SECTION 6 – STORM DRAINAGE DESIGN

(Last revised 02/2017)

6 STORM DRAINAGE DESIGN

6.1 GENERAL

The following module establishes guidelines, which will assist in the development standards set forth by the City of Fairfax. The methods, procedures, design factors, formulas, graphs, and tables presented in this manual are intended to establish minimal guidelines for addressing drainage problems and stormwater management.

Alternative design methods may be considered by the Engineer/Designer on a case-by-case basis; however, there should not be extensive variations from the criteria and procedures within this division of the PFM without the expressed approval of the City Engineer.

6.1.1 CITY OF FAIRFAX STORMWATER MANAGEMENT

It is the purpose of this division to define those storm drainage facilities which must be provided by landowners to protect the quality and quantity of state water from the potential harm of unmanaged stormwater runoff resulting from land-disturbing activities in a manner not detrimental to other inhabitants of the City or elsewhere and to preserve, where possible, presently existing natural creek channels.

The City may accept stormwater management systems for maintenance if the system provides drainage for streets that have been accepted for maintenance by the City and have been designed and constructed in accordance with the provisions of this document and the related documents outlined in paragraph 6.1.2, A, *Related Documents*, below.

6.1.2 APPLICABILITY

A. Related Documents

1) Virginia Stormwater Management Handbook, latest edition.

2) Virginia Stormwater BMP Clearinghouse.

3) Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, Virginia Erosion and Sedimentation Control Handbook, latest edition.

4) Fairfax County Public Facilities Manual for Hydrology.

5) Virginia Stormwater Management Program (VSMP) Regulations, Chapter 870.

6) Section 110-281 through 110-317 – Stormwater and Storm Drainage Facilities, City of Fairfax Municipal Code.

7) Section 110-76, City of Fairfax Municipal Code relating to the Chesapeake Bay Preservation Area Ordinance.

8) Virginia Department of Transportation (VDOT) Drainage Manual, latest edition.

6.1.3 PUBLIC WORKS DIRECTOR'S RESPONSIBILITY

The Public Works Director shall be responsible for administering the City's Virginia Stormwater Management Program in accordance with accordance with §62.1-44.15:27 of the Code of Virginia and Chapter 110, Article II, Division 11, Subdivisions I & II of the City's Zoning Ordinance.

6.1.4 DEFINITIONS

For the purposes of this division, the following words and phrases shall have the meanings respectively ascribed to them by this section:

Best management practice (BMP) means schedules of activities, prohibitions of practices, including both structural and non-structural practices, maintenance procedures, and other management practices to prevent or reduce the pollution of surface waters and groundwater systems from the impacts of land-disturbing activities.

Chesapeake Bay Preservation Areas (CBPA) means those areas delineated on the CBPA Map and the IDA Map as one of the following: (a) Resource Protection Area (RPA), (b) Resource Management Area (RMA) and (c) Intensely Developed Area (IDA).

Design storm means all possible combinations of particular storm intensity-duration events occurring on the design storm curve.

Floodplain refers to the limits of the 100-year floodplain, designated by the Federal Emergency Management Agency as the one percent annual chance water surface elevation.

Maximum peak runoff means the largest peak runoff that can occur from any of the particular storms on the design storm curve.

Metering means the controlled release of water into the primary drainage system.

Municipal detention facilities means municipally-owned facilities located along primary drainage facilities, creeks or channels, which serve the purpose of reducing peak flow by metered release and by storage of that input flow which exceeds the metered output.

On-site detention facility means a facility located on a site, which serves the purpose of collecting and detaining rainfall falling on the site for controlled release to the primary facilities as a result of land alteration.

On-site drainage facility means a facility located on a site, which serves the purpose of collecting rainfall falling on the site and routing it to primary drainage facilities, creeks, or channels.

Peak runoff means the largest runoff intensity, which will occur from a particular storm intensity-duration event on the design storm curve.

Primary creeks and channels means natural creeks and open channels located on either private or public property which serve the purpose of collecting rainfall runoff from other sites and routing it from the city to the rivers. A creek or channel shall be considered a primary facility if it accommodates a runoff flow of at least 1.5 times that amount originating from the site on which it is located.

Primary drainage facilities mean culverts, gutters, enclosed channels, etc., which serve the purpose of collecting rainfall runoff from other sites and routing it to primary creeks and channels. Drainage facilities shall be considered as primary if they accommodate a flow of at least 1.5 times that amount originating from the site on which they are located.

Resource Management Areas (RMAs) are lands contiguous to the inland boundary of a resource protection area (RPA) which have a potential for degrading water quality or diminishing the functional value of the RPA, if not properly managed. The RMA is shown on the CBPA map and includes, but is not limited to, the following land use categories: floodplains, highly erodible soils,

including steep slopes, highly permeable soils; and non-tidal wetlands not included in the RPA.

