
Solids, Bacteria, Nutrients, and Metals

Prepared by
Geosyntec Consultants, Inc.
Wright Water Engineers, Inc.

Under Support From
Water Environment Research Foundation
Federal Highway Administration
Environment and Water Resources Institute of the American Society of Civil Engineers

December 2014
Disclaimer

The BMP Database ("Database") was developed as an account of work sponsored by the Water Environment Research Foundation (WERF), the American Society of Civil Engineers (ASCE)/Environmental and Water Resources Institute (EWRI), the American Public Works Association (APWA), the Federal Highway Administration (FHWA), and U.S. Environmental Protection Agency (USEPA) (collectively, the “Sponsors”). The Database is intended to provide a consistent and scientifically defensible set of data on Best Management Practice ("BMP") designs and related performance. Although the individuals who completed the work on behalf of the Sponsors ("Project Team") made an extensive effort to assess the quality of the data entered for consistency and accuracy, the Database information and/or any analysis results are provided on an “AS-IS” basis and use of the Database, the data information, or any apparatus, method, or process disclosed in the Database is at the user’s sole risk. The Sponsors and the Project Team disclaim all warranties and/or conditions of any kind, express or implied, including, but not limited to any warranties or conditions of title, non-infringement of a third party's intellectual property, merchantability, satisfactory quality, or fitness for a particular purpose. The Project Team does not warrant that the functions contained in the Database will meet the user’s requirements or that the operation of the Database will be uninterrupted or error free, or that any defects in the Database will be corrected.

UNDER NO CIRCUMSTANCES, INCLUDING CLAIMS OF NEGLIGENCE, SHALL THE SPONSORS OR THE PROJECT TEAM MEMBERS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, OR CONSEQUENTIAL DAMAGES INCLUDING LOST REVENUE, PROFIT OR DATA, WHETHER IN AN ACTION IN CONTRACT OR TORT ARISING OUT OF OR RELATING TO THE USE OF OR INABILITY TO USE THE DATABASE, EVEN IF THE SPONSORS OR THE PROJECT TEAM HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

The Project Team’s tasks have not included, and will not include in the future, recommendations of one BMP type over another. However, the Project Team's tasks have included reporting on the performance characteristics of BMPs based upon the entered data and information in the Database, including peer reviewed performance assessment techniques. Use of this information by the public or private sector is beyond the Project Team’s influence or control. The intended purpose of the Database is to provide a data exchange tool that permits characterization of BMPs solely upon their measured performance using consistent protocols for measurements and reporting information.

The Project Team does not endorse any BMP over another and any assessments of performance by others should not be interpreted or reported as the recommendations of the Project Team or the Sponsors.
Acknowledgements

Report Preparation

Primary Authors:
Marc Leisenring, P.E., Geosyntec Consultants, Inc.
Jane Clary, Wright Water Engineers, Inc.
Paul Hobson, Geosyntec Consultants, Inc.

Reviewers:
Eric Strecker, P.E., Geosyntec Consultants, Inc.
Jonathan Jones, P.E., D.WRE, Wright Water Engineers, Inc.

Project Information

WERF Project Director:
Theresa Connor, P.E., Water Environment Research Foundation

Principal Investigators:
Eric Strecker, P.E., Geosyntec Consultants, Inc.
Jonathan Jones, P.E., D.WRE, Wright Water Engineers, Inc.

Project Steering Committee:
Susan Jones, P.E., Federal Highway Administration
Christopher Kloss, P.E., Office of Water/Office of Science & Technology, U.S. Environmental Protection Agency
Brian Parsons, P.E., Environmental and Water Resources Institute of American Society of Civil Engineers
Marcel Tchaou, Ph.D., P.E., P.H., MBA, Federal Highway Administration Office of Project Development and Environmental Review
Courtney Thompson, American Public Works Association

Project Subcommittee:
Michael E. Barrett, Ph.D., P.E., D.WRE, Center for Research in Water Resources, University of Texas
Bob Carr, P.E., Gresham, Smith and Partners
David R. Graves, CPESC, Environmental Science Bureau, New York State Dept. of Transportation
Gregory E. Granato, U.S. Geological Survey
Jesse Pritts, P.E., Engineering and Analysis Division Office of Water/Office of Science & Technology, U.S. Environmental Protection Agency

1 Contact Jane Clary (clary@wrightwater.com) or Marc Leisenring (mleisenring@geosyntec.com) with questions regarding this summary.
Table of Contents

1 INTRODUCTION .......................................................................................................... 1

2 DATA SUMMARY APPROACH ...................................................................................... 2

  2.1 BMPS ANALYZED AND DATA SCREENING APPROACH .............................................. 2
  2.2 GRAPHICAL SUMMARIES .......................................................................................... 3
  2.3 TABULAR SUMMARIES ............................................................................................ 3

3 SOLIDS ....................................................................................................................... 6

  3.1 TOTAL SUSPENDED SOLIDS .................................................................................... 6
  3.2 TOTAL DISSOLVED SOLIDS ................................................................................... 7

4 BACTERIA ................................................................................................................... 8

  4.1 ENTEROCOCCUS ...................................................................................................... 8
  4.2 ESCHERICHIA COLI ................................................................................................... 9
  4.3 FECAL COLIFORM ................................................................................................. 10

5 METALS .................................................................................................................... 11

  5.1 ARSENIC ................................................................................................................. 11
  5.2 CADMIUM ............................................................................................................... 13
  5.3 CHROMIUM ............................................................................................................. 15
  5.4 COPPER .................................................................................................................. 17
  5.5 IRON ....................................................................................................................... 19
  5.6 LEAD ...................................................................................................................... 21
  5.7 NICKEL ................................................................................................................... 23
  5.8 ZINC ....................................................................................................................... 25

6 NUTRIENTS ............................................................................................................... 27

  6.1 PHOSPHORUS ......................................................................................................... 27
  6.2 NITROGEN ............................................................................................................. 30

7 REFERENCES ............................................................................................................. 35

8 ATTACHMENTS ......................................................................................................... 35

  Attachment 1. Solids Statistical Summary Report
  Attachment 2. Bacteria Statistical Summary Report
  Attachment 3. Metals Statistical Summary Report
  Attachment 4. Nutrients Statistical Summary Report
1 INTRODUCTION

In 2010-2011, the Water Environment Research Foundation (WERF), Federal Highway Administration (FHWA), and the American Society of Civil Engineers’ Environmental and Water Resources Institute (EWRI) co-sponsored a comprehensive stormwater best management practice (BMP) performance analysis technical paper series relying on data contained in the International Stormwater BMP Database (BMPDB). This series included papers for solids, bacteria, nutrients, and metals, with each paper summarizing the regulatory context of the constituent category, primary sources, fate and transport processes, removal mechanisms, and statistical summaries of BMP performance for data contained in the BMPDB. In 2012, an update of the statistical summaries provided in that series was prepared to include the data from over 50 new studies added to the database in late 2011. This 2014 report is yet another update of the statistical summaries that includes additional study data entered into the database in 2013 and 2014. This report is not intended to replace the discussion and context provided in the previous technical papers; instead, this report provides updated statistical summaries only. Constituents summarized in this report are listed in Table 1.

