



Use of the State Department of Transportation Portal to the International Stormwater BMP Database

Prepared for

AASHTO Committee on Environment and Sustainability

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Appendix A – Data Entry User’s Guide

LIST OF ACRONYMS

µg/L	Micrograms per Liter
AADT	Average Annual Daily Traffic
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
BCa	Bias Corrected and Accelerated
BI	Grass Strip
BMP	Best Management Practice
BMPDB	International Stormwater BMP Database
BR	Bioretention
BS	Grass Swale
DB	Detention Basin
DOT	Department of Transportation
DP	Dissolved Phosphorus
<i>E. coli</i>	<i>Escherichia coli</i>
EMC	Event Mean Concentration
EPA	Environmental Protection Agency
ET	Evapotranspiration
EWRI	Environmental and Water Resources Institute
FC	Fecal Coliform
FHWA	Federal Highway Administration
HDS	Hydrodynamic Separators
HRBF	High Rate Biofiltration
HRMF	High Rate Media Filter
MF	Media Filter
mg/L	Milligrams per Liter
NCHRP	National Cooperative Highway Research Program
ND	Non-Detect
NO ₂	Nitrite
NO ₃	Nitrate
NO _x	Nitrate and Nitrate plus Nitrite
OGS	Oil/Grit Separator and Baffle Boxes
PAH	Polycyclic Aromatic Hydrocarbons
PFC	Permeable Friction Course
PP	Permeable Pavement
ROS	Regression-on-Order Statistics
RP	Retention pond
TCu	Total Copper
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TPb	Total Lead
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
TZn	Total Zinc
USEPA	United States Environmental Protection Agency
WB	Wetland Basin
WC	Wetland Channel
WERF	Water Environment Research Foundation
WRF	Water Research Foundation

Executive Summary

State departments of transportation (state DOTs) face a rapidly evolving regulatory landscape with increasing stormwater treatment demands and constituents of concern. The highway environment presents unique challenges to the deployment and successful operation of effective stormwater management systems. DOTs need data to understand the conditions under which stormwater best management practices (BMPs) are effective and how to properly deploy them to meet regulatory requirements. The International Stormwater BMP Database (BMPDB) project began in 1996 under a cooperative agreement between the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency (USEPA) to provide scientifically sound information to improve the design and selection of BMPs. The NCHRP 25-25(119) project, *Enhancing the International Stormwater BMP Database to Serve as a Highway Specific BMP Database*, added data fields, enhanced the relational structure, and created a DOT-specific Portal to the BMPDB to provide a more efficient means of delivering BMP design information, monitoring data, and performance summaries for BMP studies that are the most relevant to state DOTs. This companion study, NCHRP 25-25(120), leveraged the enhanced BMPDB to produce this data analysis report focused on BMPs installed at transportation related sites and provides guidance for using the newly created DOT-specific Portal. This report includes an inventory and interpretation of BMP performance data in the 2019 release of the BMPDB and an appendix with an updated user's guide that incorporates new DOT metadata identified under and implemented by NCHRP 25-25(119).

The inventory of DOT-related studies in the BMPDB by state and BMP type is useful for identifying areas of the country that are better represented with DOT-related BMP performance data and those where studies are lacking. Additionally, an assessment of the relative completeness of metadata associated with the drainage area tributary to DOT BMPs is provided. While the number of DOT studies currently in the BMPDB is encouraging in terms of BMP performance analysis for many pollutants, metadata related to these studies is less well populated and is a current data gap. For example, average annual daily traffic (AADT) could be more consistently reported in the future and potentially could be backfilled from other data sources.

Interpretation of the BMPDB performance data is provided in this report for DOT studies, non-DOT studies and both types of studies combined. BMP performance analysis included in this report demonstrates that there are many BMP types that provide significant pollutant reduction in highway settings. For example, most BMP types evaluated showed statistically significant reductions for total suspended solids (TSS). The performance analysis is also useful for identifying BMPs that may provide pollutant reductions, but not consistently at levels that would meet water quality targets set at receiving water standards, such as is the case for fecal indicator bacteria. Other uses of this analysis include identifying pollutants for which runoff (influent) concentrations into BMPs are similar for both DOT and non-DOT sites, as well as identifying pollutants such as copper and zinc, for which DOT sites tend to have higher concentrations in runoff than non-DOT sites. Further utilizing the BMPDB performance data for the copper and zinc example, DOTs can also identify multiple BMP types in the BMPDB that provide significant removal for these pollutants as well as the effluent quality that they have achieved.

In summary, the state DOT Portal to the BMPDB provides streamlined, online access to stormwater BMP monitoring data and performance statistics that can be used to help DOTs meet these needs: 1) BMP selection and implementation planning, 2) scientifically based support for regulatory interactions related to permit benchmarks and numeric effluent limits, 3) comparisons of local site monitoring data to national studies, and 4) development of stormwater management guidance and decision support tools, among others. To maximize the usefulness of the state DOT Portal, it is important to continue to fill data gaps identified in this report and continue to conduct high quality BMP performance monitoring studies and then submit information from those studies to further populate the BMPDB with DOT-relevant information.

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1 Introduction and Background

Following the recommendations of NCHRP Project 25-25(92) *Transferability of Post-Construction Stormwater Quality BMP Effectiveness Studies*, the Transportation Research Board (TRB) funded NCHRP 25-25(119) *Enhancing the International Stormwater BMP Database to Serve as a Highway Specific BMP Database*. NCHRP 25-25(119) updated the International Stormwater BMP Database to include additional department of transportation (DOT) relevant data fields and studies and created an online DOT Portal (<https://dot.bmpdatabase.org>) to provide streamlined access to the DOT related BMP performance data contained in the BMP Database (BMPDB).

The International Stormwater BMPDB project is a long-term research effort that features a constantly growing database of stormwater BMP studies, statistical analysis reports, monitoring guidance and other study-related publications. The overall purpose of the project is to provide scientifically sound information to help improve the design, selection and performance of BMPs as well as to inform stormwater management programs, policies, and regulations. Continued population of the database and assessment of its data will ultimately lead to a better understanding of factors influencing BMP performance and help to promote improvements in BMP design, selection and implementation. The project began in 1996 under a cooperative agreement between the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency (USEPA). In 2004, the project transitioned to a more broadly supported group of partners now led by the Water Research Foundation (WRF), including the Federal Highway Administration (FHWA), and the Environmental and Water Resources Institute (EWRI) of ASCE.

Approximately every two years, the BMPDB team generates data analysis reports that may include updates of summaries that characterize categories of BMPs and/or that involve advanced or targeted analyses. Updates of the BMP category-level statistical analysis reports focus on water quality analytes including commonly monitored constituents of solids, bacteria, metals, and nutrients (Table 1-1). This category-level analysis includes summary statistics for various BMP category-analyte combinations, and hypothesis testing comparing inflows versus outflows.

Table 1-1. Constituents Analyzed by Pollutant Category

Solids	Bacteria	Metals	Nutrients
Total suspended solids (TSS)	Fecal coliform <i>Escherichia coli</i> (<i>E. coli</i>)	Arsenic (total and dissolved)	Total phosphorus
Total dissolved solids (TDS)	Enterococcus	Cadmium (total and dissolved)	Orthophosphate
		Chromium (total and dissolved)	Dissolved phosphorus
		Copper (total and dissolved)	Total nitrogen
		Iron (total and dissolved)	Total Kjeldahl nitrogen (TKN)
		Lead (total and dissolved)	Nitrate (NO ₃)
		Nickel (total and dissolved)	Nitrate plus nitrite (NO ₃ + NO ₂)
		Zinc (total and dissolved)	Nitrate and Nitrate plus nitrite (NO _x)

This report is an update to the current suite of category-level analyses with a focus on DOT-relevant BMP studies. This DOT-focused report includes an inventory of DOT BMP studies and statistical summaries of DOT BMP performance, recommendations for additional analyses, and identification of data gaps. A discussion of BMP studies treating runoff from highways in different climate zones, levels of urbanization, and traffic volumes is also included. States and regions with limited data for specific BMPs or constituents have been identified. The statistical methods used for summarizing the data are described and references are provided to support independent analyses. The report also includes a section on how to access the Portal. Appendix A includes an updated data provider user's guide with instructions on how to

contribute new data and studies to the BMPDB. DOT-related reporting parameters recommended under NCHRP 25-25(119) have been added to the user's guide and data entry spreadsheets.

2 BMP Performance Data Statistical Analysis Approach

The BMP performance analyses provided in this report are based on the BMP performance data in the BMPDB version December 29, 2019. The analyses are based upon the distributions of influent and effluent water quality sample concentration data for individual events by BMP category, thereby providing greater weight to those BMPs for which there are a larger number of data points reported. In other words, the performance analysis presented in this technical summary is “storm-weighted,” as opposed to “BMP-weighted.” This update does not include BMP-weighted analyses (i.e., statistical analyses of individual study site central tendencies). This type of categorical analysis was excluded due to limited number of studies for some BMP categories and limited number of monitored storm events for some individual studies. In the future when the database is more thoroughly populated, BMP-weighted analyses may provide additional insight into site-specific or regional factors that affect performance. Individual studies with enough data can be analyzed independently using the DOT Portal.

The performance summaries provided in this report can be useful for identifying BMPs that tend to provide statistically significant pollutant reductions, as well as those that tend to consistently achieve target effluent concentrations. Additionally, BMP category-level analyses may identify pollutants for which runoff (influent) concentrations into BMPs are similar (or not) for both DOT and non-DOT sites. This information can assist DOTs with assessing the potential representativeness of using data (or summary statistics) from non-DOT sites. .

A summary of the BMPs analyzed and the data screening approach is provided below followed by an inventory of DOT-related studies and descriptions of the graphical and tabular summaries provided in this report.

2.1 BMPs Analyzed and Data Screening Approach

The effectiveness and range of unit treatment processes present in a particular BMP may vary depending on the BMP design. While the BMPDB supports nearly 50 structural BMP categories and subcategories, only nineteen different BMP categories were included in this analysis (see Table 2-1) due to limited data sets available for meaningful categorical comparisons and to focus the analysis on BMP types most relevant to state DOTs. To be included in this category-level summary, at least three BMP studies must be included in the BMP category, with each BMP study having influent and effluent data for at least three storms. Additional data screening included the exclusion of base flow samples from BMP studies, exclusion of grab samples for BMPs without permanent pools (i.e., only event mean concentrations (EMCs) are used except for retention ponds and wetland basins). A variety of additional screening criteria have been applied for purposes of category-level analysis to make sure that the data sets and BMP designs are reasonably representative, as documented in the “Monitoring Station” table of the BMP Database. Note that poor pollutant reduction performance of a BMP is not a reason for data exclusion.

Table 2-1. Summary of BMP Categories included in this Analysis.

BMP Category	Code	Description
Detention Basin	DB	Dry extended detention grass-lined and concrete lined basins that empties out after a storm.
Retention Pond	RP	Surface wet pond and underground vaults with a permanent pool of water; may include extended detention above pool.
Wetland Basin	WB	Similar to a retention pond (with a permanent pool of water) with more than 50 percent of its surface covered by emergent wetland vegetation.
Wetland Channel	WC	A continuously wet channel with wetland vegetation and slow velocities.
Grass Swale	BS	Shallow, vegetated channel; also called bioswale or vegetated swale.
Grass Strip	BI	Vegetated areas designed to accept laterally distributed sheet flow from adjacent impervious areas; also called buffer strips or vegetated buffers.
Bioretention	BR	Shallow, vegetated basins with a variety of planting/filtration media and often including underdrains. Also called rain gardens when underdrains are not present and biofiltration when underdrains are present.
Media Filter	MF	Filter bed with granular media, typically sand.
High Rate Biofiltration	HRBF	Manufactured devices with high rate filtration media that support plants
High Rate Media Filtration	HRMF	Manufactured devices with high rate filtration media consisting of a variety of inert and sorptive media types and configurations (e.g., cartridge filters, upflow filters, membrane filters, vertical bed filters, etc.).
Hydrodynamic Separation Devices	HDS	Manufactured devices providing gravitational settling using swirl concentrators, screens, and baffles.
Oil/Grit Separators and Baffle Boxes	OGS	Manufactured devices including oil/water separators and baffle chambers designed for removing floatables and coarse solids.
Permeable Friction Course	PF	Open-graded bituminous mixture placed over an impervious base.
Porous Pavement	PP	Full depth pervious concrete, porous asphalt, paving stones or bricks, reinforced turf rings, and other permeable surface designed to replace traditional pavement.

2.2 Inventory of DOT-Related Data

Prior to conducting an analysis of the DOT-related data currently available in the BMPDB it is important to evaluate the number of available studies and the completeness of DOT-related data fields associated. DOT-related sites are those where the primary land use activity is defined as Urban Roadway, Highway, Parking Facility, Service Plaza, or Maintenance Station. The data inventory provided in Section 3.1 includes the number of DOT-related sites in the available countries, states/provinces, and EPA rain zones as well as assessment of the data gaps of the DOT-related metadata collected about the sites. Lastly, the average annual daily traffic (AADT) data in the database are broken down geographically. Sites with unspecified land use activities (Unspecified) and non-DOT related sites (i.e., those not associated with one of the DOT related land use activities described above) are also summarized to provide a complete inventory of all studies contained in the BMPDB for the BMP categories listed in Table 2-1.

2.3 Graphical Summaries

Side-by-side box plots have been generated using the influent and effluent concentrations from the studies. For each BMP category, the influent box plots are provided on the left and the effluent box plots are provided on the right. A series of boxplots are provided for each for each pollutant-BMP combination (as defined in Table 1-1 and Table 2-1) including all sites combined, DOT sites only, and non-DOT sites only. A key to the box plots is provided in Figure 2.1.

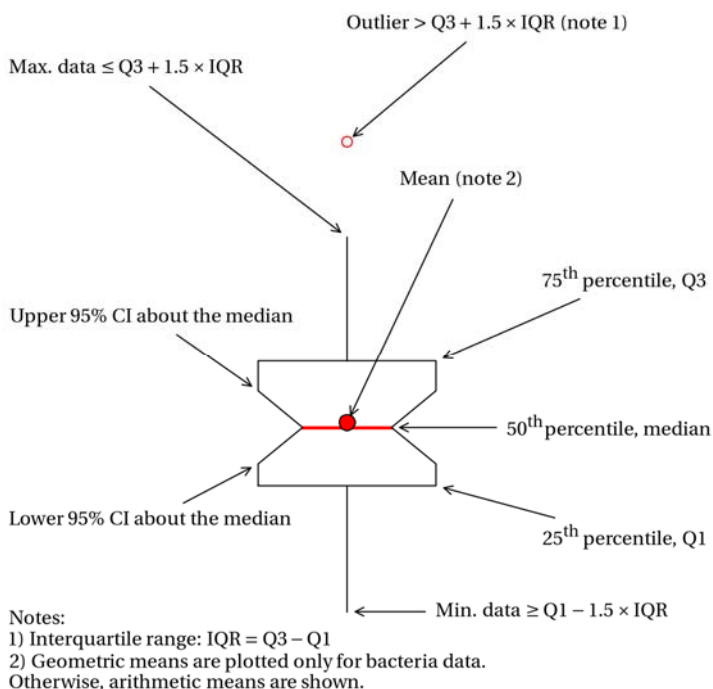


Figure 2.1. Box Plot Key

2.4 Tabular Summaries

In addition to the box plots, tables of data counts, interquartile ranges (i.e., 25th and 75th percentiles), influent/effluent medians, and 95% confidence intervals about the medians are provided. The median and interquartile ranges were selected as descriptive statistics for BMP performance because they are non-parametric (do not require distributional assumptions for the underlying data set) and are less affected by extreme values than means and standard deviations. Additionally, the median is less affected by assumptions regarding values below detection limits and varying detection limits for studies conducted by independent parties over many years.

Since confidence intervals about the median can still be affected by outliers if simple substitution is used, a robust regression-on-order statistics (ROS) method as described by Helsel and Cohn (1988) was utilized to provide probabilistic estimates of non-detects before computing descriptive statistics. When applying the ROS method, non-detect values are imputed based on their plotting positions relative to the probability distribution estimated from the detected data. Imputed values are always less than their detection limits, but if the dataset includes multiple detection limits, some imputed values may be larger than some of the detected values. Non-detect values with detection limits larger than the maximum detected value were removed from the dataset. Note that on the DOT Portal, ROS is not used to impute non-detect values. Due to the numerous filters that users may or may not apply to the data, simple substitution (i.e., half of the detection limit) is used on the Portal. As a result, statistics presented in this report will likely vary slightly from those presented by the DOT Portal's statistical summary tool.

With or without the application of the ROS method, conclusions regarding BMP performance should carefully consider the influence of large percentages of non-detects. For example, pollutant removals may be found to be statistically insignificant for a BMP, but that BMP may still provide removals at higher influent concentrations. The number of influent and effluent non-detects should be reviewed before making conclusions, particularly for dissolved metals where non-detects are most prevalent. For more information

on the influence of non-detects on dissolved metals data in the BMP Database, see the discussion in the Metals Technical Summary (Wright Water Engineers and Geosyntec, 2011), accessible at www.bmpdatabase.org.

Confidence intervals in the boxplots and tables were generated using the bias corrected and accelerated (BCa) bootstrap method described by Efron and Tibishirani (1993). This method is a robust approach for computing confidence intervals that is resistant to outliers and does not require any restrictive distributional assumptions. Comparison of the confidence intervals about the influent and effluent medians can be used to roughly identify statistically significant differences between the central tendencies of the data. However, non-parametric hypothesis tests, such as the Mann-Whitney rank sum test or the Wilcoxon signed-rank test, can provide additional and more robust results for evaluating significant differences between medians. The Mann-Whitney test applies to independent data sets, whereas the Wilcoxon test applies to paired data sets (Helsel and Hirsch, 1992).

In some cases, the Mann-Whitney and Wilcoxon hypothesis test results produce conflicting conclusions regarding statistically significant differences. Such cases are more likely to occur where there are imbalances in the number of influent and effluent samples because the Mann-Whitney test operates on the entire data set whereas the Wilcoxon test only operates on data pairs. For BMPs with short residence times and limited storage, the Wilcoxon hypothesis test results may be more reliable for evaluating whether concentration reductions are statistically significant because the test operates on the individual paired differences of influent and effluent storm event mean (EMC) concentrations. For BMPs with long residence times and/or permanent pools (e.g., wet ponds), the paired storm event hypothesis test results relying on the Wilcoxon test may be less reliable than the Mann-Whitney test because of variations in sampling program designs for collection of influent and effluent samples that may not enable accurate event-based pairing of monitoring data. For example, inflow for a storm event may mix with water from a previous event that has been stored since the previous storm. Thus, in cases where the Mann-Whitney and Wilcoxon test results conflict for BMPs with permanent pools, the Mann-Whitney results may provide a better indicator of concentration reduction performance.

In the summary tables provided in Sections 4 through 7, the final column (labeled “In vs Out” provides a concise graphic which conveys the results of three statistical tests used to determine whether the distributions of the influent and effluent pollutant concentrations at a BMP are significantly different. The three tests are as follows:

1. Check for overlap between the 95% confidence intervals of the influent and effluent medians. The absence of overlap indicates the influent and effluent medians are statistically different;
2. Mann-Whitney ranked test on the influent and effluent concentration without considering the observations as paired values. When the p-value of this statistics is less than 0.05, it is considered a positive result and influent and effluent concentrations are statistically different; and
3. Wilcoxon ranked-sum test on the influent and effluent concentration that considers only the contemporaneously paired observations. When the p-value of this statistic is less than 0.05, it is considered a positive result and influent and effluent concentrations are statistically different.

The positive comparison results (i.e., influent and effluent concentrations are different and effluent concentrations are less than influent concentrations), a solid downward pointing triangle (▼) is shown. Conversely, a hollow diamond (◇) is used to indicate that no statistical difference was found between influent and effluent concentrations. If effluent concentrations are statistically greater than influent concentrations (i.e., pollutant export occurs), then a hollow red upward triangle is used (△). In the cases where a test could not be performed due to limited data, these comparisons are excluded. In such cases, the “In vs Out” column of the summary tables is marked simply with “NA”.

Be aware that for some BMP types, a statistically significant difference between influent and effluent concentrations may not be present, but the effluent concentrations achieved by the BMP are relatively low and may be comparable to the performance of other BMPs that have statistically significant differences between inflow and outflow. For example, data sets that have low influent concentrations and similarly

low effluent concentration (i.e., clean water in = clean water out) may not show statistically significant differences. However, this does not necessarily imply that the BMP would not have been effective at higher influent concentrations. Therefore, when interpreting BMP performance, it is important to consider the magnitude of the influent and effluent concentrations in addition to the hypothesis test results for statistically significant differences.

Lastly, this report focuses solely on influent and effluent concentrations and does not characterize influent and effluent loads. For BMPs that provide significant volume reduction, load reductions may still occur in the absence of concentration reductions or even in some cases with an increase in concentrations, such as phosphorus export from biofiltration systems. Load reduction analysis by BMP category was not considered for this summary report due to uncertain or incomplete runoff volume data for many BMP studies in the BMPDB. However, volume-related data can be retrieved from the BMPDB and have been evaluated in detail for some BMP categories. For example, see *International Stormwater Best Management Practices (BMP) Database Addendum 1 to Volume Reduction Technical Summary (January 2011) Expanded Analysis of Volume Reduction in Bioretention BMPs* (Geosyntec and Wright Water Engineers 2012), accessible at www.bmpdatabase.org.

3 DOT-Related Site Data

3.1 DOT Data Inventory

The BMP Database contains 771 BMP studies as of December 2019. The discussion in this report focuses on the subset of BMP categories identified in Table 2-1, which equates to 582 individual BMP studies. In this analysis, a “DOT site” is defined as a site or study with 1 or more BMPs whose watersheds contain DOT-related activities. The tables in this section depict the total numbers of BMPs and many sites contain multiple BMPs. Table 3-1 lists the DOT-related activities at BMP study sites in the BMPDB and breaks down the representation of BMP categories (e.g., bioretention, detention basins, etc.). For comparison, non-DOT-related BMPs are included in Table 3-1 as well. Grass strips and swales are by far the most prevalent BMP category at DOT-related sites, followed by bioretention.

The breakdown of the location of these BMPs by country, EPA rain zone (see Figure 10.3), and US state are shown in Table 3-2 through Table 3-4. The overwhelming majority of BMPs in the database are in the US, including 27 states and 9 EPA rain zones. With 68 BMP studies, Caltrans is the largest DOT contributor to the BMPDB followed by NCDOT (30) and VDOT (25).

Lastly, Table 3-5 shows the completeness of the watershed and DOT-related meta data available for DOT-related sites in the BMP database, split across the various DOT activity types. In general, some of the basic watershed parameters such as land area, land use, imperviousness and geographic location are well represented. However, other transportation-related fields, including information in the newly added DOT-related fields, are less well populated. This information may not be readily available in the original reports associated with DOT study submittals; however, some of this information may be backfilled in the future.

Table 3-1. DOT-Related Activities by Each BMP Category for Analyzed Sites

Category	Urban Roadway	Highway	Parking Facility	Service Plaza	Maintenance Station	Un-specified	Non-DOT	All Sites
Detention Basin	1	6	7	0	0	2	37	53
Retention Pond	6	1	2	0	1	4	73	87
Wetland Basin	4	2	1	0	1	3	33	44
Wetland Channel	3	2	0	0	0	1	17	23
Grass Swale	2	24	7	0	1	13	10	57
Grass Strip	0	45	2	0	2	3	3	55
Bioretention	7	7	31	1	2	10	25	83
Media Filter	2	6	7	1	4	8	22	50
High Rate Biofiltration	1	1	3	0	0	0	1	6
High Rate Media Filtration	4	4	7	1	1	0	6	23
Hydrodynamic Separation Devices	1	6	4	0	2	1	16	30
Oil/Grit Separators and Baffle Boxes	2	1	3	0	3	1	9	19
Permeable Friction Course	0	6	0	0	0	0	0	6
Porous Pavement	4	2	33	0	0	1	6	46
Total	37	113	107	3	17	47	258	582

Table 3-2. Distribution of Selected BMP Study Sites by Country

Country	DOT	Non-DOT	Unspecified	All Sites
Australia	2	4	0	6
Canada	11	1	0	12
New Zealand	2	2	0	4
United States	262	251	47	560
Total	277	258	47	582

Table 3-3. Distribution of Selected BMP Study Sites by EPA Rain Zone

EPA Rain Zone	DOT	Non-DOT	Unspecified	All Sites
1	28	50	1	79
2	80	52	6	138
3	21	58	9	88
4	10	14	0	24
5	19	23	3	45
6	58	10	28	96
7	39	30	0	69
8	0	0	0	0
9	18	15	0	33
None	4	6	0	10
Total	277	258	47	582

Table 3-4. Distribution of Selected BMP Study Sites by US State

State	DOT	Non-DOT	Unspecified	All Sites
AL	1	11	0	12
CA	64	10	28	102
CO	15	15	0	30
CT	0	1	0	1
DE	4	0	0	4
FL	16	45	9	70
GA	0	2	0	2
IL	0	1	0	1
KS	9	2	0	11
MA	0	2	0	2
MD	2	18	0	20
MI	0	5	0	5
MN	2	12	1	15
MO	0	10	0	10
NC	49	19	2	70
NH	0	15	0	15
NJ	0	2	0	2
NY	0	6	0	6
OH	3	1	0	4
OR	2	10	0	12
PA	4	1	0	5
SC	4	0	0	4
SD	3	0	0	3
TX	20	35	3	58
VA	25	4	4	33
WA	31	20	0	51
WI	8	4	0	12
Outside the US	15	7	0	22
Total	277	258	47	582

Table 3-5. Percent Completeness of Relevant Metadata for the Selected BMP Study Sites

Metadata Field¹	Urban Roadway	Highway	Parking Facility	Service Plaza	Maintenance Station	Unspecified	All-DOT
ZipCode	70%	97%	79%	100%	100%	40%	84%
State	100%	100%	100%	100%	100%	100%	100%
Country	100%	100%	100%	100%	100%	100%	100%
Latitude	100%	100%	100%	100%	100%	100%	100%
Longitude	100%	100%	100%	100%	100%	100%	100%
EPARainZone	100%	99%	97%	100%	100%	100%	98%
Area_Descr	65%	66%	68%	100%	41%	75%	36%
LandUse_Descr	78%	87%	87%	100%	100%	15%	77%
Area	95%	94%	98%	100%	100%	26%	95%
Area_unit	95%	94%	98%	100%	100%	34%	95%
AreaImpervious_pct	70%	91%	80%	100%	100%	23%	67%
NRCSSoilGroup	14%	10%	21%	0%	0%	15%	19%
Vegetation_Descr	14%	8%	29%	0%	6%	17%	23%
FlowPath_Descr	5%	4%	4%	0%	0%	0%	2%
AreaServedByStorm Sewers_pct	8%	5%	13%	0%	6%	6%	14%
Roads_Descr	0%	0%	0%	0%	0%	0%	0%
PavementTypeRoad	32%	13%	8%	33%	12%	6%	5%
RoadArea	30%	14%	20%	0%	6%	9%	12%
RoadArea_units	30%	14%	9%	0%	6%	9%	12%
HasCurbGutter	8%	9%	12%	0%	6%	2%	4%
PavedAreaDrainage_Descr	11%	10%	0%	0%	0%	2%	7%
AreaParkingLots	24%	5%	49%	0%	12%	11%	11%
AreaParkingLots_unit	24%	3%	49%	0%	12%	11%	9%
ParkingLot_Descr	14%	0%	48%	33%	18%	4%	11%
DeicingMethod	8%	6%	11%	33%	0%	4%	1%
DOT_AADT	8%	39%	5%	0%	0%	4%	0%
DOT_Lane_Count	24%	39%	2%	0%	0%	0%	0%
DOT_Highway Conditions_Descr	14%	4%	3%	100%	0%	0%	0%
DOT_Highway Maintenance_Descr	0%	0%	0%	0%	0%	0%	0%
DOT_RoadType	0%	0%	0%	0%	0%	0%	0%
DOT_Resurfacing_Descr	0%	0%	0%	0%	0%	0%	0%
DOT_Shoulder_Descr	0%	0%	0%	0%	0%	0%	0%
DOT_Winter Maintenance_Descr	0%	0%	0%	0%	0%	0%	0%
DOT_Conveyance_Descr	0%	0%	0%	0%	0%	0%	0%
CostYear	16%	14%	30%	100%	47%	2%	12%
CostTotal	11%	13%	30%	100%	47%	2%	12%

1 – Field name definitions are included in the data entry user's guide provided in Appendix A.

3.2 Summary of Average Annual Daily Traffic

The Research Team has previously considered Average Annual Daily Traffic (AADT) when assessing stormwater quality and BMP performance. As such, it is also of interest to present here as an assessment of the AADT data currently available both in the range of traffic values and its geographic spread. Since the AADT data is currently quite sparse in the BMP Database, this assessment is presented in the form of “swarm plots.” Swarm plots, like box-and-whisker plots, provide an approximate visual assessment of the distribution of the data. The difference is that every individual value is shown on a swarm plot instead of the descriptive statistics shown by box-and-whisker plots. In the case of these plots, each BMP category along the x-axis is encoded with a different hue to aid in distinguishing adjacent “swarms”. Most AADT reported values are associated with Grass Strips (coded as “BI”) along Highways. California has the most BMPs with an AADT reported value. The dearth of AADT in the BMP metadata represents a significant data gap, which is why the AADT data filter in the current version of the DOT Portal has been disabled.

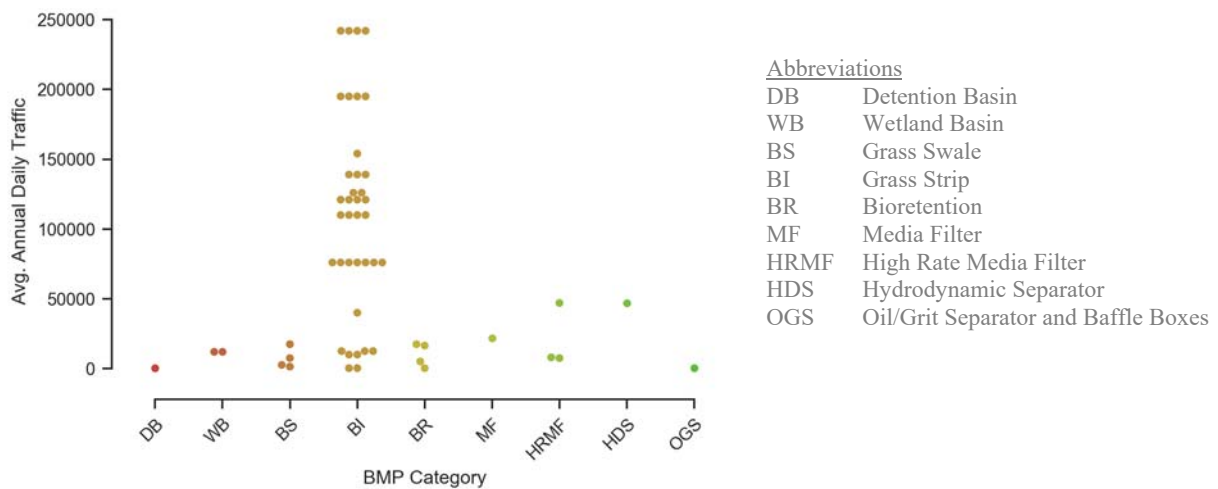
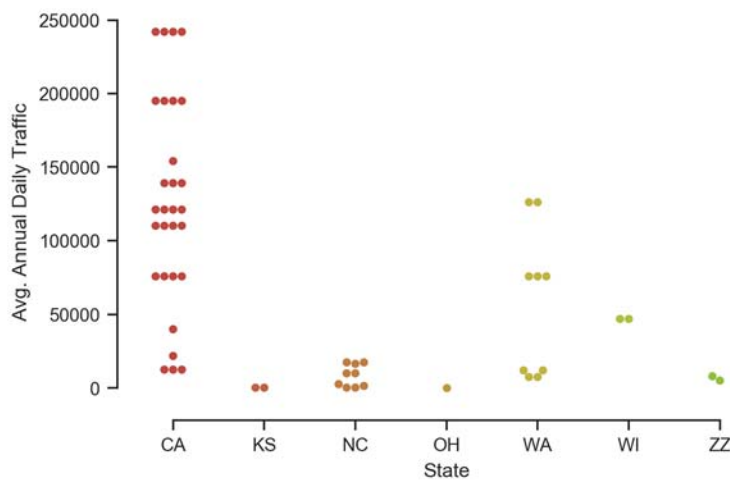


Figure 3.1. Site AADT Reported by BMP Category for Selected Study Sites



Note: ZZ = non-US

Figure 3.2. BMP Study Site AADT Reported by State

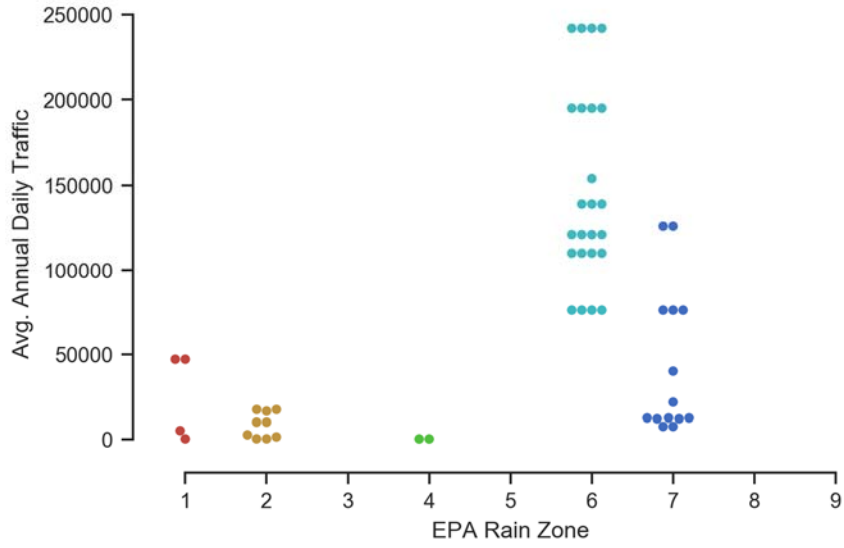


Figure 3.3. BMP Study Site AADT Reported in each EPA Rain Zone



Figure 3.4. BMP Study Site AADT Reported by various DOT Activities (Land Use)

4 Solids

A statistical summary of influent and effluent total suspended solids and total dissolved solids concentrations data contained in the BMPDB by BMP category for the selected BMP study sites is provided in the subsections below. A discussion of these results is provided in Section 8.1.

