CANAL WINCHESTER
Established 1828

Stormwater Design Manual

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STORMWATER DESIGN MANUAL

1.0 INTRODUCTION

This Manual establishes design criteria required for stormwater facilities within the Village of Canal Winchester in conjunction with Village City Code Section 1125.08 and the Ohio Environmental Protection Agency's (OEPA) NPDES Phase II Stormwater Program. While adherence to this Manual will not stop flooding or prevent damage caused by flooding, it does establish a basis for design which will:

- Minimize the damage and inconvenience of flooding;
- Provide drainage systems which continue to provide benefit over the long term;
- Minimize the expense of maintaining the drainage facilities within the Village;
- Reduce non-point-source pollution;
- Minimize new impacts on engineered and natural drainage systems;
- Prevent or reduce impacts to stream and river ecosystems.

1.1 Administration

The Director of Public Works or their Designee is authorized to administer, implement and enforce the provisions of this Manual. The Director of Public Works shall serve as the principal executive officer for stormwater management for the purposes of fulfilling the requirements of the OEPA's NPDES Phase II Stormwater Program. Compliance with this Manual will be determined by the Director of Public Works and his/her office. Engineering site plans shall not be stamped approved by the Planning and Zoning Administrator until the civil engineering plans, including provisions of this stormwater design manual, have been approved and signed by Director of Public Works and the Village Engineer-.

1.2 Drainage Policy

1.2.1 This drainage policy, control guidelines and criteria do not provide solutions to all drainage problems, nor is the Engineer restricted to these designs or procedures exclusively. Although the policies as stated will hold true for most development work, the Village realizes that there may be individual projects involving special or unusual drainage design problems that should be reviewed prior to completing the requisite Master Drainage Plan. Exceptions may be granted to the policies and criteria in such cases when engineering study(s) justify modification.

1.2.2 Experience has shown that most of the more serious flooding situations are "created". Development can lead to ever increasing flooding problems unless well-conceived, cooperative stormwater drainage and flood control programs are undertaken throughout the entire watershed. For this reason, the general policy of the Village shall be:

a. Land uses and developments which increase runoff rate or volume shall control the discharge rate of runoff prior to its release to off-site land or the Municipal Separate Storm Sewer System (MS4).

b. It is the responsibility of the property owner to not change or alter any drainage course, ditch, flood routing path or drainage system on his/her property that will cause increased runoff, or will damage or cause flooding to adjacent, upstream or downstream property owners.

c. All stormwater drainage systems, including conveyances, within a development shall be designed to have capacity and depth, including sufficient invert elevations to permit future connections, to serve that total tributary area at the design storm frequency, and based on the rate of single family, residential runoff except as noted in subsection 1.3.2.a.4 below. The system for the upstream tributary area must be extended through the development.

d. All proposed development with a runoff rate greater than that which the downstream system has capacity for, or will be designed for, will be required to control the rate of stormwater discharge.

e. All developments will be required to control the peak flow rate of stormwater discharge to that peak rate which existed prior to development.

f. A stormwater Master Drainage Plan shall be submitted to the Village for review and approval prior to the commencement of work at any proposed development site.

g. All information necessary shall be submitted to the Director of Public Works or the Village Engineer to determine how stormwater runoff should be controlled within the development prior to its release to downstream properties. The tributary area and the upstream watersheds should be determined using natural land divides unless man-made alterations are approved by the Village Engineer as the basis for watershed delineations.

1.3 Stream Corridor Protection Policy

The Stream Corridor Protection Zone (SCPZ) is established through designation of a riparian setback that will be required on all natural or man made open channels. This zone shall be kept in as natural a state as possible so that it can perform its inherent function of erosion protection, flood storage, and water quality protection. A stream corridor protection zone is not required for roadside ditch drainage features.

a. The SCPZ setback will be centered on the channel centerline. However, the position of the boundary may be modified at the Director’s discretion to include known areas of environmental sensitivity in close proximity to channels banks, to include sensitive steep slopes adjacent to a channel edge or to exclude high terrain that is adjacent to a stream channel.

b. The stream corridor protection zone for streams within the Village of Canal Winchester has been mapped by the Village. A copy of the mapped protection zones may be obtained from the Director of Public Works. The setback width on any specific parcel will be that area indicated on the Village Stream Corridor Protection Zone Map or as proposed by the property owner based upon the following formula using site specific conditions. The width of the stream corridor protection zone is defined by the following equation or the FEMA designated floodway, whichever width is wider.

$$SW = 147 \times DA^{0.38}$$

Where:

SW = Setback width measured in feet, being the total width of the protection setback at a stream channel cross-section; and

DA = Drainage area in square miles.

Note: This equation was developed and recommended by the Ohio Department of Natural Resources (ODNR) based on regional curve analysis for various water courses measured in the eastern United States region; studies conducted by Ward (2001), Williams (1986) and Leopold (1978).

c. Size:
The SCPZ shall be a combination of two overlapping areas, one streamway based and the other based on a minimum distance from the channel bank, equivalent to 1 channel width as illustrated in Figure 1.

In addition, at no point shall the distance between the setback boundary and the channel be less than:

$$Md = 14.7(DA)^{0.38}$$

Where:

Md = the minimum distance from the channel; and

DA = drainage area in square miles.

This formula estimates a minimum distance of approximately one channel width.

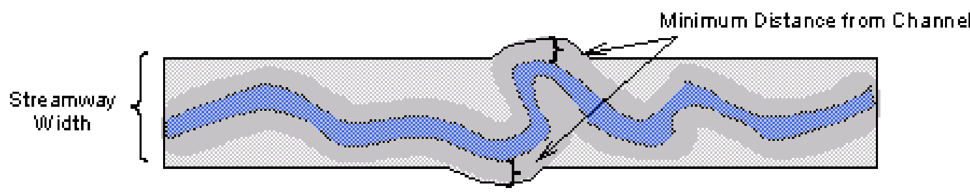


Figure 1. SCPZ as combination of the streamway and a minimum distance from the channel.

d. Location
A streamway is more a feature of a valley than individual bends or the present location of a channel, thus the setback area may not always be exactly centered over the stream, especially as streams meander. It is more apply visualized as a flood path or roughly the flood way. Thus, setback areas should be fit to the valleys. They shall be positioned so that corresponding left and right boundary elevations match and the setback area incorporates the lowest elevations in the valley.

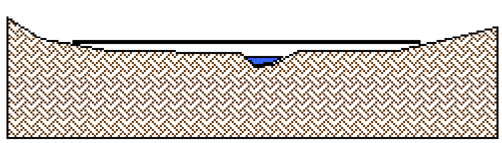


Figure 2. SCPZ Centered over Floodway

e. The minimum width will be 70 feet plus channel width (i.e., 35-feet on each side of the channel, measured from the channel bank). The maximum width will be 250 feet plus channel width.

f. The SCPZ must be clearly shown on site development plans.

g. Except as noted herein, no open channels (natural or man-made) will be enclosed within a storm sewer or conduit when an area is developed.

h. All applicable State and Federal Regulations shall be followed, including Sections 401 and 404 or the Clean Water Act. No exceptions to this rule will be allowed to raise flood elevations upstream of the project.

i. All conveyances and conduits containing a stream, if allowed, shall have the capacity to carry a minimum of a 10-year design storm from the entire upstream drainage area. In addition, a flood routing flow path shall be included to carry the 100-year storm flow. This flood routing path must be clearly shown on the site development plans, and the applicant shall provide stormwater calculations for the proposed enclosure and flood routing to the Village for approval.

1.3.1 Construction Limitations

The following conditions shall apply to all Stream Corridor Protection Zones:

a. Except as otherwise provided in this regulation, the Stream Corridor Protection Zone shall be preserved in its natural state.

b. Prior to any earthmoving or clearing and grubbing activity on a development property, the Stream Corridor Protection Zone shall be clearly delineated by the applicant or their designated representative on the site. Such delineation shall also be identified on the Erosion and Sediment Pollution Control Plan (see Village Code Section 1125.10) and this delineation shall be maintained throughout soil disturbing activity.

c. No later than the conclusion of construction, the applicant shall permanently delineate the Stream Corridor Protection Zone in an aesthetically harmonious manner, approved by the Director of Public Works, such that the location of the riparian setback boundary defining the Stream Corridor Protection Zone is apparent to the casual observer and that permits access to the zone.

d. Language preventing property owners from constructing facilities and performing activities that are prohibited within the Stream Corridor Protection Zone shall be shown on the plat or site development plans and reflected on all deeds.

e. Land contained within the Stream Corridor Protection Zone may, at the applicant's option and if approved by the Village's Council, be deeded in fee simple to the Village. Alternatively, the land contained within the Stream Corridor Protection Zones shall be preserved via dedicated conservation easement or reserve.

f. The applicant shall obtain all necessary permits from the Army Corps of Engineers, Ohio EPA, and other regulatory agencies, as needed. The applicant is responsible for all permitting fees.

1.3.2 Post-Construction Requirements

a. Permitted uses and activities. No use or activity permitted under this Manual shall be construed as allowing trespass on privately held lands.

1. Passive Uses. Uses that are passive in character shall be permitted in the Stream Corridor Protection Zone, including, but not limited to, passive recreational uses, as permitted by federal, state and local laws, such as hiking, fishing, picnicking, and similar uses. Construction of paved trails to further such passive recreation uses is also permitted. However, trails that become damaged due to natural erosion shall not be repaired but shall be moved upland or removed altogether.

2. Removal of Damaged or Diseased Trees. Damaged or diseased trees may be removed under the direction and authorization of the Urban Forester. Due to the potential for felled logs and branches to damage downstream properties and/or block watercourses or otherwise exacerbate flooding, logs and branches resulting from the removal of damaged or diseased trees that are greater than 6-inches in diameter at the cut end shall be cut into sections no longer than 6-feet, and removed.

3. Revegetation and/or Reforestation. Revegetation and/or reforestation of the riparian setback using species pursuant to Table 1. Table 1 lists species of
plants and shrubs recommended for stabilizing flood prone areas. In addition native grasses may be used. Proper selection of species is dependent on soil conditions, available water and amount of sun exposure. Proper species selection will take into account these factors.

4. Public Utilities. Sanitary sewer, storm sewer, and/or water lines and public utility transmission lines may cross the riparian setback. Any utility crossings shall be bored under waterways unless authorized by the Director of Public Works any disturbances of the setback necessary to place and/or maintain such utilities are also authorized. The placement, construction and maintenance of such utilities shall minimize disturbance to riparian areas and shall mitigate any necessary disturbances. The developer and/or landowner shall secure the appropriate state and federal permits required for installations of this type. Utilities that are parallel to the stream shall not be constructed or placed within the SCPZ. Sanitary sewer structures shall not be permitted within the SCPZ, without mitigation.

5. Public Roadways. Public roadways may cross the riparian setback and disturbances of the setback necessary to place and/or maintain the roadways may be authorized. The placement, construction and maintenance of the roadway shall minimize disturbance to riparian areas and shall mitigate any necessary disturbances. There shall be no more than two roadway crossings of the setback within any proposed

development. The developer and/or landowner shall secure the appropriate state and federal permits required for installations of this type.

