STORM WATER MANAGEMENT STANDARDS MANUAL

BY THE MAUMEE RIVER REGIONAL STORM WATER COALITION AND THE MAUMEE RIVER RAP URBAN RUNOFF ACTION GROUP

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TABLE OF CONTENTS

1. Introduction

Chapter 1: Introduction

1.1 Purpose

The Regional Storm Water Management Standards propose a storm water management philosophy that considers stream channel protection and storm water quality management in addition to flood control. These standards are based upon the current body of knowledge concerning storm water management from across the state and the country, modified as appropriate for application in Northwest Ohio. The following discussion outlines basic ideas and principals of storm water management, and provides a conceptual foundation for the design standards contained in this document.

The Regional Storm Water Management Standards were developed with the following objectives:

- Establish consistent storm water control standards throughout the region,
- Incorporate design standards that control both water quantity and quality,
- Encourage innovative storm water management practices,
- Place greater emphasis on the maintenance of facilities,
- Strengthen the protection of natural features, and
- Encourage more effective soil erosion and sedimentation control measures.

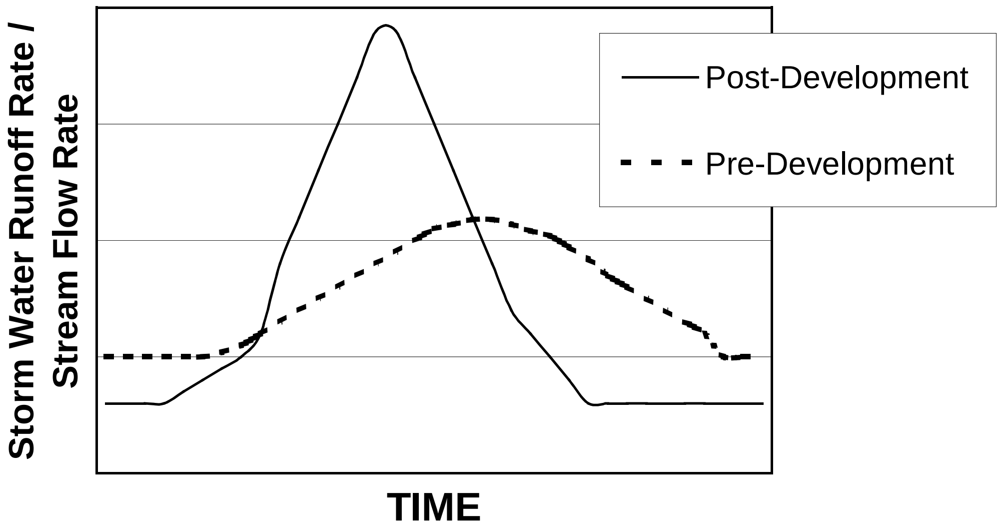
1.2 Impacts of Development on Water Quantity

The hydrology of a watershed changes immediately in response to site clearing and development of the natural landscape. A site's existing storm water storage capacity is quickly lost as vegetation is removed, natural depressions are graded and both topsoil and wetlands are eliminated. As the soil is compacted and resurfaced with impervious materials, rainfall can no longer penetrate into the ground and runs off of the land. These modifications, along with the installation of "efficient" drainage facilities, such as catch basins and pipes, greatly alter natural drainage patterns. These changes in runoff and flow will eventually cause changes in stream shape and function.

1.2.1 Changes in Watershed Hydrology

Volume and rate of storm water runoff increases with development. This is due to the combined effect of reduced infiltration, rapid time of concentration, and smoother hydraulic surfaces. As runoff is concentrated into sharper, faster and higher peaks, the magnitude and frequency of severe flooding events increase. “Bankfull” floods, which scour the channel, occur with more regularity. These floods fill the stream channel to the top of its banks, but do not spill over into the floodplain. Abrupt returns to pre-storm level discharges occur due to the more “efficient” drainage infrastructure. This lowers the level of surface waterbodies that are dependent on groundwater to maintain base flows during dry periods (Figure 1-1).

Figure 1-1. Effects of Urbanization on Stream Hydrology



1.2.2 Changes in Stream Morphology

Faced with more severe and frequent floods, stream channels must respond. They typically do so by increasing their cross sectional area to accommodate the higher flows.[1] Streambank erosion is accelerated, as channels are severely disturbed by undercutting, tree-falls and bank slumping. Sediment loads increase sharply due to erosion as well as construction site runoff. These sediments settle out and form shifting bars that often accelerate the erosion process by deflecting runoff into sensitive bank areas. Pools and riffles are eliminated as the stream adjusts to accommodate frequent floods. The changes in channel form disrupt habitats and reduce the diversity of aquatic species regardless of water quality. Sediment deposition destroys insect and benthic organism habitat as well as fish spawning areas.

1.3 Impacts of Development on Water Quality

As development occurs, changes in land use contribute new or additional pollutants to storm water runoff. In addition, the accompanying impervious surfaces provide efficient delivery of these pollutants into receiving waterways. Leaves, litter, animal droppings, exposed soil from construction sites, fertilizer and pesticides are all washed off of the

[1] Schueler, Thomas R., 2000. *The Practice of Watershed Protection: Article 1, The Importance of Imperviousness*.

land. Vehicles and deteriorating urban structures deposit trace metals, oil, and grease onto streets and parking lots. These and other toxic substances are carried by storm water and conveyed through creeks, ditches and storm drains into our rivers and lakes (Table 1-1).

Table 1-1. Categories of Primary Storm Water Contaminants

Category	Examples
Metals	Zinc, Cadmium, Copper, Chromium, Arsenic, Lead
Organic Chemicals	Pesticides, Oil , Gasoline, Grease
Pathogens	Bacteria, Viruses, Protozoa
Nutrients	Phosphorous, Nitrogen
Biochemical Oxygen Demand (BOD)	Grass clippings, Hydrocarbons, Animal waste, Fallen leaves
Sediment	Sand, Soil, Silt
Salts	Sodium Chloride, Calcium Chloride

Source: Bannerman, R.T., D.W. Owens, R.B. Dodds, and N.J. Hornewer, *Sources of Pollution in Wisconsin Stormwater*, Water, Science and Technology vol. 28, no. 3-5, 1993.

In short, the ecology of urban streams may be completely re-shaped by the extreme shifts in hydrology, morphology and water quality that can accompany the development process. The stresses that these changes place on the aquatic community, although gradual and often not immediately visible, are profound. To mitigate these impacts, it is necessary to reevaluate the way that storm water and land development are managed. The following discussion provides a framework for this reevaluation, which must encompass the entire development process from land use planning and zoning to site design and construction.

1.4 Framework for Design of Storm Water Management Systems

Thoughtful site planning can reduce the negative impacts associated with development. Towards this end, communities, regulatory agencies, and designers must begin to evaluate the impact of each individual development project over the long term, and on a watershed scale. Such an approach requires the use of controls or Best Management Practices (BMPs) that function together as a system to ensure that the volume, rate, timing and pollutant load of runoff remains similar to that which occurred under natural conditions. This can be achieved through a coordinated network of structural and nonstructural methods, designed to provide both source and site control. In such a system, each component by itself may not provide major benefits, but when combined with others becomes very effective (Figure 1-2).

Figure 1-2: Components of an Effective Storm Water Management System

Runoff Source Control
- Preserve the Natural Environment
- Preserve Floodplains and Wetlands
- Minimize Impervious Area
- Conservation Site Design
- Disconnect Impervious Areas
- Soil Erosion and Sedimentation Control
- Vegetative Practices (Filter Strips, Stream Buffers)
- Road Maintenance
- Chemical Use and Storage

Runoff Conveyance
- Vegetated Swales w/check dams
- Level Spreaders

Runoff Pretreatment
- Sediment Forebays
- Oil & Grit Separators
- Micro-pools

Runoff Treatment
- Infiltration Devices
- Filter Strips
- Retention/Detention Basins
- Storm water Wetland Systems
- Detaining First Flush
- Detaining for 25-year storm

System Maintenance
- Inspection
- Sediment Disposal
- Access

Secondary Impact Mitigation
- Stream Restoration
- Wetland Mitigation

1.4.1 Source Controls

Source controls reduce the volume of runoff generated on-site, and eliminate initial opportunities for pollutants to enter the drainage system. By working to prevent problems, source controls are the best option for controlling storm water, and include the following key practices:

- Preservation of existing natural features that perform storm water management functions, such as floodplains, wetlands and vegetation along streambanks.
- The minimization of impervious surface area through site planning that makes efficient use of paved, developed areas and maximizes open space.
- Encouraging flexible street and parking standards, and the use of permeable ground cover materials can reduce impervious surface area.
- Direction of storm water discharges to open grassed areas such as swales and lawns rather than allowing storm water to runoff from impervious areas directly into the storm water conveyance system.
- Careful design and installation of erosion control mechanisms and rigorous maintenance throughout the construction period.
- Effective erosion control measures include minimizing the area and length of time that a site is cleared and graded, and the immediate vegetative stabilization of disturbed areas.

1.4.2 Structural Controls

After the implementations of source controls, structural controls are then required to convey, pre-treat, and treat (e.g., detain, retain or infiltrate) the storm water runoff generated by development. The range of engineering and design techniques available to achieve these objectives is to some degree dictated by site configuration, soil type, and the receiving waterway. For example, flat or extremely steep topography may preclude the use of grassed swales, which are otherwise preferable to curb and gutter systems. But while each site will be unique, some universal guidelines for controlling storm water quality and quantity can be utilized.

In general, the most effective storm water quality controls are infiltration practices, which reduce both the runoff peak and volume. But to date, structural infiltration devices such as basins and, to a lesser degree, trenches have suffered high failure rates due to clogging. Therefore, an aggressive maintenance program and extensive pre-treatment measures (such as oil/grit separators, sedimentation basins and grass filter strips) must be incorporated into any storm water management system that employs these devices. In addition, these practices are only feasible for smaller drainage areas with suitable soils and low potential for groundwater contamination.

The next most effective storm water site controls reduce the runoff peak, and involve storage facilities such as retention and detention ponds. In the selection of an appropriate storm water pond design, wet ponds and extended detention ponds are generally preferable to dry detention ponds, since they hold storm water much longer, allowing more particulate matter to settle out. In addition, the aquatic plants and algae within wet ponds take up soluble pollutants (nutrients) from the water column. These nutrients are then transformed into plant materials that settle to the pond floor, decay, and are consumed by bacteria. Since these biological processes are dependent upon the presence of water, they do not occur in dry ponds.

Once all possible methods of reducing and treating storm water on-site have been implemented, excess runoff must be discharged into conveyance systems and carried off-site. Discharges must be at rates, velocities and volumes that will not cause adverse downstream impacts to land or waterways. For this purpose, vegetated swales with check dams are generally preferred to curb and gutter systems and enclosed storm drains.

Regardless of the design, any storm water system will lose effectiveness without regular maintenance. Depending on the specific BMP, maintenance must be performed at regular intervals. This may include inspection, sediment removal, maintenance of vegetation and structures, replacement of filters, et cetera. Maintenance plans should be developed concurrent with the system designs. The design must also include adequate maintenance access.

2. Development Definition and Classifications

Chapter 2: DEVELOPMENT DEFINITION AND CLASSIFICATIONS

The purpose of this section is to provide a working definition of what activities are regulated under the storm water regulations of (community). Before it is determined whether or not a development requires a permit, it must be determined what activities constitute development.

2.1 Definition of Development

Development shall be defined as finalization of a plat, re-plat, lot-split, or man-made change to real estate by private or public agencies including:

- Construction, reconstruction, significant repair, or placement of a building or any addition to a building;
- Installation of a manufactured home on a site, preparation of a site for a manufactured home, or placement of a recreational vehicle on a site for more that 180 days;
- Drilling, mining, installation of utilities, construction of roads, bridges, or similar projects;
- Clearing of land in excess of one (1) acre as an adjunct of construction;
- Construction or erection of levees, walls, fences, dams, or culverts; channel modification; filling, dredging, grading, excavating, paving, or other alterations of the ground surface; storage of materials; deposit of solid or liquid waste;
- Any other activity that might change the direction, height, volume or flow of drainage runoff and collection.

2.2 Development Does Not Include

- Repair, remodeling, or maintenance of existing building that does not substantially increase building area or impervious area.
- Gardening, plowing, and similar activities that do not involve filling, grading, or construction.
- Natural Resource Conservation Service (NRCS) approved agricultural practices.

2.3 Development Classification

All development requiring a Storm Water Management Permit shall be classified as a minor, major, or public road development. The classifications are as follows:

2.3.1 Minor Development

- Is not located in a Regulatory Floodplain or is not located in any depressional storage area that has a volume larger than 0.75 acre-foot.
- Does not disturb a cumulative total of one-tenth (1/10) or more acres of wetlands.
- Modifies a channel where the tributary drainage area is less than 100 acres, and
- Consists of:

  a. Single family detached residential development of less than ten (10) acres, and an impervious cover area of less than fifteen (15) percent.
  b. Multi-family, non-residential, and other developments of less than three (3) acres.

2.3.2 Public Road Development

Any development activity that takes place in a public right-of-way that is administered and funded by a public agency under its respective roadway jurisdiction. Maintenance and in-kind replacement do not require a permit.

2.3.3 Major Development

All other development is defined as a major development.

2.4 Development Requiring a Permit

A (community) Storm Water Management Permit will be required for any development, which meets any of the following criteria. These criteria coincide with state and federal laws (Exp. NPDES, FEMA, Wetlands Protection) and may require concurrent permit applications.

- Is located in a Regulatory Floodplain.
- Is located in a flood-prone area with one hundred (100) acres of tributary drainage area or more.

- Is located in a depressional storage area and has a storage volume of 0.75 acre-feet or more for the base flood.

- Disturbs a cumulative total of one-tenth (1/10) or more acres of wetlands

- Modifies the flood-prone area of a channel where the tributary drainage area is twenty (20) or more acres.

- Construction activities including clearing, grading, and excavating that:

    a. Result in land disturbance of one (1) or more acres.
    b. Result in land disturbance of less than one (<1) acre, but is part of a larger common plan of development or sale if the larger common plan will ultimately disturb one (1) or more acres.

- Any public road development resulting in one and one-half (1.5) acres or more of additional impervious surface per mile, for linear or non-linear projects.

3. Permit Submittal Requirements

Chapter 3: PERMIT SUBMITTAL REQUIREMENTS

The following permit submittal checklists can be used as a guideline for what should be included in a Storm Water Management Permit application

3.1 Minor Development Submittal Requirements

3.1.1 Storm water Management Permit application which includes:

- ❑ Name, legal address, and telephone number of the applicant
- ❑ Name, legal address, and telephone number of the owner if different from the applicant
- ❑ Name, legal address, and telephone number of the applicant's agent (if used).
- ❑ Applicant's or applicant agent's signature

3.1.2 Common address and legal description of the site

3.1.3 General Description (or report) of the existing and proposed drainage system including:

- ❑ Discharge points
- ❑ Storage facilities
- ❑ Storm water conveyance systems
- ❑ Wetlands, lakes, or ponds

3.1.4 Grading plan showing existing and proposed contours [minimum contour interval of 2-feet, elevations referenced to National Geodetic Vertical Datum of 1929 (NGVD)]

3.1.5 Drainage plan (same scale as the grading plan) showing existing and proposed storm water conveyance and storage features:

- ❑ Discharge points
- ❑ Storage facilities
- ❑ Storm water conveyance systems
- ❑ Streams, wetlands, lakes, or ponds

- Easements and buffer areas
- Overland flow paths
- Regulatory Floodplain and floodway boundaries
- Drainage divides

3.1.6 Drainage and detention calculations.

3.1.7 A drainage area map showing the tributary drainage area and where the development is located in the watershed.

3.1.8 A stream mitigation plan (when a stream is modified).

3.1.9 Storm Water Pollution Prevention Plan (SWPP) for all disturbed areas and Notice of Intent (NOI) (Described in Chapter 9: *Construction Site Runoff Control*).

3.2 Major Development Submittal Requirements

In addition to the requirements for minor developments, major development applications require the following information:

3.2.1 A vicinity map for the project.

3.2.2 Topographic maps (minimum contour interval of 2-feet, elevations referenced to NGVD) of the existing and proposed plans (grading, drainage, etc.) of the development which include:

- Location of all roads.
- Storm water conveyance systems.
- Overland flow paths.
- Boundaries of predominate soil types.
- Boundaries of predominate vegetation.
- Drainage easements.
- Location of retention or detention basins (including their inflow and outflow structures).

- Location of all utilities and easements.
- Location, size, and flow elevations of all storm or combined sewers.
- Specifications and dimensions of all proposed channel modifications, location, and orientation of cross-sections.
- Buffers and easements.
- Streams, wetlands, lakes, and ponds.
- Regulatory floodplain and floodway boundaries.

3.2.3 Cross-section views for the storm water management system showing:

- Existing and proposed conditions including principal dimensions of the work, and existing and proposed elevations.
- Normal water and calculated Base Flood Elevations (BFE), and overland flow.

3.2.4 Summary describing the hydrologic and hydraulic analyses performed for the project which includes:

- Names of the streams of bodies of water affected.
- Anticipated dates of initiation and completion.
- Analysis of the existing drainage system, which includes the methodology and support calculations in computing runoff rates, runoff volumes, velocities, water surface elevations, and floodplain and depression storage.
- Analysis of the methodology and support calculations used to determine the effects from upstream drainage areas.
- Analysis of the effects that the improvements will have on the receiving stream or body of water.
- All supporting design calculations and computer models.

3.2.5 A section in the hydrological summary describing how the Runoff Reduction Hierarchy (see 4.2) was used in evaluating the storm water management needs of the site.

3.2.6 A section in the hydrological summary for detention and/or retention facilities that includes:

- Plots or tabulations of volumes and surface areas with corresponding water surface elevations.
- Stage discharge or outlet rating curves.
- Design hydrographs of inflow and outflow for the 2-year and 25-year intensity-duration-frequency storm events under existing and developed conditions.

3.2.7 A Storm Water Pollution Prevention Plan (SWPP) for all disturbed areas and Notice of Intent (NOI) (Described in Chapter 9: *Construction Site Runoff Control*).

3.2.8 A Plan for the ongoing maintenance of all permanent storm water management system components, including wetlands. The plan shall include:

- The name, legal address, and telephone numbers of parties responsible for performing maintenance tasks.
- Maintenance tasks.
- A description of all permanent public or private easements.
- A description of the dedicated sources of funding for maintenance.

3.2.9 A stream mitigation plan (when a stream is modified).

3.2.10 A sealed statement from a registered professional engineer that the applicant meets the requirements of <u>(community)</u> Storm Water Management Standards.

3.3 Public Road Submittal Requirements

3.3.1 A copy of applicable US Army Corps of Engineers (USACOE), US Environmental Protection Agency (USEPA), Ohio Environmental Protection Agency (OEPA) or Michigan Department of Environmental Quality (MDEQ) permits.

- Wetlands Section 401 and 404 of the Clean Water Act consistent with Chapter 8: *Natural Wetlands Protection*.

- National Pollution Discharge Elimination System (NPDES) consistent with Chapter 9: *Construction Site Runoff Control*.

3.3.2 A copy of the proposed storm water management system.

- The location and size of all existing and proposed drainage improvements.

- Plan, section and profile views of storm sewers, field tiles, culverts, channels, and detention areas.

3.3.3 A copy of all calculations supporting the storm water management system.

4. Performance Criteria for Runoff and Detention

Chapter 4: PERFORMANCE CRITERIA FOR RUNOFF AND DETENTION

4.1 Introduction

Flood control design or water quantity management deals with capturing and detaining relatively infrequent, severe runoff events, such as the 25-year frequency storm. Water quality design requires that the more frequent storm events must be addressed. The need for managing smaller storms is directly related to urbanization and the accompanying increase in impervious area, which impairs surface water quality.

Eroded soil and other pollutants such as metals, fertilizers, pesticides, oils and grease, are flushed off by the early stages of runoff. This “first flush” carries a shock loading of these pollutants into receiving waterways. By capturing and treating the first 1-inch of runoff, up to 90% of pollutants that are washed off of the land can be removed from the storm water before it enters into the drainage system.

To manage both water quantity and quality, storm water facilities must be designed to capture and treat two different storm events:

1. Flood attenuation: The 25-year frequency storm event and larger.
2. The first flush: The first 1-inch of runoff from the entire contributing watershed.

Controlling both extremely large events, to prevent flooding, and more frequent events, to mitigate water quality impacts, can be achieved through the proper design of storm water management facilities. Among the alternatives, wet ponds and constructed wetland systems are the most effective for achieving control of both storm water volume and quality. Alternative Best Management Practices (BMPs) providing flood attenuation and treatment of the first flush and are also acceptable (Chapter 5: *Post-Construction Runoff Control*).

This chapter sets forth design and performance criteria for storm water runoff volume and rate reduction. These standards will be used by the (community) in analysis of proposed storm water management systems, in accordance with the objectives of managing both the quantity and quality of storm water runoff. The following performance standards and provisions apply to all development requiring a permit.

4.2 Runoff Reduction Hierarchy

A description of the offsite outlet and evidence of its adequacy is required. If no adequate watercourse exists to effectively handle a concentrated flow of water from the proposed development, detention and / or off site drainage improvements will be required. On-site management of storm drainage will be designed for control of flooding, downstream erosion, and water quality.

In order to meet the requirements of these standards, the Runoff Reduction Hierarchy shall be used in designing the site drainage system. Site layout and development should try to control storm water through a series of runoff control mechanisms starting with non-structural and moving toward structural mechanisms.

The following is a general overview of the Runoff Reduction Hierarchy of Best Management Practices (BMPs). More details regarding the BMPs can be found in Chapter 5: *Post-Construction Runoff Control*.

Non-Structural Controls

1. Preserve natural channels, floodplains, and wetlands
   Construction within streams, floodplains, and wetlands should be minimized to the maximum extent possible. If construction is to occur in floodplains or wetlands, the construction will adhere to the performance standards set forth in Chapter 7: *Regulatory Floodplain and Floodways* and Chapter 8: *Natural Wetlands Protection.*

2. Minimize Impervious Area- Conservation Site Design
   The increase in impervious surface area on a site tends to increase the rate and volume of storm water runoff. When developing a plan for the site, it is recommended that the site be developed to minimize impervious surfaces to the greatest extent possible.

3. Disconnect Impervious Areas
   Routing runoff to pervious areas such as lawns, grassy swales, or depressed landscape areas can reduce runoff rates and volumes from developed areas. The storm water can then filter through the grass or infiltrate into to the soil on-site.

4. Employ Pervious or Semi-Pervious Cover
   Pervious or semi-pervious cover, such as grass paving, decreases the amount and rate of runoff from areas that have historically been covered with impervious concrete or asphalt.

Structural Controls

5. Utilize Grass Swales
   Where permitted and feasible, open vegetated swales shall be used instead of curb and gutter or hard piping. Grass swales can reduce the peak rate of runoff and improve water quality.

6. Promote Infiltration of Runoff On-site - Filter Strips
   There is considerable potential for the use of infiltration practices that will cause percolation of storm water runoff into the ground before it reaches a stream or channel.

7. Promote Infiltration of Runoff On-site – Sand Filters
   Routing first flush runoff to a sand filter can reduce the amount of storm water pollutants before it is routed to a water quality structure or detention system.

8. Utilize Storm Water Wetlands
   Storm water wetland facilities provide partial treatment of the runoff. The systems remove pollutants through physical filtration, settling, and biological processes of the wetland plants.

9. Utilize Wet Detention Basins
   This structure is the most widely used measure for controling peak discharges from developing areas. Wet detention basins can also serve as water quality settling facilities, which allow pollutants to drop out before discharging to a watercourse.

10. Utilize Dry Detention Basins
    An extended dry detention basin is a storm water storage basin that provides temporary detention, but does not have a permanent pool. The main reasons for use of dry detention basins are reducing peak storm water discharges, controlling floods and preventing downstream channel scouring.

11. Construction of Storm Sewers

4.3 Runoff Calculations

This section provides guidance for standard hydrologic methods used to determine runoff quantities. Runoff quantities shall be computed for the watershed under development and the contributing watershed flowing into or through the watershed being developed. Runoff quantities shall be computed for existing and proposed site conditions.

Rainfall data for hypothetical or design events (25-year, 10-year, etc.) shall be obtained from statistical compilations and extrapolations of real data collected over a statistically significant time period. The statistical data source shall be approved by (community).

4.3.1 Minor Development

The Rationale Method ($Q = CiA$) may be used for estimation of peak runoff when the total watershed area tributary to the design point is 100 acres or less, provided analysis of downstream detention facilities in not required.

a. The rainfall intensity, “i”, will be taken from the appropriate intensity-duration-frequency curve for the NW Ohio area. Table 4-1 provides rainfall intensities for times of concentration of 10 minutes through 120 minutes:

Table 4-1. Rainfall Intensities in Inches/Hour "i"

Time of Concentration	Return Period			
Minutes	2-Years	5-Years	10-Years	25-Years
10.0	3.30	4.30	5.18	6.00
15.0	2.70	3.60	4.30	5.03
16.0	2.60	3.50	4.18	4.90
17.0	2.51	3.40	4.07	4.76
18.0	2.45	3.30	3.95	4.65
19.0	2.38	3.25	3.85	4.55
20.0	2.30	3.16	3.75	4.43
21.0	2.23	3.08	3.65	4.30
22.0	2.17	3.01	3.56	4.20
23.0	2.12	2.93	3.48	4.12
24.0	2.07	2.86	3.40	4.02
25.0	2.02	2.79	3.34	3.93
26.0	1.97	2.72	3.25	3.85
27.0	1.92	2.66	3.17	3.77
28.0	1.88	2.60	3.11	3.69
29.0	1.84	2.55	3.05	3.62
30.0	1.80	2.50	2.99	3.57
31.0	1.76	2.44	2.92	3.49
32.0	1.72	2.38	2.86	3.43
33.0	1.68	2.34	2.80	3.36
34.0	1.65	2.30	2.76	3.31
35.0	1.63	2.26	2.72	3.27
40.0	1.52	2.08	2.52	3.00
45.0	1.42	1.93	2.38	2.79
50.0	1.32	1.78	2.18	2.58
55.0	1.25	1.68	2.05	2.44
60.0	1.18	1.58	1.92	2.30
65.0	1.11	1.50	1.84	2.16
70.0	1.05	1.42	1.77	2.03
75.0	1.00	1.35	1.67	1.94
80.0	0.95	1.28	1.58	1.86
85.0	0.91	1.22	1.52	1.78
90.0	0.86	1.16	1.44	1.70
95.0	0.82	1.11	1.39	1.63
100.0	0.79	1.06	1.33	1.56
110.0	0.73	0.98	1.22	1.46
120.0	0.68	0.92	1.18	1.38

b. In residential areas, a maximum of t = 20 minutes shall be used as the time of concentration to the first pick-up point in the system. In areas other than residential, time of concentration shall be determined by the use of overland flow charts.

c. The following runoff coefficients, "C", shall be used in residential areas:

Table 4-2. Runoff Coefficients "C"

Average Lot Size	Average % Impervious	Hydrologic Soil Group			
		A	B	C	D
? of an acre or less	65	0.41	0.59	0.72	0.77
¼ of an acre	38	0.16	0.37	0.54	0.64
? of an acre	30	0.12	0.32	0.50	0.61
½ of an acre	25	0.09	0.29	0.47	0.59
1 acre	20	0.06	0.26	0.45	0.57
2 acres or more		0.05	0.23	0.41	0.50

4.3.2 Major Development

For multi-family residential, commercial, industrial areas, areas 100 acres or greater, when upstream and/or downstream storm water facilities require analysis, and for the determination of detention storage requirements; an approved hydrograph-producing runoff calculation method shall be used:

a. Natural Resource Conservation Service: TR-20, TR-55
   - TR-20 = Technical Release 20, "Computer Program for Project Formulation- Hydrology"
   - TR-55 = Technical Release 55, "Urban Hydrology for Small Watersheds"

b. U.S. Army Corps of Engineers: HEC-HMS
   - HEC-HMS = Hydrologic Engineering Center- Hydrologic Modeling System

c. U.S. Environmental Protection Agency: SWMM
   - SWMM = Storm Water Management Model

d. U.S. Environmental Protection Agency / U.S. Geological Survey: HSPF
   - HSPF = Hydrological Simulation Program- Fortran

e. Ohio DNR: Bulletin 43

4.3.3 Determination of Channel Size

The "Mannings" formula should be used to size open channels or pipe. If the "Mannings" formula is not used, the alternative method used shall be approved by (community).