4.1 Total Suspended Solids

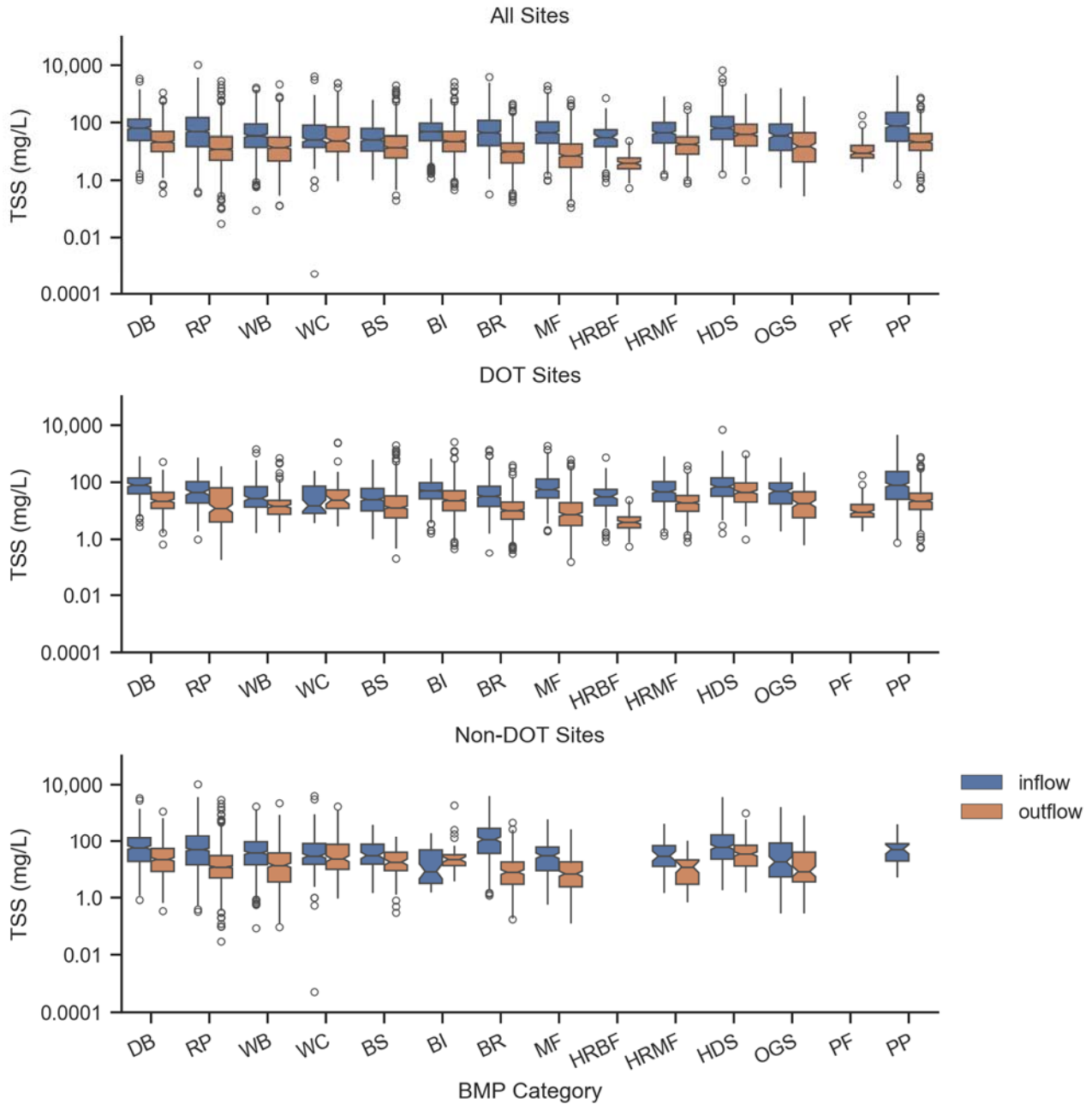


Figure 4.1. Box Plots of Influent/Effluent TSS Concentrations

Table 4-1. Influent/Effluent Summary Statistics for TSS (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th - 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	44; 575 (0.7%)	46; 611 (0.7%)	24.4 - 131	10.0 - 49.0	65.1 (57.0, 74.0)	22.0 (17.1, 22.5)	▼▼▼
	DOT	13; 176 (0.0%)	15; 214 (0.5%)	39.0 - 140	12.0 - 43.8	80.0 (64.0, 92.0)	22.0 (16.0, 23.1)	▼▼▼
	Non-DOT	31; 399 (1.0%)	31; 397 (0.8%)	18.9 - 128	8.40 - 54.0	58.1 (45.8, 68.7)	22.4 (18.0, 25.9)	▼▼▼
RP	All Sites	72; 1199 (1.1%)	74; 1191 (3.0%)	15.0 - 150	5.00 - 32.9	49.0 (41.0, 54.0)	12.0 (11.0, 13.0)	▼▼▼
	DOT	11; 143 (0.0%)	11; 173 (7.5%)	18.5 - 104	4.00 - 63.3	44.0 (30.0, 59.8)	12.0 (7.00, 18.4)	▼▼◇
	Non-DOT	61; 1056 (1.2%)	63; 1018 (2.3%)	14.4 - 158	5.00 - 30.4	49.3 (40.9, 55.0)	12.1 (11.0, 13.0)	▼▼▼
WB	All Sites	31; 601 (0.3%)	30; 563 (3.0%)	14.0 - 89.0	4.69 - 32.0	35.5 (29.7, 40.0)	14.0 (11.5, 15.2)	▼▼▼
	DOT	10; 159 (0.6%)	9; 142 (2.8%)	13.3 - 69.6	7.47 - 23.0	27.0 (19.6, 35.0)	14.3 (11.5, 15.6)	▼▼◇
	Non-DOT	21; 442 (0.2%)	21; 421 (3.1%)	14.4 - 93.1	3.60 - 37.5	37.9 (31.3, 45.3)	13.9 (11.0, 16.0)	▼▼▼
WC	All Sites	15; 269 (0.0%)	13; 219 (0.0%)	14.0 - 81.0	10.0 - 70.5	25.7 (20.5, 32.0)	24.0 (17.0, 28.0)	◇◇▼
	DOT	3; 55 (0.0%)	3; 47 (0.0%)	8.00 - 73.0	12.0 - 54.0	15.0 (9.00, 21.0)	24.0 (13.0, 26.0)	◇◇◇
	Non-DOT	12; 214 (0.0%)	10; 172 (0.0%)	15.0 - 80.5	10.0 - 75.6	29.6 (22.0, 40.0)	23.5 (17.0, 33.9)	◇▼▼
BS	All Sites	35; 582 (0.2%)	40; 656 (0.3%)	10.4 - 62.0	6.00 - 34.7	26.0 (22.0, 28.1)	13.7 (12.0, 14.9)	▼▼▼
	DOT	25; 488 (0.0%)	30; 562 (0.0%)	9.81 - 60.1	5.60 - 33.0	25.0 (21.0, 28.5)	12.9 (11.0, 14.0)	▼▼▼
	Non-DOT	10; 94 (1.1%)	10; 94 (2.1%)	15.2 - 76.2	9.00 - 39.8	30.8 (22.5, 43.6)	18.0 (13.8, 25.0)	◇▼▼
BI	All Sites	52; 920 (0.1%)	52; 711 (2.8%)	24.0 - 95.0	10.0 - 49.0	48.0 (43.0, 50.0)	23.0 (20.0, 24.0)	▼▼▼
	DOT	49; 871 (0.1%)	49; 675 (3.0%)	26.0 - 96.0	10.0 - 50.0	50.0 (44.0, 54.0)	23.0 (19.2, 24.0)	▼▼▼
	Non-DOT	3; 49 (0.0%)	3; 36 (0.0%)	3.20 - 48.0	13.5 - 32.6	8.50 (4.30, 20.0)	22.3 (13.6, 28.3)	◇△△
BR	All Sites	43; 840 (0.0%)	41; 685 (5.3%)	16.0 - 119	4.00 - 20.0	44.0 (38.0, 48.0)	10.0 (8.00, 10.0)	▼▼▼
	DOT	29; 586 (0.0%)	30; 482 (5.8%)	14.0 - 71.8	5.00 - 20.0	32.0 (28.0, 36.0)	10.1 (9.22, 12.0)	▼▼▼
	Non-DOT	14; 254 (0.0%)	11; 203 (3.9%)	36.1 - 294	3.00 - 18.1	112 (82.8, 138)	8.00 (6.00, 10.0)	▼▼▼
MF	All Sites	35; 533 (0.6%)	39; 563 (8.7%)	19.6 - 105	2.82 - 18.6	44.0 (37.0, 49.1)	7.20 (6.00, 8.00)	▼▼▼
	DOT	21; 344 (0.6%)	22; 340 (8.5%)	28.0 - 128	3.00 - 19.0	56.0 (45.9, 64.6)	7.40 (6.00, 8.20)	▼▼▼
	Non-DOT	14; 189 (0.5%)	17; 223 (9.0%)	8.98 - 60.6	2.45 - 18.3	30.0 (20.0, 35.7)	7.00 (5.11, 8.22)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th - 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
HRBF	All Sites	5; 97 (0.0%)	5; 97 (1.0%)	15.0 - 55.8	2.50 - 6.00	31.6 (21.0, 35.4)	3.90 (3.20, 4.30)	▼▼▼
	DOT	5; 97 (0.0%)	5; 97 (1.0%)	15.0 - 55.8	2.50 - 6.00	31.6 (21.0, 35.4)	3.90 (3.20, 4.30)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	18; 392 (0.5%)	18; 392 (3.8%)	20.0 - 100	8.15 - 32.6	44.0 (37.0, 53.5)	18.0 (15.0, 19.0)	▼▼▼
	DOT	14; 349 (0.6%)	14; 349 (1.4%)	21.0 - 104	9.55 - 34.0	47.0 (38.6, 57.0)	19.0 (16.0, 20.0)	▼▼▼
	Non-DOT	4; 43 (0.0%)	4; 43 (23.3%)	12.6 - 68.0	3.00 - 21.5	29.2 (17.0, 45.3)	12.1 (4.31, 15.0)	▼▼▼
HDS	All Sites	27; 488 (0.4%)	27; 452 (1.1%)	26.6 - 162	15.9 - 87.0	63.9 (56.6, 73.0)	39.0 (33.0, 43.8)	▼▼▼
	DOT	13; 229 (0.9%)	13; 229 (1.7%)	32.0 - 142	20.0 - 94.0	70.0 (47.0, 79.0)	45.0 (35.0, 50.0)	◇▼▼
	Non-DOT	14; 259 (0.0%)	14; 223 (0.4%)	22.7 - 173	13.0 - 69.7	60.7 (45.3, 64.0)	34.7 (24.5, 40.0)	▼▼▼
OGS	All Sites	16; 261 (0.4%)	16; 216 (1.9%)	11.0 - 88.0	4.38 - 44.2	36.0 (27.8, 42.0)	15.5 (11.2, 19.1)	▼▼▼
	DOT	8; 162 (0.0%)	8; 134 (0.7%)	17.4 - 94.4	5.65 - 46.1	48.6 (34.1, 61.1)	17.8 (13.5, 25.0)	▼▼▼
	Non-DOT	8; 99 (1.0%)	8; 82 (3.7%)	5.41 - 83.5	3.63 - 40.0	18.3 (8.60, 30.0)	8.42 (4.95, 17.6)	◇▼▼
PFC	All Sites	NA	6; 135 (0.0%)	NA	6.00 - 16.5	NA	9.00 (8.00, 10.0)	NA
	DOT	NA	6; 135 (0.0%)	NA	6.00 - 16.5	NA	9.00 (8.00, 10.0)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	16; 483 (0.8%)	22; 373 (0.5%)	23.0 - 226	11.0 - 41.0	77.0 (63.0, 90.0)	22.0 (18.0, 23.0)	▼▼▼
	DOT	12; 448 (0.9%)	22; 373 (0.5%)	25.0 - 236	11.0 - 41.0	80.0 (62.0, 94.0)	22.0 (18.0, 23.0)	▼▼▼
	Non-DOT	4; 35 (0.0%)	NA	19.7 - 79.1	NA	51.0 (22.7, 70.0)	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

4.2 Total Dissolved Solids

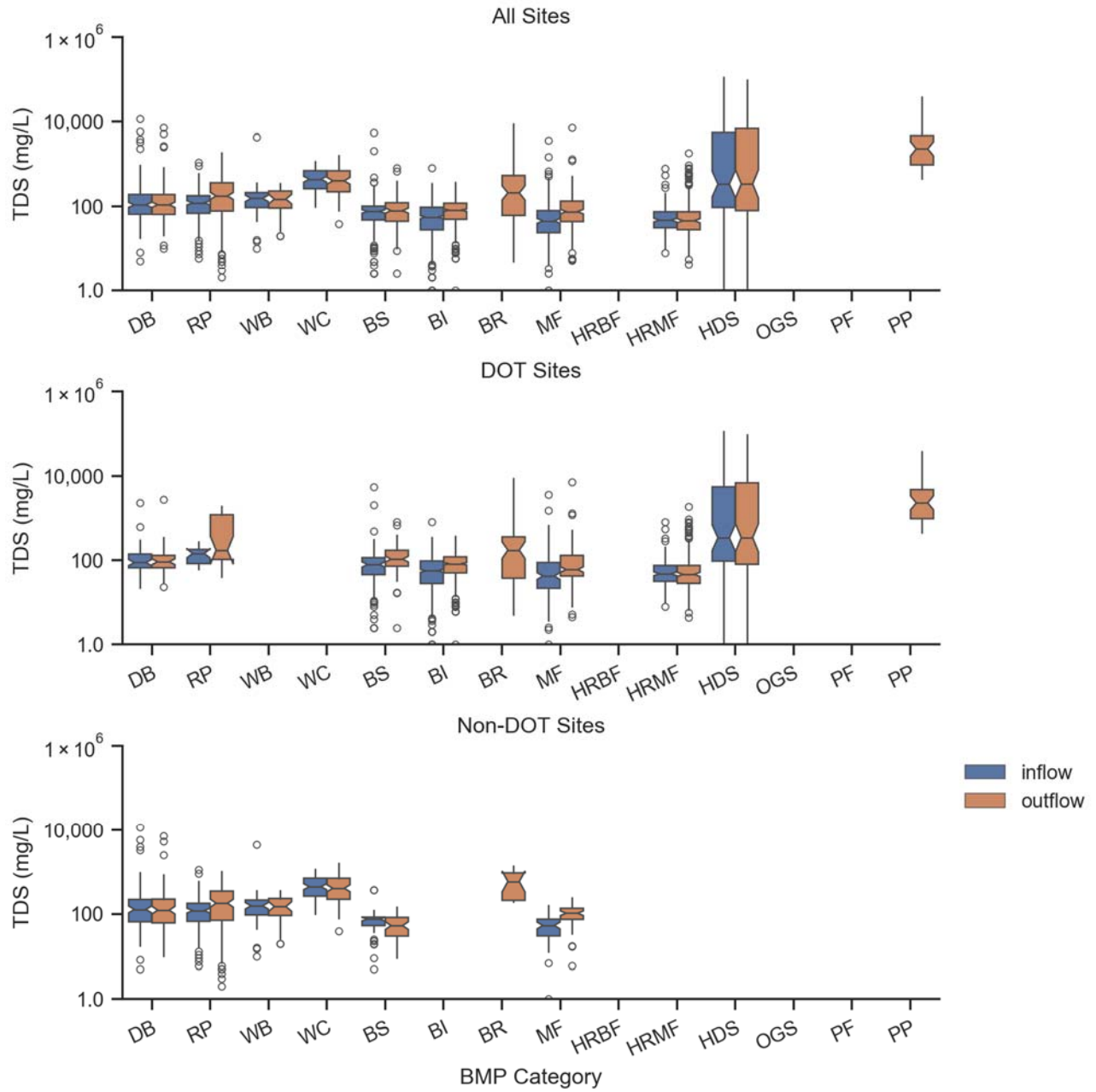


Figure 4.2. Box Plots of Influent/Effluent TDS Concentrations

Table 4-2. Influent/Effluent Summary Statistics for TDS (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	14; 156 (0.0%)	14; 140 (0.0%)	65.6 - 193	65.1 - 192	109 (86.4, 130)	110 (83.4, 120)	◇◇◇
	DOT	6; 49 (0.0%)	6; 45 (0.0%)	66.0 - 140	66.0 - 130	88.0 (68.3, 102)	92.0 (68.0, 107)	◇◇◇
	Non-DOT	8; 107 (0.0%)	8; 95 (0.0%)	65.4 - 221	61.5 - 224	128 (85.4, 142)	123 (90.0, 138)	◇◇◇
RP	All Sites	16; 169 (0.0%)	16; 156 (0.0%)	69.0 - 180	78.3 - 364	122 (100, 130)	178 (158, 206)	△△△
	DOT	3; 26 (0.0%)	3; 25 (0.0%)	83.3 - 180	104 - 1,200	145 (86.7, 171)	173 (104, 233)	◇△◇
	Non-DOT	13; 143 (0.0%)	13; 131 (0.0%)	67.0 - 178	70.9 - 348	120 (97.0, 128)	180 (146, 209)	△△△
WB	All Sites	4; 52 (0.0%)	4; 31 (3.2%)	94.8 - 213	92.0 - 233	156 (103, 181)	150 (95.3, 182)	◇◇▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	4; 52 (0.0%)	4; 31 (3.2%)	94.8 - 213	92.0 - 233	156 (102, 181)	150 (95.3, 182)	◇◇▼
WC	All Sites	6; 91 (0.0%)	6; 91 (1.1%)	264 - 703	223 - 700	442 (343, 518)	405 (306, 493)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 91 (0.0%)	6; 91 (1.1%)	264 - 703	223 - 700	442 (343, 518)	405 (306, 493)	◇◇◇
BS	All Sites	14; 161 (0.0%)	13; 130 (0.0%)	48.0 - 102	44.8 - 123	76.5 (66.0, 79.0)	80.0 (66.5, 84.0)	◇◇◇
	DOT	8; 104 (0.0%)	7; 73 (0.0%)	45.5 - 115	72.0 - 172	79.0 (65.0, 87.5)	106 (80.0, 120)	◇△△
	Non-DOT	6; 57 (0.0%)	6; 57 (0.0%)	53.0 - 84.0	30.0 - 83.0	75.5 (53.0, 77.8)	53.0 (33.0, 66.0)	◇◇◇
BI	All Sites	34; 617 (5.8%)	33; 433 (3.2%)	28.0 - 96.0	50.0 - 120	56.0 (50.0, 56.0)	82.0 (74.0, 84.0)	△△△
	DOT	34; 617 (5.8%)	33; 433 (3.2%)	28.0 - 96.0	50.0 - 120	56.0 (50.0, 56.0)	82.0 (74.0, 84.0)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	NA	7; 77 (0.0%)	NA	61.7 - 541	NA	210 (175, 298)	NA
	DOT	NA	4; 60 (0.0%)	NA	37.4 - 358	NA	173 (85.0, 244)	NA
	Non-DOT	NA	3; 17 (0.0%)	NA	210 - 937	NA	587 (210, 854)	NA
MF	All Sites	15; 196 (4.1%)	16; 193 (2.1%)	24.0 - 80.0	44.0 - 134	45.7 (37.0, 52.0)	75.7 (60.0, 89.4)	△△△
	DOT	11; 137 (4.4%)	12; 139 (2.9%)	21.6 - 88.0	42.1 - 130	42.0 (32.0, 47.8)	60.0 (50.0, 70.0)	△△△
	Non-DOT	4; 59 (3.4%)	4; 54 (0.0%)	30.3 - 75.3	74.4 - 136	53.4 (40.9, 62.3)	104 (85.0, 121)	△△△
HRMF	All Sites	6; 171 (45.0%)	6; 171 (43.3%)	31.5 - 75.0	28.2 - 75.0	47.6 (41.3, 51.2)	46.0 (38.9, 52.0)	◇◇◇
	DOT	6; 171 (45.0%)	6; 171 (43.3%)	31.5 - 75.0	28.2 - 75.0	47.6 (41.3, 51.8)	46.0 (38.9, 52.0)	◇◇◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	4; 83 (0.0%)	4; 83 (0.0%)	95.0 - 5,570	80.0 - 7,180	340 (165, 756)	342 (163, 1,230)	◇◇△
	DOT	4; 83 (0.0%)	4; 83 (0.0%)	95.0 - 5,570	80.0 - 7,180	340 (165, 756)	342 (163, 1,230)	◇◇△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	NA	3; 43 (0.0%)	NA	968 - 4,740	NA	2,300 (1,110, 3,080)	NA
	DOT	NA	3; 43 (0.0%)	NA	968 - 4,740	NA	2,300 (1,110, 3,080)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

5 Bacteria

A statistical summary of enterococcus, *Escherichia coli* (*E. coli*), and fecal coliform influent and effluent data contained in the BMPDB by BMP category for the selected BMP study sites is provided in the subsections below. A discussion of these results is provided in Section 8.2.

5.1 Enterococcus

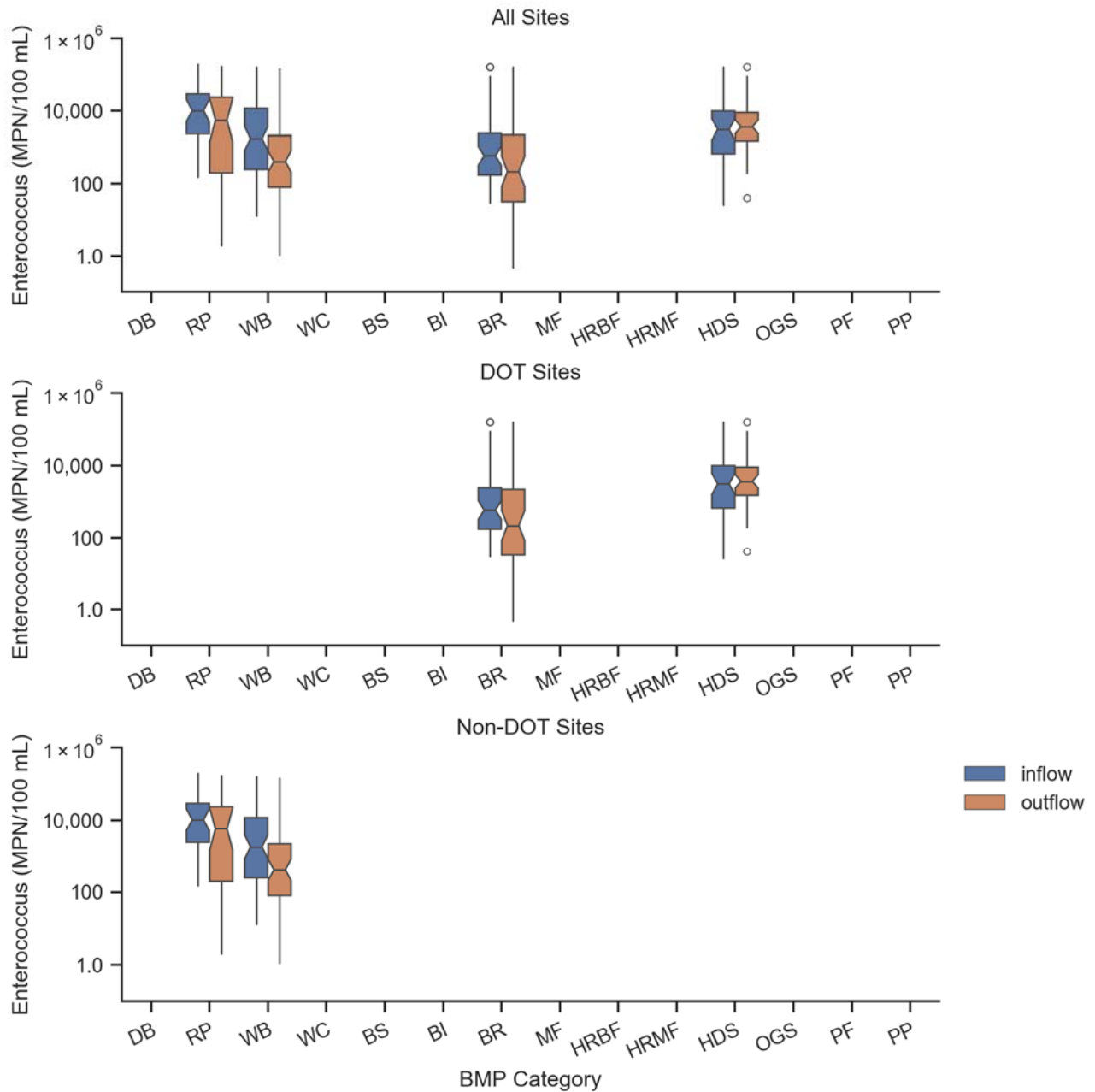


Figure 5.1. Box Plots of Influent/Effluent Enterococcus Concentrations

Table 5-1. Influent/Effluent Summary Statistics for Enterococcus (#/100 mL)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
RP	All Sites	3; 31 (0.0%)	3; 31 (0.0%)	2,350 - 29,200	201 - 23,600	10,200 (2,600, 24,100)	5,550 (234, 13,300)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 31 (0.0%)	3; 31 (0.0%)	2,350 - 29,200	201 - 23,600	10,200 (2,600, 24,100)	5,550 (234, 13,300)	◇◇◇
WB	All Sites	5; 68 (1.5%)	5; 61 (6.6%)	248 - 11,700	80.0 - 2,100	1,750 (730, 3,970)	410 (108, 594)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	5; 68 (1.5%)	5; 61 (6.6%)	248 - 11,700	80.0 - 2,100	1,750 (730, 3,970)	410 (108, 594)	▼▼▼
BR	All Sites	3; 48 (0.0%)	3; 49 (8.2%)	178 - 2,440	32.0 - 2,190	586 (225, 922)	218 (58.0, 437)	◇▼▼
	DOT	3; 48 (0.0%)	3; 49 (8.2%)	178 - 2,440	32.0 - 2,190	586 (225, 922)	218 (58.0, 437)	◇▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	4; 40 (2.5%)	4; 43 (0.0%)	664 - 9,980	1,500 - 8,980	3,180 (1,190, 5,790)	3,650 (1,700, 5,480)	◇◇◇
	DOT	4; 40 (2.5%)	4; 43 (0.0%)	664 - 9,980	1,500 - 8,980	3,180 (1,190, 5,790)	3,650 (1,700, 5,480)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

5.2 Escherichia coli

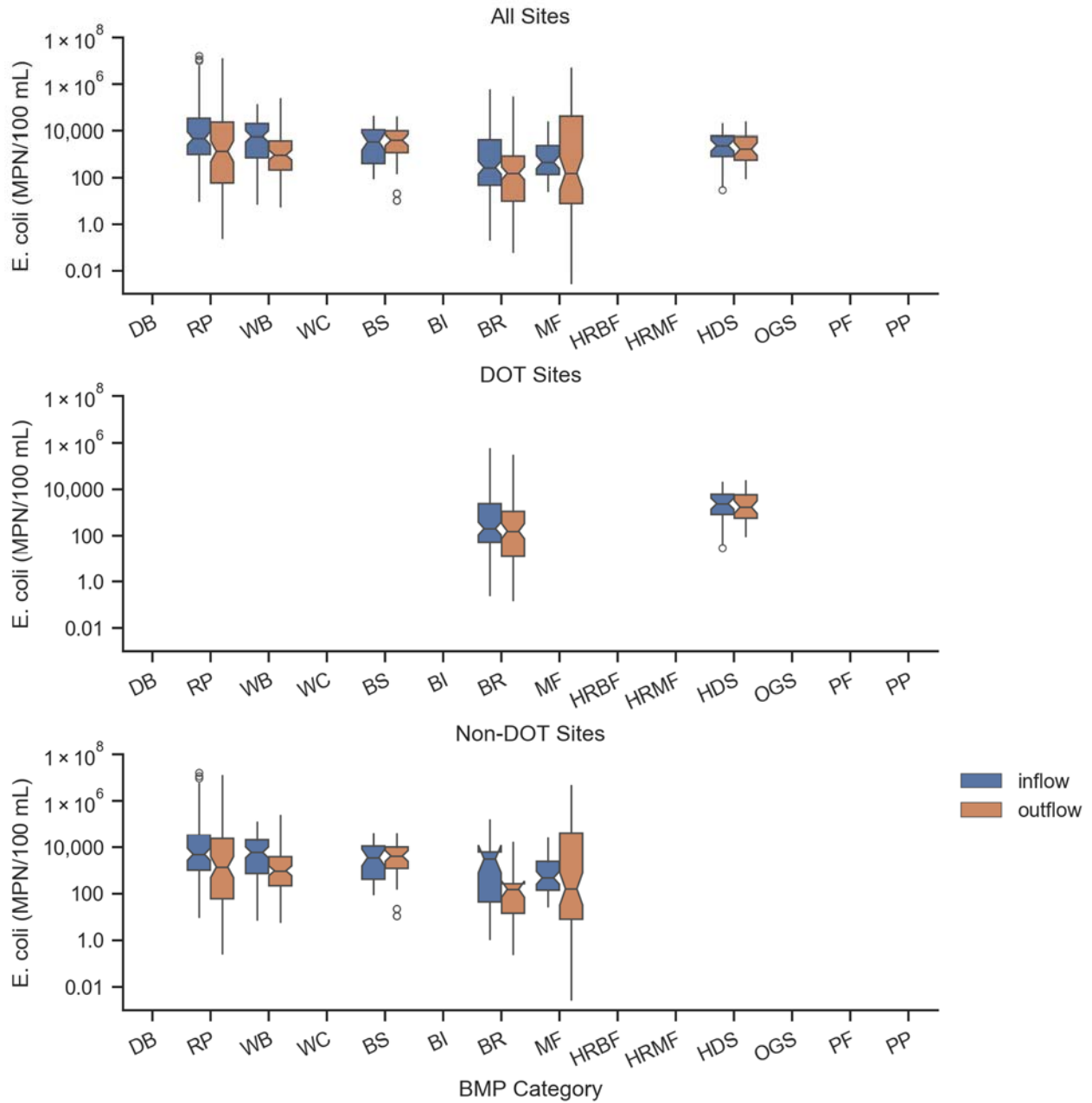


Figure 5.2. Box Plots of Influent/Effluent *E. coli* Concentrations

Table 5-2. Influent/Effluent Summary Statistics for E. coli (#/100 mL)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
RP	All Sites	6; 85 (0.0%)	6; 82 (1.2%)	1,010 - 34,100	60.0 - 23,400	4,840 (1,980, 6,740)	1,370 (374, 1,800)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 85 (0.0%)	6; 82 (1.2%)	1,010 - 34,100	60.0 - 23,400	4,840 (1,980, 6,740)	1,370 (374, 1,800)	▼▼▼
WB	All Sites	8; 96 (1.0%)	10; 88 (1.1%)	724 - 20,400	216 - 3,820	5,840 (1,900, 10,600)	949 (320, 1,410)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	8; 96 (1.0%)	10; 88 (1.1%)	724 - 20,400	216 - 3,820	5,840 (1,900, 10,400)	949 (319, 1,410)	▼▼▼
BS	All Sites	5; 39 (20.5%)	5; 39 (0.0%)	411 - 11,000	1,200 - 10,000	3,500 (411, 5,600)	4,100 (1,200, 5,900)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	5; 39 (20.5%)	5; 39 (0.0%)	411 - 11,000	1,200 - 10,000	3,500 (411, 5,600)	4,100 (1,200, 5,900)	◇◇◇
BR	All Sites	12; 121 (8.3%)	12; 120 (16.7%)	48.0 - 4,300	10.0 - 862	275 (120, 766)	158 (46.5, 212)	◇▼▼
	DOT	9; 89 (5.6%)	9; 88 (17.0%)	52.0 - 2,400	12.2 - 1,120	203 (96.3, 275)	158 (30.0, 253)	◇◇▼
	Non-DOT	3; 32 (15.6%)	3; 32 (15.6%)	43.8 - 6,080	17.5 - 265	3,100 (72.0, 4,700)	155 (26.0, 225)	◇▼▼
MF	All Sites	4; 51 (0.0%)	5; 71 (18.3%)	140 - 2,420	8.15 - 42,300	471 (156, 727)	160 (20.0, 373)	◇◇▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	4; 51 (0.0%)	5; 71 (18.3%)	140 - 2,420	8.15 - 42,300	471 (156, 727)	160 (20.0, 373)	◇◇▼
HDS	All Sites	3; 33 (0.0%)	3; 33 (0.0%)	820 - 6,100	570 - 5,800	2,400 (860, 3,400)	1,700 (780, 2,500)	◇◇◇
	DOT	3; 33 (0.0%)	3; 33 (0.0%)	820 - 6,100	570 - 5,800	2,400 (860, 3,400)	1,700 (780, 2,500)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

5.3 Fecal Coliform

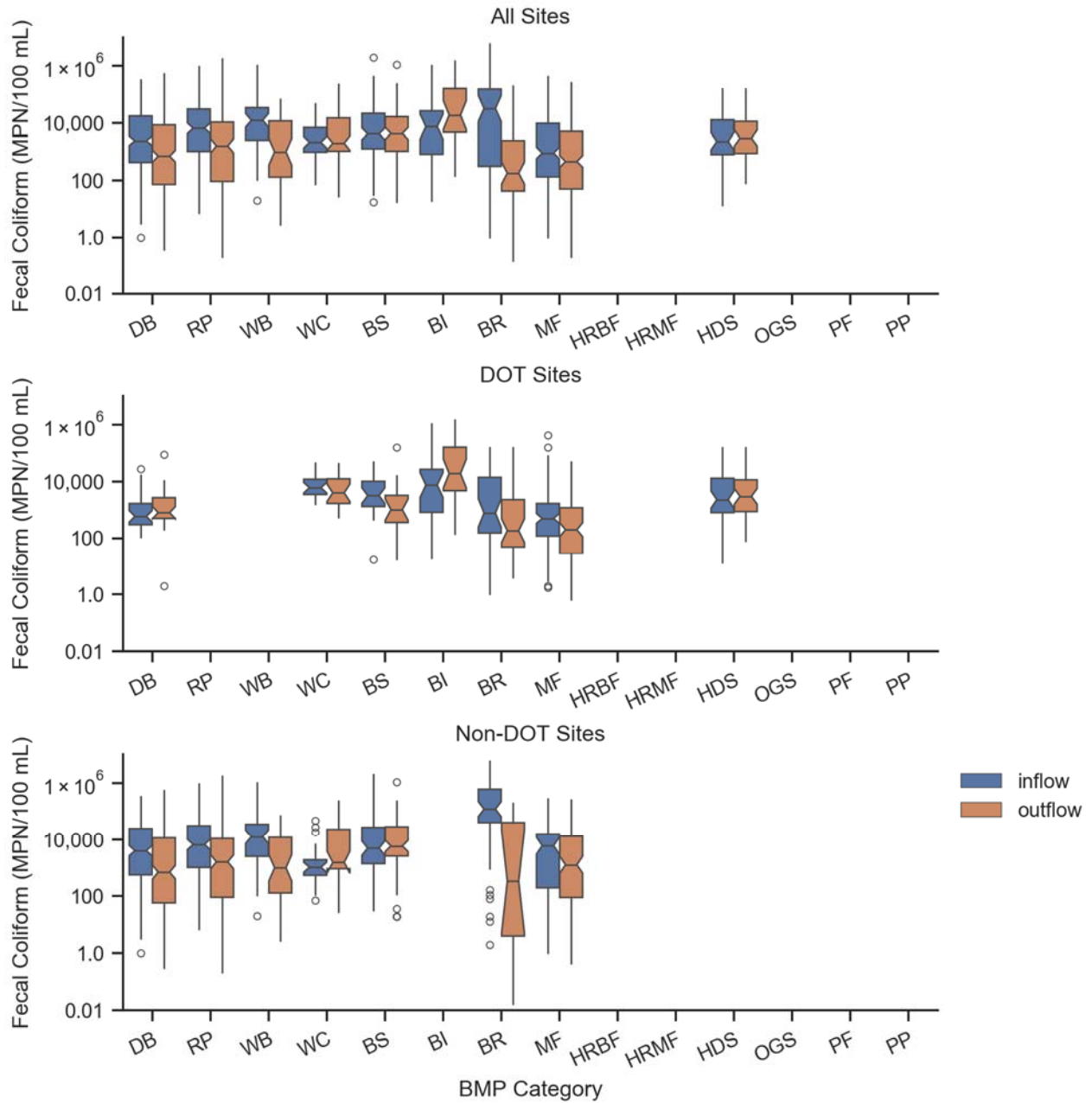


Figure 5.3. Box Plots of Influent/Effluent Fecal Coliform Concentrations

Table 5-3. Influent/Effluent Summary Statistics for Fecal Coliform (#/100 mL)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	20; 240 (2.1%)	20; 253 (2.0%)	423 - 17,800	72.0 - 8,620	2,420 (1,500, 4,000)	700 (308, 1,000)	▼▼▼
	DOT	5; 34 (0.0%)	5; 29 (0.0%)	300 - 1,680	500 - 2,700	600 (300, 1,000)	800 (300, 1,700)	◇◇◇
	Non-DOT	15; 206 (2.4%)	15; 224 (2.2%)	562 - 24,600	58.2 - 11,300	3,990 (1,940, 5,000)	700 (240, 1,450)	▼▼▼
RP	All Sites	14; 158 (0.0%)	16; 174 (8.6%)	1,020 - 30,900	91.8 - 10,800	6,590 (3,000, 11,100)	1,610 (555, 2,690)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	14; 158 (0.0%)	16; 174 (8.6%)	1,020 - 30,900	91.8 - 10,800	6,590 (3,000, 11,100)	1,610 (555, 2,690)	▼▼▼
WB	All Sites	6; 55 (1.8%)	7; 44 (6.8%)	2,520 - 34,800	130 - 11,900	12,500 (3,200, 16,500)	1,000 (230, 2,400)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 55 (1.8%)	7; 44 (6.8%)	2,520 - 34,800	130 - 11,900	12,500 (3,200, 16,500)	1,000 (230, 2,400)	▼▼▼
WC	All Sites	7; 45 (0.0%)	7; 52 (0.0%)	967 - 7,000	1,050 - 15,400	2,150 (1,230, 4,600)	2,000 (1,220, 4,000)	◇◇◇
	DOT	3; 21 (0.0%)	3; 20 (0.0%)	3,500 - 12,000	1,690 - 12,500	6,050 (2,300, 7,500)	4,000 (1,580, 10,800)	◇◇◇
	Non-DOT	4; 24 (0.0%)	4; 32 (0.0%)	540 - 1,910	920 - 23,800	1,040 (540, 1,780)	1,550 (964, 3,080)	◇◇◇
BS	All Sites	12; 91 (14.3%)	11; 82 (4.9%)	1,260 - 22,000	1,040 - 16,800	4,200 (2,000, 5,500)	4,350 (2,500, 6,100)	◇◇◇
	DOT	4; 26 (19.2%)	3; 16 (25.0%)	1,320 - 10,200	361 - 3,800	3,200 (1,380, 6,000)	1,040 (244, 2,300)	◇▼◇
	Non-DOT	8; 65 (12.3%)	8; 66 (0.0%)	1,400 - 27,000	2,600 - 28,800	4,900 (2,300, 11,000)	5,850 (3,350, 9,000)	◇◇◇
BI	All Sites	4; 30 (23.3%)	3; 23 (0.0%)	817 - 27,100	5,430 - 163,000	7,630 (835, 17,400)	19,100 (2,800, 116,000)	◇△◇
	DOT	4; 30 (23.3%)	3; 23 (0.0%)	817 - 27,100	5,430 - 163,000	7,630 (835, 17,400)	19,100 (2,800, 116,000)	◇△◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	11; 86 (4.7%)	8; 52 (21.2%)	312 - 155,000	42.2 - 2,480	32,500 (7,500, 40,000)	180 (58.2, 396)	▼▼▼
	DOT	5; 38 (7.9%)	5; 40 (25.0%)	152 - 14,000	48.5 - 2,300	825 (170, 5,000)	185 (65.1, 400)	◇▼▼
	Non-DOT	6; 48 (2.1%)	3; 12 (8.3%)	40,000 - 600,000	4.00 - 40,000	120,000 (40,000, 215,000)	835 (3.00, 20,800)	▼▼◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
MF	All Sites	19; 212 (3.8%)	22; 238 (7.6%)	132 - 9,790	50.0 - 5,140	905 (500, 1,540)	457 (214, 591)	◇▼▼
	DOT	11; 110 (5.5%)	11; 108 (11.1%)	119 - 1,680	28.2 - 1,190	500 (200, 725)	200 (50.0, 200)	◇▼▼
	Non-DOT	8; 102 (2.0%)	11; 130 (4.6%)	197 - 15,900	90.2 - 13,000	6,000 (2,380, 8,170)	1,280 (460, 2,220)	▼▼▼
HDS	All Sites	3; 40 (0.0%)	3; 40 (0.0%)	800 - 13,000	875 - 11,500	2,300 (800, 3,000)	3,000 (850, 4,000)	◇◇△
	DOT	3; 40 (0.0%)	3; 40 (0.0%)	800 - 13,000	875 - 11,500	2,300 (800, 3,000)	3,000 (850, 4,000)	◇◇△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
 ** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.
 %ND percentage of non-detects
 NA not available or less than 3 studies for BMP/constituent.
 ◇ influent/effluent comparison test indicates no significant difference in concentrations
 ▼ influent/effluent comparison test indicates significant reduction in concentrations
 △ influent/effluent comparison test indicates significant *increase* in concentrations

6 Metals

A summary of arsenic, cadmium, chromium, copper, iron, lead, nickel, and zinc data (both total and dissolved fractions) contained in the BMPDB by BMP category is provided in the subsections below. A discussion of these results is provided in Section 8.3.

