4 stormwater best management practices toolbox

This section presents a brief illustrated overview of a variety of policy/regulation, site planning, and stormwater/landscaping best management practices (BMPs). Policies and standards BMPs provide the legal framework for conservation development, while planning process BMPs are on-site strategies that preserve natural features and facilitate conservation stormwater BMPs. Stormwater BMPs are individual practices that achieve on-site stormwater management objectives. Common to many of the techniques is the use of native plants that function not only as a part of an effective stormwater management system but also as native landscapes. Following the brief descriptions, more detailed information is provided including guidance on applicable scale and land use, benefits & effectiveness, and design considerations. A more detailed toolbox is included in the Appendix.

POLICIES AND STANDARDS

Policies and Standards serve as the first step to establish and then enforce minimum standards for natural resource preservation and stormwater management. Policies express goals for natural resource, water quality, habitat, and open space preservation. Standards (along with zoning described below) are the tools used to implement the policies. Policy actions or standards may include acquisition of Conservation Easements, Stream/Wetland Restoration and Management, and adoption of Watershed Development Ordinances.

Conservation Easement: Legal mechanism for landowners to place voluntary restrictions on the future use of their land, generally requires landowner to sell, permanently relinquish, or donate the rights of development.

Conservation and Floodplain Standards: Standards established to preserve stream corridors and floodplains from urban development and other encroachments.

Watershed Development Ordinance: Ordinance to regulate development for the purpose of minimizing on-site and off-site impacts to flooding and water quality.

Wetland/Stream Management and Restoration: Practices that restore and/or create healthy aquatic ecosystems. Activities include stream corridor restoration, hydrologic restoration, and vegetative management. In some cases, creation of wetland banks and fee-in-lieu of wetland mitigation can be used as funding mechanisms for wetland creation and enhancement.
PLANNING PROCESS BMPS

Planning practices are also used to implement policy goals of maintaining high environmental quality as a watershed develops. Significant natural features and other areas to be preserved are identified using environmental planning processes. Many of these areas can then be preserved by open space requirements and other standards. Open Space/Natural Greenway delineation, Riparian Buffers, and Floodplain Standards are tools used to preserve natural resource areas from development. Conservation Development and Impervious Area Reduction are critical site-level planning and design strategies to create environmentally sensitive developments to achieve stormwater management and watershed goals.

Conservation Development: Site planning and design approaches that preserve existing natural areas and utilize naturalized drainage and detention measures for stormwater management, energy consumption, transportation efficiency, and habitat enhancement.

Impervious Area Reduction: Impervious area reduction can be achieved in a number of ways, such as: narrower streets; shorter streets in lower density residential neighborhoods; creative driveway design; shared parking facilities; and designing roads, walkways, and trails for multiple uses as an integrated system.

Open Space/Natural Greenway: Designation of open spaces and/or natural areas as greenways, in order to preserve and connect significant natural features and accommodate aesthetic, recreational and/or alternative transportation uses.

Riparian Buffer: A buffer of native vegetation along lakes, streams, and wetlands that provides water quality and habitat benefits.

ON-SITE STORMWATER BMPS

On-site stormwater BMPs are site-specific practices that can minimize onsite and offsite hydrologic and water quality impacts derived from stormwater runoff via methods of incorporating and re-establishing natural hydrologic process into an urbanized environment. These measures can be designed and implemented into new development as well as retrofitted into existing development in cost effective ways.

Bioswales: Filtration and infiltration systems planted with grasses and forbs, and designed to filter, retain and evaporate transpire stormwater. Vegetation enhances filtration, cooling, and cleansing of water to improve water quality and prevent sealing of subsoils. The bioswales typically include an infiltration trench below the vegetated swale to provide temporary storage to increase the volume of runoff water infiltrated.
Filter Strips/Level Spreaders: Filter strips are an area of dense, preferably native, vegetative cover used to filter and absorb runoff. Level spreaders are often used in conjunction with filter strips and are laid on the contour to distribute runoff over filter strip areas. Filter strips/level spreaders can be used within stream and wetland buffers to diffuse stormwater prior to discharge to streams and wetlands.

Green Roofs: Vegetated roof systems designed to capture, temporarily store, and evaporate rainwater on the top of roofs. Typically, green roofs are planted with drought and wind tolerant vegetation. Green roofs can be designed as simple, lightweight systems that provide stormwater benefits, or as more elaborate rooftop gardens that also provide outdoor space.

Naturalized Detention: Naturalized detention basins are used to temporarily store runoff and release it at a rate allowed by ordinances. Native wetland and prairie vegetation improves water quality and habitat benefits. Naturalized detention basins can be designed as either shallow marsh systems with little or no open water or as open water ponds with a wetland fringe and prairie side slopes.

Porous Pavement: Permeable or perforated paving materials with spaces that allow for the infiltration of rainwater and the transmission of water to aggregate base and subsoils. Runoff is temporarily stored in the base for infiltration into the subsoils and/or slow release to a bioswale or stormwater system.

Rain Barrels/Cisterns: A vessel used to capture and temporarily store rainwater for various uses, including landscape irrigation, reuse for graywater purposes, etc.

Rain gardens: A landscaped garden designed to retain, detain, infiltrate and evapotranspirate stormwater runoff from individual lots and roofs.

