Stormwater Drainage Manual

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Table of Contents

SECTION 1 Stream Protection Regulations

1.1. Stream Protection Policy Statement

The City has determined that establishing a Stream Corridor Protection Zone along streams is necessary to protect structures from damage caused by natural erosion. Unless otherwise exempt, all development and redevelopment projects that include a portion of the Stream Corridor Protection Zone must minimize alterations of the stream, keep new structures out of the Stream Corridor Protection Zone, and maintain a riparian corridor along the stream to minimize stream bank erosion and to protect stream habitat. Section 1 of the Manual provides stream protection standards for all development and redevelopment projects in the City.

With the exception of roadside ditches and approved roadway crossings, all Tier I (those identified on the United States Geologic Survey (USGS) quad maps with solid or blue dashed lines) and Tier II (those not classified as Tier I but having a well-defined bed and bank) streams shall remain open and shall not be enclosed within a storm sewer or other engineered structure. A Stream Corridor Protection Zone shall be established that allows for the natural, lateral movement of streams and to prevent structures from being impacted by natural stream bank erosion. Stream relocation and/or realignment projects are permitted through proper permitting requirements (including, but not limited to, requirements under Section 401 and 404 of the Clean Water Act) and the use of appropriate stream restoration techniques.

1.2. Stream Identification

A stream is a surface watercourse with a well-defined bed and bank, either natural or artificial, which confines and conducts continuous or periodic flowing water. The Applicant shall identify and label all streams within the project site and/or receiving stormwater discharges from the project site on the master drainage plan (**Section 5**) submitted as part of the Stormwater Management Report. The Applicant shall provide information that supports the classification of Tier I and Tier II streams. Such information may include, but not be limited to, copies from USGS Quad sheets showing a Tier I stream, or photographs, FEMA maps, or soils maps showing the location of a Tier II stream.

If the City determines that the submitted evidence is inconclusive, then they may require a site inspection and input from other sources of information including the U.S. Army Corps of Engineers, Ohio EPA, ODNR, or the appropriate County Soil and Water Conservation District. Final determination regarding whether the watercourse or channel meets the classification of a Tier II stream for the purposes of the Manual shall be at the discretion of the City Engineer or designee. Stream Corridor Protection Zones are not required along constructed open channels that are not classified as streams.

1.3. Stream Corridor Protection Zone

A Stream Corridor Protection Zone consists of the stream and the riparian area along the stream. Its purpose is to allow the natural, lateral movement of open water courses and prevent structures from being impacted by natural stream bank erosion.

1.3.1. Stream Corridor Setback Requirements

Zone will be extended to include slopes that are greater than 15 percent and begin at a point within the Stream Corridor Protection Zone. The maximum width of the Stream Corridor Protection Zone extension shall be to the top of the slope or to a point up-slope, as measured horizontally, where the width of the Stream Corridor Protection Zone is doubled, whichever is less. Slope protection widths may be extended beyond these limits at the City's discretion on a case-by-case basis.

Where wetlands protected under federal or statoe law are located partially within the Stream Corridor Protection Zone, the Stream Corridor Protection Zone shall be extended to include the full extent of the wetland area plus any setback from the wetland required by a Section 404 permit (see Section 1.5). Permanent Protection of the Stream Until such time as the City of Marysville adopts citywide stream corridor setbacks via codified ordinances stream corridor setbacks will be established based on the requirements of the Construction Site General Stormwater Permit as issued from Ohio EPA that is applicable to the site.

In addition to the City of Marysville stormwater regulations, construction stormwater in the City of Marysville is by governed by two construction stormwater general permits issued by Ohio EPA. The majority of the Marysville land area is covered by the Ohio EPA Statewide Construction Stormwater General Permit. Southern portions of the City are located in the Big Darby Creek Watershed and construction activities in these areas are covered by the Construction Stormwater General Permit for the Big Darby Watershed.

In most instances the Stream Corridor Protection Zone is located by placing its centerline over the centerline of the watercourse. However, individual site conditions including, but not limited to, topography and slope must be considered when determining the precise location of the Stream Corridor Protection Zone.

1.3.2. The width of the Stream Corridor Protection Corridor

The Stream Corridor Protection Zone shall be kept in as natural state as possible so that it can perform its inherent function of erosion protection, flood storage, and water quality protection. In order to ensure the permanent protection of the zone, the developer shall provide for the permanent protection of the zone.

The developer shall identify on the plat or plan and visibly delineate on the site the Stream Corridor Protection Zone prior to any construction on the site to prevent excursions onto the zone during construction. Such delineation must be submitted to the City Engineer or designee for review and approval prior to construction.

No later than the conclusion of construction, the developer shall permanently delineate the Stream Corridor Protection Zone in an aesthetically harmonious manner, approved by the City Engineer, such that the location of the zone is apparent to casual observers and permits access to the zone.

Language preventing Property Owners from constructing facilities and performing activities that are prohibited within the Stream Corridor Protection Zone, as described in **Section 1.3.3**, shall be shown on the plat and reflected on all deeds.

That portion of a lot or parcel reserved as the Stream Corridor Protection Zone may be included in the total area for computing the density permitted by the particular underlying zoning district for that parcel, even if ownership of the Stream Corridor Protection Zone is subsequently transferred. The resulting increase in net density permitted on that portion of the lot or parcel located outside of the Stream Corridor Protection Zone is acceptable to the extent that the gross density for the total area does not exceed the density prescribed by the underlying zoning district.

1.3.3. Prohibited Uses in the Stream Corridor Protection Zone

Table 1-1 lists facilities/activities that are prohibited within the Stream Corridor Protection Zone. No stormwater pipe outfalls shall be located within the Stream Corridor Protection Zone unless it is determined after review that no other alternative is feasible. Stormwater pipe outfalls shall be located outside the Stream Corridor Protection Zone and discharged into either a structural level spreader or a constructed open channel with appropriate protection from erosion.

Table 1-1

Facilities and Activities Prohibited in the Stream Corridor Protection Zone

Prohibited Facilities	Prohibited Activities*
Buildings/structures (except bridges)	Agriculture
Swimming pools	Industry/commercial business
Signs	Filling
Billboards	Excavation
Fences	Ditching/diking
Parking Lots	Removal of topsoil, sand, gravel, rock, oil, gas
Electric lines that run parallel to the stream (except for transmission lines)	Any other change in topography other than what is caused by natural forces
Utility lines or pipes that run parallel to the stream (except for necessary public sanitary, water, stormwater [see above] and public utility transmission lines as approved by the City)	Herbicides/pesticides
	Removal of native trees/vegetation except as approved by the City
Telecommunication lines that run parallel to the stream (except for transmission lines)	
Cable TV lines that run parallel to the stream	
Other improvements deemed unacceptable to the City	

***Unless designated a permitted use by the City**

1.3.4. Permitted Uses in the Stream Corridor Protection Zone

Uses permitted within the Stream Corridor Protection Zone include, but are not limited to, the following:

1) Passive uses including hiking, fishing, picnicking, and similar uses. Construction of paved trails to further such passive recreation uses is permitted. All trails, paved or unpaved, shall be designed, constructed and maintained to minimize and control soil erosion,
2) Vegetation removal on existing levees and dikes,
3) Activities by City personnel that are necessary to maintain the function of any open watercourse,
4) Removal of damaged or diseased trees.
5) Re-vegetation and/or reforestation with plantings of native species,
6) Public Utility crossings (Those utilities owned by the City, suburb, or any entity contracting with the City.
7) Street Crossings
8) Excavation for providing compensatory floodplain volume immediately adjacent to the channel, with appropriate restoration provided,
9) Construction activities associated with properly permitted stream restoration projects,
10) Disturbances resulting from permitted stream and/or wetland mitigation projects provided the mitigation is to offset impacts to local protected wetlands. (see Section 1.5), and
11) Activities related to enhancement of existing wetlands.

Disturbances within the Stream Corridor Protection Zone as a result of a permitted use must be mitigated through re-vegetation/reforestation.

1.3.5. Applicability of Stream Corridor Protection Zones

A Stream Corridor Protection Zone is required for all projects subject to the Manual, except as follows:

Exemption 1 — Stream Corridor Protection Zones will not be required along existing streams located within the Historic Uptown District.

Exemption 2 – First consideration must be given to providing the full Stream Corridor Protection Zone width as presented in Section 1.3. Based on plan review, the City may allow the Stream Corridor Protection Zone to be reduced if the project is a redevelopment, and the existing buildings already exist within the protection zone. The redevelopment shall not encroach further into the protection zone.

1.4. Floodplain Preservation and Developments within Special Flood Hazard Areas

The City prohibits the filling of FEMA designated floodplains without compensation due to potential for problems associated with flooding, erosion, and environmental impact. With the exception of fills associated with widening an existing public roadway within a FEMA designated Flood Hazard Area; fill within the FEMA delineated 100-year floodplain outside of the Stream Corridor Protection Zone must be compensated by removing an equivalent volume of material or greater. (Information on FEMA's 100-year floodplains can be obtained through ODNR's Geographic Information Management Systems metadata or directly through FEMA.) The amount of compensatory storage shall be

determined by the volume of material removed above the ordinary high-water mark of the stream and below the 100-year flood elevation established for the area. The compensation area must have an unrestricted hydraulic connection to the affected stream and provide the same rate of flood storage capture and discharge over the course of the flood event as in pre-project conditions. First consideration shall be given to expanding the stream's existing floodplain next to the existing channel and within the limits of the development site. In instances where compensatory storage within the limits of the development site is proven to be impractical, the City will consider offsite compensatory storage as long as:

1) First consideration is given to performing compensatory storage by expanding the stream's existing floodplain next to the channel.
2) The mitigation is performed as close to the proposed fill area as possible.
3) The mitigation occurs within the same hydraulic reach of the same stream in which filling is proposed to occur.
4) Where the Applicant proposes to provide compensatory storage on property owned by others, the Applicant must submit a written agreement between such landowner and the Applicant wherein the landowner agrees to convey an easement or other property interest or right to the Applicant allowing compensatory storage, and to permanently maintain such area for flood storage purposes in the event that the City approves the Applicant's proposed project.

The same hydraulic reach is defined as the reach of a stream between the nearest features controlling the flood water elevations upstream and downstream from the proposed fill area.

Disturbances created within the Stream Corridor Protection Zone for the purpose of providing compensatory floodplain storage adjacent to the stream are permitted; however, all disturbances must be mitigated through reforestation and re-vegetation. A stream bank restoration plan that incorporates bioengineering techniques shall be prepared for compensatory floodplain fill work that occurs immediately adjacent to the stream bank. The stream bank restoration plan shall be submitted as part of the Stormwater Management Report and Construction Plan submission (Part II) for the project. The means and methods for stream restoration work, including non-vegetative and vegetative materials, shall be shown in the plan. Stream bank restoration plans shall be designed and constructed based on the bankfull discharge and able to withstand the inundation, stream velocities, and channel stresses associated with the 100-year flood event without structural failure once vegetative cover is established. Stream bank restoration plans shall be submitted with the construction plans. Guidance and further references for stream bank stabilization techniques are provided under the Ohio Department of Natural Resources' Rainwater and Land Development Manual.

Embankment slopes proposed in compensatory storage areas must reasonably conform to the natural slopes adjacent to the disturbed area. The use of vertical retaining structures constructed of concrete, brick, block or other like-material is specifically prohibited. The use of crib walls with bioengineered fascines may be approved on a case-by-case basis.

1.5. Wetland Policy

The City of Marysville supports the preservation of existing wetlands and values the stormwater benefits that they provide. Wetlands have been determined to provide flood and storm control by the hydrologic absorption and storage capacity; pollution treatment by nutrient uptake from wetland plants and the filtering of silt and organic matter by settlement; protection of subsurface water resources by recharging ground water supplies; and wildlife habitat in nesting areas, feeding grounds, and cover for many species including migratory waterfowl, rare, threatened, or endangered wildlife species.

Jurisdictional and isolated wetlands on development sites shall be delineated by a qualified professional as required by the U.S. Army Corps of Engineers (Corps) and the Ohio Environmental Protection Agency (OEPA). Wetland boundaries shall be mapped in an acceptable electronic format and submitted to the City Engineer. Copies of all permit applications and any associated wetland mitigation plans shall also be submitted to the City Engineer with the Stormwater Management Report. The City may not approve stormwater management reports or plans prior to receipt of copies of approved Federal (404) and State (401) permits if the permits are required.

Where wetlands protected under federal or state law are located partially within the Stream Corridor Protection Zone, the Stream Corridor Protection Zone shall be extended to include the full extent of the wetland area plus any setback from the wetland required by a Section 404 permit.

For impacted wetlands that fall outside the Stream Corridor Protection Zone, the City encourages the mitigation of proposed impacts to occur within the limits of the development site but not outside the sub-watershed. To encourage onsite/intra-watershed wetland mitigation, the City will consider the location of mitigation projects within the Stream Corridor Protection Zones of properties that are located adjacent to a tributary stream provided that:

1) Impacts to isolated wetlands and associated mitigation plans are approved/permitted by the Corps and/or OEPA, and
2) Wetlands constructed for mitigation purposes are not used to serve as a stormwater Best Management Practice (BMP) to treat onsite stormwater runoff.

The stormwater system design for the project shall ensure that the predevelopment quantity and quality of stormwater flows directed to any protected wetlands is maintained. Constructed wetlands (including bio-retention basins) shall not be considered subject to these requirements. Existing wetlands shall not be used for stormwater management or stormwater runoff quality treatment of the development site.

SECTION 2 Stormwater Conveyance

This section describes the criteria and methodologies that shall be used to plan and design stormwater conveyance systems within the City of Marysville. Subsections include:

2.1 General Criteria

2.2 Hydrology Requirements

2.3 Design of Minor Stormwater Conveyance Systems

2.4 Design of Major Stormwater Routing Systems

2.1. General Criteria

The City's stormwater management goals are to prevent hazardous or detrimental flooding, stream bank erosion, and water quality degradation that may result from stormwater runoff from development and redevelopment projects. This section presents general criteria for meeting this goal.

2.1.1. Offsite Tributary Area

Stormwater runoff from offsite upstream tributary areas that discharge to or across a development site shall be accommodated within the stormwater facilities planned for the development site. No stormwater management plans will be approved until it is demonstrated that offsite runoff will be adequately conveyed through the development site in a manner that will not cause or contribute to hazardous or detrimental upstream and downstream flooding and erosion. The estimation of the offsite flows must be done separately from the estimation of onsite flows (i.e., separate hydrographs for offsite areas must be determined).

2.1.2. Onsite Stormwater Conveyance

Stormwater runoff generated from the proposed development site shall be accommodated, in addition to offsite flows, within the stormwater facilities planned for the development. Onsite stormwater runoff shall be conveyed through the development site to adequate stormwater control facilities designed in accordance with the requirements specified in Section 3 of this Manual. No stormwater management plans will be approved until it is demonstrated that onsite runoff will not cause flooding within the development site for the designated design storm.

2.1.3. Adequate Drainage Outlet Analysis

Surface water runoff from a development shall be drained offsite in accordance with this document to an adequate outlet(s). The City Engineer shall approve the location of the outlet(s). The outlet(s) may consist of a ditch, stream, storm sewer, retention/detention basin, etc., having sufficient capacity to accommodate the surface water runoff in a reasonable manner.
Onsite stormwater systems must discharge to one of the following offsite stormwater systems:

1) A tier I stream,
2) A tier II stream,
3) An open channel system (generally excluding roadside ditches),
4) A storm sewer system adequately sized for the intended flows

If none of the four options above are feasible, then the Applicant must demonstrate that only sheet flow is being discharged with adequate quantity and quality controls in place, since concentrated flow may cause offsite erosion unless it is discharged into a conveyance system. In general, sheet flow occurs at the upstream extent of an overland flow path, rarely exceeding a length of 300 feet in mildly sloped, undeveloped areas. In developed areas, sheet flow lengths are typically no longer than 100 to 150 feet in pervious areas, and 50 to 75 feet in impervious areas. Flow that has become concentrated must be converted to sheet flow using a level spreader (see **Section 2.3.6**) or other similar device. Flow from drainage areas with overland flow paths greater then 300 feet must discharge into one of the four defined conveyance systems listed above.

If a ditch, stream, etc. is desired as an outlet, the City Engineer shall require flow line elevations for the stream, ditch, etc. to be taken a minimum of 500 feet downstream of the anticipated outlet point to insure adequate fall/slope and capacity is available. This data shall be submitted to the City Engineer with the Preliminary Engineering Plan submittal. A minimum channel slope of 0.50% (1.0% preferred) with a minimum 5 year storm velocity of 3.0 fps is required. A minimum of 12" of freeboard (measured from the outlet pipe flow line to the ditch flow line) is desired at the proposed outlet structure.

If a buried structure, pipe, etc. is being proposed as the drainage outlet, it shall be cleaned, videoed, and tested for deflection at the discretion of the City Engineer. The City Engineer shall be contacted a minimum of two business days prior to any of this work being done. An adequate outlet is defined as an outlet functioning as designed (e.g. able to convey the 2-year storm with the 10-year hydraulic grade line not exceeding the top of grate elevation for storm sewers; 10-year storm elevation not exceeding the top of bank elevation for open channels), and able to carry the existing flows as well as the proposed flows in the post development condition.

The Applicant shall use one of the accepted hydrologic methods defined in **Section 2.2.1** to demonstrate that the offsite stormwater system can convey existing offsite flows and projected onsite flows in a manner that does not increase downstream peak water surface elevations during the 1-year through the 100-year design storms and satisfies the various design criteria in this Manual. Downstream analysis shall be performed between the outlet of the onsite system and one of the following points:

1) The next increase in pipe diameter in an existing downstream storm sewer system,
2) The downstream face of the next bridge or culvert crossing in an open conveyance system (generally excluding roadside ditches), or
3) A point designated by the City Engineer based upon known drainage issues in the downstream system.

In instances where it is determined that the existing downstream system(s) does not meet the criteria of the Manual, the City Engineer will require that more stringent release rates from onsite detention facilities built for the development site be required, and/or require the Applicant to provide the necessary downstream improvements to satisfy the conditions of this section.

The following sources of information may be utilized to establish downstream tailwater conditions:

1) Previous studies that may be on file at the City,
2) Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) and data, and/or
3) Calculations prepared by a Professional Engineer using standard engineering practice.

The Applicant must prepare a preliminary Stormwater Management Report (**Section 5**) that shall clearly show, through use of drawings, calculations, and narrative, how the proposed development project will comply with these requirements. One of the hydrologic calculation methods described in **Section 2.2** must be used, and design criteria specified in the Manual shall be used to evaluate the offsite drainage systems of the same type. The City Engineer shall review and determine the adequacy of the drainage outlet and reserves the right to require the outlet(s) to be cleaned, reconstructed and/or replaced as deemed necessary. The lack of not meeting any of the requirements mentioned above shall be cause for disapproval of the plan.

2.1.4. Agricultural Field Tile Systems

Agricultural field tiles are for agricultural drainage purposes only and, in general, may not be used as an outlet of any development or stormwater facility except in instances where the field tile is the only available outlet of the site. Field tiles that are discovered or intercepted during construction and do not exhibit evidence of conveying septic effluent shall be reconnected or connected into the proposed stormwater system. Field tiles that exhibit evidence of conveying septic effluent shall not be used for stormwater conveyance and shall be reported to the County Health Department for resolution upon discovery.

Designers preparing plans for development on existing agricultural lands shall, at a minimum, contact the respective County Engineer's office and local Soil and Water Conservation District to confirm the existence and location of existing tile systems. All visible field tile outlets and locations shall be field located and shown on the stormwater management plans. Any plan information for field tile systems received from county agencies shall also be shown.

In the event that a development proposes to discharge into an existing downstream field tile system on an adjacent property, the following requirements shall apply:

1) Runoff from the proposed development plus offsite flows currently entering the field tile system must be restricted to no more than the development's "fair-share" of full-flow hydraulic capacity of the field tile system for all storms up to and including the critical storm as defined in **Section 3.2.2**. The development's "fair-share" of the full-flow tile capacity is defined as the ratio of the development's tributary area to the total area tributary to the field tile system at the point of discharge. In no instance shall the release rate for any storm, up to and including the critical storm, exceed the 1-year predevelopment rate. Full-flow capacity, based upon the entire tributary area, shall be determined through a field survey and hydraulic evaluation of the receiving tile system to the nearest open watercourse.
2) An easement or other written owner agreement(s), as necessary, (such as making improvements to the downstream system) with the downstream owner is required for discharges to "private" (i.e., non-petitioned) field tile systems.

2.1.5. Stormwater System Diversions

The diversion of stormwater runoff from one watershed or receiving stormwater system to another is generally prohibited because such diversions have the potential to cause or exacerbate flooding, erosion, or water quality problems in receiving watercourses. For the purposes of the manual, stormwater diversions are defined as the relocation of stormwater discharges from original receiving streams or stormwater systems to other systems that did not receive such discharges prior to construction. While it is recognized that stormwater runoff from small, onsite, tributary areas must be conveyed between catch basin sub-catchments, the City will not allow the diversion of stormwater runoff from one major storm sewer system or open watercourse to another without proper documentation that includes proof of benefit and public comment. Stormwater system diversions between Tier I and Tier II watercourses shall be considered on a case-by-case basis under circumstances where it can be shown that flooding and erosion will not increase and benefits to each watercourse can be achieved as a result of diverted flows. The diversion of any stormwater runoff from one stormwater system or watercourse to another shall be at the sole discretion of the City Engineer or his/her designee.

2.2. Hydrology Requirements

The hydrology requirements provided in the Manual shall be used to determine the volume and discharge rate of stormwater from land areas. All Applicants shall satisfy the requirements of this section.

2.2.1. Acceptable Hydrologic Methods/Models

Tables 2-1 and 2-2 indicate which method must be used to design various components of the stormwater system. In general, the peak flow calculation methods (the maximum runoff flow rates at a given point as a result of a storm event) presented in **Section 2.2.3** shall be used for designing conveyances serving areas less than 200 acres (e.g., stream crossings, storm sewer systems, small open channels, swales, roadside ditches, overland flow, shallow concentrated flow, roadway curbs, and storm sewer inlets). The City allows three methods for calculating stormwater runoff peak flows:

1) The Rational Method described in **Section 2.2.3.1**,
2) USGS Regression Equations (limited to analysis of Tier I and II stream crossings draining more than 17 acres) described in **Section 2.2.3.2**, and
3) The Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service or SCS) Curve Number method described in **Section 2.2.3.3**.
4) The fundamental hydrologic components defined in **Section 2.2.2** shall be used in each of these methods.

Hydrograph methods better account for the timing of runoff in larger watersheds and storage provided by detention facilities and/or floodplains. Therefore the hydrograph methods presented in **Section 2.2.4** may be used to size any drainage component, but must be used for downstream analysis and to design detention facilities. **Section 2.2.4** defines acceptable hydrograph methods. Information regarding the water quality volume used to design stormwater quality management facilities is provided in **Section 3.3.3**.

Table 2-1

Applications of the Recommended Hydrologic Methods

Method	Manual Section	Rational Method (Section 2.2.3.1)	Regression Equations (Section 2.2.3.2)	NRCS (SCS) Curve Number Method (Section 2.2.3.3)	Approved Hydrograph Method (Section 2.2.4)	Water Quality Volume (Section 3.3.2)
Storm Sewers	2.3.1	√		√	√	
Curb Inlets & Catch Basins	2.3.2	√			√	
Culverts for Constructed Open Watercourses	2.3.3	√	√	√	√	
Culverts for Tier I or II Streams	2.3.3		√[1]		√	
Constructed Open Watercourses	2.3.7	√		√	√	
Downstream Analysis	2.1.3				√	
Detention Basins for Quantity Control	3.2.2				√	
Water Quality Controls	3.3.2					√

Table 2-2

Constraints to Using Recommended Hydrologic Methods

Peak Flow Method	Size Limitation	Applicability
• Rational Method	Up to 200 acres	Method can be used for estimating peak flows and the design of small conveyance systems.
• Regression Equations	Between 17 and 2600 acres with defined channels	Method can be used for estimating peak flows along Tier I and Tier II streams. More specific size limitations are outlined in each of the USGS reports.
• NRCS (SCS) Curve Number Method	Peak flow for areas 200 to 640 acres[2]	Method can be used for estimating peak flows and the design of larger conveyance systems
Approved Hydrograph Methods	All drainage area sizes	Method can be used for estimating peak flows and hydrographs for all design applications
Water Quality	Structural Control Limits	Method used for calculating the Water Quality Volume (WQv)

[1] For new culvert or culvert replacements developed under City projects only
[2] Mid-Ohio Regional Planning Commission, Stormwater Design Manual, 1977, pg.30

2.2.2. Hydrologic Components

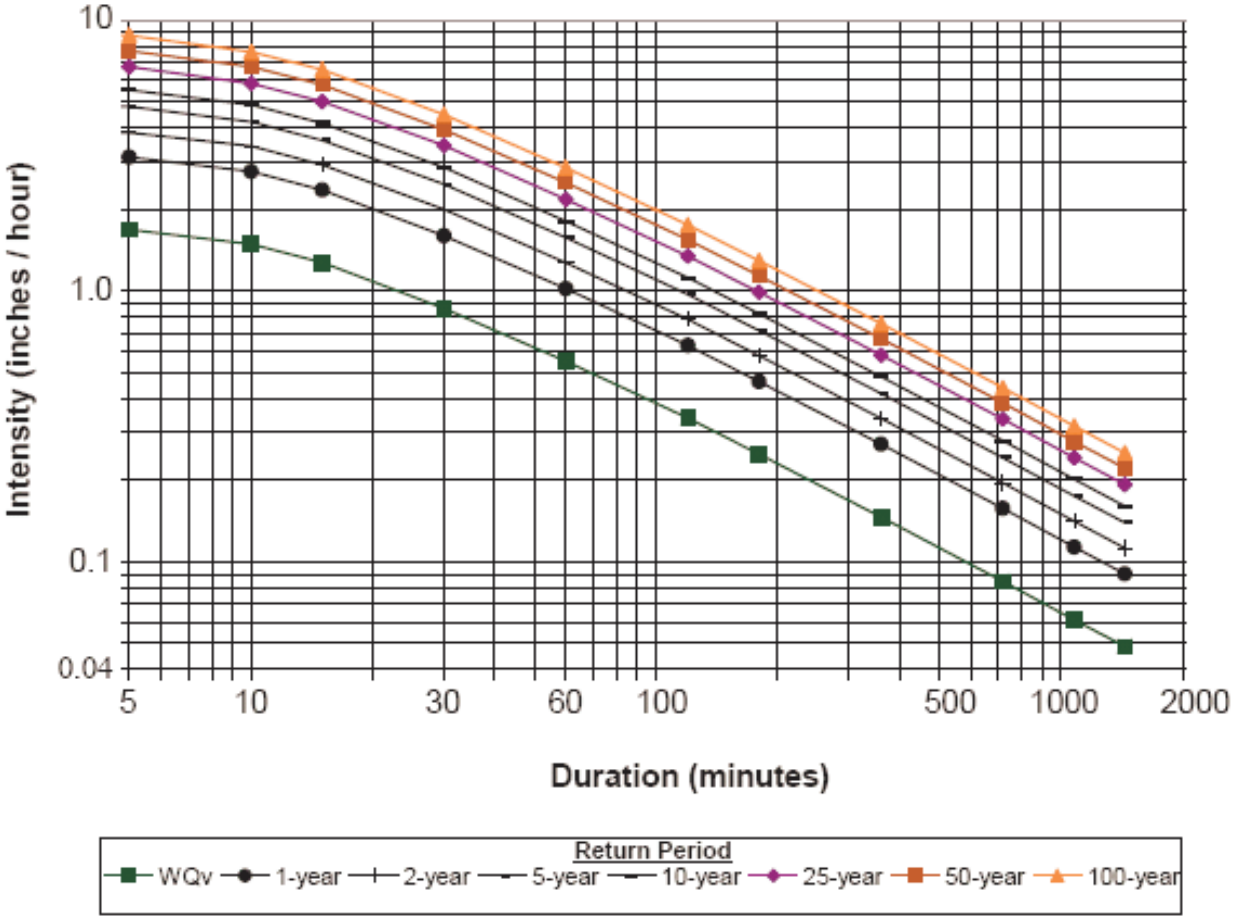
2.2.2.1. Rainfall

Rainfall intensity-duration-frequency (IDF) curves for Central Ohio[3] (Figure 2-1) shall be used in conjunction with the appropriate hydrologic method and/or model defined in **Sections 2.2.3 and 2.2.4** to determine design runoff volumes and intensities. In general, these curves shall be used directly where the rational formula is appropriate to calculate runoff, or shall be used to develop a design rainfall hyetograph for runoff calculations using hydrograph methods.

Design rainfall hyetographs shall be developed using the 24-hour rainfall volume from Figure -1, distributed over a 24-hour period with the SCS Type II distribution (**Table 2-3**). The 24-hour Type II rainfall distribution represents design rainfall intensities over a time of concentration range typical of a small urban watershed, coupled with wet antecedent conditions at the time of peak rainfall intensity.

Figure 2-1

Intensity-Duration-Frequency (IDF) Curves – Central Ohio (Section 05)



[3] Huff and Angel, Rainfall Frequency Atlas of the Midwest, 1992

Table 2-3

Type II SCS Design Storm Hyetograph

Hour	Type II Mass Curve	Delta Rain	Type II 24-Hour Distribution Rainfall (in)						
			Frequency:	100yr	50yr	25yr	10yr	5yr	2yr	1yr
			Duration:	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour
			Depth (in):	6.06	5.33	4.64	3.86	3.35	2.7	2.17
0:00	0			0.000	0.000	0.000	0.000	0.000	0.000	0.000
0:15	0.002	0.002		0.012	0.011	0.009	0.008	0.007	0.005	0.004
0:30	0.005	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
0:45	0.008	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
1:00	0.0108	0.0028		0.017	0.015	0.013	0.011	0.009	0.008	0.006
1:15	0.014	0.0032		0.019	0.017	0.015	0.012	0.011	0.009	0.007
1:30	0.017	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
1:45	0.02	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
2:00	0.023	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
2:15	0.026	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
2:30	0.029	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
2:45	0.032	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
3:00	0.0347	0.0027		0.016	0.014	0.013	0.010	0.009	0.007	0.006
3:15	0.038	0.0033		0.020	0.018	0.015	0.013	0.011	0.009	0.007
3:30	0.041	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
3:45	0.044	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
4:00	0.0483	0.0043		0.026	0.023	0.020	0.017	0.014	0.012	0.009
4:15	0.052	0.0037		0.022	0.020	0.017	0.014	0.012	0.010	0.008
4:30	0.056	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
4:45	0.06	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
5:00	0.064	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
5:15	0.068	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
5:30	0.072	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
5:45	0.076	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
6:00	0.0797	0.0037		0.022	0.020	0.017	0.014	0.012	0.010	0.008
6:15	0.085	0.0053		0.032	0.028	0.025	0.020	0.018	0.014	0.012
6:30	0.09	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
6:45	0.095	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
7:00	0.1	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
7:15	0.105	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
7:30	0.11	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
7:45	0.115	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
8:00	0.1203	0.0053		0.032	0.028	0.025	0.020	0.018	0.014	0.012
8:15	0.126	0.0057		0.035	0.030	0.026	0.022	0.019	0.015	0.012
8:30	0.133	0.007		0.042	0.037	0.032	0.027	0.023	0.019	0.015
8:45	0.14	0.007		0.042	0.037	0.032	0.027	0.023	0.019	0.015
9:00	0.1467	0.0067		0.041	0.036	0.031	0.026	0.022	0.018	0.015
9:15	0.155	0.0083		0.050	0.044	0.039	0.032	0.028	0.022	0.018
9:30	0.163	0.008		0.048	0.043	0.037	0.031	0.027	0.022	0.017
9:45	0.172	0.009		0.055	0.048	0.042	0.035	0.030	0.024	0.020
10:00	0.1808	0.0088		0.053	0.047	0.041	0.034	0.029	0.024	0.019
10:15	0.191	0.0102		0.062	0.054	0.047	0.039	0.034	0.028	0.022
10:30	0.203	0.012		0.073	0.064	0.056	0.046	0.040	0.032	0.026
10:45	0.218	0.015		0.091	0.080	0.070	0.058	0.050	0.041	0.033
11:00	0.236	0.018		0.109	0.096	0.084	0.069	0.060	0.049	0.039
11:15	0.257	0.021		0.127	0.112	0.097	0.081	0.070	0.057	0.046
11:30	0.283	0.026		0.158	0.139	0.121	0.100	0.087	0.070	0.056
11:45	0.387	0.104		0.630	0.554	0.483	0.401	0.348	0.281	0.226

Table 2-3 (Continued)

Type II SCS Design Storm Hyetograph

Hour	Type II Mass Curve	Delta Rain	Type II 24-Hour Distribution Rainfall (in)						
			Frequency:	100yr	50yr	25yr	10yr	5yr	2yr	1yr
			Duration:	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour
			Depth (in):	6.06	5.33	4.64	3.86	3.35	2.7	2.17
12:00	**0.6632**	**0.2762**		**1.674**	**1.472**	**1.282**	**1.066**	**0.925**	**0.746**	**0.599**
12:15	0.707	0.0438		0.265	0.233	0.203	0.169	0.147	0.118	0.095
12:30	0.735	0.028		0.170	0.149	0.130	0.108	0.094	0.076	0.061
12:45	0.758	0.023		0.139	0.123	0.107	0.089	0.077	0.062	0.050
13:00	0.776	0.018		0.109	0.096	0.084	0.069	0.060	0.049	0.039
13:15	0.791	0.015		0.091	0.080	0.070	0.058	0.050	0.041	0.033
13:30	0.804	0.013		0.079	0.069	0.060	0.050	0.044	0.035	0.028
13:45	0.815	0.011		0.067	0.059	0.051	0.042	0.037	0.030	0.024
14:00	0.825	0.01		0.061	0.053	0.046	0.039	0.034	0.027	0.022
14:15	0.834	0.009		0.055	0.048	0.042	0.035	0.030	0.024	0.020
14:30	0.842	0.008		0.048	0.043	0.037	0.031	0.027	0.022	0.017
14:45	0.849	0.007		0.042	0.037	0.032	0.027	0.023	0.019	0.015
15:00	0.856	0.007		0.042	0.037	0.032	0.027	0.023	0.019	0.015
15:15	0.863	0.007		0.042	0.037	0.032	0.027	0.023	0.019	0.015
15:30	0.869	0.006		0.036	0.032	0.028	0.023	0.020	0.016	0.013
15:45	0.875	0.006		0.036	0.032	0.028	0.023	0.020	0.016	0.013
16:00	0.881	0.006		0.036	0.032	0.028	0.023	0.020	0.016	0.013
16:15	0.887	0.006		0.036	0.032	0.028	0.023	0.020	0.016	0.013
16:30	0.893	0.006		0.036	0.032	0.028	0.023	0.020	0.016	0.013
16:45	0.898	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
17:00	0.903	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
17:15	0.908	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
17:30	0.913	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
17:45	0.918	0.005		0.030	0.027	0.023	0.019	0.017	0.014	0.011
18:00	0.922	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
18:15	0.926	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
18:30	0.93	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
18:45	0.934	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
19:00	0.938	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
19:15	0.942	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
19:30	0.946	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
19:45	0.95	0.004		0.024	0.021	0.019	0.015	0.013	0.011	0.009
20:00	0.953	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
20:15	0.956	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
20:30	0.959	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
20:45	0.962	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
21:00	0.9653	0.0033		0.020	0.018	0.015	0.013	0.011	0.009	0.007
21:15	0.968	0.0027		0.016	0.014	0.013	0.010	0.009	0.007	0.006
21:30	0.971	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
21:45	0.974	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
22:00	0.977	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
22:15	0.98	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
22:30	0.983	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
22:45	0.986	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
23:00	0.9892	0.0032		0.019	0.017	0.015	0.012	0.011	0.009	0.007
23:15	0.992	0.0028		0.017	0.015	0.013	0.011	0.009	0.008	0.006
23:30	0.995	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
23:45	0.998	0.003		0.018	0.016	0.014	0.012	0.010	0.008	0.007
0:00	1	0.002		0.012	0.011	0.009	0.008	0.007	0.005	0.004

2.2.2.2. Time of Concentration

A time of concentration shall be calculated for each drainage structure that is designed. This time of concentration relates the maximum amount of flow coming from any watershed to the amount of time it takes for the entire watershed to be contributing flow to the point of interest. Although some places in a watershed are "hydraulically" closer to the point of discharge than others, peak flow generation calculations with the Rational Method (**Section 2.2.3.1**) shall consider only the most hydraulically remote location in the largest drainage area contributing to the point of discharge. Time of concentration is defined by the amount of time it takes for the first drop of water from this location to reach the discharge point[4].

The time of concentration (t_c) shall be calculated as the summation of overland flow time (t_o), the time of shallow concentrated flow (t_s), and the time of pipe or open channel flow (t_d). The minimum time of concentration shall be ten (10) minutes. Time of concentration calculations shall be based on the ultimate buildout land use for the tributary area. The time of concentration calculations shall assume that upstream, offsite, undeveloped areas will be served by storm sewers with a design flow velocity of 3.0 feet/sec.

Overland Flow or Sheet Flow

Overland flow, or sheet flow, is defined as flow that maintains a uniform depth across a sloping surface with no discernible channel. In general, sheet flow occurs at the upstream extent of an overland flow path, rarely exceeding a length of 300 feet in mildly sloped, undeveloped areas. In developed areas, sheet flow lengths are typically no longer than 100 to 150 feet in pervious areas, and 50 to 75 feet in impervious areas. The overland flow time shall be calculated using Manning's kinematic equation[5]:

$$t_o = \frac{0.007(nL)^{0.8}}{P_2^{\,0.5} s^{0.4}}$$

where:

t_o = Time of overland flow (hr),
n = Manning's roughness coefficient for sheet flow
L = Flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = Slope of hydraulic grade line (land slope, ft/ft)

Table 2-4 gives Manning's n values for sheet flow for various surface conditions. These n values are for very shallow flow depths less than or equal to 0.1 foot.