Table 1. Species of Plants and Shrubs Recommended for Stabilizing Flood Prone Areas

Riparian Corridor- Trees

Botanical Name	Common Name
Acer spp.	Maple(s)
Betula nigra	River Birch
Carya spp.	Hickory(s)
Celtis occidentalis	Common Hackberry
Cercis canadensis	Eastern Redbud
Crataegus phaenopyrum	Washington Hawthorne
Crateaegus crusgalli	Cockspur Hawthorne
Fagus grandifolia	Beech
Fraxinus americana	White Ash
Gleditsia triacanthos	Honeylocust
Hamamelis virginiana	Common Witchhazel
Liriodendron tulipifera	Tulip Poplar
Liquidambar styraciflua	Sweetgum
Platanus occidentalis	Sycamore
Populus deltoides	Eastern Cottonwood
Prunus serotina	Black Cherry
Quercus alba	White Oak
Quercus palustris	Pin Oak
Quercus rubra	Red Oak
Ulmus rubra	Slippery Elm

Riparian Corridor- Shrubs

Botanical Name	Common Name
Aronia melanocarpa	Black Chokeberry
Cornus racemosa	Gray Dogwood
Cornus sericea	Redosier Dogwood
Lindera benzoin	Spicebush
*Salix spp.**	Willow(s)
Sambucus canadensis	Elderberry
Viburnum dentatum	Arrowwood Viburnum
Viburnum prunifolium	Blackhaw Viburnum
Viburnum lentago	Nannyberry Viburnum
Viburnum trilobum	American Cranberrybush

*Instream plantings for rapid shade cover and bank stabilization.

6. Construction activities associated with properly permitted stream restoration projects are permitted.

7. Disturbances resulting from permitted stream and/or wetland mitigation projects provided that mitigation is to offset impacts to local wetlands are permitted.

8. "Emergency Channel Maintenance Activity" may be authorized by the Village Engineer, as needed to restore and/or maintain the flood carrying capacity of the main channel area. Such activity may include, but not be limited to removal of offending trees or brush or the accumulation of sediment in the main channel, as necessary to restore flood flow carrying capacity of the main channel.

b. Prohibited Uses. Any use not authorized under this Manual shall be prohibited in the riparian setback. By way of example, the following uses are specifically prohibited, however prohibited uses are not limited to those examples listed here:

1. Construction. There shall be no habitable structures of any kind. A habitable structure is defined as a structure that has a ground-supported, water-impervious floor and upright foundation walls which together define an enclosure,

2. Dredging or Filling. There shall be no drilling, filling, dredging, grading, or dumping of soils, spoils, liquid or solid materials. No floodplain fill permits will be granted for areas within the Stream Corridor Protection Zone except those that are required for activities listed as permitted uses above.

3. Motorized Vehicles. There shall be no use of motorized vehicles except as needed for activities associated with those listed in 4 above.

4. Parking Lots. There shall be no parking lots or other human made impervious cover except as allowed above.

5. Stormwater Detention Facilities. Stormwater detention facilities may be located adjacent to, but not within the Stream Corridor Protection Zone, unless otherwise approved by the Director of Public Works.

6. Platted Lots. No part of any lot to be developed will be located within the Stream Corridor Protection Zone.

c. Non-conforming Uses and Structures within the Stream Corridor Protection Zone.

1. Any non-conforming use, existing at the time of passage of this regulation and within a Stream Corridor Protection Zone that is not permitted under this regulation, may be continued but shall not be changed to a new use or enlarged unless changed to a use permitted under this regulation.

2. A non-conforming use, existing at the time of passage of this regulation and within a Stream Corridor Protection Zone that is not permitted under this regulation, may be continued but shall not have the existing building footprint or roofline expanded or enlarged.

3. A non-conforming use, existing at the time of passage of this regulation and within a Stream Corridor Protection Zone that has substantial damage and that is discontinued, terminated, or abandoned for a period of six (6) months or more may not be revived, restored or re-established.

1.3.3 Maintenance of the Stream Corridor Protection Zone

a. Disturbance of Natural Vegetation. There shall be no disturbance of the natural vegetation at any time, including during construction of the remainder of the site, except for such conservation maintenance that the landowner deems necessary to control noxious weeds; for such plantings as are consistent with this Manual; for removal of invasive species and their replacement with native vegetation; and for the passive enjoyment, access, and maintenance of landscaping or lawns existing at the time of passage of this Manual except as needed for activities associated with those listed above.

b. Recommended Vegetation for Stabilizing Floodprone Areas. Proper selection of species for stabilization of floodprone areas is dependent on several factors, including soil conditions, available water and amount of sun exposure. Proper species selection and installation will take into account these factors. A list of appropriate plant species is given in Table 1.

1.4 Drainage Easements

In order to provide access for Municipal personnel for inspection and maintenance, the Developer is required to procure and convey to the Village an easement for any tile, pipe, detention basin, drainage way, flood routing path, ditch, watercourse, natural stream, man-made stream, storm sewer, or other stormwater component or facility not already within the Village right-of-way. The Owner and/or Developer will be required to follow Village Code Section 1115.15 with regard to the procurement, execution, and maintenance of the Easement, and their responsibilities to the Village and to adjacent and downstream property owners. The easement must be of sufficient width to allow cleaning, widening, deepening, replacing or other general maintenance of such drainage course or piped system.

When it is necessary to convey stormwater outside the property lines of a proposed improved area in order to discharge into an adequate outlet, the Developer:

a. is required to obtain easements and/or maintenance agreements, in a form and substance satisfactory to the Director of Public Works, from abutting property owners,

b. is responsible for maintenance agreements of such drainage course unless the easements and/or maintenance agreements require the abutting property owners to repair and maintain the drainage course satisfactorily.

All drainage easements, preservation areas, reserves and other similar areas must be shown on the final approved/signed engineering and construction plan(s) as well as on the as-built plans. Drainage easements for all on-site drainage system improvements shall be recorded for public use by final plat and deed. For off-site drainage systems improvements, easements shall be recorded for public use by either final plat or separate instrument. The maintenance of such drainage easements shall be undertaken in the manner set forth in Village Code Section 941.07 and as specified in Section 1.5, below.

1.5 Operation and Maintenance of Stormwater Facilities

The Village shall provide for inspection and routine maintenance of storm drainage facilities that have been accepted for maintenance by the Village. Municipal maintenance may include stormwater conveyance-related structure cleaning and repair. For other storm drainage facilities not accepted for maintenance by the Village, the Village may provide for remedial maintenance of such facilities based upon the severity of stormwater problems and potential hazard to public health and safety, through the abatement procedures described in below in Section 1.5.1. For the purposes of this Chapter, maintenance associated with privately owned retention/detention basins including, but not limited to, mowing, rivulet repair, basin bottom fill, seeding, fertilizing and/or algae removal, are neither considered "potentially hazardous" to the public nor are they considered "severe" stormwater problems, and maintenance will not be provided by the Village except in case of public emergency as determined by the Village.

1.5.1 Operation and Maintenance Abatement Procedures

a. Notice To Correct Improper Drainage**.**
    1. Whenever the Village finds that (i) a tract of land is inadequately drained, or (ii) there is excessive erosion or sedimentation upon such land or (iii) that there is an obstruction to or from a culvert, or water course upon such land that interferes with water naturally flowing therein or (iv) that such culvert, storm sewer or watercourse is of insufficient capacity to reasonably accommodate the flow of water, as required by this chapter, the Director of Public Works shall notify the owner or person having possession, charge, or management of such land to remove the obstruction, provide adequate drainage, fill or drain such land, enlarge the culverts, drains or watercourses, mitgate excessive erosion or sedimentation and/or accomplish any other act determined by the Director of Public Works or the Village Engineer necessary to further the purposes of this chapter. Such notice shall be served to such persons by personal delivery, by registered mail at the last known place of residence, or by posting on the premises.

    2. The owner must comply with the Village's orders within the time specified and not to exceed 30 days. Failure to comply with such order shall constitute an unlawful act. Each additional day thereafter during which the owner fails to carry out the order of the Village shall constitute a separate offense.

        A. In any case where a condition described above exists for more than 30 days after service of notice, the Director of Public works may direct the owner to fill or drain such land, remove any obstruction and, if necessary, enlarge the culverts, drains, or watercourses to meet the requirements of this manual.

        B. In the event an owner fails or refuses to comply with the Director of Public Works instruction, the Village may provide for the performance of the required work and charge the owner the established abatement costs of 2.5 times the actual cost of work.

C. Each and every owner of real property in the Village consents to the entry upon any real property in the Village for all reasonable times during normal business hours for the purpose of inspection, repair or maintenance required by this Manual.

3. Non-action by the Village to observe or recognize hazardous or unsightly conditions or to recommend denial of a permit or zoning change shall not relieve the owner or person having possession, charge or management of such land from the responsibility for the condition or damage resulting therefrom, and shall not result in the Village, its officers or agents being responsible for any condition or damage resulting therefrom.

4. Nothing in this chapter shall be construed as authorizing any person to maintain a private or public nuisance on his property, and compliance with the provisions of this chapter shall not be a defense in any action to abate such nuisance.

5. Nothing in this chapter shall be construed to prevent immediate action by the Village in emergency situations. In case of an emergency, the Village may direct that action be taken immediately to correct the condition or abate the activity to protect the public health, safety, and welfare. The Village may perform the required work and charge the owner the established abatement costs of 2.5 times the actual cost of work.

2.0 STORMWATER RUNOFF CONTROL CRITERIA

2.1 Quantitative Control

Stormwater runoff control shall address both peak rate and total volume of runoff. The peak rate of runoff from an area after development shall not exceed the peak rate of runoff from the same area before development for all storms from one year up to a 100-year return frequency, 24-hour duration storm. In addition, if it is found a proposed development will increase the volume of runoff from an area, the peak rate of runoff from certain more frequent storms must be controlled further. There are two reasons why increases in volume of runoff require a control standard more restrictive than controlling to the predevelopment condition. First, increases in volume mean runoff will be flowing for a longer period of time. When routed through a watershed, these longer flows may join at some point or points downstream thereby creating new peak flows and problems associated with peak flow (flooding and erosion). This is known as the "Routing Problem". Second, longer flow periods of large runoff quantities place a highly erosive stress on natural channels. This stress can be minimized by reducing the rate of discharge. The permissible peak rate shall be determined as follows:

a. For the purpose of determining site pre-development condition a runoff curve number (RCN) of 77 shall be used.

b. Determine the total volume of runoff from a 1-year frequency 24-hour storm, occurring over the area before and after development.

c. Determine the percentage of increase in volume due to development and using this percentage, pick the critical storm from Table 2.

Table 2. Critical Storm for Stormwater Volume Calculations

If the percentage of increase in VOLUME [of] runoff is		The Critical Storm for discharge limitations will be:
Equal to or greater than	and less than	
--	10	1 year
10	20	2 year
20	50	5 year
50	100	10 year
100	250	25 year
250	500	50 year
500	--	100 year

d. The peak rate of runoff from the critical storm occurring over the development shall not exceed the peak rate of runoff from a 1-year frequency storm occurring over the same area under predevelopment conditions. Storms of less frequent occurrence (longer return period) than the critical storm, shall have a peak rate of runoff not greater than for the same storm under predevelopment conditions. As an example, if the total volume is to be increased by 35%, the critical storm is a 5-year storm. The peak rate of runoff for all storms up to this intensity shall be controlled so as not to exceed the peak rate of runoff from a 1-year frequency storm under predevelopment conditions in the area. The runoff from a more intense storm up to a 100-year storm need only be controlled so as not to exceed the predevelopment peak rate from the same frequency of storm.

2.2 Qualitative Control

Stormwater qualitative control must be implemented into sites in accordance with general and specific requirements outlined in OEPA's permit for stormwater discharges associated with construction activity (OEPA Permit OCH000002) or its subsequent OEPA-issued revision.

2.2.1 Large Construction Sites

For all construction activities (involving the disturbance of five or more acres of land or will disturb less than five acres, but is a part of a larger common plan of development or sale which will disturb five or more acres of land), the post construction BMP(s) chosen must be able to detain stormwater runoff for protection of the stream channels, stream erosion control, and improved water quality. Structural (designed) post-construction stormwater treatment practices shall be incorporated into the permanent drainage system for the site.

