standard triggers cleaning at 60% full, then less frequent inspections (e.g., every three years) are entirely appropriate.

Permittees choosing this option must have maintenance records for double the length of time of the proposed inspection frequency. Examples of how to use this option include:

- A Phase I permittee, currently required to conduct annual inspections of catch basins, is planning to inspect once every two years. In this case, the permittee will need at least four years of annual inspection records showing that maintenance was not needed to demonstrate that the proposed two-year inspection schedule is appropriate for the area where it will be implemented.
- A Phase II community hoping to reduce the inspection schedule to once every three years will need to conduct three rounds of inspections (every two years covering six years total), with all inspections showing that the catch basins in the area did not exceed maintenance standards.
- A Phase II permittee with detailed maintenance records that go back to before 2007 could use that data to justify a four year inspection schedule prior to 2015 if the records adequately document that maintenance standards were not exceeded.

The *Less Frequent Schedule* option can only be applied to catch basins with maintenance records of physical inspections or as described in the paragraph below. Documented evidence from the subset of catch basins inspected on the circuit basis cannot be used to justify a less frequent inspection schedule for all the catch basins in the circuit.

Vactor truck crew dislodging accumulated catch basin solids during cleaning.

In the absence of maintenance records, permittees may submit a written statement to Ecology to document a specific, less frequent schedule. Permittees must base the written statement on actual inspection and maintenance experience. Permittees must certify the statement in accordance with G19 Certification and Signature of the permit, which requires a duly authorized representative to certify that the information is “true, accurate, and complete” under penalty of law.

3. Circuit Inspection Approach

Some permittees have found that sediment accumulation and the need for maintenance varies within the MS4 based on traffic volumes, land use, topography, street maintenance practices, or the configuration of the MS4. For example, catch basins in an established residential area with low traffic volumes and gentle slopes may accumulate sediment more slowly than catch basins in a high traffic volume commercial or industrial area. Similarly, catch basins along primary arterials and maintained snow routes are likely to experience increased rates of sediment accumulation. For certain areas, especially those with lower sediment accumulation rates, the ‘circuit inspection approach’ may be a useful alternative to the standard approach.

The ‘circuit inspection approach allows permittees to target inspection of certain catch basins within areas that either drain to a single point or that have similar rates of accumulation and similar maintenance needs.

According to the Definitions and Acronyms section of each permit, “A circuit means a portion of a MS4 discharging to a single point or serving a discrete area determined by traffic volumes, land use, topography, or the configuration of the MS4.” Circuits may vary in size and maintenance needs. The simplest type of circuit is a set of connected facilities that drain to a single point.

Permittees using the ‘circuit inspection approach’ must inspect a minimum of 25 percent of catch basins within a circuit, including the catch basin immediately upstream of any system outfall (within their jurisdiction). Defining a circuit with similar maintenance patterns is critical to allow a “sampling” of a limited number of catch basins to determine conclusions about all catch basins in the circuit. If the circuit is truly similar, then any 25 percent of catch basins should produce a sample that determines whether widespread maintenance within the circuit is needed.

Ecology reminds permittees using the 'circuit inspection approach' that they are responsible for ensuring that the catch basins they do not sample meet the program objective of reducing pollutants. During the first few circuit inspections, Ecology encourages permittees to conduct quality control by inspecting additional catch basins outside of the 25 percent sample to ensure the sample is actually representative of the circuit. Establishing the circuit and conducting quality control assures the jurisdiction that its 'circuit inspection approach' will work. If there are significant changes to the traffic, land use activities, or other factors, Ecology encourages the permittee to revisit the circuit delineation and adjust it accordingly.

Permittees employing the 'circuit inspection approach' can expect to encounter a variety of situations, and should rely on knowledge of their MS4 and best professional judgment to evaluate the next steps. The following are examples of some of the results and preferred responses to sampling results:

- If none of the inspected sampling of catch basins indicates that maintenance is needed, there is no need to inspect additional catch basins within the circuit.
- If all of the inspected catch basins within the circuit indicate that maintenance is needed, inspect all remaining uninspected catch basins within the circuit and perform all necessary maintenance.
- If the circuit inspection yields highly variable results (i.e., some catch basins exceed the maintenance standard while others do not), re-evaluate the 'circuit inspection approach' as applied to this area. For example, the circuit may need to be redrawn or the 'circuit inspection approach' is not appropriate for this area of the MS4.

The following examples illustrate the types of situations that may require further actions or evaluation:

- When an inspected catch basin in a circuit that drains to a single point exceeds the maintenance standard, inspect (and where needed, maintain) catch basins up-gradient of the initial inspected catch basin, beginning with the nearest catch basin. Continue inspecting up-gradient, following each branch within the circuit until reaching catch basins that represent the remaining up-gradient circuit which do not need maintenance.

How Does the Circuit Inspection Approach Work with Asset Management?

Asset management of the MS4 combines regular monitoring, adaptive management, financial considerations, sound engineering practices and other policies and procedures to provide the best and most cost-effective level of service to physical assets such as catch basins. It involves inspecting the structural defects of the catch basin to manage repairs or replacement. Maintenance standards for structural defects include checking the catch basin cover, frame, walls, bottom, or inlet/outlet pipes for cracks, fractures, settlement, or vegetation growth. Stormwater managers using the circuit sampling approach will develop other approaches to evaluate the structural function of catch basins that are not inspected as part of the sample. One cost-efficient option is to coordinate the structural evaluation with illicit discharge inspections. Structural inspections may need to be more frequent in areas of older infrastructure than in areas of new infrastructure.

- For circuits defined by similar traffic or land use conditions in which catch basins are not connected to each other, when an inspected catch basin exceeds the maintenance standard, inspect (and where needed, maintain) all remaining uninspected catch basins with the circuit. If the remaining, uninspected catch basins do not need maintenance, then evaluate why these differences in maintenance needs exist. Are there are other explanations for excess sediment, such as a nearby construction site that discharged sediment-laden runoff during a recent storm event? Or, does the discrepancy indicate that the circuit is not similar enough to support this approach?

Pierce County has integrated circuit-based inspections into their asset management program. Pierce County Road Operations (PCRO) performs annual inspections of over 4,000 circuits. Catch basins are inspected beginning with the most downstream catch basin in the circuit. Inspections proceed upstream until three up-gradient catch basins in every applicable direction are found that do not trigger maintenance per the standards, or until all catch basins in the circuit are inspected. For compliance with the 2013-2018 Phase I permit, the County will also need to assure that a minimum of 25 percent of the catch basins in each circuit are inspected.

4. Whole System Cleaning of a Circuit

Recent efforts by some Phase I permittees have demonstrated the water quality benefits of cleaning all pipes, ditches, catch basins, and inlets within a circuit that drains to a single point. Particularly in older portions of a MS4, contaminants from historical activities may have accumulated in cracks, crevices, low spots, or other areas within the conveyance system prior to the requirements for stormwater source controls and routine maintenance. For such areas, cleaning the whole system within the circuit one time during the permit cycle may make the most sense. Inspection and maintenance to address structural issues may still be needed.

The City of Tacoma recently conducted a study that showed statistically significant reductions in pollutants discharged from the MS4 following circuit-based whole system cleaning. Pollutants monitored included total suspended sediments (TSS), lead, zinc, and PAHs (including both light and heavy PAH fractions), and bis(2-ethylhexyl)phthalate (DEHP). For more information on this study, see the City of Tacoma's webpage (www.cityoftacoma.org/Page.aspx?hid=8096) for Section S8.E Program Effectiveness reports.

Permittees that implement this option will clean their whole system (within a circuit that drains to a single point) once during the five-year permit term. This may significantly reduce the inspection level of effort, which might otherwise occur annually or every other year. Permittees often combine whole system/circuit cleaning with structural inspections. Doing so may lead to early detection and rehabilitation of failing conveyance systems. Removing legacy pollutants from the MS4 and rehabilitating failing conveyances have the potential to significantly improve water quality.

Selecting the best options for the MS4

Vactor truck dumping its load at a decant facility for proper waste handling.

Ecology recommends the following steps in selecting which approach to apply to different portions of the MS4:

- *Review* system maps and maintenance records for areas with documentation to support a less frequent schedule, to identify areas of similar maintenance patterns for the circuit inspection approach, or to look for opportunities for whole system cleaning.
- *Delineate* areas for the less frequent inspection, the circuit inspection approach, or whole system cleaning.
- *Document* which catch basin approach is being applied in any portion of the MS4, and why. This information must be reflected in the Annual Report submittal.

Catch basin maintenance timelines

The permits require permittees to establish catch basin maintenance standards. Compliance with these standards helps keep catch basins functioning as designed, removes pollutants, and prevents re-suspension of pollutants during wet weather events. Permittees must at a minimum base these maintenance standards on the guidance in Chapter 4 of Volume V (Pages 4-37 through 4-38) of Ecology's 2012 *Stormwater Management Manual for Western Washington* (SWMMWW) or Chapters 5, 6 and 8 of the *Stormwater Management Manual for Eastern Washington* (2004) or another technical manual approved by Ecology. The guidance lists conditions when maintenance is needed and the results expected when maintenance is performed.

If an inspection identifies an exceedance of the maintenance standard, the permittee must conduct maintenance. Unless there are circumstances beyond the permittee's control, a permittee must complete required maintenance related to facility function within six months of the date that the maintenance standard exceedance was detected. Maintenance may include simply cleaning the catch basin to remove accumulated debris, or could include correcting structural problems that prevent the facility from functioning as designed. Permittees must dispose of catch basin waste appropriately. When conducting circuit-based whole system cleaning, permittees must be prepared to collect all material removed from the circuit and all water used in cleaning the circuit. These materials are wastes and must be properly handled, stored, tested and disposed of accordingly.

Summary

Ecology encourages permittees to consider the range of available catch basin inspection options and use local knowledge and experience to establish a program that makes the most sense for their MS4.

Over time, permittees may modify their selected approaches to improve effectiveness and efficiency, or to respond to altered land use conditions. Permittees may also change their selected approaches if they change other operational or maintenance practices, such as street sweeping. Although there may be a trial-and-error period to find the right balance of approaches, the objective of selecting an approach is to meet the catch basin maintenance standards with the appropriate level of effort.

For more information

Permittees with questions on catch basin and inlet inspection and maintenance alternatives should contact their regional permit specialist.
www.ecy.wa.gov/programs/wq/stormwater/municipal/municontacts.html

If you need this document in a format for the visually impaired, call the Water Quality Program at 360-407-6600. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Permittee	Alternative Method	Observation
Bothell	Circuit Based approach. Inspecting the first 3 catch basins above a facility. If they are dirty they clean and jet the whole system. Also, they are inspecting and jetting all pipes	Not clear if this means all 3 catch basins need to be dirty before they clean the system. Also, not sure about the size of the circuit. Presumably the jetting of all pipes keeps the catch basins from refilling quickly. There's no description about how these two strategies are used in combination with each other.
Duvall	Not using an alternative method	Must have answered the annual report question incorrectly
Federal Way	Used the method allowing for cleaning at double the length of time based on existing records – dividing up the city into "circuits" cleaning all catch basins and inventoried. Then measured annually to determine the appropriate cleaning schedule using	This strategy had some big upfront costs, but they now have data justifying the cleaning of some circuits on a 5 year schedule.
King County	Differs by custodial agency. Roads has the largest burden and they implement a circuit based approach. The Airport cleans their entire stormwater system once during the permit term.	No clear description of how a circuit is defined, no identification of how many CBs are inspected as a "subset" of a circuit.
Renton	The Parks and Golf Course Department uses **S5.C.5.d.ii** "*The Permittee may clean all pipes, ditches, catch basins, and inlets within a circuit once during the permit term. Circuits selected for this alternative must drain to a single point*" as its alternative to the standard approach of inspecting all catch basins once no later than August 1, 2017 and every two years thereafter.	No clear description of how a circuit is defined
Snohomish County	Roads Maintenance Division uses the method allowing for cleaning at double the length	Over 4 year period, the division cleaned over 12,000 CBs. In that same period, only

	of time based on existing records.	2 of those basins required more than a single cleaning (>60% full).
Seattle	Frequency of stormwater facility inspections not CBs	May be worth looking at the study done by Cascadia for SPU on alternative schedules for facilities?
Tacoma	City of Tacoma, Environmental Services (ES), Operation and Maintenance Division uses a **circuit based approach**.	Individual maintenance plans are developed for some catchments with especially heavy loads of sediment and individual problem catch basins. These maintenance plans include specific guidelines for the type of maintenance and frequency needed, and are developed as a result of observations during regular maintenance visits by staff. May be worth looking at maintenance plans?

City of Seattle
Seattle Public Utilities

January 4, 2011

Rachel McCrea
Municipal Stormwater Specialist
Water Quality Program
Department of Ecology
Northwest Regional Office
3190 160th Ave SE
Bellevue, WA 98008-5452

Re: Written Statement to Document a Less Frequent Inspection Schedule of Stormwater Facilities Regulated by the City of Seattle

Dear Ms. McCrea,

This written statement by Seattle Public Utilities (SPU) serves to justify a less frequent inspection schedule of stormwater facilities regulated by the City of Seattle (hereafter referred to as private stormwater facilities) as allowed in Special Condition S5.C.9.b.ii(3). Starting on January 1, 2012, SPU would begin conducting inspections on a frequency of once every two years.

SPU has been designated by the Mayor of Seattle as the lead agency responsible for implementation of the 2007 NPDES Phase I Municipal Stormwater Permit (permit). As the lead, SPU is responsible for implementation of Special Condition S5.C.9.b.ii for *maintenance of stormwater facilities regulated by the Permittee.* SPU has successfully implemented a private stormwater facility inspection program as required by the permit. The program is designed to determine if private stormwater facilities are in compliance with the City of Seattle Stormwater Code (SMC Chapters 22.800 – 22.808).

In 2010, SPU hired Cascadia Consulting Group to assist with a study of private stormwater facility compliance to evaluate whether there would be sufficient justification to reduce the frequency of inspections for these facilities from the level specified in the permit (annually starting in 2012). Specifically, Cascadia was hired to design and analyze data for a statistically valid study of inspected facilities to test the potential alternative schedule by estimating continued compliance levels among facilities after one year. The study sought to determine whether at least 80 percent of facilities that were found to be in compliance in 2009 remained in compliance after one year (2010). To help SPU select the private stormwater facilities to visit, Cascadia developed a study design with a randomized list of private stormwater facilities and the number of follow-up stormwater facility visits SPU needed to conduct to achieve a ±5 percent margin of error at the 95 percent confidence level.

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To implement the study, SPU conducted follow-up visits of 267 stormwater facilities that had been inspected, and found to be in compliance, or brought into compliance in 2009 to determine if they were found in compliance in the next year (2010). Based upon these follow-up visits, it has been determined that at least 80 percent of all private stormwater facilities included in this study remained in compliance one year after their previous inspection (Attachment 1. Private Stormwater Facility Inspection Study Report, Cascadia 2010).

The study, based on actual inspection results and the best professional judgment of SPU inspectors indicate that the sample population is not materially different from the overall population of private stormwater facilities. The results support the change in the inspection frequency for all private stormwater facilities that discharge to the City of Seattle's municipal separate storm sewer system to once every two years starting on January 1, 2012. However, if SPU receives a complaint about a private stormwater facility via its Water Quality Hotline or SPU determines during a Source Control Inspection that a site's stormwater facility is out of compliance, SPU will use progressive enforcement to bring the private stormwater facility into compliance with the City ordinances and rules. The study results suggest that stormwater facilities at Public Schools had a lower compliance rate than other categories. Due to the complex nature of these sites, SPU is going to devote extra resources over the next two years to require those sites to achieve compliance. If Ecology agrees with this written statement for a reduction of inspection frequency of stormwater facilities regulated by the City of Seattle for compliance with Special Condition S5.C.9.b.ii(3), SPU requests that Ecology respond in writing that the SPU approach constitutes compliance with the alternative in S5.C.9.b.ii(3).

I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violation.

Cordially,

Nancy Ahern, Director
Utility System Management Branch
Seattle Public Utilities

Attachment: Cascadia Private Stormwater Facility Inspection Study Report

cc: Bruce Bachen, SPU
Ingrid Wertz, SPU
Louise Kulzer, SPU
Kevin Buckley, SPU
Theresa Wagner, City Attorney's Office

CASCADIA
CONSULTING GROUP

To: Ellen Stewart and Kevin Buckley, Seattle Public Utilities, Stormwater Management Program

From: Jessica Branom-Zwick and Christy Shelton

Date: December 3, 2010

Subject: **Results of Study to Assess Private Stormwater Facility Inspection Schedule**

Seattle Public Utilities' (SPU) Stormwater Management Program works with private owners of stormwater facilities to ensure that systems are regularly maintained to prevent flooding, avoid property damage, and protect surface water quality. To comply with the 2007 NPDES (National Pollutant Discharge Elimination System) Phase I Municipal Stormwater permit, SPU is responsible for inspecting private stormwater facilities connected to the municipal separate storm sewer system (MS4). The permit requires SPU to conduct inspections according to the standard schedule described in the permit or according to an alternative schedule supported by maintenance records or a written statement.

Starting in 2012, the permit requires SPU to inspect all stormwater facilities regulated by SPU once each year. SPU program managers wish to discover whether annual inspections are warranted so SPU hired Cascadia Consulting Group to design and analyze data for a statistically valid study of inspected facilities to test the potential alternative schedule by estimating continued compliance levels among facilities after one year. Specifically, this study sought to determine whether at least 80 percent of facilities that were known to be in compliance in 2009 remained in compliance after one year (2010). Using this result, SPU would change the inspection frequency for compliant facilities to every two years. Accordingly, SPU seeks to propose an alternative inspection schedule, outlined in the table below.

	Standard Schedule	Potential Alternative Schedule
Initial Inspections	All private stormwater facilities connected to the MS4 inspected by February 2012	Same
Ongoing Inspections	Annual inspections for all private stormwater facilities connected to the MS4	Annual inspections for facilities inspected and <u>not</u> brought into compliance
		Inspections every two years for facilities inspected and found in or brought into compliance.

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Key Findings

Overall, **at least 80 percent of sites included in this study remained in compliance**, although rates varied by subgroup:

- 88 percent compliance among **multifamily** residential sites (n=114).
- 87 percent compliance among **single-family** residential sites (n=30).
- 80 percent compliance among **commercial or mixed use** sites (n=103).
- 40 percent compliance among **church, school, or public** sites (n=20).

Approach and Methodology

To assess whether a reduced inspection frequency is warranted, SPU conducted follow-up visits of stormwater facilities in 2010 that had been inspected in 2009 and were found in or brought into compliance. These follow-up visits determined whether the stormwater facilities that were in compliance in 2009 remained in compliance in 2010 and assessed the proportion of compliant facilities. SPU sought to determine whether at least 80 percent of these previously compliant facilities remained in compliance after one year. This section describes the population of private stormwater facilities, the population and sample sizes included in this study, and the data collected during site visits. The original study design, excluding the randomized list of sites, is presented in Attachment A.

Stormwater Facility Population Characteristics

Current data from SPU indicate that about 1,400 private stormwater treatment and flow control facilities discharge to the MS4 in Seattle, and an additional 286 are uncategorized by sewer class. In consultation with SPU project managers, facilities were arranged into six groups based on the expected facility type and the party responsible for maintenance. Table 1 presents the estimated number of private stormwater facilities flowing to the MS4, grouped by land use type. These facilities represent the total population of relevant facilities; the study sampled a subset of these facilities.

Table 1. Private Stormwater Facilities Flowing to the Separate or Partially Separate Storm Sewer Systems (MS4)

Land Use Type	Facilities
Single-family residential	560
Multifamily residential	392
Commercial or mixed use	323
Church, school, or public	84
Industrial	39
Parking lot	2
Total	1,400

- **95 percent confidence level.** If we were to repeat this study using the same random sampling methods, we expect that the confidence interval—the range defined by the margin of error around the estimate—would contain the true population value 19 out of 20 times (95%). The sample has a small chance of not representing the true population value; that risk is reduced with higher confidence levels (e.g., 99% confidence level).

To reduce the margin of error further, SPU attempted to visit all sites in the study population, increasing the sample sizes above the original study design expectations. During site visits, some sites were re-categorized or removed from the study population for the following reasons:

- Re-categorized to a more appropriate land use type (9 sites).
- Removed because they were duplicates of other sites already included in the study (3 sites).
- Removed because SPU would not be required to inspect them under its NPDES permit as the sites are either not connected to the MS4 (18 sites) or are owned by the City of Seattle and conduct self-inspections (18 sites).