<table>
<thead>
<tr>
<th>Pollutant Category</th>
<th>Summarized Constituent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids</td>
<td>Total suspended solids (TSS)</td>
</tr>
<tr>
<td></td>
<td>Total dissolved solids (TDS)</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Fecal coliform</td>
</tr>
<tr>
<td></td>
<td><em>Escherichia coli</em> (E. coli)</td>
</tr>
<tr>
<td></td>
<td>Enterococcus</td>
</tr>
<tr>
<td>Metals</td>
<td>Arsenic (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Cadmium (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Chromium (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Copper (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Iron (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Lead (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Nickel (total and dissolved)</td>
</tr>
<tr>
<td></td>
<td>Zinc (total and dissolved)</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Total phosphorus</td>
</tr>
<tr>
<td></td>
<td>Orthophosphate</td>
</tr>
<tr>
<td></td>
<td>Dissolved phosphorus</td>
</tr>
<tr>
<td></td>
<td>Total nitrogen</td>
</tr>
<tr>
<td></td>
<td>Total Kjeldahl nitrogen (TKN)</td>
</tr>
<tr>
<td></td>
<td>Nitrate (NO₃)</td>
</tr>
<tr>
<td></td>
<td>Nitrate plus nitrite (NO₃ + NO₂)</td>
</tr>
<tr>
<td></td>
<td>Nitrate and Nitrite plus nitrite (NOₓ)</td>
</tr>
</tbody>
</table>

2 The BMP Database is a long-term project that began in 1994 through the vision of members active in the Urban Water Resources Research Council of ASCE and the leadership of EPA. Funded for many years by EPA, the project is now supported by a coalition of partners including WERF, FHWA, EWRI and the American Public Works Association (APWA). The technical reports can be downloaded from [www.bmpdatabase.org/BMPPerformance.htm](http://www.bmpdatabase.org/BMPPerformance.htm).
2 DATA SUMMARY APPROACH

The BMP performance analyses provided in this report are based on the BMP performance data for selected pollutants in the BMPDB as of December 16, 2014. 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., analyses of individual study site central tendencies).

A summary of the BMPs analyzed and data screening approach is provided below followed by descriptions of the graphical and tabular summaries provided in this report. The statistical attachments provide additional detailed analysis organized by constituent and BMP type for the three main constituent categories: Solids, Bacteria, Metals, and Nutrients. Data for other pollutants not included in this report may also be available and can be obtained from www.bmpdatabase.org.

2.1 BMPs Analyzed and Data Screening Approach

The BMP categories included in this analysis are grass strips, bioretention, bioswales, composite/treatment train BMPs, detention basins (surface/grass-lined), media filters (mostly sand filters), porous pavement, retention ponds (surface pond with a permanent pool), wetland basins (basins with open water surface), a combined category including both retention ponds and wetland basins, and wetland channels (swales and channels with wetland vegetation). The effectiveness and range of unit treatment processes present in a particular BMP may vary depending on the BMP design. Several other BMP categories and sub-classes are included in the database, but these have been excluded from this analysis due to limited data sets available for meaningful categorical comparisons. Additionally, the BMPDB contains approximately 100 manufactured devices, which are no longer provided as a general BMP category for analysis in this report because of the wide range of unit treatment processes present among various manufactured devices. Green roof data sets have also been excluded from this report due to relatively small numbers of comparable data sets and significant variation in monitoring program designs. Individual BMP performance analysis reports can be viewed and downloaded from www.bmpdatabase.org for manufactured devices, green roofs, and other BMP types not included in this summary report. For example, see http://www.bmpdatabase.org/map.html to view monitoring locations with other BMP types not included in this report.

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 for the pollutant of interest. Additional data screening include the exclusion of base flow samples from BMP studies, exclusion of grab samples for BMPs without permanent pools (i.e.,

---

3 There are several viable approaches to evaluating data in the BMP Database. Two general approaches that have been presented in the past (Geosyntec Consultants and Wright Water Engineers, 2008) are the “BMP-weighted” and “storm-weighted” approaches. The BMP-weighted approach represents each BMP with one value representing the central tendency and variability of each individual BMP study, whereas the storm-weighted approach combines all of the storm events for the BMPs in each category and analyzes the overall storm-based data set. The storm-weighted approach has been selected for this report because it provides a much larger data set for analysis.
only event mean concentrations (EMCs) are used except for retention ponds and wetland basins), and exclusion of studies with a gross imbalance in the number of inflow and outflow sample results. A variety of additional screening criteria are 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, which can be downloaded from www.bmpdatabase.org. Poor performance of a BMP is not a reason for data exclusion.

2.2 Graphical Summaries

In the subsections below, side-by-side box plots for the various BMPs measurements 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 key to the box plots is provided in Figure 1.

Figure 1. Box Plot Key

2.3 Tabular Summaries

In addition to the box plots, tables of influent/effluent medians, 25th and 75th percentiles, and number of studies and data points are provided, along with 95% confidence intervals about the medians. 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. Despite use of this robust 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. The number of non-detects are tabulated for each BMP/constituent combination in the associated attachments. 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). Results of these tests are provided in the attached statistical summary reports for solids, bacteria, metals, and nutrients. 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 for a particular data set 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 on a particular date 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 pollutant removal performance.

In the summary tables which follow, effluent values in **bold green** indicate the upper 95% confidence interval of the effluent median is less than the lower 95% confidence interval of the

---

4 Due to random statistical sampling that is conducted as part of the BCa method, insignificant variations in the calculated statistical result values may occur, causing minor inconsistencies between the values presented in the attachments relative to the tables presented in the main body of the report.
influent median. Effluent values in **red bold italics** indicate the lower 95% confidence interval of the effluent median is greater than the upper 95% confidence interval of the influent median. Values are also footnoted to indicate whether the hypothesis test results presented in the attachments indicate statistically significant differences.

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.