Water Quality Volume (WQv): The selected BMP(s) must be sized to treat the water quality volume and ensure compliance with Ohio's Water Quality Standards in OAC Chapter 3745-1. The WQv shall be equivalent to the volume of runoff from a 0.75-inch rainfall and must be
determined according to one of the two following methods.

a. Through a site hydrologic study approved by the local municipal permitting authority that uses continuous hydrologic simulation and local long-term hourly precipitation records or;

b. Using the following equation:

$$WQv = C * P * A / 12$$

where:

WQv = water quality volume in acre-feet
C = runoff coefficient appropriate for storms less than 1 inch (see Table 3)
P = 0.75 inch precipitation depth
A = area draining into the BMP in acres

Table 3. Runoff Coefficients Based on the Type of Land Use

Land Use	Runoff Coefficient
Industrial & Commercial	0.8
High Density Residential (>8 Dwellings/Acre)	0.5
Medium Density Residential (4 To 8 Dwellings/Acre)	0.4
Low Density Residential (<4 Dwellings/Acre)	0.3
Open Space And Recreational Areas	0.2

Where the land use will be mixed, the runoff coefficient should be calculated using a weighted average. For example, if 60% of the contributing drainage area to the storm water treatment structure is low density residential, 30% is high density residential, and 10% is open space, the runoff coefficient is calculated as follows (0.6)(0.3) + (0.3)(0.5) + (0.1)(0.2) = 0.35.

An additional volume equal to 20 percent of the WQv shall be incorporated into the BMP for sediment storage and/or reduced infiltration capacity. Ohio EPA recommends that BMPs be designed according to the methodology included in the Rainwater and Land Development Manual.

BMPs shall be designed such that the drain time is long enough to provide treatment, but short enough to provide storage available for successive rainfall events as described in Table 4, below.

Table 4. Target Draw Down (Drain) Times for Structural Post-Construction Treatment Control Practices

Best Management Practice	Drain Time of WQv
Infiltration Basin^	24 – 48 Hours
Enhanced Water Quality Swale	24 Hours
Dry Extended Detention Basin*	48 Hours
Wet Extended Detention Basin**	24 Hours
Constructed Wetlands (above Permanent Pool)+	24 Hours
Sand & Other Media Filtration	40 Hours
Bioretention Cell^	40 Hours
Pocket Wetland#	24 Hours
Vegetated Swale and Filter Strip	24 Hours

*Dry basins must include forebay and micropool each sized at 10% of the WQv

**Provide both a permanent pool and an EDv above the permanent pool, each sized at 75% of the WQv.

+Extended detention shall be provided for the full WQv above the permanent water pool.

^The WQv shall completely infiltrate within 48 hours so there is no standing or residual water in the BMP.

#Pocket wetlands must have a wet pool equal to the WQv , with 25% of the WQv in a pool and 75% in marshes. The EDv above the permanent pool must be equal to the WQv.

The permittee may request approval from the Director of Public Works or the Village Engineer and Ohio EPA to use alternative structural post-construction BMPs. The permittee must demonstrate that the alternative BMPs are equivalent in effectiveness to those listed in Table 4, above. New construction activities shall be exempt from this condition if it can be demonstrated that the WQv is provided within an existing structural post-construction BMP, located downstream, that is part of a larger common plan of development, before being released into an open watercourse.

For redevelopment projects (i.e., developments on previously developed property), post-construction practices shall either ensure a twenty (20) percent net reduction of the site impervious area, provide for treatment of at least (20) percent of the WQv or a combination of the two.

2.2.2 Small Construction Sites

For all small land disturbance activities (which disturb one or more, but less than five acres of land and which are not a part of a larger common plan of development which will disturb five or more acres of land), a description of the measures that will be installed during the construction process to control pollutants in stormwater discharges that will occur after the construction operations have been completed must be included in the SWP3 (Storm Water Polluntion Prevention Plan). Practices may include but are not limited to stormwater detention storage (including wet basins), stormwater retention, and flow attenuation by use of open vegetated swales and natural depressions, infiltration of runoff onsite, and sequential systems which combine several practices. The SWP3 shall include an explanation of the technical basis used to select the practices to control pollution where flows exceed pre-development levels.

Velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel to provide non-erosive flow velocity from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected.

3.0 STORMWATER SYSTEM GENERAL DESIGN CRITERIA

3.1 Design Storms

a. The initial/minor drainage system is that part of the storm drainage system which is used regularly for collecting, transporting, and disposing of storm runoff from frequent and low magnitude storm events, snowmelt, and miscellaneous minor flows. The capacity of the initial drainage system should be equal to the maximum rate of runoff expected from a design storm of established frequency (i.e., Initial Storm). For purposes of design, the initial drainage system portion of the overall storm drainage system shall be designed to contain the runoff from a storm with a return period of not less than five-years.

b. The major drainage system is that part of the storm drainage system which carries the runoff which exceeds the capacity of the initial drainage system. The major drainage system shall have the capacity to carry runoff from a storm with a return period of not less than 100-years (i.e., Major Storm) without posing significant threat to property or public safety.

3.2 Initial Storm – Physical Design Criteria for On-Site Improvements

a. Depth of flow in natural channels shall not exceed bank full stage with backwater effects considered.

b. Depth of flow of the design storm in man-made ditches or swales shall not exceed 80% of the channel depth. Velocity of flow shall be determined in accordance with the design criteria for open channels in Section 4.4 c (3), and shall not exceed 5 feet per second, or a rate determined by the Village Engineer to be detrimental to the watercourse. Where flows exceed this rate, special channel lining and erosion protection shall be provided.

c. Depth of flow in road-side ditch swales shall not exceed one foot or be of such depth that flow would extend out of the right-of-way if the side ditch is less than one foot in depth. Velocity at this depth shall not exceed six feet per second for grass swales or ten feet per second for paved ditches.

d. Depth of flow in streets with curb and gutter shall not exceed the curb height. Velocity of flow in the gutter at design depth shall not exceed ten feet per second. In addition to the above, the following are maximum encroachments of the minimum five-year initial design storm onto the pavement. See Section 4.3 for specific design criteria for curb inlet design.

e. For minor streets carrying traffic from the individual residence to collector and secondary streets, the flow may spread to the crown of the street.

f. For collector and secondary streets, one lane shall be free from water.

g. For primary streets, one lane in each direction shall be free from water.

h. For freeways, no encroachment is allowed on traffic lanes.

i. In design of a storm sewer pipe conduit, the conduit may be designed on the basis of flowing full with surcharge to gutter line. Backwater effects must be considered.

3.3 Major Storm – Physical Design Criteria for On-Site Improvements

a. The major storm floodway and floodway fringe for natural streams shall be as defined by the Federal Emergency Management Agency (FEMA), U.S. Army Corps of Engineers, the Ohio Department of Natural Resources, or where such determinations have not been made by these agencies, the major storm floodway and floodway fringe for natural streams may be estimated through a technical analysis by a registered Professional Engineer in the State of Ohio, in a manner found acceptable by the Village.

b. Many of the drainage ways associated with the major storm system are in areas beyond those designated as floodway or floodway fringe. For these areas, the major storm flood limits shall be determined by the U.S. Army Corps of Engineers' HEC-RAS model or other FEMA approved model for determining water profiles using the major design storm runoff. HEC-RAS is a one-dimensional steady flow hydraulic model designed to aid hydraulic engineers in channel flow analysis and floodplain determination. One half foot of elevation must be added to the flood profile as freeboard to provide protection in the event of future encroachments into the floodway fringe or in the drainage way.

c. In order to protect the integrity of the non-street drainage rights-of-way, the design engineer is encouraged to design routing paths for multi-purpose functions. Pedestrian and bicycle paths lend themselves naturally to this application. Linear parks aligned along the major drainage corridor are also very effective, but usually require greater width than would normally be necessary for drainage purposes.

d. Where the street is designed as the major drainage system, the depth of flow shall not exceed 12-inches at gutter line for minor, collector and secondary streets, and shall not exceed 6-inches depth at crown for primary streets and freeways. The same maximum depth criteria will apply where a major drainage way crosses the street. Where a major drainage way is located outside the street, right-of-way easements will be provided.

e. In determining the required capacity of surface channels and other drainage ways provided for the major storm runoff, the street storm inlets and conduit provided for the initial design storm may be assumed to carry a portion of the total runoff volume, if appropriate. The following equation shall be used to determine the required capacity of surface channels and drainage ways in their design, when a portion of the runoff is conveyed within the initial piped system:

$$Q_{100} = C \; I_{10} A + 0.96 (I_{100} - I_{10}) A$$

and

$$Q_{\text{flood routing path}} = Q_{100} - Q_{\text{pipe}}$$

Where:

$Q_{\text{flood routing path}}$ = Design flow, major storm runoff (cfs)

Q_{pipe} = Peak flow within piped system (i.e., 5-year event) (cfs)

Q_{100} = Peak flow for 100-year event (cfs)

C = Rational runoff coefficient, site developed condition

I_{10} = rainfall intensity for 10-year storm event (inches/hour)

I_{100} = rainfall intensity for 100-year storm event (inches/hour)

A = Drainage area contributory to design point (acres)

f. Retention and Storage: Areas designed for storage of stormwater by retention should be incorporated into the natural features of the general area, when possible. Cooperative planning and joint owner construction of detention or retention facilities and use of natural land contours is encouraged. No such facilities will be permitted which may be or become aesthetically unpleasing, or which may result in construction, or maintenance problems. The Village encourages that detention or retention facilities be designed as multipurpose spaces such as open space, recreation and/or scenic areas. The Village encourages use of fountains for aeration and reserves the right to require such an appurtenance as a condition to plan approval. Dry retention and storage shall only be accepted with approval by Village Engineer.

3.4 Methods of Calculation

The following methods of calculation shall be used unless otherwise approved by the Village Engineer:

a. Rainfall volumes shall be in accordance with data for Central Ohio provided in "*Bulletin 71: Rainfall Frequency Atlas of the Midwest*", 1992 and any subsequent updates thereto.

b. Rainfall distribution for stormwater management systems is to be in accordance with SCS Type II Rainfall Distribution.

c. The appropriate Runoff Curve Number (i.e., "RCN" factor) may be determined by using Technical Release No. 55 (S.C.S.) or its Ohio Supplement.

3.5 Drainage Area Determination

The drainage area shall be determined from any of the following sources, which are listed in order of priority preference:

a. Actual field investigation;

b. County Auditor, topographic maps;

c. U.S. Geological Survey quadrangle (7.5 minute series) contour maps;
d. Soil Survey of Franklin and Fairfield County, Ohio, U.S.D.A.

4.0 STORMWATER SYSTEM SPECIFIC DESIGN SPECIFICATIONS

4.1 Roadway Culverts

a. General specifications. The size and shape of the culvert should be such that it will carry a predetermined design peak discharge need to specify without the depth of water at the entrance or the velocity at the outlet exceeding allowable limits.

b. Design procedure. The culvert design procedure recommended for use is Hydraulic Design Series No. 5, U.S. Department of Transportation.

c. Preferred construction. Single span culverts, including concrete box and slab top are preferred. Multiple cell pipe culverts, when they are the only structures that will meet the physical requirements introduced by rigid headwater controls, will be acceptable.

d. Material. The culvert material shall be concrete, at a minimum diameter of 12 inches. Corrugated steel or metal pipe material is also allowed with approval by the Village Engineer.

e. Drainage area. The drainage area in acres, and the estimated runoff or design discharge in cubic feet per second, and the storm frequency in years shall be shown on the plan for each culvert.

f. Inlet elevation. The flowline elevation at the culvert inlet should be set deep enough to provide an adequate outlet for future storm sewer improvements upstream.

g. Design storm frequency (roadway culverts), shall be:

1. 10-year frequency 24-hour storm event for private drives, local and collector streets.

