Final

WHITE PAPER
for
Stormwater Management Program Effectiveness Literature Review

Operation and Maintenance

April 2013

Prepared for:
Association of Washington Cities
and
Washington State Department of Ecology

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EXECUTIVE SUMMARY

Catch basins can capture sediments and sediment-bound pollutants in stormwater, providing some pollutant removal and acting as a pretreatment for other stormwater best management practices (BMPs) (USEPA 2006). A factor that is critical to the effectiveness of a catch basin at removing sediments is regular maintenance to remove accumulated sediments and other debris from its sump (USEPA 2006).

This paper summarizes articles included within the effectiveness study literature database (Ecology 2011a) for the Operations and Maintenance Stormwater Management Plan (SWMP) topic. In particular, the paper discusses the following Effectiveness Study Topic Null Hypotheses relating to catch basins, their maintenance, and their potential for contributing bacteria to stormwater runoff.

Hypothesis #1: Frequency of inspecting and cleaning catch basins is not dependent on land use or road size.

Several studies have been conducted that determined that different land uses result in significantly different sediment accumulations rates. These studies have shown varying sediment accumulations rates among land uses with industrial land use reporting the highest sediment accumulations followed by commercial then residential. In general these studies indicate the frequency of inspecting and cleaning catch basins is dependent on land use or road size.

Hypothesis #2: Catch basins do not contribute sufficient fecal coliform bacteria to exceed water quality standards.

The studies available within the literature database indicate catch basins are likely not a significant source of fecal coliform, but they do have the ability to re-suspend and transport bacteria bound to sediments that have settled out in the catch basin sump. They may be a source of bacteria that replicates and regrows on biofilm within the catch basin sump, however, this bacteria is not pathogenetic and not believed to be a human health concern.

Based on a review and summary of the articles included in the literature database it is recommended that additional studies or maintenance practices be completed.

1. Review maintenance and inspection records to assess sediment accumulation rates. Use the records to develop a maintenance schedule to assess the feasibility of maintaining catch basins before they reach 40 to 50 percent of their capacity. Determine if accumulation rates of catch basins may allow for a more flexible inspection schedule than that required by the National Pollutant Discharge Elimination System (NPDES) permit.
2. Look into the feasibility of WSDOT changing the design standards of catch basins to allow for local governments to size of catch basins sumps to accommodate the volume of sediment that enters the system. Pitt et al. (2000) proposed a sizing criterion based on the concentration of sediment in runoff. The catch basin is sized, with a factor of safety, to accommodate the annual sediment load in the catch basin sump.

3. Conduct additional studies to look at various BMPs and their effectiveness at removing indicator bacteria and fecal coliform from urban runoff.
4. Conduct monitoring to determine if newly implemented NPDES permit required catch basin maintenance standards have had an effect on pollutant levels, including sediment, fecal coliform, and other sediment bound pollutants.
5. Conduct additional studies on the presence of biofilm in local catch basins and gutters, their influence on downstream bacteria levels, and their likelihood of causing human health concerns.

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ABBREVIATIONS AND ACRONYMS

AADT	average annual daily traffic
BMPs	best management practices
cfu	colony forming units
CWP	Center for Watershed Protection
E-coli	Escherichia coliform bacteria
Ecology	Washington State Department of Ecology
mL	milliliters
MPN	most probable number
NPDES	National Pollutant Discharge Elimination System
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
UV	ultraviolet
WRIA	Water Resources Inventory Area
WSDOT	Washington State Department of Transportation

1.0 INTRODUCTION AND PROBLEM STATEMENT

The Stormwater Work Group (SWG) is a group of stakeholders made up of federal, tribal, state and local governments, as well as business, environmental, agriculture and research interests. They are tasked with developing a Stormwater Monitoring and Assessment Strategy for the Puget Sound Region. The Effectiveness Study Selection Subgroup (subgroup) was formed by the SWG in October 2010 to help with the process of identifying potential effectiveness studies to be conducted during the next National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit cycle. The subgroup developed a list of 22 ranked effectiveness study topics and associated questions. To help answer these questions, an Effectiveness Study Literature Review was conducted and a literature database was created (Ecology 2011a). The literature database contains over 300 publications, including journal articles, books, public information flyers and agency reports.

