# ORDINANCE APPENDIX A

# SIMPLIFIED APPROACH TO STORMWATER MANAGEMENT FOR SMALL PROJECTS

## Appendix A

# Simplified Approach to Stormwater Management for Small Projects

**Appendix A.1 –**
**Applicability, Submittal and Approval Requirements**

**Appendix A.2 –**
***"Simplified Approach to Stormwater Management for Small Projects – Handbook"* (Revised June 10, 2012)**

**Appendix A.3 –**
***"Simplified Approach – Stormwater Best Management Practices Operation, Maintenance and Inspection Plan and Agreement"* – Sample Agreement (Revised October 12, 2012)**

## Appendix A.1

# Applicability, Submittal and Approval Requirements

Westtown Township
Chester County, Pennsylvania

## Applicability:

- Small projects with less than two thousand (2,000) square feet of Proposed Impervious Surfaces (as defined in the Municipality's Stormwater Management Ordinance) and with less than ten thousand (10,000) square feet of proposed Earth Disturbance (as defined in the Municipality's Ordinance) may apply the "Simplified Approach to Stormwater Management for Small Projects" (Simplified Approach).

- Only projects that meet the above size thresholds as specified in the Municipality's Stormwater Management Ordinance may use this Simplified Approach and are then not required to submit a formal Stormwater Management Site plan to the Municipality. However, these projects are still required to address water quality and infiltration requirements as outlined in this Simplified Approach "Handbook".

- Any project with more than two thousand (2,000) square feet of Proposed Impervious Surface or more than ten thousand (10,000) square feet of proposed Earth Disturbance can NOT apply this Simplified Approach.

- The Applicant should first review the planned project with the Municipal Engineer prior to initiating the Simplified Approach to confirm the following:
  - That the proposed project is not otherwise exempt from the stormwater management control and the engineered Stormwater Management Site Plan requirements of the Municipality's Stormwater Management Ordinance;
  - That the proposed project is eligible to use this Simplified Approach;
  - To determine which components of the proposed project must be included in the calculation of "impervious surfaces (areas)"; and,
  - Whether any local conditions are known to the Municipal Engineer that would preclude the use of any of the techniques included in this Simplified Approach.

## Submittal and Approval Requirements:

Use of the Simplified Approach requires:

- The applicant to submit the following to the Municipality for review and approval prior to beginning construction:
  - A Simplified Stormwater Management Site Plan (i.e. sketch plan) and accompanying Worksheet; and
  - A completed, signed and notarized "Simplified Operation, Maintenance and Inspection Plan and Agreement".
- The first 1-inch of rainfall runoff from Proposed Impervious Surfaces (as defined by the Municipality's Ordinance) must be captured and removed on the applicant's property.
- The applicant to record the "Simplified Approach – Stormwater Best Management Practices Operation, Maintenance and Inspection Plan and Agreement" at the Chester County Office of the Recorder of Deeds after signature by the Municipality.
- A final inspection conducted by the Municipality after completion of construction.

# Simplified Approach to Stormwater Management for Small Projects

# Handbook

Errata Notes:
The following corrections are noted for Figure 6:

1. Label for BMP #1 Cistern – should read "(166 Gallons)"
2. Label for BMP #2 Infiltration Trench – should read "(20'L x 3'W x 3.5'D)"

**prepared by:**
**Borton-Lawson Engineering, Inc.**
**3897 Adler Place**
**Bethlehem, PA 18017**

**Revised June 10, 2012**

Further revised by:
**Westtown Township**
**1039 Wilmington Pike**
**West Chester, PA 19382**

for:
**Westtown Township**
as part of the
County-wide Act 167 Stormwater Management Plan for Chester County, PA

Revised Date: *September 24, 2013*

**All revisions made by McCormick Taylor were completed without consultation with Borton-Lawson and were completed at the sole discretion of McCormick Taylor.**

# STORMWATER MANAGEMENT PROCEDURES FOR MEETING THE SIMPLIFIED APPROACH REQUIREMENTS

## Introduction

This Handbook has been developed to allow homeowners or applicants for small projects to comply with stormwater management requirements of the Stormwater Management Ordinance of the Municipality, including sizing, designing, locating and installing on-lot measures, referred to herein as "Best Management Practices" (BMPs). **Only projects that meet the size thresholds specified in the Municipality's Stormwater Management Ordinance may use this Simplified Approach** and are then not required to submit a formal Stormwater Management Site plan to the Municipality. However, these projects are still required to address certain requirements, such as stormwater quality, infiltration, rate and volume management goals as outlined in this Simplified Approach Handbook.

Pennsylvania Act 167 (PA Stormwater Management Act) was authorized on October 4, 1978 (32 P.S., P.L. 864) and gave Pennsylvania Municipalities the power to regulate activities that affect flooding, streambank erosion, stormwater runoff and surface and groundwater quantity and quality. The Municipality's Stormwater Management Ordinance was prepared to comply with the PA Act 167 requirements and includes provisions allowing this Simplified Approach to be used for small projects as specified in their Ordinance.

If the guidelines presented in this Handbook are followed, the applicant may not require professional engineering services to comply with these stormwater management goals. This Handbook is organized into five sections:

- **Section 1** describes requirements and a simplified approach for designing a suitable BMP, and a description of what needs to be included on the simplified stormwater management (SWM) site plan (i.e. sketch plan).
- **Section 2** presents definitions of key terms.
- **Section 3** presents options of BMPs that can be considered for on-lot stormwater management.
- **Section 4** illustrates an example of how to obtain the size and dimensions of a BMP(s) for a sample project.
- **Section 5** describes the requirements to be met for a "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement".

The Simplified Approach requires:

- The applicant to submit the following to the Municipality for review and approval prior to beginning construction:
  - A Simplified Stormwater Management (SWM) Site Plan (i.e. sketch plan), and accompanying Worksheet, and
  - A completed and signed "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement".

- The first 1-inch of rainfall runoff from proposed impervious surfaces (as defined by the Municipality's Ordinance) must be captured and removed from the stormwater runoff leaving the applicant's property.
- The applicant to record the "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement" at the County's Recorder of Deeds after signature by the Municipality.

The purpose of requiring effective stormwater management from small projects is to help reduce stormwater runoff in the community, to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources and public safety.

### What needs to be submitted to the Municipality?

☐ Simplified Approach Worksheet (Table 4)

☐ Simplified SWM site plan (i.e. sketch plan), containing the features described in Section 1, Step 1

☐ "Simplifed Approach Operation, Maintenance and Inspection Plan and Agreement" must be signed, notarized and (after approval and signature by the Municipality) recorded at the County Recorder of Deeds.

If the applicant is using a contractor to construct the project, the worksheet and sketch plan must be shared with the contractor to ensure the BMP(s) are properly installed.

# 1. Determination of Simplified Approach Volume Requirements

All proposed impervious areas (as required by the Municipality's Ordinance) must be included in the determination of the amount of new impervious areas and the size of proposed BMPs needed to manage stormwater. Proposed impervious areas on an individual residential lot generally include, but are not limited to: roof area, pavement, sidewalks, driveways, patios, porches, permanent pools, or parking areas, etc. See the definitions provided in Section 2 and check with the Municipal Engineer to confirm what features of the proposed project must be included in the calculation of new impervious areas. Sidewalks, driveways, or patios that are constructed with gravel or pervious pavers and will not be disturbed or altered in the future may not need to be included in this calculation (check with the Municipal Engineer). In these cases, the amount of proposed impervious area may be reduced for proposed driveways, patios, and sidewalks through the use of gravel, pervious pavement, and turf pavers. All proposed impervious areas must be constructed so that runoff is conveyed to a BMP(s); no runoff may be directed to storm sewers, inlets or other impervious areas (i.e. street) without effective stormwater management from a site.

In addition, the use of low impact development is recommended to further minimize the effect of the new construction on water, land, and air. Low impact development is a method of development that incorporates design techniques that include: minimizing the amount of land disturbance, reducing the amount of impervious cover, disconnecting gutters and directing stormwater runoff to vegetated areas to infiltrate, and redirecting the flow of stormwater runoff from impervious surfaces to vegetated areas instead of the street or gutter.

Below are the steps that must be undertaken to meet the Ordinance requirements. The size and description of the proposed construction as well as important aspects related to the design of the BMP(s) must be documented in the Simplified Approach Worksheet found in Table 4. All individuals planning on using the Simplified Approach are encouraged to review the planned project with the Municipal Engineer prior to initiating the Simplified Approach to confirm the following:

- That the proposed project is not otherwise exempt from the stormwater management control and engineered Stormwater Management Site Plan requirements of the Municipality's Stormwater Management Ordinance;
- That the proposed project size is within the range eligible to use this Simplified Approach;
- To determine which components of the proposed project must be included in the calculation of "impervious areas"; and
- Whether any local conditions are known to the Municipal Engineer that would preclude the use of any of the techniques included in this Simplified Approach.

**Step 1** - Prepare the Simplified SWM Site Plan (i.e. sketch plan) that includes:

- Name and address of the owner of the property, and name and address of individual preparing the plan (if different than the property owner), along with the date of submission.
- Location of all existing structures including buildings, driveways, and roads within fifty (50) feet of the project site.

- Location of proposed structures, driveways, or other paved areas with approximate size in square feet.
- Location, and distance, of any existing surface water features, such as streams, lakes, ponds, wetlands or other natural waterbodies, within fifty (50) feet of the project site and/or BMPs. Depending upon the Municipality's requirements, the following may also be required (check with the Municipal Engineer):
    - The project and/or BMPs cannot cause earth disturbance within fifty (50) feet from a perennial or intermittent stream, wetland or waterbody. Protecting this area from non-disturbance along the aforementioned features helps protect the applicant's land from erosion, the flood carrying capacity of streams, and the water quality of the waterbody. Where the applicant cannot meet the 50-foot non-disturbance width, the applicant should work with the Municipal Engineer to determine if a reduced width is acceptable, however a minimum of at least a 10 foot non-disturbance area width should be maintained.
    - If an existing buffer is legally prescribed (i.e., deed, covenant, easement, etc.) and it exceeds this requirements, the existing buffer must be maintained.
- Location, orientation, and dimensions of all proposed BMPs. For all rain gardens/bioretention, infiltration trenches, and dry wells the length, width, and depth must be included on the plan. For rain barrels or cisterns the volume must be included.
- Location of any existing or proposed on-lot septic system and potable water wells showing rough proximity to infiltration facilities. See Section 3. Description of BMPs, for the appropriate setbacks for on-lot septic systems and potable water wells.

**Step 2** –Determine the Impervious Area to be Managed

- Determine the total area of all proposed impervious surfaces that will need to drain to one or more BMP(s).
- Also determine the total area for proposed earth disturbance to complete the project and install the BMP(s). The total earth disturbance to complete a project is often greater than the project area to allow for access from construction vehicles, stock piling of materials and excavation. The total area of earth disturbance must account for all of the construction activities necessary to construct the project.
- Determine locations where BMP(s) need to be placed so that the appropriate amount of stormwater runoff from the proposed impervious surfaces can be captured and managed.

**Step 3** – Select the BMP(s) to be Used and Determine Appropriate Sizing Criteria

- Select the BMP(s) to be used and determine the requirements of each from Section 3, Description of BMPs.
    - For instance, the back half of a garage may drain to a rain barrel and the front half of the garage and a driveway may drain to a bioretention area. Each BMP will be sized differently, manage stormwater runoff and will need to be designed to be consistent with Section 3.
- Then obtain the required storage volume and surface area needed for each of the proposed BMP(s) from the appropriate heading below.
- Complete Table 4 Simplified Approach Worksheet.

For Rain Barrels/Cisterns:

Step 3A –Select the proposed impervious area value in Column 1 of Table 1 that is closest to, but not less than the determined value.

Step 3B – Determine the volume that needs to be provided in cubic feet and gallons to satisfy the volume requirements using Columns 2 and 3 in Table 1.

For Rain Gardens/Bioretention or Dry Well #1:

Step 3A – Select the proposed impervious area value in Column 1 of Table 2 that is closest to, but not less than the determined value.

Step 3B - Determine the volume that needs to be provided in cubic feet to satisfy the volume requirements using Column 2 in Table 2.

Step 3C – Using the value from Column 2 determined above, and the depth (D) of the proposed BMP, simply determine the surface area needed from Column 3 of Table 2.

Note: The arrows under Column 3 in Table 2 indicate which range of depths is appropriate for each BMP. To determine the depth based on the area, select an area that corresponds to the required volume, and is closest to, but not more than the area to be used. To determine the area based on the depth, select a depth that is closest to, but not less than the depth that is to be used.

For Infiltration Trench or Dry Well #2:

Step 3A – Select the proposed impervious area value in Column 1 of Table 3 that is closest to, but not less than the determined value.

Step 3B - Determine the volume that needs to be provided in cubic feet to satisfy the volume requirements using Column 2 in Table 3.

Step 3C – Using the value from Column 2 determined above, and the depth (D) of the proposed BMP, simply determine the surface area needed from Column 3 of Table 3.

Note: The arrows under Column 3 in Table 3 indicate which range of depths is appropriate for each BMP. To determine the depth based on the area, select an area that corresponds to the required volume, and is closest to, but not less than the area to be used. To determine the area based on the depth, select a depth that is closest to, but not less than the depth that is to be used.

**Step 4** – Submit the final SWM Site Plan, Simplified Approach Worksheet, and signed and notarized "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement" (a sample document is provided in the accompanying appendix) to the Municipality for review and approval prior to beginning construction. After the Municipality has signed the "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement", record the Agreement at the County's Office of Recorder of Deeds. Construction can begin only after the Municipality has issued its approval of the proposed project to the applicant.

## Table 1: Simplified Approach - Calculating Rain Barrel/Cistern Storage Volume for 1" Rainfall[1]

| Column 1 | Column 2 | Column 3 | |
|---|---|---|---|
| **Proposed Impervious Area (square feet)** | **Volume of Rain Barrel/Cistern[2] (cubic feet)** | **Volume of Rain Barrel/Cistern (gallons)** | |
| $I$ | $V_{RBcf}$ | $V_{RBgal}$ | |
| Sum of all Proposed Impervious Areas | $(1*(1/12)*I)/0.75=V_{RBcf}$ | $V_{RBcf} * 7.48=V_{RBgal}$ | |
| 50 | 6 | 42 | ↑ |
| 100 | 11 | 83 | |
| 150 | 17 | 125 | **Rain Barrel** |
| 200 | 22 | 166 | ↓ |
| 250 | 28 | 208 | ↑ |
| 300 | 33 | 249 | |
| 350 | 39 | 291 | |
| 400 | 44 | 332 | |
| 450 | 50 | 374 | |
| 500 | 56 | 416 | |
| 550 | 61 | 457 | **Cistern** |
| 600 | 67 | 499 | |
| 650 | 72 | 540 | |
| 700 | 78 | 582 | |
| 750 | 83 | 623 | |
| 800 | 89 | 665 | |
| 850 | 94 | 706 | |
| 900 | 100 | 748 | |
| 950 | 106 | 790 | |
| 999 | 111 | 830 | ↓ |

[1] The typical volume of a rain barrel is between 50-200 gallons, so more than one rain barrel may be needed. Larger volumes may require a cistern.
[2] It is assumed that the rain barrel/cistern is 25% full prior to receiving runoff.

