10.4 Design Criteria

10.4.1 General Criteria

Storage may be concentrated in large basin-wide or regional facilities or distributed throughout an urban drainage system. Storage may be developed in depressed areas in parking lots, road embankments and freeway interchanges, parks and other recreation areas, and small lakes, ponds and depressions within urban developments. The utility of any storage facility depends on the amount of storage, its location within the system and its operational characteristics. An analysis of such storage facilities should consist of comparing the pre-existing discharges with the proposed design flow at a point or points downstream of the proposed storage site with and without storage. In addition to the design flow, other flows in excess of the design flow that might be expected to pass through the storage facility should be included in the analysis. The design criteria for storage facilities should include:

- release rate
- storage volume
- grading and depth requirements
- outlet works and location
- evaluation of the increase of total volume of runoff on downstream facilities

10.4.2 DEP Requirements

The following standards regarding stormwater management and stormwater detention facilities taken from Section 25-68h-3(a) and (b) of the Flood Management Statutes and Administrative Regulations shall be incorporated into all ConnDOT projects:

Sec. 25-68h-3. Stormwater management standards

(a) On-site stormwater management.

(1) The stormwater management plans for state activities shall be prepared so as to minimize any adverse increases to the peak flow rate, the timing of runoff and the volume of runoff. Hydrology studies shall be conducted at a level of detail commensurate with the probable impact of the project.

(A) A complete runoff hydrograph evaluation is required for (i) Basin Stormwater Management Plans pursuant to Section 25-68h-3 (h), (ii) Stormwater management plans for project sites resulting in significant impacts, and (iii) other state activities and critical activities as determined by the Commissioner. Hydrograph evaluations shall be conducted for existing and anticipated land use conditions for storms with average return frequencies of 2, 10 and 100 years. Where appropriate, the hydrograph analysis shall include determination of runoff for each subwatershed and routing runoff through storage impoundments and floodplain storage areas. The timing sequence of the runoff must be fully developed.

(B) Where suitable records exist, hydrographs should be developed from historic gauged flood data. For other watercourses, the hydrographs shall be developed from deterministic rainfall-runoff techniques and compared with flood flows of similar gauged watershed and an assessment made as to the need to calibrate the hydrograph based on this comparison.

(2) Stormwater management plans for project sites shall be coordinated with Basin Stormwater Management Plans, where available.

(b) Stormwater detention facilities

Facilities to temporarily store excess storm runoff shall be subject to the following requirements:

(1) Any detention facility whose failure could cause significant damage or loss of life shall be regulated as a dam pursuant to Sections 22a-401 through 22a-409 of the General Statutes.

(2) All detention facilities serving a watershed larger than 10 acres in size shall be analyzed with hydrograph and storage routing techniques.

(3) The release rates from detention facilities shall be consistent with the Basin Stormwater Management Plan for the watershed in which it is located, or comply with items 4, 5 and 6 below if there is no Basin Stormwater Management Plan.

(4) The release rate shall consider the existing and proposed flow rates at the site and downstream channels or structures, and the timing of runoff from other subwatersheds within the basin for the base flood.

(5) The waters released from a detention facility shall not increase the peak flow rate at offsite downstream points unless they have adequate flow capacity for the base flood.

(6) Extended duration detention facility discharges directly into alluvial or eroding channels shall not exceed the bankfull capacity or the 2 year flood frequency flow, whichever is less, unless it is determined said channel will be stable.

(7) Section 5-9 of the "Connecticut Guidelines for Erosion and Sediment Control" (2002) as may be amended, shall be used as a guide to construction details and materials.

(8) An operation and maintenance schedule shall be prepared for every detention facility identifying responsibilities and items of routine maintenance, after use and emergency operations in the event of a flood.

10.4.3 Release Rate

Control structure release rates shall approximate pre-developed peak runoff rates for the 2, 10, and 25-year storms, with emergency overflow capable of handling the 100-year discharge. If the basin is designed to enhance stormwater quality, as well as to control peak outflow rates, additional requirements as defined in Section 10.11 will apply. Design calculations are required to demonstrate that initial runoff and flow from the 2- and 10-year design storms are controlled for single stage structures. If so, runoff from intermediate storm return periods can be assumed to be adequately controlled. Multi-stage control structures may be required to control both runoff from the 2, 10, and 25-year storms.

10.4.4 Storage

Storage volume shall be adequate to attenuate the post-development peak discharge rates to pre-developed discharge rates for the 2, 10 and 25-year storms or other design storms depending on the downstream system design capacity. Routing calculations must be used to demonstrate that the storage volume is adequate. If sedimentation during construction causes loss of detention volume, design dimensions shall be restored before completion of the project. For detention basins, all detention volume shall be drained within the average period between storm events ordinarily 72 h.

10.4.5 Grading And Depth

Following is a discussion of the general grading and depth criteria for storage facilities followed by criteria related to detention and retention facilities.