Table 2 presents the final number of sites sampled during the study, number of eligible sites in the study population, and margins of error associated with each subpopulation by land use type. In calculating margins of error, we assumed that the sites sampled from the study population constituted both a random sample (not a sample chosen for convenience) and a representative sample (meaning the unvisited sites were not materially different from the sites sampled).

Table 2. Final Number of Site Visits, Study Population, and Margin of Error

Land Use Type	Site Visits	Study Population	Margin of Error
Single-family residential	30	32	4.5%
Multifamily residential	114	123	2.5%
Commercial or mixed use	103	103	0%
Church, school, or public	20	21	4.9%
Grand Total	267	279	1.2%

Note: The margin of error is zero for commercial or mixed use sites because all eligible sites in the study population were sampled.

The facilities inspected in 2009 and presented as the study population in Table 2 were not randomly selected from all private stormwater facilities connected to the MS4. SPU chose these facilities because they had never been inspected before; they had the oldest previous inspection dates (i.e., all other facilities of that type had been inspected more recently); or they completed the corrective actions needed to reach compliance in 2009. Because these 279 facilities did not constitute a random sample of all facilities, the results of the current analysis statistically apply only to those facilities that were known to be in compliance in 2009, not to the full population of all 1,400 private stormwater facilities. However, the results of this study would apply to all private stormwater facilities to the extent that the facilities visited formed a representative sample of all facilities, which cannot be determined through the current analysis.

Data Collection

This study used existing data from the SPU database as well as new data collected during follow-up visits to sample sites. Although this analysis only considered facility type "land use" and compliance status in 2009 and 2010, SPU inspectors also recorded additional data that could be used in future studies, including type of corrective action(s) needed in 2010 and facility size measured by number of units.

Analytical Results

Based on follow-up visits conducted by SPU inspectors, at least 80 percent of all sites included in this study remained in compliance one year after their previous inspection. Among subgroups, at least 80 percent of single-family residential, multifamily residential, and commercial or mixed use sites included in this study remained in compliance. Compliance among church, school, or public sites was much lower at an average of 40 percent. Table 3 presents the weighted average compliance rate among facilities that received site visits as well as the 95% confidence interval representing the estimated range of compliance for all sites in the study population. The confidence interval was calculated using the margins of error presented above in Table 2.

Table 3. Compliance Rates by Land Use Type

Land Use Type	Average Compliance Rate	95% Confidence Interval	
		Low	High
Single-family residential	**87%**	82%	91%
Multifamily residential	**88%**	85%	90%
Commercial or mixed use	**80%**	80%	80%
Church, school, or public	**40%**	35%	45%
Total	**81%**	**80%**	**82%**

According to the study design, SPU may decide to provide a written statement to the Department of Ecology requesting a proposed alternative inspection schedule for the land use types single-family residential, multifamily residential, and commercial or mixed use sites.

For church, school, or public sites, SPU may conduct further studies to determine whether additional characteristics of church, school, or public stormwater facilities provide more detailed information to support an alternative inspection schedule for these stormwater facilities. In particular compliance in 2010 may have been reduced because over half (12 out of 20) of the church , school, or public sites had originally been inspected in 2009 under an alternative inspection program that used different protocols for determining compliance than SPU inspectors used for other sites in this study. This study could not determine a statistically valid compliance rate among the remaining eight church, school, or public sites due to the small sample size.

Attachment A - Study Design

CASCADIA
CONSULTING GROUP

To:	Ellen Stewart and Kevin Buckley, Seattle Public Utilities, Stormwater Management Program
From:	Jessica Branom-Zwick and Christy Shelton
Date:	September 17, 2010
Subject:	**Study Design to Assess Private Stormwater Facility Inspection Schedule**

Seattle Public Utilities' (SPU) Stormwater Management Program works with private owners of stormwater facilities to ensure that systems are regularly maintained to prevent flooding, avoid property damage, and protect surface water quality. Stormwater facilities typically include storm grates, catch basins, outlet traps, and flow control structures.

To comply with the 2007 NPDES (National Pollutant Discharge Elimination System) Phase I Municipal Stormwater permit, SPU is responsible for inspecting private stormwater facilities connected to the separated stormwater system. The permit requires SPU to conduct inspections according to the standard schedule described in the permit or according to an alternative schedule supported by maintenance records or a written statement. SPU program managers believe the standard schedule, requiring annual inspections of all facilities, to be unnecessary. Accordingly, SPU proposes testing an alternative inspection schedule, outlined in the table below. SPU hired Cascadia Consulting Group to design a statistically valid study of inspected facilities to test the potential alternative schedule and estimate continued compliance levels among facilities inspected every two years.

	Standard Schedule	Potential Alternative Schedule
Initial Inspections	All facilities by February 2012	Same
Ongoing Inspections	Annually for all facilities	Annually for facilities inspected and not brought into compliance
		Every two years for facilities inspected and found in or brought into compliance.

Approach

To assess whether a reduced inspection frequency is warranted, SPU will conduct follow-up visits of stormwater facilities in 2010 that had been inspected in 2009 and were found in or brought into compliance. These follow-up visits will determine whether the stormwater facilities that were in compliance in 2009 remain in compliance in 2010 and assess the proportion of compliant facilities. SPU seeks to determine whether at least 80 percent of these previously compliant facilities remain in compliance after one year.

To achieve a reasonable level of certainty, Cascadia recommends collecting a sufficient sample size to achieve a ±5 percent margin of error at the 95 percent confidence level. These statistical terms have the following meanings:

- **±5 percent margin of error.** The true proportion of compliant facilities is within ±5 percent of the estimated proportion. The margin of error defines a **confidence interval** around the estimated value. For example, an estimated proportion of 85 percent ±5 percent means that the true proportion is expected to be between 80 and 90 percent.
- **95 percent confidence level.** If we were to repeat this study using the same random sampling methods, we expect that the confidence interval, the range defined by the margin of error around the estimate, would contain the true population value 19 out of 20 times (95%). The sample has a small chance of not representing the true population value; that risk is reduced with higher confidence levels (e.g., 99% confidence level). Although Cascadia strongly recommends using at least a 95 percent confidence interval, we also provide sample sizes for conducting the analysis using a 90 percent confidence interval as a lower-cost (but less accurate) alternative for SPU.

Population Characteristics

Current data from SPU indicate that about 1,400 private stormwater treatment and flow control facilities flow into the separated and partially separated storm sewer systems in Seattle, and an additional 286 are uncategorized by sewer class. Although information is not readily available on the specific type of facilities in use (e.g., catch basins, detention ponds, vaults, oil/water separators), land use type (e.g., residential, commercial, school) can serve as a reasonable proxy for different types of facilities. For example, commercial and multifamily residential facilities typically have catch basins, while single-family residential facilities usually do not.

In consultation with SPU project managers, facilities were arranged into six groups based on the expected facility type and party responsible for maintenance. Facilities on mixed-use properties were grouped with commercial properties because they are expected to have similar facility components and be maintained by a commercial property owner or manager. Although facilities at multifamily residential properties are expected to have similar components to facilities on commercial and mixed-use properties, they may be maintained by a homeowners' association or by a residential property owner or manager. Facilities at churches, schools, and other public institutions were grouped because they are expected to face similar budget constraints that may limit facility maintenance.

Table 1 presents the estimated number of private stormwater facilities flowing into the separated or partially separated sewer systems, grouped by land use type. These facilities represent the total population of relevant facilities, but only a portion of these are considered in this study.

Table 1. Private Stormwater Facilities on Separated or Partially Separated Sewer Systems

Land Use Type	Facilities
Single-family residential	560
Multifamily residential	392
Commercial or mixed use	323
Church, school, or public	84
Industrial	39
Parking lot	2
Total	1,400

In 2009, SPU records show that 319 stormwater facilities inspected that year were known to be in compliance. This group includes two sets of facilities. The first set includes facilities that were inspected in 2009 and found to need no corrective actions. The second set includes facilities were inspected in 2009 or earlier and were brought into compliance through corrective actions in 2009. Table 2 presents the number of facilities known to be in compliance in 2009, by land use type and corrective actions needed. These facilities inspected in 2009 represent the study population for the 2010 study as well as the maximum sample sizes that SPU can use for this study (unless additional facilities *not* inspected in 2009 are added).

Table 2. Private Stormwater Facilities in Compliance in 2009

Land Use Type	No Action Needed	Corrective Action Taken	Total Facilities
Single-family residential	23	12	**35**
Multifamily residential	46	77	**123**
Commercial or mixed use	28	85	**113**
Church, school, or public	31	15	**46**
Industrial	2	--	**2**
Parking lot	--	--	**--**
Grand Total	130	189	319

The facilities inspected in 2009 and presented in Table 2 were not randomly selected. SPU chose these facilities because they had never been inspected before; they had the oldest previous inspection dates (i.e., all other facilities of that type had been inspected more recently); or they completed the corrective actions needed to reach compliance in 2009. Because these 319 facilities do not constitute a random sample, the results of the current analysis applies only to those facilities that were known to be in compliance in 2009, not to the full population of all 1,400 private stormwater facilities. The results would apply to all private stormwater facilities only to the extent that the facilities known to be in compliance in 2009 form a representative sample of all facilities, which cannot be determined through the current analysis.

Sample Sizes

This study analyzes a relatively small population—the 319 stormwater facilities that were known to be in compliance in 2009. For the current study, we can take one of two approaches and associated statistical methods:

- **Hypothesis testing,** in which we test whether at least 80 percent of facilities remain in compliance but do not focus on the actual proportion (percentage) of facilities that remain in compliance.
- **Estimation of the proportion** and a surrounding confidence interval, in which we calculate the estimated proportion of facilities that remain in compliance and establish a range that we expect includes the true population value.

We discuss both approaches below and recommend estimating the population proportion, using a sample size sufficient to achieve a ±5 percent margin of error at the 95 percent confidence level.

Hypothesis Testing Approach

One analytical approach is to test the "null" hypothesis that at least 80 percent of facilities remain in compliance after one year. In this approach, we assume that the true population proportion is 80 percent compliance (0.8). We also use a "one-sided" test, meaning that we are interested in determining only if the population proportion is *less* than 80 percent; if it is 80 percent or higher, we do not reject our hypothesis.

In hypothesis testing, two types of errors may occur:

- **Type I errors,** in which the null hypothesis (that at least 80% of facilities remain in compliance) is *rejected* when it is actually *true* (falsely rejected). The approach used here applies a level of significance of α=0.05 (5 percent).
- **Type II errors**, in which the null hypothesis is *not rejected* when it is actually *false* (falsely accepted). The approach used here is designed to achieve at least 80 percent power (β=0.2), a commonly accepted level for increasing the likelihood of obtaining statistically significant results. The sample sizes presented below will detect an effect size of -0.1 (less than 0.8); detecting a smaller effect requires a larger sample size.

Table 3 includes sample sizes needed for testing whether at least 80 percent of facilities in each category remain in compliance. Hypothesis testing can use smaller sample sizes than estimating proportions, but this approach provides less information about the actual percentage of businesses that remain in compliance. This approach focuses on calculation of a test statistic, or *p*-value, rather than an actual estimate of the population proportion. Some literature criticizes this *null hypothesis significance testing* approach and encourages a focus on analysis of population means or proportions and associated confidence intervals. Accordingly, we recommend the **proportion estimation** approach described below.

Proportion Estimation Approach

Since we have little existing information about the true population proportion or variance, we recommend following an exploratory approach, which will provide fuller information for analysis and future inspections. In this method, rather than assuming that the proportion of facilities in compliance is 80 percent, we assume the greatest amount of variability in the population: 50 percent in compliance and 50 percent not in compliance. We also apply a two-tailed test, creating a confidence interval of values both below and above the point estimate (as distinguished from the hypothesis testing approach in which we only looked at lower values, a one-tailed test). This approach produces a point estimate of the expected population value and a confidence interval that is expected to contain the true population value. (This method can also be used to test the hypothesis of at least 80 percent compliance by comparing the confidence interval with the hypothesized range of values.)

The equations commonly used to estimate study sample size assume a very large population size, in the tens of thousands or greater. This approach produces a required sample size (n=385) that is larger than the number of facilities present in the study population (N=319). Accordingly, we apply a finite population correction to adjust for the much smaller population size in this study. To determine the sample sizes needed, we first calculate the sample size for a very large population needed to achieve the desired ±5 percent margin of error at the 95 percent confidence level; then we calculate a corrected sample size that takes into account the actual smaller population. Equation 1 is used to calculate the generic sample size for very large populations, while Equation 2 corrects the generic sample size to calculate a reduced sample size for small populations.[1]

Equation 1. Sample Size for Very Large Populations

$$n_0 = \frac{z^2pq}{E^2}$$

Equation 2. Corrected Sample Size for Small Populations

$$n_C = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where:

- n_0 is the generic sample size calculated using the equation for very large populations.
- p and q are the expected population proportions (compliant and not compliant). To estimate the population proportion, we recommend setting p and q to 0.5 (50%), the greatest level of variation, for the most conservative sample size.
- z is a value that corresponds to the desired confidence level (CL); for a 95% CL, z is set to 1.95996; for a 90% CL, z is set to 1.64485.
- E is desired maximum margin of error (for ±5%, E is set to 0.05).
- n_C is the corrected sample size for small populations.
- N is the population size.

[1] Glenn Israel, *Determining Sample Size*, University of Florida—IFAS Extension PEOD6 (1992), accessed September 17, 2010. http://edis.ifas.ufl.edu/pd006.

To estimate compliance in 2010 among the 319 facilities in compliance in 2009 would require completed follow-up visits at 175 randomly selected facilities. Given the variation in land use types, we recommend examining compliance levels according to each land use category, rather than for the overall population of private stormwater facilities.

Table 3 presents the number of follow-up visits that must be *completed* for each land use type to achieve a ±5 percent margin of error at the 95 percent confidence level for each land use type. Cascadia strongly recommends using at least a 95 percent confidence level for more reliable results, but Table 3 also provides sample sizes in this study design to conduct the analysis using a 90 percent confidence level as a lower cost alternative for SPU. For the 90 percent confidence level, the resulting confidence intervals are expected to contain the true population proportion 9 times out of 10 (rather than 19 times out of 20 for the 95% CL).

Table 3. Number of Completed Samples (n) Required for Alternative Study Approaches

Land Use Type	Study Population	Hypothesis Testing *(not recommended)*	Proportion Estimation at 95% CL (recommended)	Proportion Estimation at 90% CL *(not recommended)*
Single-family residential	35	27	33	32
Multifamily residential	123	59	94	85
Commercial or mixed use	113	56	88	80
Church, school, or public	46	33	42	40
Industrial	2	--	--	--
Grand Total	**319**	**175**	**257**	**237**

Because relative sampling error increases with smaller populations, a common rule of thumb is to conduct a conduct of census for populations of 50 or fewer. Accordingly, we recommend conducting follow-up visits to all facilities in the *Single-family residential* and *Church, school, or public* categories, regardless of confidence level. For *Industrial* stormwater facilities, the number of visits in 2009 was so small (two) that follow-up visits will not yield statistically meaningful results. Given the extremely small sample size for industrial stormwater facilities, we recommend not conducting follow-up visits for this category (though such visits could contribute to the overall analysis of facilities as a whole).

SPU estimated that an average of 5 percent of stormwater facilities contacted for follow-up visits will refuse to participate in the study. Accordingly, to ensure that the sample sizes presented in Table 3 are reached, we recommend that SPU attempt to conduct at least the number of follow-up visits presented in Table 4.

Table 4. Number of Attempted Follow-up Visits for Recommended Approach

Land Use Type	Study Population	Recommended Sample Size	Recommended Visits (n)
Single-family residential	35	35	35
Multifamily residential	123	94	99
Commercial or mixed use	113	88	93
Church, school, or public	46	46	46
Industrial	2	0	0
Grand Total	319	263	273

Data Collection and Analysis

This study will use existing data from the SPU database as well as new data collected during follow-up visits to sample sites. Existing data include the following:

- Compliance status in 2009.
- Facility type "land use."
- Whether repairs were needed to reach compliance in 2009 (optional).

During this analysis, we expect to analyze primarily compliance status in 2009 and 2010; however, we recommend that SPU collect additional data during follow-up visits that could be used in future studies, if needed. Data to be collected during follow-up visits includes the following:

- **Basic facility information.** Information includes site identification number, business name and DBA (doing business as) name, site address, and facility type. This information will help to correctly match the facilities visited in 2010 with those in compliance in 2009.
- **Compliance status in 2010.**
- **Type of corrective action(s) needed in 2010.** Inspectors should use a basic checklist to note which types of corrective actions were needed. The checklist should at least differentiate maintenance and structural actions, and it would ideally correspond to the Corrective Actions Required (CAR) fields used in SPU's database. This information could help identify whether certain corrective actions are more commonly needed than others after one year; if so, SPU could consider an alternative inspection schedule that focuses limited re-inspections or follow-up visits on those actions.
- **Facility size measured by number of units.** Inspectors should note the approximate number of stormwater units (e.g., catch basins, vaults) at each facility, if easy to do during follow-up visits. Inspectors could either report the exact number of units per facility or categorize each facility into pre-determined groups (such as single unit, 2-5 units, 6-10 units, 11-20 units, more than 20 units). This information could help identify whether larger facilities are more likely to need corrective actions after one year, indicating they may need annual inspections or follow-up visits.

Following data collection by SPU, Cascadia will analyze existing data to estimate the percentage of stormwater facilities overall and by land use type that remained in compliance in 2010. As described in the approach, we will assess whether at least 80 percent of stormwater facilities stay in compliance for one year after being found in compliance through an inspection and/or corrective actions. Analysis will also include consideration of the statistical significance of estimated compliance rates.

Potential Outcomes

If data analysis supports a compliance rate of at least 80 percent for any or all groups of stormwater facilities, then SPU expects to provide a written statement to the Department of Ecology requesting a proposed alternative inspection schedule.

If data analysis does not support that at least 80 percent of facilities remain in compliance for one year for some or all groups of stormwater facilities, then SPU may conduct additional studies to determine whether additional characteristics of stormwater facilities may provide more detailed information to support an alternative inspection schedule for a subset of stormwater facilities. Additional characteristics could include number of units, type of units, and compliance history.

If further studies do not support a minimum compliance rate of 80 percent, then SPU plans to hire additional staff to meet the standard inspection schedule while collecting additional data to support future analysis.

Attachment A4

City of Federal Way
Surface Water Management

Catch BAsin Cleaning and Evaluation Program

Program Presentation
October 20/21, 2005
Paul Bucich,P.E.,
Surface Water Manager

Attachment A4

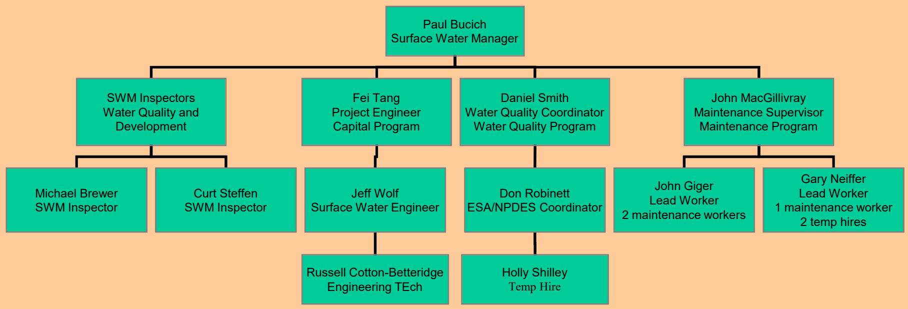
Background Information

The City of Federal Way is a dynamic and young City. Most problems are the result of prior land use activities where asphalt was king. One of the primary reasons for incorporation was surface water flooding problems.

- City Population: 86,500 +-
- City area: 21.5 square miles
- Miles of paved public streets: 257
- Number of major streams: 5
- Number of major lakes: 4
- Annual SWM collections: $3.2M
- Number of Catch Basins: 10,200
- Number of manholes: 1300

Surface Water Utility Structure

The surface water utility was formed shortly after incorporation. The utility consists of only 14 positions.