1.1 SCOPE OF THIS PAPER

This white paper aims to summarize the publications within the effectiveness study literature database (Ecology 2011a) that related to the ranked effectiveness study and Storm Water Management Plan topics #5 and #15: Operations and Maintenance. The paper specifically addresses the following Null Hypotheses relating to catch basins, their maintenance, and their potential for contributing bacteria to stormwater runoff.

Null Hypothesis #1: Frequency of inspecting and cleaning catch basins is not dependent on land use or road size.

- Do catch basins on arterial streets require more frequent cleaning vs. non-arterial streets?
- Can land use or road size/type be used to set an optimal frequency for inspection and cleaning catch basins?
- Does the land use surrounding a catch basin influence the rate of sediment accumulation in catch basins?
- Can catch basin maintenance frequency be determined by land use surrounding the catch basin?

Null Hypothesis #2: Catch basins do not contribute sufficient fecal coliform bacteria to exceed water quality standards.

- Are catch basins a significant source of fecal coliform or other pollutants?
- What frequency of catch basin maintenance is needed to reduce the level of fecal coliform to meet Total Maximum Daily Load (TMDL) requirements?

Funding for this white paper was provided the Washington State Department of Ecology.

1.2 PROBLEM STATEMENT

Most large municipalities include storm drain systems made up of hundreds of miles of conveyance pipes. These storm drain systems capture urban stormwater runoff from roadways and transport it to outfalls that drain to streams, lakes, oceans, and other water bodies. Catch basins, which are typically made up of a curb inlet or grate along with a sump, provide an inlet

for stormwater to enter these storm drain systems. Catch basins are generally considered to be a pretreatment for other stormwater best management practices (BMPs), with the catch basin sump allowing larger sediments and associated pollutants to settle out (USEPA 2006). The effectiveness of catch basins to remove debris and sediment is highly dependent on their design and sump size. Another factor that is critical to their effectiveness is regular maintenance to remove accumulated sediments and other debris from its sump (USEPA 2006).

Common pollutants associated with urban stormwater runoff include metals, motor oil, pesticides and fertilizers, and bacteria such as fecal coliform. In the 2004 United States Environmental Protection Agency (USEPA) National Water Quality Inventory it was found that eight percent of streams, seven percent of lakes, and 12 percent of estuaries were impaired by urban stormwater (Winston et al. 2011). In addition, the USEPA's National Water Quality Inventory in 2000 determined that 13 percent of the river and stream miles that were surveyed were impaired by bacteria that was indicative of the presence of fecal coliform (Hathaway et al. 2009). The often difficult task for stormwater managers is finding the source of bacteria and other stormwater pollutants in addition to determining the best ways to reduce pollutant loads in the receiving water bodies.

2.0 LITERATURE SUMMARY AND TALKING POINTS

The Operations & Maintenance null hypotheses and ranked questions are presented in Table 1. Publications from the database of effectiveness study literature (Ecology 2011a) were reviewed to research the null hypotheses and address the ranked questions. This section presents a summary of the publications reviewed and, where possible, answers to the ranked questions.

Table 1 Ranked Effectiveness Questions for Operations and Maintenance (Ecology 2011b)

Rank[1]	Null Hypothesis	Questions
5	Frequency of inspecting and cleaning catch basins is not dependent on land use or road size.	• Do catch basins on arterial streets require more frequent cleaning vs. non-arterial streets?
		• Can land use or road size/type be used to set an optimal frequency for inspection and cleaning of catch basins?
		• Does the land use surrounding a catch basin influence the rate of sediment accumulation in catch basins?
		• Can catch basin maintenance frequency be determined by land use surrounding the catch basin?
15	Catch basins do not contribute sufficient fecal coliform bacteria to exceed water quality standards	• Are catch basins a significant source of fecal coliform or other pollutants?
		• What frequency of catch basin maintenance is needed to reduce the level of fecal coliform to meet Total Maximum Daily Load (TMDL) requirements?