"Mannings Formula"

$$Q = \frac{1.49}{n} \quad AR2/3 \;\; S1/2$$

Q = flow, in cubic feet per second
A = cross sectional area, in square feet
n = Mannings coefficient of roughness
R = hydraulic radius = A/P, in feet
P = wetted perimeter
S = slope of the bottom of the drain

a. For open channels, the design manning roughness coefficient "n" shall be obtained from an approved reference table:
   - Chow, V.T., *Open Channel Hydraulics*, 1959.

Table 4-3. Channel Roughness Coefficients "n"

Common Channel Types and Descriptions	Normal
Corrugated Metal	0.025
Smooth Metal	0.013
Cement	0.012
Wood	0.013
Concrete	0.020
Brick/Masonry	0.021
Asphalt	0.015
Gravel/Rip Rap	0.025
Excavated or Dredged	0.035
Minor Streams (top width at flood stage or high bank <100 ft.)	0.050
Major Streams (top width at flood stage or high bank >100 ft.)	0.055
Floodplains	0.065

b. For closed conduits, flowing partially full, the design manning roughness coefficient "n" shall be within the ranges listed in Table 4-4.

Table 4-4. Closed Conduit Roughness Coefficients "n"

Type of Conduit	Normal	Maximum
Plastic, PVC, Polyethylene	0.010	0.013
Metal, Smooth	0.013	0.017
Cast Iron/Wrought Iron	0.014	0.017
Corrugated Metal	0.024	0.030
Cement	0.012	0.015
Concrete	0.013	0.020
Brickwork	0.014	0.017
Clay	0.013	0.018
Rubble Masonry, Cemented	0.025	0.030

4.3.4 Downstream Analysis

Downstream analysis of the impacts of drainage improvements shall be completed to a point in the receiving watercourse where an increase in the stage of the receiving stream during the design storm event is less than or equal to 0.10 feet. Analysis of downstream facilities will not be required when:

a. All discharge is retained on-site after the completion of improvements.

b. Site improvements where the storm water facilities have been designed such that:
    i. The combination of flows from off-site and on-site drainage areas results in no increase in the peak discharge from the pre-developed site during the 2-year through 100-year, 24-hour storm events.
    ii. The volume of runoff for the project site is not increased for the 2-year through100-year, 24-hour storm events.
    iii. The increase in the water level stage in the receiving water source is less than 0.1 feet immediately downstream of the outlet for the project area during peak flow for the design storm event.

4.4 Control Volumes

Detention or retention will be required for all development that is designed to discharge storm water off site, unless specific variances are issued (See 10.8 Variances). This sub-section presents a unified approach for sizing storm water detention facilities to meet pollutant removal objectives, reduce channel erosion, and pass extreme floods. Table 4-5 contains a summary of the required storage volumes and release rates.

Table 4-5. Summary of Required Storage Volumes

Sizing Criteria	Description
Water Quality Volume (**WQ_v**) (acre-feet) or "First Flush"	**$WQ_v = [(P)(R_v)(DA)]/12$** P = Rainfall depth in inches and is equal to 1". R_v = Volumetric Runoff Coefficient = 0.05+0.009(I), where I = % impervious cover of the drainage area. DA = Drainage Area to BMP in acres
Water quality volume draw down time	**24 hours**
Extreme Flood Volume (**Q_f**) (acre-feet) or "Flood Attenuation"	**Q_f = Minimum 25-year, 24-hour storm event.**
Maximum release rate	**Pre-development 5-year, 24-hour storm event**

4.5 Enclosed Drainage Structures

All structures will be constructed in accordance with governing specifications. In the event of no other governing specifications, the latest edition of the Ohio Department of Transportation (ODOT) or Michigan Department of Transportation (MDOT) standards will be observed.

4.5.1 Pumps

Storm water conveyance systems incorporating pumps shall not be permitted in developments with multiple owners, such as subdivisions and site condominiums. Variance requests, submitted in accordance with these standards, will be considered on a case-by-case basis. However, variances from this rule will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are feasible. Special requirements, such as the establishment of an operations/maintenance/replacement escrow account by the Developer may be imposed to help defray special assessments that would be levied upon future property owners for maintenance of the system.

In areas where local ordinance requires sump pump leads to be connected into an enclosed system, these taps shall be made directly into storm sewer structures or into clean-outs approved by (community). Sump pump connections to storm lines that do not collect surface drainage need not tap directly into storm sewer structures. However, long-term maintenance of such lines will be the responsibility of the property owners.

4.5.2 Capacity

Storm sewers shall be designed to flow just full for the peak runoff from a 5-year frequency storm event. The minimum velocity at just full shall be 2 feet per second. Minimum pavement gutter elevations shall be at or above hydraulic grade line for the peak runoff from a 10-year frequency storm. Use the intensity-duration-frequency curve for determining this hydraulic grade.

4.5.3 Drainage Structure Location

Drainage structures shall be located as follows:

a. To assure complete positive drainage of all areas,
b. At all low points of streets and rear yards,
c. Such that there is no flow across a street intersection,
d. Maximum spacing between access structures (catch basins or manholes) shall be 300 feet for pipe sizes of 36 inches and under and 500 feet for sizes over 36 inches, and
e. In conformance with any more stringent local requirements.

4.5.4 Catch Basins

Catch Basin type and spacing shall be designed to accept the peak runoff from a 2-year frequency storm event. The maximum allowable width of the sheet gutter flow from the face of the curb shall be limited to 8 feet into the driving lane. Curb inlets will usually be required at all intersections and cul-de-sacs to provide for more positive drainage.

4.5.5 Discharge

Discharge from enclosures shall be as follows:

a. All outlets will be designed so that velocities will be appropriate to, and will not damage, receiving waterways.

b. Outlet protection using riprap or other approved materials will be provided as necessary to prevent erosion.
c. The soils above and around the outlet will be compacted and stabilized to prevent piping around the structure. Riprap extending 3 feet above the ordinary high water mark is recommended for all outlets and should be keyed in 18" below outlet grade line.
d. When the outlet empties into a detention/retention facility, channel or other watercourse, it will be designed such that there is no over-fall from the end of the apron to the receiving waterway.

4.5.6 Pipe Criteria

Pipe shall conform to the following criteria:

a. All materials shall be of such quality as to guarantee a maintenance-free expectancy of at least 50 years and will meet all appropriate American Society for Testing and Materials (ASTM) standards.
b. Pipe under pavement shall be Type "A" or "B" Conduit. Pipe not under pavement shall be Type "C" Conduit. The designer may indicate a particular kind of pipe by inserting the specification item number after the designation of the type of conduit.
c. Pipe joints shall be such as to prevent excessive infiltration or exfiltration. All pipe except concrete elliptical shall have O-ring joints.
d. Corrugated metal pipe will be permitted only when being used as a restriction in a detention facility.
e. Type "A" and "B" Conduit shall have a minimum cover of 9" from the top outside crown to the bottom of the finished sub-grade. Type "C" Conduit with less than 18" of cover shall be reinforced concrete. Pipe shall be minimum 12" diameter beyond the first structure that picks up surface water.

5. Post-Construction Runoff Control

Chapter 5: POST-CONSTRUCTION RUNOFF CONTROL

5.1 Source Controls

5.1.1 Preservation of Natural Streams and Channels

The site layout shall be configured to keep the natural drainage system intact to the maximum extent practicable. The design should balance the storm water benefits provided by the natural drainage system against possible conflicts with the intended land use and on-site drainage improvement.

If channel modification must occur, the physical characteristics of the modified channel shall meet the existing channel in length, cross-section, slope, sinuosity, and carrying capacity.

Streams and channels will be expected to withstand all events up to the 100-year, 24-hour storm without increased erosion. Armoring banks with riprap and other manufactured materials will be accepted only where erosion cannot be prevented in other ways, such as by the use of vegetation.

5.1.2 Conservation Site Design

Description

Individual development projects can be designed to reduce the amount of impervious cover they create. Concentrating construction within a compact developed portion of the property and minimizing the area covered by impervious infrastructure accomplish this goal. Designers can utilize the resulting space to avoid sensitive natural areas such as wetlands as well as provide attractive open space in the development. Cluster development typically reserves 30-80% of the total site area for permanent community open space. The protected open space provides many environmental as well as marketing benefits.

Applicability

Innovative site planning and design techniques have been shown to sharply reduce storm water runoff from new development.[2] However, designers and engineers may be restricted in using these techniques by conflicting local zoning, parking or subdivision regulations. Clustering and conservation of natural areas should be practiced in the design phase of all development to the greatest extent practicable within existing regulations.

[2] Schueler, T.R. and R.A. Clayton, *Better Site Design: Changing Development Rules to protect the Environment*, Land Development, 1999.

Design Guidelines

Protect Natural Features
Avoid such areas such as wetlands, streams, floodplains, and steep slopes. Deliberate protection is usually required to prevent encroachment. Encroachment may include clearing trees, filling, channel modification, and replacing natural drainage systems with storm sewers (See Chapters 6, 7 & 8 for additional guidelines on buffer areas, floodplains and wetlands).

Concentrate Development
Disturb a smaller area of the property and preserve open space. In residential developments, consider using smaller lot sizes and including parks or common areas. During development of the site plan, consult with (community)- concentrated development may require a zoning or a rules variance.

Minimize Transportation Infrastructure
- Minimize the total length of streets by examining alternative layouts
- Minimize the width of streets (in accordance with (community) regulations).
- Minimize the number of parking spaces, using pervious materials in overflow parking areas (in accordance with (community) regulations).
- Reduce the number and radius of residential street cul-de-sacs (in accordance with (community) regulations).

Additional Resources
- ❑ Arendt, R.G., *Conservation Design for Subdivisions: A Practical Guide to Creating Open Space Networks*, Island Press: Washington, 1996.
- ❑ Schueler, T. R., *Site Planning for Urban Stream Protection*, Metropolitan Wahsington Council of Governments, 1995.

5.1.3 Disconnecting Rooftop Drainage

Description

Routing roof runoff to pervious areas, such as lawns, grassy swales, or depressed landscaped areas can reduce runoff rates and volumes from developed areas. The storm water can then filter through the grass or infiltrate into the soil.

Applicability

This practice is applicable for low to moderate density developments (residential and commercial) where there is sufficient land area or facilities to accept the additional flow. Disconnection will not be approved where the volume of runoff from the rooftops will cause erosion or a significant increase in the water level in the receiving stream.

Design Guidelines

Downspouts from rooftops should discharge to gently sloping, well-vegetated or landscaped areas. Erosion control devices, such as splash blocks may be needed at the discharge point.

A downspout should be provided for every 5000 square feet or less of rooftop to reduce discharge velocities and prevent erosion. At least 10 feet of infiltration area should be provided between downspout discharges and the next impervious surface.

5.1.4 Grass Paving

Description

Grass paving is a semi-pervious cover for infrequent or light traffic areas that have historically been covered with impervious concrete or asphalt. Grass paving systems are designed to carry vehicular loads, but can be covered in natural materials and allow storm water to infiltrate into the underlying soils. When covered with sod, these areas are indistinguishable from other grassed areas. The paving units vary in design and construction material, depending on the manufacturer.

Applicability

Grass paving provides the advantage of reducing imperviousness, while providing sufficient support for infrequent or light vehicular traffic. Common applications for this technology include fire lanes, overflow parking and golf cart paths. It is generally considered more aesthetically pleasing than the alternatives and allows for storm water infiltration. This technology is not recommended for frequently traveled or parked in areas, since damage can be done to the natural cover.

Design Guidelines

Grass paving should not be used in areas of high traffic or where vehicles will be parked for extended periods of time. Prior to selecting a product, the manufacturers guidelines should be considered. The manufacturer should also provide installation and maintenance procedures.

5.2 Structural Controls

5.2.1 General Guidelines

Public safety shall be a paramount consideration in storm water system and pond design. Providing safe retention is the applicant's responsibility. Pond designs will incorporate gradual side slopes, vegetative and barrier plantings, and safety shelves.

Where further safety measures are required, the applicant is expected to include them within the proposed development plans.

Storm water management systems incorporating pumps generally will not be permitted. Variance requests, submitted in accordance with these standards, will be considered on a case-by-case basis. Special requirements, such as the establishment of an operations /maintenance /replacement escrow account by the Developer, may be imposed to help defray special assessments that would be levied upon future property owners for maintenance of the system.

Detention and retention facilities shall be located on common-owned property in multi-ownership developments such as site condominiums and subdivisions, and not on private lots or condominium units. Permanent easements will be required for drainage ways (ditches, channels), swales, ponds, and sewer lines that will require maintenance.

Discharge shall outlet within the drainage basin where flows originate, and generally may not be diverted to another basin. Requirements for Storm water quantity control may be waived for developments in the downstream-most locations of a watershed, although quality management will still be necessary. Determinations will be made by the (community) on an individual site basis.

5.2.2 Grass Swales

Description

Where permitted and feasible, open vegetated swales shall be used instead of curb and gutter or hard piping to convey storm water runoff. Vegetated swales help filter storm water by allowing pollutants to settle out as the water is slowed by the vegetation and by providing an opportunity for the some of the water to infiltrate into the ground. Vegetated swales can also provide temporary retention, reducing storm water discharge rates.

Applicability

Vegetated swales are effective in low to moderate density development with sufficient land area. The soils must be able to resist erosion and support dense cover vegetation. Vegetated swales generally work best in gently sloping areas (5% maximum) where the swale is cut into the existing landscape.

Design Guidelines

Route & Length
Open vegetated swales should follow pre-development drainage patterns. Swale length should be a minimum of 200 feet when possible, to increase the contact time of storm water.

Longitudinal Slope
The maximum allowable longitudinal slope shall be 5%. The slope shall provide for sufficient drainage and uniform flow, while preventing excessive velocities. For slopes greater than 2%, a series of check dams or drop structures across swales shall be used to maintain acceptable flows.

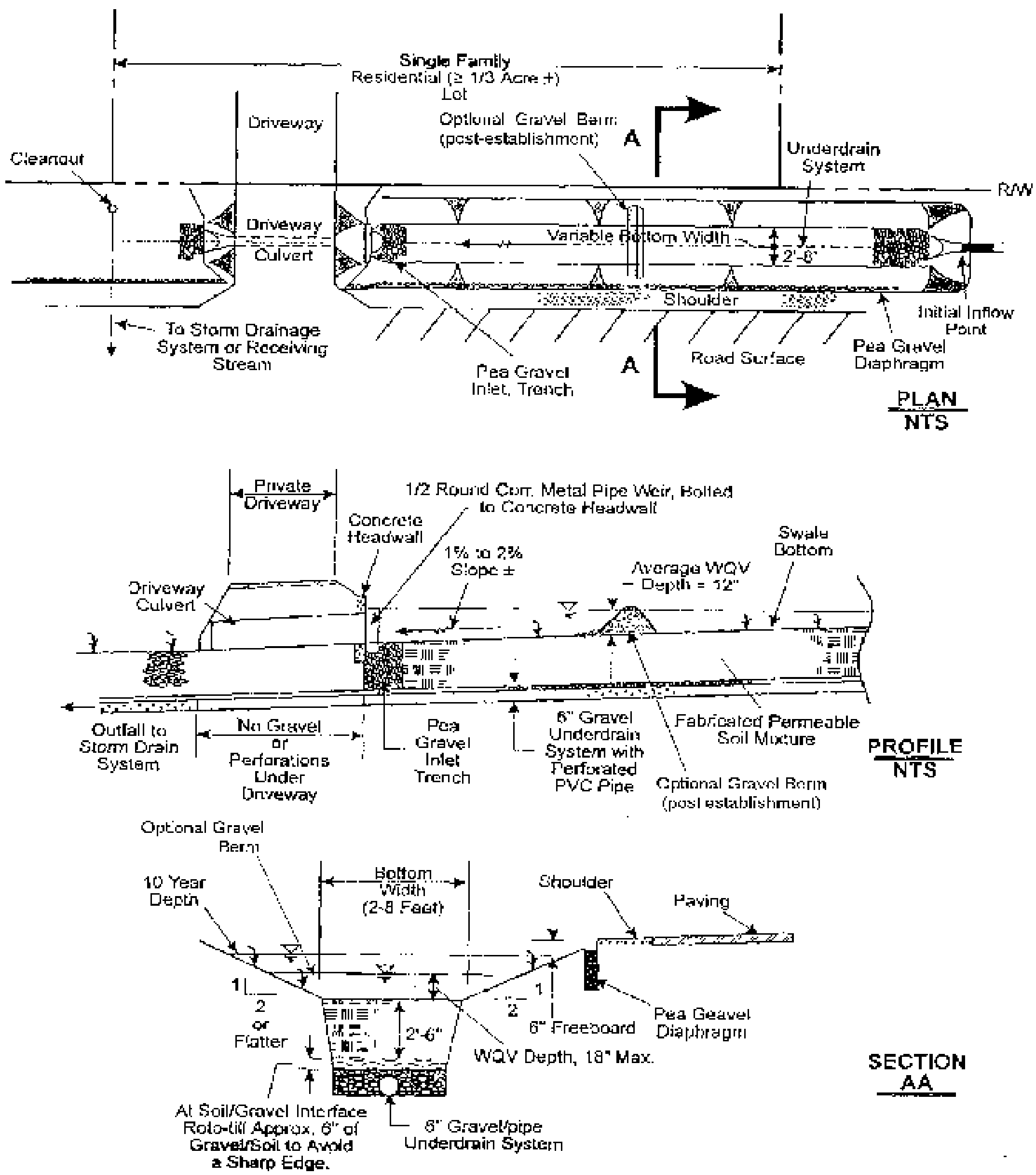
Channel Shape
Swales shall be designed to promote shallow, low velocity flow (i.e. trapezoidal channel). This maximizes the channel filtering surface, facilitates sedimentation and infiltration, and increases the travel time to the discharge point. The side slopes shall be gentle enough to maximize the filtering surface and resist bank erosion, and steep enough to adequately contain anticipated flows. The side slopes of the channel shall not be steeper than 2 Horizontal : 1 Vertical.

Capacity
The swale shall be designed to adequately convey the 10-year, 24-hour storm event at non-erosive velocities.

Flow Velocity
The bottom of the channel shall be wide enough to maintain the desired shallow flow, but narrow enough to maintain sufficient velocity to prevent rills from forming during low flows. The velocity for a 2-year, 24-hour storm shall not exceed 2 feet per second. A series of check dams or drop structures across swales shall be provided where necessary to enhance water quality performance and reduce velocities.

Channel Stabilization
Slopes and bottoms of swales shall be stabilized to prevent erosion. Commonly this is accomplished with an erosion resistant grass, such as tall fescue. If the grass is planted from seed, temporary matting is required to stabilize the soil while the grass is established. For swales in areas with steeper slopes, check dams may need to be constructed within the channel to slow the velocity.

Figure 5-1. Example of a Grass Swale Application



Source: State of Maryland, Department of the Environment. *2000 Maryland Stormwater Design Manual, Volumes I & II.*

5.2.3 Filter Strips

Description

Filter strips (a.k.a., buffer strips, vegetated filter strips, grass filter strips, and grassed filters) are vegetated areas that are intended to treat sheet flow from adjacent impervious areas. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and providing some infiltration into underlying soils. The filter strip may be planted in shrub/forest or a dense grass. The filter strip may also be a natural undisturbed area where the site characteristics mimic the design characteristics outlined below.

Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice. With proper design and maintenance, filter strips can provide relatively high pollutant removal. One challenge associated with filter strips, however, is that it is difficult to maintain sheet flow. Consequently, urban filter strips are often "short circuited" by concentrated flows, which results in little or no treatment of storm water runoff.[3]

Applicability

Filter strips can be utilized in urban settings for treating rooftop runoff, runoff from parking lots and runoff from other pervious areas. The filter strips work best with low-density development and are not recommended for controlling runoff from large commercial/industrial establishments. Filter strips work best when established with a minimum flow length of 50-70 feet, and a relatively low slope (less than 5%).

While filter strips are not recommended for higher-density development, they can be effective when used as a component in a treatment train. Filter strips do not provide enough runoff storage or infiltration to significantly reduce peak discharges or the volume of storm runoff. For this reason, a filter strip should be viewed as only one component in a storm water management system. At some sites, filter strips may help reduce the size and cost of downstream control facilities.

Design Guidelines

Treatment Length (T)
The length (direction of flow) of the filter strip should be at least 50 feet to provide water quality treatment.

Filter Width (W)
The filter strip shall be the same width of the area to be treated.

[3] The Stormwater Manager's Resource Center (SMRC). Stormwater Practice Factsheets.

Longitudinal Slope (S_o)

Filter strips shall be designed on slopes less than 10%. Greater slopes than this encourage the formation of concentrated flow. The areas to be treated by the filter strip should consist of or be graded to a uniform longitudinal slope of 5% or less to discourage concentrated flow. Both the top and toe of the slope shall be as flat as possible to encourage sheet flow and prevent erosion. A flow spreader may be required to uniformly distribute the incoming flow.

Level Spreader

Use of a pea gravel diaphragm at the top of the slope may be required. The pea gravel diaphragm (a small trench running along the top of the filter strip) serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip. The filter strip should exactly meet the elevation of the level flow spreader to help prevent erosion and concentrated flows.[4]

Drainage Length (L_1)

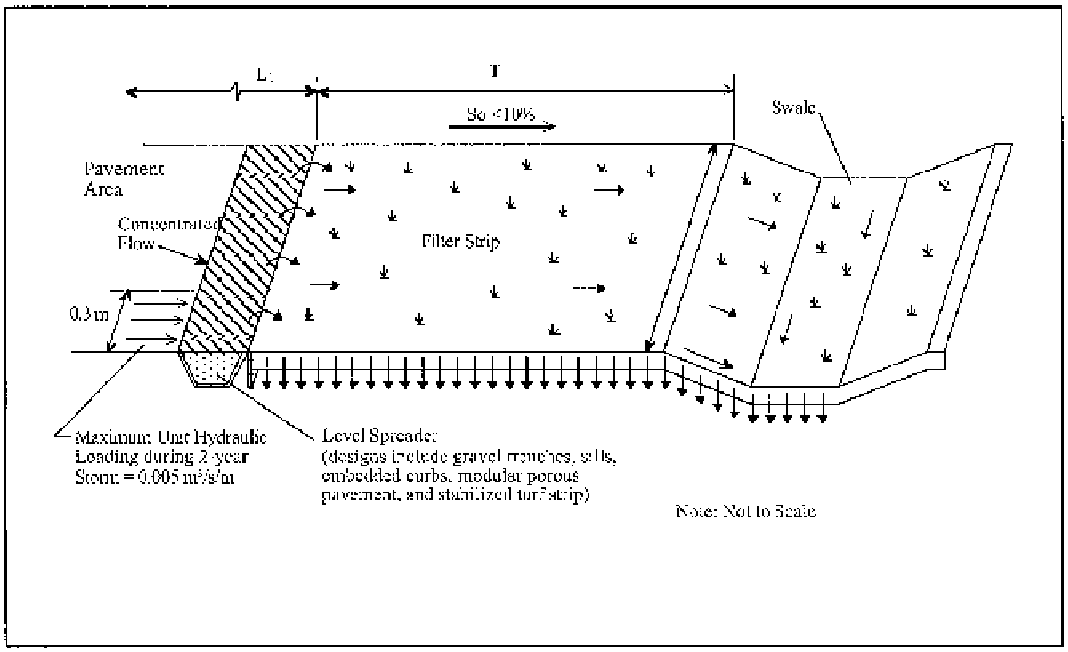
Filter strips shall be used to treat relatively small drainage areas or in combination with other practices. The limiting design factor, however, is not the drainage area the filter strip treats but rather the length of flow contributing to it. The maximum length of impervious area than can be treated with a filter strip is 100 feet.

Vegetation

The filter strip shall be planted with vegetation that can withstand relatively high velocity flows, and both wet and dry periods. A variety of species of grasses, shrubs and trees can be used, but they need to provide dense cover and resist erosion. Where natural areas are to be used as filter strips, any bare soil should be stabilized with native, non-invasive species.

[4] The Stormwater Manager's Resource Center (SMRC). Stormwater Practice Factsheets.

Figure 5-2. Example of a Filter Strip



5.2.4 Sand Filter

<u>Description</u>

A sand filter is a treatment devise, whereby the first flush of runoff is diverted into an off-line, self-contained bed of sand. The runoff is then strained through the sand, collected in underground pipes and returned back to the storm sewer or channel. Enhanced sand filters utilize layers of peat, limestone, and/or topsoil, and may also have a grass cover crop. As the storm water flows through the filter, the sand and other filtration media trap and absorb pollutants. In general, sand filters have a limited ability to reduce peak discharges and are usually designed solely to improve water quality. They are most commonly used in a treatment train, in combination with a pond or other water quantity control. **Most filtering practices cannot provide adequate storm water detention or flood attenuation and additional water quantity controls may be necessary.**

<u>Applicability</u>

Sand filtration systems are most beneficial when land space is limited or expensive, because they can be designed to be placed underground or to border the perimeter of a parking lot or other impervious surface. They are best used for smaller sites (5 acres or less) where the percent imperviousness is high.[5] The maximum contributing

[5] City of Greensboro, Stormwater Services, *Stormwater Management Manual, First Edition.* 2000.

area to an individual storm water filtering system is usually less than 10 acres. Filters have been used on larger drainage areas in the past (up to 100 acres), but these systems often clog.

Sand filters are an excellent option to treat runoff from storm water with higher levels of contaminants because storm water treated by sand filters has no interaction with, and thus no potential to contaminate groundwater. Sand filtering systems are generally applied to land uses with a high percentage of impervious surfaces. Sites with imperviousness less than 75% will require sedimentation pretreatment techniques.

The cost of construction of concrete underground sand filtration facilities is high in relation to other BMPs and the maintenance burden for the owner can be significant. However, the space savings achieved by placing the structure underground can often offset these costs.

There are three basic sand filtration BMP types (1) underground sand filter, (2) perimeter sand filter, and (3) surface sand filter. The underground filter is ideal to treat storm water from ultra-urban sites where land costs are high and space is limited. The perimeter sand filter and surface sand filter are best suited for treating parking lot runoff and other predominantly impervious surface areas.