2. 25-year frequency 24-hour storm event for arterial streets.

h. Design flow. For method of calculation, refer to Table 5

1. storm shall not exceed or cause any of the following:
2. 18-inches below the top of curb
3. 12-inches below the edge of pavement
4. 1.2 times the diameter of culvert
5. Diameter or rise plus two feet, in deep ravines
6. Property Damage – 100-year frequency headwater plus 1-foot, shall not exceed any existing or proposed building first floor elevation

Table 5. Acceptable Methods of Calculation for Design Flow in Roadway Culverts

<table>
<tr><td rowspan="3">DRAINAGE AREA (ACRES)</td><td colspan="5">STORMWATER QUANTITY</td></tr>
<tr><td rowspan="2">PEAK DISCHARGE ONLY</td><td colspan="2">PEAK DISCHARGE AND TOTAL RUNOFF VOLUME</td><td colspan="2">STORAGE VOLUME</td></tr>
<tr><td>HOMOGEN. LAND USE</td><td>NON-HOMOGEN.</td><td>HOMOGEN.</td><td>NON-HOMOGEN.</td></tr>
<tr><td>LESS THAN 200</td><td>RATIONAL OR PEAK DISCHARGE</td><td>PEAK DISCHARGE</td><td rowspan="2">(*)TABULAR HYDRO-GRAPH</td><td rowspan="2">GRAPHICAL</td><td rowspan="2">(*)STORAGE-INDICATION</td></tr>
<tr><td>200 TO 300</td><td colspan="2">PEAK DISCHARGE</td></tr>
<tr><td>GREATER THAN 300</td><td colspan="3">(*)TABULAR HYDROGRAPH</td><td colspan="2">(*)STORAGE-INDICATION</td></tr>
</table>

*Note: The “Tabular Hydrograph” and “Storage-indication” methods are preferred and are normally used to check drainage calculations submitted to the Village Engineer

Method References:

Rational: (Q = CIA); MORPC, Stormwater Design Manual, 1977

Graphical: Ibid., Pg. 143

Peak Discharge: U.S. Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release No. 55, 1986

Storage– Indication: MORPC, Stormwater Design Manual, 1977, Pg. 143.

SCS TR-20 and US Army COE HEC-1

Tabular Hydrography: SCS TR-55, Chap. 5 SCS TR-20, US Army COE’s HEC-1

USGS regression equations for Central Ohio may be used where applicable, for estimating peak flows for culvert design and to estimate peak release rates

i. Manning’s roughness coefficient (n). Manning’s Roughness Coefficient (n) should be as given in Table 6 unless an alternate value is approved by the Village Engineer.

j. Maximum allowable headwater. The maximum allowable headwater for the design storm shall not exceed or cause any of the following:

1. 18-inches below the top of curb;
2. 12-inches below the edge of pavement;
3. 1.2 times the diameter of culvert; or
4. Diameter or rise plus two feet, in deep ravines.

5. Property Damage – 100-year frequency headwater plus 1-foot, shall not exceed any existing or proposed building first floor elevation.

k. Entrance loss coefficient (Ke*).* The Entrance Loss Coefficient (Ke) should be as given in Table 6 based upon the headwall configuration unless an alternative value is approved by the Village Engineer.

Table 6. Design Coefficients for Roadway Culverts

TYPE STRUCTURE	MANNING'S ROUGHNESS COEFFICIENT (n)	ENTRANCE LOSS COEFFICIENT (Ke)*
CONCRETE PIPE	0.013	0.2
BOX: 4-sided BOX: 3-sided	0.013 weighted by wetted perimeter minimum 0.018	0.2 TO 0.5 0.2 TO 0.5
SLAB TOP	0.03 TO 0.05	0.2 TO 0.5

l. Minimum cover to subgrade. Shall be 30 inches from top of pipe to subgrade.

m. Maximum allowable outlet velocity, shall be:

1. Turf Channel 5 f.p.s.
2. Rock Protection 18 f.p.s

Notes:

- When the outlet velocity exceeds 18-feet per second, a stilling basin or other such energy dissipation structure must be used.
- The downstream channel must have the ability to handle the flow satisfactorily.

n. Structural design criteria. The structural design criteria for culverts shall be the same as that required by the Ohio Department of Transportation (ODOT).

o. Emergency flood routing. The emergency flood routing shall be capable of routing the 100-year storm over or around the culvert without creating a hazard or causing potential for erosion or personal property damage. Adequate scour protection must be included in the design.

p. End protection should be as follows:

1. 12-inch through 36-inch culverts – full-height headwall
2. 42-inch through 84-inch culverts – full height headwall with flared wings
3. Other special type headwalls must be approved before use

4.2 Storm Sewers

New storm drains, along with sanitary sewers and waterlines, shall be placed within the roadway right of way and meet the required horizontal and vertical separations as set forth by the OEPA. The criteria for designing storm sewer systems are listed below:

a. No water will be allowed to cross a street intersection unless it is carried in a storm drain. All storm sewer systems shall be designed using Manning's Equation:

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

and

$$Q = AV$$

where :

Q = Rate of discharge (cfs)
A = Area of cross-section of flow (sq.ft.)
V = Mean velocity of flow (fps)

n = Manning’s roughness coefficient
R = A/wp = Hydraulic radius (ft)
S = Slope of pipe or hydraulic grade line if surcharged (ft/ft)
wp = Wetted perimeter (ft)

c. Hydraulic Gradient Requirement shall be:

1. Based on a 5-year storm, shall not exceed window or grate elevation for an inlet or catch basin.
2. Grade line based on tailwater or 0.8 D at outlet (whichever is greater) or other critical points within the system.
3. The invert of the first storm drain appurtenance shall be above the computed floodplain elevation, unless otherwise permitted by the Village Engineer.

d. Design Flow Determination:

1. Areas under 200 acres use Rational Method Q = CiA
2. Areas between 200 and 300 acres transition between Rational Method and Technical Release 55
3. Areas over 300 acres use Technical Release 55
4. Minimum times of Concentration:
   - Curb inlet - 10 minutes
   - Catch basin - 15 minutes

e. Runoff Coefficient
    1. Based on Table 7, with 0.4 as a minimum.

f. Manning's “n” Value
    1. All storm sewers shall be based on pipe material and approved by the Village Engineer.

g. Off-site Area: The sewer must be deep enough to receive the flow from all its sources within the watershed.

h. Size: The size of the storm sewer must be adequate for flowing full, based on the design storm (see Subsection 4.2 (b), listed above) with the 5-year storm hydraulic grade line contained to the system. Pipe for storm drains shall not be less than 12 inches in diameter.

i. Solids: The gradient of the sewer must be sufficient to avoid deposition of solids.

j. Material: All storm drainpipe shall be PVC, HDPE or reinforced concrete. Other materials may be approved at the direction of the Village Engineer. All pipes shall have sufficient strength to withstand an HS-20 live load.

k. Manholes: Manholes shall be provided at all changes in alignment and grade of storm drains and at such other locations as necessary to maintain a maximum interval of 400 feet between manholes or storm drains. The main conduit, if over 24-inches in diameter, will be required to be separated from all curb and gutter inlets unless a special design is approved by the Village. Furthermore, the main conduit will be required to be separated from all deep curb and gutter inlets, which have a depth greater than 6.5 feet from invert to the top-of-casting elevation.

l. Flow Line: Unless otherwise approved by the village, the flow line of pipes shall be set such that the crown of pipes, at junctions, are at the same elevation; if the outlet elevation permits, the crown of the outlet pipe may be lower. The flowline elevations of sewers shall be set to avoid using concrete encasement.

m. Specifications: Methods of construction and trench backfill shall be as per the requirements of the Village and the City of Columbus “Construction and Materials Specifications”, latest edition, as approved for use by the Construction Services Administrator.

n. Submerged pipe outlets: The submergence of a permanent pool of water above the flowline invert elevation of a storm sewer at the outlet is discouraged and shall not be permitted to a depth greater than the ½ the pipe diameter or a depth of two-feet at the outlet, whichever is less. When submergence is allowed upon approval by the Village Engineer, special requirements shall include, but may not be limited to:

1. Submergence "zone" shall not extend beneath pavement;
2. Submergence "zone" shall not extend beyond the first manhole;
3. "O-ring" sealed gasketed pipe joints shall be installed along the storm sewer for the full length of the submergence zone;
4. Anti- seepage collars shall be installed in the submergence "zone".

o. End protection: Standard headwalls or endwalls are to be constructed at the inlet and outfall of all storm drains, and shall be pre-cast or poured in place and shown on the plan and profile. as follows:

1. 12-inch through 36-inch culverts – full-height headwall. If the outlet is not located within a channel bank or within the direct flow path of crossing floodwaters, half-headwalls at the outlet may be used if approved by the Construction Services Administrator. In no instance will half-headwalls be allowed on non-concrete conduit
2. 42-inch through 84-inch culverts – full height headwall with flared wings
3. Other special type headwalls must be approved before use

p. Minimum cover to subgrade:

1. Desirable, under pavement and within influence of traffic load - 30 inches from top of pipe to subgrade.
2. Desirable, beyond influence of traffic load – 18 inches from top of pipe to ground surface.
3. If these requirements cannot be met, the provisions in "r-encasement" below apply.

q. Maximum cover over pipe:

1. The supporting strength of the conduit, as installed, divided by a suitable factor of safety must equal or exceed the loads imposed upon it by weight of earth plus any superimposed loads.
2. The design procedure recommended for use in structural design of storm sewers is outlined within the Design Manual Concrete Pipe, available from American Concrete Pipe Association, wide trench installation.

Table 7. Runoff Coefficients “C” for Typical Land Uses in Columbus

Cover Type and Hydrologic Condition	Average percent impervious area (5)	Runoff Coefficient for Hydrologic Soil Group (7)			
		A	B	C	D
Fully developed urban areas (vegetation established) (1)					
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		0.94	0.94	0.94	0.94
Open space (lawns, parks, golf courses, cemeteries, etc)					
Poor condition (grass cover, 50%)		0.29	0.48	0.63	0.70
Fair condition (grass cover 50% to 75%)		0.07	0.30	0.48	0.58
Good condition (grass cover >75%)		NA	0.19	0.39	0.50
Commercial and business (TND – TC) (6)					
Industrial					
Residential Districts by Average Lot Size (6):					
Multi-family (TND – NC)	80	0.63	0.75	0.80	0.83
1/12 to 1/6 acre lots (TND – NG)	75	0.56	0.70	0.77	0.83
1/8 acre (TND – NE)	65	0.44	0.60	0.72	0.77
1/4 acre	38	0.19	0.40	0.56	0.65
1/2 acre	25	0.11	0.32	0.50	0.60
1 acre	20	0.08	0.29	0.48	0.58
Undeveloped or agricultural lands(1)					
Cultivated Land:					
Without conservation treatment		0.35	0.52	0.67	0.75
With conservation treatment		0.21	0.34	0.46	0.52
Pasture, grassland, or range – continuous forage for grazing. (2)	Hydrologic condition:				
	Poor	0.29	0.48	0.63	0.70
	Fair	0.07	0.30	0.47	0.58
	Good	NA	0.19	0.39	0.50
Meadow – continuous grass, protected from grazing and generally mowed for hay.		NA	0.16	0.34	0.46
Brush – brush-weed-grass mixture with brush the major element. (3)	Poor	0.06	0.27	0.44	0.56
	Fair	NA	0.13	0.37	0.48
	Good	NA	0.06	0.25	0.37
Woods. (4)	Poor	0.04	0.26	0.44	0.56
	Fair	NA	0.18	0.37	0.48
	Good	NA	0.12	0.32	0.44
Farmsteads – buildings, lanes, driveways, and surrounding lots.	--	0.17	0.39	0.54	0.63

Notes:
NA – Method to derive value is not applicable for curve number values less than 40.
(1) Average runoff condition, and Ia=0.2s.
(2) Poor: <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.
(3) Poor: <50% ground cover; Fair: 50 to 75% ground cover; Good: >75% ground cover.
(4) Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.
(5) The average percent impervious area shown was used to develop the composite CN’s which were then used to derive runoff coefficient values. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a runoff coefficient of 0.94 (or CN of 98), and pervious areas are considered equivalent to open space in good hydrologic condition.
(6) Acronyms for zoning of residential districts are as follows:
TND – TC: Traditional Neighborhood Development – Town Center
TND – NC: Traditional Neighborhood Development – Neighborhood Center
TND – NG: Traditional Neighborhood Development – Neighborhood General
TND – NE: Traditional Neighborhood Development – Neighborhood Edge
(7) These runoff coefficients were calculated from CN’s drawn from the NRCS (SCS) Peak Discharge Method from TR-55 assuming a 10-year, 24-hour storm. For larger design storms, the runoff coefficients should be increased using the following C value correction factors:
1.0 for the 10-year design storm and less
1.1 for the 25-year design storm
1.2 for the 50-year design storm