Notes:

1 Rank assigned by the SWG.

2.1 IS THE FREQUENCY OF INSPECTING AND CLEANING CATCH BASINS DEPENDENT ON LAND USE OR ROAD SIZE?

Storm drain and catch basin cleanouts have been used to control storm water pollution for many years; however, relatively few studies have been conducted to statistically determine if they have an impact on water quality (CWP 2008). Existing studies indicate that catch basins can reduce pollutants by five to 25 percent depending on the conditions of the catch basin, how frequently it is maintained and cleaned, and the type of pollutant (CWP 2008).

Regular maintenance and cleaning of the catch basins is critical to their effectiveness. Aronson et al. (1993) found that, at a minimum, catch basins should be cleaned once or twice a year. A separate study found that annual cleaning removed 54 pounds of sediment, semi-annual and quarterly cleaning removed 70 pounds of sediment, and monthly cleaning removed 160 pounds of sediment (Mineart and Singh 1994a). However, there are many factors affecting sediment accumulation rates and this frequency of cleaning may not be warranted or financially feasible for many municipalities.

The subsections below summarize the publications within the effectiveness study literature database that related to the Operations and Maintenance Ranked List of Effectiveness Topics and Potential Questions approved by the Stormwater Work Group. These summaries are meant to assist local stormwater management program staff in gaining a better understanding of the topic of catch basins and their maintenance requirements. In general, cleaning and maintaining catch basins have an impact on their effectiveness at removing sediment, and the

frequency of needing to inspect and clean catch basins is dependent on the surrounding land use, road size, and amount of road use.

2.1.1 Question: Do catch basins on arterial streets require more frequent cleaning vs. non-arterial streets?

The articles within the literature database did not specifically look at arterial versus non-arterial streets in relation to sediment accumulation within catch basins. One study completed by the Wisconsin Department of Natural Resources (WI DNR 1983) found that heavily traveled commercial streets had sediment accumulation rate that were two to three times greater than that seen on high density residential streets. This would seem to indicate that more heavily traveled roads such as commercial arterial streets would see a higher sediment accumulation rate than non-arterial streets. A better question may be to look at average annual daily traffic (AADT) to see if there is a correspondence between those values and the frequency of catch basin cleaning required.

2.1.2 Question: Can land use or road size/type be used to set an optimal frequency for inspection and cleaning catch basins?

While studies indicate that both land use and road type affect sediment accumulation rates within catch basins, there are many other factors that need to be considered as well. Other factors include weather, topography, particle size, erodability of soils, whether or not the streets have curbs (CWP 2006a) and if the street is deemed a “snow route”. In addition, the size of the catch basin sump has a significant effect on how frequently the catch basin needs to be maintained and cleaned. Pitt and Bissonnett (1984) determined catch basins should be cleaned once the sump reaches 40-50 percent of its capacity. Once they reach this point their ability to trap sediment drops significantly and they may start releasing trapped sediment back into the flow of stormwater (Pitt and Bissonnett 1984). Volume V of the Stormwater Management Manual for western Washington states catch basins should be cleaned or maintained when sediment, trash, or debris in the sump exceeds 60 percent of its capacity (Ecology 2012c).

With this many factors affecting the ability of the catch basin to trap sediment, it seems that an optimal frequency for inspection and cleaning catch basins cannot be determined based on land use or road size/type alone.

2.1.3 Question: Does the land use surrounding a catch basin influence the rate of sediment accumulation in catch basins?

Within the literature database there were several articles that referenced other studies, which determined that different land uses result in significantly different sediment accumulations rates and different catch basin clean out frequencies. Lager et al. (1977) and the Center for Watershed Protection (CWP) (2006a) state that adjacent land use is one of several factors that can affect the accumulation rate of sediment and associated pollutants and, as a result, affect how often a catch basin should be cleaned out.

