2G-1 General Information for Detention Practices

A. Introduction

Storm runoff detention is considered a viable method to reduce drainage costs. Temporarily detaining a specified acre-feet of runoff can significantly reduce downstream flood hazards, as well as pipe and channel requirements in urban areas. The main purpose of a detention facility is to store the excess storm runoff associated with increased basin imperviousness and discharge this excess at a rate similar to the rate experienced from the basin without development.

1. Excess storm runoff will be judged in comparison to the site in its pre-developed condition and should include all increases in stormwater resulting from any of the following:

    a. An increase in the impervious surface of the site, including all additions of buildings, roads and parking lots.

    b. Changes in soil absorption caused by compaction during development.

    c. Modifications in contours, including the filling or draining of small depressional areas, alterations of drainageways, or regrading of slopes.

    d. Site clearing.

    e. Alteration of drainageways or installation of collection systems to intercept street flows or to replace swales or other drainageways.

    f. Alteration of subsurface flows, including any groundwater dewatering or diversion practices such as curtain drains.

    g. Any increase in runoff that occurs by piping building downspouts that previously discharged to splash blocks.

2. Pre-developed condition means those hydraulic and hydrologic site characteristics existing prior to the development being proposed and includes all the natural storage areas and drainageways plus existing farm drainage tiles and highway drainage structures. The Jurisdictional Engineer may require the pre-developed condition to be considered in a natural state (without any man-made development) if drainage problems are occurring down stream due to existing development at the proposed site or in the basin.

3. Developed condition means those hydraulic and hydrologic site characteristics that occur following the completion of the proposed development that may result in excess runoff.

4. Post-developed peak runoff is expected to exceed pre-developed runoff from a similar storm event. Even if calculated time of concentration or curve number tables suggest lower post-developed runoff, developed sites generally have more impervious areas, compacted soils, change in soil horizon, and differing vegetation from undeveloped conditions. There may be exceptions, but careful consideration of the hydrologic method and sufficient engineering judgment are necessary to ensure calculated results meet reasonable expectations.

B. Storm detention regulations

The developer, subdivider, or applicant should construct stormwater detention facilities designed by a Professional Engineer licensed in the State of Iowa that meets the criteria of this section. Storm basins will follow Iowa Department of Natural Resources Rules and Regulations as described in the Iowa Administrative Code, Title V, Chapter 70.

1. **Conditions that require an IDNR permit:**

    a. **Dams.** Approval by the department for construction, operation, or maintenance of a dam in the floodway or floodplain of any water source will be required when the dimensions and effects of such dams exceed the thresholds established by this rule:

        1) Any dam designed to provide a sum of permanent and temporary storage exceeding 50 acre-feet at the top of dam elevation, or 25 acre-feet if the dam does not have an emergency spillway, and which has height of 5 feet or more.
        2) Any dam designed to provide permanent storage in excess of 18 acre-feet and which has a height of 5 feet or more.
        3) Any dam across a stream draining more than 10 square miles (rural only).
        4) Any dam located within one mile of an incorporated municipality, if the dam has a height of 10 feet or more, stores 10 acre-feet or more at the top of the dam elevation, and is situated such that the discharge from the dam will flow through the incorporated areas.

    b. **Low head dams.** Any low head dam on a stream draining two or more square miles in an urban area, or 10 or more square miles in a rural area.

    c. **Levees or dikes.** Approval by the department for construction, operation, and maintenance of levees or dikes will be required in the following instances:

        1) **Rural areas.** In rural areas, any levees or dikes located on the floodplain or floodway of any stream or river draining more than 10 square miles.
        2) **Urban areas.** In urban areas, any levee or dike along any river or stream draining more than two square miles.

2. **Design storm.** The design storm is the rainfall event having a return frequency of 100 years, unless higher frequencies are required by the Department of Natural Resources. Design storm duration is that critical duration of rainfall requiring the greatest detention volume, or, based on the nature of the watershed, the critical duration would be the storm that causes the greatest downstream impact.

