Appendix I: A Simple Method of Detention Basin Design

DETERMINATION OF REQUIRED VOLUME FOR DETENTION BASINS

The volume of the proposed storm water detention basins shall be determined by one of the following methods.

Method 1

Table I gives the required detention basin volumes and the corresponding permissible maximum outflow rates for various tributary area sizes. For tributary areas, acreages of which fall between those listed in the table, the next higher listed acreage shall be used.

The table is based on the following parameters:

A. 100-year frequency design storm.

B. Overall run-off coefficient C = 0.35 (pg. 51, *ASCE Manual No. 37, Design and Construction of Sanitary and Storm Sewers*, 1969).

C. Maximum permissible unit outflow rate of 0.20 cfs per acre of tributary area.

Should the design engineer, for some reason, see the need to use run-off coefficients or permissible outflow rate other than those specified under "B" or "C" above, Method 2 should be used.

Method 2

Under this method, the engineer shall make his design computations using Table II. The maximum value in column "7" shall be the required volume of detention basin. The use of this method is subject to the Livingston County Drain Commissioner's approval of the allowable outflow rate (Q_o) selected by the engineer.

Table I

Tributary Area (Acres)	Permissible Maximum Outflow (cfs)	Minimum Required Volume (Acre-Feet)
5	1.0	0.47
10	2.0	0.93
15	3.0	1.40
20	4.0	1.87
25	5.0	2.33
30	6.0	2.80
35	7.0	3.27
40	8.0	3.73
45	9.0	4.20
50	10.0	4.66
55	11.0	5.13
60	12.0	5.60
65	13.0	6.06
70	14.0	6.53
75	15.0	7.00
80	16.0	7.46
85	17.0	7.23
90	18.0	8.40
95	19.0	8.26
100	20.0	8.33

Table II

Tributary Area (A) = _____ Acres

Compound Run-off Coefficient (C) = _____ (Attach computations)

Design Constant (K_1) = A x C = _____

Allowable Outflow Rate (Q_o)* = _____ cfs

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Duration (Minutes)	**Duration (Seconds)**	**Intensity (100-yr Storm) (In/Hr)**	**Col. #2 x Col. #3 Inches**	**Inflow Volume = Col. 4 x K_1 (Cu. Ft.)**	**Outflow Volume Col. #2 x Q_o (Cu. Ft.)**	**Storage Volume Col. 5 - Col. 6 (Cu. Ft.)**
5	300	9.17	2,751			
10	600	7.86	4,716			
15	900	6.88	6,192			
20	1,200	6.11	7,332			
30	1,800	5.00	9,000			
60	3,600	3.24	11,664			
90	5,400	2.39	12,906			
120	7,200	1.90	13,680			
180	10,800	1.34	14,472			

NOTE: Figures in Columns (3) and (4) are valid where the intensity is computed by the formula $I = \frac{275}{t + 25}$ (i.e., 100-yr. curve), appropriate revisions shall be made for geographical areas where this formula does not apply.

* Allowable outflow rate Q_o to be one of the following:

Case 1: Q_o = capacity of existing discharge conduit or channel.

Case 2: Q_o = q x A where q = Permissible Discharge Rate per Acre of Tributary Area = _____ cfs/acre.

SAMPLE PROBLEMS

Example #1:

Given: A Subdivision of 30 acres with single residential Lots as follows:

Average Lot Size:	150' x 200' or 30,000 sq. ft.
Average House Dimensions:	65' x 30'
Driveway:	24' wide, concrete
Building Setback:	40'
Street R.W.W.:	60'
Pavement:	Concrete integral conc. curb & gutter 30'b-b
Sidewalk:	5' wide, concrete, both sides of the street
Drainage Outlet:	Existing roadside ditch under the Road Commission jurisdiction.
Permissible Unit Outflow:	0.15 cfs/acre

Required: Volume of Storm Water Detention Basin.

Computations:

a) Compound Run-off Coefficient (c)

Area of Lot	=	200 x 150	=	30,000 Sq.Ft.
Area of Street	=	30 x 150	=	4,500 Sq.Ft.
TOTAL AREA				34,500 Sq.Ft.

