11 Best Management Practices

A wide variety of structural and non-structural implementation practices exist that we can select to help us protect and restore our watershed. A list of potential strategies was reviewed by the steering committee to help identify which practices were deemed the most appropriate and likely to succeed in addressing the watershed goals. The list of implementation strategies is not meant to be static or exhaustive as new approaches or practices may come to our attention over time and evaluation may show that certain practices were not as effective as we originally thought they would be.

11.1 Urban Area BMPs

Urban development is the most common human land use in the watershed, accounting for nearly 45% of its land area. The highest concentrations of development are located in the north western half of the watershed around Crown Point, Gary, Hobart, Merrillville and Portage. Urban development contributes an estimated 66% of the runoff volume, 40% of the nitrogen loads, 26% of the phosphorus loads, 59% of the biological oxygen demand loads, and 59% of the sediment loads in the watershed.

The following list of BMPs have been identified for implementation in the watershed. Descriptions of the individual practices are included in the appendices. The focus is to 1) Encourage the use of Low Impact Development (LID) design principles with new development or redevelopment; 2) Retrofit existing sites or practices to provide or improve water quality benefits and enhance storage for downstream channel protection (i.e. erosion) using LID practices; and 3) restore riparian corridors and native vegetation in upland areas to improve storage, water quality and habitat benefits.

- Bioretention (Rain Gardens)
- Capture Reuse (Rain Barrels & Cisterns)
- Constructed Filter
- Detention Basin
- Infiltration Practices
- Low Impact Development Site Design
- Native Revegetation
- Pervious Pavement w/ Infiltration
- Planter Boxes
- Riparian Buffer Restoration
- Vegetated Filter Strip
- Vegetated Roof (Green Roof)
- Vegetated Swale
- Water Quality Devices

Two resources were primarily consulted in identifying urban BMP list above and BMP selection considerations below: The Center for Watershed Protection’s URBAN SUBWATERSHED RESTORATION MANUAL SERIES and the LOW IMPACT DEVELOPMENT MANUAL FOR MICHIGAN. Low Impact Development (LID) is a comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds. Low Impact Development mimics a site’s pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source. Because LID utilizes a variety of useful techniques for controlling runoff, designs can be customized according to local regulatory and resource protection requirements, as well as site constraints.
11.1.1 LID Best Management Practice Selection Considerations

Selecting which BMPs accomplish as many storm water functions as possible is important. At the same time, meeting a certain function or level of pollution or storm water volume control can require multiple BMPs integrated at the site, creating a “treatment train.” Treatment trains direct storm water to or through multiple BMPs in order to achieve quantity and/or quality storm water management objectives. Additionally, implementing BMPs as part of a treatment train can also provide a level of backup, which provides additional assurance if one BMP does not work as designed (e.g., maintenance problems, large storm event).

![Decision making process for BMP selection](image)

The following table, adapted from the LID Manual for Michigan, is intended to help identify which BMP(s) would be most suitable for a given land use. In many instances a combination of BMPs can be used at a site to improve pollutant removal and storm water volume reduction efficiency. Typical applications include modifying existing detention ponds, storage in transportation rights-of-way, parking lot retrofits, and landscapes/hardscapes.

<table>
<thead>
<tr>
<th>Best Management Practice</th>
<th>Residential</th>
<th>Commercial</th>
<th>Ultra-Urban</th>
<th>Industrial</th>
<th>Transportation Rights-of-Way</th>
<th>Recreational</th>
<th>Retrofit</th>
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</thead>
<tbody>
<tr>
<td>Bioretention</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Capture Reuse</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constructed Filter</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Detention- Dry Pond</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Detention- Wet Pond</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Infiltration- Dry Well</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Limited</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Infiltration- Basin</td>
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<td>Limited</td>
<td>Yes</td>
<td>Limited</td>
<td>No</td>
<td>Limited</td>
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<tr>
<td>Infiltration- Berm</td>
<td>Yes</td>
<td>Yes</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Infiltration- Trench</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Infiltration- Subsurface Bed</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Limited</td>
<td>No</td>
<td>Yes</td>
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</table>
Table 123: Suitability of LID practices in various urban land uses