Several CWP articles looked at differences between industrial, commercial, and residential roadways. One found that commercial/industrial land use areas accumulate sediment at a rate that is 4 times greater than residential land use areas (CWP 2008). A separate article found that heavily traveled commercial streets had accumulation rates that were two to three times greater

than streets in high density residential areas and streets in industrial areas tend to accumulate pollutants faster than commercial or residential areas (CWP 2006a).

2.1.4 Question: Can catch basin maintenance frequency be determined by land use surrounding the catch basin?

As is discussed in Section 2.1.3, surrounding land use does seem to affect the rate of sediment accumulation, and therefore the likely frequency of cleanouts, in catch basins. Pitt and Bissonnett (1984) suggest semiannual cleanouts in residential street while Mineart and Singh (1994b) suggest monthly cleanouts for industrial streets. However, as outlined in Section 2.1.2 there are many factors beyond land use that affect the sediment accumulation rates in catch basins. These factors include sump size, weather, topography, particle size, erodability of soils, whether or not the streets have curbs (CWP 2006a) and if the street is a “snow route”. Surrounding land use can be one, but shouldn’t be the sole, factor in determining catch basin maintenance frequency.

2.2 DO CATCH BASINS CONTRIBUTE SUFFICIENT FECAL COLIFORM BACTERIA TO EXCEED WATER QUALITY STANDARDS?

Indicator bacteria for freshwater environments, as defined by the USEPA, consist of Escherichia coliform bacteria (E. coli) and Enterococci bacteria. These bacteria are indicators of the potential for total coliform and fecal coliform (in addition to E. coli and Enterococci) contamination. There are no fecal coliform water quality standards for stormwater, however, the USEPA set the criteria for bacteria in recreational waters at the following levels (USEPA 1986):

- Enterococci: geometric mean of 33 colony forming units (cfu) per 100 milliliters (mL) in fresh water, 35 cfu per 100 mL in marine water.
- E. coli: geometric mean of 126 cfu per 100 mL in fresh water (no E. coli criterion for marine water)

Washington State Department of Ecology (Ecology) has additional state standards for fecal coliform organisms for fresh and marine waters, as presented in Table 2.

Table 2. Washington State Water Contact Recreation Bacteria Criteria in Fresh and Marine Waters

Category	Bacteria Indicator
Extraordinary Primary Contact Recreation	***Freshwater:*** Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten samples points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL. ***Marine:*** No criterion.
Primary Contact Recreation	***Freshwater:*** Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten samples points exist) obtained for calculating the geometric mean value exceeding 200 colonies/100 mL. ***Marine:*** Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten samples points exist) obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

Category	Bacteria Indicator
Secondary Contact Recreation	***Freshwater:*** Fecal coliform organism levels must not exceed a geometric mean value of 200 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten samples points exist) obtained for calculating the geometric mean value exceeding 400 colonies/100 mL. ***Marine:*** Fecal coliform organism levels must not exceed a geometric mean value of 70 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten samples points exist) obtained for calculating the geometric mean value exceeding 208 colonies/100 mL.

Source: Ecology 2012a

Based on the National Water Quality Inventory conducted in 2000 by the USEPA, 13 percent of the river and stream miles that were surveyed were impaired by indicator bacteria (Hathaway et al. 2009). In addition, according to the International Stormwater BMP Database (2010) as of 2010 bacteria and pathogens were the biggest cause of stream impairments within the United States, with over 10,000 stretches of streams identified as being impaired. This is typically a result of high concentrations of indicator bacteria in these stream segments.

