HYDRAULIC DESIGN ADVISORY
HDA 05-03

DATE: JUNE 21, 2005

SUBJECT: VDOT's ADOPTION & IMPLEMENTATION OF NOAA ATLAS 14 RAINFALL PRECIPITATION FREQUENCY DATA

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The U.S. National Oceanic & Atmospheric Administration (NOAA) recently released their "ATLAS 14: RAINFALL PRECIPITATION FREQUENCY DATA" which covers the Ohio River basin and surrounding states (including Virginia). This information is most readily and conveniently accessed on NOAA's Internet web site at the following address: http://hdsc.nws.noaa.gov/hdsc/pfds/orb/va_pfds.html. This new data supercedes and replaces that which is contained in Technical Paper No. 40 "Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years" (Hershfield, 1961), NWS HYDRO-35 "Five- to 60-minute precipitation frequency for the eastern and central United States" (Frederick et al., 1977) and Technical Paper No. 49 "Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States" (Miller et al., 1964). All of the rainfall information currently contained in the "VDOT Drainage Manual" was predicated on TP-40 and/or HYDRO-35. All such information is no longer valid.

With the issuance of this Hydraulic Design Advisory, the Department officially recognizes and adopts the data presented in the "ATLAS 14" publication. Henceforth, the Department will require, subject to the guidelines described below, that its implementation of this data be employed for the design of all drainage facilities for which the hydrologic design is customarily predicated on rainfall data. This will include drainage designs for the Department's own facilities as well as those that may ultimately come under the Department's jurisdiction (subdivision streets, etc.). The Department recognizes that it will take some time before everyone becomes familiar with this new information and it can be fully and universally implemented. For this reason, it will be acceptable to continue to use the rainfall data currently in the "VDOT Drainage Manual" for projects under design that have completed the Public Hearing stage prior to the issuance of this Hydraulic Design Advisory.

In using the NOAA Internet web site, it should be noted that there occasionally will be more than one rainfall station located in or near a given county or city. The total point rainfall data displayed will, therefore, be dependent upon where one places the pointer used to make the selection. It is possible to get two or more different sets of total point rainfall data for the same county or city. To avoid confusion and to simplify the implementation and application of the new rainfall data, the Department has developed a set of "B, D, & E" factors for each county and major city throughout the state. These "B, D, & E" factors have been developed for 2, 5, 10, 25, 50, & 100-yr. recurrence interval storm durations. A tabulation of these factors accompanies this Hydraulic Design Advisory. A Microsoft EXCEL spreadsheet containing this same information and which will allow the data to be digitally transferred (i.e. copied and pasted) to other spreadsheets, software data files, etc. is also available for downloading via this web site. The spreadsheet is protected to preclude the possibility of inadvertently changing the data. These "B, D, & E" factors can be employed to determine rainfall intensity through the application of the following equation:

$I_f = B / (T_c + D)^E$

Where:

I_f = Rainfall intensity for a given recurrence interval "f", in inches/hour
T_c = Watershed time of concentration (assumed equal to the storm duration), in minutes

In situations where one must determine total point rainfall (as opposed to rainfall intensity) and time of concentration (or storm duration) is usually employed using hours (as opposed to minutes), the above equation can be modified as shown below:

$R_f = T_{c(h)} (B / (T_{c(m)} + D)^E)$

Where:

R_f = Total point rainfall for a given recurrence interval "f", in inches
$T_{c(h)}$ = Watershed time of concentration (assumed equal to the storm duration), in hours
$T_{c(m)}$ = Watershed time of concentration (assumed equal to the storm duration), in minutes

When employing the new "Atlas 14" rainfall precipitation frequency data, the Department's published "B, D, & E" factors shall be employed exclusively for the purposes of developing rainfall intensities and total point rainfall values. The use of the "IDF" (intensity-duration-frequency) and "RDF" (total point rainfall-duration-frequency) curves currently shown in the VDOT Drainage Manual shall be discontinued and they will be removed from the Manual at its next revision.