3. **Release requirements**

    a. After development, the release rate of runoff for rainfall events having an expected return frequency of two years and five years should not exceed the existing, pre-developed peak runoff rate from those same storms.

Design Example #1
1) A ten-acre site has a critical storm duration of six hours after development.
2) The peak rate of runoff generated from the site by a two-year, six-hour storm *before* development is 8.5 cfs.
3) Discharge from detention during the two-year, six-hour storm *after* development should not exceed 8.5 cfs.

b. For rainfall events having an expected return frequency of 10 years to 100 years, inclusive, the rate of runoff from the developed site should not exceed the existing, pre-developed peak runoff from a five-year frequency storm of the same duration. Allowable discharge rate may be restricted due to downstream capacity.

Design Example #2
1) The ten-acre site in Design Example #1 has a peak rate of runoff from a five-year, six-hour storm before development is 12 cfs.
2) Discharge from detention during the 100-year, 50-year, 25-year, or 10-year six-hour storm after development should not exceed 12 cfs.

c. Detention of runoff generated by upstream land is not required on the new development site. Release of runoff generated off-site and routed through the detention basin should not be made in such a manner as to increase the combined off-site and on-site release rate.

d. Release of stormwater runoff from the detention basins will be made in such a manner as not to damage or devalue private or public properties.

4. **Detention volume methods**

a. The method selected for detention volume determination can be the Modified Rational Method up to 20 acres and the NRCS Urban Hydrology for Small Watersheds (Technical Release 55) publication for up to 2000 acres. The use of other technically proven methods for similar drainage areas needs approval by the Jurisdictional Engineer. For larger drainage areas, the Project Engineer should understand the details of a computerized hydrology program before selection of the program.

b. The Project Engineer will submit the stormwater detention proposal according to the drainage report as described in Section 2A-5. Also required is certification by a licensed Professional Engineer that the stormwater detention facilities design and calculations were performed by the engineer, or under the engineer's supervision, and that the facilities and design meet the criteria of this section.

C. Limitation of stormwater runoff

1. No development should cause downstream property owners, water courses, channels, or conduits to receive stormwater runoff from the proposed development site at a higher peak flow rate, or at higher velocities than would have resulted from the same storm event occurring over the site of the proposed development with the land in its natural, pre-developed condition.

2. The Project Engineer can submit to the Jurisdictional Engineer the following factors for consideration in changing storm detention requirements as a condition for approval of development:

a. Specific elements of the drainage report as outlined in Section 2A-5 and items listed in 2O.

b. Historical or potential localized drainage or flood problems adjacent to the site.

c. Historical or potential area wide drainage or flooding problems in the watershed.

d. Location of the site relative to existing drainageways and/or stormwater conveyances.

e. Extent of proposed site increase in impervious surface area.

f. Anticipated future development of the drainage basin.

g. Existing site features which may facilitate or impede detention design and/or construction.

3. Multiple and contiguous tracts of land of which only part will be initially developed but are contained in the same basin are described below under two conditions:

   a. **One owner:** The basin will be considered for stormwater detention for the entire tract. The results of the study, including staged construction of stormwater facilities, will be contained in the drainage report as outlined in Section 2A-5. As a minimum, the developed tract will require detention.

   b. **Multiple owners:** Many times, upstream undeveloped discharges occur through the proposed developed property, which cannot be avoided. Possible options for stormwater detention design in a basin with tracts having multiple owners are:

      1) **Isolation detention**
         a) Isolate the proposed development portion from the rest of the basin. Construct a detention control structure on the downstream side of a developed area and outside of a mainline channel where there is no pass-through from upstream undeveloped property. This allows the detention basin to serve only the developed area.
         b) Isolate the stormwater to be bypassed from the developed area by a split-flow structure upstream of the proposed detention basin.

      2) **Main channel detention.** Care should be exercised in not placing a control structure in a mainline channel unless it is designed for development to occur in a progressive manner. The designer needs to simulate the detention and corresponding release rate for only the developed area. A control structure that handles both flows (to be detained and pass through) has to be designed to retain the difference between the [Q_{2post}-Q_{2pre}], [Q_{5post}-Q_{5pre}], and [$Q_{100post}$-Q_{5pre}] from the developed area only and bypass the remaining upstream discharge. This can result in a complicated outlet control structure and routing system that has to split the flows within the detention basin.