## Table 2: Simplified Approach - Calculating Rain Garden/Bioretention and Dry Well #1 Storage Volume and Surface Area for 1 Inch Rainfall

| Column 1 | Column 2 | Column 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total Proposed Impervious Area (square feet)** | **Volume of Rain Garden/Bioretention or Dry Well #1[1] (cubic feet)** | **Surface Area of Rain Garden/Bioretention or Dry Well #1** Acceptable Depths for Each BMP are indicated by the arrows below **(square feet)** | | | | | | | |
| | | *Area Required for a BMP with a Depth(D) of 0.5'* | *Area Required for a BMP with a Depth(D) of 1.0'* | *Area Required for a BMP with a Depth(D) of 1.5'* | *Area Required for a BMP with a Depth(D) of 2.0'* | *Area Required for a BMP with a Depth(D) of 2.5'* | *Area Required for a BMP with a Depth(D) of 3.0'* | *Area Required for a BMP with a Depth(D) of 3.5'* | *Area Required for a BMP with a Depth(D) of 4.0'* |
| | | ← **Rain Garden /Bioretention (0.5'-1.0')** → | | ← **Dry Well #1 (1.5'-4.0')** → | | | | | |
| *I* | V | *A(sf)* | | | | | | | |
| Sum of all Proposed Impervious Areas | 1*(1/12)**I*= V | V/D=A | | | | | | | |
| 50 | 4 | 8 | 4 | 3 | 2 | 2 | 1 | 1 | 1 |
| 100 | 8 | 17 | 8 | 6 | 4 | 3 | 3 | 2 | 2 |
| 150 | 13 | 25 | 13 | 8 | 6 | 5 | 4 | 4 | 3 |
| 200 | 17 | 33 | 17 | 11 | 8 | 7 | 6 | 5 | 4 |
| 250 | 21 | 42 | 21 | 14 | 10 | 8 | 7 | 6 | 5 |
| 300 | 25 | 50 | 25 | 17 | 13 | 10 | 8 | 7 | 6 |
| 350 | 29 | 58 | 29 | 19 | 15 | 12 | 10 | 8 | 7 |
| 400 | 33 | 67 | 33 | 22 | 17 | 13 | 11 | 10 | 8 |
| 450 | 38 | 75 | 38 | 25 | 19 | 15 | 13 | 11 | 9 |
| 500 | 42 | 83 | 42 | 28 | 21 | 17 | 14 | 12 | 10 |
| 550 | 46 | 92 | 46 | 31 | 23 | 18 | 15 | 13 | 11 |
| 600 | 50 | 100 | 50 | 33 | 25 | 20 | 17 | 14 | 13 |
| 650 | 54 | 108 | 54 | 36 | 27 | 22 | 18 | 15 | 14 |
| 700 | 58 | 117 | 58 | 39 | 29 | 23 | 19 | 17 | 15 |
| 750 | 63 | 125 | 63 | 42 | 31 | 25 | 21 | 18 | 16 |
| 800 | 67 | 133 | 67 | 44 | 33 | 27 | 22 | 19 | 17 |
| 850 | 71 | 142 | 71 | 47 | 35 | 28 | 24 | 20 | 18 |
| 900 | 75 | 150 | 75 | 50 | 38 | 30 | 25 | 21 | 19 |
| 950 | 79 | 158 | 79 | 53 | 40 | 32 | 26 | 23 | 20 |
| 999 | 83 | 167 | 83 | 56 | 42 | 33 | 28 | 24 | 21 |

[1] It is assumed that the rain garden/bioretention or the dry well #1 are empty prior to receiving runoff (i.e. 0% full)

## Table 3: Simplified Approach - Calculating Infiltration Trench and Dry Well #2 Storage Volume and Surface Area for 1 Inch of Rainfall

| Column 1 | Column 2 | Column 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total Proposed Impervious Area (square feet)** | **Volume of Infiltration Trench or Dry Well #2[1] (cubic feet)** | **Surface Area of Infiltration Trench or Dry Well #2** Acceptable Depths for Each BMP are indicated by the arrows below **(square feet)** | | | | | | | |
| | | *Area Required for a BMP with a Depth(D) of 1.5'* | *Area Required for a BMP with a Depth(D) of 2.0'* | *Area Required for a BMP with a Depth(D) of 2.5'* | *Area Required for a BMP with a Depth(D) of 3.0'* | *Area Required for a BMP with a Depth(D) of 3.5'* | *Area Required for a BMP with a Depth(D) of 4.0'* | *Area Required for a BMP with a Depth(D) of 4.5'* | *Area Required for a BMP with a Depth(D) of 5.0'* |
| | | ← **Dry Well #2 (1.5'-4.0')** → | ← **Infiltration Trench (2.0'-5.0')** → | | | | | | |
| *I* | V | *A(sf)* | | | | | | | |
| Sum of all Proposed Impervious Areas | (1*(1/12)*I)/ (0.4)[1]=V | V/D=A | | | | | | | |
| 50 | 10 | 7 | 5 | 4 | 3 | 3 | 3 | 2 | 2 |
| 100 | 21 | 14 | 10 | 8 | 7 | 6 | 5 | 5 | 4 |
| 150 | 31 | 21 | 16 | 13 | 10 | 9 | 8 | 7 | 6 |
| 200 | 42 | 28 | 21 | 17 | 14 | 12 | 10 | 9 | 8 |
| 250 | 52 | 35 | 26 | 21 | 17 | 15 | 13 | 12 | 10 |
| 300 | 63 | 42 | 31 | 25 | 21 | 18 | 16 | 14 | 13 |
| 350 | 73 | 49 | 36 | 29 | 24 | 21 | 18 | 16 | 15 |
| 400 | 83 | 56 | 42 | 33 | 28 | 24 | 21 | 19 | 17 |
| 450 | 94 | 63 | 47 | 38 | 31 | 27 | 23 | 21 | 19 |
| 500 | 104 | 69 | 52 | 42 | 35 | 30 | 26 | 23 | 21 |
| 550 | 115 | 76 | 57 | 46 | 38 | 33 | 29 | 25 | 23 |
| 600 | 125 | 83 | 63 | 50 | 42 | 36 | 31 | 28 | 25 |
| 650 | 135 | 90 | 68 | 54 | 45 | 39 | 34 | 30 | 27 |
| 700 | 146 | 97 | 73 | 58 | 49 | 42 | 36 | 32 | 29 |
| 750 | 156 | 104 | 78 | 63 | 52 | 45 | 39 | 35 | 31 |
| 800 | 167 | 111 | 83 | 67 | 56 | 48 | 42 | 37 | 33 |
| 850 | 177 | 118 | 89 | 71 | 59 | 51 | 44 | 39 | 35 |
| 900 | 188 | 125 | 94 | 75 | 63 | 54 | 47 | 42 | 38 |
| 950 | 198 | 132 | 99 | 79 | 66 | 57 | 49 | 44 | 40 |
| 999 | 208 | 139 | 104 | 83 | 69 | 59 | 52 | 46 | 42 |

[1] Assumes a percent void volume of 40%

## Table-4: Simplified Approach Worksheet

Name of Property Owner(s): Date:

Name of Applicant(s) [if different than Owner(s)]:

Contact Phone #: Email Address:

Address of Project:

Description of Project:

☐ Met with Municipal Engineer to discuss proposed project. [insert date of meeting]

Distance from earth disturbance to nearest surface water feature (stream, pond, wetland, etc.)

(if required by the Municipality, circle one): 50 feet or less More than 50 feet

☐ **Step 1**: Attach Simplified SWM Site Plan (i.e. sketch plan), per Section 1, Step 1

**Step 2**: Determine the Impervious Area to be Managed

| | |
|---|---|
| | Total Proposed Impervious Area (square feet): |
| | Total Earth Disturbance (square feet): |

**Step 3**: Select the BMP(s) to be Used and Appropriate Sizing Criteria

**Rain Barrel or Cistern**

| | Proposed Impervious Surface from Column 1 in Table 1 | Volume from Column 3 in Table 1 | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

**Rain Garden/Bioretention or Dry Well #1**

| | Proposed Impervious Surface from Column 1 in Table 2 | Volume of BMP from Column 2 in Table 2 | Area Dimensions of BMP - Column 3 in Table 2 | Depth of BMP from Column 3 in Table 2 | Types of Materials to be Used |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

**Infiltration Trench or Dry Well #2**

| | Proposed Impervious Surface from Column 1 in Table 3 | Volume of BMP from Column 2 in Table 3 | Area Dimensions of BMP - Column 3 in Table 3 | Depth of BMP from Column 3 in Table 3 | Types of Materials to be Used |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

☐ **Step 4**: Complete, Sign & have Operation, Maintenance and Inspection Plan and Agreement Notarized and Recorded at the County Recorder of Deeds (when signed by Municipality)

Note: For additional BMPs, use additional sheet(s).

## 2. Definitions

These definitions apply only to this Simplified Approach to Stormwater Management for Small Projects Handbook. The definitions included in the Municipality's Stormwater Management Ordinance also apply.

**Best Management Practice (BMP)** – As defined in the Municipality's Stormwater Management Ordinance, but generally including activities, facilities, designs, measures or procedures used to manage stormwater impacts from land development and earth disturbance activities to meet stormwater quality, runoff control and groundwater recharge protection requirements. BMPs include, but are not limited to, a wide variety of practices and devices such as: infiltration facilities (dry wells and infiltration trenches), filter strips, low impact design, bioretention (rain gardens), permeable paving, grassed swales, and manufactured devices (cisterns and rain barrels). Structural stormwater BMPs are permanent appurtenances to the project site.

**Geotextile** - A fabric manufactured from synthetic fibers which provides a separation between different types of media (i.e., soil and stone), and is used to achieve specific objectives, including infiltration or filtration.

**Hotspot** - Areas where land use or activities generate highly contaminated runoff, with concentrations of pollutants that are higher than those that are typically found in stormwater (e.g. vehicle salvage yards, recycling facilities, vehicle fueling stations, fleet storage areas, vehicle equipment and cleaning facilities, and vehicle service and maintenance facilities).

**Impervious Surface** - As defined in the Municipality's Stormwater Management Ordinance, but generally including any surface that prevents the infiltration of water into the ground. Impervious surfaces generally include, but are not limited to, streets, sidewalks, pavements, driveway areas, or roofs. The applicant should review the Municipality's Stormwater Management Ordinance or consult with the Municipal Engineer to confirm what components of the proposed project are considered "impervious surfaces". Decks, swimming pools, compacted soils or stone surfaces (such as for vehicle movement or parking), among other features, may be included in the Municipality's definition of "impervious surfaces".

**Infiltration** - Movement of surface water into the soil, where it is absorbed by plant roots, transpired or evaporated into the atmosphere, or percolated downward to recharge groundwater.

**Low Impact Development** - A land development and construction approach that uses various land planning, design practices, and technologies to simultaneously conserve and protect natural resource systems, and reduce infrastructure costs.

**Percent Void Volume** – The volume of void space, expressed as a percentage, of the total volume of the storage facility (void volume + volume of solid materials providing structural support for the storage facility).

**Pervious Surface** - Any area not defined as impervious surface.

**Potable** – A water supply that is either absent of contaminants or contains contaminant levels that are below a given threshold level that makes the water as suitable for drinking.

**Runoff** - Any part of precipitation that flows over the land surface.

**Stormwater** - Drainage runoff from the surface of the land resulting from precipitation, or snow or ice melt.

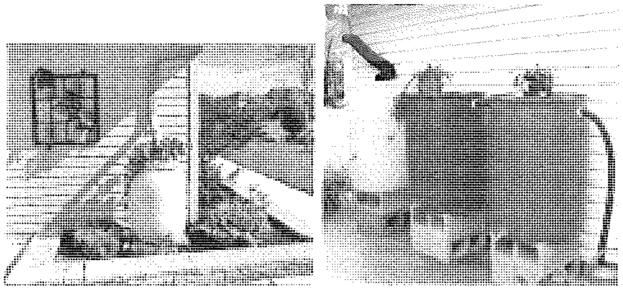
# 3. Description of BMPs

The following is a description of several types of BMPs that could be implemented. The requirements of each BMP as described below are taken directly from the PA Stormwater BMP Manual (December, 2006). Refer to the PA BMP Manual (latest version) which can be found on the PA Department of Environmental Protection's website.

**Rain Barrels/Cisterns**

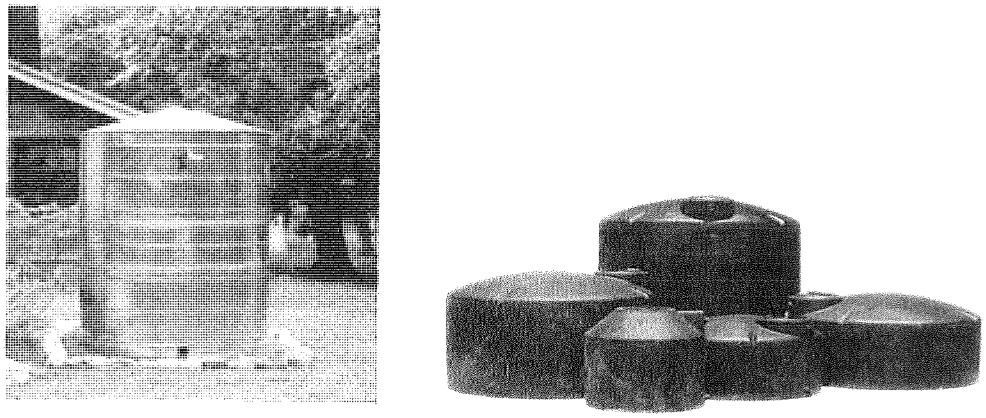
Rain Barrels are large containers that collect drainage from roof leaders and temporarily store water to be released to lawns, gardens, and other landscaped areas after the rainfall has ended. Rain Barrels are typically between 50 to 200 gallons in size. The stored water can also be used as a non-potable water supply. Cisterns are larger than rain barrels having volumes of 200 gallons or more, and can be placed either on the surface or underground. Figures 1 and 2 show examples of rain barrels and cisterns, respectively, that could be used to manage stormwater from a project. Rain barrels and cisterns are manufactured in a variety of shapes and sizes. All of these facilities must make provisions for the following items:

- There must be a means to release the water stored in the container between storm events in order for the necessary storage volume to be available for the next storm.
- Stormwater must be kept from entering other potable systems, and pipes and storage units must be clearly marked "Do Not Drink".
- An overflow outlet should be placed a few inches below the top of the storage container with an overflow pipe to divert flow away from structures once the storage containers are filled.
- Use screens to filter debris, and covers (lids) placed over the containers to prevent insects and debris from entering the storage chamber.
- Make sure cisterns are watertight and do not leak.
- Rain barrels are typically assumed to be 25% full to calculate volume since they are not always emptied before each storm. The tables contained in this Handbook were developed to account for the 25% increase in the required storage of a rain barrel or a cistern.



