Overview of Document

This document contains a summary of the data for topics included in Task 2 of the scope, specifically characterizing sources of particulates to stormwater, identifying the influence of particle size distribution (PSD) on stormwater chemistry, identifying the detrimental impacts of different particle sizes to receiving water bodies, and determining BMP effectiveness as a function of PSD. A summary is included for each topic containing the following items:

- **Scope of Work** – reviews the intent and scope of the literature search and data analysis related to the topic.
- **Literature Review** – summarizes the quantity and type of sources of information that were located to assess the related topic. Also indicates which sources were not used for analysis or assessments.
- **Results** – summarizes the findings for the topic, based on the data collected and/or analyzed.

Following the results for each topic, tables and figures are included which present the data identified and analyzed. These tables and figures have been updated and additional tables and figures have been added based on comments received during the last TAC meeting. The intent of this document is to present these tables and figures for review and provide context for the tables and figures during the review. The written content developed in this document will be incorporated into and expanded in the final report.

02 Characterize Sources to Stormwater Data Summary

Scope of Work

Identify how site-specific conditions (e.g., land use, zoning, etc.) could influence particle size distribution. This information will be used to guide the estimation of the pollutant loads and the selection of BMPs. Specifically:

- Review literature to identify what is known about the sources of suspended sediment particles that can become part of stormwater (e.g., atmospheric, windblown, erosion, land use, etc.) including the particle size range and common land uses where these sources are expected.
- Based on the information collected, attempt to characterize PSD using common Washington jurisdictional conditions (identified from interviews during the SSC project and noted in the final SSC report).

Literature Review

Data from approximately 48 studies were compiled to characterize sources of particles in stormwater to particle size. A summary of the data collected in shown in **Table 1** and **Table 2**. An overview of the sources are as follows:

- Sources included: journal articles, TAPE study results, effectiveness study results, Phase I Outfall Monitoring, Phase I BMP Monitoring, International BMP Database, and the Federal Highway Administration Highway Runoff Database.
- Study locations were primarily in Washington state as well as Oregon, Alabama, California, Florida, Massachusetts, North Carolina, Texas, South Korea, Spain, Australia, and France.

Observations

An overview of the data and results are as follows:

- Five different unit types were used to measure data with the two most common units being mg/L and percent PSD. Since the two most common unit types had the most data, only data with these units were included in the study.
- For some sources, the particle size ranges measured did not "line-up" with most of the data as such they were not included in the study.
- The two basin characteristics most reported were basin area (approximately 50% studies) and land use (approximately 95% of studies). For land use data, only the following classifications were reported: commercial, roadway, residential, industrial, and mixed use. As shown in **Table 2**, data reported in mg/L did not include the following land uses: industrial and mixed use.

- While basin area was reported for about half of the data, as shown in **Table 2**, there were only a few basin areas reported: for commercial land use six basin areas were reported from seven studies and for residential land use six basin areas were reported from six studies. Further while about 60% of the data was from roadway land use, most of these studies did not report a basin area. Because of the limited basin area data, all the basin areas were combined for all land uses (as opposed to evaluating the basin area by land use). As shown in **Figure 1** and **Figure 2** even with the data combined, it was not possible to assess whether there was a relationship between basin area and PSD ranges.
- As shown in **Table 1**, the highest concentration of PSD was reported for silt size particles. During TAC Meeting #3, the TAC suggested that the results could be skewed or an artifact of the sampling method due to how samples were collected (using an automated samplers and the size of the tube could limit the size of particles that can be collected.). Additional discussion about this will be included in the final report.
- The TAC suggested that the consultant separate the Washington data from other states to see if we see if there are any differences in the results. This will provide a comparison to assess if there are differences in PSD ranges particularly for silt size particles which are believed to be the highest concentration of particles in Washington State stormwater runoff. As such cumulative distribution curves were generated for each PSD range that include curves for all the data, Washington only data, and other states data. As shown in **Figure 3**, Washington only data and data from other states appear to measure similar concentrations for particle sizes <8, 63-250, and >1000µm. It is worth noting the amount of data in the <8 and >1000 µm ranges was lower than the amount of data found for other ranges. **Figure 3** also indicates that Washington data appears to have higher concentrations of silt sized (8-63 µm) particles and lower concentrations of fine gravel (250-1000 µm) particles.
- Methods for collecting samples are under review. Data from TAPE, Phase I Outfall Monitoring, and Effectiveness studies were collected using composite samplers. The methods used to collect samples for the remaining sources will be updated in the report.

Table 1 Summary of Contributing Basin Characteristics and Particle Size Distribution

Land Use	Units	Sample Size	<8µm Clay			8-63µm Silt			63-250µm Very Fine to Fine Sand			250-1000µm Fine Gravel			>1000µm Medium & Coarse Gravel		
		n	AM[1]	Median	GM[2]	AM[1]	Median	GM[2]	AM[1]	Median	GM[2]	AM[1]	Median	GM[2]	AM[1]	Median	GM[2]
Commercial	%	72	4.63	2.01	2.03	22.73	17.60	17.71	14.18	12.60	10.23	40.75	43.00	38.38	13.04	10.00	10.46
Commercial	mg/L	84	3.70	0.93	1.14	13.54	7.16	1.66	8.71	1.66	0.68	12.33	3.92	3.15	6.93	0.80	0.88
Residential	%	20	4.16	2.62	2.40	36.94	33.35	26.76	19.54	18.60	15.53	18.71	15.60	13.29	9.23	6.00	5.34
Residential	mg/L	61	13.91	6.94	6.44	12.24	2.11	0.43	0.55	0.02	0.03	3.61	2.47	1.38	3.18	1.73	1.06
Roadway	%	246	22.66	16.90	16.59	36.67	29.88	21.75	14.90	13.75	12.06	5.78	4.20	4.81	14.25	10.70	9.00
Roadway	mg/L	132	18.26	9.35	8.92	50.41	21.65	35.04	29.62	0.29	12.51	53.02	4.40	15.89	4.34	2.00	2.83
Industrial	%	2	10.40	10.40	9.93	73.85	73.85	73.60	4.40	4.40	4.38	4.40	4.40	4.37	1.95	1.95	1.95
Industrial	mg/L	0	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3
Mixed Use	%	2	Note 3	Note 3	Note 3	52.65	52.65	49.60	33.15	33.15	31.65	7.95	7.95	7.68	12.00	12.00	Note 3
Mixed Use	mg/L	0	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3	Note 3
Overall	%	371	10.84	5.73	7.74	35.26	28.76	37.88	14.70	13.00	14.77	21.20	14.60	13.71	12.35	10.00	6.69
Overall	mg/L	277	12.69	5.50	5.50	30.96	11.02	12.38	16.05	0.02	4.41	28.38	3.30	6.80	4.38	1.72	1.59

[1] Arithmetic mean, [2] Geometric mean, [3] Insufficient data available to estimate value.

Table 2 Summary of Basin Area Values in Dataset

Land Use	Basin Areas Reported for % Units				Basin Areas Reported for mg/L Units			
	Overall n[2]	Min	Mean/Median	Max	Overall n[2]	Min	Mean/Median	Max
Commercial	32	1.30 n=24	10.01 / 1.30	152.00 n=1	84	0.20 n=11	0.29 / 0.20	0.41 n=19
Roadway	25	0.12 n=2	22.29 / 32.00	32.00 n=17	72	0.06 n=24	13.86 / 0.41	32.00 n=31
Residential	13	0.12 n=1	77.51 / 68.00	239.00 n=2	61	0.61 n=27	4.84 / 8.20	8.20 n=34
Industrial	2	137.00 n=2	137.00 / 137.00	137.00 n=2	0	Note 1	Note 1	Note 1
Mixed Use	2	2.27 n=1	69.09 / 69.09	135.9 n=1	0	Note 1	Note 1	Note 1
Undefined	29	0.41 n=2	0.45 / 0.45	0.45 n=27	0	Note 1	Note 1	Note 1

[1] Insufficient data available to estimate value.

[2] Overall n is equal to the number of data points for each land use and unit type which were associated with a basin area.

Figure 1 All Basin Area vs. PSD %

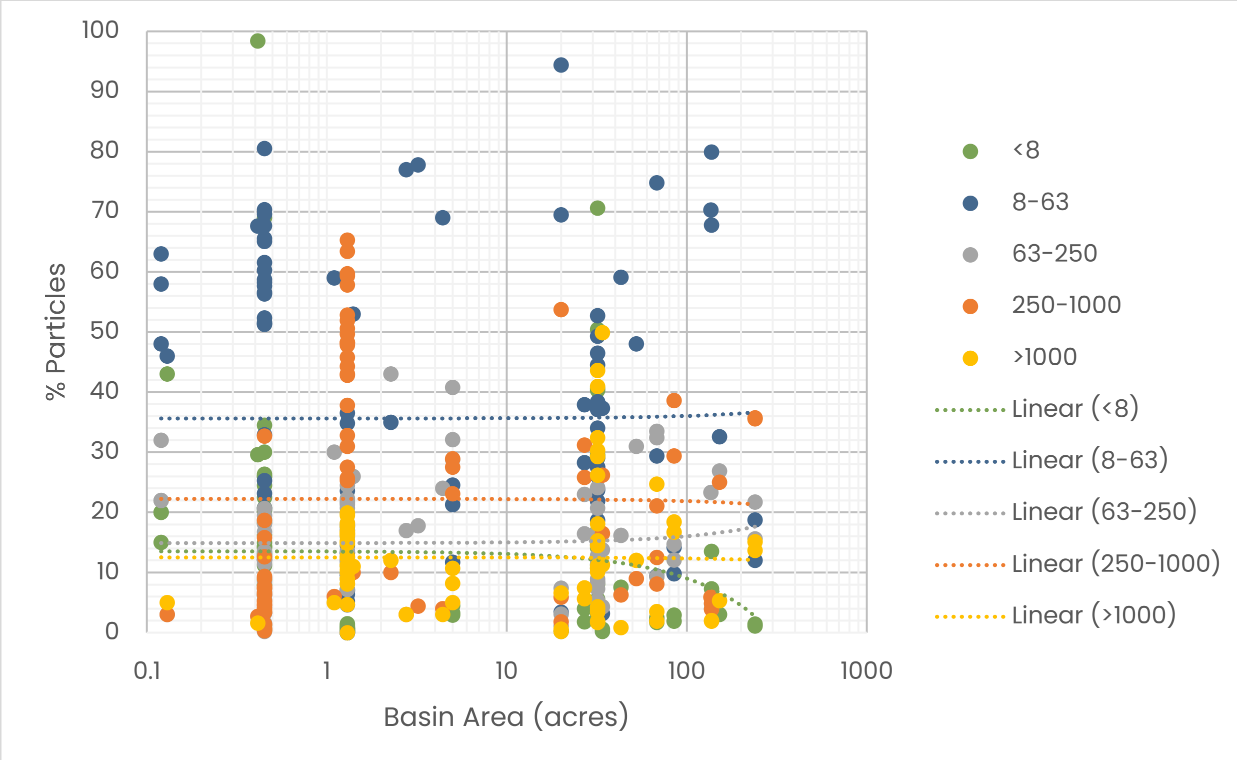


Figure 2 All Basin Area vs PSD (mg/L)

