



Chapter 10 STORMWATER DETENTION AND QUALITY

10.1 Detention Requirements

The requirements for stormwater detention are described in the Knoxville Stormwater and Street Ordinance (Chapter 22.5 of the city code) included within Appendix B. All site development projects exceeding the thresholds listed in Section 22.5-23 must incorporate stormwater detention and first flush treatment as part of the design. Additional information on the design of stormwater detention and first flush treatment is included in the Knoxville BMP Manual (ST-10 through ST-12). Stormwater detention is not required in the following two situations:

- The project site discharges stormwater runoff directly into the Tennessee River, Holston River or French Broad River without flowing through a named creek/stream, through a public drainage system, or across a downstream property boundary.
- Stormwater detention for a project site is either unwarranted or impractical. The developer must submit complete hydrologic and hydraulic computations to support this conclusion. Typically this might occur in the very lowest downstream reaches of a major watershed, if it can be proved that undetained stormwater should be discharged quickly to avoid the peak discharge timing for the entire watershed. The hydrologic analysis should include more than one representative downstream location for comparing hydrographs.

Even if stormwater detention is waived for the above two situations (as described in Section 22.5-23), the site development must still provide first flush treatment or an acceptable alternative in order to protect stormwater quality.

Typical detention BMPs are dry detention basins, wet detention basins, retention basins and constructed wetlands. Detention computations and methods are discussed in ST-10 of the Knoxville BMP Manual. As specified by ordinance, all detention computations must use NRCS design methods with Type II 24-hr storm and average antecedent moisture conditions (AMC II).

Underground detention structures are not allowed within the City of Knoxville (as explained in ST-08 of the Knoxville BMP Manual). In contrast, underground stormwater quality structures (oil/water separator or sand filtration unit) are encouraged and even required for some land uses. The difference is that stormwater quality structures do not attempt to control or store tremendous volumes of stormwater runoff, with the attendant problems of flooding, hydrostatic pressures, settlement, washout, etc. Stormwater quality structures are scientifically designed with overflow or bypass capabilities to prevent large volumes of stormwater from flowing through the structure.

10.2 Design Criteria for Detention Structures

All stormwater detention structures must attenuate the postdevelopment peak flow rates from the 1-year, 2-year, 5-year, 10-year and 100-year NRCS 24-hour design storms to discharge at or below predevelopment peak flow rates. See ST-10 in the Knoxville BMP Manual for design

computations and methods, including downloadable documents from NRCS and FHWA. Physical design criteria is listed within Section 22.5-31 of the Knoxville Stormwater and Street Ordinance (see Appendix B).

The purpose for detention structures is to slow or attenuate the peak flows downstream by controlling the release rate. The typical predevelopment and postdevelopment outflow hydrographs for a detention basin are shown in Figure 10-1. The postdevelopment peak outflow rate is limited to the predevelopment peak outflow rate as the basis of detention design. However, the postdevelopment condition is likely to discharge at or near the peak outflow rate for a few hours. It should be noted that the conglomerate effect of dozens of detention basins in a watershed may or may not reduce peak flows at a downstream location. This uncertainty is caused by factors such as the infinite types and variety of actual rainfall distributions, spacing and sizes of the detention basins, discharge characteristics for the detention basins, maintenance and conveyance of major drainage channels. Two examples of detention basin computations are given in ST-11 and ST-12 of the Knoxville BMP Manual.

The first detention example, ST-11, uses a very complex "home-made" spreadsheet (in Microsoft® Excel 97), created to compute and route hydrographs through a detention basin structure. The spreadsheet has been tested and verified; however, it tends to be very slow and cumbersome except for fairly new computers. The main purpose of the spreadsheet method is to demonstrate the types of input that are necessary for all detention computations, typical computational procedures that are used in stormwater routing, and a basis for calibrating or comparing other methods.

Worksheet #2 (*Excel file ST11-EST.xls*) is probably the most useful spreadsheet from ST-11 of the Knoxville BMP Manual, and serves as the basis of an initial volume estimate. Worksheet #2 is easy to use and faithfully reproduces the detention volume estimates generated by NRCS Technical Release 55 publication. However, TR-55 detention volume estimates and Worksheet #2 volume estimates do not take into account the first flush volume and thus need to be adjusted upwards. This is because the first flush volume is not merely briefly detained as part of the peak flow reduction, but must be fully captured and then released over a minimum 24-hour time period.