4 Haestad Methods Engineering Staff, Computer Applications in Hydraulic Engineering, 2002, pg. 56

5 United States Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

Table 2-4

Roughness Coefficients (Manning's "n") for Sheet Flow

Surface Description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Shallow Concentrated Flow

Beyond the maximum overland flow length defined in the previous section, sheet flow becomes concentrated flow and must be conveyed by a storm sewer, drainage ditch, or natural channel. The average velocity for shallow concentrated flow shall be determined from Figure 3-1 of SCS TR-55[6], in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in Appendix F of SCS TR-55.

Pipe or Open Channel Flow

The velocity of flow in an open channel or pipe shall be estimated using the Manning's Equation. The travel time for both shallow concentrated flow and open channel or pipe flow is calculated as follows[7]:

6 United States Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

7 Ohio Department of Transportation, Location and Design Manual, Volume 2 – Drainage Design, Section 1101.2.2.

t_s or t_d = L/(60V)

where:

t_s = Travel time for shallow concentrated flow in minutes
t_d = Travel time for open channel or pipe flow in minutes
L = Flow length in feet
V = Velocity in fps

2.2.2.2. Soil Variables

The hydrologic soil group (HSG) associated with soils on the project site prior to development shall be defined by Table 23 –Water Features[8] of the latest edition of the "Soil Survey of Union County". A table of the HSGs for the United States soil classifications is also provided in Appendix A of SCS TR-55[9] . Pertinent figures, tables, and infiltration parameters characterizing the soils native to the project site and the soils that will be re-graded, compacted or otherwise altered to a degree that changes their hydrologic characteristics shall be included in the Stormwater Management Report prepared for the project. Designers should be aware that hydrologic characteristics of soils on a given site can change significantly as a result of grading and compaction during construction. The use of different hydrologic soil groups that reflect the changes in post construction soil hydrology shall be considered when determining runoff estimates for post construction conditions.

2.2.3. Peak Flow Calculation Methods/Models

In general, peak flow calculation methods shall be used to design the stormwater conveyance systems within a development. The following sections describe peak flow calculation methods acceptable for use within Marysville.

2.2.3.1. Rational Method

The rational method shall be used to estimate runoff from drainage areas smaller than 200 acres. Its use shall be limited to the evaluation and design of storm sewer systems, small open channels, swales, roadside ditches, overland flow, shallow concentrated flow, roadway curbs, and storm sewer inlets. Design discharge, "Q" is obtained from the equation:

Q = cIA

where:

Q = Discharge in cubic feet per second
c = Coefficient of runoff, see **Table 2-5**. An average C is to be computed based on the percentage of each land use within the drainage area
I = Average rainfall intensity in inches per hour from Figure 2-1 for a given storm frequency and a duration equal to the time of concentration
A = Drainage area in acres

8 United States Department of Agriculture, Natural Resources Conservation Service; Ohio Department of Natural Resources, Division of Soil and Water Conservation; Ohio Agricultural Research and Development Center; and the Ohio State University Extension, Soil Survey of Union County, Supplement March 2002.

9 United States Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

Table 2-5
Runoff Coefficients "c" for Typical Land Uses in Marysville

Cover Type and Hydrologic Condition	Average percent impervious area (5)	Runoff Coefficient for Hydrologic Soil Group (6)			
		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%) Fair Condition (grass cover 50% to 75%) Good Condition (grass cover >75%)		 0.29 0.07 N/A	 0.48 0.30 0.19	 0.63 0.48 0.39	 0.70 0.58 0.50
Commercial and Business	85	0.70	0.77	0.83	0.85
Industrial	72	0.52	0.67	0.75	0.80
Residential Districts by Average Lot Size Multi-family 1/12 to 1/6 Acre 1/8 Acre 1/4 Acre 1/2 Acre 1 Acre	 80 75 65 38 25 20	 0.63 0.56 0.44 0.19 0.11 0.08	 0.75 0.70 0.60 0.40 0.32 0.29	 0.80 0.77 0.72 0.56 0.50 0.48	 0.83 0.83 0.77 0.65 0.60 0.58
Undeveloped or Agricultural Lands (1)					
Cultivated Land: Without Conservation Treatment With Conservation Treatment		 0.35 0.21	 0.52 0.34	 0.67 0.46	 0.75 0.52
Pasture, grassland, or range – continuous forage for grazing (2)	Hydrologic Condition: Poor Fair Good	 0.29 0.07 N/A	 0.48 0.30 0.19	 0.63 0.48 0.39	 0.70 0.58 0.50
Meadow – continuous grass, protected from grazing, and generally mowed for hay.	–	N/A	0.16	0.34	0.46
Brush – brush-weed-grass mixture with brush the major element. (3)	Poor Fair Good	0.06 N/A N/A	0.27 0.13 0.06	0.44 0.32 0.25	0.56 0.44 0.37
Woods (4)	Poor Fair Good	0.04 N/A N/A	0.26 0.18 0.12	0.44 0.37 0.32	0.56 0.48 0.44
Farmsteads – buildings, lanes, driveways, and surrounding lots	--	0.17	0.39	0.54	0.63

Notes:

N/A – Method to derive value is not applicable for curve number values less than 40.

1) Average runoff condition, and la=0.2s

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

3) Poor: <50% ground cover
Fair: 50 to 75% ground cover
Good: >75% ground cover

4) Poor: Forrest litter, small trees and brush are destroyed by heavy grazing
Fair: Woods are grazed but not burned, and some forest litter covers the soil
Good: Woods are protected from grazing

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.

The coefficient of runoff is expressed as a dimensionless decimal value that estimates the percentage of rainfall that becomes runoff. The residential runoff coefficients in **Table 2-5** shall be used for runoff projections using the rational formula. Runoff coefficients used to project onsite flows for multi-family, commercial, and industrial type developments must be calculated based on the actual impervious surface amounts planned for the development site. The estimation of offsite flows may be determined using the appropriate runoff coefficient for the undeveloped land uses and/or the categorical development types (residential, commercial, and industrial) listed in **Table 2-5**.

2.2.3.2. Regression Equations

The regression equations presented in USGS Report 93-135[10] is an accepted method for estimating design peak-discharge values for streams with drainage areas between 17 and 2600 acres. The application of this method is limited to the estimation of peak discharges for City funded culvert installation and replacement projects. The following equations shall be used for the various design storms:

$$Q_2 = 155\ (A)^{0.68}\ (P\text{-}30)^{0.5}\ (13\text{-}BDF)^{-0.5}$$

$$Q_5 = 200\ (A)^{0.71}\ (P\text{-}30)^{0.63}\ (13\text{-}BDF)^{-0.44}$$

$$Q_{10} = 228\ (A)^{0.74}\ (P\text{-}30)^{0.68}\ (13\text{-}BDF)^{-0.41}$$

$$Q_{25} = 265\ (A)^{0.76}\ (P\text{-}30)^{0.72}\ (13\text{-}BDF)^{-0.37}$$

$$Q_{50} = 293\ (A)^{0.78}\ (P\text{-}30)^{0.74}\ (13\text{-}BDF)^{-0.35}$$

$$Q_{100} = 321\ (A)^{0.79}\ (P\text{-}30)^{0.76}\ (13\text{-}BDF)^{-0.33}$$

where:

Q_N = peak discharge rate in cfs,

A = the drainage area in square miles,

P = average annual precipitation in inches = 37 inches for Marysville, and

BDF = the basin development factor.

The basin development factor (BDF) is determined by subdividing the drainage basin into thirds (lower, middle, and upper) with two lines drawn across the basin that are perpendicular to the main channel and principal tributaries. Four aspects of the drainage system are then evaluated within each third of the basin and assigned a value of 1 or 0:

1) ***Channel improvements*** include any straightening, enlarging, deepening, and clearing made in the main drainage channel and principal tributaries. If at least 50 percent of the upstream channels in the basin are improved, then a value of 1 is assigned.
2) ***Channel linings*** include any length of the main drainage channels and principal tributaries that have been lined with an impervious material such as concrete. A value of 1 is assigned if at least 50 percent of the upstream channels have been lined.

10 United States Geological Survey, USGS Report 93-135, *Estimation of Peak-Frequency Relations, Flood Hydrographs, and Volume-Duration-Frequency Relations of Ungaged Small Streams in Ohio*.

3) ***Storm drains or storm sewers*** are defined as enclosed drainage structures (usually pipes) frequently used on secondary tributaries where drainage is received directly from streets or parking lots. A value of 1 is then assigned when more than 50 percent of the upstream secondary tributaries consist of storm drains.

4) ***Curb and gutter streets*** frequently empty into storm drains. If more than 50 percent of the upstream basin is developed with streets and highways constructed with curbs and gutters, then a value of 1 will be assigned.

Table 2-6 provides an example for calculating the overall BDF for the entire basin that has channel improvements throughout, no channel linings, and storm drains with curb and gutter streets in the lower 2/3^{rds} of the basin:

Table 2-6

Example Determination of the Basin Development Factor

Portion of Basin	Channel Improvements	Channel Linings	Storm Drains	Curb & Gutter Streets	Basin Development Factor
Lower 1/3	1	0	1	1	3
Middle 1/3	1	0	1	1	3
Upper 1/3	1	0	0	0	1
				Total:	**7**

2.2.3.3. The NRCS (SCS) Curve Number Method

The NRCS (SCS) Curve Number method, developed in 1969, partitions the total depth of rainfall into initial abstractions, retention, and effective rainfall. This method shall be used for areas larger than 200 acres. Worksheets 2 through 6 are available in the TR-55 publication and are acceptable methods for showing calculations described in this and other applicable sections. The following equation [11] is used to estimate runoff:

$$Q = (P-I_a)^2 / [(P-I_a) + S]$$

where:

Q = runoff depth (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in)
= 1000/CN-10,
CN = runoff curve number, and

11 United States Department of Agriculture, Soil Conservation Services, Urban Hydrology for Small Watersheds, Technical Release 55, June 1986, pgs.2-1 to 2-10.

I_a = initial abstraction (in) = 0.2 * S

CN values range between 0 and 100, while practical CN values range from 30 to 98 where larger values are associated with more impervious land surface. Soil groups are classified by NRCS into four hydrologic groups: Groups A, B, C, and D. Group A soils have high infiltration rates while Group D soils have low infiltration rates. **Table 2-7** (adapted from SCS) shall be used to define curve numbers for normal antecedent moisture conditions (Type II) for various land uses and soil classifications. The residential curve numbers in **Table 2-7** shall be used for runoff projections using the SCS method. Curve numbers used to project onsite flows for multi-family, commercial, and industrial type developments must be calculated based on the actual impervious surface amounts planned for the development site. For example, an area with a directly connected impervious area (DCIA) of 70 percent with good grass cover on hydrologic soil group D soils would have the following curve number:

$CN = CN_{Impervious} * \%\ Imperviousness + CN_{pervious} * (1 - \%\ imperviousness)$

$= 98 * 0.7 + 80 * (1-0.7)$

$= 93$

The estimation of offsite flows may be determined using the appropriate curve numbers for the undeveloped land uses and/or the categorical development types (residential, commercial, and industrial) listed in **Table 2-7**. Additional information regarding the use of SCS's runoff curve number method is available in Technical Release 55 – Urban Hydrology for Small Watersheds.

The peak rate of runoff is then calculated as:

$q_p = q_u A_m Q F_p$

where:

q_p = peak discharge (cfs)
q_u = unit peak discharge (csm/in) (see **Figure 2-2**)
A_m= drainage area (mi^2)
Q = runoff depth (in)
F_p= pond and swamp adjustment factor (see **Table 2-8**)

Table 2-7
Runoff Curve Numbers (CN) for Typical Land Uses in Marysville (SCS, 1986 except as noted)

Cover Type and Hydrologic Condition	Average percent impervious area (6)	Curve Numbers for Hydrologic Soil Group			
		A	B	C	D
Fully Developed urban areas (vegetation established) (1)					
Impervious Areas: Paved Parking Lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Open Space (Lawns, parks, golf courses, cemeteries, etc.) Poor Condition (grass cover, 50%) Fair Condition (grass cover 50% to 75%) Good Condition (grass cover >75%)		 68 49 39	 79 69 61	 86 79 74	 89 84 80
Commercial and Business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts by Average Lot Size Multi-family (8) 1/12 to 1/6 Acre (8) 1/8 Acre 1/4 Acre 1/2 Acre 1 Acre	 80 75 65 38 25 20	 86 83 77 61 54 51	 91 89 85 75 70 68	 93 92 90 83 80 79	 94 94 92 87 85 84
Undeveloped or Agricultural Lands (1)					
Cultivated Land: (7) Without Conservation Treatment With Conservation Treatment		 72 62	 81 71	 88 78	 91 81
Pasture, grassland, or range – continuous forage for grazing (2)	Hydrologic Condition: Poor Fair Good	 68 49 39	 79 69 61	 86 79 74	 89 84 80
Meadow – continuous grass, protected from grazing, and generally mowed for hay.	–	30	58	71	78
Brush – brush-weed-grass mixture with brush the major element. (3)	Poor Fair Good	48 35 30(4)	67 56 48	77 70 65	83 77 73
Woods (5)	Poor Fair Good	45 36 30(4)	66 60 55	77 73 70	83 79 77
Farmsteads – buildings, lanes, driveways, and surrounding lots	--	59	74	82	86

1) Average runoff condition, and la=0.2s
2) Poor: <50% ground cover or heavily grazed with no mulch
Fair: 50 to 75% ground cover, not heavily grazed
Good: >75% ground cover, lightly or only occasionally grazed
3) Poor: <50% ground cover
Fair: 50 to 75% ground cover
Good: >75% ground cover
4) Actual curve number is less than 30; use CN=30 for runoff computations
5) Poor: Forrest litter, small trees and brush are destroyed by heavy grazing
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 covers the soil
6) The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition.
7) Source: SCS National Engineering Handbook, Section 4, Hydrology, Chapter 9, August 1972
8) Source: Curve numbers were calculated based upon percent of impervious area

2.2.4. Acceptable Runoff Hydrograph Development Methods

Peak flow methods are not appropriate for designing stormwater detention basins, evaluating downstream impacts on streams, and designing major conveyances with drainage areas larger than 200 acres. In these cases, the City requires that a hydrograph be developed and routed through the system to support design and/or evaluation. In addition, hydrograph methods may be used to design other elements of the drainage system as part of a comprehensive hydrologic/hydraulic evaluation supported by computer models or other appropriate means. Designs using hydrograph methods shall be accepted if the results are presented in the format defined in the Manual for peak flow calculations.

Several methodologies are available for defining runoff hydrographs and routing them through the drainage system. The City will accept the unit hydrograph methodology presented in this section, and may accept other equivalent methods if supported by proper documentation and a demonstrated record of successful application for drainage system design. Furthermore, hydrograph methods are generally provided by common engineering computer software, such as the NRCS TR-20, the US Army COE HEC-1 models and U.S. EPA SWMM, which may be allowed if the model results are presented in the format defined in the Manual.

2.2.4.1. Rainfall Hyetographs

All runoff hydrographs shall be based upon a design storm hyetograph defined using the 24 hour design storm rainfall volumes for the City extracted from Figure 2-1, and the 24-hour SCS Type II rainfall distribution. These design rainfall hyetographs for the various design storms referenced in the Manual are provided in **Table 2-3**.

2.2.4.2. Abstractions from Rainfall

For each catchment, abstractions from rainfall must be determined for each 15-minute rainfall volume within this hyetograph. Abstractions are comprised of depression storage and infiltration into the soil, and shall be based upon the soil and land cover characteristics of the catchment. The initial abstraction at the beginning of the design storm shall be based upon average soil moisture conditions. Changes in abstractions shall be tracked during the storm event as available depression storage and soil infiltration capacity is filled. The NRCS curve number methodology presented in **Section 2.2.3.3** is accepted by the City for defining rainfall abstractions. Other methods, including the Green-Ampt and Horton's methods[12], for determining the change in soil infiltration during a precipitation event may be used with appropriate documentation at the discretion of the City.

12 Mays, Larry, *Stormwater Collection Systems Design Handbook*, McGraw-Hill, 2001.

2.2.4.3. Unit Hydrographs

A unit hydrograph is the hydrograph of direct runoff that results from one inch of excess rainfall generated uniformly over a watershed at a constant rate during a specified time. The City will accept the SCS dimensionless unit hydrograph as the basis for developing runoff hydrographs. This method uses the table at the right, in conjunction with the equations, to develop a unit runoff hydrograph from each catchment for each 15 minute rainfall increment within the SCS Type II distribution:

$t_p = 0.666 * t_c$ and

$Q_p = P_e * 484 * A / t_p$

where:

t_p = time to peak, hours

t_c = time of concentration, hours, from **Section 2.2.2.2**

Q_p = peak flow rate from one inch of excess rainfall, cfs

P_e = excess rainfall during the 15 minute rainfall increment, in.

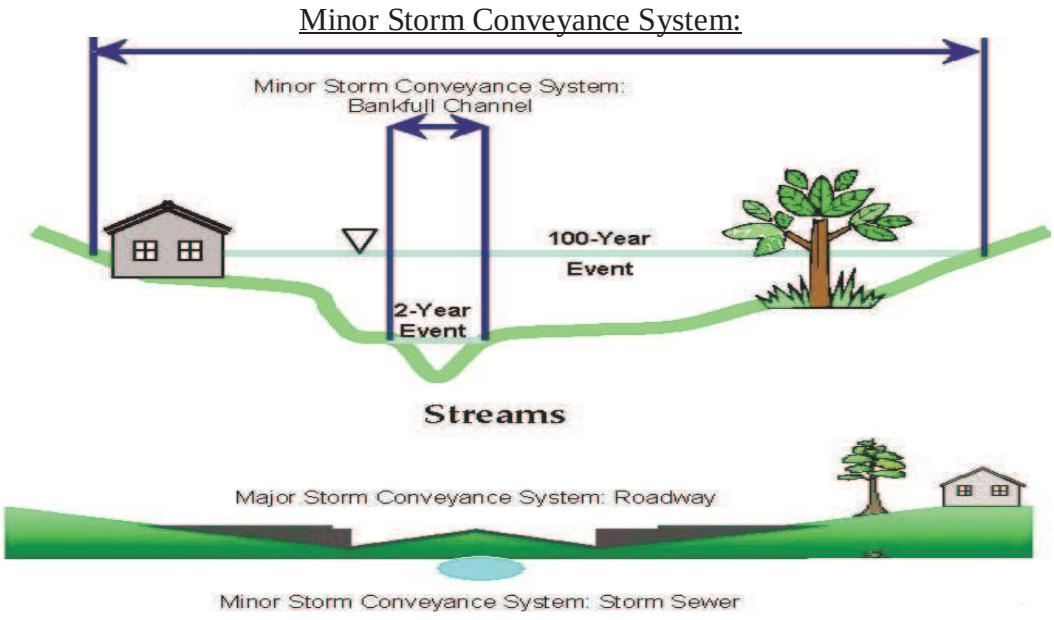
A = watershed area, mi^2

The total hydrograph responding to the SCS Type II rainfall hyetograph from the catchment is determined by adding the individual unit hydrographs determined using the previous equation. The City will accept calculations based on computer models that use the SCS unit hydrograph method to develop runoff hydrographs. In addition, the City will consider use of alternative methods for developing runoff hydrographs, including the Snyder and Clark unit hydrograph methods included in the US Army COE HEC-1 model, and the kinematic wave method included in the US Army COE HEC-1 model and U.S. EPA SWMM.

SCS Dimensionless Unit Hydrograph

t/t_p	Q/Q_p
0.0	0.000
0.2	0.100
0.4	0.310
0.6	0.660
0.8	0.930
1.0	1.000
1.2	0.930
1.4	0.780
1.6	0.560
1.8	0.390
2.0	0.280
2.2	0.207
2.4	0.147
2.6	0.107
2.8	0.770
3.0	0.055
3.2	0.040
3.4	0.029
3.6	0.021
3.8	0.015
4.0	0.011
4.2	0.008
4.4	0.006
4.6	0.004
4.8	0.002
5.0	0

2.3. Design of Minor Stormwater Conveyance Systems



Urban Drainage

Both natural streams and urban drainage systems need a minor and major storm conveyance system to accommodate flooding.

Flooding is a natural phenomenon accommodated within natural drainage systems. During rainfall events of small to moderate size, stormwater runoff is contained within the banks, or the bankfull channel, of streams. During larger, less frequent storms, runoff overflows the channel banks into the surrounding floodplain. As areas develop, portions of the natural drainage system are often replaced with underground storm sewers sized to collect and convey runoff from small to moderate storms. Properly designed developments will use streets or swales as a major storm conveyance system to convey runoff from larger, less frequent storms to the open channel drainage system. Effective drainage system design depends upon how frequently the capacity of the minor storm conveyance system should be exceeded, and how severe the impact of flooding would be within the major storm conveyance system. Frequency is expressed as a probability of occurrence in any given year. For example, the 100-year design storm event is defined as a storm that has a 1% chance of occurring in any given year. While a 100-year storm event could occur more frequently than once in every 100 years, over a very long period of time the frequency of a storm of this magnitude occurring averages to once in a hundred years.

Table 2-9 and **Table 2-10** provide a summary of the hydraulic design requirements for conveyance infrastructure discussed in this section.

On roadways with multiple through lanes in each direction, or one direction on a one-way roadway, one driving lane in each direction must be free of water. If there is only one through lane in each direction, or one direction on a one-way roadway, then the Check Storm Spread must be the same as the Maximum Design Spread. Stormwater spread on shoulders, full-time parking lanes, and other paved roadside areas and non-traffic lanes is permitted to be full width.

Table 2-9

Pavement Design Criteria (Manual Section 2.3.2)

Functional Classification	Designated Speed	Design Storm Frequency	Maximum Design Spread**	Check Storm Frequency	Check Storm Spread Criteria
Interstate Highways	All	10 year	0 feet	100 year	All traffic lanes free of water
	All	100 year	0 feet	Applies at underpasses and sag points	
Other freeways and expressways	≥ 45 mph	10 year	0 feet	25 year	*
	< 45 mph	10 year	3 feet	25 year	*
	All	50 year	3 feet	Applies at underpasses and sag points	
Major Arterial (ADT > 10000)	≥ 45 mph	10 year	0 feet	25 year	*
	<45 mph	10 year	3 feet	25 year	*
	All	50 year	3 feet	Applies at underpasses and sag points	
Minor Arterials and Collectors (ADT 3,501-10,000)	≥ 45 mph	5 year	0 feet	25 year	*
	<45 mph	5 year	½ of driving lane	Applies at underpasses and sag points	
	All	10 year	½ of driving lane	10 year	One lane open to traffic
Locals (ADT ≤ 3,500), Other parking and development areas	< 45 mph	5 year	½ of driving lane	10 year	One lane open to traffic
	< 45 mph	5 year	½ of driving lane	Applies at underpasses and sag points	

* On roadways with multiple through lanes in each direction, or one direction on a one way roadway, one driving lane in each direction must be free of water. If there is only one through lane in each direction, or one direction on a one way roadway, then the Check Storm Spread must be the same as the Maximum Design Spread. Stormwater spread on shoulders, full time parking lanes, and other paved roadside areas and non traffic lanes is permitted to be full width.
** The allowable depth of water on a roadway within the design spread shall be 1" below the top of curb or 5" maximum. 6" is permissible when a barrier shape is provided adjacent to the pavement.

Table 2-10

Storm Sewers, Culverts, Level Spreaders, and Open Watercourses Design Criteria (Manual Sections 2.3.1, 2.3.3, 2.3.6 and 2.3.7)

Functional Classification	Storm Sewers		Culverts[13]	Level Spreaders	Open Watercourses
	Design Storm	Check Storm			
Interstate highways, other freeways, and expressways	10 year	25 year	50 year	Used to prevent offsite erosion where onsite discharges cannot be directed to offsite conveyance system. This shall be limited to sites where flows are less than 30 cfs during a 10 year frequency storm.	Designed to carry the peak rate of runoff from a 10 year, 24 hour frequency storm. Those used for major storm routing shall be designed to convey the 100 year, 24 hour storm.
Major Arterial (ADT > 10000)	10 year	25 year	25 year		
Minor Arterials and collectors (ADT 3,501 – 10,000)	5 year	25 year	25 year		
Locals (ADT ≤ 3,500), other parking and development areas	5 year	10 year	10 year		

2.3.1. Storm Sewers

Storm sewer systems are designed to collect and carry stormwater runoff from the first pavement, ditch inlet, or catch basin to the predetermined outlet. Storm sewers shall generally follow the alignment of the roadway, increasing in size as necessary to accept the flow from a series of inlets. Existing drainage patterns should be perpetuated insofar as practicable, and storm sewer outlets shall be located to minimize the possibility of actionable damage for the diversion of substantial volumes of flow.

Storm sewer calculations shall be summarized onto a Storm Sewer Computation Sheet and a Storm Sewer Check Sheet, presented in **Appendix B**, for each proposed sewer run. These sheets shall be submitted to the City as part of the Stormwater Management Report (see **Section 5**).

2.3.1.1. Storm Sewer Hydrology Requirements

The Rational Method shall be used to size storm sewers, as described in **Section 2.2.3.1**. The City will also accept storm sewer designs based on hydrograph methods in **Section 2.2.4** as long as the results are tabulated in the referenced storm sewer computation and check sheets (**Appendix B**).

[13] Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design*.

2.3.1.2 Storm Sewer Hydraulic Requirements

Pipe Sizing Criteria

All storm sewer systems shall be designed using Manning's Equation:

$$Q_f = (1.49/n)\, AR^{2/3}\, S^{1/2}$$

where:

Q_f = Full flow capacity of the storm sewer (cfs)
n = Manning's roughness coefficient
R = Hydraulic radius (feet)
= A/P
A = Cross-sectional area (feet^2)
P = wetted perimeter (feet)
S = Slope of the conduit
= vertical rise of the pipe (feet) / length of the pipe (feet)

A Manning's "n" or roughness coefficient of 0.013 per ODOT 1104.4.5 shall be used to design storm sewer systems for all City-approved pipe materials.

Table 2-9 specifies the design storm frequency that shall be used to size storm sewers for various types of roadways. Storm sewer sizes may need to be increased as necessary to meet the allowable spread requirements specified in **Section 2.3.2.1**.

Storm Sewer Layout Requirements

All storm sewer systems shall be deep enough to receive the flow from all possible nearby sources within the watershed. Crown elevations for storm sewers shall be matched at junctions where possible. If the outlet elevation permits, the crown of the outlet pipe may be lowered.

Unless located within City Right-of-Way, storm sewers that are to be privately maintained shall have a minimum pipe inside diameter of eight inches. Storm sewers located within the City Right-of-Way that connect a private storm sewer system to a storm sewer owned by the City shall have a minimum inside diameter of 12 inches. Storm sewers that are to be publicly owned and maintained shall have a minimum inside diameter of 12 inches.

Storm sewers shall be designed to operate under subcritical flow conditions at all times because flow transients and/or small blockages may cause storm sewers built on supercritical slopes to surcharge unexpectedly. Drop manholes or other drop structures shall be used to maintain a mild pipe slope where ground slopes are steeper than critical slope. The maximum length between access structures shall be as follows:

1) Pipes under 60 inches in diameter – 300 feet
2) Pipes 60 inches in diameter and larger - 500 feet

All storm sewers shall be centered in the middle of easements established according to criteria in **Section 2.3.1.4**.

Headwalls shall be provided at all storm sewer outlets and shall conform to the most current edition of the City's Standard Construction Drawings.

All storm sewers and their structures shall be kept away from building foundations or sanitary sewers as much as practicable to minimize stormwater inflow into these facilities. In instances where a proposed storm sewer will cross a sanitary sewer trench, watertight joints and trench dams shall be provided along the entire length of the proposed storm sewer from each manhole on either side of the crossing. If the storm and sanitary sewers are parallel and are within 5 feet of each other, water-tight joints and trench dams shall be installed along the entire run of the storm sewer until the distance between the storm sewer and sanitary sewer trenches exceed 5 feet.

Watertight joints and trench dams shall be specified for storm sewers that are to be located along side lot lines in a single family development site or where the trench limits of the storm sewer are to be within 10 feet of a building foundation.

2.3.1.3 Hydraulic Grade Line and Energy Loss Considerations

The hydraulic grade line shall be calculated based on an observed or calculated tailwater depth in the receiving channel determined through downstream analysis or the following equation, whichever is greater:

$$T_w = (d_c + D)/2$$

where:

T_w = Tailwater depth (feet)
d_c = Critical depth in the pipe (feet)
D = Inside pipe diameter (feet)

The hydraulic grade line shall not exceed the window, grate, or casting elevation of any structure for the design storm frequency noted in **Table 2-10**.

Major energy losses within storm sewer systems are primarily caused by friction resistance between the fluid being conveyed and the pipe section conveying the flow. The following equation shall be used to calculate energy losses due to pipe friction:

$$H_{major} = S_f * L = [(Q_{HGL} * n)/(1.486 * A * R^{2/3})^2] * L$$

where:

H_{major} = Major energy loss due to friction (feet)
S_f = frictional slope (feet)
Q_{HGL} = Design flow (cfs)

n = Manning's roughness coefficient
A = cross-sectional area of the pipe (square feet)
R = hydraulic radius (feet) = cross-sectional area of the pipe (A) / wetted perimeter (P)
L = length of pipe (feet)

In addition to friction losses, localized disruptions to flow increase turbulence and cause energy losses within storm sewer systems. These disruptions, often caused by manholes or fittings, are generally called minor energy losses. Minor losses shall be calculated using the following equation:

$$H_m = K (V^2) / 2g$$

where:

H_m = minor loss (feet)
K = minor loss coefficient for the specific fitting
V = velocity (feet/s)
g = gravitational acceleration = 32.2 feet/s^2

Accepted values for common minor loss coefficients are provided in **Table 2-11**. Applicants must use the appropriate minor loss coefficients, the appropriate design flow (Q_{HGL}) as determined from **Table 2-10**, and the following equation to check that the slope of the hydraulic grade line will not exceed the ground elevation:

$$S_f = (Q_{HGL}*n/(1.486*A*R^{2/3})^2 + H_m/L$$

where:

S_f = frictional slope (feet)
Q_{HGL} = Design flow (cfs)
n = Manning's roughness coefficient
A = cross-sectional area of the pipe (square feet)
R = hydraulic radius (feet) = cross-sectional area of the pipe (A) / wetted perimeter (P)
H_m = minor loss (feet)
L = length of pipe (feet)

Flow Velocity Criteria

All storm sewers shall be designed and constructed to produce a minimum velocity of 3.0 feet per second (fps) when flowing full, unless it can be shown that this requirement cannot be met due to site conditions. In addition, storm sewers shall be designed for subcritical flow conditions with a maximum velocity of 15 ft/sec. The outlet ends of all storm sewers shall be provided with sufficient energy dissipaters and erosion protection to withstand the projected full-flow velocity from the pipe.

Table 2-11

Minor Loss Coefficients for Storm Sewers[14]

Type / Description of Structure	Coefficient K
Manhole in straight section of closed conduit	0.50
Manhole at a 45° bend	0.62
Manhole at a 90° bend	0.75
Exit closed conduit into lake (submerged)	0.90
Exit closed conduit to open channel (submerged)	0.50
Exit closed conduit to open channel (free discharge)	0.10

2.3.1.4 Pipe Material, Bedding, Cover, and Encasement Requirements

The pipe material type and surrounding conditions shall be determined by the Applicant and specified in the Report, including the depth of cover, groundwater levels (if known), location of pipe with respect to roadways or highways, and type of proposed pavement. For pipes having equivalent materials and dimensions, the cover and structural requirements for storm sewer pipes provided in Section 1008 of ODOT's L&D Manual shall be met. In instances where accepted pipe materials and dimensions but structural criteria are not included in Section 1008 of ODOT's L&D Manual, the cover and structural design of the pipe shall be in accordance with the pipe manufacturer's recommendations.

The trench bedding and backfill design for all pipes shall conform to the requirements of the ODOT Standard Construction Drawing DM-1.4. The bedding type (I or II) is specified in the ODOT CMS 603.02 for both rigid and flexible pipe.

2.3.1.5 Storm Sewer Easement Requirements

All storm sewers that are to be publicly owned and operated shall have a minimum easement of 20 feet centered on the sewer, or 5 feet beyond the minimum trench limits on either side of the trench (as specified in Standard Construction Drawings), whichever is greater. Additional easements shall also be provided along storm sewers within the public right-of-way but less than 10 feet from the right-of-way line. The added easement width shall be wide enough to provide a total access width (easement plus right-of-way) of 10 feet from the center of the storm sewer. Storm sewer easements shall be expanded to include ancillary structures such as end treatments, outfall protection, and level spreaders that are publicly owned and maintained. The width of easements shall include the area of the ancillary structure plus 10 feet around the structure's perimeter.

14 Water Environment Federation and American Society of Civil Engineers, *Design and Construction of Urban Stormwater Management Systems*, 1992.

2.3.2. Curb Inlets and Catch Basins

Stormwater inlets and catch basins direct surface runoff into a storm sewer system or culvert. The three types of stormwater inlet structures include curb inlets, catch basins, and combination inlets. Curb inlets consist of an opening in the side of a curb, catch basins are slotted inlets usually flush with the surrounding ground, and combination inlets have a curb opening and a catch basin with a slotted grate.

2.3.2.1. General Criteria

Inlets and catch basins shall be sized and spaced to restrict the spread of runoff along roadway surfaces and limit ponding in low areas. **Table 2-9** summarizes the allowable spread of runoff on various classifications of roadways.

The rational method (see **Section 2.2.3.1**) and a minimum time of concentration of 5 minutes shall be used to determine the amount of runoff that will be collected by the proposed inlet structures. Hydraulic analyses used to size and space inlets and catch basins shall be based on the methods presented in (FHWA) Hydraulic Engineering Circular No. 12 "Drainage of Highway Pavements" and Hydraulic Engineering Circular No. 22 "Urban Drainage Design Manual."

2.3.2.2. Underpass or Sag Requirements

An underpass or sag condition is a point where water can be removed only through a storm sewer system. Inlets shall be placed in low areas such as sag curves along a highway, underpasses, and other depressions where runoff may concentrate and the only outlet is the storm sewer system. The number and type of inlets to be used to drain underpass or sag locations shall be designed to achieve the roadway classifications and storm frequencies provided in **Table 2-9**.

2.3.2.3. Inlets on Continuous Grade Requirements

At a minimum, the catch basin and/or curb inlet shall be placed at the point where the flow spread is projected to reach the maximum allowable spread listed in **Table 2-9**. In addition, a basin/inlet shall be placed at intersections where necessary to prevent the gutter flow from crossing the pavement. The City may require additional inlets at intermediary points if the flow in the gutter at design conditions might create a hazard to vehicular traffic, public safety, or property flooding. The projected gutter flow approaching each basin/inlet, the flow projected to enter each basin/inlet, and the flow projected to bypass each basin/inlet shall be provided in the Stormwater Management Report.

2.3.3. Culverts

2.3.3.1. General Requirements

Stream crossings shall be located at a relatively straight and stable section of the stream. The horizontal and vertical alignment of the culvert shall generally follow the alignment of the stream at the crossing. Stream crossings at right angles to the stream are preferred to maximize hydraulic efficiency and minimize environmental impacts. If the skew angle of the culvert exceeds 45°, then either the roadway alignment or the culvert alignment (or both) shall be revised to achieve a skew angle less than 45°.

A single barrel round pipe shall be used where flow, headwater, tailwater, and pipe cover conditions allow. Where round pipes are not feasible, single barrel elliptical, pipe arch, box culvert, and three-sided structures shall be used, in order of preference. Where single barrel conduits are not feasible, multi-barreled culverts shall be used to minimize the disturbance to the stream channel and provide capacity for flows within the floodplain to minimize backwater.

2.3.3.2. Culvert Hydrology Requirements

The hydrologic computation methods specified in **Section 2.2.1** shall be used to design culverts in the City. Culverts spanning open channels conveying onsite flows shall be designed according to the same method used to design other onsite drainage facilities. Culverts spanning Tier I and Tier II watercourses shall be designed using the regression equations presented in **Section 2.2.3.2**.

2.3.3.3. Culvert Hydraulic Requirements:

Design Storm Frequency

Table 2-12 provides the design storm frequencies that shall be used to design roadway and other stream crossings:

Table 2-12

Culvert Design Storm Frequency[15]

Roadway Type	Design Storm Event
Interstate Highways, other Freeways, and Expressway	50-year
Major Arterial (ADT > 10,000)	25-year
Minor Arterial and Collectors (ADT = 3,501 - 10,000)	25-year
Local Streets (ADT ≤ 3,500), other parking and development areas	10-year

Types of Culvert Flow

Two types of flow may occur in a culvert: flow with inlet control and flow with outlet control. Designers shall determine the design flow regime for each culvert within the project, and use appropriate design nomographs for the appropriate flow condition, found in the drainage design aids contained in the ODOT L&D Manual.[16]

Tailwater Conditions

The designer shall perform hydraulic calculations necessary to determine the depth of flow in the outlet channel when the culvert is discharging the design flow. This determination shall take into account downstream constraints, obstructions, grades, confluences with other streams, or other hydraulic features that may create a backwater at the culvert outlet. The following sources contain information that might aid in establishing downstream tailwater conditions:

15 Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design.*

16 Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design.*

Previous studies that may be on file within the Division of Sewerage and Drainage, or

1) Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) and data.

The tailwater depth for the design frequency of the culvert shall be used to size the culvert.

Maximum Allowable Headwater

The headwater depth at the inlet of each roadway culvert shall not exceed any of the following conditions during the design storm listed in **Table 2-12**:

1) 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater, and 1 foot below for culverts draining less than 1000 acres,
2) 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat to rolling terrain,
3) 4 feet above the inlet crown of a culvert in a deep ravine,
4) 1 foot below the near edge of pavement for bicycle pathways, and
5) At or below the near edge of pavement for driveway culverts conveying runoff along roadside ditches.