1.3 for the 100-year design storm

r. Encasement: Class A concrete encasement shall be required within the limits of existing or proposed paved areas inside right of way, in areas influenced by traffic loading, or under paved driveway entrances adjacent to right of way as directed by the Construction Services Administrator, where the minimum cover during construction or proposed cover over the outside top of the pipe to top of subgrade is 30 inches or less. In addition, all PVC and polyethylene pipe allowed to be installed in the right of way shall be concrete encased per CMS 910. Any concrete encasement of flexible pipe shall extend from structure to structure.

s. Velocity in sewer for design flow:

1. 3 fps Minimum
2. 7 fps Maximum
3. No minimum for outlets from ponding areas

t. Maximum Length between access structures:

1. Pipes under 60-inch – 350 feet
2. Pipes 60-inch and over 400 feet

4.3 Curb Inlets

a. General: The satisfactory removal of surface water from curbed pavement is as important as any other phase of stormwater control. The spread of water on the pavement for the design storm is considered as the best control for pavement drainage. The design procedure recommended for use is Hydraulic Engineering Circular No. 12, available from the Superintendent of Documents, U.S. Government Printing Office. On combined runs of over 600 feet contributing to a sag vertical curve, an additional inlet may be required near the low point, plus or minus two-tenths foot above the inlet at the sag.

b. Design storm (curb inlets). The following shall be used:

1. Two-year storm frequency
2. Rational method of calculation
3. Ten minutes for minimum time of concentration
4. 0.015 for roughness coefficient for composite roadway paved and gutter section
5. Maximum width of spread of flow:

Street Width	Width of Spread
≤ 30 ft.	8 ft.
> 30 ft.	9 ft.

c. Underdrains: Four (4) inch curb drains connections shall be placed 30-inches below the top of the curb on the up-grade side of the inlet. It is desirable to have the storm sewers, draining to the inlets, set such that the elevation of the top of the sewer is not higher than the top of the 4-inch curb drain. In some locations a 6-inch under drain, with clean out will be required. This will be determined during plan review by the Village Engineer.

d. The maximum distance for overland flow shall be 300 feet before entering a surface yard inlet or 425 feet before entering a curb inlet. Except, that the maximum overland drainage area tributary to any yard inlet or curb inlet shall not exceed 1.5 acres. The maximum spacing for curb inlets shall not exceed 400 feet unless approved by the Village Engineer.

4.4 Open Water Courses

a. General Requirements. The requirements in this section are applicable to newly constructed open watercourses that are intended to convey flow to stormwater inlets, stormwater control facilities, streams, lakes, wetlands, or other water bodies during precipitation events. Routine maintenance is required for constructed open water courses which serve as drainage features on a site, as specified in Section 1.5 of this Manual. A constructed channel shall be shaped or graded to the required dimensions and established with a suitable lining as necessary to convey stormwater runoff without allowing channel erosion. The following guidance documents may be used for evaluation, planning, and design of constructed open watercourses to supplement the design criteria provided in the Manual.

1. NRCS Ohio Practice Standard 412, Grassed Waterways
2. NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7 - Grassed Waterways
3. Handbook 667, Stability Design of Grass-lined Open Channels
4. Federal Highway Administration, 1988, Design of Roadside Channels with Flexible Linings. Hydraulic Engineering Circular No. 15.

b. Channel Hydrology Requirements. The hydrologic computation methods specified in *Table B,* or as specified by the Village Engineer, shall be used to design open watercourses in the Village. In most cases, open watercourses shall be designed according to the same method used to design other onsite drainage facilities.

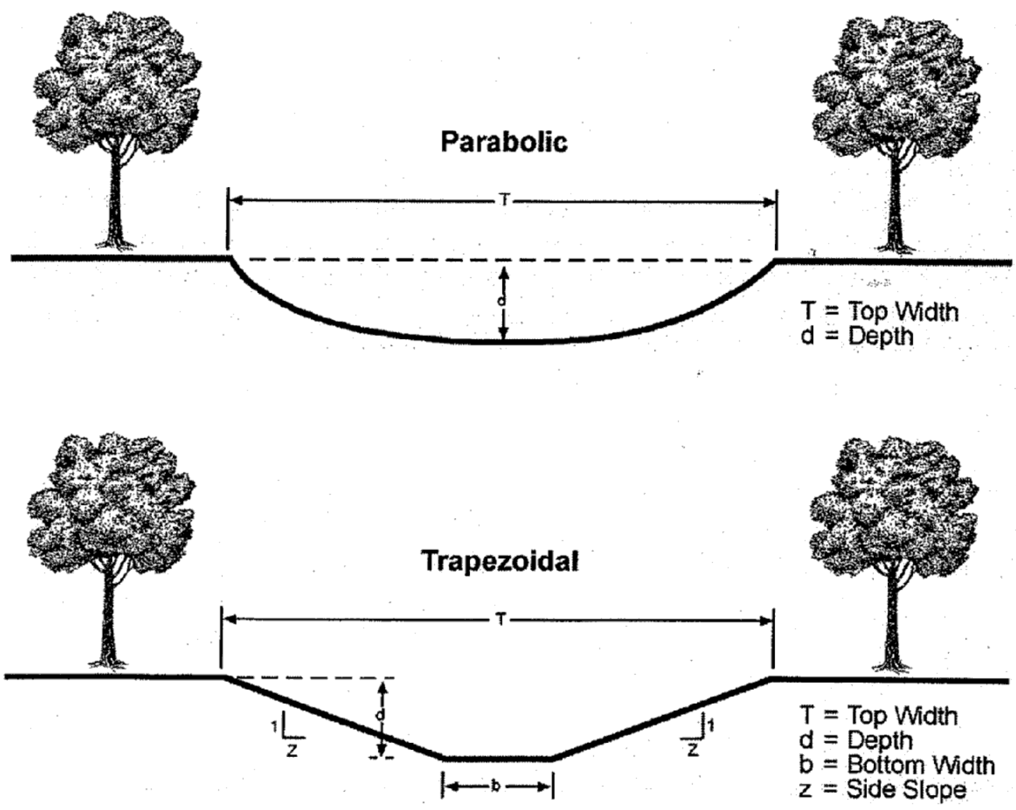
c. Channel Hydraulic Requirements.

1. Design Storm Frequency: Constructed open watercourses shall be designed to convey the 10-year design storm without causing erosion, sedimentation, or overbank flooding within and along the channel. Major Storm Physical Design Criteria (Section 3.3 of this Manual) shall be used if the channel will also serve as a flood routing channel for the 100-year design storm. Open watercourses may also be designed for stormwater quality control. ODOT's L&D Manual, Drainage Design aids

may be used for sizing open conveyances (at various side slopes). A ditch computation sheet shall be used to present open channel calculations.

2. Cross Section Shape: Parabolic and trapezoidal channel shapes (Figure 1) shall be used for open watercourses within development projects. Side slopes shall be 4(H) to 1(V) or milder, with a minimum 2-foot bottom width for trapezoidal channels, unless alternative dimensions are approved by the Village due to specific project conditions. Channel cross sections shall be designed such that erosion and sediment deposition is minimized.

Figure 3. Parabolic and Trapezoidal Channel Shapes for Open Watercourses.



3. Design Velocity: An open channel is categorized by its lining. There are three main types of channel linings: vegetated, flexible, and rigid. A vegetative lining, such as grass with mulch and sod and lapped sod, is required where site constraints and flow velocity conditions allow. Flexible linings include rock channel protection and cellular soil retaining mats and are typically less expensive than a rigid lining. The use of flexible linings, however, may require the installation of a filter fabric or

other means to protect the underlying soil, prevent washout, and prevent soil piping through the rock when using channel protection. Rigid linings include concrete and rigid block and are usually used where high velocities are unavoidable.

Final design of constructed open channels shall be consistent with velocity limitations for the selected channel lining. Maximum velocity values for selected vegetated and non-vegetated lining categories are presented in Table 1. The Manning's Equation shall be used to design an open channel that satisfies the maximum velocity criteria in the previous sections:

$$V = (1.49/n)\ R^{2/3}\ S^{1/2}$$

where:

V = average channel velocity (ft/s)
n = Manning's roughness coefficient
R = hydraulic radius (ft)
= A/P
A = cross-sectional area of the channel (ft^2)
P = wetted perimeter of the channel (ft)
S = slope of the energy grade line (ft/ft)

Recommended Manning's "n" values for open channels with vegetated and non-vegetated linings are provided in Table 5.

4. Critical Flow: Open channels shall be designed to flow under subcritical flow conditions at all times. A subcritical flow regime is characterized by a Froude Number less than 1.

$$F = V/(gD)^{0.5} < 1$$

where:

F = Froude Number
D = hydraulic depth (ft) = A/T
A = cross-sectional area of flow (ft^2)
T = top width of water surface (ft)
V = flow velocity (ft/sec)
g = acceleration due to gravity = 32.2 ($feet/sec^2$)

The Developer/Owner shall demonstrate that the calculated Froude Number is less than 1 over the anticipated range of flow conditions within the channel.

5. Rock Channel Protection Shear Stress Analysis: Type B, C or D rock channel protection shall be provided in accordance with the City of Columbus CMSC Section 601.08. Type B, C or D rock channel protection shall only be placed outside of guardrails, barriers or other unobstructed areas provided outside of the traveled way for vehicles to stop safely or regain control. The actual shear stress (r_{ac}) must be less than or equal to the allowable sheer stress (r_a) listed in Table 9 for the rock channel protection type used. The actual shear stress shall be determined for the channel slope and the depth of flow during a 10-year design storm.

The following equation is valid for discharges less than 50 cfs and with slopes less than 10%:

$$r_{ac} = 62.4 * D * S$$

where:

D = depth of flow (feet)
S = channel slope (feet/feet)
r_{ac} = actual shear stress ($lbs/feet^2$)

Table 8. Manning's Roughness Coefficients for Vegetative and Artificial Channels

Channel Lining	Roughness Coefficient
Vegetated Lining:	
Seeded	0.03 (for velocity determination only without erosion control matting on all channels) 0.04 (for depth determination along roadside channels only) 0.06 (for depth determination,
Sod	0.04 (for velocity determination on all channels) 0.04 (for depth determination along roadside channels only) 0.06 (for depth determination, except along
Flexible Lining:	
Slope Erosion Protection	0.04
Erosion Control Matting	0.04
Grouted riprap	0.02
Rock channel protection (Typical for Type C/D*) Small channels/ditches Large channels	 0.06 0.04
Rigid Lining:	
Concrete	0.015
Bituminous	0.015
Concrete block mat (tied)	0.021

Note: Increase roughness coefficient by 15% for Type B RCP.

Table 9. Allowable Sheer Stress for Rock Channel Protection

Type of Rock Channel Protection	r_{ac}
	lbs/sq.ft
B	6
C	4
D	2

In extreme site conditions, Type B or C rock channel protection shall be utilized for lining channels with steep grades (slopes 10%-25%) that carry flow from the end of a cut section down to the lowest elevation on the bottom of the channel. FHWA's HEC-15 procedures for steep gradient channels shall be used with a safety factor of 1.5. The Director of Public

Work for the Village shall be consulted if rock channel protection is proposed in instances where the peak flow during the 10-year design storm is greater than or equal to 50 cfs.

6. Outlets: All constructed open watercourses shall have a structurally sound and stable outlet with adequate capacity to prevent ponding or flooding damage. Portions of open water courses affected by back water from Tier I or Tier II streams during dry weather flow conditions shall be provided with a stable outlet.