      3) **Regional detention.** Develop a regional detention system within the watershed that handles logical segments of the watershed or the entire watershed.

D. Detention basin design methods

A detention basin is to be designed to reduce the peak inflow by temporarily storing the excess stormwater and then releasing the water volume at allowable rates over an extended period. The main objective of this section is to outline the design procedure in order to determine the detention basin storage volume required. The design of a stormwater detention basin requires both hydrologic and hydraulic information. The basic hydrologic data includes the inflow hydrograph and the allowable release. In order to determine the volume required, the inflow hydrograph needs to be developed first. The hydraulic information of a basin requires prior knowledge of the basin geometry and outlet structures. Two common methods for determining the detention basin size are the Modified Rational Method and the TR-55 Method.

1. **Modified Rational Method.** The simplest but least accurate detention routing method is the Modified Rational Method. The basis of this method is described in Section 2C-4. To find the required volume, the Modified Rational Method uses a trial method to find the critical storage for a given drainage area. For instance, the peak rate for a 100-year storm is the product of the runoff coefficient times the drainage area in acres times the intensity of a 100-year storm for a calculated time of concentration. However, the critical storage volume may be a different duration, which needs to be determined.

   The storage volume is determined by the critical (inflow) duration, and using a constant outfall release rate. As the example shows below, the allowable release rate was set at 10 cfs (Q_5 pre-developed condition at t_c of 15 minutes). The inflow hydrographs are developed using varying durations multiplied by the discharges for each Q_{100}. The outflow hydrograph for each duration, multiplied by the constant Q_5, is subtracted from the inflow hydrograph. The highest remaining storage volume is therefore selected as the final basin volume.

   There are three steps in the Modified Rational Method. They are as follows:

   a. **Step 1:** The first step is to collect the physical data for the drainage area. This is the drainage area, the time of concentration, the runoff coefficient, and the allowable release rate. A site to be developed is an existing 11.88 acre undeveloped site with an average slope (Soil Group D, C = 0.22 for Q_5) that is to be an industrial area (C = 0.9). The outlet is a small, lined channel with a capacity of 15 cfs. The t_c is 15 minutes.

   b. **Step 2:** The second step is to obtain the proper recurrence interval for the design storm and the intensity-duration relationship for the design frequency. A series of peak flows and runoff volumes are then calculated, beginning with the time of concentration of the drainage area and for increased storm durations. The allowable release rate for a detention basin needs to stay under 15 cfs and should not exceed the 5-year pre-developed condition at the duration of 15 minutes. The maximum allowable release rate is 9 cfs, the pre-developed peak flow for a 5-year frequency storm at the proposed point of discharge.

Q_s Frequency (Pre-Developed)

Duration	*Intensity*	*Discharge*
hr	*in/hr*	*cfs*
0.25	3.8	9
0.50	2.6	6.8
1.00	1.6	4.2
2.00	1.0	2.6
3.00	0.8	2
6.00	0.4	1

c. **Step 3:** The third step is to compute the release volume and the required storage until the maximum or critical storage is found. Determine the storage volume needed for a detention basin with Q_{100} inflow at the critical duration and a discharge rate not to exceed 10 cfs.