In addition, the peak headwater depth during the 100-year frequency event shall be 1 foot below the finished grade adjacent to any existing or proposed building. **Section 2.4** provides additional overtopping requirements related to culverts within major flood routing paths.

Manning's "n" Value

Acceptable materials for culverts include concrete (non and reinforced), and precast box and concrete sections. Manning's "n" value of 0.013 shall be used for the hydraulic design of concrete culverts.

Entrance Loss Coefficients

Table 2-13 shall be used to define (minor) entrance loss coefficients for culverts under outlet control conditions.

Maximum Allowable Outlet Velocity

The Applicant shall determine the cross-sectional area of flow from the culvert outlet, and use his area, the design flow, and other characteristics of the culvert to determine the outlet velocity at design conditions. If the outlet velocity is larger than the maximum velocity for the channel lining material that is listed in **Table 2-16** of **Section 2.3.5.1**, then erosion protection and/or energy dissipaters shall be required to properly armor the receiving channel and control outlet velocities. **Section 2.3.5** provides design requirements for rock protection and recommendations for energy dissipation devices at culvert outlets.

Table 2-13

Minor (Entrance) Loss Coefficients for Culverts under Outlet Control, Full or Partly Full Entrance Head Loss [17][18]

Type of Structure and Design of Entrance	Coefficient K
Pipe, Concrete	
Projecting from fill, socket end (groove end)	0.2
Projecting from fill, square cut end	0.5
Headwall or headwall and wingwalls - Socket end of pipe (groove end) - Square edge - Rounded (radius = 1/2D)	0.2 0.5 0.2
Mitered to conform to fill slope	0.7
End section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° levels	0.2
Side or slope tapered inlets	0.2
Pipe or Pipe Arch, Corrugated Metal	
Projecting from fill	0.9
Headwall or headwall and wingwalls square edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
End section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° levels	0.2
Side or slope tapered inlets	0.2

17 Water Environment Federation and American Society of Civil Engineers, *Design and Construction of Urban Stormwater Management Systems*, 1992, pg 156.

18 Federal Highway Administration, *Hydraulic Design of Highway Culverts, Hydraulic Design Series No. 5*, Report No. FHWA-IP-85-15, Washington DC, 1985

Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls) - Square edge - Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	 0.5 0.2
Wingwalls at 30° to 75° to barrel - Square edged at crown - Crown edge rounded to radius of ½ barrel dimension, or beveled top edge	 0.4 0.2
Wingwall at 10° to 25° to barrel, square edged at crown	0.5
Wingwalls parallel (extension of sides), square edged at crown	0.7
Side or slope tapered inlet	0.2

Bankfull Design Considerations

The designer shall check that any culvert sized to meet the hydraulic design conditions in this section will also convey the bankfull discharge with minimal change to the bankfull depth of flow in the adjoining channel sections, as compared to existing conditions. The bankfull discharge shall be determined using a field-obtained stream cross-section from a portion of the stream that does not exhibit bank or bed erosion.[19] If such a cross-section is not available, then the 2-year discharge shall be used to approximate the bankfull discharge. A hydraulic profile through the channel shall be prepared to demonstrate that the culvert does not alter existing water surface elevations at bankfull conditions. If significant changes in water surface elevation are determined, larger pipe sizes and/or alternative pipe shapes shall be used to reduce the impact.

The City also requires that the inverts of culverts at Tier I and Tier II stream crossings be depressed to minimize stream impacts. Depressed inverts shall be filled with substrate necessary for aquatic life to migrate through the culvert. The culvert design shall be based on the remaining pipe diameter and increased Manning's "n" after the invert has filled with substrate. **Table 2-14** shows the amount of invert depression that should be provided for different sized pipes.

Table 2-14

Allowable Conduit Invert Depression [20]

Pipe Diameter or Rise	Depression
<36 inch	None
36 to 60 inch	6 inches
66 to 120 inch	12 inches
120 to 180 inch	18 inches

19 Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design.*

20 Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design*, Table 1105-2.

2.3.3.4. Culvert Layout Requirements

Culverts shall be aligned according to the general criteria in **Section 2.3.3.1**. It is preferable that the culverts be located at or near the low point of the roadway sag vertical curve to allow for major storm routing across the roadway and along the natural routing path of the existing open channel.

Minimum Pipe Size

Minimum pipe size for roadway culverts shall be based on the fill depth over the crown of the culvert, as specified in **Table 2-15**.

Table 2-15

Minimum Allowable Pipe Size for Various Fill Depths [21]

Fill Depth	Roadway Type	
	Freeway*	Other
<8 feet	24 inch	15 inch
8 feet to < 16 feet	30 inch	24 inch
16 feet to < 32 feet	36 inch	30 inch
>32 feet	42 inch	36 inch

* or other multi-lane facilities with limited or controlled access

Structural and Cover Requirements

The cover and structural requirements for culverts shall be the same as specified for storm sewers in **Section 2.3.1.3**.

2.3.3.5. Culvert Easement Requirements

Culverts or portions of culverts and ancillary components (e.g., headwalls, and erosion protection areas) shall be located entirely within the public right-of-way or easement to provide future access and maintenance.

2.3.4. End Treatments

End treatments are used to dissipate energy and minimize erosion at the inlet and outlet of culverts and storm sewer outfalls. End treatments shall be provided at the inlet and outlet of all culverts (**Section 2.3.3**), excluding driveway culverts, and at the outlet of all storm sewer systems (**Section 2.3.1**). The selection of end treatment type is based on safety and economics. Construction of roadway culvert headwalls shall conform to the ODOT CMS, including Class C concrete for cast in place headwalls and reinforcing steel.

Cast in place pipe culvert headwalls, 8 to 84 inches in diameter, shall be comprised of Class C concrete and designed / constructed per ODOT Standard Construction Drawings. Cast in place half height headwalls will not be accepted within City limits.

21 Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design*, Figure 1002-1.

Precast headwalls approved for pipe culverts 12 to 36 inches in diameter shall be constructed per City of Marysville Standard Construction Drawings. Half height precast headwalls will not be accepted within City limits.

2.3.5. Outlet Channel Protection

2.3.5.1. Outlet Channel Protection Required

Rock channel protection is used to control erosion at the outlet of culverts and storm sewers, or for lining ditches on steep grades. It is used as a scour countermeasure at the inlet wingwalls of full-height headwalls and along the footings of 3-sided structures.

The appropriate channel protection shall be designed to prevent erosion at the outlet of a culvert or storm sewer outfall where concentrated flows generate peak velocities that exceed the maximum allowable velocity for the constructed channel lining materials listed in **Table 2-16,** or the native vegetation that exists within an existing receiving stream during the design storm event. This section provides general design criteria for two categories of outlet channel protection:

1) Rock Channel Protection and Riprap Aprons, suitable for outlet velocities up to 20 feet per second.
2) Energy Dissipation Devices, suitable for outlet velocities greater than 20 feet per second.

Table 2-16
Maximum Velocities for Channel Lining Materials ([22]) ([23]) ([24])

Channel Lining Material	Maximum Allowable Velocity (ft/s)*
Tier I and Tier II Streams	
Sand	2.0
Silt	3.5
Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay	5.0
Graded Loam or Silt to Cobbles	5.0
Coarse Gravel	6.0
Shales and Hard Pans	6.0
Vegetated Channels (per ODOT 659.09)	
Seed mixtures for urban areas	2.5**
Other seed mixtures	2.5**
Crown Vetch	2.5**
Established Seed or Sodded Channels	6.0
Flexible Linings	
Slope Erosion Protection	Follow manufacturer's criteria. Use shear stress analysis
Erosion Control Matting	
Rock Channel Protection	
Rigid Linings	
Concrete	18
Concrete block mat	18

* In addition, the maximum velocity shall not exceed the velocity under critical flow conditions at all depths within the channel up to the design flow depth.

** Velocity assumes newly seeded areas without erosion control matting provided.

22 American Association of State Highway Transportation Officials, *Model Drainage Manual,3rd Edition*, 2004.

23 Georgia Soil and Water Conservation Commission, *Manual for Erosion and Sediment Control in Georgia*, 5th Edition, 2000.

24 City of Greeley, Colorado, *Stormwater Drainage Design Criteria and Construction Specifications*, 2002.

There are four types of rock channel protection (RCP) that are used in various situations. The use of the proper type at culvert and storm sewer outlets can be determined from the ODOT L&D Drainage Design Manual, Figure 1107-1.

Type A is generally used beyond the outlet of the larger conduits having outlet velocities in excess of 12 feet per second and Type B and C for should always be specified to prevent soil piping through the rock. A fabric filter is preferred in most cases. An aggregate filter should be used when the RCP is under water. The cost of the filter is included in the unit bid price for Item 601 Rock Channel Protection with Filter.

2.3.5.2. Rock Channel Protection and Riprap Aprons

Riprap aprons (**Figure 2-3**[25]) may be used as transitions from culverts or storm sewer outfalls to stable channel sections. Riprap aprons are constructed at a zero grade for a distance related to the outlet flow rate and tailwater depth. The use of riprap aprons is restricted to outlet Froude (Fr) numbers less than or equal to 2.5. Riprap aprons are commonly used because of their low cost and ease of installation. Acceptable design procedures for riprap aprons are found in Georgia Soil and Water Conservation Commission, *Manual for Erosion and Sediment Control in Georgia*, 5th Edition, 2000.[26]

Tailwater depth

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth. If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition.

Apron length

The apron length shall be determined from the curves according to the tailwater condition:

1) Minimum Tailwater – Use **Figure 2-4**
2) Maximum Tailwater – Use **Figure 2-5**

Apron width

When the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less. If the pipe discharges onto a flat area with no defined channel, the width of the apron shall be determined as follows:

1) The upstream end of the apron, adjacent to the pipe, shall have a width three times the diameter of the outlet pipe.
2) For a Minimum Tailwater Condition, the downstream end of the apron shall have a width equal to the pipe diameter plus the length of the apron.
3) For a Maximum Tailwater Condition, the downstream end shall have a width equal to the pipe diameter plus 0.4 times the length of the apron.

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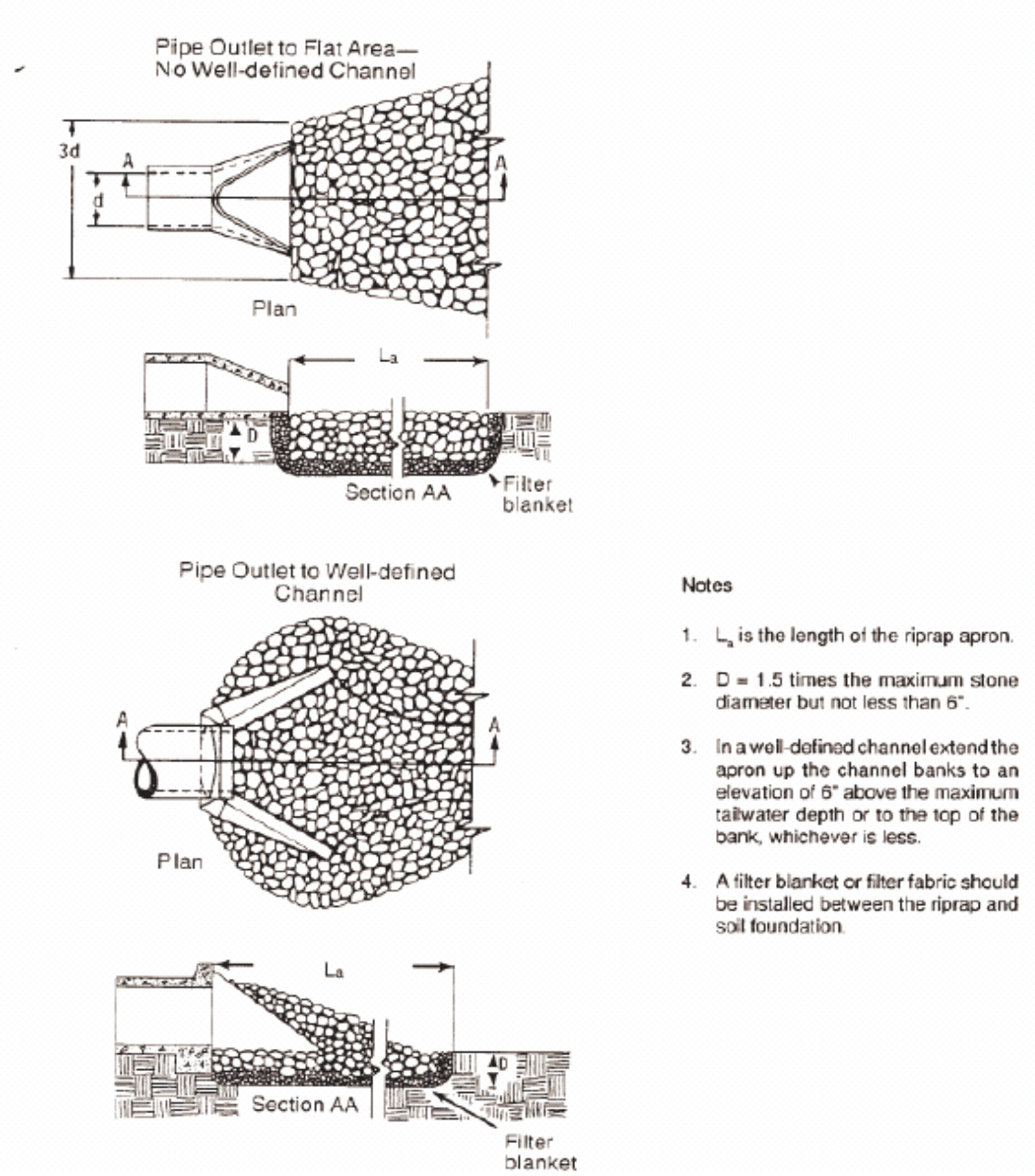
25 Georgia Soil and Water Conservation Commission, *Manual for Erosion and Sediment Control in Georgia*, 5th Edition, 2000.

26 Georgia Soil and Water Conservation Commission, *Manual for Erosion and Sediment Control in Georgia*, 28 5th Edition, 2000.

Figure 2-3

Riprap Apron Detail



Notes

1. L_a is the length of the riprap apron.
2. D = 1.5 times the maximum stone diameter but not less than 6".
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6" above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

Figure 2-4

Design of Outlet Protection – Minimum Tailwater Condition

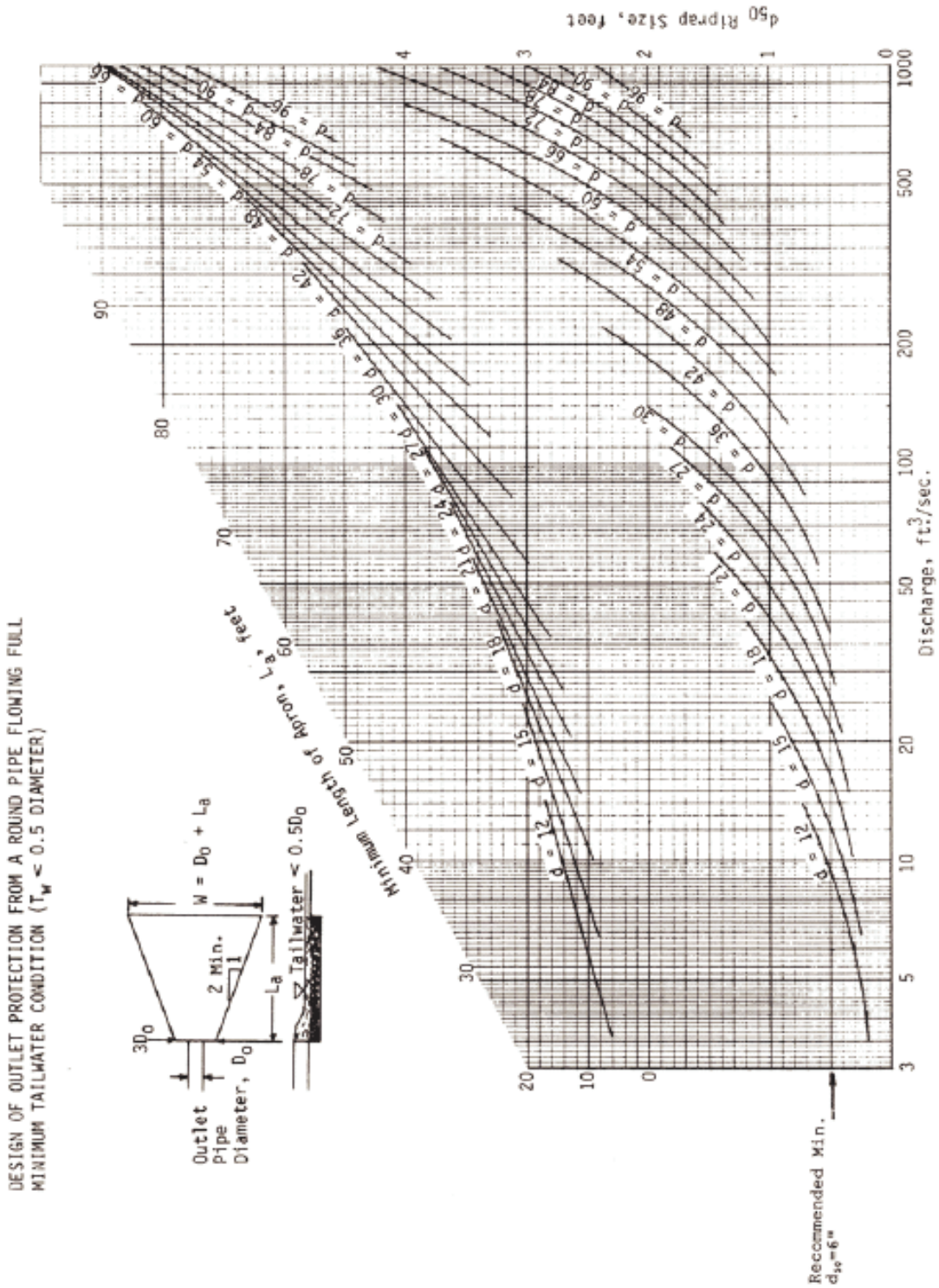
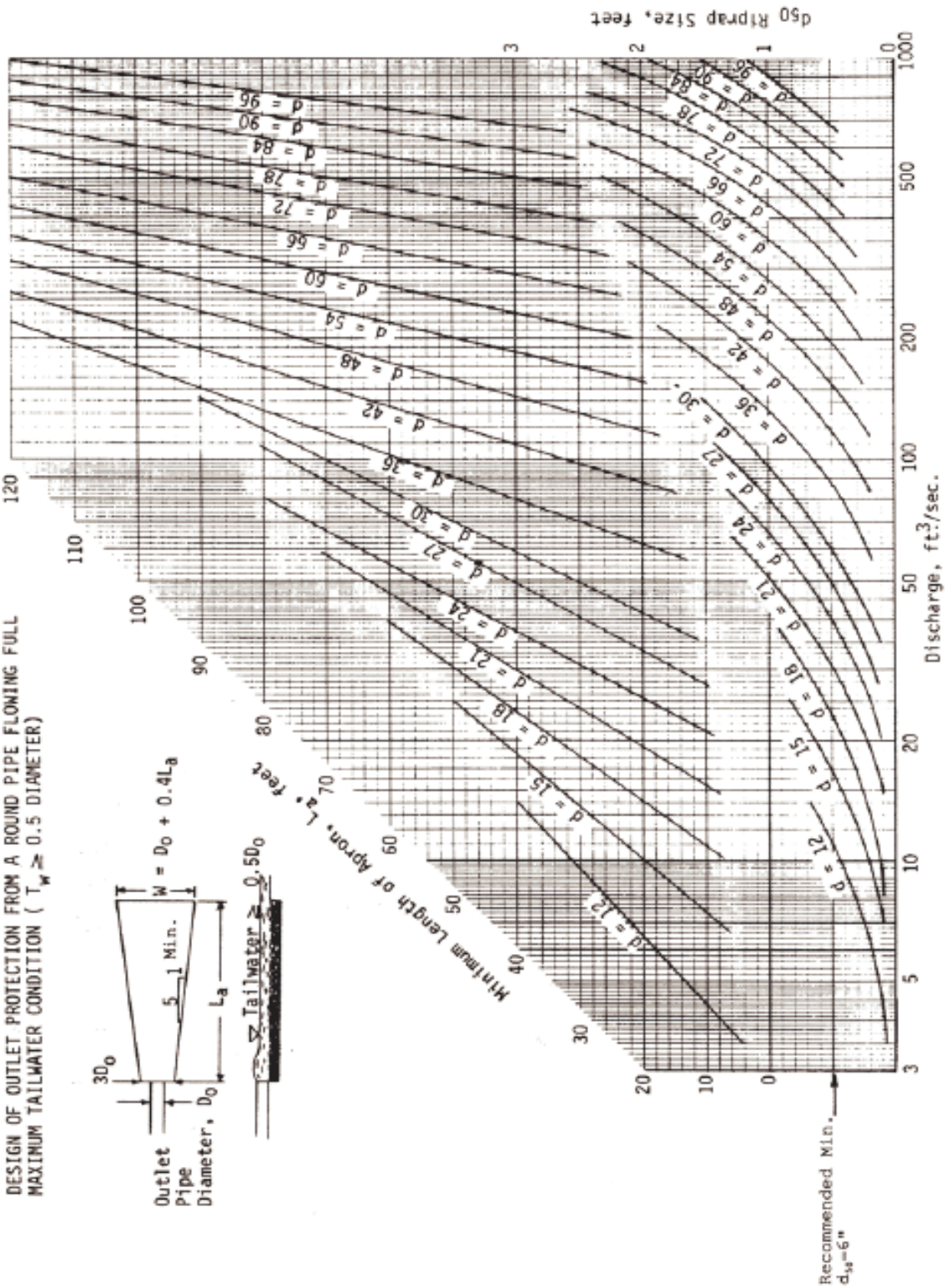


Figure 2-5

Design of Outlet Protection – Maximum Tailwater Condition



Bottom Grade

The apron shall be constructed with no slope along its length (0.0% grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel.

Side slope

If the pipe discharges into a well-defined channel, the side slopes of the channel shall not be steeper than 2:1 (horizontal: vertical).

Alignment

The apron shall be located so there are no bends in the horizontal alignment.

Materials

The median sized stone for riprap shall be determined from Figures 2-4 and 2-5 according to the tailwater condition. The materials and placement of riprap shall conform to the requirements of the ODOT CMS Section 601. At the discretion of the City Engineer, the use of flat stones (as referenced in CMS 601.04) of native material may be used as a streambed liner where it can be demonstrated that the lining will remain stable.

2.3.5.3. Energy Dissipation Devices

Energy dissipation devices[27] are required to prevent scour at culvert and storm sewer outlets and minimize potential for downstream erosion whenever the outlet velocity exceeds 20 ft/sec or the outlet discharges under supercritical flow conditions. Since energy dissipaters function by creating a hydraulic jump, performance is dependent on tailwater conditions. If there is potential for high tailwater conditions in the downstream channel and an energy dissipation device is necessary, then the device shall be designed for low tailwater conditions while the downstream channel is sized to account for higher tailwater conditions. Outlet structures shall provide uniform redistribution or spreading of the flow without excessive separation and turbulence. The maximum velocity exiting an energy dissipation device shall not exceed the maximum velocity of the downstream channel lining in **Table 2-16**.

The following sections summarize key design criteria and provide corresponding references for the design of acceptable energy dissipation devices in the City.

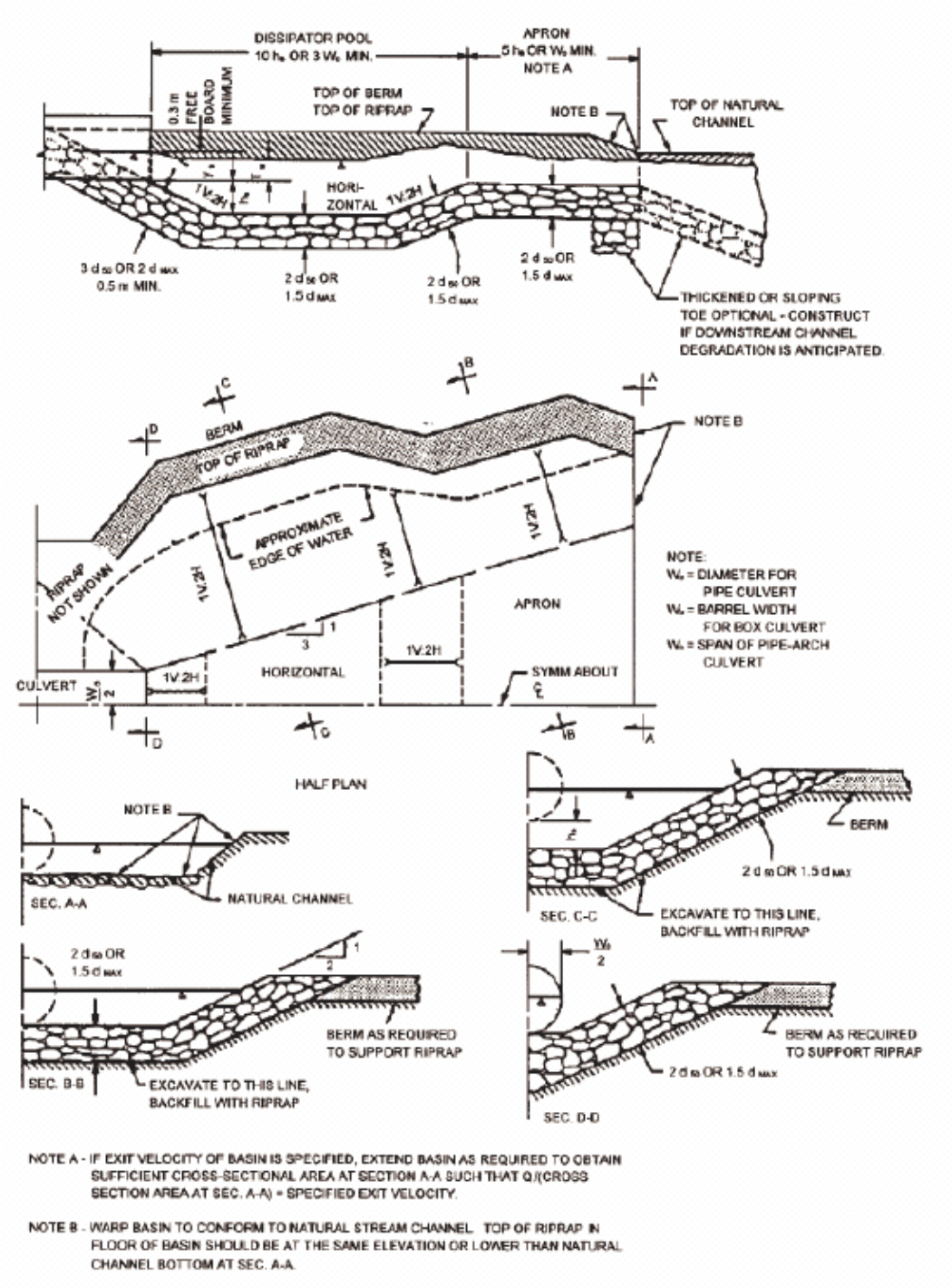
Riprap Outlet Basins

One approved method of energy dissipation at storm sewer and culvert outlets is a riprap outlet basin (**Figure 2-6**), which is composed of a dissipation pool and an apron lined with riprap of a median size (d_{50}). The dissipation pool is sized to the approximate depth of scour that would occur in a pad of riprap of size d_{50} if subjected to design discharge, and with a length sufficient to completely contain the hydraulic jump. These structures are generally used for transitions from culverts to stable channels where the Froude Number is less than 2.5. Riprap outlet basins shall be designed according to procedures contained in FWHA's HEC No. 14.

27 Atlanta Regional Commission, *Georgia Stormwater Management Manual*, Volume 2 (Technical Handbook), 1st Edition, August 2001, Section 4.5.

Figure 2-6

Riprap Outlet Basin Detail



NOTE A - IF EXIT VELOCITY OF BASIN IS SPECIFIED, EXTEND BASIN AS REQUIRED TO OBTAIN SUFFICIENT CROSS-SECTIONAL AREA AT SECTION A-A SUCH THAT Q/(CROSS SECTION AREA AT SEC. A-A) = SPECIFIED EXIT VELOCITY.

NOTE B - WARP BASIN TO CONFORM TO NATURAL STREAM CHANNEL. TOP OF RIPRAP IN FLOOR OF BASIN SHOULD BE AT THE SAME ELEVATION OR LOWER THAN NATURAL CHANNEL BOTTOM AT SEC. A-A.

Baffled Outlets

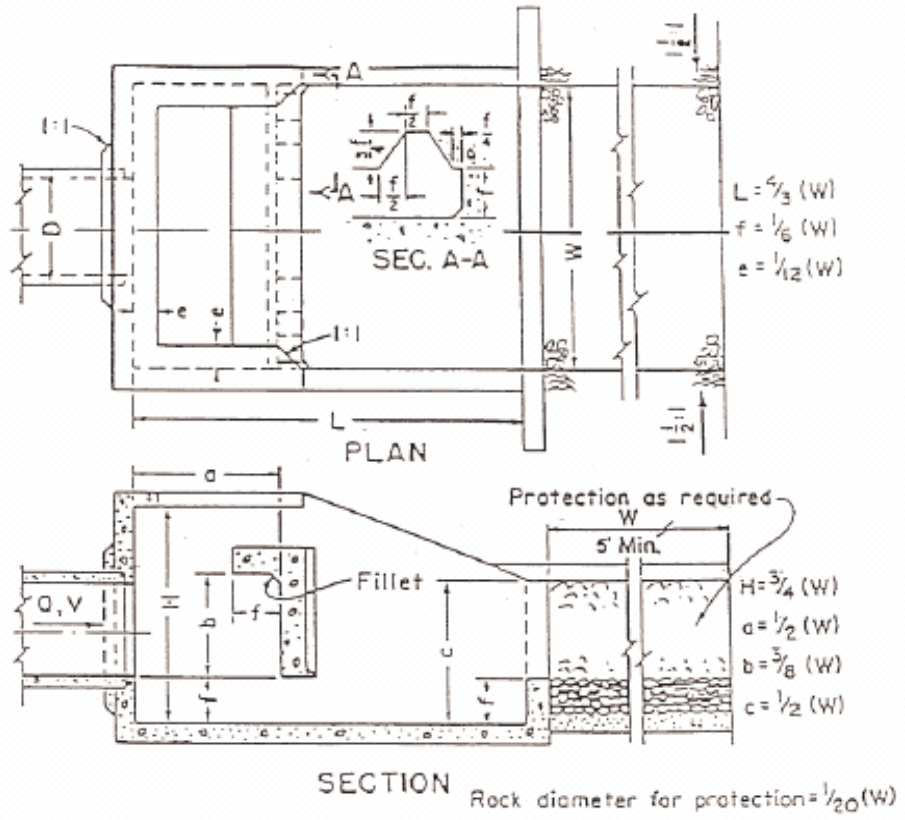
Baffled outlets (also known as Impact Basins – U.S. Bureau of Reclamation Type VI) consist of a boxlike structure with a vertical hanging baffle and an end sill (**Figure 2-7**). Energy is dissipated through the impact of water striking the baffle and the resulting turbulence. Baffled outlets may be used for outlets with a Froude number between 1 and 9 and velocities up to 50 feet/sec. Tailwater does not significantly affect the energy dissipation achieved by these structures. The U.S. Department of Interior's *Design of Small Canal Structures* report shall be used to design baffled outlets.

Forced Hydraulic Jump Basins

A forced hydraulic jump basin utilizes blocks, sills, or other roughness elements to impose exaggerated resistance to flow in order to shorten and stabilize the hydraulic jump. These types of energy dissipation are required where the design velocity and/or Froude Number exceed acceptable criteria for riprap aprons and basins, or when site constraints or environmental factors require that the length of energy dissipation be minimized. Acceptable designs include those developed by the U.S. Bureau of Reclamation, Colorado State University, and the U.S. Natural Resources Conservation Service at St. Anthony Falls Hydraulic Laboratory. The designer shall use design criteria provided in FHWA's HEC-14, *Design or Small Canal Structures* or other design criteria acceptable to the City.

Figure 2-7

Baffled Outlet Detail



2.3.6. Level Spreaders

A level spreader (**Figures 2-8** and **2-9**) is a structure that is designed to convert concentrated flow from stormwater runoff to sheet flow. The purpose of a level spreader is to 1) reduce energy from concentrated flow at stormwater outfalls that might otherwise induce erosion across an area where sheet flow currently exists, and 2) to reduce the depth and velocity of flow such that runoff can be "treated" by a water quality BMP. While level spreaders do offer energy dissipation benefits, they should not be confused with the outlet channel protection and energy dissipation devices in **Section 2.3.5** that are typically constructed at the end of outlet pipes within open watercourses.

Level spreaders are appropriate for storm sewers, detention basin outlets, or discharges from impervious areas where the peak flow during the design storm event is less than 30 cfs.[28] In instances where concentrated flows from a storm sewer or detention basin outlet exceeds 30 cfs, a constructed open channel conveyance system and/or outlet channel protection shall be provided to a Tier I or II stream. Level spreaders shall be used:

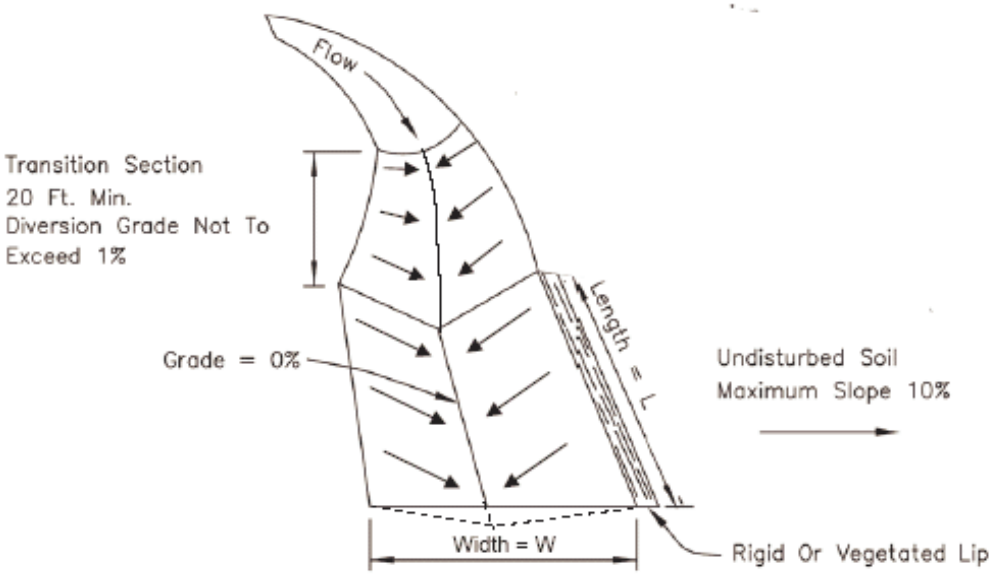
1) At the outfall of storm sewers or detention basins where the downstream, offsite, flow regime exists as sheet flow at the time of development. The area immediately downstream of the level spreader must be part of the development or owned by the Applicant.
2) At outfalls where concentrated flows less than 30 cfs are directed toward a Tier I or Tier II stream. In such instances, the conversion of concentrated flow to sheet flow shall take place outside of the Stream Corridor Protection Zone. Exceptions may be granted where it can be shown that a concentrated flow regime existed at the outfall point prior to development.
3) At outfalls where concentrated flows less than 30 cfs are directed toward an existing wetland system. In instances where the wetland is protected within a Stream Corridor Protection Zone, the conversion of concentrated flow to sheet flow shall take place outside of the Stream Corridor Protection Zone. Exceptions may be granted where it can be shown that a concentrated flow regime existed at the outfall point prior to development.
4) Upstream of water quality BMPs (e.g., filter strips; see **Section 3.3.6.3**) where "treatment" of stormwater runoff is dependent on the velocity and depth of flow.

In addition to the requirements of this section, use the Ohio Rainwater and Land Development Manual (Second Edition 1996; NRCS Design Note 24, Guide for Use of Geotextiles) to provide further guidance on the evaluation, planning, and design of level spreaders.

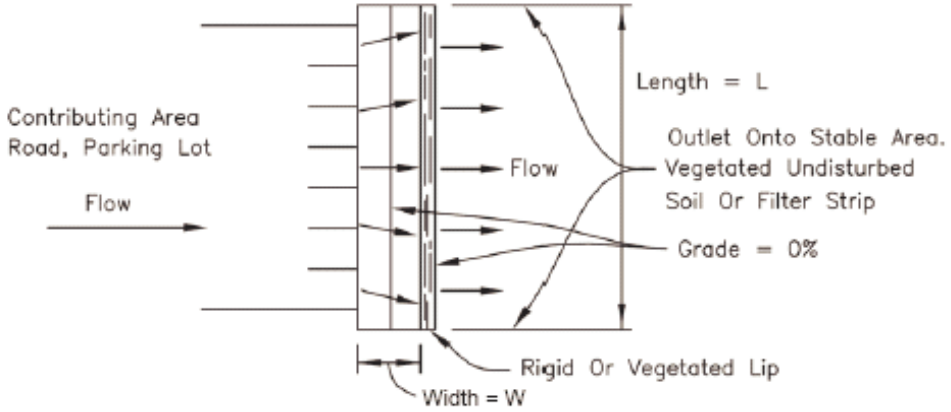
28 Ohio Department of Natural Resources, *Ohio's Rainwater and Land Development Manual*, 2nd Edition, 1996, Section 2.