There are few peer-reviewed articles that detail the efficacy of BMPs at removing or inactivating bacteria, and the majority of conventional stormwater BMPs do not appear to be effective at reducing fecal indicator bacteria (Hathaway et al. 2009). However, BMPs should provide some reduction in fecal concentrations if they are designed to maximize exposure of stormwater to sunlight, provide a habitat for microbes that prey on bacteria, or provide filtration (BMP database 2010). Conversely, some BMPs may actually contribute to bacteria levels by inadvertently providing habitat, nutrients, and conditions conducive to the regrowth and replication of fecal coliform and indicator bacteria (Wildey 2006 and BMP database 2010).

As described in Section 2.1, the subsections below summarize the publications within the effectiveness study literature database that related to the Operations and Maintenance Ranked List of Effectiveness Topics and Potential Questions approved by the Stormwater Work Group. These summaries are meant to assist local stormwater management program staff in gaining a better understanding of the topic of catch basins and their potential for contributing bacteria to stormwater runoff. In general, there are limited studies on catch basins and their ability to increase or decrease levels of bacteria in stormwater.

2.2.1 Question: Are catch basins a significant source of fecal coliform or other pollutants?

In Santa Monica Bay, a study noted that high levels of bacterial indicators were found near storm drain outlets (Haile et al. 1999). In 2003, a report by the Washington State Department of Health determined that the northern area of Dyes Inlet, near Silverdale, WA, was contaminated by bacterial pollution from Clear Creek and stormwater runoff from many of the shoreline outfalls (WSDOH 2003).

In a separate study on Clear Creek in 2005, it was found that the creek had a dry weather geometric mean of 896 most probable number (MPN)/100 mL (Fohn undated). No illicit sewer connections were discovered, and it was surmised that there were two possible sources for the contamination. The first source states the possibility of bacteria binding to fine sediment

particles in the stormwater system (Serdar 1993). The International BMP Database Summary of Fecal Indicator Bacteria (2010) also suggests that bacteria may bind to and survive longer in sediment than in the water column. As a result, sediments that settle out in catch basins could lead to increased downstream bacteria levels if the sediment is mobilized or transported to receiving waters during storm events. (BMP database 2010 and Serdar 1993)

The second, and likely more benign, possible source for the high levels of bacteria within Clear Creek, as surmised by Fohn (undated), is the condition within the catch basins and vaults. The moist sediments, slow moving water, and lack of ultraviolet (UV) light may allow for the growth of biofilm and the regrowth and replication of the bacteria (Fohn undated). Skinner et al. (2010) outlined studies completed by the city of Newport Beach, California, and the Orange County (California) Health Care Agency Water Quality Laboratory that found that biofilm in street gutters and storm drains may provide ideal conditions for the regrowth of bacteria. The biofilm provides nutrients and water, protection from microbial predators and UV light and moist conditions (Skinner et al. 2010). One such study measured bacteria levels in hose water that was introduced to a dry street gutter. The hose water was tested for fecal coliform and Enterococci at 10 meters, 45 meters, and 100 meters downstream of the start of flow. The study found that there was an increase in both bacteria with the increased distance of flow, reaching a level of 14,000 fecal coliform/100 mL and 26,000 Enterococci/100 mL at the 100 meter testing site (Skinner et al. 2010). They suspected the source of the high levels of bacteria to be from the biofilm within the street gutters. Testing of the biofilm itself confirmed this suspicion as they identified up to 9 million Enterococci and 6 million fecal coliform per 110 grams of biofilm (Skinner et al. 2010).

However, human enteric viruses, which are the primary concern with high fecal coliform levels in recreational waters, do not multiply in these biofilms found in gutters and storm drains (Skinner et al. 2010). Therefore, the bacteria that grow on these biofilm are not pathogenetic and do not carry the same human health concerns as fecal coliform from human sources. In fact the high bacteria levels associated with these biofilms may cause an overestimation of potential health issues.

In summary, the studies available indicate that catch basins are likely not a significant source of fecal coliform, but they do have the ability to transport bacteria bound to sediments that have settled out in the catch basin sump. They may be a source of bacteria that replicates and regrows on biofilm within the catch basin sump, however, this bacteria is not pathogenetic and not believed to be a human health concern.