Vegetated Swales: Vegetated stormwater features that convey, retain, infiltrate and cleanse stormwater. Native vegetation enhances filtration and retention of stormwater.
LANDSCAPING BMPS

Landscaping, as a BMP, stands alone in its own category due to the importance of vegetation in biodiversity, aesthetics, habitat, cooling of ambient air, and stormwater management. Native landscapes, including native prairies and wetlands, can improve water quality through infiltration and cleansing of stormwater runoff. Properly designed landscapes that incorporate native plants and hydrologically and ecologically appropriate vegetation can not only facilitate effectiveness of stormwater management but also provide wildlife habitat and quality open space.

Native Landscaping: Native vegetation in either large restoration or smaller garden projects. Native vegetation uses plants that are endemic to a specific geographic region prior to European settlement. Native landscapes can serve a variety of purposes, including habitat, infiltration, filtering, and evapotranspiration of stormwater, and wildlife habitat.

Stream/Wetlands Management and Restoration: Landscape restoration practices that maintain existing remnant landscapes and/or restore them to their natural state.
Tables 4.1 and 4.2 summarize the stormwater management tool applicability and effectiveness for each of the best management practices described in this toolbox. Following these tables is a vignette for each of the BMPs that begins with its definition and continues with its range of applicability, associated benefits, and finally some potential design considerations, as described below.

**Definition** - A brief description of the BMP relative to stormwater management.

**Applicability** - Where and how each BMP is the most applicable is addressed in three aspects: scale, applicable applications, and effectiveness:

**Scale**
- **Watershed/County**: Applied at a regional scale in watershed or county-wide.
- **Town/Village**: Applied at municipal or other scale with common zoning authority.
- **Neighborhood**: Applied at development or other sub-municipal scale.
- **Lot**: Applied within individual residential lot or commercial parcel.

**Applications**
- **Retrofit**: Applied to existing developed areas, infill, and redevelopment.
- **New**: Applied to new development.
- **Roofs**: Applied on roofs or used to treat roof runoff.
- **Streets**: Applied on or used to treat runoff from public/private streets and roads.
- **Driveways**: Applied on or used to treat runoff from driveways.
- **Parking Lots**: Applied on or used to treat runoff from parking lots.
- **Lawns**: Applied on or used to treat runoff from existing open lawns that are generally planted with turfs, such as parks, campuses, individual yards, etc.
- **Sensitive Areas**: Applied on ecologically sensitive areas such as remnant habitats, floodplains, wetlands, steep slopes, and highly erodible soils.

**Effectiveness**
- **Runoff Rate Control**: Practices that can control or reduce runoff rates.
- **Runoff Volume Control**: Practices that can control or reduce runoff volumes.
- **Physical Habitat Preservation/Creation**: Practices that can preserve, introduce, or provide wildlife habitats.
- **Sediment Pollution Control**: Practices that can remove suspended solids from runoff.
- **Nutrient Control**: Practices that have the ability to reduce or remove nutrients such as nitrogen and phosphorus from runoff.
- **BOD Control**: Practices that can remove constituents that exert a Biological Oxygen Demand (BOD) in runoff.
- **Other Pollutant Control**: Practices that can reduce and remove other pollutants such as heavy metals and petroleum-based hydrocarbons.

**Benefits** - Other positive effects that the individual or system of practices performs. Benefits can be specific to stormwater management or be more general to various functions and values for the quality of life.

**Design Considerations** - Design recommendations and suggestions that should be considered when implementing the specific BMP. Drawings are not illustrated for construction, but rather as a general guidance on the components of the practice.
Table 4.1 Stormwater Management Tool Applicability

<table>
<thead>
<tr>
<th>Tools</th>
<th>Scale</th>
<th>Applications</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Watershed/County</td>
<td>Town/ Village</td>
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<tr>
<td>Policies / Standards</td>
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<tr>
<td>Conservation Easement</td>
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<tr>
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<td>Conservation and Floodplain Standards</td>
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<tr>
<td>Open Space/Natural Greenway</td>
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<tr>
<td>Riparian Buffer</td>
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<tr>
<td>Site Stormwater BMPs</td>
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<tr>
<td>Bioswale</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>Rain Barrels/Cistern</td>
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<tr>
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<tr>
<td>Native Landscaping</td>
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</table>

"X" = practices that are applicable to corresponding scale and applications
### Table 4.2 Stormwater Management Tool Effectiveness

<table>
<thead>
<tr>
<th>Tools</th>
<th>Runoff Rate Control</th>
<th>Runoff Volume Control</th>
<th>Physical Habitat Preservation/Creation</th>
<th>Sediment Pollution Control</th>
<th>Nutrient Control</th>
<th>BOD Control</th>
<th>Other Pollutant Control</th>
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<td>Porous Pavement</td>
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<td>Vegetated Swale</td>
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<sup>1</sup> Prevents flood damage as a result of high flow rates

"H" = High effectiveness; "M" = Moderate effectiveness; " –" = Not Applicable
Conservation Easement

**Definition**
- Legal mechanism for landowner to place voluntary restrictions on the future use of their land. Generally requires landowner to sell, permanently relinquish, or donate the rights of development.

**Applicability**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Watershed/County</th>
<th>Town/Village</th>
<th>Neighborhood</th>
<th>Lot</th>
<th>Retrofit</th>
<th>Preventive</th>
<th>New</th>
<th>Remedial</th>
<th>Streets</th>
<th>Lawn</th>
<th>Ongoing/ Maintenance</th>
<th>Driveways</th>
<th>Sensitive Areas</th>
<th>Physical Habitat Preservation/ Creation</th>
<th>Sediment Pollution Control</th>
<th>Other Pollutant Control</th>
</tr>
</thead>
</table>

**Benefits**
- Preserves significant natural features and open space.
- Preserves created/restored natural areas from development and other disturbances.
- Provides opportunity to preserve morphologically and ecologically-based corridors that may be more difficult to preserve with fixed width buffers in many stormwater ordinances.
- Can be used as a tool to create interconnected network of open space to improve ecological functioning of overall system.