Resource Protection Areas (RPAs) are the corridors of environmentally sensitive land that lie alongside or near the shorelines of streams, rivers and other waterways. In their natural condition, RPAs protect water quality by filtering pollutants out of stormwater runoff, reducing the volume of stormwater runoff, preventing erosion and performing other important biological and ecological functions.

6.1.5 CHESAPEAKE BAY PRESERVATION AREAS

Certain areas of the City have been designated as Chesapeake Bay Preservation Areas (CBPA), which are divided into Resource Protection Areas (RPAs) and Resource Management Areas (RMAs). These areas are subject to the criteria and requirements contained in Chapter 110, Division 3 (Chesapeake Bay Preservation Ordinance) of the City's Code**.**

The purpose and intent of the Chesapeake Bay Preservation is as follows:

- Protect sensitive environmental lands within the City;
- Safeguard the quality of State waters;
- Prevent further increase in pollution of State waters;
- Reduce existing pollution of State waters; and
- Promote water resource conservation in order to provide for the health, safety, and welfare of the present and future citizens of the City.

The performance standards, review and approval procedures, and regulations for the Chesapeake Bay Preservation Areas shall be in accordance with Division 3 of the City Code and Code of Virginia, § 10.1-2100 et seq., the Chesapeake Bay Preservation Act.

Maps identifying the locations of CBPAs, RPAs, and RMAs within the City can be accessed through digital map viewer in the Fairfax County website.

A Water Quality Impact Assessment (WQIA) is required for any development or redevelopment within an RPA.

6.1.6 STORMWATER POLLUTION PREVENTION PLAN

A stormwater pollution prevention plan (SWPPP) shall be required for land disturbances in accordance with Section 110-287 of the City Code. The stormwater pollution prevention plan must address the following requirements to the extent otherwise required by state law or regulations and any applicable requirements of a state permit:

1. Control stormwater volume and velocity within the site to minimize soil erosion;
2. Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion;
3. Minimize the amount of soil exposed during construction activity;
4. Minimize the disturbance of steep slopes;
5. Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site;
6. Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration, unless infeasible;
7. Minimize soil compaction and, unless infeasible, preserve topsoil;
8. Stabilization of disturbed areas must, at a minimum, be initiated immediately whenever any clearing, grading, excavating, or other earth disturbing activities have permanently ceased on any portion of the site, or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days. Stabilization must be completed within a period of time determined by the VSMP authority. In arid, semiarid, and drought-stricken areas where initiating vegetative stabilization measures immediately is infeasible, alternative stabilization measures must be employed as specified by the VSMP authority; and
9. Utilize outlet structures that withdraw water from the surface, unless infeasible, when discharging from basins and impoundments.

6.2 STORM DRAINAGE DESIGN STANDARDS

6.2.1 PERFORMANCE STANDARDS FOR STORMWATER FACILITIES

Stormwater BMPs shall be designed in accordance with the Technical Criteria for Regulated Land-Disturbing Activities set forth in 9VAC25-870-62, Part II B of the VSMP Regulations, as stated in Section 110-309 of the City Code.

A. **Water Quality**

The following minimum water quality criteria shall be applied to the development of a site, in accordance with 9VAC25-870-63 of the State Regulations:

1) New development. The total phosphorus load of new development projects shall not exceed 0.41 pounds per acre per year.

2) Development on prior developed lands.

   a) For land-disturbing activities disturbing greater than or equal to one acre that result in no net increase in impervious cover from the predevelopment condition, the total phosphorus load shall be reduced at least 20% below the predevelopment total phosphorus load.

   b) For regulated land-disturbing activities disturbing less than one acre that result in no net increase in impervious cover from the predevelopment condition, the total phosphorus load shall be reduced at least 10% below the predevelopment total phosphorus load.

   c) For land-disturbing activities that result in a net increase in impervious cover over the predevelopment condition, the design criteria for new development shall be applied to the increased impervious area. Depending on the area of disturbance, the criteria of subdivisions a or b above, shall be applied to the remainder of the site.

   d) In lieu of subdivision c of this subsection, the total phosphorus load of a linear development project occurring on prior developed lands shall be reduced 20% below the predevelopment total phosphorus load.

   e) The total phosphorus load shall not be required to be reduced to below the applicable standard for new development unless a more stringent standard has been established by a locality.

Designers shall use the Virginia Runoff Reduction Method to determine water quality requirements for developed sites. Approved stormwater BMPs shall be found on the Virginia Stormwater BMP Clearinghouse Website http://vwrrc.vt.edu/SWC/. Design specifications and the pollutant removal efficiencies for all approved BMPs are found on the Virginia Stormwater BMP Clearinghouse Website.

B. **Water Quantity**

Facilities designed to provide downstream channel and flood protection shall comply with section 9VAC25-870-66 of the State Regulations.