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. Volume-related data can also 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](http://www.bmpdatabase.org).
### 3 SOLIDS

#### 3.1 Total Suspended Solids

**Figure 2. Box Plots of Influent/Effluent TSS Concentrations**

![Box Plots of Influent/Effluent TSS Concentrations](image)

**Table 2. Influent/Effluent Summary Statistics for TSS (mg/L)**

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>19; 361</td>
<td>19; 282</td>
<td>20.0 10.0</td>
<td>44.1 (39, 48)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>23; 399</td>
<td>23; 346</td>
<td>9.0 10.0</td>
<td>27.7 (21, 31.6)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>22; 461</td>
<td>22; 393</td>
<td>18.0 4.9</td>
<td>38.1 (31, 42)</td>
</tr>
<tr>
<td>Composite</td>
<td>10; 202</td>
<td>10; 174</td>
<td>42.4 8.0</td>
<td>87.6 (75.1, 101.5)</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>22; 321</td>
<td>22; 336</td>
<td>21.0 10.0</td>
<td>68.2 (52.3, 77.3)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>23; 381</td>
<td>23; 358</td>
<td>21.1 3.0</td>
<td>50.9 (42.8, 58)</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>8; 356</td>
<td>8; 220</td>
<td>35.0 14.0</td>
<td>90.3 (69, 115)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>56; 923</td>
<td>56; 933</td>
<td>15.0 4.3</td>
<td>47.7 (40, 54)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>19; 395</td>
<td>19; 385</td>
<td>11.0 3.5</td>
<td>24.5 (19.1, 28.9)</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>75; 1318</td>
<td>75; 1318</td>
<td>13.3 4.0</td>
<td>37.9 (34, 41.6)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>8; 171</td>
<td>8; 151</td>
<td>12.0 8.0</td>
<td>18.9 (16, 21)</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 1 shows statistically significant decreases for this BMP category.
3.2 Total Dissolved Solids

Figure 3. Box Plots of Influent/Effluent TDS Concentrations

Table 3. Influent/Effluent Summary Statistics for TDS (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11</td>
<td>208</td>
<td>24.0</td>
<td>58.0</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>12</td>
<td>112</td>
<td>41.5</td>
<td>33.0</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>6</td>
<td>69</td>
<td>70.0</td>
<td>66.0</td>
</tr>
<tr>
<td>Media Filter</td>
<td>13</td>
<td>186</td>
<td>24.5</td>
<td>44.0</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>15</td>
<td>165</td>
<td>68.0</td>
<td>72.3</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>2</td>
<td>24</td>
<td>67.3</td>
<td>143.5</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>17</td>
<td>189</td>
<td>68.0</td>
<td>76.1</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 1 shows statistically significant increases for this BMP category.
4 BACTERIA

4.1 Enterococcus

Figure 4. Box Plots of Influent/Effluent Enterococcus Concentrations

Table 4. Influent/Effluent Summary Statistics for Enterococcus (#/100 mL)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bioretention</td>
<td>3; 48</td>
<td>178</td>
<td>32</td>
<td>601 (225, 922)</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Media Filter</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>4; 53</td>
<td>227</td>
<td>30</td>
<td>997 (250, 1605)</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>6; 86</td>
<td>207</td>
<td>20</td>
<td>869 (354, 1457)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 1 shows statistically significant decreases for this BMP category.
4.2 Escherichia coli

Figure 5. Box Plots of Influent/Effluent E. coli Concentrations

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

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Out</td>
<td>In Out</td>
<td>In Out (95% Conf. Interval)</td>
<td>In Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>5; 39 5; 39</td>
<td>411 1200</td>
<td>4010 (411, 5600)</td>
<td>4182 (1200, 5900)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11000 10000</td>
</tr>
<tr>
<td>Bioretention</td>
<td>4; 61 4; 61</td>
<td>44 6.0</td>
<td>290 (52, 820)</td>
<td>101 (9, 213)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2400 2400</td>
</tr>
<tr>
<td>Composite</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
</tr>
<tr>
<td>Media Filter</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>4; 69 4; 65</td>
<td>582 10</td>
<td>2063 (1000, 3106)</td>
<td>100 (24, 172)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5500 697</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>5; 60 5; 59</td>
<td>383 88</td>
<td>1369 (694, 2336)</td>
<td>637 (279, 988)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7169 2376</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>9; 129 9; 124</td>
<td>403 36</td>
<td>1713 (988, 2433)</td>
<td>311 (100, 485)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6100 1300</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
<td>NA NA</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 2 shows statistically significant decreases for this BMP category.
### 4.3 Fecal Coliform

#### Figure 6. Box Plots of Influent/Effluent Fecal Coliform Concentrations

![Box Plots of Influent/Effluent Fecal Coliform Concentrations](image)

#### Table 6. Influent/Effluent Summary Statistics for Fecal Coliform (#/100 mL)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>In 25th Percentile</th>
<th>Out 75th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>11; 87</td>
<td>1014</td>
<td>1045</td>
<td>4236 (1350, 5000)</td>
<td>4777 (2500, 6200)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>4; 64; 4; 56</td>
<td>5477</td>
<td>4075</td>
<td>14715 (9633, 19191)</td>
<td>12287 (6805, 17162)</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>15; 170; 15; 194</td>
<td>400</td>
<td>60</td>
<td>1832 (1100, 2680)</td>
<td>727 (371, 1483)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>15; 184; 15; 169</td>
<td>120</td>
<td>33</td>
<td>996 (400, 1528)</td>
<td>420 (200, 800)**</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>10; 121; 10; 123</td>
<td>300</td>
<td>25</td>
<td>3677 (1470, 5000)</td>
<td>581 (92, 800)**</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>5; 42; 5; 39</td>
<td>2400</td>
<td>185</td>
<td>10956 (3200, 15177)</td>
<td>1031 (230, 1900)**</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>15; 163; 15; 162</td>
<td>611</td>
<td>42</td>
<td>5017 (2500, 7700)</td>
<td>679 (208, 1125)**</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 2 shows statistically significant decreases for this BMP category.
5 METALS

5.1 Arsenic

Figure 7. Box Plots of Influent/Effluent Dissolved Arsenic Concentrations

![Box Plots](image)

Table 7. Influent/Effluent Summary Statistics for Dissolved Arsenic (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 208</td>
<td>11; 148</td>
<td>0.16</td>
<td>0.24</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>8; 45</td>
<td>8; 37</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>5; 44</td>
<td>5; 42</td>
<td>0.60</td>
<td>0.63</td>
</tr>
<tr>
<td>Media Filter</td>
<td>9; 104</td>
<td>9; 100</td>
<td>0.26</td>
<td>0.33</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.
### Table 8. Influent/Effluent Summary Statistics for Total Arsenic (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 208</td>
<td>11; 149</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>8; 44</td>
<td>8; 37</td>
<td>1.07</td>
<td>0.60</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>6; 78</td>
<td>6; 72</td>
<td>1.43</td>
<td>1.20</td>
</tr>
<tr>
<td>Media Filter</td>
<td>9; 104</td>
<td>9; 100</td>
<td>0.50</td>
<td>0.48</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4; 240</td>
<td>4; 118</td>
<td>2.50</td>
<td>2.50</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>4; 25</td>
<td>4; 23</td>
<td>1.00</td>
<td>0.52</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>4; 25</td>
<td>4; 23</td>
<td>1.00</td>
<td>0.52</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibshirani (1993).
**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
### 5.2 Cadmium