Regarding the impact of the implementation of the "Atlas 14" rainfall precipitation frequency data on computer software, the Department will no longer accept drainage designs from any software package that has not been predicated on this data, subject to the previously noted implementation period. It is our understanding, from communication with the FHWA, that the rainfall database contained in their popular "HYDRAIN" software suite will not be revised to reflect the "Atlas 14" data. The Department will, therefore, no longer accept any computations from the "HYDRAIN" suite that have been predicated on its current rainfall database, subject to the previously noted implementation period. As for software in current use by the Department, the latest version of the GEOPAK software package is being revised to include the "Atlas 14" based "B, D, & E" factors developed by the Department. Appropriate revisions will be distributed as soon as they are available. The following "written-in-house" programs have been revised to incorporate the "Atlas 14" data and the "B, D, & E" factors developed by the Department:

(1) "DISCHARGE" (for determining peak discharges using the Daniel G. Anderson & Franklin Snyder methods)
(2) "VIRTOC" (for determining rainfall intensity, time of concentration, and peak discharges using the Rational Formula)
(3) "RDDITCH" (for determining roadside and median ditch capacity and protective lining requirements)

These programs will be available to both Department and external users via the usual notification and distribution procedures. In addition to the above, new ".RND" (rainfall) files for all counties and major cities have been developed for use with the commercial "EAGLE POINT WATERSHED MODELING" (version

7.0SU-B) software package currently in use by the Department. These ".RND" files are available upon request, as their distribution should not be in violation of Eagle Point's copyright since one must have the program in order to use them.

Any comments or questions related to this Hydraulic Design Advisory should be directed to

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B. D. & E factors for determining rainfall intensity in the Rational and Modified Rational Methods (based on NOAA NW-14 Atlas data)