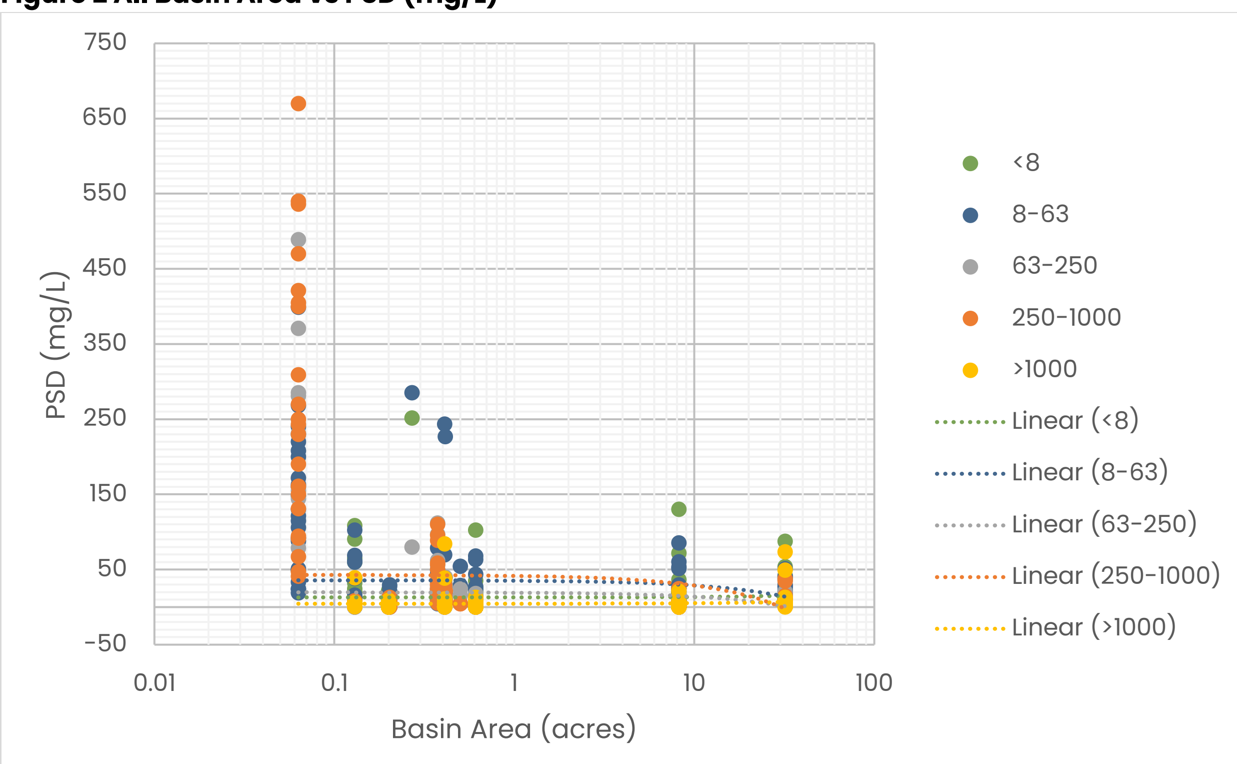
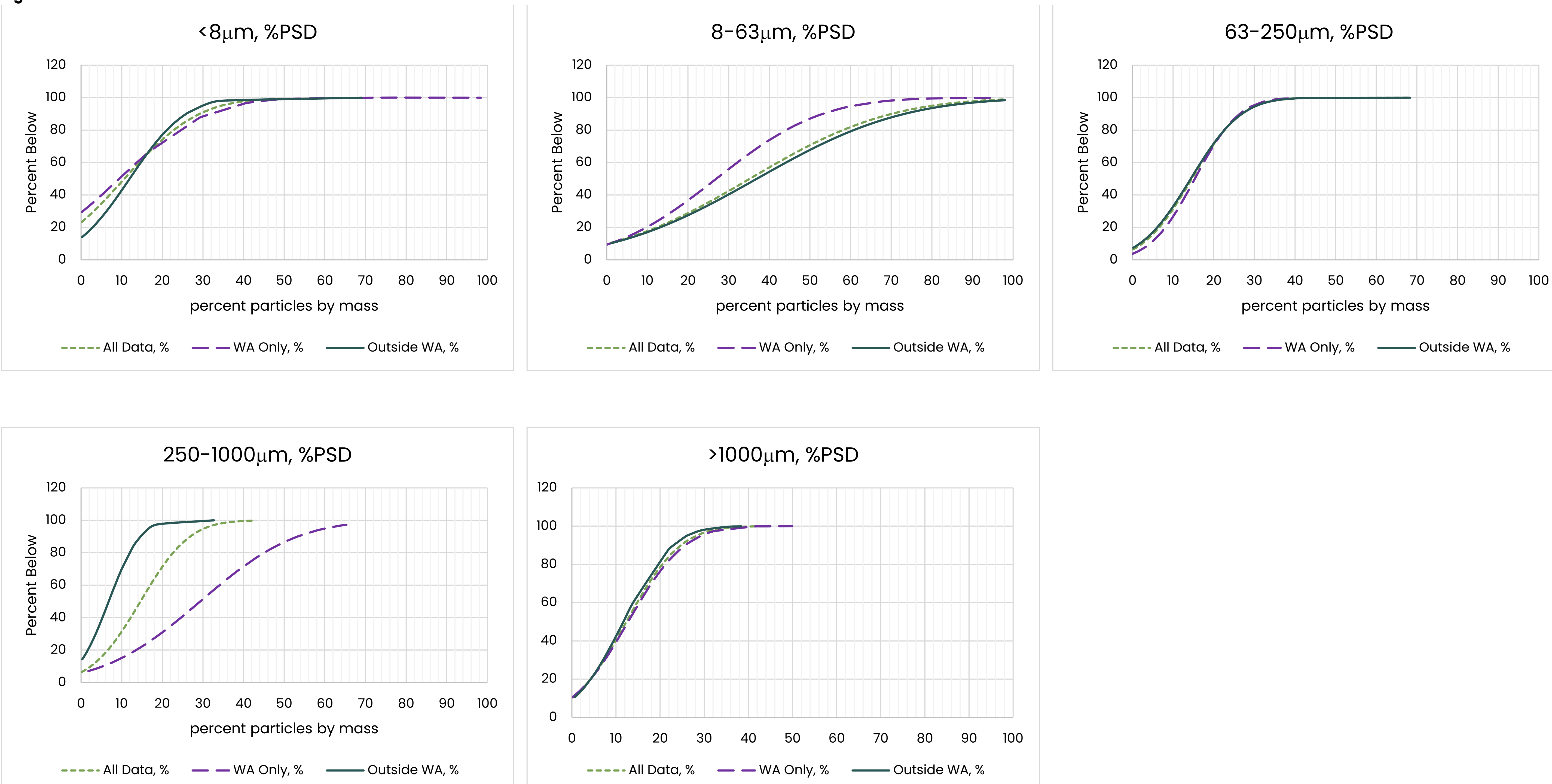


Figure 3 PSD % Cumulative Distribution Curves



03 Influence on Stormwater Chemistry

Scope of Work

Stormwater chemistry will be evaluated as a function of PSD to aid in the estimation of more accurate assessment of pollutant transport. Weighting factors for land-use based loads will be assessed and developed. These load weighting factors could potentially be used in stormwater infrastructure and watershed planning, total daily maximum load (TMDL) studies, or for estimating BMP credits. Specifically:

- Review literature and identify what is known about the influence of PSD on the speciation and mass of regulated stormwater pollutants and pollutants of concern; and identify the treatment mechanism needed to remove the respective pollutants.
- The information collected will be combined with information from characterized sources of particulates to stormwater (Section 02) and the subcontractor will attempt to determine the PSD effects on land-based pollutant loads. Depending on the information and data available, weight factors for different jurisdictional conditions may be developed (using basic statistics or a qualitative ranking system such as high, medium, low) to predict pollutant loading which could be used for selecting an appropriate BMP for a site.
- Deliverables will include discussion and guidance regarding how this information could be used in watershed plans, total daily maximum load (TMDL) studies, and for estimating BMP credits.

Literature Review

Data from 15 studies were compiled to understand the influence of particle size on stormwater chemistry. An overview of the sources are as follows:

- Sources were limited to journal articles and the NURP report. Databases and other reports containing information on stormwater chemistry related to particle size were not identified.
- Study locations included Washington, Alabama, California, Wisconsin, Nevada, Illinois, Massachusetts, Colorado, New Hampshire, New York, Ohio, Canada, the Netherlands, Korea, Sweden, Norway, and China.

Eight of the studies reviewed contained quantitative data in a format that could be used for analysis. The remaining seven studies, while relevant to the topic of particle size and stormwater chemistry, were not included in the compiled data or summary of data for the reasons listed in Error! Reference source not found..

Table 3 Summary of Sources NOT Used in Stormwater Chemistry Analysis

Sources Not Used	Reason
Boogaard, 2014	The percent of pollutants bound to sediment was reported however it was not reported as by particle size.
Cha, 2013	Study reported correlation factors as opposed to amounts of pollutants associated with different particle sizes.
Ferreira, 2013	Graph quality was too coarse to extract pollutant concentration according to particle size.
German, 2002	The results of this study were summarized in Kayhanian, 2012.
Kayhanian & Mckenzie, 2012	The study did not tie the particle sizes measured to pollutants measured in sediment samples collected.
Markiewicz, 2019	The study focuses on particle count of organic pollutants and colloid mixtures for specific particle sizes. The results were not included as they do not include regulated pollutants for Washington State.
EPA, 1983	The TAC also suggested the consultant look at the NURP study to see if it documented any information about PSD related to pollutants which could support that if silt size pollutants were targeted, this could reduce those pollutants bound with the particles. The NURP study was reviewed and no information was found on this topic.