Figure 2-8

Typical Level Spreader Applications[29]



LEVEL SPREADER FOR CONCENTRATED FLOW



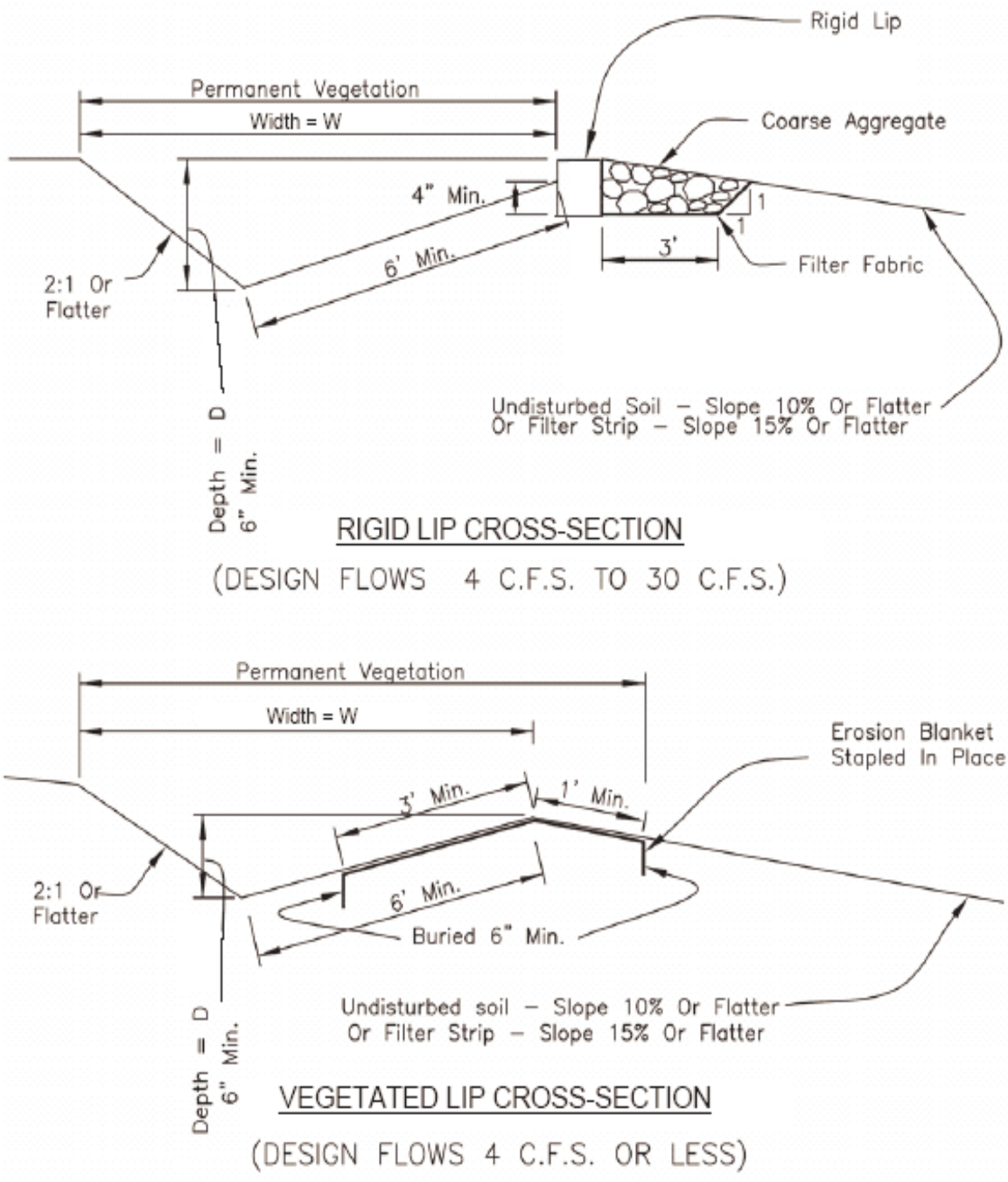
LEVEL SPREADER FOR IMPERVIOUS AREAS

NOTES:
1. Ends of spreader shall be tied into higher ground to prevent flow around the level spreader.
2. See plans for L and W dimensions.

29 United States Department of Agriculture, Natural Resources Conservation Service, *Illinois Urban Manual: A Technical Manual Designed for Urban Ecosystem Protection and Enhancement,* prepared for the Illinois EPA by Illinois NRCS.

Figure 2-9

Level Spreader Details[30]



30 United States Department of Agriculture, Natural Resources Conservation Service, *Illinois Urban Manual: A Technical Manual Designed for Urban Ecosystem Protection and Enhancement,* prepared for the Illinois EPA by Illinois NRCS.

2.3.6.1. Layout Requirements

Level spreaders shall be located and designed so that the runoff water can be released in sheet flow down a stabilized slope and will not re-concentrate after release from the level spreader until it reaches an outlet designed for concentrated flow (see **Section 2.2.2.2** for guidance on allowable overland flow lengths). Areas immediately downstream of level spreaders should be densely vegetated with a slope of less than 10 percent to avoid gully formation. Level spreaders shall be located in areas where the level lip of the spreader is not likely to be compromised by the settlement of unstable soils or traffic loadings.

2.3.6.2. Level Spreader Sizing

The length and depth of the spreader shall be determined from **Table 2-17**[31]. The minimum width (W) is in the direction that is perpendicular to the level weir. The minimum depth (D) of the level spreader shall be at least 0.5 feet measured down from the level lip. The depth may be greater to increase temporary storage capacity, improve trapping of debris, and enhance settling of any suspended solids.

Table 2-17

Level Spreader Dimensions

Flow Rate (cfs)	Minimum Depth D (ft)	Minimum Width W (ft)
0-10	0.5	10
11-20	0.6	20
21-30	0.7	30

The level lip of the spreader must be constructed at zero percent grade to ensure uniform spreading of the runoff over the entire length of the spreader. The ends of the spreader shall be tied into higher ground to prevent flow around the spreader. Side slopes within the spreader shall be 2 to 1 (horizontal to vertical) or flatter.

2.3.6.3. Level Spreader Materials

Depending on the expected design flow, the level spreader lip may be constructed of vegetated or rigid, non-erodible materials. The following defines the appropriate application and requirements for each[32]:

31 Illinois Urban Manual: A Technical Manual Designed for Urban Ecosystem Protection and Enhancement, prepared for the Illinois EPA by Illinois NRCS.

32 Illinois Urban Manual: A Technical Manual Designed for Urban Ecosystem Protection and Enhancement, prepared for the Illinois EPA by Illinois NRCS.

Vegetated Level Spreaders

For peak design flows less than or equal to 4 cfs, the level spreader lip may be vegetated. The spreader lip shall be constructed on undisturbed soil and protected using an erosion control blanket (jute mesh or excelsior blanket). The erosion control blanket shall be installed according to the manufacturer's recommendations. The blanket shall start a minimum of 4 feet above the lip and extend at least 1 foot downstream over the spreader lip. The blanket shall be secured with heavy duty staples, and the downstream and upstream sides shall be buried at least six inches in a vertical trench.

Rigid Level Spreaders

For design flows greater than 4 cfs, the level spreader lip must be constructed of a rigid, durable, non-erodible material (e.g., pressure-treated timber, concrete, precast block, or geosynthetic materials) anchored securely at least four inches below existing ground to prevent displacement. An apron of coarse aggregate shall be placed adjacent to and downstream from the rigid lip. The top of the aggregate shall be at the same elevation as the top of the lip.

Transition Zone of Level Spreader for Concentrated Flow

When used to convert concentrated flow into sheet flow (e.g., below a storm sewer or detention basin outlet), the transition zone must be stabilized using an appropriate form of outlet protection (**Section 2.3.5**).

2.3.6.4. Maintenance

A maintenance plan shall be established to maintain the level spreader, its capacity, vegetative cover, and other connected structural components such as inlets, outlets, and tile lines which are tied to the same stormwater management system. Owners of level spreaders will be held responsible for damage to downstream or nearby property as a result of poorly designed or maintained level spreaders. Maintenance program items for level spreaders are summarized in **Appendix D.**

Easements shall be provided around level spreaders that are to be publicly owned and maintained. The width of easements shall include the area of the structure plus 10 feet around the perimeter of the structure.

2.3.7. Open Watercourses

The requirements in this section are applicable to newly constructed open watercourses that are intended to convey flow to stormwater inlets, stormwater control facilities, Tier I/II streams, lakes, wetlands, or other water bodies during precipitation events. 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) Agricultural Handbook 667, Stability Design of Grass-lined Open Channels, and
4) Federal Highway Administration, 1988, Design of Roadside Channels with Flexible Linings. Hydraulic Engineering Circular No. 15.

2.3.7.1. Channel Hydrology Requirements

The hydrologic computation methods specified in **Section 2.2.1** shall be used to design open watercourses in the City. In most cases, open watercourses shall be designed according to the same method used to design other onsite drainage facilities.

2.3.7.2. Channel Hydraulic Requirements

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. Criteria in **Section 2.4** 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 using criteria provided in **Section 3.3.6.** 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.

Cross Section Shape

Parabolic and trapezoidal channel shapes (**Figure 2-10**) shall be used for open watercourses within development projects. Side slopes shall be 3(H) to 1(V) or flatter, with a minimum 2-foot bottom width for trapezoidal channels, unless alternative dimensions are approved by the City due to specific project conditions. Channel cross sections shall be designed such that erosion and sediment deposition is minimized.

Design Velocity

An open channel is categorized by its lining. There are three main types of channel linings:

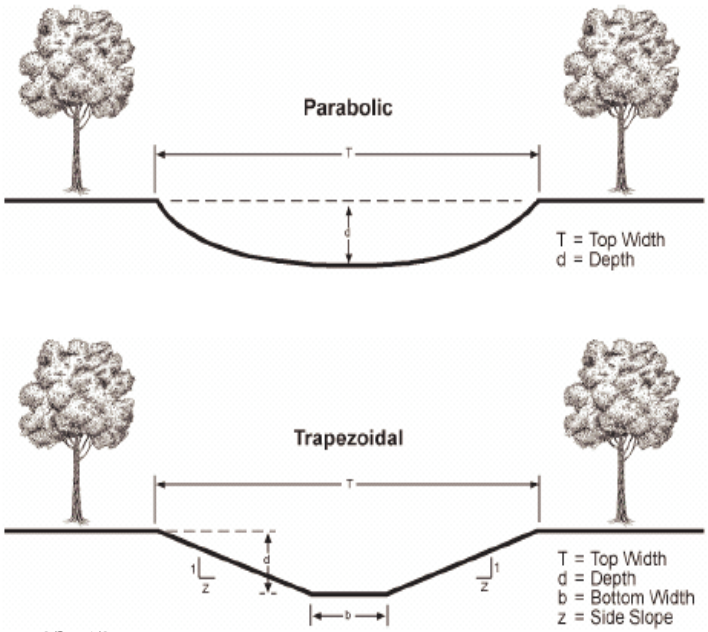
1) Vegetated,
2) Flexible, and
3) Rigid.

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 should 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 2-16**. The Manning's Equation shall be used to design an open channel that satisfies the maximum velocity criteria in the previous sections:

Figure 2-10

Parabolic and Trapezoidal Channel Shapes for Open Watercourses



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

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 2-18**.

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:

Table 2-18

Manning's Roughness Coefficients (n) for Vegetative and Artificial Channels [33]

Channel Lining Category	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, except along roadside channels)
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 roadside channels)
Flexible Lining:	
Slope Erosion Protection	0.04
Erosion Control Matting	0.04
Grouted riprap	0.02
Rock Channel Protection	
Small channels/ditches	0.06
Large channels	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.

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

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 $feet/sec^2$)

33 Adapted from Federal Highway Administration, *Hydraulic Engineering Circular 15*, 1998. Reported in Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design.*

The Stormwater Management Report shall demonstrate that the calculated Froude Number is less than 1 over the anticipated range of flow conditions within the channel.

Rock Channel Protection Shear Stress Analysis[34]

Type B, C or D rock channel protection shall be provided in accordance with ODOT CMS 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 (τ_{actual}) must be less than or equal to the allowable sheer stress (τ_{allow}) listed in **Table 2-19** 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 fifty (50) cfs and with slopes less than 10%:

$$\tau_{actual} = 62.4*D*S$$

where:

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

Table 2-19

Allowable Shear Stress for Rock Channel Protection

Type of Rock	τ_{allow} (lbs/feet^2)
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 HEC15 procedures for steep gradient channels shall be used with a safety factor of 1.5. The City Engineer 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.

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 as specified in **Section 2.3.5**.

34 Ohio Department of Transportation, *Location and Design Manual, Volume 2, Drainage Design.*

2.3.7.3. Constructed Open Watercourse Easement Requirements

Constructed open watercourses that are to be publicly owned and maintained and lie outside the public right-of-way, shall be provided with an easement that includes:

1) The full width of the channel as measured from top-of-bank to top-of-bank plus ten feet on one side, or
2) A minimum width of twenty (20) feet centered along the watercourse, whichever is greater.

Where onsite constructed open channels are designed to serve as a major flood routing path for offsite flows through the development, easement widths shall be extended to include the total flow width for the 100-year event.

2.4. Design of Major Stormwater Routing Systems

Major storm routing paths shall be provided to convey stormwater runoff that exceeds the capacity of the minor drainage system through the development to a Tier I or Tier II stream. The major storm routing path shall be designed such that the peak flood stage during the 100year design storm is at least one-foot below the first floor elevation of the structures within and adjacent to the development. The major storm routing path shall begin along swales located between structures that drain individual properties, be directed to either roads, other public rights-of-way, or constructed open watercourses through the development, to the stormwater detention facility serving the development. This detention facility shall be designed to control the 100-year event without overtopping its embankment, according to criteria in **Section 3.1**.

A hydraulic analysis shall be required to verify that the peak water surface elevation during the 100- year design storm meets the design criteria cited in this section. For preliminary design purposes, the flow in the minor drainage system during the 100-year design storm event shall equal the design capacity of the minor system.

Where streets are designated as the major routing path, the depth of water shall not exceed 18 inches (to allow access for emergency vehicles) at gutter line for local and collector streets[35]. The depth of water shall not exceed a 6-inch depth at the crown for arterial streets. This maximum depth criterion shall also apply where a major storm routing path crosses a street. The use of normal flow depths derived using the Manning's Equation will suffice for estimating inundation limits along streets. At culverts, the major storm shall be designed to flow across streets at low areas or in sags of vertical curves. Street elevations shall be set to permit the major storm to flow across the street and to prevent damage to any existing or proposed building structure. Backwater calculations shall be performed along Tier I or Tier II streams where a roadway crossing over these streams is proposed as part of the development. The backwater analysis shall proceed upstream from the roadway crossing to the boundary of the development site.

Where a major drainage way is located outside of a street right-of-way, easements shall be provided as defined in **Section 2.3.7.3**. The 100-year flood routing path shall be shown on the master drainage plan that is to be submitted with the Stormwater Management Report, as described in **Section 5**. Routing path illustrations shall include elevations along the routing path and other elevations necessary to show that the major storm is contained within the planned area and dedicated easements.

35 Water Environment Federation & American Society of Civil Engineers, *Design and Construction of Urban Stormwater Management Systems, 1992.*

A downstream analysis conducted according to the criteria in **Section 2.1.3** shall be used to define the major storm routing path between the development and the nearest Tier I or Tier II stream. The City may, at its discretion, require additional detention and/or downstream improvements to provide an adequate major storm routing path downstream of the development.

SECTION 3 Stormwater Controls

This section provides criteria and guidance for the successful design of facilities that control stormwater discharges from development and redevelopment projects to prevent flooding, stream bank erosion, and water quality impairment in downstream areas. Separate design criteria are provided for stormwater quantity and quality control facilities; however, in many cases quantity and quality controls are integrated into a single facility. This section provides criteria in five major sections:

3.1 General Criteria
3.2 Stormwater Quantity Controls
3.3 Post-Construction Stormwater Quality Controls
3.4 As-Built Surveys
3.5 Construction Stormwater Quality Controls

3.1. General Criteria

Stormwater runoff generated from onsite areas shall be controlled before it is released from the development site. Stormwater management reports or construction plans will not be approved until it is demonstrated that the onsite runoff will be controlled in a manner that is consistent with the criteria in this section. At a minimum, the following criteria shall apply to all stormwater controls described in **Sections 3.2 and 3.3**.

1) Stormwater control facilities shall not be located within the Stream Corridor Protection Zone defined using criteria in **Section 1.3** of the Manual.
2) Stormwater control facilities shall not be located within designated Federal Emergency Management Agency (FEMA) floodplain boundaries
3) Discharges from stormwater control facilities shall be directed into an approved Tier I or Tier II stream, either directly as sheet flow from a level spreader, or via a storm sewer or open channel conveyance system, according to criteria in **Section 2.1** of the Manual.
4) Stormwater runoff shall not be diverted from an existing naturally occurring wetland that is preserved according to City criteria provided in **Section 1.5** and that is not approved for filling and/or removing (as necessary) via an approved Section 404 permit issued by the U.S. Army Corps of Engineers. Wetland hydrology shall be sustained to the extent possible. The quantity and quality of this runoff shall be controlled prior to its release to the wetland system according to criteria in **Section 3.2 and 3.3** of the Manual.

3.2. Stormwater Quantity Controls

Stormwater quantity control facilities shall be designed to control runoff from small, moderate, and large storm events before it is discharged offsite. The design criteria provided in this section are intended to minimize flooding downstream of the development site and to reduce stream bank erosion. The stormwater management report for the project, prepared according to the guidelines and criteria in **Section 5**, shall show the location of the stormwater quantity control facilities and calculations defining how they were sized.

3.2.1. Stormwater Quantity Control Exemptions

Stormwater quantity controls will not be required in the following instances:

1) The construction, enlargement, or location, on a permanent foundation, of one single-family residence, one two-family residence, one three-family residence or an accessory structure appurtenant to either a single-family or two-family residence, on a single lot that is not part of a larger common plan of development.
2) Single-family residential development sites that are less than one (1) acre in size and not part of a larger common plan of development.
3) Runoff from a development is controlled by a regional stormwater facility in place at the time of development and adequately sized to serve the development area.

See **Section 3.3.1.1** to determine if the development is exempt from stormwater quality controls.

3.2.2. Hydrologic Requirements

The volume and distribution of rainfall for the storm events to be used for quantity control calculations shall be developed using the 24-hour rainfall intensity from Figure 2-1. This intensity shall be converted into a rainfall volume by multiplying it times 24 hours. The design rainfall hyetograph shall be developed by distributing this volume over the 24-hour period with the SCS Type II distribution (**Table 2-3**), as described in **Section 2.2.2.1**. Stormwater quantity control facilities shall be designed using one of the hydrograph methods defined in Section 2.2.4.

Unless otherwise exempted under the criteria in **Section 3.1**, onsite facilities to control post-development stormwater runoff from residential, commercial, and industrial development sites shall be designed according to the methodology presented below, which is derived from the critical storm method.[36] Under this methodology the percent

36 Mid-Ohio Regional Planning Commission, "Stormwater Design Manual", June 1977

increase in post-development runoff volume from a site during a 1-year storm event shall be calculated in the following manner to determine the critical storm event:

1) Determine the total volume of runoff from a 1-year, 24-hour storm, occurring over each of the site's drainage areas before and after development, using the methodology in **Section 2.2.4**.
2) Determine the percent of increase in runoff volume due to development. Using this percentage, select the critical storm from **Table 3-1**.

Table 3-1
Critical Storm Determination

If the percent of increase in runoff volume is		The critical storm runoff rate will be limited to:
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

Runoff from storm events less than or equal to the critical storm event shall be released from the site at a rate no greater than the peak runoff during a 1-year storm event under pre-developed conditions[37]. Additionally, the peak runoff rate during the 100-year storm event shall be released at a rate less than or equal to the peak runoff rate during the 10-year storm event under pre-developed conditions (where the critical storm is more frequent than a 100-year storm).

The City Engineer or his/her designee, reserves the right to require more stringent stormwater controls if it is determined that flood control benefits can be achieved in downstream portions of the watershed where flooding problems have been identified as existing prior to the proposed development.

37 In no instance shall the release rate for any storm, up to and including the critical storm event, exceed the 1-year storm event under pre-developed conditions.

3.2.3. Acceptable Methods and Criteria

Stormwater quantity controls provide temporary onsite storage to detain runoff and control downstream flooding. The City allows the following stormwater quantity control facilities:

1) Dry Detention Basins (those that drain completely dry after a precipitation event),
2) Wet Detention Basins (i.e., those with a permanent pool),
3) Parking Lot Storage,
4) Underground Storage, and
5) Green Roof Technologies.

The general criteria presented in **Section 3.1** apply to all of these types of controls. In addition, the following specific criteria apply to each type of facility. Where a single facility is designed to provide stormwater quantity and quality control, appropriate criteria from this section and **Section 3.3** shall apply. The City of Marysville may give consideration to the use of other stormwater quantity control technologies provided they meet the requirements of this section.

3.2.4. Dry and Wet Detention Basins

Detention basins are one method used to meet the peak flow control (allowable post-development runoff rate) requirements for a site. Their design may also include features to control water quality, as defined in ODOT Location and Design Manual, Volume 2, Drainage Design. In instances where detention basins are utilized to provide water quantity and water quality controls, peak flow rate and drawdown time criteria for both water quantity and water quality shall be met.

3.2.4.1. General Requirements for All Detention Basins

All proposed dry and wet detention basins shall be designed according to the general criteria in this section, as well as the specific criteria for stormwater quantity basins ODOT Location and Design Manual, Volume 2, Drainage Design

Layout and Geometry Requirements

The following criteria shall be used to define the layout and geometry of all stormwater quantity and quality detention basins in the City:

1) Detention basins shall be located on compacted fill, on slopes 3 (H) to 1 (V) or flatter, and not where infiltrating groundwater could adversely impact slope stability.
2) Detention basins shall be designed such that they readily accommodate flow from a site's major flood routing path(s) (see **Section 2.4**). Overland flow from a site shall be directed to the site detention basin(s), to ensure that site runoff is controlled.

3) The basin shall be designed with an emergency spillway for storms that exceed the 100 year, 24-hour storm event. The emergency spillway shall be designed to direct the flow to a suitable downstream flood routing path without erosion, scouring, or soil undermining, and to meet other pertinent Ohio Dam Safety requirements.
4) The basin shall be designed so that the peak water surface elevation in the basin does not overtop the basin embankment or flood structures around the basin. **Table 3-2** provides the peak water surface requirements for basins with different design intent.

Table 3-2

Peak Basin Water Surface Elevation Requirements

Basin Design Criteria	**Peak Water Surface Elevation**(1)
Water Quality Only – Larger Storms Bypassed	Peak water surface elevation during WQv must be 1 foot below the basin embankment elevation and the first floor elevations of structures near the basin.
Water Quantity – No Dam Safety Requirements (2)	Peak water surface elevation during the 100-year design event must be 1 foot below the basin embankment elevation and the first floor elevations of structures near the basin.
Basins Subject to Dam Safety Requirements (2)	Peak water surface elevation must satisfy Ohio dam safety requirements and be 1 foot below the floor elevation of structures during the 100-year design event. Refer to ODNR requirements.

Table 3-2 Notes:

(1) Requirements for a 1-foot freeboard will be waived if the detention basin is to outlet directly to a Tier I or Tier II stream. In such instances, the first floor elevations of structures near the basin must be at least 1 foot above the top of the basin embankment.
(2) Section 1521.06 of the Ohio Revised Code lists those dams and embankments that are exempt from dam safety requirements.

5) Side slopes within and adjacent to the basin shall be 4 (H) to 1 (V) or flatter to prevent bank erosion and minimize safety risks when the basin is full. The maximum cross slope for the vehicle access way shall be 10 (H) to 1 (V).
6) Detention basins shall be designed to limit the migration of groundwater from the basin towards sanitary sewers and building basements. In these cases, the City may require that a geotechnical analysis of the area be performed where the basin is proposed so that groundwater controls may be properly incorporated into the design. If the geotechnical analysis determines that exfiltration from the basin may increase infiltration into sanitary sewers or basements, then the facility design shall include compacted clay or a synthetic liner.

7) The Applicant shall submit preliminary design information to ODNR as necessary to determine the regulatory classification (Class I through Class IV) of any impoundment structures (e.g., dams, berms, embankments, levies) under Ohio dam safety regulations, and shall provide the City with documentation of ODNR's determination of the structure's classification All impoundment structures that require a dam safety permit from ODNR (Class I through III impoundment structures) shall provide sufficient design information in the Stormwater Management Report to demonstrate that dam safety permit requirements will be satisfied, including a description of the fill materials, required compaction, and other features provided to satisfy ODNR dam safety requirements, limit seepage through the impoundment structure, and protect the integrity of the structure. An as-built certification of the fill compaction shall be provided when construction is complete.
8) All inflow pipes to the detention basin that are not entirely submerged below the permanent pool elevation shall be designed with headwalls according to criteria in **Section 2.3.4**. Rock channel protection designed according to criteria in **Section 2.3.5** shall be used to minimize erosion around the headwall as well as along the side slopes of the basin under each inflow pipe or open channel.
9) If inflow to the facility is conveyed through an open watercourse, including a major storm routing path (**Section 2.4**), the open channel conveyance system shall be designed in accordance with **Sections 2.3.5 and 2.3.7.** Channel protection shall be provided along any reaches within 20 feet of the 100-year high-water mark of the basin, or to the edge of the easement (for publicly maintained basins) surrounding the basin, whichever is wider. Channel protection shall be designed according to criteria in **Section 2.3.5** and shall be used where the peak flow velocity during the 10-year, 24-hour design storm exceeds the criteria for grass watercourses as presented in **Section 2.3.7**. Such protection shall extend to the basin's bottom or 2 feet below the normal water elevation of any permanent pool.
10) Woody vegetation may not be planted or allowed to grow on the embankment, within 15 feet of the toe of the embankment, and within 25 feet from the principal spillway structure. The establishment of woody vegetation in other areas around the basin is encouraged to provide shade and moderate surface water temperatures.
11) Permanent stormwater quantity control basins, as defined herein, may be used as temporary sedimentation basins designed to control sedimentation during construction as long as the following are met:
    a) collected sediments are removed
    b) the design grade of the facility is restored, permanent vegetation is established
    c) the temporary outlet is removed
    d) permanent outlet structure is constructed as designed.

In instances where vegetation is not established, additional measures shall be taken to ensure that the area stabilized, including providing additional topsoil, additional seeding and mulching, or providing sodding in the areas where sparse ground cover occurs.

Debris Control Requirements

Debris control structures (trash racks) for both wet and dry basins may be required at the basin outlet if the potential exists for large debris to enter the detention basin through an open watercourse or large diameter inlet pipe. Debris control structures shall be designed using Hydraulic Engineering Circular No. 9, available from the U.S. Department of Transportation, Federal Highway Administration.

Outlet Facility and Outfall Protection Requirements

1) The detention basin shall be designed with an outlet control structure sized to meet the stormwater quantity control requirements presented in **Section 3.2.2**, the stormwater quality control requirements presented in **Section 3.3**, or both.
2) Seepage along any structure that extends through the embankment to the downstream slope shall be controlled using an anti-seep collar or drainage diaphragm. The collar/diaphragm shall be aligned approximately parallel to the centerline of the stormwater basin or approximately perpendicular to the direction of seepage flow, extending horizontally and vertically into the adjacent embankment and foundation to intercept potential cracks, poorly compacted soil zones or other discontinuities associated with the structure or its installation. Appropriate criteria for establishing the minimum horizontal and vertical distances from the surface of the conduit may be obtained from NRCS Technical Release 60, Amendment 1 pg 6-7, dated January 1991, or NRCS Technical Note 709 – Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR60, dated April 1985.
3) Open channels receiving discharges from the facility shall be protected with rock channel protection designed according to criteria in **Section 2.3.5** of the Manual.
4) The outlet structure shall be sized to achieve the release rates required under ODOT Location and Design Manual, Volume 2, Drainage Design, 1117.4. This outlet shall be designed to resist plugging by meeting the following criteria. The City shall not allow a single orifice outlet to be used for a dry detention basin that is less than four (4) inches in diameter. Alternative outlet designs (e.g., V-notch weir, perforated) of smaller orifice diameter shall be permitted upon City approval if acceptable design practice is proven for site conditions. For basins that do not have micropools or permanent pools, single orifices shall be adequately protected from clogging by an acceptable external trash rack.

5) The detention basin outlet structure shall be designed to retain floatables, such as debris, oil, and grease within the basin up through and including the 100-year design storm event. Acceptable floatables control devices, including perforated pipes, skimmers, baffles, inverted pipes and other devices that the City determines to be suitable.

It is recommended that detention basins be provided with a dewatering or secondary drain, where practicable, so that the basin may be emptied if the primary outlet becomes clogged and/or to drain the permanent pool to facilitate maintenance. If a dewatering drain is used, the drain should be designed to drain by gravity where possible. Where used, gravity pipes shall be made of approved materials as specified in ODOT CMS Item 603. If site conditions prevent gravity flow, the basin may be designed to drain by pumping. Basins requiring pumping may be provided with a dewatering y drain made of ductile iron pipe with mechanical joints and a quick connect coupling extended to the bottom of the basin at a point near the outlet structure. It is suggested that dewatering drains have an elbow within the basin to prevent sediment deposition, and a diameter capable of draining the basin within 24 hours.

The dewatering drain should include an operable gate, plug valve, mud valve, ball valve, or sluice gate, which should be set and locked in the closed position. Valves or gates should be located inside of the riser at a point where they will not normally be inundated and can be operated in a safe manner.

3.2.4.2. Additional Layout Requirements for Dry Detention Basins

In addition to the requirements in **Sections 3.2.2 and 3.2.4.1**, the following shall apply to the design of dry detention basins for stormwater quantity control:

1) Dry detention basins shall be designed to drain toward the outlet or micropool in order to minimize standing water and saturated soil conditions that impede maintenance and mowing of the facility.
2) Dry detention shall include a paved low flow channel or underdrain system from each inlet pipe or open channel to the basin's outfall to promote positive drainage within the detention facility. Low flow channels shall be designed per the following requirements:
   a. ***Bottom width*** – minimum width shall be six (6) feet (to allow access for maintenance equipment such as a Bobcat),
   b. ***Side slopes*** – shall not be steeper than 4 (H) to 1 (V),
   c. ***Channel slope*** – minimum slope toward the basin outlet shall be:
      i. 0.5 percent for channels with paved bottoms
      ii. 1.0 percent for detention basins with perforated underdrain system
      iii. 2.0 percent or greater with no additional drainage features
   d. ***Channel depth*** – minimum depth of channel shall be 1 foot

The bottom and side slopes of the channel shall be 6 inch minimum thickness, concrete reinforced with steel mesh to accommodate temperature stresses, and composed of air-entrained Class C concrete (per ODOT CMS Section 499); weep holes shall be designed in the concrete side walls.

3) The minimum bottom width for dry detention basins, other than the low flow channel, shall be 12 feet to allow for vehicular access for maintenance. The detention basin bottom shall be sloped to drain, and such slopes shall be sufficient to mitigate against "flat spots" developing due to construction errors and soil conditions. The minimum transverse slope for the bottoms of such facilities shall be two (2) percent.
4) Dry detention basins shall be provided with topsoil, and shall be seeded and mulched to prevent erosion. Grasses seeded within the basin should be able to survive 48 hours under water. Jute and Excelsior matting shall be used as required to stabilize slopes and prevent erosion.

3.2.4.3. Additional Layout Requirements for Wet Detention Basins

In addition to the requirements in **Sections 3.2.2 and 3.2.4.1**, the following shall apply to the design of wet detention basins.

1) The depth of wet detention basins shall be no more than 12 feet below the basin's normal water elevation. The City may approve deeper ponds that are to be privately owned and operated where practices (e.g. aeration) are proposed to prevent thermal stratification. The minimum bottom width of wet basins shall be 12 feet.
2) The perimeter of all permanent pool areas deeper than 8 feet shall be surrounded by an aquatic bench that extends at least 8 feet outward from the normal water edge, as illustrated in the City of Marysville Standard Dwg. No. STS-09. The portion of the aquatic bench within 8 feet of the shoreline shall have an average depth of 6 inches below the permanent pool to promote the growth of aquatic vegetation. The aquatic bench shall be no more than 15 inches below the permanent pool to enhance public safety, and to limit growth of dense vegetation in a manner that allows waves and mosquito predators to pass through the vegetation. The maximum slope of the aquatic bench shall be 10 (H) to 1 (V).
3) Side slopes for wet basins shall be 4 (H) to 1 (V) from the maintenance berm (see maintenance access requirements **Section 4.1.1**) down to the aquatic bench, and from the aquatic bench to the bottom of the basin.
4) At a minimum, wet detention basins shall be provided with topsoil, seeded and mulched in all areas that are above the basin's permanent pool.

5) The City recommends that wet detention basins and stormwater wetlands not be constructed any closer than 10,000 feet from the aircraft movement areas, loading ramps, or aircraft parking areas of a public-use airport (i.e., a publicly or privately owned airport open to public use) serving turbine-powered aircraft, or 5,000 feet from these areas of a public-use airport serving piston-powered aircraft as recommended by the Federal Aviation Administration (FAA), Advisory Circular Number 150/5200-33. As an alternative, dry detention facilities and green roofs are stormwater best management practices that do not maintain a permanent pool of water and are not as likely to attract large numbers of waterfowl

3.2.5. Parking Lot Storage

Parking lot storage is a stormwater quantity control method allowing shallow ponding within paved portions of the parking lot during the design storm event. Parking lot storage is a convenient multi-use structural control method where impervious parking lots are planned. The following criteria shall apply to parking lot storage facilities:

1) Ponding in parking or traffic areas shall be designed for a maximum ponding depth of eight (8) inches for all storms up to and including the 100-year event. The parking lot storage should provide a minimum of two (2) inches of freeboard prior to the flood routing discharging offsite to another property or public right of way. Flood routing or overflow to a designed conveyance system must occur after the maximum depth is reached.
2) Runoff from specific graded areas within a parking lot shall be controlled by orifices. The release rate of the flow from a parking lot storage facility shall meet the allowable post-development runoff criteria presented in **Section 3.2.2.** The minimum size outlet device shall be a 4-inch single orifice for water quantity control. Alternative outlet designs (e.g., V-notch weir, perforated) of smaller diameter shall be permitted upon City approval.
3) A site with a parking lot storage facility shall employ a separate water quality treatment BMP that meets the water quality treatment criteria presented in **Section 3.3**. This BMP may be located either downstream of the parking lot or integrated into the medians, landscaping, or other pervious areas of the parking lot.

3.2.6. Underground Storage

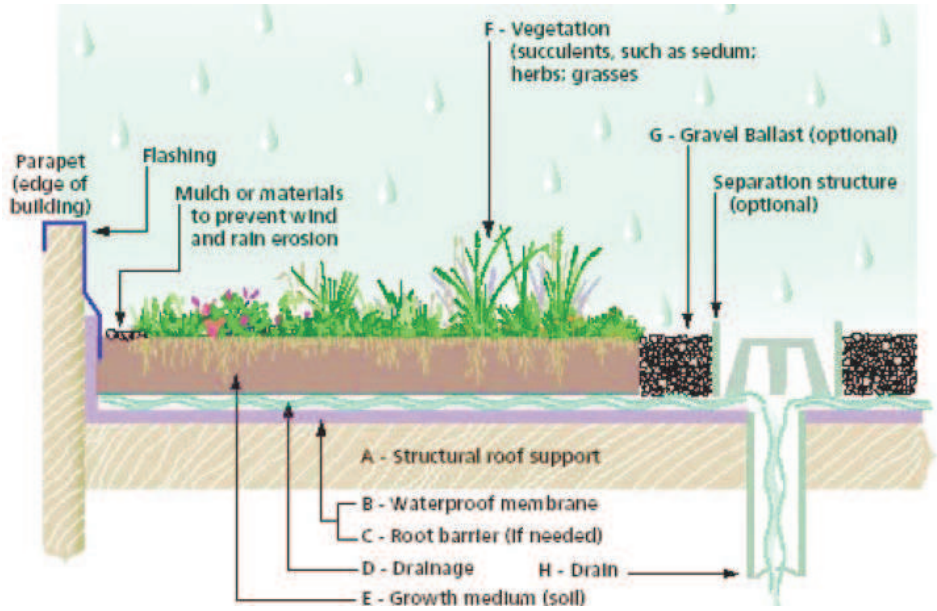
Underground storage is a stormwater quantity control method that employs an underground tank or chamber, either prefabricated or constructed in place, and has a designed release feature to control stormwater discharge. This method is most applicable where land is valuable or the site is constrained, such as in industrial, commercial, and redevelopment areas. Construction costs and operation costs, which may include pumps, make this method relatively expensive.

1) Underground storage facilities shall not be used in instances where the City is to own or operate the facility.
2) If underground storage is to be used for a site, a plan for long term maintenance of the facility shall be provided to the City, including a health and safety plan for confined space entry.
3) The release rate of the flow from a underground storage facility shall meet the allowable post-development runoff criteria presented in **Section 3.2.2**.
4) A site with a underground storage facility shall employ a separate water quality BMP that meets the water quality treatment criteria presented in **Section 3.3**.
5) The minimum size outlet device shall be a 4-inch single orifice for water quantity control. Alternative outlet designs (e.g., V-notch weir, perforated) of smaller diameter shall be permitted upon City approval.
6) Air-tight lids shall be used on all access structures, and traps shall be provided on inlet and outlet pipes to limit mosquito access to standing water.