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<tr>
<th>Practice</th>
<th>Yes</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
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</thead>
<tbody>
<tr>
<td>Native Revegetation</td>
<td></td>
<td></td>
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<tr>
<td>Pervious Pavement</td>
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<tr>
<td>Planter Box</td>
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<td></td>
<td></td>
<td></td>
<td>Limited</td>
<td>No</td>
<td>Limited</td>
</tr>
<tr>
<td>Riparian Buffer Restoration</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Vegetated Filter Strip</td>
<td>Yes</td>
<td>Yes</td>
<td>Limited</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Vegetated Roof</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Vegetated Swale</td>
<td>Yes</td>
<td>Yes</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Water Quality Device</td>
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<td>Yes</td>
<td>Limited</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The following list of retrofit opportunities comes from the Center for Watershed Protection’s URBAN SUBWATERSHED RESTORATION MANUAL SERIES-3, URBAN STORMWATER RETROFIT PRACTICES. Opportunities can be broadly categorized as either storage or onsite retrofits. In general storage retrofits treat larger drainage areas, typically are constructed on public land, and tend to be more cost effective.

Retrofit location opportunities:
- Existing storm water ponds (SR-1)
- Storage above roadway crossings (SR-2)
- New storage below outfalls (SR-3)
- Treatment in conveyance system (SR-4)
- Transportation rights-of-way (SR-5)
- Large parking lots (SR-6)
- Hotspot operations (OS-7)
- Small parking lot retrofits (OS-8)
- Individual streets (OS-9)
- Individual rooftops (OS-10)
- Little retrofits (OS-11)
- Landscapes-hardscapes (OS-12)

SR = storage retrofit, treat drainage areas ranging from 5-500 acres
OS = onsite retrofit, treat drainage areas < 5 acres

Table 124, primarily adapted from the LID Manual for Michigan, compares storm water quantity and quality functions, cost and maintenance for the various structural LID BMPs recommended. The ability of a practice to treat pathogens is based on a literature review conducted by Schueler (2000). As noted previously a combination of BMPs can be used at a site to improve pollutant removal and storm water volume reduction efficiency.
### Table 124 Function, cost, and maintenance of LID practices

<table>
<thead>
<tr>
<th>Detention- Dry Pond</th>
<th>L</th>
<th>H</th>
<th>M</th>
<th>M</th>
<th>L</th>
<th>H</th>
<th>L/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detention- Wet Pond</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>X</td>
<td>H</td>
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<td>Detention- Constructed Wetland</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>X</td>
<td>H</td>
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<td>Infiltration- Dry Well</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>M/H</td>
<td>L/M</td>
<td>X</td>
<td>M</td>
</tr>
<tr>
<td>Infiltration- Basin</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>M/H</td>
<td>M</td>
<td>X</td>
<td>L/M</td>
</tr>
<tr>
<td>Infiltration- Berm</td>
<td>L/M</td>
<td>M</td>
<td>M/H</td>
<td>M</td>
<td>M</td>
<td>X</td>
<td>L/M</td>
</tr>
<tr>
<td>Infiltration- Trench</td>
<td>M</td>
<td>L/M</td>
<td>H</td>
<td>M/H</td>
<td>L/M</td>
<td>X</td>
<td>M</td>
</tr>
<tr>
<td>Infiltration- Subsurface Bed</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>M/H</td>
<td>L</td>
<td>X</td>
<td>H</td>
</tr>
<tr>
<td>Native Revegetation</td>
<td>L/M/H</td>
<td>L/M</td>
<td>H</td>
<td>H</td>
<td>M/H</td>
<td>L/M</td>
<td>L</td>
</tr>
<tr>
<td>Pervious Pavement</td>
<td>H</td>
<td>M/H</td>
<td>H</td>
<td>M/H</td>
<td>L</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Planter Box</td>
<td>L/M</td>
<td>M</td>
<td>M</td>
<td>L/M</td>
<td>L/M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Riparian Buffer Restoration</td>
<td>L/M</td>
<td>L/M</td>
<td>M/H</td>
<td>M/H</td>
<td>M/H</td>
<td>L/M</td>
<td>L</td>
</tr>
<tr>
<td>Vegetated Filter Strip</td>
<td>L</td>
<td>L</td>
<td>M/H</td>
<td>M/H</td>
<td>M/H</td>
<td>L</td>
<td>L/M</td>
</tr>
<tr>
<td>Vegetated Roof</td>
<td>M/H</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Vegetated Swale</td>
<td>L/M</td>
<td>L/M</td>
<td>M/H</td>
<td>L/H</td>
<td>M</td>
<td>L/M</td>
<td>L/M</td>
</tr>
<tr>
<td>Water Quality Device</td>
<td>NA</td>
<td>NA</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
</tbody>
</table>