Design Guidelines

Filtering Conveyance
If runoff is delivered by a storm drainpipe or is along the main conveyance system, the filtering practice shall be designed off-line. An overflow shall be provided within the practice to pass a percentage of the WQ_v to a stabilized watercourse. In addition, overflow for the 10-year, 24-hour storm should be provided to a non-erosive outlet point (i.e., prevent downstream slope erosion). The entire treatment system (including pretreatment) shall temporarily hold at least 75% of the WQ_v prior to filtration.

Filter Bed
The filter media should consist of medium sand (Exp. ASTM C-33 concrete sand). The filter bed typically has a minimum depth of 18". The perimeter filter may have a minimum filter bed depth of 12". The filter area for sand shall be sized based on the principles of Darcy's Law. A coefficient of permeability (k) for sand of 3.5 ft/day shall be used.[6] The required filter bed area is computed using the following equation:

[6] Center for Watershed Protection, *Design of Stormwater Filtering Systems.* 1996.

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

A_f = Surface area of filter bed (ft^2)
d_f = filter bed depth (ft)
k = coefficient of permeability of filter media (ft/day)
h_f = average height of water above filter bed (ft)
t_f = design filter bed drain time (days)
(1.67 days or 40 hours is recommended maximum for sand filters)

Sedimentation Chamber
The sedimentation chamber should be designed to detain at least 50% of the WQ_v. This volume should be slowly released over a period of several hours. The extended detention time improves the removal efficiency by settling out more course sediments and helps prevent premature clogging of the filter bed.[7]

Sand Filter Chamber
Flow from the sedimentation chamber should be uniformly distributed across the sand filter. Overflow weirs along the width of the sand filter can be used to ensure uniform distribution. When flow from the sedimentation basin/chamber is by pipe, a flow distribution chamber is required.[8]

Under-drain System
Stormwater filters shall be equipped with a minimum 4" perforated pipe under drain (6" is preferred) in a gravel layer. A permeable filter fabric shall be placed between the gravel layer and the filter media.

<u>Maintenance</u>

Access
Adequate maintenance access (i.e. easement) from public or private right-of-way to the filter facility shall be reserved. For underground facilities, maintenance and inspection openings shall be provided. Large aluminum or steel doors shall provide maintenance equipment easy access to the sand filter chamber. Observation manholes or doors shall be provided for underground overflow and sedimentation chambers.

Sedimentation Chamber
Sediment should be cleaned out of the sedimentation chamber when it accumulates to a depth of more than six inches. Vegetation within the sedimentation chamber shall be limited to a height of 18 inches. The sediment chamber outlet devices shall be cleaned/repaired when draw down times exceed 36 hours. Trash and debris shall be removed as necessary.

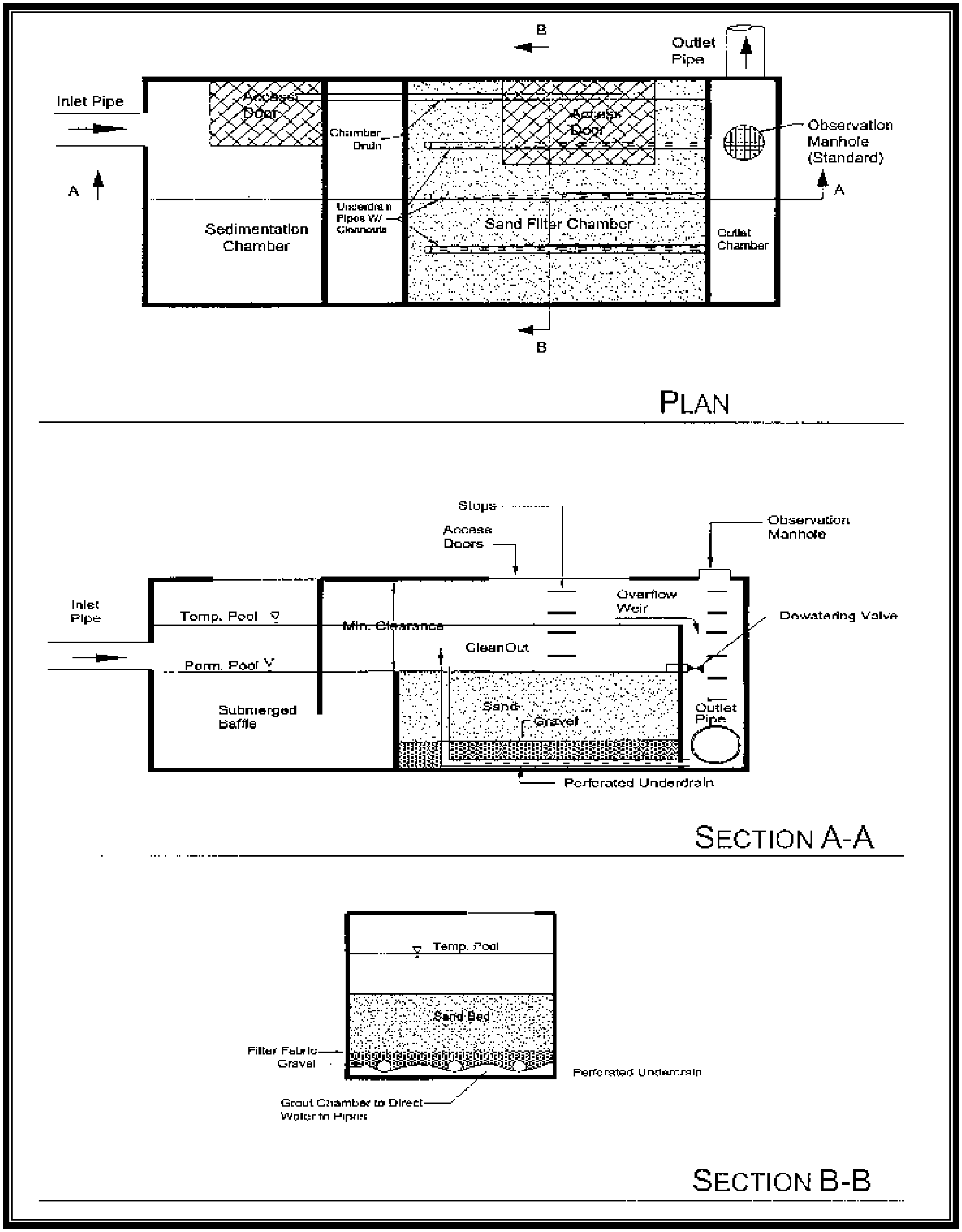
Filter Bed

[7] City of Greensboro, Storm Water Services**,** *Stormwater Management Manual, First Edition.* 2000.

Silt/sediment shall be removed from the filter bed when the accumulation exceeds one inch. When the filtering capacity of the filter diminishes substantially (i.e., when water ponds on the surface of the filter bed for more than 48 hours), the top few inches of discolored material shall be removed and shall be replaced with fresh material. The removed sediments should be disposed in an acceptable manner (i.e., landfill).

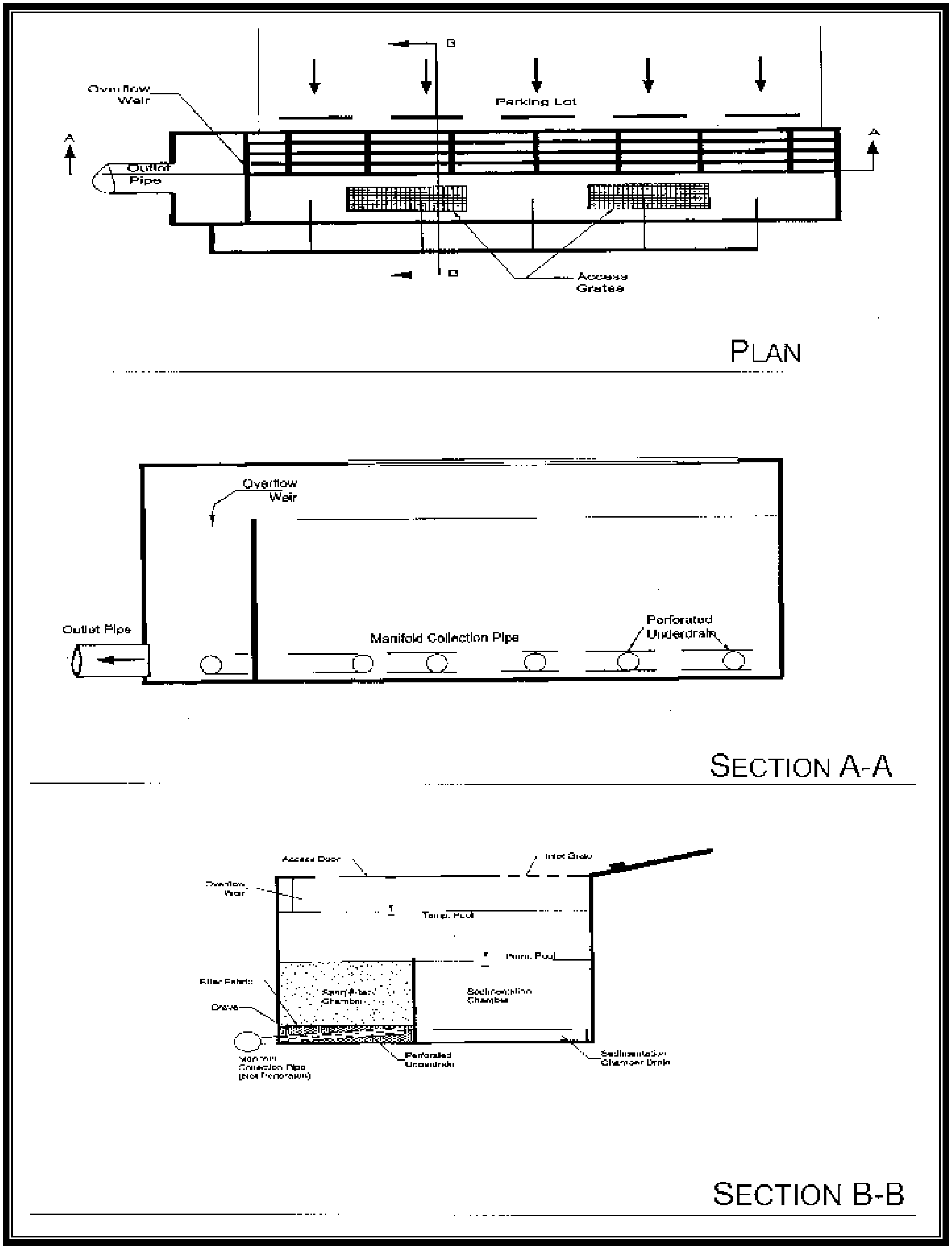
Sand filters that have a grass cover should be mowed a minimum of 3 times per growing season to maintain maximum grass heights less than 12 inches. Direct maintenance access shall be provided to the pretreatment area and the filter bed.

Figure 5-3. Example of an Underground Sand Filter



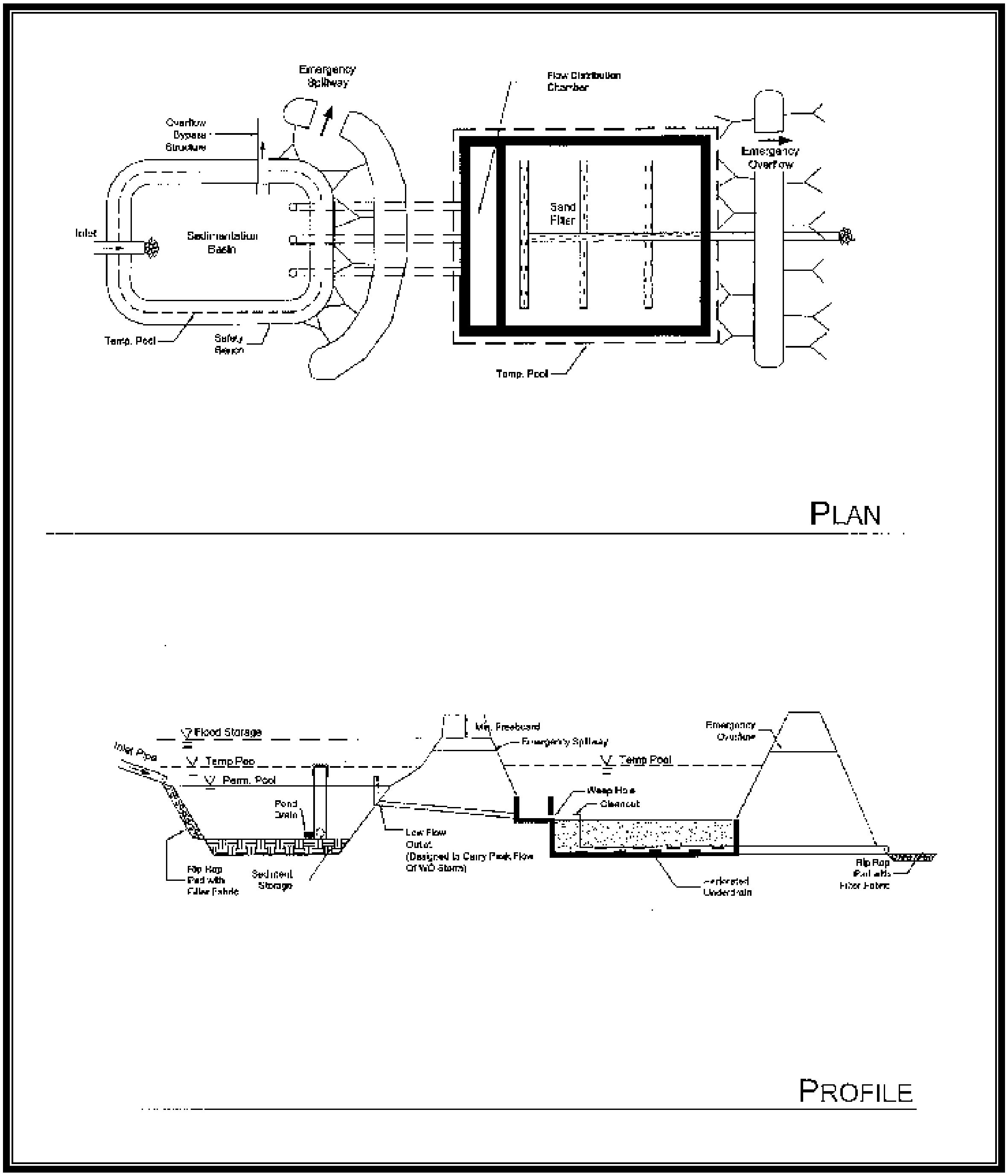
Source: City of Greensboro, Storm Water Services, *Stormwater Management Manual, First Edition.* 2000.

Figure 5-4. Example of a Perimeter Sand Filter



Source: City of Greensboro, Storm Water Services, *Stormwater Management Manual, First Edition.* 2000.

Figure 5-5. Example of a Surface Sand Filter



Source: City of Greensboro, Storm Water Services, *Stormwater Management Manual, First Edition.* 2000.

5.2.5 Storm Water Wetland

Storm water wetland / marsh systems and wet detention ponds (Section 5.2.6) will be preferred to dry ponds (Section 5.2.7). Dry ponds providing first flush detention and channel protection will be accepted when the development site's physical characteristics or other local circumstances make the use of a wet pond infeasible.

<u>Description</u>

Storm water wetlands are constructed systems that are explicitly designed to provide treatment and detention of storm water. They accomplish this by temporarily storing storm water runoff in shallow pools that create growing conditions suitable for emergent and riparian wetland plants. The systems remove pollutants through physical filtration, settling, and biological processes of the wetland plants. Storm water wetlands are similar to wet detention ponds (See Section 5.2.6), but require additional design elements to maintain the proper growing conditions for the plants.

While they are designed to mimic the ecological functions of natural wetlands, storm water wetlands are constructed systems and require periodic maintenance and adjustments to work properly. As a general rule, uncontrolled storm water runoff should never be introduced into natural wetlands[9].

<u>Applicability</u>

Land Area
Constructed wetlands are a widely applicable storm water management practice and provide excellent pollutant removal. However, wetlands consume a large area, which may limit their use on sites where land values are high or additional land is not available.

Soil Types
Maintaining minimal water levels so that the wetland plants can survive is essential to the proper function of storm water wetlands. Therefore, storm water wetlands are recommended for large drainage areas (greater than 20 acres). Sites with type A and B soils may have high infiltration losses. These sites may require clay or geo-textile liners to help maintain water levels.

Nuisance Abatement
Geese, ducks, and insects can become undesirable inhabitants of the wetland if it is not designed properly. Limiting the amount of deep, open water as well as keeping open grass areas to a minimum will discourage nuisance species. Careful consideration should be given to the possible adverse effects of attracting wildlife to the site, prior to choosing this BMP.

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[9] Schueler, T.R., *Design of Stormwater Wetland Systems: guidelines for creating diverse and effective stormwater wetlands in the mid-Atlantic Region*, Metropolitan Washington Council of Governments: Washington, 1992.

Storm Water vs. Natural Wetlands
Storm water wetlands that are separated from natural wetlands and are typically not regulated under appropriate State and Federal laws. However, State and Federal permit requirements should be reviewed prior to storm water wetland design. Required permits and certifications may include Section 401 water quality certification, Section 402 NPDES storm water construction permit, Section 404 wetlands permit, dam safety permits, and local grading permits. Generally, storm water wetlands should not be located within delineated natural wetland areas, nor be used to mitigate the loss of natural wetlands. Disruption or discharge to natural wetlands will not be allowed without a Section 404 permit and State certification under Section 401 (See Chapter 8 for additional guidelines on *Natural Wetlands Protection*).

<u>Design Guidelines</u>

Treatment Sizing Criteria & Release Rates

Water quality storage: $\mathbf{WQ_v}$
Water quality draw down time: 24 hours

Floodwater storage: $\mathbf{Q_f}$
Maximum release rate: Pre-development 5-year, 24-hour storm event

Emergency spillway capacity: Minimum 100-year, 24-hour storm event

A minimum of one foot of freeboard is required above the 25-year, 24-hour storm water elevation on all detention/retention facilities.

Forebay
A sediment forebay shall be constructed at the inlet to provide energy dissipation and to trap and localize incoming sediments. The forebay shall be a separate basin, which can be formed by gabions, a compacted earthen berm, or riprap.

The capacity of the forebay should be equivalent to 5% of the 25-year, 24-hour storm volume based on the area tributary to the inlet. It is recommended that approximately 75% of the required sediment storage be allocated to the forebay.

Direct maintenance access to the forebay for heavy equipment shall be provided. This access should allow construction equipment to get down in the forebay without disturbing the embankment.

Maintenance Elements
Adequate maintenance access (e.g. easement) from public or private right-of-way to the basin shall be reserved. The access will be on a slope of 5:1 or less, stabilized to withstand the passage of heavy equipment, and will provide direct access to both the forebay and the riser/outlet.

An adequate area for temporary staging of spoils, prior to ultimate disposal, shall be provided. This area shall be protected such that no runoff will be directed back into the Storm water management system or onto private property. For subdivisions and site condominiums, an easement dedicated to the (community) must be provided over the disposal area.

Pond Shape and Depth
Surface area to volume ratio shall be maximized to the extent feasible. In general, depths of the permanent pool should be varied and average between 3 and 6 feet. A minimum length to width ratio of 3:1 should be used unless structural measures are used to extend the flow path. Ponds should be wedge-shaped, narrower at the inlet and wider at the outlet. Irregular shorelines are preferred.

A marsh fringe should be established near the inlet or forebay and around at least 50% of the pond's perimeter. A shelf, a minimum of 4 feet wide at a depth of one foot, will surround the interior of the perimeter to provide suitable conditions for the establishment of aquatic vegetation, and to reduce the potential safety hazard to the public.

For safety purposes and to minimize erosion, basin side slopes will not be flatter than one foot vertical to 20 feet horizontal (20:1), nor steeper than one foot vertical to five feet horizontal (5:1). Steeper slopes may be allowed if fencing at least 5 feet in height is provided, although fencing is discouraged for aesthetic reasons.

Minimal Water Supply
To avoid drawdowns, a reliable supply of baseflow and/or groundwater will be required. If underlying soils are highly permeable (e.g. in the "A" or "B" hydrologic groupings); the bottom of the basin should be lined with an impermeable geo-textile or a 6-inch clay liner.

Basin Inlet/Outlet Design
Velocity dissipation measures shall be incorporated into basin designs to minimize erosion at inlets and outlets, and to minimize the re-suspension of pollutants. Inverts for inlet pipes should discharge at the elevation of the permanent pool and perpendicular to the surface to allow the pool to dissipate the energy of the inflow. Stone riprap pads should extend from the pipe invert to the pond bottom to prevent erosion.

Anti-seep collars shall be installed on any piping passing through the sides or bottom of the basin to prevent leakage through the embankment.

To the extent feasible, the distance between inlet and outlet shall be maximized. The length and depth of the flow path across basins can be maximized by:

- Increasing the length to width ratio of the entire design

- Increasing the dry weather flow path within the system to attain maximum sinuosity

Dual orifices, V-notched weirs, or other designs shall be used to assure an appropriate detention time for all storm events. Where a pipe outlet or orifice plate is to be used to control discharge, it shall have a minimum diameter of six (6) inches. If this minimum orifice size permits release rates greater than those specified in these rules, alternative outlet designs will be utilized that incorporate self-cleaning flow restrictors, such as perforated risers and “V” notch orifice plates that provide the required release rate.

The outlet shall be well protected from clogging. A reverse-slope-submerged orifice or hooded, broad crested weirs are recommended options. If a reverse-slope pipe is used, an adjustable valve may be necessary to regulate flows. Orifices used to maintain a permanent pool levels shall withdraw water at least one foot below the surface of the water.

Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet. All outlets shall be designed to be easily accessible for heavy equipment required for maintenance purposes.

All basins shall have provisions for a defined emergency spillway, routed such that the main outflow channel can pick it up. The emergency spillway shall be set at the elevation of the 25-year, 24-hour storm volume.

Where feasible, a drain for completely de-watering wet ponds shall be installed for sediment removal and other maintenance purposes.

Riser Design

Hoods or trash racks shall be installed on the riser to prevent clogging. Grate openings shall be a maximum of three (3) inches.

The riser shall be placed near or within the embankment, to provide for ready maintenance access. Inlet and outlet barrels and risers shall be constructed of materials that will reduce future maintenance requirements.

The riser pipe shall be a minimum of twenty-four (24) inches in diameter for riser pipes up to four (4) feet in height. Riser pipes greater than four (4) feet in height shall be forty-eight (48) inches in diameter. Riser pipes shall be constructed with poured-in-place concrete bottoms.

Wetland Plantings

A critical determinant of a wetland’s pollutant removal capacity is the establishment of a healthy and diverse plant community. A wetland expert or landscape architect should be employed to develop a planting plan that utilizes native wetland plants.

Suitable planting soils and water depths are essential for the establishment of viable plants. A grading plan shall be followed to create appropriate water depths. Since most basins are excavated to nutrient poor sub soils, addition of topsoil and mulch will most likely be necessary. The soil shall have adequate texture and organic matter to retain the requisite moisture for plant growth.

The operator shall monitor viability of plantings for two (2) years to ensure establishment; reinforcement and replacement plantings shall be provided as needed.

A permanent buffer strip of vegetation extending at least 25 feet in width beyond the freeboard elevation shall be maintained or restored around the perimeter of all storm water storage facilities. No lawn care chemical applications shall be applied to the buffer area, except to control noxious weeds or injurious pests.

Additional Resources
Further details on storm water wetland design may be obtained from other resources including:

- Shueler, T.R., *Design of Stormwater Wetland Systems: guidelines for creating diverse and effective Stormwater wetlands in the mid-Atlantic region.* Metropolitan Washington Council of Governments, 1992.

- Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

<u>Maintenance</u>

Maintenance Agreement
A legal entity shall be designated or established with responsibility for inspecting and maintaining the storm water wetland. The legal agreement shall list specific maintenance responsibilities (including timetables) and provide for the funding to cover inspection and maintenance.

Inlet & Outlet Inspections
The inlet and outlet of the pond shall be checked periodically to ensure that flow structures are not blocked by debris. Inspections shall be conducted monthly during wet weather conditions from March to November. It is important to design flow structures so that they can be easily inspected for debris blockage, and so that corrective action can be taken even during storm conditions.

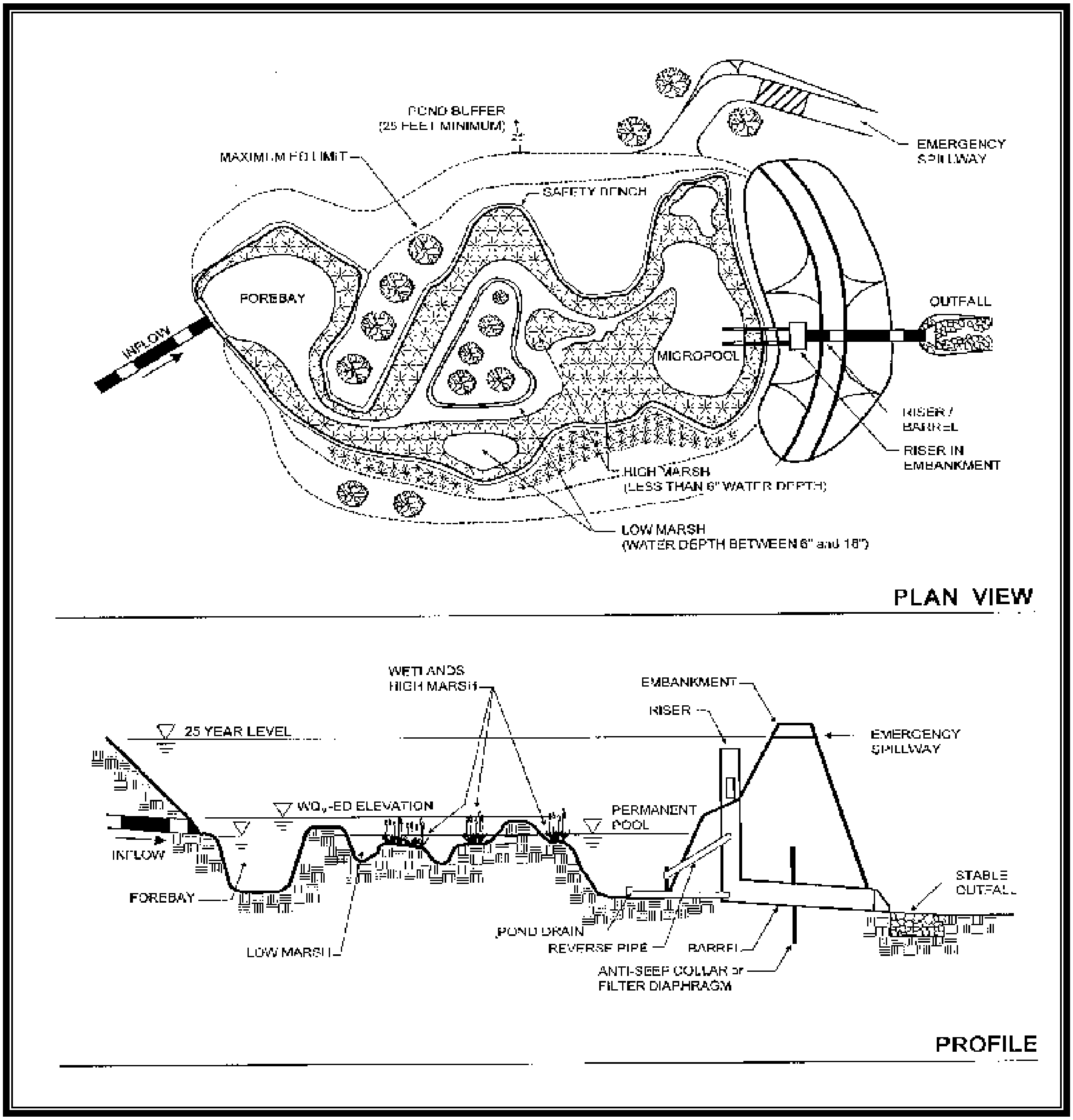
Erosion & Instability
Storm water wetlands shall be inspected annually for erosion, destabilization of side slopes, embankment settling and other signs of structural failure, and loss of storage volume due to sediment accumulation. Corrective action shall be taken in a timely manner upon identification of problems.

