Appendix O: Trail Creek Flow Study

Watershed Land Use Types and the Corresponding Cover Type Assumptions for Curve Number Calculations

Developed Agriculture Pasture/Grassland	Pasture, grassland, or range with continuous forage for grazing
Developed Agriculture Row Crop	Pasture, grassland, or range with continuous forage for grazing
Developed Non-Vegetated	Urban: Commercial and Business
Developed Urban High Density	Urban: Commercial and Business
Developed Urban Low Density	Residential: 1 acre
Palustrine Forest Deciduous	Wood or Forest Land: good cover
Palustrine Herbaceous Deciduous	Wood or Forest Land: good cover
Palustrine Shrubland Deciduous	Meadow
Palustrine Woodland Deciduous	Wood or Forest Land: good cover
Terrestrial Forest Deciduous	Wood or Forest Land: good cover
Terrestrial Forest Evergreen	Wood or Forest Land: good cover
Terrestrial Forest Mixed	Wood or Forest Land: thin stand
Terrestrial Shrubland Deciduous	Meadow
Terrestrial Woodland Deciduous	Wood or Forest Land: good cover
Unclassified Cloud/Shadow	Highest % (Wood or Forest for E1)
Water	Dirt

E1 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
2742.45	3619.9	1309.01	182.28	34.04

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of E1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	828.98	10.51%	288.22	380.44	137.57	19.16
Developed Agriculture Row Crop	2652.71	33.63%	922.30	1217.40	440.23	61.30
Developed Non-Vegetated	42.81	0.54%	14.88	19.65	7.10	0.99
Developed Urban High Density	15.48	0.20%	5.38	7.10	2.57	0.36
Developed Urban Low Density	23.66	0.30%	8.23	10.86	3.93	0.55
Palustrine Forest Deciduous	1251.93	15.87%	435.28	574.54	207.76	28.93
Palustrine Herbaceous Deciduous	98.16	1.24%	34.13	45.05	16.29	2.27
Terrestrial Forest Deciduous	2436.82	30.89%	847.24	1118.32	404.40	56.31
Terrestrial Forest Evergreen	57.85	0.73%	20.11	26.55	9.60	1.34
Terrestrial Forest Mixed	14.13	0.18%	4.91	6.48	2.34	0.33
Terrestrial Shrubland Deciduous	159.17	2.02%	55.34	73.05	26.42	3.68
Terrestrial Woodland Deciduous	65.31	0.83%	22.71	29.97	10.84	1.51
Unclassified Cloud/Shadow	228.78	2.90%	79.54	104.99	37.97	5.29
Water	11.98	0.15%	4.16	5.50	1.99	0.28
TOTAL	7887.77	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Flow Rates are for a 1 yr 24 hr storm

Flow Rate are ~~CWQ~~ flows for a 1 yr 24 hr storm

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	14122.90	26250.32	10868.24	1609.19	52850.64
Developed Agriculture Row Crop	45192.87	84000.29	34778.05	5149.36	169120.57
Developed Non-Vegetated	1324.73	1807.53	667.84	93.99	3894.08
Developed Urban High Density	478.93	653.48	241.44	33.98	1407.83
Developed Urban Low Density	419.48	738.26	310.15	45.92	1513.81
Palustrine Forest Deciduous	10881.92	31599.92	14543.46	2227.70	59252.99
Palustrine Herbaceous Deciduous	853.23	2477.70	1140.33	174.67	4645.93
Terrestrial Forest Deciduous	21181.11	61507.67	28308.12	4336.10	115333.00
Terrestrial Forest Evergreen	502.83	1460.17	672.03	102.94	2737.97
Terrestrial Forest Mixed	221.05	427.95	180.54	27.10	856.64
Terrestrial Shrubland Deciduous	1660.23	4236.75	1875.47	286.91	8059.35
Terrestrial Woodland Deciduous	567.72	1648.60	758.75	116.22	3091.29
Unclassified Cloud/Shadow	1988.58	5774.61	2657.69	407.09	10827.97
Water	299.83	450.72	172.93	24.63	948.11

Total Sum	434540.19
Total Acres	7853.73
Composite Number	55.33
Flow	10.936 cfs

E2 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
4259.63	4505.23	1518.2	213.37	40.39

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of E2	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	1105.23	10.49%	446.80	472.56	159.24	22.38
Developed Agriculture Row Crop	3385.58	32.13%	1368.64	1447.56	487.81	68.56
Developed Non-Vegetated	67.27	0.64%	27.19	28.76	9.69	1.36
Developed Urban High Density	15.29	0.15%	6.18	6.54	2.20	0.31
Developed Urban Low Density	38.69	0.37%	15.64	16.54	5.58	0.78
Palustrine Forest Deciduous	1418.45	13.46%	573.42	606.48	204.38	28.72
Palustrine Herbaceous Deciduous	111.33	1.06%	45.00	47.60	16.04	2.25
Terrestrial Forest Deciduous	3719.96	35.30%	1503.82	1590.52	535.98	75.33
Terrestrial Forest Evergreen	111.81	1.06%	45.20	47.81	16.11	2.26
Terrestrial Forest Mixed	19.62	0.19%	7.93	8.39	2.83	0.40
Terrestrial Shrubland Deciduous	219.87	2.09%	88.88	94.01	31.68	4.45
Terrestrial Woodland Deciduous	72.44	0.69%	29.28	30.97	10.44	1.47
Unclassified Cloud/Shadow	229.91	2.18%	92.94	98.30	33.13	4.66
Water	21.50	0.20%	8.69	9.19	3.10	0.44
TOTAL	10536.94	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	21892.96	32606.38	12580.35	1879.96	68959.65
Developed Agriculture Row Crop	67063.49	99881.32	38536.68	5758.78	211240.27
Developed Non-Vegetated	2420.22	2646.05	911.07	129.40	6106.74
Developed Urban High Density	550.14	601.48	207.10	29.42	1388.13
Developed Urban Low Density	797.77	1125.02	440.44	65.82	2429.05
Palustrine Forest Deciduous	14335.44	33356.36	14306.26	2211.68	64209.74
Palustrine Herbaceous Deciduous	1125.12	2617.97	1122.83	173.58	5039.50
Terrestrial Forest Deciduous	37595.44	87478.83	37518.92	5800.26	168393.46
Terrestrial Forest Evergreen	1129.98	2629.29	1127.68	174.33	5061.27
Terrestrial Forest Mixed	356.98	553.76	217.71	32.98	1161.43
Terrestrial Shrubland Deciduous	2666.55	5452.57	2249.28	347.28	10715.68
Terrestrial Woodland Deciduous	732.08	1703.44	730.59	112.95	3279.06
Unclassified Cloud/Shadow	2323.60	5406.66	2318.87	358.49	10407.61
Water	625.75	753.75	269.49	38.75	1687.74

Total Sum:	560079.32
Total Acres:	10496.55
Composite Number:	53.36
Flow Rate:	7.75

E3 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
5186.29	4988.59	1696.77	287.33	171.4

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M2	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	1310.14	10.63%	551.05	530.05	180.28	30.53
Developed Agriculture Row Crop	3670.73	29.77%	1543.93	1485.08	505.12	85.54
Developed Non-Vegetated	134.41	1.09%	56.53	54.38	18.50	3.13
Developed Urban High Density	20.05	0.16%	8.43	8.11	2.76	0.47
Developed Urban Low Density	42.39	0.34%	17.83	17.15	5.83	0.99
Palustrine Forest Deciduous	1539.36	12.48%	647.46	622.78	211.83	35.87
Palustrine Herbaceous Deciduous	118.03	0.96%	49.65	47.75	16.24	2.75
Terrestrial Forest Deciduous	4767.94	38.67%	2005.42	1928.98	656.10	111.10
Terrestrial Forest Evergreen	111.81	0.91%	47.03	45.24	15.39	2.61
Terrestrial Forest Mixed	19.63	0.16%	8.26	7.94	2.70	0.46
Terrestrial Shrubland Deciduous	244.71	1.98%	102.92	99.00	33.67	5.70
Terrestrial Woodland Deciduous	87.20	0.71%	36.68	35.28	12.00	2.03
Unclassified Cloud/Shadow	229.11	1.86%	96.37	92.69	31.53	5.34
Water	35.01	0.28%	14.73	14.16	4.82	0.82
TOTAL	12330.51	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	27001.60	36573.24	14242.51	2564.47	80381.82
Developed Agriculture Row Crop	75652.56	102470.22	39904.40	7185.07	225212.25
Developed Non-Vegetated	5031.34	5002.68	1738.55	297.54	12070.11
Developed Urban High Density	750.42	746.14	259.30	44.38	1800.24
Developed Urban Low Density	909.35	1166.25	460.85	82.98	2619.43
Palustrine Forest Deciduous	16186.58	34253.00	14827.88	2762.04	68029.50
Palustrine Herbaceous Deciduous	1241.15	2626.45	1136.97	211.79	5216.37
Terrestrial Forest Deciduous	50135.58	106093.74	45927.23	8555.02	210711.58
Terrestrial Forest Evergreen	1175.71	2487.96	1077.02	200.62	4941.30
Terrestrial Forest Mixed	371.61	524.25	208.03	37.97	1141.86
Terrestrial Shrubland Deciduous	3087.75	5742.08	2390.81	444.77	11665.41
Terrestrial Woodland Deciduous	916.93	1940.36	839.97	156.46	3853.72
Unclassified Cloud/Shadow	2409.17	5098.13	2206.95	411.10	10125.34
Water	1060.23	1161.46	419.13	72.61	2713.43

Total Sum:	640482.36
Total Acres:	12159.11
Composite Number:	52.68
Flow Rate:(cfs)	6.63 6.89

W1 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1119.78	5541.2	2013.24	320.18	128.1

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of W1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	1534.4425	16.82%	188.35	932.05	338.63	53.86
Developed Agriculture Row Crop	3520.3564	38.59%	432.12	2138.32	776.90	123.56
Developed Non-Vegetated	159.0765	1.74%	19.53	96.63	35.11	5.58
Developed Urban High Density	49.2400	0.54%	6.04	29.91	10.87	1.73
Developed Urban Low Density	20.5138	0.22%	2.52	12.46	4.53	0.72
Palustrine Forest Deciduous	793.8318	8.70%	97.44	482.19	175.19	27.86
Palustrine Herbaceous Deciduous	99.4471	1.09%	12.21	60.41	21.95	3.49
Palustrine Shrubland Deciduous	13.9458	0.15%	1.71	8.47	3.08	0.49
Terrestrial Forest Deciduous	2535.4325	27.79%	311.22	1540.06	559.54	88.99
Terrestrial Forest Evergreen	28.3698	0.31%	3.48	17.23	6.26	1.00
Terrestrial Forest Mixed	44.4067	0.49%	5.45	26.97	9.80	1.56
Terrestrial Shrubland Deciduous	182.1681	2.00%	22.36	110.65	40.20	6.39
Terrestrial Woodland Deciduous	115.6529	1.27%	14.20	70.25	25.52	4.06
Unclassified Cloud/Shadow	5.4352	0.06%	0.67	3.30	1.20	0.19
Water	20.2571	0.22%	2.49	12.30	4.47	0.71
TOTAL	9122.5762	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	9229.15	64311.11	26751.97	4523.83	104816.07
Developed Agriculture Row Crop	21173.76	147544.17	61375.04	10378.69	240471.66
Developed Non-Vegetated	1737.85	8889.56	3299.98	530.40	14457.79
Developed Urban High Density	537.93	2751.64	1021.47	164.18	4475.22
Developed Urban Low Density	128.42	847.31	357.64	60.48	1393.85
Palustrine Forest Deciduous	2436.04	26520.24	12263.22	2145.34	43364.84
Palustrine Herbaceous Deciduous	305.17	3322.32	1536.27	268.76	5432.52
Palustrine Shrubland Deciduous	51.35	491.31	218.51	38.18	799.36
Terrestrial Forest Deciduous	7780.50	84703.44	39167.71	6852.03	138503.68
Terrestrial Forest Evergreen	87.06	947.78	438.26	76.67	1549.76
Terrestrial Forest Mixed	245.29	1780.24	754.60	129.36	2909.49
Terrestrial Shrubland Deciduous	670.82	6417.81	2854.36	498.70	10441.70
Terrestrial Woodland Deciduous	354.90	3863.72	1786.62	312.55	6317.80
Unclassified Cloud/Shadow	16.68	181.58	83.96	14.69	296.91
Water	179.03	1008.97	388.93	63.28	1640.21