Assume the following individual run-off coefficients:

Building and Paved Surfaces:	0.90
Lawns and Unpaved Surfaces:	0.20

Thus:

House: 65' x 30'	=	1950 S.F.	@	0.90	=	1755
Pavement: 150' x 15'	=	2250 S.F.	@	0.90	=	2025
Drive Apron: 55' x 24'	=	1320 S.F.	@	0.90	=	1188
Sidewalk: 150' x 5'	=	750 S.F.	@	0.90	=	675
Lawns & Natural Areas	=	28,230 S.F.	@	0.20	=	5646
TOTALS	=	34,500 S.F.				11,289

$$\text{Compound C} = \frac{11{,}289}{34{,}500} = 0.33 \text{ - (Use C = 0.35)}$$

b) Permissible Maximum Outlet Rate

30 acres @ 0.20 cfs/acre = 4.5 cfs

c) Required Volume of Detention Basin

Since Compound C = 0.35 and Outlet Rate is at 0.20 cfs/acre, Table I may be used.

Therefore the required minimum volume of detention basin will be
2.8 acre feet or 2.8 x 43,560 = 121,910 cubic feet

Example #2:

Given: An apartment site occupying 60 acres. The percentages of area used will be as follows:

Buildings:	40%
Parking Areas, Streets, & Walks:	40%
Parks and Greenbelts:	20%

The only permissible drainage outlet is a natural drainage channel which has a capacity of 15 cfs and currently drains the area of development. There are no other off-site or upstream tributary areas.

Required: Minimum volume of Storm Water Detention Basin.

Computations:

a) Compound Run-off Coefficient.

Assume the following individual run-off coefficients:

Buildings:	40%
Paving & Parking:	40%
Parks and Greenbelts:	20%

Thus:

Buildings:	60 x 0.40	=	24 acres	@ 0.90	=	21.6
Pavements:	60 x 0.40	=	24 acres	@ 0.90	=	21.6
Lawn Areas:	60 x 0.20	=	12 acres	@ 0.20	=	2.4
			60 acres			45.6

$$\text{Compound C} = \frac{45.6}{60} = 0.76$$

b) Maximum Permissible Outflow Rate (Q_o) =12 cfs
(or 0.20 cfs per acre)

c) Required Volume of Detention Basin:

Since the values of C and Q^o do not meet the criteria of Method #2, (Table II) has to be used.

The minimum detention volume thus computed = 446,861 Cu.Ft.
or 10.2 Acre Ft.

Example #2
Sample Problem

Tributary Area (A) = 60 Acres

Compound Run-off Coefficient (C) = 0.76 (Attach computations)

Design Constant (K_1) = A x C = 60 x 0.76 = 45.6

Allowable Outflow Rate (Q_o)* = 12 cfs

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Duration (Minutes)	**Duration (Seconds)**	**Intensity (100-yr Storm) (In/Hr)**	**Col. #2 x Col. #3 Inches**	**Inflow Volume = Col. 4 x K_1 (Cu. Ft.)**	**Outflow Volume Col. #2 x Q_o (Cu. Ft.)**	**Storage Volume Col. 5 - Col. 6 (Cu. Ft.)**
5	300	9.17	2,751	125,446	2,700	122,746
10	600	7.86	4,716	215,050	5,400	209,650
15	900	6.88	6,192	282,355	8,100	274,255
20	1,200	6.11	7,332	334,339	10,800	323,539
30	1,800	5.00	9,000	410,400	16,200	394,200
60	3,600	3.24	11,664	531,878	32,400	499,478
90	5,400	2.39	12,906	588,514	48,600	539,914
120	7,200	1.90	13,680	623,808	64,800	559,008
180	10,800	1.34	14,472	659,923	97,200	562,723

NOTE: Figures in Columns (3) and (4) are valid where the intensity is computed by the formula $I = \frac{275}{t+25}$ (i.e., 100-yr. curve), appropriate revisions shall be made for geographical areas where this formula does not apply.

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