**Figure 9. Box Plots of Influent/Effluent Dissolved Cadmium Concentrations**

**Table 9. Influent/Effluent Summary Statistics for Dissolved Cadmium (µg/L)**

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 207</td>
<td>0.05</td>
<td>0.11 (0.09, 0.19)</td>
<td>0.23</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>12; 83</td>
<td>0.10</td>
<td>0.20 (0.15, 0.30)</td>
<td>0.40</td>
</tr>
<tr>
<td>Bioretention</td>
<td>4; 98</td>
<td>0.02</td>
<td>0.03 (0.02, 0.03)</td>
<td>0.05</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin****</td>
<td>8; 135</td>
<td>0.07</td>
<td>0.12 (0.10, 0.14)</td>
<td>0.22</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10; 117</td>
<td>0.10</td>
<td>0.19 (0.12, 0.20)</td>
<td>0.20</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4; 250</td>
<td>0.03</td>
<td>0.06 (0.05, 0.07)</td>
<td>0.10</td>
</tr>
<tr>
<td>Retention Pond****</td>
<td>3; 54</td>
<td>0.20</td>
<td>0.27 (0.21, 0.33)</td>
<td>0.48</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>4; 36</td>
<td>0.06</td>
<td>0.12 (0.07, 0.16)</td>
<td>0.21</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>7; 90</td>
<td>0.12</td>
<td>0.20 (0.18, 0.23)</td>
<td>0.33</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.

****Conclusions are limited for this BMP category due to a large percentage of non-detects in the influent.
Figure 10. Box Plots of Influent/Effluent Total Cadmium Concentrations

Table 10. Influent/Effluent Summary Statistics for Total Cadmium (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 208</td>
<td>11; 149</td>
<td>0.20</td>
<td>0.06</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>14; 136</td>
<td>14; 124</td>
<td>0.35</td>
<td>0.19</td>
</tr>
<tr>
<td>Bioretention****</td>
<td>6; 127</td>
<td>6; 112</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Composite****</td>
<td>5; 90</td>
<td>5; 87</td>
<td>0.12</td>
<td>0.25</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>12; 168</td>
<td>12; 173</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>Media Filter</td>
<td>16; 194</td>
<td>16; 194</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Porous Pavement****</td>
<td>4; 264</td>
<td>4; 130</td>
<td>0.13</td>
<td>0.25</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>24; 366</td>
<td>24; 404</td>
<td>0.17</td>
<td>0.09</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>7; 125</td>
<td>7; 136</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>31; 491</td>
<td>31; 540</td>
<td>0.14</td>
<td>0.10</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>3; 69</td>
<td>3; 54</td>
<td>0.18</td>
<td>0.20</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.
****Conclusions are limited for this BMP category due to a large percentage of non-detects in the influent.
5.3 Chromium

Figure 11. Box Plots of Influent/Effluent Dissolved Chromium Concentrations

![Box Plots of Influent/Effluent Dissolved Chromium Concentrations](image)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 208</td>
<td>1.00</td>
<td>1.00</td>
<td>1.98 (1.55, 2.20)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>6; 37</td>
<td>1.00</td>
<td>1.00</td>
<td>1.30 (1.00, 2.80)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>4; 58</td>
<td>0.43</td>
<td>0.41</td>
<td>0.95 (0.59, 1.35)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10; 114</td>
<td>0.50</td>
<td>0.53</td>
<td>0.95 (0.62, 1.00)</td>
</tr>
<tr>
<td>Porous Pavement***</td>
<td>4; 262</td>
<td>0.50</td>
<td>1.70</td>
<td>0.50 (0.50, 0.50)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>4; 67</td>
<td>1.00</td>
<td>0.87</td>
<td>1.23 (1.00, 1.48)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>4; 67</td>
<td>1.00</td>
<td>0.87</td>
<td>1.23 (1, 1.48)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.
****Conclusions are limited for this BMP category due to a large percentage of non-detects in the influent.
Table 12. Influent/Effluent Summary Statistics for Total Chromium (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>12;</td>
<td>211</td>
<td>2.90</td>
<td>1.28</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>6;</td>
<td>37</td>
<td>1.80</td>
<td>1.50</td>
</tr>
<tr>
<td>Bioretention</td>
<td>3;</td>
<td>72</td>
<td>1.47</td>
<td>0.06</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>5;</td>
<td>68</td>
<td>2.53</td>
<td>1.59</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10;</td>
<td>115</td>
<td>1.20</td>
<td>0.82</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4;</td>
<td>264</td>
<td>2.06</td>
<td>2.37</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>12;</td>
<td>153</td>
<td>2.35</td>
<td>1.00</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>12;</td>
<td>153</td>
<td>2.35</td>
<td>1.00</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>3;</td>
<td>70</td>
<td>1.00</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.

****Conclusions are limited for this BMP category due to a large percentage of non-detects in the influent.
5.4 Copper

Figure 13. Box Plots of Influent/Effluent Dissolved Copper Concentrations

Table 13. Influent/Effluent Summary Statistics for Dissolved Copper (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 221</td>
<td>4.80</td>
<td>2.80</td>
<td>10.94 (8.00, 12.00)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>16; 172</td>
<td>3.30</td>
<td>3.49</td>
<td>6.58 (5.00, 7.86)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>7; 125</td>
<td>3.03</td>
<td>2.81</td>
<td>5.21 (4.10, 5.99)</td>
</tr>
<tr>
<td>Composite</td>
<td>2; 31</td>
<td>9.24</td>
<td>5.90</td>
<td>18.34 (9.48, 30.0)</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>9; 186</td>
<td>2.00</td>
<td>1.29</td>
<td>4.79 (3.65, 6.035)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>11; 189</td>
<td>1.64</td>
<td>1.50</td>
<td>3.75 (2.65, 4.1)</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>7; 351</td>
<td>2.40</td>
<td>2.85</td>
<td>4.90 (4.00, 5.00)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>16; 363</td>
<td>3.09</td>
<td>2.30</td>
<td>4.90 (4.29, 5.40)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>6; 106</td>
<td>2.69</td>
<td>1.18</td>
<td>3.97 (3.33, 4.38)</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>22; 469</td>
<td>3.00</td>
<td>2.00</td>
<td>4.54 (4.16, 4.90)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
Table 14. Influent/Effluent Summary Statistics for Total Copper (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>12; 225, 12; 163</td>
<td>10.00</td>
<td>4.70</td>
<td>23.21</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>19; 320, 19; 256</td>
<td>5.00</td>
<td>4.40</td>
<td>10.81</td>
</tr>
<tr>
<td>Bioretention</td>
<td>13; 294, 13; 259</td>
<td>4.80</td>
<td>3.50</td>
<td>8.75</td>
</tr>
<tr>
<td>Composite</td>
<td>6; 108, 6; 98</td>
<td>6.82</td>
<td>4.01</td>
<td>11.79</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>15; 249, 15; 250</td>
<td>4.13</td>
<td>1.85</td>
<td>8.88</td>
</tr>
<tr>
<td>Media Filter</td>
<td>20; 345, 20; 330</td>
<td>4.97</td>
<td>2.46</td>
<td>9.74</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>11; 397, 11; 246</td>
<td>7.50</td>
<td>4.00</td>
<td>11.54</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>40; 715, 40; 717</td>
<td>4.43</td>
<td>2.70</td>
<td>8.95</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>10; 243, 10; 238</td>
<td>4.18</td>
<td>2.00</td>
<td>7.23</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>50; 958, 50; 955</td>
<td>4.26</td>
<td>2.40</td>
<td>8.35</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
5.5 Iron