			2-YR			5-YR			10-YR			25-YR			50-YR			100-YR	
COUNTY/CITY	#	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E
Arlington	00	52.73	11.25	0.83	50.63	10.50	0.77	45.98	9.25	0.72	41.35	7.75	0.66	38.56	7.00	0.61	32.29	5.00	0.55
Accomack	01	65.77	13.00	0.88	56.63	11.50	0.79	49.92	10.00	0.73	39.98	7.50	0.65	37.31	6.50	0.61	32.84	5.25	0.55
Albemarle	02	49.02	10.50	0.82	55.71	11.50	0.80	46.95	9.50	0.73	40.11	7.75	0.66	35.68	6.50	0.61	31.09	5.00	0.55
Alleghany	03	51.16	13.25	0.88	39.11	10.00	0.77	40.84	10.00	0.74	36.37	8.75	0.67	29.66	6.50	0.60	26.46	5.00	0.55
Amelila	04	59.23	12.25	0.86	55.73	11.25	0.79	47.70	9.50	0.73	40.73	7.75	0.66	36.22	6.50	0.61	33.29	5.75	0.56
Amherst	05	60.72	13.00	0.88	57.10	12.00	0.81	43.80	9.25	0.72	39.61	8.00	0.66	34.36	6.50	0.60	30.80	5.25	0.55
Appomattox	06	51.76	11.50	0.84	54.03	11.25	0.80	47.13	10.00	0.73	40.72	8.25	0.67	34.36	6.50	0.60	30.14	5.00	0.55
Augusta	07	46.46	12.25	0.85	44.03	10.75	0.79	41.63	10.00	0.74	32.39	7.25	0.64	32.48	7.25	0.62	27.18	5.25	0.55
Bath	08	46.46	12.25	0.85	47.91	11.50	0.80	38.95	9.50	0.72	34.24	7.75	0.66	30.19	6.25	0.60	28.05	5.50	0.56
Bedford	09	47.85	11.25	0.83	48.76	10.75	0.78	45.55	10.00	0.73	40.49	8.50	0.67	33.51	6.50	0.60	29.36	5.00	0.55
Bland	10	36.34	10.00	0.81	41.14	10.75	0.78	38.52	9.75	0.73	32.99	7.75	0.66	29.71	6.50	0.60	26.71	5.25	0.55
Botetourt	11	51.98	12.25	0.85	51.47	11.50	0.80	44.82	9.75	0.73	36.34	7.50	0.65	33.51	6.50	0.60	29.23	5.00	0.55
Bristol	102	41.68	11.50	0.83	41.14	10.75	0.78	42.11	10.75	0.75	31.43	7.75	0.65	27.32	6.00	0.59	26.45	5.50	0.56
Brunswick	12	62.82	12.25	0.85	55.69	10.50	0.78	49.74	9.25	0.72	41.54	7.25	0.65	40.85	7.00	0.62	33.99	5.00	0.55
Buchanan	13	46.78	11.50	0.85	51.34	12.25	0.82	41.75	9.75	0.74	34.41	7.25	0.65	31.36	6.00	0.60	29.24	5.00	0.56
Buckingham	14	54.24	11.50	0.85	54.80	11.50	0.80	44.53	9.25	0.72	39.48	7.75	0.66	33.09	6.00	0.59	30.63	5.25	0.55
Campbell	15	46.46	12.25	0.85	44.03	10.75	0.79	41.63	10.00	0.74	32.39	7.25	0.64	32.48	7.25	0.62	27.18	5.25	0.55
Caroline	16	65.88	12.75	0.88	58.28	11.50	0.80	51.24	10.00	0.74	39.77	7.25	0.65	36.12	6.25	0.60	32.97	5.25	0.55
Carroll	17	54.24	11.50	0.85	52.48	10.75	0.79	48.34	10.00	0.74	38.91	7.75	0.65	35.14	6.50	0.61	30.77	5.00	0.55
Charles City	18	61.04	11.50	0.85	55.05	10.50	0.77	52.12	9.75	0.73	42.40	7.50	0.65	39.29	6.50	0.61	34.58	5.00	0.55
Charlotte	19	59.23	12.25	0.86	56.63	11.50	0.79	53.27	10.50	0.75	40.16	7.75	0.65	36.03	6.50	0.60	31.51	5.00	0.55
Charlottesville (city)	104	49.02	10.50	0.82	55.71	11.50	0.80	46.95	9.50	0.73	40.11	7.75	0.66	35.68	6.50	0.61	31.09	5.00	0.55
Chesapeake (city)	131	78.62	13.00	0.88	74.36	12.25	0.81	56.41	9.25	0.72	51.18	8.25	0.66	46.33	7.00	0.62	39.60	5.25	0.56
Chesterfield	20	52.72	10.75	0.83	49.08	9.75	0.76	50.71	10.00	0.73	39.77	7.25	0.65	37.31	6.50	0.61	32.29	5.00	0.55
Clarke	21	41.52	8.75	0.82	47.08	9.00	0.80	41.34	7.25	0.73	37.79	5.75	0.67	36.75	5.00	0.64	34.34	4.00	0.59
Craig	22	44.29	11.50	0.84	41.60	10.50	0.77	43.45	10.50	0.75	34.24	7.75	0.66	32.48	7.25	0.62	28.23	5.50	0.56
Culpeper	23	58.30	12.25	0.86	56.46	11.50	0.80	45.25	9.25	0.72	42.03	8.25	0.67	34.33	6.00	0.59	32.38	5.25	0.56
Cumberland	24	60.86	12.75	0.87	56.46	11.50	0.80	46.95	9.50	0.73	36.73	7.00	0.64	33.82	6.00	0.59	32.07	5.50	0.56
Danville (city)	108	50.48	10.50	0.82	39.15	8.75	0.72	35.48	7.75	0.66	33.76	6.75	0.62	33.66	6.25	0.59	34.46	6.00	0.57
Dickenson	25	53.26	12.75	0.87	44.86	10.75	0.79	44.28	10.50	0.75	35.17	7.75	0.65	35.11	7.25	0.62	29.39	5.00	0.55
Dinwiddie	26	61.04	11.50	0.85	57.21	10.75	0.78	54.03	10.00	0.74	44.17	7.75	0.66	40.85	7.00	0.62	34.12	5.00	0.55
Essex	28	61.14	12.00	0.86	59.79	11.50	0.80	51.93	10.00	0.74	41.19	7.50	0.65	40.52	7.25	0.62	33.95	5.25	0.56
Fairfax	29	55.09	11.50	0.84	54.20	11.00	0.79	47.70	9.50	0.73	39.18	7.25	0.65	36.34	6.50	0.60	32.29	5.00	0.55
Fauquier	30	54.24	11.50	0.85	54.80	11.50	0.80	48.34	10.00	0.74	41.03	8.25	0.66	35.44	6.50	0.60	31.38	5.00	0.55
Floyd	31	60.86	12.75	0.87	53.32	10.75	0.79	46.45	9.25	0.72	40.41	7.75	0.65	38.96	7.25	0.62	32.00	5.00	0.55
Fluvanna	32	60.98	12.75	0.88	51.10	10.75	0.79	47.55	10.00	0.74	38.60	7.75	0.65	34.59	6.50	0.61	30.33	5.25	0.55