Observations

Despite eight studies being identified, there was insufficient data to perform any statistical correlations or additional analyses to assess the influence of particle size distribution on stormwater chemistry. Error! Reference source not found.**Table 4** and **Table 5** provide a summary of data from the sources that was in a format that could be analyzed. **Table 4** summarizes data related to metals, while **Table 5** summarizes the data related to nutrients. The data is organized to show the average concentration of each parameter attached to different sediment particle sizes, for different land uses. These sources reported metal concentrations related to particle size distribution, and primarily for roadway surfaces. Based on the limited available data, the concentrations of copper, zine, phosphorus, and nitrogen appear to be higher for smaller particle sizes (clay and silt sizes) regardless of land use. This could suggest that targeting removal of smaller solids could reduce higher concentrations of these pollutants. Because of the limited amount of data, more research is needed to evaluate this.

Table 4 Summary of PSD and Metals Stormwater Chemistry

Land Use	Units	Copper						Zinc					
		<8µm Clay	8-63µm Silt	63-125µm Very Fine Sand	125-250µm Fine Sand	>250µm Medium Sand & Larger	Number of Sources	<8µm Clay	8-63µm Silt	63-125µm Very Fine Sand	125-250µm Fine Sand	>250µm Medium Sand & Larger	Number of Sources
Roadway	µg/g	-	720	250	218	508	4	-	1890	963	749	416	4
Residential	µg/g	420	110	162	-	-	1	680	293	460	-	-	1
Commercial	µg/g	220	130	-	-	-	1	1200	750	-	-	-	1
Industrial	µg/g	150	138	288	85	-	2	550	578	496	284	-	2
Roadway	µg/L	9	-	-	-	-	1	27	-	-	-	-	1
Residential	µg/L	-	-	-	-	-	0	-	-	-	-	-	0
Commercial	µg/L	-	-	-	-	-	0	-	-	-	-	-	0
Industrial	µg/L	-	-	-	-	-	0	-	-	-	-	-	0

Table 5 Summary of PSD and Nutrients Stormwater Chemistry

Land Use	Units	Phosphorus						Nitrogen					
		<8µm Clay	8-63µm Silt	63-125µm Very Fine Sand	125-250µm Fine Sand	>250µm Medium Sand & Larger	Number of Sources	<8µm Clay	8-63µm Silt	63-125µm Very Fine Sand	125-250µm Fine Sand	>250µm Medium Sand & Larger	Number of Sources
Roadway	ug/g	-	-	-	-	-	0	-	-	-	-	-	0
Residential	ug/g	710	817	620	-	-	1	3000	1645	1030	-	-	1
Commercial	ug/g	910	950	-	-	-	1	4300	720	-	-	-	1
Industrial	ug/g	-	-	670	-	-	1	-	-	560	-	-	1
Roadway	ug/L	-	-	-	-	-	0	-	-	-	-	-	0
Residential	ug/L	-	-	-	-	-	0	-	-	-	-	-	0
Commercial	ug/L	-	-	-	-	-	0	-	-	-	-	-	0
Industrial	ug/L	-	-	-	-	-	0	-	-	-	-	-	0

04 Impacts to Waterbodies

Scope of Work

Identify detrimental impacts of different particle sizes to receiving water bodies - Identify what is known about the stormwater related impacts on receiving water bodies based on specific ranges of particle sizes. This information will also be used to guide the selection of BMPs based on discharge locations (e.g., infiltration vs. surface water bodies). Specifically:

- Review literature and identify what is known about the stormwater-related impacts of PSD on receiving water bodies for specific range of particle sizes. This information will be used in Task 3 to guide the selection of BMPs based on discharge locations (e.g., infiltration vs. discharge to water bodies).
- Using the information collected assess whether a threshold or categories of impact can be determined for whether/when there is a benefit to receiving waters for targeting removal of different PSD and selecting BMPs based on PSD effectiveness. Using the information available, qualitative categories of impact will be developed that identify species and/or conditions that are more sensitive (e.g., high, medium, low).
- Deliverables will include discussion and guidance regarding how this information could be used to identify receiving water bodies that need to be protected and when to locate BMPs that are more effective for reducing specific PSD ranges upstream of these water bodies.

Literature Review

Data from 5 studies was located that identify detrimental impacts of different particle sizes to receiving water bodies. An overview of the sources are as follows:

- Sources were limited to journal articles. Databases and other reports containing information on impacts to waterbodies related to particle size were not identified.
- Study locations included Louisiana, Canada, and China.

Three of the studies reviewed contained quantitative data that was able to be used for analysis. The remaining two studies, while relevant to the topic of impacts to water bodies, were not included in the compiled data or summary of data for the reasons listed in Error! Reference source not found..

Table 6 Summary of Sources Not Used in Impacts to Waterbodies Analysis

Sources Not Used	Reason
Revitt, 2014	Study reports concentrations in catch basin water and does not report what concentrations make it past the catch basin sump.
Selbig, 2012	Graph quality was too coarse to extract pollutant concentration.

Observations

Insufficient data was collected from the three studies to perform statistical correlations or additional analyses to assess the influence of particle size distribution on stormwater chemistry. **Table 7**, **Table 8**, and

Author	Water Body Type	Basin Area (ac)	Primary Land Use		Clay <8	Silt 8-63	6
Jeng, 2004	Lake	3,187,659	Various; Urban Watershed	Actual Range	0.45-30	>30	
				Amount (mg/L, %, etc.)	95.2%	4.8%	

Table 9 display the summary of data identified in literature sources.

It is worth noting that this item was included in the study because of TAPE requirements to test PSD and to assess if a reason it was included was to protect receiving water bodies from a particular particle size range that was more detrimental. However, based on discussion with staff involved in TAPE, the reason why PSD testing is required is because most particles in Washington State are believed to be silt size. Thus, the reason PSD testing is conducted as part of TAPE is to better understand the BMP performance related to particle size rather than how they affect the receiving waters.

Table 7 Quantitative PSD Data Retrieved from Literature

Author	Water Body Type	Basin Area (ac)	Primary Land Use		PSD					
					Clay	Silt	Fine Sand	Coarse Sand	Fine Gravel	
					<8	8-63	63-125	125-250	250-1000	Units
Ma, 2018	NA; sewer pipe sediment	12.4	Residential	Actual Range	<20	20-63	63-125	125-250	>250	um
				Amount (mg/L, %, etc.)	72%	20%	6%	2%	1%	%

Table 8 Quantitative PSD and Chemistry Data Retrieved from Literature

Author	Water Body Type	Basin Area (ac)	Primary Land Use		Fecal Coliform						E. Coli					
					Clay	Silt	Fine Sand	Coarse Sand	Fine Gravel		Clay	Silt	Fine Sand	Coarse Sand	Fine Gravel	
					<8	8-63	63-125	125-250	250-1000	Units	<8	8-63	63-125	125-250	250-1000	Units
Jeng, 2004	Lake	3,187,659	Various; Urban Watershed	Actual Range	0.45-30	>30	-	-	-	um	0.45-30	>30	-	-	-	um
				Amount (mg/L, %, etc.)	95.2%	4.8%	-	-	-	%	96.8%	3.2%	-	-	-	%

Table 9 Quantitative Data Retrieved from Literature, without PSD Data

Author	Water Body Type	Basin Area (ac)	Primary Land Use	Pollutant Concentration or Loading		
				Copper	Zinc	Units
Hall, 1999	River	17,792	Various; Urban Watershed	164	557	mg/kg

05 Determine BMP Effectiveness as a Function of PSD

Scope of Work

For structural, operational, and source control BMPs, we will report on BMP effectiveness based on the range of particle sizes and considerations for maintenance. This information will be used to identify BMPs that are more effective at removing specific ranges of particles. Specifically: Identify the specific types of BMPs that will be included in this study which will be confirmed at the first TAC meeting. This is expected to include structural, maintenance, and source control types BMPs.

- For each BMP identified, we will develop a permit-related definition that includes the physical characteristics, treatment mechanisms, and stormwater related function. For BMPs included in the SSC Project, we will use that definition.
- Collect and synthesize BMP effectiveness data for a range of particle sizes. This will include developing tables that summarize BMP effectiveness as a function of PSD, sources, and discharge locations. This is expected to include consolidating the data/information in the table using basic statistics.

Literature Search

Data from approximately 41 sources were compiled to characterize sources of particles in stormwater to particle size. An overview of the sources are as follows:

- Sources included: journal articles, TAPE study results, effectiveness study results, Phase I BMP Monitoring, and the International BMP Database.
- Study locations were primarily in Washington state as well as Oregon, Alabama, Texas, and New Zealand.

Observations

The remaining tables and figures summarize f the effectiveness of each BMP to remove particle sizes followed by the sources used for the assessment. **Table 10** lists the BMPs for which data was located and provides a definition of the BMP along with treatment mechanism and approved stormwater functions. **Table 11**, **Table 12**, D2.3 Data Summary Tables

Table 15, and **Table 17** summarize the number of sources per BMP, number of data points per BMP, average influent and average effluent concentrations, and effectiveness for removing different particle sizes for different unit types. **Table 18** and Error! Reference source not found. and **Figure 5** provide an overall summary of particle removal by BMP. **Table 13**, **Table 14**, and **Table 16** display the minimum and maximum influent and effluent concentrations for each BMP. **Figure 6** through **Figure 15** are box plots which display the influent and effluent concentration ranges as well as median concentrations per BMP and particle size range. Lastly, **Table 19** summarizes the sources that were reviewed to collect the data included in this section.

The BMPs with the highest overall removal of particles in any size range appear to be the proprietary StormGarden Biofilter System and Kraken, as shown in **Table 18**. Non-proprietary BMPs with greater than 50% removal for clay and silt sized particles included bioinfiltration swales and ponds. bioretention, and wet vaults. BMPs with greater than 50% removal for any PSD range are highlighted in gray in **Table 18**. It is worth noting this results on based on only one two studies.