**Design Considerations**
- Conservation easements, along with floodplain/open space zoning, ordinance buffer requirements, and conservation design should be used to preserve and create natural resource networks.
- Conservation easements are best suited to areas not subject to land use change and therefore cannot readily be preserved through the development process.
- Conservation easements may also be used to preserve high quality uplands and other areas not readily preserved through zoning and/or stormwater ordinances.
**Wetland / Stream Management & Restoration**

**Definition**
- Practices that maintain a healthy ecosystem and/or restore a deteriorated ecosystem to its natural state.

**Benefits**
- Preserves significant natural features and their habitat, runoff moderation, and water quality benefits.
- Reduces the impact to natural systems by floods and other natural perturbations and improves recovery from these disturbances by preserving natural processes and functions.

**Design Considerations**
- Conduct a thorough analysis of existing and historic conditions of the restoration site, surrounding area, and watershed to understand system processes and functions.
- Establish stewardship program with local governments, stakeholders, interest groups, and communities to ensure sustained management and monitoring efforts on managed/restored ecosystems.
- Management and stewardship activities should be recognized as ongoing activities. Intensiveness of stewardship activities will decrease as system health and processes are restored.
Watershed Development Ordinance

Definition

➢ Ordinance to regulate development for the purpose of minimizing on-site and off-site impacts to flooding and water quality.

Applicability

➢ Scale
  □ Watershed/County
  □ Town/Village
  □ Neighborhood
  □ Lot

➢ Applications
  □ Retrofit
  □ Preventive
  □ New
  □ Remedial
  □ Streets
  □ Lawns
  □ Driveways
  □ Sensitive Areas

➢ Effectiveness
  □ Runoff Rate Control
  □ Runoff Volume Control
  □ Nutrient Control
  □ BOD Control
  □ Phosphorus Control
  □ Sediment Pollution Control
  □ Other Pollutant Control

Benefits

➢ Provides consistent standard throughout watershed.
➢ Prevents/minimizes degradation of watershed resources.
➢ Establishes orderly rules and procedures for development activities.

Design Considerations

➢ Ordinances should comprehensively address stormwater management, floodplain management, stream and wetland preservation, and soil erosion and sediment control.
➢ Ordinances should include standards to address runoff volumes, runoff rates, and water quality.
➢ Ordinances should provide flexibility in methods of meeting standards.
➢ Ordinances should facilitate watershed resources restoration activities.
Conservation Development

Definition
➢ Site planning and design approach that preserves existing natural areas and utilizes naturalized drainage and detention measures for stormwater management, energy consumption, transportation efficiency, and habitat enhancement.

Applicability
➢ Scale
 □ Watershed/County  □ Town/Village
 □ Neighborhood  □ Lot

➢ Applications
 □ Retrofit  □ Preventive  □ New  □ Remedial
 □ Streets  □ Lawn
 □ Ongoing/ Maintenance
 □ Driveways  □ Sensitive Areas
 □ Physical Habitat Preservation/ Creation  □ Sediment Pollution Control
 □ Other Pollutant Control

➢ Effectiveness
 □ Runoff Rate Control  □ Runoff Volume Control
 □ Nutrient Control  □ BOD Control

Benefits
➢ Preserves significant natural features and open space.
➢ Minimizes changes in runoff volumes, rates, and water quality typically associated with urban development.
➢ Improves views and site aesthetics, while at the same time providing site drainage and water quality functions.

Design Considerations
➢ On-site natural areas should be identified and preserved.
➢ Existing natural drainageways should be incorporated into site plan.
➢ Roadway should generally follow ridge lines.
   Impervious runoff should be routed through naturalized drainage systems integrated into the site plan.
➢ Use of native vegetation adapted to expected hydrologic conditions will improve runoff reduction and water quality benefits.
➢ Naturalized drainage systems should be preserved from construction site runoff during establishment.
Floodplain Zoning

Definition
➢ Zoning regulations established to preserve stream corridors and floodplains from urban development and other encroachments.

Applicability
➢ Scale
   - Watershed/County
   - Town/Village
➢ Applications
   - Retrofit
   - Preventive
   - Roofs
   - Parking Lots
➢ Effectiveness
   - Runoff Rate Control
   - Nutrient Control

Benefits
➢ Preserves stream corridors and riparian wetlands and provides natural buffer.
➢ Enhances safety and quality of life.
➢ Protects properties from flood damages.
➢ Preserves natural floodplain functions.

Design Considerations
➢ Zoning regulations should allow for and encourage riparian corridor restoration.
Impervious Area Reduction

Definition
- Impervious area reduction can be achieved by reducing street widths and building setbacks, examining parking lot requirements, and through building design alternatives.

Benefits
- Reduces runoff volumes and rates and associated pollutants.
- Reduces urban heat island effect and thermal impacts to waterbodies.
- Reduces development and maintenance costs.

Design Considerations
- Impervious area reductions can be achieved through reduced road widths, shared parking, reduced setbacks, and other measures. These reductions will often require changes in subdivision code.
- Street length can often be reduced by clustering development onto portions of the site.
- Benefits of impervious area reduction are enhanced when combined with methods to “disconnect” impervious surfaces, e.g. vegetated swales, bioswales, filter strips/level spreaders, etc.
Open Space / Natural Greenway

Definition
- Designation of linear open space and/or natural areas as greenways to preserve and connect significant natural features and to accommodate aesthetic, recreational, and/or transportation uses.