Source (picture on left): http://www.rfcity.org/Eng/Stormwater/YourProperty/YourProperty.htm
Source (picture on right): :http://www.floridata.com/tracks/transplantedgardener/Rainbarrels.cfm

**Figure 1: Rain Barrels**



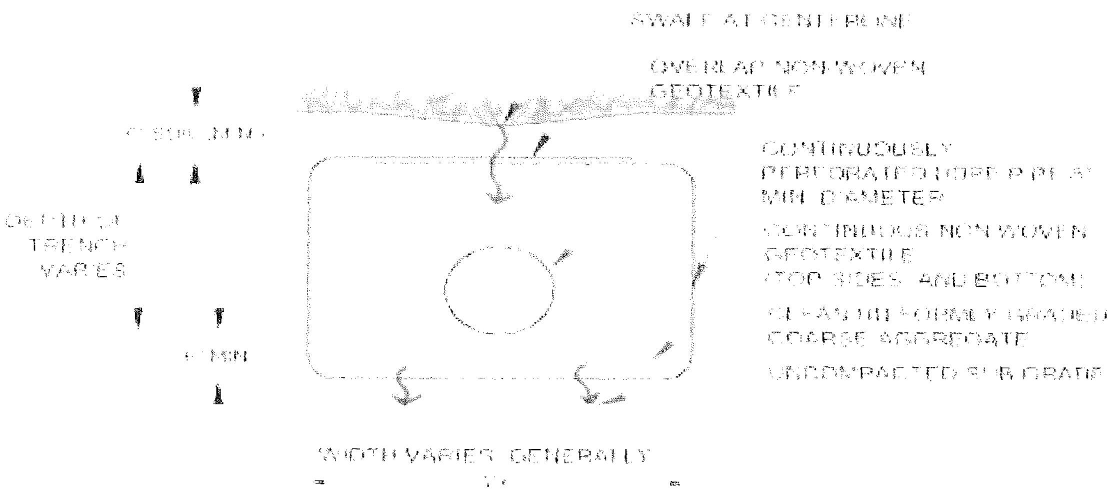
Source (for both pictures): Pennsylvania Stormwater BMP Manual (PADEP, 2006)

**Figure 2: Cisterns**

## Infiltration Trench

An infiltration trench is a long, narrow, rock-filled trench, with or without a perforated pipe placed within the rock to distribute water evenly along the trench, that receives stormwater runoff, and has no outlet. Runoff is stored in the void space between the stones and in the pipe, and infiltrates through the bottom of the trench into the underlying soil matrix. Figure 3 shows a typical cross-section of an infiltration trench configuration. Infiltration trenches shall incorporate or make provisions for the following elements:

- These facilities should be located a minimum of ten (10) feet (or as otherwise required by the Municipality) from the building foundation to avoid foundation seepage problems, and are not recommended if their installation would create a risk of flooding other structures constructed at or below grade.
- Perforated pipe placed within the rock is to be set level.
- The width is limited to between **3 to 8 feet**, and the depth ranges from **2 to 5 feet**.
- Trench should be wrapped in nonwoven geotextile (top, sides, and bottom).
- There should be a positive overflow that allows stormwater that cannot be stored or infiltrated to be discharged into a nearby vegetated area.
- Roof downspouts may be connected to infiltration trenches, but should contain a cleanout to collect sediment and debris before entering the infiltration area.
- Infiltration testing is recommended to ensure soil is capable of infiltrating stormwater.
- It is recommended that there be a 2 foot clearance above the regularly occurring seasonal high water table, and have a minimum depth to bedrock of 2 feet.
- The infiltration trench should be at least 50 feet from individual water supply wells, 100 feet from community or municipal water supply wells, and 50 feet from any septic system component. It should not be located near stormwater Hotspots (refer to B.2 Definitions).
- The infiltration trench should be located so that it presents no threat to sub-surface structures such as building foundations and basements.
- Protect infiltration areas from compaction by heavy equipment during and after construction.
- Infiltration trenches should be constructed after all earth disturbance associated with a given project or site is stabilized to avoid clogging.
- The ratio of the drainage area which stormwater runoff is collected from to the area of the footprint (bottom area) of the infiltration portion of the facility should be as small as possible with a ratio of less than 5:1 preferred.



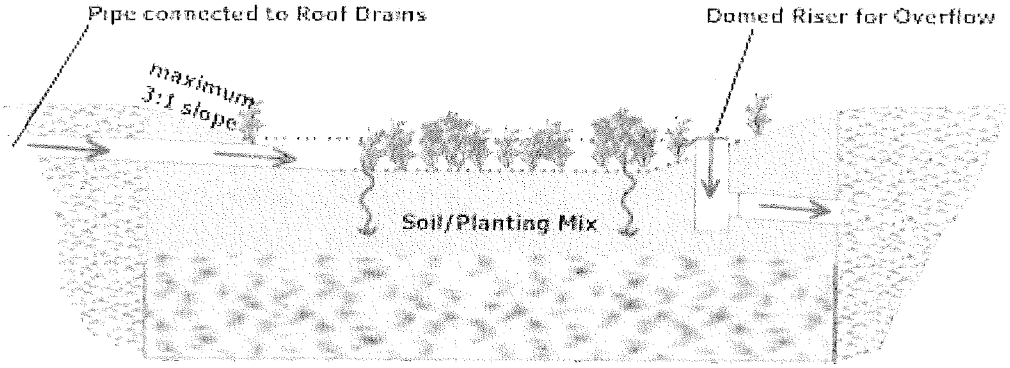
Source: Pennsylvania Stormwater BMP Manual (PADEP, 2006)

Figure 3: Cross-Section of Typical Infiltration Trench

### Rain Garden/Bioretention Area

A Rain Garden (Bioretention Area) is an excavated depression area on the surface of the land in which native vegetation is planted to filter and use stormwater runoff. Runoff ponds on top of the surface of the rain garden and then infiltrates into an enhanced soil/planting mix below the surface where plants can use the water to grow. Bioretention improves water quality, with the vegetation planted in the facility filtering the water, and the root systems encouraging or promoting infiltration. Figure 4 shows a cross-section of a typical rain garden. Key elements of a rain garden include:

- Recommended ponding depths not exceeding **1 foot**.
- Native vegetation that can tolerate dry and wet weather.
- An overflow area where, if the bioretention area were to overflow, the overflow would flow over pervious surfaces (i.e. grass, meadow), and would not cause harm to property, or;
- An overflow, such as a domed riser, to allow excess flow from large storms to travel to other infiltration areas, pervious areas, or connected storm systems designed to receive the excess runoff.
- For most areas, slopes should be limited to 3:1, maximum; however, where space is limited, 2:1 side slopes may be acceptable with approval from the municipal engineer.
- The soil/planting mix depth should not be less than 1.5 feet deep and typically consist of a mixture of topsoil, sand and compost (i.e. mulch). The topsoil, sand and compost should be uniformly mixed by volume in a 50%, 30%, 20% mixture, respectively.



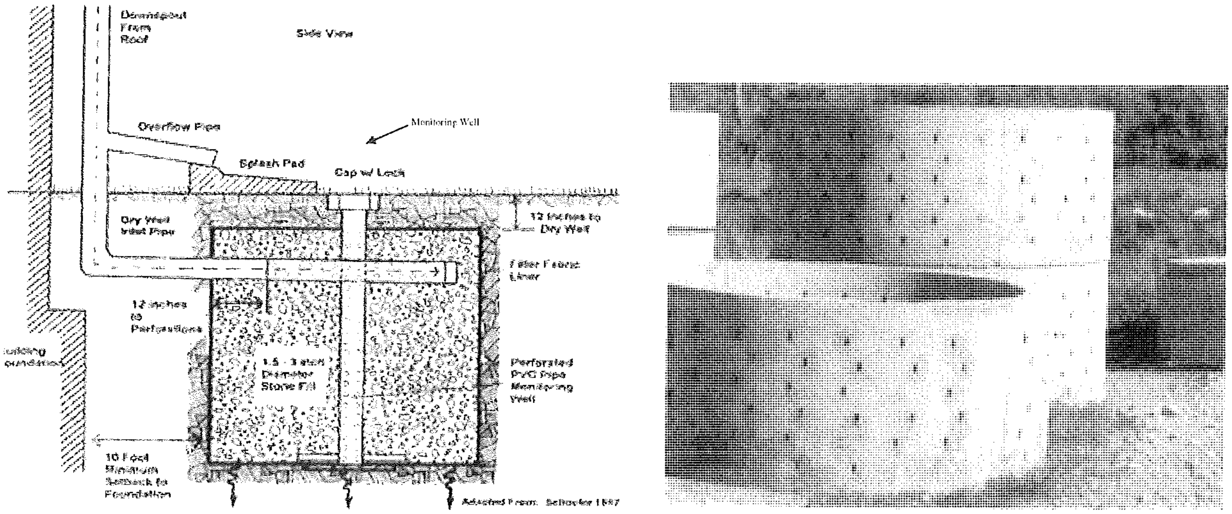
Source: Pennsylvania Stormwater BMP Manual (PADEP, 2006)

Figure 4: Cross-Section of Typical Rain Garden/Bioretention Area

## Dry Wells

A dry well, also referred to as a seepage pit, is a subsurface storage facility that temporarily stores and infiltrates runoff from the roofs of buildings or other impervious surfaces. A dry well can be either a structural prefabricated chamber (Dry Well #1) or an excavated pit filled with stone fill (Dry Well #2). Dry Wells discharge the stored runoff via infiltration into the surrounding or underlying soils. Figure 5 shows a typical prefabricated dry well and a typical dry well configuration with stone fill. The following elements shall be incorporated into all dry well designs:

- These facilities should be located a minimum of ten (10) feet (or as otherwise required by the Municipality) from the building foundation to avoid foundation seepage problems, and are not recommended if their installation would create a risk of flooding other structures constructed at or below grade.
- Dry well should be constructed after all earth disturbance associated with a given project or site is stabilized to avoid clogging.
- During construction, compaction of the subgrade soil in the bottom of the dry well should be avoided, and construction should be performed only with light machinery.
- For Dry Well #2 designs, the depth of dry well should be between **1.5 feet to 4 feet**. Gravel fill should consist of uniformly graded stone with an average diameter of between one and one half and two (1.5 –2.0) inches with the gravel fill wrapped in a nonwoven geotextile to separate the stone fill from the surrounding soil.
- At least 1 foot of soil must be placed over the top of the dry well.
- Dry wells should be inspected at least four (4) times annually as well as after large storm events.
- Dry wells should have overflow pipes to allow high volumes of runoff to overflow the facility and flow into a connected infiltration area, pervious area, or other connected storm sewer designed to receive the excess runoff.
- Every dry well must have at least one monitoring well to assist in the inspection of the dry well to determine how much water is retained within the well during dry weather periods.
- Infiltration testing is recommended to ensure the underlying soil is capable of infiltrating the needed volume of stormwater.



Source (for picture on left): http://www.seagrant.sunysb.edu/pages/BMPsForMarinas.htm
Source (for picture on right): http://www.copelandconcreteinc.net/1800652.html

**Figure 5: Typical Dry Well Configuration filled with Stone Fill (DRY WELL #2) (Left) and Structural Prefabricated Chamber (DRY WELL #1) (Right)**

## 4. Example

### Simplified Approach to Stormwater Management for a Residential Garage and Driveway addition

Joe Homeowner wants to build a 400 square foot two car garage, and a 540 square foot (30′ long x 18′ wide) impervious driveway that is graded so that the stormwater runoff drains to the grassy area along one edge of the driveway. (An annotated copy of Table 1 is provided below as Table 5 and an annotated copy of Table 3 is provided below as Table 6, and outlines the steps of this example) and a completed Table 4 is provided as Table 7.

**STEP 1** – Make a sketch of the site plan as shown in Figure 6.

**STEP 2** - Determine the total area of all proposed impervious surfaces to drain to each BMP:

| | | | |
|---|---|---|---|
| Garage Roof (Front) | 10 ft. x 20 ft. | = | 200 sq. ft |
| Garage Roof (Rear) | 10 ft. x 20 ft. | = | 200 sq. ft. |
| Driveway | 30 ft. x 18 ft. | = | 540 sq. ft. |
| | | | ------------- |
| **Total Proposed Impervious Surface** | | | **940 sq. ft.** |
| **Total Proposed Earth Disturbance Area** | | | **2,500 sq. ft. (estimated)** |

Note: If the driveway used pervious pavement (i.e. paving blocks), then the total impervious area would only be 400 square feet, and no stormwater management practices would need to control runoff from the project.

**STEP 3** – Select the BMP(s) to be Used and Appropriate Sizing Criteria

Select a BMP or combination of BMPs from Section 3 to be used to satisfy the volume requirement. Determine the length, width, depth and other requirements for the BMPs in Section 3. A BMP needs to be placed to catch runoff from the back of the garage, and a BMP needs to be placed to capture runoff from the front of the garage and the driveway. Figure 6 shows the direction the runoff flows and the locations where the BMPs are to be placed.

Joe Homeowner would like to use a rain barrel (BMP #1) to capture the runoff from the rear of the garage and an infiltration trench (BMP #2) to capture runoff from the front of the garage and the driveway.

**<u>BMP #1 (Rain Barrel/Cistern) – Steps 3A and 3B</u>**

**STEP 3A** - Select the proposed impervious area value for BMP #1, the rain barrel or cistern, in Column 1 that is closest to, but not less than 200 in Table 1:

The value in Column 1 that is closest to but is not less than 200 is 200.

**STEP 3B** - Determine the volume that BMP #1 must be to satisfy the volume requirements using Columns 2 and 3 in Table 1:

The volume in gallons of the rain barrel/cistern to be used as BMP #1, assuming the rain barrel/cistern is 25% full, is determined by finding the value in Column 3 for the same row that corresponds to the impervious area value determined in Step 1. Therefore, the volume of BMP #1, the rain barrel/cistern must be ≥ 166 gallons. Depending on the size of the rain barrel(s), a combination of rain barrels could be used in succession as shown in Figure 1, or a cistern could be used.

### BMP #2 (Infiltration Trench) - Steps 3A through 3C

**STEP 3A** - Select the proposed impervious area value for BMP #2, the infiltration trench, using Column 1 in Table 6:

Find the row in Column 1 that is closest to but not less than 740 (200 from the front of the garage + 540 from the driveway). Therefore, the value selected is 750.

**STEP 3B** - Determine the volume that BMP #2, the infiltration trench must be to satisfy the volume requirements using Column 2 in Table 6:

The volume of the infiltration trench to be used as BMP #2, assuming a percent void volume of 40%, is determined by finding the value Column 2 that is in the same row as 750 square feet from Column 1 as described in Step 2. Therefore, the volume of BMP #2 must be 156 cubic feet.

**STEP 3C** - Utilizing the value from Column 2 determined above, and the surface area that the proposed BMP will occupy, determine the depth needed using Column 3 in Table 6:

Joe Homeowner would like to place the infiltration trench along the edge of the driveway so it would have a length of 20 feet. The smallest width that can be used, as stated in the infiltration trench requirements in Section 3, is 3 feet. Therefore, the area of the infiltration trench is:

20 feet * 3 feet = 60 square feet

To find the minimum depth of the trench move toward the right side of the table from 156 cubic feet in Column 2 to Column 3, and find the column with a value of as close to but not more than 60 square feet, which is 52 square feet. Then obtain the minimum depth of the facility by reading the depth from the column heading at the top of the table. Therefore, the depth of the trench would need to be 3 feet.

