

CHAPTER 6 DETENTION/RETENTION AND WATER QUALITY

6.1 Scope

New development shall have stormwater management facilities per the Stormwater Management Ordinance. These facilities shall be designed to provide either flood protection or channel protection. To determine which is required, the developer may perform a flood study downstream of the proposed development to the point of interest, where the development constitutes 10% of the total watershed. The flood study must be performed based on the parameters in Section 6.1.1. If the post development water surface is within two feet or less of the lowest entry to a structure, then a flooding problem will be assumed to exist.

Where a flooding problem exists (i.e. a complaint is on file with the City) or is assumed to exist as a result of the flood study, flood protection detention must be installed to control runoff as set forth in section 6.4.2.D.

Developers may try to demonstrate, with proper supporting information, that there will not be a flooding problem because there are no structures or roads that can flood downstream to the point of interest. This must be demonstrated to the satisfaction of City staff and the supporting information must include, at a minimum, a drawing showing the drainage area with the most up-to-date topo and planimetrics showing structures and roads.

If the developer does not wish to perform a flood study, then flood protection detention must be provided.

If no flooding problem exists, or none is assumed to exist as a result of the flood study, channel protection detention must be provided.

6.1.1 Flood Study Parameters

A. Hydrology

NRCS modeling as given in Chapter 2 using a fully developed condition in all areas contributing to the point of interest.

B. Hydraulics

Use the Army Corps of Engineers HEC-RAS program with flow analyzed as subcritical. The modeling of the stream may need to be carried downstream beyond the point of interest to account for backwater effects of bridges, culverts or other stream obstructions.

C. The City hydrology model will be made available to the engineer. As part of the study, the engineer will modify and/or add to that model and provide a copy of the approved hydrology and hydraulics model back to the City before a permit will be issued for the development.

6.2 Access and Easements

Permanent access and buffers must be provided for maintenance of a detention facility with the following minimum requirements:

- 6.2.1** The water surface of the design storage pool shall be a minimum of 20 feet from building structures. A greater distance may be necessary when the detention facility might compromise foundations or if slope stability is a consideration. The vertical separation between the maximum ponding elevation and the lowest floor of applicable surrounding structures shall be a minimum of 2.0 feet.
- 6.2.2** A 15 foot wide access strip, with cross slopes less than 5 horizontal to 1 vertical, shall be provided around the perimeter of the facility, unless it can be demonstrated that all points of the facility can be maintained with less access provided.
- 6.2.3** The property owner shall also maintain a minimum 15 foot wide reinforced turf or gravel surface access route to the 2-year storm elevation in the detention facility from a street or parking lot at slopes no greater than 12%.
- 6.2.4** Structures, inlet pipes, outlet pipes, spillways, and appurtenances required for the operation of the facility shall also be provided access which is no less than easement widths established in Chapter 4 and 5, Enclosed Systems and Open Channels, respectively.

In developments where a public street is proposed across the top of the dam of a permanent lake, a right-of-use agreement shall be executed between the City of Columbia and the developer/owner. This right-of-use agreement shall specify that the City of Columbia will maintain the street pavement, sidewalks, street curb inlets and accompanying piping. The ownership, maintenance of the dam, outlet structures and overflow spillway shall be the responsibility of the developer/owner or the homeowners association.

Easements shall be provided per the Stormwater Management Ordinance.

6.3 Maintenance and Continued Performance

Maintenance responsibility for all elements of the detention facility shall be designated prior to construction of any stormwater management facility.