6.1 Arsenic

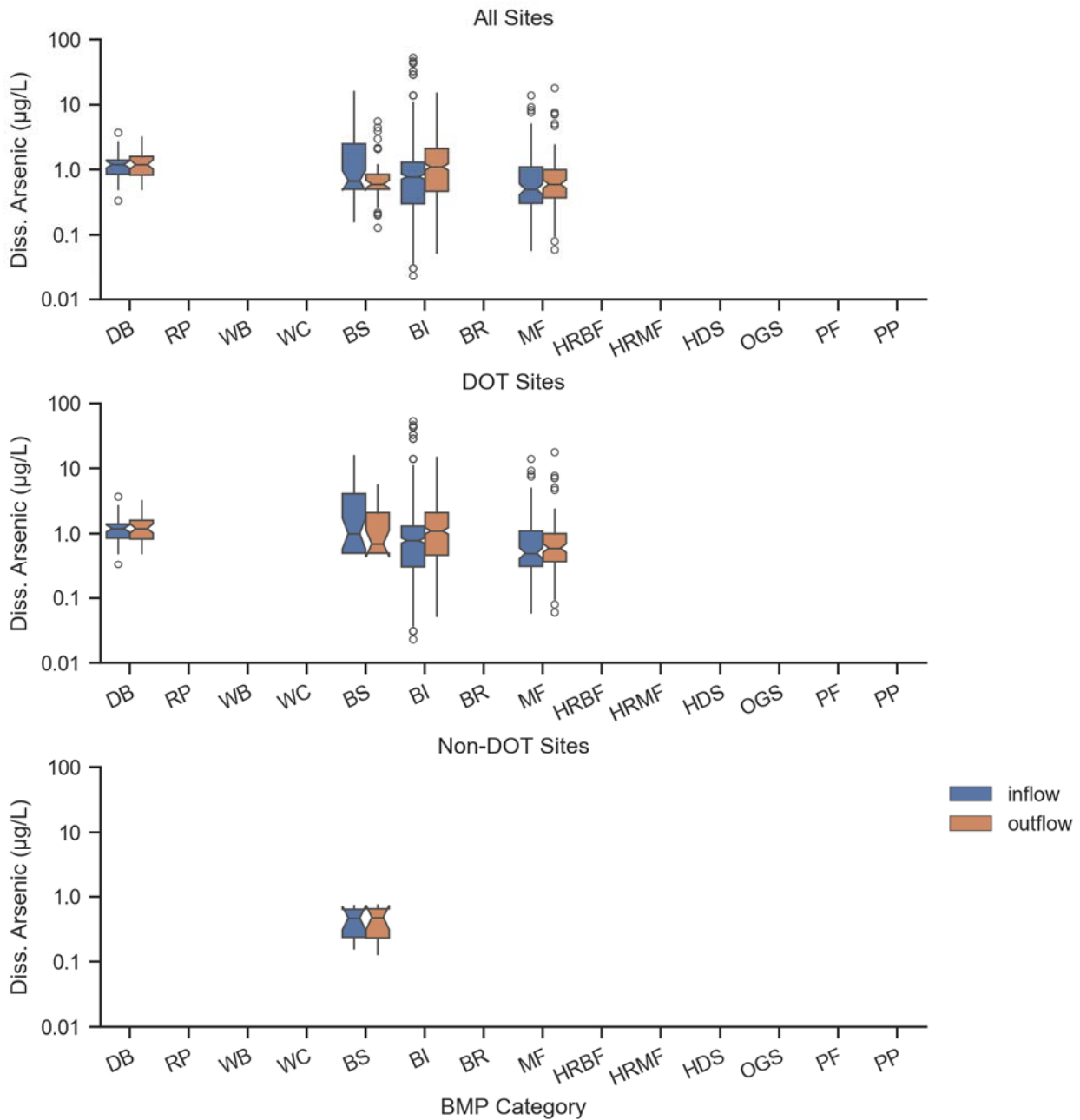


Figure 6.1. Box Plots of Influent/Effluent Dissolved Arsenic Concentrations

Table 6-1. Influent/Effluent Summary Statistics for Dissolved Arsenic ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	5; 41 (2.4%)	5; 39 (0.0%)	0.850 - 1.40	0.825 - 1.60	1.20 (0.850, 1.20)	1.20 (1.00, 1.40)	◇◇◇
	DOT	5; 41 (2.4%)	5; 39 (0.0%)	0.850 - 1.40	0.825 - 1.60	1.20 (0.850, 1.20)	1.20 (1.00, 1.40)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BS	All Sites	9; 51 (0.0%)	8; 37 (0.0%)	0.500 - 2.50	0.500 - 0.850	0.680 (0.500, 0.730)	0.600 (0.500, 0.620)	◇◇◇
	DOT	6; 37 (0.0%)	5; 23 (0.0%)	0.500 - 4.10	0.500 - 2.10	1.00 (0.530, 1.90)	0.700 (0.500, 0.900)	◇◇◇
	Non-DOT	3; 14 (0.0%)	3; 14 (0.0%)	0.238 - 0.642	0.233 - 0.650	0.470 (0.210, 0.530)	0.480 (0.215, 0.620)	◇◇◇
BI	All Sites	34; 617 (35.7%)	33; 433 (30.5%)	0.300 - 1.30	0.466 - 2.10	0.780 (0.690, 0.800)	1.10 (0.770, 1.20)	△△△
	DOT	34; 617 (35.7%)	33; 433 (30.5%)	0.300 - 1.30	0.466 - 2.10	0.780 (0.690, 0.800)	1.10 (0.770, 1.20)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	10; 110 (14.5%)	10; 106 (23.6%)	0.305 - 1.10	0.370 - 1.00	0.500 (0.500, 0.585)	0.600 (0.500, 0.630)	◇◇◇
	DOT	10; 110 (14.5%)	10; 106 (23.6%)	0.305 - 1.10	0.370 - 1.00	0.500 (0.500, 0.585)	0.600 (0.500, 0.635)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

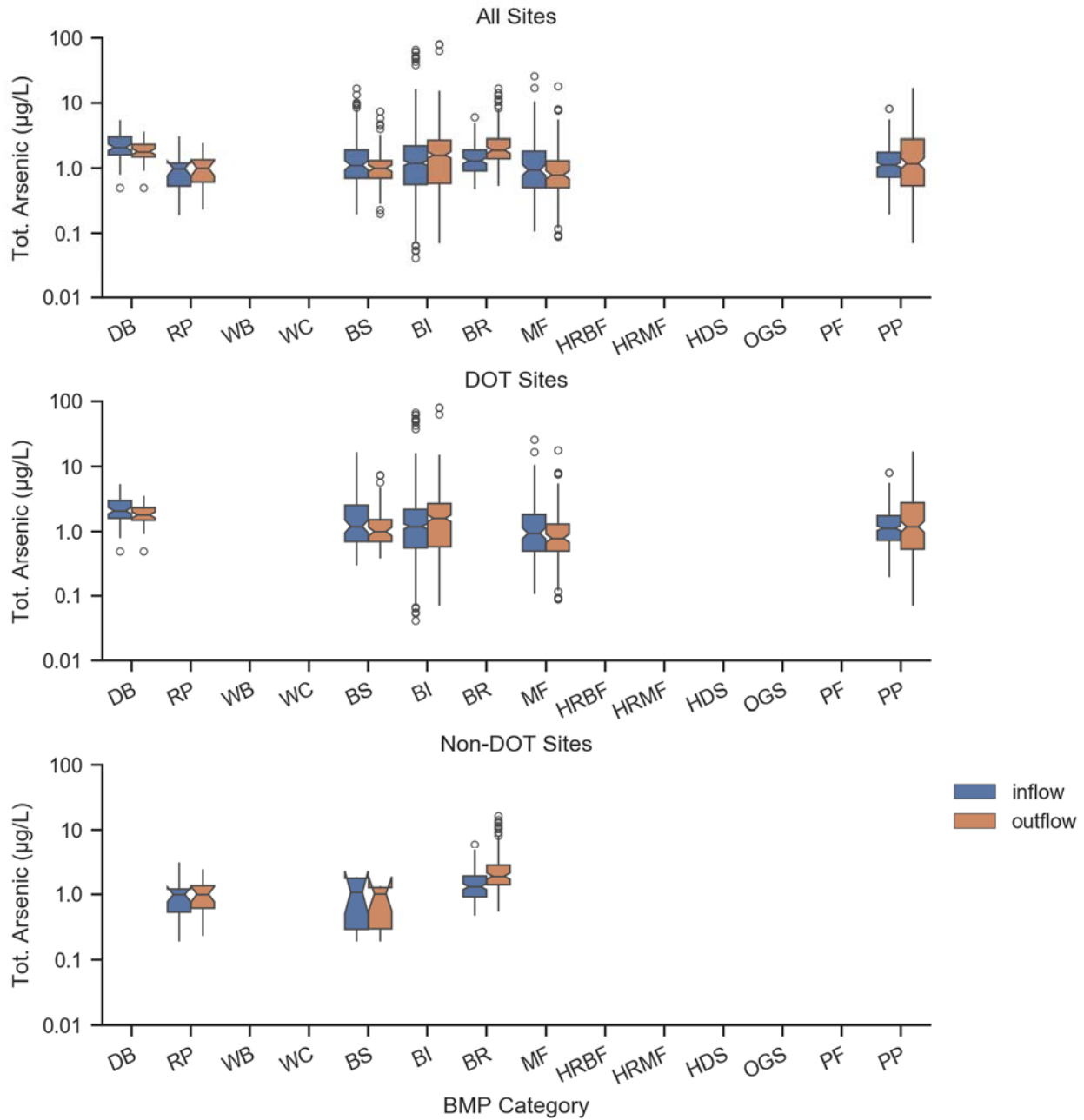


Figure 6.2. Box Plots of Influent/Effluent Total Arsenic Concentrations

Table 6-2. Influent/Effluent Summary Statistics for Total Arsenic ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	6; 72 (41.7%)	6; 44 (2.3%)	1.60 - 3.0	1.49 - 2.32	2.09 (1.86, 2.50)	1.80 (1.6, 2.1)	◇◇▼
	DOT	6; 72 (41.7%)	6; 44 (2.3%)	1.60 - 3.0	1.49 - 2.32	2.09 (1.86, 2.50)	1.80 (1.6, 2.1)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
RP	All Sites	3; 25 (4.0%)	3; 21 (4.8%)	0.53 - 1.2	0.61 - 1.35	0.99 (0.53, 1.0)	1.0 (0.51, 1.0)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 25 (4.0%)	3; 21 (4.8%)	0.53 - 1.2	0.61 - 1.35	0.99 (0.53, 1.0)	1.0 (0.51, 1.0)	◇◇◇
BS	All Sites	10; 93 (1.1%)	9; 78 (0.0%)	0.70 - 1.9	0.70 - 1.32	1.11 (0.90, 1.5)	1.00 (0.90, 1.1)	◇◇▼
	DOT	7; 79 (1.3%)	6; 64 (0.0%)	0.70 - 2.55	0.70 - 1.53	1.20 (0.80, 1.40)	1.00 (0.90, 1.10)	◇◇▼
	Non-DOT	3; 14 (0.0%)	3; 14 (0.0%)	0.29 - 1.75	0.30 - 1.26	1.07 (0.275, 1.68)	1.01 (0.300, 1.25)	◇◇▼
BI	All Sites	34; 605 (24.3%)	33; 428 (24.1%)	0.56 - 2.2	0.58 - 2.7	1.20 (1.20, 1.30)	1.60 (1.20, 1.70)	◇△△
	DOT	34; 605 (24.3%)	33; 428 (24.1%)	0.56 - 2.2	0.58 - 2.70	1.20 (1.20, 1.30)	1.60 (1.20, 1.70)	◇△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	4; 126 (34.1%)	3; 97 (22.7%)	0.908 - 1.90	1.40 - 2.80	1.31 (1.15, 1.50)	1.89 (1.60, 2.10)	△△△
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	4; 126 (34.1%)	3; 97 (22.7%)	0.908 - 1.90	1.40 - 2.80	1.31 (1.15, 1.50)	1.89 (1.60, 2.10)	△△△
MF	All Sites	10; 110 (7.3%)	10; 106 (20.8%)	0.50 - 1.83	0.50 - 1.30	0.940 (0.68, 1.15)	0.790 (0.59, 1.0)	◇◇◇
	DOT	10; 110 (7.3%)	10; 106 (20.8%)	0.50 - 1.83	0.50 - 1.30	0.94 (0.68, 1.15)	0.79 (0.59, 1.0)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	4; 292 (76.0%)	7; 174 (70.7%)	0.73 - 1.75	0.53 - 2.8	1.12 (1.04, 1.22)	1.19 (0.912, 1.45)	◇◇△
	DOT	4; 292 (76.0%)	7; 174 (70.7%)	0.73 - 1.75	0.53 - 2.78	1.12 (1.04, 1.22)	1.19 (0.912, 1.45)	◇◇△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

6.2 Cadmium

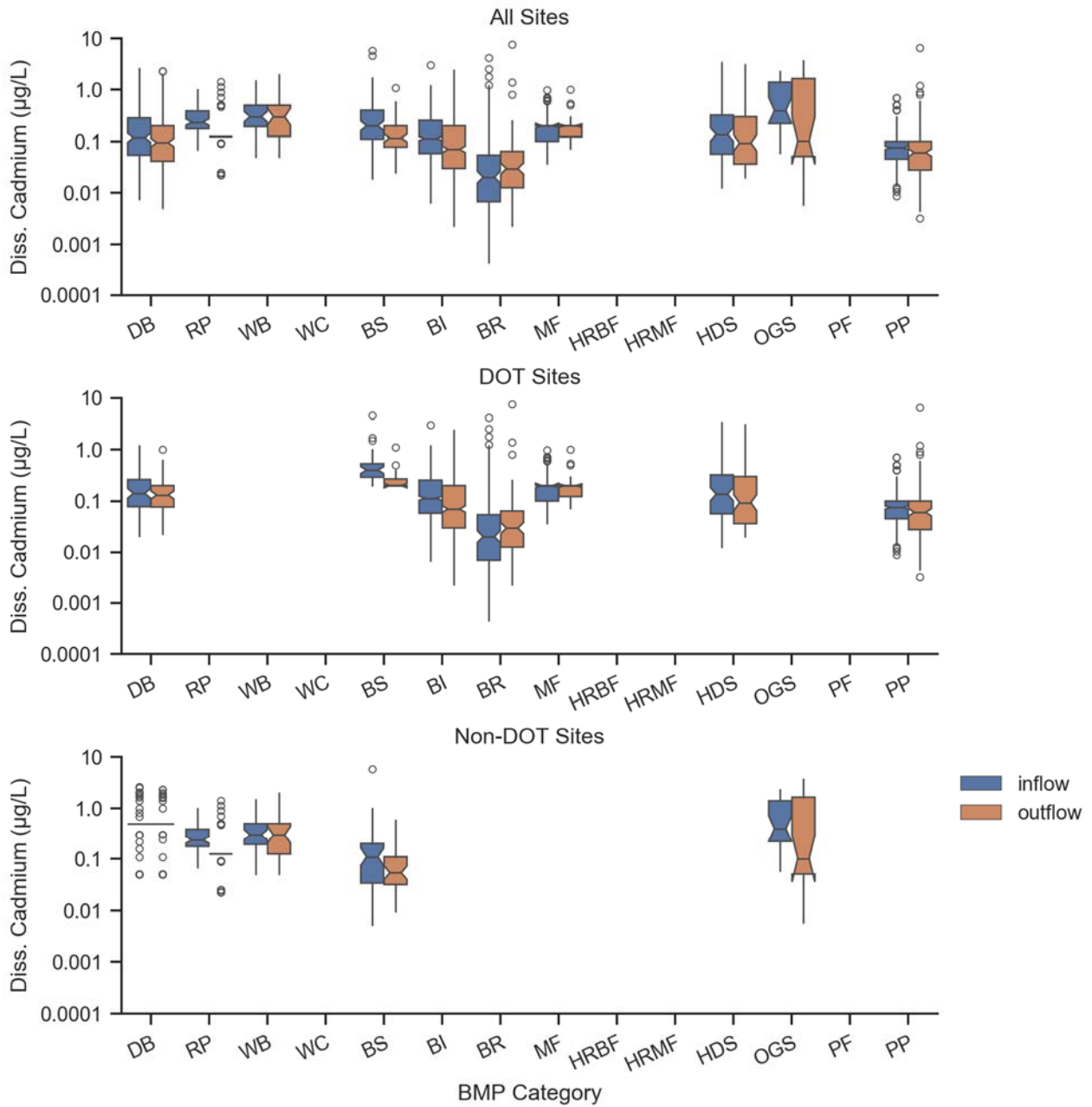


Figure 6.3. Box Plots of Influent/Effluent Dissolved Cadmium Concentrations

Table 6-3. Influent/Effluent Summary Statistics for Dissolved Cadmium ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	11; 171 (72.5%)	11; 176 (76.7%)	0.054 - 0.284	0.0412 - 0.200	0.117 (0.0927, 0.158)	0.0946 (0.0733, 0.115)	◇◇◇
	DOT	6; 76 (53.9%)	6; 70 (54.3%)	0.0777 - 0.263	0.0765 - 0.20	0.142 (0.106, 0.200)	0.131 (0.0981, 0.200)	◇◇◇
	Non-DOT	5; 96 (87.5%)	5; 106 (91.5%)	NA	NA	NA	NA	NA
RP	All Sites	6; 76 (77.6%)	4; 83 (90.4%)	0.175 - 0.387	0.125 - 0.125	0.235 (0.192, 0.277)	0.125 (0.125, 0.125)	▼▼◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 76 (77.6%)	4; 83 (90.4%)	0.175 - 0.387	0.125 - 0.125	0.235 (0.192, 0.277)	0.125 (0.125, 0.125)	▼▼◇
WB	All Sites	6; 42 (81.0%)	5; 33 (84.8%)	0.192 - 0.500	0.125 - 0.500	0.300 (0.300, 0.500)	0.300 (0.170, 0.500)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 42 (81.0%)	5; 33 (84.8%)	0.192 - 0.500	0.125 - 0.500	0.300 (0.300, 0.500)	0.300 (0.170, 0.500)	◇◇◇
BS	All Sites	13; 88 (33.0%)	12; 74 (52.7%)	0.110 - 0.400	0.0775 - 0.200	0.200 (0.200, 0.300)	0.116 (0.0941, 0.153)	▼▼▼
	DOT	6; 37 (0.0%)	5; 23 (0.0%)	0.290 - 0.530	0.200 - 0.270	0.400 (0.200, 0.400)	0.200 (0.200, 0.200)	▼▼▼
	Non-DOT	7; 51 (56.9%)	7; 41 (70.7%)	0.0340 - 0.200	0.0318 - 0.110	0.110 (0.0415, 0.110)	0.0540 (0.0339, 0.0674)	◇◇▼
BI	All Sites	34; 614 (48.4%)	32; 431 (65.2%)	0.0580 - 0.255	0.0300 - 0.200	0.114 (0.100, 0.130)	0.0700 (0.0584, 0.0793)	▼▼▼
	DOT	34; 614 (48.4%)	32; 431 (65.2%)	0.058 - 0.255	0.030 - 0.200	0.114 (0.100, 0.131)	0.0700 (0.0584, 0.0793)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	7; 150 (74.0%)	7; 103 (67.0%)	0.0068- 0.0542	0.0127 - 0.0640	0.0203 (0.0142, 0.0276)	0.0298 (0.0191, 0.0360)	◇◇◇
	DOT	7; 150 (74.0%)	7; 103 (67.0%)	0.0068 - 0.0542	0.0127 - 0.0640	0.0203 (0.0145, 0.0279)	0.0298 (0.0191, 0.0360)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 110 (24.5%)	11; 106 (46.2%)	0.100 - 0.200	0.122 - 0.200	0.200 (0.110, 0.200)	0.200 (0.136, 0.200)	◇◇▼
	DOT	11; 110 (24.5%)	11; 106 (46.2%)	0.100 - 0.200	0.122 - 0.200	0.200 (0.100, 0.200)	0.200 (0.136, 0.200)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	7; 84 (21.4%)	7; 84 (17.9%)	0.0567 - 0.325	0.0364 - 0.300	0.136 (0.0810, 0.200)	0.0932 (0.0600, 0.190)	◇◇▼
	DOT	7; 84 (21.4%)	7; 84 (17.9%)	0.0567 - 0.325	0.0364 - 0.300	0.136 (0.0810, 0.200)	0.0932 (0.0600, 0.190)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	3; 25 (48.0%)	3; 27 (37.0%)	0.221 - 1.40	0.0510 - 1.65	0.397 (0.221, 0.700)	0.102 (0.0520, 1.10)	◇◇▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 25 (48.0%)	3; 27 (37.0%)	0.221 - 1.40	0.0510 - 1.65	0.397 (0.221, 0.700)	0.102 (0.0520, 1.10)	◇◇▼
PP	All Sites	4; 304 (63.2%)	7; 148 (65.5%)	0.0452 - 0.100	0.0278 - 0.100	0.0750 (0.0644, 0.0783)	0.0605 (0.0421, 0.0717)	◇▼◇
	DOT	4; 304 (63.2%)	7; 148 (65.5%)	0.0452 - 0.100	0.0278 - 0.100	0.0750 (0.0644, 0.0786)	0.0605 (0.0421, 0.0717)	◇▼◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

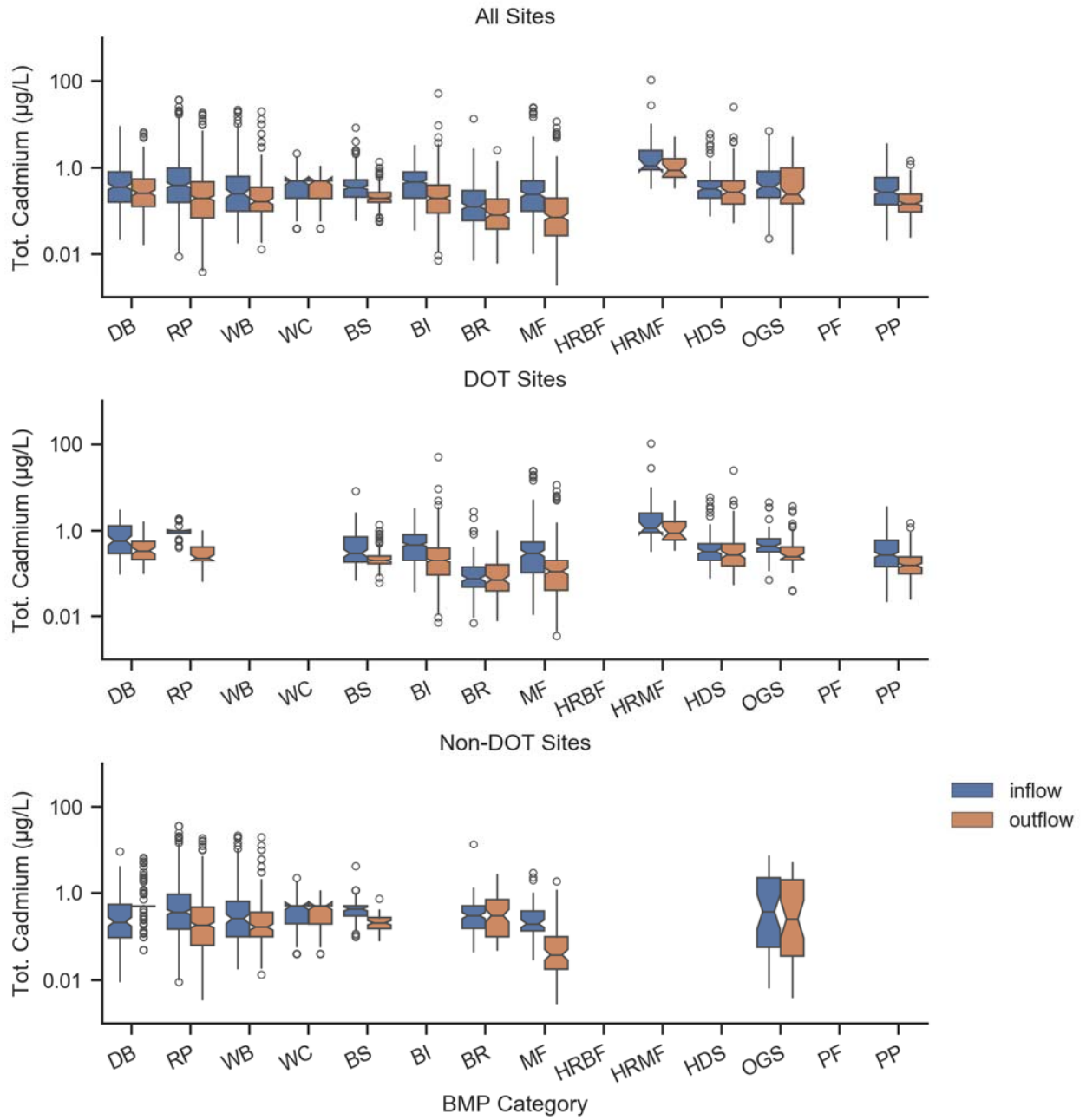


Figure 6.4. Box Plots of Influent/Effluent Total Cadmium Concentrations

Table 6-4. Influent/Effluent Summary Statistics for Total Cadmium ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	18; 234 (60.7%)	17; 219 (68.0%)	0.162 - 0.813	0.128 - 0.553	0.368 (0.294, 0.431)	0.265 (0.210, 0.314)	◇▼▼
	DOT	7; 85 (37.6%)	6; 70 (44.3%)	0.296 - 1.30	0.215 - 0.570	0.590 (0.413, 0.70)	0.343 (0.292, 0.40)	▼▼▼
	Non-DOT	11; 149 (73.8%)	11; 159 (80.5%)	0.0957 - 0.540	0.50 - 0.50	0.219 (0.161, 0.271)	0.50 (0.50, 0.50)	△△◇
RP	All Sites	33; 518 (38.2%)	35; 545 (54.5%)	0.159 - 1.0	0.0696 - 0.477	0.40 (0.30, 0.437)	0.20 (0.154, 0.20)	▼▼▼
	DOT	3; 21 (4.8%)	3; 52 (53.8%)	0.870 - 1.0	0.193 - 0.420	1.0 (1.0, 1.0)	0.234 (0.20, 0.310)	▼▼▼
	Non-DOT	30; 497 (39.6%)	32; 490 (54.3%)	0.150 - 0.926	0.0637 - 0.467	0.361 (0.30, 0.40)	0.186 (0.138, 0.20)	▼▼▼
WB	All Sites	9; 154 (43.5%)	9; 149 (59.7%)	0.10 - 0.636	0.100 - 0.357	0.255 (0.20, 0.30)	0.168 (0.105, 0.190)	▼▼◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	9; 154 (43.5%)	9; 149 (59.7%)	0.10 - 0.636	0.100 - 0.357	0.255 (0.20, 0.30)	0.168 (0.105, 0.190)	▼▼◇
WC	All Sites	7; 55 (23.6%)	7; 52 (44.2%)	0.201 - 0.50	0.197 - 0.50	0.50 (0.226, 0.50)	0.50 (0.278, 0.50)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	7; 55 (23.6%)	7; 52 (44.2%)	0.201 - 0.50	0.197 - 0.50	0.50 (0.226, 0.50)	0.50 (0.278, 0.50)	◇◇◇
BS	All Sites	17; 188 (35.6%)	16; 164 (37.8%)	0.212 - 0.530	0.160 - 0.270	0.354 (0.285, 0.410)	0.199 (0.194, 0.20)	▼▼▼
	DOT	9; 117 (29.9%)	8; 95 (29.5%)	0.180 - 0.720	0.165 - 0.260	0.30 (0.221, 0.348)	0.20 (0.196, 0.20)	▼▼▼
	Non-DOT	8; 70 (44.3%)	8; 59 (40.7%)	0.293 - 0.502	0.154 - 0.270	0.425 (0.370, 0.448)	0.210 (0.170, 0.250)	▼▼▼
BI	All Sites	35; 620 (13.9%)	34; 437 (37.3%)	0.20 - 0.810	0.0904 - 0.40	0.480 (0.40, 0.50)	0.20 (0.20, 0.220)	▼▼▼
	DOT	35; 620 (13.9%)	34; 437 (37.3%)	0.20 - 0.810	0.0904 - 0.40	0.480 (0.40, 0.50)	0.20 (0.20, 0.220)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	13; 232 (48.3%)	14; 216 (58.3%)	0.0605 - 0.30	0.0386 - 0.190	0.130 (0.10, 0.152)	0.0825 (0.0645, 0.0989)	▼▼▼
	DOT	9; 110 (39.1%)	11; 112 (34.8%)	0.0474 - 0.138	0.0387 - 0.157	0.0751 (0.061, 0.094)	0.0705 (0.060, 0.0916)	◇◇▼
	Non-DOT	4; 115 (53.9%)	3; 89 (80.9%)	0.156 - 0.50	0.10 - 0.70	0.30 (0.20, 0.30)	0.30 (0.20, 0.50)	◇◇◇
MF	All Sites	21; 264 (47.0%)	23; 286 (64.7%)	0.10 - 0.50	0.0271 - 0.20	0.247 (0.20, 0.30)	0.0732 (0.0585, 0.10)	▼▼▼
	DOT	15; 203 (42.9%)	16; 196 (61.2%)	0.102 - 0.547	0.040 - 0.20	0.30 (0.20, 0.330)	0.110 (0.0754, 0.197)	▼▼▼
	Non-DOT	6; 61 (60.7%)	7; 89 (71.9%)	0.137 - 0.381	0.0179 - 0.10	0.20 (0.165, 0.248)	0.0384 (0.0288, 0.0502)	▼▼◇
HRMF	All Sites	3; 23 (47.8%)	3; 23 (47.8%)	0.910 - 2.55	0.609 - 1.64	1.15 (0.870, 2.29)	0.884 (0.60, 1.30)	◇◇▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	3; 23 (47.8%)	3; 23 (47.8%)	0.910 - 2.55	0.609 - 1.64	1.15 (0.870, 2.29)	0.884 (0.60, 1.30)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	8; 102 (25.5%)	8; 103 (27.2%)	0.20 - 0.50	0.146 - 0.50	0.333 (0.280, 0.40)	0.280 (0.185, 0.300)	◇◇▼
	DOT	8; 102 (25.5%)	8; 103 (27.2%)	0.20 - 0.50	0.146 - 0.50	0.333 (0.280, 0.40)	0.280 (0.185, 0.300)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	9; 118 (31.4%)	9; 89 (15.7%)	0.206 - 0.840	0.149 - 1.01	0.371 (0.345, 0.454)	0.250 (0.212, 0.340)	▼◇▼
	DOT	4; 78 (35.9%)	4; 48 (8.3%)	0.322 - 0.648	0.209 - 0.420	0.441 (0.363, 0.486)	0.256 (0.220, 0.330)	▼▼◇
	Non-DOT	5; 40 (22.5%)	5; 41 (24.4%)	0.0571 - 2.23	0.0360 - 2.0	0.370 (0.104, 1.20)	0.250 (0.0430, 0.470)	◇◇◇
PP	All Sites	4; 294 (63.9%)	8; 180 (76.1%)	0.141 - 0.60	0.0965 - 0.248	0.277 (0.237, 0.313)	0.150 (0.132, 0.171)	▼▼▼
	DOT	4; 294 (63.9%)	8; 180 (76.1%)	0.141 - 0.60	0.0965 - 0.248	0.277 (0.237, 0.313)	0.150 (0.132, 0.171)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

6.3 Chromium

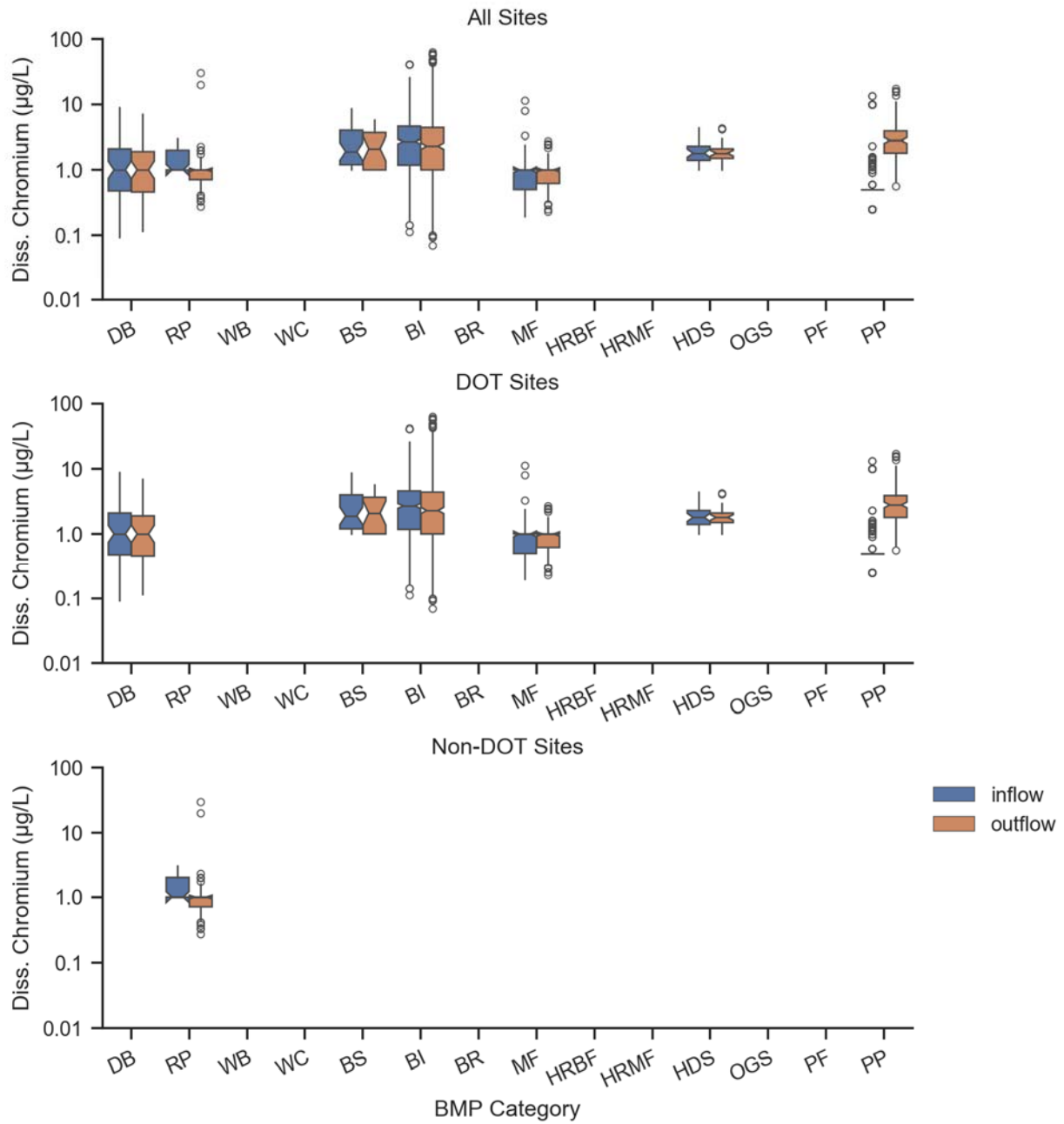


Figure 6.5. Box Plots of Influent/Effluent Dissolved Chromium Concentrations

Table 6-5. Influent/Effluent Summary Statistics for Dissolved Chromium (µg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	5; 60 (45.0%)	5; 53 (45.3%)	0.477 - 2.10	0.458 - 1.90	1.00 (0.524, 1.10)	1.00 (0.458, 1.00)	◇◇▼
	DOT	5; 60 (45.0%)	5; 53 (45.3%)	0.477 - 2.10	0.458 - 1.90	1.00 (0.524, 1.10)	1.00 (0.458, 1.00)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
RP	All Sites	5; 33 (0.0%)	3; 72 (47.2%)	1.00 - 2.00	0.709 - 1.00	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	◇▼◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	5; 33 (0.0%)	3; 72 (47.2%)	1.00 - 2.00	0.709 - 1.00	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	◇▼◇
BS	All Sites	6; 37 (0.0%)	5; 23 (0.0%)	1.20 - 4.00	1.00 - 3.70	1.90 (1.20, 2.70)	2.10 (1.00, 3.20)	◇◇◇
	DOT	6; 37 (0.0%)	5; 23 (0.0%)	1.20 - 4.00	1.00 - 3.70	1.90 (1.20, 2.70)	2.10 (1.00, 3.00)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BI	All Sites	34; 617 (14.4%)	33; 434 (17.3%)	1.18 - 4.60	1.00 - 4.40	2.70 (2.20, 2.80)	2.30 (2.00, 2.70)	◇◇◇
	DOT	34; 617 (14.4%)	33; 434 (17.3%)	1.18 - 4.60	1.00 - 4.40	2.70 (2.20, 2.80)	2.30 (2.00, 2.70)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 121 (18.2%)	11; 106 (15.1%)	0.500 - 1.00	0.620 - 1.00	1.00 (0.705, 1.00)	1.00 (1.00, 1.00)	◇◇▼
	DOT	11; 121 (18.2%)	11; 106 (15.1%)	0.500 - 1.00	0.620 - 1.00	1.00 (0.705, 1.00)	1.00 (1.00, 1.00)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	3; 29 (0.0%)	3; 29 (0.0%)	1.40 - 2.30	1.50 - 2.10	1.80 (1.30, 1.80)	1.80 (1.50, 2.00)	◇◇◇
	DOT	3; 29 (0.0%)	3; 29 (0.0%)	1.40 - 2.30	1.50 - 2.10	1.80 (1.30, 1.80)	1.80 (1.50, 2.00)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	4; 316 (88.0%)	5; 146 (8.9%)	0.50 - 0.50	1.80 - 3.90	0.50 (0.50, 0.50)	2.80 (2.31, 2.95)	△△△
	DOT	4; 316 (88.0%)	5; 146 (8.9%)	0.50 - 0.50	1.80 - 3.90	0.50 (0.50, 0.50)	2.80 (2.31, 2.95)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

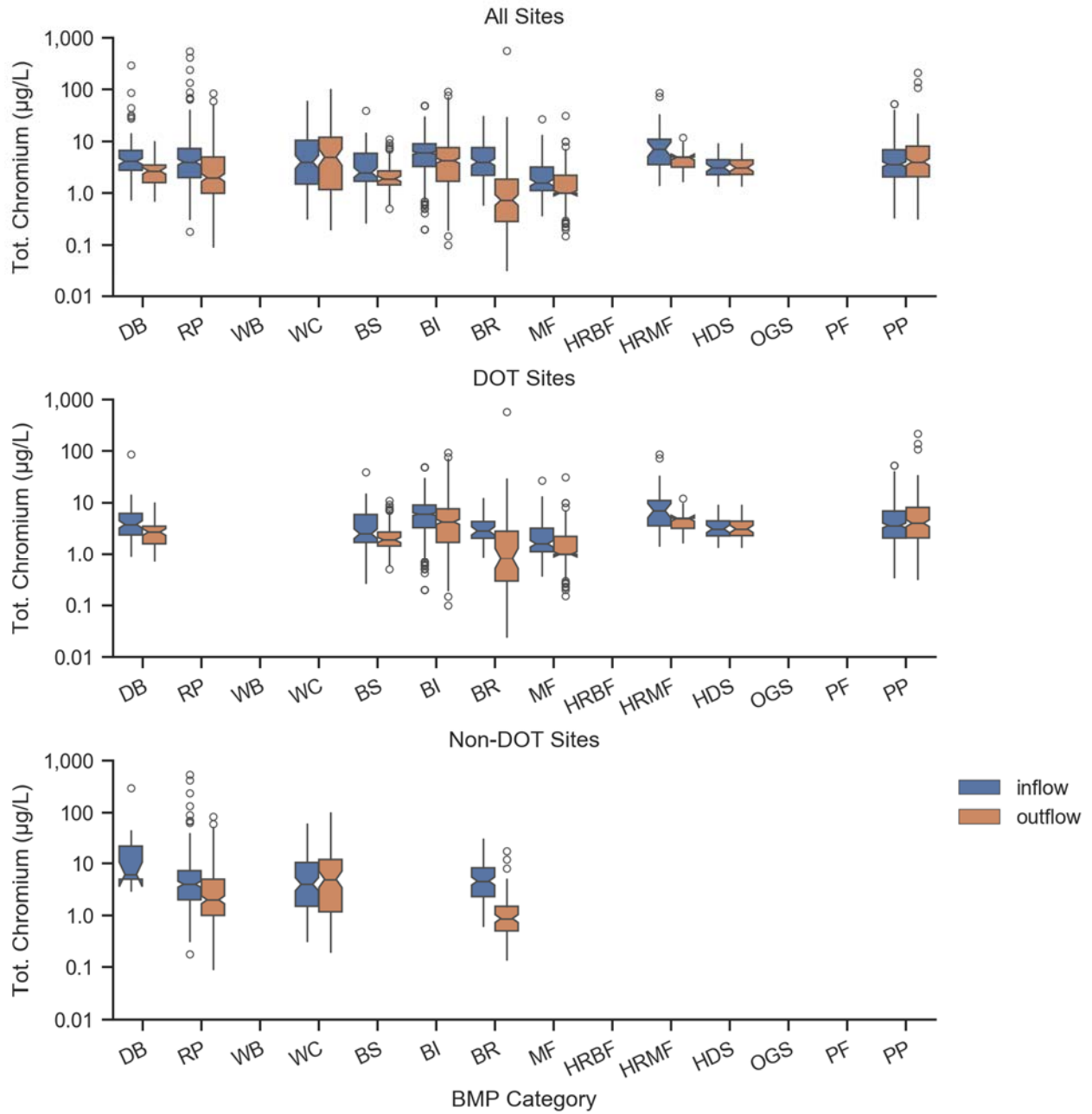


Figure 6.6. Box Plots of Influent/Effluent Total Chromium Concentrations

Table 6-6. Influent/Effluent Summary Statistics for Total Chromium ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	10; 102 (28.4%)	6; 69 (43.5%)	2.77 - 6.70	1.60 - 3.50	4.12 (3.34, 4.90)	2.70 (1.99, 3.10)	▼▼▼
	DOT	7; 84 (34.5%)	6; 69 (43.5%)	2.38 - 6.20	1.60 - 3.50	3.79 (3.00, 4.12)	2.70 (1.99, 3.10)	◇▼▼
	Non-DOT	3; 18 (0.0%)	NA	5.00 - 23.5	NA	6.18 (5.00, 8.79)	NA	NA
RP	All Sites	17; 233 (29.6%)	16; 211 (25.1%)	2.00 - 7.30	1.00 - 5.00	4.00 (3.00, 4.09)	2.00 (1.00, 2.00)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	17; 233 (29.6%)	16; 211 (25.1%)	2.00 - 7.30	1.00 - 5.00	4.00 (3.00, 4.09)	2.00 (1.00, 2.00)	▼▼▼
WC	All Sites	6; 113 (21.2%)	6; 100 (25.0%)	1.50 - 10.5	1.18 - 12.0	4.00 (3.00, 5.00)	4.97 (3.00, 5.00)	◇◇△
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 113 (21.2%)	6; 100 (25.0%)	1.50 - 10.5	1.18 - 12.0	4.00 (3.00, 5.00)	4.97 (3.00, 5.00)	◇◇△
BS	All Sites	8; 83 (2.4%)	7; 67 (7.5%)	1.70 - 5.90	1.45 - 2.70	2.50 (2.40, 3.60)	1.90 (1.60, 2.20)	▼▼▼
	DOT	8; 83 (2.4%)	7; 67 (7.5%)	1.70 - 5.90	1.45 - 2.70	2.50 (2.40, 3.60)	1.90 (1.60, 2.20)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BI	All Sites	35; 620 (5.8%)	34; 438 (10.3%)	3.27 - 9.00	1.70 - 7.60	6.00 (5.70, 6.40)	4.25 (3.70, 4.90)	▼▼▼
	DOT	35; 620 (5.8%)	34; 438 (10.3%)	3.27 - 9.00	1.70 - 7.60	6.00 (5.70, 6.40)	4.25 (3.70, 4.90)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	7; 167 (34.1%)	7; 152 (66.4%)	2.21 - 7.60	0.284 - 1.87	4.00 (3.20, 4.63)	0.738 (0.504, 0.883)	▼▼▼
	DOT	3; 40 (75.0%)	4; 58 (60.3%)	2.05 - 4.33	0.295 - 2.81	2.85 (2.36, 3.59)	0.818 (0.428, 1.18)	▼▼◇
	Non-DOT	4; 127 (21.3%)	3; 94 (70.2%)	2.31 - 8.30	0.503 - 1.50	4.60 (3.40, 5.40)	0.870 (0.707, 1.05)	▼▼▼
MF	All Sites	11; 122 (9.8%)	12; 124 (11.3%)	1.13 - 3.20	1.00 - 2.23	1.60 (1.50, 2.20)	1.00 (1.00, 1.26)	▼▼▼
	DOT	11; 122 (9.8%)	12; 124 (11.3%)	1.13 - 3.20	1.00 - 2.23	1.60 (1.50, 2.20)	1.00 (1.00, 1.26)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	3; 31 (32.3%)	3; 31 (32.3%)	3.56 - 11.0	3.18 - 5.00	7.00 (3.60, 7.24)	4.99 (3.18, 5.00)	◇▼▼
	DOT	3; 31 (32.3%)	3; 31 (32.3%)	3.56 - 11.0	3.18 - 5.00	7.00 (3.60, 7.24)	4.99 (3.18, 5.00)	◇▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	3; 38 (15.8%)	3; 38 (18.4%)	2.28 - 4.44	2.30 - 4.40	3.10 (2.60, 3.58)	3.10 (2.50, 3.60)	◇◇◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	3; 38 (15.8%)	3; 38 (18.4%)	2.28 - 4.44	2.30 - 4.40	3.10 (2.60, 3.58)	3.10 (2.50, 3.60)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	4; 318 (51.6%)	9; 198 (49.0%)	2.06 - 6.90	2.08 - 8.10	3.62 (3.29, 4.10)	4.00 (3.14, 5.00)	◇◇◇
	DOT	4; 318 (51.6%)	9; 198 (49.0%)	2.06 - 6.90	2.08 - 8.10	3.62 (3.29, 4.10)	4.00 (3.14, 5.00)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