Table 10 Definitions of BMPs Analyzed

BMP Name	Source for Definition	Definition	Treatment Mechanisms	Stormwater Related Functions
Biofiltration Swale	WSDOT HRM	Vegetation-lined channels designed to remove suspended solids using filtration as stormwater travels in shallow concentrated flow through the swale.	Filtration, Biological uptake, Sorption, Ion Exchange	Treatment: Basic
Bioinfiltration Swale	Phase 1 Monitoring Tacoma	Grass-lined swales that remove stormwater pollutants by percolation into the ground (HRM)	Filtration, Infiltration, Biological uptake, Sorption, Ion Exchange	Treatment: Basic, Enhanced, Oil Control
Bioinfiltration Pond	Phase 1 Monitoring Tacoma	Grass-lined shallow ponds that remove stormwater pollutants through percolation into the ground. Designed to contain runoff treatment below the first 6" of pond depth then overflow into higher permeability infiltration BMP (HRM).	Infiltration, Biological uptake, Sorption, Ion Exchange	Flow Control Treatment: Basic, Enhanced, Oil Control
Bioretention	SWMMWW	Bioretention areas are shallow landscaped depressions, with a designed soil mix (the bioretention soil mix) and plants adapted to the local climate and soil moisture conditions that infiltrate stormwater.	Infiltration, Filtration, Adsorption, Biological Action	Flow Control Treatment: Basic, Enhanced, Oil Control

BMP Name	Source for Definition	Definition	Treatment Mechanisms	Stormwater Related Functions
Dry detention basin	Charters, 2015	This type of detention basin does not have a permanent pool and the accumulated runoff usually is discharged up to 72 hours after collection (Ferreira and Strenstrom, 2013). Also described as open basins that provide live storage to enable the reduction of stormwater runoff flow rates and matching of pre-developed flow durations discharge (HRM).	Sedimentation, Infiltration	Flow Control
Extended Detention Basin	Karamalegoes, 2005	Open basins (detention pond) that provide live storage to enable the reduction of stormwater runoff flow rates and matching of pre-developed flow durations. (HRM)	Sedimentation, Infiltration	Flow Control
Filterra	TAPE GULD Document	Filterra is an engineered biofiltration device with components similar to bioretention in pollutant removal and application, but that provides treatment of high volume/flows.	Proprietary product; not specified	Treatment: Basic, Enhanced, Phosphorus. Oil Control
High Rate Media Filtration	International BMP Database	Manufactured devices with high rate filtration media consisting of a variety of inert and sorptive media types and configurations.	Not Specified	Varies

BMP Name	Source for Definition	Definition	Treatment Mechanisms	Stormwater Related Functions
Jellyfish	Contech - TAPE	The Jellyfish Filter is a stormwater quality treatment technology that provides high flow pretreatment and membrane filtration in a single unit. (Contech)	Proprietary product; not specified	Treatment: Basic, Phosphorus
Media Filter Drain	WSDOT HRM	Linear flow-through stormwater runoff treatment device along highway side slopes and medians. The four components include: a gravel no-vegetation zone, a grass strip, a media filter drain (MFD) mix bed, and conveyance system for flows leaving the MFD mix. The conveyance system typically consists of a gravel-filled underdrain trench.	Infiltration, Ion exchange, Carbonate precipitation, and Biofiltration	Treatment: Basic, Enhanced, Phosphorus
MWS-Linear Modular Wetland	TAPE GULD Document	A biofiltration system that uses horizontal flow to provide treatment in a small footprint.	Proprietary product; not specified	Treatment: Basic, Enhanced, Phosphorus
Oil/Grit Separator	International BMP Database	Manufactured devices including oil/water separators and baffle chambers designed for removing floatables and coarse solids.	Gravitational settling, Trapping	Oil Control

BMP Name	Source for Definition	Definition	Treatment Mechanisms	Stormwater Related Functions
Porous Pavement - Modular Blocks	International BMP Database	Full-depth pervious concrete, porous asphalt, paving stone or bricks, reinforced turf rings, and other permeable surface designed to replace traditional pavement.	Sedimentation, Infiltration, Filtration, Adsorption, Biodegradation	Flow Control
Sand Filter	SWMMWW	A basic sand filter basin is constructed so that its surface is at grade and open to the elements. Instead of infiltrating to native soils, stormwater filters through a constructed sand bed with an underdrain system.	Filtration	Treatment: Basic
Wet Vault	Phase 1 Monitoring Tacoma	A wet vault is an underground structure similar in appearance to a detention vault, except that a wet vault has a permanent pool of water (wetpool) which dissipates energy and improves the settling of particulate pollutants. Being underground, the wet vault lacks the biological pollutant removal mechanisms, such as algae uptake, present in surface wetponds. (Tacoma Stormwater Manual)	Sedimentation	Flow Control

BMP Name	Source for Definition	Definition	Treatment Mechanisms	Stormwater Related Functions
StormGarden Biofilter System	TAPE GULD Document	StormGarden is a micro-bioretention system engineered for high flow treatment and pollutant removal. Stormgarden has a "Runoff Reduction Infiltration Panel" that allows some runoff to infiltrate into the ground.	Proprietary product; not specified	TSS - Basic Phosphorus Treatment
The BioPod BioFilter	TAPE GULD Document	Biopod uses biofiltration design for filtration, sorption, and biological uptake. It uses a high-flow media. It comes in a single-piece unit composed of precast concrete.	Proprietary product; not specified	Treatment: Basic, Enhanced, Phosphorus
The Kraken	TAPE GULD Document	The Kraken Filter utilizes pretreatment and membrane filtration in vault and manhole configurations. The device uses reusable filter inserts which require low maintenance.	Proprietary product; not specified	Treatment: Basic, Phosphorus

Table 11 BMP Effectiveness Summary; Average Influent and Effluent Concentrations, mg/L

BMP	Units	Sources	Average Influent						Average Effluent						% Removal				
			Data Points	<3.9	3.9-62.5	62.5-250	250-500	>500	Data Points	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9 µm	3.9-62.5 µm	62.5-250 µm	250-500 µm	>500 µm
Bioinfiltration Swale	mg/L	1	27	12.5	10.9	0.7	3.9	3.3	20	6.2	0.1	0.0	2.5	1.9	51%	100%	97%	37%	41%
Biofiltration Swale		0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Bioretention	mg/L	1	1	19.5	14.4	0.1	2.2	2.1	1	5.0	1.2	ND	1.8	1.6	74%	92%	-	15%	22%
Dry detention basin	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Extended Detention Basin	mg/L	2	1	ND	20.5	ND	27.6	10.1	1	ND	8.2	ND	18.3	8.3	-	60%	-	34%	18%
Bioinfiltration Pond	mg/L	1	34	15.0	13.3	0.4	3.4	3.1	35	3.7	0.5	0.02	2.1	1.6	75%	96%	96%	37%	49%
Wet Vault	mg/L	1	30	7.4	13.7	0.02	6.2	6.9	46	3.6	1.2	0.05	3.0	3.0	52%	92%	0%	51%	56%
Sand Filter	mg/L	1	4	ND	75.2	23.6	10.3	ND	4	ND	92.1	9.9	2.9	ND	-	-22%	58%	72%	-
Bioretention Plus Jellyfish (proprietary)	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
High Rate Media Filtration	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Porous Pavement - Modular Blocks	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Oil/Grit Separator	mg/L	3	1	4.4	2.3	0.01	4.9	3.9	1	2.8	1.2	0.13	2.4	2.3	36%	46%	0%	51%	41%
MWS-Linear Modular Wetland	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Porous Pavement - Modular Blocks	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Filterra	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
The BioPod BioFilter	mg/L	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Media Filter Drain	mg/L	1	48	10.4	16.4	1.6	2.7	2.1	0	ND	ND	ND	ND	ND	-	-	-	-	-
StormGarden Biofilter System	mg/L	1	17	9.1	15.7	4.0	4.0	3.0	17	1.5	1.8	0.9	0.7	0.4	83%	89%	77%	83%	85%
The Kraken	mg/L	1	14	21.5	22.7	7.9	10.4	12.6	14	3.0	2.8	0.9	0.8	0.3	86%	88%	88%	93%	97%

Table 12 BMP Effectiveness Summary, Average Influent and Effluent Concentrations, %

BMP	Units	Sources	Average Influent						Average Effluent						% Removal				
			Data Points	<3.9	3.9-62.5	62.5-250	250-500	>500	Data Points	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9 µm	3.9-62.5 µm	62.5-250 µm	250-500 µm	>500 µm
Bioinfiltration Swale	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Biofiltration Swale		1	1	43.0	46.0	3.0	3.0	5.0	1	71.0	12.0	0.0	10.0	7.0	-65%	74%	100%	-233%	-40%
Bioretention	%	1	1	98.4	0.0	0.0	0.0	1.6	8	79.0	6.6	0.8	1.6	13.9	20%	-	-	-	-771%
Dry detention basin	%	1	1	9.0	12.0	52.0	27.0	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Extended Detention Basin	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Bioinfiltration Pond	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Wet Vault	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Sand Filter	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
Bioretention Plus Jellyfish (proprietary)	%	1	0	ND	ND	ND	ND	ND	1	99.9	0.1	ND	ND	ND	-	-	-	-	-
High Rate Media Filtration	%	1	1	0.6	32.5	20.3	ND	10.0	1	0.5	5.4	2.0	ND	0.0	11%	83%	90%	-	100%
Porous Pavement - Modular Blocks	%	1	0	ND	ND	ND	ND	ND	1	85.7	14.3	ND	ND	ND	-	-	-	-	-
Oil/Grit Separator	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
MWS-Linear Modular Wetland	%	1	27	30.0	61.6	10.0	6.4	ND	27	23.2	41.3	7.5	4.2	ND	23%	33%	25%	35%	-
Porous Pavement - Modular Blocks	%	1	0	ND	ND	ND	ND	ND	1	85.7	14.3	ND	ND	ND	-	-	-	-	-
Filterra	%	1	4	4.1	10.7	4.9	5.6	ND	4	4.8	0.0	0.2	2.2	ND	-17%	100%	96%	61%	-
The BioPod BioFilter	%	1	17	23.2	32.4	12.4	ND	17.5	17	39.8	34.8	9.7	ND	6.6	-72%	-8%	22%	-	62%
Media Filter Drain	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
StormGarden Biofilter System	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-
The Kraken	%	0	0	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	-	-	-	-	-