Embankment Maintenance
Embankments shall be maintained to preserve their integrity as impoundment structures, including, but not limited to, vegetative maintenance (mowing, control of woody vegetation), rodent control, erosion control and repair, and outlet control structure maintenance and repair.

Hazardous Substance Storage
For sites where hazardous substances may be stored and used (e.g. certain commercial and industrial developments), a spill response plan shall be developed that clearly defines the emergency steps to be taken in the event of an accidental release of harmful substances that may migrate to the pond. As a result of this plan, design elements such as shut-off valves or gates may be needed.

Sediment Removal
Sediment removal in the forebay and/or wetland should occur every 5 to 7 years or after 50% of total capacity has been lost. Sediments excavated from storm water ponds that do not receive runoff from designated hotspots are not considered toxic or hazardous material, and can be safely disposed by either land application or land filling. Sediment testing may be required prior to sediment disposal when a hotspot land use is present. Sediment removed from storm water ponds should be disposed of according to an approved erosion and sediment control plan.

Figure 5-6. Example of a Storm Water Wetland



Source: Schueler, T.R. *Design of Stormwater Wetland Systems: guidelines for creating diverse and effective stormwater wetlands in the mind-Atlantic Region.* Metropolitan Washington Council of Governments: Washington, 1992.

5.2.6 Wet Detention Ponds

<u>Description</u>

Wet detention ponds are one of the most widely accepted BMP's for meeting water quantity requirements and providing limited storm water quality treatment. The "wet pond" improves water quality by detaining the storm water for an extended period of time in a permanent pool, which allows pollutants to settle out. Runoff from each rain event is detained and treated in the pond until it is displaced by runoff from the next storm event. Pollutants removed include suspended solids, organic matter, dissolved metals, and nutrients.

There are several common modifications that can be made to the ponds to increase their pollutant removal effectiveness. The first is to increase the settling area for sediments through the addition of a sediment forebay. Heavier sediments will drop out of suspension as runoff passes through the sediment forebay, while lighter sediments will settle out as the runoff is retained in the permanent pool. A second common modification is the construction of shallow ledges along the edge of the permanent pool. The ledges allow emergent wetland plants to grow, adding some of the biological benefits of a storm water wetland (Section 5.2.5).

<u>Applicability</u>

Land Area
Land constraints, such as small sites or highly developed areas, may preclude the installation of a wet pond. The wet pond BMP is most applicable for large industrial and commercial facilities and residential subdivisions. Owners of smaller properties may cooperatively construct one large pond to serve several sites. Fewer, cooperative ponds are preferred to numerous individual smaller ponds. Wet detention ponds are effective in meeting both storm water quantity and quality goals. Additionally, they can provide an amenity to properties through "water front" designation, fountain pools, wildlife habitat, etc.

Soils
Wet detention ponds must be able to maintain a permanent pool of water. Therefore, similar to storm water wetlands, wet ponds are recommended for medium to large drainage areas (greater than 10 acres). Sites with highly permeable soils (e.g. in the "A" or "B" hydrologic groupings) may require clay or geo-textile liners to help maintain water levels.

Retrofit
Wet ponds provide opportunities for retrofit coverage for existing development. With minor excavation and/or modification of the outlet, existing dry ponds can be converted to wet ponds. The retrofits can generate greater water quality benefits for the receiving stream, helping the <u>(community)</u> meet water quality goals.

Design Guidelines

Treatment Sizing Criteria & Release Rates

Water quality storage: $\mathbf{WQ_v}$
Water quality draw down time: 24 hours

Floodwater storage: $\mathbf{Q_f}$
Maximum release rate: Pre-development 5-year, 24-hour storm event

Emergency spillway capacity: Minimum 100-year, 24-hour storm event

A minimum of one foot of freeboard is required above the 25-year, 24-hour storm water elevation on all detention/retention facilities.

Forebay
A sediment forebay shall be constructed at the inlet to provide energy dissipation and to trap and localize incoming sediments. The forebay shall be a separate basin, which can be formed by gabions, a compacted earthen berm, or riprap.

The capacity of the forebay should be equivalent to 5% of the 25-year, 24-hour storm volume based on the area tributary to the inlet. It is recommended that approximately 75% of the required sediment storage be allocated to the forebay.

Direct maintenance access to the forebay for heavy equipment shall be provided. This access should allow construction equipment to get down in the forebay without disturbing the embankment.

Maintenance Elements
Adequate maintenance access (e.g. easement) from public or private right-of-way to the basin shall be reserved. The access will be on a slope of 5:1 or less, stabilized to withstand the passage of heavy equipment, and will provide direct access to both the forebay and the riser/outlet.

An adequate area for temporary staging of spoils, prior to ultimate disposal, shall be provided. This area shall be protected such that no runoff will be directed back into the Storm water management system or onto private property. For subdivisions and site condominiums, an easement dedicated to the (community) must be provided over the disposal area.

Pond Shape and Depth
Surface area to volume ratio shall be maximized to the extent feasible. Average depth of the permanent pool should be a minimum of 3 feet. A minimum length to width ratio of 3:1 should be used unless structural measures are used to extend the flow path. Ponds should be wedge-shaped, narrower at the inlet and wider at the outlet.

Minimal Water Supply

To avoid drawdowns, a reliable supply of baseflow and/or groundwater will be required. If underlying soils are highly permeable (e.g. in the "A" or "B" hydrologic groupings); the bottom of the basin should be lined with an impermeable geo-textile or a 6-inch clay liner.

Basin Inlet/Outlet Design

Velocity dissipation measures shall be incorporated into basin designs to minimize erosion at inlets and outlets, and to minimize the re-suspension of pollutants. Inverts for inlet pipes should discharge at the elevation of the permanent pool and perpendicular to the surface to allow the pool to dissipate the energy of the inflow. Stone riprap pads should extend from the pipe invert to the pond bottom to prevent erosion.

Anti-seep collars shall be installed on any piping passing through the sides or bottom of the basin to prevent leakage through the embankment.

To the extent feasible, the distance between inlet and outlet shall be maximized. The length and depth of the flow path across basins can be maximized by:

- Increasing the length to width ratio of the entire design
- Increasing the dry weather flow path within the system to attain maximum sinuosity

Dual orifices, V-notched weirs, or other designs shall be used to assure an appropriate detention time for all storm events. Where a pipe outlet or orifice plate is to be used to control discharge, it shall have a minimum diameter of six (6) inches. If this minimum orifice size permits release rates greater than those specified in these rules, alternative outlet designs will be utilized that incorporate self-cleaning flow restrictors, such as perforated risers and “V” notch orifice plates that provide the required release rate.

The outlet shall be well protected from clogging. A reverse-slope-submerged orifice or hooded, broad crested weirs are recommended options. If a reverse-slope pipe is used, an adjustable valve may be necessary to regulate flows. Orifices used to maintain a permanent pool levels shall withdraw water at least one foot below the surface of the water.

Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet. All outlets shall be designed to be easily accessible for heavy equipment required for maintenance purposes.

All basins shall have provisions for a defined emergency spillway, routed such that the main outflow channel can pick it up. The emergency spillway shall be set at the elevation of the 25-year, 24-hour storm volume.

Where feasible, a drain for completely de-watering wet ponds shall be installed for maintenance purposes.

Riser Design

Hoods or trash racks shall be installed on the riser to prevent clogging. Grate openings shall be a maximum of three (3) inches.

The riser shall be placed near or within the embankment, to provide for ready maintenance access. Inlet and outlet barrels and risers shall be constructed of materials that will reduce future maintenance requirements.

The riser pipe shall be a minimum of twenty-four (24) inches in diameter for riser pipes up to four (4) feet in height. Riser pipes greater than four (4) feet in height shall be forty-eight (48) inches in diameter. Riser pipes shall be constructed with poured-in-place concrete bottoms.

Buffer

A permanent buffer strip of vegetation extending at least 25 feet in width beyond the freeboard elevation shall be maintained or restored around the perimeter of all storm water storage facilities. No lawn care chemical applications shall be applied to the buffer area, except to control noxious weeds or injurious pests.

Additional Resources

Further details on storm water wetland design may be obtained from other resources including:

- Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

<u>Maintenance</u>

Maintenance Agreement

A legal entity shall be designated or established with responsibility for inspecting and maintaining any detention pond. The legal agreement shall list specific maintenance responsibilities (including timetables) and provide for the funding to cover inspection and maintenance.

Inlet & Outlet Inspections

The inlet and outlet of the pond shall be checked periodically to ensure that flow structures are not blocked by debris. Inspections shall be conducted monthly during wet weather conditions from March to November. It is important to design flow structures so that they can be easily inspected for debris blockage, and so that corrective action can be taken even during storm conditions.

Erosion & Instability

Ponds shall be inspected annually for erosion, destabilization of side slopes, embankment settling and other signs of structural failure, and loss of storage volume due to sediment accumulation. Corrective action shall be taken in a timely manner upon identification of problems.

Embankment Maintenance

Embankments shall be maintained to preserve their integrity as impoundment structures, including, but not limited to, vegetative maintenance (mowing, control of woody vegetation), rodent control, erosion control and repair, and outlet control structure maintenance and repair.

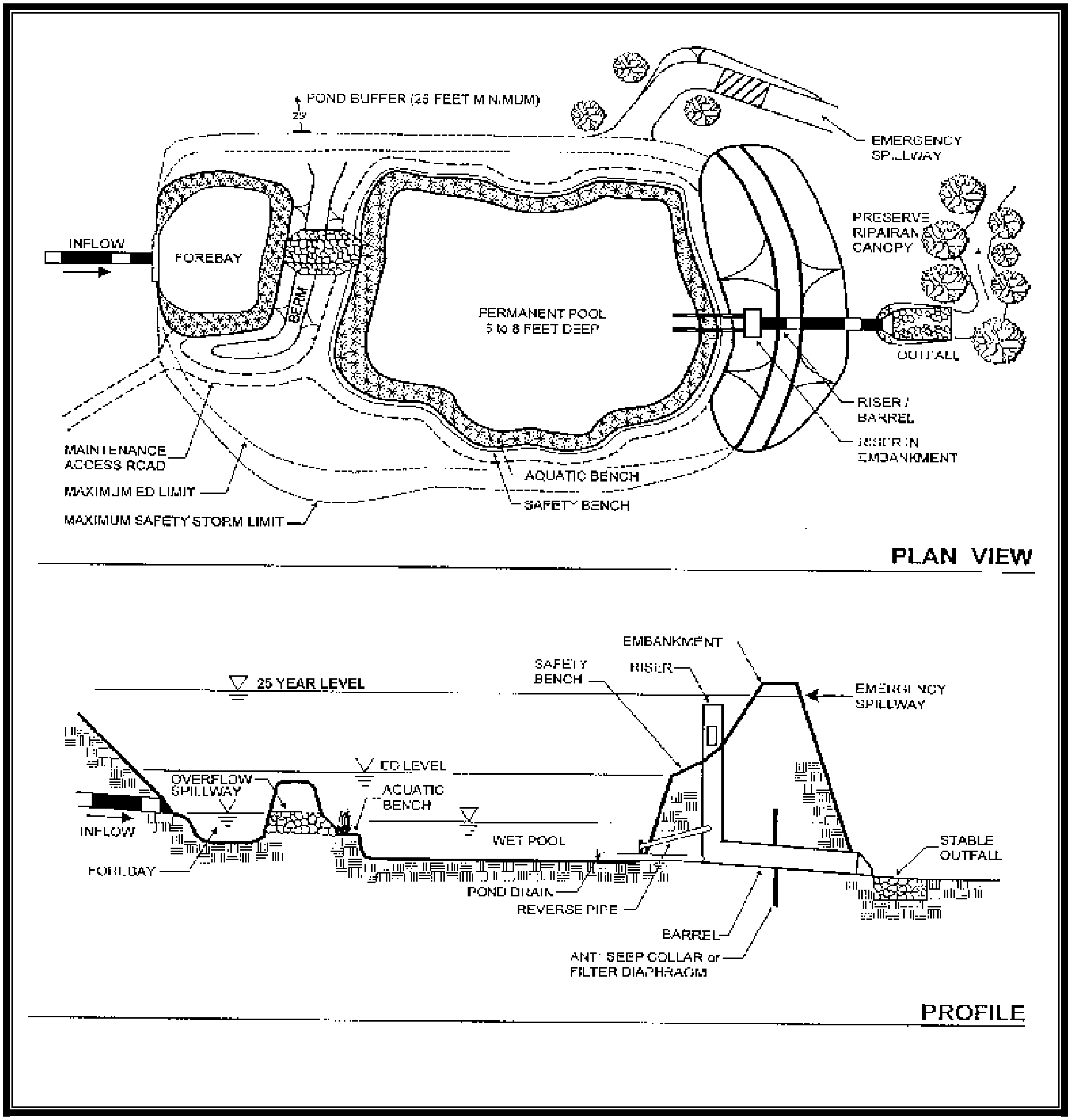
Hazardous Substance Storage

For sites where hazardous substances may be stored and used (e.g. certain commercial and industrial developments), a spill response plan shall be developed that clearly defines the emergency steps to be taken in the event of an accidental release of harmful substances that may migrate to the pond. As a result of this plan, design elements such as shut-off valves or gates may be needed.

Sediment Removal

Sediment removal in the forebay and/or pond should occur every 5 to 7 years or after 50% of total capacity has been lost. Sediments excavated from storm water ponds that do not receive runoff from designated hotspots are not considered toxic or hazardous material, and can be safely disposed by either land application or land filling. Sediment testing may be required prior to sediment disposal when a hotspot land use is present. Sediment removed from storm water ponds should be disposed of according to an approved erosion and sediment control plan.

Figure 5-7. Example of a Wet Detention Pond



Source: Maryland Department of the Environment. *2000 Maryland Stormwater Design Manual.*

5.2.7 Dry Extended Detention Basins

Description

A dry extended detention basin is a storm water storage basin that provides temporary detention, but does not have a permanent pool. The main reasons for use of dry detention basins are reducing peak storm water discharges, controlling floods and preventing downstream channel scouring. A dry basin with extended detention does remove course suspended solids, but has limited effectiveness with other pollutants. It is one of the most common and lowest cost alternative for large runoff volumes.

Sedimentation occurs in these basins; however, later runoff events will scour the bottom and move the sediments downstream. If water quality improvement is an objective, a dry detention basin is not a recommended best management practice. Dry detention basin effectiveness is rated low to moderate compared to other stormwater BMPs.

Applicability

Dry extended detention basins are generally recommended for contributing watersheds of 10 acres or more. While extended detention is applicable to smaller drainage areas, the designs of non-clogging outlet control devices for the associated lower release rate can be problematic. A larger watershed and corresponding higher release rate allows for an outlet configuration to overcome this constraint. Impermeable soils are problematic if the pond bottom is designed to remain dry between storm events.

Extended dry detention basins can be a highly effective component of a larger "treatment train". The basin can serve as a pre-treatment facility to remove course sediment from the storm water, which can then be directed to a second system such as a sand filter.

Basins that are usually dry can be used for multiple purposes, such as recreation fields. Detention basins can be landscaped to provide an aesthetically attractive appearance. Provision of a low flow channel offers greater flexibility in selecting and maintaining vegetation to accomplish this purpose, as well as facilitating recreational use.

Design Guidelines

Treatment Sizing Criteria & Release Rates

Water quality storage: $\mathbf{WQ_v}$
Water quality draw down time: 24 hours

Floodwater storage: $\mathbf{Q_f}$
Maximum release rate: Pre-development 5-year, 24-hour storm event

Emergency spillway capacity: Minimum 100-year, 24-hour storm event

A minimum of one foot of freeboard is required above the 25-year, 24-hour storm water elevation on all detention/retention facilities.

Maintenance Elements

Adequate maintenance access (e.g. easement) from public or private right-of-way to the basin shall be reserved. The access will be on a slope of 5:1 or less, stabilized to withstand the passage of heavy equipment, and will provide direct access to both the forebay and the riser/outlet.

An adequate area for temporary staging of spoils, prior to ultimate disposal, shall be provided. This area shall be protected such that no runoff will be directed back into the Storm water management system or onto private property. For subdivisions and site condominiums, an easement dedicated to the <u>(community)</u> must be provided over the disposal area.

Pond Shape and Depth

A minimum length to width ratio of 3:1 shall be used unless structural measures are used to extend the flow path. Ponds should be wedge-shaped, narrower at the inlet and wider at the outlet.

Basin Inlet/Outlet Design

Velocity dissipation measures shall be incorporated into basin designs to minimize erosion at inlets and outlets, and to minimize the re-suspension of pollutants. Stone riprap pads should extend from pipe inlets to the pond bottom to prevent erosion.

Anti-seep collars shall be installed on any piping passing through the sides or bottom of the basin to prevent leakage through the embankment.

To the extent feasible, the distance between inlet and outlet shall be maximized. The length and depth of the flow path across basins can be maximized by:

- Increasing the length to width ratio of the entire design
- Increasing the dry weather flow path within the system to attain maximum sinuosity

Dual orifices, V-notched weirs, or other designs shall be used to assure an appropriate detention time for all storm events. Where a pipe outlet or orifice plate is to be used to control discharge, it shall have a minimum diameter of six (6) inches. If this minimum orifice size permits release rates greater than those specified in these rules, alternative outlet designs will be utilized that incorporate self-cleaning flow restrictors, such as perforated risers and “V” notch orifice plates that provide the required release rate.

The outlet shall be well protected from clogging. A reverse-slope orifice or hooded, broad crested weirs are recommended options. If a reverse-slope pipe is used, an adjustable valve may be necessary to regulate flows.

Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet. All outlets shall be designed to be easily accessible for heavy equipment required for maintenance purposes.

All basins shall have provisions for a defined emergency spillway, routed such that the main outflow channel can pick it up. The emergency spillway shall be set at the elevation of the 25-year, 24-hour storm volume.

Low Flow Channel
A low flow channel, stabilized against erosion, will be provided through the basin. This channel should have a minimum grade of 0.5% and the remainder of the basin should drain toward this channel at a grade of at least 1%.

Riser Design
Hoods or trash racks shall be installed on the riser to prevent clogging. Grate openings shall be a maximum of three (3) inches.

The riser shall be placed near or within the embankment, to provide for ready maintenance access. Inlet and outlet barrels and risers shall be constructed of materials that will reduce future maintenance requirements.

The riser pipe shall be a minimum of twenty-four (24) inches in diameter for riser pipes up to four (4) feet in height. Riser pipes greater than four (4) feet in height shall be forty-eight (48) inches in diameter. Riser pipes shall be constructed with poured-in-place concrete bottoms.

<u>Maintenance</u>

Maintenance Agreement
A legal entity shall be designated or established with responsibility for inspecting and maintaining any detention pond. The legal agreement shall list specific maintenance responsibilities (including timetables) and provide for the funding to cover inspection and maintenance.

Inlet & Outlet Inspections
The inlet and outlet of the pond shall be checked periodically to ensure that flow structures are not blocked by debris. Inspections shall be conducted monthly during wet weather conditions from March to November. It is important to design flow structures so that they can be easily inspected for debris blockage, and so that corrective action can be taken even during storm conditions.

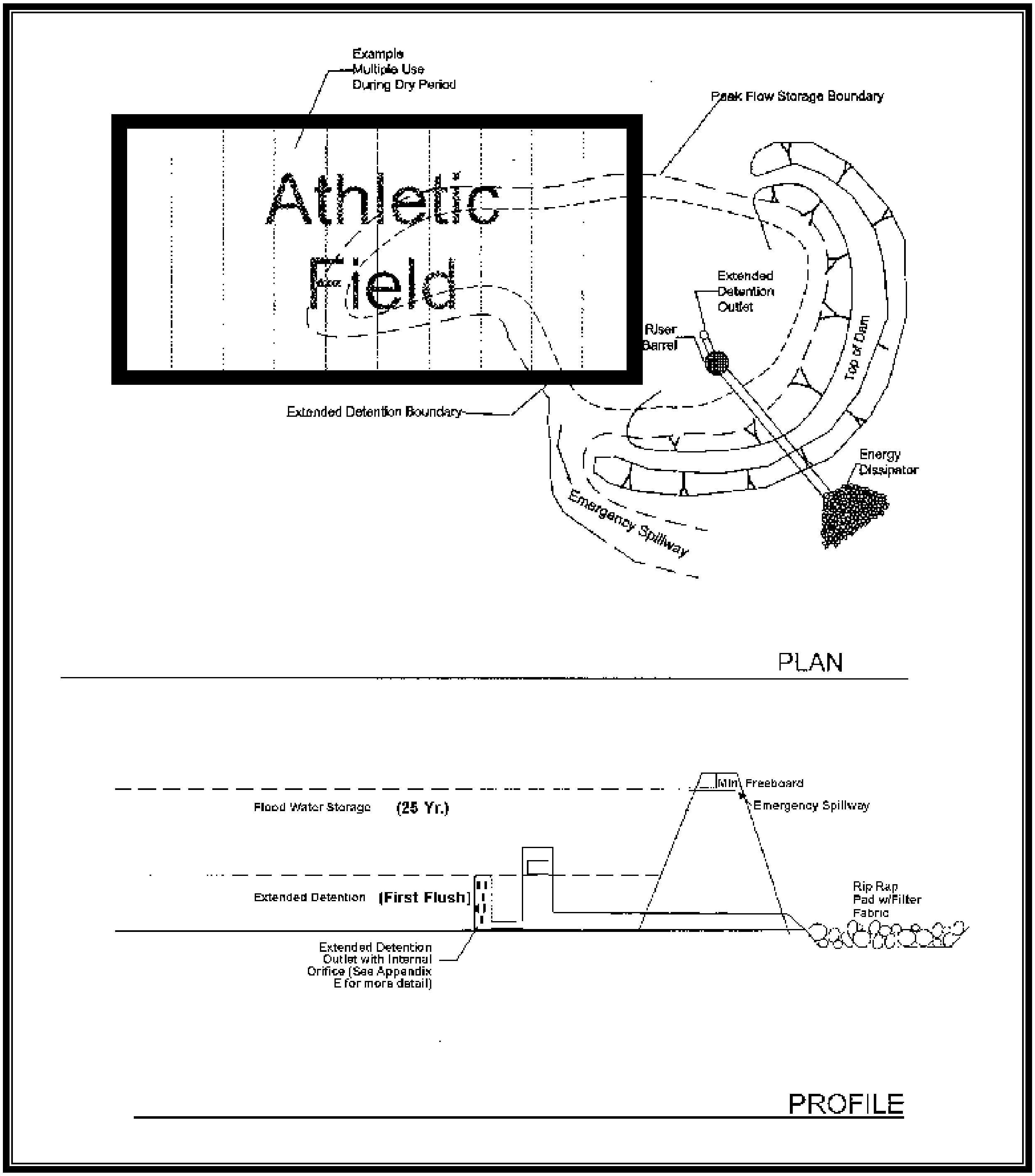
Erosion & Instability
Ponds shall be inspected annually for erosion, destabilization of side slopes, embankment settling and other signs of structural failure, and loss of storage volume due to sediment accumulation. Corrective action shall be taken in a timely manner upon identification of problems.

Embankment Maintenance
Embankments shall be maintained to preserve their integrity as impoundment structures, including, but not limited to, vegetative maintenance (mowing, control of woody vegetation), rodent control, erosion control and repair, and outlet control structure maintenance and repair.

Hazardous SubstanceStorage
For sites where hazardous substances may be stored and used (e.g. certain commercial and industrial developments), a spill response plan shall be developed that clearly defines the emergency steps to be taken in the event of an accidental release of harmful substances that may migrate to the pond. As a result of this plan, design elements such as shut-off valves or gates may be needed.

Sediment Removal
Sediment removal in the forebay and/or pond should occur every 5 to 7 years or after 50% of total capacity has been lost. Sediments excavated from storm water ponds that do not receive runoff from designated hotspots are not considered toxic or hazardous material, and can be safely disposed by either land application or land filling. Sediment testing may be required prior to sediment disposal when a hotspot land use is present. Sediment removed from storm water ponds should be disposed of according to an approved erosion and sediment control plan.

Figure 5-8. Example of a Dry Extended Detention Basin



Source: City of Greensboro, Storm Water Services, *Storm Water Management Manual, First Edition.* 2000.

5.3 Additional Storm Water Management BMP's.

Additional Best Management Practices (BMPs), other than those detailed within these rules, provide effective water quality and quantity control and may be approved by (community).

Recommended Resources
Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.
Schueler, T.R. and H. K. Holland, Editors, *The Practice of Watershed Protection* Center for Watershed Protection, 2000.

6. Buffer Areas

Chapter 6: BUFFER AREAS

6.1 Introduction

Buffer areas shall be established adjacent to all surface waters in new development through deed restrictions or provisions of master condominium agreements. Buffer areas are defined as zones where construction, paving and chemical application are restricted. Plantings capable of filtering storm water shall be established and preserved. Minimum widths shall be based on the type of application.

6.2 Linear Buffers

Linear buffers shall be designated along all surface flow channels.

a. When the distance across the channel between the ordinary high water marks is greater than 20 feet, the minimum buffer width shall be 30 feet on each side of the channel.

b. When the distance across the channel between the ordinary high water marks is less than 20 feet, the minimum buffer width shall be 20 feet on each side of the channel.

6.3 Waterbody Buffers

Waterbody buffers encompass all non-linear bodies of water and include exceptional functional value wetlands, lakes and ponds.

a. For all water bodies with a surface area greater than one (1) acre, a minimum buffer width of 30 feet extending from the delineated water body boundary shall be established.

b. For all water bodies with a surface area less than or equal to one (1) acre, a minimum buffer width shall be established such that the area of the buffer is one-half (1/2) the area of the water body, to a minimum width of 10 feet.