**Figure 15. Box Plots of Influent/Effluent Dissolved Iron Concentrations**

![Box Plots of Influent/Effluent Dissolved Iron Concentrations](image)

**Table 15. Influent/Effluent Summary Statistics for Dissolved Iron (µg/L)**

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>4; 67</td>
<td>23.2</td>
<td>46.0</td>
<td>47.8 (30.0, 73.0)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Media Filter</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4; 260</td>
<td>35.8</td>
<td>70.0</td>
<td>70.6 (60.0, 80.0)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>5; 115</td>
<td>19.6</td>
<td>27.2</td>
<td>53.2 (31.0, 60.0)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>5; 115</td>
<td>19.6</td>
<td>27.2</td>
<td>53.3 (31.0, 60.0)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.
**Figure 16. Box Plots of Influent/Effluent Total Iron Concentrations**

![Box Plots of Influent/Effluent Total Iron Concentrations](image)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>4; 67</td>
<td>291</td>
<td>789 (490, 1000)</td>
<td>1800</td>
</tr>
<tr>
<td></td>
<td>4; 53</td>
<td>135</td>
<td>616 (190, 897)</td>
<td>1330</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>3; 55</td>
<td>39.0</td>
<td>152 (40, 180)</td>
<td>514</td>
</tr>
<tr>
<td></td>
<td>3; 49</td>
<td>40.0</td>
<td>142 (44, 220)</td>
<td>350</td>
</tr>
<tr>
<td>Bioretention</td>
<td>3; 44</td>
<td>253</td>
<td>515 (280, 615)</td>
<td>1027</td>
</tr>
<tr>
<td></td>
<td>3; 42</td>
<td>478</td>
<td>1027 (510, 1380)***</td>
<td>805</td>
</tr>
<tr>
<td>Composite</td>
<td>3; 67</td>
<td>477</td>
<td>1593 (820, 2170)</td>
<td>5095</td>
</tr>
<tr>
<td></td>
<td>3; 56</td>
<td>157</td>
<td>1593 (820, 2170)</td>
<td>454</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Media Filter</td>
<td>7; 144</td>
<td>257</td>
<td>608 (437, 754)</td>
<td>211 (163, 258)**</td>
</tr>
<tr>
<td></td>
<td>7; 132</td>
<td>113</td>
<td>211 (163, 258)**</td>
<td>421</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>16; 317</td>
<td>393</td>
<td>1037 (820, 1200)</td>
<td>265 (224, 301)**</td>
</tr>
<tr>
<td></td>
<td>16; 312</td>
<td>153</td>
<td>265 (224, 301)**</td>
<td>485</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>18; 404</td>
<td>269</td>
<td>686 (540, 825)</td>
<td>277 (240, 300)**</td>
</tr>
<tr>
<td></td>
<td>18; 399</td>
<td>165</td>
<td>277 (240, 300)**</td>
<td>480</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.
### 5.6 Lead

**Figure 17. Box Plots of Influent/Effluent Dissolved Lead Concentrations**

![Box Plots of Influent/Effluent Dissolved Lead Concentrations](image)

**Table 17. Influent/Effluent Summary Statistics for Dissolved Lead (µg/L)**

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 220</td>
<td>0.10</td>
<td>0.09</td>
<td>0.49 (0.24, 0.90)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>14; 112</td>
<td>0.60</td>
<td>0.49</td>
<td>1.35 (0.83, 1.52)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>5; 101</td>
<td>0.04</td>
<td>0.02</td>
<td>0.07 (0.05, 0.08)</td>
</tr>
<tr>
<td>Composite</td>
<td>3; 33</td>
<td>0.24</td>
<td>0.08</td>
<td>2.56 (0.32, 10.2)</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>8; 164</td>
<td>0.23</td>
<td>0.22</td>
<td>0.64 (0.44, 0.92)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10; 155</td>
<td>0.32</td>
<td>0.42</td>
<td>1.00 (1.00, 1.00)</td>
</tr>
<tr>
<td>Porous Pavement****</td>
<td>4; 292</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50 (0.50, 0.50)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>11; 163</td>
<td>0.17</td>
<td>0.12</td>
<td>1.00 (0.66, 2.00)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>4; 36</td>
<td>0.38</td>
<td>0.35</td>
<td>0.67 (0.39, 0.84)</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>15; 199</td>
<td>0.19</td>
<td>0.15</td>
<td>0.90 (0.56, 1.06)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.

****Conclusions are limited for this BMP category due to a large percentage of non-detects in the influent.
Table 18. Influent/Effluent Summary Statistics for Total Lead (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>12; 225</td>
<td>3.10</td>
<td>0.68</td>
<td>7.94</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>18; 279</td>
<td>1.32</td>
<td>1.26</td>
<td>3.91</td>
</tr>
<tr>
<td>Bioretention</td>
<td>7; 138</td>
<td>0.86</td>
<td>0.09</td>
<td>2.15</td>
</tr>
<tr>
<td>Composite</td>
<td>8; 140</td>
<td>8.33</td>
<td>2.00</td>
<td>21.8</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>13; 223</td>
<td>2.19</td>
<td>1.32</td>
<td>7.37</td>
</tr>
<tr>
<td>Media Filter</td>
<td>19; 297</td>
<td>2.69</td>
<td>0.71</td>
<td>10.2</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>8; 338</td>
<td>0.49</td>
<td>0.07</td>
<td>2.24</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>39; 618</td>
<td>3.00</td>
<td>1.00</td>
<td>9.05</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>8; 145</td>
<td>7.00</td>
<td>3.00</td>
<td>2.38</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>47; 763</td>
<td>2.00</td>
<td>1.00</td>
<td>7.11</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>5; 91</td>
<td>1.05</td>
<td>1.00</td>
<td>3.47</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
5.7 Nickel