Table 13 BMP Influent and Effluent Summary Statistics, %

			Minimum Influent					Minimum Effluent					Maximum Influent					Maximum Effluent				
BMP	Units	Sources	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500
Bioinfiltration Swale	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Biofiltration Swale	%	1	98.4	ND	ND	ND	1.6	ND	ND	ND	ND	ND	98.4	ND	ND	ND	1.6	100	46.3	6.67	5	93.8
Bioretention	%	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dry detention basin	%	1	98.4	ND	ND	ND	1.6	ND	ND	ND	ND	ND	98.4	ND	ND	ND	1.6	100	46.3	6.67	5	93.8
Extended Detention Basin	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bioinfiltration Pond	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Wet Vault	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sand Filter	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bioretention Plus Jellyfish (proprietary)	%	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
High Rate Media Filtration	%	1	ND	ND	ND	ND	ND	99.9	0.1	ND	ND	ND	ND	ND	ND	ND	ND	99.9	0.1	ND	ND	ND
Porous Pavement - Modular Blocks	%	1	0.6	32.5	20.3	ND	10.0	0.49	5.4	2.04	ND	ND	0.55	32.5	20.3	ND	10	0.49	5.4	2.04	ND	ND
Oil/Grit Separator	%	0	ND	ND	ND	ND	ND	85.7	14.3	ND	ND	ND	ND	ND	ND	ND	ND	85.7	14.3	ND	ND	ND
MWS-Linear Modular Wetland	%	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Porous Pavement - Modular Blocks	%	1	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	171.01	201.59	20.66	32.7	ND	85.4	70.29	22.4	23.7	ND
Filterra	%	1	ND	ND	ND	ND	ND	85.7	14.3	ND	ND	ND	ND	ND	ND	ND	ND	85.7	14.3	ND	ND	ND
The BioPod BioFilter	%	1	2.4	ND	ND	2.0	ND	1.32	ND	ND	ND	ND	5.96	25.07	15.04	11.21	ND	7.44	ND	0.51	8.47	ND
Media Filter Drain	%	0	2.5	12.3	4.3	ND	1.7	12.95	ND	ND	ND	ND	70.6	52.7	24.1	ND	43.6	100	77.5	38.5	ND	28.5
StormGarden Biofilter System	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
The Kraken	%	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 14 BMP Influent and Effluent Summary Statistics, mg/L

			Minimum Influent					Minimum Effluent					Maximum Influent					Maximum Effluent				
BMP	Units	Sources	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500
Bioinfiltration Swale	mg/L	ND	0.0	ND	0.0	0.0	ND	0.01	ND	0.01	0.01	102.39	67.97	18.01	12.29	12.83	34.49	0.82	0.02	8.92	6.27	ND
Biofiltration Swale	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bioretention	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dry detention basin	mg/L	0	19.5	14.4	0.1	2.2	2.1	4.98	1.21	ND	1.82	1.64	19.5	14.4	0.11	2.15	2.09	4.98	1.21	ND	1.82	1.64
Extended Detention Basin	mg/L	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bioinfiltration Pond	mg/L	1	ND	20.5	ND	27.6	10.1	ND	8.2	ND	18.3	8.3	ND	20.5	ND	27.6	10.1	ND	8.2	ND	18.3	8.3
Wet Vault	mg/L	1	ND	0.0	ND	0.0	0.0	ND	0.01	ND	0.01	0.01	130.0	85.2	9.4	24.3	21.0	31.2	15.57	0.02	11.4	6.59
Sand Filter	mg/L	1	1.5	0.0	0.0	0.0	0.0	0.02	0.01	0.02	0.01	0.01	34.9	243.6	0.05	37.4	84.3	12.6	24.7	1.25	9.12	9.36
Bioretention Plus Jellyfish (proprietary)	mg/L	0	ND	17.6	10.5	4.8	ND	ND	13.6	4.79	1.6	ND	ND	226.7	40.0	21.5	ND	ND	286.8	16.7	4.4	ND
High Rate Media Filtration	mg/L	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Porous Pavement - Modular Blocks	mg/L	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil/Grit Separator	mg/L	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWS-Linear Modular Wetland	mg/L	0	4.4	2.3	0.0	4.9	3.9	2.84	1.22	0.13	2.37	2.32	4.44	2.25	0.01	4.86	3.9	2.84	1.22	0.13	2.37	2.32
Porous Pavement - Modular Blocks	mg/L	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Filterra	mg/L	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
The BioPod BioFilter	mg/L	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Media Filter Drain	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
StormGarden Biofilter System	mg/L	1	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	41.3	90.1	63.5	10.3	7.5	ND	ND	ND	ND	ND
The Kraken	mg/L	1	1.2	1.1	0.5	0.5	0.2	ND	ND	ND	ND	ND	41.4	39.7	17.5	15	8.5	3.5	5.9	3.5	2.5	3.5

Table 15 BMP Effectiveness Summary, mg/L Finer

			Average Influent						Average Effluent						% Removal				
BMP	Units	Sources	Data Points	<3.9	3.9-62.5	62.5-250	250-500	>500	Data Points	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500
High Rate Media Filtration	mg/L Finer	3	1	ND	209.2	287.3	275.5	547.5	1	ND	29.2	34.6	24.2	25.9	-	86%	88%	91%	95%

Table 16 Influent and Effluent Summary Statistics, mg/L Finer

			Minimum Influent					Minimum Effluent					Maximum Influent					Maximum Effluent				
BMP	Units	Sources	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500	<3.9	3.9-62.5	62.5-250	250-500	>500
High Rate Media Filtration	mg/L Finer	3	ND	209.2	287.3	275.5	547.5	ND	29.2	34.6	24.2	25.9	ND	209.2	287.3	275.5	547.5	ND	29.2	34.6	24.2	25.9

Table 17 BMP Effectiveness Summary, Street Sweeping

			% Removal				
BMP	Units	Sources	<3.9	3.9-62.5	62.5-250	250-500	>500
Mechanical Street Sweeper	%	2	-	56.5	52.9	44.4	61
Vacuum Street Sweeper	%	2	-	65.0	69.9	85.9	87.7
Regenerative Air Street Sweeper	%	3	-133	-73.5	41.8	80.0	79.0

Table 18 Effectiveness Summary by BMP and Particle Size

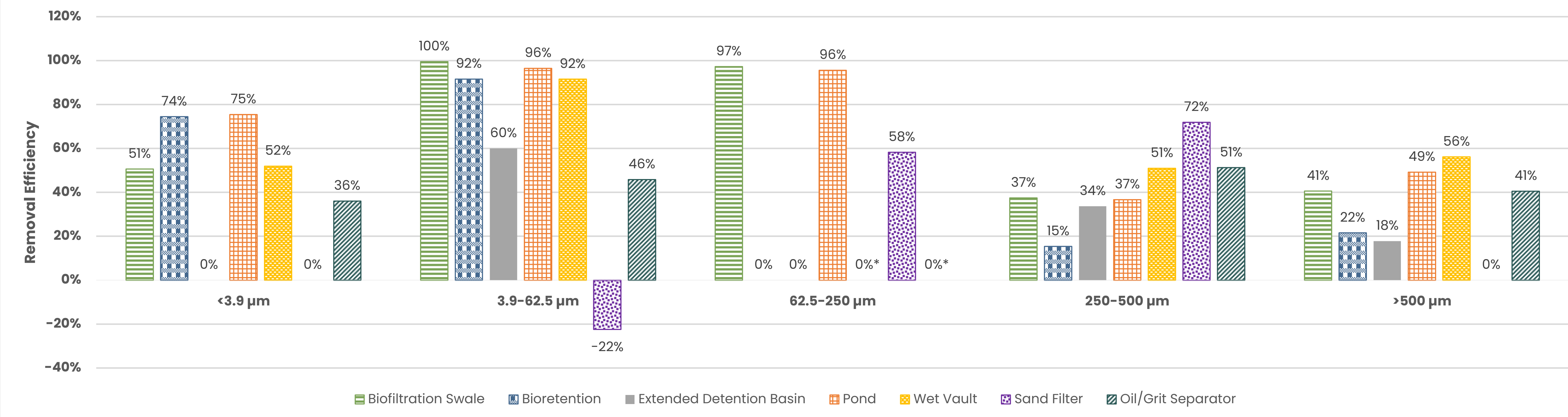
BMP	Units	Sources	Data Points	% Removal[1]				
				<3.9 µm	3.9-62.5 µm	62.5-250 µm	250-500 µm	>500 µm
Biofiltration Swale	%	1	1	-65%	74%	100%	-233%	-40%
Bioinfiltration Swale	mg/L	1	27	51%	100%	97%	37%	41%
Bioinfiltration Pond	mg/L	1	34	75%	96%	96%	37%	49%
Vegetated filter strip	mg/L	0	0	-	-	-	-	-
Bioretention	mg/L	1	1	74%	92%	-	15%	22%
Bioretention Plus Jellyfish (proprietary)	mg/L	0	0	-	-	-	-	-
Dry detention basin	mg/L	0	0	-	-	-	-	-
Extended Detention Basin	mg/L	2	1	-	60%	-	34%	18%
Filterra	%	1	4	-17%	100%	95%	61%	-
High Rate Media Filtration	%	1	1	11%	83%	90%	-	100%
Media Filter Drain[2]	mg/L	1	48	-	-	-	-	-
Oil/Grit Separator	mg/L	3	1	36%	46%	0%[3]	51%	41%
Porous Pavement - Modular Blocks	mg/L	0	0	-	-	-	-	-
Porous Pavement - Modular Blocks	mg/L	0	0	-	-	-	-	-
Sand Filter	mg/L	1	4	-	-22%	58%	72%	-
Wet Vault	mg/L	1	30	52%	92%	0%[3]	51%	56%
MWS-Linear Modular Wetland	%	1	27	23%	33%	25%	35%	-
The BioPod BioFilter	%	1	17	-72%	-8%	22%	-	62%
StormGarden Biofilter System	mg/L	1	17	83%	89%	77%	83%	85%
The Kraken	mg/L	1	14	86%	88%	88%	93%	97%

[1] Text is color-coded according to ranges of values. Black text includes values less than zero up to 50%. Blue text includes values between 50-75%. Red text includes values greater than 75%.

[2] Only influent data was available for the BMP.

[3] Removal efficiency was estimated from very low values for influent and effluent (<0.2%). As such, removal efficiency is approximated to be 0% for the associated particle size range.

Figure 4 Percent Removal by BMP and Particle Size



*Removal efficiency was estimated from very low values for influent and effluent (<0.2%). As such, removal efficiency is approximated to be 0% for the associated particle size range.

