



**Environmental
Protection**

CRITERIA FOR DETENTION FACILITY DESIGN

Bureau of Water & Sewer Operations

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Contents

Criteria.....	1
I. Detention Facilities with a variable outflow	3
II. Detention Facilities within an approximately constant outflow	4
III. Weighted effective runoff coefficient for series detention systems.....	5
IV. Maximum storage depth with an orifice tube outlet	6
General	8
Example 1.....	9
Example 2.....	10
Example 3.....	11
Example 4.....	12
Stormflow Calculations	13
Sample 1	14
Sample 2.....	15

Criteria

The following procedure is to be used to compute the total site developed storm flow in cubic feet per second (cfs), " Q_{DEV} ", the Allowable Flow in cfs, " Q_{ALL} ", the detention facility maximum release rate in cfs, " Q_{DRR} ", the required detention facility volume in cubic feet (ft^3), " V_R ", and the detention facility maximum storage depth in feet, (ft.), " S_D ". It is used for house connection proposals and site connection proposals, for storm flow generated totally within the site, to be detained within the site, and not receiving any street flow.

The detention facility is designed to provide the maximum volume required for the storm with a 10 year (yr.) return frequency. Porous open bottom detention facilities must be located a minimum of 3 ft. above the ground water table to prevent possible ground water infiltration into the sewer system and 10 ft. minimum (and/or per Construction Code) away from Building Foundation. The use of open bottom detention facilities requires the submission of boring logs to establish ground water levels and soil permeability when infiltration credit is applicable.

The method described below is based on an article entitled, "A simple method of retention basin design", by Glen Yrjanainen and Alan W. Warren, which appeared in Water and Sewage Works, December 1973, and "Storm Water Detention for Drainage, Water Quality, and CSO Management", by Peter Stahre and Ben Urbonas, published by Prentice Hall, 1990.

Detention storage volume is computed by calculating the difference between the inflow and outflow hydrographs, by the basic equation:

$$V_R = \int_{t_0}^t (Q_{IN} - Q_{OUT}) 60 dt$$

where:

- V_R = the required detention storage volume in ft^3
- t_0 = the beginning of the time of storage in minutes (min.)
- t = the total time that storage is required in min.
- Q_{IN} = the average inflow rate to the facility in cfs
- Q_{OUT} = the average outflow rate from the facility in cfs

The average inflow rate in cfs is computed based on the, “Rational Method”, by the equation:

$$Q_{IN} = C_{WT}iA_T$$

where: Q_{IN} = the average inflow rate in cfs during the rainfall event
 C_{WT} = the weighted runoff coefficient for the tributary area
 i = the average rainfall intensity in inches per hour (in/hr) for the event
 A_T = the area tributary to the detention facility in acres (ac.)

The weighted runoff coefficient for an area tributary to a detention facility is computed by the equation:

$$C_{WT} = (C_1A_1 + C_2A_2 + \dots \text{etc.}) / A_t$$

where: C_{WT} = the weighted runoff coefficient for the tributary area
 C_1 = the runoff coefficient for the area classified as roof
 A_1 = the area classified as roof in square feet (ft²)
 C_2 = the runoff coefficient for the area classified as paved
 A_2 = the area classified as paved in ft²
 A_t = the area tributary to the detention facility in ft²

The average rainfall intensity in in/hr, i , is computed for the storm with a 10 yr. return frequency by the equation:

$$i_{10} = 140 / (t + 15)$$

where: i_{10} = the average rainfall intensity in in/hr for the storm with a 10 yr. return frequency
 t = the duration of a rainfall event in min. for the storm with a 10 yr. return frequency

The “Rational Method”, assumes a uniform block rainfall distribution over the entire tributary area for the duration of the rainfall event, that the runoff hydrograph has the same shape with respect to time as the rainfall hyetograph, and that the use of a weighted runoff coefficient for the tributary area is valid. For urban areas of 400 ac. or less these assumptions are appropriate.

Under the new rule for stormwater management for discharge to a combined sewer system the maximum release rate in cfs, Q_{RR} , to which the site stormwater flow rate to the combined sewer will be restricted shall be the greater of 0.25 cfs or 10% of the Allowable Flow. If the Allowable Flow is less than 0.25 cfs, the site stormwater release rate to the combined sewer shall be the Allowable Flow. For discharge to a separate storm sewer system the maximum release rate in cfs, Q_{RR} , to which the site stormwater flow rate to the storm sewer will be restricted will be the Allowable Flow. The Allowable Flow in cfs, Q_{ALL} , is computed in accordance with the, “Rational Method”, by the equation:

$$Q_{ALL} = C_{DP} i_{DP} A_{DP} / 43,560$$

- where:
- Q_{ALL} = the Allowable Flow rate in cfs
 - C_{DP} = the runoff coefficient for the site, from the drainage plan
 - i_{DP} = the most upstream rainfall intensity in in/hr, from the drainage plan
 - A_{DP} = the area of the site tributary to the sewer in ft², as per the drainage plan

The maximum release rate in cfs from a detention facility, Q_{DRR} , is not always the same as the maximum release rate in cfs to which the site stormwater flow rate will be restricted, Q_{RR} . In cases where a detention facility discharges to another facility in series, the maximum release rate from the upstream facility may be greater than the Allowable Flow and or the maximum release rate from the site, Q_{RR} . The maximum release rate in cfs from a detention facility which is connected to a sewer, Q_{DRR} , will depend on whether the connection is to a combined sewer or to a separate storm sewer, the number of connections proposed, if any stormwater flow will be discharged unrestricted, if any constant and continuous stormwater recycling and reuse is proposed, or if any infiltration credit is proposed. Constant and continuous stormwater recycling and reuse and infiltration credit reduce the required detention volume, but do not increase the maximum release rate to the sewer system, Q_{RR} . For a site where the total site stormwater discharges through a connection with no unrestricted discharge the maximum release rate from the detention facility, Q_{DRR} , will be equal to the maximum stormwater release rate from the site, Q_{RR} .

