Appendix A

Acceptable Hydrologic Methods and Models

A.1 Acceptable Hydrologic Methods and Models

The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this guidebook unless circumstances make consideration of another storm intensity criteria appropriate.

- Rational Method & Modified Rational Method
- Natural Resource Conservation Service TR-55
- TR-20, HEC-1, and SWMM computer models

These methods are given as valid in principle, and are applicable to most storm water management design situations in the District of Columbia. Other methods may be used when the District reviewing authority approves their application.

A.2 Rational and Modified Rational Methods

These methods will be permitted for use in a development of five acres or less. When applying these methods, the following steps must be taken in the design consideration:

- In the case of more than one sub-drainage area, the longest time of concentration shall be selected.

- Individual sub-drainage flows shall not be summed to get the total flow for the watershed.

- The runoff coefficient, C, shall be a composite of the future site development conditions for all contributing areas to the discharge point. Runoff coefficient factors for typical District of Columbia land uses are provided in Table A.1.

- The flow time in storm sewers shall be taken into account in computing the watershed time of concentration.

- The storm duration shall be dependent upon the watershed time of concentration.

- The storm intensity can be selected from the selected storm duration.

Table A.1 Runoff Coefficient Factors for Typical District of Columbia Land Uses

Zone	Predominant Use	Minimum Lot Dimensions		Runoff Coefficient C
		Width (feet)	Area (sq ft)	
R-1-A	One-family detached dwelling	75	7,500	0.60
R-1-B	One-family detached dwelling	50	5,000	0.65
R-2	One-family semi-detached dwelling	30	3,000	0.65
R-3	Row dwelling	20	2,000	0.70
R-4	Row dwelling	18	1,800	0.75
R-5-A	Low density apartment	--	--	0.70
R-5-B	Medium density apartment house	--	--	0.75
R-5-C	Medium high density apartment house	--	--	0.80
R-5-D	High density building	--	--	0.80
C	Commercial	--	--	0.85 - 0.95
M	General Industry	--	--	0.80 - 0.90
Park		--	--	0.35

A.3 Natural Resource Conservation Service TR-55 (Desktop Model)

Application of the TR-55 Model to determine peak discharge and the volume of detention storage in a project drainage area shall be dependent upon the following conditions:

- Use Type II and 24-hour rainfall distributions as developed by the Natural Resource Conservation Service (Figure A.1 and Table A.2).
- Average antecedent moisture conditions are defined as a total of 1.4" to 2.1" of rainfall during the five-day period immediately preceding the design rainfall. Adjustments shall be made to simulate dry or wet antecedent moisture conditions.
- All flow shall be assumed to be sheet flow, shallow concentrated flow, or open channel flow.
- Drainage areas exceeding 25 acres that are heterogeneous with respect to land use, Runoff Curve Number (RCN) or Time of Concentration (T_c) shall require a separate hydrological

analysis for each sub-area including T_c, RCN, soils and land use. Hydrographs shall be combined in a way described by Table 5-2 of the TR-55 publication.

A.4 HEC-1, TR-55, Quick TR-55, TR-20, and SWMM Computer Models

If the application of the above high-speed computer models is needed, the complete input data file printout and diskette will be submitted with the storm water management plans at the 85% submittal stage. Submission of storm water management plans shall include the following computer model documentation:

- For the TR-20 method, supporting computation for T_c and a drainage area map indicating all hydrologic sub-areas shall be submitted.

- For the TR-55 & TR-20 methods, sheet flow length shall be less than 100 feet; use a 24-hour rainfall for each design storm to compute the travel time for sheet flow.

- For all computer models, supporting computation prepared for the data input file, such as hard copy and diskette, shall be submitted with the storm water management plans.

In general, designs shall be based on the following criteria:

- Inflow-outflow hydrographs shall be computed for each design storm presented graphically, and submitted for all plans.

- Pre-development runoff conditions shall be computed for the existing land use of the property, assuming good hydrologic conditions and land with grass cover.

- Post-development shall be computed using a NRCS runoff curve number for future land use assuming good hydrologic and appropriate land use conditions.