6.4 Performance Criteria

6.4.1 General Provisions

- A.** Detention/retention facilities shall have 1,000 acres or less area tributary to the facility.
- B.** Dams which are greater than 10 feet in height but do not fall into State or Federal requirement categories shall be designed in accordance with the latest edition of SCS Technical Release No. 60, "Earth Dams and Reservoirs", as highest hazard rated structures.
- C.** All lake and pond development must conform to local, state, and federal regulations. Legal definitions and regulations for dams and reservoirs can be found in the Missouri Code of State Regulations, Division 22.
- D.** Projects involving replacement of, or additions or other improvements to, existing structures or pavement or other impervious surfaces
 - 1. No detention is required on such projects within the central business district.
 - 2. Such projects that do not increase the amount of impervious surface shall install detention, as determined in Section 6.1, for 1.5 times the area of any parts of the site where pavements and/or structures are removed and replaced.
 - 3. Such projects which increase impervious surface shall provide detention as determined in Section 6.1, for 1.5 times the area of the additional impervious surface and 1.5 times the area of any other parts of the site where pavements and/or structures are removed and replaced.
 - 4. Each successive project on a given site will be required to provide detention as specified in the above sections until the entire site is brought to the standards for new development in this manual, at which time nothing further will be required.
 - 5. Such projects shall also conform to the water quality goals and BMP criteria as specified in Section 6.8.1 Water Quality for Previously Developed Sites.
 - 6. Such projects less than 3000 square feet shall provide a Small Site BMP, as outlined in Section 6.8.3 and Appendix A, which will be considered to satisfy both flood protection detention and water quality requirements.

6.4.2 Computational Methods

A. Time of Concentration and Travel Time

Refer to Chapter 2, Hydrology for acceptable hydrology methods.

B. Temporary Storage Volume

A preliminary value of the storage requirement may be obtained through methods outlined in (SCS, 1986, Chapter 6) or other acceptable methods. The storage shall be checked during routing of design hydrographs through the basin and adjusted appropriately.

C. Hydrograph Routing

The storage indication method (Modified Puls) of routing a hydrograph through a detention basin may be utilized. Reference: Chow, 1964.

D. Release Rate

Channel Protection

Release rate for the channel protection volume shall be such that the time between the centers of mass of the inflow and outflow hydrographs of the 1-year storm shall be at least 24 hours, except that one half inch shall be the smallest control orifice size. (See section 6.4.3.D.)

Flood Protection

The maximum release rate from any development and redevelopment shall be controlled by limiting the post-development storm water release rates to the predevelopment rates for the 1, 2, 10 and 100 year storms (the 100%, 50%, 10% and 1%, respectively) .

Where flood protection detention is installed in redeveloping areas as outlined in Section 6.4.1.D, the predevelopment rate shall be determined per Chapter 2, Sections 2.2.2.B and 2.2.2.E.

6.4.3. Primary Outlet Works

The primary outlet shall be designed to meet the following requirements:

- A.** The outlet shall be designed to function without requiring attendance or operation of any kind or requiring use of equipment or tools, or any mechanical devices.
- B.** All discharge from the detention facility when inflow is equal to or less than the 25-year inflow shall be via the Primary outlet.

- C. The design discharge rate via the outlet shall continuously increase with increasing head and shall have hydraulic characteristics similar to weirs, orifices or pipes.
- D. For dry detention basins, the design shall allow for discharge of at least 80 percent of the detention storage volume within 24 hours after the peak or center of mass of the inflow has entered the detention basin, except that discharges for channel protection basins shall be governed by 6.4.2.D.
- E. Retention basins (Ponds) shall be designed with a non-clogging outlet such as a reverse-slope pipe, or a weir outlet with a trash rack. A reverse-slope pipe draws from below the permanent pool extending in a reverse angle up to the riser and establishes the water elevation of the permanent pool. Because these outlets draw water from below the level of the permanent pool, they are less likely to be clogged by floating debris.
- F. The Director may require openings be protected by trash racks, grates, stone filters, or other approved devices to insure that the outlet works will remain functional.
- G. Control structures that are small require particular attention to prevent clogging. One way of doing so is to make an underdrain system the primary outlet for the very small basins. To do so, the soil above the underdrain should be free draining such as sandy loam or loamy sand such that the soil and the inlet perforations of the underdrain provide far in excess of the design discharge. The control for the basin can then be provided by a cap on the underdrain.

6.4.4 Emergency Spillways

The emergency spillway may either be combined with the outlet works or be a separate structure or channel meeting the following criteria:

A. Capacity

In cases where the impoundment/emergency spillway is not regulated by either State or Federal agencies, the emergency spillway shall be designed to pass the 1% storm with 1 foot of freeboard from the design stage to the top of dam, assuming zero available storage in the basin and zero flow through the primary outlet. This design provides an added level of protection in the event of a clogged primary outlet or a subsequent 1% storm event that occurs before the flood pool from the initial storm event recedes to the principal outlet elevation.