**Selected BMPs:**

**BMP #1: Rain barrel(s) that provides for at least 166 gallons, and**
**BMP #2: A 20′ long x 3′ wide x 3′ deep infiltration trench**

### Table 5: Example – Calculating Storage Volume for Rain Barrel/Cistern

| Column 1 | Column 2 | Column 3 | |
|---|---|---|---|
| Proposed Impervious Area (square feet) | Volume of Rain Barrel/Cistern[1] (cubic feet) | Volume of Rain Barrel/Cistern (gallons) | |
| *I* | $V_{RBcf}$ | $V_{RBgal}$ | |
| Sum of all Proposed Impervious Areas | $(1*(1/12)*I)/0.75=V_{RBcf}$ | $V_{RBcf} * 7.48=V_{RBgal}$ | |
| 50 | 6 | 42 | ↑ |
| 100 | 11 | 83 | **Rain Barrel** |
| 150 | 17 | 125 | |
| $\boxed{2}$ 200 | 22 | $\boxed{3}$ 166 | ↓ |
| 250 | 28 | 208 | ↑ |
| 300 | 33 | 249 | |
| 350 | 39 | 291 | |
| 400 | 44 | 332 | |
| 450 | 50 | 374 | |
| 500 | 56 | 416 | |
| 550 | 61 | 457 | |
| 600 | 67 | 499 | **Cistern** |
| 650 | 72 | 540 | |
| 700 | 78 | 582 | |
| 750 | 83 | 623 | |
| 800 | 89 | 665 | |
| 850 | 94 | 706 | |
| 900 | 100 | 748 | |
| 950 | 106 | 790 | |
| 999 | 111 | 830 | ↓ |

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[1] Assume that the rain barrel/cistern is 25% full

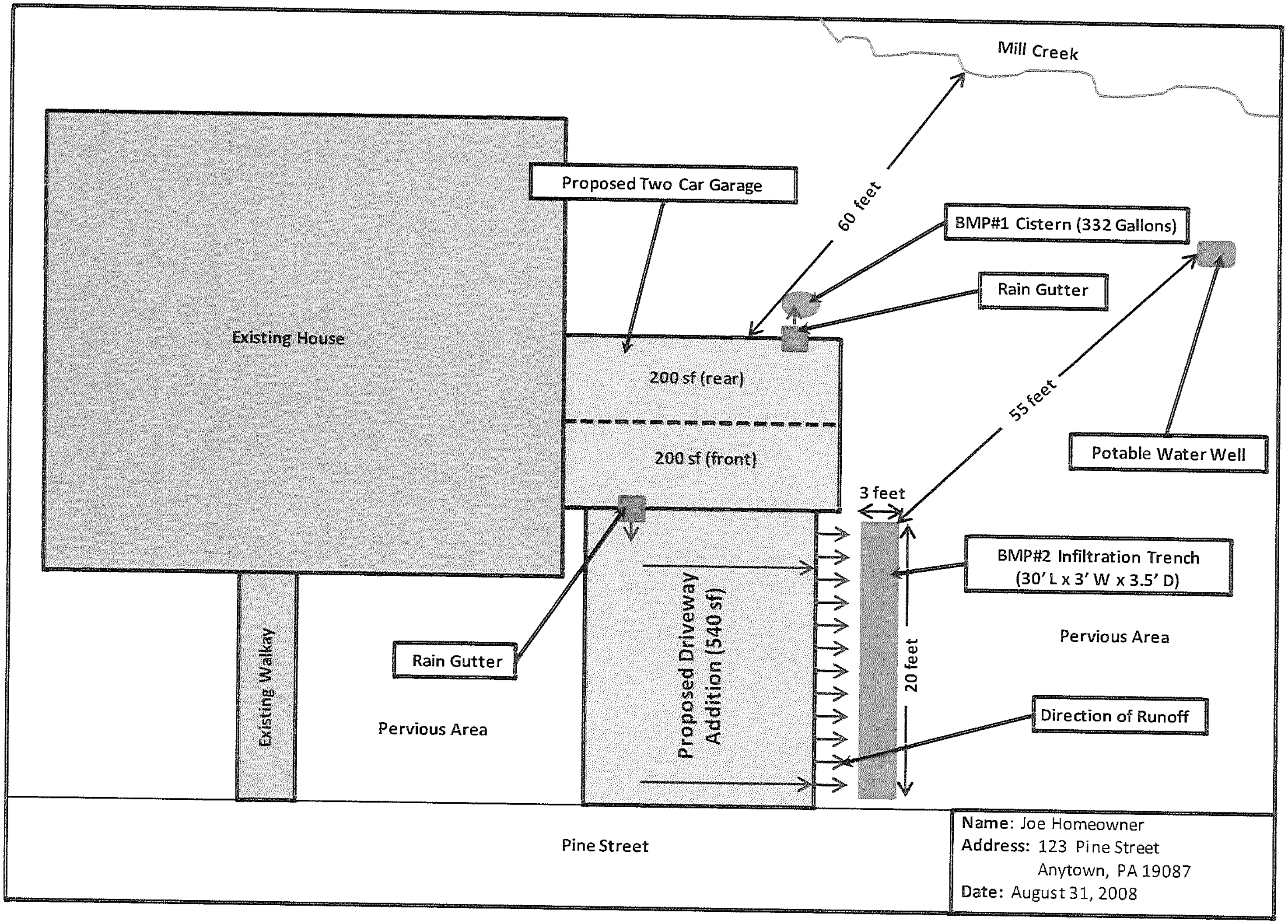

Figure 6: Example of Simplified Stormwater Management Site Plan for Joe Homeowner

**Table 6: Example – Calculating Storage Volume Surface Area and Depth for Infiltration Trench**

| Column 1 | Column 2 | Column 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total Proposed Impervious Area (square feet)** | **Volume of Infiltration Trench or Dry Well #2[1] (cubic feet)** | **Surface Area of Infiltration Trench or Dry Well #2** Acceptable Depths for Each BMP are indicated by the arrows below **(square feet)** | | | | | | | |
| | | *Area Required for a BMP with a Depth(D) of 1.5'* | *Area Required for a BMP with a Depth(D) of 2.0'* | *Area Required for a BMP with a Depth(D) of 2.5'* | *Area Required for a BMP with a Depth(D) of 3.0'* | *Area Required for a BMP with a Depth(D) of 3.5'* | *Area Required for a BMP with a Depth(D) of 4.0'* | *Area Required for a BMP with a Depth(D) of 4.5'* | *Area Required for a BMP with a Depth(D) of 5.0'* |
| | | | Infiltration Trench (2.0'-5.0') | | | | | | |
| | | Dry Well #2 (1.5'-4.0') | | | | | | | |
| *I* | V | *A(sf)* | | | | | | | |
| Sum of all Proposed Impervious Areas | $(I*(1/12)*f)/(0.4)^1=V$ | V/D=A | | | | | | | |
| 50 | 10 | 7 | 5 | 4 | 3 | 3 | 3 | 2 | 2 |
| 100 | 21 | 14 | 10 | 8 | 7 | 6 | 5 | 5 | 4 |
| 150 | 31 | 21 | 16 | 13 | 10 | 9 | 8 | 7 | 6 |
| 200 | 42 | 28 | 21 | 17 | 14 | 12 | 10 | 9 | 8 |
| 250 | 52 | 35 | 26 | 21 | 17 | 15 | 13 | 12 | 10 |
| 300 | 63 | 42 | 31 | 25 | 21 | 18 | 16 | 14 | 13 |
| 350 | 73 | 49 | 36 | 29 | 24 | 21 | 18 | 16 | 15 |
| 400 | 83 | 56 | 42 | 33 | 28 | 24 | 21 | 19 | 17 |
| 450 | 94 | 63 | 47 | 38 | 31 | 27 | 23 | 21 | 19 |
| 500 | 104 | 69 | 52 | 42 | 35 | 30 | 26 | 23 | 21 |
| 550 | 115 | 76 | 57 | 46 | 38 | 33 | 29 | 25 | 23 |
| 600 | 125 | 83 | 63 | 50 | 42 | 36 | 31 | 28 | 25 |
| 650 | 135 | 90 | 68 | 54 | 45 | 39 | 34 | 30 | 27 |
| 700 | 146 | 97 | 73 | 58 | 49 | 42 | 36 | 32 | 29 |
| Step 3A 750 | Step 3B 156 | 104 | 78 | Step 3C | 52 | 45 | 39 | 35 | 31 |
| 800 | 167 | 111 | 83 | 67 | 56 | 48 | 42 | 37 | 33 |
| 850 | 177 | 118 | 89 | 71 | 59 | 51 | 44 | 39 | 35 |
| 900 | 188 | 125 | 94 | 75 | 63 | 54 | 47 | 42 | 38 |
| 950 | 198 | 132 | 99 | 79 | 66 | 57 | 49 | 44 | 40 |
| 999 | 208 | 139 | 104 | 83 | 69 | 59 | 52 | 46 | 42 |

[1] Assumes a percent void volume of 40%

## Table 7: Simplified Approach Worksheet – Example for *Joe Homeowner*

Name of Property Owner(s): **Joe Homeowner** Date: **8/26/12**

Name of Applicant(s) [if different than Owner(s)]: **N/A**

Contact Phone #: **610-555-1234** Email Address: **joe@homeowner.com**

Address of Project: **123 Pine St., Anytown, PA 19355**

Description of Project: **Add a 2-car garage and driveway**

☐ Met with Municipal Engineer to discuss proposed project. [date of meeting 6/1/12]

Distance from earth disturbance to nearest surface water feature (stream, pond, wetland, etc.)

(if required by the Municipality, circle one): 50 feet or less [✓ More than 50 feet]

☒ **Step 1**: Attach Simplified SWM Site Plan (i.e. sketch plan), per Section .1, Step 1

**Step 2**: Determine the Impervious Area to be Managed

Total Proposed Impervious Area (square feet): **940 sq. feet**

Total Earth Disturbance (square feet): **~ 2,500 sq. feet**

**Step 3**: Select the BMP(s) to be Used and Appropriate Sizing Criteria

**Rain Barrel or Cistern**

| | Proposed Impervious Surface from Column 1 in Table 1 | Volume from Column 3 in Table 1 | | | |
|---|---|---|---|---|---|
| | **200 sq. feet** | **166 gallons** | | | |
| | | | | | |
| | | | | | |

**Rain Garden/Bioretention or Dry Well #1**

| | Proposed Impervious Surface from Column 1 in Table 2 | Volume of BMP from Column 2 in Table 2 | Area Dimensions of BMP - Column 3 in Table 2 | Depth of BMP from Column 3 in Table 2 | Types of Materials to be Used |
|---|---|---|---|---|---|
| | **N/A** | | | | |
| | | | | | |
| | | | | | |

**Infiltration Trench or Dry Well #2**

| | Proposed Impervious Surface from Column 1 in Table 3 | Volume of BMP from Column 2 in Table 3 | Area Dimensions of BMP - Column 3 in Table 3 | Depth of BMP from Column 3 in Table 3 | Types of Materials to be Used |
|---|---|---|---|---|---|
| | **740 sq. feet** | **156 cubic feet** | **20 ft by 3 ft** | **3 ft** | **Infiltration trench, uniformly graded aggregate, 8" HDPE pipe, geotextile, grass planted on top.** |
| | | | | | |

☒ **Step 4**: Complete, Sign & have Operation, Maintenance and Inspection Agreement Notarized and Recorded at the County Recorder of Deeds (when signed by the Municipality)

Note: For additional BMPs, use additional sheet(s).

## 5. Simplified Approach Operation, Maintenance and Inspection Plan and Agreement

It is the property owner's responsibility to properly maintain BMPs. It is also the property owner's responsibility to inform any future buyers of the function, operation, and maintenance needed for any BMPs on the property prior to the purchase of the property. The accompanying sample "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement" (see accompanying appendix) outlines the maintenance required for each type of BMP, the responsibilities of the property owner, and the rights of the Municipality in regards to inspection and enforcement of the maintenance requirements.

The "Simplified Approach Operation, Maintenance and Inspection Plan and Agreement" must be signed, notarized and submitted to the Municipality. Following the signature by the Municipality, the property owner must have the Agreement recorded at the County Recorder of Deeds, so that the Agreement will be applicable to future property owners.

## Appendix A.3

# Simplified Approach – Stormwater Best Management Practices Operation, Maintenance, and Inspection Plan and Agreement

# SAMPLE AGREEMENT

## A.3 Simplified Approach - Stormwater Best Management Practices Operation, Maintenance, and Inspection Plan and Agreement

# SAMPLE AGREEMENT

It is the Landowner's responsibility to properly maintain BMPs. It is also the Landowner's responsibility to inform any future buyers of the function, operation, and maintenance needed for any BMPs on the property prior to the purchase of the property. The following maintenance agreement outlines the inspection and maintenance required for each type of BMP, the responsibilities of the Landowner, and the rights of the Municipality in regards to inspection and enforcement of the maintenance requirements.

The Operation, Maintenance and Inspection Plan and Agreement must be signed, notarized and submitted to the Municipality. Following approval and signature by the Municipality, the Landowner must have the Agreement recorded at the Chester County Office of the Recorder of Deeds, so that the Agreement will be applicable to future landowners.

**REVISED**
**Chester County Water Resources Authority**
**February 12, 2013**

# SIMPLIFIED APPROACH STORMWATER BEST MANAGEMENT PRACTICES OPERATION, MAINTENANCE, AND INSPECTION PLAN AND AGREEMENT

**THIS AGREEMENT**, made and entered into this ____________ day of _________, 20___, by and between
_________________________________, (hereinafter the "Landowner"), and
________________________________(City, Borough, Township), Chester County, Pennsylvania, (hereinafter "Municipality").

### WITNESSETH

**WHEREAS**, the Landowner is the owner of certain real property by virtue of a deed of conveyance recorded in the land records of Chester County, Pennsylvania, at Deed Book ___________ and Page ______, (hereinafter "Property"); and

**WHEREAS**, the Landowner recognizes that the stormwater management best management practices or BMPs (hereinafter referred to as "BMP" or "BMP(s)") located on the Property at

_____________________________________________________________________________

_________________________________ (address of Property where BMP is located) must be inspected and maintained; and

**WHEREAS**, the Municipality and the Landowner, for itself and for its administrators, executors, successors, heirs, and assigns, agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that on-site BMP(s) be constructed and maintained on the Property; and

**WHEREAS**, for the purposes of this Agreement, the following definitions shall apply:

BMP – "Best Management Practice;" activities, facilities, designs, measures or procedures used to manage stormwater impacts from land development, to protect and maintain water quality and ground water recharge and to otherwise meet the purposes of the Municipality's Stormwater Management Ordinance, including, but not limited to infiltration trenches, dry wells, bioretention, rain gardens, permeable paving, rain barrels and cisterns, etc. The BMP(s) are permanent appurtenances to the Property; and

Conveyance – As specifically identified in the Simplified Stormwater Management Site Plan (herein after "Plan"), a man-made, existing or proposed facility, structure or channel used for the transportation or transmission of stormwater from one place to another, including pipes, drainage ditches, channels and swales (vegetated and other), gutters, and like facilities or features. The conveyances identified in the Plan are permanent appurtenances to the Property; and

**WHEREAS**, the Municipality requires that the BMP(s) and conveyances as shown on Plan and in accordance with the sizing calculations found on the Simplified Method Worksheet (herein after "Worksheet") be constructed by the Landowner; the BMP(s) shall further be maintained by the Landowner, its administrators, executors, successors, heirs, and assigns in accordance with the associated operation and maintenance requirements included herein. The Plan and Worksheet are attached hereto and incorporated herein together as Exhibit "A" hereto; and

**WHEREAS**, the Municipality requires that stormwater management BMP(s) be constructed and adequately inspected, operated and maintained by the Landowner, its administrators, executors, successors, heirs, and assigns, in accordance with the following maintenance requirements:

## 1. Infiltration Trenches

a. At least twice a year and after significant rainfall events the Landowner is to inspect the infiltration trench and remove any accumulated debris, sediment and invasive vegetation.

b. Vegetation along the surface of an infiltration trench is to be maintained in good condition, and any bare spots are to be revegetated as soon as possible.

c. Vehicles are not to be parked or driven on an infiltration trench, and care is to be taken to avoid excessive compaction by mowers.

d. Any debris, such as leaves blocking flow from reaching an infiltration trench, is to be routinely removed.