Benefits
- Preserves large contiguous natural areas and resources.
- Provides opportunity for wildlife movement and habitat within an ecological network.
- Provides alternative and connected passive recreation and transportation opportunities.

Applicability
- Scale
  - Watershed/County
  - Town/Village
- Applications
  - Retrofit
  - Preventive
  - New
  - Remedial
  - Streets
  - Lawn
  - Parking Lots
- Effectiveness
  - Runoff Rate Control
  - Runoff Volume Control
  - Nutrient Control
  - BOD Control
- Neighborhood
- Lot
- Ongoing/Maintenance
- Driveways
- Sensitive Areas
- Physical Habitat Preservation/Creation
- Sediment Pollution Control
- Other Pollutant Control

Design Considerations
- A natural resources inventory should be completed to identify significant natural features and functioning ecological networks.
- Significant cultural features should also be integrated into the network.
- Buffer requirements, open space/floodplain zoning, conservation easements, and conservation design should be used together to implement greenway networks.
Riparian Buffer

Definition

- A buffer of native vegetation along lakes, streams, and wetlands that provides water quality and habitat benefits.

Applicability

- Scale: Watershed/County, Town/Village, Neighborhood, Lot
- Applications: Retrofit, Preventive, New, Remedial, Streets, Driveways, Parking Lots, Lawns, Sensitive Areas
- Effectiveness: Runoff Rate Control, Runoff Volume Control, Physical Habitat Preservation/Creation, Sediment Pollution Control, Other Pollutant Control

Benefits

- Preserves natural functions of lakes, streams, and wetlands.
- Naturally attenuates flow rates.
- Provides filtering of lateral surface and groundwater inflows.
- Helps stabilize streambanks and shorelines against erosion.

Design Considerations

- Riparian buffer width should be dependent on lake, stream, or wetland quality, ground slope, and size of feature.
- Buffer should be planted with native riparian vegetation.
- Buffers are often established/preserved through a watershed development ordinance.
Bioswale

Definition
- Vegetated swale system with an infiltration trench designed to retain and temporarily store stormwater. Bioswales are planted with native grasses and forbs that enhance filtration, cooling, and cleansing of water in order to improve water quality and prevent sealing of subsoils.

Applicability
- Scale
  - Watershed/County
  - Town/Village
- Applications
  - Retrofit
  - Preventive
  - New
  - Remedial
  - Streets
  - Lawn
  - Parking Lots
- Effectiveness
  - Runoff Rate Control
  - Runoff Volume Control
  - Nutrient Control
  - BOD Control

Benefits
- Reduces impervious runoff volumes and rates.
- Recharges groundwater and sustains base flows.
- Reduces sediment and nutrient runoff.
- Can reduce detention needs.

Design Considerations
- Bioswales must be sized and designed to account for drainage area and soils.
- Filtration benefits can be improved by planting native deep-rooted vegetation.
- Infiltration storage should be designed to drain in 24 hours to prevent sealing of subsoils.
- Topsoil should be amended with compost and/or sand to improve organic content for filtering and to achieve adequate infiltration rates.
- Bioswales should be protected from construction site runoff to prevent sealing of topsoil and/or subsoils.
- Direct entry of stormwater runoff into infiltration trench should be prevented to preserve groundwater quality and to prevent sealing of subsoils.
- Underdrain should be sufficiently low in the trench to provide adequate drainage of aggregate base of adjacent paved areas but sufficiently high to provide infiltration storage.
Filter Strip/
Level Spreader

Definition

- A **filter strip** is an area with dense, preferably native, vegetative cover used to filter and absorb runoff from impervious areas. A **level spreader** is a trench laid on the contour to distribute runoff over filter strip areas.

Benefits

- Reduces runoff volumes and rates by allowing runoff to infiltrate over a large area.
- Recharges groundwater and sustains base flows.
- Reduces sediment and nutrient runoff.
- Deconcentrates storm sewer and detention basin discharges to dissipate energy, reduce scour, and better mimic historic runoff patterns to receiving waterbody.
- Can reduce detention needs.

Design Considerations

- Filter strips/level spreaders must be sized and designed to account for drainage area, slope, and soils. Chronic hydraulic overloading of filter strips may cause erosion.
- Filtration benefits can be improved by planting native deep-rooted vegetation and by minimizing the slope.
- Infiltration storage within the level spreader trench should be designed to drain in 24 hours to prevent sealing of subsoils.
- Compaction of filter strips should be avoided and/or topsoil should be amended with leaf compost and coarse sand to improve filtration, infiltration, and plant establishment.
- Runoff should be diverted away from filter strips during construction until vegetation is established.
Green Roof

Definition
- Vegetated roof system designed to retain and slow rainwater runoff on the top of roofs. Green roofs are generally planted with drought and wind tolerant vegetation.

Applicability
- Scale: Watershed/County, Town/Village, Neighborhood, Lot
- Applications: Retrofit, Preventive, New, Remedial, Streets, Lawn, Driveways, Non-Buildable, Remedial, Streets
- Effectiveness: Runoff Rate Control, Runoff Volume Control, Nutrient Control, BOD Control

Benefits
- Significantly reduces runoff volumes and rates as well as thermal impacts (50 - 90% reduction in annual runoff).
- Can reduce detention needs.
- Contributes to reduction in urban heat island effect.
- Can reduce energy requirements associated with heating and cooling.
- Creates opportunities for outdoor space as roof top gardens.