C. **On-site Drainage Facilities**

On-site drainage shall be adequate to prevent flooding or damage to any structure located on the site. Gutters and inlets shall be adequate to limit the spread of water in the street to ten feet. Where culverts, storm sewers or other enclosed conduits have been approved for use by the director of public works or his designee as storm drainage transport they shall, in addition to meeting other requirements, be adequate in the opinion of the director of public works or his designee to prevent flood damage to private or public

property. Conduits used in conjunction with gutters and inlets shall be adequate to limit the system hydraulic grade line to no higher than one foot below the grade of the gutter.

Where on-site drainage facilities are proposed by a developer he shall specify the following:
1) Safety factors.
2) Material identification.
3) Cleaning, maintenance, inspection provisions.

Design storms shall be as specified:

Usage	Design Storm
Streets, gutters and inlets	10-year storm
Culverts/storm sewers	100-year storm*
Channels/Natural	10- year storm (capacity) 2- year (Linear Requirement)

* In the absence of potentially damaged private or public property the 25-year design storm shall be used as a minimum

D. **Storm Sewer Easements**

The following are the minimum easements for storm sewers:

Pipe Size - ID (in.)	Easement Width (ft.)
15-18	10
21-33	15
36-48	20
54-72	24

Where multiple pipes are installed, the edge of the easement shall be 5’ clear from outside of the pipe.

Where easement does not follow established lot lines, add 5’ to the easement width on the side toward the building.

E. **Channel Easements**

The following are the minimum easements for channels:

Top Width of Channel	Easement Width (ft.)
<2’	10’
2’ – 4’	10’ greater than top width with minimum of 5’ on one side
>4’	15’ greater than top width with minimum of 5’ on one side

Channels to be maintained by the City shall be within dedicated storm drainage easements.

6.2.2 PIPE AND STRUCTURE DESIGN

6.2.2.1 GENERAL

All pipes shall conform to the VDOT Road and Bridge Specifications. Use pipe and methods of joining in accordance with the following:

PIPE MATERIAL	USE CONDITIONS
Plain Concrete Pipe (ASTM C14)	Not allowed
Reinforced Concrete Pipe (ASTM C76)	15” min, for driveways and roadways
High Density Polyethylene Pipe	48” maximum
Corrugated Aluminum Alloy Pipe (Round or Arch)	Not allowed
Aluminum Coated Metal Pipe	Not allowed

6.2.2.2 MAXIMUM PIPE LENGTH BETWEEN STRUCTURES

To permit maintenance of pipe drainage systems, unless otherwise approved by the City Engineer, the maximum length of pipe runs shall not exceed the distances provided in the table below without a catch basin or manhole junction box.

PIPE MATERIAL	**SIZE** (inches)	**MAXIMUM LENGTH** (feet)
Plain Concrete Pipe	Not allowed	Not allowed
Reinforced Concrete Pipe	15 to 48	425
	54 and 60	800[1]
	66 and larger	1000[1]

[1]This length may be exceeded with approval of the City Engineer on a case-by-case basis.

6.2.2.3 STRUCTURE PLACEMENT REQUIREMENTS:

A. **Pipes 48-inch or less**:

1) At all vertical or horizontal changes in direction

2) At all junctions
3) At all catch basins

B. **Pipes greater than 48 inches but less than 66 inches**:

1) At all vertical or horizontal changes in direction except where horizontal curves are proposed in the pipeline and the pipe manufactured with bevels for that purpose.
2) At junctions where the intersecting branch line is greater than half the diameter of the main being tapped.
3) At all catch basins

C. **Pipes 66 inches in diameter or greater**:

1) At all vertical or horizontal changes in direction except where horizontal curves are proposed in the pipeline and the pipe manufactured with bevels for that purpose.
2) At junctions where the intersecting branch line is greater than half the diameter of the main being tapped.
3) An integral riser for a catch basins and manholes, inclusive of steps in the riser section only, will be allowed as long as the main is designed and manufactured to carry the weight of the riser, grate and frame and any superimposed traffic loads. Risers shall be eccentric. If the main slope exceeds 1%, a standard manhole or manhole junction box is to be provided.

6.2.2.4 LATERAL TAPS/BRANCHES (NOT PERMITTED WITHOUT JUNCTION BOX)

A. **Lateral Taps**: Lateral lines may be connected directly to the main line where the line being tapped is 54-inch and larger in diameter provided:

1) The branch line is *less than half the main diameter*, and
2) Provided the centerline of the branch pipe tap is located at the spring line (vertical centerline) of the line being tapped with a vertical deviation (or offset), from the centerline of the main line being tapped, of +/- 10% of the main line diameter.
3) Provided access to the main line is met elsewhere along the main being tapped.