Figure 19. Box Plots of Influent/Effluent Dissolved Nickel Concentrations

Table 19. Influent/Effluent Summary Statistics for Dissolved Nickel (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 208</td>
<td>1.19</td>
<td>1.52</td>
<td>2.56 (2.06, 2.80)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>5; 31</td>
<td>2.80</td>
<td>2.00</td>
<td>4.92 (2.90, 5.90)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>5; 68</td>
<td>1.32</td>
<td>1.31</td>
<td>2.33 (2.00, 2.75)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10; 114</td>
<td>0.82</td>
<td>0.74</td>
<td>1.74 (1.00, 2.00)</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4; 262</td>
<td>0.63</td>
<td>0.24</td>
<td>1.10 (0.96, 1.30)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>4; 43</td>
<td>1.05</td>
<td>1.23</td>
<td>1.81 (1.30, 2.00)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>4; 43</td>
<td>1.05</td>
<td>1.23</td>
<td>1.81 (1.30, 2.00)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibshirani (1993).
**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
Figure 20. Box Plots of Influent/Effluent Total Nickel Concentrations

Table 20. Influent/Effluent Summary Statistics for Total Nickel (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 208</td>
<td>11; 149</td>
<td>3.20</td>
<td>2.10</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>5; 31</td>
<td>5; 23</td>
<td>5.15</td>
<td>2.35</td>
</tr>
<tr>
<td>Bioretention</td>
<td>3; 65</td>
<td>3; 56</td>
<td>2.10</td>
<td>3.23</td>
</tr>
<tr>
<td>Composite</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>6; 76</td>
<td>6; 70</td>
<td>3.10</td>
<td>2.00</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10; 115</td>
<td>10; 109</td>
<td>2.00</td>
<td>1.12</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4; 264</td>
<td>4; 130</td>
<td>2.40</td>
<td>1.20</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>10; 113</td>
<td>10; 109</td>
<td>2.50</td>
<td>2.00</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>10; 113</td>
<td>10; 109</td>
<td>2.50</td>
<td>2.00</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>3; 68</td>
<td>3; 53</td>
<td>2.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

NA – not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 3 shows statistically significant decreases for this BMP category.
***Hypothesis testing in Attachment 3 shows statistically significant increases for this BMP category.
5.8 Zinc

Figure 21. Box Plots of Influent/Effluent Dissolved Zinc Concentrations

Table 21. Influent/Effluent Summary Statistics for Dissolved Zinc (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>11; 221</td>
<td>14.0</td>
<td>6.00</td>
<td>33.7 (27.0, 38.0)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>16; 172</td>
<td>17.1</td>
<td>13.5</td>
<td>33.2 (27.3, 35.8)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>6; 126</td>
<td>10.7</td>
<td>2.72</td>
<td>19.7 (15.0, 24.0)</td>
</tr>
<tr>
<td>Composite</td>
<td>3; 67</td>
<td>10.0</td>
<td>3.04</td>
<td>30.0 (20.0, 40.0)</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>9; 186</td>
<td>5.44</td>
<td>3.00</td>
<td>13.1 (9.20, 15.5)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>11; 189</td>
<td>11.2</td>
<td>1.82</td>
<td>29.2 (21.0, 36.0)</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>7; 351</td>
<td>6.40</td>
<td>0.38</td>
<td>13.4 (11.1, 15.1)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>18; 360</td>
<td>10.0</td>
<td>5.60</td>
<td>23.0 (19.0, 25.0)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>6; 106</td>
<td>13.3</td>
<td>4.07</td>
<td>21.8 (18.8, 24.3)</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>24; 466</td>
<td>11.0</td>
<td>5.2</td>
<td>22.6 (19.5, 23.95)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>3; 64</td>
<td>4.61</td>
<td>3.04</td>
<td>11.7 (6.32, 16.9)</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for analyzed BMPs for total zinc.
Figure 22. Box Plots of Influent/Effluent Total Zinc Concentrations

Table 22. Influent/Effluent Summary Statistics for Total Zinc (µg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>12; 225</td>
<td>12; 163</td>
<td>48.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>21; 354</td>
<td>21; 286</td>
<td>20.0</td>
<td>17.8</td>
</tr>
<tr>
<td>Bioretention</td>
<td>14; 329</td>
<td>14; 293</td>
<td>24.0</td>
<td>5.00</td>
</tr>
<tr>
<td>Composite</td>
<td>8; 148</td>
<td>8; 131</td>
<td>52.8</td>
<td>20.0</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>15; 249</td>
<td>15; 251</td>
<td>21.5</td>
<td>6.00</td>
</tr>
<tr>
<td>Media Filter</td>
<td>23; 387</td>
<td>23; 358</td>
<td>23.3</td>
<td>4.19</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>12; 409</td>
<td>12; 256</td>
<td>20.5</td>
<td>1.73</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>47; 787</td>
<td>47; 760</td>
<td>29.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>13; 271</td>
<td>13; 266</td>
<td>33.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>60; 1058</td>
<td>60; 1026</td>
<td>30.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>4; 107</td>
<td>4; 86</td>
<td>13.5</td>
<td>10.0</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 3 shows statistically significant decreases for analyzed BMPs for total zinc.
6 NUTRIENTS