Design Considerations
- Structural load capacity of existing roof system must be evaluated.
- Plant material, such as succulents, that are drought tolerant, should be used on lightweight "extensive" green roof systems.
- A wider range of vegetation may be used on heavier, "intensive" green roof systems with deeper growing medium.
- Use of a granule drainage layer will improve retention and detention benefits relative to drain boards.
Naturalized Detention

Definition
➢ Naturalized detention basins are used to temporarily store runoff and release it at a rate allowed by ordinances. Native wetland and prairie vegetation improves water quality and habitat benefits. Naturalized detention may also be used as a retrofit to achieve water quality benefits.

Applicability
➢ Scale  ❌ Watershed/County  ✔ Town/Village
➢ Applications  ❌ Retrofit  ✔ New
■ Preventive  ❌ Remedial
■ Roofs  ✔ Streets
■ Parking Lots  ✔ Lawn
➢ Effectiveness  ❌ Runoff Rate Control  ❌ Runoff Volume Control
■ Nutrient Control  ✔ BOD Control

Benefits
➢ Reduces runoff rates.
➢ Recognized by virtually all stormwater agencies as approved method of controlling stormwater runoff.
➢ Very effective at removing sediment and associated pollutants.
➢ Provides attractive site amenity when properly designed and not used as sole BMP on sites with high pollutant/nutrient runoff.

Design Considerations
➢ Should be sized to control release to allowable rate.
➢ Size should reflect use of upstream BMPs.
➢ Water level fluctuations should be limited to 3-4 feet (during 100-year storm) to maximize plant diversity.
➢ Shallow water entry angles will minimize shoreline erosion, improve water quality benefits, increase aquatic habitat and plant diversity and provide safety ledge.
➢ May be used as retrofit along stream corridors to prevent direct discharge of stormwater runoff.
Porous Pavement

Definition
- Permeable or perforated paving materials or pavers with spaces that allow transmission of water to aggregate base and subsoils. Runoff is temporarily stored in the base for infiltration into the subsoils and/or slow release to storm drain system.

Applicability
- **Scale**
  - Watershed/County
  - Town/Village
- **Applications**
  - Retrofit
  - Preventive
  - New
  - Remedial
  - Streets
  - Lawn
  - Parking Lots
  - Runoff Rate Control
  - Runoff Volume Control
- **Effectiveness**
  - Nutrient Control
  - BOD Control
  - Neighborhood
  - Lot
  - Ongoing/ Maintenance
  - Driveways
  - Sensitive Areas
  - Physical Habitat Preservation/ Creation
  - Sediment Pollution Control
  - Other Pollutant Control

Benefits
- Reduces runoff volumes and rates.
- Recharges groundwater and sustains base flow.
- Filters sediments and associated pollutants from runoff.
- Can reduce detention needs.

Design Considerations
- Base and subbase materials should be coarse aggregate with no fines to allow adequate drainage and to prevent frost heave.
- Subgrade should be graded at minimum 1% slope to allow drainage when water entry rate exceeds infiltration capacity of subsoils.
- Subsoils should be compacted to the minimum level necessary to achieve structural stability.
- Geotextiles should be used between base and subgrade to improve structural stability and separate base from subgrade.
- Underdrains should be placed at edge of pavement to provide drainage as necessary to prevent ponding in the base for periods greater than 24 hours.
Rain Barrel/ Cistern

Definition
➢ A vessel used to capture and temporarily store rainwater for various uses, including graywater reuse and irrigation.

Applicability
➢ Scale
  □ Watershed/County  □ Town/Village  □ Neighborhood  □ Lot
➢ Applications
  □ Retrofit  □ New  □ Ongoing/ Maintenance
  □ Preventive  □ Remedial  □ Driveways
  □ Roofs  □ Streets  □ Sensitive Areas
  □ Parking Lots  □ Lawn  □ Physical Habitat Preservation/ Creation
  □ Runoff Rate Control  □ Runoff Volume Control  □ Sediment Pollution Control
➢ Effectiveness
  □ Nutrient Control  □ BOD Control

Benefits
➢ Reduces runoff volumes.
➢ Conserves water for reuse.
➢ Provides irrigation water during watering restrictions.

Design Considerations
➢ At the residential scales, rain barrels located at downspouts will typically be used.
➢ One inch of rainfall over 1,000 square feet of roof area is equivalent to 625 gallons of rainwater.
➢ Rain barrels can be used in combination with rainwater gardens, green roofs, and other stormwater BMPs to increase stormwater benefits.
➢ Larger cisterns in some settings may be used to provide graywater for use in toilet flushing and other non-potable uses.
Rainwater Garden

Definition
- A landscaped garden designed to retain and detain stormwater runoff from individual lots and roofs.

Applicability
- Scale
  - Watershed/County
  - Town/Village
- Applications
  - Retrofit
  - Preventive
  - New
  - Remedial
  - Streets
  - Lawn
- Effectiveness
  - Runoff Rate Control
  - Runoff Volume Control
  - Nutrient Control
  - BOD Control
- Neighborhood
- Lot
- Ongoing/ Maintenance
- New
- Remedial
- Streets
- Lawn
- Physical Habitat Preservation/ Creation
- Sediment Pollution Control
- Preventive
- Remedial
- Ongoing/ Maintenance
- Retrofit
- Preventive
- New
- Remedial
- Streets
- Lawn
- Physical Habitat Preservation/ Creation
- Sediment Pollution Control
- Preventive
- Remedial
- Ongoing/ Maintenance
- Retrofit
- Preventive
- New
- Remedial
- Streets
- Lawn
- Physical Habitat Preservation/ Creation
- Sediment Pollution Control

Benefits
- Reduces runoff volumes and rates from lawns, roofs, and driveways.
- Recharges groundwater and sustains base flows.
- Reduces sediment and nutrient runoff.
- Can reduce detention needs.
- Can increase aesthetic value for the properties.
- Can provide wildlife habitat.