Total Sum:	576870.85
Total Acres:	8994.48
Composite Number:	64.14
Flow Rate (cfs)	57.49

72.44

W2 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1275.1	939	227.15	54.65	4.51

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of W2	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	317.39	12.69%	161.85	119.19	28.83	6.94
Developed Agriculture Row Crop	311.30	12.45%	158.75	116.90	28.28	6.80
Developed Urban Low Density	18.26	0.73%	9.31	6.86	1.66	0.40
Palustrine Forest Deciduous	128.00	5.12%	65.27	48.07	11.63	2.80
Palustrine Herbaceous Deciduous	9.49	0.38%	4.84	3.56	0.86	0.21
Terrestrial Forest Deciduous	1618.08	64.71%	825.14	607.65	146.99	35.37
Terrestrial Forest Evergreen	22.80	0.91%	11.63	8.56	2.07	0.50
Terrestrial Forest Mixed	2.26	0.09%	1.15	0.85	0.20	0.05
Terrestrial Shrubland Deciduous	42.82	1.71%	21.83	16.08	3.89	0.94
Terrestrial Woodland Deciduous	30.05	1.20%	15.32	11.28	2.73	0.66
TOTAL	2500.43	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	7930.77	8224.12	2277.80	582.70	19015.38
Developed Agriculture Row Crop	7778.54	8066.26	2234.07	571.51	18650.39
Developed Urban Low Density	474.99	466.39	131.07	33.53	1105.99
Palustrine Forest Deciduous	1631.81	2643.70	813.95	215.41	5304.87
Palustrine Herbaceous Deciduous	120.93	195.92	60.32	15.96	393.13
Terrestrial Forest Deciduous	20628.61	33420.57	10289.55	2723.12	67061.85
Terrestrial Forest Evergreen	290.70	470.97	145.00	38.37	945.05
Terrestrial Forest Mixed	51.75	55.90	15.78	4.09	127.51
Terrestrial Shrubland Deciduous	655.04	932.60	276.17	72.99	1936.80
Terrestrial Woodland Deciduous	383.04	620.57	191.06	50.56	1245.24

Total Sum:	115786.22
Total Acres:	2495.92
Composite Number:	46.39
Flow Rate (cfs)	0.25

W3 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
680.6	475.51	40.2	27.15	0.22

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of W3	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	139.74	11.42%	77.72	54.30	4.59	3.10
Developed Agriculture Row Crop	267.38	21.85%	148.71	103.90	8.78	5.93
Developed Urban Low Density	2.12	0.17%	1.18	0.82	0.07	0.05
Palustrine Forest Deciduous	16.40	1.34%	9.12	6.37	0.54	0.36
Terrestrial Forest Deciduous	724.04	59.17%	402.70	281.35	23.79	16.06
Terrestrial Forest Evergreen	19.97	1.63%	11.10	7.76	0.66	0.44
Terrestrial Forest Mixed	3.28	0.27%	1.82	1.27	0.11	0.07
Terrestrial Shrubland Deciduous	45.15	3.69%	25.11	17.54	1.48	1.00
Terrestrial Woodland Deciduous	5.62	0.46%	3.12	2.18	0.18	0.12
TOTAL	1223.69	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	3808.45	3746.87	362.67	260.44	8178.43
Developed Agriculture Row Crop	7286.99	7169.17	693.93	498.32	15648.41
Developed Urban Low Density	60.10	55.99	5.50	3.95	125.54
Palustrine Forest Deciduous	228.01	350.46	37.71	28.01	644.19
Terrestrial Forest Deciduous	10067.54	15474.40	1665.00	1236.95	28443.89
Terrestrial Forest Evergreen	277.61	426.70	45.91	34.11	784.33
Terrestrial Forest Mixed	82.06	84.09	8.29	6.04	180.48
Terrestrial Shrubland Deciduous	753.32	1017.54	105.30	78.13	1954.29
Terrestrial Woodland Deciduous	78.10	120.04	12.92	9.60	220.64

Total Sum:	56180.19
Total Acres:	1223.47
Composite Number:	45.92
Flow Rate:	0.19

M1 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
10238.88	12941.01	4933.59	799.9	470.6

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M1	A	B	C	D
Developed Agriculture Pasture/Grassland	4081.96	13.89%	1422.35	1797.72	685.36	111.12
Developed Agriculture Row Crop	8595.25	29.25%	2994.99	3785.40	1443.13	233.98
Developed Non-Vegetated	363.84	1.24%	126.78	160.24	61.09	9.90
Developed Urban High Density	159.47	0.54%	55.57	70.23	26.78	4.34
Developed Urban Low Density	219.97	0.75%	76.65	96.88	36.93	5.99
Palustrine Forest Deciduous	2688.79	9.15%	936.90	1184.16	451.45	73.19
Palustrine Herbaceous Deciduous	268.88	0.92%	93.69	118.42	45.14	7.32
Palustrine Shrubland Deciduous	20.37	0.07%	7.10	8.97	3.42	0.55
Terrestrial Forest Deciduous	11509.67	39.17%	4010.52	5068.93	1932.46	313.32
Terrestrial Forest Evergreen	208.63	0.71%	72.70	91.88	35.03	5.68
Terrestrial Forest Mixed	79.56	0.27%	27.72	35.04	13.36	2.17
Terrestrial Shrubland Deciduous	586.65	2.00%	204.42	258.36	98.50	15.97
Terrestrial Woodland Deciduous	276.25	0.94%	96.26	121.66	46.38	7.52
Unclassified Cloud/Shadow	235.93	0.80%	82.21	103.90	39.61	6.42
Water	89.05	0.30%	31.03	39.22	14.95	2.42
TOTAL	29384.26	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A	B	C	D	Sums
Developed Agriculture Pasture/Grassland	69695.10	124042.64	54143.19	9334.02	257214.95
Developed Agriculture Row Crop	146754.73	261192.58	114007.58	19654.34	541609.24
Developed Non-Vegetated	11283.33	14741.80	5742.30	940.92	32708.35
Developed Urban High Density	4945.58	6461.46	2516.90	412.41	14336.36
Developed Urban Low Density	3909.11	6587.67	2917.73	503.00	13917.51
Palustrine Forest Deciduous	23422.62	65128.91	31601.23	5635.98	125788.73
Palustrine Herbaceous Deciduous	2342.26	6512.90	3160.13	563.60	12578.89
Palustrine Shrubland Deciduous	212.89	520.21	242.77	43.24	1019.11
Terrestrial Forest Deciduous	100262.99	278791.20	135272.43	24125.41	538452.04
Terrestrial Forest Evergreen	1817.39	5053.43	2451.98	437.30	9760.10
Terrestrial Forest Mixed	1247.51	2312.56	1028.57	179.76	4768.40
Terrestrial Shrubland Deciduous	6132.50	14985.12	6993.35	1245.65	29356.62
Terrestrial Woodland Deciduous	2406.47	6691.43	3246.75	579.05	12923.70
Unclassified Cloud/Shadow	2055.19	5714.66	2772.81	494.52	11037.19
Water	2233.99	3215.71	1300.70	215.74	6966.14

Total Sum:	1612437.32
Total Acres:	28913.66
Composite Number:	55.77
Flow Rate: CC	45.86

M2 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
11353.19	14478.22	6413.83	886.84	1984.22

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M2	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	4822.53	13.73%	1559.12	1988.28	880.80	121.79
Developed Agriculture Row Crop	9394.17	26.75%	3037.13	3873.12	1715.79	237.24
Developed Non-Vegetated	506.55	1.44%	163.77	208.85	92.52	12.79
Developed Urban High Density	624.79	1.78%	202.00	257.60	114.11	15.78
Developed Urban Low Density	1124.09	3.20%	363.42	463.45	205.31	28.39
Palustrine Forest Deciduous	3224.77	9.18%	1042.57	1329.54	588.98	81.44
Palustrine Herbaceous Deciduous	285.17	0.81%	92.20	117.57	52.09	7.20
Palustrine Shrubland Deciduous	20.37	0.06%	6.58	8.40	3.72	0.51
Terrestrial Forest Deciduous	13400.42	38.16%	4332.35	5524.86	2447.50	338.42
Terrestrial Forest Evergreen	208.69	0.59%	67.47	86.04	38.12	5.27
Terrestrial Forest Mixed	82.43	0.23%	26.65	33.99	15.06	2.08
Terrestrial Shrubland Deciduous	679.84	1.94%	219.79	280.29	124.17	17.17
Terrestrial Woodland Deciduous	394.36	1.12%	127.50	162.59	72.03	9.96
Unclassified Cloud/Shadow	234.88	0.67%	75.94	96.84	42.90	5.93
Water	113.57	0.32%	36.72	46.82	20.74	2.87
Total	35116.63	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	76396.95	137191.21	69583.55	10230.26	293401.97
Developed Agriculture Row Crop	148819.37	267245.09	135547.03	19928.29	571539.78
Developed Non-Vegetated	14575.28	19213.74	8696.70	1215.28	43701.00
Developed Urban High Density	17977.63	23698.86	10726.79	1498.97	53902.25
Developed Urban Low Density	18534.27	31514.58	16219.30	2384.58	68652.73
Palustrine Forest Deciduous	26064.13	73124.55	41228.81	6270.78	146688.28
Palustrine Herbaceous Deciduous	2304.91	6466.57	3645.96	554.54	12971.98
Palustrine Shrubland Deciduous	197.52	487.00	264.09	40.12	988.73
Terrestrial Forest Deciduous	108308.77	303867.03	171325.18	26058.04	609559.02
Terrestrial Forest Evergreen	1686.77	4732.33	2668.17	405.82	9493.09
Terrestrial Forest Mixed	1199.24	2243.04	1159.27	172.78	4774.34
Terrestrial Shrubland Deciduous	6593.75	16256.85	8815.95	1339.16	33005.71
Terrestrial Woodland Deciduous	3187.38	8942.41	5041.87	766.85	17938.52
Unclassified Cloud/Shadow	1898.45	5326.22	3003.01	456.75	10684.43
Water	2643.56	3839.44	1804.58	255.25	8542.83

Total Sum:	1885844.65
Total Acres:	33132.41
Composite Number:	56.92
Flow Rate:	72.29

M3 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
12100.21	14932.42	6472.92	913.2	2201.92

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M3	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	4969.68	13.57%	1642.07	2026.41	878.41	123.93
Developed Agriculture Row Crop	9639.38	26.32%	3185.02	3930.51	1703.80	240.37
Developed Non-Vegetated	525.28	1.43%	173.56	214.18	92.84	13.10
Developed Urban High Density	694.79	1.90%	229.57	283.31	122.81	17.33
Developed Urban Low Density	1196.95	3.27%	395.49	488.06	211.57	29.85
Palustrine Forest Deciduous	3450.93	9.42%	1140.25	1407.13	609.97	86.05
Palustrine Herbaceous Deciduous	286.00	0.78%	94.50	116.62	50.55	7.13
Palustrine Shrubland Deciduous	20.37	0.06%	6.73	8.30	3.60	0.51
Terrestrial Forest Deciduous	14113.54	38.54%	4663.35	5754.87	2494.63	351.94
Terrestrial Forest Evergreen	208.65	0.57%	68.94	85.08	36.88	5.20
Terrestrial Forest Mixed	82.50	0.23%	27.26	33.64	14.58	2.06
Terrestrial Shrubland Deciduous	684.18	1.87%	226.07	278.98	120.93	17.06
Terrestrial Woodland Deciduous	400.21	1.09%	132.24	163.19	70.74	9.98
Unclassified Cloud/Shadow	235.41	0.64%	77.78	95.99	41.61	5.87
Water	113.15	0.31%	37.39	46.14	20.00	2.82
Total	36621.02	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	80461.31	139822.60	69394.56	10409.82	300088.29
Developed Agriculture Row Crop	156065.79	271205.21	134600.31	20191.28	582062.59
Developed Non-Vegetated	15446.84	19704.92	8727.40	1244.36	45123.52
Developed Urban High Density	20431.83	26064.08	11543.90	1645.94	59685.74
Developed Urban Low Density	20170.21	33188.40	16713.78	2507.22	72579.60
Palustrine Forest Deciduous	28506.13	77392.37	42697.61	6626.16	155222.27
Palustrine Herbaceous Deciduous	2362.46	6413.93	3538.58	549.15	12864.12
Palustrine Shrubland Deciduous	201.87	481.64	255.58	39.61	978.70
Terrestrial Forest Deciduous	116583.84	316517.93	174623.91	27099.55	634825.23
Terrestrial Forest Evergreen	1723.55	4679.33	2581.60	400.63	9385.12
Terrestrial Forest Mixed	1226.68	2220.24	1122.84	170.75	4740.52
Terrestrial Shrubland Deciduous	6781.95	16180.75	8586.16	1330.76	32879.63
Terrestrial Woodland Deciduous	3305.94	8975.41	4951.76	768.45	18001.56
Unclassified Cloud/Shadow	1944.58	5279.41	2912.67	452.01	10588.67
Water	2691.92	3783.39	1740.03	251.13	8466.46