6.1 Phosphorus

Figure 23. Box Plots of Influent/Effluent Total Phosphorus Concentrations

Table 23. Influent/Effluent Summary Statistics for Total Phosphorus (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>19; 360</td>
<td>19; 276</td>
<td>0.075</td>
<td>0.097</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>22; 393</td>
<td>22; 341</td>
<td>0.062</td>
<td>0.095</td>
</tr>
<tr>
<td>Bioretention</td>
<td>27; 515</td>
<td>27; 435</td>
<td>0.062</td>
<td>0.080</td>
</tr>
<tr>
<td>Composite</td>
<td>10; 184</td>
<td>10; 166</td>
<td>0.173</td>
<td>0.086</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>21; 307</td>
<td>21; 322</td>
<td>0.169</td>
<td>0.114</td>
</tr>
<tr>
<td>Media Filter</td>
<td>22; 365</td>
<td>22; 349</td>
<td>0.070</td>
<td>0.040</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>7; 325</td>
<td>7; 192</td>
<td>0.119</td>
<td>0.071</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>54; 874</td>
<td>54; 867</td>
<td>0.088</td>
<td>0.045</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>17; 376</td>
<td>17; 369</td>
<td>0.078</td>
<td>0.053</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>71; 1250</td>
<td>71; 1236</td>
<td>0.082</td>
<td>0.047</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>8; 165</td>
<td>8; 146</td>
<td>0.090</td>
<td>0.093</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.
***Hypothesis testing in Attachment 4 shows statistically significant increases for this BMP category.
Table 24. Influent/Effluent Summary Statistics for Orthophosphate (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>13; 276</td>
<td>13; 219</td>
<td>0.010</td>
<td>0.016</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>6; 175</td>
<td>6; 145</td>
<td>0.016</td>
<td>0.033</td>
</tr>
<tr>
<td>Bioretention</td>
<td>18; 268</td>
<td>18; 239</td>
<td>0.007</td>
<td>0.043</td>
</tr>
<tr>
<td>Composite</td>
<td>3; 51</td>
<td>3; 42</td>
<td>0.065</td>
<td>0.034</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Media Filter</td>
<td>7; 116</td>
<td>7; 115</td>
<td>0.020</td>
<td>0.015</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>5; 142</td>
<td>5; 87</td>
<td>0.030</td>
<td>0.042</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>33; 527</td>
<td>33; 508</td>
<td>0.020</td>
<td>0.006</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>9; 259</td>
<td>9; 250</td>
<td>0.019</td>
<td>0.011</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>42; 786</td>
<td>42; 758</td>
<td>0.020</td>
<td>0.008</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>3; 84</td>
<td>3; 63</td>
<td>0.010</td>
<td>0.038</td>
</tr>
</tbody>
</table>

NA = not available or less than 3 studies for BMP/constituent.
*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).
**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.
***Hypothesis testing in Attachment 4 shows statistically significant increases for this BMP category.
Table 25. Influent/Effluent Summary Statistics for Dissolved Phosphorus (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>3; 21</td>
<td>3; 17</td>
<td>0.060</td>
<td>0.180</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>6; 65</td>
<td>6; 53</td>
<td>0.030</td>
<td>0.045</td>
</tr>
<tr>
<td>Bioretention</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Composite</td>
<td>8; 167</td>
<td>8; 153</td>
<td>0.073</td>
<td>0.042</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>10; 137</td>
<td>10; 137</td>
<td>0.050</td>
<td>0.030</td>
</tr>
<tr>
<td>Media Filter</td>
<td>10; 111</td>
<td>10; 100</td>
<td>0.013</td>
<td>0.016</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>4; 214</td>
<td>4; 110</td>
<td>0.030</td>
<td>0.040</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>18; 373</td>
<td>18; 360</td>
<td>0.070</td>
<td>0.030</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>5; 115</td>
<td>5; 115</td>
<td>0.044</td>
<td>0.023</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>23; 488</td>
<td>23; 475</td>
<td>0.060</td>
<td>0.030</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>5; 92</td>
<td>5; 89</td>
<td>0.048</td>
<td>0.060</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 4 shows statistically significant increases for this BMP category.
6.2 Nitrogen

**Figure 26. Box Plots of Influent/Effluent Total Nitrogen Concentrations**

![Box Plots of Influent/Effluent Total Nitrogen Concentrations](image)

**Table 26. Influent/Effluent Summary Statistics for Total Nitrogen (mg/L)**

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>8</td>
<td>138</td>
<td>8</td>
<td>122</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>8</td>
<td>241</td>
<td>8</td>
<td>207</td>
</tr>
<tr>
<td>Bioretention</td>
<td>13</td>
<td>245</td>
<td>13</td>
<td>194</td>
</tr>
<tr>
<td>Composite</td>
<td>7</td>
<td>138</td>
<td>7</td>
<td>127</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>5</td>
<td>90</td>
<td>5</td>
<td>89</td>
</tr>
<tr>
<td>Media Filter</td>
<td>9</td>
<td>154</td>
<td>9</td>
<td>151</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>26</td>
<td>397</td>
<td>26</td>
<td>425</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>7</td>
<td>232</td>
<td>7</td>
<td>235</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>33</td>
<td>629</td>
<td>33</td>
<td>660</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>5</td>
<td>81</td>
<td>5</td>
<td>78</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.
Table 27. Influent/Effluent Summary Statistics for Total Kjeldahl Nitrogen (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>Out</td>
<td>In</td>
</tr>
<tr>
<td>Biofilter - Grass Strip</td>
<td>18; 352</td>
<td>0.75</td>
<td>0.75</td>
<td>1.20 (1.12, 1.40)</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>18; 314</td>
<td>0.33</td>
<td>0.41</td>
<td>0.70 (0.55, 0.83)</td>
</tr>
<tr>
<td>Bioretention</td>
<td>21; 410</td>
<td>0.60</td>
<td>0.55</td>
<td>1.10 (0.86, 1.10)</td>
</tr>
<tr>
<td>Composite</td>
<td>7; 136</td>
<td>0.80</td>
<td>0.54</td>
<td>1.57 (1.26, 1.80)</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>13; 205</td>
<td>0.82</td>
<td>0.83</td>
<td>1.37 (1.10, 1.50)</td>
</tr>
<tr>
<td>Media Filter</td>
<td>20; 316</td>
<td>0.56</td>
<td>0.29</td>
<td>0.96 (0.84, 1.08)</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>6; 345</td>
<td>1.40</td>
<td>0.70</td>
<td>2.17 (1.80, 2.30)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>36; 498</td>
<td>0.76</td>
<td>0.70</td>
<td>1.23 (1.10, 1.31)</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>8; 96</td>
<td>0.61</td>
<td>0.62</td>
<td>0.99 (0.84, 1.12)</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>44; 594</td>
<td>0.73</td>
<td>0.67</td>
<td>1.16 (1.06, 1.25)</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>6; 120</td>
<td>0.94</td>
<td>0.85</td>
<td>1.44 (1.30, 1.60)</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.
### Table 28. Influent/Effluent Summary Statistics for NO$_3$ as Nitrogen (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile In</th>
<th>25th Percentile Out</th>
<th>Median (95% Conf. Interval)* In</th>
<th>Median (95% Conf. Interval)* Out</th>
<th>75th Percentile In</th>
<th>75th Percentile Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>12; 228</td>
<td>0.290</td>
<td>0.180</td>
<td>0.60 (0.48, 0.68)</td>
<td>0.44 (0.33, 0.51)**</td>
<td>1.10</td>
<td>0.96</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>11; 95</td>
<td>0.230</td>
<td>0.260</td>
<td>0.49 (0.34, 0.60)</td>
<td>0.45 (0.30, 0.52)</td>
<td>0.86</td>
<td>0.77</td>
</tr>
<tr>
<td>Bioretention</td>
<td>3; 32</td>
<td>0.168</td>
<td>0.195</td>
<td>0.31 (0.18, 0.40)</td>
<td>0.39 (0.20, 0.48)</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>Composite</td>
<td>3; 54</td>
<td>0.213</td>
<td>0.150</td>
<td>0.49 (0.37, 0.65)</td>
<td>0.28 (0.18, 0.33)**</td>
<td>0.77</td>
<td>0.43</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>6; 82</td>
<td>0.392</td>
<td>0.360</td>
<td>0.76 (0.52, 0.88)</td>
<td>0.65 (0.47, 0.73)</td>
<td>1.20</td>
<td>1.00</td>
</tr>
<tr>
<td>Media Filter</td>
<td>12; 178</td>
<td>0.200</td>
<td>0.300</td>
<td>0.32 (0.27, 0.35)</td>
<td>0.22 (0.19, 0.26)**</td>
<td>0.56</td>
<td>0.46, 0.63**</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>15; 251</td>
<td>0.250</td>
<td>0.120</td>
<td>0.49 (0.40, 0.54)</td>
<td>0.26 (0.19, 0.28)**</td>
<td>0.83</td>
<td>0.50</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>5; 48</td>
<td>0.127</td>
<td>0.032</td>
<td>0.29 (0.15, 0.42)</td>
<td>0.08 (0.05, 0.12)**</td>
<td>0.67</td>
<td>0.16</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>20; 299</td>
<td>0.22</td>
<td>0.10</td>
<td>0.47 (0.36, 0.48)</td>
<td>0.22 (0.19, 0.26)**</td>
<td>0.81</td>
<td>0.50</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>4; 82</td>
<td>0.120</td>
<td>0.100</td>
<td>0.20 (0.16, 0.24)</td>
<td>0.17 (0.10, 0.20)</td>
<td>0.31</td>
<td>0.30</td>
</tr>
</tbody>
</table>