L= Low, M= Medium, H= High, X= Yes

### 11.2 Agricultural Area BMPs

Agriculture is the second common human land use in the watershed, accounting for nearly 28% of its land area. The highest concentrations of agricultural land are located in the southeastern portion of the watershed. An estimated 53% of the nitrogen loads, 68% of the phosphorus loads, 32% of the biological oxygen demand loads, and 40% of the sediment loads in the watershed originate from agricultural production.

The following best management practices have been identified from the NRCS Field Office Technical Guide (FOTG) for Indiana to control sediment, nutrients, and pathogens from row crop production and livestock operations on agricultural lands. The selection of which BMPs are most appropriate for a field or site is based on a Conservation Plan which is developed between the NRCS district conservationist and landowner. A Conservation Plan must be in place for a landowner to eligible for Farm Bill programs or Section 319 Cost-Share program funding.
• Access Control
• Alternative Watering Systems
• Conservation Cover
• Cover Crops
• Critical Area Planting
• Denitrifying Bioreactor
• Drainage Water Management
• Fencing
• Field Border
• Filter Strips
• Forage and Biomass Planting
• Stabilization Structures
• Grassed Waterway
• Manure Management Planning
• Manure Storage Facilities
• Nutrient Management
• Open Channel (Two-Stage Ditch)
• Prescribed Grazing
• Riparian Herbaceous Cover
• Riparian Forest Cover
• Residue and Tillage Management, No Till
• Residue and Tillage Management, Reduced Till
• Saturated Buffer

11.3 Priority Preservation Areas BMPs
The priority preservation area includes a mix of urban and agricultural land uses adjacent to or near sensitive natural areas. All of the BMPs referenced above for urban and agricultural areas still apply to the priority preservation area. However there are some additional measures that are very important and specific to this area.

Conservation Planning
Conservation planning includes identifying key natural areas within the landscape, assessing the conservation value of each parcel identified, establishing conservation targets for the parcel, landowner education on the value of land preservation, and identifying conservation options to landowners.

Dam Removal or Modification
Dam removal or modification can help restore fish passage, sediment and nutrient transport, riverine habitat characteristics, and stream flows.

Natural Area Preservation
Natural area preservation can include acquisition, conservation easements, or land donation of key natural area parcels.

Natural Area Restoration
Natural area restoration can vary greatly depending on the level of disturbance at a site. For more heavily disturbed sites, or portions of sites, restoration activities may include more intensive measures such as conversion back to natural land cover (e.g., agricultural to forest or grassland) or restoring hydrology (e.g., wetland or floodplain restoration). Natural area restoration can also include ongoing activities such as invasive species control, fire reintroduction for fire-dependent communities (e.g., prairies), or opening the tree canopy (e.g., oak savanna).