Total Sum:	1947492.03
Total Acres:	34419.10
Composite Number:	56.58
Flow Rate:	70.02

70.75

M4 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
12162.98	14943.69	6478.04	913.29	2288.01

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M4	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	4970.84	13.51%	1643.55	2019.30	875.36	123.41
Developed Agriculture Row Crop	9647.95	26.23%	3189.98	3919.28	1698.99	239.53
Developed Non-Vegetated	529.56	1.44%	175.09	215.12	93.26	13.15
Developed Urban High Density	728.02	1.98%	240.71	295.74	128.20	18.07
Developed Urban Low Density	1214.00	3.30%	401.40	493.16	213.78	30.14
Palustrine Forest Deciduous	3470.65	9.43%	1147.53	1409.88	611.18	86.17
Palustrine Herbaceous Deciduous	286.00	0.78%	94.56	116.18	50.36	7.10
Palustrine Shrubland Deciduous	20.37	0.06%	6.73	8.27	3.59	0.51
Palustrine Woodland Deciduous	1.53	0.00%	0.51	0.62	0.27	0.04
Terrestrial Forest Deciduous	14185.82	38.56%	4690.38	5762.69	2498.11	352.19
Terrestrial Forest Evergreen	208.66	0.57%	68.99	84.76	36.74	5.18
Terrestrial Forest Mixed	82.43	0.22%	27.25	33.49	14.52	2.05
Terrestrial Shrubland Deciduous	684.40	1.86%	226.29	278.02	120.52	16.99
Terrestrial Woodland Deciduous	400.23	1.09%	132.33	162.59	70.48	9.94
Unclassified Cloud/Shadow	236.21	0.64%	78.10	95.96	41.60	5.86
Water	119.67	0.33%	39.57	48.61	21.07	2.97
TOTAL	36786.35	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Palustrine Woodland Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	80534.03	139331.81	69153.48	10366.48	299385.80
Developed Agriculture Row Crop	156309.18	270430.31	134220.59	20120.39	581080.47
Developed Non-Vegetated	15583.40	19791.46	8766.04	1249.01	45389.90
Developed Urban High Density	21423.45	27208.53	12051.22	1717.08	62400.29
Developed Urban Low Density	20471.18	33535.09	16888.98	2531.75	73427.00
Palustrine Forest Deciduous	28688.24	77543.32	42782.43	6634.73	155648.72
Palustrine Herbaceous Deciduous	2364.06	6389.96	3525.49	546.74	12826.25
Palustrine Shrubland Deciduous	202.01	479.84	254.63	39.44	975.91
Palustrine Woodland Deciduous	12.64	34.15	18.84	2.92	68.55
Terrestrial Forest Deciduous	117259.40	316948.13	174867.59	27118.59	636193.71
Terrestrial Forest Evergreen	1724.74	4661.93	2572.09	398.88	9357.64
Terrestrial Forest Mixed	1226.47	2210.07	1117.74	169.86	4724.14
Terrestrial Shrubland Deciduous	6788.68	16125.39	8557.09	1325.34	32796.51
Terrestrial Woodland Deciduous	3308.31	8942.25	4933.64	765.11	17949.32
Unclassified Cloud/Shadow	1952.53	5277.62	2911.79	451.56	10593.50
Water	2848.88	3986.33	1833.43	264.42	8933.06

Total Sum:	1951750.77
Total Acres:	34498.34
Composite Number:	56.58
Flow Rate:	69.55

70.34

M5 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
12179.95	14977.19	6478.17	913	2526.04

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M5	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	4975.51	13.42%	1634.58	2009.97	869.38	122.53
Developed Agriculture Row Crop	9652.57	26.04%	3171.11	3899.38	1686.62	237.70
Developed Non-Vegetated	532.53	1.44%	174.95	215.13	93.05	13.11
Developed Urban High Density	822.61	2.22%	270.25	332.31	143.74	20.26
Developed Urban Low Density	1328.33	3.58%	436.39	536.61	232.10	32.71
Palustrine Forest Deciduous	3471.01	9.36%	1140.31	1402.20	606.50	85.48
Palustrine Herbaceous Deciduous	285.57	0.77%	93.82	115.36	49.90	7.03
Palustrine Shrubland Deciduous	20.37	0.05%	6.69	8.23	3.56	0.50
Palustrine Woodland Deciduous	3.15	0.01%	1.03	1.27	0.55	0.08
Terrestrial Forest Deciduous	14227.88	38.38%	4674.21	5747.69	2486.08	350.38
Terrestrial Forest Evergreen	208.59	0.56%	68.53	84.27	36.45	5.14
Terrestrial Forest Mixed	82.45	0.22%	27.09	33.31	14.41	2.03
Terrestrial Shrubland Deciduous	684.42	1.85%	224.85	276.49	119.59	16.85
Terrestrial Woodland Deciduous	402.71	1.09%	132.30	162.69	70.37	9.92
Unclassified Cloud/Shadow	235.17	0.63%	77.26	95.00	41.09	5.79
Water	141.82	0.38%	46.59	57.29	24.78	3.49
TOTAL	37074.69	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Palustrine Woodland Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	80094.24	138688.08	68681.40	10292.24	297755.96
Developed Agriculture Row Crop	155384.24	269057.31	133243.12	19967.12	577651.79
Developed Non-Vegetated	15570.39	19791.66	8746.70	1245.83	45354.58
Developed Urban High Density	24052.01	30572.71	13511.27	1924.47	70060.45
Developed Urban Low Density	22255.81	36489.42	18336.11	2747.75	79829.10
Palustrine Forest Deciduous	28507.83	77120.83	42455.02	6581.73	154665.42
Palustrine Herbaceous Deciduous	2345.43	6344.99	3492.92	541.50	12724.84
Palustrine Shrubland Deciduous	200.72	477.17	252.66	39.12	969.66
Palustrine Woodland Deciduous	25.86	69.97	38.52	5.97	140.33
Terrestrial Forest Deciduous	116855.25	316122.73	174025.58	26978.90	633982.45
Terrestrial Forest Evergreen	1713.19	4634.60	2551.35	395.53	9294.67
Terrestrial Forest Mixed	1218.98	2198.43	1109.38	168.53	4695.32
Terrestrial Shrubland Deciduous	6745.45	16036.24	8490.92	1314.65	32587.27
Terrestrial Woodland Deciduous	3307.53	8947.70	4925.71	763.62	17944.57
Unclassified Cloud/Shadow	1931.52	5225.24	2876.49	445.94	10479.19
Water	3354.54	4697.86	2155.89	310.83	10519.12

Total Sum:	1958654.72
Total Acres:	34548.65
Composite Number:	56.69
Flow Rate:	72.54

49

M6 Curve Number Calculations
Calculations performed June 29-30, 2006
Calculations checked/edited July 7, 2006

Acres of Each Soil Type in Watershed

A	B	C	D	Null
12188.18	15012.27	6476.8	912.86	3308.4

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M6	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	4974.53	13.13%	1599.82	1970.51	850.15	119.82
Developed Agriculture Row Crop	9657.30	25.48%	3105.81	3825.45	1650.43	232.62
Developed Non-Vegetated	533.94	1.41%	171.72	211.50	91.25	12.86
Developed Urban High Density	1360.45	3.59%	437.52	538.90	232.50	32.77
Developed Urban Low Density	1567.46	4.14%	504.10	620.90	267.88	37.76
Palustrine Forest Deciduous	3470.64	9.16%	1116.17	1374.79	593.13	83.60
Palustrine Herbaceous Deciduous	285.72	0.75%	91.89	113.18	48.83	6.88
Palustrine Shrubland Deciduous	20.37	0.05%	6.55	8.07	3.48	0.49
Palustrine Woodland Deciduous	3.15	0.01%	1.01	1.25	0.54	0.08
Terrestrial Forest Deciduous	14251.35	37.60%	4583.27	5645.25	2435.55	343.27
Terrestrial Forest Evergreen	208.63	0.55%	67.10	82.64	35.65	5.03
Terrestrial Forest Mixed	82.46	0.22%	26.52	32.66	14.09	1.99
Terrestrial Shrubland Deciduous	684.48	1.81%	220.13	271.14	116.98	16.49
Terrestrial Woodland Deciduous	402.57	1.06%	129.47	159.47	68.80	9.70
Unclassified Cloud/Shadow	234.54	0.62%	75.43	92.91	40.08	5.65
Water	160.68	0.42%	51.68	63.65	27.46	3.87
TOTAL	37898.27	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Palustrine Woodland Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A	B	C	D	Sums
Developed Agriculture Pasture/Grassland	78391.30	135965.39	67161.52	10065.06	291583.27
Developed Agriculture Row Crop	152184.86	263956.26	130383.94	19539.79	566064.85
Developed Non-Vegetated	15282.74	19458.37	8577.50	1221.80	44540.41
Developed Urban High Density	38939.71	49579.03	21855.07	3113.09	113486.90
Developed Urban Low Density	25709.01	42221.29	21162.35	3171 46	92264.11
Palustrine Forest Deciduous	27904.16	75613.47	41519.17	6437 02	151473.82
Palustrine Herbaceous Deciduous	2297.20	6224.85	3418.05	529.93	12470.03
Palustrine Shrubland Deciduous	196.49	467.90	247.11	38.26	949.76
Palustrine Woodland Deciduous	25.32	68.61	37.67	5.84	137.44
Terrestrial Forest Deciduous	114581.74	310488.57	170488.50	26432.09	621990.90
Terrestrial Forest Evergreen	1677.38	4545.29	2495.81	386 94	9105.41
Terrestrial Forest Mixed	1193.38	2155.85	1085.13	164.86	4599.22
Terrestrial Shrubland Deciduous	6603.96	15726.02	8305.45	1286.01	31921.44
Terrestrial Woodland Deciduous	3236.67	8770.58	4815.90	746.64	17569.80
Unclassified Cloud/Shadow	1885.71	5109.82	2805.79	435.00	10236 32
Water	3720.70	5219.31	2389.09	344 47	11673.56

Total Sum:	1980067.24
Total Acres:	34589.87
Composite Number:	57.24
Flow Rate:	83.83

Soil Type Acreages for Watershed E1
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	169.91	A	2742.45
BtA	843.63	A	
ChB	384.29	A	
ChC	348.21	A	
ChD	242.61	A	
Ho	78.61	A	
Mm	180.28	A	
Nf	219.49	A	
OaC	166.55	A	
OaE	7.46	A	
Pa	25.21	A	
TyA	76.20	A	
Br	78.85	B	3619 90
Ck	0 98	B	
Ed	10.65	B	
Fh	187.11	B	
Gf	155.08	B	
HaA	17.68	B	
Hk	300.82	B	
Md	183.20	B	
Mp	69.72	B	
Mx	1297.90	B	
Qu	105.83	B	
RIA	7.93	B	
RIB2	226.54	B	
RIC2	129.91	B	
RID2	63.63	B	
Sb	124.57	B	
SeA	252.62	B	
SeB	60.22	B	
So	5.50	B	
TcA	10.90	B	
TcB	126.77	B	
TcC2	95.09	B	
TcD2	105.93	B	
Wa	2.48	B	
BaA	841.62	C	1309.01
MrB2	71.25	C	
MrC2	1.88	C	
MrD2	9.90	C	
Pe	229.51	C	
Sa	98.44	C	
We	7.58	C	
Wh	48.82	C	
Cd	47.28	D	182.28
Hh	55.03	D	
Hm	79.98	D	
Ua	23 73	Null	34.04
W	10.31	Null	
	7887.68		7887.68