Table 1: Storage Duration Values

Duration (1)	*Q_{100} Intensity* (2)	*Q_{100} Inflow* (3)	*Q_{100} Volume* (4)	*Release Vol. Q_5* (5)	*$Q_{100} – Q_5$ Storage* (6)
hr	*in/hr*	*cfs*	*cu. ft.*	*cu. ft.*	*cu. ft.*
0.25	7.48	80	72,000	8100	63,900
0.50	5.12	55	99,000	16,200	82,800
1.00	3.25	35	126,000	32,400	93,600
2.00	2.00	21	151,200	64,800	86,400
3.00	1.48	16	122,800	97,200	75,600
6.00	0.87	9	194,400	216,000	0
Column (3)	Peak Flow = Q = CIA Example: 0.9 x 7.48 x 11.88 = 80 cfs				
Column (4)	Runoff Volume = Q (Col 3) x Duration of Storm (Col 1) x 3600 Example: 80 cfs x 0.25 hrs x 3600 = 72,000 cu. ft.				
Column (5)	Release Volume = 9 cfs x Duration of Storm (Col 1) x 3600 Example: 9 x 0.25 x 3600 = 8100 cu. ft.				
Column (6)	Required Storage = Runoff Volume (Col 4) – Release Volume (Col 5) Example: 72,000 – 8100 = 63,900 cu. ft.				

As Table 1 shows, the critical duration is one hour, since it produces the largest detention volume of 93,600 cubic feet. Therefore, the detention basin needs to be designed to accommodate the 93,600 cubic feet of storage with at least a 1-foot freeboard for the detention dike. The basin emergency spillway release rate should be determined based on the onsite discharge greater than the 100-year post-developed peak discharge plus any contributing offsite 100-year developed peak discharge.

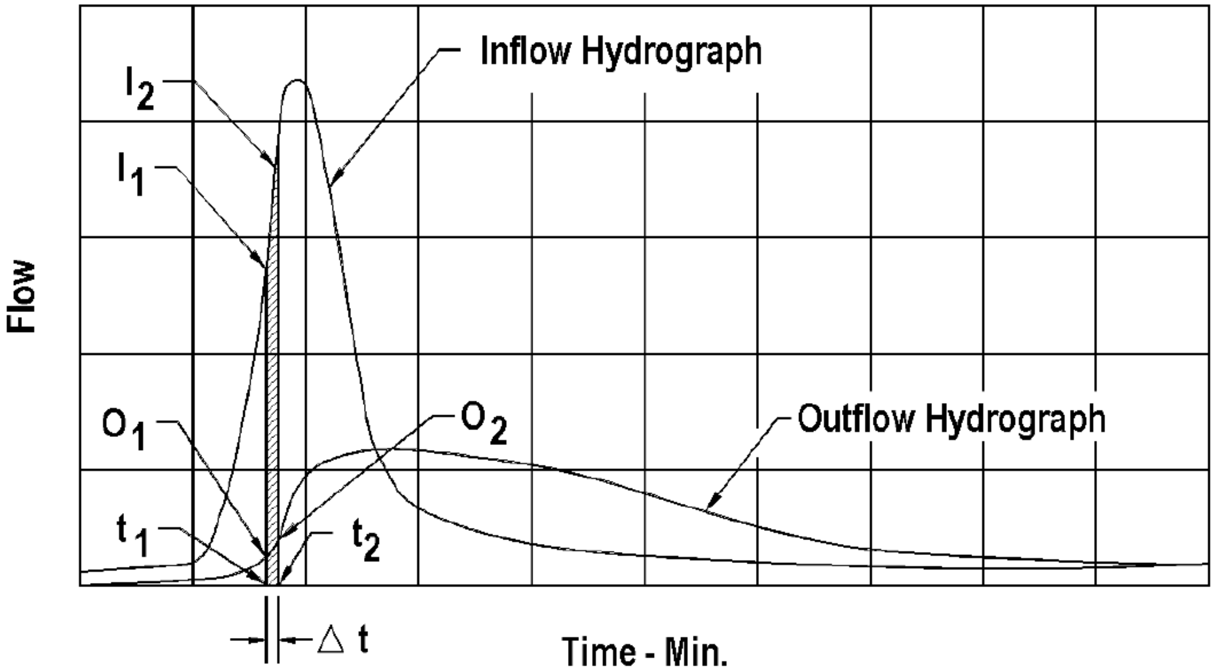
2. **TR-55 detention basin.** The most commonly used method for routing an inflow hydrograph through a detention pond is the Storage Indication or modified Puls method. This method begins with the continuity equation which states that the inflow minus the outflow equals the change in storage (I-O=ΔS). By taking the average of two closely spaced inflows and two closely spaced outflows, the change in storage can be determined. This is expressed by Equation 1 and illustrated graphically in Figure 1.