Design Considerations
- Rainwater gardens must be sized and designed based on drainage area, soils, and desired runoff volume reduction.
- Filtration and nutrient control benefits can be improved by planting native vegetation.
- The soils in the top 18” to 24” should be amended with leaf compost and coarse sand to enhance organic content and improve permeability.
- Where subsoil infiltration rates are low (less than 0.5 to 1.0 in/hr), a gravel trench with underdrains should be used to encourage drainage between events.
- Maximum ponding depths should generally be limited to 6” to 12” unless underdrains are used.
Vegetated Swales

Definition
- Vegetated swales are planted stormwater features that convey, retain, infiltrate, and cleanse stormwater.

Applicability
- Scale:
  - Watershed/County
  - Town/Village
- Applications:
  - Retrofit
  - Preventive
  - Roofs
  - Parking Lots
- Effectiveness:
  - Runoff Rate Control
  - Nutrient Control
  - Runoff Volume Control
  - BOD Control
- Town/Village
  - Neighborhood
  - Lot

Benefits
- Reduces runoff volumes and rates.
- Provides conveyance and water quality benefits in one stormwater feature.
- Reduces sediment and nutrient runoff.
- With proper design, can reduce detention needs.

Design Considerations
- Vegetated swales must be sized to convey design runoff rate (typically 10-year storm).
- Filtration benefits can be substantially improved by planting native deep-rooted grasses and forbs and by minimizing the slope.
- Topsoil may be amended with compost and/or coarse sand to improve organic content for filtering and to improve infiltration and retention of runoff.
- Vegetated swales should be protected from construction site runoff to prevent sealing of topsoil and/or subsoils.
## Native Landscaping

### Definition
- Establishment of native vegetation in either large restoration projects or smaller gardening projects. Native landscaping is often a component of other BMPs such as detention, filter strips, bioswales, and rainwater gardens.

### Applicability
- **Scale**:  
  - Watershed/County  
  - Town/Village  
  - Neighborhood  
  - Lot  
- **Applications**:  
  - Retrofit  
  - Preventive  
  - New  
  - Remedial  
  - Streets  
  - Lawns  
  - Driveways  
  - Sensitive Areas  
  - Sediment Pollution Control  
- **Effectiveness**:  
  - Runoff Rate Control  
  - Runoff Volume Control  
  - Nutrient Control  
  - BOD Control  
- **Ongoing/Maintenance**
- **Physical Habitat Preservation/Creation**
- **Other Pollutant Control**

### Benefits
- Reduces runoff volumes.
- Increases infiltration rates.
- Increases ability to remove nutrients.
- Increases organic content of soils.
- Increases permeability of compacted soils.
- Reduces irrigation and fertilization requirements.
- Reduces use of fossil fuels and air pollution relative to turf landscapes that require regular mowing and maintenance.
- Provides wildlife habitat.

### Design Considerations
- Some local "weed" ordinances may need to be amended to allow native and taller vegetation.
- Plant diversity and health is maximized by annual burning. Plots may be mowed and then burned to prevent spread of fire on small sites. Fall burning will select for prairie wildflowers.
- On compacted soils, amendment may be necessary to increase organic content, improving success of establishment.
Ravine Management

Definition
- Ravines are unique landscape features that are extremely sensitive to stormwater runoff that can lead to slope erosion and downcutting of the ravine floor. Ravines require active management to protect and restore their unique hydrologic and habitat conditions.

Applicability
- **Scale**
  - Watershed/County
  - Town/Village
  - Neighborhood
  - Lot
- **Applications**
  - Retrofit
  - Preventive
  - New
  - Remedial
  - Roof
  - Parking Lots
  - Streets
  - Lawn
  - Driveways
  - Sensitive Areas
- **Effectiveness**
  - Runoff Rate Control
  - Runoff Volume Control
  - Nutrient Control
  - BOD Control
  - Physical Habitat Preservation/Creation
  - Sediment Pollution Control
  - Other Pollutant Control

Benefits
- Protects unique habitats that occur in very few other landscapes.
- Prevents property loss and infrastructure damage that can result from slumping of ravine slide slopes and/or severe gully erosion.
- Reduces downstream water quality impairment associated with severe erosion that can occur in ravines.

Design Considerations
- Thin the forest canopy, practice burn management, and encourage growth of ground level vegetation to stabilize slopes and restore unique ravine habitat.
- Prevent surface runoff from adjacent lawns, parking lots, and roofs that can cause severe gully erosion of side slopes.
- Prevent direct storm sewer discharges that can lead to downcutting of the ravine floor and subsequent failure of adjacent slopes.
- Where existing storm sewer discharges are present, armor ravine bottom with angular stone to prevent erosion and downcutting of ravine floor. Use poorly sorted stone to prevent soil erosion beneath the armor stone.
- Consider restricting culverts at ravine road crossings to reduce stormwater flows and downstream erosive forces. This practice should be limited to previously disturbed and degraded ravines since stormwater ponding in the ravines will diminish vegetation quality in the flooded areas.
This section provides site scale "Templates" that demonstrate application of the stormwater BMPs and techniques within different land use types.

The templates are generally 40-acre sites and are designed to illustrate conservation-based development and land management techniques and to contrast those techniques to more typical conventional development. The concepts illustrated in these templates are transferable to most development plans.