I. Detention Facilities with a variable outflow

For a detention facility where the outflow is controlled by means of an outlet orifice tube, subject to a head which increases as the depth of storage increases, in a storage facility with an approximately uniform area with respect to storage height, and for roof detention by means of controlled flow roof drains, the average flow rate out of the detention facility is approximately 2/3 of the maximum outflow rate. The following procedure is used to compute the maximum required detention storage volume in ft³:

1. Compute the duration of the storm in minutes with a 10 yr. return frequency, t_V , which requires the maximum detention volume with outflow controlled by an orifice or by controlled flow roof drains, by the equation:

$$t_V = 0.27(C_{WT} A_t / Q_{DRR})^{0.5} - 15$$

- where:
- t_V = the duration of the storm in min. with a 10 yr. return frequency requiring the maximum detention volume with a variable outflow
 - C_{WT} = the weighted runoff coefficient for the area tributary to the detention facility
 - A_t = the area tributary to the detention facility in ft²
 - Q_{DRR} = the detention facility maximum release rate in cfs

2. Compute the maximum required detention volume in ft^3 with outflow controlled by an orifice tube or by controlled flow roof drains, V_V , by the equation:

$$V_V = [0.19C_{WT}A_t/(t_V + 15) - 40Q_{DRR}] t_V$$

- where:
- V_V = the maximum required detention volume in ft^3 with a variable outflow
 - C_{WT} = the weighted runoff coefficient for the area tributary to the detention facility
 - A_t = the area tributary to the detention facility in ft^2
 - t_V = the duration of the storm in min., with a 10 yr. return frequency, requiring the maximum detention volume with a variable outflow
 - Q_{DRR} = the detention facility maximum release rate in cfs

3. For roof detention compute the duration of the storm in minutes with a 10 yr. return frequency, t_V , which requires the maximum detention volume, and compute the maximum required detention volume in ft^3 with outflow controlled by controlled flow roof drains, V_V , with a detention facility maximum release rate in cfs, Q_{DRR} , as in I-1 through I-2 above. Confirm that the detention volume provided on the controlled flow roof, based on the slopes and geometry of the roof, is equal to or greater than the volume required, V_V , and that the actual release rate from the roof does not exceed the proposed maximum release rate in cfs for the roof, Q_{DRR} , following the procedure detailed in the DEP "Guidelines for the Design and Construction of Stormwater Management Systems".

II. Detention Facilities within an approximately constant outflow

For a detention facility where the outflow is approximately constant, as by the use of a pump characterized by a steep curve operating over a narrow head range, or by the use of an orifice tube subject to an approximately constant head, the average flow rate out of the detention facility is approximately 95% of the maximum outflow rate. The following procedure is used to compute the required detention storage volume in ft^3 .

1. Compute the duration of the storm in min. with a 10 yr. return frequency, t_C , which requires the maximum detention volume with an approximately constant outflow, by the equation:

$$t_C = 0.23(C_{WT}A_t/Q_{DRR})^{0.5} - 15$$

- where:
- t_C = the duration of the storm in min., with a 10 yr. return frequency, requiring the maximum detention volume with an approximately constant outflow
 - C_{WT} = the weighted runoff coefficient for the area tributary to the detention facility
 - A_t = the area tributary to the detention facility in ft^2
 - Q_{DRR} = the detention facility maximum release rate in cfs

2. Compute the maximum required detention volume in ft^3 with an approximately constant outflow, V_C , by the equation:

$$V_C = [0.19C_{WT}A_t / (t_C + 15) - 57Q_{DRR}] t_C$$

where:

- V_C = the maximum required detention volume with an approximately constant outflow
 C_{WT} = the weighted runoff coefficient for the area tributary to the detention facility
 A_t = the area tributary to the detention facility in ft^2
 t_C = the duration of the storm in min., with a 10 yr. return frequency, requiring the maximum detention volume with an approximately constant outflow
 Q_{DRR} = the detention facility maximum release rate in cfs

III. Weighted effective runoff coefficient for series detention systems

1. A. When the flow from a roof which has been restricted by controlled flow roof drains is discharged to a subsurface detention facility, the weighted effective weighted runoff coefficient for the roof, C_{WE} , is based on the average rainfall intensity in in/hr, i_{10} , for the duration in min. of the storm with a 10 yr. return frequency, as computed under I-1, t_V , for which the roof detention volume in ft^3 , V_V , was computed. Compute the weighted effective runoff coefficient for the roof with runoff restricted by controlled flow roof drains, C_{WE} , by the equation:

$$C_{WE} = 311Q_{DRR}(t_V + 15) / A_t$$

- where: C_{WE} = the weighted effective weighted runoff coefficient for the roof with runoff restricted by controlled flow roof drains
 Q_{DRR} = the maximum release rate from the roof in cfs
 t_V = the duration in min of the rainfall event for which the roof detention volume was computed
 A_t = the area of the roof in ft^2 tributary to the roof detention
 $311 = 43,560 \text{ ft}^2 \text{ per ac.} / 140$

- B. Use this effective weighted runoff coefficient for the roof with runoff restricted by controlled flow roof drains, C_{WE} , to compute the weighted runoff coefficient for the area tributary to the sub- surface detention facility, C_{WT} , to which this restricted roof will discharge, as on page 2 above. Compute the maximum required detention volume in ft^3 , V_V as in I-1 through I-2, or V_C as in II-1 through II-2.