Maintenance Activities

A large percentage of the utility activities and funding goes to annual maintenance activities. The city maintains the 6 large Capital facilities as well as 85 smaller, developer built facilities. In addition, the city contracts for street sweeping, vactor cleaning, TV services, jet rodding, and waste disposal. Maintenance is a high priority for the Council and citizens of Federal Way.

Maintenance activities include:

- Annual minor CIP projects
- **Catch basin evaluation program and cleaning**
- CPS unit monitoring and cleaning
- Pond maintenance
- Water Quality enhancements of older ponds
- Flood response
- Installation of WQ improvements around lakes
- Maintenance of WQ facilities in right of way
- Weed control – state training
- Training on new procedures
- Annual certifications
- Reconstruction of facilities

Attachment A4

Major Program Elements

The Utility is composed of three primary areas: Capital Improvement, Water Quality, and **Maintenance**.

- Separate Operation and Maintenance Manual
- 2000 - $175,000 on CB cleaning
- 2005 - $133,000 on CB cleaning

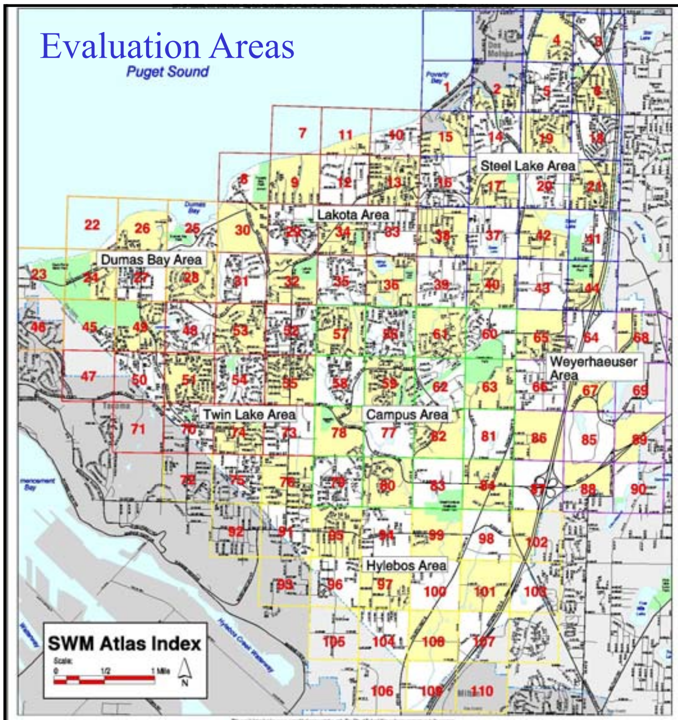
What are we doing differently?

Evaluation Program

Evaluation was initiated as a means to determine if we were wisely spending our limited utility tax dollars.

- Started in 2002
- Means to reduce annual expenditures
- Are we cleaning “clean” structures?
- Determine frequency for cleaning
- Find “special structures”
- Manage increasing infrastructure assets and costs
- NPDES Permit requirement to maintain infrastructure – Pierce County Maintenance Manual, Page 26 – sediment removal @ 60%

Attachment A4



For evaluation, City was broken into 7 distinct areas based on average land use.

Residential

Commercial

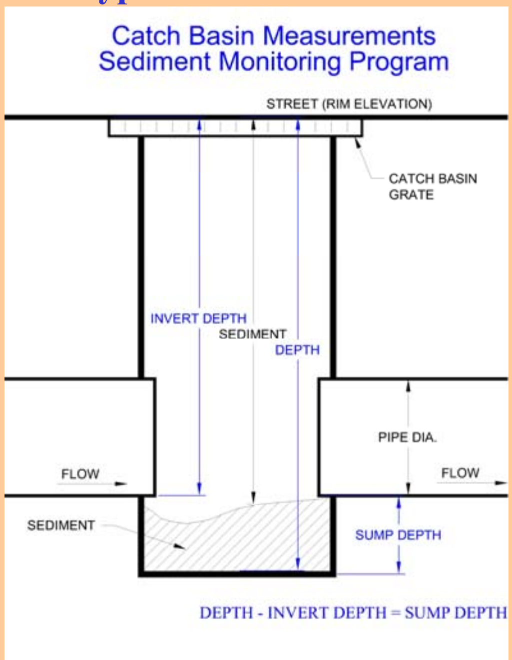
Mixed use

Arterials are a special consideration.

Citywide Infrastructure

Attachment A4

Typical Catch Basin



Evaluation Process

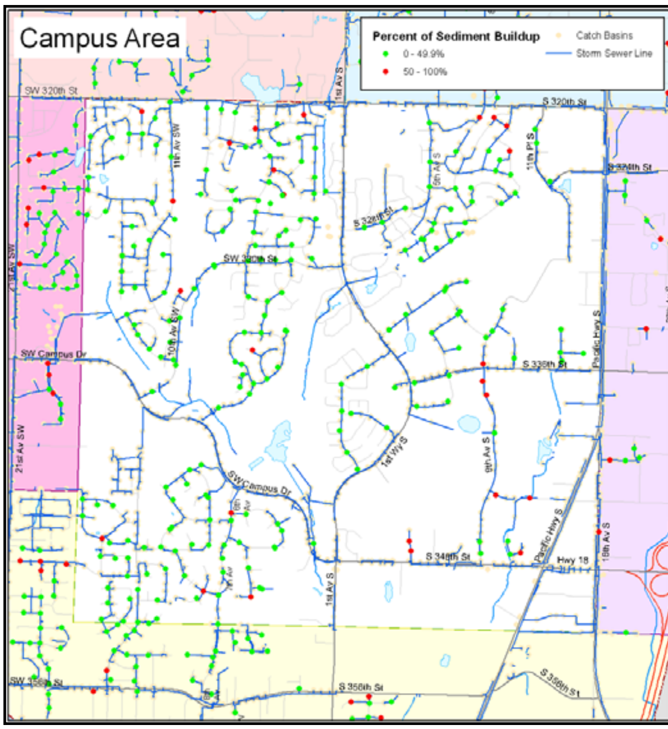
- 1) Clean the area first!
- 2) Hire Temps. ☺ ☺ ☺
- 3) Do the work during the *summer*!
- 4) Need standard safety equipment and a vehicle with arrow board.
- 5) Use existing data base to identify and map structures to be evaluated (generate if needed)
- 6) Carefully track the progress
- 7) Determine if small sumps should be included
- 8) Record data and do again next year (except cleaning before hand…)

Attachment A4

Data sheets

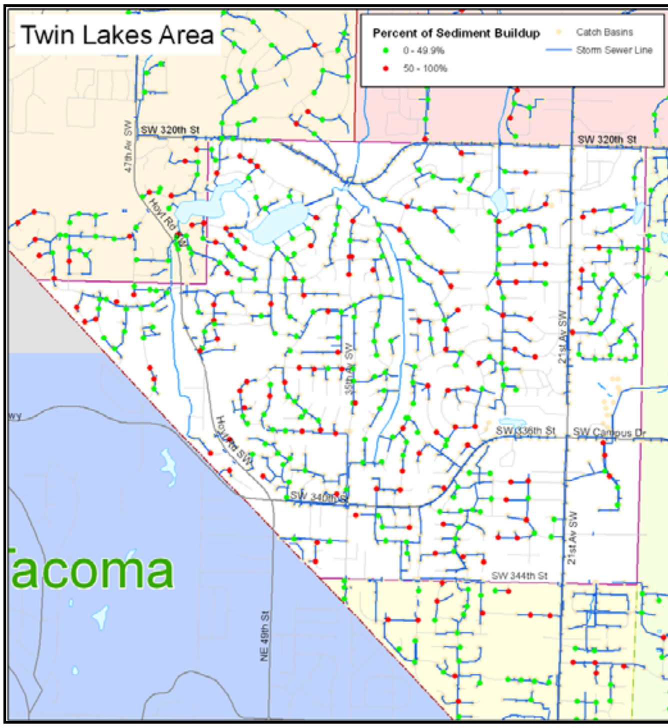
- If everything goes according to plan, should have spread sheets filled with data like this:

					Spot Check:9/11/03		Spot Check:6/22/04		Spot Check:6/6/05	
Map	CB/MH #	Sump	Invert	Sump depth	Sediment	% Full	Sediment	% Full	Sediment	% Full
723NE	64	60	48	12	59	8%	58	17%	58	17%
723NE	78	42	27	15	42	0%	42	0%	40	13%
723NE	68	45	35	10	44	10%	40	50%	39	60%
723NE	83	110	55	55	81	53%	71	71%	70	73%
723NE	90	67	50	17	59	47%	58	53%	58	53%
723NE	119	59	45	14	58	7%	55	29%	57	14%
723NE	131	67	47	20	67	0%	67	0%	66	5%
723NE	121	66	50	16	66	0%	65	6%	63	19%
723NE	100	67	59	8	67	0%	66	13%	67	0%
723NE	94	75	53	22	53	100%	66	41%	56	86%
723NE	22	95	69	26	95	0%	95	0%	35	231%
723NE	152	55	37	18	55	0%	53	11%	43	67%
723NE	161	62	42	20	61	5%	61	5%	47	75%
723NE	172	62	42	20	62	0%	54	40%	53	45%
723NE	184	64	42	22	63	5%	52	55%	51	59%
723NE	248	93	74	19	83	53%	93	0%	92	5%
723NE	251	94	69	25	94	0%	90	16%	84	40%
723NE	233	57	36	21	57	0%	45	57%	40	81%
723NE	32	82	60	22	82	0%	80	9%	72	45%
723NE	28	137	115	22	135	9%	131	27%	131	27%
723NE	199	69	54	15	69	0%	69	0%	67	13%
723NE	220	106	85	21	106	0%	106	0%	105	5%
723NE	183	77	63	14	77	0%	76	7%	74	21%
723NE	165	59	47	12	59	0%	58	8%	59	0%
723NE	153	75	66	9	75	0%	72	33%	71	44%
723NE	137	78	65	13	78	0%	72	46%	70	62%
723NE	4112	59	36	23	57	9%	57	9%	57	9%
723NE	4272	62	51	11	62	0%	61	9%	62	0%
723NE	4201	63	52	11	63	0%	62	9%	63	0%
723NE	253	67	52	15	67	0%	66	7%	66	7%
723NE	245	73	57	16	68	31%	67	38%	62	69%

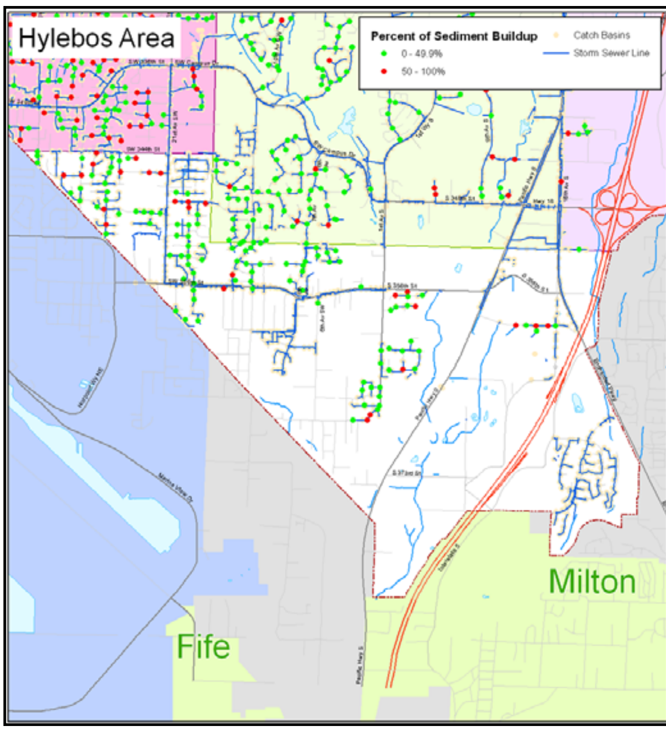


Campus Infrastructure

Attachment A4



Twin Lakes Infrastructure

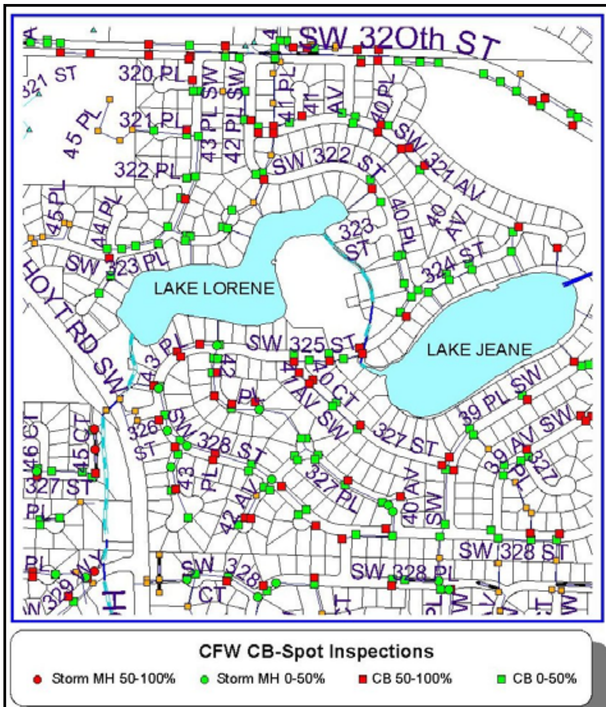


Hylebos Infrastructure

Attachment A4

Catch Basin Sediment Level/Cleaning Status Summary

Cleaning Area	2002	Status	2003	Status	2004	Status	2005	Status	2006	Status	2007
Twin Lakes	Dec	Clean	Oct	14%	June	25%	June	36%			
Campus			Dec	Clean	July	11%	June	13%			
Hylebos					Jan	Clean	May	27%			
Weyerhaeuser					Feb	Clean	April	38%			
Lakota					April	Clean	June	30%			
Steel Lake					June	Clean	June	20%			
Dumas Bay					June	Clean	July	27%			



Early attempts to quantify sediment accumulation levels.

Different structure shapes could significantly skew area results.

Older systems tend to have smaller sumps.

Attachment A4

Conclusions

- Sediment accumulations vary significantly by land use
- Residential areas do not need cleaned annually if system (including pipes) are cleaned once
- Industrial areas need more attention (Doh!)
- Arterials are to be cleaned annually
- Significant cost savings can be achieved by knowing your system needs
- NPDES permits require proper maintenance schedules

Capital Program

Capital Program is where the rubber hits the road. Citizens judge us on how they are impacted due to flooding of roads and property.

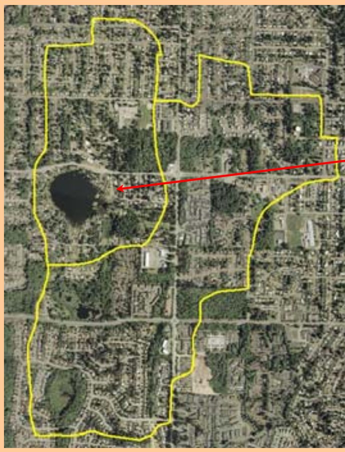
S. 373rd road flooding November of 2001

Fish Ladder at S. 359th

Attachment A4

Capital Facilities Program

The Capital Program varies from year to year but typically accounts for $1.25M annually in expenditures. The program has constructed 6 large regional facilities and corrected numerous drainage problems. It encompasses the following elements: flood control, fish passage, stream restoration, water quality facilities, conveyance improvements, and small works improvements.



Two different Regional projects:

Mirror Lake

SW 356th

Capital Facilities Program Stream Restoration

The Capital Program has seen a large increase in stream restoration efforts in 2004 and 2005. Two large efforts of note include these projects.

Lakota Creek Restoration was located along SR-509 which was closed for a week.

West Hylebos Creek Restoration required the use of a helicopter to deliver logs to inaccessible locations

Attachment A4

Water Quality Program

The water quality program consists of source control, illicit discharge tracking, water quality sampling, annual macroinvertebrate sampling, public education and outreach, stream team volunteers, participation with local environmental groups monitoring for salmon usage of streams, and evaluation of new W.Q. products.

Kitts Outlet Station

Sampling for:
- Dissolved Oxygen
- Temperature
- pH
- Specific Conductivity
- Flow
- Rainfall (at some locations)

Water Quality Stations

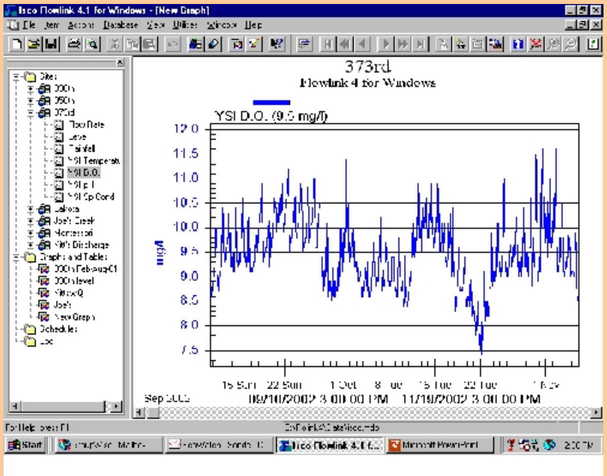
Water quality probes are downloaded, cleaned and calibrated once a month by SWM staff

Calibration set-up in office

Close-up of water quality probe

Water Quality Stations

Water quality data are analyzed by SWM staff for long term trends



Example of Flow Link software data file for S. 373rd Street – Dissolved Oxygen 9/10/02-11/10/02

Surface Water Flow

Nine (9) water quality stations collect real-time flow data, Recording level and velocity measurements every 15 minutes

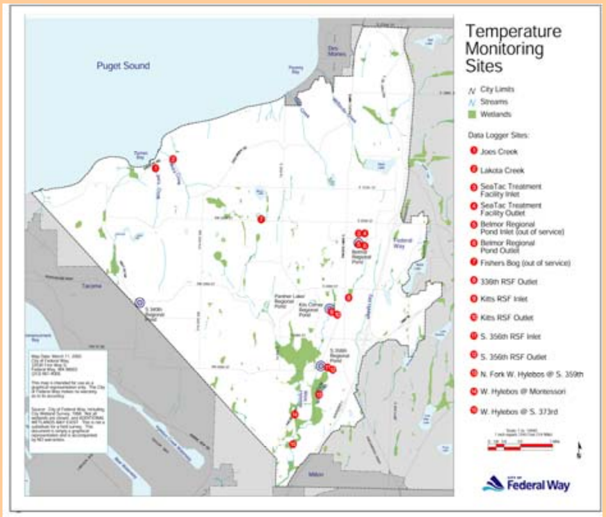
Water quality flow probes must be periodically field calibrated to ensure that flow data is accurately recorded.

SWM staff calculating total stream discharge in West Hylebos Creek using a hand-held current velocity meter

Close-up of current velocity meter

Water Temperature Loggers

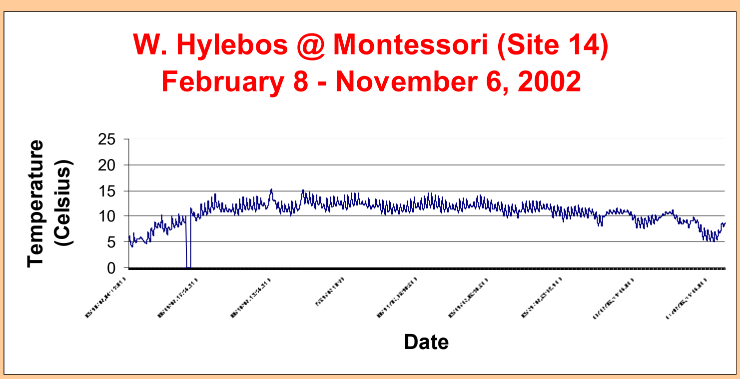
Surface water temperature loggers are deployed at eighteen (18) sites throughout the City



Onset Computer Corporation
TidBit Temperature Logger
downloaded once per month

Water Temperature Loggers

Temperature data are analyzed by SWM staff for long term trends and compare to DOE Water Quality Standards for surface waters



To date, the data indicates that surface waters in Federal Way comply with the older state standards for temperature discharges. Additional years' of data are needed to establish true trends and compliance with new requirements.

Attachment A4

Macroinvertebrate Sampling

Annual sampling for macroinvertebrates (bugs) is conducted at five (5) sites throughout the City. Samples are collected by SWM staff and volunteers -- then sorted, identified and counted by a contract laboratory.

•Biological monitoring can be a useful tool to indicate the health of our local streams.