- Drainage areas exceeding 25 acres that are heterogenous with respect to land-use, RCN, runoff coefficient and T_c shall require a separate hydrological analysis for each sub-area, including T_c, RCN/C, soil type and land use.

- Pre-development time of concentration shall be based on the sum total of computed or estimated overland flow time and travel in natural swales, streams, creeks and rivers, but never less than six minutes.

- Post-development time of concentration shall be based on the sum total of the inlet time and travel time in improved channels or storm drains, but shall not be less than six minutes.

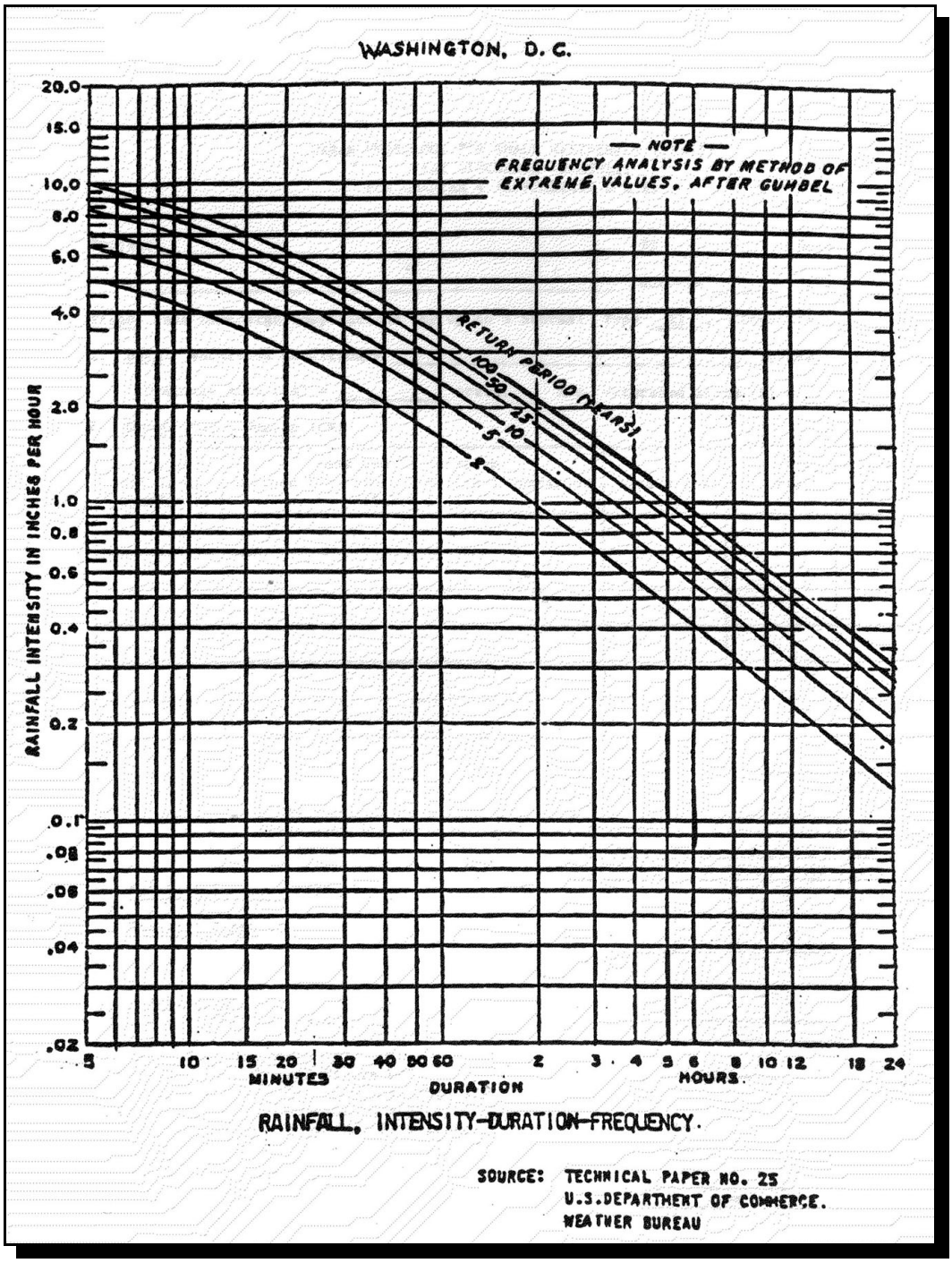

Figure A.1 District of Columbia Rainfall Intensity - Duration - Frequency Curve

Table A.2 Depth-Duration-Intensity-Frequency Rainfall Values for the District of Columbia

	1 Year		2 Year		5 Year		10 Year		15 Year		20 Year		25 Year		50 Year		100 Year	
Time (min)	**d**	**i**	**d**	**i**	**d**	**i**	**d**	**i**	**d**	**i**	**d**	**i**	**d**	**i**	**d**	**i**	**d**	**i**
5	0.38	4.60	0.44	5.28	0.54	6.42	0.61	7.34	0.63	7.56	0.64	7.63	0.66	7.93	0.72	8.61	0.74	8.89
10	0.65	3.88	0.74	4.44	0.89	5.34	1.02	6.11	1.05	6.30	1.06	6.36	1.10	6.64	1.20	7.20	1.25	7.90
15	0.83	3.32	0.96	3.83	1.15	4.59	1.32	5.27	1.36	5.44	1.38	5.50	1.43	5.72	1.54	6.14	1.61	6.42
20	0.97	2.91	1.12	3.36	1.35	4.04	1.55	4.65	1.61	4.82	1.63	4.88	1.69	5.08	1.78	5.35	1.86	5.59