B. **Saddle connections on new or existing lines**: A saddle connection is permitted when a branch line joins a larger main. However, the saddle connection will be allowed only on pipe 60-inch diameter and larger pipe and where the branch line is *less than half the main diameter*. Otherwise, either place a manhole or construct a manhole junction box at the tie.

6.2.2.5 STRUCTURES IN RELATION TO STREAMS/FLOODPLAINS:

Storm drainage manholes, pipe, or other drainage structures shall be located so that they will not interfere with free discharge of the flood

flows of the stream to which they are proposed to tie. Portions of manholes above grade subject to hydrodynamic forces of flooding shall be designed to resist the flood forces with a Safety Factor of 2.5. Considerations shall be given for impact from debris.

Overland relief: All drainageways, including overland relief pathways, must be separated from buildings. Grading plans for construction of dwellings shall show proposed grading necessary to ascertain adequate drainage and to show that overland relief will be provided for a 100-year storm. See paragraph 6-1503 Overlot Grading In Residential Areas of the *Fairfax County Public Facilities Manual*.

For other floodplain requirements see Chapter 110, Article II, Division 2, Floodplains, Section 110-56 through 110-60 of the City Code.

6.2.2.6 PROJECT GRADING

All buildable areas shall be reasonably graded in such a way as to provide for positive drainage away from building sites in accordance with the applicable paragraphs of Chapter 18 of the International Building Code (IBC), as amended which and will be enforced by the City Code Enforcement Officials.

6.2.3 HYDROLOGIC ANALYSIS

Unless otherwise specified by the City Engineer, the prescribed design storms are the one-year, two-year, and 10-year 24-hour storms using the site-specific rainfall precipitation frequency data recommended by the U.S. National Oceanic and Atmospheric Administration (NOAA) Atlas 14. Partial duration time series shall be used for the precipitation data. All hydrologic analyses shall be based on the existing watershed characteristics and how the ultimate development condition of the subject project will be addressed. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) synthetic 24-hour rainfall distribution and models, including, but not limited to Technical Release Number 55 (TR-55) and Technical Release Number 20 (TR-20); hydrologic and hydraulic methods developed by the U.S. Army Corps of Engineers (USACE); or other standard hydrologic and hydraulic methods, shall be used to conduct the analyses. It is recognized that there are many hydrologic and hydraulic methods available, especially in the form of computer software. Other hydrologic and hydraulic methods may be pre-approved by the City for specific applications provided it is demonstrated that the alternatives are appropriate for the purpose intended.

For drainage areas of 200 acres or less, the City Engineer may allow for the use of the Rational Method for evaluating peak discharges.

If the hydrographs are needed for drainage areas of 200 acres or less, the City Engineer may allow for the use of the Modified Rational Method for evaluating volumetric flows to stormwater conveyances.

6.2.4 OPEN CHANNEL DESIGN

Open channels, where allowed, shall be designed according to the criteria within this section. The designer's calculations shall include the runoff from the property being developed and the runoff from contributing off-site areas, assuming ultimate development in accordance with the requirements of Section 6.2.1 of this manual, *Performance Standards for Stormwater Management Facilities.* Open channel systems shall consist of roadside swales and ditches, off-road drainage and flood channels, and natural streams.

The Virginia Erosion and Sediment Control Regulations, Minimum Standard 19 requires that properties and waterways, downstream from new development sites, shall be protected from sediment deposition, erosion, and damage due to increases in the volume, velocity, and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration.

6.2.4.1 OFF-ROAD DRAINAGE SYSTEM

The design of the off-road drainage system shall include the watershed affecting the subdivision and shall be extended to a watercourse or drainage way adequate to receive the storm drainage. Swales and channels shall be constructed true to definition and shall join the contours of the surrounding topography in such a manner that will create a gently rolling natural appearance. Side drainpipes alongside property lines shall be extended to the back drainage easement.

When the drainage system is outside of the road right-of-way, the subdivision shall make provision for dedicating an easement to the City of Fairfax to provide for the future maintenance of said system.

6.2.4.2 REQUIRED DOCUMENTATION FOR OPEN CHANNEL DESIGNS

The following information must be submitted to the City of Fairfax for the design of open channels, but is not limited the following:

A. Vicinity Map: A vicinity map of the site and subject reach.

B. Site Map: A detailed map of the area and subject reach.

C. Watershed Map: A watershed map showing existing and proposed drainage area boundaries along with all sub-area delineations and all areas of existing or proposed development.

D. Discharge Calculations: Discharge calculations specifying the methodology and key assumptions used, along with computed discharges at key locations. The designer's calculations shall include the runoff from the property being developed and the runoff from contributing off site areas, assuming ultimate development in accordance with paragraph *6.2.1, Performance Standards for Stormwater Management Facilities*.

E. Hydraulic Calculations: Hydraulic calculations specifying the methodology used. All assumptions and values of design parameters must be clearly stated.