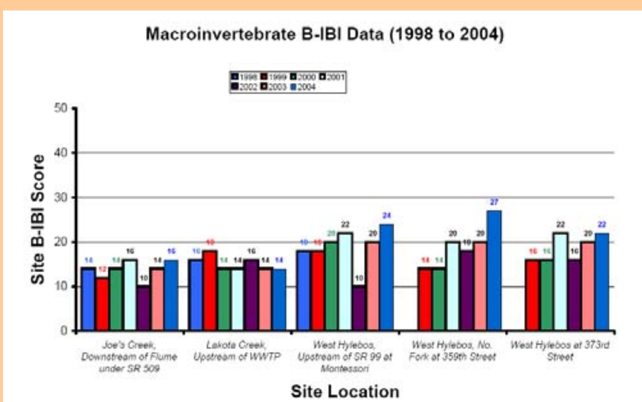
•The presence of a large population of diverse macroinvertebrates (bugs) indicates good water quality.

•Salmon rely on macroinvertebrates for food.

•The score of a stream is measured as excellent, good, fair, poor and very poor. This information provides the opportunity to investigate the types of influences acting upon a watershed.

Macroinvertebrate Scoring

The condition of Federal Way streams have shown some improvement in recent years, however their scores remain in the Poor – Very Poor range.



Condition Ranges

Excellent
46-50

Good
38-44

Fair
28-36

Poor
18-26

Very Poor
10-16

Attachment A4

Illicit Discharge Detection and Elimination Program

The goal of this program is to detect and eliminate prohibited discharges to the municipal stormwater system

Program elements include:

- **Mapping and inspecting stormwater outfalls**
- **Detect and eliminate illicit stormwater connections and prohibited stormwater discharges**
- **Enforcement of Stormwater Ordinance**
- **Provide education to businesses and the general public**

Illicit Discharge Detection and Elimination Program

- **Approximately 100 water quality source control inspections have been conducted annually**
- **Enforcement action has resulted in the correction of numerous prohibited stormwater discharges.**

Attachment A4

Illicit Discharge Detection and Elimination Program

- **Smoke testing and dye testing are tools used to detect the presence of illicit connections and prohibited stormwater discharges**

Smoke identifies location of stormwater catch basins on Enchanted Parkway

Bright-colored dyes are used to track stormwater flows

A program for inspecting existing private commercial facilities. Also inspect new construction (SF) for ESC measures.

- Inspection of commercial stormwater facilities
  - Two inspectors
  - 590 per year
  - 99% compliance with our inspection results
  - 75-80% in need of maintenance on first inspection
  - Many older systems – KC standards
    - Apartment complexes most difficult
    - Condominiums close second
  - Utilize smoker to find old systems often buried and illegal connections
- Utilize same inspectors for single family home construction sites
  - Cradle to grave approach
  - IECA certification is a goal

The program has been very successful over the past three years bringing facilities into compliance with their original design parameters.

- Developed comprehensive database in 2001
  - Identification of property owners
  - Types of stormwater systems
  - Inspection history
  - System design information

- Hard copy files kept
  - Maps, histories, pipes, ponds, swales, etc.
  - Uses King County “D” file numbers from pre-annexation/incorporation.

Inspection of 590 facilities is beyond capabilities of one FTE

Commercial Inspection Program

Inspection Procedures:

- Advance postcards mailed to all businesses in area - up to 60 days out.
- Request permission to enter property if no easement exists (many older systems)
- Assumes permission if no response
- Opportunity for representative to walk with inspector
- City inspector to identify himself upon entering property

Attachment A4

Commercial Inspection Program

Correction procedures follow existing City Codes

- 30-Day Correction Notice
  - Letter sent identifying issues needing attention
  - List of vendors providing services attached
  - Requires response within 30 days or…
- 10-Day Correction Notice
  - If no contact with business owner, 10-day letter sent
  - Usually occurs because 30-day went to wrong party
  - Certified mail
  - Usually gets their attention
- Notice of Violation (NOV)
  - NOV may lead to criminal and/or civil offences
  - Really gets their attention

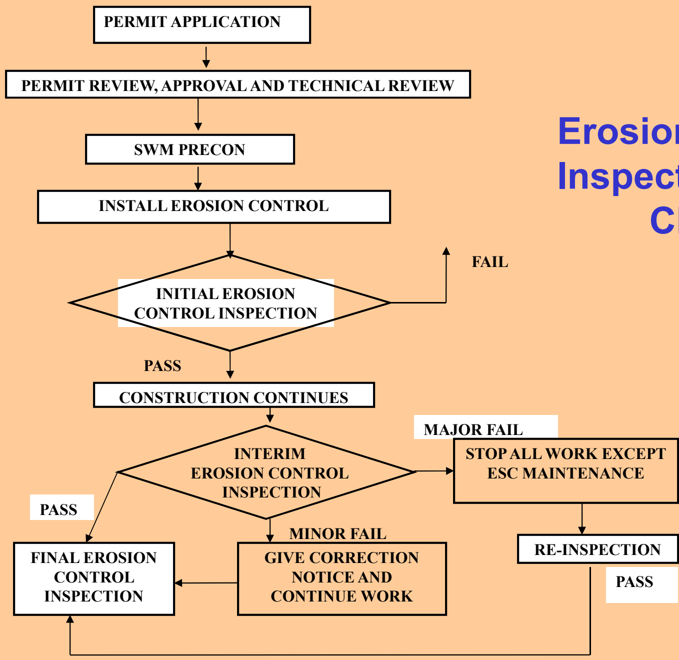
Attachment A4

Commercial Inspection Program

We prefer these types of letters:

- Interim Correction Notice
  - Letter sent identifying issues needing attention
  - Issues are minor and at discretion of inspector
  - Does not require return notification to City
  - Requires correction before next inspection
- Site in Compliance
  - Postcard delivered onsite by inspector
  - System functioning fine, no action needed
  - See them next year ☺
  - Inspection results entered into database

Single Family Construction



Erosion Control Inspection Flow Chart

Public Education and Involvement

The utility has one person assigned to public education and involvement outside of that which occurs with CIP projects or maintenance activities. In 2003 a staff position was identified specifically to be tasked with this activity. It is an area where growth is expected either through contracting with others or in-house activity.

Public Education and Involvement opportunities:

Brochures produced for mailing to residents
Annual report on utility activities
Numerous volunteer activities – stream restoration, refuse cleanup, invasive weed removal, salmon watcher program, grate keepers program, rainfall data collection, water quality data sampling, etc.
Quarterly newsletter for volunteers and others mailed and posted on website
Car wash kits and work with local car wash organizations for tickets
School curriculum development
Posters for restaurants
Website – posted info
Participation in salmon recovery efforts – WRIA's 9 and 10

Steel Lake Aquatic Weeds Management

Surface Water Management has been partnering with the residents of Steel Lake to combat the on-going problem of invasive aquatic weeds.

- **In 2003, Lake residents were successful in the formation of the first Lake Management District in Federal Way. It became effective in 2004.**
- **SWM is presently working with the lake residents on the second annual work plan to control aquatic weeds after a successful first year.**
- **In 2005 SWM will be working with North Lake residents and Ecology on a second aquatic weeds grant and control efforts.**

NPDES Phase II Permit is coming

The city currently meets or exceeds the older Puget Sound Plan for Comprehensive Stormwater Program elements. We currently meet or exceed most of the Tri-County Stormwater Plank elements. So what are we worried about?

<u>Areas of concern include but may not be limited to:</u>

Arbitrary assumption of third party liability under CWA for elements not envisioned to be in the Phase II permit.

Diversion of funds from activities asked for by Council or citizens – lake management issues, maintenance levels of existing infrastructure, preparation for GASB 34 compliance, expensive water quality sampling, "*monitoring*" unknowns, etc.

Loss of self directed program activities. Imposition of inappropriate standards regardless of actual basin needs. Need to develop expensive and time consuming basin plans to refute Ecology general standards, e.g., level 2 flow control everywhere, application of pre-forested conditions in urban centers, use of 6-month storm for treatment at all times, in all locations.

Questions and Answers

Federal Way Surface Water
Management

October 20/21, 2005

Attachment A5

Sediment Evaluation Program

The program was initiated in 2002 as a means to determine if we are <u>efficiently</u> and <u>cost-effectively</u> maintaining our Catch Basins

Program Goals

- Reduce Annual Expenditures
- To Avoid Cleaning “Clean” Structures
- To Determine an Appropriate Cleaning Schedule
- To Comply with NPDES Permit Requirements to Maintain Infrastructure
- To Satisfy NPDES Permit Requirements to Inspect Catch Basins

The Process…

- In 2002 all structures were inventoried
- The City was broken into 7 distinct areas based on average land use

- Twin Lakes
- Dumas Bay
- Steel lake
- Weyerhaeuser
- Campus
- Lakota
- Hylebos

- A number of Catch Basins in each area were selected to be measured annually
- Then the Measuring Began!

The Data has proven Valuable

- Literature Review indicates that cleaning should be done at least annually
- Our study indicates a less frequent cleaning schedule is sufficient (resulting in $$ saved)
- Ecology's General Rule- The decision to reduce inspection and/or maintenance frequency shall be based on records of double the length of time of the proposed frequency
- Our goal is to collect 10 years of data

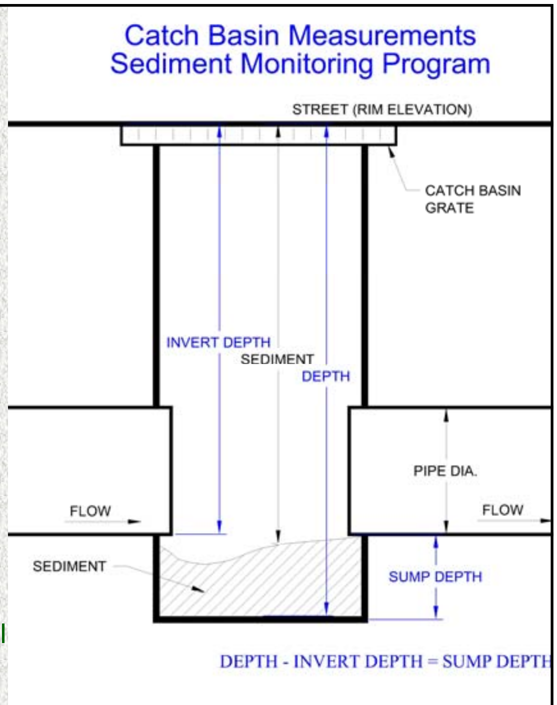
The Measurements

•The measurements of each structure were taken during the initial inventory in 2002

•The annual program involves measuring from the Rim to the Sediment

•Percent Full is Calculated

Depth – Rim to Sediment = % Full
Depth - Invert



Example Excel Database

CAMPUS AREA			Spot Check: 7/12/04		Spot Check: 06/20/05		Spot Check: 06/01/06		Spot Check: 08/07	
CB/ MH #	Sump	Invert	Sediment	% Full	Sediment	% Full	Sediment	% Full	Sediment	% Full
3808	62	47	57	33%	58	27%	55	47%	55	47%
4223	59	42	58	6%	55	24%	52	41%	50	53%
4408	59	43	56	19%	59	0%	53	38%	52	44%
3738	108	62	107	2%	102	13%	108	0%	107	2%
3868	207	183	206	4%	197	42%	203	17%	200	29%
484	63	47	60	19%	60	19%	60	19%	60	19%
3834	64	52	63	8%	58	50%	58	50%	58	50%
3975	82	64	82	0%	82	0%	82	0%	82	0%
474	91	69	90	5%	91	0%	91	0%	91	0%
4145	58	44	57	7%	58	0%	57	7%	57	7%
4008	55	40	50	33%	50	33%	49	40%	48	47%
3945	36	31	36	0%	36	0%	35	20%	34	40%
516	74	59	69	33%	68	40%	68	40%	38	240%
7339	48	34	48	0%	48	0%	38	71%	28	143%
4459	64	43	58	29%	51	62%	55	43%	50	67%
Avg.				**14%**		**22%**		**25%**		**43%**

Factors that determine Sediment Levels

- Storm Intensities
- Sanding during Snow Events
- Structure Sump Depths
- Frequency of Street Sweeping
- Land Use
- Of Course, Cleaning

Analyzing the Data

- A <u>sample</u> is selected and data from the sample is used to make a generalization about the larger <u>population</u>
- How well the sample actually represents the population is gauged by two important statistics- the confidence interval and the margin of error
- We have selected a 90% confidence interval. This means that we are 90% sure that the true value falls within our margin of error
- Margin of error: Indicates how far a sample's result can stray from the true value of the population