$$\frac{\Delta S}{\Delta t} = \frac{I_1 + I_2}{2} - \frac{O_1 + O_2}{2}$$

Equation 1

where:
ΔS = change in storage, ft^3
Δt = time interval, min
I = Inflow, ft^3
O = Outflow, ft^3

Figure 1: Routing Hydrograph Schematic[1]



Equation 1 can be rearranged so that all of the known values are on the left side of the equation, and all of the unknown values are on the right hand side of the equation, as shown in Equation 2. Now the equation, with two unknowns, S_2 and O_2, can be solved with one equation. The following procedure can be used to route a storm through the reservoir or detention basin.

$$\frac{I_1 + I_2}{2} + \left(\frac{S_1}{\Delta t} + \frac{O_1}{2}\right) - O_1 = \left(\frac{S_2}{\Delta t} + \frac{O_2}{2}\right)$$ **Equation 2**

a. Develop an inflow hydrograph, stage discharge curve, and stage-storage curve for the proposed storage facility.
   1) An inflow hydrograph should be prepared according to the techniques described in the previous section. The stage discharge curve, often called a performance curve, defines the relationship between the depth of water and the discharge, or outflow, from a storage basin. A typical performance curve will plot stage (water elevation), in feet, on the horizontal axis, with calculated discharge, in cfs, on the vertical axis.
   2) A typical storage facility will have both a principal and emergency outlet. The principal outlet is usually designed with a capacity sufficient to convey the design storm. The structure for the principal outlet will typically consist of a pipe culvert, weir, or orifice. The emergency outlet is designed to handle the extreme storm events that are larger than the design storm.
   3) The stage-storage curve defines the relationship between the depth of water and storage volume in the storage facility. The volume of storage can be calculated by using simple geometric formulas expressed as a function of storage depth. This relationship between storage volume and depth defines the stage-storage curve. A typical stage-storage curve plots the water surface elevation, in feet, on the vertical axis, and the storage, in ft^3, on the horizontal axis.

[1] Source: HEC-22: Urban Drainage Design Manual, FHWA.

b. Select a routing time period, Δt, to provide a minimum of five points on the rising limb of the inflow hydrograph.

c. Use the stage-storage and stage-discharge data developed in Step 'a' to develop a storage indicator numbers table. The storage indicator number is the set of unknown values on the right-hand side of Equation 2.

$$\frac{S_2}{\Delta t} + \frac{O_2}{2}$$

A typical storage indicator numbers table contains the following column headings:

(1)	(2)	(3)	(4)	(5)	(6)
Stage	Discharge (O_2)	Storage (S)	$\frac{O_2}{2}$	$\frac{S_2}{\Delta t}$	$\frac{S_2}{\Delta t} + \frac{O_2}{2}$
ft	cfs	ft^3	cfs	cfs	cfs

1) The discharge (O_2) and storage (S_2) are obtained from the stage-discharge and stage-storage curves, respectively.
2) The Δt value should be the same as the time interval used in the tabulated inflow hydrograph.

d. Develop a storage indicator numbers curve by plotting the outflow (column 2) vertically against the storage indicator numbers in column (6). An equal value line plotted as $O_2 = S_2/\Delta t + O_2/2$ should also be plotted. If the storage indicator curve crosses the equal value line, a smaller time increment (Δt) is needed.

e. The routing can now be performed by developing a routing table. A typical routing table contains the following column headings:

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time	Inflow	$\frac{(I_1 + I_2)}{2}$	$\frac{S_1}{\Delta t} + \frac{O_1}{2}$	O_1	$\frac{S_2}{\Delta t} + \frac{O_2}{2}$	O_2
hr	cfs	cfs	cfs	cfs	cfs	cfs