F. Plotted Cross-Sections: Typical existing and proposed cross-sections.

6.2.4.3 USAGE, IMPROVEMENT AND PRESERVATION OF CREEKS AND CHANNELS

A. Natural creeks and drainage channels may be used where available to route stormwater runoff from the city.
B. Natural drainage systems will be improved where necessary in accordance with 9VAC25-870-66 of the State Stormwater Regulations. To the maximum degree possible, these improvements shall be made in such a manner as to preserve, enhance or restore the vegetation, including trees, along the creek line so that the aesthetic, environmental and ecological values of the vegetation are not lost to the community.
C. Land disturbances within resource protection areas or resource management areas may require a water quality impact assessment in accordance with Section 110-85 of the City Code.

6.2.4.4 LANDOWNER'S DUTIES AND RESPONSIBILITIES

A. **Natural drainage channels on private property**: Where natural drainage channels pass through a landowner's property, it shall be the responsibility of the landowner to maintain the natural channel in a manner which will not be detrimental to other inhabitants of the City. No change shall be made in the contours of any land which affects the course, width or elevation of any floodplain or natural or other drainage channel in any manner which will obstruct, interfere with, or change the drainage of such land without providing adequate drainage in connection therewith, as approved by the City Engineer. The bounds of the natural stream channel are to be considered as extending to the water level identified for the 100-year storm as defined in this section. All natural stream modifications and maintenance are to be accomplished in accordance with the City of Fairfax Public Facilities Manual as they may be hereafter revised and promulgated by the City Engineer and approved by the City Council from time to time.

B. **Maintenance of on-site drainage facilities**:

1) The landowner and his successors in title to the facilities and the site served thereby shall be responsible for the repair, replacement and other maintenance of the facility.

2) The landowner and his successors shall perform periodic maintenance on the facilities and such other repairs, replacements or maintenance thereon as may be required by the city engineer.

3) The City Engineer, his agent or representative, may inspect the facilities from time to time to determine the necessity of repair, replacement or other maintenance thereof.

4) If the facilities are determined to be in need of repair, replacement or other maintenance, the city engineer, his agent or representative, shall serve on the landowner a written notice describing the condition of the facilities and specifying the required repairs, replacements or other maintenance to be made to correct such deficiencies. Such notice shall require the landowner to comply with the terms thereof within 10 days of receipt.

5) Any landowner aggrieved by the determination of the City Engineer, his agent or representative, may appeal such determination to the City Council within 10 days of the receipt of notice thereof. Such appeal shall be placed on the agenda for the next public council meeting after notice of the appeal is given.

6) Upon refusal or neglect by the landowner or his successors to comply with the repairs, replacements or other maintenance required by the City Engineer, the City, through its agents or employees, may repair, replace or otherwise maintain such facilities.

7) If the City, through its agents or employees, repairs, replaces or otherwise maintains any facility after complying with the notice requirements of this section, the costs or expenses thereof shall be charged to and paid by the landowner and/or his successors and may be collected by the City as taxes and levies are collected.

8) Every charge authorized by this section with which the landowner or his successors has been assessed and which remains unpaid shall constitute a lien against the property.

6.2.4.5 OPEN CHANNEL DESIGN CRITERIA

The proper hydraulic design of a channel is of primary importance in insuring that flooding, sedimentation and erosion problems do not occur. The following general criteria should be used in the design of open channels:

A. **Design Frequencies**

Proposed channel outfall shall be checked in accordance with 9VAC25-870-66 of the State Stormwater Regulations for compliance with Virginia Erosion and Sediment Control Handbook, latest edition Regulations Minimum Standard 19 (MS-19).

B. Channel Geometry, Slope & Velocity

1) Channel Side Slope

In grass-lined channels, the normal maximum side slope will be 3 horizontal to 1 vertical (3:1) for no greater than 50 feet, which is the practical limit for mowing equipment. In some areas, local soil conditions may dictate the use of side slopes flatter than 3:1 to ensure slope stability. The side slopes of a channel shall be a function of channel material. The side slopes throughout the entire length of a channel shall be stable.

2) Channel Bottom Width

In grass-lined channels, the minimum channel bottom width shall be 3 feet. In concrete-lined channels, the minimum bottom width shall be 2 feet except where concrete lined roadside ditches are used where "V" shaped ditches are permissible.

3) Channel Flow-Line Slope/Velocities

Excessive flow velocities in open channels can cause erosion and destabilize side slopes, and may pose a threat to safety. Velocities, which are too low, may allow the deposition of sediment and subsequent channel clogging.

Slope of the channel flow-line (invert) is generally governed by topography and the energy head required for flow. Since flow-line slope directly affects channel velocities, channels should have sufficient grade to prevent significant siltation. However, slopes should not be so large as to create erosion problems. The maximum channel invert slope will be limited by the maximum flow velocities given in Table 3.17A, *Permissible Velocities of Grass-line Channels* of the *Virginia Erosion and Sediment Control Handbook, last edition*. Appropriate channel drop structures may be used to limit channel invert slopes in steep areas.