Campus Area

Approximate Number of Structures

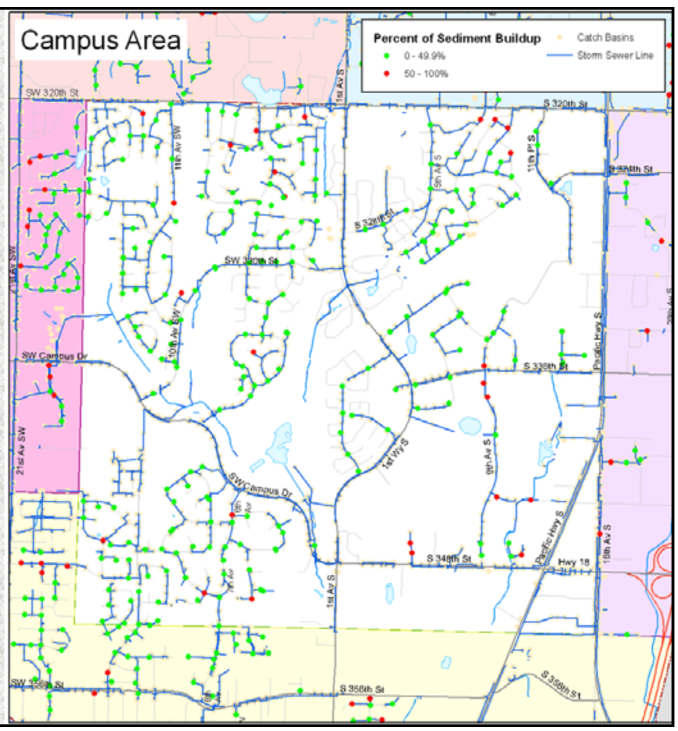
3358

Number of Structures Measured

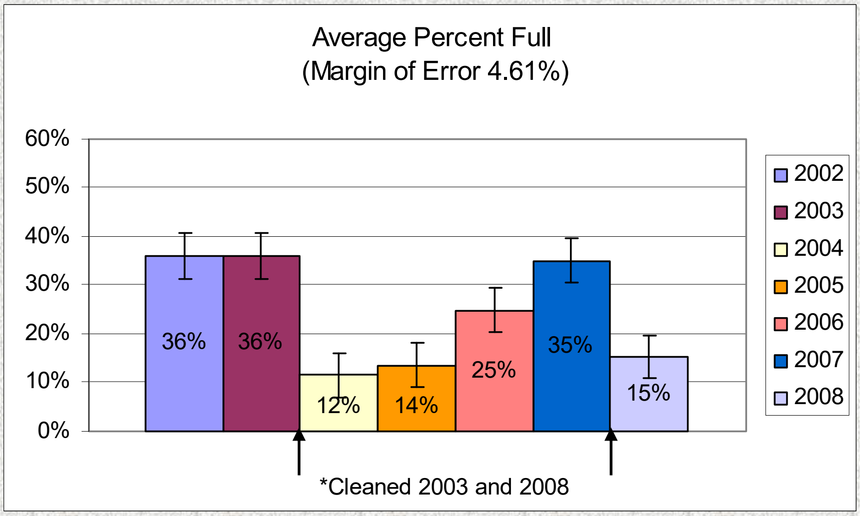
291

Percent Measured

9%



Campus Area



*5 year Cleaning Schedule

Twin Lakes Area

Approximate Number of Structures

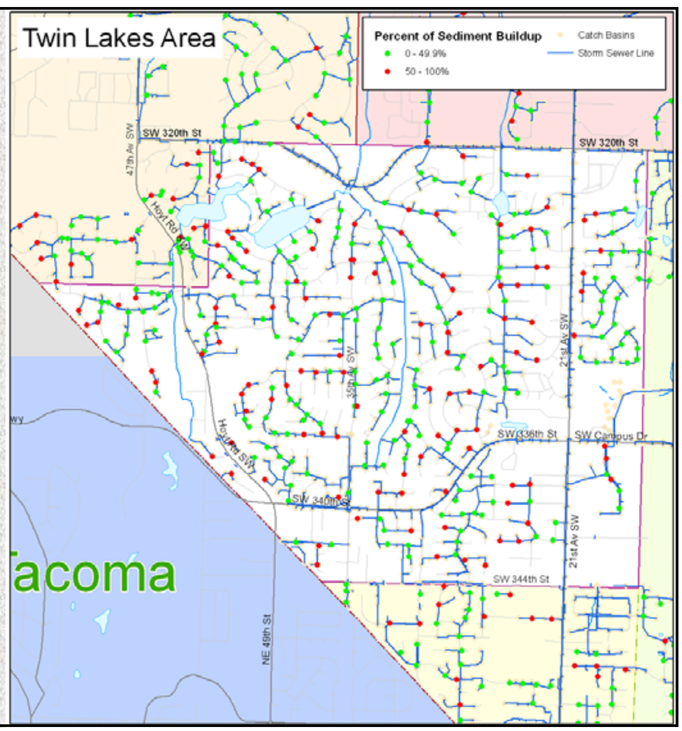
2077

Number of Structures Measured

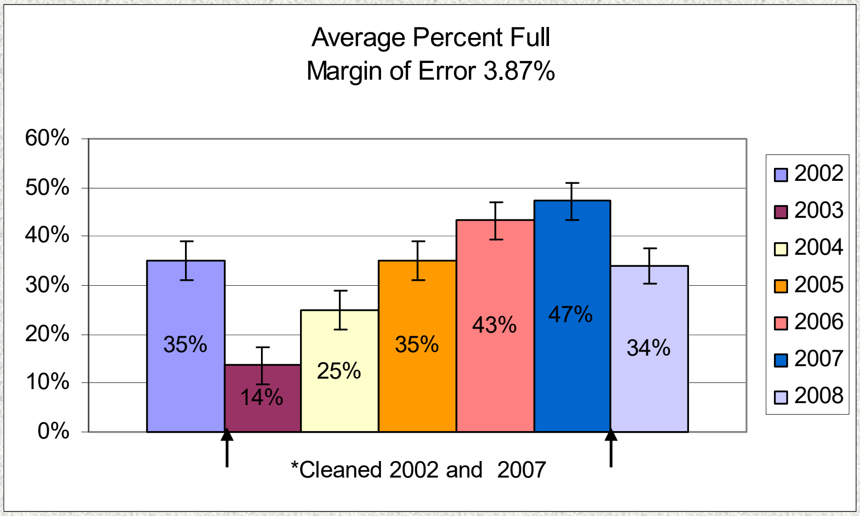
372

Percent Measured

18%



Twin Lakes Area



*5 year Cleaning Schedule

Hylebos Area

Approximate Number of Structures

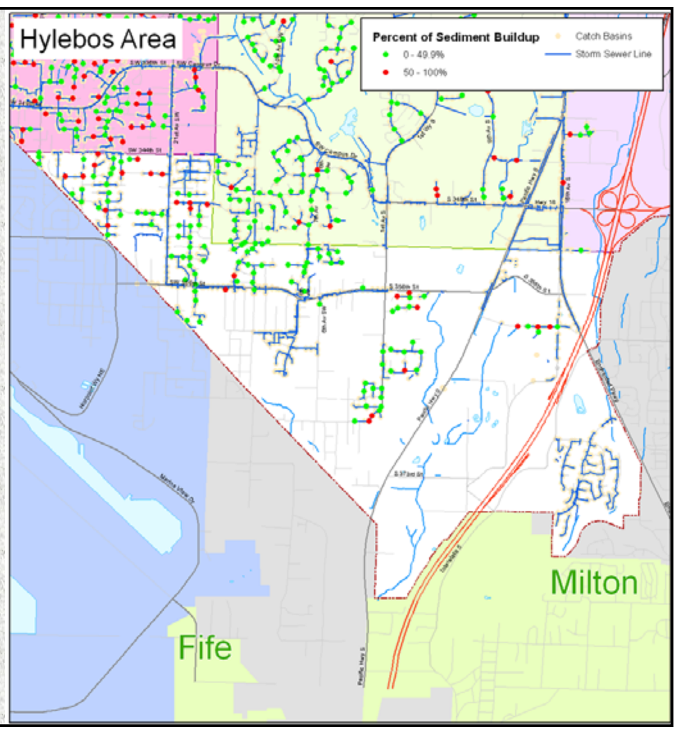
939

Number of Structures Measured

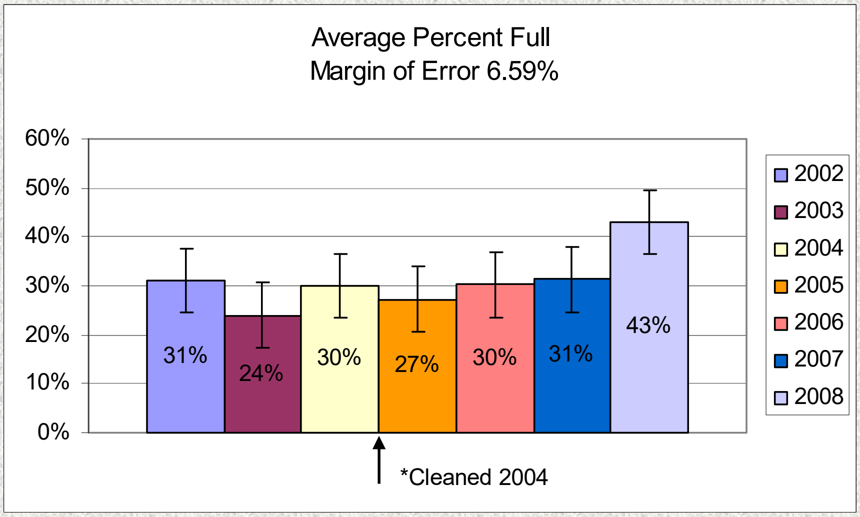
134

Percent Measured

14%



Hylebos Area



*4-5 year Cleaning Schedule

Dumas Bay Area

Approximate Number of Structures

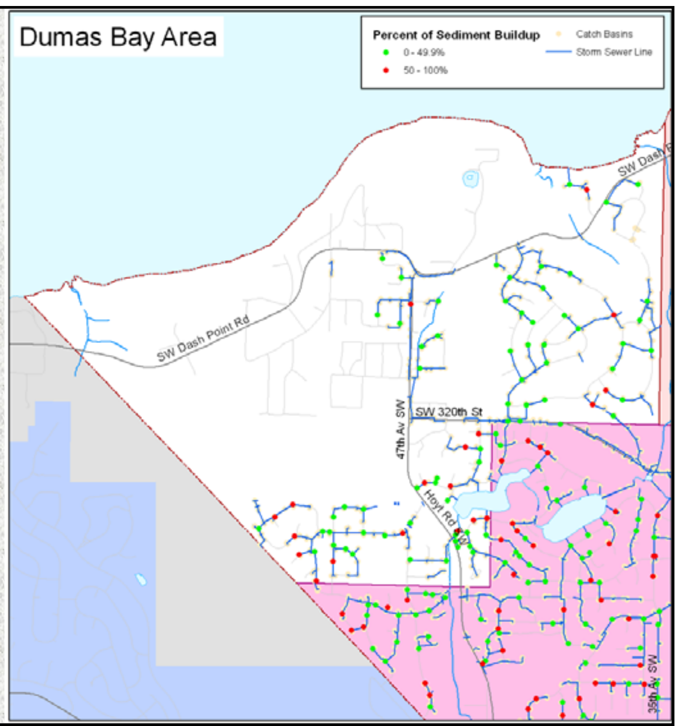
639

Number of Structures Measured

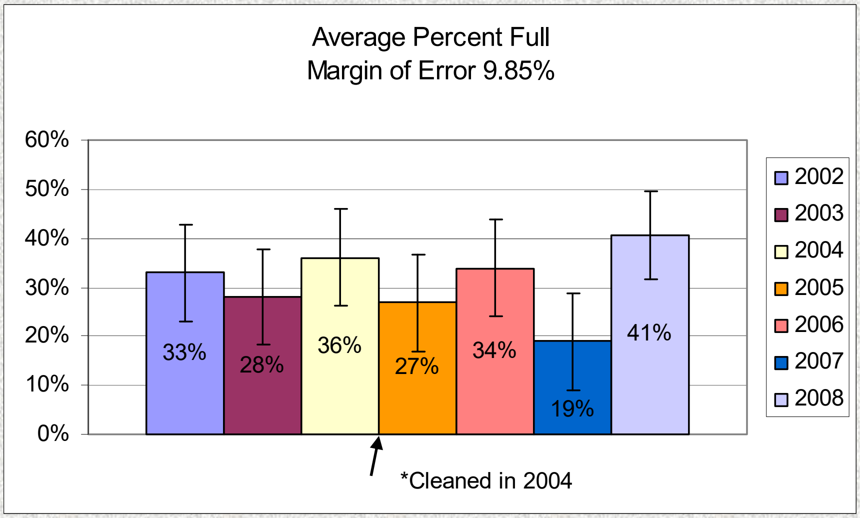
63

Percent Measured

10%



Dumas Bay Area



*4-5 year Cleaning Schedule

Lakota Area

Approximate Number of Structures

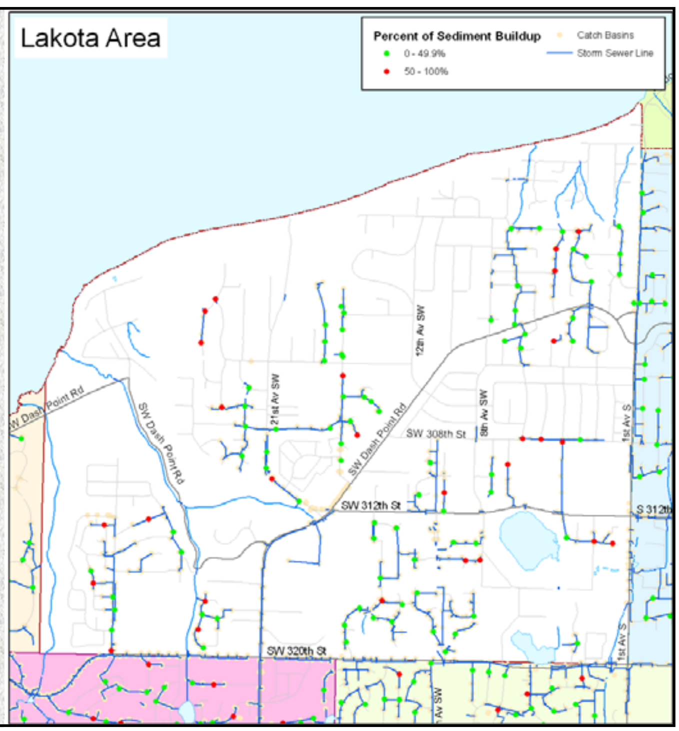
915

Number of Structures Measured

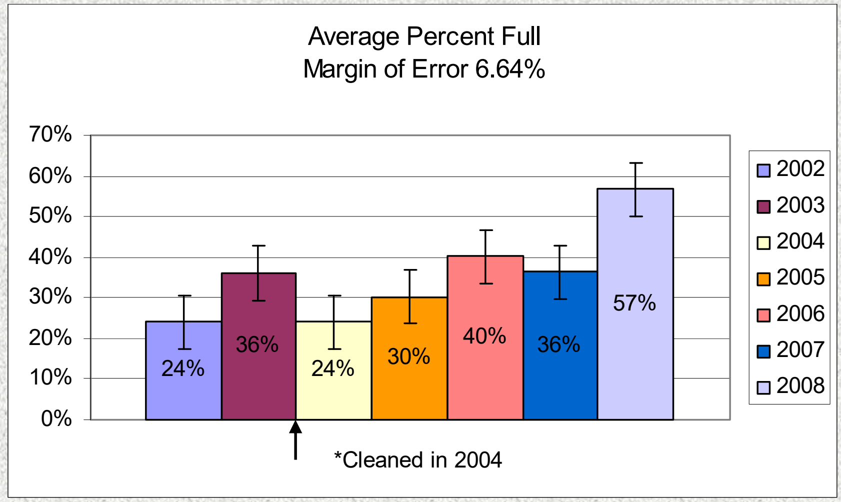
132

Percent Measured

14%



Lakota Area



*3-4 year Cleaning Schedule

Steel Lake Area

Approximate Number of Structures

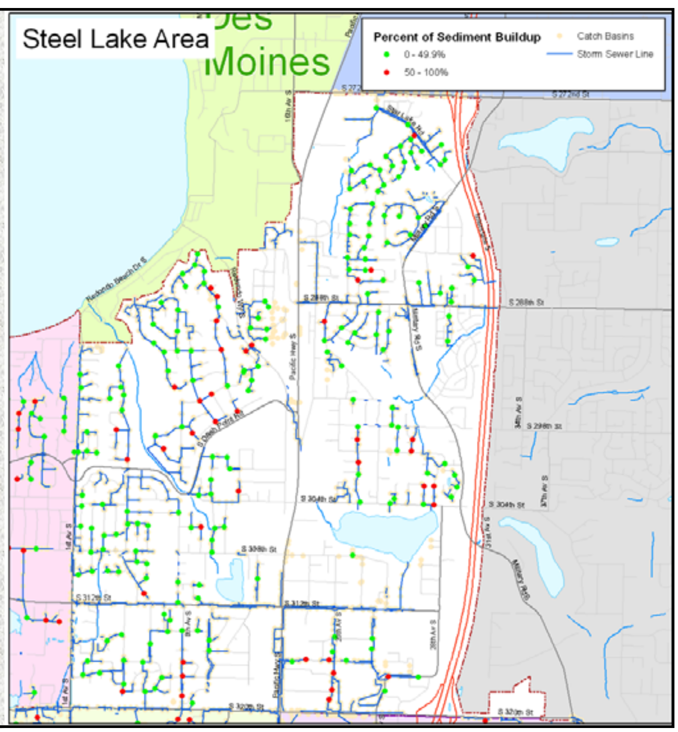
2827

Number of Structures Measured

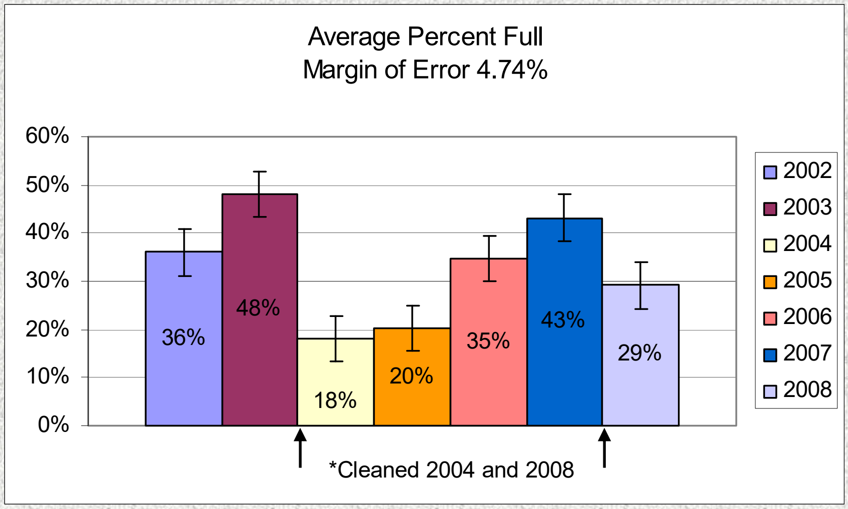
272

Percent Measured

10%



Steel Lake Area



*4-5 year Cleaning Schedule

Weyerhaeuser Area

Approximate Number of Structures

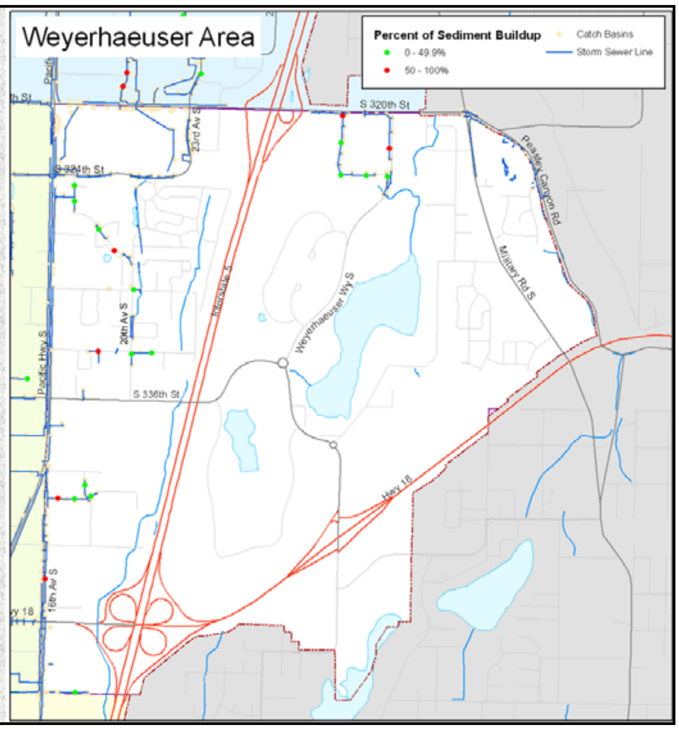
685

Number of Structures Measured

55

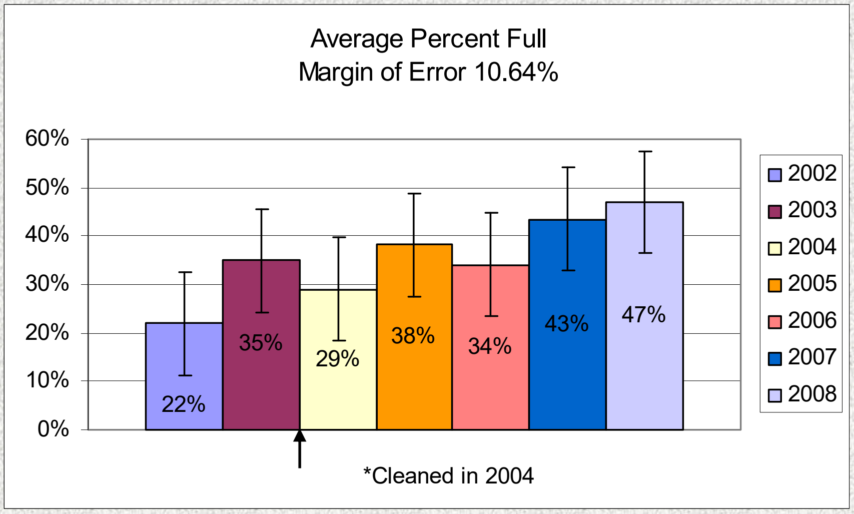
Percent Measured

8%



Attachment A5

Weyerhaeuser Area



*4-5 year Cleaning Schedule

Changes to the Program per the NPDES Permit

- Include structures upstream from outfalls
- Structural maintenance needs will begin to be documented and will need to be corrected within a 6 month timeframe
- Some changes will be made to the number of CBs measured in each area to target a 5% margin of error

Vactor Schedule

2008 Steel Lake(1650) Campus (1760) *Total 3410*	**2009** Hylebos (328) Dumas Bay (328) Weyerhaeuser (102) *Total 758*	**2010** Lakota (604) *Total 604*
2011 Twin Lakes (2077) *Total 2077*	**2012** Steel Lake (2827) Weyerhaeuser (685) *Total 3512*	**2013** Campus (3358) Lakota (915) Total 4237
2014 Hylebos (939) Dumas Bay (639) *Total 1578*	**2015** Steel Lake (2827) *Total 2827*	**2016** Weyerhaeuser (658) Lakota (915) *Total 1600*

Conclusion

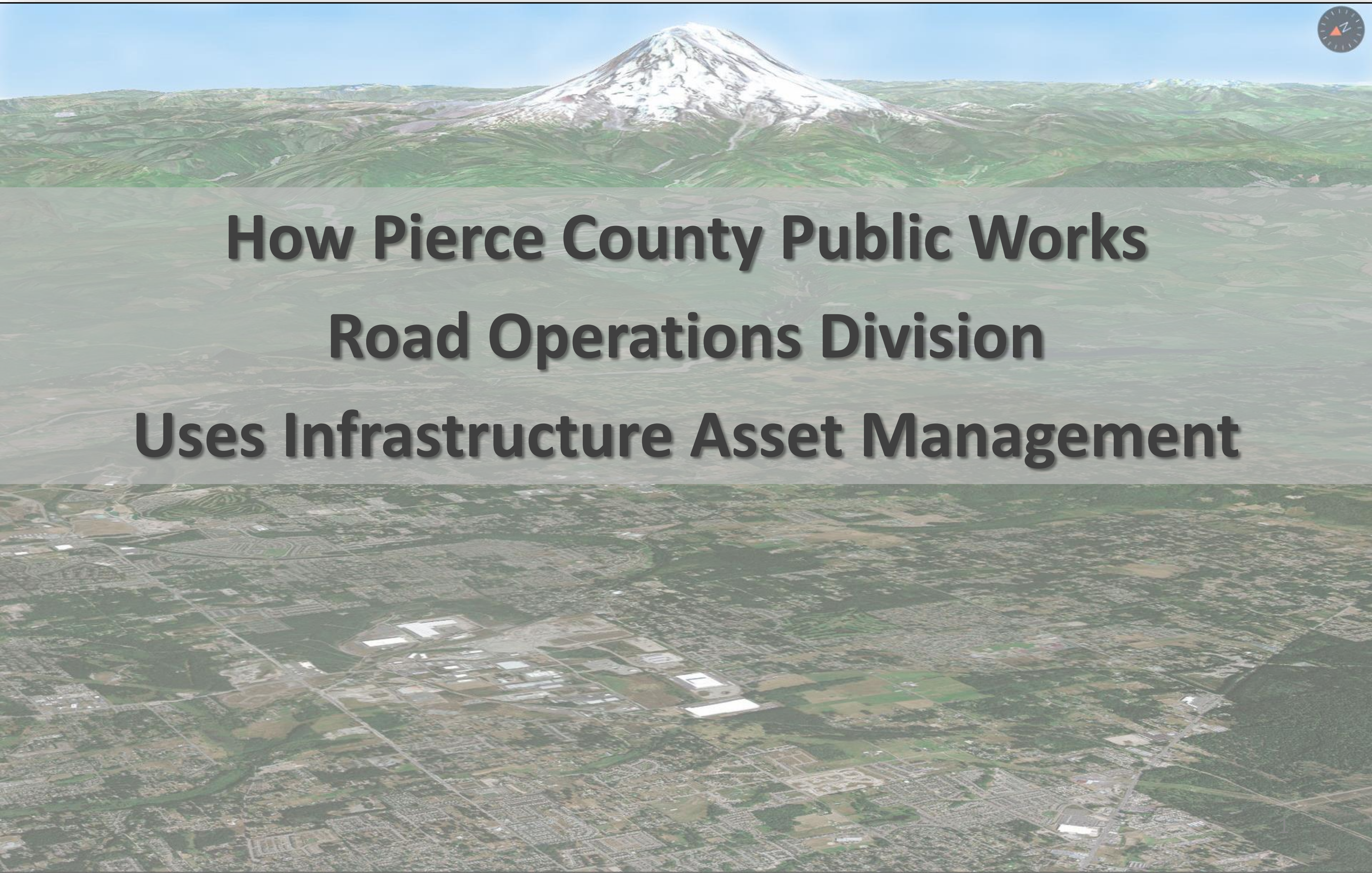
- We will continue taking measurements for 3 more years

•After that, inspections can be reduced and will focus on the requirements of the Permit

Attachment A6

Infrastructure Asset Management

Pierce County
Public Works and Utilities



How Pierce County Public Works
Road Operations Division
Uses Infrastructure Asset Management