2. A. When the flow from an area which has been restricted by detention and a controlled flow device is discharged to a subsurface detention facility, the weighted effective weighted runoff coefficient for the area which has been restricted by detention and a controlled flow device, C_{WE} , is based on the average rainfall intensity in in/hr, i_{10} , for the duration in min. of the storm with a 10 yr. return frequency, as computed under I-1 t_V , for which the detention volume in ft^3 , V_V , was computed.. Compute the weighted effective runoff coefficient for the area with runoff restricted by detention and a controlled flow device, by the equation:

$$C_{WE} = 311 Q_{DRR} (t_V + 15) / A_t$$

where: C_{WE} = the weighted effective runoff coefficient for the area with runoff restricted by detention and a controlled flow device
 Q_{DRR} = the maximum release rate in cfs from the area with runoff restricted by detention and a controlled flow device
 t_V = the duration in min of the rainfall event for which the detention volume was computed
 A_t = the area of the roof in ft^2 tributary to the roof detention
 311 = $43,560 \text{ ft}^2$ per ac./140

- B. Use this weighted effective runoff coefficient for the area with runoff restricted by detention and a controlled flow device, C_{WE} , to compute the weighted runoff coefficient for the area tributary to the subsurface detention facility, C_{WT} , to which this area with runoff restricted by detention and a controlled flow device will discharge, as on page 2 above. Compute the maximum required detention volume in ft^3 , V_V as in I-1 through I-2, or V_C as in II-1 through II-2.

IV. Maximum storage depth with an orifice tube outlet

An orifice tube outlet may be used to restrict the flow rate from detention facilities to the maximum release rate in cfs, Q_{DRR} . Flow through an orifice tube outlet in cfs is a function of the coefficient of discharge for the type of orifice tube, the cross sectional area of the orifice tube in ft^2 , the square root of twice the acceleration due to gravity, and the square root of the head in ft. on the orifice tube outlet, measured from the center of the tube.

Two types of orifice tube outlet are used. To maximize the head, or to minimize the orifice tube diameter (dia.), use a Re-entrant orifice tube outlet, where the tube projects into the outlet control structure one dia. To minimize the head, or to maximize the orifice tube dia., use a Flush orifice tube outlet, where the tube is flush with the wall of the outlet control structure. The maximum length of the orifice tube outlet is 2 ft., after which it must enlarge by at least one dia. size.

The minimum requirements for an outlet control structure are shown on “**SAMPLE 1 OUTLET CONTROL STRUCTURE WITH REENTRANT ORIFICE TUBE**” and on “**SAMPLE 2 FLUSH OUTLET CONTROL STRUCTURE WITH FLUSH ORIFICE TUBE**”, on pages 14 and 15. The maximum required detention volume in ft^3 , V_R , must be provided between the elevation of the invert of the orifice tube outlet, and the elevation of the maximum storage depth in ft., S_D . To avoid clogging and maximize the subsurface storage depth, the minimum size orifice tube outlet used is two inches (in.) in dia. DEP requires a Declaration of Maintenance, recorded as a Deed Restriction against the property when the dia. of the orifice tube outlet is less than three in.

Flow through an orifice tube in cfs is computed by the equation:

$$Q_{DRR} = C_D A_O (2g h)^{0.5}$$

where:

Q_{DRR} = the detention facility maximum release rate in cfs

C_D = the coefficient of discharge for the type of orifice tube outlet, Re-entrant or Flush

A_O = the area of the orifice tube in ft^2

g = the acceleration due to gravity, 32.2 ft/sec^2

h = the maximum head in ft. on the orifice tube outlet, measured from the center of the orifice tube

and the maximum storage depth in ft., S_D , is equal to the maximum head in ft., h , plus one half of the dia. of the orifice tube outlet in ft.

1. Compute the maximum storage depth in ft. of a detention facility with a Re-entrant orifice tube outlet, S_{DR} , with a C_D of 0.52, by the equation:

$$S_{DR} = 1,930(Q_{DRR})^2 / (d_O)^4 + d_O / 24$$

where:

S_{DR} = the maximum storage depth in ft. for a Re-entrant orifice tube outlet

Q_{DRR} = the detention facility maximum release rate in cfs

d_O = the nominal dia. of the orifice tube outlet in in.

2. Compute the maximum storage depth in ft. of a detention facility with a Flush orifice tube outlet, S_{DF} , with a C_D of 0.61, by the equation:

$$S_{DF} = 1,400(Q_{DRR})^2 / (d_O)^4 + d_O / 24$$

where:

S_{DF} = the maximum storage depth in ft. for a Flush orifice tube

Q_{DRR} = the detention facility maximum release rate in cfs

d_O = the nominal dia. of the orifice tube outlet in in.