Soil Type Acreages for Watershed E2
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	213.65	A	4259 63
BtA	1129.44	A	
ChB	815.67	A	
ChC	672.68	A	
ChD	271.73	A	
Ho	78 93	A	
Mm	197.78	A	
Nf	241.30	A	
OaC	196.08	A	
OaE	7.46	A	
Pa	25.12	A	
TyA	409.80	A	
Br	81.87	B	4505 23
Ck	4.24	B	
Ed	10.65	B	
Fh	296.34	B	
Gf	162.12	B	
HaA	27.91	B	
Hk	303.15	B	
Md	182.50	B	
Mp	69.72	B	
Mx	1464.86	B	
Ph	4.21	B	
Qu	105.73	B	
RlA	7 93	B	
RlB2	270.71	B	
RlC2	147.30	B	
RlD2	68.94	B	
Sb	124.57	B	
SeA	456.04	B	
SeB	140.86	B	
So	5.50	B	
TcA	60.25	B	
TcB	172.94	B	
TcC2	226.61	B	
TcD2	105.93	B	
Wa	4.34	B	
BaA	982.55	C	1518.20
MrB2	97.65	C	
MrC2	27.75	C	
MrD2	23.34	C	
Pe	232.40	C	
Sa	98.62	C	
We	7.58	C	
Wh	48.30	C	
Cd	50.38	D	213 37
Hh	67.96	D	
Hm	95.04	D	
Ua	30.03	Null	40 39
W	10.36	Null	
	10536.82		10536 82

Soil Type Acreages for Watershed E3
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	229.82	A	5186.29
BtA	1370.49	A	
ChB	1039.41	A	
ChC	810.64	A	
ChD	297.21	A	
Ho	78.80	A	
Mm	215.45	A	
Nf	244.41	A	
OaC	375.30	A	
OaE	7.46	A	
Pa	25.18	A	
TyA	492.13	A	
Br	92.91	B	4988.59
Ck	4.24	B	
Ed	10.65	B	
Fh	395.97	B	
Gf	171.17	B	
HaA	27.68	B	
Hk	302.77	B	
Md	182.97	B	
Mp	69.72	B	
Mx	1504.37	B	
Ph	4.21	B	
Qu	105.79	B	
RIA	9.51	B	
RIB2	273.46	B	
RIC2	147.31	B	
RID2	69.26	B	
Sb	124.57	B	
SeA	586.99	B	
SeB	260.67	B	
So	14.99	B	
TcA	60.25	B	
TcB	186.22	B	
TcC2	272.63	B	
TcD2	105.94	B	
Wa	4.35	B	
BaA	1097.05	C	1696.77
MrB2	120.27	C	
MrC2	34.45	C	
MrD2	29.57	C	
Pe	241.04	C	
Sa	98.50	C	
We	14.04	C	
Wh	61.85	C	
Cd	60.95	D	287.33
Hh	68.05	D	
Hm	158.33	D	
Ua	142.30	Null	171.40
W	29.09	Null	
	12330.38		12330.38

Soil Type Acreages for Watershed W1
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	255.62	A	1119.78
BtA	48.89	A	
ChB	422.84	A	
ChC	285.50	A	
ChD	48.91	A	
Mm	50.18	A	
TyA	7.83	A	
Br	816.53	B	5541.20
Ed	63.04	B	
Fh	163.51	B	
Gf	367.31	B	
HaA	176.33	B	
Hk	476.72	B	
Md	76.27	B	
Mx	75.74	B	
Ph	66.25	B	
RIA	7.46	B	
RIB2	294.03	B	
RIC2	255.20	B	
RID2	255.88	B	
RIF	11.16	B	
Sb	260.81	B	
SeA	3.20	B	
SeB	111.00	B	
So	0.96	B	
TcA	137.01	B	
TcB	808.31	B	
TcC2	671.32	B	
TcD2	395.21	B	
TcF	16.02	B	
Wa	31.92	B	
BaA	1569.25	C	2013.24
MrB2	46.03	C	
MrC2	14.02	C	
MrD2	11.33	C	
Pe	262.73	C	
We	8.02	C	
Wh	101.86	C	
Hh	240.25	D	320.18
Hm	79.93	D	
Ua	99.19	Null	128.10
W	28.91	Null	
	9122.50		9122.50

Soil Type Acreages for Watershed W2
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	54.72	A	1275 10
BtA	72.54	A	
ChB	546.58	A	
ChC	361.13	A	
ChD	134.33	A	
Mm	3.94	A	
TyA	101.86	A	
Br	18.62	B	939.00
Ck	54.97	B	
Fh	44.45	B	
Gf	33.65	B	
HaA	8.03	B	
Hk	6.40	B	
Mx	25.45	B	
RIA	0.02	B	
RIB2	98.88	B	
RIC2	101.37	B	
RID2	36.52	B	
RIF	84.02	B	
SeA	4.99	B	
SeB	35.05	B	
TcA	3.53	B	
TcB	142.79	B	
TcC2	129.07	B	
TcD2	70.60	B	
TcF	15.89	B	
Wa	24.71	B	
BaA	26.61	C	227 15
MrB2	123.18	C	
MrC2	41.67	C	
Pe	16.12	C	
Wh	19.57	C	
Hh	4.77	D	54.65
Hm	49.88	D	
Ua	4.51	Null	4.51
	2500.41		2500.41

Soil Type Acreages for Watershed W3
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
BtA	23.06	A	680 60
ChB	254.12	A	
ChC	266.81	A	
ChD	64.54	A	
Mm	7.14	A	
TyA	64.93	A	
Br	42.92	B	475 51
Ck	30.76	B	
Fh	26.73	B	
Gf	11.91	B	
HaA	13.09	B	
Hk	12.68	B	
Mx	7.06	B	
RlB2	87.49	B	
RlC2	73.86	B	
RlD2	15.20	B	
SeA	2.14	B	
SeB	19.33	B	
TcB	58.37	B	
TcC2	41.86	B	
TcD2	26.35	B	
Tr	5.73	B	
BaA	13.26	C	40.20
MrB2	9.64	C	
MrC2	14.49	C	
Pe	1.73	C	
Wh	1.07	C	
Hh	1.10	D	27 15
Hm	26.05	D	
Ua	0.22	Null	0.22
	1223.67		1223.67

Soil Type Acreages for Watershed M1
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	588.17	A	10238.88
BtA	2210.12	A	
ChB	2676.02	A	
ChC	1842.73	A	
ChD	561.95	A	
Ho	82.66	A	
Mm	277.39	A	
Nf	271.21	A	
OaC	784.47	A	
OaE	7.46	A	
Pa	25.17	A	
TyA	911.54	A	
Br	1162.11	B	12941.01
Ck	130.83	B	
Ed	73.69	B	
Fh	802.45	B	
Gf	627.14	B	
HaA	247.61	B	
Hk	799.03	B	
Md	259.90	B	
Mp	69.72	B	
Mx	1919.11	B	
Ph	70.47	B	
Qu	105.65	B	
RIA	16.97	B	
RIB2	754.33	B	
RIC2	579.50	B	
RID2	377.88	B	
RIF	94.75	B	
Sb	397.18	B	
SeA	674.97	B	
SeB	486.10	B	
So	42.49	B	
TcA	200.84	B	
TcB	1226.30	B	
TcC2	1124.66	B	
TcD2	598.67	B	
TcF	32.07	B	
Tr	5.73	B	
Wa	60.89	B	
BaA	3567.19	C	4933.59
MrB2	322.06	C	
MrC2	104.85	C	
MrD2	40.90	C	
Pe	582.00	C	
Sa	98.65	C	
We	22.06	C	
Wh	195.87	C	
Cd	63.27	D	799.90
Hh	361.48	D	
Hm	375.14	D	

Map Symbol	Total Acres	Type	Acres
Ua	348.09	Null	470.60
UoC	8.32	Null	
W	114.19	Null	
	29383.97		29383.97

Soil Type Acreages for Watershed M2
June 23 & 29. 2006

Map Symbol	Total Acres	Type	Acres
Ad	587.76	A	11353.19
BtA	2755.89	A	
ChB	2675.03	A	
ChC	1842 19	A	
ChD	561.52	A	
Ho	82.98	A	
Mm	277 39	A	
Nf	441.69	A	
OaC	1177.68	A	
OaE	7 46	A	
Pa	25.13	A	
TyA	918.47	A	
Br	1243.97	B	14478.22
Ck	130.83	B	
Ed	73.69	B	
Fh	1119.18	B	
Gf	649.94	B	
HaA	258.50	B	
Hk	807 12	B	
Md	260.15	B	
Mp	69.72	B	
Mx	2260.94	B	
Ph	70.47	B	
Qu	105.64	B	
RIA	16.81	B	
RIB2	756.46	B	
RiC2	580.82	B	
RID2	377.39	B	
RIF	94.59	B	
Sb	408.74	B	
SeA	1218.74	B	
SeB	606.98	B	
So	114.20	B	
TcA	201.12	B	
TcB	1227.30	B	
TcC2	1125.12	B	
TcD2	599.11	B	
TcF	32.10	B	
Tr	5.73	B	
Wa	62.90	B	
BaA	4556.64	C	6413.83
MrB2	355.39	C	
MrC2	109.24	C	
MrD2	40.90	C	
Pe	678.03	C	
Sa	455.12	C	
We	22.06	C	
Wh	196.45	C	
Cd	129.55	D	886.84
Hh	367.26	D	
Hm	390.03	D	

Map Symbol	Total Acres	Type	Acres
Ua	512.85	Null	1984.22
UoC	700.08	Null	
Uv	623.06	Null	
W	148.23	Null	
	35116 30		35116.30

Soil Type Acreages for Watershed M3
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	598.10	A	12100.21
BtA	2923.19	A	
ChB	2674.40	A	
ChC	1841.56	A	
ChD	561.48	A	
Ho	82.54	A	
Mm	374.33	A	
Nf	513.44	A	
OaC	1580.07	A	
OaE	7.46	A	
Pa	25.18	A	
TyA	918.47	A	
Br	1244.00	B	14932.42
Ck	130.83	B	
Ed	73.69	B	
Fh	1208.19	B	
Gf	649.90	B	
HaA	258.49	B	
Hk	808.21	B	
Md	259.50	B	
Mp	69.72	B	
Mx	2414.49	B	
Ph	70.47	B	
Qu	105.94	B	
RIA	16.87	B	
RIB2	755.87	B	
RIC2	580.15	B	
RID2	381.77	B	
RIF	94.58	B	
Sb	408.54	B	
SeA	1371.15	B	
SeB	663.34	B	
So	117.11	B	
TcA	200.70	B	
TcB	1226.14	B	
TcC2	1123.24	B	
TcD2	598.29	B	
TcF	32.09	B	
Tr	5.73	B	
Wa	63.42	B	
BaA	4558.01	C	6472.92
MrB2	365.36	C	
MrC2	109.46	C	
MrD2	40.90	C	
Pe	680.83	C	
Sa	462.14	C	
We	60.68	C	
Wh	195.54	C	
Cd	154.83	D	913.21
Hh	367.16	D	
Hm	391.22	D	

Map Symbol	Total Acres	Type	Acres
Du	23.64	Null	2201.92
Ua	523.48	Null	
UoC	821.00	Null	
Uv	669.97	Null	
W	163.83	Null	
	36620.68		36620.68