Pierce County Public Works

Road Operations Division

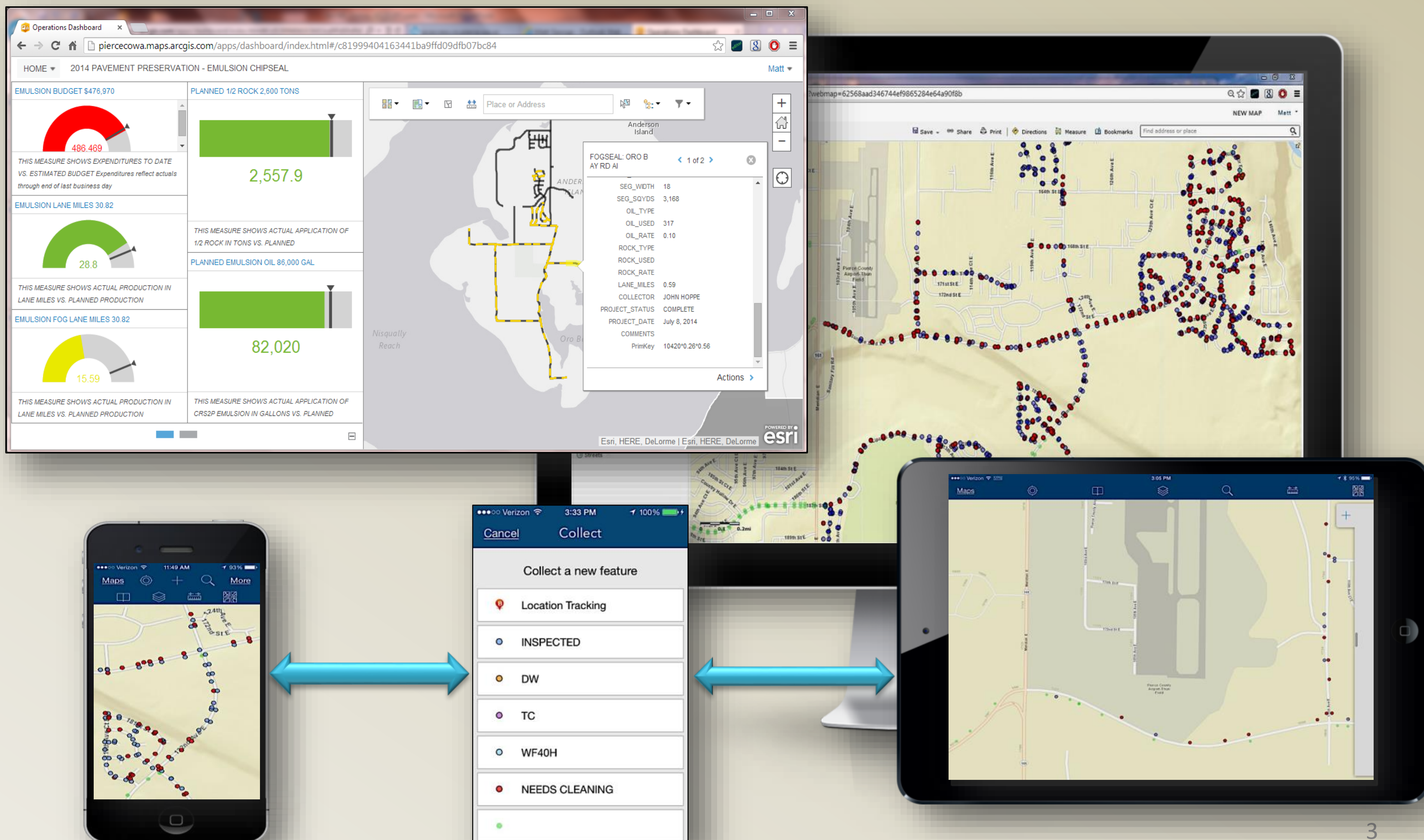
- $29.5M Annual Budget
- 164 FTEs
    - 24 Seasonal Employees
- 3 Facilities
- 10 Active Pit Sites (no active mining)
- 210 Vehicles and Equipment

- 3,150 Lane Miles
- 22,200 Catch Basins
- 550 Miles of Pipe

Pierce County
Public Works and Utilities

Attachment A6

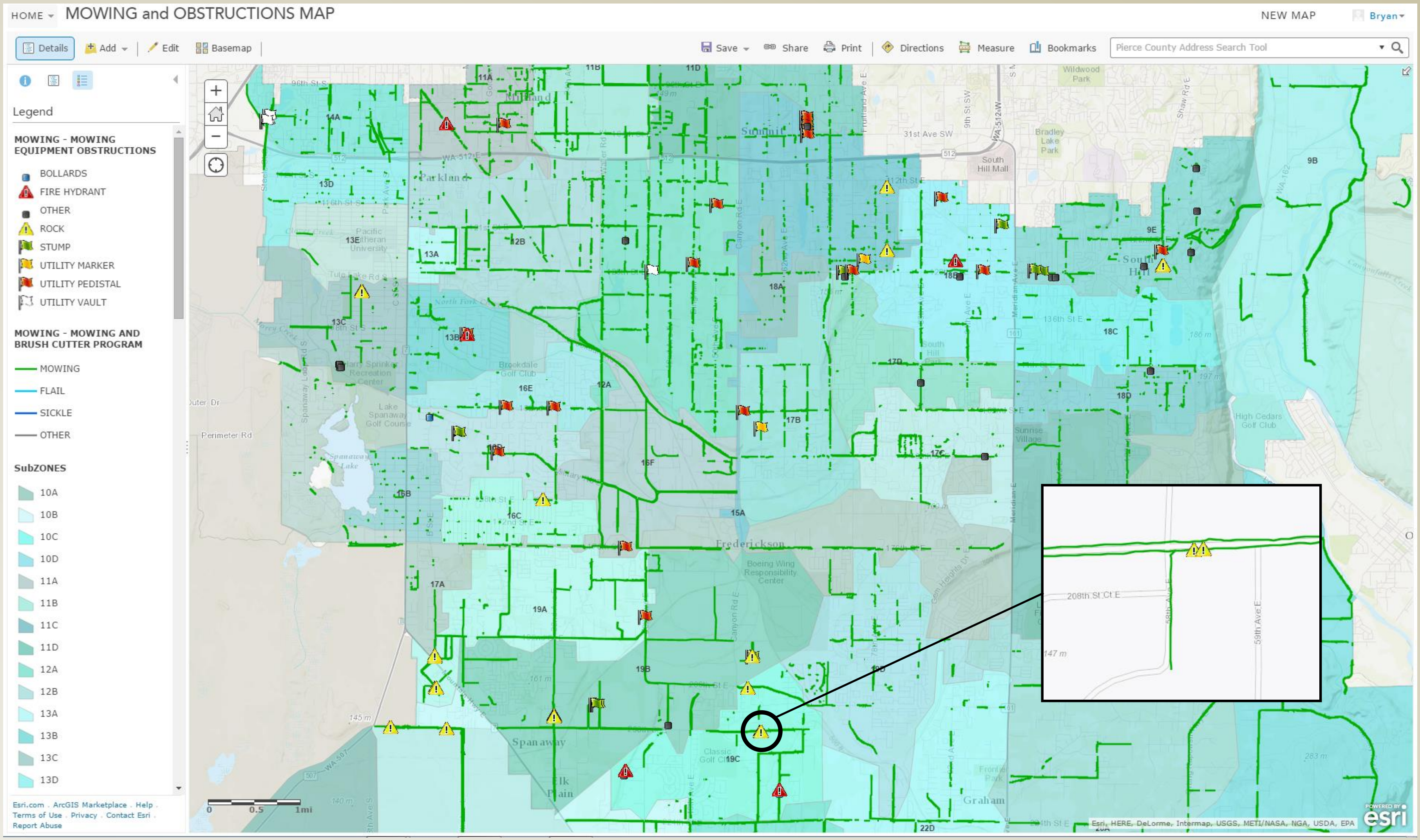
Why Do Asset Management Now?



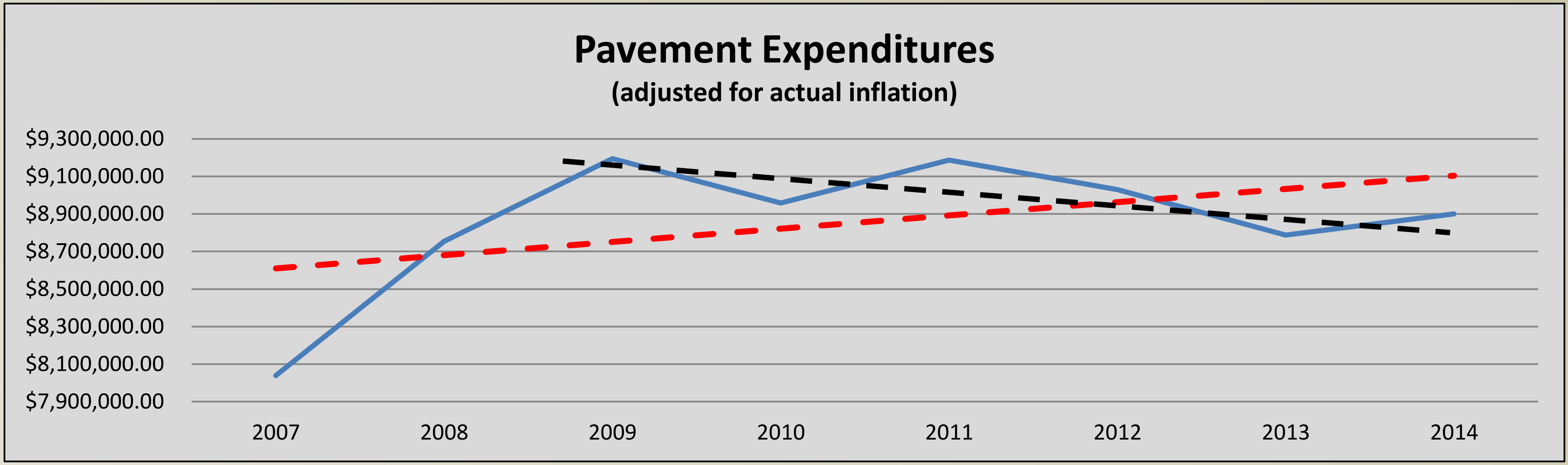
Pierce County
Public Works and Utilities

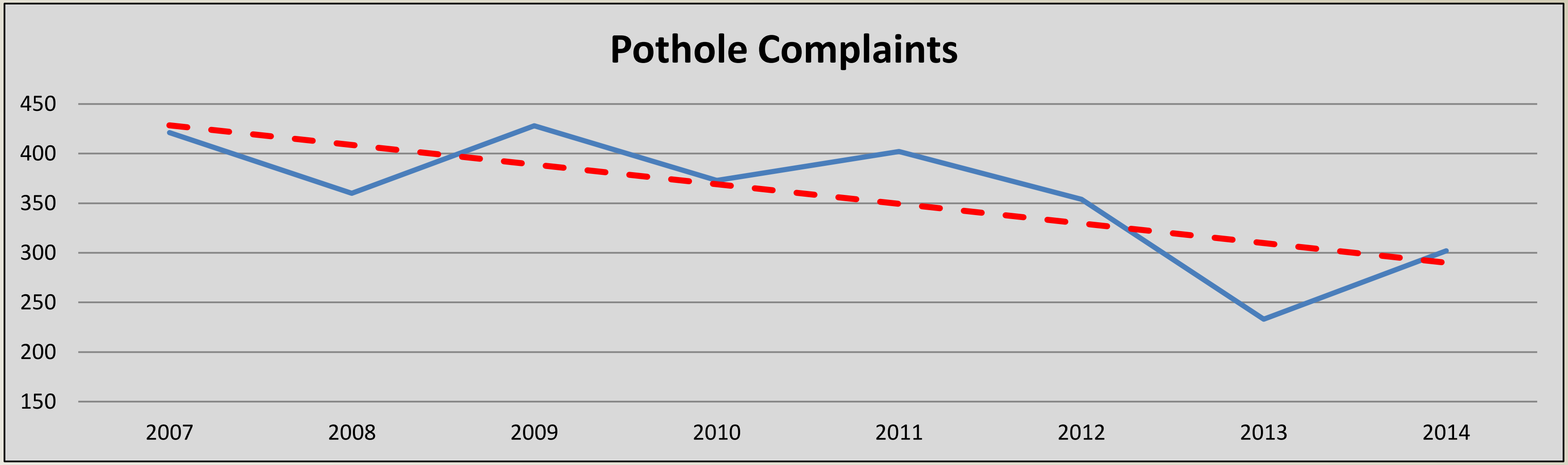
Attachment A6

Current Example using Technology

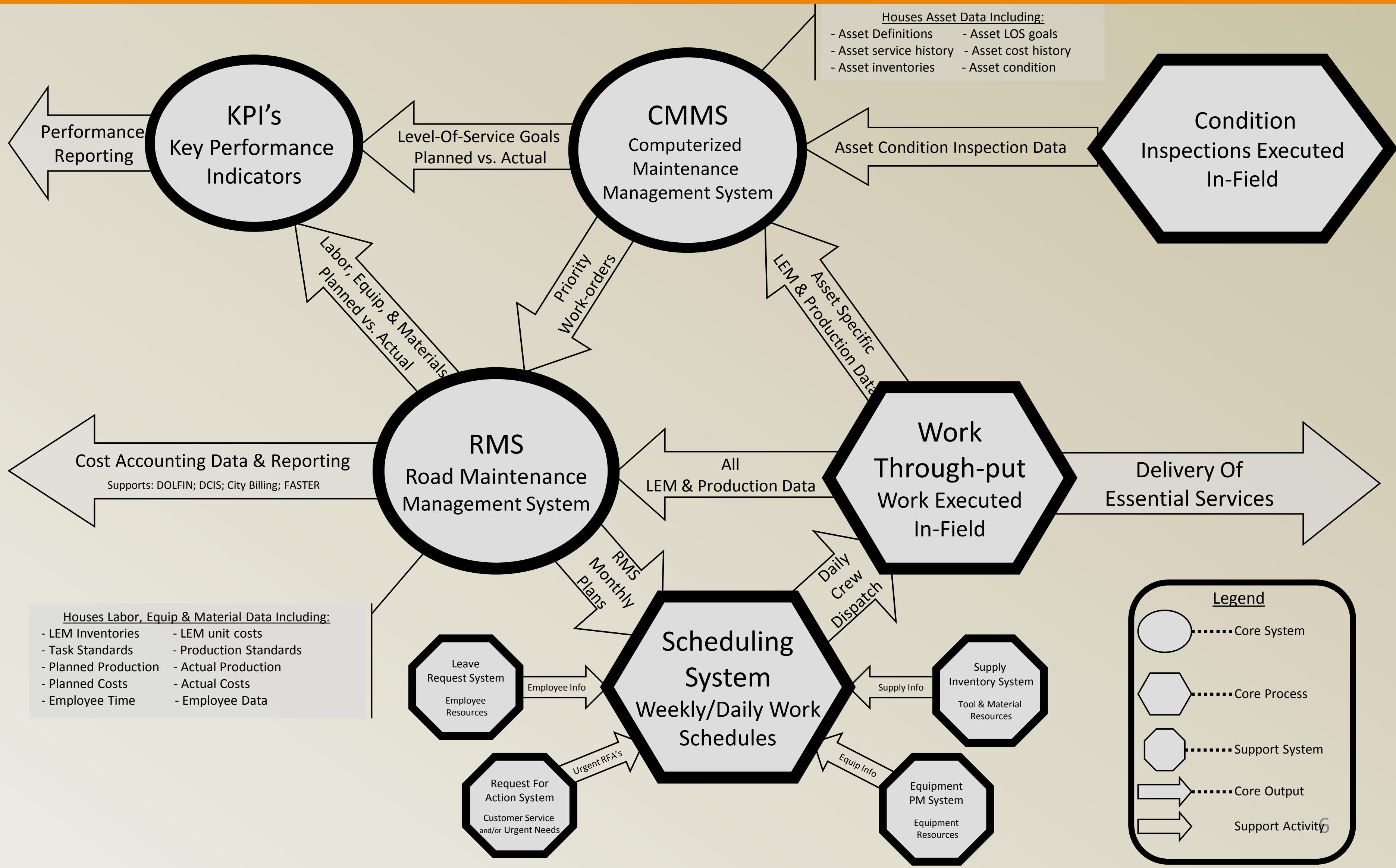


Save Money and Improve Effectiveness





Pierce County Road Operations Work Flow Chart



Pierce County's 8 Elements of Assessment Management

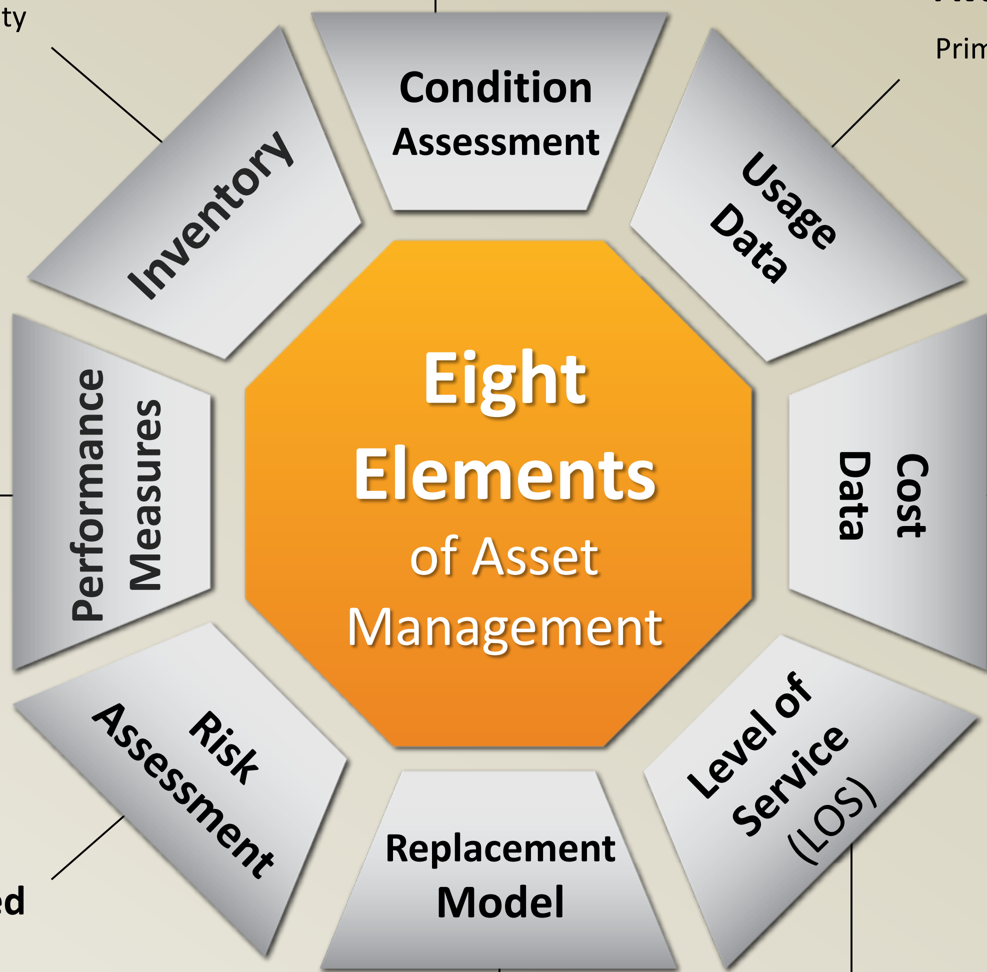
Large initial investment

Field and office resource activity

Work must integrate through hardware/software systems

Available Information

Primarily ADT, population info



Payroll and/or cost accounting system

Procedures, metrics, business rules housed in your manuals and CMMS system

Asset Condition Rating Scale per Function Standard

Defect Severity

A 0 - 3 None to low
B 4 - 6 Moderate
C 7 - 9 High

Defect Extent

1,4,7 Single or Isolated (<10%)
2,5,8 Several or Sporadic (10-50%)
3,6,9 Predominant (50-100%)

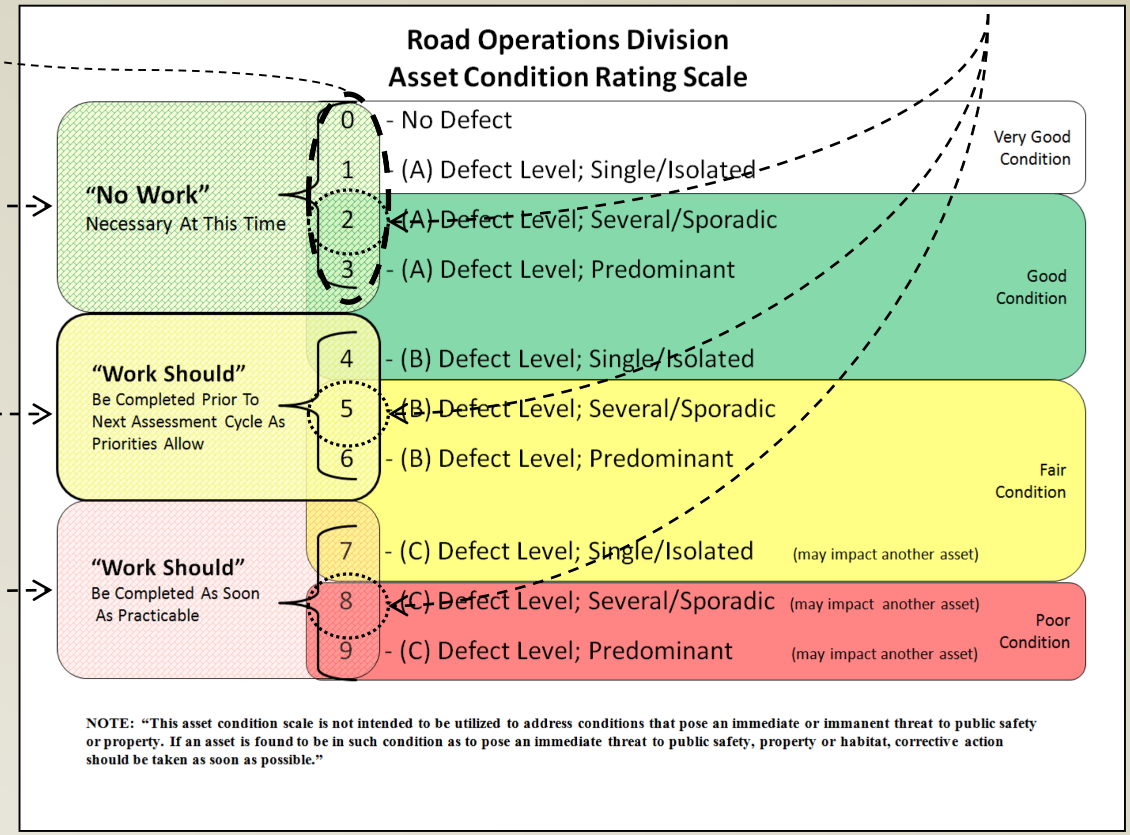
Work Order Prioritization

No Work Necessary
No or tolerable defects;, no work warranted at this time

Work Order Created
Low to moderate priority; should be completed as competing priorities allow

Work Order Created
Moderate to high priority; should be completed as soon as practicable. Condition may affect another asset.