2. **Bioretention/Rain Garden**

   a. Any debris, such as leaves blocking flow from reaching a bioretention/rain garden, is to be routinely removed.
   b. Pruning and weeding are required as needed including removal of invasive species, especially while vegetation is being established for a bioretention/rain garden.
   c. Mulch cover is to be maintained in a bioretention/rain garden, re-spread and replaced as needed to prevent erosion, reduce weed growth and assist with plant survival, without restricting the infiltration of stormwater.
   d. At least twice a year the Landowner is to inspect the bioretention/rain garden for sediment buildup, ground cover and vegetative conditions and make any repairs as needed.
   e. Watering is required as needed, including during periods of extended dry weather and drought.
   f. Trees and shrubs in a bioretention/rain garden are to be inspected at least twice per year by the Landowner to evaluate their health. If they are in poor health they are to be replaced.

3. **Dry Wells**

   a. Dry wells are to be inspected by the landowner at least four (4) times a year and after significant rainfalls, and debris, trash, sediment, and any other waste material need to be removed and disposed of at suitable disposal or recycling sites and in compliance with local, state, and federal waste regulations.
   b. For dry wells, gutters are to be regularly cleaned out and ensure that proper connections are maintained to facilitate the effectiveness of the dry well.
   c. The filter screen for downspouts or roof gutters which intercepts roof runoff and conveys it to the dry well must be cleaned and replaced as necessary.
   d. Dry wells that are damaged are to be fixed or replaced within two (2) weeks of being damaged.
   e. If an intermediate sump box exists in conjunction with a dry well, it must be cleaned out at least once per year.

4. **Rain Barrels and Cisterns**

   a. Rain Barrels and Cisterns are to be cleared of debris routinely at least every three (3) months and after significant storms to allow stormwater from gutters to enter them.
   b. Gutters that directly convey rain water to dry wells, rain barrels, and cisterns are to be routinely cleared of trash and debris at least every three (3) months and after significant rainfall events.
   c. Rain Barrels and cisterns should be routinely emptied to allow for storage of additional rain water.
   d. Overflow outlets from rain barrels and cisterns must be kept free and clear of debris.
   e. Rain Barrels and cisterns that are damaged are to be fixed or replaced within two (2) weeks of being damaged.

**NOW, THEREFORE**, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto, intending to be legally bound hereby, agree as follows:

1. The foregoing recitals to this Agreement are incorporated as terms of this Agreement and obligations of the Landowner as if fully set forth in the body of this Agreement.

2. The Landowner shall construct the BMP(s) in accordance with the specifications identified in the Plan and Worksheet.

3. The Landowner shall inspect, operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality and in accordance with the specific inspection and maintenance requirements outlined in this Agreement.

4. The Landowner hereby grants permission to the Municipality, its authorized agents and employees, to enter upon the Property from the public right-of-way or roadway, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) whenever it deems necessary for compliance with this Agreement and the Municipality's Stormwater Ordinance. Whenever possible, the Municipality shall notify the Landowner prior to entering the Property.

5. The Landowner acknowledges that, per the Municipality's Stormwater Ordinance, it is unlawful, without written approval of the Municipality, to:
   1. Modify, remove, fill, landscape, alter or impair the effectiveness of any BMP or conveyance that is constructed as part of the Plan;
   2. Place any structure, fill, landscaping, additional vegetation, yard waste, brush cuttings, or other waste or debris into a BMP or conveyance that would limit or alter the functioning of the BMP or conveyance;
   3. Allow the BMP or conveyance to exist in a condition which does not conform to the Plan or this Agreement; and
   4. Dispose of, discharge, place or otherwise allow pollutants including, but not limited to, deicers, pool additives, household chemicals and automotive fluids to directly or indirectly enter any BMP or conveyance.

6. In the event the Landowner fails to operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality the Landowner shall be in violation of this Agreement and the

Landowner agrees that the Municipality or its representatives may, in addition to and not in derogation or diminution of any remedies available to it under the Stormwater Ordinance or other statutes, codes, rules or regulations, or this Agreement, enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s). It is expressly understood and agreed that the Municipality is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Municipality.

7. In the event the Municipality, pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality for all expenses (direct and indirect) incurred within thirty (30) calendar days of delivery of an invoice from the Municipality. Failure of the Landowner to make prompt payment to the Municipality may result in enforcement proceedings, which may include the filing of a lien against the Property, which filing is expressly authorized by the Landowner.

8. The intent and purpose of this Agreement is to ensure the proper maintenance of the onsite BMP(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or effect any additional liability of any party for damage alleged to result from or be caused by stormwater runoff.

9. The Landowner, its executors, administrators, assigns, heirs, and other successors in interests, hereby release and shall release the Municipality, its employees, agents and designated representatives from all damages, accidents, casualties, occurrences or claims which might arise or be asserted against the Municipality and/or its said employees, agents or representatives, arising out of the construction, presence, existence, or maintenance of the BMP(s) either by the Landowner or Municipality. In the event that a claim is asserted or threatened against the Municipality, its employees, agents or designated representatives, the Municipality shall notify the Landowner and the Landowner shall defend, at his own expense, any claim, suit, action or proceeding, or threatened claim, suit, action or proceeding against the Municipality or, at the request of the Municipality, pay the cost, including attorneys' fees, of defense of the same undertaken on behalf of the Municipality. If any judgment or claims against the Municipality, its employees, agents or designated representatives shall be allowed, the Landowner shall pay all damages, judgments or claims and any costs and expenses incurred by the Municipality, including attorneys fees, regarding said damages, judgment or claims.

10. The Municipality may enforce this Agreement in accordance with its Stormwater Ordinance, at law or in equity, against the Landowner for breach of this Agreement. Remedies may include fines, penalties, damages or such equitable relief as the parties may agree upon or as may be determined by a Court of competent jurisdiction. Recovery by the Municipality shall include its reasonable attorneys fees and costs incurred in seeking relief under this Agreement.

11. Failure or delay in enforcing any provision of this Agreement shall not constitute a waiver by the Municipality of its rights of enforcement hereunder.

12. The Landowner shall inform future buyers of the Property about the function of, operation, inspection and maintenance requirements of the BMP(s) prior to the purchase of the Property by said future buyer, and upon purchase of the Property the future buyer assumes all responsibilities as Landowner and must comply with all components of this Agreement.

13. This Agreement shall inure to the benefit of and be binding upon, the Municipality and the Landowner, as well as their heirs, administrators, executors, assigns and successors in interest.

This Agreement shall be recorded at the Office of the Recorder of Deeds of the County of Chester, Pennsylvania, and shall constitute a covenant running with the Property and/or equitable servitude, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Municipality:

____________________________________

(SEAL) For the Landowner:

____________________________________

ATTEST:

__________________________ (City, Borough, Township)
County of Chester, Pennsylvania

I, ________________________________, a Notary Public in and for the County and State aforesaid, whose commission expires on the _________ day of ________________, 20__, do hereby certify that ____________________________________ whose name(s) is/are signed to the foregoing Agreement bearing date of the __________ day of _________________, 20__, has acknowledged the same before me in my said County and State.

**GIVEN UNDER MY HAND THIS** ____________ day of __________, 20__.

NOTARY PUBLIC (SEAL)

# ORDINANCE APPENDIX B

# SITE DESIGN PROCESS

# NATURAL HYDROLOGY SITE DESIGN PROCESS

## INTRODUCTION

Section 304 identifies a natural hydrology site design process that strives to minimize disturbances to land, site hydrology, and natural resources, and maintain the natural hydrologic regime, drainage patterns and flow conditions of a site to the maximum extent practicable. This appendix is intended to build on that process by providing additional information for achieving site designs that best maintain pre-construction stormwater runoff conditions, protect site amenities, and preserve natural resources. This appendix describes the following components of the natural hydrology site design process:

- Design Principles and Techniques;
- Design Process;
- Design Practices; and
- References.

Some common drainage design approaches for land development radically alter natural hydrologic conditions by constructing collection and conveyance systems that are designed to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach has often led to the degradation of water quality, reduced groundwater recharge, and increased volumes of runoff, as well as the expenditure of additional resources for detaining and managing increased volumes of concentrated runoff at some downstream location.

The natural hydrology site design process encourages land development site designs that minimize post-development runoff rates and volumes, and that minimize needs for artificial conveyance and storage facilities. This process strives to incorporate the desired land development into the natural hydrologic landscape in a manner that maintains and utilizes existing site hydrology features and functions to minimize generation of new stormwater. This avoids cumulative environmental impacts often associated with land development, and reducing the need for and size of constructed stormwater facilities. This approach minimizes the disturbance of land area, natural features and site hydrology; preserves significant concentrations of open space, woodlands, and corridors of environmentally sensitive features; and incorporates landscape-based BMPs and low impact development techniques to minimize the utilization of more intrusive structural stormwater facilities.

With this design process, the primary goals of a land development project can be achieved while minimizing the negative environmental impacts and avoiding management costs associated with unnecessary stormwater runoff. The fundamental principle of this design process is that site hydrology features are considered "up front" in the land development design process and are prioritized as integral aspects to be maintained and utilized within the site design, rather than being first sacrificed for space needed for traditional site layout or for construction of more intrusive stormwater facilities.

Natural hydrology site design is not a new approach but rather a holistic process that combines certain principles of Low Impact Development, Conservation Design, and Sustainable Design, and focuses on reducing unnecessary alterations to the natural patterns and functions of existing on-site hydrologic features. These natural hydrologic features tend to perform their "hydrologic function" (i.e., infiltration, evapotranspiration, flow attenuation, pollutant removal, etc.) very efficiently and sometimes have the hydrologic capacity to perform that function on increased runoff loadings from the built environment. However, care must be taken to adequately characterize the capacity of their hydrologic function and avoid overwhelming the feature with excessive runoff loadings, thus causing unintended impairments that are completely counter-productive to the purpose of natural hydrology site design.

Preserving natural hydrologic conditions requires careful site design considerations. Natural hydrology site design should serve as the foundation of the overall site design approach, and when applied in conjunction with the design professional's overall land development goals and desired outcomes, can help shape the overall vision and conceptual layout of the land development project.

Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. Applying this site design process helps maintain site hydrology and manage stormwater by: minimizing the generation of stormwater runoff (achieved by designing to the land, considering site drainage patterns and infiltration characteristics, reducing grading and compaction, and considering scale and placement of buildings); managing stormwater as close to the point of generation as possible (by disconnecting impervious surfaces and distributing storm flows to landscaped-based BMPs); providing open and vegetated channel conveyance (as needed to treat water quality, reduce velocity and infiltrate); and managing remaining conveyed stormwater in common open space (as needed to disperse low velocity storm flows, treat water quality, infiltrate, and release). A well-designed site will contain a mix of all those features.

## DESIGN PRINCIPLES AND TECHNIQUES

Natural hydrology site design involves identifying and prioritizing natural resources and natural and man-made hydrologic features, and incorporating such features into the overall site design to take advantage of their efficiencies of hydrologic performance, their cost efficiencies of reducing the need for or size of constructed stormwater facilities, and their aesthetic amenities. The five Design Principles to be achieved by this approach are as follows:

- Minimize land disturbance – both surface and subsurface.
- Minimize the cumulative area to be covered by impervious and compacted surfaces.
- Designing to the land, so that the layout of constructed and landscape features utilizes the natural topography and minimizes grading.
- Design the constructed stormwater management system to take advantage of the natural hydrologic landscape to achieve the required stormwater runoff control standards.
- Refine the site design and layout to optimize the cumulative benefits of the natural

hydrologic features, the constructed stormwater management system, and the land development components to achieve the minimum post-construction runoff volume, peak discharge rates and pollutant loads from the proposed land development site.

Techniques to be applied to achieve the design principles are presented in Table B.1.

## DESIGN PROCESS

The first step in applying natural hydrology site design is to identify, delineate and assess the functions of all existing natural resources and natural and man-made hydrologic features that: are located within the project site; will receive discharge from the project site; or, may be impacted by runoff or disturbance from the proposed land development project. This includes:

- Streams, waterways, springs, wetlands, vernal pools, and water bodies;
- Drainage patterns, conveyances and discharge points;
- Natural infiltration areas and patterns;
- Areas of natural vegetation that provide significant evapotranspiration, pollutant removal, bank stabilization, flow attenuation, or riparian buffer functions;
- Floodplains; and
- Other features that contribute to the overall hydrologic function and value of the site and its receiving streams.

Once this inventory and assessment are completed, these identified resources and features are then prioritized for their ability to provide hydrologic function and performance for managing runoff from the proposed site improvements. Specifically, they should be prioritized as follows:

- Those to be incorporated into the site design in a manner that provides for their protection from any disturbance or impact from the proposed land development;
- Those to be protected from further disturbance or impact and for which the proposed land development will provide improvement to existing conditions;
- Those that can be incorporated into and utilized as components of the overall site design in a manner that protects or improves their existing conditions while utilizing their hydrologic function (e.g., for infiltration, evapotranspiration, or reducing pollutant loads, runoff volume or peak discharge rates, etc.) to reduce the need for or size of constructed BMPs; and
- Those that may be considered for alteration, disturbance or removal.

These prioritizations are then applied as the basis on which to begin the site design lay-out, grading, construction, and permanent ground cover designs to achieve the five (5) Design Principles outlined above. The following section describes just a few of the many design practices, methods and techniques that are available to achieve the landowner's desired land development goals and the desired environmental efficiencies intended by natural hydrology site design.