B. D. & E factors for Virginia for determining rainfall intensity in the Rational and Modified Rational Methods (based on NOAA NW-14 Atlas data)

			2-YR			5-YR			10-YR			25-YR			50-YR			100-YR	
COUNTY/CITY	#	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E
Franklin	33	54.24	11.50	0.85	52.48	10.75	0.79	48.34	10.00	0.74	38.91	7.75	0.65	35.14	6.50	0.61	30.77	5.00	0.55
Frederick	34	44.35	9.50	0.84	45.41	8.50	0.79	43.33	7.75	0.75	37.02	5.75	0.67	35.19	4.75	0.63	33.81	3.75	0.59
Fredericksburg (city)	111	65.52	13.25	0.88	60.63	12.00	0.81	49.92	10.00	0.73	41.35	7.75	0.66	38.56	7.00	0.61	30.46	4.50	0.54
Giles	35	48.45	12.25	0.87	47.31	12.00	0.81	38.52	9.75	0.73	34.13	8.25	0.67	28.63	6.50	0.60	26.45	5.50	0.56
Gloucester	36	60.97	11.50	0.84	60.74	11.25	0.79	53.07	9.50	0.73	43.62	7.50	0.65	40.14	6.50	0.60	35.98	5.25	0.55
Goochland	37	59.23	12.25	0.86	55.73	11.25	0.79	47.70	9.50	0.73	40.73	7.75	0.66	36.22	6.50	0.61	31.51	5.00	0.55
Grayson	38	43.44	11.50	0.84	47.31	12.00	0.81	38.69	9.50	0.73	33.62	7.75	0.66	32.48	7.25	0.62	27.65	5.25	0.55
Greene	39	46.81	10.50	0.82	57.10	12.00	0.81	48.11	10.00	0.74	38.01	7.25	0.65	34.64	6.25	0.61	31.75	5.25	0.56
Greensville	40	56.78	11.25	0.84	55.17	10.75	0.78	52.82	10.00	0.74	41.80	7.50	0.65	38.93	6.50	0.61	34.24	5.25	0.55
Halifax	41	62.13	12.25	0.87	54.16	10.75	0.78	49.92	10.00	0.73	42.69	8.25	0.67	36.22	6.50	0.61	31.60	5.25	0.55
Hampton (city)	114	64.31	11.50	0.85	64.94	11.50	0.80	57.19	10.00	0.74	44.49	7.25	0.64	41.77	6.50	0.60	37.02	5.00	0.55
Hanover	42	55.94	11.50	0.84	53.49	10.75	0.78	47.18	9.25	0.72	39.98	7.50	0.65	36.53	6.50	0.60	32.68	5.25	0.56
Harrisonburg (city)	115	43.01	11.25	0.84	44.71	10.50	0.80	39.71	9.25	0.74	32.17	6.50	0.65	28.85	5.25	0.60	28.34	4.75	0.57
Henrico	43	55.94	11.50	0.84	53.49	10.75	0.78	47.18	9.25	0.72	39.98	7.50	0.65	36.53	6.50	0.60	32.68	5.25	0.56
Henry	44	52.73	11.25	0.83	50.63	10.50	0.77	46.45	9.25	0.72	38.59	7.25	0.65	35.26	6.50	0.60	31.09	5.00	0.55
Highland	45	36.67	10.00	0.81	34.94	8.93	0.74	34.82	8.46	0.71	32.93	7.09	0.66	33.21	6.98	0.64	29.31	6.40	0.59
Isle of Wight	46	71.07	12.25	0.86	65.58	11.25	0.79	54.11	9.25	0.72	47.20	7.50	0.65	46.41	7.25	0.62	38.84	5.25	0.56
James City	47	70.63	12.75	0.87	57.84	10.50	0.78	55.61	10.00	0.74	48.54	8.50	0.67	38.78	6.00	0.59	36.77	5.25	0.56
King George	48	62.71	12.75	0.87	54.16	10.75	0.78	48.93	9.50	0.73	43.35	8.25	0.67	36.12	6.25	0.60	32.92	5.00	0.55
King & Queen	49	65.74	12.75	0.87	49.83	9.75	0.76	*50.43*	9.50	0.73	44.67	8.25	0.66	37.20	6.25	0.60	32.80	4.75	0.55
King William	50	62.90	12.25	0.86	51.80	10.00	0.77	51.51	10.00	0.73	41.19	7.50	0.65	40.52	7.25	0.62	33.21	5.00	0.55
Lancaster	51	60.12	11.50	0.84	61.61	11.50	0.80	53.83	9.75	0.74	44.47	7.75	0.66	39.83	6.50	0.61	35.83	5.25	0.56
Lee	52	51.05	12.25	0.86	45.70	10.75	0.78	38.28	8.75	0.71	38.78	8.50	0.67	34.62	6.75	0.61	31.95	5.75	0.56
Lexington (city)	117	44.29	11.50	0.84	46.49	11.50	0.79	39.05	9.25	0.72	33.28	7.25	0.65	33.34	7.25	0.62	27.07	5.00	0.55
Loudoun	53	61.40	12.25	0.88	44.34	8.75	0.76	46.93	8.75	0.74	41.48	7.25	0.67	36.12	5.50	0.61	33.25	4.50	0.56
Louisa	54	60.86	12.75	0.87	61.41	12.25	0.82	45.25	9.25	0.72	40.11	7.75	0.66	35.68	6.50	0.61	31.05	5.00	0.55
Lunenburg	55	60.15	12.25	0.85	49.08	9.75	0.76	50.71	10.00	0.73	39.77	7.25	0.65	39.34	7.25	0.62	32.50	5.25	0.55
Lynchburg (city)	118	46.46	12.25	0.85	44.03	10.75	0.79	41.63	10.00	0.74	32.39	7.25	0.64	32.48	7.25	0.62	27.18	5.25	0.55
Madison	56	54.24	11.50	0.85	53.17	10.75	0.79	46.61	9.25	0.73	41.85	8.00	0.67	37.33	6.50	0.62	33.01	5.25	0.57
Martinsville (city)	120	52.73	11.25	0.83	50.63	10.50	0.77	46.45	9.25	0.72	38.59	7.25	0.65	35.26	6.50	0.60	31.09	5.00	0.55
Mathews	57	65.67	12.25	0.86	58.83	10.75	0.78	52.39	9.25	0.72	48.24	8.25	0.67	40.45	6.50	0.60	37.10	5.25	0.56
Mecklenburg	58	60.15	12.25	0.85	49.08	9.75	0.76	50.71	10.00	0.73	39.77	7.25	0.65	39.34	7.25	0.62	32.50	5.25	0.55
Middlesex	59	72.66	13.25	0.88	61.46	11.25	0.79	52.39	9.75	0.73	45.09	7.75	0.66	40.37	6.50	0.61	36.12	5.25	0.56
Montgomery	60	47.29	11.75	0.85	44.20	10.75	0.78	44.28	10.50	0.75	35.12	7.75	0.66	33.34	7.25	0.62	27.24	5.00	0.55
Nelson	62	51.90	11.25	0.84	49.81	10.50	0.77	45.25	9.25	0.72	38.59	7.25	0.65	36.22	6.50	0.61	32.21	5.25	0.56
New Kent	63	62.82	12.25	0.85	55.69	10.50	0.78	49.27	9.25	0.72	43.85	7.75	0.66	41.70	7.25	0.62	34.75	5.25	0.55