Urgent Work & Emergencies
Emergencies are responded to immediately; emergency work orders are not created as part of an assessment rating process



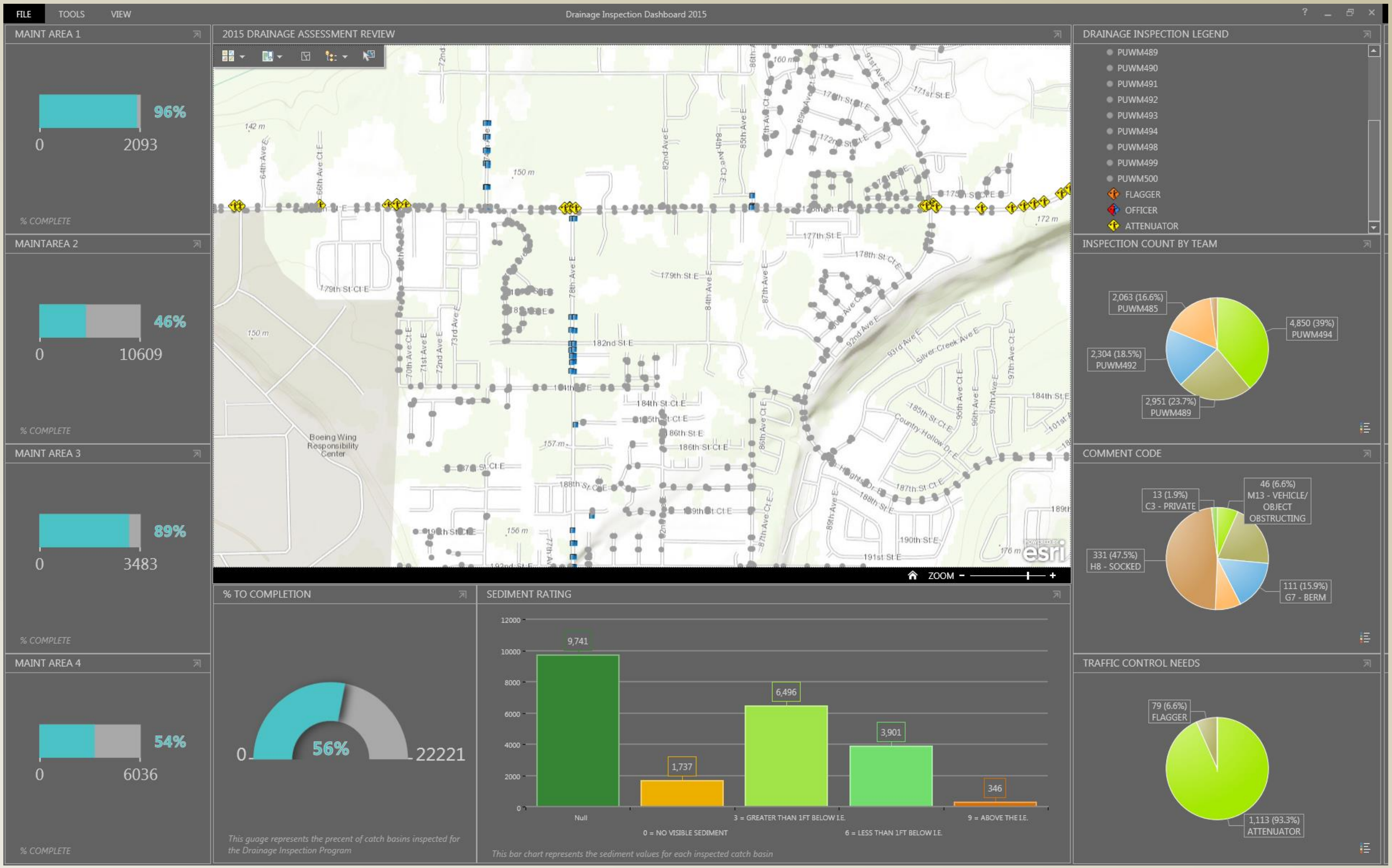
Performance Measures

Provide understanding of asset condition in terms easily understood by the public:

- Very Good Condition
- Good Condition
- Fair Condition
- Poor Condition

Condition Assessment Tools

Condition Assessment Tools – Assessment Dashboard



Asset Management Save Money

Catch Basin Asset Management

- 2003 – 2009: Catch Basin Cleaning - $70.17

- 2010: Catch Basin Cleaning and Inspection - $119.00
- 2011: Catch Basin Cleaning and Inspection - $97.65
- 2012: Catch Basin Cleaning and Inspection - $70.34
- 2013: Catch Basin Cleaning and Inspection - $58.44

2010 to 2013 we saw a 24% drop in overall cost for the inspection and cleaning of our stormwater drainage infrastructure

Pierce County Public Works and Utilities

The Challenges

Leading Change

- Cultural anchors
- Loyalty to legacy systems
- Perceptions of criticism
- Localized compare/contrast reactions
- Learning to trust the instrumentation
    - spatial disorientation reference

- Preserving trust between management and staff
    - Reward and rally the early adopters
    - Celebrate the short term wins
    - Be patient

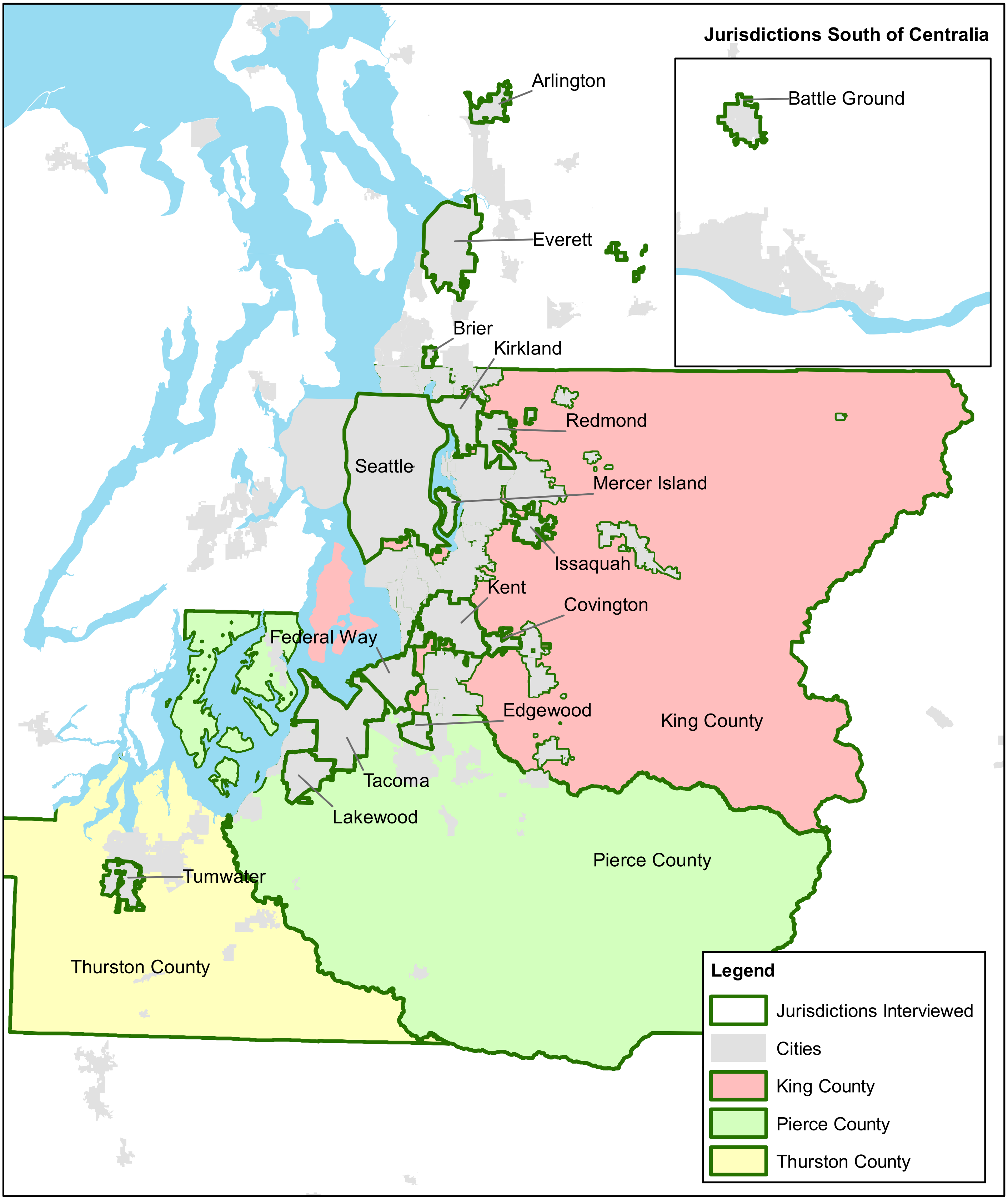
Questions?

Bruce Wagner
Pierce County Public Works
Road Operations Manager
bwagner@co.pierce.wa.us *253-798-6051*

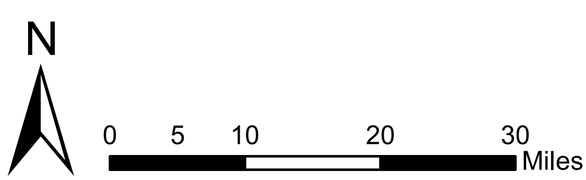
Bryan Chappell
Pierce County Public Works
Water Quality Supervisor
bchappe@co.pierce.wa.us

ATTACHMENT B

INTERVIEWS DOCUMENTATION



OSBORN CONSULTING INCORPORATED



Western Washington Catch Basin Study

Summary of Interviews

Washington State

Figure B-1

Prepared by , 3/23/2018

Jurisdiction	Redmond	Pierce County	SPU	Lakewood
Date of Interview	11/15/2017	1/9/2018	11/20/2017	11/16/2017
Person Interviewed	Peter Holte	Dan Smith	Kate Rhoads	Greg Vigoren
Job Title	Stewardship Coordinator		Municipal Stormwater Specialist	Surface Water Division Manager
Contact Information - Phone	(425) 556-2822	(253) 798-4652	(206) 684-8298	(253) 983-7771
Contact Information - Email	pholte@redmond.gov	dsmith8@co.pierce.wa.us	kate.rhoads@seattle.gov	gvigoren@cityoflakewood.us
Alternate Contact	Jerallyn Roetenmeyer	Bryan Chappell		
Job Title	NPDES Contact			
Contact Information - Phone	(425) 556-2824	(253) 798-3561 / 253-208-0727 / 253-255-3430		
Contact Information - Email	jroetemeyer@redmond.gov	bchappe@co.pierce.wa.us		
Question				
Program Schedule/Management				
What drives the decision to pursue or not pursue circuit based inspections.	Cleaned all basins within 5 years for the last permit. Currently studying changing to a circuit basis. Working on modeling a circuit-based inspection schedule in one drainage basin while continuing to track more data about CBs and their system. Will implement circuit-based inspections during one year in one part of the city and all CBs cleaned in the other part of the city.	Circuit inspections are not performed any longer. All CBs are inspected. Inspections happen very quickly by measuring whether they have 12in clear space below the invert. This system ends up cleaning a lot more than other jurisdictions, but results in less cleaning of downstream structures (vaults). Have seen less water over roadway events: a reduction of 90% of these events.	SPU does not do circuit based inspections because they wouldn't work for off-line systems.	Circuit-based inspections are not performed. Inspection and cleaning is done for half the system every year.
If using circuit based inspections, what is your interpretation/decision tree of when failure in inspection of a catch basin happens?	Relying on the fact sheet from Ecology to determine how to do circuit-based inspections (provided in Attachment A). Inspections will start at the most upstream catch basin from the outfall and inspect 25% from that outfall. If the last CB was found dirty they will continue cleaning until they find a clean CB.	Circuit inspections before: identify bottom CB before it leaves the ROW; inspect until 3 CBs in a row were clean; made the assumption the rest of the system was cleaned. For a couple of years they did full inspection for asset management.	N/A	N/A
Does your jurisdiction have a combined inspection and cleaning program or are they separate events? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from doing a new method?	Done it both ways. Inspecting and cleaning in the same time has been more efficient in terms of staff and resources. Function critical vs. non-function critical (helps protect the water vs. asset management question), prioritize safety, NPDES, and then asset management. Didn't have capacity to do it in the past to do both in the same time. Maintenance and Operations Crew Supervisor has decided to do inspection separately and then clean all at once.	Inspection separate from cleaning. They start with CBs that have needed to be cleaned all of the last 3 years. Recording sediment both at inspection and cleaning and flagging CBs that have increased in amount of sediment.	Pilot study was inconclusive whether it was more efficient to do inspection and maintenance in the same time. Results of the study will be available Feb-March 2018.	Inspect and clean at the same time. Roughly 60% of catch basins inspected would need cleaning every year. Makes work more efficient. Cheaper than to inspect only. Takes about 4-5 months of the year. Inspecting about half every year. Cleaned about 2,000 of the half of the CBs inspected every year.
Is inspection/maintenance done in-house or contracted out to a consultant/contractor? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from changing your method?	In-house crews. Have not contracted it out before.	All in-house crews (Operations Crews that are trained for asset management). In the process of hiring a dedicated crew.	In-house crew. Have not contracted it out before.	Contracted out, because City management doesn't support bringing it in-house.
Are there any cost savings you have realized through other changes in your CB Inspection and cleaning program?	No further information provided.	No further information provided.	Sediment depth measurements are a large time waster and didn't help with any decisions.	No cost savings, just efficiency in keeping the system clean.

Jurisdiction	Redmond	Pierce County	SPU	Lakewood
Program Costs:				
What is the total number of CBs in your jurisdiction?	No further information provided.	23,000	Already provided information in the survey.	6,800
What is the total cost of the CB maintenance program including inspections, cleaning, maintenance, sweeping etc.? OR, if not answerable, what activities are included in your maintenance cost total?	Contact stormwater supervisor: Ernie Fix (425-556-2758).	Submitted additional cost information. Maintenance Technician from Operations 2012 onwards has inspections separated from flooding events.	Already provided information in the survey.	Total budget item for CB maintenance: $480,000 separate for filter insert: $45,000 Includes about 800 hours ($130,000) for video inspections.
What components are included in your costs for inspections and/or maintenance (e.g., data management, training, office staff, equipment the city owns, disposal fees, etc) ?	No further information provided.	Costs capture labor, equipment and materials, including all the data management, training, office staff, disposal.	No further information provided.	Costs includes jetting lines, video inspections, and other cleanings. Video inspections are probably the largest cost item.
BMPs:				
Are there any BMPs you are currently implementing that target sediment removal before capture in CBs? o street sweeping, o WetVaults, o socks/filters on CBs, o curbs, o impervious shoulders, etc. o other.	Used to have a leaf sucker (talk to Ernie about this). Andy Rheaume has a pilot project for street sweeping. Member of the SWG. Contact number (425-556-2741). Private systems inspections (included CBs in the program not just flow control and water quality structures).	Have tried to enhance sweeping program. Look at where it is more difficult to clean CBs (high traffic roads, confined spaces, etc.). Multi-lane roads trying to sweep twice a month and arterial roads once a month. More CBs on residential roads than on other roads - have been trying to increase that frequency as well. Two decant facilities and 4 Vactors. Implementing top-down measuring approach to identify how much freeboard you have in the system. Also working on getting rid of legacy issues (builders cleaning concrete in CBs, etc.).	Looked at the data for areas that needed more inspections and weren't able to see much. 9 year period. How many times a CB needed to be cleaned. Did not find any trends. Certain areas needed cleaning one year or another due to development happening in the specific basins. Implementing street sweeping on arterials and line-cleaning mostly in the Duwamish because there is not a lot of curb and gutter in the basin.	Street sweeping frequency is based on principal arterial/local access roads and incidental ($150,000/year). Have hydrodynamic separators in about 64 vaults. They are inspected by internal staff and a contractor cleans the vaults. Inspections usually happen before the beginning of the rainy season. Other BMPs include perc filters, storm filters and O/W separators, and some bioswales. No changes in CBs cleaned, because most of the systems were installed at the end of the line rather than at the headwaters.
Are there any lessons learned or cost savings from implementing them?	No further information provided.	No further information provided.	No further information provided.	Copied contract from Kenmore.

Jurisdiction	Thurston County	Everett	Kent	Kirkland
Date of Interview	**11/16/2017**	**12/18/2017**	**11/30/2017**	**1/2/2018**
Person Interviewed	**Ryan Langan**	**Grant Moen**	**Laura Haren**	**Jenny Gaus**
Job Title	**Stormwater Operations Manager**	**Senior Engineer**	**Environmental Conservation Analyst**	**Surface Water Engineering Supervisor**
Contact Information - Phone	**(360) 867-2099**	**(425) 257-8947**	**(253) 856-5537**	**(425) 587-3850**
Contact Information - Email	**langanr@co.thurston.wa.us**	**gmoen@everettwa.gov**	**lharen@kentwa.gov**	**jgaus@kirklandwa.gov**
Alternate Contact			**Chris Couvillion**	**Wess Sayers**
Job Title			**Storm Drainage Field Supervisor**	
Contact Information - Phone			**(253) 856-5633**	
Contact Information - Email			**ccouvillion@kentwa.gov**	**wesayers@kirklandwa.gov**
Question				
Program Schedule/Management				
What drives the decision to pursue or not pursue circuit based inspections.	Not doing circuit-based inspections because it would be cost prohibitive. Higher level of service by cleaning 1/3 of the catch basins every year.	Inspections are not based on circuits. Seemed to be more labor intensive because if finding one CB that did not meet requirements, then you would need to clean the entire system. Also, due to the requirements to inspect for structural integrity, the CBs would have to be visited more frequently anyway.	Inspections are not based on circuits. Looking to try a combination of circuit and non-circuit inspections for comparison.	Inspections are not based on circuits. A lot of work to define the circuits. Inspecting everything seemed easier.
If using circuit based inspections, what is your interpretation/decision tree of when failure in inspection of a catch basin happens?	Understand circuit based inspection as needing to inspect three structures upstream from the outfall. If they fail continue, until three structures in a row pass.	N/A	25% starting at the outfall structure. Based on the common discharge or common use (CBs involved with sanding and deicing will be cleaned every year).	N/A
Does your jurisdiction have a combined inspection and cleaning program or are they separate events? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from doing a new method?	Separated inspection from cleaning. because only about 20% of CBs inspected needed cleaning.	Inspect first and then clean, because only around 30% of CBs inspected need cleaning.	Inspections first. Create work orders to those that need to be cleaned. Some areas may start cleaning at the same time as inspections. Traffic control in high traffic areas may be more efficient with cleaning and inspections together. Anticipate cost savings for personnel, interruption of traffic.	Separate. Used to have a combined way of doing it, but decided to separate because Vactor trucks are expensive. Do not have data to back any cost savings.
Is inspection/maintenance done in-house or contracted out to a consultant/contractor? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from changing your method?	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.
Are there any cost savings you have realized through other changes in your CB Inspection and cleaning program?	No further information provided.	No further information provided.	No further information provided.	No further information provided.