## Table B.1 – Site Design Process Principles and Techniques

| Design Principles | Design Techniques |
|---|---|
| **Minimize land disturbance – both surface and subsurface.** | • Maintain the natural soil structure and vegetative cover that are often critical components of maintaining the hydrologic functions of natural infiltration, bioretention, flow attenuation, evapotranspiration, and pollutant removal.<br>• Protect, or improve, natural resources to reduce the needs for environmental mitigation, future environmental restoration, and cumulative flow and water quality impacts of unnecessary disturbances within the watershed system.<br>• Minimize the disturbance of natural surface and groundwater drainage features and patterns, discharge points and flow characteristics, natural infiltration and evapotranspiration patterns and characteristics, natural stream channel stability, and floodplain conveyance, etc. |
| **Minimize the cumulative area to be covered by impervious and compacted surfaces.** | • Minimize the size of individual impervious surfaces.<br>• Separate large impervious surfaces into smaller components.<br>• Disconnect runoff from one impervious surface to another.<br>• Avoid unnecessary impervious surfaces.<br>• Utilize porous materials where suited in lieu of impervious materials. |
| **Designing to the land, so that the layout of constructed and landscape features utilizes the natural topography and minimizes grading.** | • Prioritize on-site hydrologic features (i.e., for protection, improvement, utilization, or alteration) and natural site drainage patterns and infiltration characteristics and consider them for the cornerstones of the conceptual site design.<br>• Reduce grading and compaction by applying selective grading design methods to provide final grading patterns tthat preserve existing topography where it most benefits natural hydrologic functions and where needed; this results in graded areas that evenly distribute runoff and minimize concentrated runoff flows.<br>• Consider the scale and placement of buildings and other infrastructure to minimize impact to natural hydrologic features.<br>• Incorporate unique natural, scenic, and historic site features into the configuration of the development, and ensure flexibility in development design to meet community needs for complimentary and aesthetically pleasing development, such as can be achieved through Conservation Design and Sustainable Design approaches. |

| Design Principles | Design Techniques |
|---|---|
| **Design the constructed stormwater management system to take advantage of the natural hydrologic landscape to achieve the required stormwater runoff control standards.** | • Incorporate natural hydrologic features that have been selected for their available capacity and function into the overall system of site runoff controls.<br>• Incorporate Low Impact Development (or similar) BMPs and distribute storm flows to:<br>o Reduce runoff;<br>o Manage stormwater at or as close to the point of generation as possible;<br>o Disconnect discharges from streets and municipal storm sewer systems; and<br>o Select and design BMPs to give first priority to nonstructural and vegetation (landscape-based) BMPs, second priority to surface structural BMPs, third priority to subsurface structural BMPs, and design subsurface BMPs as shallow as possible.<br>• Provide open channel conveyance, as needed, to:<br>o Treat water quality;<br>o Reduce runoff velocity; and<br>o Promote infiltratation and evapotranspiration of runoff.<br>• Manage remaining conveyed stormwater from small storms in common open space areas to achieve multiple objectives:<br>o Disperse storm flows and reduce velocity;<br>o Treat water quality; and<br>o Promote infiltrate and evapotranspiration of runoff.<br>• Provide for appropriate conveyance to retention or detention storage facilities as needed for flows from large storm events.<br>• Maintain open space functions consistent with common area uses (passive recreation, on-site sewage management, scenic vistas, etc). |
| **Refine the site design and layout to optimize the cumulative benefits of the natural hydrologic features, the constructed stormwater management system, and the land development components to achieve the minimum post-construction runoff volume, peak discharge rates and pollutant loads from the proposed land development site.** | Apply site design techniques and practices as appropriate based on:<br>• Conservation Design principles and practices.<br>• Sustainable Design principles and practices.<br>• Low Impact Development Design principles and practices. |

## DESIGN PRACTICES

Numerous practices and strategies can be considered where their aim is to sustain and utilize the benefits of existing site hydrology and minimize the generation of new stormwater runoff. Following are brief descriptions of various practices that can be used to achieve the principles of the natural hydrology site design process.

### Site Layout Practices

The following site layout practices are but a few of the methods by which the natural hydrology site design process described above can be implemented. Such practices are less functions of regimented codes and procedures than about understanding and recognizing the benefits and values that existing resources can contribute to the desired outcomes of the land development project. In some circumstances, communication among design engineers, land planning and environmental professionals, knowledgeable developers, community representatives, and regulatory authorities is also beneficial to combine their collective understanding and perspectives to create effective planning efforts.

***Preserving Natural Drainage Features***. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. Unfortunately, some common land development practices encourage just the opposite pattern -- streets and adjacent storm sewers typically are located in the natural headwater valleys and swales, thereby replacing natural drainage functions with an impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Designing developments to fit site topography retains much of the natural drainage function. In addition, designing with the land minimizes the amount of site grading, reduces the amount of compaction that can alter site infiltration characteristics, and can result in cost savings to the developer.

***Protecting Natural Depression Storage Areas***. Depressional storage areas have no surface outlet, or drain very slowly following a storm event. They can be commonly seen as ponded areas in fields during the wet season or after large runoff events. Some development practices eliminate these depressions by filling or draining, thereby eliminating their ability to reduce surface runoff volumes and trap pollutants. The volume and release-rate characteristics of depressions should be protected in the design of the development site to assist in reducing runoff volumes and reducing runoff rates. Designing around the depression, or incorporating its storage as additional capacity in required detention facilities, treats this area as a site amenity rather than a detriment.

***Avoiding Introduction of Impervious Areas***. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways, and other features producing impervious surfaces should be evaluated to minimize impacts on runoff. In many instances, municipalities have the ability to reduce impervious cover by providing incentives or opportunities in their zoning and subdivision/ land development ordinances to reduce road width, reduce or modify cul-de-sac dimensions, reduce or modify curbing requirements, and reduce or modify sidewalk requirements.

***Disconnecting Impervious Surfaces.*** Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as storm sewer). Two basic ways to reduce hydraulic connectivity are routing roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff from these sources, and should help reduce concentration of runoff to a single point within the project site.

***Routing Roof Runoff Over Lawns.*** Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connections of downspouts to "driveway-to-street-to-storm sewers" or parking lots. The practice also discourages sloping driveways and parking lots to the street. Crowning the driveway, to run off to the lawn, uses the lawn as a filter strip.

***Reducing Street Widths.*** Street widths can be reduced by either eliminating on-street parking and/or by reducing roadway widths. Designers should select the narrowest practical street width for the design conditions (speed, curvature, etc.). Narrower neighborhood streets should be considered and encouraged under select conditions. Reduced street widths also can lower maintenance needs and costs.

***Limiting Sidewalks to One Side of the Street.*** A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines as an alternative to reduced sidewalks, where appropriate.

***Reducing Building Setbacks.*** Reducing building setbacks (from streets) reduces the size of impervious areas of driveways and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

***Constructing Compact Developments or Conservation Design*:** Low impact cluster or compact development can reduce the amount of impervious area for a given number of lots. Savings result from reduced street length, which also contributes to a reduction in development and long-term maintenance costs. Reduced site disturbance and preservation of open space help buffer sensitive natural areas and retain more of a site's natural hydrology. Development can be designed so that areas of high infiltration soils are reserved as stormwater infiltration areas. Construction activity can be focused onto les -sensitive areas without affecting the gross density of development.

## Stormwater Best Management Practices

Stormwater best management practices (BMPs) are intended to supplement natural hydrology site design techniques where needed. Structural in nature, such practices include bioretention facilities, rain gardens, swales and other engineered stormwater BMPs. Listed here are techniques intended to help manage stormwater predominantly at or near the source, rather than traditional techniques that largely release runoff over an extended period of time to adjacent properties and streams. This list, in no way exhaustive, gives examples of a few of the most common practices.

***Bioretention.*** This type of BMP combines open space with stormwater treatment. Soil and plants, rather than sand filters, treat and store runoff. Infiltration and evapotranspiration are achieved, often coupled with an underdrain to collect water not infiltrated or used in the root zone.

***Rain Gardens.*** Typically rain gardens are shallow depression areas containing a mix of water tolerant native plant species. The intent is to capture runoff for storage and use in the root zone of plants. Intended largely as a way of managing stormwater through evapotranspiration (ET), rain gardens often function as infiltration facilities as well.

***Reducing the Need for Storm Sewers.*** Increasing the use of natural or vegetated drainage swales can reduce the need for extending storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a "reasonable" time. The practice requires educating local citizens, who may expect runoff to disappear shortly after a rainfall event.

***Using Permeable Paving Materials.*** These materials include permeable interlocking concrete paving blocks or porous bituminous concrete, among others. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads. Surfaces for which seal coats may be applied should refrain from using permeable paving materials.

## SOURCES

*Conservation Design for Stormwater Management*, Delaware Department of Natural Resources and Environmental Control and the Brandywine Conservancy, September 1997.

*Conservation Design: Techniques for Preserving Natural Hydrologic Functions*, White Paper prepared for New Castle County, Delaware Drainage Code, John M. Gaadt, AICP, September 2007.

*Growing Greener, Conservation by Design*, a program of the Natural Lands Trust, www.natlands.org/.

Guidance on MS4 Ordinance Provisions, Document Number 392-0300-003, by the Pennsylvania Department of Environmental Protection.

Low Impact Development Center, http://www.lowimpactdevelopment.org/.

PA Department of Environmental Protection, Best Management Practices Manual, 2006.

# ORDINANCE APPENDIX C

# RUNOFF COEFFICIENTS AND CURVE NUMBERS

**TABLE C-1. RUNOFF CURVE NUMBERS**

*Source:* Table 2-2a, Table 2-2b, and Table 2-2c from U. S. Department of Agriculture, Natural Resources Conservation Service, June 1986, *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*, Second Edition.

**TABLE C-2. RATIONAL RUNOFF COEFFICIENTS**

*Source:* Table F.2 from Delaware County Planning Department, December 2011, *Crum Creek Watershed Act 167 Stormwater Management Plan*.

**TABLE C-3. MANNING'S 'n' VALUES**

*Source:* Table 3-1 from United States Army Corps of Engineers, January 2010, *HEC-RAS River Analysis System, Hydraulic Reference Manual*, Version 4.1.

**FIGURE C-1. REDEVELOPMENT PROJECTS RUNOFF CRITERIA ADJUSTMENT FOR PRE-DEVELOPMENT CONDITIONS**

*Source:* Figure B-3 from the Delaware County Planning Department and Chester County Planning Commission, June 2002, *Act 167 Stormwater Management Plan Chester Creek Watershed.*

**TABLE C-1. RUNOFF CURVE NUMBERS**
(3 pages)

*Source:* Table 2-2a, Table 2-2b, and Table 2-2c from U. S. Department of Agriculture, Natural Resources Conservation Service, June 1986, *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*, Second Edition.

## TABLE C-2. RATIONAL RUNOFF COEFFICIENTS
(1 page)

*Source:* Table F.2 from Delaware County Planning Department, December 2011, *Crum Creek Watershed Act 167 Stormwater Management Plan*.

## TABLE C-3. MANNING'S 'n' VALUES

(3 pages)

*Source:* Table 3-1 from United States Army Corps of Engineers, January 2010, *HEC-RAS River Analysis System, Hydraulic Reference Manual*, Version 4.1.

**Table 2-2a** Runoff curve numbers for urban areas [1]

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type and hydrologic condition | Average percent impervious area [2] | A | B | C | D |
| *Fully developed urban areas (vegetation established)* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.) [3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only) [4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| *Developing urban areas* | | | | | |
| Newly graded areas (pervious areas only, no vegetation) [5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

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[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

**Table 2-2b** Runoff curve numbers for cultivated agricultural lands [1/]

| Cover description | | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|---|
| Cover type | Treatment [2/] | Hydrologic condition [3/] | A | B | C | D |
| Fallow | Bare soil | — | 77 | 86 | 91 | 94 |
| | Crop residue cover (CR) | Poor | 76 | 85 | 90 | 93 |
| | | Good | 74 | 83 | 88 | 90 |
| Row crops | Straight row (SR) | Poor | 72 | 81 | 88 | 91 |
| | | Good | 67 | 78 | 85 | 89 |
| | SR + CR | Poor | 71 | 80 | 87 | 90 |
| | | Good | 64 | 75 | 82 | 85 |
| | Contoured (C) | Poor | 70 | 79 | 84 | 88 |
| | | Good | 65 | 75 | 82 | 86 |
| | C + CR | Poor | 69 | 78 | 83 | 87 |
| | | Good | 64 | 74 | 81 | 85 |
| | Contoured & terraced (C&T) | Poor | 66 | 74 | 80 | 82 |
| | | Good | 62 | 71 | 78 | 81 |
| | C&T+ CR | Poor | 65 | 73 | 79 | 81 |
| | | Good | 61 | 70 | 77 | 80 |
| Small grain | SR | Poor | 65 | 76 | 84 | 88 |
| | | Good | 63 | 75 | 83 | 87 |
| | SR + CR | Poor | 64 | 75 | 83 | 86 |
| | | Good | 60 | 72 | 80 | 84 |
| | C | Poor | 63 | 74 | 82 | 85 |
| | | Good | 61 | 73 | 81 | 84 |
| | C + CR | Poor | 62 | 73 | 81 | 84 |
| | | Good | 60 | 72 | 80 | 83 |
| | C&T | Poor | 61 | 72 | 79 | 82 |
| | | Good | 59 | 70 | 78 | 81 |
| | C&T+ CR | Poor | 60 | 71 | 78 | 81 |
| | | Good | 58 | 69 | 77 | 80 |
| Close-seeded or broadcast legumes or rotation meadow | SR | Poor | 66 | 77 | 85 | 89 |
| | | Good | 58 | 72 | 81 | 85 |
| | C | Poor | 64 | 75 | 83 | 85 |
| | | Good | 55 | 69 | 78 | 83 |
| | C&T | Poor | 63 | 73 | 80 | 83 |
| | | Good | 51 | 67 | 76 | 80 |

[1] Average runoff condition, and $I_a$=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

**Table 2-2c** Runoff curve numbers for other agricultural lands [1]

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type | Hydrologic condition | A | B | C | D |
| Pasture, grassland, or range—continuous forage for grazing. [2] | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Meadow—continuous grass, protected from grazing and generally mowed for hay. | — | 30 | 58 | 71 | 78 |
| Brush—brush-weed-grass mixture with brush the major element. [3] | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | 30 [4] | 48 | 65 | 73 |
| Woods—grass combination (orchard or tree farm). [5] | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | 79 |
| Woods. [6] | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | 30 [4] | 55 | 70 | 77 |
| Farmsteads—buildings, lanes, driveways, and surrounding lots. | — | 59 | 74 | 82 | 86 |

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[1] Average runoff condition, and $I_a = 0.2S$.

[2] *Poor:* <50%) ground cover or heavily grazed with no mulch.
*Fair:* 50 to 75% ground cover and not heavily grazed.
*Good:* > 75% ground cover and lightly or only occasionally grazed.

[3] *Poor:* <50% ground cover.
*Fair:* 50 to 75% ground cover.
*Good:* >75% ground cover.

[4] Actual curve number is less than 30; use CN = 30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6] *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.
*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.