C. Channel Protection

1) Drainage Ways

The subdivision shall adequately protect all ditches and drainage ways to the satisfaction of the City. Ditches and open channels shall be stabilized, seeded, and mulched, sodded or armored, depending on grades and types of soils. Seeding, sodding, and armoring operations shall be in compliance with the *City of Fairfax Public Facilities Manual* and the *Virginia Erosion and Sediment Control Handbook*, latest edition. There must be a good stand of permanent grass and/or native plant materials to meet this requirement. Calculation shall be made to determine the need for riprap outlet protection at pipe outlets.

The watercourse or ditch easement shall be wide enough to contain said ditch with ample clearance for the operation of maintenance equipment in accordance with the minimum easement requirements for channel.

2) **Downstream Protection – Channel Analysis**

The design of an adequate drainage system must (a) account for both off-site and on-site stormwater runoff; (b) honor natural drainage divides; (c) convey stormwater runoff and discharge into an adequate channel; and (d) provide sufficient easement for channels. An adequate channel shall be defined as a natural or man-made channel or pipe which can convey the stormwater runoff without overtopping its banks, surcharging the system, or creating erosive velocities. (Reference Virginia Erosion and Sediment Control Handbook, latest edition - Minimum Standard MS-19 (9VAC25-840-40 *Minimum Standards*). Adequate drainage must also include provisions for overland relief to accommodate stormwater runoff in excess of the design storms without damaging or endangering adjacent structures or properties. See Virginia Department of Conservation and Recreation Technical Bulletin No. 1, *Stormwater Management & Erosion and Sediment Control Program Stream Channel Erosion Control Policy Guidance*.

Adequacy of all channels and pipes shall be in accordance with 9VAC25-870-66 of the State Stormwater Regulations.

3) **Channel Erosion Control**

Erosion protection is necessary to ensure that channels maintain their capacity and stability and to avoid excessive transport and deposition of eroded material.

Erosion and Sedimentation Control Plans, permit applications, and fees shall be submitted in accordance with City Code. **The City of Fairfax has local review authority for erosion and sedimentation control plans. Plans must be submitted to the Planning Department.**

All Erosion and Sediment Control Plans measures shall be designed in accordance with the Virginia Erosion and Sediment Control Law and the City of Fairfax's City Code, whichever is more stringent. The Designer is to reference the *Virginia Erosion and Sediment Control Handbook,* latest edition. This manual contains valuable information and tools for developing plans to minimize soil erosion and prevent sedimentation pollution associated with land-disturbing activities.

6.2.4.6 OVERLOT GRADING PLAN IN RESIDENTIAL AREAS

Overlot grading plan in residential areas with easement. Overlot drainage calculations provided for 100-year storm verifying separation from buildings both laterally and vertically. Easements should be provided wide enough to cover 25-year Storm.

See Section 6-1503 – *Overlot Grading in Residential Areas* of the Fairfax County Public Facilities Manual.

6.2.5 CULVERT DESIGN

The purpose of this section is to establish standard procedures and criteria for Culvert Design for the City of Fairfax.

6.2.5.1 INTRODUCTION

A drainage system shall be designed and constructed by the developer to provide for the proper drainage of the surface water of the subdivision and the drainage area of which it is part. The storm drainage system shall follow existing topography as nearly as practical. Additional design information shall be submitted to indicate that provision has been made for the adequate disposal of surface water without any damage to the developed or undeveloped land downstream or below the proposed subdivision. A copy of all drainage computations shall be submitted, clearly stating any assumptions made.

The designer's calculations shall include the runoff from the property being developed and the runoff from contributing off-site areas, assuming ultimate development in accordance with the current zoning regulations and the Land Use Plan.

6.2.5.2 PIPE CULVERT DESIGN - GENERAL

Private drainage culverts and public drainage culverts within a subdivision or site development sub-basin shall be designed according to this section.

Pipe culverts shall be aligned parallel to the longitudinal axis of the channel, as much as possible, to ensure maximum hydraulic efficiency and to minimize erosion. In areas where a change in alignment is necessary, the change shall be accomplished at junction boxes or upstream of the culvert in the open channel. Appropriate erosion protection shall be provided.

Pipe culverts crossing beneath the roadway shall be designed to span from ditch line to ditch line.

6.2.5.3 ROADWAY DRAINAGE SYSTEM

The road storm drainage system shall serve as the primary drainage system and shall be designed to carry roadway, adjacent land, and

building storm water drainage. No stormwater shall be permitted into the City's sanitary sewer system.