General

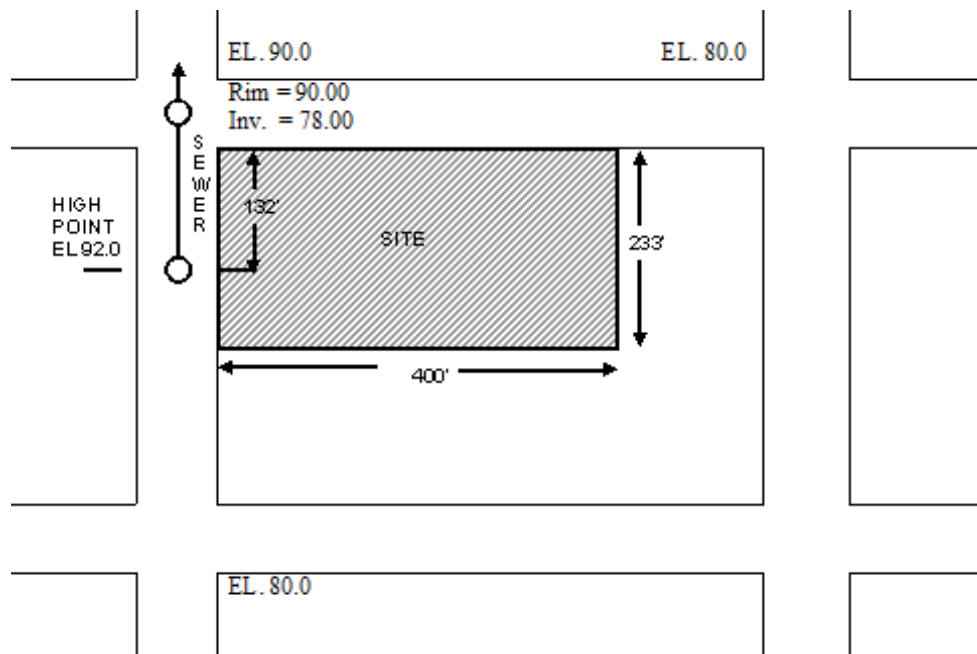
There are many ways to restrict the developed site storm flow to the maximum release rate in cfs, Q_{DRR} , and of providing the required detention volume in ft^3 , V_R . Whatever means is used, volume provided below the elevation of the invert of the orifice tube outlet, or above the elevation of the maximum storage depth, S_D , is not counted in computing the volume provided. Volume has been provided in poured in place reinforced concrete tanks, pre cast solid vertical reinforced concrete rings, reinforced concrete and corrugated metal pipes, steel and fiberglass tanks, gravel beds, slotted vertical reinforced concrete rings and gravel beds, perforated pipe and gravel beds, storm water storage modules, solid HDPE pipes, perforated HDPE pipes and gravel beds, infiltrator type systems, synthetic turf athletic field under drain systems, above ground ponds, rain gardens, and rain water reuse or recycling systems.

Example 1

A site in the Bronx connecting to a pre-1964 15 in. Drainage Plan combined sewer, where only a portion the site is allowable to the sewer. All the storm flow discharges through the subsurface detention facility.

Given:

- Area = 93,200 ft²
- Roof = 29,000 ft² @ 0.95 runoff coefficient
- Paved = 48,000 ft² @ 0.85 runoff coefficient
- Grass = 16,200 ft² @ 0.20 runoff coefficient
- $C_{WT} = [(29,000)0.95 + (48,000)0.85 + (16,200)0.20]/93,200 = 0.768$
- $Q_{ALL} = 132(100)/24,800 = 0.53$ cfs
- $Q_{DEV} = [(29,000)0.95 + (48,000)0.85 + (16,200)0.20]/7,320 = 9.78$ cfs.
- $Q_{DRR} = 0.25$ cfs



A. Outflow will be controlled by an orifice tube and will vary with the depth of storage.

$$t_V = 0.27[(0.768)(93,200)/0.25]^{0.5} - 15 = 129.5 \text{ min.}$$

$$V_V = [(0.19)(0.768)(93,200)/(129.5 + 15) - 40(0.25)] 129.5 = 10,895 \text{ ft}^3$$

To maximize the storage depth, use a 2 in. dia. Re-entrant orifice tube outlet.

$$S_{DR} = 1,930[(0.25)^2/(2)^4] + 2/24 = 7.62 \text{ ft.}$$

B. Outflow will be constant and will not vary with the depth of storage. Use a 1/2 gpm pump = 0.25 cfs.

$$t_C = 0.23[(0.768)(93,200)/0.25]^{0.5} - 15 = 108.1 \text{ min.}$$

$$V_C = [(0.19)(0.768)(93,200)/(108.1 + 15) - 57(0.25)] 108.1 = 10,404 \text{ ft}^3$$

To minimize the pressure relief MH depth, use a 3 in. dia. Flush orifice tube outlet.

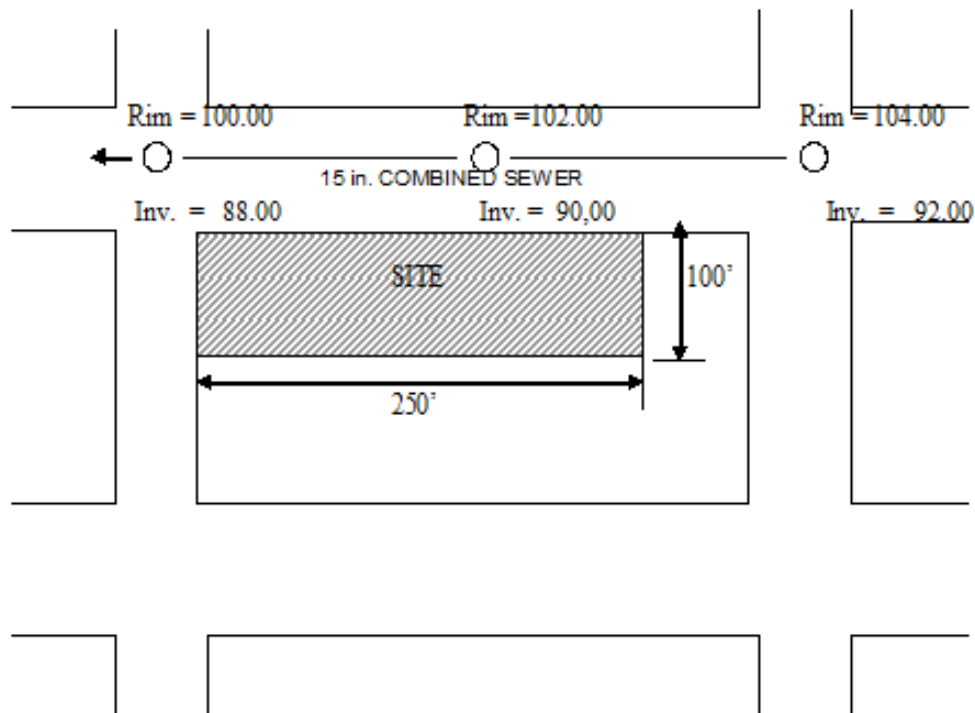
$$S_{DF} = 1,400 [(110/449)^2/(3)^4] + 3/24 = 1.21 \text{ ft.}$$