Soil Type Acreages for Watershed M4
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	597.99	A	12162.98
BtA	2922.85	A	
ChB	2674.84	A	
ChC	1841.64	A	
ChD	561.49	A	
Ho	82.64	A	
Mm	374.22	A	
Nf	512.89	A	
OaC	1643.28	A	
OaE	7.46	A	
Pa	25.22	A	
TyA	918.47	A	
Br	1243.98	B	14943.69
Ck	130.83	B	
Ed	73.69	B	
Fh	1219.91	B	
Gf	649.99	B	
HaA	258.35	B	
Hk	808.22	B	
Md	260.48	B	
Mp	69.72	B	
Mx	2412.75	B	
Ph	70.47	B	
Qu	105.75	B	
RIA	16.90	B	
RIB2	754.77	B	
RIC2	581.02	B	
RID2	381.44	B	
RIF	94.89	B	
Sb	408.32	B	
SeA	1371.93	B	
SeB	663.35	B	
So	117.11	B	
TcA	200.59	B	
TcB	1225.99	B	
TcC2	1124.07	B	
TcD2	597.98	B	
TcF	32.06	B	
Tr	5.73	B	
Wa	63.41	B	
BaA	4558.85	C	6478.04
MrB2	364.29	C	
MrC2	109.38	C	
MrD2	40.90	C	
Pe	680.68	C	
Sa	462.05	C	
We	65.75	C	
Wh	196.14	C	
Cd	154.87	D	913.29
Hh	367.55	D	
Hm	390.87	D	

Map Symbol	Total Acres	Type	Acres
Du	35.54	Null	2288.01
Ua	549.31	Null	
UoC	864.34	Null	
Uv	670.42	Null	
W	168.39	Null	
	36786.00		36786.00

Soil Type Acreages for Watershed M5
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	598.16	A	12179.95
BtA	2922.31	A	
ChB	2674.24	A	
ChC	1842.26	A	
ChD	561.50	A	
Ho	82.88	A	
Mm	374.02	A	
Nf	513.10	A	
OaC	1660.38	A	
OaE	7.46	A	
Pa	25.21	A	
TyA	918.47	A	
Br	1244.20	B	14977.19
Ck	130.83	B	
Ed	73.69	B	
Fh	1252.36	B	
Gf	650.28	B	
HaA	258.26	B	
Hk	808.13	B	
Md	260.00	B	
Mp	69.72	B	
Mx	2414.01	B	
Ph	70.47	B	
Qu	105.80	B	
RiA	17.04	B	
RIB2	755.08	B	
RIC2	579.91	B	
RID2	381.86	B	
RIF	94.87	B	
Sb	408.51	B	
SeA	1371.38	B	
SeB	663.40	B	
So	117.11	B	
TcA	200.36	B	
TcB	1226.08	B	
TcC2	1124.27	B	
TcD2	598.48	B	
TcF	31.97	B	
Tr	5.73	B	
Wa	63.41	B	
BaA	4558.28	C	6478.17
MrB2	364.70	C	
MrC2	109.39	C	
MrD2	40.90	C	
Pe	680.30	C	
Sa	462.63	C	
We	65.75	C	
Wh	196.23	C	
Cd	154.82	D	913.00
Hh	367.11	D	
Hm	391.08	D	

Map Symbol	Total Acres	Type	Acres
Du	44.28	Null	2526.04
Ua	565.63	Null	
UoC	1062.88	Null	
Uv	679.00	Null	
W	174.26	Null	
	37074.35		37074.35

Soil Type Acreages for Watershed M6
June 23 & 29, 2006

Map Symbol	Total Acres	Type	Acres
Ad	597.78	A	12188 18
BtA	2922.93	A	
ChB	2674 58	A	
ChC	1842.23	A	
ChD	561.54	A	
Ho	82.85	A	
Mm	374.18	A	
Nf	512.98	A	
OaC	1660.45	A	
OaE	14.97	A	
Pa	25.22	A	
TyA	918.48	A	
Br	1243.98	B	15012.27
Ck	130.83	B	
Ed	73.69	B	
Fh	1286.99	B	
Gf	649.91	B	
Hk	807 87	B	
Md	259.37	B	
Mp	69.72	B	
Mx	2413.61	B	
Ph	70.47	B	
Qu	105 81	B	
RlB2	755.24	B	
RlC2	580.36	B	
RlD2	382.36	B	
RlF	95.01	B	
RlA	16.98	B	
Sb	408.71	B	
SeA	1371.14	B	
SeB	662.93	B	
So	117.11	B	
TcB	1226.26	B	
TcC2	1124.99	B	
TcD2	598.87	B	
TcA	200.62	B	
TcF	31.97	B	
Tr	5.73	B	
Wa	63.33	B	
HaA	258.41	B	
BaA	4556.57	C	6476.80
MrB2	365.29	C	
MrC2	109.54	C	
MrD2	40.90	C	
Pe	680.00	C	
Sa	462.37	C	
We	65.75	C	
Wh	196 38	C	

Map Symbol	Total Acres	Type	Acres
Cd	154.90	D	912.86
Hh	366 88	D	
Hm	391 09	D	
Du	45.28	Null	3308.40
Ua	565.13	Null	
UoC	1686.75	Null	
Uv	819.20	Null	
W	192 04	Null	
	37898.52		37898.52

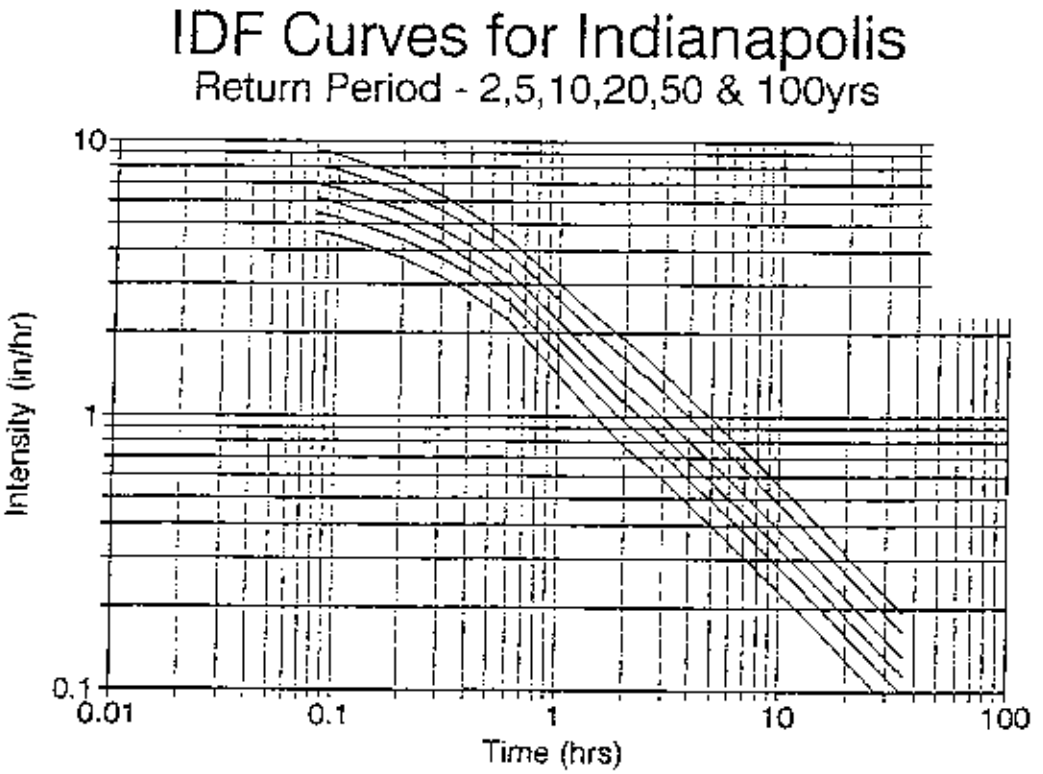


Figure 2.2.2
Intensity - Duration - Frequency Relationship for Indianapolis by IDF Equation
(adapted from Purdue et al., 1992)

2.2.5 Chen's Method

The coefficients and exponents in Table 2.2.3 are not available for all locations of interest to a drainage engineer. In such cases the rainfall intensity-duration-frequency data for a site will have to be estimated. An accurate method to generate this intensity-duration-frequency information has been developed by Chen (FHWA, 1976). This method has been shown to be valid across the United States. Maps showing rainfall depth curves across the entire continental United States are located at the end of Appendix A. Figures 2.2.4 through 2.2.6 enable rainfall depths in Indiana to be determined for Chen's method. The procedure is as follows:

1. From the rainfall atlases in Figures 2.2.4-2.2.6, estimate the following:
   a. The 10-year, 1-hour rainfall depth, p_1^{10}
   b. The 10-year, 24-hour rainfall depth, p_{24}^{10}
   c. The 100-year, 1-hour rainfall depth, p_1^{100}

2. Compute the following parameters:
   a. $(p_1^{10}) / (p_{24}^{10})$
   b. $X = (p_1^{100}) / (p_1^{10})$

3. Estimate a_1, d', and n' from Figure 2.2.3.

4. Determine the intensity corresponding to the 10-year, 1-hr rainfall depth, i_1^{10}, which is equal to p_1^{10}.

5. Calculate the parameter a', where a' is defined below:

$$a' = a_1 \; i_1^{10} \; \log(10^{(2-x)} \; T_r^{(X-1)})$$

where T_r is the recurrence interval in years.

6. Determine the rainfall intensity-duration-frequency formula:

$$i_t^{T_r} = \frac{a'}{(60t + d')^{n'}} \qquad (inches/hour) \qquad (2.2.14)$$

$$i_t^{T_r} = \frac{2.54\ a'}{(60t + d')^{n'}} \qquad (cm/hr) \qquad (2.2.15)$$

where the time, t, has units of hours and the intensity is $i_t^{T_r}$.