B. D. & E factors for Virginia for determining rainfall intensity in the Rational and Modified Rational Methods (based on NOAA NW-14 Atlas data)

			2-YR			5-YR			10-YR			25-YR			50-YR			100-YR	
COUNTY/CITY	#	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E
Newport News (city)	121	64.31	11.50	0.85	64.94	11.50	0.80	57.19	10.00	0.74	44.49	7.25	0.64	41.77	6.50	0.60	37.02	5.00	0.55
Norfolk (city)	122	60.83	11.25	0.84	64.03	11.50	0.80	51.92	9.25	0.72	47.96	8.25	0.66	39.29	6.00	0.59	37.10	5.25	0.56
Northampton	65	61.14	12.00	0.86	51.80	10.00	0.77	50.43	9.50	0.73	41.80	7.50	0.65	40.85	7.00	0.62	34.58	5.25	0.55
Northumberland	66	59.28	11.50	0.85	60.70	11.50	0.80	52.30	10.00	0.73	44.98	8.25	0.66	41.70	7.25	0.62	34.58	5.25	0.55
Nottoway	67	62.14	12.00	0.86	55.67	10.75	0.79	53.53	10.50	0.75	39.77	7.25	0.65	36.11	6.25	0.60	32.50	5.25	0.55
Orange	68	58.30	12.25	0.86	49.81	10.50	0.77	46.95	9.50	0.73	40.11	7.75	0.66	35.68	6.50	0.61	30.10	4.75	0.54
Page	69	39.07	8.50	0.82	41.80	8.25	0.78	40.62	7.50	0.74	38.83	6.50	0.68	32.66	4.50	0.62	34.36	4.50	0.60
Patrick	70	69.66	12.75	0.87	58.05	10.75	0.78	50.00	9.25	0.72	44.80	7.75	0.66	39.29	6.50	0.61	34.89	5.25	0.56
Pittsylvania	71	50.48	10.50	0.82	39.15	8.75	0.72	35.48	7.75	0.66	33.76	6.75	0.62	33.66	6.25	0.59	34.46	6.00	0.57
Powhatan	72	55.09	11.50	0.84	53.32	10.75	0.79	49.13	10.00	0.74	42.03	8.25	0.67	37.41	7.00	0.61	32.74	5.50	0.56
Prince Edward	73	42.34	9.75	0.78	54.20	11.00	0.79	48.19	9.50	0.73	40.73	7.75	0.66	34.33	6.00	0.59	31.56	5.25	0.55
Prince George	74	60.12	11.50	0.84	62.36	11.50	0.80	53.51	10.00	0.74	42.40	7.50	0.65	37.20	6.00	0.59	34.71	5.25	0.55
Prince William	76	52.66	11.50	0.85	46.85	10.00	0.77	47.55	10.00	0.74	40.37	8.25	0.66	35.14	6.50	0.61	31.09	5.25	0.55
Pulaski	77	45.53	12.25	0.86	47.31	12.00	0.81	34.60	8.50	0.71	34.79	8.25	0.67	28.35	6.00	0.59	26.38	5.25	0.55
Rappahannock	78	60.32	12.25	0.87	49.28	9.75	0.78	48.73	9.25	0.74	40.59	7.25	0.66	38.67	6.50	0.62	33.55	4.75	0.56
Richmond	79	62.90	12.25	0.86	59.05	11.50	0.80	53.81	10.00	0.74	44.32	8.25	0.66	39.21	6.75	0.61	34.42	5.25	0.56
Richmond (city)	127	57.69	11.50	0.85	54.99	10.75	0.78	47.91	9.25	0.72	41.66	7.75	0.65	36.88	6.50	0.60	33.15	5.25	0.56