Example 2

A site in Brooklyn where the total site is allowable to a 15 in. combined Drainage Plan sewer, and all of the storm flow discharges through the subsurface detention facility.

Given:

- Area = 25,000 ft²
- Roof = 6,000 ft² @ 0.95 runoff coefficient
- Paved = 10,000 ft² @ 0.85 runoff coefficient
- Grass = 9,000 ft² @ 0.20 runoff coefficient
- $C_{WT} = [(6,000)0.95 + (10,000)0.85 + (9,000)0.20]/25,000 = 0.640$
- $Q_{ALL} = 250(100)/17,400 = 1.44$ cfs
- $Q_{DEV} = [(6,000)0.95 + (10,000)0.85 + (9,000)0.20]/7,320 = 2.19$ cfs
- $Q_{DRR} = 0.25$ cfs



A. Outflow will be controlled by an orifice tube and will vary with the depth of storage.

$$t_V = 0.27[(0.64)(25,000)/0.25]^{0.5} - 15 = 53.3 \text{ min.}$$

$$V_V = [(0.19)(0.64)(25,000)/(53.3 + 15) - 40(0.25)]53.3 = 1,839 \text{ ft}^3$$

To maximize the storage depth use a 2 in. dia. Flush orifice tube outlet.

$$S_{DF} = 1,400[(0.25)^2/(2)^4] + 2/24 = 5.55 \text{ ft.}$$

B. Outflow will be constant and will not vary with the depth of storage. Use a 112 gpm pump.

$$t_C = 0.23[(0.64)(25,000)/0.25]^{0.5} - 15 = 43.2 \text{ min.}$$

$$V_C = [(0.19)(0.64)(25,000)/(43.2 + 15) - 57(0.25)]43.2 = 1,641 \text{ ft}^3$$

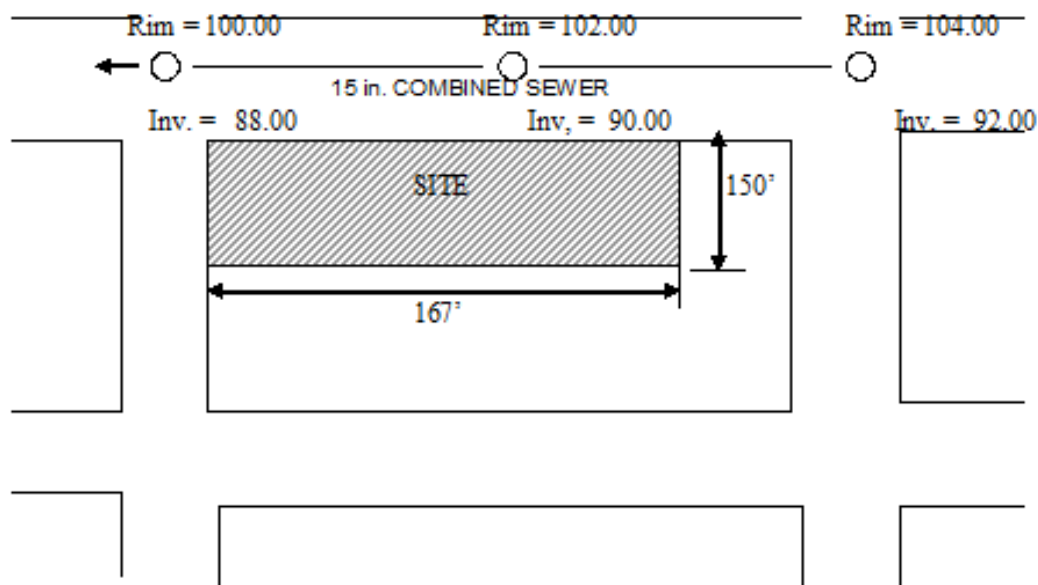
To minimize the pressure relief MH depth, use a 3 in. dia. Flush orifice tube outlet.

$$S_{DF} = 1,400 [(110/449)^2/(3)^4] + 3/24 = 1.21 \text{ ft.}$$

Example 3

A 25,050 ft² site in Queens where only 100 ft. of the 150 ft. depth of the site is allowable to a 15 in. combined Drainage Plan sewer. Roof detention is proposed for a 126.5 ft. by 126.5 ft. roof. The roof will be restricted to 0.64 cfs using 8 drains with 1 weir each @ 9.1 gpm/in per weir, in accordance with “Guidelines for the Design and Construction of Stormwater Management Systems”. The total roof area is used for detention, and will discharge in series through a subsurface detention facility, with a Flush orifice tube outlet.