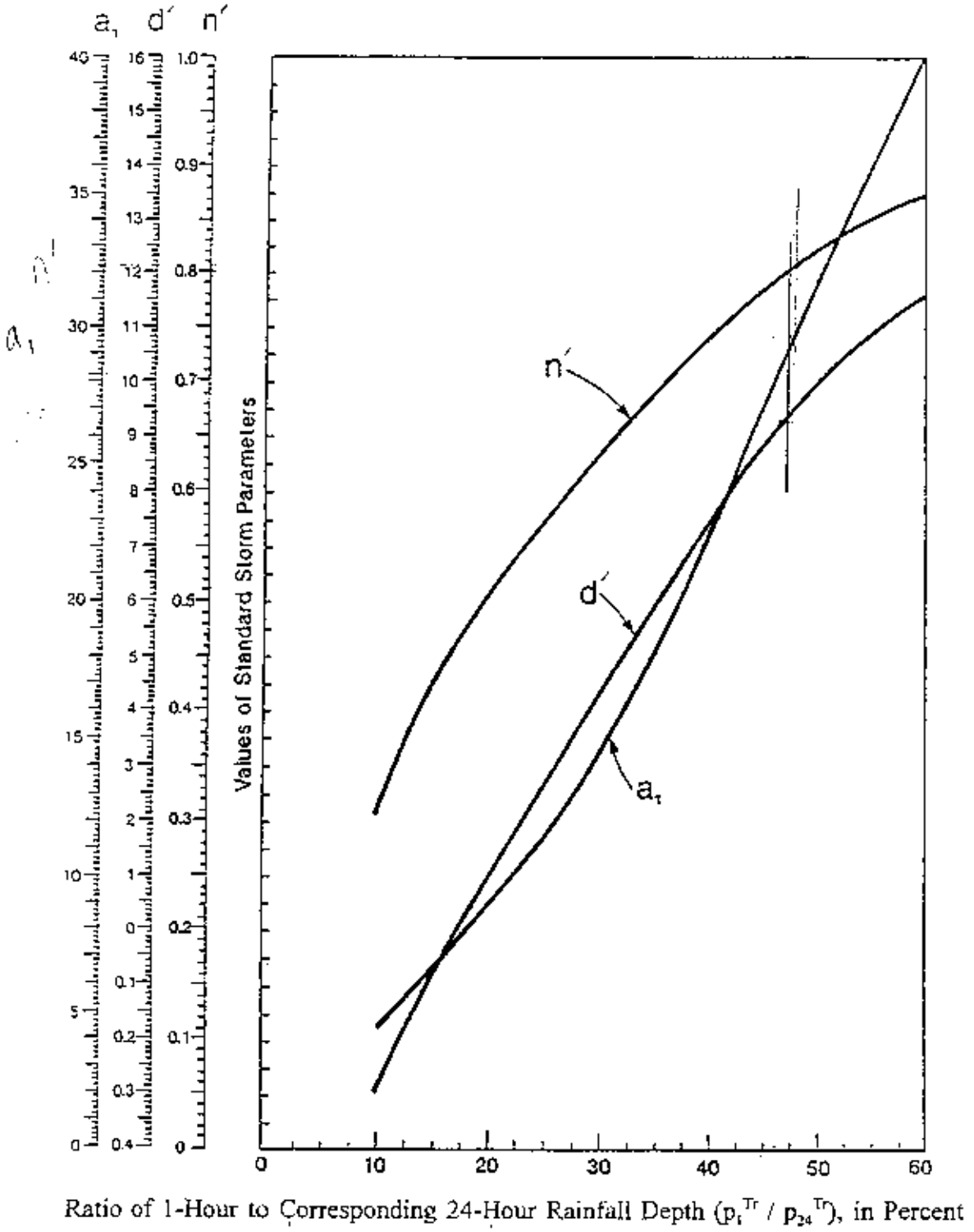


Figure 2.2.3
Chen's Method Parameters as a Function of p_1^{10}/p_{24}^{10}

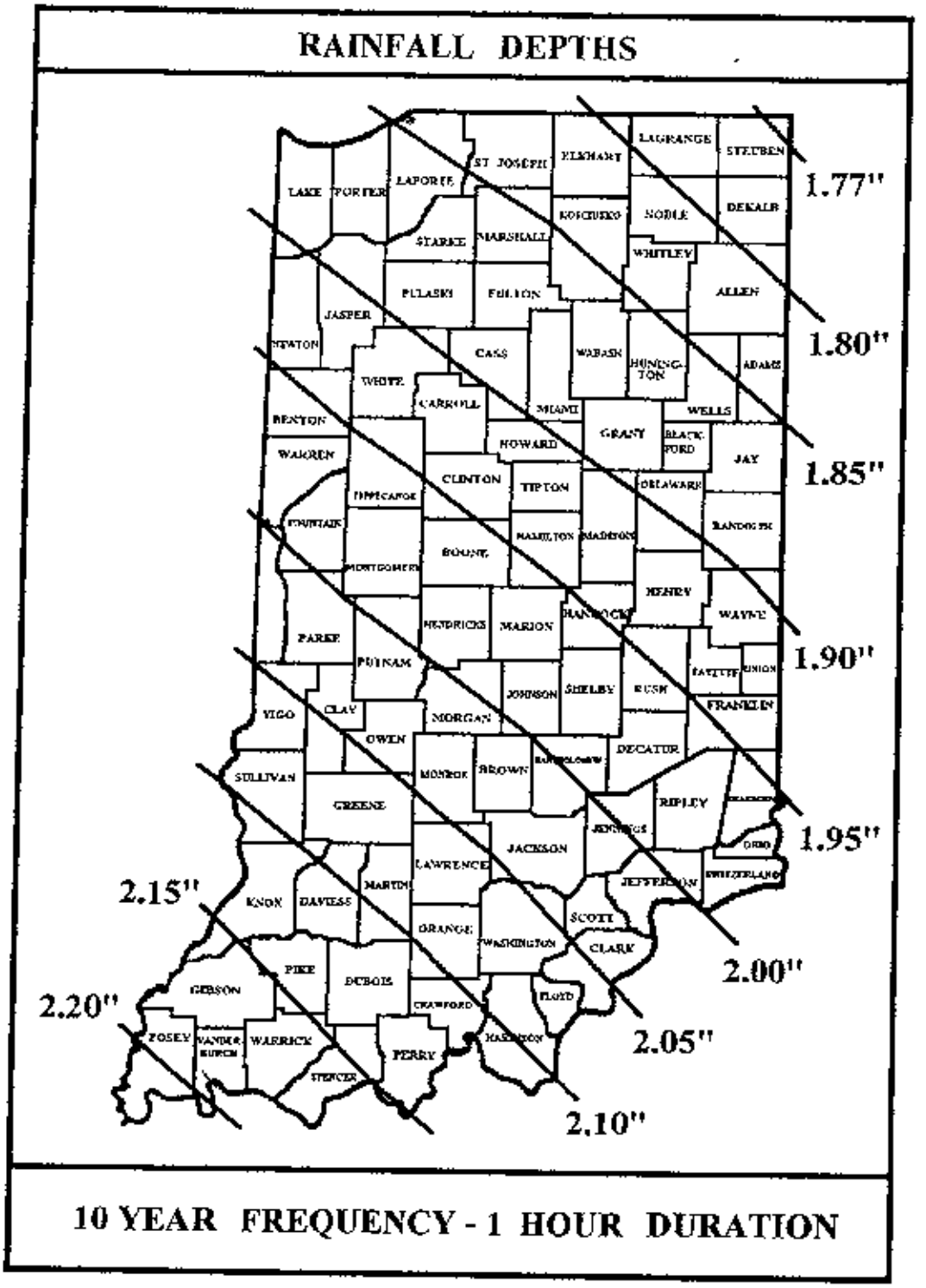
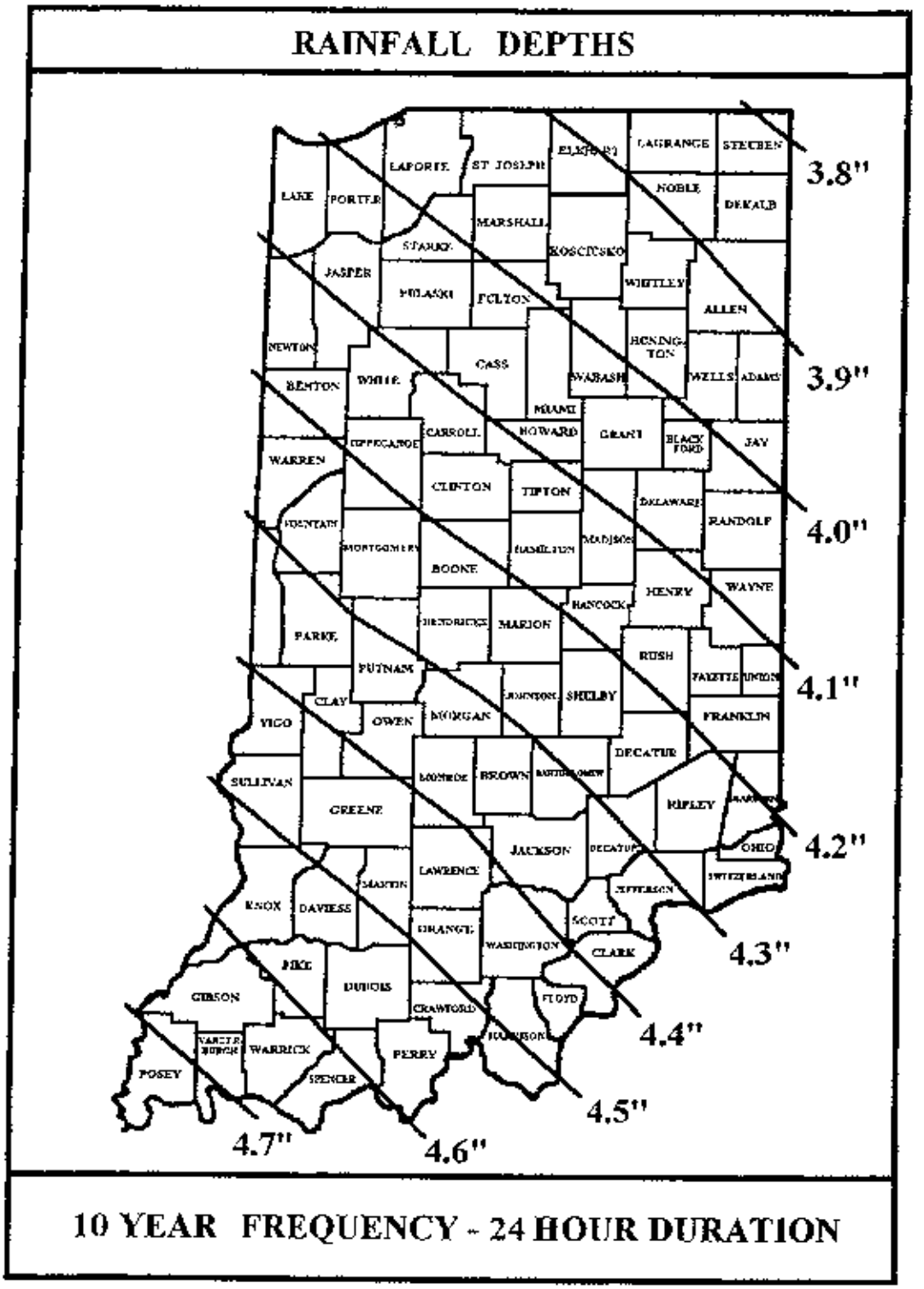


Figure 2.2.4
Depth - Duration - Frequency Curves
(adapted from Technical Paper 40, 1961)



10 YEAR FREQUENCY - 24 HOUR DURATION

Figure 2.2.5
Depth - Duration - Frequency Curves
(adapted from Technical Paper 40, 1961)

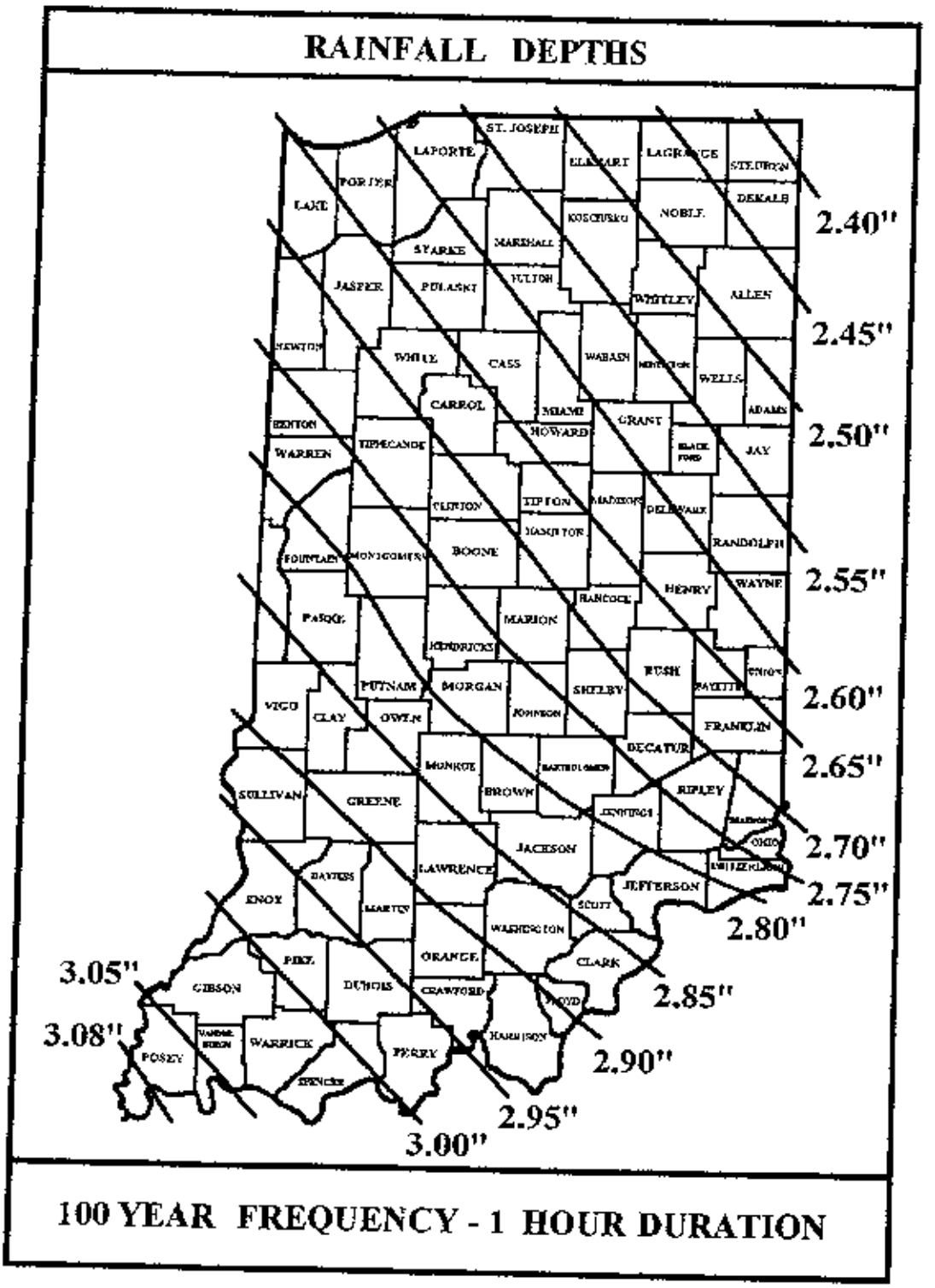


Figure 2.2.6
Depth - Duration - Frequency Curves
(adapted from Technical Paper 40, 1961)