6.4 Additional Requirements

a. The buffer width shall be modified if steep slopes are within close proximity to the stream and drain into the stream system. In those cases, the buffer width shall be adjusted.
   i. 0 – 14 % Slopes: No change.
   ii. 15 – 25 % Slopes: Add 25 feet.
   iii. > 25 % Slopes: Add 50 feet.

b. When protected wetlands or floodplain extend beyond the edge of the required buffer widths, the buffer shall be adjusted so that the buffer consists of the extent of the protected wetlands or floodplain (See Chapters 7 & 8: *Regulatory Floodplains and Floodways & Natural Wetlands Protection*).

c. An easement shall be recorded with the (community) to ensure the preservation of the buffer area, in accordance with this chapter, into the future.

d. No buffers shall be required for wetlands, other than for exceptional functional value wetland or wetlands with existing native vegetative buffers. If the delineated buffer is less than 30 feet, there shall be a minimum setback of 30 feet from the edge of the delineated wetland. In situations where a 30-foot setback is not feasible, then best management practices shall be implemented to offset the encroachment impacts.

e. Buffer areas shall be made up of native vegetation. The use of Northwest Ohio riparian vegetation is preferred in the buffer strip. Types of Buffers (furthest to closest to water course):
   i. A multipurpose buffer of grass to shrubs to fast growing trees.
   ii. A grass buffer to stiff-grass buffer.
   iii. A normal grass buffer.

f. The boundary of the buffer area for channels and waterbodies shall be determined by reference to the ordinary high water mark. For wetlands the boundary of the buffer area shall be determined by the wetland delineation report. A property may contain a buffer area that originates from a channel or waterbody located on another property.

g. Constructed or water management features which require a buffer may not be located such that the required boundaries of buffer areas extend into adjoining property or the ultimate boundaries of public right-of-way as determined by the local road authority.

h. If an existing buffer area is disturbed during construction, the vegetated buffer strip shall be stabilized.

i. Access through buffer areas shall be provided, when necessary, for maintenance purposes.

j. Roadside drainage swales, ditches or channels shall have the minimum buffer width of 10 feet measured from the top of bank on the non-roadside.

k. Where practical, storm water shall discharge into a buffer area. Such discharges shall enter the buffer as unconcentrated flow with appropriate energy dissipation measures to prevent excessive erosion and scour.

l. All buffer areas shall be maintained free from development including disturbance of the soil, dumping or filling, erection of structures and placement of impervious surfaces except as defined in 6.5.

6.5 Permitted Uses

a. A buffer area may be used for passive recreation (e.g., bird watching, walking, jogging, bicycling, horseback riding and picnicking) and it may contain pedestrian, bicycle or equestrian trails, provided that the created path is no wider than ten (10) Feet. If the path leads to a wetland or waterway, it must be a winding path to inhibit erosion.

b. Structures and impervious surfaces may occupy a maximum of 20 percent of the required buffer provided the runoff from such facilities is diverted away from the wetland or channel or such runoff is directed to enter the buffer area as un-concentrated flow.

c. Utility maintenance and maintenance of drainage facilities and drainage easements shall be allowed.

d. Anchoring and placement of boat docks and piers.

e. Chemical application to buffer strips shall be limited to those required for control of noxious weeds or injurious pests.

6.6 Water Pollution Hazards

The following land uses and/or activities are designated as potential water pollution hazards, and must be set back from any surface water by the minimum distance indicated below:

a. Storage of hazardous substances - (150 feet)

b. Above ground or underground petroleum storage facilities - (150 feet)

c. Drain fields from onsite sewage disposal and treatment systems (i.e., septic systems) - (100 feet)

d. Raised septic systems - (250 feet)

e. Solid waste landfills or junkyards - (300 feet)

f. Concentrated Animal Feeding Operations (CAFO)- (250 feet)

g. Subsurface discharges from a wastewater treatment plant - (100 feet)

7. Regulatory Floodplain and Floodways

Chapter 7: REGULATORY FLOODPLAIN AND FLOODWAYS

7.1 Introduction

Floodplains and their associated stream, wetland, and shoreline area are a significant asset due to the multiple benefits related to flood attenuation, environmental quality, natural resource management, and recreation. The standards in this section are designed to control floodplain alterations in order to eliminate, or at a minimum, severely restrict the impact of new development upon existing development and floodplains. Decisions to alter floodplains, especially floodways and streams with floodplains, must be the result of careful planning to evaluate existing conditions, future impacts, and human needs.

It is the purpose of this section to promote the public health, safety and general welfare, and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

a. Protect human life and health;

b. Minimize expenditure of public money for costly food control projects;

c. Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;

d. Minimize prolonged business interruptions;

e. Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in areas of special flood hazard;

f. Help maintain a stable tax base by providing for the proper use and development of areas of special flood hazard so as to minimize future flood blight areas; and

g. Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.

7.2 Lands to Which This Section Applies

The storm water management permit applicant must identify floodplain limits utilizing the best available references. Nothing contained herein shall prohibit the application of these regulations to land that can be demonstrated by engineering survey to lie within any Regulatory Floodplain. Conversely, any lands (except for those located in Regulatory Floodway) that can be demonstrated by topographic survey certified by a registered professional engineer or registered land surveyor to lie beyond the Regulatory Floodplain, and show to the satisfaction of (community), to have been higher than the Base Flood Elevation (BFE) as of the effective date of the first floodplain mapping denoting the site to be in a Special Flood Hazard Area (SFHA), shall not be subject to the regulations of this section.

7.2.1 Regulatory Floodplain

The Regulatory Floodplain is delineated within a development by projecting the BFE onto the site topography. The BFE shall be as delineated by the 100-year flood profiles, as indicated on the floodplain studies noted below:

a. Regulatory Floodplain profiles, approved by (community) for regulatory use

b. Federal Emergency Management Agency (FEMA) Flood Insurance Study profiles, or

c. In the case of FEMA delineated "AH Zones" the elevation noted on the map shall be the BFE. In the case of FEMA delineated "AO Zones" (Areas of shallow flooding) the BFE shall be the depth number shown on the map added to the highest adjacent grade, or at least two feet above the highest adjacent grade if no depth number is provided, or

d. When no base flood elevation information exists, a Registered Professional Engineer using an appropriate model or technique shall determine the BFE. In the case of riverine Regulatory Floodplains, the flood elevation shall be submitted to (community) for approval prior to issuance of a storm water management permit.

e. For a non-riverine Regulatory Floodplain, the historic flood of record plus three feet may be used for the BFE instead of performing a detailed hydrologic and hydraulic study.

7.2.2 Regulatory Floodway

The Location of the Regulatory Floodway shall be delineated on the topographic site maps. Where interpretation is necessary to determine the exact location of the Regulatory Floodway boundary, (community) should be contacted.

7.3 Prohibited Uses

Any use, which when combined with all other existing and anticipated uses, causes an increase in the water surface elevations of the BFE beyond that which is allowed in this section, shall be prohibited within an area lying within Special Flood Hazard Areas.

a. No structure or land shall be located, erected, constructed, repaired, extended, converted, enlarged, or altered without full compliance with the terms of this section and all other applicable regulations which apply to uses within the Regulatory Floodplain, unless specifically exempted.

b. Modification and disturbance of natural riverine Regulatory Floodplains shall be avoided to protect existing hydrologic and environmental functions. Such disturbances shall be minimized and all negative impacts mitigated.

c. No development shall be allowed in the Regulatory Floodplain that shall singularly or cumulatively create damaging or potentially damaging increase in flood heights or velocity or threat to public health, safety, and welfare or impair the natural hydrologic functions of the Regulatory Floodplain or channel.

d. For all projects involving channel modification, fill, stream maintenance, or levees, the flood carrying capacity of the Regulatory Floodplain shall be maintained.

e. The placement of retention/detention basins within a floodplain is discouraged. Where retention/detention basins are proposed within a floodplain, information will be provided to verify that the facility will operate as designed during flood events.

7.4 Open Space Uses

The following open space uses shall be permitted within areas of special flood hazard provided that such uses do not require the "development" of the land, as defined in Chapter 2. In addition, no permitted use shall adversely affect the efficiency or restrict the capacity of the channels or cause any increase in elevation of the base flood within the floodway of the main stream or floodways of any tributary to the main stream, drainage ditch or any other drainage facility or system.

a. Agricultural uses such as, but not limited to, the following: general farming, pasture, grazing, outdoor plant nurseries, horticulture, viticulture, truck farming, forestry, sod farming and wild crop harvesting.

b. Cemeteries and private or public recreational uses such as driving ranges, archery ranges, picnic grounds, boat ramps, swimming areas, parks, wildlife and nature preserves, game farms, fish hatcheries, shooting preserves, target ranges, trap and skeet ranges, hunting and fishing areas, hiking and horseback riding trails, bike trails and unpaved airplane landing strips.

c. Residential uses such as lawns, gardens, and play areas.

7.5 Permitted Uses

Uses permitted only upon issuance of a Storm Water Management Permit by (community), excluding designated floodway areas, include the following:

a. Uses or structures accessory to open space or exempted uses.

b. Tennis Courts, golf courses.

c. Marinas, boat rentals, docks, piers, wharves. Piers and wharves constructed by earth fill or other similar construction shall be permitted provided the resulting displaced floodplain volume is provided elsewhere on the property.

d. Structures or other uses shall be permitted within an area lying within areas of special flood hazard, excluding floodway areas, to the extent they are not prohibited by any other ordinance and they meet the requirements specified.

7.6 Additional Performance Standards for the Regulatory Floodway.

The regulatory floodway is defined as the stream channel plus that portion of the overbanks that must be kept free from encroachment in order to discharge the 100-year flood without increasing flood levels by more than 1.0 foot.

The intention of the floodway is not to preclude development. However, Federal Emergency Management Agency (FEMA) regulations make (community) responsible for prohibiting encroachments, including fill, new construction, and substantial improvements, within the floodway unless it has been demonstrated through hydrologic and hydraulic analyses that the proposed encroachment will not increase flood levels within (community).

In areas that fall within the 1-percent annual chance floodplain, but are outside the floodway (termed the "floodway fringe"), development will, by definition, cause no more than a 1.0-foot increase in the 1-percent annual chance water-surface elevation. Floodplain management through the use of the floodway concept is effective because it allows communities to develop in flood-prone areas if they so choose, but limits the future increases of flood hazards to no more than 1.0 foot

The only development in a Regulatory Floodway which will be allowed are appropriate uses which will not cause an increase in flood heights for all flood events up to and including the base flood. Only the construction, modification, repair, or replacement of the following appropriate uses will be allowed in the Regulatory Floodway:

a. Public flood control structures and private improvements relating to the control of drainage and flooding of existing buildings, erosion, water quality, or habitat for fish and wildlife;

b. Structures or facilities relating to functionally water dependent uses such as facilities and improvements relating to recreational boating and as modifications or additions to existing wastewater treatment facilities;

c. Storm and sanitary sewer outfalls;

d. Underground and overhead utilities if sufficiently flood-proofed;

e. Recreational facilities such as playing fields and trail systems including any related fencing (at least 50% open when viewed form any one direction) built parallel to the direction of flood flows, and including open air pavilions;

f. Detached garages, storage sheds, or other non-habitable structure without toilet facilities, accessory to existing buildings that will not block flood flows nor reduce Regulatory Floodway storage;

g. Bridges, culverts and associated roadways, sidewalks and railways, necessary for crossing over the Regulatory Floodway or for providing access to other appropriate uses in the Regulatory floodway and any modification thereto;

h. Parking lots (where the existing depth of flooding for the base flood event is less than one foot) and aircraft parking aprons both built at or below ground elevation and any modifications thereto;

i. Flood-proofing activities to protect previously existing lawful structures including the construction of water tight window wells, elevating structures, or the construction of flood walls around residential, commercial, or industrial principal structures where the outside toe of the floodwall shall be no more than ten (10) feet away from the exterior wall of the existing structure, and which are not considered to be substantial improvements to the structure.

j. The replacement, reconstruction, or repair of damaged building, provided that the outside dimensions of the building are not increased and, provided that the building is not damaged to 50% or more of the building's market value before it was damaged.

k. Modifications to an existing building, which are not substantial improvements, that would not increase the enclosed floor area of the building below the base flood elevation (BFE), and which will not block flood flows including but not limited to, fireplaces, bay windows, desks, patios, and second story additions. No enclosed floor areas may be built on stilts.

All appropriate uses shall require a Storm Water Management Permit from (community).

7.7 Construction Standards

Except as specified in section 7.5 (Permitted Uses) and 7.6 (Additional Performance Standards for the Regulatory Floodway), all structures and substantial improvements to structures shall be constructed with the lowest floor including the basement, elevated one (1) foot or more above the BFE.

If structures or additions to structures are to be constructed on fill, it shall be excavated from the same property from and area lying below the BFE. If suitable foundation material is not available on the same property below the BFE, then such material may be brought in from another source provided an equal volume of the material from below BFE is removed from the area controlled by the applicant.

All filling, excavating and / or removal work associated with the elevation of any structure or addition to a structure shall be carried out under plans approved by (community) or their designee.

Structures shall be constructed and placed on the building site so as to offer the minimum obstruction to the flow of floodwaters.

7.7.1 Utilites

Public utility facilities, roads, railroad tracks and bridges are to be designed so as to not increase the flood level more than ½ foot in any one reach or for the cumulative effect of several reaches, with every reasonable effort being exerted to hold the increase in the flood level to the absolute minimum necessary. Protection to the BFE is to be provided where failure or interruption of these public facilities would result in damage to the public health or safety or where such facilities are essential to the orderly functioning of the area.

Within flood prone areas new and replacement potable water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems.

New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems and discharges from the systems into the flood waters, and on-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

7.7.2 Development Proposals

All subdivision proposals, including manufactured home subdivisions, and other proposed new developments shall include BFE data performed in accordance with standard engineering practices. No plat will be approved when more than ten (10) percent of the planned lots are below the BFE at the building site. All subdivision proposals, including manufactured home subdivisions, shall:

a. Be consistent with the need to minimize flood damage.

b. Have public utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage.

c. Have adequate drainage provided to reduce exposure to flood damage.

8. Natural Wetlands Protection

Chapter 8: NATURAL WETLANDS PROTECTION

8.1 Introduction

Wetlands improve the environment by holding storm water, filtering out chemicals and sediment, recharging surface and ground water aquifers, increasing biological diversity and adding to wildlife habitat. Protection of naturally occurring wetlands is very difficult when the value of land for development is considered by most to be higher than the environmental benefit. Currently, the U.S. Army Corps of Engineers (USACOE) regulates certain activities in wetlands that are adjacent to surface tributaries or navigable waters. Other federal and state agencies have the authority to protect isolated wetlands. Unfortunately, many of these wetlands are being destroyed due to enforcement difficulties in spite of the laws. This standard is designed to ensure compliance with federal and state laws.

8.2 Wetlands Values/Functions

Wetlands have many values to humans. The harvest of wetland-dependent fish, shellfish, fur bearing animals and waterfowl add to our economy as well as recreational opportunities. In the environment, wetlands moderate the effects of floods, improve water quality, facilitate aquifer recharge, and have aesthetic qualities.

Each wetland type represents a uniquely dynamic natural ecosystem that can, in concert with one another, provide all habitat requirements for a wide range of plants, animals and waterfowl. A diversity of wetland habitats provides enhanced values.

Nutrient availability is an important contribution of wetland ecosystems. As wetlands cycle from wet to dry, the oxidation of organic matter releases nutrients. This fertility can result in greater population of invertebrate food organisms making ponds more attractive to wildlife. The drying of wetland soils by midsummer also increases wetland fertility by allowing lush vegetation to develop, creating more organic matter and food for wildlife.

Wetlands also provide aesthetic value that is enjoyed my many. Photographers, artists, writers, and others visit these areas to experience the natural beauty and capture its essence.

8.3 Wetlands Identification

Wetlands are a combination of three components that must all be present to meet the test of being a wetland; hydric soils, hydric plants and wetland hydrology.

Ohio administrative code describes wetlands as "areas where the water table is at, near, or above the land surface long enough each year to support the growth of water dependent vegetation and to result in the formation of characteristic wet soil types. These include marshes, swamps, bogs and similar areas."

Michigan's wetland statute, Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, defines a wetland as "land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life, and is commonly referred to as a bog, swamp, or marsh." The definition applies to public and private lands regardless of zoning or ownership.

The U.S. Department of Agriculture (USDA), US Natural Resources Conservation Service (NRCS), describes hydric soils in their soil survey reports. Lists of hydric soils are available upon request from the County Soil and Water Conservation Districts or NRCS offices. County soil surveys indicate where the soils occur. In general, hydric soils have a dark surface color with higher organic matter contents than surrounding upland soils. Contact the NRCS office for additional information.

Hydric vegetation consists of plants that grow in predominantly wet soil conditions. Five categories of plant-types list the frequency of plants occurrence in different water regimes:

a. Obligate wetland (>99%)

b. Facultative wetland (67-99%)

c. Facultative (34-66%)

d. Facultative upland (1-33%)

e. Obligate Upland (< 1%)

Lists of all commonly occurring plants are available for Ohio and Michigan, identifying which of the five categories the plants are grouped in. For determining which specific plant species fall in which category, reference should be made to the publication, "*National List of Plant Species that Occur in Wetlands*". The U.S. Fish and Wildlife Service (USFWS) prepared this publication with cooperation from other agencies.

Wetland hydrology is the driving force behind wetland formation. Of the three technical criteria for wetland determination, wetland hydrology is often the least exact and most difficult to identify in the field. Because of the difficulty of establishing wetland hydrology, the emphasis on delineating wetlands is often placed on hydrophytic vegetation and hydric soils in the absence of significant hydrologic modifications. Even so, wetland hydrology should always be considered.

Wetland hydrology means permanent or periodic inundation, or soil saturation for a significant period of the growing season.

Thus, all wetlands are at least periodically wet. The degree of wetness of an area is influenced by precipitation, stratification of the soil, topography, permeability, and plant cover. The frequency and duration of soil saturation can distinguish wetlands from non-wetlands with duration having the stronger influence. The duration can be affected by the condition of outlet channel: log jams, siltation reducing low water flows, and smoothness of the channel banks.

Hydrology varies annually, seasonally, and daily; consideration should be given to the time of year that the hydrologic determination is being made, especially when considering the presence/absence of field indicators. Seasonal and long-term variations in water permanence and related vegetative character can result in significant changes.

8.4 Wetlands Delineation

The USFWS maintains a National Wetlands Inventory (NWI) and local agencies have prepared more detailed inventories for a few jurisdictions. However, these maps are woefully inaccurate in NW Ohio and SE Michigan. Wetland delineations shall be performed for all sites that exhibit any of the wetland characteristics referenced in section 8.3 *Wetlands Identification* prior to any soil disturbance. The delineation shall be performed in accordance with methodology outlined the "*Corps of Engineers Wetland Delineation Manual*" (1987). Personnel performing wetland delineations should have a background in biology, soils, and hydrology.

8.5 Wetlands Protection

This section governs natural wetlands (distinct from storm water wetland systems that are constructed expressly for storm water management purposes). Permits will be required for the discharge of dredged or fill material into waters of the United States, **except** as provided in 33 CFR Section 323.4. Requirements that irreversible impacts to jurisdictional wetlands be mitigated are imposed through various legislation and regulations:

a. USACOE regulatory program regulations (33CFR 320-331) administered under the authority of Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act.

b. Council of Environmental Quality (CEQ) regulations and guidelines implemented through the National Environmental Policy Act (NEPA),

c. U.S. Executive Order 11990, "Protection of Wetlands",

d. State Water Quality Certification through Section 401(a) of the CWA,

e. Ohio Administrative Code Chapter 3745 and Ohio Revised Code Chapter 6111, and

f. Michigan's wetland statute, Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451

A federal Section 404 permit cannot be issued by the COE unless the State of Ohio Environmental Protection Agency (OEPA) or Michigan Department of Environmental Quality (MDEQ) issues a Section 401 Water Quality Certification. If OEPA or MDEQ issues a Section 401 Certification for the project, the conditions become requirements of the federal permit. If OEPA or MDEQ denies the Section 401 Certification, the COE must deny the Section 404 permit without prejudice.

Construction of wetlands for the sole purpose of storm water treatment is exempt from these requirements (*Chapter 5: Post-Construction Best Management Practices, Section 5.2.5*). However, storm water wetlands will generally not be accepted under mitigation requirements.

8.6 Nationwide and Regional Permits

Nationwide Permits (NWPs) are a type of general permit issued by the USACOE Chief of Engineers and are designed to regulate with little, if any, delay or paperwork certain activities having minimal impacts (33 CFR Part 330). USACOE District or Division Engineers may authorize other activities on a regional basis through regional general permits. The general permits are proposed, issued, modified, and reissued (extended), and revoked from time to time after an opportunity for public notice and comment. An activity authorized under a NWP or regional permit only if that activity and the permitee satisfy all of the terms and conditions of the permit. An individual permit may still authorize activities that are not authorized under a nationwide or regional permit.

8.7 General Requirements

Natural wetlands shall be protected from damaging modification and adverse changes in runoff quality and quantity associated with land developments. Before approval of the Storm Water Management permit, all necessary wetland permits shall be in place.

Direct discharge of untreated storm water to a natural wetland is prohibited. All runoff from the development will be pre-treated to remove sediment and other pollutants prior to discharge to a wetland. Such treatment facilities will be constructed before property grading begins.

Site drainage patterns shall not be altered in any way that will modify existing water levels in protected wetland without proof that all applicable permits have been obtained.

Whenever possible, a permanent buffer strip, preferably vegetated with native plant species, shall be maintained or restored around the periphery of wetlands in accordance with Chapter 5: *Post-Construction Runoff Control*. Wetlands shall be protected during construction by appropriate soil erosion and sediment control measures.

8.7.1 Antidegredation Rules

All applicants for Section 401 Certification are required to present a Preferred Design Alternative, Non-Degradation Alternative, Minimal Degradation Alternative and Mitigation Techniques. Applicants must demonstrate there is no other less environmentally damaging practicable alternative to filling in wetlands before mitigation is considered. Social and economic justification may be presented to demonstrate how one alternative is viable over another alternative.

8.7.2 Compensatory Mitigation

Appropriate and practicable compensatory mitigation is required for unavoidable adverse impacts that remain after all appropriate and practicable minimization has been satisfied. Compensatory actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands) should be undertaken when practicable, in areas adjacent or continuous to the discharge site (on-site compensatory mitigation). If on-site compensatory mitigation is not practicable, off-site compensatory mitigation should be undertaken in the same geographic area if practicable (i.e., in close proximity and, to the extent possible, the same watershed). In determining compensatory mitigation, the functional values lost by the resource to be impacted must be considered. Mitigation ratios are based on location and type of wetland impacted.

9. Active Construction Soil Erosion and Sediment Control

Chapter 9: CONSTRUCTION SITE RUNOFF CONTROL

9.1 Introduction

Erosion and Sedimentation are naturally occurring geologic phenomena. Man's land development activities, however, have initiated severe, highly undesirable and damaging alterations in the natural cycle by drastically accelerating the erosion-sedimentation process. Present-day streams and rivers in NW Ohio carry much higher sediment loads than in the past. Significantly increased amounts of sand, silt, and clay wash into these waterways from farmland and urbanizing areas. During the construction process, soil is the most vulnerable to erosion by wind and water. This eroded soil endangers water resources by reducing water quality, and causing the siltation of aquatic habitat for fish and other desirable species. Eroded soil also necessitates repair of sewers and ditches, and the dredging of lakes.

9.2 National Pollution Discharge Elimination System (NPDES) Construction Permit Compliance

9.2.1 Permit Coverage

This permit will cover new and existing discharges composed entirely of storm water discharges associated with construction activity. Construction activities covered by this permit include any clearing, grading, excavation, grubbing and/or filling activities that result in the disturbance of one (1) or more acres of total land. Operations that result in the disturbance of less than one acre of total land, which are not part of a larger common plan of development, are exempt from coverage under this permit.

9.2.2 Notice Of Intent

Owners or developers of storm water discharges associated with construction activity must submit a Notice of Intent (NOI) to comply with Ohio Environmental Protection Agency's (EPA) or Michigan DEQ's Construction General Permit and provide a copy to (community) with their Storm Water Management Permit application.

9.3 Storm Water Pollution Prevention Plan

The five major phases of developing a SWPPP are (1) planning and organization; (2) assessment; (3) BMP selection and plan design; (4) implementation; and (5) evaluation and site inspection.

All development that disturbs greater than one (1) acre of land shall have a Storm Water Pollution Prevention Plan (SWPPP) including the following [*The same plan developed for the NPDES NOI (9.2) may be submitted*]:

9.3.1 Applicant Information

Name and telephone numbers of parties responsible for maintenance of erosion and sediment control practices.

9.3.2 Site Map

A map that identifies natural resources including: soils, forest cover, and resources protected under other chapters of this code. This map should be prepared at the same scale as the drainage plan (Chapter 3*: Permit Submittal Requirements*).

9.3.3 Installation and Maintenance Schedule

A sequence of construction on the development site including stripping and clearing, rough grading, construction of utilities, infrastructure and buildings and final grading and landscaping. Sequencing shall identify the expected date on which clearing will begin, the estimated duration of exposure of cleared areas, areas of clearing, installation of temporary erosion and sediment control measures, and establishment of permanent vegetation.

9.3.4 Erosion and Sediment Control Measures

All erosion and sediment control measures necessary to meet the objectives of this local regulation throughout all phases of construction and after completion of development of the site. Depending upon the complexity of the project, the drafting of intermediate plans may be required at the close of each season.

9.3.5 Re-vegetation Plan

Seeding mixtures and rates, types of sod, method of seedbed preparation, expected seeding dates, type and rate of lime and fertilizer application, and kind and quantity of mulching for both temporary and permanent vegetative control measures.

9.4 Soil Erosion and Sediment Control Measures

For any land disturbance activity disturbing greater than one (1) acre of land, the following criteria shall be met:

9.4.1 Minimize Disturbance

Soil disturbance shall be conducted in such a manner as to minimize erosion. Wherever feasible, natural vegetation should be retained and protected. The smallest practical area of raw land should be exposed at any one time during active construction. Soils stabilization measures shall consider the time of year, site topography and the use of temporary or permanent measures. Only disturb areas that you intend to work in the next 45 days.

9.4.1.1 Vegetation Protection Areas

Description

Vegetation that exists on-site prior to development may be protected so it will continue to survive after construction.

Applicability

Vegetation protection areas may be used to protect areas of forest, or specimen trees, or buffer areas (Chapter 6: *Buffer Areas*).

Design Guidelines

Map
The vegetation protection areas shall be shown on the site map. Fencing shall be placed to delineate the areas as shown on the map.

Fencing
Vegetation protection areas shall be fenced prior to beginning clearing operations. Fence materials shall be metal fence posts with two strands of high tensile wire, plastic fence, or snow fence. Fence shall remain around the protection area until after final grading has been completed.

Signage
Signage shall clearly identify the vegetation protection area and state that no clearing or equipment is allowed within it.

9.4.2 Timing of Sediment Trapping Practices

Sediment control practices shall be functional throughout earth disturbing activity. Settling facilities, sediment barriers, and other practices intended to trap sediment shall be implemented as the first step of grading and within 7 days from the start of grubbing. They shall continue to function until the up-slope development area is re-stabilized. Phasing of construction activities shall be required on all sites disturbing greater than 30 acres, with the size of each phase to be established at plan review and as approved by (community).

9.4.3 Stabilization of Denuded Areas

Permanent or temporary soil stabilization shall be applied to denuded areas within 7 days after final grade is reached on any portion of the site, and shall also be applied within 7 days to denuded areas that may not be at final grade, but will remain dormant for longer than 45 days. At the close of the construction season, the entire site must be stabilized, using a heavy mulch layer, or another method that does not require germination to control erosion.

The goal of temporary stabilization is to provide cover, quickly. This shall be accomplished by seeding with fast growing grassed and then covering them with mulch. Outside the growing season (November 1 - March 31) only mulch shall be applied.

9.4.3.1 Mulching

Description

Applying a protective layer of mulch (usually straw) to bare soil reduces erosion by shielding the surface form raindrop impact and encouraging re-vegetation by holding moisture and creating favorable conditions for seed germination.