3.2.7. Green Roof Technologies

Green roofs are systems used to control runoff volume, improve air and water quality, and promote energy conservation. They typically include layers of drainage material and planting media on a high-quality membrane to minimize leakage. These systems use foliage and lightweight soil mixtures to potentially absorb, filter, and detain rainfall. There are two types of green roofs:

1) Extensive green roofs, illustrated in **Figure 3-1**, typically use drought tolerant roof covers of succulents, grasses and mosses which require little to no maintenance. These roofs are not intended for recreation, are generally less expensive than intensive green roofs, and are typically not designed for public access.
2) Intensive green roofs are typically more elaborately designed roof landscapes, such as roof gardens, that are intended for human interaction and need to be engineered to conform to the additional load requirements for such activities. Alternative or intensive green roofs will only be approved upon City review and must be justified by the Applicant.



3.2.7.1. Design Guidelines and Performance Standards

Developers may use green roof technology on new development and redevelopment projects as a best management practice (BMP) to assist in satisfying the City's stormwater quantity and quality control requirements. The City will accept submittals with green roof components if they are designed to retain at least 50 percent of the average annual precipitation in the Marysville area (approximately 19 inches per year) and satisfy the design criteria and monitoring requirements defined in this section. **Table 3-3**[38] presents general guidelines and performance standards that shall be used to design green roofs for redevelopment projects in Marysville. These criteria are based on a review of recent literature about green roof installations in North America and Europe and may be revised as industry-wide design and material standards develop. More guidance on the design of green roof systems is available in the Guidelines for the Planning, Execution, and Upkeep of Green-Roof Sites, 2002.

38 Adapted from *Stormwater Management Manual, pgs. 2-37:24*, City of Portland – Clean River Works, Environmental Services, September 2004. General information also from the *Introductory Manual for Greening Roofs*, Public Works and Government Services of Canada, December 2002

3.2.7.2. Maintenance Requirements

While green roofs should be designed to minimize maintenance requirements, some maintenance is necessary to ensure its continued stormwater management performance. **Table 3-4**[39] presents the minimum maintenance requirements that shall be provided for green roof installations. The developer shall include specific requirements in a maintenance plan, as defined in **Section 4**.

3.2.7.3. Monitoring Requirements

Currently, field data documenting the effectiveness of green roofs at reducing stormwater quantity and improving runoff quality are under development. Since green roofs are an emerging technology, they may be used on new development and redevelopment projects as a best management practice to assist in satisfying the City's stormwater quantity and quality control requirements, if the developer agrees to monitor their performance for three years after the project is complete. Monitoring is required to gain a better understanding of a number of highly-variable factors that control the stormwater benefits of green roofs, namely:

1) The antecedent moisture content of the growing media,
2) Criteria for establishment of the vegetation layer,
3) Species of plants and soil which make up the vegetation layer,
4) How control levels vary with the intensity of the rainfall,
5) How control levels vary by season, and
6) Limits on roof pitch

The maintenance plan for the project shall define a monitoring program consisting of visual inspections, rainfall monitoring, flow monitoring, pollutant sampling, and reliability testing to demonstrate that the City's performance standards are achieved. The City will work with the Applicant to define an acceptable monitoring program for the project. The City plans to use the data collected, along with data from similar climatic regions, to contribute toward establishing design criteria for green roofs in future editions of the Manual.

39 Adapted from *Stormwater Management Manual, pgs. 3-11,* City of Portland – Clean River Works, Environmental Services, September 2004.

Table 3-3

Extensive Green Roof System Components

Major Green Roof Component	Design Requirement
Structural roof support (for both existing and new construction)	Adequate to hold an additional 10 – 25 psf (pounds per square foot) of saturated soil weight (in addition to snow load requirements)
Waterproof Membrane (Impermeable Material)	Acceptable material includes modified asphalts (bitumens), synthetic rubber (EPDM), hypolan (CPSE), and reinforced PVC
Protection Boards or Materials	Composed of soft fibrous materials; used to protect the waterproof membrane
Root Barrier (as needed)	Typically required for roofs with modified asphalt waterproof membranes while not required for EPDM and PVC membranes. (Check with waterproof membrane manufacturer to determine if required)
Drainage Layer	Range of acceptable manufactured products from plastic to gravel layers; minimum recommended thickness is 20mm
Growth Medium (Soil)	3–6 inches of well-draining material weighing 10 – 25 psf when saturated
Vegetation	Drought and extreme-weather (heat, cold, high winds) tolerant Mature plant growth patterns which cover at least 90% of the overall surface within 2 years. Self-sustaining, low-maintenance, fire resistant perennials or self-sowing species Four methods recommended to install the vegetation: vegetation mats, plugs/potted plants, sprigs, & seeds Acceptable vegetation includes mosses, succulents, or grasses which are shown to thrive in plant hardiness Zone 5[40] .
Gravel Ballast (as needed)	Dependent upon operational and structural design issues
Drain	Must safely drain runoff from the roof to an appropriate stormwater conveyance system
Leak Detection	Some companies recommend the incorporation of an electronic leak detection system between or underneath the waterproof membrane to pinpoint the exact location of water leaks. [41]
Minimum Roof Slope	Chapter 15 of the Ohio Building Code provides minimum roof slope criteria for various roof materials. Minimum slopes shall also comply with recommendations provided by the green roof manufacturer.
Maximum Roof Slope	25%

40 Zone 5, as defined by the U.S. Department of Agriculture falls within most of Ohio and includes areas with average annual minimum temperature ranges between -10 and -20 degrees Fahrenheit.

41 *Design Guidelines for Green Roofs*, Peck, S., Kuhn, M., and Arch, B – Ontario Association of Architects.

Table 3-4

Green Roof Maintenance Requirements

Major Green Roof Component	Maintenance Requirements
Soil Substrate/Growing Medium	Inspected annually for evidence of erosion from wind or water
Structural Components	Operated & maintained in accordance with manufacturer's requirements; drain inlets kept unrestricted
Debris & Litter	Remove after major storms to prevent clogging of inlet drains and interference with plant growth
Vegetation	Maintain as needed to provide 90% plant cover
Irrigation	Regularly irrigate during first two years of installation until 90 percent plant cover is achieved. Irrigate as necessary to maintain 90 % plant cover through hand watering or automatic sprinklers
Spill Prevention	Use preventative measures for mechanical systems when handling substances that could potentially contaminate stormwater
Training and/or Written Guidance Information	Provide to all Property Owners and tenants
Aesthetics	Maintained as an asset to the Property Owner/community
Insects	Prevent infestation that prevent maintenance of 90 percent plant cover criteria.
Inspections	Recommended twice annually

3.3. Post-Construction Stormwater Quality Controls

Stormwater quality control facilities shall be designed to control runoff from small storm events before discharged offsite. The design criteria provided in this section, or alternative criteria approved by the City, are intended to reduce pollutants contained in stormwater runoff and to reduce stream bank erosion during frequent storm events. The Stormwater Management Report for the project, prepared according to the guidelines and criteria in **Section 5**, shall include the rationale for selecting appropriate stormwater quality controls, a master drainage plan (if applicable) showing their location, and calculations defining how they were sized.

3.3.1. General Requirements

3.3.1.1. Stormwater Runoff Quality Control

Unless otherwise exempted, all runoff from development sites shall be directed to one or more stormwater quality controls designed according to:

1) Ohio EPA's Authorization for Stormwater Discharges Associated with Construction Activity under the National Pollutant Discharge Elimination System (Construction General Permit), latest version (http://www.epa.state.oh.us/dsw/permits/CGP_renewal_final_s.pdf),
2) Ohio EPA's Post-Construction Q&A Document, latest version (http://www.epa.state.oh.us/dsw/storm/CGP-PC-Q&A.html), and
3) Criteria provided in this section, as well as **Section 3.1.**

Additional criteria are presented in this section to assist Applicants in:

1) determining the size of stormwater quality control facilities,
2) laying out stormwater quality controls within the site, and
3) specifying features of stormwater facilities that will ensure proper function and maintenance in a manner that is acceptable to the City

As they apply to post-construction water quality controls, the definitions, exemptions, variances, and stormwater quality criteria applicable to new development, redevelopment, small construction sites, and large construction sites, as referenced in the Construction General Permit and attending Q&A document, shall apply unless otherwise noted in the Manual. In instances where conflicts exist between OEPA criteria and the criteria presented in this section, the more stringent standards shall apply.

All stormwater quality control facilities shall be sized to completely capture and treat the WQv determined for the entire contributing drainage area, according to the criteria contained in **Section 3.3.2**. Stormwater quality control facilities may be integrated with the stormwater quantity controls addressed under **Section 3.2**. If not integrated, flows exceeding the capacity of the stormwater quality control shall be conveyed to a stormwater quantity control facility before being discharged offsite.

3.3.1.2. Illicit Discharge and Illegal Dumping Control

An illicit discharge is any discharge into the storm drainage system that is not composed entirely of stormwater[42]. All Illicit Discharges shall meet the City's Illicit Discharge and Connection Ordinance (Chapter 939).

42 U.S. EPA and Ohio EPA regulations allow certain non-stormwater discharges to enter the storm drainage system that are commonly not a source of pollution. Applicants should refer to the latest Ohio Environmental Protection Agency (OEPA) NPDES permit issued to the City of Marysville to determine authorized non-stormwater discharges.

3.3.2. Water Quality Volume (WQv) Determination

The following formula shall be used to determine the design water quality volume (WQ_v)[43]:

$$WQ_v = C * P * (A/12)$$

where:

WQ_v = water quality volume in acre-feet
C = runoff coefficient appropriate for storms less than 1 inch
P = precipitation depth = 0.75 inch, and
A = drainage area in acres

3.3.2.1. Runoff Coefficients for Water Quality

Runoff coefficients appropriate for the various single family residential are presented in **Table 3-5**. Runoff coefficients for non-single family residential developments shall be determined using the following equation[44]:

$$C=0.858i^3-0.78i^2+0.774i+0.04.$$

where:

i = fraction of the drainage area that is impervious

Per OEPA criteria[45], the minimum runoff coefficient for commercial and industrial developments shall be 0.8. A minimum runoff coefficient of 0.5 for multi-family developments shall be used. Detailed criteria for using the WQ_v to design each accepted type of stormwater quality control facility is found in subsequent sections of the Manual.

43 Ohio Environmental Protection Agency, Authorization for Stormwater Discharges Associated with Construction Activity Under the National Pollutant Discharge Elimination System. OEPA Permit No. OHC000003

44 ASCE/WEF, "Urban Runoff Quality Management", 1997.

45 Ohio Environmental Protection Agency, Authorization for Stormwater Discharges Associated with Construction Activity Under the National Pollutant Discharge Elimination System. OEPA Permit No. OHC000003

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Table 3-5

Runoff Coefficients for Determining WQv

Land Use	Runoff Coefficient for WQv
Commercial/Business and Industrial	0.8
Multi-family	0.6
1/12 – 1/8 Acre Lots	0.6
1/8 Acre Lots	0.5
1/4 Acre Lots	0.4
1/2 Acre Lots	0.3
Undeveloped	0.2

3.3.3. Stormwater Quality Control – Acceptable Methods and Criteria

Four general categories of stormwater quality control facilities have been approved for use in the City:

1) Group 1 – Stormwater Basins
2) Group 2 – Media Filters
3) Group 3 – Vegetated or Grassy Swales and Filter Strips
4) Group 4 – Controls for Commercial Activity Areas and Redevelopment

The facilities listed above shall conform to the design guidelines set forth in the ODNR Rainwater and Land Development Manual.

Table 3-6 presents guidance information that may be used to select appropriate control facilities for the site. The designer shall present written documentation in their Plan supporting selection of appropriate control measures based upon site conditions.

Table 3-6

Major Selection Criteria for Stormwater Quality Controls

Criteria	Group 1: Stormwater Basins	Group 2: Media Filters	Group 3: Vegetated Swales and Filter Strips	Group 4: Controls for Commercial Activity Areas
Drainage Area	> 10 ac	<5 ac	<5 ac	<5 ac
Land Required	2-3%	> 5%	> 5%	Varies
Cold Weather Issues	Impacts of Pavement Deicers	Impacts of Pavement Deicers Clogging from Icing	Impacts of Pavement Deicers	Clogging from Icing
Locational Conflicts	Separation from buildings and sanitary sewers	Separation from buildings and sanitary sewers Minimum elevation difference across filter	Requires mild slopes	Varies
Mosquito and Vector Control Issues	Excessive aquatic vegetation Habitat for mosquito predator species	Media clogging causes stagnant water	Zero slopes, rutting, impermeable soils causing standing water	Sediment debris buildup causes stagnant water
Pollutant Removal	Meets Ohio EPA Criteria for New Development	Meets Ohio EPA Criteria for New Development	Meets Ohio EPA Criteria for New Development	Pretreatment for Commercial Activity Areas

Within each group, detailed design criteria are presented in subsequent sections that govern feasibility, conveyance, pretreatment, treatment, environmental/landscaping and maintenance requirements. The following major design considerations shall be addressed during design and documented in the Plan:

1) ***Drainage Area*** —The drainage area sizes provided in **Table 3-6** are based on literature review of demonstrated design criteria, and are provided for guidance purposes only. Significant departures from this guidance may require that the designer provide additional information, upon request, to demonstrate that the facility will function properly if the actual drainage area varies significantly from this guidance. Designers should keep in mind, however, that stormwater basins serving areas smaller than 10 acres may require extremely small outlets that are prone to clogging. Wet basins and stormwater wetlands typically require larger drainage areas or alternative water sources to sustain a permanent pool and maintain aquatic vegetation. An acceptable alternative to treating runoff from the entire site using a single BMP is to divide the development into smaller catchment areas where treatment can be provided by several smaller BMPs located throughout the development site.

2) ***Hydraulics*** —Design the facility with an outlet to control release rates and prevent clogging, provide storage for intense rain events, and install an observable high-flow bypass.

3) ***Sediment Management*** — Design the facility with pre-treatment for coarse sediments and a sediment storage volume for finer sediments.

4) ***Health & Safety*** — Design facilities containing a permanent pool with a healthy aquatic habitat for mosquito control and an aquatic bench with a maximum slope of 10 (H) to 1 (V) to increase public safety.

5) ***Aesthetics*** — Provide features that "hide" accumulated silt & debris and integrate the facility with overall site design.

6) ***Maintainability*** — Design the facility to minimize the amount and frequency of maintenance, to ease required maintenance activities, and to eliminate emergency / extraordinary maintenance requirements. Design criteria in the Manual are intended to facilitate maintenance, are required for facilities that will be maintained by the City, and are recommended for other facilities. If a design is proposed that does not include some or all of these features, the maintenance plan shall explain how maintenance activities shall be performed.

7) ***Accessibility*** — Design the facility to eliminate physical barriers (e.g., curbs and steep slopes) to entry for maintenance or emergency access, use strong, lightweight, non-corroding materials at access points (e.g., manhole covers and doors) to underground facilities, and provide legal right of entry for publicly maintained basins.

8) ***Durability*** — Design the facility to include strong, light-weight materials for "removable" features, reinforced concrete structures for "permanent" features, and hardy, disease-resistant vegetation.

9) ***Separation from buildings and sanitary sewers*** — Keep water quality controls that allow infiltration of runoff into the ground away from buildings, sanitary sewers, and building laterals to minimize infiltration/inflow into sanitary sewers.

10) ***Cold Weather Issues*** — Stormwater quality control facilities shall be designed to operate effectively under cold weather conditions. Design considerations include use of outlets that will not clog when frozen, additional pre-treatment and/or sediment storage/disposal in areas where sand or other solids are used for pavement deicing, and salt-tolerant plants in controls that incorporate vegetation.

11) ***Mosquito and Vector Control*** — Design criteria are included in the Manual that minimize conditions causing mosquito breeding without significantly compromising the effectiveness of controls that rely upon permanent pools of water and vegetation. The following guiding principals apply:
    a. Areas of facilities outside the permanent pool shall be designed to drain completely toward the outlet or permanent pool within 72 hours of a precipitation event. Small depressions in paved, rip-rap, and/or vegetated areas shall not be allowed, and shall be eliminated if they form.
    b. Wet detention basins and wetlands shall be designed to maximize habitats that promote colonization of the facility by mosquito predators (i.e., dragonflies, diving beetles, and mosquito fish). These facilities shall also incorporate large areas of open water to allow waves to propagate through vegetated areas, drowning mosquito larvae.

c. Underground and enclosed vaults containing certain stormwater quality controls are particularly susceptible to mosquito breeding. Facilities not intended to include a permanent pool of water shall be designed to drain without allowing standing water to remain, and shall not permit any trapped debris or sediment to create standing water. Air-tight lids shall be used on all access structures, and traps shall be provided on inlet and outlet pipes to limit mosquito access to standing water.
d. The maintenance plan for the facility shall address mosquito monitoring and control activities, including periodic harvesting of aquatic vegetation, removal of invasive/exotic and/or emigrant vegetation, removal of trash, debris sediment accumulation, and cleaning/rejuvenation of media filters.

3.4. As-built Surveys

As-built surveys will be required from the developer or property owner responsible for constructing stormwater facilities and conveyance systems. At a minimum, the developer shall field survey the location of each stormwater outfall and the outfall structure of each stormwater (quantity and quality) control structure that is constructed as part of the development site. Only stormwater outfalls that discharge directly into an open watercourse need to be located. **Exhibit A** and **Exhibit B**, provided in **Appendix E**, shall be complete and submitted to the City Engineer for each outfall and stormwater control structure that were constructed as part of the project.

1) As a condition of final acceptance, the property owner shall be responsible for providing as-built surveys to verify the final grades and elevations of stormwater detention basins and wetlands whether they are privately owned or are to be owned and operated by the City.

The purpose of as-built surveys is to demonstrate conclusively that the facilities are constructed to the elevations, slopes, grades, and volumes shown on the approved plans on file with the City. When ordered by the City to ensure that design grades and volumes within stormwater control facilities are achieved, an as-built survey shall be conducted once:

1) All structures on surrounding lots of a stormwater control facility are constructed and final lot grading for each lot is established, and
2) The conversion of a temporary sediment basin to a permanent stormwater control facility is complete after the site is built-out to the point where the temporary sediment basin is no longer needed. As-built surveys will only be accepted if they are conducted after the sediment in the temporary basin has been removed and re-graded, vegetation has been established, and the permanent riser structure(s) is in place.

As-built surveys shall be conducted by a Professional Surveyor registered in the State of Ohio and shall employ standard survey techniques. The Professional Surveyor performing the as-built survey shall be responsible for reduction of notes and any plotting necessary to make the notes interpretable. A final report and original field notes shall be furnished to the City for review and record purposes. A minimum of two bench marks that are referenced to the same vertical datum as the construction plans shall be provided on the as-built survey drawings. As-built surveys shall be in addition to, and separate from, other construction surveys which the City or its agents may conduct. The developer, contractor, or other entity constructing the stormwater facilities shall correct the discrepancies necessary to ensure that the stormwater facility will function as designed. The as-built surveys shall be re-performed as necessary to demonstrate plan conformance.

3.5. Construction Stormwater Quality Controls

Construction stormwater quality control facilities shall be designed to control runoff from construction sites during storm events before being discharged into watercourses, lakes, and/or wetlands. The requirements for construction best management practices (BMPs) are intended to adequately reduce sediment and related pollutants contained in construction stormwater runoff. In general, a Stormwater Pollution Prevention Plan (SWP3) is required for development sites that disturb more than one (1) acre, and must be submitted with the construction plans as part of the plan approval process. Projects that are not required to submit a SWP3 are still required to implement construction BMPs regardless of size. The City's Erosion and Sediment Pollution Control Regulation (Regulations) sets forth the runoff control and erosion and sediment control standards as well as the plan requirements for SWP3s. A copy of the City's Regulations is provided in **Appendix A**.

3.5.1. Additional Requirements

Over the years it has been necessary for the City of Marysville to adopt additional standards for the design and placement of construction site BMPs. Changes in technology and regulatory requirements have made it necessary to develop additional criteria intended to supplement the standards provided in the Regulations. The following additional criteria shall apply to development projects planned within the City of Marysville:

1) The City of Marysville utilizes the **ODNR (Ohio Department of Natural Resources) Rainwater and Land Development Manual**, latest edition, as the principal reference for erosion and sediment control practices and standards.
2) Stormwater Pollution Prevention Plans – SWP3s are required for sites that will disturb at least one acre or more. SWP3s are not required on sites smaller than one acre, however, the implementation of construction stormwater BMPs is required.
3) Sediment Basins – Sediment basins and appropriately sized risers are required to control sediment discharges for locations receiving runoff from tributary areas of 5 acres or more.
4) The use of straw bales for catch basin and curb inlet protection is not an approved practice in the City of Marysville.

SECTION 4 Operation and Maintenance of Stormwater Controls

This section provides requirements to ensure successful performance of stormwater control facilities once they have been constructed. Included in this section are requirements for facility inspection and maintenance, and maintenance and access easement requirements to allow for maintenance in and around stormwater facilities.

4.1. Stormwater Control Facility Maintenance Responsibilities

It is essential that any approved stormwater control facility be properly maintained in order to assure its performance. The maintenance responsibilities for the stormwater controls are the responsibility of the property owner. For common stormwater facilities for a subdivision the stormwater facilities must be located in a reserve to be maintained by the Property Owners Association. All developments must provide the City with an operations and maintenance plan for the proposed stormwater control facility(ies).

4.1.1. Stormwater Control Facility Access and Easement Requirements

For stormwater control facilities that are to be operated and maintained by property owners associations, the developer shall place the stormwater control facility in a dedicated reserve that includes the area of the control facility when flooded during the 100-year event, appurtenances to the facility such as forebay(s), benches, risers, outlet pipes, etc., and a minimum width of 20 feet around the perimeter of the facility. Any reserve containing stormwater control facilities shall include a dedicated accessway from public right-of way, having a minimum width of 20 feet. The reserve shall include a vehicle accessway having a minimum width of 20 feet around the perimeter of each facility, into the bottoms of detention basins, and to each inlet structure and outlet structure. Vehicle accessways shall have a cross slope no steeper than 10 (H) to 1 (V) (and shall be sloped toward the direction of detention basin facilities). The vehicle accessway shall be stabilized with suitable materials (e.g., concrete, gravel, articulated block, geogrids, or other means of stabilization) adequate to prevent rutting by the maintenance vehicles. All access routes shall be designed to allow the turn-around of maintenance vehicles. The developer shall provide fencing or other markings to delineate the reserve containing stormwater facilities from adjoining properties. (Note: decorative fence is the preferred option in residential subdivisions)

For stormwater control facilities conveying stormwater from off-site properties, or from public right-of-way, the developer shall provide to the City a minimum 20-foot wide easement for such inlet and outlet pipes, etc., that convey stormwater to/from a public conveyance system.

(Note: These criteria are recommended for basins that will be owned and operated for an individual lot but are not required unless off-site stormwater is conveyed through the control facilities. The basin's maintenance plan shall discuss how maintenance access and operations will be performed if alternatives are used).

4.1.2. Stormwater Control Facility Maintenance Plan

A maintenance plan for all stormwater controls must be prepared and submitted for review and approval by the City for the Applicant during the Plan approval process. At a minimum, maintenance plans for stormwater controls shall include a method and frequency for the following activities:

1) Inspection of all permanent structures,
2) Debris/clogging control through appropriate removal and disposal ,
3) Vegetation control (mowing, harvesting, wetland plants),
4) Erosion repair,
5) Non-routine maintenance should include pollutant and sediment removal and the "rejuvenation" or replacement of filters and appropriate soils,
6) Disposal of collected pollutants, sediments, and filter media in accordance with local, state and federal regulations, and
7) Mosquito monitoring and abatement, encompassing inspections for conditions conducive to mosquito breeding, routine (e.g., vegetation control, debris and sediment removal) and non-routine (e.g., restoration of grade to eliminate ponding) activities to address these conditions, and conditions where the use of insecticides may be warranted.

Appendix D provides guidance for the preparation of maintenance plans that summarize the maintenance requirements for each type of stormwater control structure presented in the Manual. Submitted stormwater control maintenance plans shall be customized to appropriately suit the individual facility(s) that are to be constructed. Methods and frequencies for inspections and maintenance activities for stormwater control facilities that are not presented in the Manual shall be provided by the Applicant.

4.1.3. Maintenance Inspection and Reporting Requirements

The Property Owner, its administrators, executors, successors, heirs or assigns shall maintain the stormwater control facility or facilities in good working condition acceptable to the City and in accordance with the schedule of long term maintenance activities provided in the approved stormwater control facility maintenance plan for the stormwater control facility or facilities. Maintained infrastructure shall include all pipes and channels built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater from the facility. "Maintain" is herein defined as good working condition so that these facilities are performing their design functions.

The purpose of maintenance inspections is to assure safe and proper functioning of the stormwater control facilities. The Property Owner shall perform periodic inspections of the stormwater control facility and its appurtenances at a frequency stipulated in the approved stormwater control facility maintenance plan. Inspections shall cover all elements for the stormwater control facility as defined in the stormwater control facility maintenance plan. Inspections shall include the completion of dated and signed inspection checklists provided in the stormwater control facility maintenance plan and the notation of all deficiencies observed during the inspection. The Property Owner shall maintain copies of complete dated and signed inspection checklists in a maintenance inspection log, along with recorded dates and descriptions of maintenance activities performed by the Property Owner to remedy the deficiencies observed during prior inspections. The maintenance inspection log shall be kept on the property and shall be made available to the City upon request. A copy of the Maintenance Inspection

Log shall be submitted annually by December 31st of each year to the Public Service Director. Maintenance Inspection Logs shall be submitted to:

City of Marysville
Division of Public Service
655 North Maple Street
Marysville, Ohio 43040

Where applicable, language explaining the maintenance, inspection, and reporting responsibilities in accordance with approved stormwater control facility maintenance plans shall be provided on the plat and recorded with all deeds to the property.

SECTION 5 Stormwater Management Report

A stormwater management system shall be designed and incorporated into each development project proposed within the City. The design of proposed stormwater management systems shall be summarized in a bound stormwater management report (Report) and submitted to the City for review and approval. The Report shall contain all pertinent stormwater calculations for detention/retention basins, storm sewers, culverts, open channels, and other stormwater management features, including best management practices (BMPs) as specified in Part I of this document. The following components shall be included in, and considered part of, the Report:

1) Master Drainage Plan (if applicable),
2) Calculations,
3) Stormwater Quality BMP Maintenance Plan(s),
4) Easements (if applicable),
5) Geotechnical investigation reports (if applicable),
6) Stormwater Pollution Prevention Plan (SWP3), and
7) Non-City Submittals/Permits.

The master drainage plan shall be folded and inserted in a separate sleeved page(s) or pocket(s) of the Report. Construction plans and the SWP3 shall be submitted with the Report, but not attached to it. The Report shall contain divider pages with labeled tabs that clearly identify each component listed above. Each component of the Stormwater Management Report shall be prepared and submitted in accordance with the following requirements.

5.1. Master Drainage Plan Requirements

For developments five (5) acres or greater, or developments that are to be constructed in multiple phases, the general site layout, including the layout of the proposed stormwater system, shall be depicted on a separate master drainage plan. The master drainage plan(s) shall be based on the state plane coordinate system and show all existing and proposed features, including trees. The master drainage plan should show all features indicated in the Manual, including but not limited to:

1) Project title,
2) North arrow and scale,
3) Project boundaries,
4) Existing and proposed topography at two-foot contour intervals covering the total development area and any offsite drainage areas tributary to the development site. The total upstream watershed(s) tributary to the development site shall be delineated,
5) Pre-development and post-development sub-basins, including onsite and offsite contributory area. The acreages shall be annotated,
6) The location and capacity of the immediate downstream receiving waterway or drainage system (adequate outlet)
7) Pre-development and post-development major routing flow paths to and from stormwater control facilities,

8) Any Tier I and Tier II streams, as defined in **Section 1.2**, that traverse the property and their respective Stream Corridor Protection Zones, including areas containing slopes 15 percent or greater that are adjacent to Type I and Type II streams, as defined in Section 1.2,
9) The location of proposed stormwater quality and quantity control facilities, storm drains, and constructed open watercourses proposed for the site,
10) Existing field tile locations (After an adequate field tile search has been completed with the assistance of the Union Soil and Water Conservation District (USWCD),
11) Lines designating the phases of multiphase development projects,
12) Street layouts and existing and proposed utility lines,
13) Flood Hazard limits and classifications,
14) The boundary of each wetland on the site (at a minimum the wetland boundaries of the current phase of a multi-phase project shall be shown), defined during a jurisdictional determination, and the wetland setback boundary established under criteria in **Section 1.5** of the Manual, and
15) Identify all stormwater outfalls and provide state plane coordinates, size (e.g., diameter), and type (open channel or piped) of each outfall for each.

The master drainage plan(s) is to be prepared on a 22-inch by 34-inch sheet on a scale of not less than 1 inch = 100 feet. Larger development projects will require multiple sheets with match lines. In the event there is significant offsite tributary area to the proposed project, a second additional master drainage plan showing the entire drainage area is required. Deviations from master drainage plan requirements for unique projects or circumstances may be permitted upon written approval from the City Engineer.

5.2. Calculation Requirements

Calculations shall be provided for all of the stormwater conveyance and stormwater control facilities required by the Manual and shall be stamped and sealed by a Professional Engineer registered in the State of Ohio. Calculations shall be organized and presented in a manner that demonstrates compliance with the City's stormwater management requirements. Specific requirements follow.

5.2.1. Stream Corridor Protection Calculations

Calculations to determine the width of the Stream Corridor Protection Zone for Type I and Type II streams and wetlands shall be presented in the following format:

1) ***Stream Corridor Protection Zone Calculations*** — Provide calculations and/or jurisdictional determinations supporting the calculated width of the Stream Corridor Protection Zone based on the requirements of **Sections 1.3 and 1.5**. A contour map delineating the tributary area used to calculate the Stream Corridor Protection Zone for each stream shall be submitted.
2) ***100-year Floodway Limits*** — Provide a FEMA map showing the limits of the 100-year floodway overlain with the calculated Stream Corridor Protection Zone limits determined above. The limits of the Stream Corridor Protection Zone will be the greater of the calculated limits or the 100-year floodway.

3) ***Slope Protection*** — Existing slopes 15 percent or greater that are adjacent to Type I and Type II streams are part of the Stream Corridor Protection Zone and shall be identified and annotated on the master drainage plan.
4) ***Wetland Protection*** — Delineated wetland boundaries shall be identified and shown on the stormwater management site plan. The limits of the final Stream Corridor Protection Zone shall be extended to include the entire wetland boundary for wetlands that are partially located within the greater of the calculated limits of the preliminary zone or the limits of the 100-year floodway.

5.2.2. Compensatory Floodplain Fill Calculations

Demonstrate that any volume of fill placed in the 100-year floodplain (outside of the Stream Corridor Protection Zone) is compensated with an equal volume of material removed above the ordinary high water table and below the 100-year flood elevation. Show the volume calculations for the fill and the compensating storage.

5.2.3. Impervious Area Calculations

Provide calculations that were used to quantify the amount of impervious area that will be on the site once construction is complete. Impervious area calculations shall be provided in square feet and based on building footprint, paved parking, and private drive and sidewalk not within the public right-of-way.

5.2.4. Storm Sewer Calculations

Storm sewer calculations shall be presented in the following format:

1) ***Capacity*** — Demonstrate that the capacity of the storm sewer pipes is sufficient to convey the design storm on **Table 2-9** without surcharging. Calculations shall be prepared on the tabulation sheet provided in **Appendix B**.
2) ***Hydraulic and Energy Grade Line*** — Demonstrate that the sewer system is designed to convey the design storm on **Table 2-9** such that the HGL stays below the gutter line of the overlying roadway or the top of castings of the drainage structures outside the roadway. Also indicate the appropriate Manning's "n" value for the selected pipe material, and indicate the minor loss values at all applicable points in the system, according to criteria in **Section 2.3.1**. The HGL and EGL shall be shown on the tabulation sheet provided in **Appendix B**.
3) ***Tailwater*** — List all tailwater assumptions and their source for applicable design storm events.
4) ***Velocities*** — Tabulate the storm sewer flow velocities in each segment, and demonstrate that the sewers are designed to produce velocities within the limits specified in **Section 2.3.1.2.**
5) ***Pavement Spread*** — Provide calculations that demonstrate that the pavement spread limits do not exceed the criteria presented in **Section 2.3.2.**

5.2.5. Culvert Calculations

Culvert calculations shall be presented in the following format:

1) ***100-year HGL*** — Demonstrate that the water elevation resulting from the 100-year storm event provides at least one (1) foot of elevation difference from proposed or existing residential dwellings or places of business. The flood elevation shall be shown on the stormwater management master drainage plan for the project.
2) ***Bankfull Calculations*** — Provide the calculations used to determine the bankfull depth of the stream as required in **Section 2.3.3.3.**
3) ***Design Storm*** — Provide calculations demonstrating that the headwater elevations for a 10-year event (25-year for arterial streets) are within the limits specified in **Section 2.3.3.3.** The following calculation methods will be accepted by the City:
    a. Hand calculations and the use of nomographs per Federal Highway Administration Hydraulic Design Series No. 5
    b. Model output from computer programs such as HY-8, ODOT CDSS or similar may be used.
4) ***Velocities*** — Tabulate the culvert flow velocities, and demonstrate that the velocities do not exceed the velocity limits specified in **Section 2.3.3.3**. Adequate velocity dissipation (i.e. rock channel protection) shall be provided on the inlet and outlet side of the culvert.
5) ***Tailwater and Energy Loss*** — List all tailwater assumptions and their source for applicable design storm events. List the energy loss assumptions at the entrance/exit of the structure.

5.2.6. Constructed Open Watercourse Calculations

For constructed open watercourses, the Applicant shall submit calculations demonstrating that the design criteria in **Section 2.3.7** have been satisfied. At a minimum, the following calculations shall be provided:

1) ***Design Velocity*** — Calculations showing that the channel lining can withstand the peak velocity during the 5-year design storm without erosion.
2) ***Channel Dimensions*** — Provide calculations showing the normal water depth, critical flow depth, and water surface width during the 10-year design storm.
3) ***100-year HGL*** — Demonstrate that the hydraulic grade line resulting from the 100-year storm event does not rise to within one foot of the finished grade adjacent to any buildings along the channel.

5.2.7. Flood Routing Calculations

Calculate the water surface profile along the major stormwater routing system using a standard step backwater profile calculation, or using a computer model able to compute backwater curves, such as HEC-RAS or U.S. EPA SWMM. Demonstrate that the water elevation resulting from the 100-year storm event does not encroach within one foot of the finished grade adjacent to any buildings along the channel and meets the depth restrictions presented in **Section 2.4**. The applicable flood elevation for the appropriate storm event shall be shown on the master drainage plan for the project.

5.2.8. Stormwater Detention Calculations

Calculations for stormwater detention facilities shall be based on methodologies that utilize dynamic hydrograph routing techniques (i.e., methods that allow variable inflows and outflows with respect to time and account for the basin's stage-storage-outflow characteristics). software/models that utilize this methodology and technique that are deemed acceptable to the City include, but are not limited to, HydroCAD, SWMM, TR-20, PONDPAK, and HEC-1. The City will not accept methodologies that do not perform dynamic routing of hydrographs. If a model is used to perform stormwater detention calculations, the name and a description of the model must be provided, each model input parameter must be defined, and a complete set of model input data must be included. The calculations for detention facilities shall be presented in the following format:

1) ***Critical Storm Calculations*** — Show the calculations of the total volume of runoff from a one-year, 24-hour storm, before and after development. Show the calculations of percent increase in runoff volume, and reference **Table 3-1** in **Section 3.2.2** to determine the critical storm.
2) ***100-year Storm Release Rate Calculations*** — The runoff from a more intense storm need only be controlled so as not to exceed the pre-development peak rate from the same frequency of storm. The critical storm shall be computed for each sub-catchment of a parcel. The allowable release rates are to be based on the individual sub-catchment. If the development has multiple outlets it may have differing critical storms for each outlet.
3) ***Basin Inflow and Outflow Hydrograph Calculations*** — Show the calculations or model input/output that produced the inflow and outflow hydrographs to and from the retention/detention basin. Hydrographs should be shown graphically, with a tabular

summary of the peak flow and volume, for all design storms that were considered in the design process. The City will not accept calculations or model input that provide tabular listings of inflow and/or outflow hydrographs.

4) ***Stage-Storage Calculations*** — Show the calculations of the stage-storage relationship for each detention facility.

5.2.9. Water Quality Volume (WQv) Calculations

The Applicant shall prepare a set of water quality volume and facility sizing calculations for control facilities required under **Section 3.3** of the Manual. Examples of pertinent calculations shall meet all requirements provided within the ODNR Rainwater and Land Development Manual. At a minimum, the following calculations shall be provided:

1) ***Water Quality Volume Calculations*** — Show the calculations of extended detention, permanent pool, forebay, and sediment storage volumes and depths, as described in **Section 3.3.2.**
2) ***Water Quality Drawdown*** — Show calculations or model output that demonstrates the release of the WQv over the time period(s) specified in **Section 3.3.2.**

5.3. Stormwater Quality BMP Maintenance Plan Requirements

The maintenance plan for water quality BMPs on single-family residential (with the exception of detention basins and constructed wetlands within single family developments that are maintained by the City), commercial, or industrial sites shall define the specific maintenance requirements for each type of control facility designed. Criteria for preparing the maintenance plan are contained in **Section 4**, and specific maintenance requirements for each type of control are included in **Appendix D.**

5.4. Compensatory Floodplain Restoration Plan Requirements

The stormwater management report shall include a site grading plan with supporting calculations indicating areas where floodplain fill and compensatory floodplain storage are proposed. The amount of compensatory storage and the methods used to provide the necessary compensatory storage shall be determined using the criteria in **Section 1.4**.

5.5. Easement Preparation Requirements

Dedicated easements to the City of Marysville shall be provided to allow maintenance and access to all stormwater facilities located outside of public right-of-way that are to be publicly owned or operated. Easements shall be designated on the construction plans as platted or deeded, existing or proposed. All existing easements shall be identified by the plat book and page number, or official record number of the deed. Preliminary plats and/or easement descriptions and exhibits shall be included with the stormwater management report submittal and construction drawings.