• 1 year, 24 hr storm

$a_1 = 27.6$ $b = 9.6$ $n = 0.81$

$P_1^{10} = 1.84''$ $P_1^{100} = 3.97''$ $P_1^{100} = 2.58''$ $\frac{P_1^{10}}{P_1^{100}} = \frac{1.84}{3.97} = 46.35\%$

$X = \frac{P_1^{100}}{P_1^{10}} = \frac{2.58}{1.84} = 1.4026$

$t = 24$ hr

$T_r = 1$ yr

$i^{10} = P_1^{10} = 1.84''/hr$

$i^{100} = a_1 \log\left(10^{(R-1)} \frac{T_r}{r}^{(Y-1)}\right)$

$= 27.6 \log\left(10^{(1-1)} \frac{T_r}{r}^{(1-1)}\right)$

$i^{100} = 54.46 \log\left(\frac{T_r}{r}\right)$

$i_t^{T_r} = \frac{a'}{(b' + d')^{n'}}$

$= \frac{54.46 \log(3.96\, T_r^{0.0050})}{(60t + 9.6)^{0.81}}$

$i_{24}^{1} = \frac{54.46 \log(3.96 \times 1)}{(60(24) + 9.6)^{0.81}} = 0.0224$ in/hr

$(0.0224 \text{ in/hr} \times 24 \text{ hr}) = \boxed{0.538'' = P(t)}$ [illegible]

Other Equations Used For Analysis:

$S = \left(\frac{2}{5}\right)^{2} - 1$ $R(t) = \frac{(P(t) - 0.25)^2}{P(t) + 0.25} = \frac{(2.148 - 0.25)^2}{2.148 + 0.25}$

[illegible] E

$$S = \frac{1000}{53.92} - 10 = 8.0734'' = S$$

$$R(t) = \frac{2.148 - 0.2(8.0734)}{2.148 + 0.8(8.0734)} = 0.039'' = R(t)$$

[illegible]

$$S = \frac{1000}{[illegible]} - 10 = 8.7406'' = S$$

$$R(t) = \frac{2.148 - 0.2(8.7406)}{2.148 + 0.8(8.7406)} = 0.0[illegible]'' = R(t)$$

[illegible] E

$$S = \frac{1000}{52.32} - 10 = 8.98'' = S$$

$$R(t) = \frac{2.148 - (0.2)(8.98)}{(2.148 + 0.8(8.98))} = [illegible]'' = R(t)$$

[illegible] D

$$S = \frac{1000}{64.14} - 10 = 5.59'' = S$$

$$R(t) = \frac{(2.148 - (0.2)(5.59))}{2.148 + (0.8)(5.59)} = 0.189'' = R(t)$$

[illegible] D2

$$S = \frac{1000}{46.39} - 10 = 11.56'' = S$$

$$R(t) = \frac{2.148 - 0.2(11.56)}{2.148 + 0.8(11.56)} = 0.00236'' = R$$

[illegible] D3

$$S = \frac{1000}{45.92} - 10 = 11.78 = S$$

$$R(t) = \frac{(2.148 - 0.2(11.78))}{2.148 + 0.8(11.78)} = 0.0037'' = R(t)$$

[illegible]

Watershed M1

$$S = \frac{1000}{58.77} - 10 = 7.93'' = S$$

$$R(t) = \frac{2.148 - 0.8(7.93)}{2.148 + 0.8} = 0.037'' = R(t)$$

Watershed M2

$$S = \frac{1000}{57.16} - 10 = 7.57'' = S$$

$$R(t) = \frac{2.148 - 0.8(7.57)}{2.148 + 0.8(7.57)} = 0.049'' = R(t)$$

Watershed M3

$$S = \frac{1000}{59.52} - 10 = 7.8'' = S$$

$$R(t) = \frac{2.148 - 0.8(7.8)}{2.148 + 0.8(7.8)} = [illegible] = R(t)$$

Watershed M4

$$S = \frac{1000}{59.72} - 10 = 7.67'' = S$$

$$R(t) = \frac{2.148 - 0.8(7.67)}{2.148 + 0.8(7.67)} = 0.046'' = R(t)$$

Watershed M5

$$S = \frac{1000}{56.09} - 10 = 7.64'' = S$$

$$R(t) = \frac{2.148 - 0.8(7.64)}{2.148 + 0.8(7.64)} = 0.047'' = R(t)$$

Watershed M6

$$S = \frac{1000}{57.24} - 10 = 7.47'' = S$$

$$R(t) = \frac{2.148 - 0.8(7.47)}{2.148 + 0.8(7.47)} = 0.053'' = R(t)$$

Watershed E1

Acres of Each Soil Type in Watershed = Values from "Soil Type Acres" for Watershed E1 [illegible]

Acres of Given Land Use for Each Soil Type Total:

Acres = Fraction [illegible] of watershed [illegible]

% of E1 = Acres Column / Total Acres in Watershed = 882.92 / 7887.77 = 11.2 %

A (ac) = (% of E1)(Acres − A in Wetland)

= (0.1051)(8[illegible] − [illegible]) = 8[illegible] ac

[illegible]

Curve Numbers for Given Land Use:

Land Use Type = Land [illegible]

Curve Numbers for A, B, C, D = Estimated curve numbers for each [illegible] based on Table 3.3.3 + Table 3.3.4 of the [illegible] (assumptions listed below)

Meadow in Good Condition – Palustrine Emergent Persistent, Terrestrial Grass and Herbaceous

Woods for Forest:

[illegible] – Terrestrial Forest Mixed

Good Condition – Palustrine Herbaceous Persistent, Palustrine Woody [illegible] Terrestrial Forest Evergreen, Terrestrial Forest [illegible], Undifferentiated Cloud Shadows

Stone & Road:

Dirt – Water Use [illegible]

Commercial & Business – Developed Non-residential, [illegible] Urban High Density

Residential:

Large – Developed Urban Low Density

Pasture, grassland or [illegible] – Developed Agriculture Pasture/Grassland [illegible] Resource

Curve Number x Acres of Land Use for Each Soil Type Table:

A(ac) = (CN from Curve Number for Each Land Use Table) X (A(ac) from Acres of Each Land Use for Each Soil Type Table)

= (49)(288.00)

= 14126.40 ac

B(ac), C(ac), D(ac) calcd similarly

Sums = A(ac) + B(ac) + C(ac) + D(ac)

= 12100.90 + 2560.30 + 10912.54 + 16707.19 = 52850.64 ac

Total Sum = Sum of Sums = 43[illegible] = 43[illegible].17 ac

Total Acres = Total Watershed Area − Null Acres

= 7887.77 − 34.04

= 7853.73 ac

Composite CN = $\frac{\text{Total Sum}}{\text{Total Acres}} = \frac{43[illegible].17}{7853.73} = 55.33$

- For simplification purposes, these calculations assume that whatever percentage of the given watershed's total land use acreage is the same percentage of each soil type A-D is located within the specified land use (i.e. 10.5% of Watershed's total is designated Agriculture Pasture/Grassland. Therefore 10.5% of Soil Type A or 288.00 ac of 2742.45 ac is located in the designated Agriculture Pasture/Grassland land use)

Table 3.3.3
Runoff Curve Numbers for Urban Areas (SCS, 1986)

Cover Type and Hydrologic Condition		Curve Numbers for Hydrologic Soil Group			
		A	B	C	D
Undeveloped Areas					
Cultivated Land					
Without conservation treatment		72	81	88	91
With conservation treatment		62	71	78	81
Pasture or range land					
Poor condition		68	79	86	89
Good condition		39	61	74	80
Meadow					
Good condition		30	58	71	78
Wood or forest land					
Thin stand, poor cover, no mulch		45	66	77	83
Good cover		25	55	70	77
Fully developed urban areas (with established vegetation)					
Open space (lawns, parks, golf courses, cemeteries)					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved curb and storm sewers (excluding right-of-way)		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89
Urban Districts					
Commercial and business	(85% impervious)	89	92	94	95
Industrial (72% impervious)		81	88	91	93
Residential					
1/8 acre or less, townhouses	(65% impervious)	77	85	90	92
1/4 acre	(38% impervious)	61	75	83	87
1/3 acre	(30% impervious)	57	72	81	86
1/2 acre	(25% impervious)	54	70	80	85
1 acre	(20% impervious)	51	68	79	84
2 acre		46	65	77	82
Developing Urban Areas					
Newly graded areas (no vegetation)		77	86	91	94

Table 3.3.4
Runoff Curve Numbers for Agricultural Lands (SCS, 1986)

Cover Type and Hydrologic Condition	Curve Numbers for Hydrologic Soil Group			
	A	B	C	D
Pasture, grassland, or range with continous forage for grazing				
Poor	68	79	86	89
Fair	49	69	79	84
Good	39	61	74	80
Meadow with continuous grass, protected from grazing and generally mowed for hay	30	58	71	78
Brush/brush-weed-grass mixture with brush being the major element				
Poor	48	67	77	83
Fair	35	56	70	77
Good	30	48	65	73
Woods and grass combination (orchard or tree farm)				
Poor	57	73	82	86
Fair	43	65	76	82
Good	32	58	72	79
Woods				
Poor	45	66	77	83
Fair	36	60	73	79
Good	30	55	70	77
Farmsteads	59	74	82	86

The curve number method may also be used in determining the time distribution of the runoff. In this manual, the CN method is used in conjunction with the synthetic dimensionless and triangular unit hydrograph methods to determine the storm hydrograph. The procedure used in this operation is outlined below.

1. Determine the basin curve number.

2. Given the rainfall depth and storm duration, determine the time distribution of the rainfall This distribution can be the SCS Type II or Huff Distributions discussed in Chapter 2.

Trail Creek Watershed Study
July 11, 2006
IN20040385
Hydrograph Calculations

Watershed	Travel Length, L (ft)	Beginning Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	*Velocity, v (ft/s)	Area, A_m (mi^2)	Time of Concentr-ation, t_c (hr)	ΔD (hr)	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
E1	26,706	905	630	0.010	1.6	12.33	4.64	0.62	3.09	1,932	8.25	5.16
E2	33,283	905	625	0.0084	1.5	16.48	6.16	0.82	4.11	1,941	10.97	6.86
E3	39,270	905	610	0.0075	1.4	19.28	7.79	1.04	5.19	1,797	13.87	8.67
W1	24,687	670	625	0.002	0.5	14.26	13.72	1.82	9.14	755	24.41	15.27
W2	16,524	925	635	0.018	2.19	3.91	2.10	0.28	1.40	1,365	3.73	2.33
W3	13,403	910	670	0.018	2.19	1.91	1.70	0.23	1.13	817	3.03	1.89
M1	48,133	905	605	0.006	1.21	45.95	11.05	1.47	7.36	3,020	19.66	12.30
M2	61,431	905	590	0.005	1.0	54.91	17.06	2.27	11.37	2,337	30.37	18.99
M3	70,693	905	590	0.004	0.8	57.26	24.55	3.26	16.36	1,694	43.68	27.32
M4	73,874	905	590	0.004	0.8	57.52	25.65	3.41	17.10	1,628	45.65	28.55
M5	76,531	905	585	0.004	0.8	57.97	26.57	3.53	17.71	1,584	47.29	29.58
M6	81,853	905	585	0.004	0.8	59.22	28.42	3.78	18.94	1,513	50.58	31.63

*Any watershed with a slop less than 0.005 has a velocity less than 1 ft/s. It was assumed that slope = 0.004 has a velocity of 0.8 ft/s and slope = 0.002 has a velocity of 0.5 ft/s.