Applicability

Mulch can be used throughout construction to limit areas of bare soil that are susceptible to erosion. Mulch shall be used in conjunction with seeding to establish vegetation. Mulch can also be used by itself when the season does not allow vegetation to grow.

Design Guidelines

Types of Mulch & Application Rates
Mulch shall consist of one of the following:

- Straw— Applied at a rate of 2 tons / acre or 90 lbs. / 1,000 sq. ft.,
- Hydroseeders— Wood cellulose fiber shall be used at 1 ton / arce or 46 lbs. / 1,00 sq. ft., or
- Other— Other acceptable mulches include mulch matting applied according to the manufacturers recommendations.

9.4.3.2 Matting

Description

Matting such as jute or excelsior can be used to stabilize easily eroded areas such as channels, steep slopes, and embankments while vegetation is becoming established.

Applicability

Matting should be used on:

- Channels where designed flow exceeds 3.5 fps,
- Steep slopes, embankments or streambanks, and

- Problems areas that have highly erosive soils or are slow to establish vegetation.

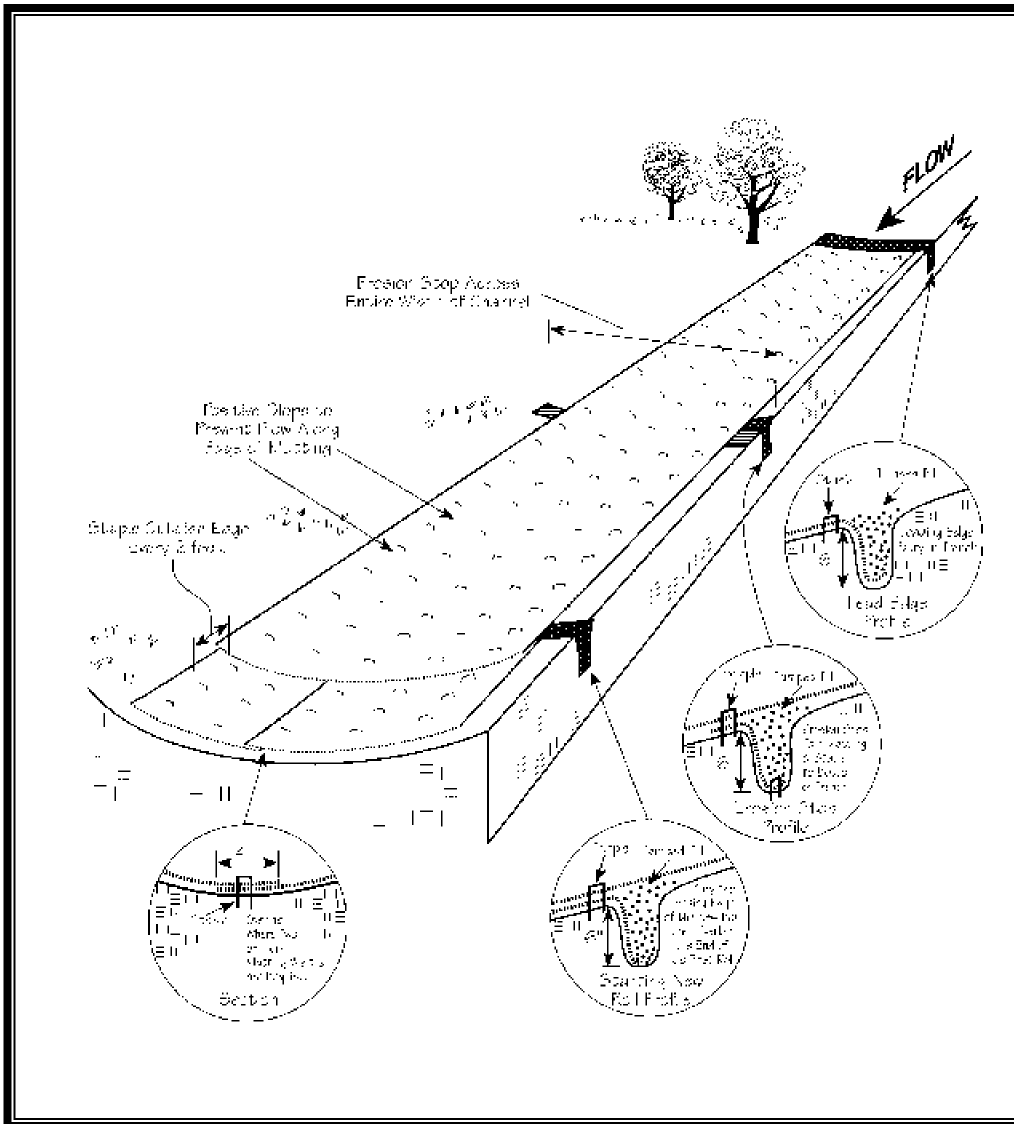
Design Guidelines

Material
Excelsior matting shall be at least 48 in. wide and weigh an average of 0.75 lb. / sq. yd. or greater. Jute matting shall be at least 48 in. wide and weigh an average of 1.2 lbs. / sq. yd. or greater. Matting made of other material that provides equal or greater stabilization and is approved by (community) may be substituted.

Site Preparation
After the site has been shaped and graded a seedbed shall be prepared that is mostly free of large rocks and other foreign materials greater than 1.5 in. in diameter. The site shall be prepared to ensure the matting has good contact with the soil.

Anchoring
Matting shall be held in place as recommended by the manufacturer and as adequate for site conditions. Sod staples are the most commonly used anchors. Sod staples should be No. 11 gauge wire or heavier and be 6 to 10 in. in length. Longer staples shall be used in sandy or loose soils.

Figure 9-1. Example of Matting Installation



Source: Mecklenburg, Dan, *Rainwater and Land Development*, *Second Edition*, Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.3.3 Temporary Seeding

<u>Description</u>

Temporary seeding provides erosion control on denuded areas between construction operations. Quick growing species are used and mulch should be applied to provide immediate, temporary soil stabilization. Temporary seeding should be used in locations where construction operations allow vegetation to be established.

Applicability
Temporary seeding shall be applied to exposed soil where additional work is not scheduled fro more than 45 days. Permanent seeding shall be applied if the areas will be idle for more than a year (9.4.13.1).

Design Guidelines

Species Selection

Temporary Seeding Species Selection			
Seeding Dates	Species	Lbs. / 1,000 ft.^{2}	Lbs. / acre
March 1 – August 15	Oats	3	4 bushels
	Tall Fescue	1	40
	Annual Ryegrass	1	40
	Perennial Ryegrass	1	40
	Tall Fescue	1	40
	Annual Ryegrass	1	40
August 16 – November 1	Rye	3	2 bushels
	Tall Fescue	1	40
	Annual Ryegrass	1	40
	Wheat	3	2 bushels
	Tall Fescue	1	40
	Annual Ryegrass	1	40
	Perennial Ryegrass	1	40
	Tall Fescue	1	40
	Annual Ryegrass	1	40
November 2 - February 28	Use mulch only, sodding, or dormant seeding.		
Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition*, Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996. Other species approved by (community) may be substituted.			

Seedbed
The seedbed shall be loose and free of excessive rock to ensure successful establishment. However, temporary seeding should not be postponed if ideal seedbed preparation is not possible.

Soil Amendments
A soil evaluation should be conducted on the site to determine the need for lime and/or fertilizer.

Seeding Method
Seed shall be applied uniformly with a cyclone seeder, drill, cultipacker seeder, or hydroseeder.

Mulching
Applications of temporary seeding shall include mulch, which shall be applied during or immediately following seeding. See 9.4.3.1 for Mulching guidelines.

9.4.4 Stabilization of Stockpiles

Soil stockpiles shall be stabilized or covered at the end of each workday.

9.4.5 Settling Facilities

Concentrated storm water runoff from denuded areas flowing at rates that exceed the design capacity of sediment barriers shall pass through a sediment-settling facility (i.e. sediment pond). Settling facilities shall be installed within 7 days of the first grubbing or grading within the drainage area.

There are two types of acceptable sediment ponds: sediment traps and sediment basins. A sediment trap is appropriate when the contributing drainage area is 10 acres or less. The outlet is an earthen embankment with a simple stone spillway. A sediment basin shall be required for drainage areas larger than 10 acres. The sediment basin outlet shall be an engineered riser pipe designed to provide adequate settling time and prevent erosion.

9.4.5.1 Sediment Traps

<u>Description</u>

Sediment traps are one of the most commonly used and cost-effective measures for treating sediment-laden runoff. Sediment traps are usually placed near the edge of construction sites, out of the way of most construction activity. They have sediment-trapping efficiencies of 50-80% and require minimal maintenance compared to other practices.

<u>Applicability</u>

Sediment traps are used where the total contributing drainage area is less than 10 acres. Larger sites shall utilize a sediment basin, with designed control volumes.

<u>Design Guidelines</u>

Sediment Trap Size
The volume of the sediment trap shall be at least 67 cubic yards per acre of contributing drainage area. The volume shall be measured from below the crest elevation of the outlet. The total volume may be achieved by a combination of excavation and/or a compacted embankment.

Sediment Trap Shape
The sediment trap desing shall incorporate the following features to improve trapping efficiency:

- Length-to-width ratio greater than 2:1, where length is the distance between the inlet and the outlet,
- A wedge shape with the inlet located at the narrow end,
- Shallow depth and maximum surface area.

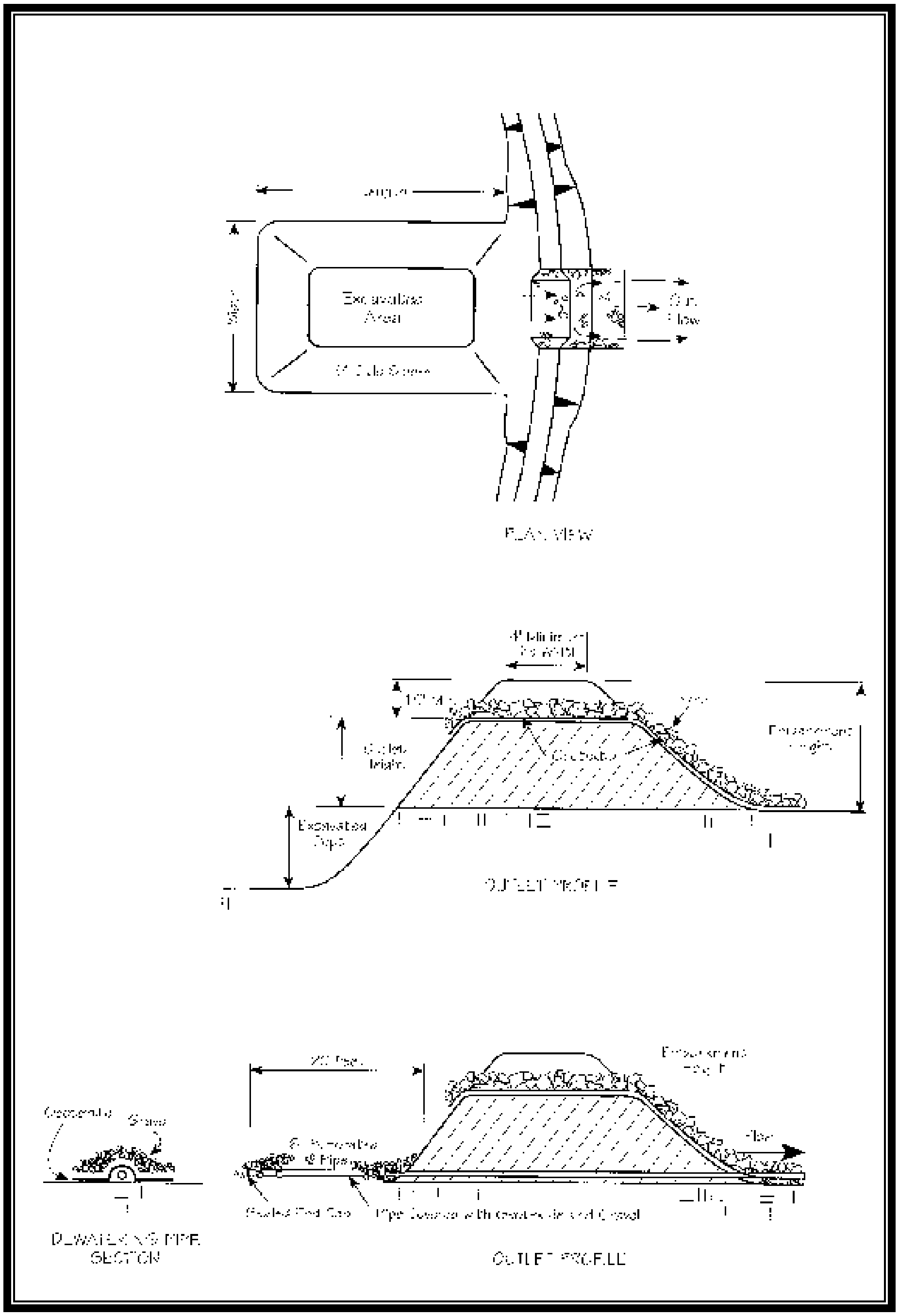
Embankments
The area under the embankment shall be cleared, grubbed, and striped of any vegetation and root mat. Fill material used for the embankment shall be free of roots or other woody vegetation as well as oversized rocks, stones and organic materials. Embankments shall not exceed 5 ft. in height. The embankment shall be at least 1.5 feet above the outlet crest. The top width of embankments must be at least 4 ft. wide with side slopes of 2:1 or flatter. The embankment shall be compacted during its construction.

Excavation
Excavated side slopes shall not exceed 2:1 unless a safety fence is constructed around the trap area.

Outlet
Geotextile shall be placed over the bottom and slopes of the outlet spillway. Geotextile shall continue downstream of the embankment to form an apron on the surrounding ground. To prevent from flowing under the Geotextile, the sections placed nearest the front shall overlap the following sections by at least 2 ft. Rock used in the outlet spillway shall be palace 1 ft. thick on the geotextile. The rick shall be between Type C and Type D rock where D_{50} is about 8 in.

Maintenance
Sediment clean out shall prevent sediment from occupying more than 40% of the trap's volume. When sediment is removed, the sediment trap shall be restored to its original dimensions. Removed sediment shall be deposited in a suitable area and stabilized so that it will not erode.

Figure 9-2. Example of a Sediment Trap



Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.5.2 Sediment Basins

Description

A sediment basin is a settling pond that releases runoff at a controlled rate. It is designed to detain runoff long enough that most of the suspended sediments settle to the bottom. The outlet structure is a designed pipe riser and barrel. **Sediment basins can often be modified after construction to meet the permanent storm water detention requirements** (See Chapter 5: *Post-Construction Runoff Control*).

Applicability

Sediment basins designed under these guidelines are limited to sites where:

- Failure of the structure will not result in damage to homes or buildings, interruption of utilities, or endangering human life;
- The drainage area is 100 acres or less;
- The height of the dam is 25 ft or less; and
- The basin will be removed or modified within 36 months after its construction.

Sediment basins exceeding these limits shall conform to Ohio or Michigan Dam Safety Laws, or USDA Natural Resources Conservation Service Standards for ponds; whichever is most restrictive.

Design Guidelines

Runoff Calculations
Runoff calculations must be based upon the worst soil-cover conditions expected to prevail in the contributing drainage area during the anticipated life of the structure. Runoff shall be calculated by accepted engineering methods outlined in Chapter 4: *Design Criteria for Runoff and Detention*.

Volume
The minimum volume of sediment basins shall be 67 cy (0.04 ac. ft.) for each acre of drainage area. This volume is measured below the top of the principal spillway's crest elevation. Sediment basins shall be cleaned out before sediment accumulation reduces the volume to 35 cy / ac. The cleanout elevation should be clearly marked on the riser (*See maintenance section below*).

Depth
The pool shall be configured to maximize the optimum depth of 3 ft. Depths over 5 ft. should be avoided. The depth shall be measured to the top of the principal outlet.

Shape
The length-to-width ratio shall be greater that 6:1 and less than 20:1 wherever possible. The width shall be calculated by dividing the surface area by the shortest flow path in the basin.

Baffles
If the length to width ratio cannot be achieved or greater trapping efficiency is required, porous baffles may be incorporated into the design. Baffles shall be constructed of jute matting, rock, plastic safety fence, or other material that will reduce turbulent currents. Baffle height shall be greater that the principal spillway and less than the emergency spillway.

Safety
Sediment basins shall be constructed with side slopes of 2:1 or flatter. Basins will be surrounded with safety fence and posted with warning signs where appropriate.

Embankment
Embankments should have side slopes of 2:1 or flatter. The area under the embankment shall be cleared, grubbed, and striped of any vegetation and root mat. Fill material used for the embankment shall be free of roots or other woody vegetation as well as oversized rocks, stones and organic materials. Construction equipment shall be operated over each layer in a manner that will result in the required degree of compaction. The embankment dimensions will meet the following requirements:

Embankment Dimensions	
Embankment Height (ft.)	Minimum Top Width (ft.)
<15	8
15-20	10
>20	12

Principal Spillway
Capacity: The principal spillway must pass at least 1 cfs / ac. of drainage area when the water surface is at the crest of the emergency spillway. The principal spillway will generally pass less than the 1-year frequency storm.

Crest Elevation: The riser pipe's elevation must be a minimum of 1 ft. below the elevation of the emergency spillway.

Dewatering: Dewatering capability should be a part of the sediment basin design. Cleanout of relatively dry materials can be handled with on-site equipment rather than expensive draglines, often needed to handle wet materials.

Riser Base: The principal spillway shall be weighted with concrete to prevent floatation. The minimum safety factor against floatation shall be 1.1.

Trash Rack: To prevent the riser from becoming clogged with construction debris, a trash rack should be used.

Anti-seep Collars: Anti-seep collars shall be used on the barrel of the principal spillway to prevent seepage and erosion of the embankment. Anti-seep collars may not be needed if the embankment is less than 10 ft. and the barrel is 12 in. or smaller if made from corrugated metal pipe or 8 in. or smaller if made from smooth walled conduit.

Outlet protection: The outlet must be armored with rock or other stable material and not cause erosion.

Emergency Spillway

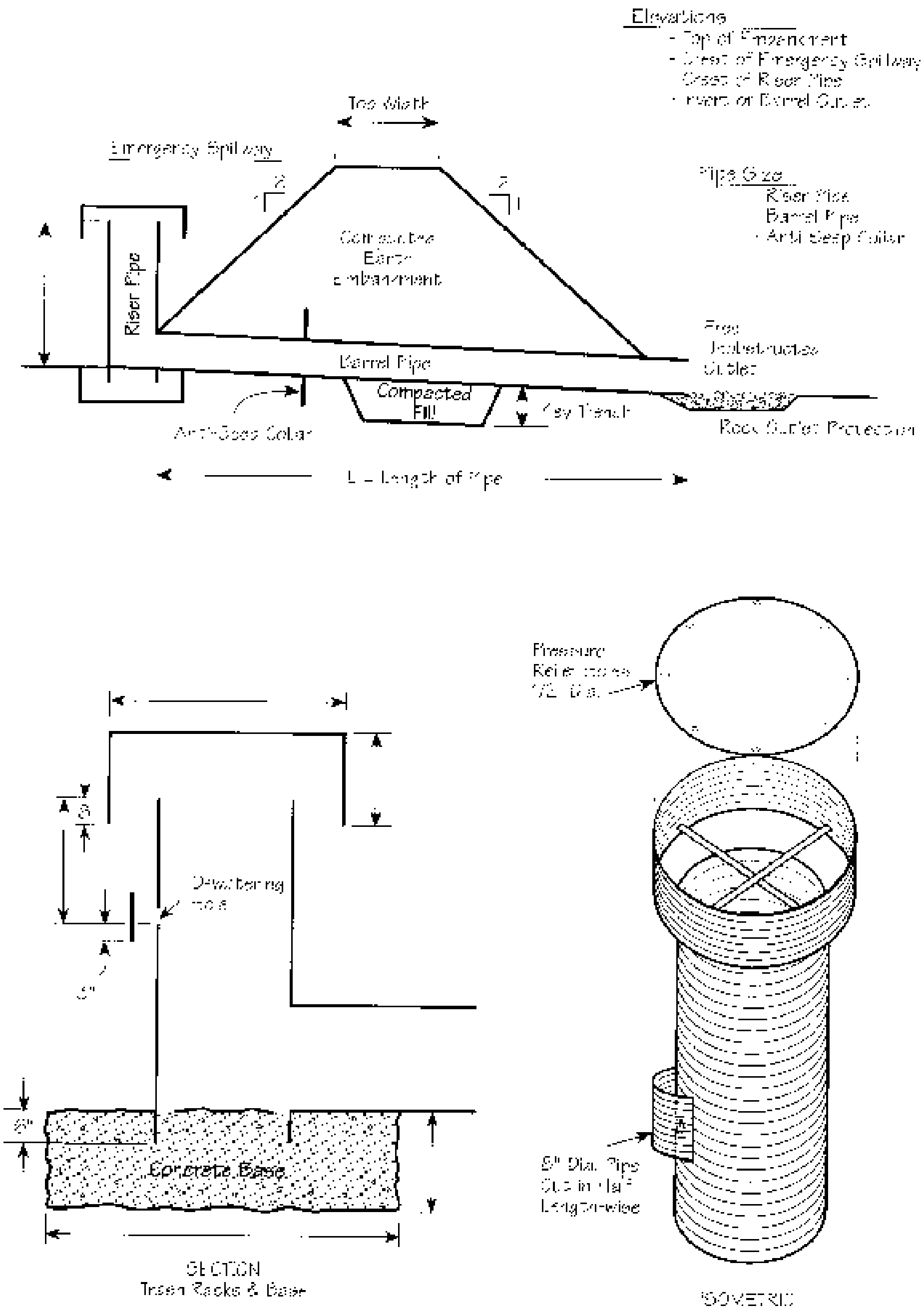
Capacity: The emergency spillway shall have the capacity to pass at least 4 cfs / ac. of drainage area with a minimum freeboard of 1 ft. before overflowing the embankment.

Location: The emergency spillway shall be cut in undisturbed ground. Accurate construction of the spillway elevation is critical and shall be within a tolerance of 0.2 ft.

Maintenance

Sediment shall be removed and the sediment basin restored to its original dimensions before the sediment has filled one-half the pond’s original depth or as indicated on the plans. Sediment removed from the basin shall be placed and stabilized so that it will not erode.

Figure 9-3. Example of a Sediment Basin



Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.6 Sediment Barriers

Sediment barriers shall intercept sheet flow runoff from denuded areas. Sediment barriers, such as silt fences or diversions directing runoff to settling facilities, shall protect adjacent properties and water resources form sediment transported by sheet flow. Sediment barriers must be installed within 7 days of the first grubbing or grading within the control area.

9.4.6.1 Silt Fence

Description

Silt fence is a sediment-trapping practice utilizing a geotextile fence to cause sediment deposition. Silt fence reduces transport of sediment by slowing runoff and dissipating concentrated flow into uniform sheet flow.

Applicability

Silt fence is only appropriate for small drainage areas on relatively flat slopes or around small storage piles. Silt fence in not suitable where runoff is concentrated in a ditch, pipe or streambed. Combination barriers constructed of silt fence supported by wire mesh or straw bales and silt fence embedded within rock check dams may be effective within small channels.

Design Guidlines

Level Contour
Silt fence shall be placed on the level contour of the land so that flows are dissipated into uniform sheet flow. Silt fence should never concentrate runoff, which will result if it is placed up and down slopes rather thon on the level contour.

Flow Around Ends
To prevent water ponded by the silt fence from flowing around the ends, each end shall be constructed upslope so that the ends are at a higher elevation.

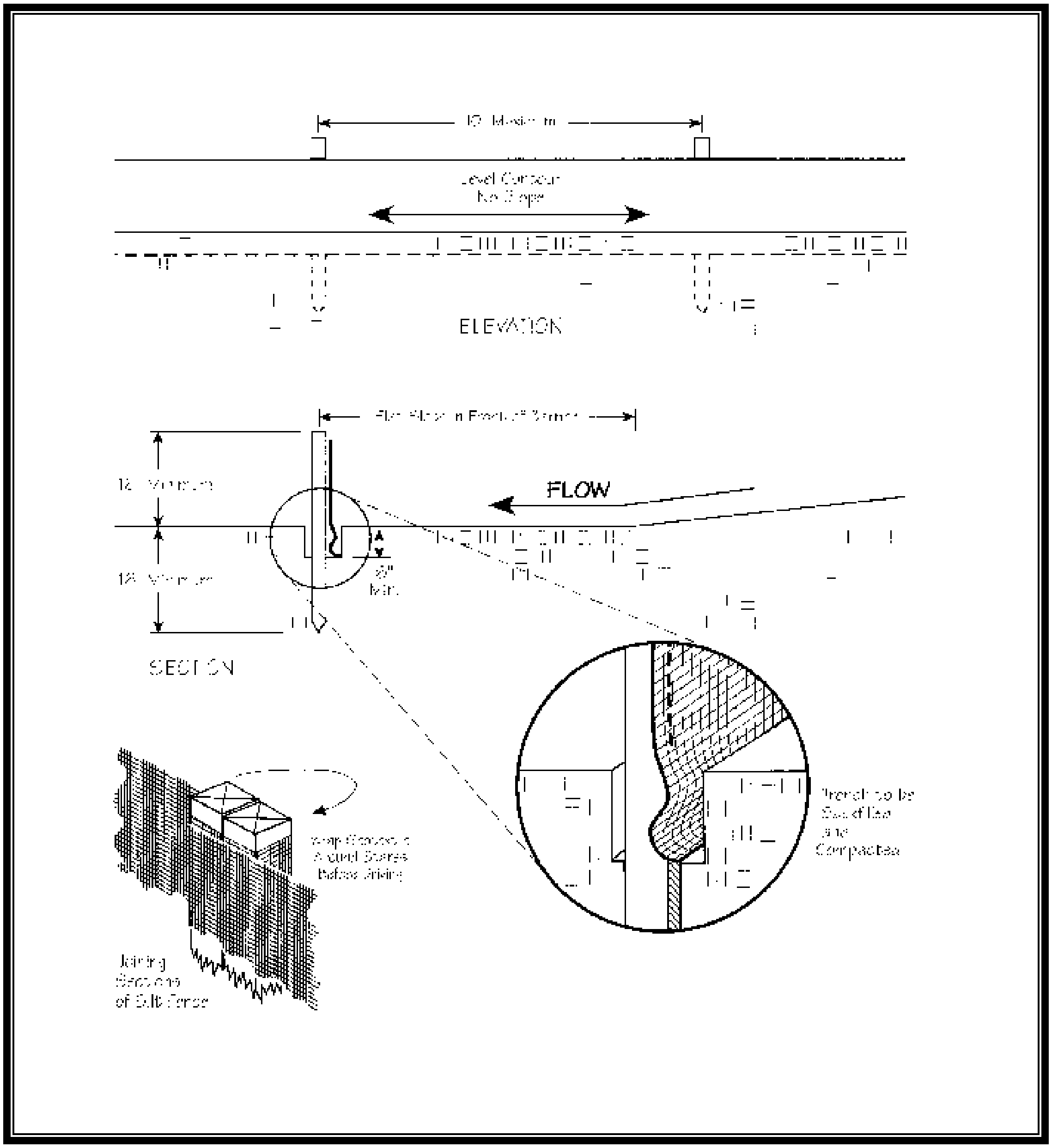
Vegetation
Vegetation shall be preserved several feet in front and behind the silt fence where possible. Vegetation has the effect of dissipating flow energies and enhancing sediment deposition.