2.2.2 Question: What frequency of catch basin maintenance is needed to reduce the level of fecal coliform to meet TMDL requirements?

A TMDL is a calculation of the maximum amount of a pollutant that can be discharged to a body of water while ensuring the water body still safely meets the water quality standards. They serve as a way to improve the health of our local water bodies by setting a goal of how much a certain pollutant needs to be reduced to meet water quality standards and providing implementation plans on how to reach that goal. Table 3 presents water bodies within western Washington, organized by Water Resource Inventory Area (WRIA) and county that have a TMDL for fecal coliform.

Table 3. Fecal coliform TMDLs for western Washington, listed by County and WRIA.

WRIA	Counties	Water body Name
01 – Nooksak	Whatcom	Johnson Creek Lake Whatcom[1] Nooksack River Whatcom Creek[1]
03 – Lower Skagit-Samish	Skagit	Samish Watershed Skagit Basin
05 – Stillaguamish	Snohomish	Stillaguamish River
07 – Snohomish	Snohomish	Snohomish River & Tributaries Allen Creek Quilceda Creek French Creek Woods Creek Pilchuck River Marshlands (Wood Creek) Snoqualmie River Basin
	King	Snoqualmie River Basin
08 – Cedar-Sammamish	Snohomish	Bear-Evans Creek Basin Little Bear Creek & Tributaries Trout Stream Great Dane Creek Cutthroat Creek North Creek Swamp Creek
	King	Bear-Evans Creek Basin Issaquah Creek Basin Little Bear Creek North Creek Pipers Creek Swamp Creek
09 – Duwamish Green	King	Fauntleroy Creek Soos Creek[1]
10 – Puyallup White	Pierce	Clarks Creek Meeker Creek Puyallup River Watershed South Prairie Creek
11 – Nisqually	Pierce	Nisqually Watershed Tributaries Lynch Creek Ohop Creek Red Salmon Creek Unnamed Tributary to Red Salmon Creek Wash Creek
	Thurston	Nisqually Watershed Tributaries McAllister Creek Little McAllister Creek Medicine Creek mouth
13 – Deschutes	Thurston	Budd Inlet[1] Capitol Lake[1] Deschutes River[1] Henderson Inlet Watershed
14 – Kennedy-Goldsborough	Mason	Oakland Bay and Hammersley Inlet Totten/Eld Inlets Tributaries
	Thurston	Totten/Eld Inlets Tributaries

WRIA	Counties	Water body Name
15 – Kitsap	Kitsap	Liberty Bay Tributaries
16 – Skokomish Dosewallips	Mason	Skokomish River and Tributaries Purdy Creek Weaver Creek Ten Acre Creek Hunter Creek
	Jefferson	Skokomish River
18 – Elwha-Dungeness	Clallam	Dungeness Bay Matriotti Creek Dungeness River and Tributaries Meadowbrook Creek Golden Sands Cooper Creek Dungeness River RM 1.0 Irrigation Ditch 1 Irrigation Ditch 2
22 – Lower Chehalis	Grays Harbor	Grays Harbor Wildcat Creek
23 – Upper Chehalis	Grays Harbor	Black River
	Lewis Creek	Upper Chehalis River and Tributaries Dillenbaugh Lincoln Creek Newaukum River Salzer Creek Scatter Creek Skookumchuck
24 – Willapa	Pacific	Willapa River Unnamed Creek (Central St. drain @ Coast Seafoods) Riverdale Creek Wilson Creek Falls Creek Fern Creek
27 – Lewis	Lewis	Lewis River, East Fork[1]
	Skamania	Lewis River, East Fork[1]
28 – Salmon-Washougal	Clark	Gibbons Creek Lacamas Creek[1] Salmon Creek

Notes:
[1]The fecal coliform TMDLs for these water bodies are under development
Source: Ecology 2012b