11.4 Watershed-Wide BMPs
These practices can be used throughout the watershed.

- Education and Outreach
- Floodplain Reconnection/Two-Stage Ditch
- Native Revegetation
- Riparian Buffer Restoration
- Septic system maintenance
- Streambank Stabilization & Shoreline Protection
- Wetland Restoration

11.5 BMP Recommendations for Critical Areas
The following table includes recommended BMPs for Tier 1 critical areas in the watershed. The table also includes information on why the catchment area was critical and the human land cover area potentially available for treatment by the BMPs. The recommendations are not intended to be exhaustive or prescriptive. Any number or combination of implementation activities might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or other locations where sources contribute indirectly to the water quality impairment.

<table>
<thead>
<tr>
<th>Catchment Area</th>
<th>Reasons for Being Critical</th>
<th>Urban (ac.)</th>
<th>Cropland (ac.)</th>
<th>Pasture (ac.)</th>
<th>Suggested BMP</th>
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<tbody>
<tr>
<td>3</td>
<td>E. coli Nutrients Sediment Physical Habitat Aquatic Life</td>
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<td>1,490</td>
<td>97</td>
<td>Floodplain reconnection</td>
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<td></td>
<td>Streambank stabilization</td>
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<td></td>
<td>Riparian buffer restoration</td>
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<td></td>
<td>Native revegetation</td>
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<td>Bioretention</td>
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<td>Capture Reuse</td>
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<td>Infiltration practices</td>
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<td>Vegetated swale</td>
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<td>Wet pond</td>
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<td>Pervious pavement</td>
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<td>Cover crop</td>
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<td>Nutrient management</td>
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<td>Septic system maintenance</td>
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<tr>
<td>Catchment Area</td>
<td>Reasons for Being Critical</td>
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<td>Cropland (ac.)</td>
<td>Pasture (ac.)</td>
<td>Suggested BMP</td>
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</tr>
<tr>
<td>21 E. coli</td>
<td>Dissolved Oxygen Nitrients Sediment Ammonia Physical Habitat Aquatic Life</td>
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<td>2,605</td>
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<td>Riparian buffer restoration</td>
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<td>Septic system maintenance</td>
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<td>Education and outreach</td>
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</table>

<p>| 27             | E. coli                  | 27         | 27          | 27          | Floodplain reconnection |
|                | Dissolved Oxygen Nutrients Sediment Physical Habitat Aquatic Life | 733        | 651         | 11          | Streambank stabilization |
|                |                           |            |             |             | Riparian buffer restoration |
|                |                           |            |             |             | Native revegetation |
|                |                           |            |             |             | Wetland restoration |
|                |                           |            |             |             | Detention basin |
|                |                           |            |             |             | Cover crop |
|                |                           |            |             |             | Conservation tillage |
|                |                           |            |             |             | Grasped waterway |
|                |                           |            |             |             | Filter strip/Field border |
|                |                           |            |             |             | Conservation cover |
|                |                           |            |             |             | Nutrient management |
|                |                           |            |             |             | Manure management |
|                |                           |            |             |             | Drainage water management |</p>
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<td>Septic system maintenance</td>
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<td>Education and outreach</td>
</tr>
</tbody>
</table>

Table 125  BMP recommendations for tier 1 critical areas

### 11.6 Estimated Load Reductions from BMPs

The following table provides a general overview of the load reductions anticipated from implementing some of the various practices recommended in the previous sections. These load reductions were estimated using the EPA Region 5 spreadsheet model. This model likely be used the most frequently in assessing site specific load reductions during implementation.