- **General**

The construction of storage facilities usually requires excavation or placement of earthen embankments to obtain sufficient storage volume. Vegetated embankments shall be less than 6 m (20 ft) in height and shall have side slopes no steeper than 1V:4H (vertical to horizontal). Side slopes shall be benched at intervals of 1.5 m (5 ft). Riprap-protected embankments shall be no steeper than 1V:2H. Geotechnical slope stability analysis is required for embankments greater than 3 m (10 ft) in height and is mandatory for embankment slopes steeper than those given above and should be performed by a qualified Geotechnical Engineer.

A minimum freeboard of 0.3 m (1 ft) above the 100-year water surface elevation shall be provided for impoundments. Certain impoundment depths and volumes may classify the embankment structure as a dam which are governed by federal and state regulations (see Section 10.5, Dams).

Other considerations when setting depths include flood elevation requirements, public safety, land availability, land value, present and future land use, water table fluctuations, soil characteristics, maintenance requirements and required freeboard. Aesthetically pleasing features are also important. Fencing of basins is addressed in Section 10.16.

- **Detention**

Areas above the normal high water elevations of storage facilities should be sloped at a minimum of 5% toward the facilities to allow drainage and to prevent standing water. Careful finish grading is required to avoid creation of upland surface depressions that may retain runoff. The bottom area of storage facilities should be graded toward the outlet to prevent standing water conditions. A minimum 2% bottom slope is recommended. A low flow or pilot channel constructed across the facility bottom from the inlet to the outlet is recommended to convey low flows and prevent standing water conditions wherever possible. In dual purpose basins (quality and quantity control) a sediment forebay should also be included in the design.

- **Retention**

The maximum depth of permanent storage facilities will be determined by site conditions, design constraints, and environmental needs. In general, if the facility provides a permanent pool of water, a depth sufficient to discourage growth of weeds (without creating undue potential for anaerobic bottom conditions) should be considered. A depth of 1.5m (5 ft) to 3m (10 ft) is generally reasonable unless fishery requirements dictate otherwise. Aeration may be required in permanent pools to prevent anaerobic conditions. Where aquatic habitat is required, the appropriate wildlife experts should be contacted for site specific criteria relating to such things as depth, habitat, and bottom and shore geometry.

10.4.6 Outlet Works

Outlet works selected for storage facilities typically include a principal spillway and an emergency overflow, and must be able to accomplish the design functions of the facility. Outlet works can take the form of combinations of drop inlets, pipes, weirs and orifices. The principal spillway is intended to convey the design storm without allowing flow to enter an emergency outlet. For large storage facilities, selecting a flood magnitude for sizing the emergency outlet should be consistent with the potential threat to downstream life and property if the basin embankment were to fail. The minimum flood to be used to size the emergency outlet is the 100-year flood. The sizing of a particular outlet works shall be based on results of hydrologic routing calculations.

10.4.7 Location

To minimize design costs and to obtain regulatory approval, storage facilities should be designed to avoid inland wetlands and watercourses. A local or state inland wetlands permit will be required if a facility is proposed in a wetland area. A local inland wetland permit may also be required if the storage facility is located in the upland review area established by municipal regulation.

A state water diversion permit from the DEP's Inland Water Resources Division will be required if the contributing drainage area to the storage facility is greater than 40.5 hectares (100 acres). If the contributing drainage is less than 40.5 hectares (100 acres) and no inland wetlands or watercourses are involved then a diversion permit will not be required. However, if wetlands and/or watercourses or floodplains are involved, a diversion permit may be required and a permit need determination should be sought from the DEP.

On-site detention may be undesirable when the site is located in the lower portions of a watershed before the confluence with a perennial watercourse. If detention is located in the lower reaches of a watershed, there is a risk, depending on the size and release rate of the basin, that the peak flows from the outlet control structure could combine with the peak flows from the upper reaches, thus increasing peak flows or sustaining peak flows over longer periods. Likewise, the hydrographs of several storage facilities located within a particular watershed when combined may increase or sustain peak flows. These increases could result in prolonged flooding and channel erosion along and within the perennial stream course downstream of the site.

To avoid this problem, a hydrologic analysis is required by an engineer. Locate the area downstream that is to be targeted for protection from additional runoff. A target area might be a flood prone road crossing, eroding stream bank or reach of stream where homes are currently endangered. Delineate the watershed to the targeted area. Determine where the proposed detention basin is located within that watershed. Conduct a hydrograph analysis to determine the timing of peak discharges. Use the Natural Resources Conservation Service (NRCS) Technical Releases 20 or 55, U.S. Army Corps of Engineers HEC-1 or other appropriate methods which produce hydrographs to evaluate existing and post-development conditions.

If the hydrograph analysis shows that detention is detrimental to the target area, but nearby downstream concerns are present, other methods to decrease peak flows from the site will need to be utilized.