The terms “conservation” and “conventional” are used throughout this section in reference to the various site planning and stormwater techniques utilized on development projects. “Conservation” refers to techniques and BMPs that are based on ecologically sensitive design and planning principles. Conservation templates combine various sustainable design concepts with such names as “green design”, “low-impact development”, “sustainable development”, “ecological design”, “smart growth”, and others. Conservation development uses site planning techniques to protect on site sensitive areas and distributed stormwater management techniques that integrate runoff management throughout the site plan. These strategies are designed to integrate stormwater, habitat, livability, restoration, and other ecological goals to achieve overall superior site plans.

“Conventional” is the second design descriptor used in this section, and refers to practices that are typically being utilized in land development and building construction today in the Midwest. Even though conservation and conventional designs are both allowed by code, conventional designs and techniques are seen most often, and thus represent the default designs and practices for a majority of communities and developments. Conventional developments rarely consider ecological health and the other goals of this project, beyond the minimum necessary to meet regulatory requirements.

The templates are provided to help guide local authorities, land owners, and designers in implementing stormwater BMPs. The seven templates discussed in this section are:

- Commercial/Industrial
- Moderate Density Residential
- Rural Residential
- Estate Residential
- Agricultural
- Stream Corridors
- Depressional Wetlands

The relative cost of conservation development versus conventional is highly dependent on the specifics of the development site and the design characteristics of the plan. However, studies indicate that the cost of conservation development can be less than conventional at several levels. A cost comparison of the templates presented in this section shows that the conservation versions of the commercial and residential templates have lower expected construction costs relative to the conventional versions. A study on the municipal fiscal impact of conservation design indicates that conservation development should generally have a greater positive impact on revenues vs costs at the municipal level than conventional development. Finally, another study indicates that conservation development that increases retention of stormwater runoff should have a positive impact on the economy due to reduced flooding and improved water quality as well as reduced infrastructure cost and increased aquifer recharge.

2. Alternative Futures Fiscal Study, Blackberry Creek Watershed, Kane County, Illinois, Center for Governmental Studies, Northern Illinois University, 2004
3. The Downstream Economic Benefits of Stormwater Retention, Department of Agriculture and Consumer Economics, University of Illinois, 2003
Template Methodology and Design Exercise

For each land use or ecosystem template, two versions are provided: 1) a conventional template using current default or standard-of-practice site design and planning techniques, and 2) a conservation template, which uses environmental design principles and integrated best management practices for stormwater management. Both templates in each land use category have been designed with identical numbers of units, commercial square footage, etc., but are arranged and organized in different ways over the site, and use different stormwater management and landscaping techniques.

Although the site planning and stormwater management concepts illustrated in the conservation templates can be applied to development sites, the templates should not be viewed as “stencils” to be “stamped” across the watershed. A significant element of conservation design is adapting the site and stormwater plan to the specific conditions of the site.

Template Design Principles

General environmental design principles are incorporated into the example urban conservation templates to protect and/or enhance stormwater quality.

1. Development avoids natural features to the extent possible, including: streams, wetlands, remnant natural areas, and critical habitats.
2. Water features are protected, buffered, linked, and enhanced/restored where possible.
3. The site plan respects site topography, utilizing natural drainage patterns to minimize the need for built infrastructure.
4. Clustering of built areas, a range of lot sizes, and other design techniques are used to create views, privacy, and amenities for each home site. This facilitates protection of site natural areas, integration of naturalized stormwater management systems, and linked habitat areas, while also leading to efficient utilization of site topography and provisions for common open space.
5. Created native landscapes are integrated as part of the stormwater management system to utilize their natural filtration, infiltration, storage, and transpiration processes as well as their habitat and aesthetic benefits.
6. Where appropriate, engineered systems based on natural processes are utilized as part of the stormwater management system for the purpose of enhancing groundwater recharge, stabilizing site and regional hydrology, and minimizing irrigation needs.
7. Stormwater is managed as close to its source as feasible to take advantage of the areas permeable soils to emulate existing conditions.
8. Conservation site planning and design techniques used in the templates are generally cost-effective and have been used and proven in existing developments in the Midwest.

The focus of these principles is on protection of aquatic habitat from the direct and indirect impacts of development and prevention of flooding and streambank erosion. However, it should be noted that there are many other “green” design and planning principles (i.e., energy conservation) that are not directly addressed as part of this project as their link to watershed protection is less direct.
Commercial/Industrial developments include retail, light industrial and offices in various scales from large scale “big box” retail stores and light industrial and office park development, to smaller scale restaurants, shops, and individual offices.

- **Conventional Template**
  The Conventional Template is laid out as a typical strip mall, with two “big box” retail establishments, isolated outlet shops, parking, landscaping, and stormwater detention according to code.

### BMPs Applied in the Conservation Template

- Policy/Regulations
  - Conservation Easement
  - Stream/Wetland Management and Restoration
  - Watershed Development Ordinance
- Planning/Zoning
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
- Riparian Buffer

- Site Stormwater BMPs
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales
- Landscaping
- Native Landscaping
Moderate Density Residential

Moderate density residential development is defined for this project as having a gross density of approximately 2 units per acre with lot sizes ranging from 6,000 to 15,000 square feet with municipal water and sewer service. Typically, these developments are under municipal jurisdiction, but may occur in unincorporated areas as part of planned unit developments (PUD's).

- **Conservation Template**

  The Conservation Template includes narrower streets and an integrated, naturalized stormwater system that hosts trails and public open space and allows every residence to back to open space.