7. Natural Channel Design:
Natural channel design shall be used for open channel stormwater conveyance, in appropriate locations, with plan approval of the Village. See ODNR Rainwater and Land Development Manual.

4.5 Detention Facilities

Areas designed for storage of stormwater by retention shall be incorporated into the natural features of the general area, when possible. Cooperative planning and joint owner construction of detention or retention facilities and use of natural land contours is encouraged. The Village encourages that detention or retention facilities be designed as multipurpose spaces such as open space, recreation and/or scenic areas. The Village encourages use of fountains for aeration and reserves the right to require such an appurtenance as a condition to plan approval.

a. Ownership and maintenance. The owner and thus responsible party to provide maintenance and operation of a stormwater management facility (i.e., detention, retention basin, etc.), whether public or private. Only documentation of the operation and maintenance plan for a facility and the final engineering and construction plans are validated with appropriate signatures, shall the owner present a final plat and approved plans to the Planning and Zoning Commission and then to the Council for acceptance. No lot sales will be permitted until this is done. Maintenance requirements and final design of all detention basins must be followed as specified in Village Code Section 941.09.

b. Location: All stormwater management facilities will be located in a reserve/open space as shown on the preliminary plat and final plat and will be owned by a homeowners association or an entity otherwise approved by the Village's Council.

c. Types of facilities: In development and developing urban and suburban areas, several means for controlling stormwater runoff could be used. This usually involves storing runoff on or below the ground surface. The following types of storage facilities may be considered for detention and are subject to approval by the Village and OEPA as required within the State General Construction Permit: rooftops, parking lots, underground tanks and surface basins or ponds and man-made stormwater wetland systems. All surface detention shall be wet or permanent-pool basins. No dry detention basins are permitted.

4.5.1 Parking Lot Storage.

Parking lot storage is surface storage where shallow ponding is designed to flood specific graded areas of the parking lot. Controlled release features are incorporated into the surface drainage system of the parking lot. Parking lot storage is a convenient multi-use structural control method where impervious parking lots are planned. Design features include small ponding areas with controlled release by pipe-size and slope, and increased curb heights.

The major disadvantage is the inconvenience to users during the ponding function. This type of design component should therefore not be proposed for critical use facilities. This inconvenience can be minimized with proper design consideration. Clogging of the flow control device and icy conditions during cold weather are maintenance problems. Parking lot design and construction grades are critical factors. This method is intended to control the runoff directly from the parking area, and is usually not appropriate for storing large runoff volumes.

a. Ponding areas in parking or traffic areas shall be designed for a maximum potential depth of twelve (12) inches.

b. Flood routing or overflow must occur after the maximum depth is reached.

4.5.2 Tank Storage

Tank storage utilizes an underground tank or chamber, either prefabricated or constructed in place, which has a special controlled release feature. This method is most applicable where land area is valuable, such as in industrial and commercial areas. Construction cost and operation costs make this method relatively expensive. Storage trenches, a variation on basic tank storage, are rock-filled underground storage tanks. The storage is provided within the void spaces between the rock material.

4.5.3 Wet Detention Basins

Wet Detention Basins (Ponds) are permanent ponds where functional stormwater management storage is provided above the normal water level with special features for controlled release. Historically, wet detention basins have proven extremely effective in abating increased runoff and channel erosion from urbanized areas. They are a major Soil Conservation land treatment practice. Wet detention basins must be constructed outside of any existing stream channels and outside of the stream corridor protection zone.

All wet detention basins must meet water quality and quantity detention criteria in Section 2 of this Manual as specified in OEPA's General Construction Permit.

Some problems encountered with wet detention basins are: site reservation (land requirements), permanent easements, complexity of design and construction, safety hazards and maintenance problems. However, the recreational, aesthetic, and water quality benefits of permanent wet detention ponds justify their use in many applications. Gradual slopes of 4:1 are required where a wet retention basin is to be constructed adjacent to an existing single-family development for that part along the existing single-family section, if a sufficient submerged bench cannot be constructed in the basin (see Section 4.5.3 b below).

a. The Village encourages use of fountains for aeration and reserves the right to require such an appurtenance as a condition to plan approval.

b. The side slopes for a Wet Detention basin shall be:
   - A maximum slope of 2:1 horizontal to vertical below the permanent storage pool;
   - A minimum 5 foot wide, 2-foot maximum depth submerged bench at waters edge around perimeter of the permanent storage pool;
   - A maximum 3:1 horizontal to vertical above the submerged bench.

c. Unless otherwise approved by the Village, a minimum of 20 % of the pool area shall be ten-feet deep for water-quality benefit.

d. Rock Channel Protection Type D, may be required to be placed at the normal water elevation, around the entire perimeter of the basin, five feet wide, centered on the normal water elevation.

e. Debris-control structures: Debris-control structures may be required and shall be considered as an essential part of the design. The procedure recommended for use is Hydraulic Engineering Circular No. 9, available from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. For dams and levies over ten feet in height, refer to Section 1521.062, O.R.C.

f. Submerged Outlet/Inlet Structures:
   1. The Village permits the use of submerged storm outlets. Submerged Outlets may consist of a siphon pipe where such pipe is no smaller than 12 inches in diameter. For smaller outlet requirements, a bolted-on orifice plate may be used as the control feature, to be placed at the structure within the embankment. The siphon pipe material must be concrete. When using a submerged outlet, a stormwater detention basin must also include one or more additional stage outlet(s) with sufficient capacity to convey the 100-year storm discharge without overtopping the pond embankment.

   2. Inlet pipes that are equal to or larger in diameter than 36-inches must be submerged to at least the “springline” of the pipe (i.e., normal pool at a depth equal to the elevation at one-half the diameter of the pipe). When an inlet pipe is at least partially submerged at the pond, the conditions listed below must also be met.

   3. Submergence of inlet pipes is limited to the next upstream manhole or catch basin along the storm sewer system.

4. All lengths of submerged storm pipe shall include "o-ring" sealed gasket pipe joints.

5. All lengths of the submerged storm pipe shall have bedding and backfill material consistent with the compacted embankment material.

6. Riser Outlet Structures: Catch basins/manholes used as the outlet structures may have a maximum elevation that is no more than 1.5 feet above the normal pool elevation and may include windows and grate-top openings. Where a catch basin is used as a second-stage outlet structure, the slope of the pond embankment must be graded to reduce the visibility of the structure.

   Calculations must show that the capacity of the window(s)/grate top does not exceed the capacity of the "barrel" of the riser structure (calculated using the orifice equation).

7. Structure Requirements: All headwall structures shall be in accordance with Village Standard Drawing ST-07-01 (36-inch diameter or less) or the City of Columbus Standard Drawings AA-S167 (greater than 36-inch diameter). All riser structures shall be in accordance with Village Standard Drawing XX (modified as necessary.)

8. Bedding/Backfill Material: The bedding and backfill material for all storm pipe outlets shall consist of 100 percent cohesive embankment material or controlled-density fill. Where inlet storm pipes are submerged, bedding and backfill material for those pipes shall consist of 100 percent cohesive embankment material to the next structure upstream along the storm sewer system.

9. Anti-Seep Collars:
   - Anti-seep collars shall be used at all outlet storm pipe locations and shall be located (spaced) and sized in accordance with the criteria provided below. All anti-seep collars shall be constructed with material that provides a watertight connection to the pipe and is of a material that is compatible to the pipe. Anti-seep collars shall also be used along the submerged portion of any storm inlet pipes.

   - The anti-seep collars shall be located along the length of the outlet pipe within the saturation zone of the embankment (refer to Exhibit No. 1), at approximately equal spacing and at intervals not exceeding 25 feet. The saturation zone is considered to extend through the embankment from the elevation of the riser (normal pool) to the downstream embankment toe.

   - The anti-seep collars shall be designed to increase the length along the line of seepage (along the outlet pipe) by at least 15 percent. The proper design of the anti-seep collars may be achieved by either:

- Selecting the number of collars and determining the minimum projection of the collar away from the outlet pipe:

  V = 0.075 x (L/N); or

- Selecting the projection of the collar away from the outlet pipe and determining the minimum number of collars:

  N = 0.075 x (L/V)

  Where:
  V = collar projection in feet
  N = number of collars
  L = length of outlet pipe within the saturation zone

11. Emergency Spillways: Emergency Spillways, when included in the designed pond outlet feature, must meet all of the following criteria:
    - They shall not operate (convey flow) for any design storm less than the 50-year event.

    - They shall be reinforced with concrete or designed erosion control materials (geotextiles) consisting of 100 percent synthetic, non-biodegradable materials [the plans shall include a specification for the intended geotextile, referencing the required physical properties or the specific material. Reference the State of Ohio, Department of Transportation Construction and Material Specifications Section 712.11, Type "E."

    - They must include a designed "control section" that, when combined with the capacity of the principal spillway, will pass the major storm flood discharge up to the 100-year event [the plans must include a detail demonstrating the necessary dimensions of the control section, both width and breadth.

12. Miscellaneous: The following general criteria must be met:
    - Roof drain (downspout) outlets directly to the pond are not permitted

    - All orifice plates shall conform to the requirements of Village of Canal Winchester.

    - All inlet structures (e.g., pipe headwalls) must be recessed into the adjoining pond grading to diminish the amount the structure is visible.

4.6 Stormwater Treatment Wetlands

This technique involves design of a stormwater management facility that is intended to provide a water-quality benefit and incorporates a wetland system for water treatment. Use of this type of system may be proposed but will require prior authorization by Director of Public Works and the Village Engineer. Suggested design guidelines include:

a. Urban Runoff Quality Management: WEF Manual of Practice No. 23 and ASCE Manual and Report on Engineering Practice No. 87,. Water Environment Federation and American Society of Civil Engineers, 1998.

b. Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland Systems, Thomas R. Schueler, Anascotia Restoration Team, Department of Environmental Programs, Metropolitan Washington Council of Governments, October 1992. E.

Proper wetlands design must create the proper conditions for wetland plants to thrive, as well as the proper hydrologic conditions to detain the water quality volume of runoff, and perhaps the flood control volume as well. Additional design details may be provided by the Village Engineer.

4.7 Bioretention (Rainwater and Land Development, ODNR)

Bioretention practices are stormwater basins that utilize a soil media, mulch and vegetation to treat runoff and improve water quality for small drainage areas. Bioretention BMPs provide effective treatment for many runoff quality problems including reduction of total suspended solids, heavy metals, organic compounds, bacteria and nutrients (phosphorous and nitrogen) by promoting settling, adsorption, microbial breakdown, and nutrient assimilation by plants.

4.7.1 Description

A bioretention area consists of a depression that allows shallow ponding of runoff and gradual percolation through a soil media, after which it either infiltrates through undisturbed soils or enters the storm sewer system through an underdrain system. Bioretention BMPs are sized for common storm events (the water quality volume) with runoff volumes from larger events typically designed to bypass the BMP.

A bioretention BMP is generally applicable for limited contributing drainage areas, generally less than 2 acres.

4.7.2 Design Considerations

a. Suitable soils: The bioretention BMP must be designed so that the runoff storage capacity will be drained between 40 and 72 hours either through infiltration into the existing soils under the facility or through the underdrain system. Facilities designed without an underdrain system shall have a qualified professional certify that in-situ soils are appropriate for infiltration. This certification shall include a description of the soil depth and horizons that correspond to the design elevations of the bioretention practice.

b. Setbacks to Prevent Water Damage: Appropriate setbacks from property lines, wells, septic systems, basements and building foundations shall be maintained to prevent damage to these systems or offsite areas.

c. Long Term Maintenance and Easements: Since bioretention combines plant materials with the temporary storage and filtering of stormwater, frequent regular maintenance is required. A legal and enforceable maintenance agreement shall be in place and executed.