6.2.5.4 DESIGN FREQUENCY

The minimum design frequency for culverts shall conform to the table below:

Minimum Design Frequency for Storm Drainage Culverts	
Condition	**Minimum Design Frequency***
Normal Runoff	10-year
Primary road crossings	25-year
Secondary roads and other locations	10-year
Flooding of building structures	100-year
Curb and gutters, curb and gutter inlets	2-year

*Culverts should be checked for the effects of the 100-year storm. No flooding of building structures shall result from the 100-year design flow.

6.2.5.5 HYDRAULIC DESIGN OF CULVERTS

The City of Fairfax uses the design procedures of VDOT *Drainage Manual issued April 2002, Chapter 8 – Culverts* or the Hydraulic Design Series No. 5 (HDS-5) for the design of pipe culverts. *HDS-5* was designed to analyze flow in pipes using many different variables. The procedures in the United States Department of Transportation (USDOT) Federal Highway Administration (FHWA) *Urban Drainage Design Manual*, Hydraulic Engineering Circular 22 (HEC-22), 3rd edition issued September 2009 also may be utilized. HEC-22 utilizes many of the same procedures in pipe culvert analysis with references to HDS-5.

6.2.5.6 CURB INLET DESIGN

Curb storm drainage inlets shall be provided at intervals along roadways. Refer to the VDOT *Drainage Manual issued April 2002, Chapter 9 – Storm Drains*, or the USDOT Federal Highway Administration *Urban Drainage Design Manual*, -HEC-22 for curb inlet design methodology.

Gutters and inlet spacing and sizing shall be adequate to limit the spread of water to 10 feet into the roadway. See Chapter 9 of the VDOT Drainage Manual for more details.

Storm drainage inlets will be placed so that crosswalks will not be flooded during the design storm intensity.

6.2.5.7 EROSION CONTROL

Inlet and/or outlet protection is necessary to ensure those channels upstream and downstream of pipe culverts maintain stability and to avoid excessive transport and deposition of eroded material.

All erosion and sediment control measures shall be designed in accordance with the *Virginia Erosion and Sediment Control Handbook,* latest revision. This manual contains valuable information and tools for developing plans to minimize soil erosion and prevent sedimentation pollution associated with land-disturbing activities.

6.2.6 DETENTION DESIGN

Detention and retention facilities reduce the peak rate of discharge of storm drainage systems by allowing flow to be discharged later at a controlled rate. These facilities may also mitigate downstream erosion and may provide some removal of pollutants associated with the increased runoff of stormwater from new developments.

6.2.6.1 ON-SITE DETENTION SYSTEMS

On-site detention systems shall be designed in accordance with 9VAC25-870-66 of the State Stormwater Regulations. Stormwater detention facility is incorporated in the design of storm drainage systems to reduce the peak rate of discharge of the drainage system, reduce downstream erosion problems, possibly reduce the capital cost of the drainage system and help eliminate the environmental problems normally associated with the increased runoff of stormwater from new developments.

A. The design of on-site detention shall include the following:

1) **Spillways**: All detention facilities shall contain spillways so designed and constructed as to convey that excess flow which could occur from a standard project storm without damage to the facility or upstream or downstream properties within the city. Spillways shall be designed in accordance with the Virginia Department of Environmental Quality (DEQ) Stormwater Design Specification, Appendix B: Principle Spillway. Emergency spillways for ponds with watersheds less than 20 acres may be designed to discharge the 100-year, 2-hour storm.

2) **Structural Safety Factors**: Standard engineering safety factors are to be applied to all detention facilities.

3) **Erosion Control**: The proper material for channel linings is to be provided to prevent erosion from the mean design channel velocity. All erosion and sediment control measures shall be designed in accordance with the *Virginia Erosion and Sediment Control Handbook, latest edition.*

4) **Debris**: Most spillways will be subject to some degree of trash and debris associated with incoming flows. Therefore, all control structures, including detention should have a trash rack or debris control device in accordance with DEQ Stormwater Design Specification, Appendix B: Principle Spillway. Debris is to be removed periodically to maintain efficient hydraulic functioning.

6.2.7 BMP DESIGN

All water quality BMPs shall be designed in accordance with the technical criteria for regulated land-disturbing activities set forth in 9VAC25-870-62, Part II B of the State Stormwater Regulations, as stated in Section 110-309 of the City Code.

BMP design shall reference the Virginia Stormwater BMP Clearinghouse Website http://www.vwrrc.vt.edu/swc/.

6.3 POLICY AND EXECUTION

All construction shall conform to the American Society for Testing and Materials (ASTM) standards, the VDOT Road and Bridge Specifications as amended from time to time and the applicable section of the specifications in the City of Fairfax Public Facilities Manual.

6.3.1 GENERAL

6.3.1.1 EASEMENTS FOR CITY MAINTENANCE

All storm sewers and channels to be maintained by the City of Fairfax shall be within dedicated storm easements.