As outlined above, catch basins may be lead to increased fecal coliform levels downstream if sediment bound bacteria that have settled in the sump are mobilized or transported during storm events. To reduce the effects of the sediment bound bacteria catch basins should be maintained and cleaned once the sump reaches 40-50 percent of its capacity. After this point the ability of the catch basin to trap sediment drops significantly, and may start releasing trapped sediment, and therefore bacteria, back into the flow of stormwater (Pitt and Bissonette 1984). There are many factors that affect how quickly the catch basin sump may reach this capacity, including size of the sump, adjacent land use, weather, topography, particle size, erodability of soils, and whether or not the streets have curbs (CWP 2006a). An accurate determination of how quickly a catch basin sump will reach 40-50 percent of its capacity, and

therefore how frequently they should be maintained, requires periodic site visits to measure accumulated sediments.

Catch basins may also be a source of fecal coliform from the replication and detachment of bacteria on biofilm within the storm drains. However, the bacteria that grow on the biofilm in storm drains are not likely to be associated with the human enteric viruses and therefore are not likely to be a human health concern.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Catch basins can be effective at removing sediments and associated sediment bound pollutants from stormwater runoff. This includes fecal coliform and other bacteria that otherwise may impair the downstream lakes, streams and other water bodies. However, without regular maintenance catch basins may also contribute to increased pollutant levels in our receiving waters, particularly bacteria, by allowing trapped sediments to be mobilized during storm events.

How frequently catch basins need to be maintained to minimize their contribution to increased pollutant levels is dependent on several factors. These factors include size of the catch basin sump, surrounding land use, weather, topography, road type, particle size, erodability of soils, and whether or not the streets have curbs (CWP 2006a).

In western Washington, the Washington State Department of Transportation (WSDOT) has design criteria for catch basins as outlined in Table 3.

Table 4. WSDOT catch basin design criteria.

Catch Basin Type	Dimensions (inches)	Minimum Sump Depth (inches)
Type 1[1]	26 x 22	21
Type 1L[2]	32 x 28	18
Type 1P[3]	26 x 22	32
Type 2[4]	48, 65, 60, 72 or 96 (diameter)	24

Notes:
[1] WSDOT Standard Plan B-5.20-01 (2011)
[2] WSDOT Standard Plan B-5.40-01 (2011)
[3] WSDOT Standard Plan B-5.60-01 (2011)
[4] WSDOT Standard Plan B-10.20-10 (2012)

In addition, Volume V of the Stormwater Management Manual for western Washington states catch basins should be cleaned or maintained when sediment, trash, or debris in the sump exceeds “60 percent of the sump depth as measured from the bottom of the basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe” (Ecology 2012c).

Based on a review and summarization of the articles included in the literature database it is recommended that additional studies be completed. These studies should look at the feasibility and effectiveness of various maintenance practices to improve the effectiveness of catch basins at removing sediments and sediment-bound pollutants as well as their effectiveness in reducing fecal coliform levels. A few of these recommendations include:

1. Review maintenance and inspection records to assess sediment accumulation rates. Use the records to develop a maintenance schedule to assess the feasibility of maintaining catch basins before they reach 40 to 50 percent of their capacity. Determine if accumulation rates of catch basins may allow for a more flexible inspection schedule than that required by the NPDES permit.

2. Look into the feasibility of changing the design standards of catch basins to allow for local governments to size of catch basins sumps to accommodate the volume of sediment that enters the system. Pitt et al. (2000) proposed a sizing criterion based on the concentration of sediment in runoff. The catch basin is sized, with a factor of safety, to accommodate the annual sediment load in the catch basin sump.
3. Conduct additional studies to look at various BMPs and their effectiveness at removing indicator bacteria and fecal coliform from urban runoff.
4. Conduct monitoring to determine if newly implemented NPDES permit required catch basin maintenance standards have had an effect on pollutant levels, including sediment, fecal coliform, and other sediment bound pollutants.
5. Conduct additional studies on the presence of biofilm in local catch basins and gutters, their influence on downstream bacteria levels, and their likelihood of causing human health concerns.

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