<table>
<thead>
<tr>
<th>Practice (Contributing Area)</th>
<th>Estimated Load Reduction</th>
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<tbody>
<tr>
<td></td>
<td>Nitrogen (lb/year)</td>
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<tr>
<td><strong>Urban/Rural Development Areas</strong></td>
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<tr>
<td>Bioretention</td>
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<tr>
<td>Detention- Dry Pond (100 ac.)</td>
<td>269</td>
</tr>
<tr>
<td>Detention- Wet Pond</td>
<td>492</td>
</tr>
<tr>
<td>Detention- Constructed Wetland (100 ac.)</td>
<td>179</td>
</tr>
<tr>
<td>Infiltration- Basin</td>
<td>537</td>
</tr>
<tr>
<td>Infiltration- Trench</td>
<td>492</td>
</tr>
<tr>
<td>BMP</td>
<td>Load Reductions (Units)</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Pervious Pavement</td>
<td>761  66  NA  36</td>
</tr>
<tr>
<td>Vegetated Filter Strip (100 ac.)</td>
<td>358  46  1,823  29</td>
</tr>
<tr>
<td>Vegetated Swale (100 ac.)</td>
<td>90   25  1,083  26</td>
</tr>
<tr>
<td>Water Quality Device</td>
<td>NA  NA  NA  NA</td>
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<tr>
<td><strong>Agricultural Areas</strong></td>
<td></td>
</tr>
<tr>
<td>No-Till/Strip-Till (100 ac.)</td>
<td>435  218  NA  167</td>
</tr>
<tr>
<td>Cover Crops (100 ac.)</td>
<td>271  136  NA  94</td>
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<tr>
<td>Filter Strips (100 ac.)</td>
<td>340  171  NA  110</td>
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<tr>
<td>Grassed Waterway (100 ft.)</td>
<td>34   17   NA  17</td>
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<tr>
<td>Critical Area Planting (100 ac.)</td>
<td>324  162  NA  107</td>
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<tr>
<td><strong>Watershed-Wide</strong></td>
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<tr>
<td>Conservation Cover</td>
<td>324  162  NA  107</td>
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<tr>
<td>Two-Stage Ditch</td>
<td>46   23   NA  23</td>
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<tr>
<td>Wetland Restoration (10 ac.)</td>
<td>252  126  NA  89</td>
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<tr>
<td>Riparian Forest Buffer (100 ac.)</td>
<td>148  74   NA  56</td>
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<tr>
<td>Riparian Herbaceous Cover (100 ac.)</td>
<td>324  162  NA  107</td>
</tr>
<tr>
<td>Streambank Stabilization (100 ft.)</td>
<td>46   23   NA  23</td>
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</tbody>
</table>

Table 126  Summary of load reductions anticipated with each BMP

The STEPL model was used to approximate load reductions and progress towards meeting load reduction goals anticipated from a few of the key recommend BMPs watershed wide and within each catchment area. The BMPs selected for this general analysis were considered to have broad applicability throughout the watershed and their pollutant removal efficiencies were readily available in the model. The following tables are formatted to show progress (increasing rates) in implementation over time. For example, the first table shows increasing adaptation of cover crops on cultivated land. Rows highlighted in red correspond to the Tier 1 critical areas.
## Table 127  Anticipated load reductions from cover crops

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<th>Site</th>
<th>Row Crop</th>
<th>10% Coverage (~2,500 ac)</th>
<th>25% Coverage (~6,500 ac)</th>
<th>50% Coverage (~13,000 ac)</th>
<th>75% Coverage (~19,500 ac)</th>
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<td>N</td>
<td>P</td>
<td>S</td>
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<tr>
<td></td>
<td>Acres</td>
<td>lb/yr</td>
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Table 128  Anticipated load reductions from reduced tillage
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Table 129: Anticipated load reductions from bioretention
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Table 130  Anticipated load reductions from conservation cover
## Deep River-Portage Burns Waterway Watershed

January 18, 2017

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**Total** | **1,057** | **4,228** | **12,685** | **21,141**

**Reduction Needed** | **3,866** | **3,866** | **3,866** | **3,866**

**% Meet** | **27%** | **>100%** | **>100%** | **>100%**

**Table 131** Anticipated load reductions from streambank stabilization