Figure 5 Percent Removal by Proprietary BMP and Particle Size

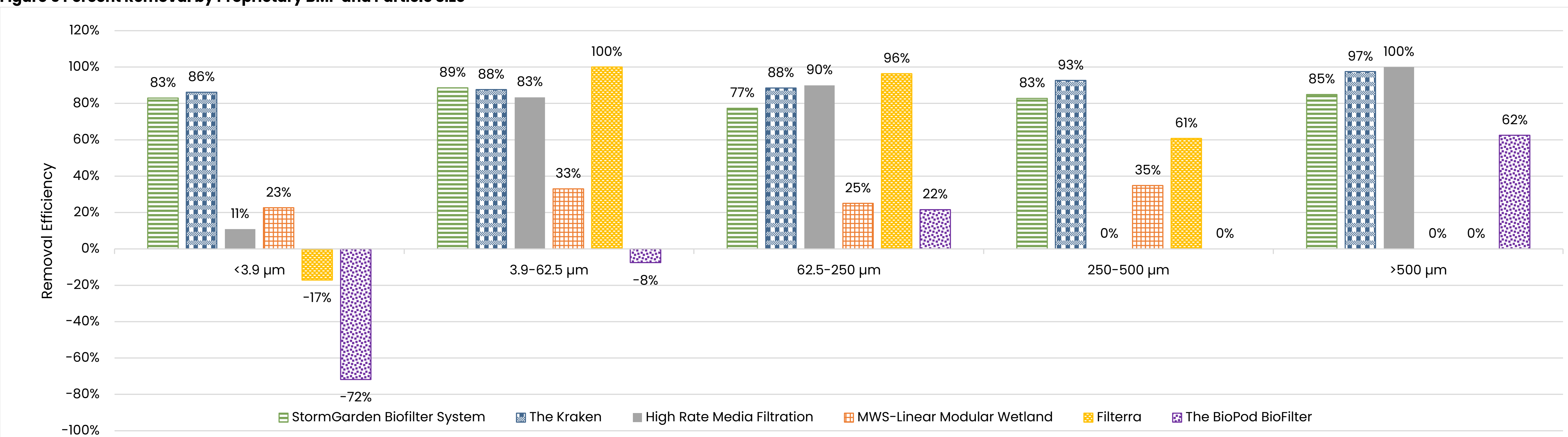


Figure 6 Influent and Effluent Concentrations by BMP, <3.9µm Particle Size

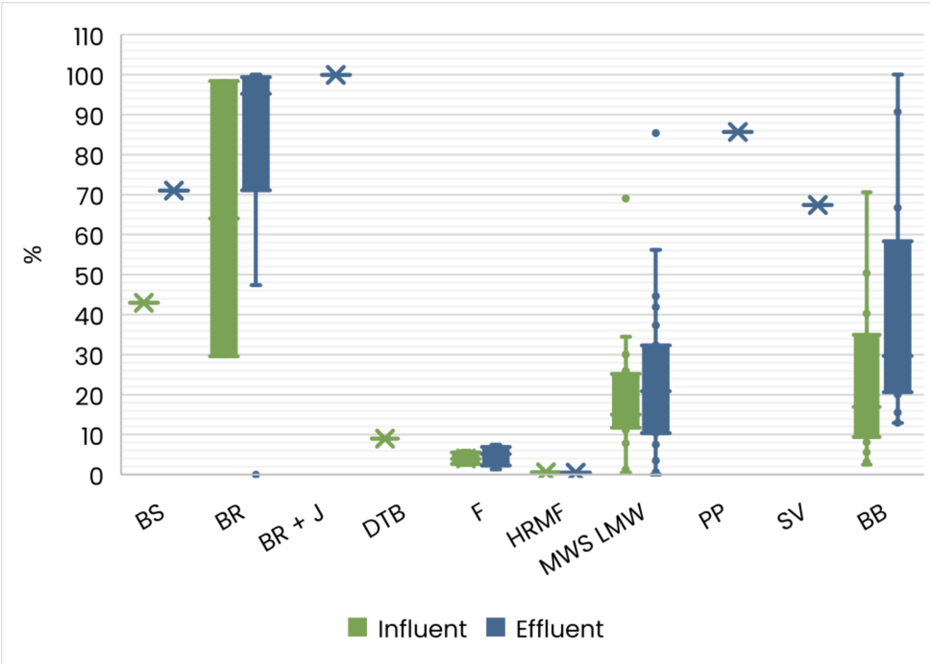


Figure 8 Influent and Effluent Concentrations by BMP, 3.9-62.5µm Particle Size

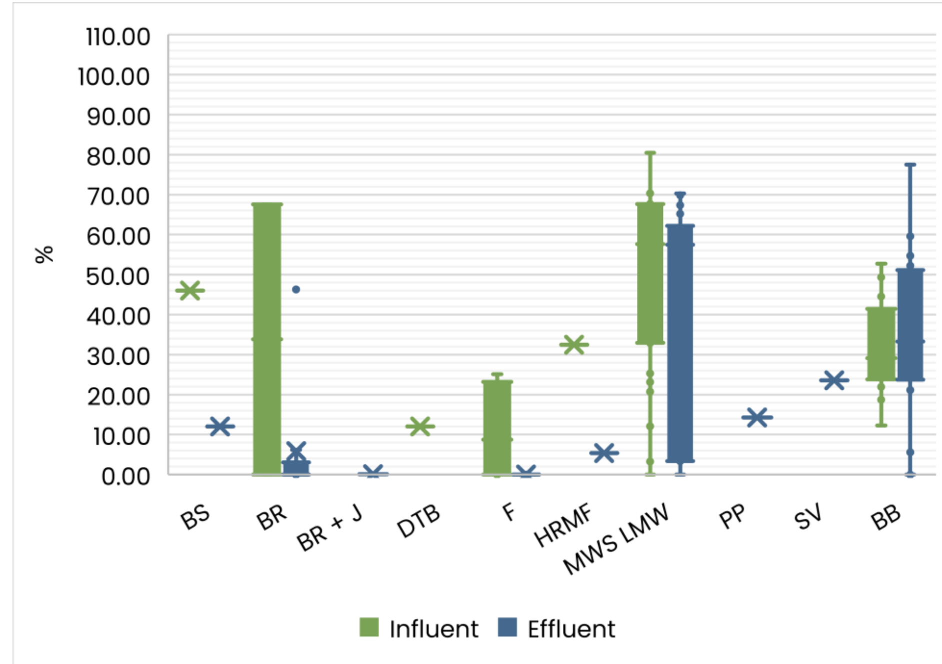


Figure 10 Influent and Effluent Concentrations by BMP, 62.5-250µm Particle Size

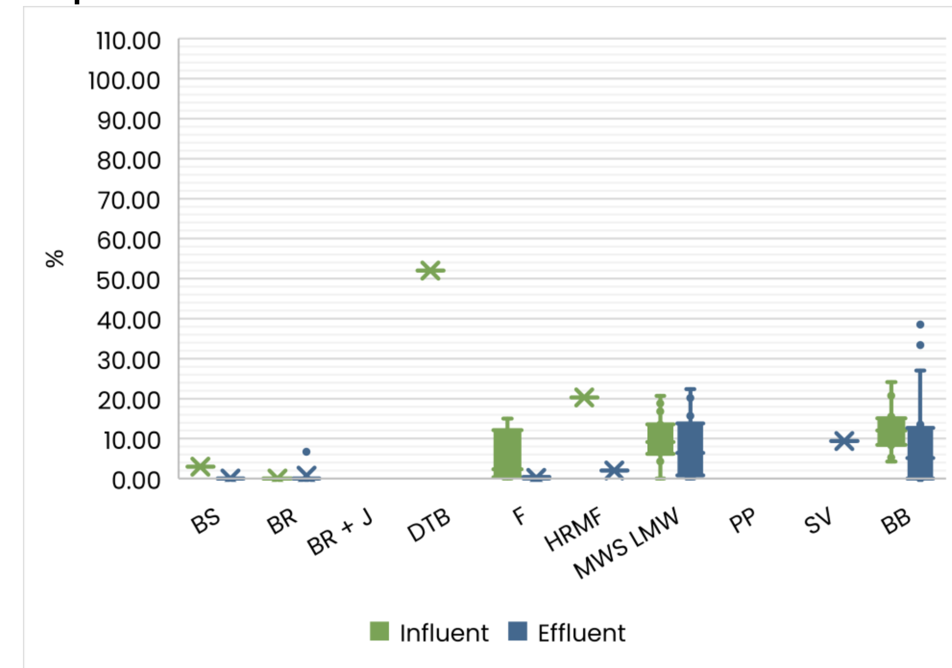


Figure 7 Influent and Effluent Concentrations by BMP, 250-500µm Particle Size

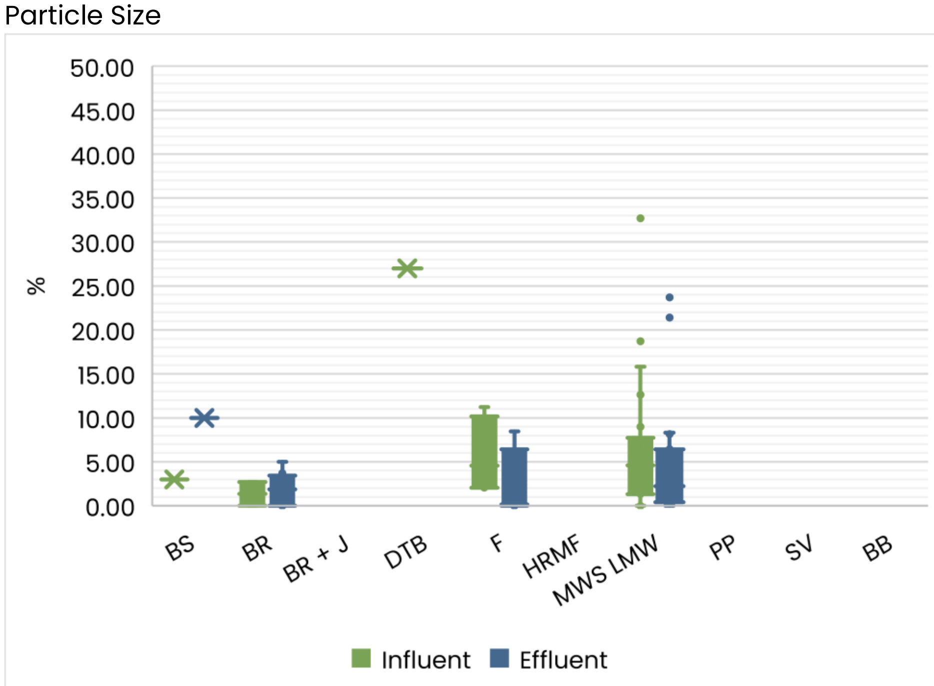


Figure 9 Influent and Effluent Concentration by BMP, >500µm Particle Size

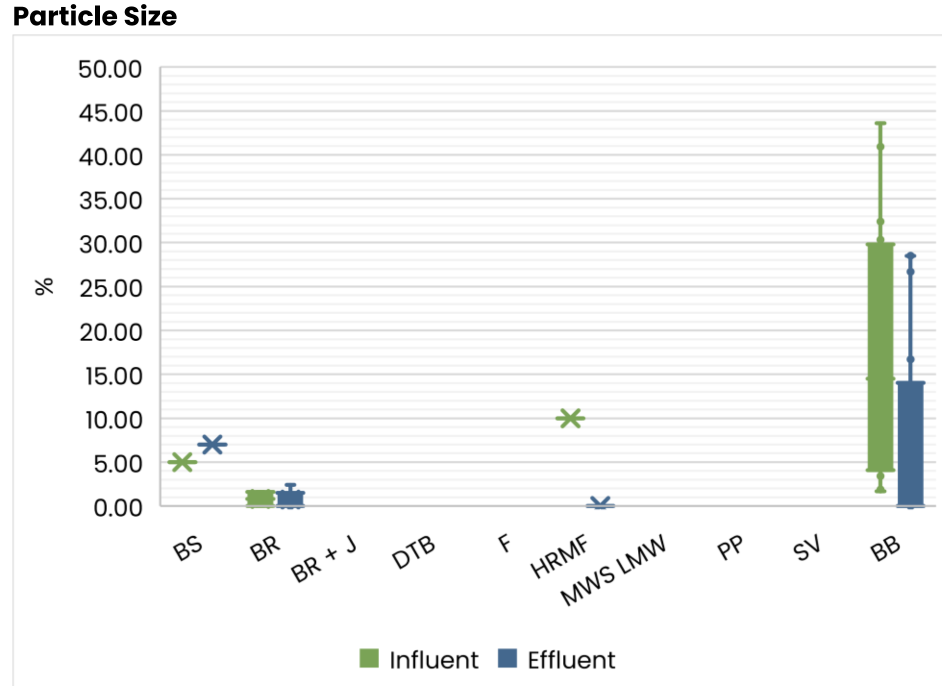


Figure 11 Influent and Effluent Concentration by BMP, <3.9µm Particle Size

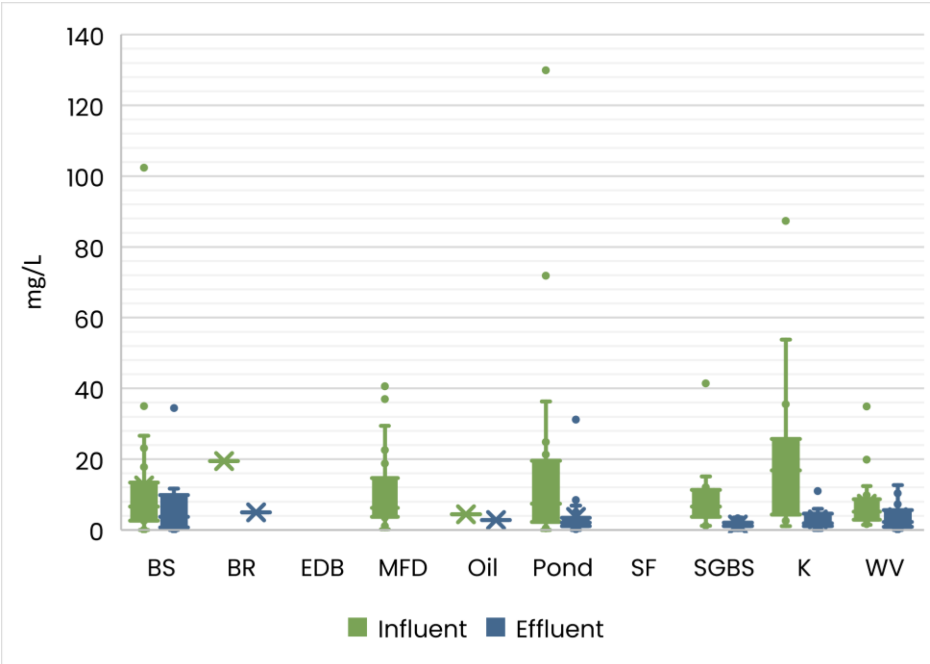


Figure 12 Influent and Effluent Concentration by BMP, 250-500µm Particle Size

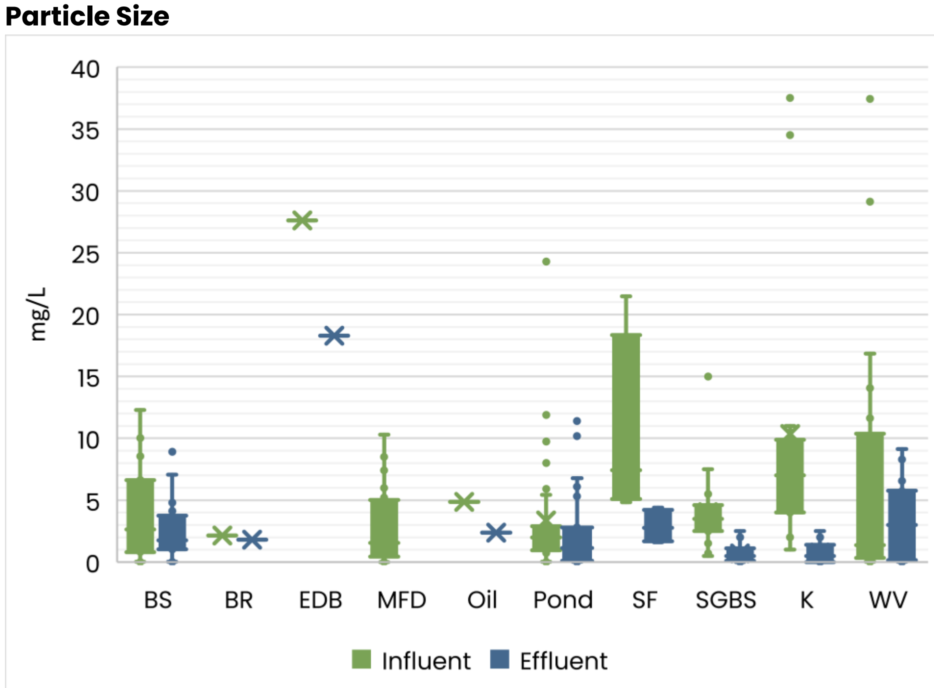


Figure 13 Influent and Effluent Concentration by BMP, 3.9-62.5µm Particle Size

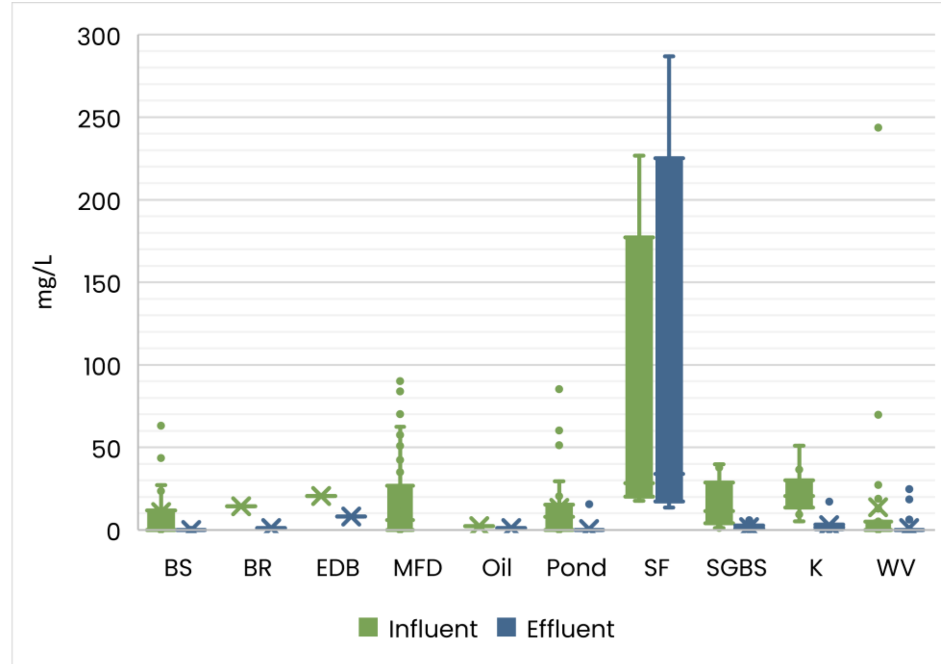


Figure 14 Influent and Effluent Concentration by BMP, >500µm Particle Size

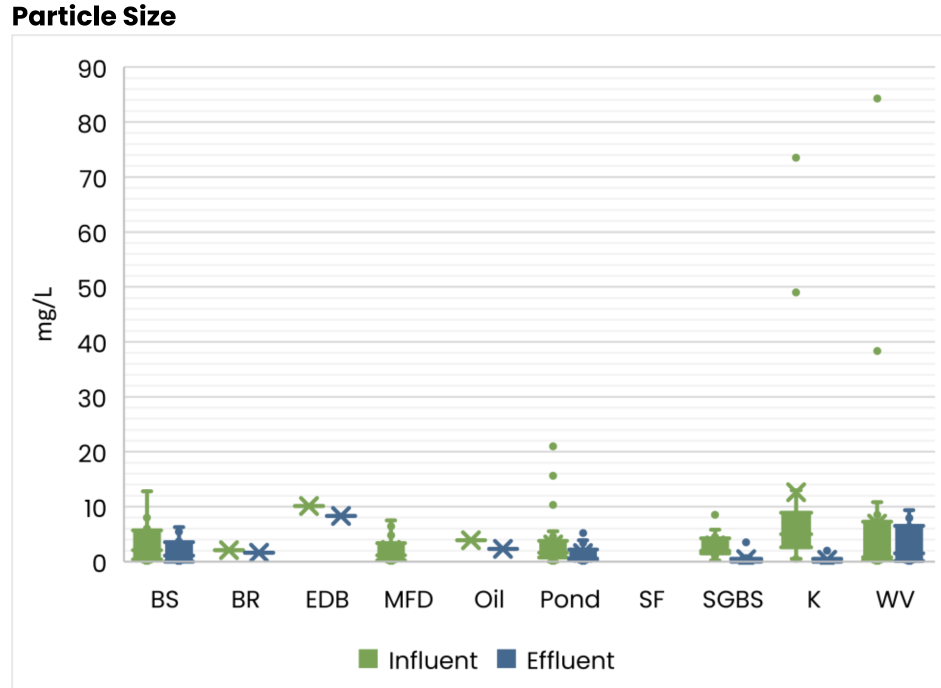


Figure 15 Influent and Effluent Concentration by BMP, 62.5-250µm Particle Size

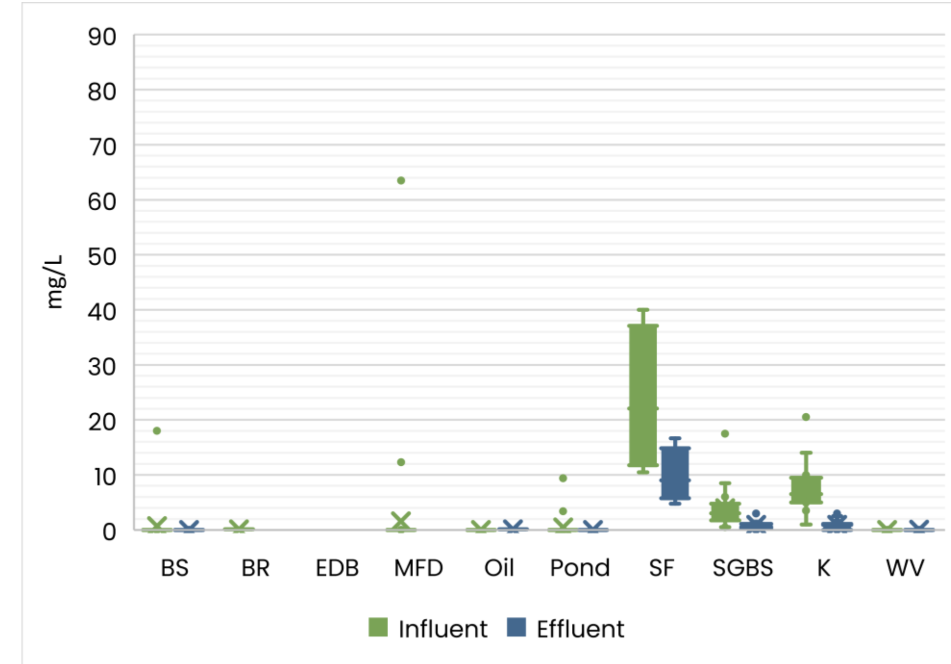


Table 19 Inventory of BMP Data Reviewed

Source	Identifier	Source Type	BMP Type	Solids Parameter	Effluent Data	PSD info included	Particle Range	Comments
TAPE	GULD22 Database	Database	Compost Amended Biofiltration Swale; Standard Biofiltration Swale	PSD	Yes	Yes	Coarse Sand (>500 um), Medium Sand (250-500 um), Fine Sand (125-250 um), Very fine Sand (62.5-125 um), Silt (3.9-62.5 um), Clay (1.0-3.9 um), Colloid (<1 um)	
TAPE	GULD23 Database	Database	Media Filter Drain	PSD	No	Yes	>500 um, 250-500 um, 125-250 um, 62.5-125 um, 3.9-62.5 um, 1.0-3.9 um, <1 um	
TAPE	GULD02 Database	Database	Media Filter Drain	TSS	NO	No	-	No Particle size distribution
TAPE	GULD03 Database	Database	Media Filter Drain	TSS	Yes	No	-	No Particle size distribution
TAPE	GULD05 Database	Database	Media Filter	PSD, concentration	Yes	Yes	>1,>5,>16,>32,>74,>420	
TAPE	GULD06 Database	Database	Media Filter	PSD, % finer	Yes	YES	<3.9, 3.9-62.5, 62.5-250, >250	
TAPE	GULD07 Database	Database	Media Filter	TSS, concentration	Yes	No	-	No Particle size distribution