# TABLE F-2

# RATIONAL RUNOFF COEFFICIENTS

| | HYDROLOGIC SOIL GROUP | | | |
|---|---|---|---|---|
| LAND USE DESCRIPTION | A | B | C | D |
| Cultivated land : without conservation treatment | .49 | .67 | .81 | .88 |
| : with conservation treatment | .27 | .43 | .61 | .67 |
| Pasture or range land: poor condition | .38 | .63 | .78 | .84 |
| : good condition | ---* | .25 | .51 | .65 |
| Meadow: good condition | ---* | ---* | .44 | .61 |
| Woods: thin stand, poor cover, no mulch | ---* | .34 | .59 | .70 |
| : good cover | ---* | ---* | .45 | .59 |
| Open spaces, lawns, parks, golf courses, cemeteries | | | | |
| Good condition: grass cover on 75% or more of the area | ---* | .25 | .51 | .65 |
| Fair condition: grass cover on 50% to 75% of the area | ---* | .45 | .63 | .74 |
| Commercial and business areas (85% impervious) | .84 | .90 | .93 | .96 |
| Industrial districts (72% impervious) | .67 | .81 | .88 | .92 |
| Residential: | | | | |
| Average lot size Average % impervious | | | | |
| 1/8 acre or less 65 | .59 | .76 | .86 | .90 |
| 1/4 acre 38 | .25 | .49 | .67 | .78 |
| 1/3 acre 30 | ---* | .49 | .67 | .78 |
| 1/2 acre 25 | ---* | .45 | .65 | .76 |
| 1 acre 20 | ---* | .41 | .63 | .74 |
| Paved parking lots, roofs, driveways, etc. | .99 | .99 | .99 | .99 |
| Streets and roads: | | | | |
| Paved with curbs and storm sewers | .99 | .99 | .99 | .99 |
| Gravel | .57 | .76 | .84 | .88 |
| Dirt | .49 | .69 | .80 | .84 |

Notes: Values are based on SCS definitions and are average values.
Values indicated by ---* should be determined by the design engineer based on site characteristics.

Source : New Jersey Department of Environmental Protection, Technical Manual for Stream Encroachment, August 1984

### *Table 3-1 Manning's 'n' Values*

| Type of Channel and Description | Minimum | Normal | Maximum |
|---|---|---|---|
| A. *Natural Streams* | | | |
| 1. **Main Channels** | | | |
| a. Clean, straight, full, no rifts or deep pools | 0.025 | 0.030 | 0.033 |
| b. Same as above, but more stones and weeds | 0.030 | 0.035 | 0.040 |
| c. Clean, winding, some pools and shoals | 0.033 | 0.040 | 0.045 |
| d. Same as above, but some weeds and stones | 0.035 | 0.045 | 0.050 |
| e. Same as above, lower stages, more ineffective slopes and sections | 0.040 | 0.048 | 0.055 |
| f. Same as "d" but more stones | 0.045 | 0.050 | 0.060 |
| g. Sluggish reaches, weedy. deep pools | 0.050 | 0.070 | 0.080 |
| h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush | 0.070 | 0.100 | 0.150 |
| 2. **Flood Plains** | | | |
| a. Pasture no brush | | | |
| 1. Short grass | 0.025 | 0.030 | 0.035 |
| 2. High grass | 0.030 | 0.035 | 0.050 |
| b. Cultivated areas | | | |
| 1. No crop | 0.020 | 0.030 | 0.040 |
| 2. Mature row crops | 0.025 | 0.035 | 0.045 |
| 3. Mature field crops | 0.030 | 0.040 | 0.050 |
| c. Brush | | | |
| 1. Scattered brush, heavy weeds | 0.035 | 0.050 | 0.070 |
| 2. Light brush and trees, in winter | 0.035 | 0.050 | 0.060 |
| 3. Light brush and trees, in summer | 0.040 | 0.060 | 0.080 |
| 4. Medium to dense brush, in winter | 0.045 | 0.070 | 0.110 |
| 5. Medium to dense brush, in summer | 0.070 | 0.100 | 0.160 |
| d. Trees | | | |
| 1. Cleared land with tree stumps, no sprouts | 0.030 | 0.040 | 0.050 |
| 2. Same as above, but heavy sprouts | 0.050 | 0.060 | 0.080 |
| 3. Heavy stand of timber, few down trees, little undergrowth, flow below branches | 0.080 | 0.100 | 0.120 |
| 4. Same as above, but with flow into branches | 0.100 | 0.120 | 0.160 |
| 5. Dense willows, summer, straight | 0.110 | 0.150 | 0.200 |
| 3. **Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged** | | | |
| a. Bottom: gravels, cobbles, and few boulders | 0.030 | 0.040 | 0.050 |
| b. Bottom: cobbles with large boulders | 0.040 | 0.050 | 0.070 |

*Table 3-1 (Continued) Manning's 'n' Values*

| Type of Channel and Description | Minimum | Normal | Maximum |
|---|---|---|---|
| B. *Lined or Built-Up Channels* | | | |
| 1. **Concrete** | | | |
| a. Trowel finish | 0.011 | 0.013 | 0.015 |
| b. Float Finish | 0.013 | 0.015 | 0.016 |
| c. Finished, with gravel bottom | 0.015 | 0.017 | 0.020 |
| d. Unfinished | 0.014 | 0.017 | 0.020 |
| e. Gunite, good section | 0.016 | 0.019 | 0.023 |
| f. Gunite, wavy section | 0.018 | 0.022 | 0.025 |
| g. On good excavated rock | 0.017 | 0.020 | |
| h. On irregular excavated rock | 0.022 | 0.027 | |
| 2. **Concrete bottom float finished with sides of:** | | | |
| a. Dressed stone in mortar | 0.015 | 0.017 | 0.020 |
| b. Random stone in mortar | 0.017 | 0.020 | 0.024 |
| c. Cement rubble masonry, plastered | 0.016 | 0.020 | 0.024 |
| d. Cement rubble masonry | 0.020 | 0.025 | 0.030 |
| e. Dry rubble on riprap | 0.020 | 0.030 | 0.035 |
| 3. **Gravel bottom with sides of:** | | | |
| a. Formed concrete | 0.017 | 0.020 | 0.025 |
| b. Random stone in mortar | 0.020 | 0.023 | 0.026 |
| c. Dry rubble or riprap | 0.023 | 0.033 | 0.036 |
| 4. **Brick** | | | |
| a. Glazed | 0.011 | 0.013 | 0.015 |
| b. In cement mortar | 0.012 | 0.015 | 0.018 |
| 5. **Metal** | | | |
| a. Smooth steel surfaces | 0.011 | 0.012 | 0.014 |
| b. Corrugated metal | 0.021 | 0.025 | 0.030 |
| 6. **Asphalt** | | | |
| a. Smooth | 0.013 | 0.013 | |
| b. Rough | 0.016 | 0.016 | |
| 7. **Vegetal lining** | 0.030 | | 0.500 |

*Table 3-1 (Continued) Manning's 'n' Values*

| Type of Channel and Description | Minimum | Normal | Maximum |
|---|---|---|---|
| C. *Excavated or Dredged Channels* | | | |
| 1. **Earth, straight and uniform** | | | |
| a. Clean, recently completed | 0.016 | 0.018 | 0.020 |
| b. Clean, after weathering | 0.018 | 0.022 | 0.025 |
| c. Gravel, uniform section, clean | 0.022 | 0.025 | 0.030 |
| d. With short grass, few weeds | 0.022 | 0.027 | 0.033 |
| 2. **Earth, winding and sluggish** | | | |
| a. No vegetation | 0.023 | 0.025 | 0.030 |
| b. Grass, some weeds | 0.025 | 0.030 | 0.033 |
| c. Dense weeds or aquatic plants in deep channels | 0.030 | 0.035 | 0.040 |
| d. Earth bottom and rubble side | 0.028 | 0.030 | 0.035 |
| e. Stony bottom and weedy banks | 0.025 | 0.035 | 0.040 |
| f. Cobble bottom and clean sides | 0.030 | 0.040 | 0.050 |
| 3. **Dragline-excavated or dredged** | | | |
| a. No vegetation | 0.025 | 0.028 | 0.033 |
| b. Light brush on banks | 0.035 | 0.050 | 0.060 |
| 4. **Rock cuts** | | | |
| a. Smooth and uniform | 0.025 | 0.035 | 0.040 |
| b. Jagged and irregular | 0.035 | 0.040 | 0.050 |
| 5. **Channels not maintained, weeds and brush** | | | |
| a. Clean bottom, brush on sides | 0.040 | 0.050 | 0.080 |
| b. Same as above, highest stage of flow | 0.045 | 0.070 | 0.110 |
| c. Dense weeds, high as flow depth | 0.050 | 0.080 | 0.120 |
| d. Dense brush, high stage | 0.080 | 0.100 | 0.140 |

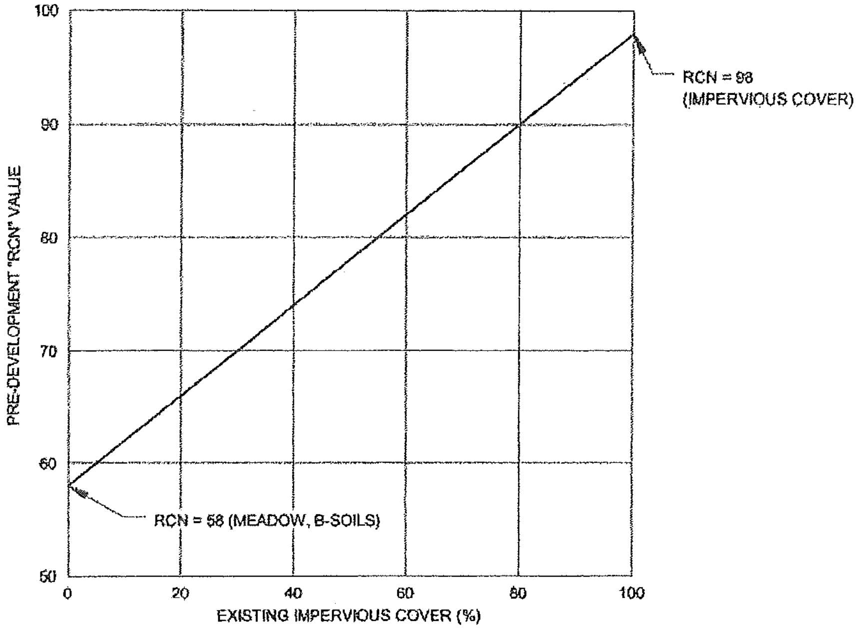
Other sources that include pictures of selected streams as a guide to n value determination are available (Fasken, 1963; Barnes, 1967; and Hicks and Mason, 1991). In general, these references provide color photos with tables of calibrated n values for a range of flows.

Although there are many factors that affect the selection of the n value for the channel, some of the most important factors are the type and size of materials that compose the bed and banks of a channel, and the shape of the channel. Cowan (1956) developed a procedure for estimating the effects of these factors to determine the value of Manning's n of a channel. In Cowan's procedure, the value of n is computed by the following equation:

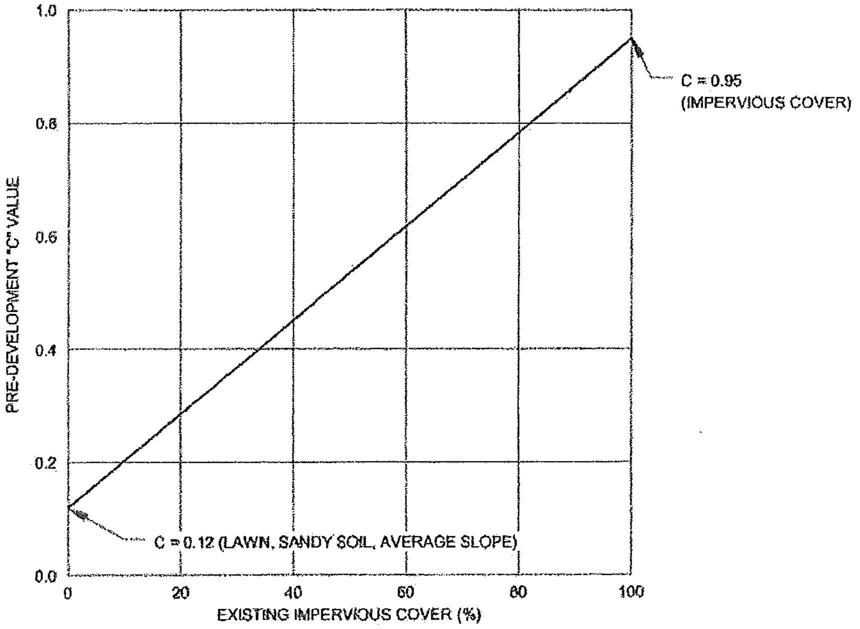
# FIGURE C-1

## REDEVELOPMENT PROJECTS
## RUNOFF CRITERIA ADJUSTMENT FOR PRE-DEVELOPMENT CONDITIONS

### NRCS METHODOLOGY
### RCN ADJUSTMENT



### RATIONAL FORMULA
### C ADJUSTMENT



# ORDINANCE APPENDIX D

# WEST NILE VIRUS DESIGN GUIDANCE

# WEST NILE VIRUS GUIDANCE

(This source is from the Monroe County, PA Conservation District that researched the potential of West Nile Virus problems from BMPs due to a number of calls they were receiving)

## Monroe County Conservation District Guidance: Stormwater Management and West Nile Virus

**Source: Brodhead McMichaels Creeks Watershed Act 167 Stormwater Management Ordinance Final Draft 2/23/04**

The Monroe County Conservation District recognizes the need to address the problem of nonpoint source pollution impacts caused by runoff from impervious surfaces. The new stormwater policy being integrated into Act 167 stormwater management regulations by the PA Department of Environmental Protection (PADEP) will make nonpoint pollution controls an important component of all future plans and updates to existing plans. In addition, to meet post-construction anti-degradation standards under the state National Pollutant Discharge Elimination System (NPDES) permitting program, applicants will be required to employ Best Management Practices (BMPs) to address nonpoint pollution concerns.

Studies conducted throughout the United States have shown that wet basins and in particular constructed wetlands are effective in traditional stormwater management areas such as channel stability and flood control and are one of the most effective ways to remove stormwater pollutants (United States Environmental Protection Agency 1991, Center for Watershed Protection 2000). From Maryland to Oregon, studies have shown that as urbanization and impervious surfaces increase in a watershed, the streams in those watersheds become degraded (CWP 2000). Although there is debate over the threshold of impervious cover when degradation becomes apparent (some studies show as little as 6% while others show closer to 20%), there is agreement that impervious surfaces cause nonpoint pollution in urban and urbanizing watersheds and that degradation is ensured if stormwater BMPs are not implemented.

Although constructed wetlands and ponds are desirable from a water quality perspective, there may be concerns about the possibility of these stormwater management structures becoming breeding grounds for mosquitoes. The Conservation District feels that although it may be a valid concern, **municipalities should not adopt ordinance provisions prohibiting wet basins for stormwater management.**

## Mosquitoes

The questions surrounding mosquito production in wetlands and ponds have intensified in recent years by the outbreak of the mosquito-borne West Nile Virus. As is the case with all vector-borne maladies, the life cycle of West Nile Virus is complicated, traveling from mosquito to bird, back to mosquito, and then to other animals including humans. *Culex pipiens* was identified as the vector species in the first documented cases from New York in 1999. This species is still considered the primary transmitter of the disease across its range. Today there are some 60 species of mosquitoes that inhabit Pennsylvania. Along with *C. pipiens*, three other species have been identified as vectors of West Nile Virus while four more have been identified as potential vectors.