Roanoke	80	47.62	11.50	0.85	47.08	10.75	0.79	47.73	10.75	0.75	38.78	8.50	0.67	34.84	7.25	0.62	29.06	5.25	0.55
Roanoke (city)	128	47.62	11.50	0.85	47.08	10.75	0.79	47.73	10.75	0.75	38.78	8.50	0.67	34.84	7.25	0.62	29.06	5.25	0.55
Rockbridge	81	44.29	11.50	0.84	46.49	11.50	0.79	39.05	9.25	0.72	33.28	7.25	0.65	33.34	7.25	0.62	27.07	5.00	0.55
Rockingham	82	43.01	11.25	0.84	44.71	10.50	0.80	39.71	9.25	0.74	32.17	6.50	0.65	28.85	5.25	0.60	28.34	4.75	0.57
Russell	83	46.78	11.50	0.85	43.36	10.75	0.78	38.95	9.50	0.72	37.76	8.75	0.67	31.10	6.50	0.60	28.76	5.25	0.56
Scott	84	51.20	12.75	0.87	52.43	12.75	0.82	42.17	10.00	0.74	35.47	8.00	0.66	33.34	7.25	0.62	28.29	5.25	0.56
Shenandoah	85	45.21	9.25	0.85	44.82	8.50	0.80	43.22	7.75	0.75	39.74	6.25	0.69	35.16	4.75	0.64	32.71	3.50	0.59
Smyth	86	52.17	12.75	0.87	44.20	10.75	0.78	46.01	10.75	0.75	36.42	8.25	0.66	34.52	7.25	0.62	29.06	5.25	0.55
Southampton	87	67.40	12.25	0.86	65.69	11.50	0.80	54.56	9.50	0.73	44.83	7.50	0.65	41.23	6.50	0.60	38.91	5.75	0.57
Spotsylvania	88	65.52	13.25	0.88	60.63	12.00	0.81	49.92	10.00	0.73	41.35	7.75	0.66	38.56	7.00	0.61	30.46	4.50	0.54
Stafford	89	65.52	13.25	0.88	60.63	12.00	0.81	49.92	10.00	0.73	41.35	7.75	0.66	38.56	7.00	0.61	30.46	4.50	0.54
Staunton (city)	132	46.46	12.25	0.85	44.03	10.75	0.79	41.63	10.00	0.74	32.39	7.25	0.64	32.48	7.25	0.62	27.18	5.25	0.55
Suffolk (city)	133	78.09	12.81	0.88	60.79	10.45	0.77	54.21	9.02	0.72	47.94	7.41	0.65	45.23	6.47	0.62	42.16	5.42	0.58
Surry	90	63.47	11.50	0.85	58.83	10.75	0.78	52.39	9.25	0.72	45.72	7.75	0.66	40.68	6.50	0.60	36.45	5.25	0.55
Sussex	91	60.01	11.25	0.84	78.66	13.25	0.85	54.30	10.00	0.73	46.30	8.25	0.66	42.87	7.25	0.62	35.65	5.25	0.55
Tazewell	92	44.30	12.00	0.85	47.70	12.25	0.82	36.89	9.25	0.73	34.19	8.00	0.66	29.66	6.25	0.60	27.24	5.00	0.55
Virginia Beach (city)	134	61.66	11.25	0.84	61.78	10.75	0.79	56.67	10.00	0.73	49.63	8.25	0.67	40.32	6.00	0.59	37.86	5.25	0.56
Warren	93	44.97	9.50	0.84	44.54	8.75	0.78	41.57	7.75	0.73	39.56	6.50	0.68	33.97	4.75	0.61	34.11	4.25	0.59
Washington	95	41.68	11.50	0.83	41.14	10.75	0.78	42.11	10.75	0.75	31.43	7.75	0.65	27.32	6.00	0.59	26.45	5.50	0.56