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

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 4 shows statistically significant increases for this BMP category.
Figure 29. Box Plots of Influent/Effluent NO₂ + NO₃ as Nitrogen Concentrations

Table 29. Influent/Effluent Summary Statistics for NO₂ + NO₃ as Nitrogen (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>7; 132</td>
<td>0.12</td>
<td>0.25 (0.17, 0.29)</td>
<td>0.42</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>10; 267</td>
<td>0.10</td>
<td>0.25 (0.2, 0.29)</td>
<td>0.50</td>
</tr>
<tr>
<td>Bioretention</td>
<td>22; 435</td>
<td>0.20</td>
<td>0.35 (0.31, 0.37)</td>
<td>0.70</td>
</tr>
<tr>
<td>Composite</td>
<td>7; 112</td>
<td>0.36</td>
<td>0.59 (0.47, 0.72)</td>
<td>1.40</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>9; 154</td>
<td>0.21</td>
<td>0.44 (0.33, 0.53)</td>
<td>0.70</td>
</tr>
<tr>
<td>Media Filter</td>
<td>9; 162</td>
<td>0.24</td>
<td>0.36 (0.31, 0.40)</td>
<td>0.59</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>7; 358</td>
<td>0.34</td>
<td>0.60 (0.53, 0.64)</td>
<td>1.35 (1.22, 1.51)</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>30; 439</td>
<td>0.16</td>
<td>0.39 (0.34, 0.43)</td>
<td>0.80</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>8; 220</td>
<td>0.09</td>
<td>0.25 (0.20, 0.30)</td>
<td>0.50</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>38; 659</td>
<td>0.126</td>
<td>0.34 (0.31, 0.37)</td>
<td>0.67</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>4; 65</td>
<td>0.41</td>
<td>0.77 (0.52, 0.99)</td>
<td>2.86</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibshirani (1993).

**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 4 shows statistically significant increases for this BMP category.

Pollutant Category Statistical Summary Report
December 2014
### Figure 30. Box Plots of Influent/Effluent NO$_x$ as Nitrogen Concentrations

![Box Plots of Influent/Effluent NO$_x$ as Nitrogen Concentrations](image)

### Table 30. Influent/Effluent Summary Statistics for NO$_x$ as Nitrogen (mg/L)

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Count of Studies and EMCs</th>
<th>25th Percentile</th>
<th>Median (95% Conf. Interval)*</th>
<th>75th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilter - Grass Strip</td>
<td>19; 360</td>
<td>0.20</td>
<td>0.41 (0.36, 0.46)</td>
<td>0.87</td>
</tr>
<tr>
<td>Biofilter - Grass Swale</td>
<td>21; 478</td>
<td>0.10</td>
<td>0.26 (0.23, 0.29)</td>
<td>0.50</td>
</tr>
<tr>
<td>Bioretention</td>
<td>24; 468</td>
<td>0.20</td>
<td>0.35 (0.31, 0.37)</td>
<td>0.53</td>
</tr>
<tr>
<td>Composite</td>
<td>10; 166</td>
<td>0.33</td>
<td>0.56 (0.45, 0.65)</td>
<td>1.05</td>
</tr>
<tr>
<td>Detention Basin</td>
<td>15; 236</td>
<td>0.26</td>
<td>0.53 (0.43, 0.60)</td>
<td>0.87</td>
</tr>
<tr>
<td>Media Filter</td>
<td>21; 340</td>
<td>0.21</td>
<td>0.34 (0.30, 0.37)</td>
<td>0.59</td>
</tr>
<tr>
<td>Porous Pavement</td>
<td>7; 358</td>
<td>0.34</td>
<td>0.60 (0.53, 0.64)</td>
<td>1.35 (1.22, 1.51)***</td>
</tr>
<tr>
<td>Retention Pond</td>
<td>45; 690</td>
<td>0.19</td>
<td>0.43 (0.40, 0.47)</td>
<td>0.82</td>
</tr>
<tr>
<td>Wetland Basin</td>
<td>13; 270</td>
<td>0.09</td>
<td>0.26 (0.20, 0.29)</td>
<td>0.52</td>
</tr>
<tr>
<td>Wetland Basin/Retention Pond</td>
<td>58; 960</td>
<td>0.16</td>
<td>0.38 (0.34, 0.40)</td>
<td>0.73</td>
</tr>
<tr>
<td>Wetland Channel</td>
<td>8; 147</td>
<td>0.18</td>
<td>0.34 (0.27, 0.40)</td>
<td>0.73</td>
</tr>
</tbody>
</table>

*Computed using the BCa bootstrap method described by Efron and Tibishirani (1993).

**Hypothesis testing in Attachment 4 shows statistically significant decreases for this BMP category.

***Hypothesis testing in Attachment 4 shows statistically significant increases for this BMP category.
7 REFERENCES


8 ATTACHMENTS

Attachment 1. Solids Statistical Summary Report
Attachment 2. Bacteria Statistical Summary Report
Attachment 3. Metals Statistical Summary Report
Attachment 4. Nutrients Statistical Summary Report