Given: Area= 25,050 ft²
 Roof= 16,000 ft² @0.95 runoff coefficient, sloped 0.5% both ways, 126.5' by 126.5'
 Paved= 6,100 ft² @ 0.85 runoff coefficient
 Grass= 2,950 ft² @ 0.20 runoff coefficient
 $C_{WS} = [(16,000)0.95 + (6,100)0.85 + (2,950)0.20]/25,050 = 0.837$
 $Q_{ALL} = 167(100)/18,200 = 0.92$ cfs
 $Q_{DEV} = [(16,000)0.95 + (6,100)0.85 + (2,950)0.20]/7,320 = 2.87$ cfs
 $Q_{DRR} = 0.25$ cfs;



Restrict roof to 0.64 cfs with 8 drains with 1 weir each; $A_t = 16,000$ ft²

$$t_V = 0.27[(0.95)(16,000)/0.64]^{0.5} - 15 = 26.6 \text{ min.}$$

$$V_V = [(0.19)(0.95)(16,000)/(26.6 + 15) - 40(0.64)]26.6 = 1,156 \text{ ft}^3$$

As per “Guidelines for the Design and Construction of Stormwater Management Systems” the volume provided is equal to or greater than 1,156 ft³ and the actual release rate from the roof does not exceed 0.64 cfs.

$$C_{WE} = 311(0.64)(26.6 + 15)/16,000 = 0.518$$

$$C_{WT} = [(16,000)0.518 + (6,100)(0.85) + (2,950)(0.20)]/25,050 = 0.561$$

$$t_V = 0.27[(0.561)(25,050)/0.25]^{0.5} - 15 = 49.0 \text{ min.}$$

$$V_V = [(0.19)(0.561)(25,050)/(49 + 15) - 40(0.25)]49 = 1,555 \text{ ft}^3$$

To maximize the storage depth use a 2 in Flush orifice tube outlet.

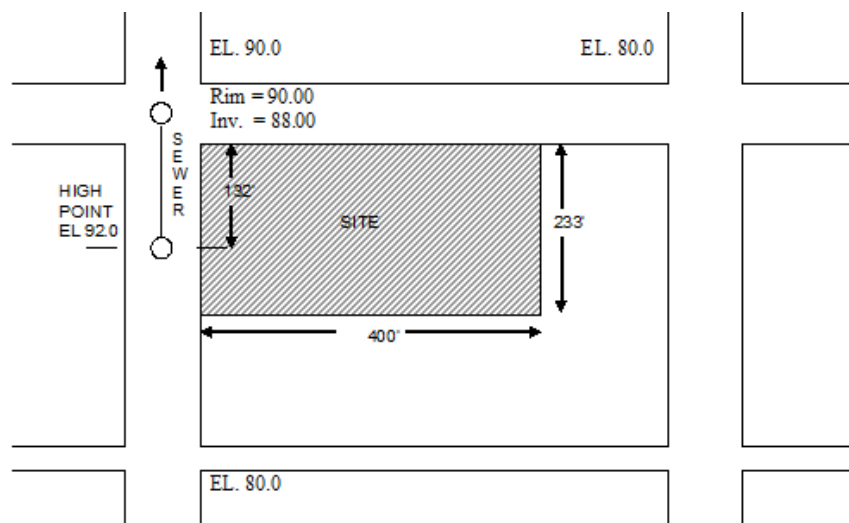
$$S_{DF} = 1,400[(0.25)^2 / (2)^4] + 2/24 = 5.55 \text{ ft.}$$

Example 4

A site in Manhattan connecting to a 12 in. Drainage Plan storm sewer, where only a portion the site is allowable to the sewer. The grass area and 4,000 ft² of paved area will discharge unrestricted. The remainder of the site will discharge through a subsurface detention facility.

Given:

$$\begin{aligned} \text{Area} &= 93,200 \text{ ft}^2 \\ \text{Roof} &= 60,000 \text{ ft}^2 @ 0.95 \text{ runoff coefficient} \\ \text{Green Roof} &= 20,000 \text{ ft}^2 @ 0.70 \text{ runoff coefficient} \\ \text{Paved} &= 10,000 \text{ ft}^2 @ 0.85 \text{ runoff coefficient} \\ \text{Grass} &= 3,200 \text{ ft}^2 @ 0.20 \text{ runoff coefficient} \\ C_{WS} &= [(60,000)0.95 + (20,000)0.70 + (10,000)0.85 + (3,200)0.20]/93,200 = 0.86 \\ Q_{ALL} &= 132(100)/12,200 = 1.08 \text{ cfs} \\ Q_{DEV} &= [(60,000)0.95 + (20,000)0.70 + (10,000)0.85 + (3,200)0.20]/7,320 = 10.95 \text{ cfs} \\ Q_{DRR} &= 1.08 - [(4,000)0.85 + (3,200)0.20]/7,320 = 0.53 \text{ cfs} \\ C_{WT} &= [(60,000)0.95 + (20,000)0.70 + (6,000)0.85]/86,000 = 0.885; A_t = 86,000 \text{ ft}^2 \end{aligned}$$



- A. Outflow will be controlled by an orifice tube and will vary with the depth of storage.

$$t_V = 0.27[(0.885)(86,000)/0.53]^{0.5} - 15 = 87.3 \text{ min.}$$

$$V_V = [(0.19)(0.885)(86,000)/(87.3 + 15) - 40(0.53)]87.3 = 10,488 \text{ ft}^3$$

To maximize the storage depth, use a 3 in. dia. Re-entrant orifice tube outlet.

$$S_{DR} = 1,930[(0.53)^2/()] + 3/24 = 6.82 \text{ ft.}$$

- B. Outflow will be constant and will not vary with the depth of storage. Use a 240 gpm pump.

$$t_C = 0.23[(0.885)(86,000)/0.53]^{0.5} - 15 = 72.2 \text{ min.}$$

$$V_C = [(0.19)(0.885)(86,000)/(72.2 + 15) - 57(0.53)]72.2 = 9,791 \text{ ft}^3$$

To minimize the pressure relief MH depth, use a 4 in. dia. Flush orifice tube outlet.