6.4 Copper

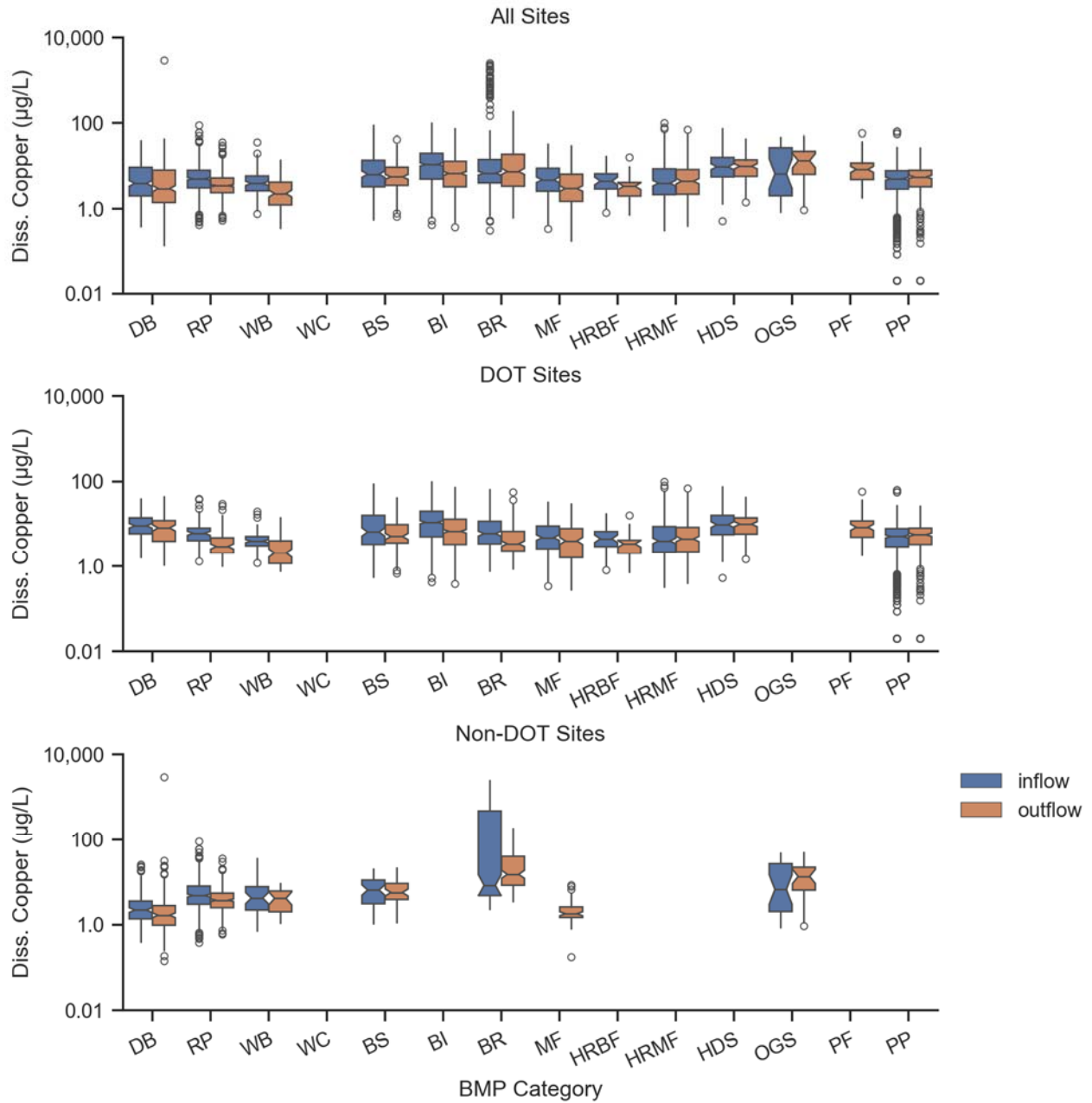


Figure 6.7. Box Plots of Influent/Effluent Dissolved Copper Concentrations

Table 6-7. Influent/Effluent Summary Statistics for Dissolved Copper ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	14; 258 (14.3%)	14; 270 (23.0%)	2.01 - 9.40	1.41 - 8.07	3.96 (3.59, 5.02)	2.99 (2.23, 3.20)	▼▼▼
	DOT	6; 120 (1.7%)	6; 108 (1.9%)	5.87 - 14.0	3.90 - 12.0	9.10 (7.80, 10.1)	8.10 (5.91, 9.50)	◇◇▼
	Non-DOT	8; 138 (25.4%)	8; 162 (37.0%)	1.37 - 3.57	0.974 - 2.79	2.20 (1.86, 2.50)	1.66 (1.30, 1.90)	◇▼◇
RP	All Sites	22; 432 (6.9%)	22; 424 (9.0%)	3.11 - 8.00	2.40 - 5.30	5.08 (4.60, 5.50)	3.50 (3.19, 3.80)	▼▼▼
	DOT	4; 88 (0.0%)	4; 91 (0.0%)	4.04 - 8.00	2.02 - 4.73	6.06 (5.19, 6.60)	2.95 (2.46, 3.35)	▼▼◇
	Non-DOT	18; 344 (8.7%)	18; 333 (11.4%)	3.00 - 8.00	2.50 - 5.47	4.80 (4.10, 5.16)	3.72 (3.30, 4.00)	▼▼▼
WB	All Sites	9; 125 (10.4%)	8; 110 (20.9%)	2.65 - 5.90	1.24 - 4.23	3.95 (3.33, 4.30)	2.29 (1.76, 3.33)	◇▼◇
	DOT	3; 83 (4.8%)	3; 77 (7.8%)	3.05 - 5.09	1.16 - 4.00	3.95 (3.33, 4.27)	2.05 (1.47, 3.33)	◇▼◇
	Non-DOT	6; 42 (21.4%)	5; 25 (36.0%)	2.20 - 7.75	2.00 - 6.13	4.21 (2.65, 5.91)	4.12 (2.00, 5.44)	◇◇◇
BS	All Sites	16; 174 (4.0%)	16; 141 (2.1%)	3.30 - 13.7	3.56 - 9.46	6.50 (5.00, 7.87)	5.63 (4.83, 6.74)	◇◇▼
	DOT	9; 122 (0.0%)	9; 89 (0.0%)	3.31 - 16.0	3.56 - 9.70	6.50 (4.59, 8.60)	5.10 (4.30, 6.33)	◇◇▼
	Non-DOT	7; 52 (13.5%)	7; 52 (5.8%)	3.08 - 11.1	3.89 - 9.24	6.49 (5.00, 7.93)	5.66 (4.94, 7.66)	◇◇▼
BI	All Sites	37; 669 (2.2%)	36; 478 (4.4%)	5.00 - 20.0	3.30 - 13.0	11.0 (8.40, 11.0)	6.75 (6.12, 7.59)	▼▼▼
	DOT	37; 669 (2.2%)	36; 478 (4.4%)	5.00 - 20.0	3.30 - 13.0	11.0 (8.40, 11.0)	6.75 (6.12, 7.59)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	16; 360 (2.8%)	14; 261 (7.3%)	4.07 - 14.3	3.41 - 19.0	6.85 (5.99, 7.87)	7.54 (6.50, 8.40)	◇◇▼
	DOT	12; 204 (4.9%)	11; 133 (14.3%)	3.41 - 11.6	2.32 - 6.71	5.94 (5.08, 7.00)	3.44 (2.76, 3.86)	▼▼▼
	Non-DOT	4; 156 (0.0%)	3; 128 (0.0%)	4.80 - 474	8.37 - 40.0	8.35 (6.60, 10.00)	15.1 (12.6, 19.2)	△△△
MF	All Sites	12; 170 (5.9%)	16; 233 (5.6%)	2.60 - 8.95	1.50 - 6.50	4.80 (3.87, 5.55)	3.00 (2.35, 3.50)	▼▼▼
	DOT	12; 170 (5.9%)	12; 165 (7.9%)	2.60 - 8.95	1.60 - 7.80	4.80 (3.92, 5.55)	4.00 (3.00, 4.15)	◇◇▼
	Non-DOT	NA	4; 68 (0.0%)	NA	1.47 - 2.61	NA	1.80 (1.60, 1.98)	NA
HRBF	All Sites	4; 38 (10.5%)	4; 38 (7.9%)	2.92 - 6.65	2.00 - 4.15	4.50 (2.95, 5.00)	3.40 (2.30, 3.84)	◇▼▼
	DOT	4; 38 (10.5%)	4; 38 (7.9%)	2.92 - 6.65	2.00 - 4.15	4.50 (2.95, 5.00)	3.40 (2.30, 3.84)	◇▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	12; 210 (11.9%)	12; 210 (10.0%)	2.17 - 8.68	2.21 - 8.34	4.00 (3.68, 4.72)	4.45 (3.72, 5.05)	◇◇◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	12; 210 (11.9%)	12; 210 (10.0%)	2.17 - 8.68	2.21 - 8.34	4.00 (3.68, 4.72)	4.45 (3.72, 5.05)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	8; 106 (5.7%)	8; 106 (4.7%)	5.61 - 16.0	5.77 - 14.0	9.70 (8.00, 12.1)	9.95 (7.90, 11.0)	◇◇△
	DOT	8; 106 (5.7%)	8; 106 (4.7%)	5.61 - 16.0	5.77 - 14.0	9.70 (8.00, 12.1)	9.95 (7.90, 11.0)	◇◇△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	3; 26 (0.0%)	3; 26 (0.0%)	2.03 - 27.0	6.45 - 22.1	8.21 (2.18, 22.8)	13.5 (6.96, 17.5)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 26 (0.0%)	3; 26 (0.0%)	2.03 - 27.0	6.45 - 22.1	8.21 (2.18, 22.8)	13.5 (6.96, 17.5)	◇◇◇
PFC	All Sites	NA	3; 69 (0.0%)	NA	4.88 - 11.8	NA	8.40 (5.93, 9.33)	NA
	DOT	NA	3; 69 (0.0%)	NA	4.88 - 11.8	NA	8.40 (5.93, 9.33)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	7; 405 (13.6%)	10; 244 (6.1%)	2.90 - 7.80	3.30 - 8.00	5.10 (4.70, 5.50)	5.60 (5.00, 6.00)	◇◇△
	DOT	7; 405 (13.6%)	10; 244 (6.1%)	2.90 - 7.80	3.30 - 8.00	5.10 (4.70, 5.50)	5.60 (5.00, 6.00)	◇◇△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

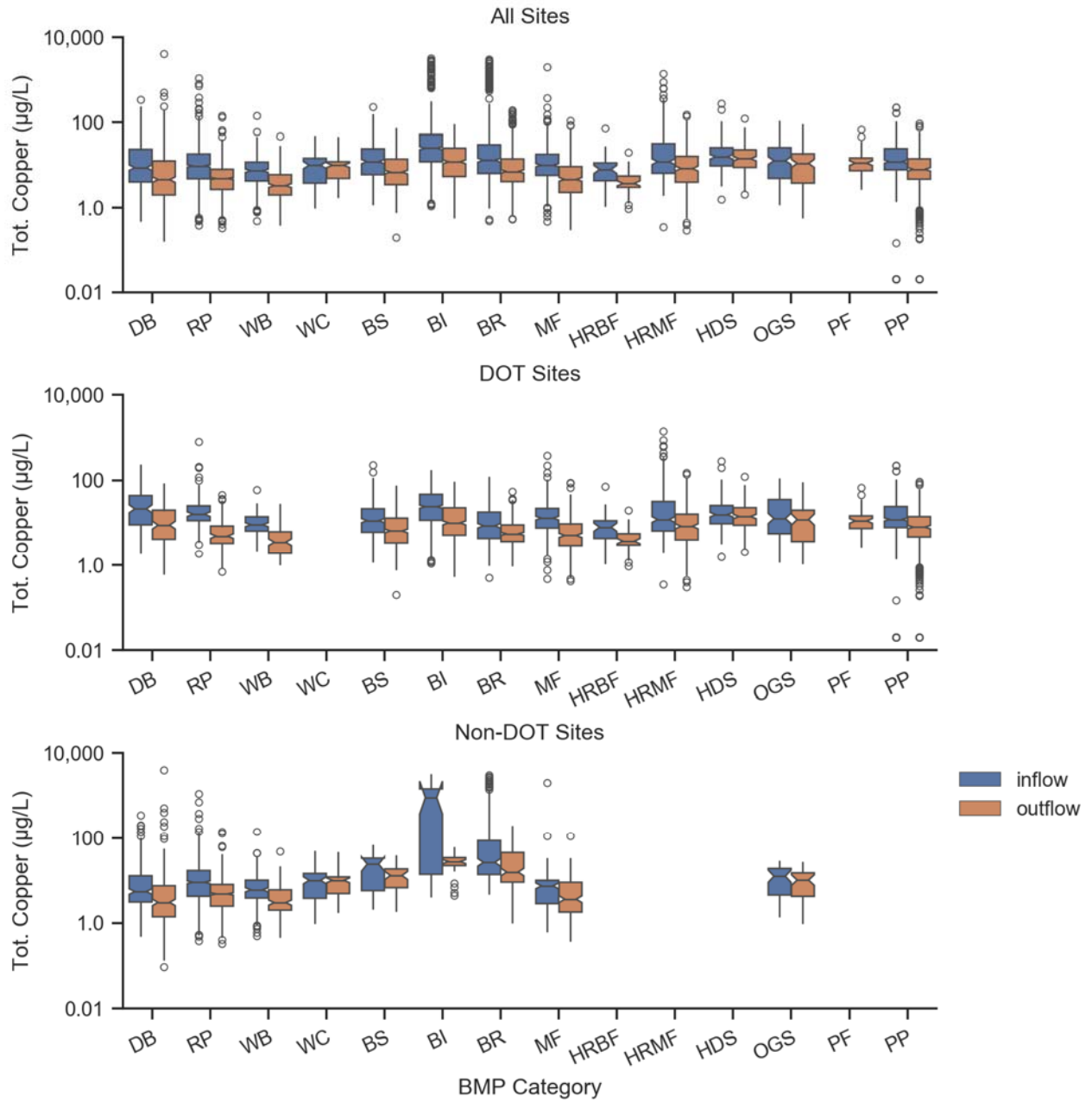


Figure 6.8. Box Plots of Influent/Effluent Total Copper Concentrations

Table 6-8. Influent/Effluent Summary Statistics for Total Copper ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	23; 359 (6.4%)	23; 370 (19.5%)	4.04 - 23.5	2.00 - 12.5	8.75 (7.25, 10.0)	4.58 (3.74, 5.46)	▼▼▼
	DOT	8; 133 (0.8%)	8; 138 (2.2%)	9.05 - 44.0	4.13 - 20.0	21.5 (15.9, 28.0)	8.92 (6.70, 11.0)	▼▼▼
	Non-DOT	15; 226 (9.7%)	15; 232 (29.7%)	3.10 - 12.8	1.40 - 7.47	5.46 (4.77, 6.27)	3.04 (2.11, 3.64)	▼▼▼
RP	All Sites	52; 934 (8.8%)	54; 922 (16.9%)	4.80 - 18.3	2.70 - 8.00	9.59 (8.90, 10.0)	4.88 (4.44, 5.00)	▼▼▼
	DOT	6; 102 (0.0%)	6; 138 (3.6%)	11.3 - 25.3	3.30 - 8.46	16.1 (13.3, 17.4)	4.92 (4.30, 5.55)	▼▼▼
	Non-DOT	46; 832 (9.9%)	48; 784 (19.3%)	4.24 - 17.0	2.48 - 8.00	8.99 (8.00, 9.26)	4.80 (4.26, 5.00)	▼▼▼
WB	All Sites	14; 298 (8.1%)	14; 258 (18.2%)	4.27 - 11.8	2.00 - 6.00	7.40 (6.46, 8.21)	3.32 (3.00, 3.99)	▼▼▼
	DOT	5; 128 (12.5%)	5; 107 (8.4%)	6.43 - 14.0	1.89 - 6.19	9.11 (8.18, 9.91)	3.53 (2.50, 4.04)	▼▼▼
	Non-DOT	9; 170 (4.7%)	9; 151 (25.2%)	3.84 - 10.1	2.00 - 6.00	6.00 (4.54, 6.31)	3.00 (3.00, 4.00)	▼▼▼
WC	All Sites	7; 123 (6.5%)	7; 120 (5.8%)	3.79 - 14.5	4.90 - 12.0	10.0 (5.40, 10.0)	10.0 (10.0, 10.0)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	7; 123 (6.5%)	7; 120 (5.8%)	3.79 - 14.5	4.90 - 12.0	10.0 (5.40, 10.0)	10.0 (10.0, 10.0)	◇◇◇
BS	All Sites	23; 378 (8.7%)	27; 476 (9.5%)	6.00 - 24.1	3.50 - 13.9	12.1 (10.2, 14.0)	6.90 (6.00, 7.80)	▼▼▼
	DOT	16; 326 (9.2%)	20; 424 (10.1%)	6.02 - 21.6	3.40 - 13.0	11.3 (9.75, 12.9)	6.50 (5.55, 7.25)	▼▼▼
	Non-DOT	7; 52 (5.8%)	7; 52 (3.8%)	5.75 - 33.2	6.75 - 18.5	24.1 (14.0, 24.3)	13.0 (10.9, 15.0)	◇▼▼
BI	All Sites	41; 745 (0.4%)	40; 526 (0.4%)	12.0 - 52.0	5.44 - 25.0	25.0 (22.0, 26.0)	12.0 (10.0, 13.0)	▼▼▼
	DOT	38; 678 (0.4%)	37; 486 (0.4%)	11.5 - 47.0	5.15 - 22.8	24.1 (22.0, 26.0)	10.1 (9.30, 12.0)	▼▼▼
	Non-DOT	3; 67 (0.0%)	3; 40 (0.0%)	14.0 - 1,450	22.2 - 34.2	904 (723, 1,010)	27.5 (24.0, 31.5)	▼▼▼
BR	All Sites	30; 512 (0.4%)	27; 469 (2.6%)	6.40 - 30.0	4.12 - 14.0	13.1 (11.5, 15.2)	7.13 (6.40, 8.20)	▼▼▼
	DOT	20; 319 (0.6%)	21; 313 (3.2%)	4.32 - 18.0	3.65 - 9.00	8.60 (7.40, 9.62)	5.56 (5.08, 5.80)	▼▼▼
	Non-DOT	10; 193 (0.0%)	6; 156 (1.3%)	13.7 - 86.8	9.08 - 45.3	26.4 (21.1, 29.5)	15.7 (13.5, 17.8)	▼▼▼
MF	All Sites	27; 434 (6.9%)	30; 458 (12.7%)	5.77 - 18.0	2.30 - 9.27	10.0 (9.50, 11.0)	4.65 (4.00, 5.21)	▼▼▼
	DOT	16; 276 (6.5%)	17; 268 (11.9%)	7.60 - 22.0	2.94 - 9.50	13.0 (11.0, 14.0)	5.10 (4.23, 5.77)	▼▼▼
	Non-DOT	11; 158 (7.6%)	13; 190 (13.7%)	2.85 - 10.0	1.80 - 9.00	7.42 (4.50, 8.15)	3.62 (2.57, 4.43)	▼▼▼
HRBF	All Sites	4; 46 (2.2%)	4; 46 (6.5%)	4.33 - 11.3	3.03 - 5.57	7.95 (5.40, 8.90)	3.75 (3.20, 4.80)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	4; 46 (2.2%)	4; 46 (6.5%)	4.33 - 11.3	3.03 - 5.57	7.95 (5.40, 8.90)	3.75 (3.20, 4.80)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	13; 258 (1.6%)	13; 258 (4.7%)	6.47 - 31.9	4.00 - 16.1	12.1 (10.5, 14.2)	8.35 (7.00, 9.32)	▼▼▼
	DOT	13; 258 (1.6%)	13; 258 (4.7%)	6.47 - 31.9	4.00 - 16.1	12.1 (10.6, 14.2)	8.35 (7.00, 9.40)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	12; 162 (0.6%)	12; 162 (1.2%)	9.60 - 25.8	8.85 - 22.9	15.7 (13.0, 17.5)	14.2 (12.0, 16.2)	◇◇▼
	DOT	12; 162 (0.6%)	12; 162 (1.2%)	9.60 - 25.8	8.85 - 22.9	15.7 (13.0, 17.5)	14.2 (12.0, 16.2)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	11; 155 (0.0%)	11; 128 (0.8%)	4.90 - 25.8	3.80 - 18.4	12.8 (8.72, 14.4)	11.1 (6.25, 13.6)	◇▼▼
	DOT	5; 109 (0.0%)	5; 80 (0.0%)	5.58 - 35.5	3.65 - 19.9	12.8 (8.72, 18.2)	12.0 (4.60, 14.7)	◇▼▼
	Non-DOT	6; 46 (0.0%)	6; 48 (2.1%)	4.53 - 19.0	4.22 - 15.0	12.5 (6.15, 14.2)	10.2 (6.10, 13.6)	◇◇▼
PFC	All Sites	NA	3; 69 (0.0%)	NA	7.42 - 14.7	NA	11.2 (8.53, 13.2)	NA
	DOT Sites	NA	3; 69 (0.0%)	NA	7.42 - 14.7	NA	11.2 (8.53, 13.2)	NA
	Non-DOT Sites	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	12; 459 (2.6%)	17; 323 (13.9%)	7.80 - 24.3	4.70 - 14.1	12.1 (11.2, 12.8)	8.00 (7.00, 8.20)	▼▼▼
	DOT Sites	12; 459 (2.6%)	17; 323 (13.9%)	7.80 - 24.3	4.70 - 14.1	12.1 (11.2, 12.8)	8.00 (7.00, 8.20)	▼▼▼
	Non-DOT Sites	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

6.5 Iron

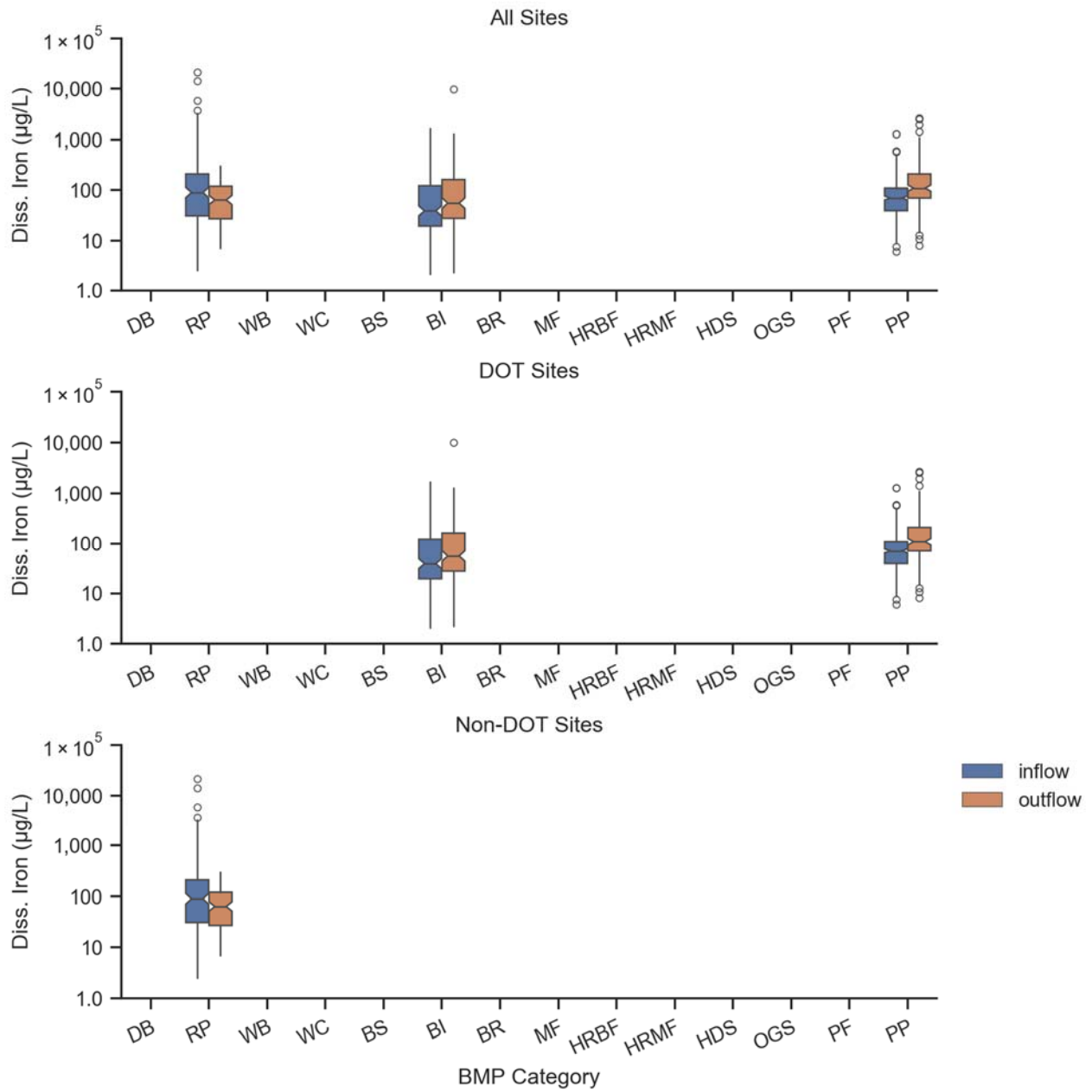


Figure 6.9. Box Plots of Influent/Effluent Dissolved Iron Concentrations

Table 6-9. Influent/Effluent Summary Statistics for Dissolved Iron ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
RP	All Sites	6; 164 (10.4%)	5; 125 (20.8%)	31.0 - 210	27.2 - 120	90.0 (60.0, 110)	64.0 (46.0, 72.2)	◇ ▼ ▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 164 (10.4%)	5; 125 (20.8%)	31.0 - 210	27.2 - 120	90.0 (60.0, 110)	64.0 (46.0, 72.2)	◇ ▼ ▼
BI	All Sites	12; 159 (36.5%)	12; 132 (25.8%)	19.5 - 123	27.8 - 162	39.0 (30.0, 49.0)	55.5 (40.5, 69.5)	◇ ▲ ▲
	DOT	12; 159 (36.5%)	12; 132 (25.8%)	19.5 - 123	27.8 - 162	39.0 (30.0, 49.0)	55.5 (40.5, 69.5)	◇ ▲ ▲
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	4; 314 (26.8%)	4; 146 (13.7%)	39.3 - 110	70.0 - 210	70.0 (56.2, 70.0)	110 (90.0, 115)	▲ ▲ ▲
	DOT	4; 314 (26.8%)	4; 146 (13.7%)	39.3 - 110	70.0 - 210	70.0 (56.2, 70.0)	110 (90.0, 115)	▲ ▲ ▲
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

▲ influent/effluent comparison test indicates significant *increase* in concentrations

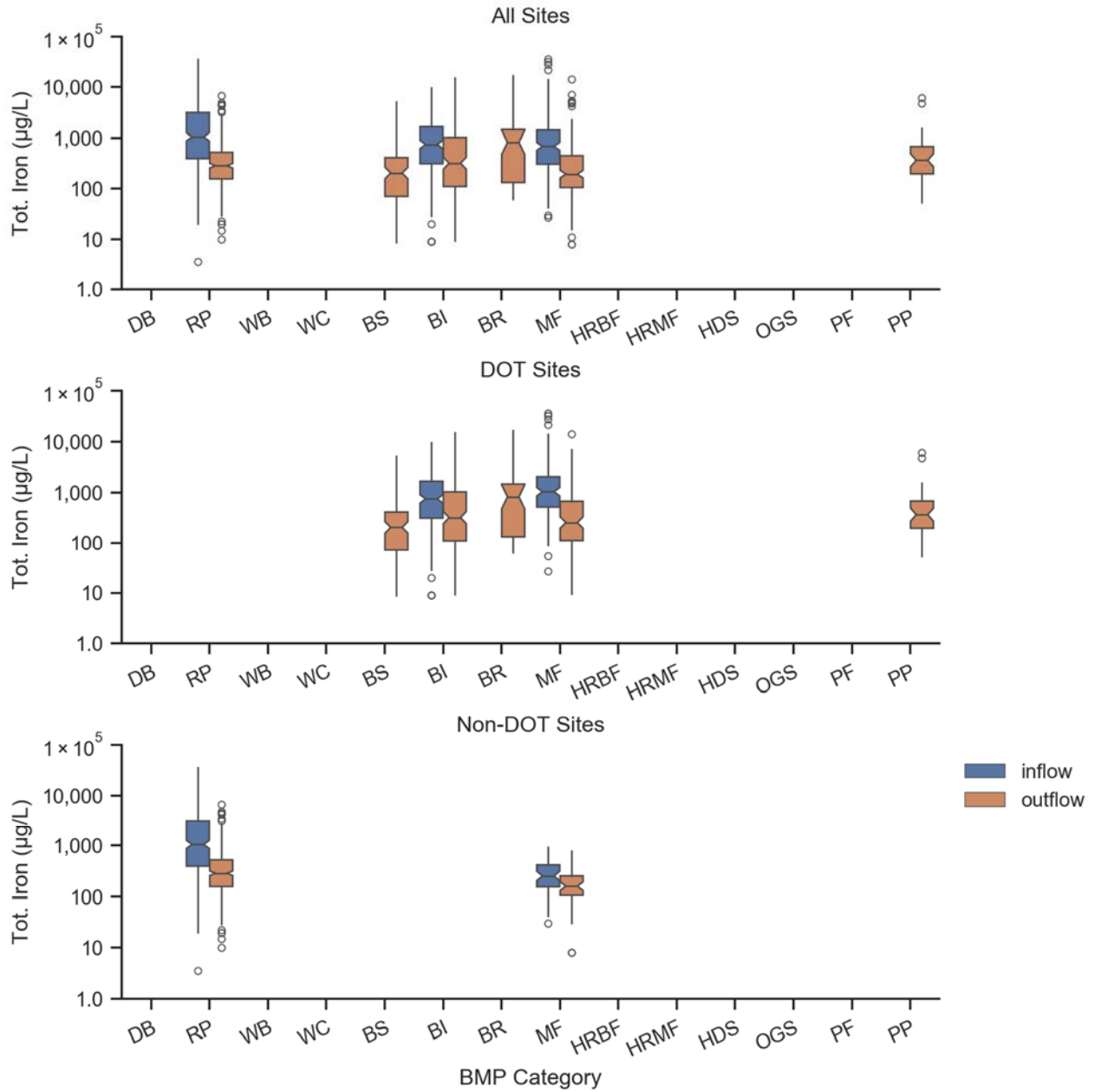


Figure 6.10. Box Plots of Influent/Effluent Total Iron Concentrations

Table 6-10. Influent/Effluent Summary Statistics for Total Iron (µg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
RP	All Sites	16; 317 (1.3%)	18; 345 (2.0%)	393 - 3,160	157 - 523	1,050 (820, 1,200)	285 (240, 345)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	16; 317 (1.3%)	18; 345 (2.0%)	393 - 3,160	157 - 523	1,050 (820, 1,200)	285 (240, 345)	▼▼▼
BS	All Sites	NA	4; 110 (6.4%)	NA	70.8 - 411	NA	204 (115, 241)	NA
	DOT	NA	4; 110 (6.4%)	NA	70.8 - 411	NA	204 (115, 241)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BI	All Sites	14; 192 (6.2%)	13; 162 (10.5%)	312 - 1,660	111 - 1,030	746 (553, 920)	320 (240, 402)	▼▼▼
	DOT	14; 192 (6.2%)	13; 162 (10.5%)	312 - 1,660	111 - 1,030	746 (553, 920)	320 (240, 402)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	NA	3; 49 (0.0%)	NA	133 - 1,460	NA	820 (188, 1,100)	NA
	DOT	NA	3; 49 (0.0%)	NA	133 - 1,460	NA	820 (188, 1,100)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	9; 184 (0.0%)	9; 165 (1.2%)	305 - 1,430	106 - 449	685 (515, 797)	195 (163, 243)	▼▼▼
	DOT	6; 130 (0.0%)	6; 116 (1.7%)	516 - 2,040	113 - 670	1,030 (752, 1,210)	255 (182, 332)	▼▼▼
	Non-DOT	3; 54 (0.0%)	3; 49 (0.0%)	155 - 416	106 - 254	253 (168, 315)	159 (117, 183)	◇▼▼
PP	All Sites	NA	3; 43 (16.3%)	NA	197 - 678	NA	365 (196, 379)	NA
	DOT	NA	3; 43 (16.3%)	NA	197 - 678	NA	365 (196, 379)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

6.6 Lead

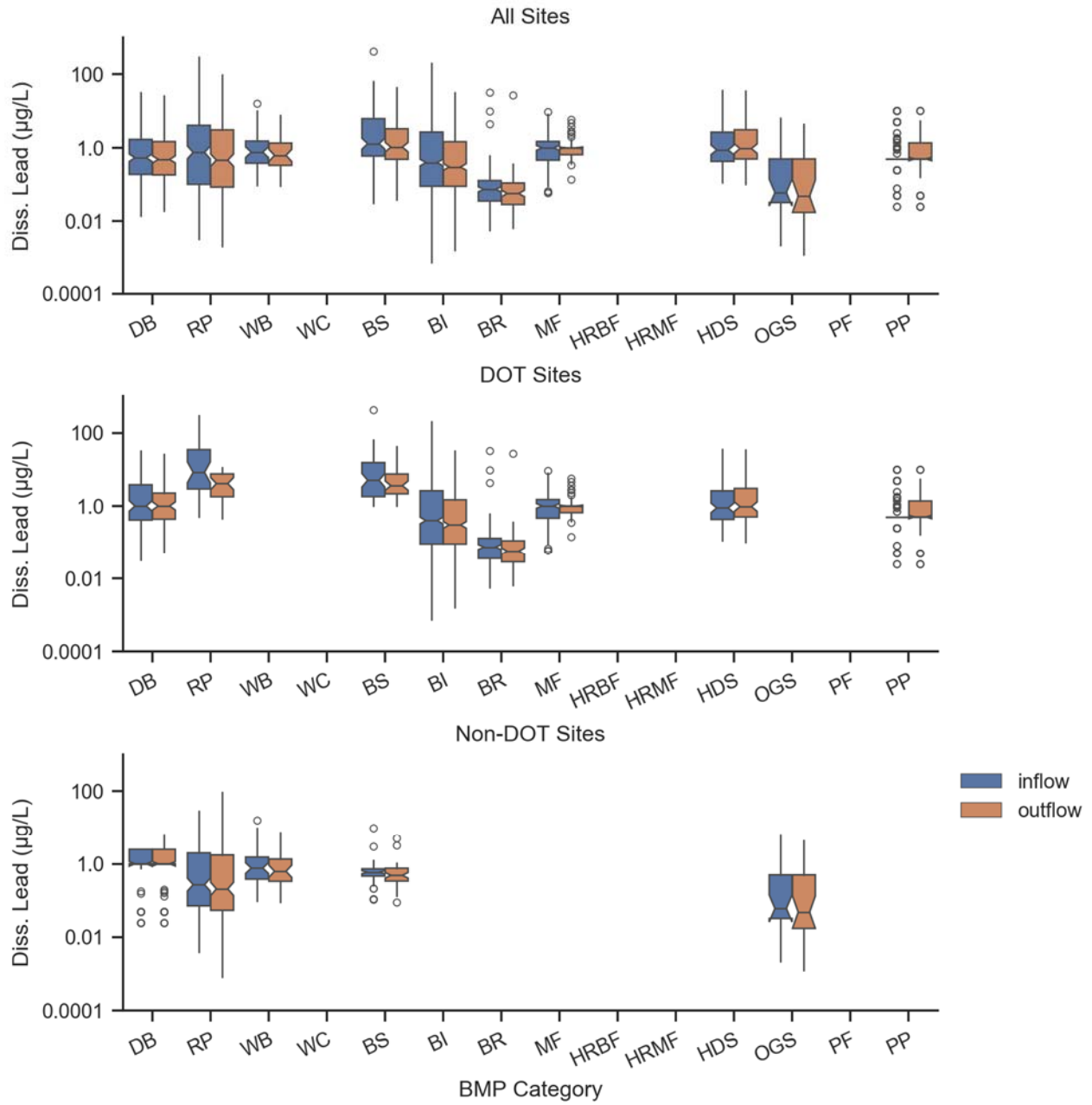


Figure 6.11. Box Plots of Influent/Effluent Dissolved Lead Concentrations

Table 6-11. Influent/Effluent Summary Statistics for Dissolved Lead ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	12; 210 (65.2%)	12; 209 (67.5%)	0.190 - 1.70	0.184 - 1.49	0.539 (0.388, 0.776)	0.486 (0.359, 0.649)	◇◇▼
	DOT	6; 111 (40.5%)	6; 100 (43.0%)	0.410 - 3.80	0.434 - 2.25	1.00 (1.00, 1.60)	1.00 (0.751, 1.40)	◇◇▼
	Non-DOT	6; 99 (92.9%)	6; 109 (89.9%)	1.00 - 2.50	1.00 - 2.50	1.00 (1.00, 1.20)	1.00 (1.00, 2.50)	◇◇◇
RP	All Sites	16; 203 (45.3%)	15; 209 (47.4%)	0.101 - 4.00	0.0853 - 3.00	0.753 (0.342, 1.00)	0.464 (0.261, 1.00)	◇◇◇
	DOT	3; 35 (0.0%)	3; 35 (2.9%)	2.92 - 35.0	1.80 - 7.55	8.33 (3.40, 17.0)	4.10 (2.20, 6.67)	◇▼▼
	Non-DOT	13; 168 (54.8%)	12; 174 (56.3%)	0.0713 - 2.00	0.0540 - 1.77	0.270 (0.160, 0.447)	0.207 (0.116, 0.337)	◇◇▼
WB	All Sites	6; 42 (59.5%)	5; 33 (60.6%)	0.383 - 1.53	0.334 - 1.35	0.764 (0.477, 1.10)	0.625 (0.369, 0.908)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 42 (59.5%)	5; 33 (60.6%)	0.383 - 1.53	0.334 - 1.35	0.764 (0.477, 1.10)	0.625 (0.369, 0.908)	◇◇◇
BS	All Sites	14; 114 (15.8%)	14; 97 (19.6%)	0.600 - 6.07	0.490 - 3.21	1.30 (0.701, 1.50)	1.05 (0.760, 1.60)	◇◇▼
	DOT	7; 62 (8.1%)	7; 45 (11.1%)	1.80 - 15.4	2.15 - 7.50	5.05 (2.20, 6.70)	3.60 (2.50, 4.80)	◇◇▼
	Non-DOT	7; 52 (25.0%)	7; 52 (26.9%)	0.464 - 0.731	0.339 - 0.760	0.590 (0.480, 0.614)	0.485 (0.406, 0.530)	◇◇◇
BI	All Sites	34; 624 (47.8%)	33; 446 (55.4%)	0.0901 - 2.60	0.0900 - 1.47	0.399 (0.277, 0.483)	0.302 (0.226, 0.383)	◇◇▼
	DOT	34; 624 (47.8%)	33; 446 (55.4%)	0.0901 - 2.60	0.0900 - 1.47	0.399 (0.277, 0.483)	0.302 (0.226, 0.383)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	10; 169 (65.1%)	9; 111 (55.9%)	0.0354 - 0.129	0.0285 - 0.110	0.074 (0.056, 0.0822)	0.0570 (0.0380, 0.0712)	◇◇◇
	DOT	10; 169 (65.1%)	9; 111 (55.9%)	0.0354 - 0.129	0.0285 - 0.110	0.074 (0.056, 0.0822)	0.0570 (0.0380, 0.0712)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 156 (22.4%)	11; 152 (32.2%)	0.464 - 1.50	0.654 - 1.00	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	◇◇▼
	DOT	11; 156 (22.4%)	11; 152 (32.2%)	0.464 - 1.50	0.654 - 1.00	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	7; 88 (22.7%)	7; 88 (19.3%)	0.428 - 2.59	0.500 - 3.02	0.883 (0.640, 1.10)	0.959 (0.690, 1.38)	◇◇◇
	DOT	7; 88 (22.7%)	7; 88 (19.3%)	0.428 - 2.59	0.500 - 3.02	0.883 (0.640, 1.10)	0.959 (0.690, 1.38)	◇◇◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	3; 26 (23.1%)	3; 27 (33.3%)	0.0323 - 0.500	0.0174 - 0.500	0.0605 (0.0320, 0.293)	0.048 (0.008, 0.064)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 26 (23.1%)	3; 27 (33.3%)	0.0323 - 0.500	0.0174 - 0.500	0.0605 (0.0320, 0.293)	0.048 (0.008, 0.064)	◇◇◇