- **Conventional Template**

  The Conventional Template includes wide roads, no public open space, and storm sewers discharging into turf and/or rip-rap lined detention basins.

**BMPs Applied in the Conservation Template**

- Policy/Regulations
  - Conservation Easement
  - Stream/Wetland Management and Restoration
  - Watershed Development Ordinance
- Planning/Zoning
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
  - Riparian Buffer
- Site Stormwater BMPs
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales
  - Landscaping
  - Native Landscaping

Conservation Moderate Density Residential Template
Rural Residential

The Rural Residential Template is defined as having lots averaging approximately 1.25 acres, a gross density of 0.55 units per acre, served by private wells and septic systems. Typically, rural residential development is limited to unincorporated areas. However, more recently, many developments of this density have come under municipal jurisdiction, and would then often be served by municipal water and sewer.

- **Conventional Template**

  The Conventional Template includes a cul-de-sac drained with storm sewers discharging into detention basins.

- **Conservation Template**

  The Conservation Template includes a narrow lane and a naturalized stormwater system that utilizes the landscape to filter, evapotranspire, and absorb runoff as well as hosting walking/biking trails.

### BMPs Applied in the Conservation Template

- **Policy/Regulations**
  - Conservation Easement
  - Stream/Wetland Management and Restoration
  - Watershed Development Ordinance

- **Planning/Zoning**
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
  - Riparian Buffer

- **Site Stormwater BMPs**
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales

- **Landscaping**
  - Native Landscaping

Conventional Rural Residential Template

Conservation Rural Residential Template
Estate Residential

Estate residential development is defined as having lots averaging approximately 2.5 acres in size, a gross density of approximately 0.2 units per acre, served by private well and septic systems. Estate residential developments occur almost exclusively in unincorporated areas.

- **Conservation Template**
  The Conservation Template has shorter driveways and uses native plantings and a conservation easement. The Conservation Template disturbs the minimum amount of land necessary to install the roads, houses, and septic systems. The remainder is undisturbed or is restored.

- **Conventional Template**
  The Conventional Template has longer driveways and is primarily landscaped with lawn.

**BMPs Applied in the Conservation Template**

- Policy/Regulations
  - Conservation Easement
  - Watershed Development Ordinance
- Planning/Zoning
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
  - Riparian Buffer

- Site Stormwater BMPs
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales
  - Landscaping
  - Native Landscaping
Agricultural lands are cultivated and manipulated for the production of food crops and/or livestock for sale beyond the immediate use of the farmer or landowner.

- **Conservation Template**
  The Conservation Template includes a variety of techniques and environmentally sound agricultural practices that can improve the hydrology and water quality of the watershed. These practices include contour plowing, native seed production, reduced or no-till techniques, organic farming, biodynamic or permaculture techniques, animal grazing on native grassland, and buffer zones.

### BMPs Applied in the Conservation Template

- Policy/Regulations
  - Conservation Easement
  - Stream/Wetland Management and Restoration
  - Watershed Development Ordinance
- Planning/Zoning
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
  - Riparian Buffer
- Site Stormwater BMPs
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales
- Landscaping
  - Native Landscaping
Stream Corridors

Stream corridors are linear spaces along streams, creeks and rivers.

- **Conservation Template**
  The Conservation Template depicts a healthy stream corridor with the freedom to meander naturally and includes wetlands and floodplains adjacent to the stream. The developed areas represent lands that may be agricultural or urban land uses. These developed areas in the conservation version will have little impact on the stream provided that the management practices outlined in the conservation versions of the urban and agricultural templates are used. Level spreaders and filter strips should be used to dissipate the energy of concentrated stormwater runoff and eliminate point discharges.

- **Conventional Template**
  The Conventional Template represents a degraded stream corridor, which has been channelized and often includes no natural buffer.

**BMPs Applied in the Conservation Template**

- Policy/Regulations
  - Conservation Easement
  - Stream/Wetland Management and Restoration
  - Watershed Development Ordinance
- Planning/Zoning
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
  - Riparian Buffer
- Site Stormwater BMPs
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales
- Landscaping
  - Native Landscaping
Depressional Wetlands

Depressional wetlands are landscape features generally distinct from flowing streams and have vegetation, hydrology and soils characteristics of wet conditions. Historically, depressional wetlands were located where the ground dropped below the water table and therefore served as discharge zones or flow-through zones. The areas in yellow represent developed areas for agricultural or urban land uses.

- Conventional Template
In the Conventional Template, the hydrology has been manipulated through agricultural or urban development, and many of these wetlands now receive a much greater amount of surface runoff and a reduction in groundwater discharge.

- Conservation Template
In the Conservation Template, the developed areas utilize the practices outlined in the conservation versions of the other described templates. These developed areas in the conservation version will have little impact on the stream provided that the management practices outlined in the conservation versions of the urban and agricultural templates are used. Level spreaders and filter strips should be used to dissipate the energy of concentrated stormwater runoff and eliminate point discharges.

BMPs Applied in the Conservation Template
- Site Stormwater BMPs
  - Bioswales
  - Filter Strips/Level Spreaders
  - Green Roofs
  - Naturalized Detention and Infiltration Trench
  - Porous Pavement
  - Rain Barrels/Cisterns
  - Rain Gardens
  - Vegetated Swales
- Landscaping
  - Native Landscaping

- Policy/Regulations
  - Conservation Easement
  - Stream/Wetland Management and Restoration
  - Watershed Development Ordinance

- Planning/Zoning
  - Conservation Development
  - Floodplain Zoning
  - Impervious Area Reduction
  - Open Space/Natural Greenway
  - Riparian Buffer