All descriptions and drawings involving City owned property rights shall apply standard survey techniques. When preparing easement documents for acceptance, the following guidelines must be followed:

1) ***Legal Descriptions*** — Shall be the original typed document prepared single spaced on letter size paper and also digitally in WORD form, signed, sealed and dated by a registered

surveyor. Metes and bounds descriptions are required; centerline descriptions will not be accepted.

2) ***Pictorial Exhibit*** — Shall be the original document prepared on legal size paper, signed, sealed and dated by a registered surveyor and also digitally in Adobe Acrobat (PDF) form.
3) ***Format*** — Documents are to be labeled or referenced to as Exhibit A, B, or so on.
4) ***Required Language*** — Descriptions and/or pictorial exhibits shall not include caveats such as: subject to covenants, exceptions, or restrictions of record, nor shall they include a purpose such as: installing, replacing, and maintaining a storm sewer, ditch or basin.
5) ***Contacts*** — For stormwater development plans, the name, mailing address and phone number of the person who will sign or obtain the signatures on the easement document shall be provided.

When approved by the City Engineer, easement information will be sent to the City Law Director's for Deed of Easement preparation. When the deed is prepared, the City Engineer will contact the designated contact person to obtain the signatures and return the signed originals. The developer/property owner shall record the deeds. Signed and recorded Deeds of Easement must be returned to the City Engineer prior to the payment of construction inspection fees.

5.6. Geotechnical Investigation and Evaluation

5.6.1. Utility Installation Requirements

A copy of any geotechnical investigation reports and recommendations performed as part of the stormwater design process (if applicable) shall be included in the stormwater management report. Geotechnical investigations and recommendations may be warranted in instances where exfiltration of stormwater into sanitary sewers is possible or where underlying soils of a wet detention basin are insufficient to maintain a permanent pool of water. Geotechnical investigations submitted with the stormwater management report must be prepared and signed by a professional engineer licensed in the State of Ohio and experienced in geotechnical engineering.

5.6.2. Geotechnical Investigation Requirements

A geotechnical investigation and report will be required for the following:

1) When an existing pond with an embankment height of 6-ft is proposed to become part of the stormwater control system to be incorporated into any development.
2) When proposed detention/retention facility includes an embankment that exceeds six (6) feet in height with more than five (5) acre-feet of storage behind it, and does not otherwise require a permit from ODNR.

If an ODNR dam permit is required, a special agreement will be required with the City. A geotechnical investigation report required under this section shall contain the following information to be submitted for evaluation by the City Engineer:

Geotechnical Investigation:

1) The geotechnical report shall include
   a. General description of facility;
   b. Photos of existing conditions;

c. Site Characterization, i.e. geology, topography, cultural features, groundwater elevations,
d. Detailed boring locations.
e. Discuss the current conditions, including presence of trees, inlet/outlet structures, etc.

2) Describe proposed usage including embankment height, inlet/outlet structures, pump station, etc.
3) Provide soil borings with standard penetration tests around the perimeter of the basin. The borings shall be located every 400 feet along the embankment with a minimum of two borings on the downstream side. In addition, a minimum of one boring should be drilled on all other embankments.
4) The soil borings shall include continuous split-spoon sampling to a minimum depth of 10-feet below the bottom of the basin. The data collected shall include Standard Penetration Testing blow counts. Additional "undisturbed" soil samples shall be collected for the appropriate testing.
5) More borings may be needed if unsuitable materials are encountered.

Laboratory Testing and Analysis:

1) Samples must be classified by a geologist or geotechnical engineer based upon the Unified Classification System according to ASTM D2488.
2) There shall be hand penetrometer readings taken on every cohesive sample.
3) For undisturbed samples shall be tested for a minimum of the following :
   a. Unconfined compression
   b. Unit weight
   c. Moisture contents
   d. Grain-size analysis
   e. Atterberg limits
   f. One point proctor for existing embankment soils.
   g. Moisture-Density (proctor) Curve for proposed embankment soils
   h. Loss on Ignition (at 750ºC) if organic material is encountered
4) Each soil strata for which undisturbed samples have not been collected shall have the following testing performed:·
   a. Atterberg limits
   b. Grain-size analysis
   c. Loss on Ignition performance at 750 degrees Celsius (organic materials).
5) Retain all samples for review.
6) Perform seepage analysis on the facility as it affects stormwater detention time.
7) Perform stability analysis on the (existing or proposed) embankments.
8) For existing ponds discuss how the requirements of **Section 3.2** pertaining to the safety bench will be addressed. This applies to ponds that have dwelling units contiguous to them. Isolated ponds (e.g. golf course ponds) will not be subject to this requirement.
9) If there are trees and/or stumps on the embankments, they must be identified for removal, including the root system, and backfilled with suitable soils that are compacted to 95% Standard Proctor.
10) The report shall contain the recommendations and signature of an Ohio Registered Professional Engineer.

11) Three copies of the report shall be submitted to the City Engineer for review and comment. One copy of the report on CD (PDF format) shall also be provided.

5.7. Non-City Submittals/Permits

A copy of the applications for the following permits/approvals that shall be included in the stormwater management report may include, but are not limited to:

1) Dam permits as issued by the Ohio Department of Natural Resources (ODNR) for detention pond embankments meeting ODNR dam criteria,
2) 401 Water Quality Certification Permits issued by the Ohio Environmental Protection Agency,
3) 404 Permits for impacts to regulated streams and wetlands issued by the U.S. Army Corps of Engineers, and
4) Jurisdictional Water Determination Report
5) Industrial NPDES Stormwater Permit application to Ohio Environmental Protection Agency,
6) Notice of Intent for coverage under the Ohio Environmental Protection Agency NPDES Construction General Permit, and a copy of the stormwater pollution prevention plan prepared under this permit.
7) Pertinent Letter of Map Revision (LOMR) applications and approvals.

The City may not approve stormwater management reports or plans prior to receipt of copies of approval Federal (404) and State (401) permits if the permits are required.

City of Marysville
Stormwater Drainage Manual

December 2010

City Engineer – Valerie Klingman, P.E., P.S.
Public Service Director – John Mitchell

Appendix A
Erosion and Sediment Pollution Control Regulations

CHAPTER 937
Storm Water Management

937.01 DEFINITIONS.

a) For the purpose of this chapter, the words and phrases shall be defined as follows, unless the content clearly indicates or requires a different meaning.

1) **Authorized Enforcement Agency.** Employees or designees of the director of the municipal agency designated to enforce this ordinance.

2) **Best Management Practices (BMP's)** Schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention and educational practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants directly or indirectly into storm water, receiving waters, or storm water conveyance systems. BMP's also include treatment practices, operating procedures, and practices to control site runoff, spillage or leaks, sludge or water disposal, or drainage from raw materials storage.

3) **City Engineer.** The City of Marysville Engineer or his/her designee.

4) **Clean Water Act.** The federal Water Pollution Control Act (33 U.S.C.& 1251 et seq.) and any subsequent amendments.

5) **Clearing**. Any activity that removes vegetative cover.

6) **Construction Activity.** Activities subject to NPDES Construction Permits, that result in land disturbance of one acre or more.

7) **Credit.** A reduction in a customer's storm water service fee, other than single family, given for certain qualifying activities which reduce either the impact of increased storm water runoff or reduces the City's costs of providing storm water management.

8) **Detention Facility.** A facility, by means of a single control point, which provides temporary storage of storm water runoff in ponds, parking lots, depressed areas, rooftops, buried underground vaults or tanks, etc., for future release, and is used to delay and attenuate flow.

9) **Developer.** A person, firm or corporation that presumes to excavate or fill, build structures or otherwise improve a specific parcel or tract of land.

10) **Drainage Facilities** Various drainage works that may include conduits, manholes, energy dissipation structures, channels, outlets, retention/detention basins and other structure components.

11) **Erosion and Sediment Plan.** A set of plans prepared by or under the direction of a licensed professional engineer indicating the specific measures and sequencing to be used to control sediment and erosion on a development site during and after construction.

12) **Equivalent Runoff/Residential Unit (ERU)**. A value based on the parameters used in the Storm water Management Utility rate structure which represents a unit of storm water runoff. This value

is used to facilitate comparison of the number of billing units of various properties. Each ERU is equivalent to 2,700 square feet of impervious area and that all residential single-family properties shall be assigned one 1) ERU.

13) **Grading**. Excavation or placement of fill material to achieve plan design.

14) **Grass Waterway**. A natural or constructed watercourse or outlet that is shaped or graded, and planted with suitable vegetation for the purpose of dispersing runoff without causing erosion.

15) **Hazardous Materials.** Any material, including any substance, waste, or combination thereof, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

16) **Illegal Discharge**. Any direct or indirect non-storm water discharge to the storm drain system, except as exempted in Section 938.08 a.

17) **Illicit Connections**. An illicit connection is defined as either of the following:

A) Any drain or conveyance, whether on the surface or subsurface that allows an illegal discharge to enter the storm drain system including but not limited to any conveyances that allow any non-storm water discharge including sewage, process wastewater, and wash water to enter the storm drain system and any connections to the storm drain system from indoor drains and sinks, regardless of whether said drain or connection had been previously allowed, permitted, or approved by an authorized enforcement agency or,
B) Any drain or conveyance connected from a commercial or industrial land use to the storm drain system that has not been documented in plans, maps, or equivalent records and approved by an authorized enforcement agency.

18) **Impervious Surface.** Surfaces on or in a lot or parcel of real property which reduce the rate of infiltration of storm water into the earth.

19) **Industrial Activity**. Activities subject to NPDES Industrial Storm Water Permits as defined in 40 CFR, Section 122.26 b)(14).

20) **Intensity of Development Factor.** The runoff coefficient or percentage of impervious coverage on or in a lot or parcel of real property. The numerical value for each such land use is based upon generally accepted engineering standards and review of and application of said standards to local conditions.

21) **Municipal Separate Storm Sewer System (MS4).** The system of

conveyances (including sidewalks, roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned and operated by the **City of Marysville** and designed or used for collecting or conveying storm water, and that is not used for collecting or conveying sewage.

22) **National Pollutant Discharge Elimination System (NPDES) StormWater Discharge Permit** Permit issued by EPA (or by a State under authority delegated pursuant to 33 USC § 1342b)) 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.

23) **Non-Storm Water Discharge**. Any discharge to the storm drain system that is not composed entirely of storm water.

24) **Perimeter Control** A barrier that prevents sediment from leaving a site by filtering sediment-laden runoff or diverting it to a sediment trap or basin.

25) **Person**. Any individual, association, organization, partnership, firm, corporation or other entity recognized by law and acting as either the owner or as the owner's agent.

26) **Phasing.** Clearing a parcel of land in distinct phases, with the stabilization of each phase completed before the clearing of the next.

27) **Pollutant**. Anything which causes or contributes to pollution. Pollutants may include, but are not limited to: paints, varnishes, and solvents; oil and other automotive fluids; non-hazardous liquid and solid wastes and yard wastes; refuse, rubbish, garbage, litter, or other discarded or abandoned objects, ordinances, and accumulations, so that same may cause or contribute to pollution; floatables; pesticides, herbicides, and fertilizers; hazardous substances and wastes; sewage, fecal coliform and pathogens; dissolved and particulate metals; animal wastes; wastes and residues that result from constructing a building or structure; and noxious or offensive matter of any kind.

28) **Premises**. Any building, lot, parcel of land, or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.

29) **Retention Facility.** A detention facility that maintains a permanent pool of water as well as having flood peak flow reduction capability.

30) **Routing** An engineering technique described as computation of the movement and attenuation of an inflow hydrograph as it passes through the storm water system, resulting in a discharge hydrograph at the downstream end of the element, such as a pipe, channel or detention basin, and accounts mathematically for the

effects of storage on flow through the element. "Level pool routing" assumes that a retention/detention facility maintains an "even" or "level" surface water elevation.

31) **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.

32) **Sediment Control** Measures that prevent eroded sediment from leaving the site.

33) **Site.** A parcel of land or a contiguous combination thereof, where grading work is performed as a single unified operation.

34) **Siltation.** The accumulation of fine earth or sand carried by moving or running water and deposited as a sediment.

35) **Stabilization.** The use of practices that prevent exposed soil from eroding.

36) **Start of Construction.** The first land-disturbing activity associated with a development, including land preparation such as clearing, grading, and filling; installation of streets and walkways; excavation for basements, footings, piers, or foundations; erection of temporary forms; and installation of accessory buildings such as garages.

37) **Storm Water.** Storm water runoff, snowmelt runoff, and surface runoff and drainage.

38) **Storm Water System.** All man-made drainage facilities, structures and natural watercourses used for collecting and conducting storm water, surface runoff, street wash water and drainage but which excludes sanitary sewage and industrial waste, other than unpolluted cooling water to, through and from drainage areas to the points of final outlet including, but not limited to, any and all of the following: conduits and appurtenance features, canals, creeks, channels, catch basins, ditches, streams, gulches, gullies, flumes, culverts, siphons, retention or detention basins, dams, floodwalls, levees and pumping stations.

39) **Storm Water Utility.** This Utility is responsible for providing public storm water management to citizens and/or consumers. The Utility is comprised of structures, equipment, personnel, and processes required for the storm water system.

40) **Subsurface Water Drainage.** The process of directing excess water away from the root zones of plants by natural or artificial means, such as by using a system of pipes and drains placed below ground surface level.

41) **Surface Water Drainage.** The diversion or orderly removal of excess surface water by the development of surface water inlets to

subsurface drains, and the slope of the land utilizing systems of natural or constructed channels to carry away the surplus water.

42) **Watercourse.** A natural or artificial channel through which water flows continuously or intermittently in a definite direction.

43) **Watershed.** A region draining to a specific river, river stream or body of water.

44) **Zoning Permit.** A permit issued by the municipality for the construction or alteration of buildings, ground improvements, and grading, including the control of erosion, sediment, and runoff.

937.02 ORGANIZATION OF UTILITY.

The Storm Water Utility shall be administered by the Public Service Director or his/her duly authorized agent. The Storm Water Utility will hereafter be referred to as the "Utility".

937.03 RESPONSIBILITY.

a) The Utility and the City Engineer shall work together to monitor the design, operation, maintenance, inspection and construction of all storm water systems in the City. The City Engineer shall be responsible for the design of public storm water systems in the City. The Utility shall inspect, operate and maintain the storm system as prescribed in Sections 937.05, 937.11, 937.15 and 937.16. For purposes of this Code, public storm water drainage facilities begin at the grating or opening where water enters from a curb and gutter or swale, and ends at the outlet structure where water flows into a channel or natural watercourse.

b) The Utility shall be responsible for controlling siltation and sedimentation that will adversely affect storm sewers, drainage ditches, watercourses and other drainage facilities or that will pollute public waters and watercourses.

938.04 SEVERABILITY.

The provisions of this ordinance are hereby declared to be severable. If any provision, clause, sentence, or paragraph of this ordinance or the application thereof to any person, establishment, or circumstances shall be held invalid, such invalidity shall not affect the other provisions or application of this ordinance.

937.05 OPERATION AND MAINTENANCE OF STORM WATER SYSTEMS.

a) The responsibility for operation and maintenance of all storm water systems within the City is as follows:
   1) The Utility shall be responsible for operation and maintenance of public drainage facilities on public land and in street rights-of-way.
   2) The developer/owner shall be responsible for operation and maintenance associated with storm water drainage facilities on private property.
   3) Where public facilities are in easements, the owner of the property is

responsible for aesthetic maintenance such as lawn mowing, litter pickup, etc. The owner shall also ensure that no structures, plantings, dirt or debris interfere with the drainage facility's proper operation and maintenance in accordance with Section 521.05.

937.06 LAND AND FACILITIES AFFECTED FROM OUTSIDE THE CITY.

Where storm water drains from lands outside the City, facilities within the City shall be designed in accordance with this Code as if the entire drainage area was within the City.

937.07 RULES AND REGULATIONS.

a) GENERAL

1) The Public Service Director, in concert with the City Engineer, shall be responsible for enforcement of the Storm Water Management Code and shall not allow any development of land area unless such development meets the design requirements herein. The Public Service Director shall serve as the principal executive officer for storm water management for the purposes of fulfilling the requirements of the Environmental Protection Agency's NPDES Phase II storm water program.

2) The Planning Commission shall not approve the final plat of any development or subdivision over which it has jurisdiction without certification from the Public Service Director and the City Engineer, that such development or subdivision has been designed to be in full compliance with the design requirements herein, and all applicable storm water pollution control standards required by the Ohio EPA under the NPDES Phase II Storm water Program and as specified by the Ohio EPA in the Post Construction requirements of the State General Construction Permit.

b) DESIGN STANDARDS

1) The City Engineer shall determine technical acceptability of land development storm water management methods. The City Engineer shall also determine the acceptability of the hydrologic design. Best Management Practices listed within the State General Construction Permit (OEPA Permit OHC 000003) or its subsequent OEPA-issued revision shall be followed in the storm water management methods.

2) The United States Department of Agriculture Soil Conservation Service soil classification mapping of the City shall be used to determine soil classification for the purpose of all storm water management design unless more detailed data is prepared by competent authority and reviewed by the City Engineer, and accepted by the Public Service Director.

3) Predevelopment site runoff will be calculated using the curve number method with a curve number reflecting existing land use. Undeveloped land shall be treated as "agricultural with conservation treatment."

c) STORM WATER RUNOFF POLICY

1) The Storm Water Runoff Policy requires that 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. The purposes of this policy are to:

   A) Permit development without increasing the flooding potential of other lands.

   B) Reduce damage to receiving streams and impairment of their quality or capacity which may be caused by increases in the quantity and rate of storm water discharge.

   C) Establish a basis for design of storm water drainage systems on lands below undeveloped areas which will preserve the rights and options of both dominant and servient property owners and assure long-term adequacy of storm drainage systems.

   D) Conform to standards and obligations contained in regulations promulgated by the Ohio EPA.

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 storm water drainage and flood control programs are undertaken throughout the entire watershed. For this reason, the general policy of the City of Marysville is:

   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.

   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 damage or cause flooding to adjacent, upstream or downstream property owners.

   C) All storm water 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 predevelopment runoff except as noted in Subsection d) below. The system for the upstream tributary area must be extended through the development.

   D) All proposed development with a combined surface and subsurface 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 storm water discharge, so as to not exceed the available capacity of the downstream system. It may be necessary for the developer to make downstream improvements to satisfy the conditions of this section.

   E) All information necessary to determine how storm water runoff should be controlled within the development prior to its release

to downstream properties shall be submitted to the City. The tributary area and the upstream watersheds should be determined using natural land divides unless man-made alterations are approved by the City Engineer as the basis for watershed delineations.

3) The Storm water Runoff Policy applies to all land developments not specifically exempted as provided under the appropriate section of this Policy.

4) Other sections of this Policy specify the performance requirements of on-site drainage systems and runoff control standards.

d) DRAINAGE EASEMENTS

1) An adequate utility easement conveyed to the City that provides access for Municipal personnel shall be required as determined by the City Engineer, along any tile, pipe, detention basin, drainage way, flood routing path, ditch, watercourse, natural stream, man-made stream, storm sewer or any other watercourse deemed necessary by the City Engineer which is not already within the street right-of-way. The easement shall be of sufficient width to allow cleaning, widening, deepening, replacing or other general maintenance of such drainage course or piped system.

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

   A) shall be responsible to obtain easements and/or maintenance agreements, in a form and substance satisfactory to the Public Service Director and the City Engineer, from abutting property owners,

   B) shall remain 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.

3) All drainage easements, preservation areas, reserves and other similar areas shall be shown on the "final engineering and construction plan(s)". Drainage easements for all on-site drainage system improvements shall be recorded for public use by final plat by the applicant. For off-site drainage systems improvements, easements should 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 Section 937.05.

4) Each purchaser of a lot for a single-family residence must be provided with a graphic depiction of all drainage easements, floodway routing, flood hazard areas, and other water-courses contained or designed into that lot.

5) The Public Service Director, or his/her designee, is hereby authorized to inspect such drainage easement areas. If the Public Service Director, or his/her designee determines that maintenance is needed, he/she shall notify

the property owner whose property requires maintenance and/or any other parties who, in the sole determination of the Public Service Director, directly benefit from such easement. The manner in which notice of the required maintenance, and the carrying out thereof, shall be as follows:

A) The Public Service Director, or his/her designee shall cause written notice to be served on the property owner and/or any other parties benefiting from the easement notifying such parties that maintenance of the drainage course is necessary and that a contract with a contractor acceptable to the Public Service Director for such repair and maintenance must be delivered to the Public Service Director, or his/her designee within fourteen (14) days of the notice. The notice will be served upon the property owner and/or benefited parties at the tax billing address for such premises reflected upon the records of the Union County Auditor. Service shall be accomplished by any means permitted for service of summons under the Ohio Rules of Civil Procedure. Each property affected by such notice shall also be posted with such notice by the Public Service Director or his/her designee.

B) In those instances where the address of the owner is unknown, it shall be sufficient to publish a notice once a week in a newspaper of general circulation in Union County, Ohio setting forth the substance of the notice and time frame for compliance. The time frame for compliance shall be no less than fourteen (14) days after the publication.

C) If the property owner and/or benefiting parties fail to comply with the notice, the City shall cause such repairs, replacement, maintenance and abatement procedures to be implemented as determined appropriate by the Public Service Director. The cost of such repair, replacement, abatement and other procedures deemed appropriate by the Public Service Director shall be immediately due and payable to the City in the amounts and in the proportions determined by the Public Service Director. Additionally, the Public Service Director may assess an administrative fee as the Director deems appropriate against all benefiting property owners or benefiting parties in an amount not to exceed 10% of cost of such repair, replacement, abatement and other procedures, as determined by the City Engineer. Such cost shall be reimbursed to the City by all benefiting property owners or benefiting parties in an amount equally (or proportionally by area drained) apportioned amongst each respective property owner, for each instance where a notice is served under this section. The cost and administrative fee shall be due and payable within thirty (30) days after the same are assessed.

D) Any fees or costs which remain unpaid for a period in excess of fifteen (15) days after the bill date shall be considered delinquent and subject to a five percent (5%) penalty for late

payment. Delinquent accounts are subject to charges and penalties as set forth under 937.20 and 937.21

E) Any owner or benefiting party aggrieved by an action(s) of the Public Service Director under this section may take an appeal to the Utility Claims Board of Appeals within thirty (30) days of the date service of notice of such action upon the property owner and/or benefiting party.

e) EXEMPTIONS

1) Exemptions are appropriate for certain land use activities which clearly do not generate significant increases in storm water runoff. Where exemptions are granted under this Section, they shall apply to the requirements for runoff control only and do not imply a relaxation of requirements for adequate and proper on-site drainage or the ability of the system to accept runoff from tributary land. The following land uses and developments are exempted from storm water runoff controls:

A) Land preparation for agricultural crops, orchards, woodlots, sod farms, and nursery operations.

B) Land grading or leveling for erosion control under direction of the local soils conservation district, or other government agencies that are charged with responsibility for environmental protection.

C) Land developments with a combined area of less than one acre.

D) Single family residential developments that are a portion of a subdivision originally consisting of one or more acres and where the area of the remaining undeveloped or not permanently stabilized lots is less than one acre.

E) Multi-family residential or commercial developments which total less than one acre.

F) Redevelopment of existing buildings, their related parking lots, and structures where less than one acres is to be altered by grading, draining, removing existing ground cover, or paving; and of which one acre or less will be impervious areas, such as roofs, walks, and parking areas, when redevelopment is completed.

G) Situations where existing and adequate off-site storm water runoff control facilities provide the required control. However, this shall not be construed to imply the first development requesting use shall have full use of available capacity. Rather, such exemption shall be calculated based on a proportional use of available storage capacity to ensure that later developments have a similar opportunity to utilize a portion of the storage capacity.

f) STORM WATER RUNOFF CONTROL CRITERIA

1) Quantitative Control. Storm water quantity control shall be implemented pursuant to the criteria specified as follows:

A) Storm water 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 frequency, 24-hour storm. In addition, if it is found that 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. They are:

1) 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 the problems associated with peak flow (flooding). This is known as the "Routing Problem."

2) 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:

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

ii. Determine the percentage of increase in volume due to development and using this percentage, pick the critical storm from the following table (Table A):

Table A. Critical Storm for Discharge 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

B) 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 peak rate 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 *an* 1-year frequency storm under predevelopment conditions in the area. The runoff from a more intense storm up to a 100-year storm needs only to be controlled so as not to exceed the predevelopment peak rate from the same frequency of storm.

C) Storage volume, generally, does not have to be provided for off-site upstream drainage areas. However, flow from such areas must be routed through the drainage systems in the development under consideration, at its existing rate of flow, whether surface, subsurface, or both.

2) Qualitative Control. Storm water quality control shall be implemented into sites within developing areas in accordance with the general and specific requirements outlined in the Ohio EPA-issued General Permit for Storm water Discharges associated with Construction Activity (OEPA Permit No. OHC000003, Part IIIG.2.e), or any subsequent OEPA-issued revision.

g) STORM WATER SYSTEM DESIGN

Storm water drainage and management facilities including underground pipes, inlets, culverts, catch basins, and retention or detention basins shall meet the design requirements specified in the Construction and Material Specifications and City Storm Water Policies.

h) ROUTINE AND REMEDIAL MAINTENANCE

The City will provide for inspection and routine maintenance of storm drainage facilities that have been accepted for maintenance by the City. A maintenance agreement policy for all privately held storm water management facilities must be submitted to the City Engineer, and recorded as a restrictive covenant on the property deed for that facility prior to review and approval of the site development plans by the City. Municipal maintenance may include storm water conveyance-related structure cleaning and repair. For other storm drainage facilities not accepted for maintenance by the City, the City may provide for remedial maintenance of facilities based upon the severity of storm water problems and potential hazard to public health and safety, through the abatement procedures described in Section I, below. For the purposes of this Policy, 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" storm water problems, and maintenance will not be provided by the City except in case of public emergency as determined by the City Engineer.

i) DRAINAGE CORRECTIONS.

1) Notice to Correct Drainage.

A) When the Public Service Director finds that a tract of land is inadequately drained or that there is an obstruction to a culvert, covered drain, or other natural or man-made watercourse that interferes with water naturally flowing therein or that such culvert, drain or watercourse is of insufficient capacity to reasonably accommodate the flow of water; or that a condition which alters, impairs, reduces, restricts or otherwise damages any part of the storm water system or which may do so in the event of a severe rainstorm constitutes a public hazard or nuisance, the Public Service Director or his/her duly authorized representative shall notify the owner or person having possession, charge or management of such land to remove the obstruction or provide the necessary drainage. Such notice shall be served on such persons by personal delivery, by mail at the last known place of residence or by posting on the premises.

B) The owner must comply with the orders of the Public Service Director within the time specified, not to exceed ten (10) days. Failure to comply with such order shall constitute an unlawful act. Each and every day thereafter during which the owner fails to carry out the order of the Public Service Director or his/her duly authorized representative, shall constitute a separate offense as specified in Section 937.99.

2) Emergencies and Abatement.

In case of an emergency, the Director of Administration may direct that action be taken immediately to correct the condition or abate the activity to protect the public health, safety and welfare. The Utility may perform the required work and charge the owner the abatement costs.

3) Notice.

A) In any case, where a condition described in Section 937.07.I exists for more than ten (10) days, the Public Service Director shall serve written notice on the property owner directing the owner within a specified period of time, to fill or drain such land, remove any obstruction; and, if necessary, enlarge the culverts, drains or watercourse to meet the requirements of this Code.

B) After service of notice or after publication in a paper of general circulation in the City for two 2) consecutive weeks, the owner,

or his agent or attorney, shall comply with the directions of the Public Service Director's notice within the time therein specified. In the event an owner fails or refuses to comply with the Public Service Director's notice, the City may perform the required work and charge the owner the abatement costs. If the owner is more than thirty (30) days delinquent in payment after notice, provisions in 937.99 shall apply.

C) Owners of real property in the City consent to the entry of City employees or their agents, upon any real property in the City, for all reasonable times during normal business hours for the purpose of inspection, repair or maintenance required by this policy.

D) Non-action by the City 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 City, its officers or agents being responsible for any condition or damage resulting therefrom.

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

4) Abatement Costs. The Director of Administration shall account for all costs associated with an emergency or abatement including, but not limited to, administration, notification, inspection, serving of papers or documents, legal counsel, force account labor, enforcement, operational services and outside contracted services. These costs shall be added to the owner's storm water drainage service charge.

5) Penalty. This section shall not be construed to relieve the owner of any penalties prescribed by Section 937.99.

937.08 COOPERATION WITH FEDERAL, STATE AND OTHER AGENCIES AND POLITICAL SUBDIVISIONS.

The City, upon the recommendation of the Mayor and approval by Council, may enter into agreements with other political subdivisions including the Cities, County, State of Ohio, federal government and other agencies having power to regulate storm water as provided by law where required. The City shall have the right to enter into agreements to make drainage improvements, where required, and as provided by law.

937.09 NATIONAL FLOOD INSURANCE PROGRAM.

The Utility shall assist the City Engineer in the administration of the National Flood Insurance Program, pursuant to Chapter 1313 - Flood Damage Prevention Code.

937.10 PERMITS PROCESS.

a) It shall be unlawful for any person or organization to construct, enlarge, alter, repair, relocate, or demolish a storm sewer, natural watercourse or other drainage facilities without first obtaining a proper permit from the City Engineer and paying the prescribed fee.

b) Permits are required for the following improvement categories:
   1) Connection into the public storm water system.
   2) Improvements which are or will become public facilities.
   3) Improvements within dedicated but unimproved street rights-of-way.
   4) Improvements which require retention or detention facilities.

c) An application shall be made by the owner of the property involved or his authorized agent employed in connection with the proposed work.

d) A permit shall expire by limitation when no work is started within one hundred eighty (180) days from the date of issuance. However, one 1) renewal, which shall be valid for one hundred eighty (180) days commencing upon expiration of the original permit, shall be granted upon written application made prior to the expiration of the original permit.

937.11 PLAN REVIEW PROCESS.

a) Plans for improvements made within the City that require storm water drainage facilities and/or changes or alterations to existing storm water drainage facilities must be submitted to the City Engineer for review and approval. Plans and applications may be submitted directly to the Utility or through the Development permit process. All drainage improvements must be in compliance with Chapter 1313 - Flood Damage Prevention Code. The City Engineer shall have thirty (30) days after the date of receipt of application to review each plan submitted. Plans that are not approved must be resubmitted after revisions are made. No permit shall be issued until a plan is approved, or the need for a permit is waived, by the City Engineer.

b) All applications for permits shall be accompanied by five 5) sets of plans and two 2) sets of specifications. In addition to the plans and specifications, the applicant shall provide all statements, calculations, drawings and other supporting data regarding the manner in which storm water runoff from the project site on the proposed development area will be controlled.

c) Every improvement shall be provided with a storm water system capable of handling storm waters flowing onto the improvement site from other areas as well as storm water from the site itself. The drainage system shall be designed to discharge into an adequate drainage outlet facility without producing any adverse effect on adjacent or downstream properties.

d) A storm drainage facility shall be constructed when the storm water flow from the tributary area, as determined by the City Engineer, is a hazard to adjoining property.

e) The storm water drainage system shall not be combined with any part of the sanitary sewer system, nor shall sanitary water be discharged thereto.

937.12 PERMIT REVIEW.

It shall be the responsibility of the City Engineer and the Public Service Director to examine the application as described in the plan review process. If the examination reveals no objections to the proposed plan and it appears that the proposed work will be in compliance with codes, laws and ordinances applicable thereto and the proposed construction or work will be in conformance with this Code, the application shall be approved and a permit issued, as soon as practicable. If the examination reveals otherwise, the application shall be rejected and the findings shall be communicated in writing to the applicant.

937.13 PERMIT FEES.

The owner/developer shall pay a permit fee and an inspection fee as for all storm water facilities to be constructed. These fees shall be as defined in Section 1100 in this code.

937.14 PERMIT REVOKED.

a) The Public Service Director or the City Engineer may revoke the permit or stop work for any of the following reasons:
   1) When there is a violation of any provision of this Code, any ordinance of the City or statute of the State relating to the project.
   2) When the continuance of any work becomes dangerous to life or property.
   3) When there is a violation of any condition on which the issuance of the permit was based.
   4) When any false statement or misrepresentation has been made upon the application, plans or specifications on which the issuance of the permit or approval was based.
   5) When work is discontinued for a period of one 1) year or when, in the opinion of the Public Service Director or City Engineer, the completion of the work has been unduly delayed.

b) No revoked permit may be reissued until the plans and uncompleted work are made to comply with all the requirements of all laws, codes, regulations and ordinances then in effect.

937.15 INSPECTION AND SURVEILLANCE.

a) After an application is approved and a permit is issued, construction can begin. It shall be the responsibility of the Public Service Director, or his/her designee, to inspect (or designate others to inspect) the premises for which permits have been issued.

b) When the Public Service Director or his/her designee finds the drainage facility, or the construction thereof, is contrary to the approved plans, or presents an unsafe or dangerous condition in connection with the provisions of

this Code or of any law or ordinance relating to the same subject matter, the Public Service Director or his/her designee, shall give written notice to the owner of the premises or the contractor responsible for the work. The notice shall state where and in what respect the work does not conform to the approved plans, or state the defective condition and law violated, and shall specify a reasonable period of time in which to conform to the plans or the Code.

c) Notice, as required by this provision, is to be served on the owner and permitee, agent, contractor or other person responsible for the work or violation related to this Code, by personal delivery or by certified mail addressed to his last known place of residence or place of business. If the owner and permitee, agent or contractor fails to comply with said notice within the time period specified, such failure shall result in a revocation of the permit.

d) In every instance, a revocation notice of the permit shall be in writing and shall be served upon the owner and permitee, his agent or the person having charge of the work. A revocation notice shall also be posted alongside the permit. After the notice is received or posted, it shall be unlawful for any person to proceed with any operation for which such permit was issued. No part of the fees for such permit shall be returned.

937.16 RIGHT OF ENTRY FOR SURVEY AND EXAMINATION.

a) The employees of the Utility, or its agents including contractors and their employees, consultants and their employees, may enter upon lands within the City to make surveys and examinations to accomplish the necessary preliminary findings to establish a Master Plan and for detailed analysis to prepare final plans and specifications for the proposed improvements.

b) Where improvements are made that require periodic maintenance or inspection upon the lands by the Utility, the owner of such lands must grant the City a perpetual easement and right of entry around and access to any storm water channel or facility, including storm sewers.

c) Where improvements are required upon lands, the owner of such lands must grant the City a temporary right of entry for construction and specification purposes where required. This consent shall provide the City with the right of access only during the period of construction.

937.17 STORM WATER ENTERPRISE FUND.

All revenues generated by or on behalf of the Utility including storm water drainage service charges, permit and inspection fees, direct charges and interest earnings shall be deposited in the Storm water Fund, hereby created, and used exclusively for carrying out the purpose of Chapter 937.

937.18 ESTABLISHMENT OF STORM DRAINAGE SERVICE CHARGES.

a) Application. A storm water drainage service charge is imposed on each and every lot or parcel of land within the City and on the owner thereof, excepting only public streets, boulevards, alleys, viaducts, sidewalks, curbing, street

crossings, grade separations and other public ways, highway structures and appurtenances belonging to the City.

1) Road and freeway rights-of-way shall be exempted from the storm water drainage service charge because they function as part of the storm water collection and conveyance system. Railroads and other rights-of-way will be charged as described herein.
2) Properties that have existing storm water detention facilities, or those planning such facilities, may have their storm water drainage service charges reduced as determined by the Public Service Director. The detention facilities must be in accordance with the hydrologic, hydraulic and structural design requirements of the rules and regulations developed by the Utility under Section 937.07. Facilities of a temporary nature will not be allowed a decrease in their charges.

b) Monthly Charge per Equivalent Runoff/Residential unit (ERU). Bills for storm water service shall be rendered monthly. The monthly charge per ERU shall be as established below. One ERU is equivalent to 2,700 square feet. The monthly charge per ERU shall be reviewed annually beginning in 2005 and adjusted to meet the Utility's budget for the next five year's operations and capital improvements. Any increase to the ERU charge noted below shall be approved by Council.

c) Schedule of Fees. Each single-family property shall be billed as One 1) ERU. All non single-family property owners' bill shall be based on impervious area. Effective January 1, 2009, One 1) ERU Value shall be billed at $2.75 per month.

d) Continuance of Fee Structure. The maximum ERU permitted under this section shall never exceed the equivalent of 2,700 square feet and the billing per month shall never be less than two dollars and seventy-five cents ($2.75) per month for one 1) ERU value.

937.19 COLLECTION OF STORM WATER DRAINAGE SERVICE CHARGE.

The storm water drainage service charge shall be paid by the owner of each lot or parcel which is subject to this charge when billed.

937.20 DELINQUENT CHARGES.

Each bill for Storm water service remaining unpaid fifteen days after the bill date shall become delinquent and subject to a five percent (5%) penalty for late payment. Should the past due date of a bill coincide with a Saturday, Sunday or a legal holiday, it will automatically be extended to the first full business day following.

937.21 COUNTY CERTIFICATION.

All bills for Storm water delinquent as of August 15 of each year shall have a final written notice issued with full payment due by August 31. Delinquent accounts after such final notice shall be forwarded to the County Auditor who shall place such amount on the tax duplicate of the owner's property and collect such charges and penalties in the same manner as other taxes are collected.

937.22 STORM WATER CREDIT.

a) Credits will be given to non-single family properties for reducing peak flow of runoff from a property using storm water detention or retention or by providing maintenance on the part of the public, open channel storm water systems passing through the property.

b) In order to receive credits, property owners must complete an application packet. In order to receive certain levels of credit, a registered professional engineer must perform engineering calculations. The City will institute the credit, if applicable, after reviewing the application packet. Details of the credit program and all applications shall be contained in the storm water credit manual. The Credit Manual and application forms are available at the Engineering Department, and on the City of Marysville website.

c) A minimum peak flow credit of twenty-five percent (25%) can be obtained by having a storm water detention facility that meets City standards and functions as designed. A peak flow credit of up to fifty percent (50%) can be obtained by providing an engineering analysis.