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

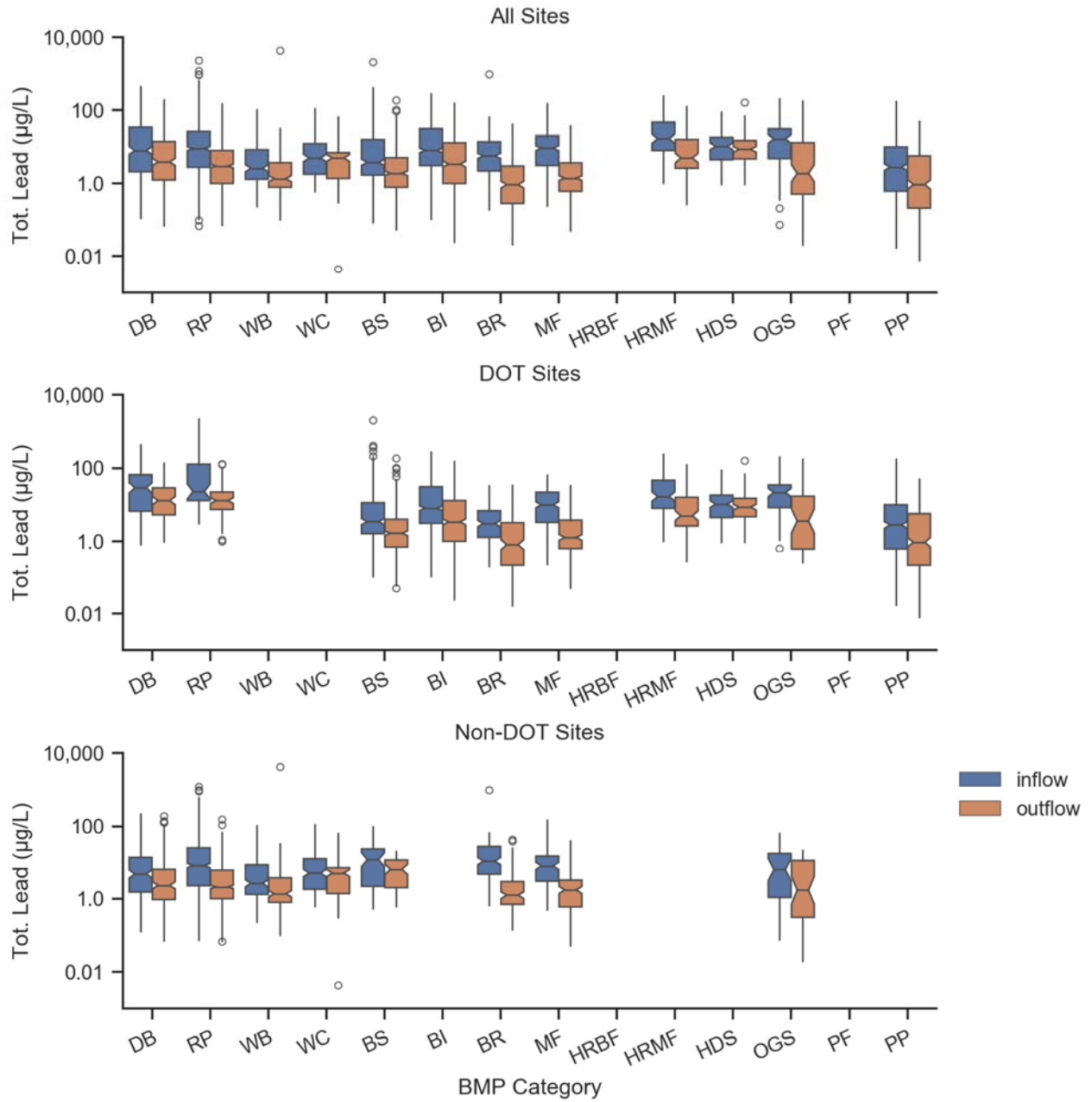


Figure 6.12. Box Plots of Influent/Effluent Total Lead Concentrations

Table 6-12. Influent/Effluent Summary Statistics for Total Lead ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	20; 315 (33.3%)	19; 289 (44.3%)	2.10 - 34.1	1.25 - 14.0	8.00 (5.30, 10.0)	3.89 (2.89, 5.16)	▼▼▼
	DOT	7; 128 (28.1%)	6; 109 (35.8%)	6.65 - 66.2	5.29 - 29.0	29.0 (17.0, 37.0)	13.0 (7.00, 14.0)	▼▼▼
	Non-DOT	13; 187 (36.9%)	13; 180 (49.4%)	1.52 - 13.4	0.944 - 6.32	4.72 (2.73, 6.38)	2.30 (1.75, 3.14)	◇▼▼
RP	All Sites	51; 832 (18.5%)	52; 850 (28.5%)	2.79 - 26.0	1.00 - 8.01	9.00 (6.80, 9.50)	3.00 (2.37, 3.00)	▼▼▼
	DOT	6; 59 (0.0%)	6; 91 (0.0%)	13.0 - 130	7.44 - 22.4	23.0 (14.8, 32.9)	13.0 (8.60, 13.8)	▼▼▼
	Non-DOT	45; 773 (19.9%)	46; 759 (31.9%)	2.27 - 24.4	1.00 - 6.00	8.00 (6.00, 9.00)	2.09 (2.00, 2.61)	▼▼▼
WB	All Sites	10; 174 (2.9%)	10; 154 (22.7%)	1.30 - 8.40	0.789 - 3.72	2.63 (2.00, 3.99)	1.35 (1.00, 1.84)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	10; 174 (2.9%)	10; 154 (22.7%)	1.30 - 8.40	0.789 - 3.72	2.63 (2.00, 3.99)	1.35 (1.00, 1.84)	▼▼▼
WC	All Sites	10; 164 (7.3%)	9; 136 (10.3%)	1.80 - 12.3	1.38 - 7.00	5.01 (4.00, 6.00)	5.00 (2.05, 5.00)	◇▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	10; 164 (7.3%)	9; 136 (10.3%)	1.80 - 12.3	1.38 - 7.00	5.01 (4.00, 6.00)	5.00 (2.00, 5.00)	◇▼▼
BS	All Sites	22; 337 (22.8%)	26; 450 (42.4%)	1.70 - 15.9	0.787 - 5.08	3.80 (2.65, 4.03)	1.90 (1.59, 2.00)	▼▼▼
	DOT	14; 266 (23.7%)	18; 379 (46.7%)	1.62 - 11.4	0.694 - 4.00	3.45 (2.50, 3.90)	1.66 (1.40, 1.90)	▼▼▼
	Non-DOT	8; 71 (19.7%)	8; 70 (18.6%)	2.18 - 22.8	2.00 - 11.4	11.6 (3.38, 18.8)	6.33 (3.00, 7.51)	◇▼▼
BI	All Sites	37; 666 (5.6%)	36; 477 (20.1%)	3.10 - 31.0	1.00 - 13.0	8.05 (6.80, 9.10)	3.40 (2.50, 3.80)	▼▼▼
	DOT	37; 666 (5.6%)	36; 477 (20.1%)	3.10 - 31.0	1.00 - 13.0	8.05 (6.80, 9.10)	3.40 (2.50, 3.80)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	26; 325 (15.4%)	22; 289 (36.3%)	2.20 - 13.8	0.283 - 3.00	5.70 (4.44, 6.09)	0.932 (0.723, 1.07)	▼▼▼
	DOT	18; 177 (19.8%)	18; 181 (28.7%)	1.28 - 6.87	0.212 - 3.23	3.05 (2.35, 4.06)	0.80 (0.44, 0.985)	▼▼▼
	Non-DOT	8; 148 (10.1%)	4; 108 (49.1%)	4.67 - 26.7	0.699 - 2.93	10.6 (6.95, 13.9)	1.24 (0.93, 1.51)	▼▼▼
MF	All Sites	26; 388 (11.3%)	27; 397 (31.2%)	3.12 - 20.0	0.610 - 3.67	9.30 (7.53, 11.0)	1.40 (1.10, 1.70)	▼▼▼
	DOT	16; 264 (9.1%)	16; 249 (27.7%)	3.29 - 22.1	0.630 - 3.80	10.0 (7.60, 12.0)	1.27 (1.00, 1.60)	▼▼▼
	Non-DOT	10; 124 (16.1%)	11; 148 (37.2%)	3.00 - 14.6	0.595 - 3.22	7.82 (5.58, 9.86)	1.73 (1.13, 2.00)	▼▼▼
HRMF	All Sites	6; 90 (11.1%)	6; 90 (21.1%)	8.00 - 46.7	2.62 - 16.0	16.8 (12.8, 24.3)	5.00 (4.80, 5.77)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	6; 90 (11.1%)	6; 90 (21.1%)	8.00 - 46.7	2.62 - 16.0	16.8 (12.1, 24.3)	5.00 (4.80, 5.77)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	9; 106 (17.0%)	9; 106 (17.9%)	4.47 - 18.3	4.70 - 15.0	10.4 (7.47, 13.1)	8.60 (6.70, 10.3)	◇◇▼
	DOT	9; 106 (17.0%)	9; 106 (17.9%)	4.47 - 18.3	4.70 - 15.0	10.4 (7.47, 13.1)	8.60 (6.67, 10.3)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	9; 117 (0.0%)	9; 89 (5.6%)	4.80 - 30.6	0.511 - 13.1	16.6 (10.1, 19.2)	1.90 (0.632, 3.75)	▼▼▼
	DOT	4; 78 (0.0%)	4; 48 (0.0%)	8.40 - 34.9	0.612 - 17.2	21.7 (15.4, 26.4)	3.60 (0.671, 6.13)	▼▼▼
	Non-DOT	5; 39 (0.0%)	5; 41 (12.2%)	1.08 - 17.1	0.309 - 11.0	6.20 (1.80, 11.0)	1.70 (0.407, 3.91)	◇▼▼
PP	All Sites	10; 439 (46.2%)	18; 307 (60.9%)	0.617 - 10.0	0.211 - 5.70	2.80 (2.07, 4.34)	0.941 (0.708, 1.21)	▼▼▼
	DOT	10; 439 (46.2%)	18; 307 (60.9%)	0.617 - 10.0	0.211 - 5.70	2.80 (2.07, 4.34)	0.941 (0.708, 1.21)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

6.7 Nickel

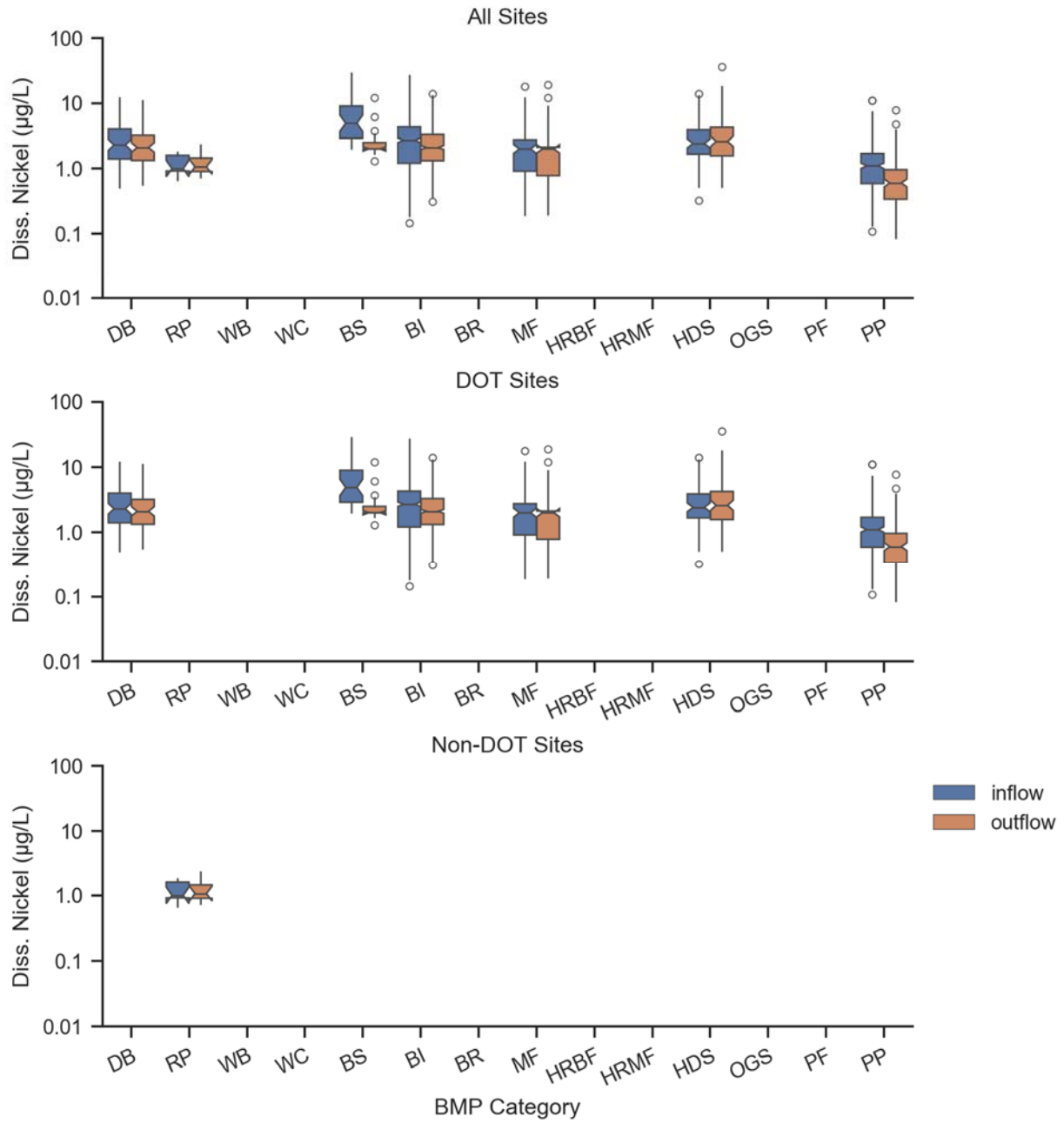


Figure 6.13. Box Plots of Influent/Effluent Dissolved Nickel Concentrations

Table 6-13. Influent/Effluent Summary Statistics for Dissolved Nickel (µg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	6; 75 (20.0%)	6; 69 (15.9%)	1.40 - 4.00	1.33 - 3.20	2.30 (2.00, 2.70)	2.10 (1.80, 2.50)	◇◇◇
	DOT	6; 75 (20.0%)	6; 69 (15.9%)	1.40 - 4.00	1.33 - 3.20	2.30 (2.00, 2.70)	2.10 (1.60, 2.50)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
RP	All Sites	3; 9 (0.0%)	3; 8 (0.0%)	0.915 - 1.60	0.902 - 1.45	1.00 (0.704, 1.60)	1.06 (0.777, 1.40)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 9 (0.0%)	3; 8 (0.0%)	0.915 - 1.60	0.902 - 1.45	1.00 (0.704, 1.60)	1.06 (0.777, 1.40)	◇◇◇
BS	All Sites	6; 37 (0.0%)	5; 23 (0.0%)	2.90 - 9.00	2.00 - 2.50	4.90 (4.30, 5.70)	2.00 (2.00, 2.50)	▼▼▼
	DOT	6; 37 (0.0%)	5; 23 (0.0%)	2.90 - 9.00	2.00 - 2.50	4.90 (4.30, 5.70)	2.00 (2.00, 2.50)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BI	All Sites	34; 617 (25.4%)	33; 435 (32.0%)	1.20 - 4.30	1.32 - 3.30	2.70 (2.50, 2.80)	2.10 (2.00, 2.50)	◇▼▼
	DOT	34; 617 (25.4%)	33; 435 (32.0%)	1.20 - 4.30	1.32 - 3.30	2.70 (2.50, 2.80)	2.10 (2.00, 2.50)	◇▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 121 (22.3%)	11; 116 (31.9%)	0.910 - 2.75	0.779 - 2.12	2.00 (1.00, 2.00)	2.00 (1.07, 2.00)	◇◇◇
	DOT	11; 121 (22.3%)	11; 116 (31.9%)	0.910 - 2.75	0.779 - 2.12	2.00 (1.00, 2.00)	2.00 (1.07, 2.00)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	6; 74 (8.1%)	6; 75 (6.7%)	1.66 - 3.89	1.57 - 4.25	2.42 (2.00, 3.23)	2.60 (2.00, 3.00)	◇◇◇
	DOT	6; 74 (8.1%)	6; 75 (6.7%)	1.66 - 3.89	1.57 - 4.25	2.42 (2.00, 3.23)	2.60 (2.00, 3.00)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	4; 304 (42.1%)	4; 137 (73.0%)	0.588 - 1.70	0.338 - 0.961	1.10 (0.891, 1.20)	0.599 (0.477, 0.695)	▼▼▼
	DOT	4; 304 (42.1%)	4; 137 (73.0%)	0.588 - 1.70	0.338 - 0.961	1.10 (0.891, 1.20)	0.599 (0.477, 0.695)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

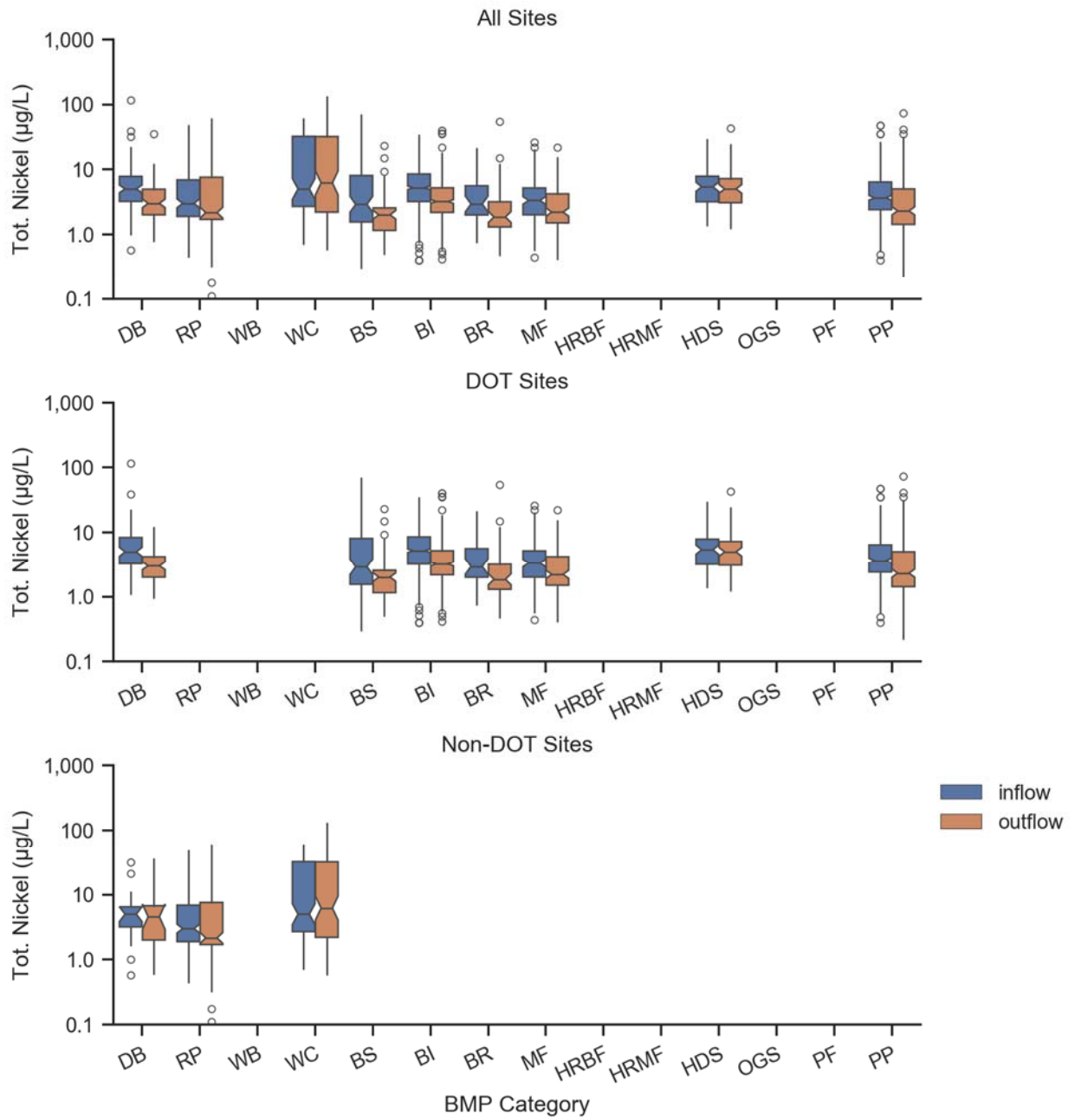


Figure 6.14. Box Plots of Influent/Effluent Total Nickel Concentrations

Table 6-14. Influent/Effluent Summary Statistics for Total Nickel ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	10; 102 (5.9%)	9; 87 (13.8%)	3.21 - 7.80	2.00 - 4.95	5.00 (4.75, 5.55)	3.00 (2.26, 3.30)	▼▼▼
	DOT	7; 84 (7.1%)	6; 69 (15.9%)	3.24 - 8.32	2.00 - 4.20	5.00 (4.70, 5.60)	3.00 (2.40, 3.30)	▼▼▼
	Non-DOT	3; 18 (0.0%)	3; 18 (5.6%)	3.20 - 6.50	2.00 - 6.74	5.00 (2.00, 6.01)	4.56 (2.00, 6.09)	◇◇◇
RP	All Sites	11; 169 (37.3%)	12; 150 (30.0%)	1.89 - 6.89	1.70 - 7.59	3.00 (2.70, 3.80)	2.15 (2.00, 2.66)	▼◇▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	11; 169 (37.3%)	12; 150 (30.0%)	1.89 - 6.89	1.70 - 7.59	3.00 (2.70, 3.80)	2.15 (2.00, 2.66)	▼◇▼
WC	All Sites	6; 111 (21.6%)	6; 98 (27.6%)	2.69 - 32.2	2.20 - 32.0	5.00 (3.00, 7.19)	6.21 (3.25, 20.0)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 111 (21.6%)	6; 98 (27.6%)	2.69 - 32.2	2.20 - 32.0	5.00 (3.00, 7.19)	6.21 (3.25, 20.0)	◇◇◇
BS	All Sites	8; 83 (0.0%)	7; 67 (0.0%)	1.55 - 8.05	1.15 - 2.55	2.90 (2.30, 4.00)	2.00 (1.30, 2.10)	▼▼▼
	DOT	8; 83 (0.0%)	7; 67 (0.0%)	1.55 - 8.05	1.15 - 2.55	2.90 (2.30, 4.00)	2.00 (1.30, 2.10)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BI	All Sites	35; 616 (10.1%)	34; 439 (14.6%)	3.20 - 8.50	2.18 - 5.20	5.20 (4.60, 5.60)	3.20 (2.80, 3.30)	▼▼▼
	DOT	35; 616 (10.1%)	34; 439 (14.6%)	3.20 - 8.50	2.18 - 5.20	5.20 (4.60, 5.60)	3.20 (2.80, 3.30)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	3; 33 (57.6%)	4; 52 (40.4%)	1.99 - 5.60	1.30 - 3.17	2.93 (2.06, 3.90)	1.85 (1.43, 2.18)	◇▼◇
	DOT	3; 33 (57.6%)	4; 52 (40.4%)	1.99 - 5.60	1.30 - 3.17	2.93 (2.06, 3.90)	1.85 (1.47, 2.18)	◇▼◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 122 (9.0%)	12; 124 (21.8%)	2.00 - 5.17	1.50 - 4.20	3.32 (2.65, 3.61)	2.20 (2.00, 2.74)	◇▼▼
	DOT	11; 122 (9.0%)	12; 124 (21.8%)	2.00 - 5.17	1.50 - 4.20	3.32 (2.60, 3.61)	2.20 (2.00, 2.74)	◇▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	6; 75 (4.0%)	6; 75 (4.0%)	3.17 - 7.85	3.07 - 7.21	5.40 (4.00, 6.00)	5.00 (3.44, 5.20)	◇◇◇
	DOT	6; 75 (4.0%)	6; 75 (4.0%)	3.17 - 7.85	3.07 - 7.21	5.40 (4.00, 6.00)	5.00 (3.44, 5.20)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
PP	All Sites	4; 318 (13.2%)	7; 190 (16.8%)	2.40 - 6.40	1.42 - 5.00	3.65 (3.30, 3.80)	2.30 (1.80, 2.40)	▼▼▼
	DOT	4; 318 (13.2%)	7; 190 (16.8%)	2.40 - 6.40	1.42 - 5.00	3.65 (3.30, 3.84)	2.30 (1.80, 2.45)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

6.8 Zinc

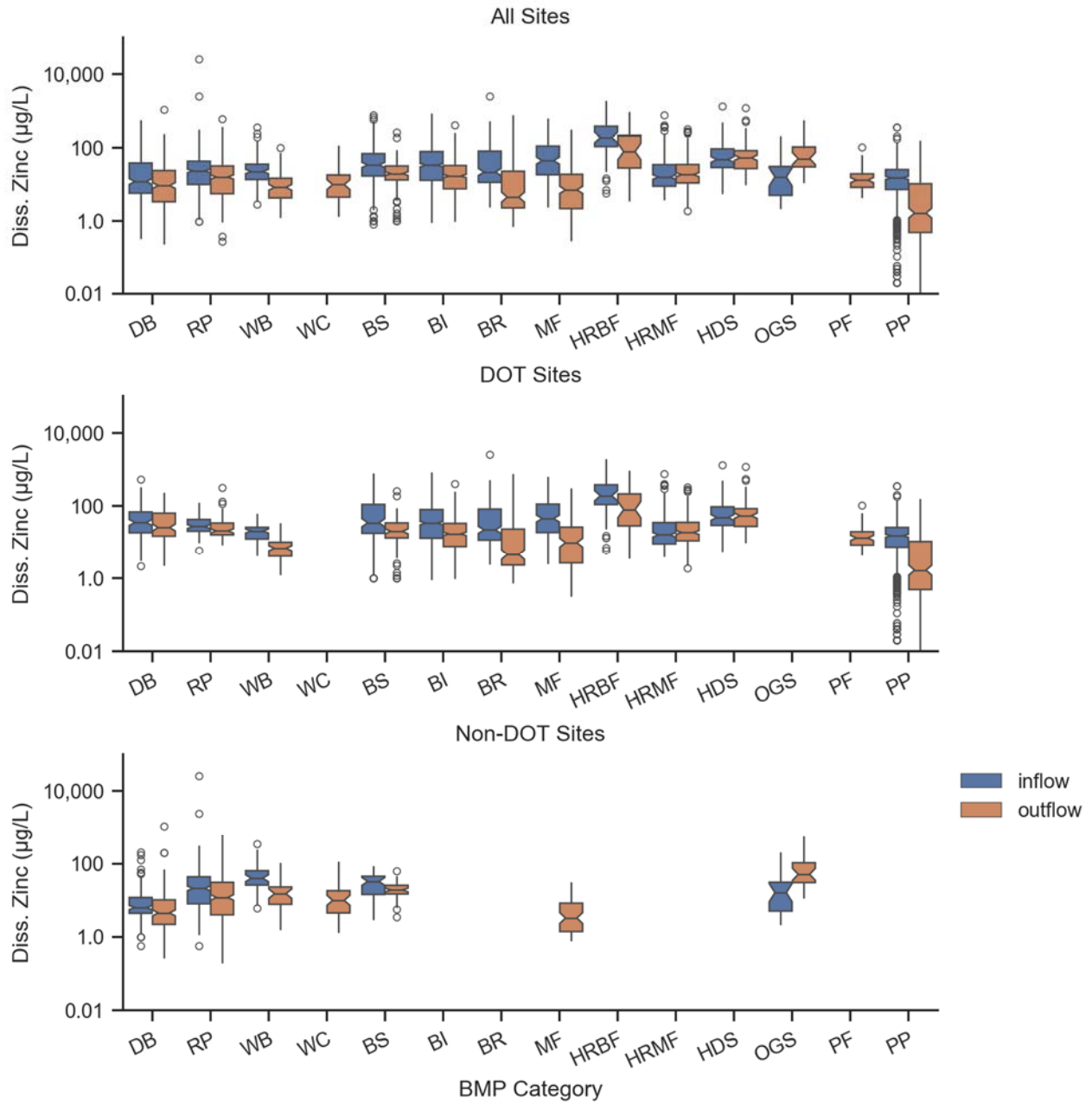


Figure 6.15. Box Plots of Influent/Effluent Dissolved Zinc Concentrations

Table 6-15. Influent/Effluent Summary Statistics for Dissolved Zinc ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	14; 258 (3.9%)	14; 271 (6.3%)	5.78 - 38.5	3.38 - 24.0	12.1 (9.10, 14.1)	9.38 (7.00, 10.6)	◇▼▼
	DOT	6; 120 (6.7%)	6; 109 (7.3%)	18.2 - 68.2	14.7 - 63.0	34.9 (24.1, 42.7)	25.4 (21.0, 34.0)	◇◇▼
	Non-DOT	8; 138 (1.4%)	8; 162 (5.6%)	4.42 - 11.9	2.20 - 10.3	6.31 (5.33, 6.92)	4.52 (3.09, 5.68)	◇▼◇
RP	All Sites	25; 431 (5.8%)	25; 413 (8.0%)	10.0 - 43.3	5.60 - 32.0	23.4 (20.0, 26.0)	16.0 (13.9, 17.6)	▼▼▼
	DOT	6; 91 (1.1%)	6; 78 (0.0%)	20.1 - 42.5	16.0 - 33.8	27.0 (23.1, 30.0)	20.5 (18.4, 26.5)	◇▼◇
	Non-DOT	19; 340 (7.1%)	19; 335 (9.9%)	8.00 - 43.7	4.00 - 30.8	21.0 (16.4, 25.0)	11.9 (8.65, 14.6)	▼▼▼
WB	All Sites	9; 125 (3.2%)	8; 110 (3.6%)	13.7 - 35.8	4.32 - 14.8	22.6 (20.1, 25.0)	8.35 (6.65, 9.00)	▼▼▼
	DOT	3; 83 (3.6%)	3; 77 (0.0%)	12.3 - 25.8	4.05 - 10.0	20.4 (16.8, 21.5)	6.82 (5.62, 8.27)	▼▼◇
	Non-DOT	6; 42 (2.4%)	5; 33 (12.1%)	26.0 - 63.9	7.75 - 23.0	39.9 (30.9, 45.9)	15.1 (9.00, 19.1)	▼▼▼
WC	All Sites	NA	3; 50 (56.0%)	NA	4.52 - 18.3	NA	9.93 (5.65, 10.0)	NA
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	NA	3; 50 (56.0%)	NA	4.52 - 18.3	NA	9.93 (5.65, 10.0)	NA
BS	All Sites	16; 174 (2.9%)	16; 141 (5.0%)	17.1 - 69.4	13.3 - 32.0	34.2 (27.3, 35.8)	19.8 (16.7, 21.7)	▼▼▼
	DOT	9; 122 (0.8%)	9; 89 (3.4%)	17.6 - 110	13.2 - 34.0	34.4 (26.6, 48.0)	20.0 (16.0, 22.0)	▼▼▼
	Non-DOT	7; 52 (7.7%)	7; 52 (7.7%)	14.4 - 45.2	14.8 - 25.5	32.7 (27.3, 35.4)	19.0 (16.2, 22.2)	▼▼▼
BI	All Sites	37; 669 (5.4%)	36; 478 (12.8%)	13.0 - 79.0	7.62 - 33.0	33.6 (30.0, 39.0)	17.0 (15.0, 19.0)	▼▼▼
	DOT	37; 669 (5.4%)	36; 478 (12.8%)	13.0 - 79.0	7.62 - 33.0	33.6 (30.0, 39.0)	17.0 (15.0, 19.0)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	11; 187 (12.8%)	10; 135 (17.0%)	11.4 - 81.3	2.30 - 23.0	21.9 (15.6, 26.5)	4.51 (3.03, 5.48)	▼▼▼
	DOT	11; 187 (12.8%)	10; 135 (17.0%)	11.4 - 81.3	2.30 - 23.0	21.9 (15.6, 26.5)	4.51 (3.03, 5.48)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 167 (1.2%)	15; 228 (17.1%)	18.5 - 112	2.20 - 19.0	44.8 (33.3, 54.0)	7.15 (4.49, 8.90)	▼▼▼
	DOT	11; 167 (1.2%)	11; 161 (24.2%)	18.5 - 112	2.64 - 26.0	44.8 (33.3, 54.0)	9.70 (6.50, 13.0)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	Non-DOT	NA	4; 67 (0.0%)	NA	1.40 - 8.32	NA	3.27 (2.20, 4.28)	NA
HRBF	All Sites	4; 38 (0.0%)	4; 38 (7.9%)	109 - 377	28.2 - 212	189 (148, 312)	79.0 (46.5, 105)	▼▼▼
	DOT	4; 38 (0.0%)	4; 38 (7.9%)	109 - 377	28.2 - 212	189 (148, 312)	79.0 (46.5, 105)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	12; 218 (0.5%)	12; 218 (1.8%)	9.00 - 34.8	11.0 - 35.2	16.0 (14.0, 18.5)	18.6 (15.6, 20.1)	◇◇△
	DOT	12; 218 (0.5%)	12; 218 (1.8%)	9.00 - 34.8	11.0 - 35.2	16.0 (14.0, 18.5)	18.6 (15.6, 20.1)	◇◇△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	8; 105 (0.0%)	8; 106 (0.0%)	29.1 - 94.0	27.3 - 83.8	48.0 (42.0, 57.0)	53.6 (38.4, 65.1)	◇◇◇
	DOT	8; 105 (0.0%)	8; 106 (0.0%)	29.1 - 94.0	27.3 - 83.8	48.0 (42.0, 57.0)	53.6 (38.9, 65.0)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
OGS	All Sites	3; 25 (0.0%)	3; 27 (0.0%)	5.07 - 31.0	30.4 - 106	16.1 (5.07, 24.0)	50.9 (30.7, 70.0)	△△△
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 25 (0.0%)	3; 27 (0.0%)	5.07 - 31.0	30.4 - 106	16.1 (5.07, 24.0)	50.9 (30.0, 70.0)	△△△
PFC	All Sites	NA	3; 68 (0.0%)	NA	8.38 - 19.5	NA	13.1 (10.0, 16.4)	NA
	DOT	NA	3; 68 (0.0%)	NA	8.38 - 19.5	NA	13.1 (10.0, 16.4)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	7; 405 (13.3%)	10; 244 (49.2%)	7.30 - 25.6	0.489 - 10.5	15.1 (13.0, 16.3)	1.66 (1.08, 2.60)	▼▼▼
	DOT	7; 405 (13.3%)	10; 244 (49.2%)	7.30 - 25.6	0.489 - 10.5	15.1 (13.0, 16.3)	1.66 (1.08, 2.56)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
 ** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.
 %ND percentage of non-detects
 NA not available or less than 3 studies for BMP/constituent.
 ◇ influent/effluent comparison test indicates no significant difference in concentrations
 ▼ influent/effluent comparison test indicates significant reduction in concentrations
 △ influent/effluent comparison test indicates significant increase in concentrations