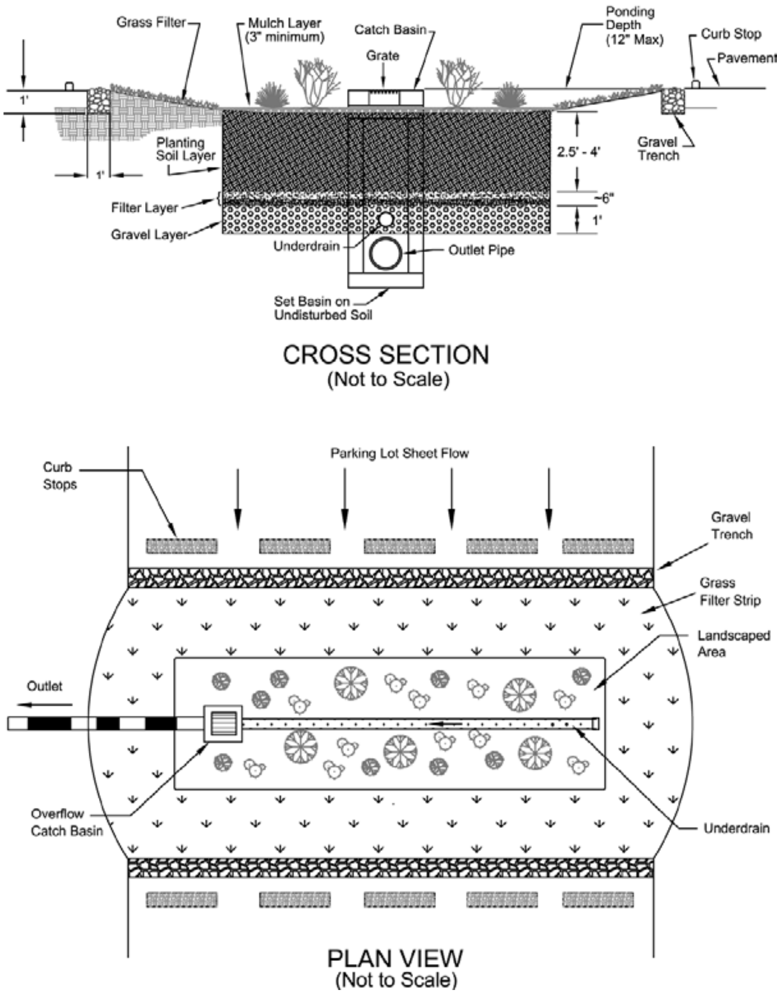


Figure 4. Bioretention Cell Layout (Rainwater and Land Development, ODNR)

d. Surface Area: The surface area of the bioretention cell will generally be between 5 and 10 percent of the contributing drainage area.

e. Construct Bioretention after Site Stabilization: Bioretention facilities shall be constructed after all other areas of the drainage area have been constructed and finally stabilized. Sediment-laden runoff from actively eroding sites will cause the premature failure of bioretention facilities.

f. Detention: All bioretention practices shall be designed to treat the water quality volume by initially ponding that volume and allowing it to infiltrate through a soil medium within the practice. Ohio EPA requires that runoff treated with a bioretention practice have a minimum drawdown time of 40 hours. While detention practices begin discharging soon after water begins to pond, each practice shall regulate the release of water such that no more than one-half of the water quality volume is released in less than one-third of the drawdown period (40 hours).

g. Area Dimensions: The minimum recommended width of the landscaped ponded area shall be 10 feet, with the length generally exceeding 2:1 (length:width). Pretreatment and conveyance areas may increase the overall size dedicated to the practice.

4.7.3 General Components of Bioretention Practices

a. Pretreatment Area: Sediment or other pollutants before runoff enters the practice. A level stone trench at the edge of pavement, perpendicular to flow and a grassed area are typical options for pretreatment. Where flow is concentrated, a grassed swale, stabilized flow entrances or forebay may be necessary.

b. Landscaped ponding area: The depth of ponding shall generally be less than 6 inches, but may be designed up to 12 inches. The depth of ponding is controlled by the height of the overflow structure or berm containing runoff.

c. Mulch: A minimum of 3 inches of coarse shredded hardwood mulch is provided around plants and over the planting soil. Pine mulches and fine or chipped hardwood mulches may not be used since they tend to float and move.

d. Planting Soil: The planting soil filters and detains runoff, and much of the pollutant removal occurs in this zone. The planting soil or created soil mix shall be between 2.5 feet and 4 feet in depth (settled). Soils and soil mixes must be certified by a qualified laboratory (1 test per 100 cubic yards of soil), and shall consist of 85% sand, 7% compost, and 8% sandy loam soil, or 70 % sand and 30% sphagnum peat moss. The sand shall consist of a concrete sand gradation.

e. Filter Layer: Designers may choose to use either geotextile to prevent fines from the planting soil from migrating down through the underdrain or to the subsoil below the practice.

f. Gravel Layer and Underdrain system:

   1. A gravel bed 8-12inches (minimum of 3inches thick) consisting of # 57 washed stone shall be provided as a drainage medium and bedding material for underdrain pipes.

   2. Underdrains shall be a perforated pipe capable of withstanding the expected load above it and exceeding the drainage capacity of the planting soil layer.

g. Overflow and Routing: Bioretention facilities shall have a non-erodible means of discharging flow exceeding the capacity of the practice such as an overflow pipe or drop inlet set at the maximum ponding elevation.

h. Planting Materials: Species planted in bioretention practices shall be adapted to the region, pollution tolerant, and able to survive the variable moisture conditions. Most plants should be facultative (found equally in wetland or upland conditions) though some species found in either environment may be acceptable. Native and non-invasive plants shall be used.

4.8 Grass Filter Strips (Rainwater and Land Development, ODNR)

4.8.1 Description

Grass filter strips, also known as vegetated filter strips, treat the water quality of small sheet flows from developed areas. They are uniform strips of dense turf or meadow grasses with minimum slope, best suited to accept diffuse flows from roads and highways, roof downspouts, and very small parking lots. Though grass filter strips alone do not meet OEPA treatment standards for water quality, they are an ideal component of stream buffers or as pretreatment to a structural practice.

Natural meadow areas also may be used for grass filter strips. Grass filter strips are most often located in landscaping areas around building and parking lot perimeters, in greenbelts or along conservation easements, and median strips in parking lots and streets. The site's topography must allow shallow slopes and sheet flow runoff through the filter strip.

4.8.2 General Criteria for Grass Filter Strips

a. Grass Filter Strip design shall be based on Rainwater and Land Development (Ohio ODNR, etc).

b. Submittals/Plans: Runoff calculations, drainage area, slope of drainage & GFS, planting plan, soil info, slope length, schedule, other design components (spreader bar, etc).

c. The filter strip shall abut the contributing drainage area.

d. The limiting design factor for grass filter strips is not the drainage area to the practice, but rather the length of flow leading to it. In general, the length of flow from impervious surfaces should not exceed 75 feet, and the length of flow from impervious surfaces should not exceed 150 feet.

e. The slope of grass filters strips shall be 1 to 5%.

f. Slope Length: A higher level of pollutant removal is achieved the longer the slope length (the distance water flows through a filter strip). Grass filter strips must have a minimum slope length of 25 feet, but shall be designed to provide a slope length based on their slope within the ranges noted in Table 10.

Table 10. Filter Strip Flow Length

Slope of Filter Strip	75% Particulate Trap Efficiency	90% Particulate Trap Efficiency
1%	25 ft	50 ft
2%	30 ft	120 ft
3%	40 ft	135 ft
4%	60 ft	170 ft
5%	75 ft	210 ft

g. Ground Water: Filter strips shall be separated from ground water by at least 2 to 4 feet to prevent contamination and to assure that the filter strip does not remain wet between storms.

h. Soils: Filter strips will be less effective as the clay fraction of the soil increases, since this limits the infiltration of runoff associated with proper treatment. Filter strips are not suitable in very poor soils that cannot sustain a grass cover.

i. Assuring Sheet Flow: Level spreaders shall be used if needed to assure an even flow onto the grass filter strip.

j. Establishing Vegetation: Dense vegetation is critical to effective filter strips. Poor stands of vegetation may even result in a grass filter strip eroding and becoming a source of pollution. A tool to select the appropriate vegetation based on site specific conditions is available on the internet from the USDA Natural Resource Conservation Service at: http://ironwood.itc.nrcs.usda.gov/Netdynamics/Vegspec/pages/HomeVegspec.htm.

Some common grasses suitable for use in Ohio include perennial ryegrass, tall fescue, red fescue and Kentucky bluegrass as well as Canada wild rye, Chinese silvergrass, orchardgrass, smooth brome, switchgrass, timothy and western wheatgrass. Salt-tolerant vegetation such as creeping bentgrass should be selected in areas that may be salted in the winter.

Seeding of the filter strip shall be completed no later than September 30th to assure sufficient vegetation by October 31st.

k. Pedestrian and Vehicular Traffic: Heavy use should be avoided to minimize soil compaction and maintain quality dense vegetation.

l. Maintenance:
Only a minimum amount of maintenance should be necessary to ensure continued functioning of grass filter strips.
1. The most significant concern is gully formation from unexpected concentrated flows. If rills and gullies occur, they must be repaired and stabilized with seed or sod. Measures must be taken to eliminate the concentrated flow.

2. Filter strips should be inspected annually to assure that the level spreader is not clogged and to remove built-up sediment.

3. Grass within the filter strip shall be maintained as lawn. Grass height should be about 3 to 4 inches. Vegetation must be kept healthy.

4.8.3 Specifications for Filter Strips

a. Filter strips shall be graded to prevent runoff from concentrating. Depressions, ridges and swales shall be graded out to achieve a uniform slope having a level grade across the slope.

b. To assure that runoff remains as sheet flow through the filter strip, a level spreader shall be used at the top of the slope. The rock or grass level spreader must be placed on a contour, and shall have a minimum width and depth of 1 foot.

c. Soil compaction shall be minimized in the filter strip area. Work shall be performed only when the soil moisture is low.

d. A subsoiler, plow or other implement shall be used to decrease soil compaction and allow maximum infiltration. Subsoiling shall be done when the soil moisture is low enough to allow the soil to crack or fracture.

e. Because a dense vegetation is critical for effective filter strips, only a dense stand of vegetation without rills or gullies shall be acceptable. If rills or gullies form or if vegetative cover is not dense, a new seedbed shall be prepared and replanted.

f. The filter strip shall be seeded no later than September 30th to assure that vegetation establishes prior to the onset of winter weather.

5.0 REFERENCES

Guidance Manual for On-Site Stormwater Quality Control Measures, Village of Sacramento,
CA Dept. of Utilities, January 2000.

Revised Manual for New Jersey: Best Management Practices for Control of Nonpoint Source Pollution from Stormwater, New Jersey Dept. of Agriculture, New Jersey Dept. of Community Affairs, New Jersey Dept. of Environmental Protection and New Jersey Dept.
of Transportation, May 2000

National Menu of Best Management Practices for Storm Water Phase II, United States Environmental Protection Agency, August 2002

VegSpec and PLANTS Database, United States Dept. of Agriculture, Natural Resource Conservation Service, http://plants.usda.gov

6.0 GLOSSARY

The following definitions shall apply to this Manual:

Attenuation: to reduce the amount, volume or concentration of pollutants or surface water.

100-year flood: A flood which has the probability of occurring once every one-hundred (100) years or having a one (1) percent chance of occurring each year.

Baseflow: Minimum, long-persistence flow in streams produced mainly by seepage; sometimes called subsurface flow.

Best management practice(s) (BMP): Measures including structural and non-structural BMPs that are determined to be the most effective, practical means of preventing or reducing point source or non-point source pollution inputs to storm water runoff and water bodies (see Practices).

Channel: Natural or artificial watercourse of perceptible extent, with a definite bed and banks to confine and conduct continuously or periodically flowing water. Channel flow thus is that water which flows by gravity and is characterized by a free water surface within the banks of a defined channel.