$$S_{DF} = 1,400 [(240/449)^2/(4)^4] + 4/24 = 1.70 \text{ ft.}$$

Stormflow Calculations

1. Developed Site Stormflow

Used by the Department of Environmental Protection to compute developed site stormflow in cfs:

where:

$$Q_{DEV} = C_{WS} A_S / 7,320$$

Q_{DEV} = the developed flow rate in cfs
 C_{WS} = the weighted runoff coefficient for the site area
 A_S = the site area in ft^2

2. Runoff Coefficients

The developed site stormflow is computed using the following runoff coefficients:

- C = 0.95 for roof areas
- “ = 0.85 for paved areas
- “ = 0.70 for a green roof with 4 in. of growing media
- “ = 0.70 for porous asphalt/concrete areas
- “ = 0.70 for synthetic turf athletic fields with gravel bed and under drains
- “ = 0.65 for a gravel parking lot
- “ = 0.30 for undeveloped areas
- “ = 0.20 for grass, planted, bio-swales, or landscaped areas

3. Allowable Stormflow for Sites 10,000 ft^2 or Less

The allowable stormflow should be computed based on the Drainage Plan for the fronting sewer. As a general guideline, unless the Drainage Plan indicates otherwise, for sites with both depth and width no larger than 100 ft., with an area, A_S , no greater than 10,000 ft^2 , connecting to a Drainage Plan Sewer fronting the entire site, the storm Allowable Flow in cfs is computed as follows:

Bronx-pre 1964.....	$Q_{ALL} = A_S / 24,800$
Bronx-post 1964.....	$Q_{ALL} = A_S / 14,500$
Brooklyn.....	$Q_{ALL} = A_S / 17,400$
Manhattan.....	$Q_{ALL} = A_S / 12,200$
Queens.....	$Q_{ALL} = A_S / 18,200$
Staten Island Combined.....	$Q_{ALL} = A_S / 24,400$
Staten Island Storm.....	$Q_{ALL} = C_Z * A_S / 7,320$

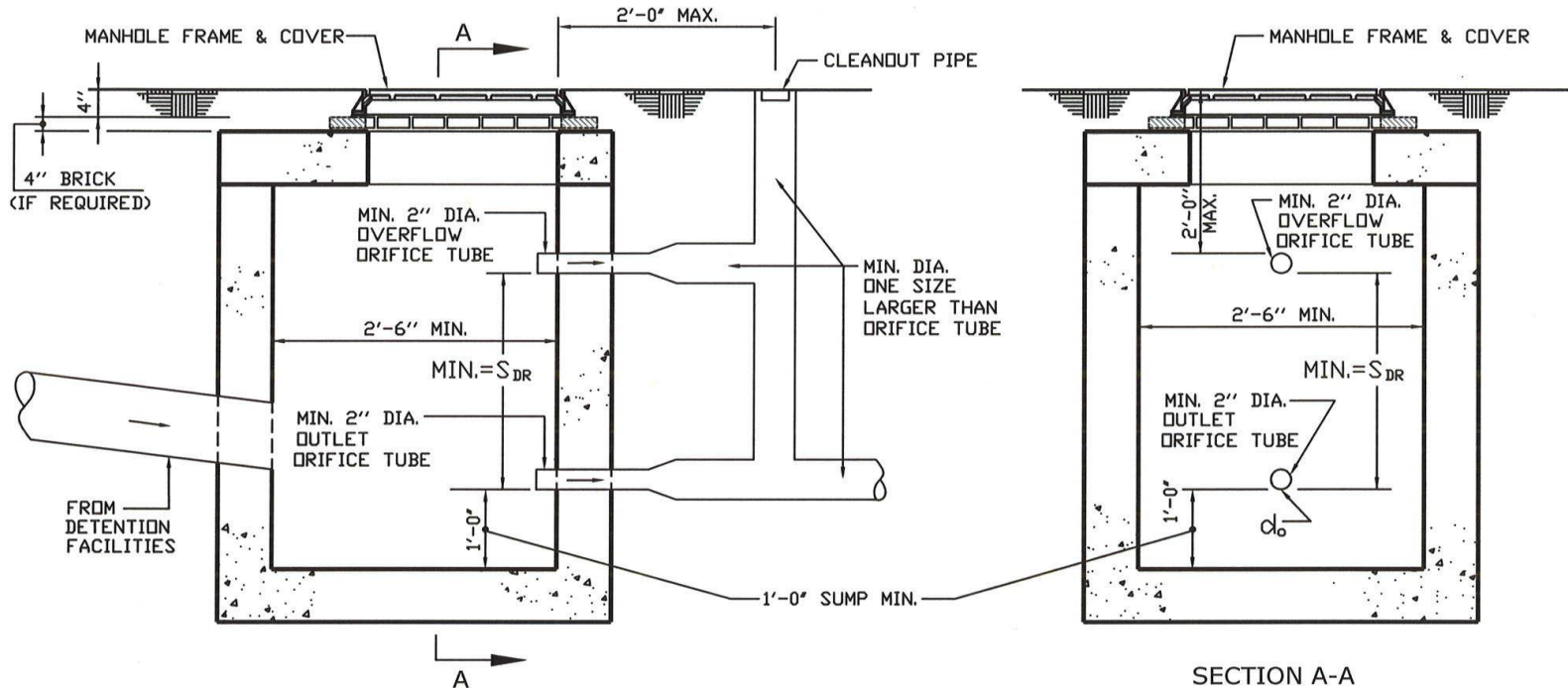
A Drainage Plan Sewer is a sewer constructed with Capital Funds by DEP or its prior Agencies. The title box of the Construction Drawing, and or, the Record Drawing, will indicate if the sewer is a Drainage Plan Sewer. For sites with any dimension greater than 100 ft., or where the Drainage Plan Sewer does not front the entire site, the runoff coefficient, C_{DP} , the upstream rainfall intensity in in/hr, i_{DP} , and the area in ft^2 allowable to the sewer, A_{DP} , are determined from the Drainage Plan. WPA sewers, private drains, highway drains, TC's, plumbers drains, state highway sewers, railroad sewers, and watercourse diversions, are not drainage plan sewers. The availability of any of these sewers/drains for flow must be examined and determined individually.