Jurisdiction	Thurston County	Everett	Kent	Kirkland
Program Costs:				
What is the total number of CBs in your jurisdiction?	Already provided information in the survey.	Already provided information in the survey.	18,900	15,690 in 2014 Surface Water Master Plan. With new development, probably have added ~50 CBs per year.
What is the total cost of the CB maintenance program including inspections, cleaning, maintenance, sweeping etc.? OR, if not answerable, what activities are included in your maintenance cost total?	Already provided information in the survey.	Already provided information in the survey.	Already provided information in the survey.	Costs provided for through November 2017.
What components are included in your costs for inspections and/or maintenance (e.g., data management, training, office staff, equipment the city owns, disposal fees, etc) ?	Costs include staff wages, benefits and overhead, cost of vehicle. Costs do not include disposal because it is recycled in-house.	Costs do not include disposal of waste. Solid waste handling is done at in-house facility.	Included in the costs are fuel costs, vehicle rentals, maintenance, wages, products, disposal costs. Sweeping is not included, as it is contracted out separately.	Costs do not include all overhead, data management, or disposal fees. A fleet charge recovers the maintenance, repair, and replacement for the equipment.
BMPs:				
Are there any BMPs you are currently implementing that target sediment removal before capture in CBs? o street sweeping, o WetVaults, o socks/filters on CBs, o curbs, o impervious shoulders, etc. o other.	Street sweeping program. BMPs are mostly end of pipe systems prior to infiltration.	The street sweeping program removes large amount of sediments. Different depending on use and historic knowledge of the area. Sweeping right after the sanding efforts in the winter time has removed significant amounts of sediment.	Some BMPs include leaf vacuums for gutter lines to prevent debris in CBs, Filterra and vault systems, and filter socks in CBs for areas with sanding routes.	Each street is swept every two months. Arterials and higher use streets are swept more often. Also targeting problem CBs areas. Development department are very careful about erosion control. WaterWorks grant to do on-site training on erosion control on small sites. Cleaning pipes as well when CBs are cleaned and pipes show more than 1/3 full. Active IDDE program. The city goes out to clean whenever there is a report. Changed snow practices from using sand to using more deicers. Used to do more streambank stabilization, but now focusing more on flow control.
Are there any lessons learned or cost savings from implementing them?	Can't quantify savings or implement tracking for the BMPs.	No way to track effects of BMPs relative to maintenance costs.	Running a city Vactor truck facility rather than disposing the soils reduces the costs with disposal and beneficially reusing them on other sites.	The number of IDDEs and work orders has gone up as a result of community involvement. However, no way of quantifying cost savings.

Jurisdiction	Tacoma	Tumwater	WSDOT	King County WLRD
Date of Interview	11/15/2017	1/4/2018	1/8/2018	1/4/2018 and 1/16/2018
Person Interviewed	Mike Rose	Dan Smith	Trett Sutter	Doug Navetski
Job Title	Professional Engineer	Water Resources Program Manager	Stormwater Compliance Specialist	NPDES Contact
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Alternate Contact		Amy Georgeson		Brent Dhoore
Job Title		Water Resources Specialist		Roads Division
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Question				
Program Schedule/Management				
What drives the decision to pursue or not pursue circuit based inspections.	Circuit-based inspections are performed. Better data is needed for efficiency to be evaluated. Intermediate inspection randomly (negligible). Plans to perform some data analysis on sediment accumulation. Trying to use the data to drive the pipe cleaning and sweeping program. Seeing improvements on CB cleaning from doing better maintenance with other programs.	Inspections are not based on circuits. Fifty percent of the catch basins are inspected every year.	Have looked at circuit-based but are not far enough along with definitions of circuits or mapping. Within the NPDES boundaries, inspections performed once a year. Cleaning/repair within 6 months of the inspections. 2 years of tracking inventory.	Circuit-based inspections under the Roads Department (80-90% of the inventory).
If using circuit based inspections, what is your interpretation/decision tree of when failure in inspection of a catch basin happens?	Broken entire city network into convenient geographical boundaries (topography based): 6 general areas broken out into sub-basins. Hit 33% of each sub-basin for cleaning and inspections. Cleaned every single catch basin every 2.5 years. Currently looking to develop return frequencies for geographical areas. One basin with mixed residential and commercial required extensive amount of cleaning.	N/A	N/A	Circuits are formed by CBs that share the same outfall. An outfall is when the water leaves the ROW. Initial inspection includes the 25% most downstream end of the circuit, including the outfall if it is a structure. If all 25% pass the clean threshold (less than 50% full), no cleaning required. If any of those 25% fail, they will be cleaned. If the most upstream (top CB) fails, then it triggers inspection up the circuit until two CBs pass. Structural integrity inspections are done at time of the sediment inspection.
Does your jurisdiction have a combined inspection and cleaning program or are they separate events? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from doing a new method?	Inspect and clean in the same time, because they clean regardless of the sediment depth. Used the cleaning program for a year to remove left behind CB filter socks after construction contracts to have a better system. The costs for removing the filter socks was around $80-100k.	Inspect and clean at the same time. Seems to work well for them. Haven't tried to separate.	In more urban areas (when lane closures need to happen) they usually have the vactor truck follow the inspection crew. In more rural areas that are farther away, will likely have inspection a couple of months before.	Parks Department does inspection and cleaning together (only a few hundred CBs focused in the same area). WLRD and Roads have separate events. Majority of inspections pass, so it makes sense to send the inspector first and then follow-up with the Vactor when cleaning.
Is inspection/maintenance done in-house or contracted out to a consultant/contractor? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from changing your method?	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.	All done by Roads department (county staff). All other departments contract with Roads.
Are there any cost savings you have realized through other changes in your CB Inspection and cleaning program?	Efficiency seen from the GIS mapping of existing and new infrastructure and tracking CB inspections digitally. Realized efficiencies for contaminated/source control questions response and were able to plan routes more efficiently. With the same crew and resources, crews are now able to do inspection and cleaning every 2.5 years for the entire system compared to 7 years it took before digital records.	No further information provided.	No further information provided.	Size of the inventory drives the program decisions. Smaller inventory allows for inspection and cleaning. For large jurisdictions, can only inspect what they can clean in 6 months.

Jurisdiction	Tacoma	Tumwater	WSDOT	King County WLRD
Program Costs:				
What is the total number of CBs in your jurisdiction?	20,000	No further information provided.	Statewide: 34,000 CBs. Overall inventory is 50,000 CBs. Western: 26,000 CBs, all basins within NPDES boundaries. All inventory is 40,000 CBs.	Over 20,000-23,000 structures in the inventory, CBs are a little less.
What is the total cost of the CB maintenance program including inspections, cleaning, maintenance, sweeping etc.? OR, if not answerable, what activities are included in your maintenance cost total?	$250,000, roughly.	No further information provided.	Statewide: $14.9M (CBs, stormwater BMPs) for two years. Western: $12.3M dedicated to assets on the west side of the Cascades. 2015-2017 spending on just CB: $7.5M - 2 years spending. (about $5.5M spent on the west side).	No further information provided.
What components are included in your costs for inspections and/or maintenance (e.g., data management, training, office staff, equipment the city owns, disposal fees, etc) ?	No further information provided.	No further information provided.	Costs include maintenance and inspection of ponds, vaults, etc. Costs includes manhours for inspection and cleaning, disposal, vehicles, and equipment. Does not include equipment purchases, data management, training, or office staff.	No further information provided.
BMPs:				
Are there any BMPs you are currently implementing that target sediment removal before capture in CBs? o street sweeping, o WetVaults, o socks/filters on CBs, o curbs, o impervious shoulders, etc. o other.	Implementing an aggressive sweeping program: all city is swept twice a year, downtown sweeping is completed continuously. Two shifts (evening and morning) once a week cycle for the downtown areas. Heavier arterial roads get swept every one-three months. Driven not by data, but by experience. Zonar program to track trucks that sweep to keep track of the streets swept. Difficult to quantify costs. Tons of materials removed. Some studies show that it doesn't matter. Efficiency realized by having a reduced number of calls from clogged CBs.	Have a street sweeping program.	Have looked at additional sweeping, because a sweeper is much cheaper equipment to operate. Socks and filters haven't worked out well because they typically get forgotten and have caused more flooding events.	SW treatment facilities and sweeping program (recovering sand after storm events). Street sweeping would be the only BMP that they actively target. A grant from Ecology is allowing them to look for scour areas candidates for retrofit structures.
Are there any lessons learned or cost savings from implementing them?	No further information provided.	No further information provided.		

Jurisdiction	Brier	Covington	Edgewood	Federal Way
Date of Interview	1/9/2018	12/1/2017		12/8/2017
Person Interviewed	Rich Maag		Jeremy Metzler	Tony Doucette
Job Title			Senior Engineer/Surface Water Program Manager	Surface Water Management Project Engineer
Contact Information - Phone	(425) 775-5440	(253) 480-2465	(253) 952-3299	(253) 835-2753
Contact Information - Email	rmaag@ci.brier.wa.us	bparrish@covingtonwa.gov	jeremy@cityofedgewood.org	tony.doucette@cityoffederalway.com
Alternate Contact				
Job Title				
Contact Information - Phone				
Contact Information - Email				
Question				
Program Schedule/Management				
What drives the decision to pursue or not pursue circuit based inspections.	The city will start doing circuit-based inspections.	Inspections are not based on circuits. Approach is to clean half the city every year.	Inspections are not based on circuits. Pierce County does inspections for Edgewood.	Circuit-based inspections are performed for 7 sub-basins. City performed a cleaning study between 2005 and 2007 timeframe. The cleaning study helped break down the system into circuits that are now cleaned between once every 3 years and every 5 years.
If using circuit based inspections, what is your interpretation/decision tree of when failure in inspection of a catch basin happens?	Process for circuit-based inspections will be to start at the lowest CB and inspect as many as needed. If 6/7 CBs are clean then assume that the rest is clean. The process will also entail some spot checks.	N/A	N/A	Measured sediment in all CBs in the public ROW the year before they were due for cleaning. Cleaning the following year.
Does your jurisdiction have a combined inspection and cleaning program or are they separate events? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from doing a new method?	Have done it combined, but will move to inspections first and then cleaning.	Inspects and cleans at the same time.		Inspections one year, and then cleaning the next year.
Is inspection/maintenance done in-house or contracted out to a consultant/contractor? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from changing your method?	In-house crew. Have not contracted it out before.	Contracted out.	Contracted out.	In-house inspections and contracted Vactor.
Are there any cost savings you have realized through other changes in your CB Inspection and cleaning program?	No further information provided.	The program seems to be working fine, and haven't looked at any improvements or efficiencies.	No further information provided.	No further information provided.

Jurisdiction	Brier	Covington	Edgewood	Federal Way
Program Costs:				
What is the total number of CBs in your jurisdiction?	1,700	3,400	980	12,528
What is the total cost of the CB maintenance program including inspections, cleaning, maintenance, sweeping etc.? OR, if not answerable, what activities are included in your maintenance cost total?	Already provided information in the survey.	Submitted with the survey.	Changes in inspection requirements and additional works responsible for the higher costs in the later years.	Already provided information in the survey.
What components are included in your costs for inspections and/or maintenance (e.g., data management, training, office staff, equipment the city owns, disposal fees, etc) ?	Costs include manhours only and disposal fees.	Costs include only the Vactor contractor.	No further information provided.	Costs include disposal costs.
BMPs:				
Are there any BMPs you are currently implementing that target sediment removal before capture in CBs? o street sweeping, o WetVaults, o socks/filters on CBs, o curbs, o impervious shoulders, etc. o other.	The city does street sweeping consistently and keeps a very good eye on construction sites. Sweeping right after snow events that required sand applications was found to remove significant amounts of sediment.	The city has a street sweeping contract.	No further information provided.	Street sweeping also contracted out. Sweeping is intensified around high-use intersections that require oil booms.
Are there any lessons learned or cost savings from implementing them?		The city has not looked at reductions in costs.	No further information provided.	Years that they have to clean most is right after heavy snow years.

Jurisdiction	Mercer Island	Issaquah	Arlington	Battle Ground
Date of Interview		**1/4/2018**	**12/6/2017**	**12/1/2017**
Person Interviewed	**Brian Hartvigson**	**Harvey Walker**	**Ken Clarke**	**Kelly Uhacz**
Job Title	**Right-Of-Way Manager**	**Manager of Storm and Sewer Operation**	**Stormwater Technician**	**Associate Stormwater Engineer**
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Alternate Contact			**Mike Wallaneck?**	
Job Title				
Contact Information - Phone			**360.403.3541**	
Contact Information - Email				
Question				
Program Schedule/Management				
What drives the decision to pursue or not pursue circuit based inspections.	Inspections are not based on circuits. All catch basins cleaned on a 2-year cycle.	Divided into 25 circuits based on the outfalls and areas. Program started in August 2017 and has been working well so far. Trying to get the circuits into GIS for tracking.	Inspections are not based on circuits. The city is divided into 3-4 parts and cleaning frequencies favor streets that have sanding activities in the winter.	Not sure what circuit-based inspections mean. Currently, the city is inspecting all of the CBs.
If using circuit based inspections, what is your interpretation/decision tree of when failure in inspection of a catch basin happens?	N/A	Per talking with Pierce County: go upstream until they find 5 clean basins (below threshold for cleaning) in a row. Inspections start at the last basin before it enters the waters of the state/ponds, etc.	N/A	N/A
Does your jurisdiction have a combined inspection and cleaning program or are they separate events? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from doing a new method?	Performing cleaning as we go. It is more efficient because you don't need to come back.	Cleaning is separate from inspections. With sanding operations, they clean catch basins more (often even 3-4 times a year).	Combined inspection and maintenance. Haven't documented the sump depth. An iPad app has allowed them to track CBs and amount of sediment.	Only about 25% needed to be cleaned, but the city is not tracking specific numbers.
Is inspection/maintenance done in-house or contracted out to a consultant/contractor? Did you have a different structure in the past? Have you found any cost efficiencies or lessons learned from changing your method?	Contracted out.	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.	In-house crew. Have not contracted it out before.
Are there any cost savings you have realized through other changes in your CB Inspection and cleaning program?	Contract because the jurisdiction doesn't have the right equipment.	No further information provided.	Low-tech tracking methods (i.e., spot of green paint on the CB when it is maintained).	No further information provided.

Jurisdiction	Mercer Island	Issaquah	Arlington	Battle Ground
Program Costs:				
What is the total number of CBs in your jurisdiction?	4,641	7,500	3,500	2,000 (used to have 1,800, but have been growing).
What is the total cost of the CB maintenance program including inspections, cleaning, maintenance, sweeping etc.? OR, if not answerable, what activities are included in your maintenance cost total?	Costs cover everything including the waste disposal.	Already provided information in the survey.	Already provided information in the survey.	Already provided information in the survey.
What components are included in your costs for inspections and/or maintenance (e.g., data management, training, office staff, equipment the city owns, disposal fees, etc) ?	Type I and Type II have a different cost structure. Pond cleaning by the hour. Type II - $37 Type I - $24 Costs do not include mobilization and disposal.	Cost data does not include data management, disposal costs, training, management, office/management. Costs include some equipment fees/parts used.	Included in the costs are man-hours, street sweeping and Vactor trucks. Solids from cleaning are stockpiled, and once a year they are tested and disposed. Waste management is not included in the costs.	Includes costs for data management.
BMPs:				
Are there any BMPs you are currently implementing that target sediment removal before capture in CBs? o street sweeping, o WetVaults, o socks/filters on CBs, o curbs, o impervious shoulders, etc. o other.	City has a robust in-house street sweeping. Almost all the sediment structure vaults are mid cycle of the drainage basin. Found that these sediment vaults reduced the sediment downstream. Not a lot of cost savings tracked or realized, just better results for sediment capture. The city does make use of filter socks when needed.	SW Rehabilitation Program: Look at systems where they can improve and at isolated CBs that are not currently visited. Contract sweepers to clean sanded roads, cleaning leaves, etc.	Biggest sediment removal and control is street sweeping, which is completed every other month. Filter socks are standard for construction sites.	Only street sweeping, rotation through the city (3 times a year). Have a few treatment BMPs in the city, but the city doesn't track performance (10-12 filter vaults with Storm Filters).
Are there any lessons learned or cost savings from implementing them?	The city found significant improvements in sediment removal from ensuring car washes had proper barriers for containing wastes.	No further information provided.	CMA (Calcium Magnesium Acetate) replacement for sanding the roads to keep streets clean.	

ATTACHMENT C

COST INFORMATION DATA SUMMARY

ATTACHMENT C

COST INFORMATION DATA SUMMARY

Phase	Jurisdiction	Size	Year									
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Phase 1	Port of Seattle	Medium		$ 62.83	$ 67.70	$ 87.61	$ 98.45	$ 107.26	$ 91.03	$ 142.99		
Phase 1	Seattle Public Utilities	Large	$ 29.34	$ 49.65	$ 37.69	$ 27.83	$ 30.94	$ 24.57	$ 31.33	$ 32.43		
Phase 1	WSDOT	Large				$ 30.56	$ 41.15	$ 54.89	$ 40.83	$ 37.95		
Phase 1	Pierce County	Large			$ 26.23	$ 40.59	$ 34.04	$ 30.20	$ 28.34	$ 26.45	$ 32.99	$ 36.17
Phase 2	City of Battle Ground	Small		$ 0.34	$ 13.97	$ 18.72	$ 0.23	$ 9.41	$ 8.61	$ 2.19		
Phase 2	City of Brier	Small				$ 11.76	$ 10.00	$ 2.94	$ 1.18	$ 1.18		
Phase 2	City of Edgewood	Small	$ 17.38	$ 20.35	$ 21.73	$ 22.63	$ 23.76	$ 24.95	$ 137.53	$ 250.11		
Phase 2	City of Poulsbo	Small	$ 70.55	$ 73.47	$ 73.47	$ 74.05	$ 75.77	$ 76.69	$ 77.92	$ 79.20		
Phase 2	City of Arlington	Medium								$ 8.57		
Phase 2	City Of Covington	Medium	$ 18.31	$ 20.18	$ 12.60	$ 5.62	$ 12.34	$ 27.23	$ 14.80	$ 16.45		
Phase 2	City of Issaquah	Medium						$ 2.03	$ 7.00	$ 6.61		
Phase 2	City of Lakewood	Medium	$ 6.18	$ 6.18	$ 6.18	$ 8.47	$ 15.88	$ 16.14	$ 25.29	$ 25.69		
Phase 2	City of Mercer Island	Medium								$ 60.00		
Phase 2	Thurston County	Medium						$ 120.80	$ 144.78	$ 122.02		$ 37.49
Phase 2	City of Everett	Large			$ 16.36	$ 16.36	$ 16.36	$ 7.88	$ 7.88	$ 7.88		
Phase 2	City of Federal Way	Large	$ 9.30	$ 11.87	$ 11.89	$ 11.91	$ 11.93	$ 13.09	$ 12.82	$ 14.13		
Phase 2	City of Kent	Large					$ 178.71	$ 289.73	$ 281.51	$ 286.67		
Phase 2	City Of Tacoma	Large										$ 12.50
Phase 2	City of Kirkland	Large							$ 14.55	$ 20.04	$ 29.12	