30	1.13	2.26	1.35	2.70	1.64	3.27	1.90	3.79	1.97	3.95	2.02	4.03	2.10	4.19	2.24	4.49	2.32	4.65
45	1.29	1.72	1.57	2.09	1.93	2.57	2.25	3.01	2.37	3.16	2.44	3.25	2.54	3.38	2.83	3.77	2.96	3.94
60	1.38	1.38	1.70	1.70	2.13	2.13	2.51	2.51	2.66	2.66	2.76	2.76	2.87	2.87	3.22	3.22	3.39	3.39
80	1.49	1.12	1.81	1.36	2.33	1.75	2.77	2.08	2.96	2.22	3.10	2.32	3.22	2.42				
100	1.55	0.93	1.89	1.13	2.48	1.49	2.98	1.79	3.20	1.92	3.37	2.02	3.51	2.10				
120	1.58	0.79	1.94	0.97	2.60	1.30	3.14	1.57	3.40	1.70	3.61	1.80	3.75	1.87				
150	1.65	0.66	2.00	0.80	2.75	1.10	3.34	1.34	3.65	1.46	3.90	1.56	4.06	1.62				
180	1.68	0.56	2.04	0.68	2.86	0.95	3.50	1.17	3.87	1.29	4.16	1.39	4.32	1.44				
360			2.13	0.35	3.29	0.55	4.15	0.69	4.68	0.78	5.23	0.87	5.43	0.91				
720			2.16	0.18	3.73	0.31	4.84	0.40	5.64	0.47	6.49	0.54	6.75	0.56				
1440			2.17	0.09	4.18	0.17	5.62	0.23	6.79	0.28	8.04	0.34	8.35	0.35				

Notes: t = time in minutes
d = rainfall depth in inches
i = rainfall intensity in inches per hour
In general, i = (60 * d) / t

- Hydrologic Soil Groups approved for use in the District of Columbia are contained in the *Soil Survey of the District of Columbia Handbook.*

- On sites where substantial grading has occurred or will occur, or on fill sites, adjustments (see Table A.3) shall be made to the hydrologic soil group classifications.

- Schematic diagrams must be provided for all TR-20 and HEC-1 routings.

Table A.3 Soil Group Adjustment

Existing Soil	Adjusting Soil
A	B
B	C
C	D
D	D