6.3.1.2 WETLANDS, WATERSHEDS, BUFFERS PERMIT REQUIREMENTS

All stream impacts by crossings, pipe placement, excavation, regrading, clearing, maintenance, etc. shall be subject to the applicable USACE 404 and DEQ permit requirements in affect at the time of the permit application as well as the applicable provisions for development in the Chesapeake Bay Preservation Areas, Virginia Erosion & Sedimentation Regulations and the provisions of the Virginia Stormwater Management Regulations. Construction within jurisdictional wetlands and buffers shall conform to the applicable permit requirements of the issuing agency.

6.3.2 PLAN SUBMITTALS

The purpose of this section is to establish the design procedures and criteria for storm drainage design on systems either owned or maintained by the City of Fairfax or those systems otherwise required to meet certain criteria related to stormwater management (e.g., dry or wet detention basins, Best Management Practices, etc.). It is also the purpose of this section to outline the minimal plan

submittal requirements for plan review and approval of both City-owned and private stormwater facilities, as applicable.

6.3.2.1 SUBMITTAL REQUIREMENTS

7 complete sets of site plan drawings and **2** complete sets of sitework calculations shall be submitted to the City of Fairfax, Attn: Planning Department for review and approval. The submission shall include:

A. **Certification Requirements**

The following certifications shall appear on the first Stormwater Management sheet in the plan set.

B. **Designer's Certification**

"I hereby certify that, to the best of my ability, this plan has been prepared in accordance with the latest City of Fairfax Public Facilities Manual and City Code."

Signature:_____
Printed Name and Title:_____
Date:_____ Registration Number: _____

C. **Owner's/Developer's Certification**

"I/We hereby certify that all site construction, drainage and grading will be done pursuant to this plan and that the applicable Stormwater Management conditions and requirements of the City of Fairfax, the State of Virginia and the Federal Government and its agencies are hereby made part of this plan."

Signature:_____
Printed Name:_____
Title:_____ Date:_____

D. **Checklist of Stormwater Standards**

Applicants shall submit a completed Virginia Stormwater Management Program Checklist found on the City of Fairfax website, Stormwater and Floodplain Management, Virginia Stormwater Management Program

6.3.2.2 STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

An approved SWPPP shall include, but not be limited to, the following components:

1. An erosion and sediment control plan

2. A stormwater management plan
3. A pollution prevention plan
4. Additional TMDL requirements

The SWPPP shall be amended whenever there is a change in design, construction, operation, or maintenance that has a significant effect on the discharge of pollutants to state waters and that has not been previously addressed in the SWPPP. The SWPPP must be maintained at a central location onsite. If an onsite location is unavailable, notice of the SWPPP's location must be posted near the main entrance at the construction site.

A. **Erosion and Sediment Plan**

An erosion and sediment control plan consistent with the requirements of the Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities. Prior to land disturbance, this plan must be approved by either the City of Fairfax or the department in accordance with the Virginia Erosion and Sediment Control Law and attendant regulations.

B. **Stormwater Management Plan**

A stormwater management plan shall be developed for a land-disturbing activity. Individual lots in new residential, commercial, or industrial developments shall not be considered separate land-disturbing activities. A stormwater management plan shall consider all sources of surface runoff and all sources of subsurface and groundwater flows converted to surface runoff.

Stormwater management plans shall be developed in accordance with Section 110-287 of the City Code.

C. **Pollution Prevention Plan (PPP)**

A plan for implementing pollution prevention measures during construction activities shall be developed, implemented, and updated as necessary. The pollution prevention plan shall detail the design, installation, implementation, and maintenance of effective pollution prevention measures to minimize the discharge of pollutants. At a minimum, such measures must be designed, installed, implemented, and maintained to:

1. Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge;

2. Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on the site to precipitation and to stormwater; and
3. Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures.

The pollution prevention plan shall include effective best management practices to prohibit the following discharges:

1. Wastewater from washout of concrete, unless managed by an appropriate control;
2. Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials;
3. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance; and
4. Soaps or solvents used in vehicle and equipment washing.

Discharges from dewatering activities, including discharges from dewatering of trenches and excavations, are prohibited unless managed by appropriate controls.

D. **Additional TMDL requirements**

If a specific Waste Load Allocation (WLA) for a pollutant has been established in an approved TMDL and is assigned to stormwater discharges from a construction activity, additional control measures must be identified and implemented by the operator so that discharges are consistent with the assumptions and requirements of the WLA.

6.3.2.2 ADDITIONAL REQUIREMENTS

Approval of Stormwater Management Plans and Calculations by the City of Fairfax does not complete the City of Fairfax review process. All other applicable City Departments, State, and Federal agencies must also approve the plan as warranted. It shall be the sole responsibility of the Owner/Developer/Designer to acquire all applicable approvals.

6.4 REFERENCES

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END OF SECTION 6

Back to Top