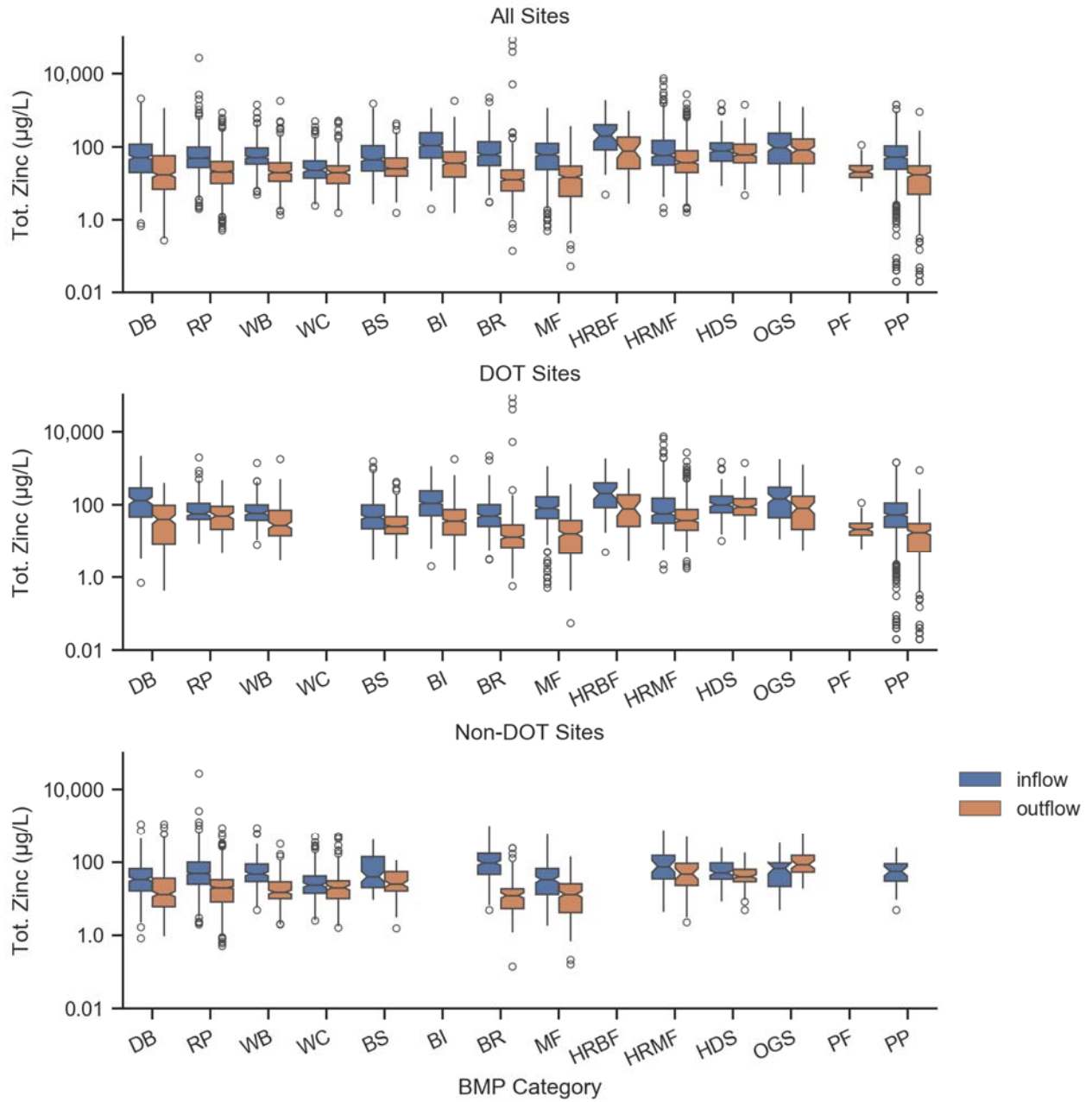


Figure 6.16. Box Plots of Influent/Effluent Total Zinc Concentrations

Table 6-16. Influent/Effluent Summary Statistics for Total Zinc ($\mu\text{g/L}$)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	26; 393 (4.6%)	27; 430 (8.8%)	20.0 - 119	6.94 - 58.0	51.7 (40.4, 58.3)	17.3 (14.5, 21.6)	▼▼▼
	DOT	10; 153 (10.5%)	11; 184 (15.8%)	46.0 - 288	8.36 - 96.5	130 (88.0, 154)	40.0 (21.7, 53.0)	▼▼▼
	Non-DOT	16; 240 (0.8%)	16; 246 (3.7%)	16.2 - 66.2	6.00 - 36.2	34.0 (24.5, 38.4)	13.3 (10.7, 15.6)	▼▼▼
RP	All Sites	60; 1032 (7.1%)	63; 995 (11.8%)	27.3 - 100	10.0 - 40.0	50.0 (45.0, 50.2)	21.2 (20.0, 23.0)	▼▼▼
	DOT	10; 138 (0.7%)	10; 134 (3.7%)	39.6 - 109	21.1 - 90.3	57.0 (50.0, 70.0)	50.0 (40.0, 61.3)	◇▼▼
	Non-DOT	50; 894 (8.1%)	53; 861 (13.0%)	24.8 - 100	8.10 - 32.9	48.6 (43.4, 50.0)	20.0 (17.0, 20.0)	▼▼▼
WB	All Sites	19; 342 (1.2%)	19; 308 (11.0%)	34.1 - 94.6	11.5 - 37.1	52.5 (45.3, 57.5)	20.1 (17.0, 22.9)	▼▼▼
	DOT	9; 158 (0.6%)	9; 143 (0.7%)	37.3 - 99.1	14.2 - 70.0	59.1 (45.1, 64.5)	27.6 (21.4, 31.0)	▼▼▼
	Non-DOT	10; 184 (1.6%)	10; 165 (20.0%)	29.2 - 88.7	10.0 - 28.8	47.6 (41.6, 56.0)	15.1 (13.0, 17.0)	▼▼▼
WC	All Sites	8; 149 (7.4%)	8; 144 (11.1%)	14.0 - 41.7	10.0 - 30.6	23.5 (20.0, 30.0)	20.0 (13.5, 22.0)	◇▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	8; 149 (7.4%)	8; 144 (11.1%)	14.0 - 41.7	10.0 - 30.6	23.5 (20.0, 30.0)	20.0 (13.5, 22.0)	◇▼▼
BS	All Sites	27; 425 (10.8%)	31; 513 (23.6%)	22.0 - 109	16.0 - 50.0	45.6 (40.0, 51.0)	25.8 (22.6, 28.8)	▼▼▼
	DOT	18; 340 (12.4%)	22; 428 (26.6%)	22.0 - 99.0	16.0 - 47.5	45.8 (40.0, 51.0)	25.9 (21.7, 28.7)	▼▼▼
	Non-DOT	9; 85 (4.7%)	9; 85 (8.2%)	20.0 - 141	16.1 - 54.9	40.0 (27.0, 93.0)	25.0 (21.0, 41.9)	◇▼▼
BI	All Sites	41; 724 (0.6%)	40; 530 (2.8%)	50.0 - 240	15.0 - 74.0	112 (99.0, 120)	36.0 (29.2, 39.0)	▼▼▼
	DOT	41; 724 (0.6%)	40; 530 (2.8%)	50.0 - 240	15.0 - 74.0	112 (99.0, 120)	36.0 (29.2, 39.0)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	29; 500 (1.2%)	26; 454 (14.3%)	31.0 - 140	6.26 - 23.4	62.0 (52.5, 69.0)	12.8 (11.0, 14.0)	▼▼▼
	DOT	19; 322 (0.6%)	20; 317 (7.9%)	25.2 - 101	6.67 - 28.0	49.8 (42.0, 57.0)	13.0 (10.3, 14.0)	▼▼▼
	Non-DOT	10; 178 (2.2%)	6; 137 (29.2%)	46.1 - 175	5.34 - 18.5	94.8 (70.3, 111)	12.2 (9.74, 13.7)	▼▼▼
MF	All Sites	31; 508 (3.0%)	34; 531 (13.6%)	24.0 - 126	4.43 - 30.1	62.3 (55.5, 69.5)	15.0 (12.3, 16.3)	▼▼▼
	DOT	19; 331 (1.2%)	20; 323 (15.2%)	42.0 - 166	4.54 - 37.0	82.0 (70.0, 89.3)	16.0 (12.1, 20.0)	▼▼▼
	Non-DOT	12; 177 (6.2%)	14; 208 (11.1%)	13.0 - 66.5	4.15 - 25.5	33.2 (23.6, 39.4)	13.2 (11.3, 15.8)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
HRBF	All Sites	4; 46 (0.0%)	4; 46 (13.0%)	83.2 - 396	25.3 - 191	204 (123, 276)	79.0 (32.0, 96.0)	▼▼▼
	DOT	4; 46 (0.0%)	4; 46 (13.0%)	83.2 - 396	25.3 - 191	204 (123, 276)	79.0 (32.0, 96.0)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	19; 344 (2.0%)	19; 344 (2.6%)	32.0 - 152	20.0 - 79.2	59.8 (51.2, 69.0)	38.1 (32.6, 43.0)	▼▼▼
	DOT	15; 305 (2.3%)	15; 305 (2.6%)	31.0 - 151	20.0 - 74.0	58.0 (50.0, 68.1)	37.0 (30.6, 40.0)	▼▼▼
	Non-DOT	4; 39 (0.0%)	4; 39 (2.6%)	34.5 - 153	22.9 - 92.5	76.0 (36.0, 104)	47.4 (21.9, 70.0)	◇◇▼
HDS	All Sites	18; 268 (0.0%)	18; 262 (1.9%)	41.0 - 130	36.9 - 120	79.0 (66.7, 88.0)	62.2 (54.5, 69.4)	◇▼▼
	DOT	12; 162 (0.0%)	12; 162 (0.0%)	60.3 - 172	52.0 - 147	100 (81.0, 121)	88.0 (71.0, 102)	◇◇▼
	Non-DOT	6; 106 (0.0%)	6; 100 (5.0%)	34.0 - 94.8	28.9 - 63.1	50.5 (40.0, 63.1)	40.0 (34.1, 49.0)	◇▼▼
OGS	All Sites	10; 154 (0.0%)	10; 126 (0.0%)	35.0 - 232	35.2 - 166	97.9 (79.2, 138)	83.2 (64.6, 106)	◇◇▼
	DOT	5; 110 (0.0%)	5; 81 (0.0%)	44.2 - 302	21.0 - 171	149 (102, 184)	81.0 (46.3, 123)	◇▼▼
	Non-DOT	5; 44 (0.0%)	5; 45 (0.0%)	21.6 - 95.0	53.0 - 153	67.5 (34.5, 81.6)	85.5 (63.2, 102)	◇△◇
PFC	All Sites	NA	3; 69 (0.0%)	NA	14.6 - 31.0	NA	21.2 (15.9, 24.7)	NA
	DOT	NA	3; 69 (0.0%)	NA	14.6 - 31.0	NA	21.2 (15.9, 24.7)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	16; 495 (9.9%)	20; 331 (30.5%)	24.6 - 107	5.04 - 30.6	52.9 (50.0, 59.8)	17.3 (11.7, 20.0)	▼▼▼
	DOT	12; 460 (10.7%)	20; 331 (30.5%)	24.0 - 111	5.04 - 30.6	52.8 (50.0, 59.9)	17.3 (11.7, 20.0)	▼▼▼
	Non-DOT	4; 35 (0.0%)	NA	30.0 - 90.5	NA	56.0 (34.0, 64.5)	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

7 Nutrients

A summary of phosphorus and nitrogen data contained in the BMPDB by BMP category is provided in the subsections below. A discussion of these results is provided in Section 8.4.

7.1 Phosphorus

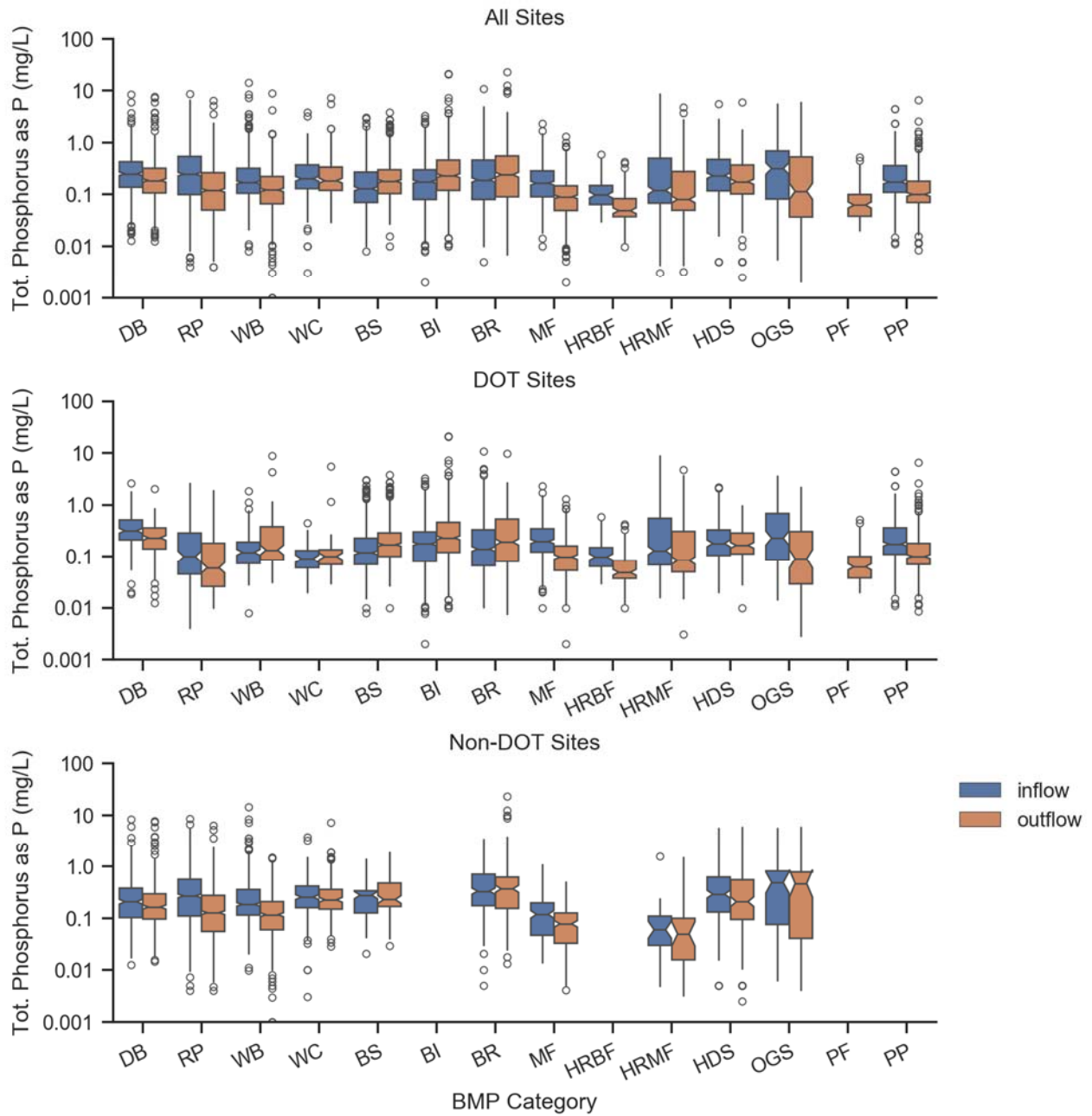


Figure 7.1. Box Plots of Influent/Effluent Total Phosphorus Concentrations

Table 7-1. Influent/Effluent Summary Statistics for Total Phosphorus (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	43; 542 (1.5%)	44; 577 (1.7%)	0.138 - 0.428	0.107 - 0.320	0.250 (0.216, 0.262)	0.186 (0.170, 0.200)	▼▼▼
	DOT	13; 168 (0.0%)	14; 196 (1.5%)	0.210 - 0.513	0.140 - 0.359	0.316 (0.280, 0.373)	0.230 (0.200, 0.250)	▼▼▼
	Non-DOT	30; 374 (2.1%)	30; 381 (1.8%)	0.103 - 0.382	0.0967 - 0.297	0.208 (0.182, 0.230)	0.164 (0.147, 0.178)	▼▼▼
RP	All Sites	71; 1161 (0.9%)	75; 1138 (2.0%)	0.0996 - 0.542	0.050 - 0.263	0.246 (0.220, 0.268)	0.120 (0.104, 0.130)	▼▼▼
	DOT	11; 142 (1.4%)	11; 175 (3.4%)	0.0453 - 0.285	0.0260 - 0.181	0.0996 (0.0660, 0.150)	0.0602 (0.0480, 0.0822)	◇▼▼
	Non-DOT	60; 1019 (0.9%)	64; 963 (1.8%)	0.110 - 0.567	0.0558 - 0.277	0.270 (0.245, 0.290)	0.128 (0.111, 0.140)	▼▼▼
WB	All Sites	27; 690 (0.3%)	27; 647 (1.4%)	0.106 - 0.319	0.0660 - 0.222	0.170 (0.154, 0.177)	0.122 (0.108, 0.134)	▼▼▼
	DOT	5; 128 (0.0%)	5; 120 (0.0%)	0.0730 - 0.190	0.0853 - 0.378	0.121 (0.0985, 0.140)	0.134 (0.105, 0.171)	◇△△
	Non-DOT	22; 562 (0.4%)	22; 527 (1.7%)	0.115 - 0.360	0.060 - 0.210	0.185 (0.170, 0.200)	0.117 (0.105, 0.133)	▼▼▼
WC	All Sites	15; 256 (0.4%)	13; 214 (0.0%)	0.129 - 0.372	0.120 - 0.338	0.201 (0.179, 0.230)	0.184 (0.160, 0.208)	◇◇▼
	DOT	3; 55 (0.0%)	3; 47 (0.0%)	0.060 - 0.130	0.070 - 0.135	0.090 (0.070, 0.090)	0.10 (0.070, 0.120)	◇◇◇
	Non-DOT	12; 201 (0.5%)	10; 167 (0.0%)	0.160 - 0.420	0.150 - 0.361	0.256 (0.217, 0.290)	0.227 (0.188, 0.250)	◇◇▼
BS	All Sites	34; 574 (0.3%)	39; 671 (0.3%)	0.070 - 0.270	0.104 - 0.300	0.129 (0.118, 0.140)	0.180 (0.167, 0.190)	△△△
	DOT	24; 483 (0.0%)	29; 580 (0.0%)	0.070 - 0.226	0.100 - 0.287	0.118 (0.110, 0.126)	0.170 (0.150, 0.176)	△△△
	Non-DOT	10; 91 (2.2%)	10; 91 (2.2%)	0.126 - 0.340	0.169 - 0.480	0.280 (0.226, 0.290)	0.230 (0.220, 0.252)	◇◇◇
BI	All Sites	49; 874 (8.4%)	49; 663 (3.2%)	0.080 - 0.30	0.120 - 0.460	0.177 (0.156, 0.190)	0.230 (0.210, 0.240)	△△△
	DOT	49; 874 (8.4%)	49; 663 (3.2%)	0.080 - 0.30	0.120 - 0.460	0.177 (0.156, 0.190)	0.230 (0.210, 0.240)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	47; 850 (4.8%)	44; 667 (3.1%)	0.080 - 0.460	0.090 - 0.553	0.190 (0.170, 0.210)	0.240 (0.190, 0.270)	◇△△
	DOT	32; 586 (3.6%)	32; 470 (2.8%)	0.066 - 0.330	0.080 - 0.531	0.140 (0.120, 0.159)	0.191 (0.163, 0.227)	△△△
	Non-DOT	15; 264 (7.6%)	12; 197 (4.1%)	0.175 - 0.712	0.155 - 0.625	0.334 (0.280, 0.380)	0.370 (0.260, 0.400)	◇◇◇
MF	All Sites	32; 494 (1.4%)	35; 525 (5.1%)	0.0900 - 0.285	0.0490 - 0.147	0.165 (0.150, 0.180)	0.0900 (0.0800, 0.0973)	▼▼▼
	DOT	19; 317 (2.2%)	19; 308 (7.8%)	0.122 - 0.346	0.0534 - 0.160	0.196 (0.175, 0.212)	0.0977 (0.0865, 0.106)	▼▼▼
	Non-DOT	13; 177 (0.0%)	16; 217 (1.4%)	0.0471 - 0.198	0.0330 - 0.127	0.119 (0.0967, 0.132)	0.0780 (0.0660, 0.0860)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
HRBF	All Sites	5; 94 (0.0%)	5; 94 (8.5%)	0.0639 - 0.149	0.0373 - 0.0831	0.0976 (0.0823, 0.111)	0.0486 (0.0401, 0.0560)	▼▼▼
	DOT	5; 94 (0.0%)	5; 94 (8.5%)	0.0639 - 0.149	0.0373 - 0.0831	0.0976 (0.0823, 0.111)	0.0486 (0.0401, 0.0560)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HRMF	All Sites	19; 349 (1.7%)	19; 351 (3.1%)	0.0680 - 0.500	0.0496 - 0.277	0.120 (0.100, 0.135)	0.0800 (0.0710, 0.0920)	▼▼▼
	DOT	15; 320 (0.3%)	15; 322 (1.2%)	0.0687 - 0.550	0.0500 - 0.307	0.129 (0.110, 0.169)	0.0834 (0.0781, 0.0980)	▼▼▼
	Non-DOT	4; 29 (17.2%)	4; 29 (24.1%)	0.0300 - 0.110	0.0158 - 0.100	0.060 (0.020, 0.070)	0.0500 (0.0134, 0.0501)	◇◇◇
HDS	All Sites	23; 338 (0.3%)	23; 303 (1.7%)	0.117 - 0.474	0.102 - 0.370	0.230 (0.192, 0.270)	0.176 (0.150, 0.197)	◇▼▼
	DOT	10; 134 (0.0%)	10; 135 (0.0%)	0.105 - 0.328	0.112 - 0.285	0.180 (0.140, 0.195)	0.165 (0.140, 0.180)	◇◇▼
	Non-DOT	13; 204 (0.5%)	13; 168 (3.0%)	0.132 - 0.627	0.0950 - 0.556	0.292 (0.233, 0.363)	0.209 (0.159, 0.260)	◇▼▼
OGS	All Sites	10; 170 (4.7%)	10; 138 (10.9%)	0.0815 - 0.691	0.0367 - 0.530	0.316 (0.210, 0.428)	0.115 (0.0700, 0.214)	◇▼▼
	DOT	5; 107 (5.6%)	5; 81 (14.8%)	0.0855 - 0.683	0.0291 - 0.304	0.227 (0.150, 0.309)	0.0900 (0.0410, 0.100)	▼▼▼
	Non-DOT	5; 63 (3.2%)	5; 57 (5.3%)	0.0760 - 0.822	0.0410 - 0.787	0.492 (0.345, 0.569)	0.471 (0.0675, 0.526)	◇◇◇
PFC	All Sites	NA	6; 124 (0.0%)	NA	0.0380 - 0.100	NA	0.0625 (0.0500, 0.0740)	NA
	DOT	NA	6; 124 (0.0%)	NA	0.0380 - 0.100	NA	0.0625 (0.0500, 0.0740)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	11; 420 (1.0%)	19; 339 (1.5%)	0.110 - 0.360	0.0700 - 0.180	0.175 (0.160, 0.210)	0.100 (0.0950, 0.110)	▼▼▼
	DOT	11; 420 (1.0%)	19; 339 (1.5%)	0.110 - 0.360	0.0700 - 0.180	0.175 (0.160, 0.210)	0.100 (0.0950, 0.110)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant increase in concentrations

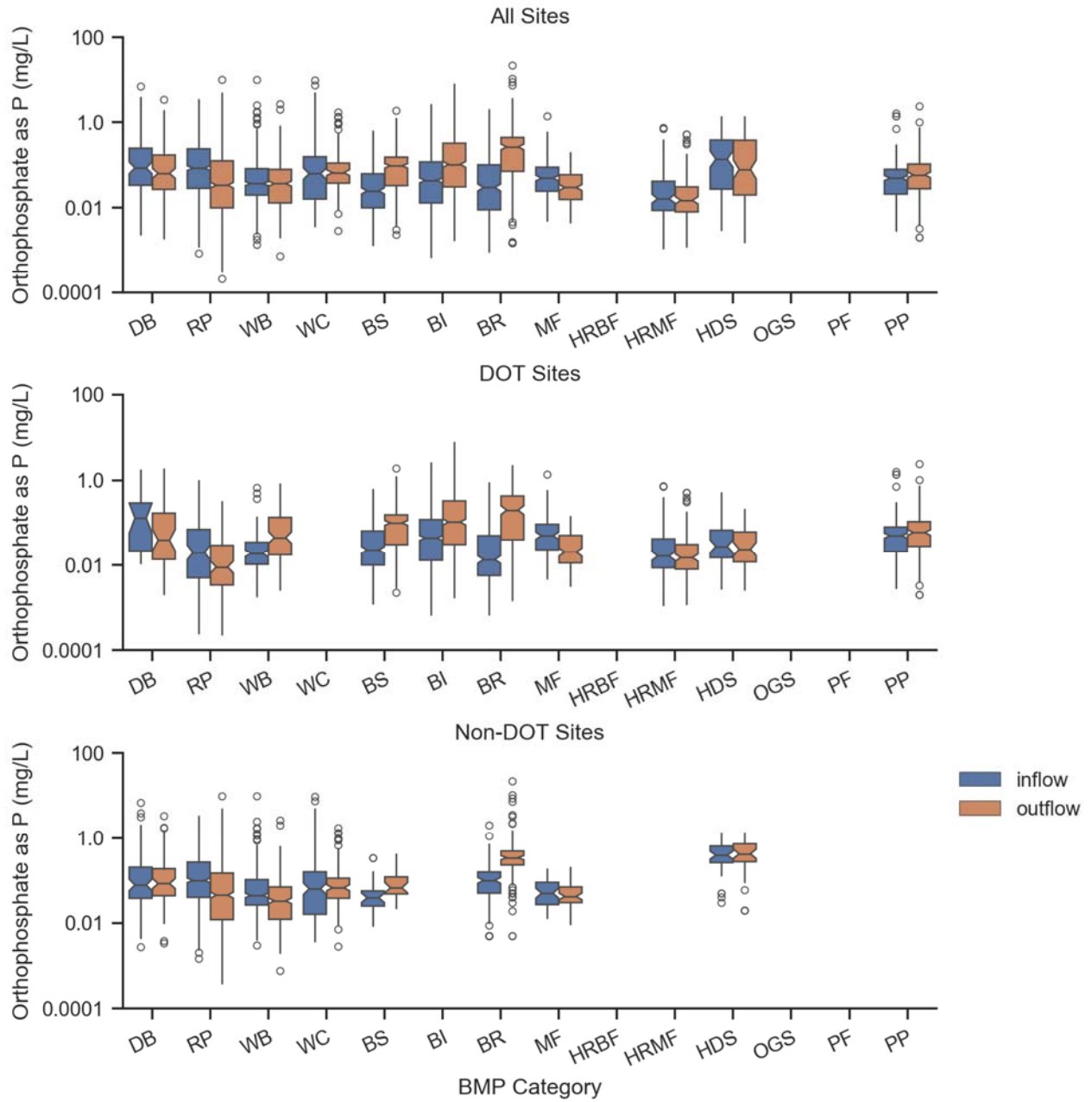


Figure 7.2. Box Plots of Influent/Effluent Orthophosphate Concentrations

Table 7-2. Influent/Effluent Summary Statistics for Orthophosphate (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	10; 98 (18.4%)	11; 116 (31.0%)	0.0339 - 0.253	0.0271 - 0.175	0.0868 (0.0579, 0.130)	0.0646 (0.0422, 0.0875)	◇◇◇
	DOT	3; 25 (8.0%)	4; 46 (43.5%)	0.0218 - 0.294	0.0137 - 0.170	0.130 (0.0155, 0.140)	0.0392 (0.0175, 0.0665)	◇◇◇
	Non-DOT	7; 73 (21.9%)	7; 70 (22.9%)	0.0379 - 0.204	0.0438 - 0.188	0.0779 (0.0515, 0.110)	0.0841 (0.0604, 0.119)	◇◇◇
RP	All Sites	42; 734 (10.8%)	43; 687 (18.6%)	0.0288 - 0.243	0.00999 - 0.127	0.0856 (0.070, 0.095)	0.034 (0.028, 0.039)	▼▼▼
	DOT	7; 109 (40.4%)	7; 111 (44.1%)	0.00501 - 0.0701	0.00339 - 0.0296	0.020 (0.0085, 0.033)	0.0090 (0.0057, 0.011)	◇▼▼
	Non-DOT	35; 625 (5.6%)	36; 576 (13.7%)	0.0399 - 0.269	0.0120 - 0.148	0.100 (0.0800, 0.108)	0.0450 (0.0332, 0.0490)	▼▼▼
WB	All Sites	13; 482 (9.1%)	14; 454 (9.3%)	0.0199 - 0.0832	0.0130 - 0.0798	0.0371 (0.033, 0.040)	0.037 (0.031, 0.040)	◇◇▼
	DOT	4; 113 (17.7%)	4; 107 (11.2%)	0.0104 - 0.0350	0.0175 - 0.135	0.019 (0.014, 0.022)	0.045 (0.035, 0.056)	△△◇
	Non-DOT	9; 368 (6.2%)	10; 346 (8.4%)	0.0264 - 0.104	0.0123 - 0.0700	0.044 (0.038, 0.050)	0.033 (0.0265, 0.038)	◇▼▼
WC	All Sites	8; 138 (4.3%)	6; 113 (6.2%)	0.0160 - 0.158	0.0380 - 0.112	0.0635 (0.040, 0.093)	0.067 (0.054, 0.080)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	8; 138 (4.3%)	6; 113 (6.2%)	0.0160 - 0.158	0.0380 - 0.112	0.0635 (0.040, 0.093)	0.067 (0.054, 0.080)	◇◇◇
BS	All Sites	11; 300 (5.7%)	15; 418 (1.2%)	0.010 - 0.0630	0.0333 - 0.155	0.025 (0.021, 0.030)	0.097 (0.0850, 0.105)	△△△
	DOT	8; 274 (4.7%)	12; 392 (1.3%)	0.01000 - 0.0645	0.0307 - 0.155	0.023 (0.018, 0.026)	0.10 (0.089, 0.11)	△△△
	Non-DOT	3; 26 (15.4%)	3; 26 (0.0%)	0.0253 - 0.0575	0.0480 - 0.121	0.039 (0.017, 0.039)	0.067 (0.049, 0.086)	△△△
BI	All Sites	40; 731 (22.7%)	40; 553 (12.3%)	0.0130 - 0.120	0.0310 - 0.330	0.044 (0.034, 0.05)	0.105 (0.0900, 0.120)	△△△
	DOT	40; 731 (22.7%)	40; 553 (12.3%)	0.0130 - 0.120	0.0310 - 0.330	0.044 (0.034, 0.05)	0.105 (0.0900, 0.120)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	25; 400 (21.2%)	24; 350 (3.7%)	0.00895 - 0.103	0.0720 - 0.450	0.03 (0.019, 0.040)	0.270 (0.203, 0.298)	△△△
	DOT	20; 269 (29.4%)	20; 241 (5.0%)	0.00567 - 0.0500	0.0400 - 0.430	0.0135 (0.010, 0.017)	0.200 (0.130, 0.230)	△△△
	Non-DOT	5; 130 (3.8%)	4; 109 (0.9%)	0.0500 - 0.157	0.230 - 0.490	0.100 (0.070, 0.105)	0.340 (0.270, 0.360)	△△△
MF	All Sites	11; 179 (12.3%)	10; 168 (24.4%)	0.0245 - 0.0900	0.0157 - 0.0600	0.050 (0.032, 0.051)	0.030 (0.020, 0.0310)	▼▼▼
	DOT	6; 129 (13.2%)	5; 114 (35.1%)	0.0232 - 0.0930	0.0112 - 0.0507	0.050 (0.030, 0.0590)	0.0204 (0.0173, 0.0285)	▼▼▼
	Non-DOT	5; 49 (8.2%)	5; 54 (1.9%)	0.0270 - 0.0900	0.0300 - 0.0700	0.050 (0.034, 0.060)	0.0420 (0.0340, 0.0525)	◇◇▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
HRMF	All Sites	7; 113 (17.7%)	7; 113 (18.6%)	0.00863 - 0.0420	0.00800 - 0.0310	0.0164 (0.0137, 0.021)	0.0150 (0.0110, 0.0180)	◇◇◇
	DOT	7; 113 (17.7%)	7; 113 (18.6%)	0.00863 - 0.0420	0.00800 - 0.0310	0.0164 (0.0137, 0.021)	0.015 (0.0110, 0.0180)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	6; 90 (11.1%)	6; 83 (13.3%)	0.0275 - 0.392	0.0200 - 0.389	0.140 (0.0517, 0.255)	0.080 (0.0330, 0.110)	◇◇◇
	DOT	3; 46 (19.6%)	3; 47 (23.4%)	0.015 - 0.0675	0.0119 - 0.0610	0.028 (0.021, 0.0385)	0.024 (0.015, 0.033)	◇◇▼
	Non-DOT	3; 44 (2.3%)	3; 36 (0.0%)	0.260 - 0.641	0.274 - 0.725	0.390 (0.313, 0.509)	0.419 (0.343, 0.577)	◇◇◇
PP	All Sites	11; 239 (15.1%)	13; 192 (6.2%)	0.021 - 0.0800	0.0280 - 0.107	0.050 (0.0426, 0.057)	0.0595 (0.0430, 0.0710)	◇△△
	DOT	11; 239 (15.1%)	13; 192 (6.2%)	0.021 - 0.0800	0.0280 - 0.107	0.050 (0.0426, 0.057)	0.0595 (0.0430, 0.0710)	◇△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

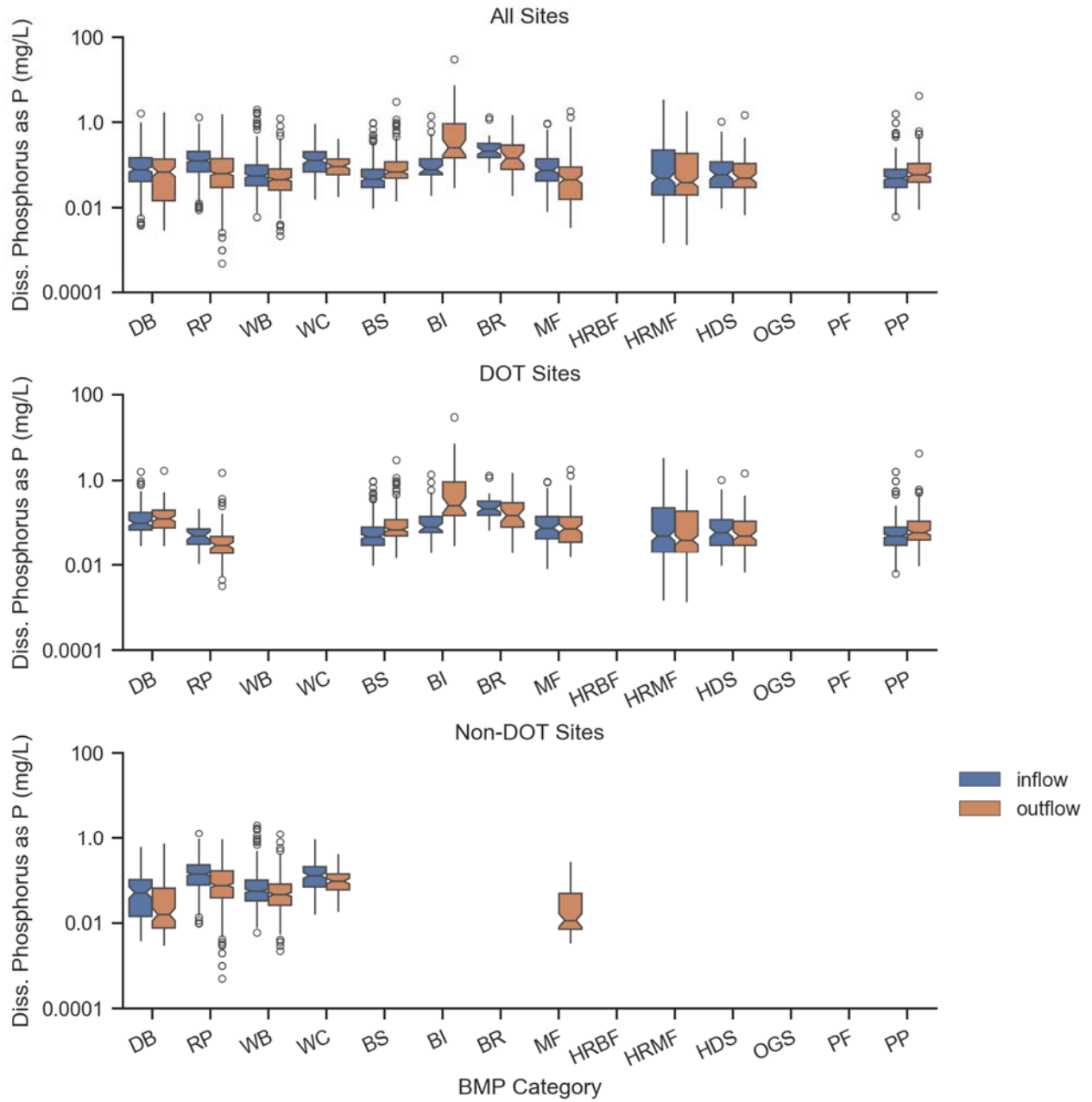


Figure 7.3. Box Plots of Influent/Effluent Dissolved Phosphorus Concentrations

Table 7-3. Influent/Effluent Summary Statistics for Dissolved Phosphorus (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	14; 195 (5.1%)	14; 182 (6.0%)	0.0415 - 0.150	0.0147 - 0.140	0.0800 (0.0690, 0.0924)	0.0700 (0.0474, 0.0800)	◇◇◇
	DOT	7; 92 (0.0%)	7; 85 (0.0%)	0.0687 - 0.178	0.0770 - 0.200	0.0995 (0.0840, 0.135)	0.127 (0.0990, 0.140)	◇◇◇
	Non-DOT	7; 103 (9.7%)	7; 97 (11.3%)	0.0143 - 0.104	0.00766 - 0.0655	0.0518 (0.0277, 0.0680)	0.0158 (0.0110, 0.0222)	▼▼◇
RP	All Sites	20; 396 (2.5%)	23; 435 (7.8%)	0.0700 - 0.212	0.0300 - 0.144	0.129 (0.114, 0.145)	0.0642 (0.0550, 0.0700)	▼▼▼
	DOT	4; 35 (2.9%)	5; 68 (25.0%)	0.0318 - 0.0726	0.0190 - 0.0484	0.0506 (0.0367, 0.0600)	0.0300 (0.0220, 0.0332)	▼▼◇
	Non-DOT	16; 361 (2.5%)	18; 367 (4.6%)	0.0775 - 0.230	0.0390 - 0.167	0.140 (0.127, 0.160)	0.0760 (0.0670, 0.0856)	▼▼▼
WB	All Sites	8; 325 (0.3%)	7; 298 (0.7%)	0.0330 - 0.101	0.0260 - 0.0818	0.0565 (0.0490, 0.0610)	0.0467 (0.0418, 0.0506)	◇▼◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	8; 325 (0.3%)	7; 298 (0.7%)	0.0330 - 0.101	0.0260 - 0.0818	0.0565 (0.0490, 0.0610)	0.0467 (0.0418, 0.0506)	◇▼◇
WC	All Sites	5; 109 (3.7%)	4; 80 (2.5%)	0.0700 - 0.209	0.0600 - 0.141	0.130 (0.0960, 0.151)	0.0955 (0.0769, 0.102)	◇▼◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	5; 109 (3.7%)	4; 80 (2.5%)	0.0700 - 0.209	0.0600 - 0.141	0.130 (0.0960, 0.151)	0.0955 (0.0769, 0.102)	◇▼◇
BS	All Sites	12; 170 (4.1%)	11; 146 (2.1%)	0.0300 - 0.0800	0.0500 - 0.120	0.0480 (0.0400, 0.0500)	0.0700 (0.0600, 0.0700)	△△△
	DOT	12; 170 (4.1%)	11; 146 (2.1%)	0.0300 - 0.0800	0.0500 - 0.120	0.0480 (0.0400, 0.0500)	0.0700 (0.0600, 0.0700)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BI	All Sites	5; 40 (0.0%)	6; 45 (0.0%)	0.0600 - 0.143	0.150 - 0.920	0.0800 (0.0600, 0.0800)	0.260 (0.142, 0.300)	△△△
	DOT	5; 40 (0.0%)	6; 45 (0.0%)	0.0600 - 0.143	0.150 - 0.920	0.0800 (0.0600, 0.0800)	0.260 (0.142, 0.300)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	4; 36 (27.8%)	4; 36 (8.3%)	0.152 - 0.325	0.0800 - 0.314	0.218 (0.170, 0.250)	0.150 (0.0900, 0.190)	◇◇◇
	DOT	4; 36 (27.8%)	4; 36 (8.3%)	0.152 - 0.325	0.0800 - 0.314	0.218 (0.170, 0.250)	0.150 (0.0900, 0.190)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
MF	All Sites	11; 86 (3.5%)	15; 155 (1.3%)	0.0428 - 0.142	0.0158 - 0.0907	0.0769 (0.0600, 0.0895)	0.0468 (0.0300, 0.0517)	▼▼◇
	DOT	11; 86 (3.5%)	11; 85 (1.2%)	0.0428 - 0.142	0.0354 - 0.140	0.0769 (0.0600, 0.0895)	0.0750 (0.0500, 0.0800)	◇◇◇
	Non-DOT	NA	4; 70 (1.4%)	NA	0.00716 - 0.0494	NA	0.0116 (0.00828, 0.0241)	NA