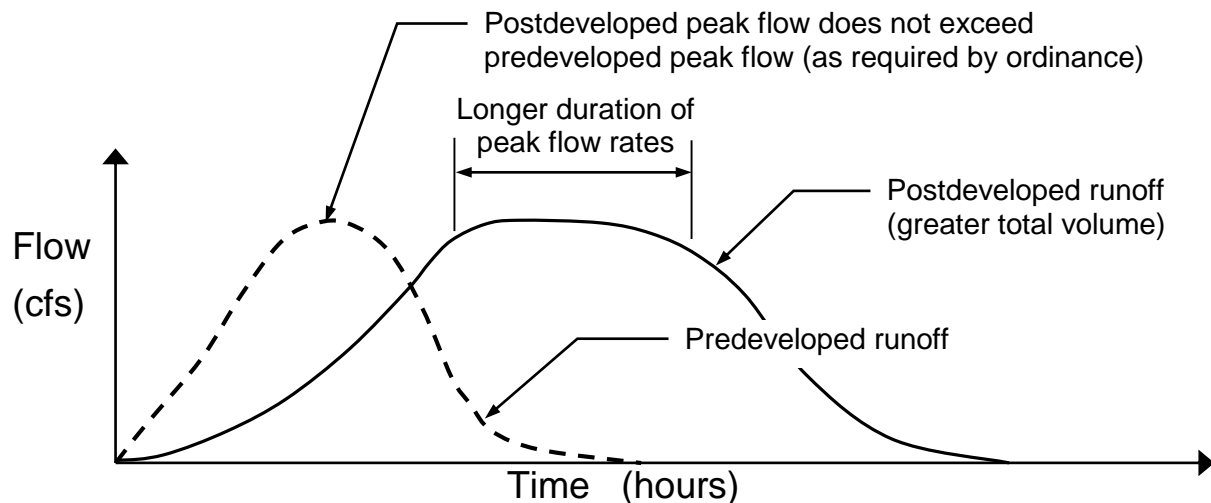


Figure 10-1

Typical Detention Hydrograph

The second example of detention basin computations (ST-12 of the Knoxville BMP Manual) are HEC-1 and HEC-HMS computer runs for a simple detention basin. The HEC-1 computer program

(or the successor windows-based computer program HEC-HMS) is a nationally recognized and trusted free software, developed by the U.S. Army Corps of Engineers, for the purpose of computing and routing hydrographs. The following guidelines should be followed for using HEC-1 (or HEC-HMS) for detention computations:

- Enter the NRCS Type II rainfall distribution, preferably using increments of 0.1 hours as in the Knoxville BMP Manual ST-11 example, using either incremental (PI cards) or cumulative values (PC cards).
- To increase computational precision by a decimal point, multiply basin area (BA card), the pond areas or volumes (SA or SV cards), and the pond outflow rating (SQ cards) by a factor of 10. After the computation is finished, divide the peak inflow rates and peak outflow rates by a factor of 10. The computations should clearly document that this method is being used to increase precision, so that engineers who might review this computation in the future would understand the rationale.
- The pond outflow rating and volume (SQ and SV cards) must be computed at regular intervals, either by hand or preferably by a computer program or spreadsheet, before entering the SQ and SV values into the HEC-1 program.

The Stormwater Engineering Division currently uses Haestad Methods PondPack™ for regulatory review of proposed detention basins and also for checking the as-built conditions. PondPack™ is a very flexible and user-friendly software, and it allows many types of outlet structures with almost any combination of weirs, orifices or culverts. It is understood that the PondPack™ program is relatively expensive, represents a sizable investment in software and training for any potential user, and is therefore not required by the Engineering Department.

10.3 Stormwater Quality Considerations

The stormwater ordinance also requires that the first flush volume for any stormwater detention structure must be contained and then slowly released over a minimum time period of 24 hours and maximum time period of 72 hours. First flush treatment must be provided at locations that would normally provide stormwater detention, even if detention requirements are exempted because the project site flows directly into Fort Loudoun Lake or one of its tributary rivers.

The first flush volume is described in ST-10 of the Knoxville BMP Manual. The purpose is to allow settling and filtering for the first 1/2" of stormwater runoff, which typically contains dust, deicing sands and salt, oils and automotive fluids from leaking vehicles, tire particles, brake pad particles, trash, debris, leaves and small sticks, etc. Preventing the first flush volume from entering the natural streams and creeks has greatly benefited water quality of streams, fish and other aquatic life, city parks, greenways, and residents who live near natural streams and creeks.

The first flush volume for a typical dry detention basin is shown in ST-01 of the Knoxville BMP Manual. The first flush volume is slowly released over a 24-hour period by an underground sand filter, aboveground sand filter, or small discharge orifices. Methods for capturing floatable debris, sediments and other debris can be incorporated into a detention outlet structure at no cost.