C_Z^* is based on zoning

Sample 1



DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER & SEWER OPERATIONS



OUTLET AND OVERFLOW ORIFICE TUBES SAME SIZE AND PROJECTION OF TUBE EQUAL TO DIAMETER OF TUBE

$$S_{DR} = 1,930(Q_{DRR}/d_o^2)^2 + d_o/24$$

S_{DR} = THE MAXIMUM STORAGE DEPTH IN FT. FOR A RE-ENRANT OUTLET ORIFICE TUBE

Q_{DRR} = THE DETENTION MAXIMUM RELEASE RATE IN CFS

d_o = THE NOMINAL DIA. OF THE ORIFICE TUBE IN INCHES

SAMPLE-1

OUTLET CONTROL STRUCTURE WITH REENRANT ORIFICE TUBE

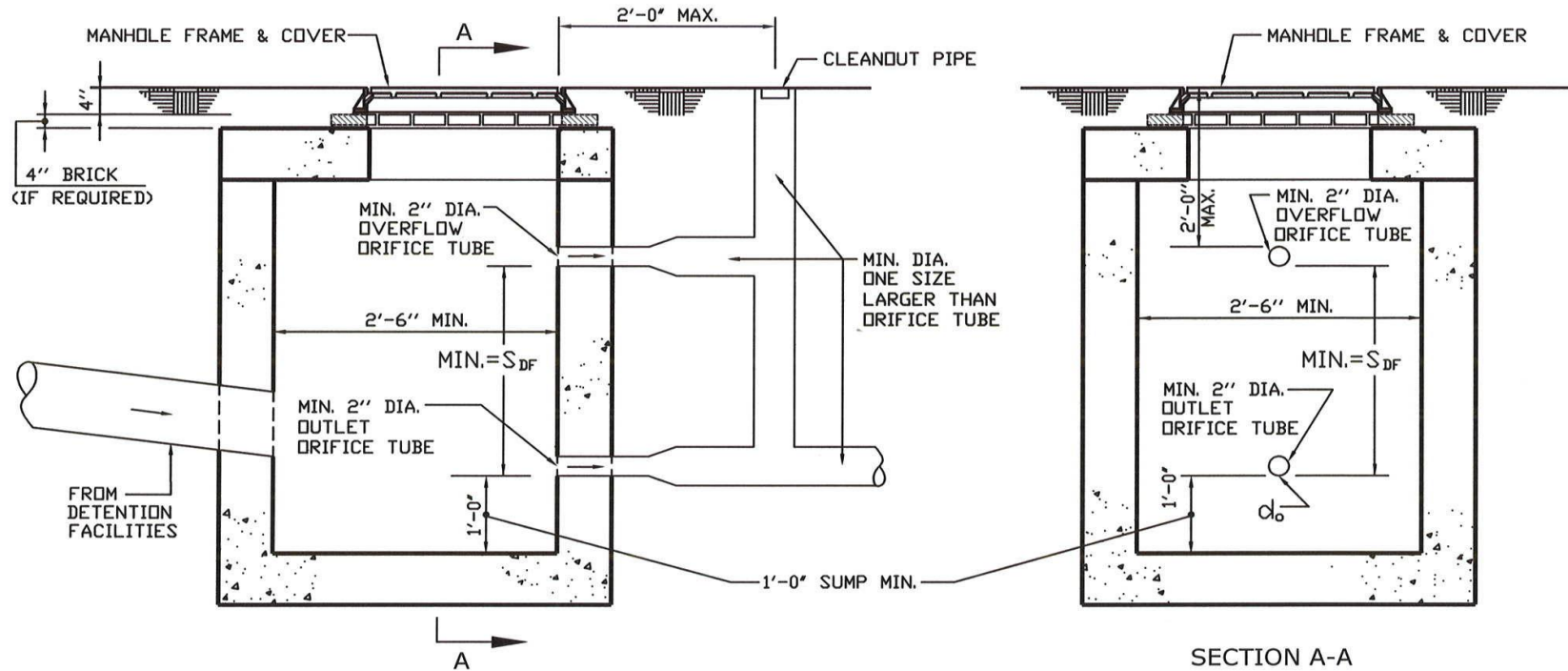
N.T.S.

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MARCH 29, 2012
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Sample 2



DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER & SEWER OPERATIONS



OUTLET AND OVERFLOW ORIFICE TUBES SAME SIZE AND
OUTLET TUBE IS FLUSH WITH WALL

$$S_{DF} = 1,400(Q_{RR} / d_o^2)^2 + d_o^2 / 24$$

S_{DF} = THE MAXIMUM STORAGE DEPTH IN FT. FOR
A FLUSH OUTLET ORIFICE TUBE

Q_{DRR} = THE DETENTION MAXIMUM RELEASE RATE IN CFS

d_o = THE NOMINAL DIA. OF THE ORIFICE TUBE IN INCHES

SAMPLE-2

OUTLET CONTROL STRUCTURE WITH FLUSH ORIFICE TUBE

N.T.S.

REVISED-SEPTEMBER 7, 2012
MARCH 29, 2012
VM/YL