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
HRMF	All Sites	9; 194 (14.4%)	9; 194 (14.9%)	0.0200 - 0.228	0.0200 - 0.190	0.0500 (0.0367, 0.0535)	0.0400 (0.0300, 0.0500)	◇◇▼
	DOT	9; 194 (14.4%)	9; 194 (14.9%)	0.0200 - 0.228	0.0200 - 0.190	0.0500 (0.0367, 0.0535)	0.0400 (0.0300, 0.0500)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	5; 71 (1.4%)	5; 71 (1.4%)	0.0300 - 0.120	0.0300 - 0.110	0.0600 (0.0380, 0.0700)	0.0500 (0.0300, 0.0560)	◇◇▼
	DOT	5; 71 (1.4%)	5; 71 (1.4%)	0.0300 - 0.120	0.0300 - 0.110	0.0600 (0.0380, 0.0700)	0.0500 (0.0300, 0.0560)	◇◇▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	4; 264 (6.8%)	4; 126 (3.2%)	0.0300 - 0.0800	0.0400 - 0.110	0.0500 (0.0425, 0.0575)	0.0600 (0.0480, 0.0600)	◇△△
	DOT	4; 264 (6.8%)	4; 126 (3.2%)	0.0300 - 0.0800	0.0400 - 0.110	0.0500 (0.0425, 0.0575)	0.0600 (0.0480, 0.0600)	◇△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

7.2 Nitrogen

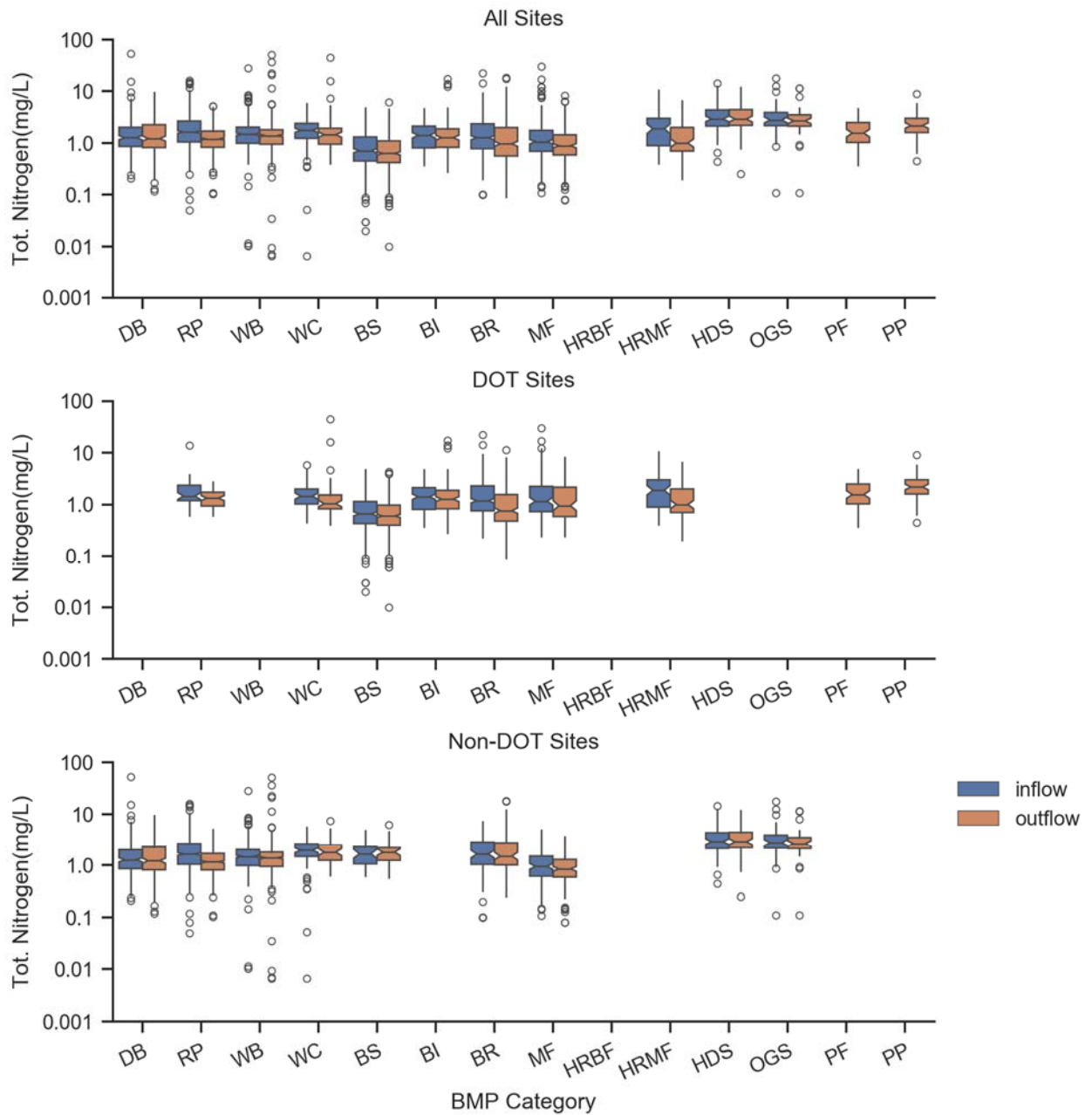


Figure 7.4. Box Plots of Influent/Effluent Total Nitrogen Concentrations

Table 7-4. Influent/Effluent Summary Statistics for Total Nitrogen (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	16; 210 (0.0%)	16; 195 (0.0%)	0.861 - 2.01	0.818 - 2.26	1.27 (1.13, 1.39)	1.22 (1.05, 1.34)	◇◇▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	16; 210 (0.0%)	16; 195 (0.0%)	0.861 - 2.01	0.818 - 2.26	1.27 (1.13, 1.39)	1.22 (1.05, 1.34)	◇◇▼
RP	All Sites	35; 618 (0.0%)	37; 602 (0.0%)	1.05 - 2.66	0.830 - 1.70	1.63 (1.49, 1.75)	1.20 (1.13, 1.25)	▼▼▼
	DOT	6; 46 (0.0%)	6; 76 (0.0%)	1.19 - 2.36	0.938 - 1.73	1.46 (1.26, 1.73)	1.33 (1.22, 1.45)	◇▼▼
	Non-DOT	29; 572 (0.0%)	31; 526 (0.0%)	1.05 - 2.68	0.813 - 1.70	1.65 (1.50, 1.80)	1.16 (1.11, 1.24)	▼▼▼
WB	All Sites	12; 427 (0.0%)	12; 435 (0.0%)	0.990 - 2.02	0.950 - 1.81	1.48 (1.39, 1.55)	1.39 (1.28, 1.45)	◇▼◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	12; 427 (0.0%)	12; 435 (0.0%)	0.990 - 2.02	0.950 - 1.81	1.48 (1.39, 1.55)	1.39 (1.28, 1.45)	◇▼◇
WC	All Sites	8; 127 (0.0%)	7; 95 (0.0%)	1.24 - 2.40	0.950 - 1.93	1.76 (1.56, 1.90)	1.45 (1.05, 1.58)	◇▼▼
	DOT	3; 55 (0.0%)	3; 47 (0.0%)	1.02 - 1.99	0.825 - 1.53	1.45 (1.21, 1.65)	1.04 (0.810, 1.05)	▼▼▼
	Non-DOT	5; 72 (0.0%)	4; 48 (0.0%)	1.48 - 2.65	1.25 - 2.51	1.96 (1.79, 2.31)	1.80 (1.48, 1.83)	◇◇▼
BS	All Sites	14; 354 (0.0%)	18; 470 (0.0%)	0.450 - 1.31	0.420 - 1.10	0.710 (0.640, 0.792)	0.630 (0.574, 0.650)	◇▼◇
	DOT	11; 320 (0.0%)	15; 436 (0.0%)	0.428 - 1.14	0.398 - 0.973	0.660 (0.600, 0.745)	0.600 (0.530, 0.624)	◇◇◇
	Non-DOT	3; 34 (0.0%)	3; 34 (0.0%)	1.06 - 2.27	1.25 - 2.20	1.67 (1.26, 2.10)	1.80 (1.42, 2.10)	◇◇◇
BI	All Sites	9; 154 (0.0%)	10; 146 (0.0%)	0.805 - 2.12	0.827 - 1.88	1.41 (1.10, 1.60)	1.27 (1.13, 1.39)	◇◇◇
	DOT	9; 154 (0.0%)	10; 146 (0.0%)	0.805 - 2.12	0.827 - 1.88	1.41 (1.10, 1.60)	1.27 (1.13, 1.39)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	27; 386 (0.3%)	25; 318 (0.0%)	0.778 - 2.35	0.562 - 1.99	1.26 (1.15, 1.36)	0.964 (0.815, 1.06)	▼▼▼
	DOT	20; 303 (0.3%)	18; 232 (0.0%)	0.754 - 2.29	0.478 - 1.56	1.18 (1.01, 1.31)	0.759 (0.680, 0.848)	▼▼▼
	Non-DOT	7; 83 (0.0%)	7; 86 (0.0%)	1.04 - 2.86	1.02 - 2.77	1.65 (1.30, 1.76)	1.50 (1.20, 1.80)	◇◇◇
MF	All Sites	14; 228 (0.0%)	14; 231 (0.0%)	0.693 - 1.76	0.588 - 1.44	1.06 (0.939, 1.18)	0.886 (0.814, 0.968)	◇▼▼
	DOT	5; 112 (0.0%)	4; 88 (0.0%)	0.728 - 2.24	0.585 - 2.16	1.16 (0.970, 1.31)	0.948 (0.823, 1.21)	◇◇▼
	Non-DOT	9; 116 (0.0%)	10; 143 (0.0%)	0.617 - 1.51	0.593 - 1.30	0.950 (0.877, 1.13)	0.850 (0.740, 0.942)	◇◇▼
HRMF	All Sites	3; 81 (0.0%)	3; 81 (0.0%)	0.890 - 3.00	0.700 - 2.00	1.88 (1.20, 2.27)	1.00 (0.900, 1.20)	◇▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	3; 81 (0.0%)	3; 81 (0.0%)	0.890 - 3.00	0.700 - 2.00	1.88 (1.20, 2.27)	1.00 (0.900, 1.20)	◇▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	3; 82 (0.0%)	3; 68 (0.0%)	2.13 - 4.36	2.19 - 4.43	2.92 (2.48, 3.36)	2.91 (2.35, 3.44)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 82 (0.0%)	3; 68 (0.0%)	2.13 - 4.36	2.19 - 4.43	2.92 (2.48, 3.36)	2.91 (2.35, 3.44)	◇◇◇
OGS	All Sites	3; 48 (0.0%)	3; 42 (0.0%)	2.16 - 3.90	2.12 - 3.51	2.78 (2.35, 3.24)	2.67 (2.22, 3.17)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	3; 48 (0.0%)	3; 42 (0.0%)	2.16 - 3.90	2.12 - 3.51	2.78 (2.35, 3.24)	2.67 (2.22, 3.17)	◇◇◇
PFC	All Sites	NA	3; 66 (0.0%)	NA	1.03 - 2.49	NA	1.55 (1.45, 1.84)	NA
	DOT	NA	3; 66 (0.0%)	NA	1.03 - 2.49	NA	1.55 (1.45, 1.84)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	NA	7; 66 (0.0%)	NA	1.60 - 3.01	NA	2.18 (1.88, 2.53)	NA
	DOT	NA	7; 66 (0.0%)	NA	1.60 - 3.01	NA	2.18 (1.88, 2.53)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
 ** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.
 %ND percentage of non-detects
 NA not available or less than 3 studies for BMP/constituent.
 ◇ influent/effluent comparison test indicates no significant difference in concentrations
 ▼ influent/effluent comparison test indicates significant reduction in concentrations
 ▲ influent/effluent comparison test indicates significant increase in concentrations

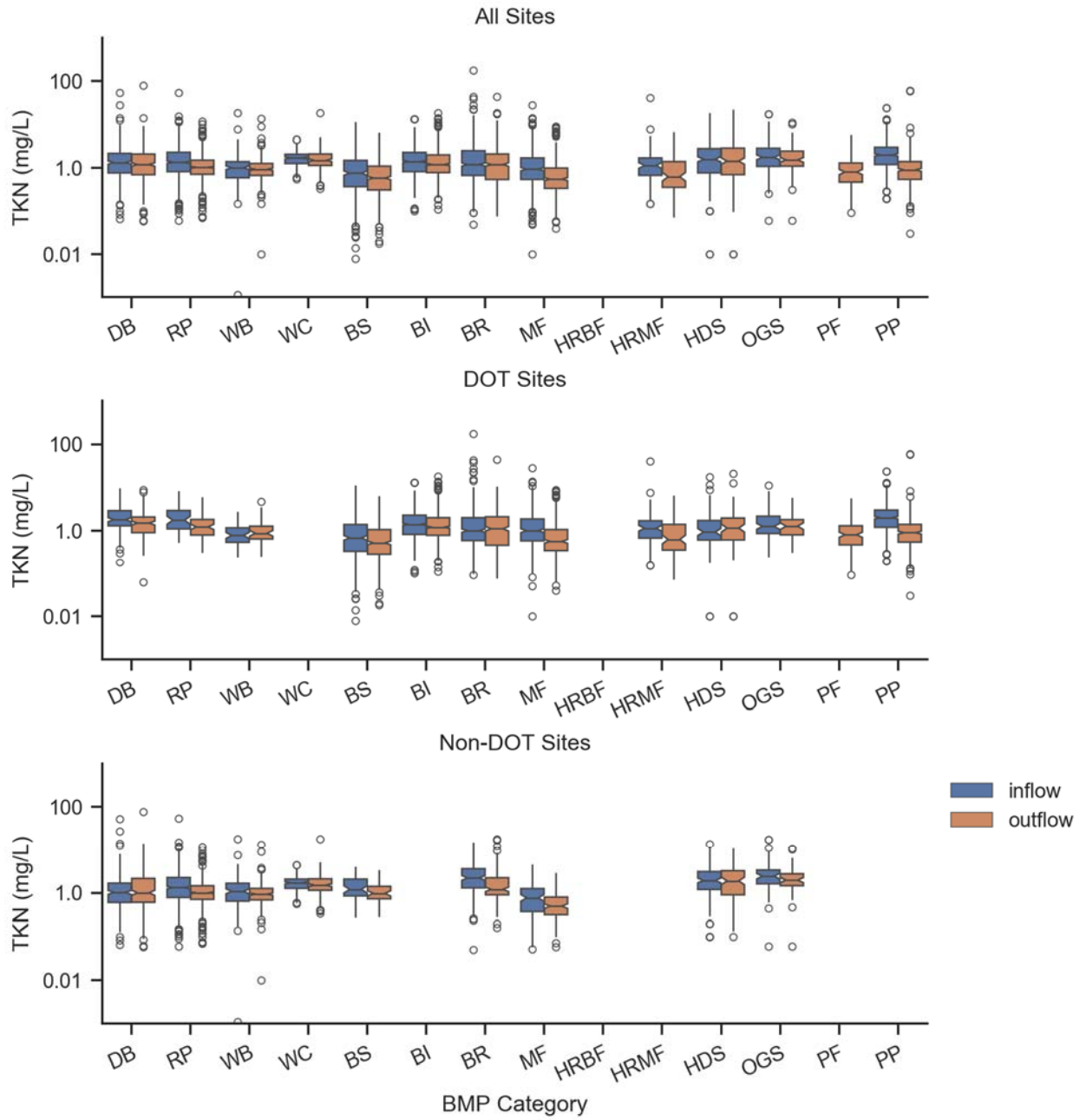


Figure 7.5. Box Plots of Influent/Effluent Total Kjeldahl Nitrogen Concentrations

Table 7-5. Influent/Effluent Summary Statistics for Total Kjeldahl Nitrogen (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	25; 358 (2.0%)	26; 367 (3.5%)	0.768 - 2.17	0.697 - 2.09	1.33 (1.15, 1.40)	1.20 (1.00, 1.30)	◇◇▼
	DOT	9; 134 (0.0%)	10; 161 (1.9%)	1.30 - 2.90	0.900 - 2.07	1.80 (1.50, 2.00)	1.50 (1.20, 1.60)	◇▼▼
	Non-DOT	16; 224 (3.1%)	16; 206 (4.9%)	0.600 - 1.67	0.606 - 2.15	1.02 (0.871, 1.11)	0.999 (0.850, 1.12)	◇◇◇
RP	All Sites	47; 654 (1.8%)	52; 704 (2.4%)	0.820 - 2.30	0.714 - 1.51	1.35 (1.23, 1.40)	1.03 (0.982, 1.08)	▼▼▼
	DOT	7; 52 (0.0%)	7; 84 (3.6%)	1.10 - 2.92	0.793 - 1.82	1.75 (1.40, 2.10)	1.22 (1.01, 1.40)	◇▼▼
	Non-DOT	40; 602 (2.0%)	45; 620 (2.3%)	0.783 - 2.25	0.707 - 1.46	1.32 (1.20, 1.40)	1.00 (0.940, 1.02)	▼▼▼
WB	All Sites	15; 188 (6.4%)	17; 274 (4.7%)	0.593 - 1.39	0.671 - 1.27	1.01 (0.868, 1.08)	0.928 (0.854, 0.971)	◇◇◇
	DOT	3; 57 (5.3%)	3; 50 (6.0%)	0.538 - 1.17	0.642 - 1.27	0.776 (0.610, 0.960)	0.870 (0.717, 1.06)	◇◇△
	Non-DOT	12; 131 (6.9%)	14; 224 (4.5%)	0.645 - 1.66	0.687 - 1.26	1.08 (0.922, 1.21)	0.930 (0.834, 0.980)	◇▼▼
WC	All Sites	9; 154 (1.9%)	9; 161 (1.2%)	1.27 - 2.07	1.14 - 2.10	1.70 (1.58, 1.80)	1.50 (1.45, 1.65)	◇◇◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	9; 154 (1.9%)	9; 161 (1.2%)	1.27 - 2.07	1.14 - 2.10	1.70 (1.58, 1.80)	1.50 (1.45, 1.65)	◇◇◇
BS	All Sites	21; 384 (0.0%)	25; 489 (0.2%)	0.370 - 1.49	0.310 - 1.10	0.759 (0.666, 0.864)	0.583 (0.505, 0.660)	▼▼◇
	DOT	14; 331 (0.0%)	18; 436 (0.2%)	0.333 - 1.39	0.285 - 1.06	0.682 (0.590, 0.776)	0.520 (0.466, 0.592)	◇▼▼
	Non-DOT	7; 53 (0.0%)	7; 53 (0.0%)	0.850 - 2.07	0.730 - 1.41	1.20 (1.01, 1.32)	0.970 (0.800, 1.02)	◇◇▼
BI	All Sites	46; 855 (0.0%)	44; 630 (0.0%)	0.820 - 2.28	0.782 - 2.00	1.40 (1.20, 1.40)	1.20 (1.10, 1.22)	◇▼◇
	DOT	46; 855 (0.0%)	44; 630 (0.0%)	0.820 - 2.28	0.782 - 2.00	1.40 (1.20, 1.40)	1.20 (1.10, 1.22)	◇▼◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	31; 612 (1.8%)	30; 525 (1.5%)	0.670 - 2.50	0.540 - 2.10	1.20 (1.10, 1.30)	1.20 (0.951, 1.20)	◇▼▼
	DOT	24; 449 (1.3%)	24; 385 (1.6%)	0.590 - 2.00	0.460 - 2.10	1.00 (0.870, 1.10)	1.11 (0.840, 1.30)	◇◇◇
	Non-DOT	7; 163 (3.1%)	6; 140 (1.4%)	1.30 - 3.60	0.900 - 2.23	2.20 (1.80, 2.50)	1.20 (1.10, 1.40)	▼▼▼
MF	All Sites	27; 428 (4.2%)	27; 448 (5.1%)	0.541 - 1.70	0.337 - 0.994	0.936 (0.841, 1.00)	0.551 (0.480, 0.600)	▼▼▼
	DOT	18; 314 (1.6%)	17; 307 (2.9%)	0.581 - 1.87	0.346 - 1.06	0.999 (0.900, 1.18)	0.565 (0.493, 0.625)	▼▼▼
	Non-DOT	9; 114 (11.4%)	10; 140 (9.3%)	0.371 - 1.25	0.314 - 0.799	0.764 (0.603, 0.856)	0.494 (0.412, 0.598)	▼▼▼
HRMF	All Sites	6; 86 (5.8%)	6; 86 (20.9%)	0.675 - 1.70	0.356 - 1.40	1.14 (0.826, 1.20)	0.626 (0.530, 0.710)	▼▼▼

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	6; 86 (5.8%)	6; 86 (20.9%)	0.675 - 1.70	0.356 - 1.40	1.14 (0.826, 1.20)	0.626 (0.530, 0.710)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	10; 207 (0.0%)	10; 173 (0.6%)	0.770 - 2.79	0.700 - 2.87	1.59 (1.40, 1.80)	1.44 (1.20, 1.70)	◇◇◇
	DOT	5; 73 (0.0%)	5; 75 (0.0%)	0.607 - 1.72	0.610 - 1.96	0.930 (0.700, 1.26)	1.15 (0.730, 1.24)	◇◇△
	Non-DOT	5; 134 (0.0%)	5; 98 (1.0%)	1.20 - 3.09	0.900 - 3.23	1.92 (1.59, 2.25)	1.88 (1.52, 2.15)	◇◇◇
OGS	All Sites	7; 139 (2.2%)	7; 100 (5.0%)	1.09 - 2.85	1.10 - 2.45	1.76 (1.43, 2.02)	1.53 (1.40, 1.83)	◇◇◇
	DOT	3; 82 (1.2%)	3; 50 (2.0%)	0.860 - 2.16	0.800 - 1.81	1.26 (1.09, 1.60)	1.27 (0.950, 1.40)	◇◇◇
	Non-DOT	4; 57 (3.5%)	4; 50 (8.0%)	1.61 - 3.36	1.46 - 2.75	2.42 (1.95, 2.80)	1.96 (1.55, 2.34)	◇◇◇
PFC	All Sites	NA	6; 134 (0.0%)	NA	0.470 - 1.30	NA	0.804 (0.640, 0.931)	NA
	DOT	NA	6; 134 (0.0%)	NA	0.470 - 1.30	NA	0.804 (0.640, 0.931)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	11; 449 (0.4%)	21; 353 (4.5%)	1.20 - 3.00	0.544 - 1.40	2.00 (1.70, 2.10)	0.900 (0.762, 0.900)	▼▼▼
	DOT	11; 449 (0.4%)	21; 353 (4.5%)	1.20 - 3.00	0.544 - 1.40	2.00 (1.70, 2.10)	0.900 (0.762, 0.900)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

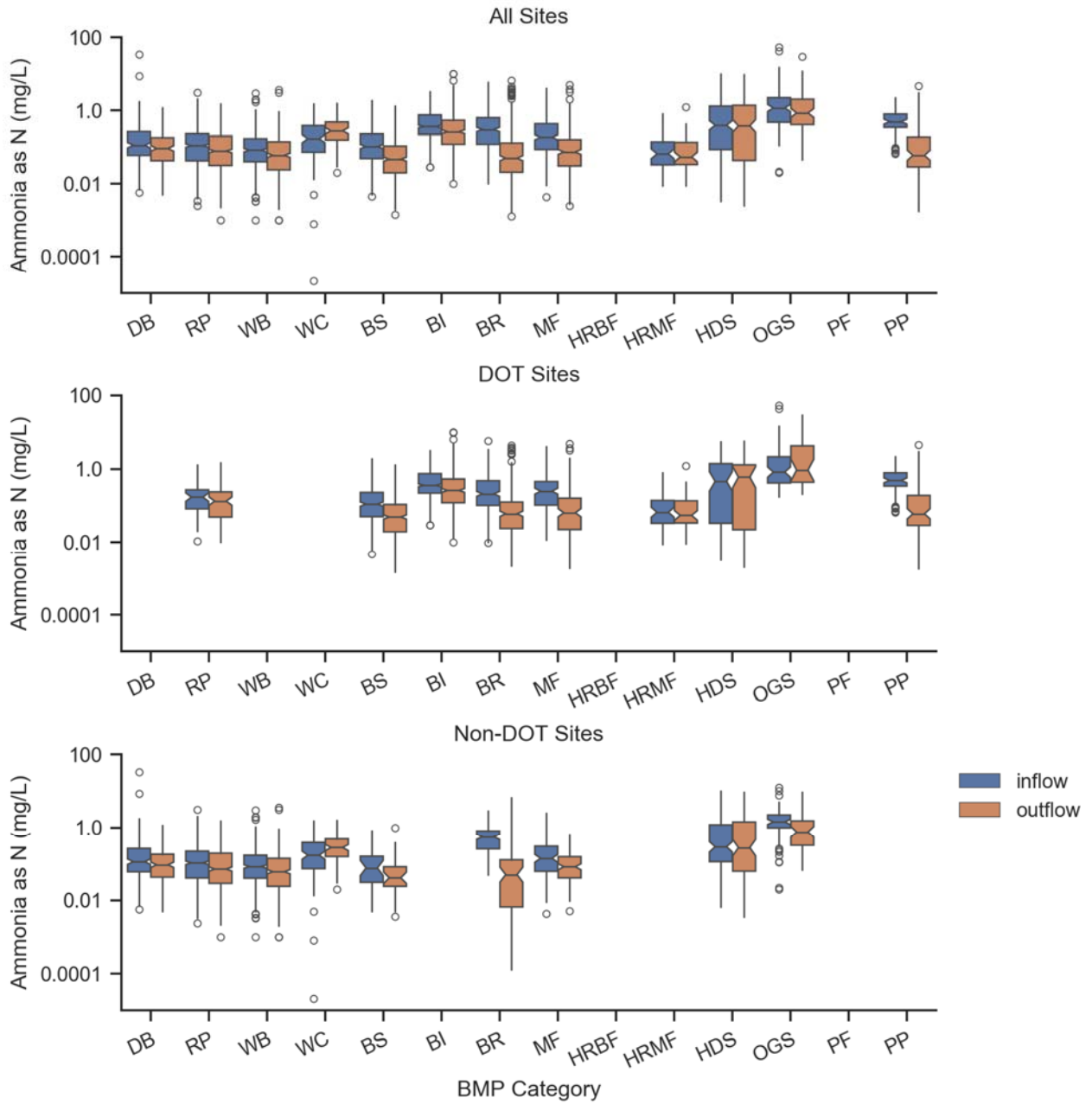


Figure 7.6. Box Plots of Influent/Effluent Ammonia as N Concentrations

Table 7-6. Influent/Effluent Summary Statistics for Ammonia as N (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	14; 188 (9.0%)	14; 174 (16.7%)	0.0597 - 0.262	0.0428 - 0.181	0.113 (0.0841, 0.130)	0.0928 (0.0756, 0.111)	◇▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	14; 188 (9.0%)	14; 174 (16.7%)	0.0597 - 0.262	0.0428 - 0.181	0.113 (0.0841, 0.130)	0.0928 (0.0756, 0.110)	◇▼▼
RP	All Sites	42; 654 (6.7%)	45; 644 (7.8%)	0.0425 - 0.229	0.0317 - 0.200	0.110 (0.0968, 0.123)	0.0785 (0.0675, 0.0910)	▼▼▼
	DOT	7; 51 (7.8%)	8; 91 (11.0%)	0.0816 - 0.271	0.0488 - 0.237	0.171 (0.0997, 0.190)	0.133 (0.0890, 0.167)	◇◇▼
	Non-DOT	35; 603 (6.6%)	37; 553 (7.2%)	0.0405 - 0.220	0.0290 - 0.193	0.105 (0.0925, 0.118)	0.0710 (0.0600, 0.0830)	▼▼▼
WB	All Sites	14; 430 (1.4%)	14; 433 (2.1%)	0.0400 - 0.170	0.0240 - 0.140	0.0831 (0.0747, 0.0900)	0.0600 (0.0560, 0.0700)	▼▼▼
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	14; 430 (1.4%)	14; 433 (2.1%)	0.0400 - 0.170	0.0240 - 0.140	0.0831 (0.0747, 0.0900)	0.0600 (0.0560, 0.0700)	▼▼▼
WC	All Sites	6; 104 (10.6%)	5; 83 (12.0%)	0.0729 - 0.382	0.157 - 0.480	0.170 (0.115, 0.190)	0.276 (0.220, 0.326)	△△◇
	DOT	NA	NA	NA	NA	NA	NA	NA
	Non-DOT	6; 104 (10.6%)	5; 83 (12.0%)	0.0729 - 0.382	0.157 - 0.480	0.170 (0.115, 0.190)	0.276 (0.220, 0.326)	△△◇
BS	All Sites	15; 352 (5.7%)	19; 467 (10.9%)	0.0488 - 0.227	0.0200 - 0.107	0.104 (0.0900, 0.127)	0.0470 (0.0400, 0.0520)	▼▼▼
	DOT	10; 323 (5.3%)	14; 438 (10.7%)	0.0500 - 0.230	0.0192 - 0.108	0.110 (0.0892, 0.126)	0.0490 (0.0400, 0.0540)	▼▼▼
	Non-DOT	5; 29 (10.3%)	5; 29 (13.8%)	0.0310 - 0.160	0.0240 - 0.0820	0.0760 (0.0310, 0.0960)	0.0410 (0.0240, 0.0500)	◇◇▼
BI	All Sites	35; 518 (4.2%)	35; 387 (10.6%)	0.220 - 0.750	0.120 - 0.535	0.359 (0.330, 0.420)	0.260 (0.220, 0.280)	▼▼▼
	DOT	35; 518 (4.2%)	35; 387 (10.6%)	0.220 - 0.750	0.120 - 0.535	0.359 (0.330, 0.420)	0.260 (0.220, 0.280)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	21; 374 (4.3%)	22; 330 (25.5%)	0.120 - 0.630	0.0208 - 0.130	0.300 (0.220, 0.320)	0.0500 (0.0500, 0.0600)	▼▼▼
	DOT	16; 244 (6.1%)	18; 232 (16.4%)	0.101 - 0.480	0.0237 - 0.125	0.210 (0.176, 0.249)	0.0600 (0.0459, 0.0700)	▼▼▼
	Non-DOT	5; 130 (0.8%)	4; 98 (46.9%)	0.255 - 0.808	0.00656 - 0.127	0.545 (0.455, 0.610)	0.0500 (0.0115, 0.0500)	▼▼▼
MF	All Sites	16; 254 (9.1%)	17; 269 (20.8%)	0.0866 - 0.431	0.0307 - 0.160	0.186 (0.148, 0.214)	0.0742 (0.0568, 0.0828)	▼▼▼
	DOT	8; 156 (11.5%)	8; 145 (35.2%)	0.103 - 0.455	0.0223 - 0.160	0.249 (0.181, 0.300)	0.0640 (0.0440, 0.0770)	▼▼▼
	Non-DOT	8; 98 (5.1%)	9; 124 (4.0%)	0.0618 - 0.302	0.0408 - 0.156	0.140 (0.114, 0.169)	0.0820 (0.0614, 0.0986)	▼▼▼
HRMF	All Sites	4; 52 (36.5%)	4; 52 (38.5%)	0.0330 - 0.139	0.0336 - 0.136	0.0660 (0.0459, 0.0795)	0.0543 (0.0431, 0.0802)	◇◇◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25 th – 75 th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	4; 52 (36.5%)	4; 52 (38.5%)	0.0330 - 0.139	0.0336 - 0.136	0.0660 (0.0459, 0.0795)	0.0543 (0.0431, 0.0802)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	9; 219 (5.9%)	9; 184 (12.0%)	0.0863 - 1.30	0.0435 - 1.37	0.390 (0.242, 0.480)	0.377 (0.200, 0.695)	◇◇◇
	DOT	6; 93 (12.9%)	6; 94 (16.0%)	0.0330 - 1.40	0.0221 - 1.30	0.460 (0.130, 0.640)	0.600 (0.125, 0.830)	◇◇◇
	Non-DOT	3; 126 (0.8%)	3; 90 (7.8%)	0.114 - 1.19	0.0624 - 1.42	0.290 (0.210, 0.400)	0.275 (0.113, 0.440)	◇◇◇
OGS	All Sites	7; 121 (9.9%)	7; 80 (23.8%)	0.472 - 2.22	0.407 - 2.01	1.16 (0.855, 1.40)	0.847 (0.497, 1.18)	◇◇▼
	DOT	3; 63 (0.0%)	3; 28 (0.0%)	0.416 - 2.16	0.435 - 4.30	0.823 (0.508, 1.02)	0.942 (0.433, 3.20)	◇◇◇
	Non-DOT	4; 58 (20.7%)	4; 52 (36.5%)	0.980 - 2.21	0.320 - 1.52	1.43 (1.20, 1.68)	0.756 (0.426, 1.12)	▼▼▼
PP	All Sites	4; 74 (5.4%)	8; 86 (36.0%)	0.343 - 0.790	0.0289 - 0.190	0.490 (0.400, 0.570)	0.0600 (0.0400, 0.0800)	▼▼▼
	DOT	4; 74 (5.4%)	8; 86 (36.0%)	0.343 - 0.790	0.0289 - 0.190	0.490 (0.400, 0.570)	0.0600 (0.0400, 0.0800)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.

%ND percentage of non-detects

NA not available or less than 3 studies for BMP/constituent.

◇ influent/effluent comparison test indicates no significant difference in concentrations

▼ influent/effluent comparison test indicates significant reduction in concentrations

△ influent/effluent comparison test indicates significant *increase* in concentrations

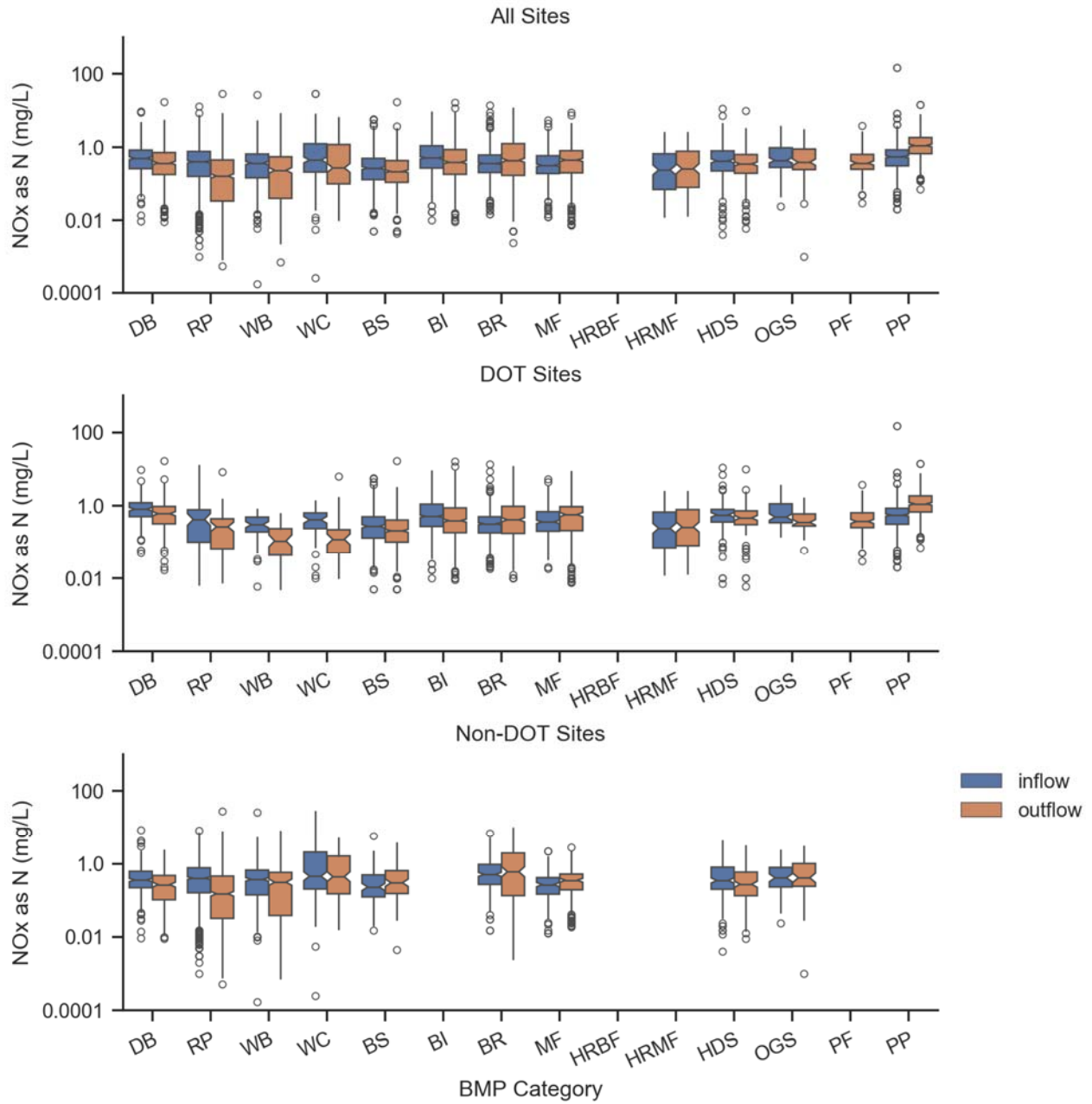


Figure 7.7. Box Plots of Influent/Effluent NO_x as Nitrogen Concentrations

Table 7-7. Influent/Effluent Summary Statistics for NO_x as Nitrogen (mg/L)

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
DB	All Sites	30; 409 (1.7%)	30; 412 (3.9%)	0.260 - 0.840	0.180 - 0.718	0.500 (0.428, 0.525)	0.372 (0.325, 0.413)	▼▼▼
	DOT	10; 153 (0.0%)	10; 172 (0.0%)	0.500 - 1.20	0.317 - 0.953	0.800 (0.670, 0.860)	0.603 (0.500, 0.670)	▼▼▼
	Non-DOT	20; 256 (2.7%)	20; 240 (6.7%)	0.220 - 0.620	0.103 - 0.475	0.357 (0.320, 0.389)	0.267 (0.215, 0.307)	▼▼▼
RP	All Sites	60; 958 (3.5%)	62; 932 (7.1%)	0.160 - 0.771	0.0338 - 0.451	0.400 (0.367, 0.421)	0.163 (0.140, 0.190)	▼▼▼
	DOT	9; 74 (4.1%)	9; 101 (8.9%)	0.101 - 0.772	0.0659 - 0.437	0.420 (0.238, 0.470)	0.264 (0.120, 0.285)	◇▼▼
	Non-DOT	51; 884 (3.5%)	53; 831 (6.9%)	0.160 - 0.770	0.0320 - 0.458	0.400 (0.370, 0.430)	0.150 (0.112, 0.160)	▼▼▼
WB	All Sites	22; 561 (0.9%)	22; 523 (7.5%)	0.146 - 0.655	0.0400 - 0.550	0.370 (0.320, 0.390)	0.234 (0.170, 0.313)	▼▼▼
	DOT	3; 57 (1.8%)	3; 50 (10.0%)	0.190 - 0.487	0.0433 - 0.234	0.303 (0.240, 0.409)	0.109 (0.0574, 0.152)	▼▼▼
	Non-DOT	19; 503 (0.6%)	19; 472 (7.0%)	0.140 - 0.668	0.0384 - 0.577	0.370 (0.331, 0.396)	0.311 (0.202, 0.357)	◇▼▼
WC	All Sites	14; 237 (0.0%)	12; 192 (0.0%)	0.210 - 1.25	0.100 - 1.19	0.450 (0.350, 0.520)	0.273 (0.200, 0.390)	◇▼▼
	DOT	3; 55 (0.0%)	3; 47 (0.0%)	0.235 - 0.635	0.0500 - 0.220	0.410 (0.320, 0.510)	0.120 (0.0600, 0.140)	▼▼▼
	Non-DOT	11; 182 (0.0%)	9; 145 (0.0%)	0.203 - 2.08	0.150 - 1.63	0.453 (0.320, 0.600)	0.440 (0.280, 0.630)	◇◇▼
BS	All Sites	28; 518 (4.1%)	32; 618 (0.5%)	0.130 - 0.498	0.110 - 0.434	0.270 (0.239, 0.290)	0.219 (0.196, 0.230)	▼▼▼
	DOT	18; 424 (2.8%)	22; 524 (0.0%)	0.130 - 0.497	0.101 - 0.404	0.273 (0.250, 0.300)	0.205 (0.176, 0.222)	▼▼▼
	Non-DOT	10; 94 (9.6%)	10; 94 (3.2%)	0.123 - 0.493	0.153 - 0.645	0.230 (0.170, 0.260)	0.300 (0.220, 0.350)	◇◇△
BI	All Sites	48; 870 (1.1%)	47; 670 (3.3%)	0.270 - 1.10	0.182 - 0.868	0.510 (0.440, 0.540)	0.390 (0.350, 0.430)	▼▼▼
	DOT	48; 870 (1.1%)	47; 670 (3.3%)	0.270 - 1.10	0.182 - 0.868	0.510 (0.440, 0.540)	0.390 (0.350, 0.430)	▼▼▼
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
BR	All Sites	40; 789 (2.5%)	38; 609 (3.4%)	0.204 - 0.618	0.170 - 1.26	0.360 (0.330, 0.380)	0.441 (0.380, 0.507)	◇△△
	DOT	27; 539 (0.9%)	28; 433 (2.1%)	0.180 - 0.498	0.174 - 0.960	0.320 (0.270, 0.349)	0.412 (0.350, 0.480)	△△△
	Non-DOT	13; 250 (6.0%)	10; 176 (6.8%)	0.270 - 0.955	0.134 - 1.96	0.507 (0.442, 0.604)	0.600 (0.320, 0.925)	◇◇△
MF	All Sites	30; 466 (2.6%)	31; 483 (3.3%)	0.192 - 0.589	0.200 - 0.810	0.320 (0.289, 0.340)	0.450 (0.397, 0.480)	△△△
	DOT	19; 323 (2.8%)	19; 317 (1.9%)	0.200 - 0.684	0.207 - 0.940	0.361 (0.320, 0.391)	0.570 (0.470, 0.626)	△△△
	Non-DOT	11; 143 (2.1%)	12; 166 (6.0%)	0.147 - 0.415	0.193 - 0.520	0.267 (0.230, 0.297)	0.351 (0.300, 0.397)	△△△
HRMF	All Sites	6; 130 (10.0%)	6; 129 (10.9%)	0.0700 - 0.665	0.0799 - 0.780	0.240 (0.120, 0.393)	0.260 (0.130, 0.400)	◇◇◇

BMP Category	DOT Class	Study & Sample Count (% ND)		Interquartile Range (25th – 75th %tiles)		Median (95% Conf. Interval)*		In vs Out**
		In	Out	In	Out	In	Out	
	DOT	6; 130 (10.0%)	6; 129 (10.9%)	0.0700 - 0.665	0.0799 - 0.780	0.240 (0.120, 0.393)	0.260 (0.130, 0.400)	◇◇◇
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
HDS	All Sites	15; 258 (1.2%)	15; 224 (2.2%)	0.225 - 0.800	0.195 - 0.635	0.425 (0.353, 0.500)	0.350 (0.288, 0.409)	◇▼▼
	DOT	6; 77 (3.9%)	6; 79 (3.8%)	0.357 - 0.790	0.302 - 0.720	0.560 (0.424, 0.596)	0.462 (0.380, 0.570)	◇◇▼
	Non-DOT	9; 181 (0.0%)	9; 145 (1.4%)	0.200 - 0.800	0.133 - 0.587	0.346 (0.280, 0.386)	0.273 (0.223, 0.308)	◇▼▼
OGS	All Sites	8; 141 (0.7%)	8; 103 (1.9%)	0.281 - 0.972	0.245 - 0.896	0.440 (0.390, 0.470)	0.390 (0.330, 0.450)	◇◇◇
	DOT	3; 80 (0.0%)	3; 46 (0.0%)	0.341 - 1.12	0.278 - 0.595	0.489 (0.400, 0.610)	0.350 (0.316, 0.430)	◇▼◇
	Non-DOT	5; 61 (1.6%)	5; 57 (3.5%)	0.230 - 0.787	0.240 - 1.01	0.410 (0.243, 0.427)	0.410 (0.240, 0.505)	◇◇◇
PFC	All Sites	NA	6; 133 (0.0%)	NA	0.250 - 0.640	NA	0.370 (0.330, 0.410)	NA
	DOT	NA	6; 133 (0.0%)	NA	0.250 - 0.640	NA	0.370 (0.330, 0.410)	NA
	Non-DOT	NA	NA	NA	NA	NA	NA	NA
PP	All Sites	11; 442 (0.9%)	20; 345 (1.4%)	0.310 - 0.850	0.670 - 1.85	0.550 (0.480, 0.590)	1.12 (0.950, 1.22)	△△△
	DOT	11; 442 (0.9%)	20; 345 (1.4%)	0.310 - 0.850	0.670 - 1.85	0.550 (0.480, 0.590)	1.12 (0.950, 1.22)	△△△
	Non-DOT	NA	NA	NA	NA	NA	NA	NA

*Confidence interval about the median; computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
 ** Each symbol represents an influent/effluent comparison test. Left position compares overlap of 95% confidence intervals around influent/effluent medians. Middle position compares Mann-Whitney rank-sum hypothesis test P-value to a significance value of 0.05. Right position compares Wilcoxon signed-rank hypothesis test P-value to a significance value of 0.05.
 %ND percentage of non-detects
 NA not available or less than 3 studies for BMP/constituent.
 ◇ influent/effluent comparison test indicates no significant difference in concentrations
 ▼ influent/effluent comparison test indicates significant reduction in concentrations
 △ influent/effluent comparison test indicates significant increase in concentrations

8 Discussion

Based on the results of the data analysis, key observations related to BMP performance are provided according to analyte category. Statistically significant findings for BMP performance for pollutants are highlighted, along with general observations of differences between DOT and non-DOT sites.