TAPE	GULD14 Database	Database	Media Filter	TSS, concentration	Yes	No	-	No Particle size distribution
TAPE	GULD17 Database	Database	Media Filter	SSC, concentration	Yes	No	-	No Particle size distribution
TAPE	GULD18 Database	Database	Media Filter	TSS, % finer	Yes	YES	<4, <63, <125, <500	
TAPE	GULD19 Database	Database	Canister Filter	TSS, %	Yes	YES	<2, 2-4, 4-8, 8-16, 16-31, 31-63, 63-128	Has some odd data (percentage over 100%)
TAPE	GULD24 Database	Database	Hydrodynamic Separator	SSC, concentration	Yes	No	-	No Particle size distribution
TAPE	GULD26 Database	Database	Swale	TSS, concentration	Yes	No	-	No Particle size distribution
TAPE	GULD29 Database	Database	Media Filter	TSS, %	Yes	YES	1-2, 2-5, 5-15, 15-25, 25-50, 50-100, >100	
TAPE	GULD30 Database	Database	Hydrodynamic Separator	TSS, concentration	Yes	No	-	No Particle size distribution
TAPE	GULD31 Database	Database	Media Filter	PSD, concentration	Yes	YES	<62.5, <100, <250, <500	
TAPE	GULD32 Database	Database	Media Filter	PSD, concentration	Yes	YES	1-3.9, 3.9-62.5, 62.5-125, 125-500, >500	

Source	Identifier	Source Type	BMP Type	Solids Parameter	Effluent Data	PSD info included	Particle Range	Comments
TAPE	GULD36 Database	Database	Media Filter	TSS, concentration	Yes	YES	1-3.9, 3.9-62.5, 62.5-125, 125-500, >501	
Phase 1 Monitoring Reports	Attachment C- Seattle 2012	Database	Mesocosm Treatment	PSD	Yes	Yes	>500, 500-250, 250-125, 125-62.5, 62.5-3.9, 3.9-1, <1	
Phase 1 Monitoring Reports	King County 2012 BMP effective	Database	Sand Filter, Detention Basin					
Phase 1 Monitoring Reports	King County 2010 BMP effective	Database	Sand Filter	TSS, PSD (mean + median)	No	No	-	No Particle size distribution
Phase 1 Monitoring Reports	Attatchment C- Seattle 2011	Database	Mesocosm Treatment	PSD	Yes	No	>500, 500-250, 250-125, 125-62.5, 62.5-3.9, 3.9-1, <2	Not enough new information; see Seattle, 2012
Phase 1 Monitoring Reports	BMP Evaluation - Tacoma 2015	Database	Biofiltration, wet vaults	TSS	Yes	Yes	<1, 1-3.9, 3.9-62.5, 62.5-125, 125-250, 250-500, >500	
Literature Search	Carbone, 2014	Literature	Sand-Zelbrite Filter Media	TSS	No	No	-	In graph form, No Table
Literature Search	Charters, 2015	Literature	Hydrodynamic separator, dry detention pond, pond and wetland	TSS	No	Yes	<2 ,2-63, 63-2000, >2000 ; <8, 8-20, 20-100, >100; <70, 70 - 150, 150-250 , 250-425, >425	