937.23 APPEALS.

The Utility Claims Board of Appeals, as set forth in Chapter 935 of the Codified Ordinances, shall hear appeals. A property owner may appeal a decision made by an agent of the City of Marysville, pursuant to this chapter, by sending a notice of appeal to the Utility Claims Board of Appeals, 125 E. 6th Street, Marysville, Ohio 43040, within ten (10) days of receiving the decision.

937.99 PENALTY.

Any person being the owner, agent, or having control of the premises, architect, engineer, contractor, builder, subcontractor, foreman, mechanic, employee, or any other person who pleads guilty or is convicted of a violation of the provisions of this Code, or of any certificate, order, or permit issued thereunder, shall be deemed guilty of a misdemeanor and, upon conviction thereof, shall be fined not more than five hundred dollars ($500.00). Each and every day on which such person continues to violate the provisions of this Code, after having once been notified of such violation, shall be deemed to be a separate offense.

The imposition of any fine or penalty pursuant to this policy shall not preclude the City Attorney from instituting any appropriate legal proceeding and pursuing any and all available legal remedies in a Court of proper jurisdiction to correct or abate a violation, require compliance with this policy or other applicable chapters, ordinances, regulations or rules of the City or State of Ohio as determined to be appropriate by the City Attorney. Fines or penalties delinquent for more than thirty (30) days after the final notice shall be forwarded to the County Auditor who shall place such amount on the tax duplicate and collect such charges and penalties in the same manner as other taxes are collected.

Chapter 938
Erosion and Sediment Control

938.01 PURPOSE

This ordinance will promote the public welfare by guiding, regulating, and controlling the design, construction, use, and maintenance of any development or other activity that disturbs or breaks the topsoil or results in the movement of earth on land in the City of Marysville.

938.02 DEFINITIONS

For definitions see 937.01

938.03 PERMITS

a) No person shall be granted a Zoning permit for land-disturbing activity that would require the uncovering of *10,000 or more square feet* without an Erosion and Sediment Control Plan approved by the City of Marysville.

b) No Zoning permit is required for the following activities:
   1) Any emergency activity that is immediately necessary for the protection of life, property, or natural resources.
   2) Existing nursery and agricultural operations conducted as a permitted main or accessory use.

c) Each application shall bear the name(s) and address(es) of the owner or developer of the site, and of any consulting firm retained by the applicant together with the name of the applicant's principal contact at such firm and shall be accompanied by a filing fee.

d) Each application shall include a statement that any land clearing, construction, or development involving the movement of earth shall be in accordance with the Erosion and Sediment Control Plan. A supervisor for the contractor, knowledgeable in the Erosion and Sediment Control Plan, shall be on site on all days when construction or grading activity takes place.

e) Permit reviews shall be conducted as set forth in 937.12 of this code.

938.04 PLAN REQUIREMENTS

a) The Erosion and Sediment Control Plan shall include the following:
   1) A natural resources map identifying soils, forest cover, and resources protected under other chapters of this code. Scale of the map shall be no smaller than 1"=100', unless otherwise directed by the City Engineer.

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

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

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

5) Provisions for maintenance of control facilities, including easements and estimates of the cost of maintenance.

b) Modifications to the plan shall be processed and approved or disapproved by the City Engineer in written authorization to the permittee, and shall include:
   1) Major amendments of the erosion and sediment control plan submitted to the City Engineer
   2) Field modifications of a minor nature

938.05 DESIGN REQUIREMENTS

a) Grading, erosion control practices, sediment control practices, and waterway crossings shall meet the design criteria set forth in the Construction and Material Specifications. The design shall be adequate to prevent transportation of sediment from the site to the satisfaction of City Engineer. Cut and fill slopes shall be *no greater than 3:1*, except as approved by City Engineer to meet other community or environmental objectives.

b) Clearing, except that necessary to establish sediment control devices, shall not begin until all sediment control devices have been installed and have been stabilized.

c) Phasing shall be required on all sites disturbing greater than 30 acres, with the size of each phase to be established at plan review and as approved by City Engineer.

d) Erosion control requirements shall include the following:
   1) Soil stabilization shall be completed within *five days* of clearing or inactivity in construction.
   2) If seeding or another vegetative erosion control method is used, it shall become established within *two weeks* or the City Engineer may require the site to be reseeded or a non-vegetative option employed.
   3) Special techniques that meet the design criteria outlined in the Construction and Material Specifications on steep slopes or in drainage ways shall be used to ensure stabilization.
   4) Soil stockpiles must be stabilized or covered within 7 days if they will be dormant for more than 21 days but less than one year, and not

within surface waters of the State.

5) The entire site must be stabilized, using a heavy mulch layer or another method that does not require germination to control erosion, at the close of the construction season.
6) Techniques shall be employed to prevent the blowing of dust or sediment from the site.
7) Techniques that divert upland runoff past disturbed slopes shall be employed.

e) Sediment controls requirements shall include
   1) Settling basins, sediment traps, or tanks and perimeter controls.
   2) Settling basins that are designed in a manner that allows adaptation to provide long term stormwater management, if required by the City Engineer.
   3) Protection for adjacent properties by the use of a vegetated buffer strip in combination with perimeter controls

f) Waterway and watercourse protection requirements shall include:
   1) If a stream will be crossed regularly during construction, the temporary stream crossing shall be approved by the City Engineer and installation must comply with the Construction and Material Specifications.
   2) Stabilization of the watercourse channel before, during, and after any in-channel work until final acceptance by the City Engineer.
   3) All on-site stormwater conveyance channels designed according to the criteria outlined in Construction and Material Specifications.
   4) Stabilization adequate to prevent erosion located at the outlets of all pipes and paved channels

g) Construction site access requirements shall include:
   1) A temporary access road provided at all sites
   2) other measures required by City Engineer in order to ensure that sediment is not tracked onto public streets by construction vehicles or washed into storm drains

938.06 INSPECTION

a) City Engineer shall make inspections as hereinafter required and either shall approve that portion of the work completed or shall notify the permittee wherein the work fails to comply with the Erosion and Sediment Control Plan as approved. Plans for grading, stripping, excavating, and filling work bearing the approval of the City Engineer shall be maintained at the site during the progress of the work. To obtain inspections, the permittee shall notify City Engineer at least three business days before the following:
   1) Start of construction, including installation of sediment and erosion control measures.
   2) Completion of site clearing
   3) Completion of rough grading
   4) Completion of final grading
   5) Close of the construction season
   6) Completion of final landscaping

b) The permittee or his/her designee shall make regular inspections of all control measures in accordance with the inspection schedule outlined on the approved Erosion and Sediment Control Plan(s). The purpose of such inspections will be to determine the overall effectiveness of the control plan and the need for additional control measures. All inspections shall be documented in written form, and made available upon request of the City Engineer.

c) City Engineer shall enter the property of the applicant as deemed necessary to make regular inspections to ensure the validity of the reports filed under Section B.

938.07 PERFORMANCE

a) **Stop-Work Order; Revocation of Permit**
In the event that any person holding a Zoning Permit pursuant to this ordinance violates the terms of the permit or implements site development in such a manner as to materially adversely affect the health, welfare, or safety of persons residing or working in the neighborhood or development site so as to be materially detrimental to the public welfare or injurious to property or improvements in the neighborhood, City Engineer may suspend or revoke the Zoning Permit.

b) **Violation**
No person shall construct, enlarge, alter, repair, or maintain any grading, excavation, or fill, or cause the same to be done, contrary to or in violation of any terms of this ordinance.

938.99 PENALTY

Any person being the owner, agent, or having control of the premises, architect, engineer, contractor, builder, subcontractor, foreman, mechanic, employee, or any other person who pleads guilty or is convicted of a violation of the provisions of this Code, or of any certificate, order, or permit issued thereunder, shall be deemed guilty of a misdemeanor and, upon conviction thereof, shall be fined not more than five hundred dollars ($500.00). Each and every day on which such person continues to violate the provisions of this Code, after having once been notified of such violation, shall be deemed to be a separate offense.

The imposition of any fine or penalty pursuant to this policy shall not preclude the City Attorney from instituting any appropriate legal proceeding and pursuing any and all available legal remedies in a Court of proper jurisdiction to correct or abate a violation, require compliance with this policy or other applicable chapters, ordinances, regulations or rules of the City or State of Ohio as determined to be appropriate by the City Attorney.

Fines or penalties delinquent for more than thirty (30) days after the final notice shall be forwarded to the County Auditor who shall place such amount on the tax duplicate and collect such charges and penalties in the same manner as other taxes are collected.

Chapter 939

Illicit Discharge and Connection Ordinance

939.01 PURPOSE/INTENT.

The purpose of this ordinance is to provide for the health, safety, and general welfare of the citizens of **The City of Marysville** through the regulation of illicit discharges to the municipal separate storm sewer system (MS4). This ordinance establishes methods for controlling the introduction of pollutants into the MS4 in order to comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit process as required by the Ohio Environmental Protection Agency (OEPA). The objectives of this ordinance are:

a) To regulate the contribution of pollutants to the MS4 by storm water discharges

b) To prohibit illicit connections and discharges to the MS4.

c) To establish legal authority to carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to ensure compliance with this ordinance.

939.02 DEFINITIONS

Refer to Section 937.01 for definitions.

939.03 APPLICABILITY.

This ordinance shall apply to all water entering the storm drain system generated on any developed and undeveloped lands unless explicitly exempted by the City Engineer and approved by the Public Service Director.

939.04 RESPONSIBILITY FOR ADMINISTRATION.

The City Engineer and the Public Service Director shall work together to administer, implement, and enforce the provisions of this ordinance. Any powers granted or duties imposed upon the City Engineer or the Public Service Director may be delegated in writing by the City Engineer or the Public Service Director to persons or entities acting in the beneficial interest of or in the employ of the City of Marysville.

939.05 COMPATIBILITY WITH OTHER REGULATIONS.

This ordinance is not intended to modify or repeal any other ordinance, rule, regulation, or other provision of law. The requirements of this ordinance are in addition to the requirements of any other ordinance, rule, regulation, or other provision of law, and where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule, regulation, or other provision of law, whichever provision is more restrictive or imposes higher protective standards for human health or the environment shall control.

939.06 SEVERABILITY.

The provisions of this ordinance are hereby declared to be severable. If any provision, clause, sentence, or paragraph of this ordinance or the application thereof to any person, establishment, or circumstances shall be held invalid, such invalidity shall not affect the other provisions or application of this ordinance.

939.07 ULTIMATE RESPONSIBILITY.

The standards set forth herein and promulgated pursuant to this ordinance are minimum standards; therefore this ordinance does not intend or imply that compliance by any person will ensure that there will be no contamination, pollution, or unauthorized discharge of pollutants.

939.08 DISCHARGE PROHIBITIONS.

a) PROHIBITION OF ILLEGAL DISCHARGES.

No person shall throw, drain, or otherwise discharge, cause, or allow others under its control to throw, drain, or otherwise discharge into the MS4 any pollutants or waters containing any pollutants, other than storm water. The commencement, conduct or continuance of any illegal discharge to the storm drain system is prohibited.

Exemptions

The following discharges are **exempt** from discharge prohibitions established by this ordinance:

1) Water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water.
2) Discharges or flow from firefighting.
3) Discharges associated with dye testing, however this activity requires a verbal notification to the City Engineer prior to the time of the test.
4) Discharges from off lot household sewage treatment systems permitted by the Union County Board of Health for the purpose of discharging treated sewage effluent, in accordance with Ohio Administrative Code 3701-29-02(6), until such time as the Ohio EPA issues a NPDES permitting mechanism for residential 1, 2, 3 family dwellings. These discharges are exempt unless such discharges are deemed to be creating a public nuisance by the Union County

Board of Health. When NPDES permit coverage is available, discharges will no longer be exempt until an appropriate NPDES permit has been issued and approved by the Ohio EPA.

5) The prohibition shall not apply to any non-storm water discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under the authority of the United States Environmental Protection Agency (EPA), provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system.
6) Other discharges specified in writing by the City Engineer as being necessary to protect public health and safety.

b) PROHIBITION OF ILLICIT CONNECTIONS.

1) The construction, use, maintenance or continued existence of illicit connections to the storm drain system is prohibited.
2) This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.
3) A person is considered to be in violation of this ordinance if the person connects a line conveying sewage to the MS4, or allows such a connection to continue.
4) Improper connections in violation of this ordinance must be disconnected and redirected, as necessary, to an approved onsite wastewater management system or the sanitary sewer system upon approval of the City Engineer.
5) Any drain or conveyance that has not been documented in plans, maps or equivalent, and which may be connected to the storm sewer system, shall be located by the owner or occupant of that property upon receipt of written notice of violation from the City Engineer requiring that such locating be completed. Such notice will specify a reasonable time period within which the location of the drain or conveyance is to be determined, that the drain or conveyance be identified as storm sewer, sanitary sewer or other, and that the outfall location or point of connection to the storm sewer system, sanitary sewer system or other discharge point be identified. Results of these investigations are to be documented and provided to the City Engineer.

939.09 WATERCOURSE PROTECTION.

Every person owning property through which a watercourse passes, or such person's lessee, shall keep and maintain that part of the watercourse within the property free of trash, debris, excessive vegetation, and other obstacles that would pollute, contaminate, or significantly retard the flow of water through the watercourse. In addition, the owner or lessee shall maintain existing privately owned structures within or adjacent to a watercourse, so that such structures will not become a hazard to the use, function, or physical integrity of the watercourse.

939.10 INDUSTRIAL OR CONSTRUCTION ACTIVITY DISCHARGES. (Submission of NOI)

a) Any person subject to an industrial or construction activity NPDES storm water discharge permit shall comply with all provisions of such permit. Proof of compliance with said permit may be required in a form acceptable to the City Engineer prior to the allowing of discharges to the MS4.

b) The owner or operator of a facility, including construction sites, required to have an NPDES permit to discharge storm water associated with industrial activity shall submit a copy of the Notice of Intent (NOI) to the City Engineer at the same time the operator submits the original Notice of Intent to the OEPA as applicable.

c) The copy of the Notice of Intent may be delivered to the City Engineer either in person or by mailing it to: **Notice of Intent to Discharge Storm Water**
City Engineer
125 East Sixth Street
Marysville, Ohio 43040

d) A person commits an offense if the person operates a facility that is discharging storm water associated with industrial activity without having submitted a copy of the Notice of Intent to do so to the City Engineer.

939.11 COMPLIANCE MONITORING

a) RIGHT OF ENTRY: INSPECTION AND SAMPLING.

The City Engineer shall be permitted to enter and inspect facilities subject to regulation under this ordinance as often as may be necessary to determine compliance with this ordinance.

1) If a discharger has security measures in force which require proper identification and clearance before entry into its premises, the discharger shall make the necessary arrangements to allow access to representatives of the City Engineer.
2) Facility owners and operators shall allow the City Engineer ready access to all parts of the premises for the purposes of inspection, sampling, examination and copying of records that must be kept under the conditions of an NPDES permit to discharge storm water, and the performance of any additional duties as defined by state and federal law.
3) The City Engineer shall have the right to set up on any permitted facility such devices as are necessary in the opinion of the City Engineer to conduct monitoring and/or sampling of the facility's storm water discharge.
4) The City Engineer has the right to require the discharger to install monitoring equipment as necessary. The facility's sampling and monitoring equipment shall be maintained at all times in a safe and proper operating condition by the discharger at its own expense. All devices used to measure storm water flow and quality shall be calibrated to ensure their accuracy.
5) Any temporary or permanent obstruction to safe and easy access to the facility to be inspected and/or sampled shall be promptly removed by the owner or operator at the written or oral request of the City Engineer and shall not be replaced. The costs of clearing such access shall be borne by the owner or operator.

6) Unreasonable delays in allowing the City Engineer access to a permitted facility is a violation of a storm water discharge permit and of this ordinance. A person who is the owner or operator of a facility with an NPDES permit to discharge storm water associated with industrial activity commits an offense if the person denies the City Engineer reasonable access to the permitted facility for the purpose of conducting any activity authorized or required by this ordinance.

b) SEARCH WARRANTS.

If the City Engineer has been refused access to any part of the premises from which storm water is discharged, and he/she is able to demonstrate probable cause to believe that there may be a violation of this ordinance, or that there is a need to inspect and/or sample as part of a routine inspection and sampling program designed to verify compliance with this ordinance or any order issued hereunder, or to protect the overall public health, safety, and welfare of the community, then the City Engineer may seek issuance of a search warrant from any court of competent jurisdiction.

939.12 REQUIREMENT TO PREVENT, CONTROL, AND REDUCE STORM WATER POLLUTANTS BY THE USE OF BEST MANAGEMENT PRACTICES. (BMP)

City Engineer will adopt requirements identifying Best Management Practices for any activity, operation, or facility which may cause or contribute to pollution or contamination of storm water, the storm drain system, or waters of the United States. The owner or operator of such activity, operation, or facility shall provide, at their own expense, reasonable protection from accidental discharge of prohibited materials or other wastes into the municipal storm drain system or watercourses through the use of these structural and non-structural BMPs. Further, any person responsible for a property or premise that is, or may be, the source of an illicit discharge, may be required to implement, at said person's expense, additional structural and non-structural BMPs to prevent the further discharge of pollutants to the MS4. Compliance with all terms and conditions of a valid NPDES permit authorizing the discharge of storm water associated with industrial activity, to the extent practicable, shall be deemed compliance with the provisions of this section. These BMPs shall be part of a storm water management plan (SWMP) as necessary for compliance with requirements of the NPDES permit.

939.13 NOTIFICATION OF SPILLS.

Notwithstanding other requirements of law, as soon as any person responsible for a facility or operation, or responsible for emergency response for a facility or operation has information of any known or suspected release of materials which are resulting or may result in illegal discharges or pollutants discharging into storm water, the storm drain system, or waters of the United States, said person shall take all necessary steps to ensure the discovery, containment, and cleanup of such release. In the event of such a release of hazardous materials said person shall immediately notify emergency response agencies of the occurrence via emergency dispatch services. In the event of a release of non-hazardous materials, said person shall notify the City Engineer no later than the next business day. Notifications in person or by phone shall be confirmed by written notice addressed and mailed to the City Engineer within two **[2]** business days of the phone notice. If the discharge of prohibited materials emanates from a commercial or industrial establishment, the owner or operator of such establishment shall also retain an on-site written record of the discharge and the actions taken to prevent its recurrence. Such records shall be retained for at least five **[5]** years.

Failure to provide notification of a release as provided above is a violation of this ordinance.

939.14 VIOLATIONS, ENFORCEMENT, AND PENALTIES.

a) Violations.

It shall be unlawful for any person to violate any provision or fail to comply with any of the requirements of this ordinance. Any person who has violated or continues to violate the provisions of this ordinance, may be subject to the enforcement actions outlined in this section or may be restrained by injunction or otherwise abated in a manner provided by law.

In the event the violation constitutes an immediate danger to public health or public safety, the City Engineer is authorized to enter upon the subject private property, without giving prior notice, to take any and all measures necessary to abate the violation and/or restore the property. The City Engineer is authorized to seek costs of the abatement as outlined in 939.17.

b) Warning Notice.

When the City Engineer finds that any person has violated, or continues to violate, any provision of this ordinance, or any order issued hereunder, the City Engineer may serve upon that person a written Warning Notice, specifying the particular violation believed to have occurred and requesting the discharger to immediately investigate the matter and to seek a resolution whereby any offending discharge will cease. Investigation and/or resolution of the matter in response to the Warning Notice will in no way relieve the alleged violator of liability for any violations occurring before or after receipt of the Warning Notice. Nothing in this subsection shall limit the authority of the City Engineer to take any action, including emergency action or any other enforcement action, without first issuing a Warning Notice.

c) Notice of Violation.

Whenever the City Engineer finds that a person has violated a prohibition or failed to meet a requirement of this ordinance, the City Engineer may order compliance by written notice of violation to the responsible person.

The Notice of Violation shall contain:

1) The name and address of the alleged violator;
2) The address when available or a description of the building, structure or land upon which the violation is occurring, or has occurred;
3) A statement specifying the nature of the violation;
4) A description of the remedial measures necessary to restore compliance with this ordinance and a time schedule for the completion of such remedial action;
5) A statement of the penalty or penalties that shall or may be assessed against the person to whom the notice of violation is directed;
6) A statement that the determination of violation may be appealed to the Utility Claims Board of Appeals by filing a written notice of appeal within ten **[10]** days of service of notice of violation; and
7) A statement specifying that, should the violator fail to restore compliance within the established time schedule, the work will be

done by a designated governmental agency or a contractor and the expense thereof shall be charged to the violator.

Such notice may require without limitation:

1) The performance of monitoring, analyses, and reporting;
2) The elimination of illicit connections or discharges;
3) That violating discharges, practices, or operations shall cease and desist;
4) The abatement or remediation of storm water pollution or contamination hazards and the restoration of any affected property
5) Payment of a fine to cover administrative and remediation costs; and
6) The implementation of source control or treatment BMPs.

d) Compensatory Action.

In lieu of enforcement proceedings, penalties, and remedies authorized by this ordinance, the City Engineer may impose alternative compensatory actions upon a violator, such as storm drain stenciling, attendance at compliance workshops, creek cleanup, etc.

e) Suspension Of MS4 Access.

1) Emergency Cease and Desist Orders

When the City Engineer finds that any person has violated, or continues to violate, any provision of this ordinance, or any order issued hereunder, or that the person's past violations are likely to recur, and that the person's violation(s) has (have) caused or contributed to an actual or threatened discharge to the MS4 or waters of the United States which reasonably appears to present an imminent or substantial endangerment to the health or welfare of persons or to the environment, the City Engineer may issue an order to the violator directing it immediately to cease and desist all such violations and directing the violator to:

A) Immediately comply with all ordinance requirements; and
B) Take such appropriate preventive action as may be needed to properly address a continuing or threatened violation, including immediately halting operations and/or terminating the discharge.

Any person notified of an emergency order directed to it under this Subsection shall immediately comply and stop or eliminate its endangering discharge. In the event of a discharger's failure to immediately comply voluntarily with the emergency order, the City Engineer may take such steps as deemed necessary to prevent or minimize harm to the MS4 or waters of the United States, and/or endangerment to persons or to the environment, including immediate termination of a facility's water supply, sewer connection, or other municipal utility services. The City Engineer may allow the person to recommence its discharge when it has demonstrated to the satisfaction of the City Engineer that the period of endangerment has passed, unless further termination proceedings are initiated against the discharger under this ordinance. A person that is

responsible, in whole or in part, for any discharge presenting imminent endangerment shall submit a detailed written statement, describing the causes of the harmful discharge and the measures taken to prevent any future occurrence, to the City Engineer within ten **10** days of receipt of the emergency order. Issuance of an emergency cease and desist order shall not be a bar against, or a prerequisite for, taking any other action against the violator.

2) Suspension due to Illicit Discharges in Emergency Situations

The City Engineer may, without prior notice, suspend MS4 discharge access to a person when such suspension is necessary to stop an actual or threatened discharge which presents or may present imminent and substantial danger to the environment, or to the health or welfare of persons, or to the MS4 or waters of the United States. If the violator fails to comply with a suspension order issued in an emergency, the City Engineer may take such steps as deemed necessary to prevent or minimize damage to the MS4 or waters of the United States, or to minimize danger to persons.

3) Suspension due to the Detection of Illicit Discharge

Any person discharging to the MS4 in violation of this ordinance may have their MS4 access terminated if such termination would abate or reduce an illicit discharge. The City Engineer will notify a violator of the proposed termination of its MS4 access. The violator may petition the City Administrator for a reconsideration.

A person commits an offense if the person reinstates MS4 access to premises terminated pursuant to this Section, without the prior approval of the City Engineer.

f) Civil Penalties.

In the event the alleged violator fails to take the remedial measures set forth in the notice of violation or otherwise fails to cure the violations described therein within fourteen **[14]** days, or such greater period as the City Engineer shall deem appropriate, after the City Engineer has taken one or more of the actions described above, the City Engineer may impose a penalty not to exceed one thousand dollars $**[1000]** (depending on the severity of the violation) for each day the violation remains unremedied after receipt of the notice of violation.

g) Criminal Prosecution.

Any person that has violated or continues to violate this ordinance shall be liable to criminal prosecution to the fullest extent of the law, and shall be subject to a criminal penalty of one thousand dollars $**[1000]** per violation per day and/or imprisonment for a period of time not to exceed thirty **[30]** days. Each act of violation and each day upon which any violation shall occur shall constitute a separate offense.

939.15 APPEAL OF NOTICE OF VIOLATION.

Any person receiving a Notice of Violation may appeal the determination of the City Engineer. The notice of appeal must be received within ten **[10]** days from the date of the Notice of Violation. Hearing on the appeal before the Utility Claims Board of Appeals shall take place within thirty **[30]** days from the date of receipt of the notice of appeal. The decision of the Utility Claims Board of Appeals shall be final.

939.16 ENFORCEMENT MEASURES AFTER APPEAL.

If the violation has not been corrected pursuant to the requirements set forth in the Notice of Violation, or, in the event of an appeal, within fourteen **[14]** days of the decision of the municipal authority upholding the decision of the City Engineer, then representatives of the City Engineer shall enter upon the subject private property and are authorized to take any and all measures necessary to abate the violation and/or restore the property. It shall be unlawful for any person, owner, agent or person in possession of any premises to refuse to allow the government agency or designated contractor to enter upon the premises for the purposes set forth above.

939.17 COST OF ABATEMENT OF THE VIOLATION.

Within thirty **[30]** days after abatement of the violation, the owner of the property will be notified of the cost of abatement, including administrative costs. The property owner may file a written protest objecting to the amount of the assessment within ten **[10]** days. Delinquent accounts after such final notice shall be forwarded to the County Auditor who shall place such amount on the tax duplicate of the owner's property and collect such charges and penalties in the same manner as other taxes are collected.

939.18 VIOLATIONS DEEMED A PUBLIC NUISANCE.

In addition to the enforcement processes and penalties provided, any condition caused or permitted to exist in violation of any of the provisions of this ordinance is a threat to public health, safety, and welfare, and is declared and deemed a nuisance, and may be summarily abated or restored at the violator's expense, and/or a civil action to abate, enjoin, or otherwise compel the cessation of such nuisance may be taken.

939.19 REMEDIES NOT EXCLUSIVE.

The remedies listed in this ordinance are not exclusive of any other remedies available under any applicable federal, state or local law and it is within the discretion of the City Engineer to seek cumulative remedies.

The City Engineer may recover all attorney's fees court costs and other expenses associated with enforcement of this ordinance, including sampling and monitoring expenses.

City of Marysville
Stormwater Drainage Manual

December 2010

City Engineer – Valerie Klingman, P.E., P.S.
Public Service Director – John Mitchell

Appendix B
Sample Calculation Worksheets

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1										**Storm Sewer Design**							**Consultant:**			
2										**Project Name**							**User Name:**			
3										**Design Year Storm Summary Report**							**Date:**			
4																				
5																				
6																				
7																				
8	**Structure**	**Structure**	**Drainage**	**ΣA**	**Runoff**	**cA**	**ΣcA**	**Inlet**	**Total**	**Rainfall**	**Discharge**	**Length**	**Slope**	**Pipe**	**Mannings**	**Mean**	**Capacity**	**T.C.**	**Inv**	**Inv**
9	**#**	**Type**	**Area**	**(ac)**	**Coeff**	**(ac)**	**(ac)**	**Time**	**Time**	**Intensity**	**Q**	**(ft)**	**(%)**	**Size**	**"n"**	**Velocity**	**(cfs)**		**Down**	**Up**
10			**(ac)**		**c**			**(min)**	**(min)**	**(in/hr)**	**(cfs)**			**(in)**		**(ft/s)**				
11																				
12																				
13	4	Catch Basin	0.48	0.48	0.66	0.32	0.32	10.00	10.00	4.50	1.43							908.00	904.85	
14												133.03	0.56%	12	0.013	3.40	2.67			
15	3	Curb Inlet	0.24	0.72	0.66	0.16	0.48	10.00	10.65	4.41	2.10							907.77	904.10	904.10
16												123.48	0.44%	12	0.013	3.02	2.37			
17	2	Curb Inlet	0.82	1.60	0.66	0.54	1.05	10.00	11.33	4.31	4.51							907.25	903.06	903.56
18												118.06	0.33%	18	0.013	3.42	6.05			
19	1	Manhole	0.45	3.04	0.66	0.30	1.84	10.00	11.91	4.23	7.77							906.90	902.17	902.67
20												79.66	0.21%	24	0.013	3.31	10.39			
21	HW1	Headwall							12.31									904.92		902.00
22																				
23																				
32																				
33																				
34																				
37										SAMPLE CALCULATION WORKSHEET										
38																				
39																				
40																				
41																				
42																				
43																				
44																				
45																				
46																				
47																				
48																				

	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**Storm Sewer Design**					**Consultant:**			
2	**Project Name**					**User Name:**			
3	**Design Year HGL Summary Report**					**Date:**			
4									
5									
6									
7				**10 YEAR HYD. GRADE LINE**					
8	**Structure**	**10 yr**	**Discharge**	**Slope**	**Junction**	**Junction**	**Friction**	**10 yr HGL**	**10 yr HGL**
9	**#**	**Rainfall**	**Q**	**(%)**	**Loss**	**Loss**	**Head loss**	**Down**	**Up**
10		**Intensity**	**(c.f.s.)**		**Coefficient**	**(ft)**	**(ft)**		
11									
12									
13	4	5.25	1.66				0.00	905.65	
14				0.00%	0.75	0.13			
15	3	5.13	2.44				0.00	904.90	904.97
16				0.00%	0.50	0.07			
17	2	4.99	5.22				0.00	904.26	904.36
18				0.00%	0.50	0.09			
19	1	4.88	8.98				0.00	903.77	903.94
20				0.00%	1.00	0.17			
21	HW1	4.81							903.60
22									
23									
32									
33									
34									
37									
38									
39			SAMPLE CALCULATION WORKSHEET						
40									
41									
42									
43									
44									
45									
46									
47									
48									

City of Marysville
Stormwater Drainage Manual

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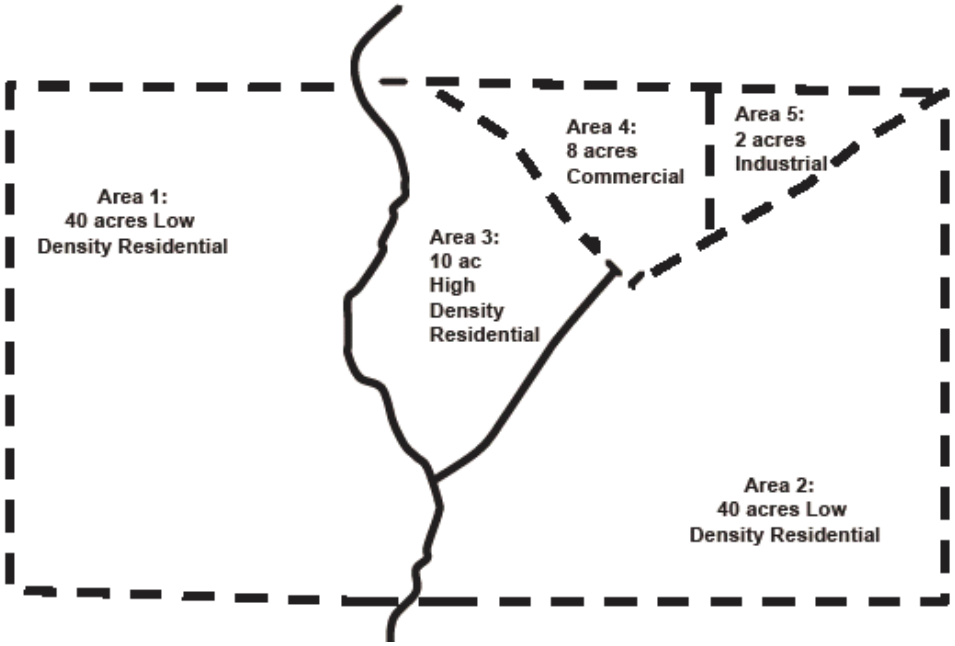
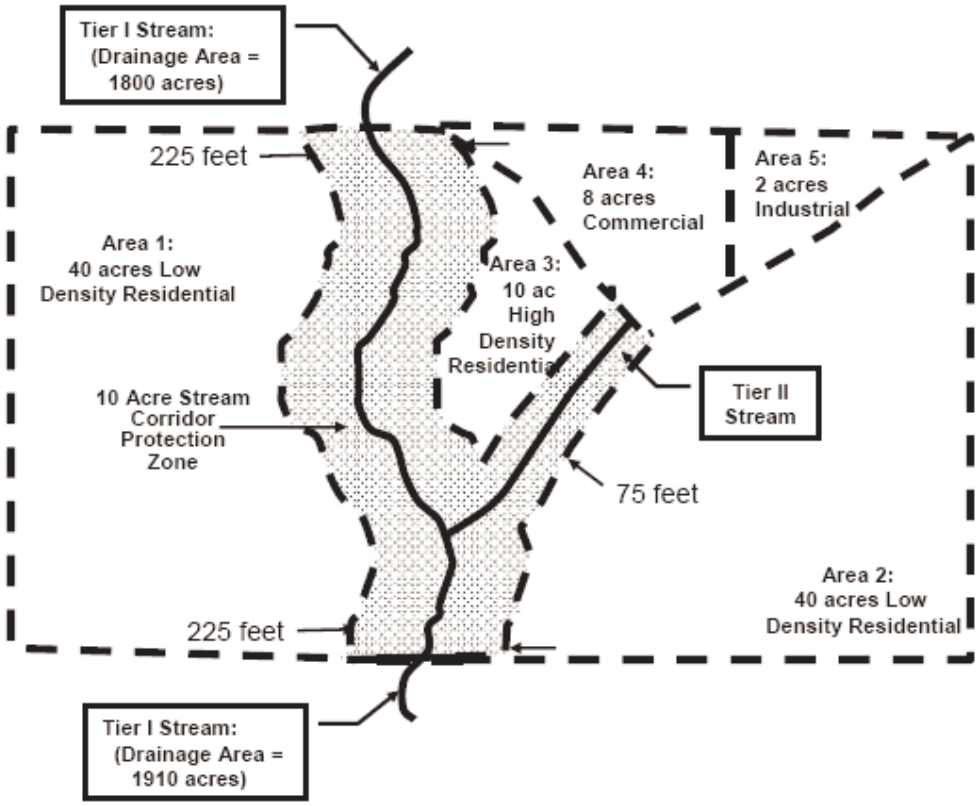
Appendix C
Example Calculations for Stream Corridor Protection Zone and Stormwater Quality Controls

Example 110 Acre Development Site: Area Details



Area Identifier	Size (ac)	Equivalent Land Use (Table 3-5: Runoff Coefficients for Determining WQv)	Runoff Coefficient for WQv
Area 1: Low Density Residential	40	½ acre lots	0.3
Area 2: Low Density Residential	40	½ acre lots	0.3
Area 3: High Density Residential	10	1/8 acre lots (TND-NE)	0.5
Area 4: Commercial	8	Commercial/Business (TND-TC) and Industrial	0.8
Area 5: Industrial	2	Commercial/Business (TND-TC) and Industrial	0.8

Example 110 Acre Development Site: Stream Corridor Protection Zone Delineation



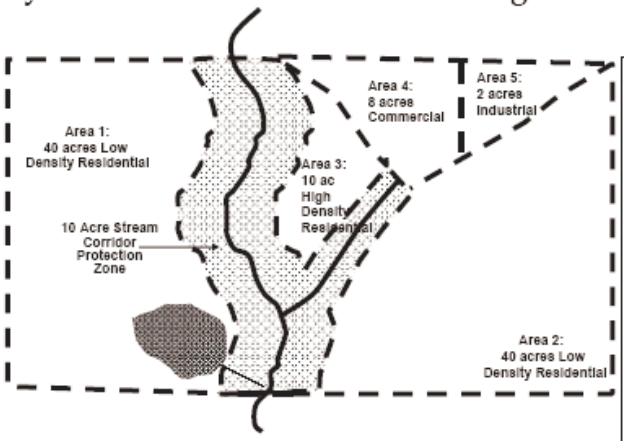
Stream Corridor Protection Zone Delineation Calculations (Section 1.3.1)
Stream Corridor Protection Zone Widths shall be determined by the contributing drainage area in acres as shown in **Table 1-1**.

Tier I Stream at Upstream Project Limit:
Stream Corridor Protection Zone Width for 1800 acre contributing drainage area is 225 feet as determined by **Table 1-1**.

Tier I Stream at Downstream Project Limit:
Stream Corridor Protection Zone Width for 1910 acre contributing drainage area is 225 feet as determined by **Table 1-1**.

Tier II Stream:
Stream Corridor Protection Zone Width for 10 to 20 acre contributing drainage area is 75 feet minimum as determined by **Table 1-1**.