B. D. & E factors for Virginia for determining rainfall intensity in the Rational and Modified Rational Methods (based on NOAA NW-14 Atlas data}

			2-YR			5-YR			10-YR			25-YR			50-YR			100-YR	
COUNTY/CITY	#	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E	B	D	E
Westmoreland	96	55.94	11.50	0.84	58.28	11.50	0.80	54.10	10.50	0.75	41.98	7.75	0.66	39.93	7.25	0.62	33.44	5.25	0.55
Williamsburg (city)	137	70.63	12.75	0.87	57.84	10.50	0.78	55.61	10.00	0.74	48.54	8.50	0.67	38.78	6.00	0.59	36.77	5.25	0.56
Winchester (city)	138	44.35	9.50	0.84	45.41	8.50	0.79	43.33	7.75	0.75	37.02	5.75	0.67	35.19	4.75	0.63	33.81	3.75	0.59
Wise	97	53.26	12.75	0.87	44.86	10.75	0.79	44.28	10.50	0.75	36.41	8.00	0.66	35.11	7.25	0.62	29.23	5.00	0.55
Wythe	98	50.79	13.00	0.88	44.18	11.25	0.80	42.97	10.75	0.75	35.80	8.25	0.67	31.03	6.50	0.61	28.29	5.25	0.56
York	99	69.54	12.75	0.87	58.89	10.75	0.78	55.09	10.00	0.73	45.72	7.75	0.66	40.68	6.50	0.60	38.41	5.75	0.57