6.4.5 Draw Down Provision

Drain works consisting of valves, gates, pipes, and other devices as necessary to completely drain the facility in 72 hours or less when required for maintenance or inspection shall be provided. Pumping will be considered as an alternative if the design engineer can show this is a readily available, viable solution.

6.4.6 Erosion Control

Primary outlet works, emergency spillways, and drain works, as well as conveyance system entrances to detention basins, shall be equipped with energy dissipating devices as necessary to limit shear stresses on receiving channels. See Table 5.1.4.1 in Appendix F for shear stress criteria.

6.5 Detention Methods

In addition to the foregoing criteria, the following shall be applicable, depending on the detention alternative(s) selected:

6.5.1 Wet Bottom Basins/Retention Facility

For basins designed with permanent pools:

A. Sediment Forebay

A sediment forebay shall be provided to trap coarse particles. Refer to Section B.13 in Appendix B for guidance.

B. Minimum Depth

The minimum normal depth of water before the introduction of excess stormwater shall be four feet plus a sedimentation allowance of not less than 5 years accumulation. Sedimentation shall be determined in accordance with the procedures shown in Figure 6.5.1 in Appendix F.

C. Depth for Fish

If the pond is to contain fish, at least one-quarter of the area of the permanent pool must have a minimum depth of 10 feet plus sedimentation allowance.

D. Side Slopes

The side slopes shall conform as closely as possible to regraded or natural land contours, and should not exceed three horizontal to one vertical. Slopes exceeding this limit shall require erosion control, safety measures and a geotechnical analysis.

6.5.2 Dry Bottom Basins/Detention Facility

For basins designed to be normally dry:

A. Sediment Forebay

A sediment forebay shall be provided to trap coarse particles. Refer to Section B.13 in Appendix B for guidance.

B. Interior Drainage

Provisions must be incorporated to facilitate interior drainage to outlet structures. Grades for drainage facilities shall not be less than ½ percent unless water quality features requiring flat surfaces are incorporated in the bottom.

C. Earth Bottoms

Earth bottoms shall be sodded or vegetated with appropriate native, non-invasive vegetation. A turf-type tall fescue blend is an acceptable alternative.

D. D. Side Slopes

The side slopes of dry ponds should be relatively flat to reduce safety risks and help to lengthen the effective flow path. Slopes shall not be steeper than three horizontal to one vertical and at least 25% of the perimeter shall have a slope of 5 to 1 or flatter.

E. Multipurpose Feature

These shall be designed to serve secondary purposes for recreation, open space, or other types of use which will not be adversely affected by occasional or intermittent flooding, if possible.

6.5.3 Rooftop Storage

Detention storage may be met in total or in part by detention on roofs. Details of such designs shall include the depth and volume of storage, details of outlet devices and downdrains, elevations and details of overflow scuppers, and

emergency overflow provisions. Consideration shall also be given to wave action on structural loading conditions. Connections of roof drains to sanitary sewers are prohibited. Design loadings and special building and structural details shall be subject to approval by the Director.

6.5.4 Parking Lot Storage

Paved parking lots may be designed to provide temporary detention storage of stormwater on a portion of their surfaces. Generally, such detention areas shall be in the more remote portions of such parking lots. Depths of storage shall be limited to a maximum depth of seven inches, and such areas shall be located so that access to and from parking areas is not impaired.

6.5.5 Ponds and Lakes

Detention storage and/or stormwater quality treatment in natural ponds or lakes is not allowed. Detention storage and/or stormwater quality treatment in naturalized ponds and lakes is strongly discouraged. "Naturalized" in this context refers to ponds and lakes which were not created for urban stormwater management which have native vegetation on the banks and/or which have native plants or animals in the permanent pool.

Using such ponds or lakes for stormwater storage and treatment will likely lead to accelerated eutrophication which will ruin the water body or cause greatly increased maintenance.

6.5.6 Other Storage

All or a portion of the detention storage may also be provided in underground or surface detention areas, including, but not limited to, oversized storm sewers, vaults, tanks, swales, etc.

6.6 Required Submittals

6.6.1 The Owner shall submit the following information and data to the Director.

- A.** Elevation-area-volume curves for the storage facility including notation of the storage volumes allocated to runoff, sediment, and permanent residual water storage for other uses (wet basins only).
- B.** Inflow hydrographs for all design storms.
- C.** Stage-discharge rating curves for each emergency spillway, primary outlet works and combined outlets and overflows.