8.1 Solids

Analysis for solids focused on total suspended solids (TSS) and total dissolved solids (TDS). Primary observations for TSS include:

- Median influent TSS concentrations are similar between DOT and non-DOT sites and generally range between 25 and 75 mg/L. The exceptions include:
 - Influent TSS is low for grass strips for non-DOT sites.
 - Influent TSS is high for bioretention for non-DOT sites.
- All BMPs with sufficient data for analysis show statistically significant reductions.
- The BMPs with the lowest effluent concentrations are bioretention, media filters, and high rate biofiltration with effluent concentrations ranging from 4 to 10 mg/L.

Primary observations for TDS include:

- TDS data are limited for many BMP types.
- The available data are insufficient to distinguish performance between DOT and non-DOT sites.
- No BMP with sufficient data has statistically significant concentration reductions for TDS.
- Retention ponds, grass swales, grass strips, and media filters are shown to increase TDS concentrations.
- Without advanced treatment, volume reduction is likely the only effective method for reducing TDS loads to receiving waters, based on the BMP types currently analyzed in the BMPDB.

8.2 Bacteria

Enterococcus, *E. coli* and fecal coliform are the three fecal indicator bacteria included in this analysis. EPA's currently recommended recreational water quality criteria include enterococcus or *E. coli*. Although fecal coliform is no longer recommended by EPA as a fecal indicator in its recreational water use criteria, some states still include fecal coliform in regulations, as do many TMDLs. Active disinfection is not a practice evaluated in this analysis, although several disinfection practices are included in the BMPDB itself.

Findings for enterococcus include:

- Sufficient data for analysis were only available for retention ponds, wetland basins, bioretention, and hydrodynamic separators.
- Insufficient data exist to distinguish BMP performance between DOT and non-DOT sites.
- Wetland basins and bioretention were the only BMP types in this BMPDB analysis with statistically significant reductions in concentrations.

- No BMP in the BMPDB reliably achieves median effluent concentrations below EPA's recommended freshwater recreational water quality criteria of 35 cfu/100mL for enterococcus.

Findings for *E. coli* include:

- Sufficient data for analysis are only available for retention ponds, wetland basins, s, bioretention, media filters, and hydrodynamic separators.
- Insufficient data exist to distinguish BMP performance between DOT and non-DOT sites.
- Retention ponds, wetland basins, bioretention, and media filters show statistically significant reductions for *E. coli*.
- No BMP in this BMPDB analysis can reliably achieve median effluent concentrations below EPA's recommended freshwater recreational water quality criteria of 126 cfu/100mL.

Findings for fecal coliform include:

- There are limited data for fecal coliform for many BMP types.
- Insufficient data exist to distinguish BMP performance between DOT and non-DOT sites.
- Retention ponds, wetland basins, bioretention, and media filters show statistically significant reductions in fecal coliform concentrations.
- Bioretention and media filters BMPs at DOT sites achieve median effluent concentrations at or below EPA's recommended freshwater recreational water quality criteria of 200 cfu/100 mL; influent concentrations were above this value but were at least an order of magnitude lower than non-DOT sites.
- Grass strips and hydrodynamic separators indicate statistically significant increases in fecal coliform concentrations.

8.3 Metals

Metals in this analysis include the total and dissolved forms of arsenic, cadmium, chromium, copper, iron, lead, nickel and zinc.

Findings for arsenic include:

- Sufficient data for analysis are only available for detention basins, retention ponds, grass swales, grass strips, and porous pavement.
- Insufficient data exist to distinguish BMP performance for arsenic between DOT and non-DOT sites.
- Only detention basins, media filters and grass buffers and swales had dissolved arsenic data. None of these practices reduced dissolved arsenic concentrations.
- Grass strips and bioretention indicate an increase in arsenic concentrations.
- Detention basins and porous pavement show marginal arsenic concentration reductions.

Findings for cadmium include:

- A limited number of data points and high percentage of non-detects are present for dissolved cadmium.
- Insufficient data exist to distinguish BMP performance for cadmium between DOT and non-DOT sites.
- When influent concentrations are detectable, many BMP types show statistically significant reductions for both total and dissolved cadmium.
- Media filters and bioretention achieve the lowest total cadmium median effluent concentrations that range from 0.03 to 0.07 µg/L.

Findings for chromium include:

- There are a limited number of data points and a high percentage of non-detects for dissolved chromium.
- Insufficient data exist to distinguish BMP performance for chromium between DOT and non-DOT sites.
- When influent concentrations are detectable, many BMP types show statistically significant reductions for total chromium.
- Bioretention followed by media filters achieves the lowest total chromium median effluent concentrations ranging from 0.3 to 1.0 µg/L.

Findings for copper include:

- Influent concentrations at DOT sites are often higher than at non-DOT sites, but there are some high values for two grass strips and two bioretention cells for non-DOT sites due to a research study treating four areas of a picnic shelter with copper roofing (Towson Glen, MD).
- Many BMP types show statistically significant reductions for both total and dissolved copper.
- With total median effluent concentrations less than 5 µg/L, the best performing BMPs are detention basins, retention ponds, wetland basins, media filters, and high rate biofiltration.

Findings for iron include:

- Sufficient data for analysis are only available for retention ponds, grass strips, and media filters.
- Insufficient data exist to distinguish BMP performance for iron between DOT and non-DOT sites.
- Statistically significant reductions are observed for all BMP types with median effluent concentrations ranging from 160-320 µg/L total iron.
- Grass strips indicate potential increases in dissolved iron, but the median influent concentrations were low (~34 µg/L) compared to the other BMP types.

Findings for lead include:

- There is a high percentage of non-detects for dissolved lead, which could be associated with the phase out of leaded gasoline from 1985 to 1996. While there are about 20 sites that were installed and monitored prior to the complete phase out of leaded gasoline, all lead data for highway sites is from 1995 to current.
- DOT sites tend to have higher influent concentrations than non-DOT sites.

- Many BMP types show statistically significant reductions for total lead.
- Wetland basins, bioretention, media filters, and porous pavement have the lowest total median effluent concentrations ranging from 0.7 to 1.2 µg/L

Findings for nickel include:

- Sufficient data for analysis are only available for detention basins, retention ponds, wetland channels, grass swales, grass strips, bioretention, media filters, hydrodynamic separators, and porous pavement.
- Insufficient data exist to distinguish BMP performance for nickel between DOT and non-DOT sites.
- Most of these BMP types show statistically significant reductions for total nickel with median effluent concentrations ranging between 1.6 and 4 µg/L.
- Wetland channels had some of the highest concentrations with median influent concentrations above 18 µg/L total nickel. This result appears to be driven from a large data set from a study in Fremont, California called the “Demonstration Urban Stormwater Treatment (DUST) Marsh System” that was installed in 1984.

Findings for zinc include:

- Influent concentrations at DOT sites are generally higher than non-DOT sites, but not consistently.
- Many BMP types show statistically significant reductions for both total and dissolved zinc.
- Bioretention, media filters, and porous pavement are the top performers with total median effluent concentrations of 12 to 16 µg/L.

8.4 Nutrients

Nutrients included in this analysis include total phosphorus, orthophosphate, dissolved phosphorus, total nitrogen, TKN and nitrate (with several reporting forms).

Findings for phosphorus include:

- Median influent total phosphorous concentrations are similar between DOT and non-DOT sites and generally range between 0.1 and 0.4 mg/L.
- Many BMPs show statistically significant reductions for phosphorus, but grass swales, grass strips, and bioretention show phosphorus export.
- Detention basins are demonstrated to be effective for total phosphorus, but not dissolved phosphorus or orthophosphate.
- The best performing BMPs for total phosphorus reduction are media filters, high rate biofiltration, and high rate media filtration with total phosphorus median effluent concentrations of 0.05 to 0.1 mg/L.
- The best performing BMPs for dissolved phosphorus and orthophosphate appear to be retention ponds and wetland basins. However, no BMP appears to be able to reduce OP below about 0.01 mg/L.

Findings for nitrogen include:

- Median influent concentrations are similar between DOT and non-DOT sites and generally range between 0.7 and 2.9 mg/L for total nitrogen and between 0.2 and 0.7 mg/L for nitrate.
- Many BMPs show statistically significant reductions in total nitrogen forms with media filters producing the lowest median effluent concentrations of 0.9 and 0.5 mg/L for total nitrogen and TKN, respectively.
- Bioretention, media filters, high rate media filters, and porous pavement show nitrate export indicating that ammonification and nitrification of organic nitrogen is likely occurring.
- For the removal of nitrate, the best performing BMPs are retention ponds, wetland basins, and wetland channels.

8.5 Data Gaps and Needs

While the International Stormwater BMP Database is the largest known repository of the BMP performance data with currently 771 individual BMP sites, data gaps remain for many locations, BMP categories, constituents, and study meta-data. Study sites are particularly needed in Midwest, Southwest, Northern Plains, and Rocky Mountain States. There are no studies in EPA rain zone 8 and very few in rain zones 4 and 9.

More DOT-related BMP studies are needed. Currently 277 DOT-related BMP studies are contained in the BMPDB, but the number of BMP types and geographic regions represented is very limited. Only 13 state DOTs are currently represented and only 4 of these have more than 10 studies. Caltrans and NCDOT are the best represented DOTs in the BMP Database followed by WsDOT and VDOT. Highway and other urban roadway BMP studies are needed in most other states.

For the DOT studies that are available, average annual daily traffic (AADT) data and other relevant metadata are still needed. Of the 150 highway and urban roadway sites, only 47 (31%) have reported AADT data. Watershed and other land use information is also missing for many studies. With additional future effort, some of this information could be back-filled into the database by conducting spatial overlays with available state DOT roadway classification and characterization data sets. For older sites, historical AADT data for the period of BMP monitoring may be needed rather than current AADT.

Regarding constituents, the BMPDB datasets are particularly sparse for:

- Fecal indicator bacteria
- Heavy metals other than copper, lead, and zinc
- Oxygen demanding substances such as BOD, COD, and TOC
- Organic pollutants, such as TPH, PAHs, PCBs, phthalates, and dioxins

Of the general BMP categories evaluated, porous pavement and permeable friction course studies followed by wetland basins and media filters are among the least represented in the database. Considering the treatment that BMPs can provide and the potential applicability of these types and others in the highway environment, additional studies are needed to strengthen confidence (statistical and otherwise) in their performance. This is also true for manufactured devices that provide high rate biofiltration and high rate media filtration. Available data indicates that these devices are performing well for multiple water quality constituents and are often the only option for highly constrained locations in need of treatment.

For all BMP categories, more data on BMP design information as well as studies with design variations are also needed. For example, additional media filter and biofiltration studies with more engineered media

mixes (e.g. peat, biochars, oxide-coated sands, etc.) and innovative designs (e.g., outlet control, internal water storage, etc.) could be useful in understanding how these variations are more effective (or not).

8.6 Potential Future Analyses and DOT Portal Enhancements

With the existing data and more so as the database is further populated, there are several options for additional analyses of the BMPDB data such as correlating performance with influent concentrations and study metadata, regressing influent and effluent concentrations, analyzing available volume data, and computing load reductions. Analyses that may be useful to DOTs may include hypothesis testing to evaluate statistical differences between DOT and non-DOT sites to assess representativeness and transferability of non-DOT data to DOT sites.

Some of these additional analyses could be incorporated into the DOT Portal data analysis output. Other potential functionality improvements include:

- Add EPA Rain Zones filter or map layer to interactive map.
- Add zoom to map feature after data queries are made to provide a spatial view of the available BMP studies.
- Add influent and effluent correlation hypothesis tests and regression plots to data summary output.
- While it is important to restrict statistical analysis to individual constituents, it would be helpful to be able to group constituents for data download for efficiency.
- Include control sites when downloading data for an associated test site.
- Allow analyses of single state data sets (including DOTs).

9 Summary and Conclusion

State DOTs need data to understand which stormwater BMPs are effective at achieving water quality goals and meeting constantly evolving regulatory requirements. The International Stormwater BMPDB is the largest repository of stormwater BMP performance data that is continuously populated and actively maintained. The recently added BMP studies and enhanced relational structure of the BMPDB has increased the relevance of the BMPDB to state DOTs. The categorical performance summaries provided in this report demonstrates that there are many BMP types that provide significant pollutant reduction in highway settings, but some BMPs are more effective than others at treating certain pollutants and achieving target effluent concentrations than others. The state DOT Portal to the BMPDB provides streamlined, online access to stormwater BMP monitoring data and performance statistics that can be used to support DOTs with BMP selection and implementation planning, scientifically based support for regulatory interactions related to permit benchmarks and numeric effluent limits, comparisons of local site monitoring data to national studies, and development of stormwater management guidance and decision support tools, among others. To maximize the usefulness of the state DOT Portal, it is important to continue to fill data gaps identified in this report and continue to conduct high quality BMP performance monitoring studies and then submit information from those studies to further populate the BMPDB with DOT-relevant information.

10 Accessing and Using the DOT Portal

The DOT Portal to the International Stormwater BMP Database can be accessed from <https://dot.bmpdatabase.org>. There is also a link to the Portal from the main BMP Database home page (www.bmpdatabase.org). The Portal website works best using a modern browser, such as Chrome, Firefox, Safari, or Microsoft Edge.

When arriving at the Portal home page (Figure 10.1), the user is presented with five options for navigating the website:

- Transportation BMP Summary Analysis – this takes the user to the data analysis tool.
- Retrieve BMP Data via Map – this takes the user to the interactive map.
- Urban Stormwater BMP Database – this takes the user to the main BMP Database home page (www.bmpdatabase.org).
- Contribute Data – this takes the user to a subpage with information and guidance on how to submit data to the BMP Database.
- About – this takes the user to provides a brief history of the BMP Database and the DOT portal and identifies the project sponsors and technical review panel.

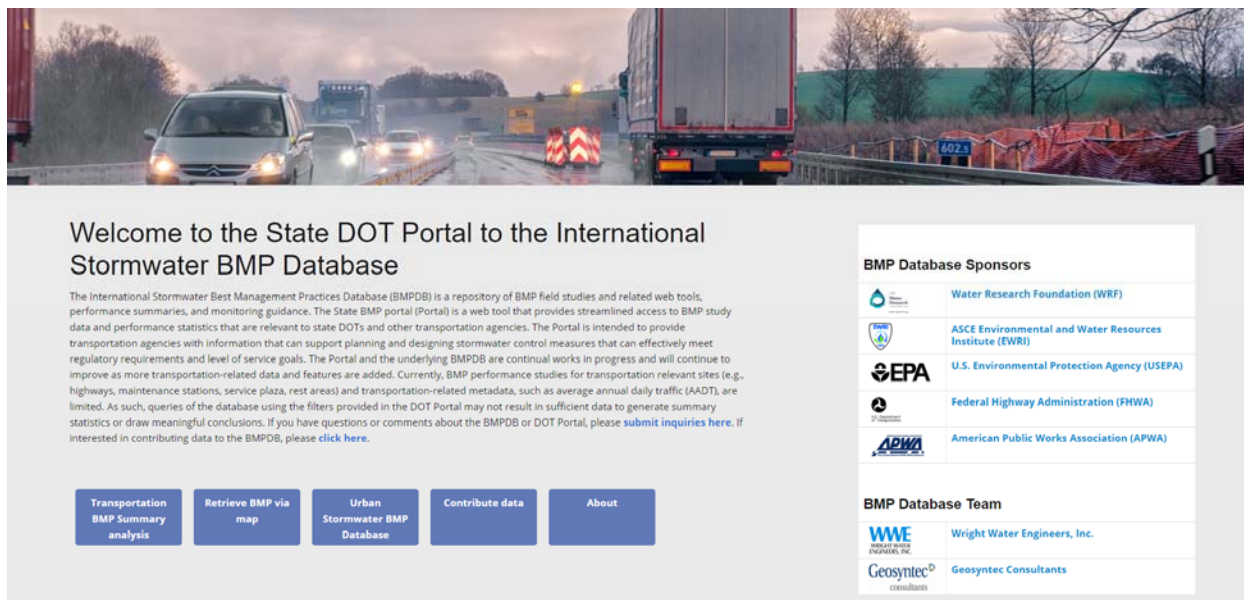


Figure 10.1. Screenshot of DOT Portal Home Page

The next two sections provide a brief overview of how to access data using the data analysis tool and interactive map.

10.1 Data Analysis Tool

The data analysis tool allows a user to conduct simple queries of the BMP Database, download influent and effluent data sets, and run statistical analyses. When first arriving at the data analysis tool, the user is

presented with several dropdown menus for filtering the data (Figure 10.2). The available data fields include:

- Parameter Group – this is a required selection that is used to narrow down the available water quality parameters (constituents) in the next dropdown menu. Only one parameter group is allowed per data query.
- Parameter – this is a required selection to identify the water quality parameter to include in the data analysis. Only one parameter is allowed per data query.
- BMP Category – this is the type of BMP (e.g., detention basins) for which to run the data analysis. Multiple BMP categories may be selected to allow a grouping of data for download or analysis.
- Site Type – this is the DOT-related land use activity (e.g., highways, parking lots, etc.) for which to run the data analysis. Multiple site types may be selected to allow a grouping of data for download or analysis.
- EPA Rain Zones – nine rainfall zones as defined by EPA (Figure 10.3) are presented. Multiple rainfall zones may be selected.
- AADT Ranges – a data selection slider to filter BMP study sites based on AADT is presented. However, this feature is currently disabled due to currently limited data available for AADT.

Figure 10.2. DOT Portal Data Query Tool

After data field selections are made, the user can either select the “Submit” button to generate statistical summaries and data plots or can download the data. Two options for downloading the data are available. “Download All Data” will generate a comma delimited (.csv) text file of all data regardless of whether the

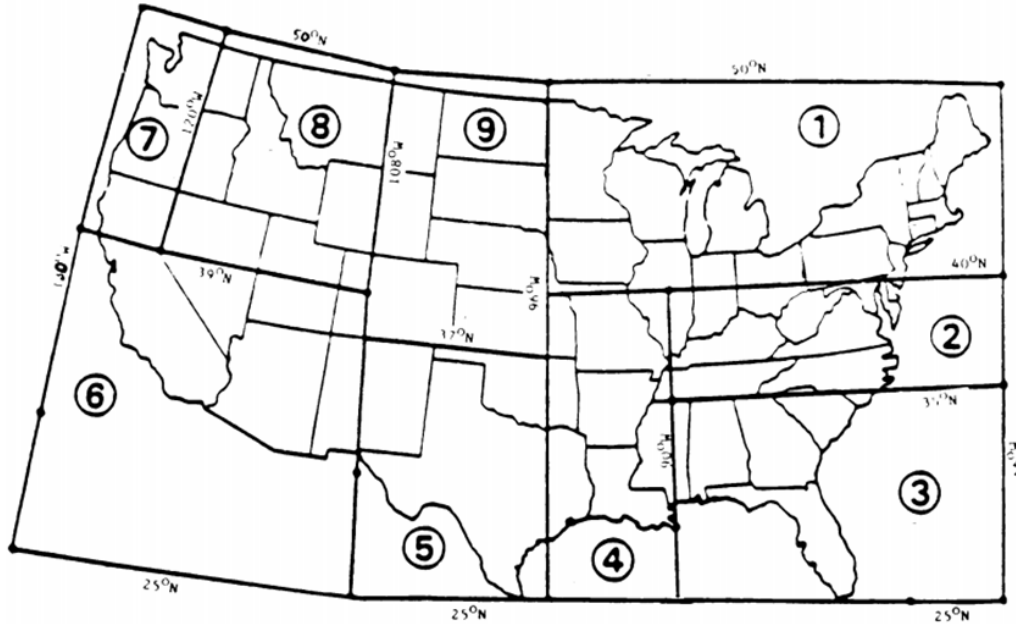
influent and effluent data sets are paired for each storm event. “Download Paired Data Only” will only download the influent/effluent data pairs.

If sufficient data are available, various summary statistics and data plots of influent and effluent concentrations are produced after submitting the query. The number of influent and effluent event mean concentrations (EMCs) and the percent non-detects (NDs) is provided along with the 25th and 75th percentiles, medians, means, and standard deviations. A simple comparison of the influent and effluent summary statistics is provided by indicating whether the effluent statistic increased or decreased as compared to the influent statistic.

Hypothesis test results are also provided to evaluate whether the influent and effluent concentrations are statistically different from each other. The Mann-Whitney rank sum test evaluates whether the medians of the inflow and outflow EMCs are equal. This test assumes the inflow and outflow EMCs are independent. The Wilcoxon signed rank test evaluates whether the median of the differences of the inflow and outflow EMCs is greater than zero. This test assumes the inflow and outflow EMCs are dependent (paired). The t-Test evaluates whether the means of the inflow and outflow EMCs are equal. This test assumes that the inflow and outflow EMCs are normally distributed. This test is run on the raw data and log-transformed data. For each of these tests, if the p-value resulting from a test is less than the selected alpha (α) significance value, then the null hypothesis the data sets are equal is rejected and therefore the data sets can be assumed to be different. Figure 10.4 shows an example of the tabular output generated from the data analysis tool.

For graphical output, the tool generates influent/effluent boxplots, probability plots, scatterplots, and time series plots. All data plots in the tool are interactive. Users can hover over the data points to identify their values and can zoom and pan on the plots. The probability plots include independently ranked influent and effluent data plotted on a normal probability scale (theoretical quantiles = Z score). Because the y-axis is log scale, if the data plot on a straight line on the probability plot, the sample data may arise from a lognormally distributed population. It is important to note that the influent and effluent values are not paired by storm event in these plots.

Figure 10.5 includes example boxplots and probability plots. Figure 10.6 includes an example scatterplot and time series plot.

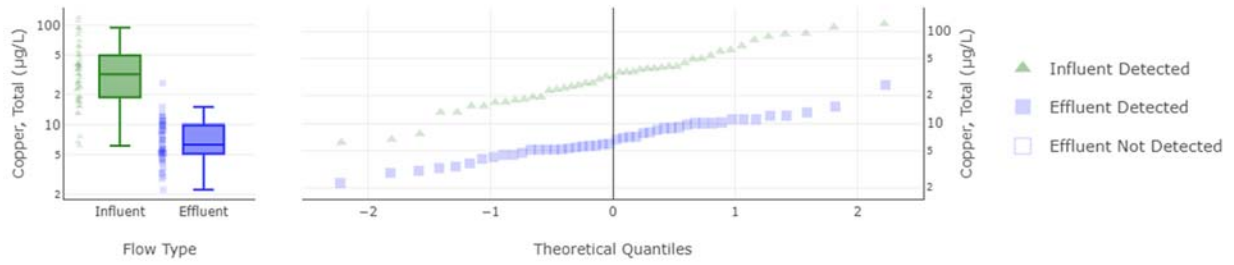


Source: NPDES Phase I regulations, 40 CFR Part 122, Appendix E (USEPA 1990)
Figure 10.3. EPA rainfall zones.

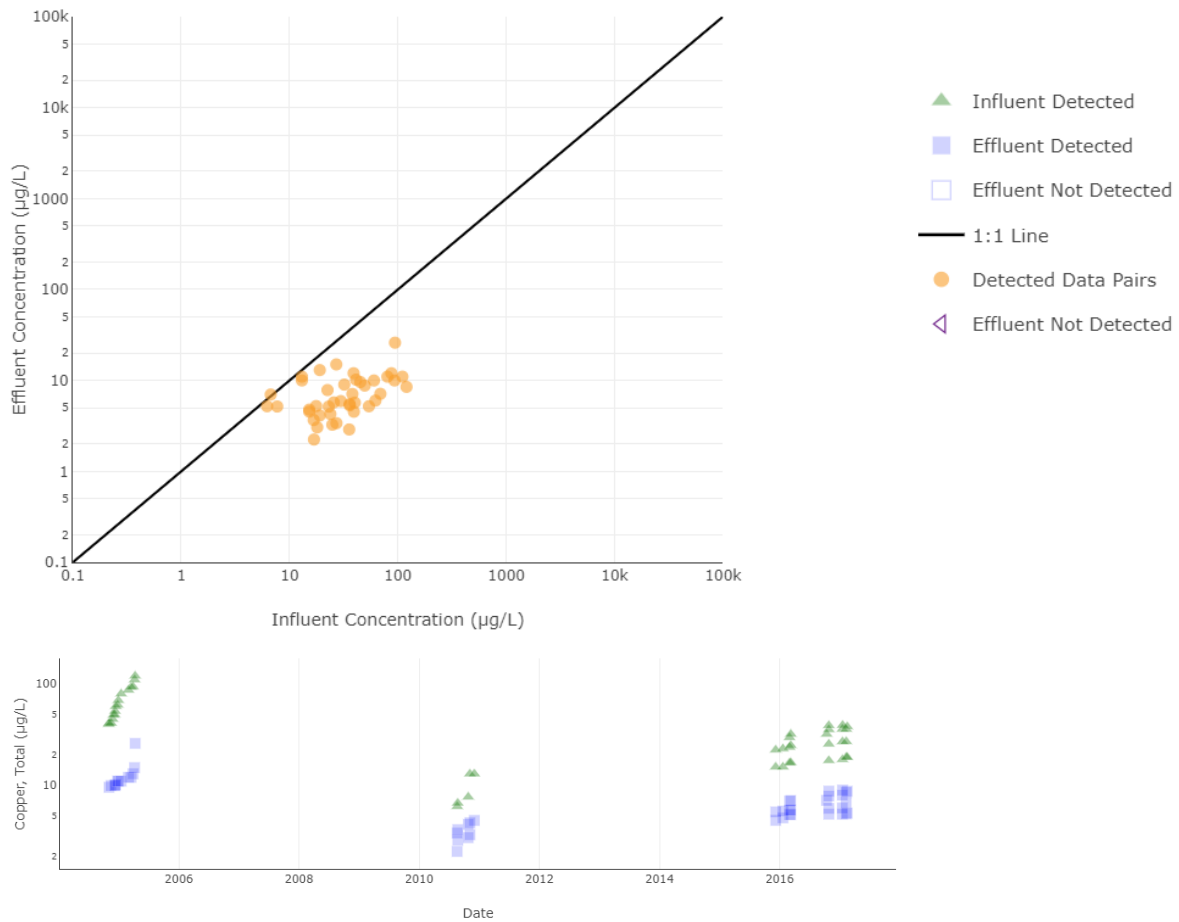
Basic Statistics			
Statistic	Influent	Effluent	Comparison
Number of EMCs	666	495	Decreased
Percent of NDs (%)	0	0.26	Increased
25th Percentile (mg/L)	41	18	Decreased
*Median (mg/L)	68	33	Decreased
75th Percentile (mg/L)	119.75	66.25	Decreased
Mean (mg/L)	103.25	72.61	Decreased
Standard Deviation (mg/L)	140.1	159.17	Increased
Coef. of Variation	1.36	2.19	Increased

Hypothesis Testing					
Statistical Test	Data	Null Hypothesis	p-value	Diff Between Infi & Effl	
				a = 0.05	a = 0.10
Mann-Whitney	Raw	The medians of the inflow and outflow EMCs are equal.	0.0000	Different	Different
Wilcoxon	Raw	The medians of the differences of the inflow and outflow EMCs are equal.	0.0000	Different	Different
t-Test (Assume Unequal Variance)	Raw	The means of the inflow and outflow EMCs are equal.	0.000673	Different	Different
t-Test (Assume Unequal Variance)	Log	The means of the inflow and outflow EMCs are equal.	0.0000	Different	Different

Query parameters: TSS, Grass Strips, Highways, EPA Rain Zone 6.
Figure 10.4. Example tabular output of data analysis tool.



Query parameters: Total Copper, Bioretention, Highways, All Rain Zones.
Figure 10.5. Example boxplots (left) and probability plots (right) from data analysis tool.

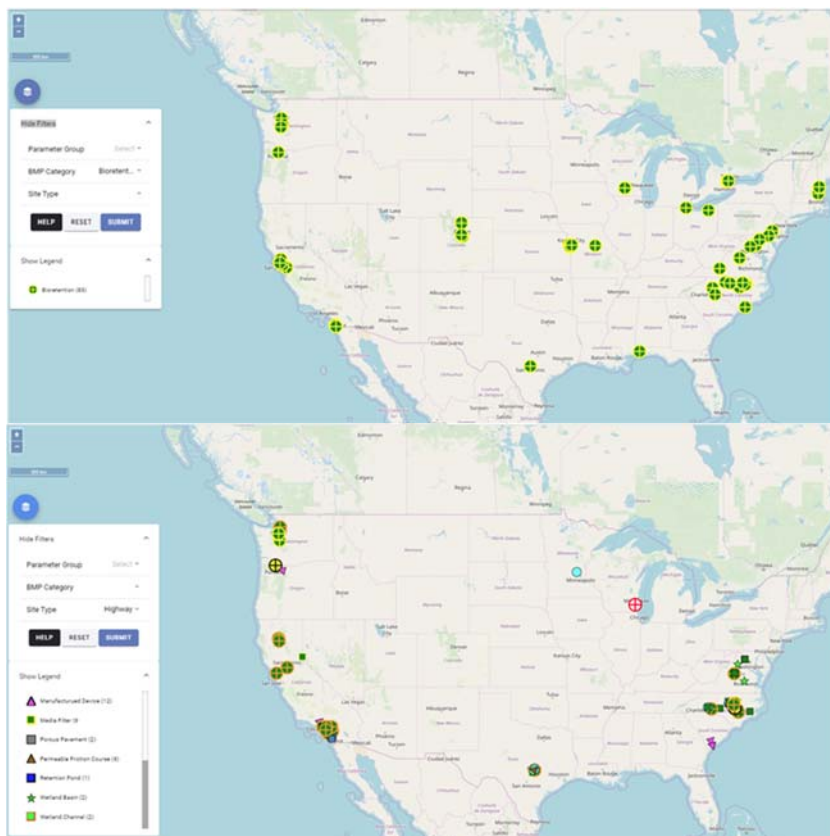


Query parameters: Total Copper, Bioretention, Highways, All Rain Zones.
Figure 10.6. Example scatterplot (top) and time series plot (bottom) from data analysis tool.

10.2 Interactive Map

Another way to access BMP study data from the DOT Portal is the interactive map. The map identifies each BMP study by the latitude and longitude coordinates provided by the data provider. BMPs are symbolized according to their BMP type. Users can toggle base map layers on and off and navigate the map using standard pan and zoom functions. Simple data filters can be applied to identify studies of interest. A common map workflow may proceed as follows:

1. Select Show Filters
2. Apply Desired Filters
 - a. Parameter Group
 - b. Parameter
 - c. BMP Category
 - d. Site Type
3. Select Submit to update Map
 - a. Wait a few seconds for query to complete
 - b. Message box will indicate number of BMP sites that were successfully retrieved
4. Zoom/pan to a geographic region of the map



Top figure shows all bioretention sites. Bottom figure shows all highway BMP sites.

Figure 10.7. Example map displays of BMP studies in the Portal.

To access data for an individual study, zoom to the study and click the icon. The Site ID, Site Name, Location, and BMP Category will display in a pop-up window. There will be links for the summary report and flow & precipitation report for the study. If photos or BMP schematics are available, there will be a link for that as well. Water quality data can be explored and retrieved by selecting a parameter group and parameter from the dropdown menu. Once a parameter is selected, the data analysis tool will be launched and the data for the study can be downloaded or if adequate data are available, summary statistics and data graphs can be generated. Refer to Section 10.1 for details on the data analysis tool output.

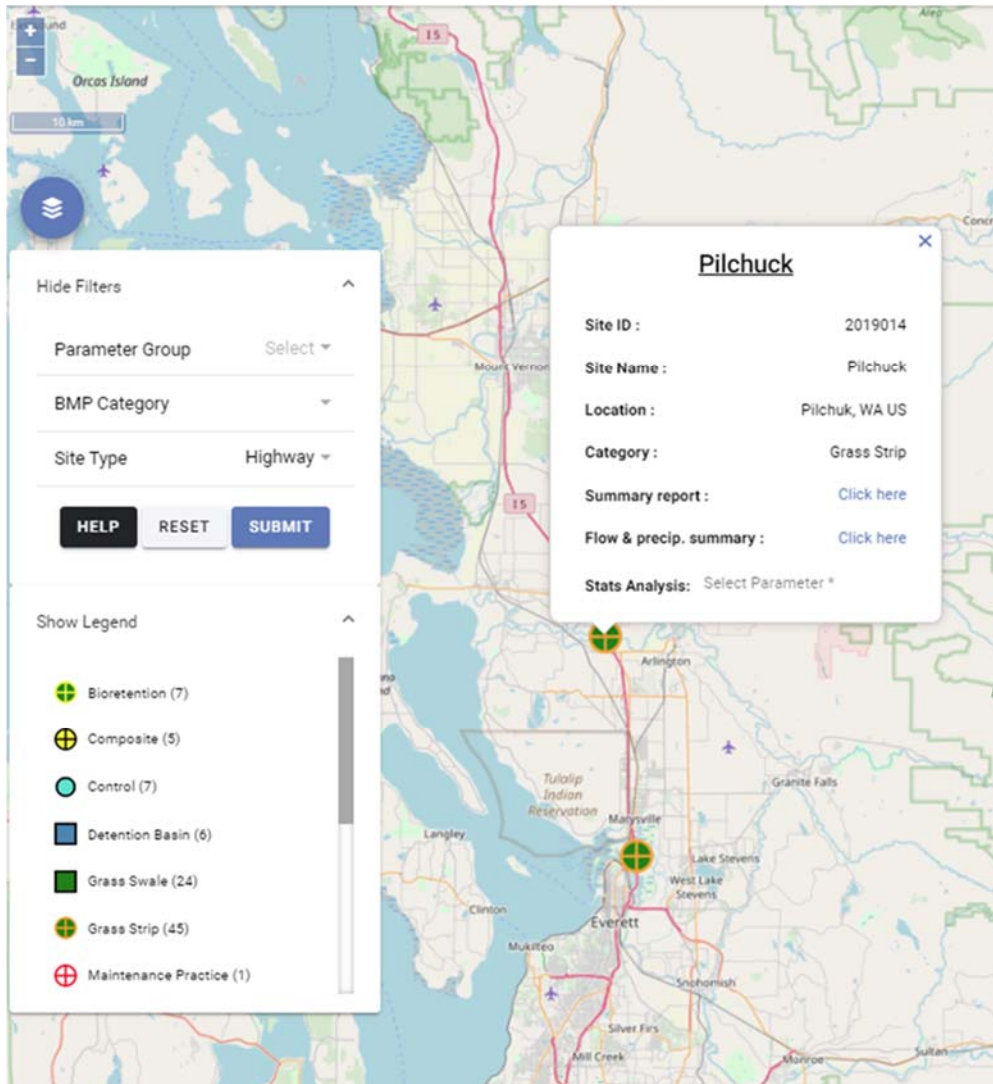


Figure 10.8. Example map display of an individual BMP study site.

11 References

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Appendix A

Data Entry User's Guide