1) Columns (1) and (2) are obtained from the inflow hydrograph.
2) Column (3) is the average inflow over the time interval.
3) The initial values for columns (4) and (5) are generally assumed to be zero since there is no storage or discharge at the beginning of the hydrograph when there is no inflow into the basin.
4) The left side of Equation 2 is determined algebraically as columns (3)+(4)-(5). This value equals the right side of Equation 2 or $S_2/\Delta t+O_2/2$ and is placed in column (6).
5) Enter the storage indicator curve with $S_2/\Delta t + O_2/2$ (column 6) to obtain O_2 (column 7).
6) Column (6) ($S_2/\Delta t + O_2/2$) and column (7) (O_2) are transported to the next line and become $S_1/\Delta t + O_1/2$ and O_1 in columns (4) and (5), respectively. Because ($S_2/\Delta t + O_2/2$) and O_2 are the ending values for the first time step, they can also be said to be the beginning values for the second time step.
7) Columns (3), (4), and (5) are again combined and the process is continued until the storm is routed.

8) Peak storage depth and discharge (O_2 in column (7)) will occur when column (6) reaches a maximum. The storage indicator numbers table developed in Step c is entered with the maximum value of $S_2/\Delta t + O_2/2$ to obtain the maximum amount of storage required. This table can also be used to determine the corresponding elevation of the depth of stored water.
9) The designer needs to verify that the peak value in column (7) does not exceed the allowable discharge for the design storm.

f. Plot O_2 (column 7) versus time (column 1) to obtain the outflow hydrograph.

E. Determining storage volume

The final design of a detention facility requires three items:
- an inflow hydrograph
- a stage vs. storage curve
- a stage vs. discharge curve

1. To check the capacity of a basin with a known volume, use the methods described in the previous sections.

   a. Develop an inflow hydrograph for the storm in question.

   b. Develop the stage-storage and stage-discharge curves for the basin.

   c. Route the storm through the basin to determine the outflow hydrograph. Check the peak of the outflow hydrograph to ensure that it does not exceed the allowable value. Also, check the peak storage volume to ensure that it does not exceed the capacity of the basin.

2. Analyzing a known basin utilizing the methods developed in the previous sections is relatively straightforward. However, determining the required size of a proposed basin is an iterative process, and can be quite time consuming without a method to develop a preliminary volume estimate. Fortunately, TR-55 provides a method for determining quick estimates of detention basin volumes.

   a. Figure 2 relates two ratios: peak outflow to peak inflow discharge (q_o/q_i) and storage volume to runoff volume (V_s/V_r). The value for q_i is determined by the peak of the inflow hydrograph. The value for q_o is normally dictated by the allowable release rate. The volume of runoff can be calculated with Equations 1 and 2 (note: $V_r = Q$).

   The relationships in Figure 2 were determined on the basis of single stage outflow devices. Some were controlled by pipe flow, others by weir flow. Verification runs were made using multiple stage outflow devices, and the variance was similar to that in the base data.

   b. The method can therefore be used for both single- and multiple-stage outflow devices. The only constraints are that:

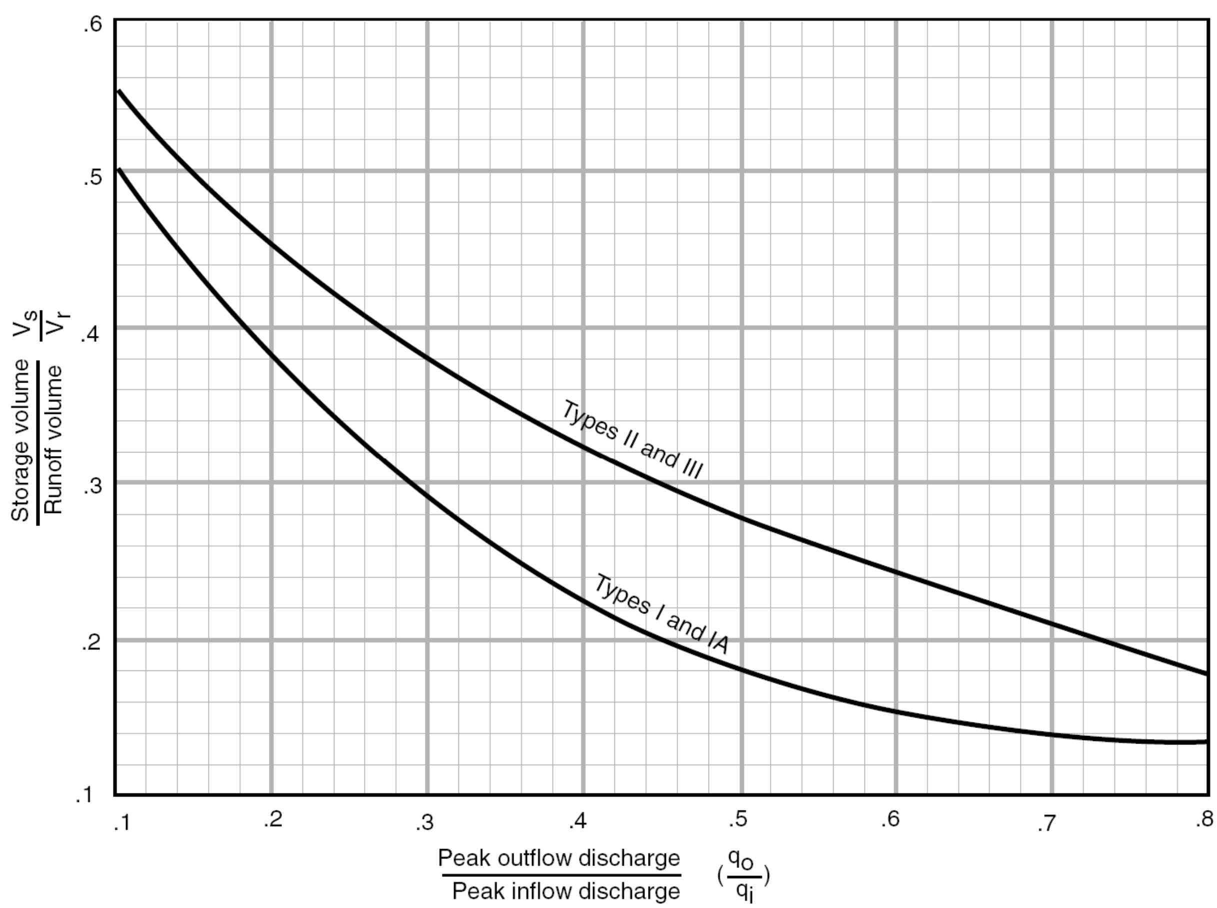
   1) Each stage requires a design storm and a computation of the storage required for it.
   2) The discharge of the upper stage(s) includes the discharge of the lower stage(s).

c. The brevity of the procedure allows the designer to examine many combinations of detention basins. When combined with the Tabular Hydrograph Method, the procedure's usefulness is increased. Its principal use is to develop preliminary indications of storage adequacy. It is also adequate however, for final design of small detention basins.

This estimating technique becomes less accurate as the q_o/q_I ratio approaches the limits shown in Figure 2. The curves in Figure 2 depend on the relationship among available storage, outflow device, inflow volume, and shape of the inflow hydrograph. When the storage volume (Vs) required is small, the shape of the outflow hydrograph is sensitive to the rate of the inflow hydrograph. Conversely, when Vs is large, the inflow hydrograph shape has little effect on the outflow hydrograph. In such instances, the outflow hydrograph is controlled by the hydraulics of the outflow device and the procedure therefore yields consistent results. When the peak outflow discharge (q_o) approaches the peak inflow (q_i), the parameters that affect the rate of rise of a hydrograph, such as rainfall volume, curve number, and time of concentration, become especially significant.

The procedure should not be used to perform final design if an error in storage of 25% cannot be tolerated. Figure 2 is biased to prevent undersizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and routing will often pay for itself through reduced construction costs.