Seams
Seams between sections of silt fence shall be overlapped with the end stakes of each section wrapped together before driving into the ground.

Maintenance

Silt fence shall allow runoff to pass only as diffuse flow through the geotextile fabric. If runoff overtops the silt fence, flows under or around the ends, or in any other way becomes a concentrated flow, one of the following shall be performed, as appropriate: 1) The layout of the silt fence shall be changed, 2) Accumulated sediment shall be removed, 3) Other practices shall be installed.

Figure 9-4. Example of Silt Fence Installation



Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.7 Storm Sewer Inlet Protection

Description

All storm sewer inlets that accept water runoff from the development area shall be protected so that sediment-laden water will not enter the storm sewer system without first being treated to remove sediment, unless the storm sewer system drains to a settling facility.

When working properly, inlet protection will slow runoff may cause water to pond. When used on curb inlets, streets can temporarily flood during heavy storms. Consult with (community) before installing curb inlet protection.

Applicability

Inlet protection essentially clock storm drain inlets. The effect on the site’s drainage that will result from blocking storm drain inlets must be considered. This practice is not recommended as the primary means of sediment control. It should only be used if it is not possible to divert the runoff away from the storm drain inlets.

Design Guidelines

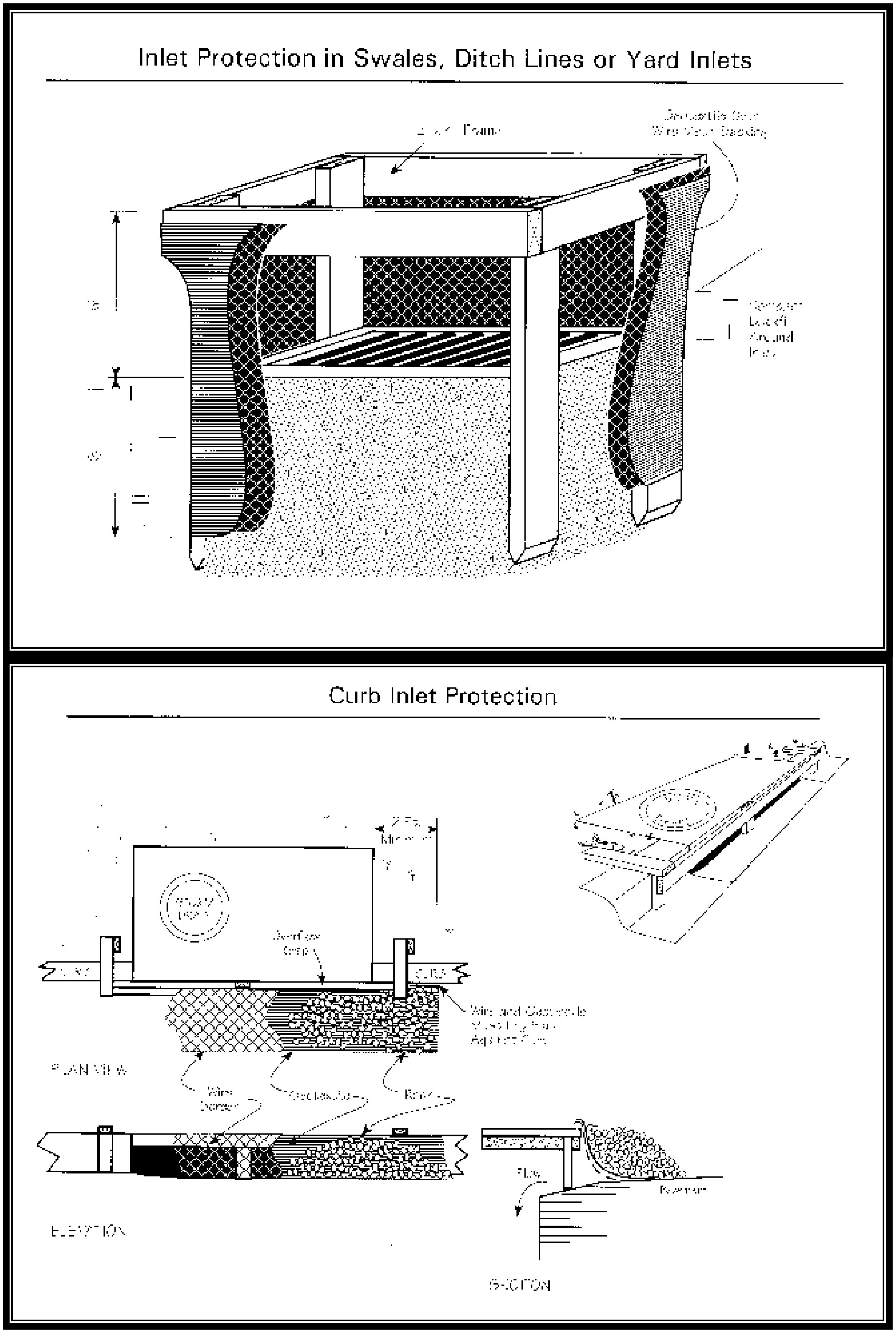
Frame
A wooden frame shall be constructed of 2 X 4 in. construction grade lumber. For inlets in swales, ditch lines and yards, the posts shall be driven 1 ft. into the ground at all four corners. For curb inlets, the end spacers shall be a minimum of 1 ft. beyond both ends of the throat opening.

Wire Mesh
Wire mesh shall be of sufficient strength to support the geotextile cloth with water fully impounded against it. It shall be stretched tightly around the frame and fastened securely to the frame.

Geotextile Cloth
The Geotextile cloth shall have an equivalent opening size (EOS) of 20-40 sieve and be resistant to sunlight. For inlets in swales ditch lines, and yards, the geotextile shall extend from the top of the frame to 18 in. below the inlet elevation. For curb inlets the cloth shall be a continuous piece, with a minimum width of 30 in. and 4 ft longer than the throat length of the inlet (2 ft. on each side).

Rock
For curb inlets, two-inch stone shall be placed over the wire mesh and geotextile in such a manner as to prevent sediment-laden water from entering the inlet under or around the geotextile.

Figure 9-5. Examples of Inlet Protection Techniques



Source: Mecklenburg, Dan, *Rainwater and Land Development*, *Second Edition*, Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.8 Dewatering Activities

If de-watering is required, adjacent properties shall be protected. Discharges shall enter an effective sediment and erosion control measure.

9.4.9 Disposition of Temporary Practices

All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization is achieved or after the temporary measures are no longer needed. Trapped sediment and other disturbed soil areas shall be permanently stabilized.

9.4.10 Construction Access Routes

Description

A stabilized matte of aggregate underlain with filter cloth shall be located at any point where traffic will be entering or leaving a construction site or from a public right-of-way, street, alley, or parking area. Individual lots should have their own drive once construction on the lot begins.

Applicability

A construction entrance shall be used:

- Where construction vehicles leave active construction areas onto surfaces,
- Where runoff is not intercepted by sediment controls,
- At all points of egress from the construction site to public roads, and
- Where frequent vehicle and equipment ingress/egress is expected.

Design Guidelines

Bedding
A geotextile cloth shall be placed over the entire area prior to placing stone. It shall have Grab Tensile Strength of at least 200 lbs. and Mullen Burst Strength of at least 190 lbs.

Stone
Two-inch stone shall be used, or recycled concrete equivalent. The stone layer shall be at least 6 in. thick.

Length – Width
The construction entrance shall be as long as required to stabilize high traffic areas, but not less than 50 ft. (for single residence lots a 30 ft. minimum length applies). The entrance shall be at least 10 ft wide, but not less than the full width at which ingress/egress occurs.

Culvert

A pipe or culvert shall be placed under the entrance if needed to prevent surface water form flowing across the entrance or form being directed onto a public road.

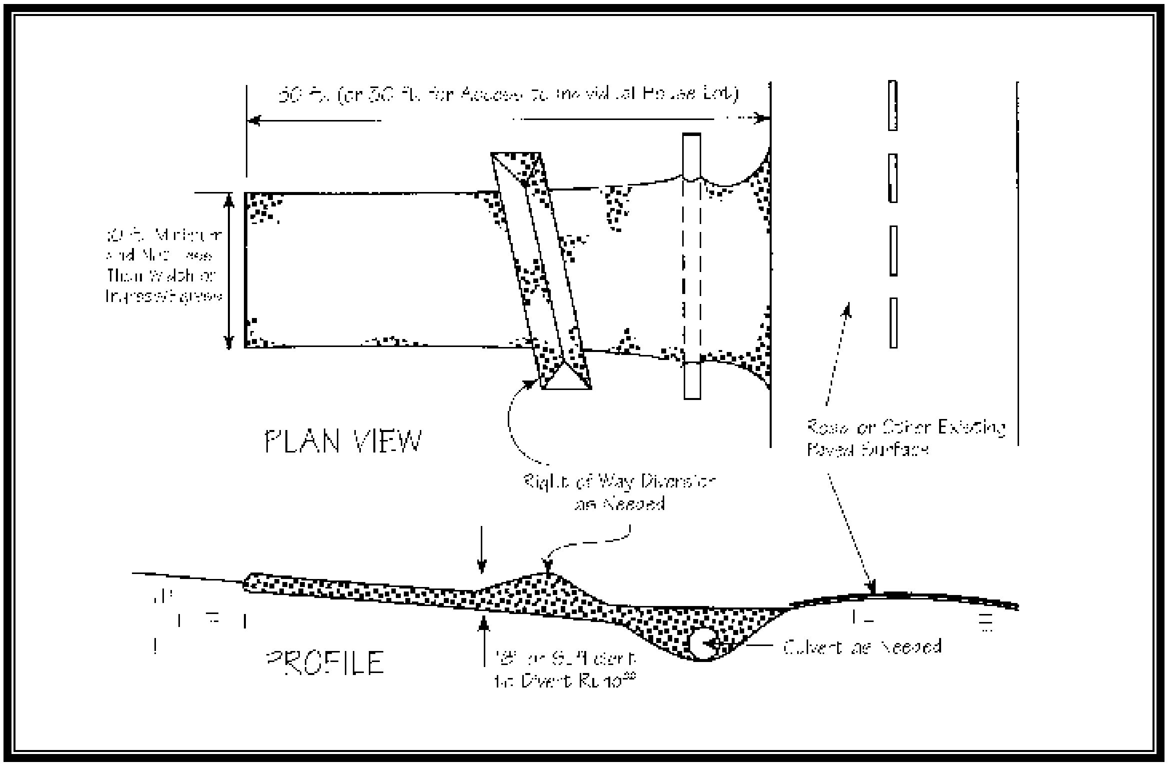
Water Bar

A water bar shall be constructed as part of the construction entrance if needed to prevent surface runoff form flowing the length of the construction entrance and out onto public roads or existing paved surfaces.

Maintenance

Top dressing of additional stone shall be applied as conditions demand. Mud spilled, dropped, washed, or tracked onto public roads, or any surface where runoff is not intercepted by sediment controls, shall be removed immediately. Removal shall be achieved by scraping or sweeping.

Figure 9-6. Example of Construction Entrance



Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.11 Cut and Fill Slopes

Cut and fill slopes shall be no greater than 2:1, except as approved by (community) to meet other community or environmental objectives. Cut and Fill Slopes shall be designed and constructed in such a manner that will minimize erosion. Consideration shall be given to the length and steepness of the slope, soil type, up-slope drainage area, groundwater conditions, and slope stabilization.

9.4.12 Stabilization of Outfalls and Channels

Outfalls and constructed or modified channels shall be designed and constructed to withstand the expected velocity of flow from a post-development, 10-year, 24-hour storm without eroding.

9.4.13 Establishment of Permanent Vegetation

Permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until ground cover is achieved which, in the opinion of (community), provides adequate cover and is mature enough to control soil erosion satisfactorily and to survive adverse weather conditions.

9.4.13.1 Permanent Seeding

Description

Permanent seeding includes preparing the seedbed, seeding, and the establishment of perennial vegetation to stabilize the soil. Permanent seeding prevents reduces runoff and prevents sediment pollution, by promoting infiltration.

Applicability

Permanent seeding should be applied to:

- Areas or portions of construction sites that can be brought to final grade. Application of permanent seeding should not be delayed while construction on other portions of the site is being completed.
- Areas that will be disturbed again, but will be dormant for a year or more.

Design Guidelines

Seedbed Preparation
A subsoiler, plow, or other implement shall be used to reduce soil compaction and allow maximum infiltration. Subsoiling should not be done on slip-prone areas where soil preparation should be limited to what is necessary for establishing vegetation.

Soil Amendments
Agricultural ground limestone shall be applied to acid soil as recommended by a soil evaluation. In lieu of a soil evaluation, lime shall be applied at a rate of 100 lbs./1000 sq. ft. or 2 tons /ac. Fertilizer shall be applied as recommended by a soil evaluation. In lieu of a soil evaluation, fertilizer shall be applied at a rate of 12 lbs./1,000 sq. ft. or 500 lbs./ac. of 10-10-10 or 12-12-12 analysis. The lime and fertilizer shall be worked into the soil with a disk harrow, spring tooth harrow or

other suitable field implement to a depth of 3 in. On sloping land the soil shall be worked on the contour.

Seeding Dates and Soil Conditions
Ideal seeding dates include March 1 to May 31 and August 1 to September 30. With use of additional mulch and irrigation, seedings may be make throughout the growing season. Tillage/seedbed preparation should be done when the soil is dry enough to crumble and not form ribbons when compressed by hand.

Mulching or Matting
See 9.4.3: *Stabilization of Denuded Areas*

Irrigation
Permanent seeding shall include irrigation to establish vegetation during dry or hot weather or on adverse site conditions as needed to provide adequate moisture for seed germination and plant growth.

Species Selection

Permanent Seeding Species Selection			
Seed Mix	Seeding Rate		Notes
Species	Lbs. / 1,000 ft.^{2}	Lbs. / acre	
General Use			
Creeping Red Fescue Domestic Ryegrass Kentucky Bluegrass	½-1 ¼-½ ¼-½	20-40 10-20 10-20	
Tall Fescue	1	40	
Dwarf Fescue	1	40	
Steep Banks or Cut Slopes			
Tall Fescue	1	40	
Crown Vetch Tall Fescue	¼ ½	10 20	*Do not seed later that August*
Flat Pea Tall Fescue	½ ½	20 20	*Do not seed later that August*
Road Ditches and Swales			
Tall Fescue	1	40	
Dwarf Fescue Kentucky Bluegrass	2 ¼	90 5	
Lawns			
Kentucky Bluegrass Perennial Ryegrass	1 ½ 1 ½	60 60	
Kentucky Bluegrass Creeping Red Fescue	1 ½ 1 ½	60 60	*Shaded Areas*
Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996. Other species approved by (community) may be substituted.			

9.4.13.2 Sodding

Description

Sod can be used to provide immediate soil stabilization in erosive areas such as drainage ways and on steep slopes.

Applicability

Sod may be used where immediate cover is required or preferred and where vegetation will be adequate stabilization. Appropriate uses include swales, around drop inlets, and lawns.

Design Guidelines

Site Preparation
A subsoiler, plow or other implement shall be used to reduce soil compaction and allow maximum infiltration. Subsoiling shall not be done on slip-prone areas where soil preparation should be limited to what is necessary for establishing vegetation.

Sod Installation
Sod shall be harvested, delivered and installed within a period of 48 hrs. Sod not transplanted within this period shall be inspected and approved prior to installation. The sod shall be kept moist and covered during hauling and preparation. During dry periods with excessively high temperatures, the soil shall be lightly irrigated immediately prior to laying the sod. Sod shall not be placed on frozen soil.

On sloping areas where erosion may be a problem the sod shall be secured with staples or pegs. The sod shall be laid with the long edge parallel to the contour and with staggered joints. The first row of sod shall be laid in a straight line, with subsequent rows placed parallel and tightly wedged against each other.

As sodding is completed in any one section, the entire area shall be rolled or tamped to ensure solid contact of roots with the soil surface. Sod shall be watered immediately after rolling or tamping until the sod and soil surface below are thoroughly wet.

Sod Maintenance
In the absence of adequate rainfall during the first week, watering shall be performed daily or as often as necessary and in sufficient quantities to maintain moist soil to a depth of 4 in.

9.4.14 Working In or Crossing Streams

Streams, including bed and banks, shall be re-stabilized immediately after in-channel work is completed, interrupted, or stopped. To the extent practicable, construction vehicles shall be kept out of streams. Where in-channel work is necessary, precautions shall be taken to stabilize the work area during construction to minimize erosion.

If construction vehicles must cross a live (wet) stream regularly during construction, a temporary stream crossing shall be provided.

Description

A stream crossing provided construction traffic temporary access across a stream, while reducing the amount of disturbance and sediment pollution. There are three typical kinds of stream crossings: bridges, culverts, and fords. The type chosen for each application will depend on site characteristics.

Applicability

These structures create a channel constriction, which can cause flow backups or wahouts during periods of high flow. They should be planned to be in service for the shortest practical period of time and be removed as soon as possible. The design guidelines pertain primarily to the environmental impacts of stream crossings. From a safety stand point, the designer must also ensure the crossing is capable of withstanding the expected loads form heavy equipment. The designer must also be aware that such structures are subject to the rules and regulations of the U.S. Army Corps of Engineers for in-stream modifications (*A Section 404 permit may be required*).

Design Guidelines

Bridge
Bridges are preferable to the other types of stream crossings because they cause the least disturbance to the stream. Bridges are most applicable for narrow, deep channels such as small streams and drainage ditches.

Culvert
Culvert stream crossings are most suitable for wide-stream channels and for traffic that is too heavy for a bridge crossing. No other fill than clean stone free from soil shall be placed within the stream channel. In streams with spawning fish, culvert crossings should not be constructed between March 15 and June 15.

Ford
Fords may be used where very little construction traffic is anticipated. Fords should NOT be used to cross deep channels with stream banks greater than 4 ft high. No other fill than clean stone free from soil shall be placed within the stream channel. In streams with spawning fish, fords should not be constructed between March 15 and June 15.

Crossing Location
Stream crossings shall be constructed where they will cause the least disturbance to the channel and surrounding vegetation. Good locations are straight, shallow sections.

Crossing Alignment
Stream crossings should be made perpendicular (90°) to the channel to minimize the length of channel disturbed. Crossings deviating up to 30° from perpendicular are acceptable as long as they minimize channel disturbance.

Width of Crossing
Stream crossings shall be made as narrow as practical to minimize channel and bank disturbance.

Approach
The approach to the stream crossing shall not direct sediment-laden runoff to the stream. Runoff shall be diverted with water bars or sediment barriers as needed to prevent sediment-laden runoff from reaching the stream.

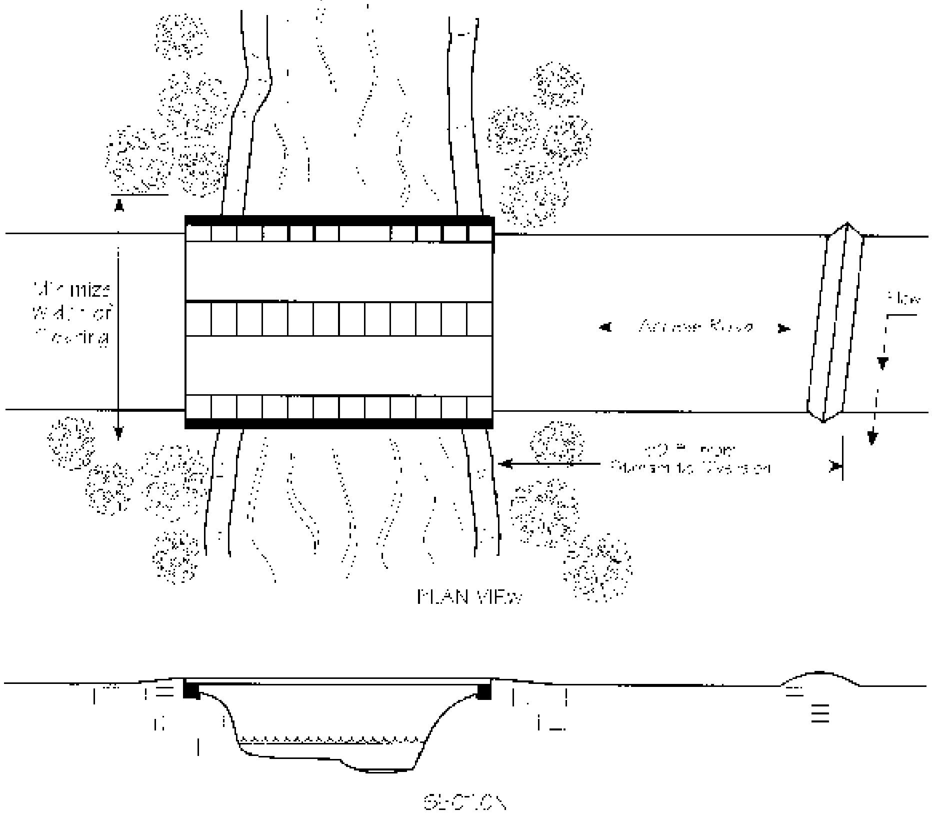
Removal and Stabilization
To minimize disturbance and obstructions, all temporary crossings and other structures shall be removed as soon as they are no longer needed. A small amount of clean stone and rock may be left in the stream when removing it would cause more disturbance than leaving it in place. The streambanks must be stabilized, ideally with woody vegetation and should meet the Buffer requirements of Chapter 6 (*Buffer Areas*).

Maintenance
Mud spilled, dropped, washed, or tracked onto the crossings, shall be removed immediately. Removal shall be achieved by scraping or sweeping. For culvert crossings, a top dressing of additional stone shall be applied as conditions demand.

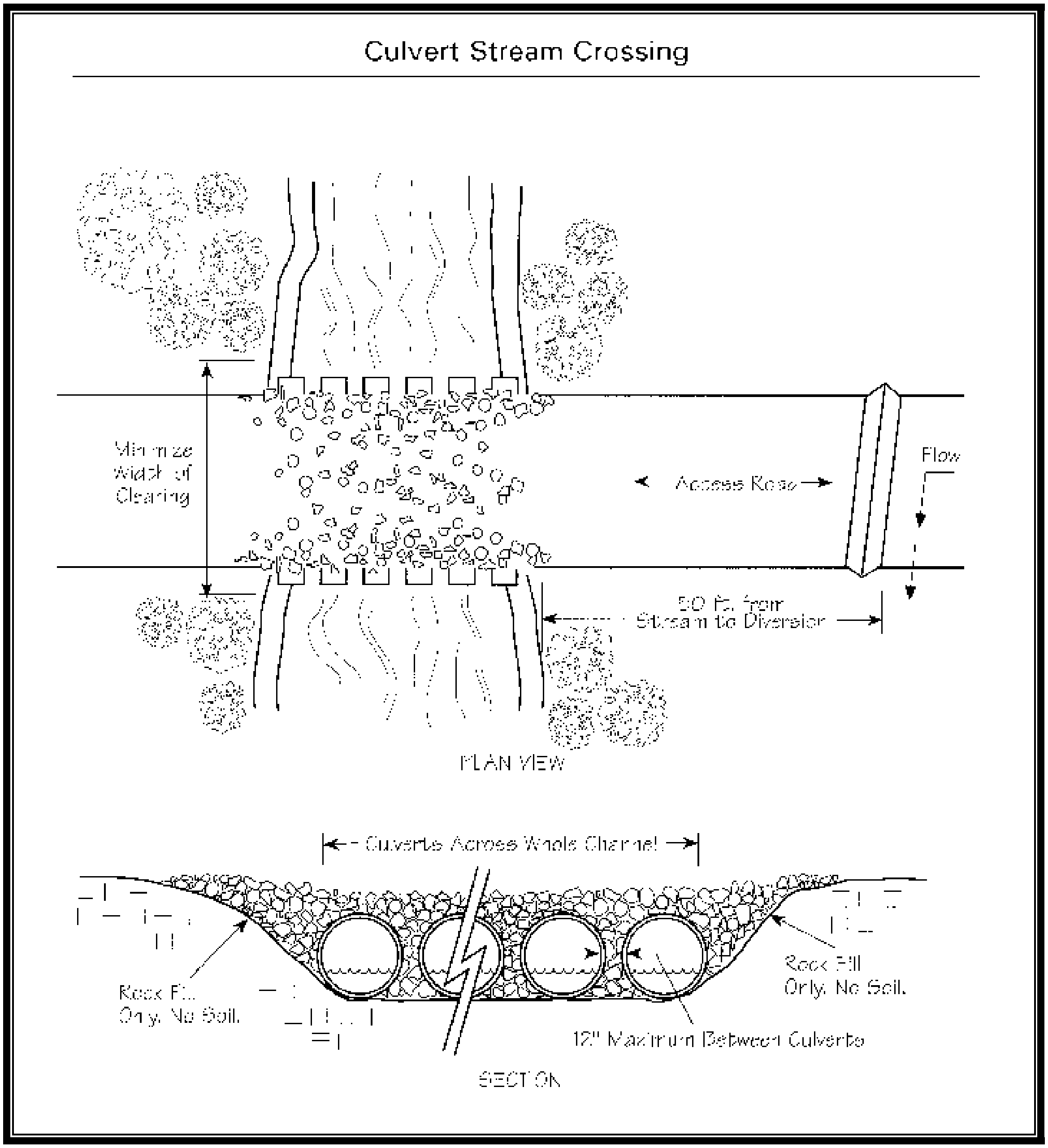
Figure 9-7. Examples of Stream Crossings

Temporary Access Bridge

This specification does not define the strength of the temporary bridge. It shall be the contractor's responsibility to select bridge construction materials with adequate strength for the anticipated construction traffic loads.



Source: Mecklenburg, Dan, *Rainwater and Land Development*, *Second Edition*, Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.