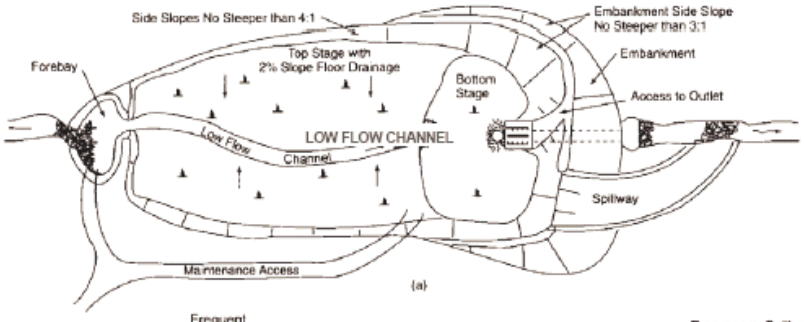
Example 110 Acre Development Site:
Dry Extended Detention Basin Sizing for Area 1



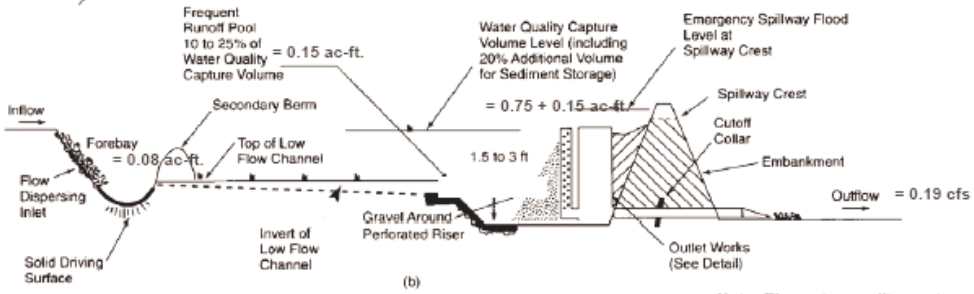
Area 1:
Extended Dry Detention Pond

WQV = P * C * A / 12 (Sec. 3.3.2)
WQV = (0.75" * 0.3 * 40 ac) / 12
= .75 ac-ft
Extended Detention = WQV (Sec. 3.3.4)
= .75 ac-ft
Sediment Storage = 0.2 * WQV (Sec. 3.3.4)
= .15 ac-ft
Forebay = 0.1 * WQV (Sec. 3.3.4.1)
= 0.08 ac-ft
Micropool = 0.2 * WQV (Sec. 3.3.4.1)
= 0.15 ac-ft
Discharge = Extended Detention Volume / Drawdown time (Sec. 3.3.4)
= (.75 ac-ft / 48 hrs) * (43560sf/ac)(1h/3600s)
= .19 cfs
Assume max depth = 5 ft
4 inch diameter perforated riser with 1/4 inch perforations
Area of perforation = 0.049 in^2
Flow through perforation (Sec. 3.3.4.1)
= $AC(64.4\ H)^{1/2}$
= $(0.049/144)^{*}0.8(64.4^{*}5)^{1/2}$
= 0.005 cfs
Number of perforations (Sec. 3.3.4.1)
= 0.19 cfs / 0.005 cfs
= 38 (Use 5 rows with 8 perforations per row with each row 4 inches apart)

Extended Dry Detention Basin Site



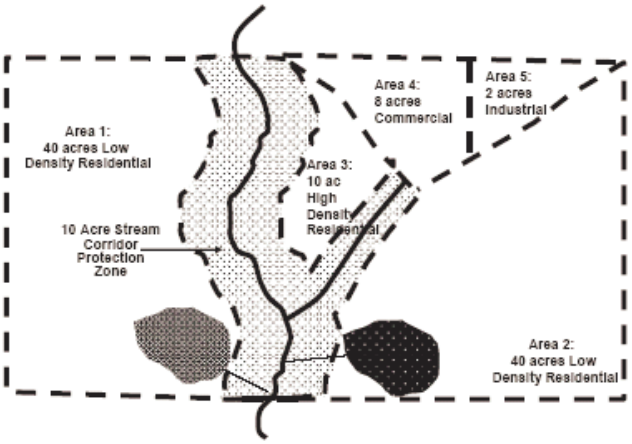
(a)



(b)

Note: The water quality capture volume plus sediment storage volume includes the forebay volume and micropool volume.

Example 110 Acre Development Site:
Wet Detention Basin Sizing for Area 2



Area 2:
Wet Detention Pond

WQV = P * C * A / 12 (Sec. 3.3.2)
WQV = (0.75" * 0.3 * 40 ac) / 12
= .75 ac-ft

Extended Detention = 0.75 * WQV (Sec. 3.3.4)
= .56 ac-ft

Permanent Pool = 0.75 * WQV (Sec. 3.3.4)
= .56 ac-ft

Sediment Storage = 0.2 * WQV (Sec. 3.3.4)
= .15 ac-ft

Forebay = 0.1 * WQV (Sec. 3.3.4.1)
= 0.06 ac-ft

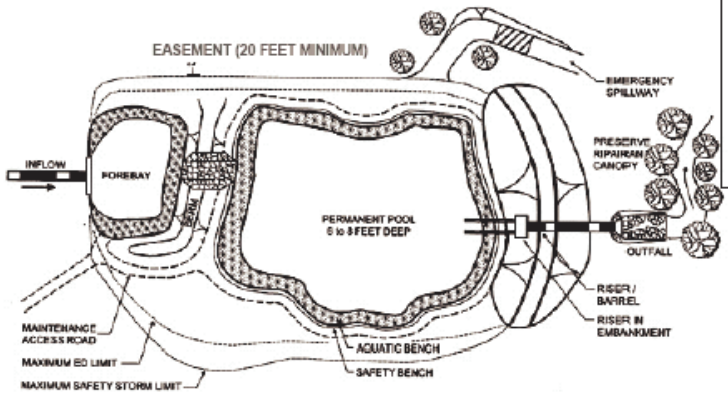
Discharge = Extended Detention Volume / Drawdown time (Sec. 3.3.4)
= (.56 ac-ft / 24 hrs)*(43560sf/ac)(1hr/3600s)
= .28 cfs

Assume Max depth = 5 ft

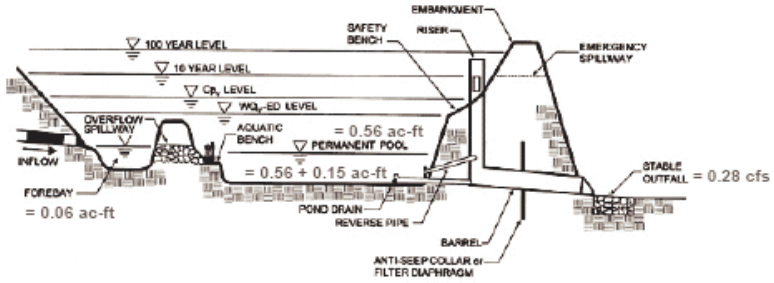
Outlet orifice size: (Sec. 3.3.4.1)
$Q = AC(64.4\ H)^{1/2}$
$0.28 = A*0.66(64.4*5)^{1/2}$
$A = 0.024\ ft^2$
$= \pi * D^2/4$
$D = (4*0.024\ ft^2/\pi)^{1/2} * 12$
= 2 Inches

Extended Dry Detention Basin Site

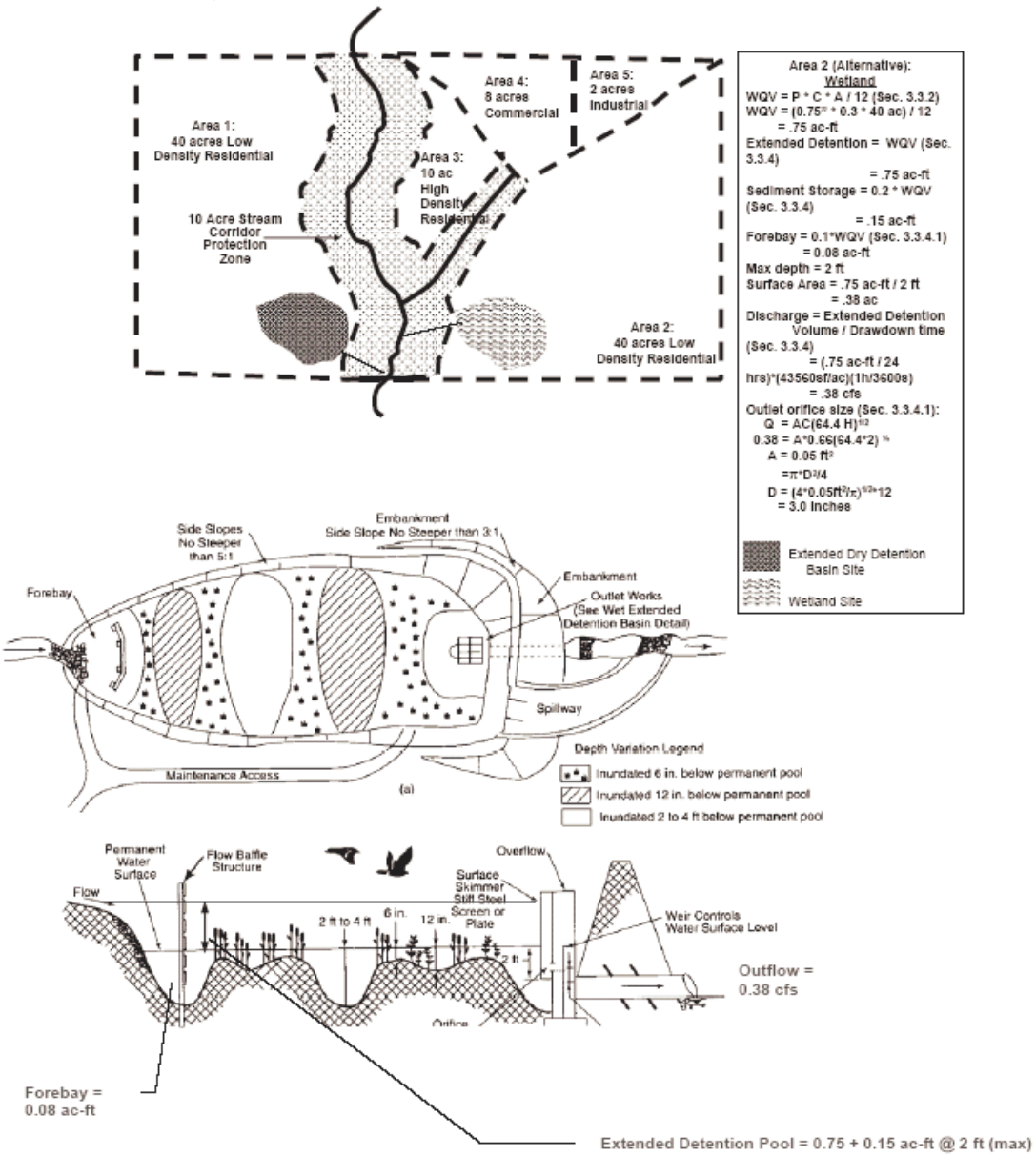
Wet Detention Basin Site



PLAN VIEW



PROFILE



Example 110 Acre Development Site: Wetland Water Balance for Area 2

The following ***water balance calculation*** shall be performed to demonstrate that any proposed stormwater wetland is sufficient to maintain normal pool elevation(s) during a thirty day drought at summer evaporation rates. The City requires that the permanent pool of any proposed stormwater wetland shall be at least two times the volume of evapotranspiration during a thirty day drought at summer evaporation rates or 0.75WQv, whichever is greater.

The change in water storage is given by:

ΔV = Inflows – Outflows

Potential inflow sources include rainfall-runoff and baseflow, and potential outflows include basin discharges, evaporation and evapotranspiration. During a drought, assume that there is no rainfall-runoff, baseflow, or basin discharges.

Therefore:

$\Delta V = - (E_t) * A * T$

where:

ΔV = change in volume of the permanent pool (ac-ft/month)

E_t = Evapotranspiration rate (inches/day)

= 75 percent of the summertime pan evaporation rate[1]

A = surface area of permanent pool (acres)

T = Duration of drought = 30 days

The pan evaporation rate reported by NOAA for the region including the City of Columbus is 0.2 inches/day for all of the summer months of June, July and August.

Therefore:

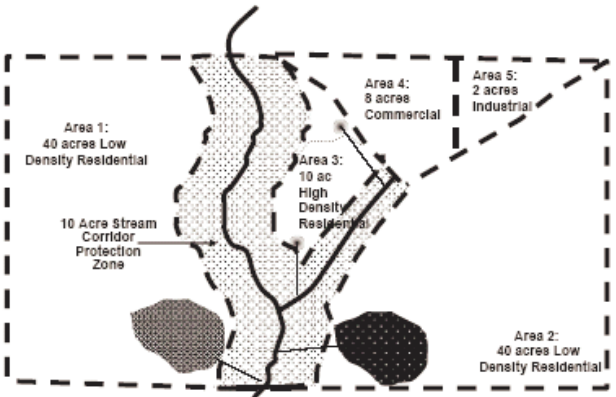
ΔV = - (0.75*0.2 inches / day) * A *30 days *1 foot/12 inches

= -0.375 * A ac-ft

In other words, the volume of water lost to evapotranspiration in the wetlands will be 0.375 times the area of the wetland, and the permanent pool depth will decrease approximately 0.375 ft (4 inches) during a one-month drought where no rainfall occurs. The permanent pool volume must be twice the evapotranpiration volume, i.e., 0.75 times the area of the wetland, or 0.75 times the WQ_v, whichever is greater. Vegetation selected for constructed wetlands must be able to tolerate a drawdown of this depth.

[1] *Treatment Wetlands*, pg. 192.

Example 110 Acre Development Site: Bioretention Facility Sizing for Area 3

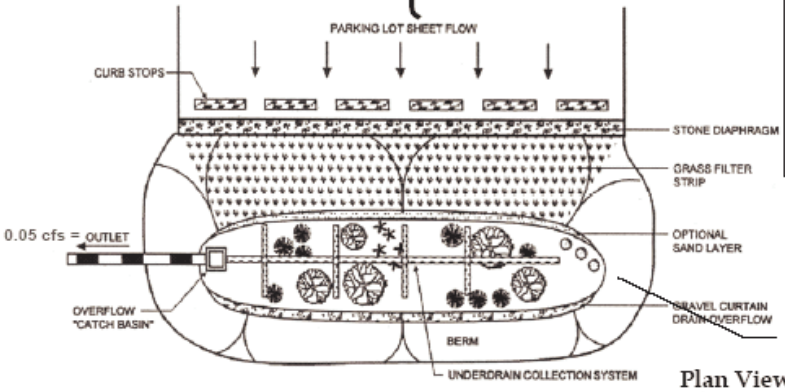


Area 3:
Bioretention
WQV = P * C * A / 12 (Sec. 3.3.2)
WQV = (0.75" * 0.5 * 10 ac) / 12
= .31 ac-ft = 13,612 cu. ft.
Maximum Drainage Area = 5 ac.
→ 10 ac / 5 ac per filter = 2 units
Volume per Unit = WQV / 2
= 6,806 cu. ft.
Sediment Storage = 0.2 * vol (Sec. 3.3.4)
= 1,361 cu. ft.
Discharge = Volume / Drawdown (Sec. 3.3.5.1)
= 6,806 cu. ft. / 40 hrs
= .05 cfs
Surface Area of each Facility
d = planting media depth = 4 ft
h = max depth water = 1 ft
K = planting media permeability
= 1.2×10^{-5} ft/sec
A = WQv*d/(3600*k*T*(h+d)) (Sec. 3.3.5.1)
= .16ac-ft*4ft/(3600*1.2×10^{-5}ft/s *40 hr*(1 ft + 4 ft)
= .074 ac = 3227 ft²

Extended Dry Detention Basin Site

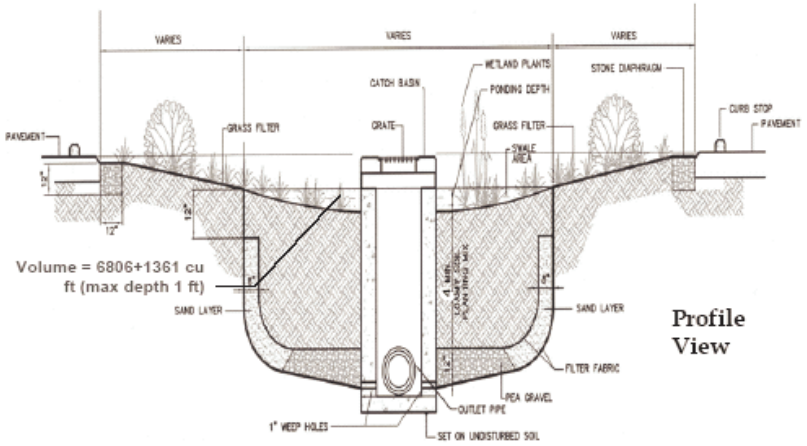
Wet Detention Basin Site

Bioretention Facility Site



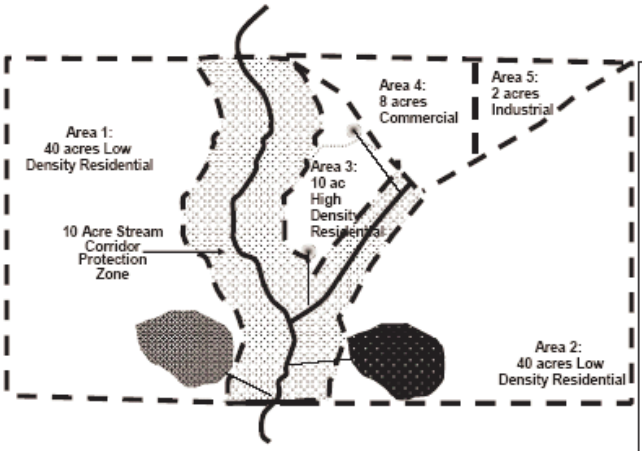
Area = 3,227 sq ft

Plan View



Profile View

Example 110 Acre Development Site:
Extended Dry Detention Swale for Area 4



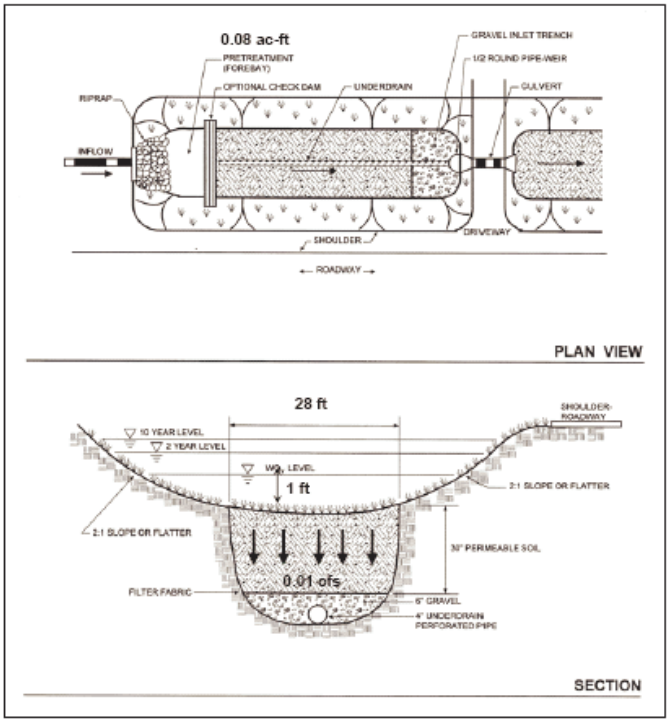
Extended Dry Detention Swales

WQV = P*C*A/12
WQV = (0.75"*0.75*8ac)/12
= 0.38 ac-ft = 16,335 cu.ft.
Extended Detention = WQV
= .38 ac-ft
Sediment Storage = 0.2 * WQV
= .08 ac-ft
Discharge = Extended Detention
Volume / Drawdown time
= .38 ac-ft / 40 hrs
= .01 cfs
Assume max depth = 1 ft
Surface Area = .38 ac-ft / 1 ft
= .38
acres
Assume swale length = 600 ft
Swale width =28 ft

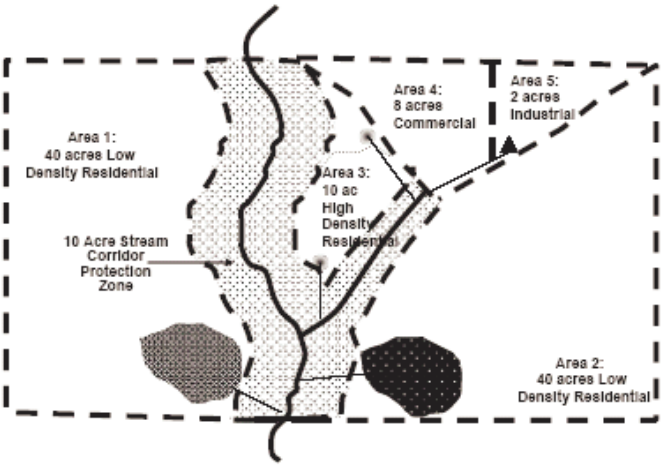
Extended Dry Detention Basin Site

Wet Detention Basin Site

Bioretention Facility Site



Example 110 Acre Development Site:
Sand Filter Water Quality Treatment for Area 5



Area 5:
Sand Filter

WQV = P * C * A / 12 (Sec. 3.3.2)
WQV = (0.75" * 0.8 * 2 ac) / 12
= .1 ac-ft (43560sf/ac)
= 4,356 cu ft

Sedimentation Basin = WQV (Sec. 3.3.5.2)
= 4,356 cu ft

Sediment Storage = 0.2 * WQV (Sec. 3.3.4)
= 871 cu ft

Discharge = Extended Detention Volume / Drawdown time (Sec. 3.3.5.2)
= 4,356 cu ft / 40 hrs
= .03 cfs

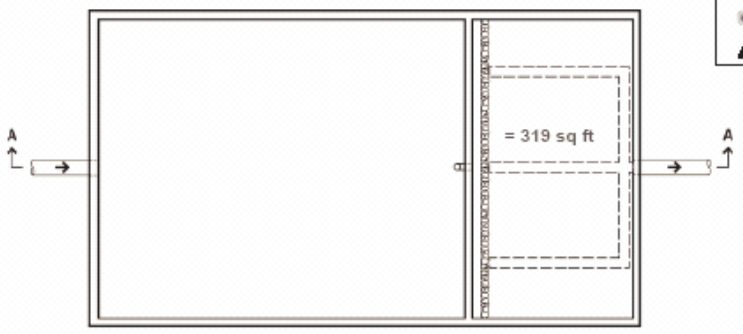
Assume depth on filter = 4 ft (Sec. 3.3.5.2, L&G#2)

Surface area, sand filter
Af = WQv*d/(k*t*(h+d)) (Sec. 3.3.5.2)

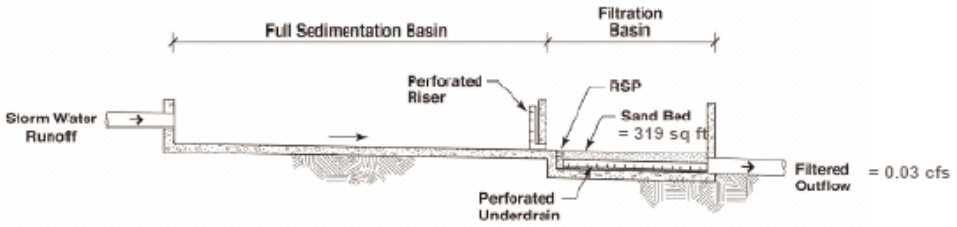
$$= \frac{4{,}356 \text{ cu ft} * 1.5 \text{ ft}}{(3.5 \text{ ft/day} * 1.67 \text{ day} * (2 \text{ ft} + 1.5 \text{ ft}))}$$

= 319 sq ft

Extended Dry Detention Basin Site
Wet Detention Basin Site
Bioretention Facility Site
Sand Filter Site



PLAN



SECTION A-A

Example < 5 Acre Development Site:
Vegetated Swale for 4 acre Development Site

Vegetated Swales

WQV = P*C*A/12

WQV = (0.75"*0.75*4ac)/12

= 0.19 ac-ft = 8,168 cu.ft.

$t_o = 1.8(1.1-C)L^{1/2} / s^{1/3}$

$t_o = 1.8(1.1-0.75)100^{1/2} / 0.03^{1/3}$

t_o = 20 minutes

Using Figure 2-1, intensity = 1.1 in/hr

Qp = C*I*A = 0.75*1.1"/hr*4 ac

= 3.3 cfs (Peak flow)

Since Qp >1 cfs, 4 swales should serve the 4 ac site, with Qp=0.82 cfs

$Q = (1.49/n) A R^{2/3} S^{1/2}$

$0.82 \text{ cfs} = (1.49/0.25) A R^{2/3} 0.03^{1/2}$

$0.79 = A R^{2/3}$

Max depth, d, is 2 in (0.17ft)

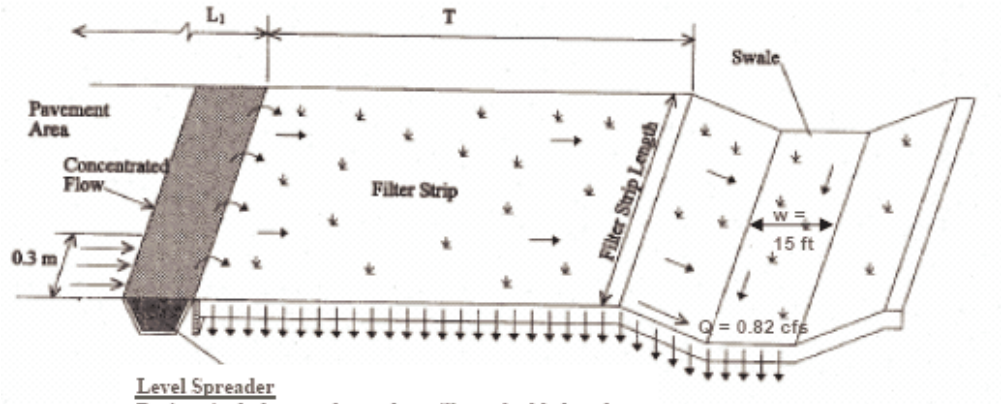
With wide channel assumption:

A = wd

R = d

$0.79 = w*(0.17)^{5/3}$

w = 15 ft



Level Spreader

Designs include gravel trenches, sills, embedded curbs, modular porous pavement, stabilized turf strip)

Note: Not to Scale

The City of Marysville
Stormwater Drainage Manual

December 2010

City Engineer – Valerie Klingman, P.E., P.S.
Public Service Director – John Mitchell

Appendix D
Operation and Maintenance Inspection Report Checklists

Operation and Maintenance Report for Stormwater Basins and Wetlands (*)				
Inspector Name:		**Project Location (inc. SP coordinates)**		
Inspection Date/Time:				
Stormwater Pond				
Normal Pool:		**Watershed:**		
Normal Dry:		**OwnerName:**		
Inspection Items	**Checked? Yes/No**	**Maintenance Needed? Yes/No**	**Inspection Frequency**	**Comments**
Pond Components				
1. Embankment and Emergency Spillway				
a. Adequate vegetation and ground cover			A	
b. Embankment Erosion			SA	
c. Animal Burrows			A	
d. Unauthorized Plantings			A	
e. Cracking, bulging, or sliding of dam				
i. Upstream Face			A	
ii. Downstream Face			A	
iii. At or beyond toe				
Upstream			A	
Downstream			A	
iv. Emergency Spillway			A	
f. Pond, toe & chimney drains clear and functioning			A	
g. Leaks on downstream face			A	
h. Abutment protection or riprap failures			A	
i. Visual settlement or horizontal misalignment of top of dam				
j. Emergency spillway clear of debris			A	
j. Other (specify)			A	
2. Riser and principle Spillway				
Type: Reinforced concrete_____ Corrugated pipe_____ Masonry_____ a. Low flow device obstructed			A	
b. Low flow trash rack i. Debris removal necessary			A	
ii. Corrosion control			A	

Inspection Items	Checked? Yes/No	Maintenance Needed? Yes/No	Inspection Frequency	Comments
c. Weir Trash Rack i. Debris removal necessary			A	
ii. Corrosion control			A	
d. Excessive sediment accumulation inside riser			A	
e. Concrete/Masonry condition riser and barrels i. Cracks or displacement			A	
ii. Minor spalling (<1”)			A	
iii. Major spalling (rebar exposed)			A	
iv. Joint failures			A	
v. Water tightness			A	
f. Metal pipe condition			A	
g. Control valve i. Operational/exercised			A	
ii. Chained and locked			A	
h. Pond drain valve i. Operational/exercised			A	
ii. Chained and locked			A	
i. Outfall channels flowing			A	
j. Other (specify)			A	
3. Permanent pool (wet ponds)				
a. Undesirable vegetative growth			M	
b. Floating or floatable debris removal required			M	
c. Visible pollution			M	
d. High water marks			M	
e. Shoreline problems			M	
f. Sediment accumulation			M	
g. Other (specify)			M	
4. Sediment Forebay				
a. Sedimentation noted			M	
b. Sediment removal when depth <20% design depth			M	
5. Dry pond areas				
a. Vegetation adequate			M	
b. Undesirable vegetative growth			M	
c. Undesirable woody vegetation			M	
d. Low flow channels clear of obstructions			M	
e. Standing water or wet spots			M, S	
f. Sediment and/or trash accumulation			M	
g. Other (specify)			M	

Inspection Items	Checked? Yes/No	Maintenance Needed? Yes/No	Inspection Frequency	Comments
6. Condition of outfalls into pond				
a. Riprap failures			A, S	
b. Slope erosion			A, S	
c. Storm drain pipes			A, S	
d. Endwalls/headwalls			A, S	
e. Other (Specify)			A, S	
7. Other				
a. Encroachments on ponds or easement area			M	
b. Complaints from residents (describe on back)			M	
c. Aesthetics			M	
i. Grass height			M	
ii. Graffiti removal necessary			M	
iii. Other			M	
d. Any public hazards (specify)			M	
e. Maintenance access			M	
f. Monitor mosquito larvae presence (seasonal)			M	
8. Constructed wetland areas				
a. Vegetation healthy and growing (50% surface area coverage)			M	
b. Evidence of invasive species			M	
c. Excessive sedimentation in wetland area			M	

Inspection Frequency Key: A = Annual, SA = Semi-annual, M = Monthly, S = After major storm

(*) Source: Georgia Stormwater Management Manual – Adapted from Watershed Management Institute, Inc. (1997)

Summary

1. Inspectors Remarks: _____
_____
_____
_____
_____
_____

Overall condition of Facility (Check one)
_____ Acceptable
_____ Unacceptable

2. Dates any maintenance must be completed by:
_____
_____

CERTIFICATION STATEMENT

I CERTIFY UNDER PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION ON THIS FORM AND BELIEVE THE INFORMATION IS TRUE, ACCURATE AND COMPLETE.

Authorized Representative Signature Title Date

Operation and Maintenance Report for Media Filters (*)				
Inspector Name:		**Project Location (inc. SP coordinates)**		
Inspection Date/Time:				
Site Status/Owner Name:				
		Watershed:		
Inspection Items	**Checked? Yes/No**	**Maintenance Needed? Yes/No**	**Inspection Frequency**	**Comments**
Bioretention and Sand Filter (if applicable) Facilities				
1. Debris removal				
a. Bioretention and contributing areas clean of debris			M	
b. No dumping of yard waste into practice			M	
c. Any dumping of yard wastes into facility			M	
d. Litter (branches, etc.) been removed			M	
2. Vegetation (if applicable)				
a. Plant height not less than design water depth			M	
b. Fertilizer per specification			M	
c. Plant composition according to approved plans			M	
d. No placement of inappropriate plants			M	
e. Grass height not greater than 6 inches			M	
f. No evidence of erosion			M	
3. Check dams/energy dissipators/sumps				
a. No evidence of sediment buildup			A,S	
b. Sumps should not be more than 50% full of sediment			A,S	
c. No evidence of erosion at downstream toe of drop structures			A,S	
4. Dewatering				
a. Dewaters between storms			M	
b. No evidence of standing water			M	
5. Sediment deposition				
a. Swale clean of sediments			A	
b. Sediments should not be > than 20% of swale design depth			A	
6. Outlets/overflow spillway				
a. Good condition (no need for repair)			A,S	
b. No evidence of erosion			A,S	
c. No evidence of blockages			A,S	

Inspection Items	Checked? Yes/No	Maintenance Needed? Yes/No	Inspection Frequency	Comments
7. Integrity of facility				
a. Filter bed has not been blocked or filled inappropriately			A	
b. Vandalism			A	
Sand Filter Facilities				
1. Media/Filtration Chamber				
a. Media removal/disposal if drain time > 72 hours			M	
b. Media removal/disposal if <90% of design depth			SA	
c. Check for cracks/leakage			SA	
2. Sedimentation Chamber				
a. Clear of sediment buildup (7 to 10-year cleanout recommended)			A	
b. Check for cracks/leakage			SA	

Inspection Frequency Key: A = Annual, SA = Semi-annual, M = Monthly, S = After major storm

(*) Source: Georgia Stormwater Management Manual – Adapted from Watershed Management Institute, Inc. (1997)

Summary

1. Inspectors Remarks: _____
_____
_____
_____
_____
_____

Overall condition of Facility (Check one)

_____ Acceptable

_____ Unacceptable

2. Dates any maintenance must be completed by:

_____

_____

CERTIFICATION STATEMENT

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Authorized Representative Signature Title Date

Operation and Maintenance Report for Vegetated Swales, Filter Strips and Level Spreaders(*)				
Inspector Name:			**Project Location (inc. SP coordinates)**	
Inspection Date/Time:				
Site Status/Owner Name:				
			Watershed:	
Inspection Items	**Checked? Yes/No**	**Maintenance Needed? Yes/No**	**Inspection Frequency**	**Comments**
Vegetated Swales and Filter Strips (Vegetated Swales, as applicable)				
1. Debris removal				
a. Facility and adjacent areas clear of debris			M	
b. Inlets and outlets clear of debris			M	
c. Any dumping of yard wastes into facility			M	
d. Has litter (branches, etc.) been removed			M	
2. Vegetation				
a. Adjacent area stabilized			M	
b. Grass mowed to height of 3 inches			M	
c. Plant height not less than design water depth			M	
d. Fertilizer per specification			M	
e. Evidence of erosion present			M	
f. Is plant composition according to approved plans			M	
g. Any unauthorized or inappropriate plantings			M	
h. Any dead or diseased plants			M	
i. Any evidence of plant stress from inadequate watering			M	
j. Any evidence of deficient stakes or wires			M	
3. Oil and grease				
a. Any evidence of filter clogging			M	
4. Dewatering				
a. Facility dewaters between storms			M	
5. Check dams/energy dissipators/sumps				
a. Any evidence of sedimentation buildup			A,S	
b. Are sumps greater than 50% full of sediment			A,S	
c. Any evidence of erosion at downstream toe of drop structures			A,S	

Inspection Items	Checked? Yes/No	Maintenance Needed? Yes/No	Inspection Frequency	Comments
6. Sediment deposition				
a. Swale clean of sediment			A	
b. Sediment should not be > than 20% of swale design depth			A	
7. Outlets/overflow spillway				
a. Good condition (no need for repair)			A,S	
b. Any evidence of erosion			A,S	
c. Any evidence of blockages			A,S	
8. Integrity of facility				
a. Has facility been blocked or filled inappropriately			A	
b. Check for evidence of erosion/washout of inlet/outlet filter media			A	
9. Bioretention planting soil				
a. Any evidence of planting soil erosion			A	
10. Organic layer				
a. Mulch covers entire area (NO voids) and to specified thickness			A	
b. Mulch is in good condition			A	
Level Spreaders				
a. Vegetated area has vigorous stand of grass			SA, S	
b. Spreaders uniformily distributes flow over level lip			SA, S	
c. Check for evidence of erosion/washout of inlet/outlet filter media			A	

Inspection Frequency Key A = Annual, SA = Semi-annual, M = Monthly, S = After major storm

(*) Source: Georgia Stormwater Management Manual – Adapted from Watershed Management Institute, Inc. (1997)

Summary

1. Inspectors Remarks: _____
   _____
   _____
   _____
   _____
   _____

Overall condition of Facility (Check one)
_____ Acceptable
_____ Unacceptable

2. Dates any maintenance must be completed by:
   _____
   _____

CERTIFICATION STATEMENT

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Authorized Representative Signature Title Date

City of Marysville
Stormwater Drainage Manual

December 2010

City Engineer – Valerie Klingman, P.E., P.S.
Public Service Director – John Mitchell

Appendix E
As-Built Location Forms

City of Marysville Stormwater Outfall Asbuilt Location Form

This form must be filled out and submitted for each constructed outfall that discharges directly to an open watercourse. Please submit completed forms to:

City of Marysville Engineers Office
125 East Sixth Street
Marysville, Ohio, 43040

<u>Stormwater Outfall As-built Location</u>

Date of field location:_____
Project Name (Include Section and Phase): _____

State Plane Coordinate of outfall location
Northing _____,
Easting _____,
Elevation _____,

Check all that apply:
Pipe Shape: _____ Circular _____ Other
_____ Pipe arch
_____ Elliptical
_____ Box section

Pipe Material:

_____ Concrete
_____ Corrugated Metal (CMP_
_____ Ductile Iron (DI)
_____ Vitrified Clay
_____ High-Density Polyethylene (HDPE)
_____ Polyvinyl Chloride (PVC)
_____ Other Describe: _____

Pipe Size: _____ inches inside diameter, or
_____ inches (rise) x _____ inches (span)

Name of receiving stream, if known _____

Maintenance responsibility:

_____ City of Marysville or
_____ Private property owner/Home Owners Association

City of Marysville Stormwater Control Facility As-built Location Form

This form must be filled out and submitted for the location of each outlet structure of a stormwater control facility. Please submit completed forms to:

City of Marysville Engineers Office
125 East Sixth Street
Marysville, Ohio, 43040

Stormwater Control Structure As-built Location

Date of field location: _____
Project Name (Include Section and Phase):_____

State Plane Coordinate of (check those that apply):

_____ principle spillway location for dry detention basins, wet detention basins, and constructed stormwater wetlands

_____overflow catch basin or standpipe for bioretention facilities

_____outlet end of sand filters

_____outlet end of vegetated swales or filter strips that are designed to serve as a water quality BMP only

_____overflow catch basin or standpipe for dry extended detention swales

Northing _____

Easting _____

Is facility intended to provide (check those that apply):

_____ water quality control only
_____ water quantity control only, or
_____ water quality control and water quantity control

Maintenance responsibility:
_____ City of Marysville or
_____ Private property owner/Home Owners Association