The project designer may also consider alternative means of providing stormwater quality such as oil/water separators, grit chambers, long expanses of stormwater filter swales, or constructed wetlands. For some land uses, these stormwater quality structures may be used in place of the first

flush volume. For critical land uses such as large parking lots and gasoline stations, these structures are required in addition to first flush treatment volume (as part of a Special Pollution Abatement Permit - see Chapter 7 of the Knoxville BMP Manual). A project designer may wish to contact the Stormwater Engineering Division for unusual methods of stormwater treatment prior to submittal. See Chapter 4 of the Knoxville BMP Manual (Figure 4-2 in particular) for stormwater treatment removal goals, typical pollutants, and approximate removal rates for urban BMP designed structures.

10.4 Permanent Maintenance Agreements

If there is a stormwater detention or stormwater quality structure shown on the design plans, the Stormwater Engineering Division requires that the current property owner (as well as any future owners of this property) enter into a permanent maintenance agreement with the City of Knoxville. This legal document, called *Covenants for Permanent Maintenance of Stormwater Facilities* (CPMSF), is recorded in the permanent land records with the Knox County Register of Deeds, in addition to being fully described on the final plat. The CPMSF document is prepared by the Stormwater Engineering Division using information supplied by the property owner, and must be signed and executed prior to the issuance of a site development permit. The CPMSF is further described as an engineering policy in Appendix C and shown in the Chapter 2 flowcharts.

A list of engineering policies that describe the CPMSF document, reporting requirements, and maintenance responsibilities of the project owner includes:

- Policy 02 - Covenants for Permanent Maintenance of Stormwater Facilities (CPMSF)
- Policy 06 - Maintenance Access for Stormwater Management Facilities
- Policy 07 - Maintenance Responsibility for Stormwater Drainage Systems
- Policy 11 - Sediment Disposal for Detention Basins
- Policy 14 - Stormwater Enforcement Guidelines
- Policy 18 - Underground Stormwater Facility Maintenance
- Policy 19 - Underground Stormwater Facility Recordkeeping and Reporting

10.5 Facility and Access Easements

Stormwater detention easements are described in Policy 05 (included in Appendix C). There are two types of easements for stormwater detention basins and stormwater quality structures:

- Facility easements: Encompasses the entire stormwater detention basin or stormwater quality structure. Minimum size 20' x 20'.
- Access easements: Provides access to the facility easement, if the easement is not immediately adjacent to the public right-of-way. Minimum 20' wide.

A facility easement is always required. The facility easement is not allowed to encroach upon any other existing or proposed easements. The preferred name for showing the facility easement for a stormwater detention basin on plans or plats is *Stormwater Detention Basin Easement*. The

preferred name for showing the facility easement for a stormwater quality structure on plans or plats is *Water Quality Facility Easement*. A facility easement allows city engineering personnel (stormwater inspectors, grading equipment operators, stormwater monitoring personnel) to investigate and inspect the detention basin or stormwater quality structure as needed to determine proper functioning, need for maintenance, etc. In addition, minor repairwork and maintenance may be performed if there is an emergency or urgent condition, or if the property owner is negligent to perform maintenance as directed.

The preferred name for showing the second type of easement on plans or plats is *Stormwater Detention Basin 20' Access Easement* or *Water Quality Structure 20' Access Easement*. This access easement is not necessary at locations where the facility easement abuts the public right-of-way for at least 20 feet and is easily traversable by potential grading equipment such a dozer or backhoe. Otherwise, an access easement will be required.

The detention basin access easement must be shown on the plat, but does not require a recorded written legal document to be in effect. It is not necessary to build an actual road to the detention basin as part of the easement agreement (although the property owner should generally have some means of vehicle access to the detention basin for his maintenance needs). An access easement must not contain any buildings or structures, large trees or heavy shrubbery, utility poles or manholes, overhead utility lines without adequate clearance, deep ditches or channels, etc. If the property owner wishes, the access easement may contain:

- small shrubs of little or no value that can be easily removed or cleared.
- fences that can be easily removed (or ideally a gate through the fence)
- portable structures that can be quickly moved
- vehicles or equipment

The City of Knoxville is not responsible for damage to any structures, utilities or vegetation located within a facility access easement, whenever such access is deemed necessary by city inspection personnel. The City of Knoxville is not responsible for repair or replacement of structures, utilities and vegetation. A facility access easement is normally intended for heavy equipment access rather than ordinary passenger vehicle access. A city stormwater inspector will normally gain access to a detention basin or water quality facility by parking nearby.