D. Routing curves for all design storms with time plotted as the abscissa and the following plotted as ordinates:

1. Cumulative inflow volume.
2. Cumulative discharge volume.
3. Cumulative storage.
4. Stage elevation

E. Operation and maintenance procedures for the facility including frequency of inspection and cleaning.

6.7 Additional Requirements:

6.7.1 Access

Provisions shall be made to permit access and use of auxiliary equipment to facilitate emptying, cleaning, maintenance, or for emergency purposes.

6.7.2 Underground Storage

Underground detention facilities shall be designed with adequate access for maintenance (cleaning and sediment removal). Such facilities shall be provided with positive gravity outlets. Venting shall be sufficient to prevent accumulation of toxic or explosive gases.

6.8 Water Quality Goals and BMP Selection

Water quality goals and BMP selection shall be met by following the March 2008 edition of the “Manual of Best Management Practices for Stormwater Quality” developed by the Kansas City Mid-America Regional Council (MARC) and the Kansas City Metro Chapter of the American Public Works Association (APWA), hereafter referred to as the KCBMP Manual.

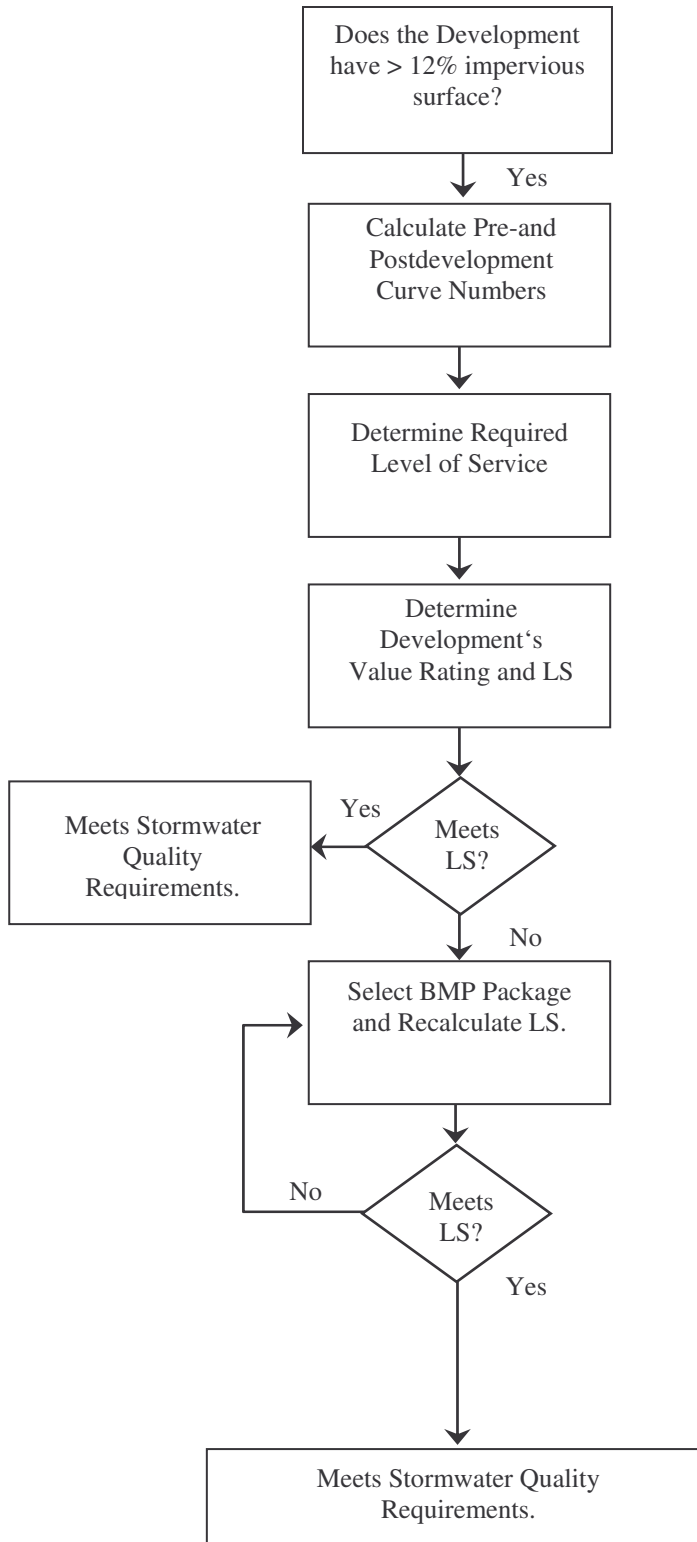
Sections 4 through 8 of the above manual are adopted with exceptions as noted below:

A. Exceptions

1. Section 4.1 Development Conditions
2. Figures 4 and 5 in Section 4.2.
3. The steps for determining a Level of Service for previously developed sites in section 4.2.
4. Section 5.1 Stream Buffers

The following Figure 6.8 presents the process to determine water quality management design requirements.

Figure 6.8 Stormwater Quality Management Procedures



6.8.1 Water Quality for Previously Developed Sites

For work being done on previously developed sites that includes replacement of, or additions or other improvements to, existing structures or pavement or other impervious surfaces, there are two options for meeting water quality goals:

Option 1 Provide treatment for all impervious disturbed areas (areas where pavement and/or buildings etc. are removed and replaced), all additional impervious areas and an area of the existing undisturbed impervious surface on the site that equals 50 percent of all removed and replaced impervious area and additional impervious area.

A Level of Service of 8 shall be required for the total area required to be treated.

Option 2 Provide treatment for the entire site as outlined below.

First determine the existing condition percent impervious and the proposed redevelopment percent impervious. Next, determine which percent impervious range applies to each development condition. Developed sites are grouped into four percent impervious ranges as follows (See Table 6.8.1.3):

- Range 1: less than 12 percent
- Range 2: 13 to 25 percent
- Range 3: 26 to 65 percent
- Range 4: greater than 65 percent.

The LS for previously developed sites is based on the increase in percent impervious range. If the pre and post development percent impervious range is the same, the LS is 4. If the proposed development is one range higher, the LS is 5; if the proposed development is two ranges higher, the LS is 6, and so on. The LS ratings corresponding to these increases in percent impervious ranges are presented in Table 6.8.1.4. If the proposed development percent impervious range drops from the existing condition, the LS is 4.

6.8.2 Further Guidance/Requirements

A. KCBMP Section 8.5.5 Porous Pavement Design Requirements and Considerations

1. Three-to-one impervious-to-pervious shall govern the surface area of the pervious pavement.
2. Landscaped area (including turf, but excepting tree islands) must drain away from porous pavements.
3. If roof drains are routed directly to the rock storage layer beneath the pavement, pretreatment must be provided to remove sediments and debris. The pretreatment must be easily accessible for cleaning and must be sized to allow the design flow into the storage layer in a 50% clogged condition.

4. Signage must be specified as part of the plan and installed with the development to clearly delineate the area of porous pavement and prohibit the uses of sand or cinders in winter conditions and prohibit sealing the area.
5. Stone used under the pavement must be double washed.

B. KCBMP Sections 8.2 Infiltration Basins and 8.3 Infiltration Trenches

1. Infiltration practices require a soils report per 12A-88 (f) (3). The design infiltration rate shall be 20% of the rate determined by the soils report.
2. Stormwater infiltration practices shall not be allowed to treat areas that may constitute stormwater hotspots as outlined in Section 4.4 of the KCBMP Manual.
3. Sand and stone in infiltration basins must be double washed.

6.8.3 Small Area BMP

For small impervious areas (less than 3000 square feet) a rain garden equal to 20% of the contributing impervious area may be installed. This area is to catch, filter and infiltrate the water quality storm from the impervious area.

These BMPs should be kept a minimum of 10 feet from building foundations. It is the desing engineer's responsibility to ensure that the BMP does not cause damage to adjacent structures, properties or operations.

Guidance for the small area BMPs may be found in Appendix A.

An extensive vegetated roof, a minimum of 3" thick, may be used for buildings. This option will provide other benefits such as increased roof life and less energy required for cooling than other buildings. It is strongly encouraged to work with a designer who has experience in detailing green roofs if this option is chosen.

6.8.4 Conflicting Language, Definitions or Rules

In any conflict between the KCBMP Manual and other sections of the City of Columbia Stormwater Management and Water Quality Manual, the City of Columbia manual shall take precedence.

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