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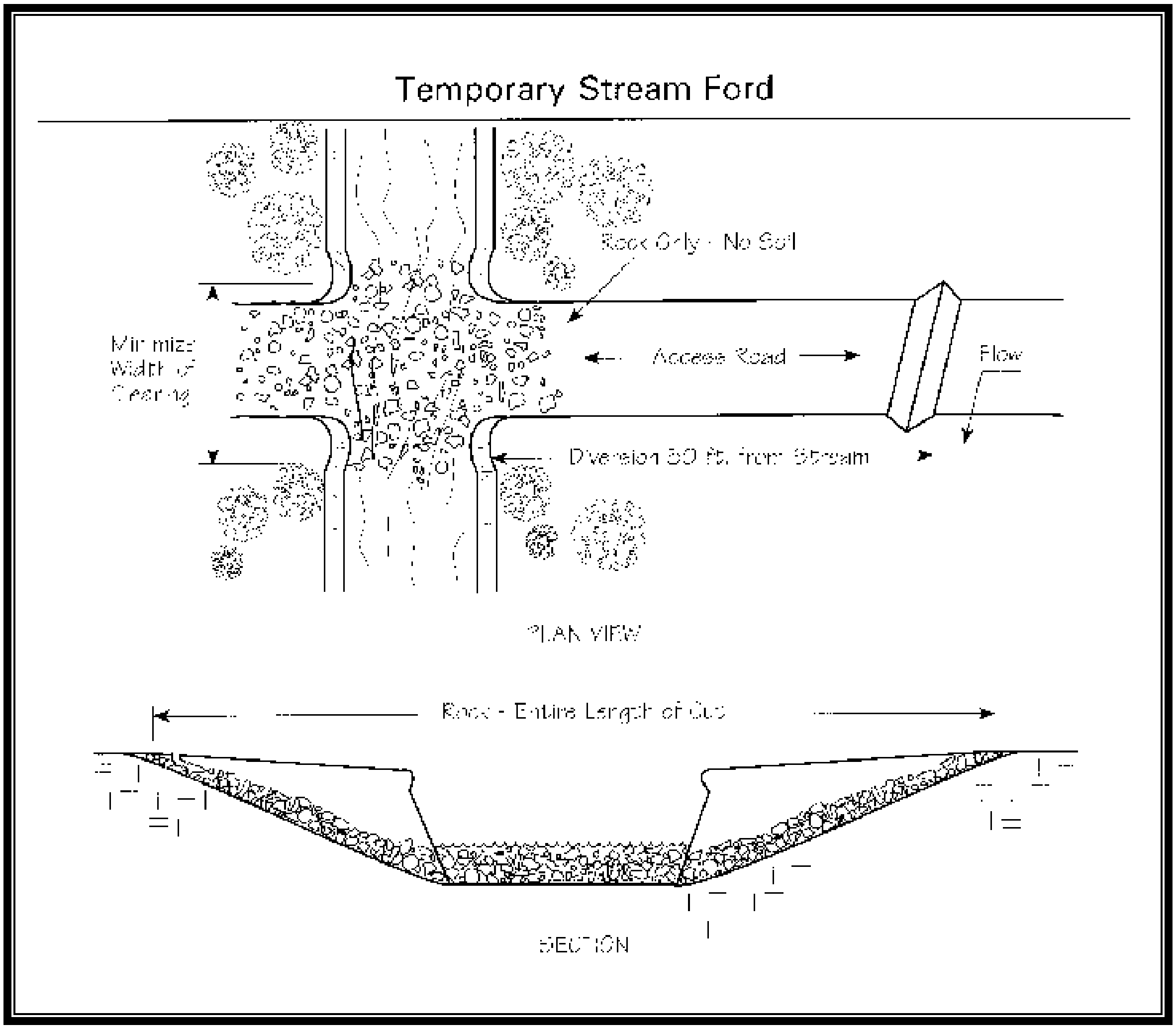

Source: Mecklenburg, Dan, *Rainwater and Land Development, Second Edition,* Ohio Department of Natural Resources, Division of Soil and Water Conservation, 1996.

9.4.15 Sloughing and Dumping

No soil, rock, debris, or any other material shall be dumped or placed into a water resource or into such close proximity that it may readily slough, slip, or erode into a water resource unless such dumping or placing is authorized for such purposes as, but not limited to, construction of bridges, culverts, fords, and erosion control structures. Spoil piles from construction activities shall be placed at least 20 ft. from any stream bank or waterway.

Unstable soils prone to slipping or landslides shall not be graded, excavated, filled or have loads imposed upon them unless the work is done in accordance with a qualified professional engineer’s recommendations to correct, eliminate, or adequately address such problems.

9.5 Maintenance

All temporary and permanent erosion and sediment control must be continuously maintained in an effective working condition.

Inspections shall be conducted by qualified personnel once every 7 days and within 24 hours of a 0.5” or greater rainfall.

10. Inspection and Enforcement

Chapter 10: INSPECTION AND ENFORCEMENT

10.1 Prohibition of Non-Storm Water Discharges

All discharges covered by these standards shall be composed entirely of storm water. Discharges of material other than storm water must be in compliance with an individual NPDES permit or alternative general permit issued for the discharge.

The discharge of hazardous substances in the storm water discharge(s) from a facility shall be minimized in accordance with the applicable Storm Water Pollution Prevention Plan (SWPPP) for the facility, and in no case, during any 24-hour period, shall the discharge(s) contain a hazardous substance equal to or in excess of reportable quantities.

10.2 Guarantees for Completion of Work

All persons proposing earth-disturbing activities requiring a permit shall provide a performance bond in the form of a letter of credit, cash on deposit, traditional bond, or other pledging of securities, as deemed adequate by (community). The performance bond will be retained by (community) until measures identified in these standards and/or the permitee's SWPPP have been completed to the satisfaction of (community). The performance bond shall be 100% of the design engineer's estimate for constructing the storm water management facilities and establishing vegetative stabilization on the site.

10.3 Facility Design

All storm water BMP's shall be designed in a manner to minimize the need for maintenance, and reduce the chances of failure. Design guidelines are outlined in these standards and the recommended BMP manuals. Final design of facilities requiring a permit shall be approved by (community).

10.4 Access and Easements

The property owner shall provide storm water easements and covenants for access to the facility for inspections and maintenance. Easements and covenants shall be recorded with (community) prior to the issuance of a permit.

Easements shall preserve storm water runoff conveyance, infiltration, and detention areas and facilities, including flood routes for the 100-year storm event. The purpose of the easement shall be specified in the maintenance agreement signed by the property owner.

10.5 Inspections

The person(s) or organization(s) responsible for maintenance shall inspect storm water BMPs on a regular basis, as outlined in the SWPPP.

Authorized representatives of (community) may enter at reasonable times upon any property to conduct on-site inspections or required maintenance.

For BMP's maintained by the property owner or homeowners association, inspection and maintenance reports shall be filed with (community), as provided for in the SWPPP.

Authorized representatives of (community) may conduct inspections to confirm the information in the reports.

When it is determined that there is a violation or the development area is not in compliance, the following procedure will be followed:

a. The inspector representing (community) will notify the site superintendent of the violation and the work required to be in compliance with these standards and/or the approved SWPPP. Notification may be verbal or in writing.
b. One week following the inspection during which the violation was noted or after a time period mutually agreed to by the inspector and the site superintendent, the inspector will re-inspect the site.
c. If the violation still exists (community) may issue, by certified mail, an order to comply. The order shall describe the problem and the work needed, and specify a date whereby the work must be completed.
d. On the date specified in the order to comply the site will be re-inspected.
e. If the violation still exists the issue may be reported to (community) for consideration. If (community) determines that a violation exists one or all of the following options may be pursued:
    i. The development permit may be suspended. Since no earth-disturbing activity can proceed without a permit, this action constitutes a stop work order until the violation is corrected.
    ii. An injunction or other appropriate relief may be sought through the court of competent jurisdiction.
    iii. The performance bond may be used by (community) to abate the erosion, sedimentation, pollution, or water management problem caused by the subject site.
f. The inability to perform any of the inspection and enforcement procedures as defined in this section will not preclude the use of any other procedure nor will the procedure be binding in cases of severe hazard or threat to public welfare as determined by (community).

10.6 Certification by Registered Professional

For any sites that required a professional site plan, a certification letter shall be submitted after soil erosion and storm water runoff control facilities have been installed to affirm that construction has been completed in accordance with the approved SWPPP. This certification letter can be prepared by one of the following registered professionals: civil engineer, land surveyor, architect, and/or landscape architect unless it was specified by (community) that a civil engineer prepare a plan, it would need to be a civil engineer that approves the plan. If there are changes during the course of construction, (community) may require final "as built" drawings for final approval of the site work.

10.7 Penalties for Violation

10.7.1 Revocation of Permit(s)

No permit will be revoked or suspended until a hearing is held by (community). Written notice of such hearing will be served on the permit holder either personally or by registered mail.

10.7.2 Fines

Failure to comply with the requirements of these standards shall constitute a violation, and any person convicted thereof shall be fined not more than ($_____) dollars per day for each day the violation exists.

10.8 Variances

(Community) may grant a variance to these standards where the applicant or permit holder can show that compliance with all or part of these standards is not appropriate. A variance may be granted if the probability of water management problems is slight because of exceptional topographic or other physical condition of the development area. Requests for variances shall be submitted to (community) and shall include justification for the granting of the variance.

10.9 Appeals

Any person aggrieved by an order, requirement, determination, or any other action or inaction by (community) or its representatives in relation to these standards may appeal to the Court of Common Pleas. Such an appeal shall be made in conformity with Chapters 2505 and 2506 of the Ohio Revised Code. Written notice shall be served to (community).

Definitions

DEFINITIONS

AH Zone
Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding with a constant water-surface elevation (usually areas of ponding) where average depths are between 1 and 3 feet. The BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

AO Zone
Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. The depth should be averaged along the cross section and then along the direction of flow to determine the extent of the zone. Average flood depths derived from the detailed hydraulic analyses are shown within this zone. In addition, alluvial fan flood hazards are considered Zone AO. Mandatory flood insurance purchase requirements apply.

Applicant
Any person, firm or governmental agency who owns property or the duly appointed representative and wishes to develop that property and one who executes the necessary forms to procure the permit to carry out such development from (community).

Appropriate Use
Only uses of the Regulatory Floodway that are permissible and will be considered for permit issuance.

A.S.T.M.
American Society for Testing Materials.

Backwater
Water held or pushed back by a dam or current.

Bankfull Flood
A condition where streamflow completely fills the stream channel up to the top of the bank. In undisturbed watersheds, this occurs on average every 2 years and controls the shape and form of natural channels.

Barrel
The concrete or corrugated metal pipe that passes runoff from the riser through the embankment, and finally discharges to the pond's outfall.

Base Flood
The flood having one percent probability of being equaled or exceeded in any given year. The base flood is also known as the 100-year frequency storm event.

Base Flood Elevation (BFE)
The elevation delineating the level of flooding resulting from the 100-year flood frequency elevation.

Base Flow
The portion of stream flow that is not due to runoff from precipitation, usually supported by water seepage from natural storage areas such as ground water bodies, lakes or wetlands.

Best Management Practice (BMP)
A practice or combination of practices that prevent or reduce Storm water runoff and/or associated pollutants.

Borings
Cylindrical samples of a soil profile used to determine infiltration capacity.

Buffer Strip
A zone where plantings capable of filtering Storm water are established or preserved, and where construction, paving and chemical applications are prohibited.

Capacity (Adequate Downstream Storm Water Capacity)
A storm water management facility shall be considered to have adequate downstream storm water capacity if the facility can be shown to accommodate up to and including the 100-year frequency storm runoff without increasing property damage to the adjacent property or to a point downstream known to (community) to be a restriction causing significant backwater.

Catch Basin
A collection structure below ground designed to collect and convey water into the storm sewer system. It is designed so that sediment falls to the bottom of the catch basin and not directly into the pipe.

Channel
Any river, stream, creek, brook, branch, natural or artificial waterway, flowage, slough, ditch, conduit, culvert, gully, ravine, swale, wash, or natural or man-made drainage way; in or into which surface or groundwater flows either perennially or intermittently.

Channel Modification
Alteration of a channel by changing the physical dimensions or materials of its bed or banks. Channel modification includes damming, rip-rapping or other armoring, widening, deepening, straightening, relocating, lining and significant removal of bottom material or woody vegetation of the channel. Channel modification does not include the clearing of dead or dying vegetation, debris, or trash from the channel.

Check Dam
1) An earthen, aggregate or log structure, used in grass swales to reduce velocity, promote sediment deposition, and enhance infiltration.
2) A log or gabion structure placed perpendicular to a stream to enhance aquatic habitat.

Community
Any municipality, unincorporated county or township, or special district acting as the designated management agency for storm water runoff.

Concentrated Animal Feeding Operation (CAFO)

A facility is an animal feeding operation (AFO) if animals are stabled/confined, or fed/maintained, for 45 days or more within any 12-month period, and the facility does not produce any crops, vegetation or forage growth. A CAFO is an AFO which:

- Has more than 1,000 animal units (AU), or
- Has 301 to 1,000 AU and wastes are discharged through man-made conveyance or directly into US waters, or
- Is designated a CAFO by the permitting authority on a case-by-case basis

Culvert
A closed conduit used for the passage of surface water under a road, or other embankment.

Denuded/Disturbed
An area where the land surface has been cleared, grubbed, compacted, or otherwise modified.

Depressional Storage Area
Non-Riverine depressions where storm water collects.

Design Storm
A rainfall event of specified size and return frequency, (e.g., a storm that occurs only once every 25 years). Typically used to calculate the runoff volume and peak discharge rate to or from a BMP.

Detention
The temporary storage of storm runoff, to control peak discharge rates and provide gravity settling of pollutants.

Detention Basin
A constructed basin that temporarily stores water before discharging into a surface water body. Can be classified into three groups:

1. **Dry Detention Basin**
   A basin that remains dry except for short periods following large rainstorms or snow melt events. This type of basin is less effective at removing pollutants.
2. **Extended Dry Detention Basin**

A dry detention basin that has been modified to increase the length of time that Storm water will be detained, typically between 24-40 hours. Extended detention allows pollutants to settle out before Storm water is discharged from the basin.

3. **Wet Detention Basin**
A wet detention facility is designed to maintain a permanent pool of water after the temporary storage of storm water runoff. Pollutant removal rates are dependent on the volume to the pool. Permanent pool volume equal to 0.5-1.0 in. of runoff per acre impervious area will reliably achieve moderate to high removal rates.

Detention Time
The amount of time that a volume of water will remain in a detention basin.

Development
Development shall be defined as finalization of a plat, re-plat, lot-split, or man-made change to real estate by private or public agencies including:

- Construction, reconstruction, significant repair, or placement of a building or any addition to a building;
- Installation of a manufactured home on a site, preparation of a site for a manufactured home, or placement of a recreational vehicle on a site for more that 180 days;
- Drilling, mining, installation of utilities, construction of roads, bridges, or similar projects;
- Clearing of land in excess of one (1) acre as an adjunct of construction;
- Construction or erection of levees, walls, fences, dams, or culverts; channel modification; filling, dredging, grading, excavating, paving, or other alterations of the ground surface; storage of materials; deposit of solid or liquid waste;
- Any other activity that might change the direction, height, volume or flow of drainage runoff and collection.

Discharge
The rate of flow typically expressed as a volume of water passing a point in a given time. Usually expressed as cubic feet per second.

Drainage Area (Also see **Watershed)**
The land area above a given point that contributes storm water to that point.

Drawdown
The gradual reduction in water level in a pond BMP due to the combined effect of infiltration and evaporation.

Easement
A legal right, granted by a property owner to another entity, allowing that entity to make limited use of the property involved for a specific purpose. Easements are recorded on the title to the land and transfer with the sale of land. Also known as a **right-of-way**.

Exceptional Functional Value Wetland
Any wetland identified as such in the USEPA Advanced Identification Study (ADID) of the area or any wetland that through functional assessment meets the criteria defined in that study for determining exceptional functional value.

Extended Detention
A Storm water design feature that provides for the holding and gradual release of Storm water over a longer period of time than that provided by conventional detention basins, typically 24-40 hours. Extended detention allows pollutants to settle out before Storm water is discharged from the basin.

FEMA
Federal Emergency Management Agency and its regulations codified as 44 CFR 1-399.

Fill
Added earth that is designed to change the contour of the land.

First Flush
The delivery of a highly concentrated pollutant loading during the early stages of a storm, due to the washing effect of runoff on pollutants that have accumulated on the land.

Floodplain (*see Regulatory Floodplain*)

Flood-Prone Area
Any area inundated by the **base flood**.

Floodway (*see Regulatory Floodway*)

Floodway Fringe
Areas that fall within the 1-percent annual chance (100-year) floodplain, but are outside the floodway.

Flow Path
The distance that a parcel of water travels through a storm water detention pond or wetland. It is defined as the distance between the inlet and outlet, divided by the average width.

Flow Splitter
An engineered, hydraulic structure designed to divert a portion of stream flow to a BMP located out of the channel, or to direct Storm water to a parallel pipe system, or to bypass a portion of baseflow around a pond.

Forebay
A small, separate storage area near the inlet to a detention basin, used to trap and settle incoming sediments before they can be delivered to the basin. For basins with a single inlet, a forebay may occupy 5-20% of the normal pool area. Forebays should be large

enough to avoid scour and re-suspension of trapped sediment and sized for ease of construction and cleanout. Forebays should have a water depth of at least 3 feet.

Freeboard
The space from the top of an embankment to the highest water elevation expected for the largest design storm to be stored or conveyed. The space is required as a safety margin in a pond, basin or channel.

Gabion
A large rectangular box of heavy gage wire mesh that holds large cobbles and boulders. Used in streams and ponds to change flow patterns, stabilize banks, or prevent erosion.

Geotextile Cloth
Textiles of relatively small mesh or pore size. The two major classifications are as follows:
1) Permeable. This allows water to pass through while holding sediments back.
2) Impermeable. This type prevents both runoff and sediment from passing through.

Ground Water
Naturally existing water beneath the earth's surface between saturated soil particles and rock that supplies wells and springs.

Ground Water Table
The upper surface or top of the saturated portion of the soil or bedrock layer, indicates the uppermost extent of groundwater.

Hazardous Substance
Substance that has any of the following characteristics:
- Ignitable: A substance that is flammable (has a flash point under 140 degrees Fahrenheit) such as solvents, points or cleaning products.
- Toxic: Substance that if improperly managed can contaminate groundwater and be harmful or fatal to animals and humans.
- Corrosive: Substances that are acids or alkaline that can burn tissue or corrode metal.
- Reactive: A broad range of substances that are unstable, explosive or can create toxic fumes.

Hydric Soil
A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part.

Hydrograph
A graph showing variation in the water depth or discharge in a stream or channel, over time, at a specific point along a stream.

Hydrology
The distribution and circulation of water on the surface of the land and underground.

Hydrophytic Vegetation
Plant life growing in water, soil or on a substrate that is at lease periodically deficient in oxygen as a result of excessive water content.

Impervious Surface
Any hard-surfaced, man made area that does not readily absorb or retain water , including but not limited to building roofs, parking and driveway areas, graveled areas, sidewalks and paved recreation areas.

Infiltration
The absorption of water into the ground, expressed in terms of inches/hour.

Intensity-Duration-Frequency Curve
Curve showing the probability of various short-period rainfall rates for various durations of precipitation at a given location. Often a family of curves is shown, each depicting a specific occurrence frequency or return period in years.

Invert
The interior surface of the bottom of any pipe.

Level-Spreader
A device used to spread out Storm water runoff uniformly over the ground surface as sheet flow i.e., not through channels. The purpose of level spreaders is to prevent concentrated, erosive flows from occurring, and to enhance infiltration.

Linear Buffer
Strip of land along linear waterbodies including streams, ditches, and rivers where development is restricted.

Major Development
Development that:

- Is located in any other portion of a Regulatory Floodplain or Floodway or is located in a depressional storage area that has a volume larger than 0.75 acre-feet.
- Disturb a cumulative total of one-tenth (1/10) or more acres of wetlands.
- Modifies a channel where the tributary drainage area is greater than 100 acres, and
- Consists of: Single family detached residential development greater than ten (10) acres, and an impervious cover area greater than fifteen (15) percent; or Multi-family, non-residential, and other developments greater than three (3) acres.

Manhole
A structure that allows access into the sewer system.

Manning's Roughness Coefficient ("n")
A coefficient used in Manning's Equation to describe the resistance to flow due to the surface roughness of a culvert or stream channel.

Minor Development
Development that:

- Is not located in a Regulatory Floodplain or Floodway or is not located in a depressional storage area or has a volume larger than 0.75 acre-feet.
- Does not disturb a cumulative total of one-tenth (1/10) or more acres of wetlands.
- Modifies a channel where the tributary drainage area is less than 100 acres, and
- Consists of: Single family detached residential development of less than ten (10) acres, and an impervious cover area of less than fifteen (15) percent, or Multi-family, non-residential, and other developments of less than three (3) acres.

Mitigation (*see Wetland Mitigation*)
Measures taken to eliminate or minimize damage from development activities, such as construction in Wetlands or Regulatory Floodplain filling, by replacement of the resource.

Morphology (Stream Morphology)

Nationwide Permit (NWP)
A general permit that authorizes categories of activities throughout the United States, and are valid for an individual project only if the conditions of the appropriate permit type are met. As with all general permits, NWPs include specific project limitations which ensure that adverse effects will be no more than minimal and that the aquatic environment will be protected.

NGVD
National Geodetic Vertical Datum of 1929.

Non-point Source Pollution
Storm water conveyed pollution that is not identifiable to one particular source, and is occurring at locations scattered throughout the drainage basin. Typical sources include erosion, agricultural activities, and runoff from urban lands.

NPDES
As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

Off-line BMP
A water quality facility designed to treat Storm water that has been diverted outside of the natural watercourse or storm sewer system.

Off-site Detention
Detention provided at a regional detention facility as opposed to storage on-site.

One Hundred Year Flood (100-year flood)
The flood that has a 1 percent chance of occurring in any given year.

Ordinary High Water Mark
The line between upland and bottomland that persists through successive changes in water level, below which the presence of water is so common or recurrent that, the character of the soil and vegetation is markedly different from the upland.

Orifice
An opening in a wall or plate.

Peak Discharge
The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

Plat, Platting Process
A legal procedure, and the document that depicts it, whereby a larger piece of property is divided into smaller sections, and is accompanied by a full description of the original property, the dimension of each lot to be subdivided, and all relevant deed restrictions and easements.

Pretreatment
Technique to capture or trap coarse sediments within runoff, before they enter a BMP to preserve storage volumes or prevent clogging. Examples include swales, forebays and micropools.

Protected Wetland
Any wetland protected by state law or local government regulation.

Public Road Development
Any development activity which takes place in a public right-of-way or part thereof that is administered and funded by a public agency under its respective roadway jurisdiction. Rehabilitative maintenance and in-kind roadway replacement are considered to be a public road development if located in a Regulatory Floodpalin. A public road development located within a Regulatory Floodway and which has been approved by the ODOT or MDOT is exempt from this ordinance.

Rational Formula
A simple technique for estimating peak discharge rates for very small developments, based on the rainfall intensity, watershed time of concentration, and a runoff coefficient.

Regulatory Floodplain
Riverine or non-riverine depressional areas. Projecting the base flood elevation onto the best available topography shall delineate floodplain boundaries. A flood prone area is a Regulatory Floodplain if it meets the following descriptions:

a. Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.
b. Any non-riverine area with a storage volume of 0.75 acre-foot or more when inundated by the base flood.
c. Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map and located with the best available topography to be inundated by the base flood.

Regulatory Floodway
The channel and that portion of the Regulatory Floodplain adjacent to a stream or channel which is needed to store and convey the existing and anticipated future 100 year frequency flood discharge with no more than 0.1 foot increase in stage due to loss of flood conveyance or storage, and no more than a 10% increase in velocities.

Release Rate
The rate of discharge in volume per unit time from a detention facility.

Retention
The holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass.

Retention Basin
A Storm water management facility designed to capture runoff that does not discharge directly to a surface water body. The water is "discharged" by infiltration or evaporation. Also known as a Wet Pond.

Reverse Slope Pipe
A technique for regulating extended detention times that are resistant to clogging. A reverse slope pipe is a pipe that extends downwards from the riser into the permanent pool and sets the water surface elevation of the pool. The lower end of the pipe is located up to 1 foot below the water surface.

Right-of-Way
(*See Easement*)

Riparian Lands
Land directly adjacent to a surface water body.

Riprap
A combination of large stones, cobbles and boulders used to line channels, stabilize banks, reduce runoff velocities, or filter out sediment.

Riser
A vertical pipe extending from the bottom of a basin that is used to control the discharge rate from the basin for a specified design storm.

Riverine
Relating to, formed by, or resembling a stream (including creeks and rivers).

Runoff
The excess portion of precipitation that does not infiltrate into the ground, but "runs off" and reaches a stream, water body or storm sewer.

Runoff Coefficient
The ratio of the amount of water that is NOT absorbed by the surface to the total amount of water that falls during rainstorm.

Sediment
Soil material that is transported from its site of origin by water. May be in the form of bed load, suspended or dissolved.

Sheet Flow
Runoff which flows over the ground surface as a thin, even layer, not concentrated in a channel.

Short Circuiting
The passage of runoff through a BMP in less than the theoretical or design detention time.

Soil Group, Hydrologic
A classification of soils by the Natural Resource Conservation Service into four runoff potential groups. The groups range from “A Soils” which are very permeable and produce little runoff, to “D Soils” which are relatively impermeable and produce much more runoff.

Special Flood Hazard Area (SFHA)
Any area subject to inundation by the base flood from a river, creek, stream, or any other identified channel or ponding and shown on the Regulatory Floodplain map. The SFHA is the area that is expected to be inundated by a 1% annual chance flood.

Spillway
A depression in the embankment of a pond or basin, used to pass peak discharges in excess of the design storm.

Source Controls
Source control Best Management Practices (BMPs) keep pollutants from entering storm water in the first place. Source control BMPs are aimed at preventing or minimizing

pollutants through performing routine work in a way that eliminates, or greatly reduces, the likelihood of contaminants getting into storm water.

Storm Water Wetland
A conventional storm water wetland is a shallow pool that creates growing conditions suitable for the growth of marsh plants. Storm water wetlands are designed to maximize pollutant removal through wetland uptake, retention and settling. These constructed systems are not located within delineated natural wetlands.

Stream
A river, creek, or surface waterway that has definite banks, a bed, and visible evidence of continued flow or continued occurrence of water, including the connecting water of the Great Lakes. Even if water flow is intermittent, it is classified as a stream.

Structural Controls
Structural controls are Best Management Practices (BMPs) which require the construction of a structure or other physical modification on the site.

Substantial Improvement
Any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure. The term does not include either 1.) any project for improvement of a structure to comply with existing state or local health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions or 2.) any alteration of a structure listed on the National Register of Historical Places or State Inventory of Historical Places.

Swale
A natural depression or wide shallow ditch used to temporarily convey, store, or filter runoff.

SWPPP (Storm Water Pollution Prevention Plan)

A documented, step-by-step process for ensuring that pollutants from your activities are not making their way into the storm water discharges from your site. Specifically, the pollution prevention plan requires that you select and implement best management practices (BMPs).

Time of Concentration
The time it takes for surface runoff to travel from the hydraulically farthest portion of the watershed to the design point.

Timing
The relationship in time of how runoff from sub-watersheds combines within a watershed.

Treatment Train
A storm water treatment train consisting of several BMPs utilized together such as conservation site design, overland conveyance via vegetated swales, soil erosion and sedimentation control, etc.

Underdrain
Perforated pipe installed to collect and remove excess runoff.

Waterbody Buffer
A vegetated area, including trees, shrubs and herbaceous vegetation, which exists or is established to protect a lake, reservoir or coastal estuarine area. Alteration of this natural area is strictly limited.

Watershed
The complete area or region of land draining into a common outlet such as a river or body of water.

Weir
A structure that extends across the width of a channel, and is used to impound, measure, or in some way alter the flow of water through the channel.

Wetland
Land characterized by the presence of water at a frequency and duration sufficient to support and that under normal circumstances does support wetland vegetation or aquatic life and is commonly referred to as a bog, swamp, or marsh. A wetland will contain predominance, not just an occurrence, of wetland vegetation and hydric soils.

Wetland Mitigation
A regulatory term that refers to the process of constructing new wetland acreage to compensate for the loss of natural wetlands during the development process. Mitigation seeks to replace structural and functional qualities of the natural wetland type that has been destroyed. Storm water wetlands typically do not count for credit as mitigation, because their construction does not replicate all the ecosystem functions of a natural wetland.

Wet Pond
A pond structure that provides for the storage of runoff by means of a permanent pool of water.

Wetted Perimeter
The wetted surface of a stream, culvert cross-section, or pond that causes resistance to flow. The water to surface interface is a distance, typically expressed in feet.

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