Literature Search	Deletic, 1999	Literature	Grass Filter Strip	SS	No	No	-	In old graph.
Literature Search	German, 2002	Literature	Street Sweeping	% Finer	No	No	<2mm, <.25 mm	No useful PSD
Literature Search	Gharabaghim, 2006	Literature	Vegetative Filter Strips	Sediment Load	No	No	.5-2.9, 2.9-6.4, 6.4-12, 12-39, 39-68, 68-151	Ranges too varied from standard.
Literature Search	Karamalegos, 2005	Literature	Vegetated filter strips, detention basin	SSC (mg/L); % Total Mass	No	Yes		
Literature Search	Li, 2007	Literature	Constructed wetland	-	No	No	-	No tables with particle size distribution
Literature Search	Marsalek, 1997	Literature	Pond	None	No	No	-	No TSS or SSC reported.

D2.3 Data Summary Tables

Source	Identifier	Source Type	BMP Type	Solids Parameter	Effluent Data	PSD info included	Particle Range	Comments
Literature Search	Nara, 2005	Literature	Swales	D10, D50, D90	No	No	-	Data has D10, D50, D90 but no particle size ranges
Literature Search	NAS, 2006	Literature	Various	TSS	No	No	-	No Particle size distribution
Literature Search	Stagge, 2012	Literature	Swales	TSS	No	No	-	No Particle size distribution
Literature Search	Vietz, 2014	Literature	Various	TSS	No	No	-	No Particle size distribution
International BMP Database	InternationalBMPDatabase_FilteredtoPSD	Database	Various	Various	Various	Yes	Various	Includes large dataset
Literature Search	SF TER	Study	Sand Filter	TSS, concentration	Yes	Yes	<62.5, 62.5-250, >250	
Literature Search	GU TER	Study	Bioretention	TSS, concentration	Yes	Yes	<62.5, 62.5-250, >250	
Literature Search	Breault, Smith, and Sorenson, 2003-04	Study	Street Sweeping	PSD	No	Yes	> 2.00 mm, 250um-2mm, 125um-250um, 63um-125um, <63um	
Literature Search	CWP, 2006	Literature review	Street Sweeping	PSD, % Efficiency	N/A	Yes	Various >2000um, 840-200um, 246-840um, 104-246um, 43-104um, <43um; <43um,43-246um, >246um; >2000um, 1000-2000um, 600-1000um, 250-600um, 125-250um, 63-125um, <63um	
Literature Search	USGS, 2009-11	Study	Street Sweeping	PSD, % Efficiency	N/A	Yes	<0.125mm,0.125-2.00mm, >2.00mm	
Literature Search	Sarter, Boyd, and Agardy, 1974	Literature	Street Sweeping	PSD, % Efficiency	N/A	Yes	<43um,43-104um, 104-246um, 246-840um, 840-2000um, >2000um	
Literature Search	SPU 2018	Study	Street Sweeping	PSD, % Efficiency	N/A	Yes	>500um, 250-500um, 62.5-250um, 3.9-62.5um, <3.9um	