Figure 2: Approximate Detention Basin Routing for All Rainfall Types[2]



[2] Source: TR-55: Urban Hydrology for Small Watershed, USDA/NRCS.

d. The purpose of Figure 2 is to provide a starting point for the size of the basin. The volume of the basin must be determined by developing a hydrograph and routing the design storm through the basin. The process may have to be repeated several times to achieve a basin that has sufficient volume and meets specific inlet and outlet controls.

F. Detention facilities requirements

1. Earthen detention

a. Slopes on embankments should be at least 4:1 or flatter and should have appropriate temporary and permanent erosion control stabilization.

b. Detention bottom cross-slopes to the main detention swale or channel will be 2% minimum. Concrete paved swale or channel bottom (cunette) and subsurface drains is required for slopes less than 1.5%. The Jurisdictional Engineer may require a pilot channel in detention bottom.

c. The embankment top should be at least 6 feet wide.

d. Freeboard should be a minimum of 1 foot above the controlled emergency spillway discharge. If there is not room for an emergency spillway, the minimum freeboard above the 100-year surface elevation of the structure should be increased to 2 feet.

e. The embankment should be protected from catastrophic failure due to overtopping following IDNR requirements where applicable. Overtopping can occur when the pond outlets become obstructed or when a larger than 100-year storm occurs. Failure protection for the embankment may be provided in the form of a buried, heavy riprap layer on the entire downstream face of the embankment or a separate emergency spillway having a minimum capacity of twice the maximum developed inflow rate for the 100-year storm. The spillway is also needed to control the release point of the overflows. Structures should not be permitted in the path of the emergency spillway or Overflow, and easements should be considered. The invert of the emergency spillway should be set equal to or above the 100-year water surface elevation. Stormwater easements need to be considered downstream of the emergency spillway.

2. Parking lot storage

a. Paved parking lots may be designed to provide temporary detention storage of stormwater on a portion of their surfaces not to exceed 25%.

b. Outlets should be designed to empty the stored waters slowly, and depths of storage must be limited to 9 inches so as to prevent damage to parked vehicles. The minimum pipe size for the outlet is 12 inches in diameter where a drop inlet is used to discharge to a storm sewer or drainageway.

Where a weir and a small diameter outlet through a curb are used, the size and shape are dependent on the discharge/storage requirements. A minimum pipe size of 6 inches in diameter is recommended.

c. To assure that the detention facility performs as designed, maintenance access will be provided. The outlet should be designed to minimize unauthorized modifications that affect function. Any repaving of the parking lot will be evaluated for impact on volume and release rates and are subject to approval.

d. Storage areas should be posted with warning signs.

3. **Multipurpose basins.** Dry bottom basins may 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.

4. **Maintenance.** The owner of the detention basin may be the developer, homeowner, homeowner's association, or Jurisdiction. The method of ownership of the detention basin including easements, should be defined in the Jurisdiction's ordinance. The owner will be responsible for the maintenance of all stormwater detention facilities.

   For cluster and planned developments, the developer will be responsible for the maintenance of all improvements until such time as 80% of the development is completed or until such time as 80% of the lots in the development have been sold or rented. The transfer of these improvements to the owner for the purpose of maintenance should not be affected until the developer has received final approval, final inspection, and a certificate of compliance from the Jurisdiction. Thereafter, any detention improvements will be maintained in perpetuity and cannot be developed for any other use that would limit or cause to limit their use for detention.

   Maintenance of the detention area must be performed on a regular basis to ensure the basin will operate as designed when needed. Maintenance should include:

   - Mowing to control trees and weeds. No trees should be permitted in the impoundment dam.
   - Checking for the integrity of the dam, including repair of varmint holes, and low places in the dam other than the emergency spillway.
   - Ensuring the emergency spillway is operating properly and at the proper elevation.
   - Ensuring all valves and gates are exercised regularly and in operating order.
   - Inspecting outlet orifices to ensure proper operation, including the proper operation of any orifice plates.
   - Ensuring the inlet to the basin allows proper flow to the detention area.
   - Ensuring inlet, outlet, and emergency spillways are free from obstructions.
   - Inspecting any related signs are in place and legible.
   - Inspect fence, if any, for continuity.
   - Inspect erosion control to ensure it is adequate.