The four known vectors in NE Pennsylvania are *Culex pipiens*, *C. restuans*, *C. salinarius*, and *Ochlerotatus japonicus*. All four of these species prefer, and almost exclusively use, artificial containers (old tires, rain gutters, birdbaths, etc.) as larval habitats. In the case of *C. pipiens*, the most notorious of the vector mosquitoes, the dirtier the water, the better they like it. The important factor is that these species do not thrive in functioning wetlands where competition for resources and predation by larger aquatic and terrestrial organisms is high.

The remaining four species, *Aedes vexans*, *Ochlerotatus Canadensis*, *O. triseriatus*, and *O. trivittatus*, are currently considered potential vectors due to laboratory tests (except the *O. trivittatus*, which did have one confirmed vector pool for West Nile Virus in PA during 2002). All four of these species prefer vernal habitats and ponded woodland areas following heavy summer rains. These species may be the greatest threat of disease transmission around stormwater basins that pond water for more than four days. This can be mitigated, however, by establishing ecologically functioning wetlands.

## Stormwater Facilities

If a stormwater wetland or pond is constructed properly and a diverse ecological community develops, mosquitoes should not become a problem. Wet basins and wetlands constructed as stormwater management facilities should be designed to attract a diverse wildlife community. If a wetland is planned, proper hydrologic soil conditions and the establishment of hydrophytic vegetation will promote the population of the wetland by amphibians and other mosquito predators. In natural wetlands, predatory insects and amphibians are effective at keeping mosquito populations in check during the larval stage of development while birds and bats prey on adult mosquitoes.

The design of a stormwater wetland must include the selection of hydrophytic plant species for their pollutant uptake capabilities and for not contributing to the potential for vector mosquito breeding. In particular, species of emergent vegetation with little submerged growth are preferable. By limiting the vegetation growing below the water surface, larvae lose protective cover, and there is less chance of anaerobic conditions occurring in the water.

Stormwater ponds can be designed for multiple purposes. When incorporated into an open space design, a pond can serve as a stormwater management facility and a community amenity. Aeration fountains and stocked fish should be added to keep larval mosquito populations in check.

Publications from the PA Department of Health and the Penn State Cooperative Extension concerning West Nile Virus identify aggressive public education about the risks posed by standing water in artificial containers (tires, trash cans, rain gutters, bird baths) as the most effective method to control vector mosquitoes.

## Conclusion

The Conservation District understands the pressure faced by municipalities when dealing with multifaceted issues such as stormwater management and encourages the incorporation of water quality management techniques into stormwater designs. As Monroe County continues to grow, conservation design, infiltration, and constructed wetlands and ponds should be among the preferred design options to reduce the impacts of increases in impervious surfaces. When designed and constructed appropriately, the runoff mitigation benefits to the community from these design options will far outweigh their potential to become breeding grounds for mosquitoes.

# ORDINANCE APPENDIX E

# STORMWATER
# BEST MANAGEMENT PRACTICES
# AND CONVEYANCES
# OPERATION AND MAINTENANCE AGREEMENT

## SAMPLE AGREEMENT

REVISED
Chester County Water Resources Authority
February 19, 2013

# STORMWATER BEST MANAGEMENT PRACTICES (BMPs) AND CONVEYANCES
# OPERATION AND MAINTENANCE AGREEMENT

**THIS AGREEMENT**, made and entered into this ____________ day of _________, 20___, by and between _________________________________________, (hereinafter the "Landowner"), and ___________________________________, Chester County, Pennsylvania, (hereinafter "Municipality");

## WITNESSETH

**WHEREAS**, the Landowner is the owner of certain real property by virtue of a deed of conveyance recorded in the land records of Chester County, Pennsylvania, at Deed Book ___________ and Page ______, (hereinafter "Property"); and

**WHEREAS**, the Landowner is proceeding to build and develop the Property; and

**WHEREAS**, the stormwater Best Management Practices (herein after BMP(s)) And Conveyances Operations and Maintenance Plan approved by the Municipality (hereinafter referred to as the "O&M Plan") for the Property, which is attached hereto as Appendix A and made part hereof, provides for management of stormwater within the confines of the Property through the use of BMP(s) and conveyances; and

**WHEREAS**, the Municipality and the Landowner, for itself and its administrators, executors, successors, heirs, and assigns, agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that stormwater BMP(s) and conveyances be constructed and maintained on the Property; and

**WHEREAS**, for the purposes of this agreement, the following definitions shall apply:
**BMP – "Best Management Practice"** –Those activities, facilities, designs, measures, or procedures as specifically identified in the O&M Plan, used to manage stormwater impacts from land development, to meet state water quality requirements, to promote groundwater recharge, and to otherwise meet the purposes of the Municipality's Stormwater Management Ordinance. BMPs may include, but are not limited to, a wide variety of practices and devices, from large-scale retention ponds and constructed wetlands to small-scale underground treatment systems, infiltration facilities, filter strips, low impact design, bioretention, wet ponds, permeable paving, grassed swales, riparian or forested buffers, sand filters, detention basins, manufactured devices, and operational and/or behavior-related practices that attempt to minimize the contact of pollutants with stormwater runoff. The BMPs indentified in the O&M Plan are permanent appurtenances to the Property; and

**Conveyance** – As specifically identified in the O&M Plan, a man-made, existing or proposed facility, structure or channel used for the transportation or transmission of stormwater from one place to another, including pipes, drainage ditches, channels and swales (vegetated and other), gutters, stream channels, and like facilities or features. The conveyances identified in the O&M Plan are permanent appurtenances to the Property; and

**WHEREAS,** the Municipality requires, through the implementation of the O&M Plan, that stormwater management BMPs and conveyances, as required by said O&M Plan and the Municipality's Stormwater Management Ordinance, be constructed and adequately inspected, operated and maintained by the Landowner, its administrators, executors, successors in interest, heirs, and assigns.

**NOW, THEREFORE,** in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto, intending to be legally bound hereby, agree as follows:

1. The foregoing recitals to this Agreement are incorporated as terms of this Agreement as if fully set forth in the body of this Agreement.

2. The Landowner shall construct the BMP(s) and conveyance(s) in accordance with the final design plans and specifications as approved by the Municipality ______________________________________(title of approved plans) _____________(date).

3. The Landowner shall inspect, operate and maintain the BMP(s) and conveyance(s) as shown on the O&M Plan in good working order acceptable to the Municipality and in accordance with the specific inspection and maintenance requirements in the approved O&M Plan.

4. The Landowner hereby grants permission to the Municipality, its authorized agents and employees, to enter upon the Property from a public right-of-way or roadway, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) and conveyance(s) whenever it deems necessary for compliance with this Agreement, the O&M Plan and the Municipality's Stormwater Management Ordinance. Whenever possible, the Municipality shall notify the Landowner prior to entering the Property.

5. The Municipality intends to inspect the BMP(s) and conveyance(s) at a minimum of once every [__________] years to determine if they continue to function as required.

6. The Landowner acknowledges that, per the Municipality's Stormwater Ordinance, it is unlawful, without written approval of the Municipality, to:
    a. Modify, remove, fill, landscape, alter or impair the effectiveness of any BMP or conveyance that is constructed as part of the approved O&M Plan;
    b. Place any structure, fill, landscaping, additional vegetation, yard waste, brush cuttings, or other waste or debris into a BMP or conveyance that would limit or alter the functioning of the BMP or conveyance;
    c. Allow the BMP or conveyance to exist in a condition which does not conform to the approved O&M Plan or this Agreement; and
    d. Dispose of, discharge, place or otherwise allow pollutants including, but not limited to, deicers, pool additives, household chemicals, and automotive fluids to directly or indirectly enter any BMP or conveyance.

7. In the event that the Landowner fails to operate and maintain the BMP(s) and conveyance(s) as shown on the O&M Plan in good working order acceptable to the Municipality, the Landowner shall be in violation of this Agreement, and the Landowner agrees that the Municipality or its representatives may, in addition to and not in derogation or diminution of any remedies available to it under the Stormwater Ordinance or other statutes, codes, rules or regulations, or this Agreement, enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s) and conveyance(s). It is expressly understood and agreed that the Municipality is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Municipality.

8. In the event that the Municipality, pursuant to this Agreement, performs work of any nature or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality for all expenses (direct and indirect) incurred within [______] days of delivery of an invoice from the Municipality. Failure of the Landowner to make prompt payment to the Municipality may result in enforcement proceedings, which may include the filing of a lien against the Property, which filing is expressly authorized by the Landowner.

9. The intent and purpose of this Agreement is to ensure the proper maintenance of the onsite BMP(s) and conveyance(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or affect any additional liability on any party for damage alleged to result from or be caused by stormwater runoff.

10. The Landowner, for itself and its executors, administrators, assigns, heirs, and other successors in interest, hereby releases and shall release the Municipality's employees, its agents and designated representatives from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees, agents or representatives arising out of the construction, presence, existence, or maintenance of the BMP(s) and conveyance(s) either by the Landowner or Municipality. In the event that a claim is asserted or threatened against the Municipality, its employees, agents or designated representatives, the Municipality shall notify the Landowner, and the Landowner shall defend, at his own expense, any claim, suit, action or proceeding, or any threatened claim, suit, action or proceeding against the Municipality, or, at the request of the Municipality, pay the cost, including attorneys' fees, of defense of the same undertaken on behalf of the Municipality. If any judgment or claims against the Municipality's employees, agents or designated representatives shall be allowed, the Landowner shall pay all damages, judgments or claims and any costs and expenses incurred by the Municipality, including attorneys, regarding said damages, judgments or claims.

11. The Municipality may enforce this Agreement in accordance with its Stormwater Ordinance, at law or in equity, against the Landowner for breach of this Agreement. Remedies may include fines, penalties, damages or such equitable relief as the parties may agree upon or as may be determined by a Court of competent jurisdiction. Recovery by the Municipality shall include its reasonable attorney's fees and costs incurred in seeking relief under this Agreement.

12. Failure or delay in enforcing any provision of this Agreement shall not constitute a waiver by the Municipality of its rights of enforcement hereunder.

13. The Landowner shall inform future buyers of the Property about the function of, operation, inspection and maintenance requirements of the BMP(s) prior to the purchase of the Property by said future buyer, and upon purchase of the Property the future buyer assumes all responsibilities as Landowner and must comply with all components of this Agreement.

14. This Agreement shall inure to the benefit of and be binding upon, the Municipality and the Landowner, as well as their heirs, administrators, executors, assigns and successors in interest.

15. Additional items or conditions, as required by the Municipality (per Subsection 703.B of this Ordinance), as attached herein:

This Agreement shall be recorded at the Office of the Recorder of Deeds of Chester County, Pennsylvania, and shall constitute a covenant running with the Property, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Municipality:

________________________________

(SEAL) For the Landowner:

________________________________

ATTEST:

__________________________ (City, Borough, Township)

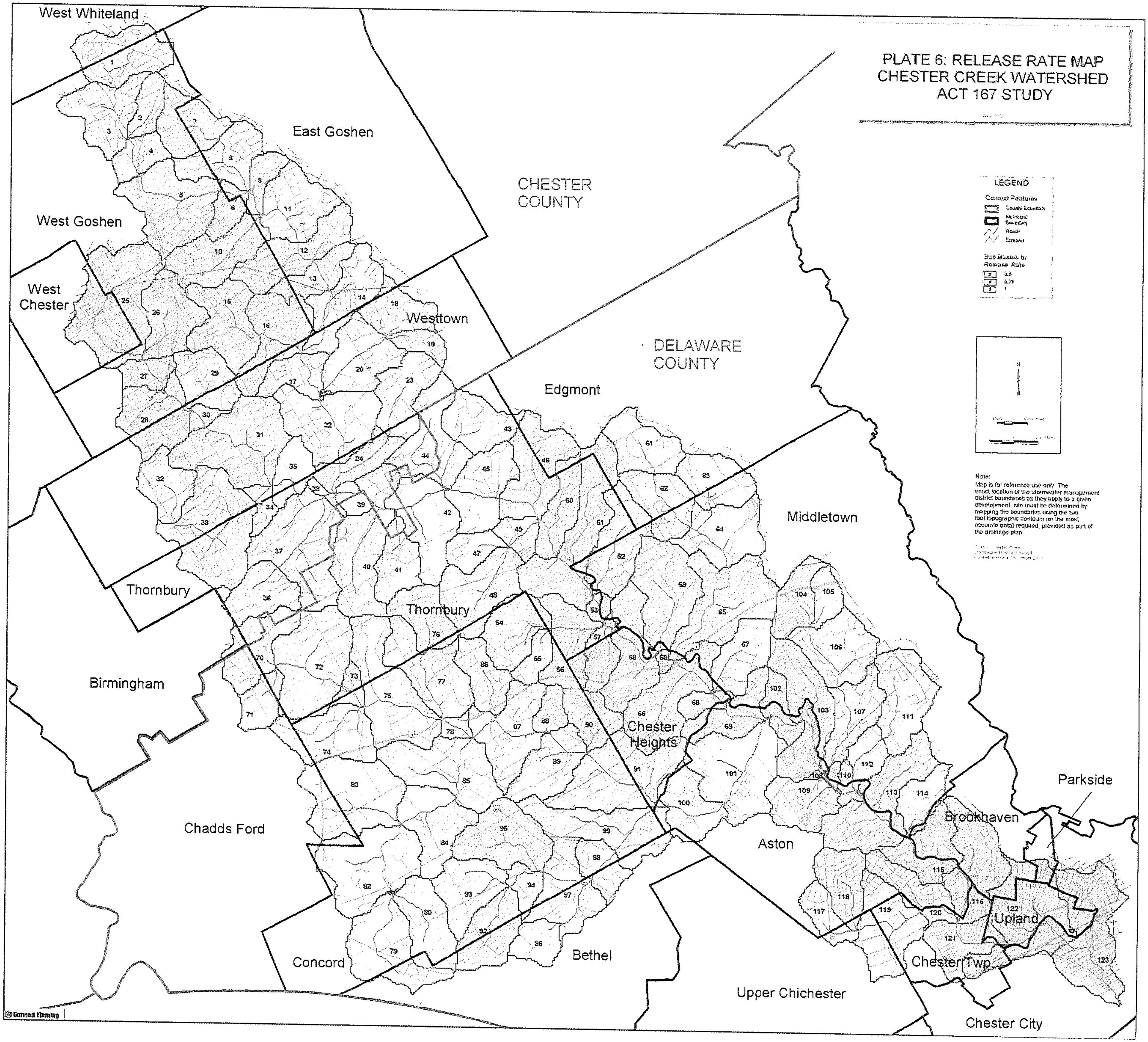
County of Chester, Pennsylvania
I, _______________________________, a Notary Public in and for the County and State aforesaid, whose commission expires on the ________ day of _______________, 20__, do hereby certify that _______________________________ whose name(s) is/are signed to the foregoing Agreement bearing date of the _________ day of _______________, 20__, has acknowledged the same before me in my said County and State.

**GIVEN UNDER MY HAND THIS** __________ day of __________, 20__.

__________________________ ______________________________

**NOTARY PUBLIC** **(SEAL)**

# PLATE 6: RELEASE RATE MAP
# CHESTER CREEK WATERSHED
# ACT 167 STUDY



Note:
Map is for reference use only. The exact location of the stormwater management district boundaries as they apply to a given development site must be determined by mapping the boundaries using the two-foot topographic contours (or the most accurate data) required, provided as part of the drainage plan