Contamination: The presence of or entry into a public water supply system, the MS4, Waters of the State, or Waters of the United States of any substance which may be deleterious to the public health and/or the quality of water.

Conveyance: Any pipe, channel, inlet, drain, or other structure that facilitates the movement or removal of water.

Dam: an artificial barrier usually constructed across a stream channel to impound water. Dams must have spillway systems to safely convey normal stream and flood flows over, around, or through the dam. Spillways are commonly constructed of non-erosive materials such as concrete. Dams should also have a drain or other water-withdrawal facility to control the pool or lake level and to lower or drain the lake for normal maintenance and emergency purposes.

Design Storm: A rainfall event of specified size and return frequency (e.g., a storm that occurs only once every 2 years), which is used to calculate the runoff volume and peak flow rate.

Detention: Runoff enters an area of detention faster than it leaves. It occurs in depressions, the natural landscape, or constructed stormwater facilities. While detention can be designed into ponds with or without a permanent pool, dry ponds often are referred to as detention ponds.

Detention Basin: a facility designed for the temporary storage of stormwater runoff for the purpose of delaying and attenuating flow to the downstream receiving system. For the purpose of this design manual, this definition excludes storage in areas of parking lots, rooftops, underground tanks and other water quality-based applications, such as bio-retention basins.

Detention Storage: Storm runoff collected and stored for a short period of time and then released at a rate much less than the inflow rate. (e.g. a dry reservoir)

Development: Any action in preparation for construction activity which results in an alteration of either land or vegetation, including but not limited to clearing, grubbing, grading, filling, excavation or any other development operations and the construction of new facilities, buildings, parking areas, recreational areas, etc.

Dike: an artificial barrier used to divert or restrain flood waters from tidal bodies of water.

Discharge: Any substance introduced to the Waters of the State or to surface runoff which is collected or channeled by the MS4 which do not lead to treatment works and/or the addition of any pollutant to the Waters of the State from a point source.

Disturbed: Earth surface subject to erosion due to the removal of vegetative cover and/or earthmoving activities.

Ditch: An open channel constructed for the purpose of drainage or irrigation with intermittent flow.

Drainage: A general term applied to the removal of surface or subsurface water from a given area, either by gravity or by pumping, commonly applied herein to surface water.

Drainage system or drainageway: The surface and subsurface system for the removal of water from the land, including both the natural elements of streams, marshes, swales and ponds, whether of an intermittent or continuous nature, and man-made elements which include culverts, ditches, channels, storage facilities and the storm sewer system.

Easement: Property titled to the Village for the operation and maintenance of storm water drainage and management systems.

Engineer: A Professional Engineer registered in the State of Ohio as required by Chapter 4733 of the Ohio Revised Code.

Environmental Protection Agency (EPA): The U.S. Environmental Protection Agency or, where appropriate, a designation for the Administrator or other duly authorized official of such Agency.

Erosion: The general process whereby soil or surface material is moved by flowing surface or subsurface water or is worn away by the action of wind, water, ice or gravity.

Erosion control: Measures that reduce or prevent erosion.

Extended Detention: A stormwater design feature that provides for the gradual release of a volume of stormwater (typically 0.25 - 0.75 inch per impervious acre) over a 24 to 48-hour interval to increase settling of urban pollutants and protect channels from degradation.

Facility: Any operation, including construction sites, required by the Federal Clean Water Act to have a permit to discharge storm water associated with activities subject to NPDES

Permits as defined in 40 CFR, Part 122.

Flood: A temporary rise in the level of rivers, streams, watercourses and lakes which results in inundation of areas not ordinarily covered by water.

Flood Plain: The relatively level land to either side of a channel, which is inundated during high flows. It is often used to reference the 100-year flood plain.

Forebay: A distinct area near an inlet of a pond to enhance deposition of incoming sediments.

Geotextile: A woven or nonwoven, water-permeable fabric generally made of synthetics such as polypropylene. It's used to slowly pass runoff or as bedding for rock to keep the rock separate from adjacent soil.

Grading: Changing the ground surface condition, elevation, and/or slope through excavation or fill of material.

Hydrologic Soil Group: One of four classifications of soil based on the minimum infiltration characteristics for bare soil after prolong wetting as used by the United States Department of Agriculture Natural Resources Conservation Service *Technical Release No. 55, Urban Hydrology for Small Watersheds.*

Impervious Surface: Any constructed surface; including but not limited to, rooftops, sidewalks, roads, and parking lots; covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water and prevent precipitation and runoff from infiltrating soils. Soils compacted by urban development are also highly impervious.

Infiltration: The gradual downward flow of water from the surface through soil to groundwater.

Landscape: To mow, seed, sod, plant, and to do other activities which are not earth changes.

Larger common plan of development or sale: means a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under one plan.

Levee: an artificial barrier that diverts or restrains flood waters from streams and lakes.

Material: Soil, sand, gravel, clay, or any other organic or inorganic material.

Municipal Separate Storm Sewer System (MS4): As defined at 40 CFR 122.26(b)(8), "means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

A. Owned or operated by a State, Village, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)…including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity.

B. Designed or used for collecting or conveying storm water;
C. Which is not a combined sewer; and
D. Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR
122.2."

National Pollutant Discharge Elimination System (NPDES): A national program under Section 402 of the Clean Water Act for regulation of discharges of pollutants from point sources to Waters of the United States. Discharges are illegal unless authorized by an NPDES permit.
NPDES Permit: A permit issued by the EPA (or by a State under authority delegated pursuant to 33 USC § 1342(b)) that authorizes the discharge of pollutants to Waters of the United States, whether the permit is applicable on an individual, group, or general area-wide basis.

Ohio EPA: The Ohio Environmental Protection Agency.

Operate: To drive, conduct, work, run, manage, or control a tool, piece of equipment, vehicle, or facility.

Owner: Any person with a legal or equitable interest in a piece of the land or parcel.

Permeability: The capacity for transmitting runoff through a material or into soil. The relevant soil property is the saturated hydraulic conductivity, that is the amount of water that would move vertically through a unit of saturated soil per unit time under hydraulic gradient.

Permittee: The applicant in whose name a valid permit is duly issued.

Pollutant: Anything which causes or contributes to pollution

Pollution: The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any Water of the State or Water of the United States, that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Practices: Schedules of activities, prohibitions of practices, maintenance procedures and other management practices and techniques (both structural and non-structural) used to lessen the environmental impacts of land use and to prevent or reduce the pollution of Waters of the State. BMPs also include treatment requirements, operating procedures and practices to control facility and/or construction site runoff, spillage or leaks, sludge or waste disposal or drainage from raw material storage. Techniques may involve basins, vegetation, altering construction operations, open space development, riparian buffers or other means of limiting environmental impacts.

Rainwater and Land Development Manual: A manual describing construction and post-construction best management practices and associated specifications prepared by the Ohio Department of Natural Resources Division of Soil and Water Conservation. The compilation of technical standards and design specifications are methods of controlling construction related surface runoff, erosion and sedimentation. A copy of the manual may be obtained by contacting the Village Engineer or the Ohio Department of Natural Resources, Division of Soil & Water Conservation.

Return period: Also known as the *recurrence interval*, it is the average period between precipitation events or flood events of a certain size based on the records and statistics.

Riparian Corridor: An area of trees, shrubs, and surrounding vegetation located adjacent to streams, rivers, lakes, ponds, and wetlands which serve to stabilize erodible soil, improve both surface and ground water quality, increase stream shading and enhance wildlife habitat.

Riprap: Rock or stone placed over a bedding of geotextile, sand or gravel used to armor slopes against flowing water or wave action.

Runoff: The portion of rainfall, precipitation, melted snow or irrigation water that flows across the ground surface and is eventually returned to streams.

Runoff coefficient: The fraction of total rainfall that will appear at the conveyance as runoff.

Sediment: Soils or other surface materials (including, but not limited to rock, sand, gravel and organic material or residue associated with or attached to the solid) that can be transported or deposited by the action of wind, water, ice or gravity as a product of erosion or sedimentation.

Sediment pollution: Degradation of Waters of the State by sediment as a result of failure to apply management or conservation practices to abate wind or water soil erosion, specifically in conjunction with earth-disturbing activities on land used or being developed for commercial, industrial, residential or other non-farm purposes.

Sediment settling pond: A sediment trap, sediment basin or permanent basin that has been temporarily modified for sediment control, as described in the latest edition of the Rainwater and Land Development Manual.

Sedimentation: The processes that operate at or near the surface of the ground to deposit soils, debris and other materials either on the ground surfaces or in water channels or the action of deposition of sediment that is determined to have been caused by erosion.

Sheet Flow: Diffuse runoff flowing overland in a thin layer not concentrated and not in a defined channel.

Site: The entire area of land surrounding the discharge activity.

Site map: A plan or set of plans showing the details of any earth-disturbing activity of a site.

Soil erosion: The movement of soils that occurs as a result of wind, rain, precipitation, or flowing water.

Soil Hydraulic Conductivity: The property describing permeability or the ability of water to move through soils, typically measured in saturated conditions (Ks).

Stabilization: Vegetative or structural soil-cover controlling erosion (including but not limited to permanent and temporary seed, mulch, sod, pavement, etc.) or the use of vegetative and/or structural practices that prevent exposed soil from eroding.

State: The State of Ohio.

Storm drainage system: All facilities, channels, and areas which serve to convey, filter, collect and/or receive storm water, either on a temporary or permanent basis.

Stormwater: **W**ater runoff resulting from precipitation, snow melt, or irrigation runoff as defined in 40 Code of Federal Regulation 122.26(b)(13).

Stormwater conveyance system: All storm sewers, channels, streams, ponds, lakes, etc. used for conveying concentrated storm water runoff or storing storm water runoff and filtering pollutants

Stormwater Pollution Prevention Plan (SWP3): A set of plans and specifications, prepared and approved in accordance with the specific requirements of the Village Engineer and the Ohio EPA, NPDES Permit #OHC000003. The SWP3 shall be certified by an Engineer, and shall indicate the storm water management strategy, including the specific measures and sequencing to be used to manage storm water on a development site before, during and after construction and shows the details of any earth-disturbing activity on the site.

Stormwater retention/detention BMPs: Retention storage and detention storage that control storm water by gathering runoff in wet ponds, or dry basins, and slowly releasing it to receiving waters or drainage systems. These practices can be designed to both control storm water volume and settle out particulates for pollutant removal.

Stormwater runoff: Surface water runoff which converges and flows primarily through water conveyance features such as swales, gullies, waterways, channels or storm sewers.

Stormwater Treatment: The removal of pollutants from urban runoff and improvement of water quality, accomplished largely by deposition and utilizing the benefits of natural processes.

Stream: A system including permanent or seasonally flowing water, often with a defined channel (bed and bank), flood plain, and riparian ecosystem.

Structure: Anything manufactured, constructed or erected which is normally attached to or positioned on land, including, but not limited to buildings, portable structures, earthen structures, roads, parking lots, and paved storage areas.

Topography: The relative slopes, positions and elevations of the landscape's surface.

Underdrain System: The drainage system utilized in bioretention and occasionally detention practices to maintain positive drainage.

Village: The Village of Canal Winchester.

Village Engineer: The Village of Canal Winchester Village Engineer.

Water Quality Volume (CPWQv): The volume of storm water runoff which shall be captured and treated prior to discharge from the developed site after construction is complete. CPWQv is equivalent to the volume generated by a 0.75 inch rainfall. The extended detention volume captured for the purposes of treating pollutants and protecting stream stability downstream. This volume is prescribed by the Ohio EPA Construction General Permit.

Watercourse: any natural or constructed conveyance of water including, but not limited to lake, pond, stream, river, creek, ditch, channel, canal, conduit, gutter, culvert, drain, gully, swale, or wash in which water flows either continuously or intermittently which are delineated by the Village of Canal Winchester.

Watershed: A region draining to a specific river, river stream or body of water.

Wetland: An area that is inundated or saturated by surface or ground-water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated or hydric soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.