Equations:

Travel Length, Beginning Elevation, Ending Elevation - measured in ArcView

Slope = (Beginning Elevation - Ending Elevation) / Travel Length

Velocity - read off of Figure 3.4.5 in the HERPICC manual

Area - Calculated previously for CN calculations

$\Delta D = 0.133 \times t_c$ (duration of unit excess rainfall)

$t_c = L/(3600 \times v)$

$t_p = \Delta D/2 + 0.6t_c$

$q_p = 484 \times A_m \times Q' / t_p$

$Q' = 1''$

$t_b = 2.67 \times t_p$

$t_r = 1.67 \times t_p$

Trail Creek Watershed Study
July 11, 2006
IN20040385
Triangular Unit Hydrograph Calculations

Watershed	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
E1	3.09	1,932	8.25	5.16
E2	4.11	1,941	10.97	6.86
E3	5.19	1,797	13.87	8.67
W1	9.14	755	24.41	15.27
W2	1.40	1,355	3.73	2.33
W3	1.13	817	3.03	1.89
M1	7.36	3,020	19.66	12.30
M2	11.37	2,337	30.37	18.99
M3	16.36	1,694	43.68	27.32
M4	17.10	1,628	45.65	28.55
M5	17.71	1,584	47.29	29.58
M6	18.94	1,513	50.58	31.63

Watershed E1

Time (hr)	Flow (cfs)
0	0
3.09	1,932
8.25	0

Watershed E2

Time (hr)	Flow (cfs)
0	0
4.11	1,941
10.97	0

Watershed E3

Time (hr)	Flow (cfs)
0	0
5.19	1,797
13.87	0

Watershed W1

Time (hr)	Flow (cfs)
0	0
9.14	755
24	0

Watershed W2

Time (hr)	Flow (cfs)
0	0
1.40	1,355
3.73	0

Watershed W3

Time (hr)	Flow (cfs)
0	0
1.13	817
3.03	0

Watershed M1

Time (hr)	Flow (cfs)
0	0
7.36	3,020
19.66	0

Watershed M2

Time (hr)	Flow (cfs)
0	0
11.37	2,337
30.37	0

Watershed M3

Time (hr)	Flow (cfs)
0	0
16.36	1,694
43.68	0

Watershed M4

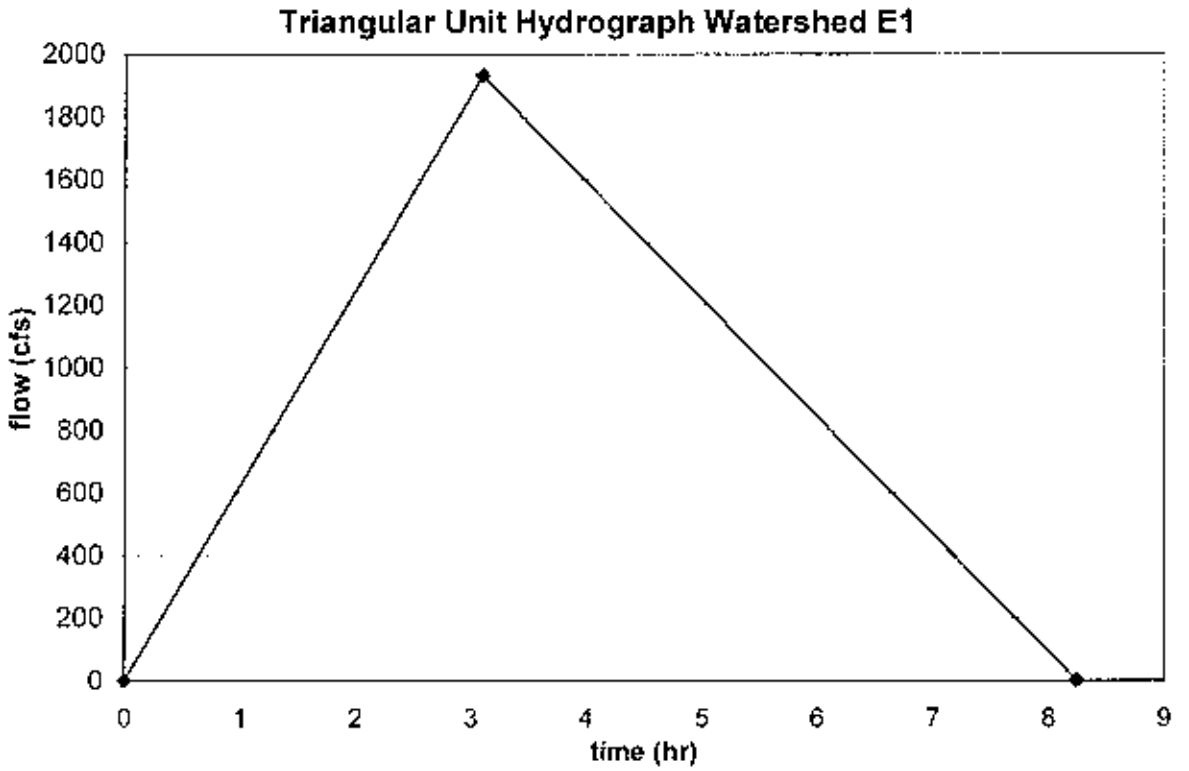
Time (hr)	Flow (cfs)
0	0
17.10	1,628
45.65	0

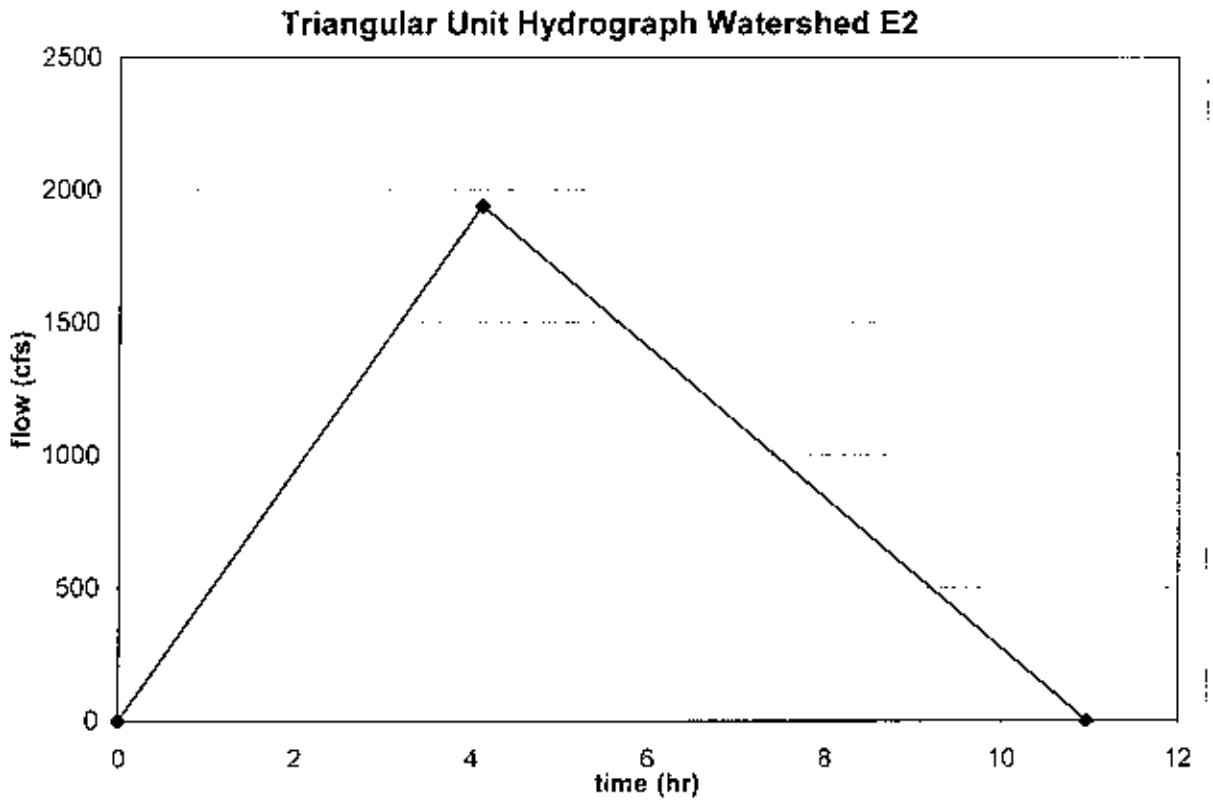
Watershed M5

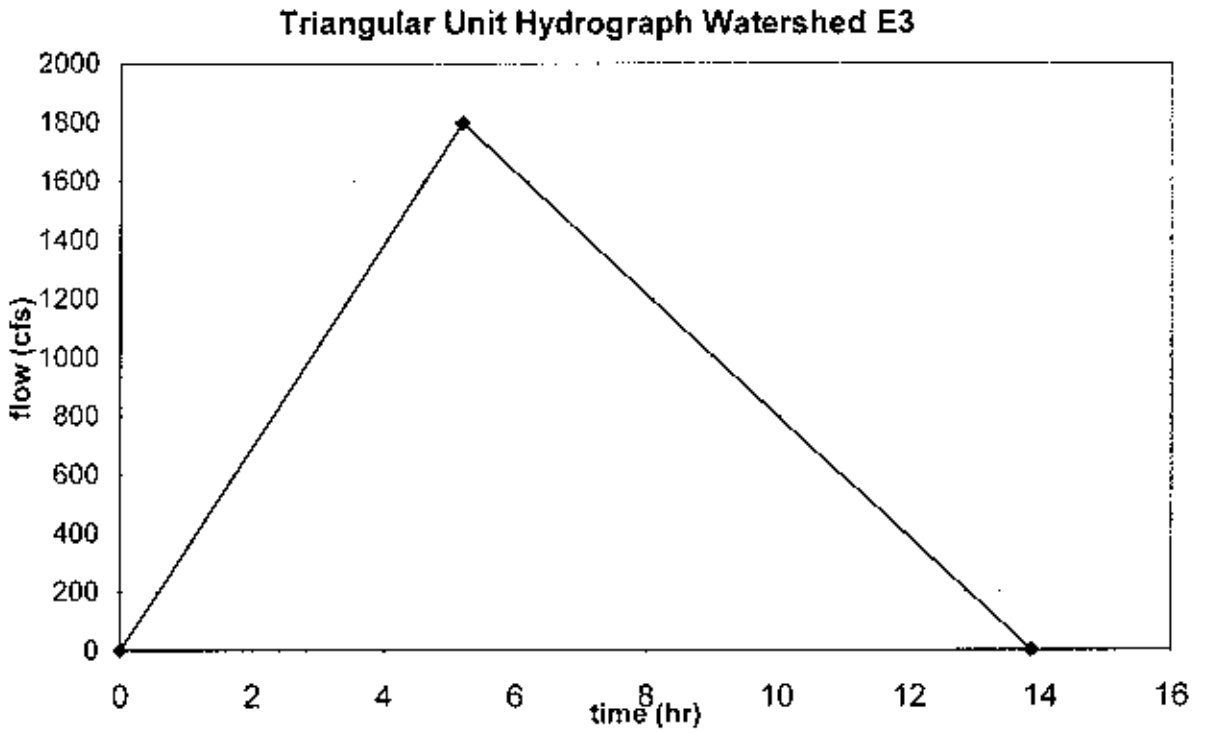
Time (hr)	Flow (cfs)
0	0
17.71	1,584
47.29	0

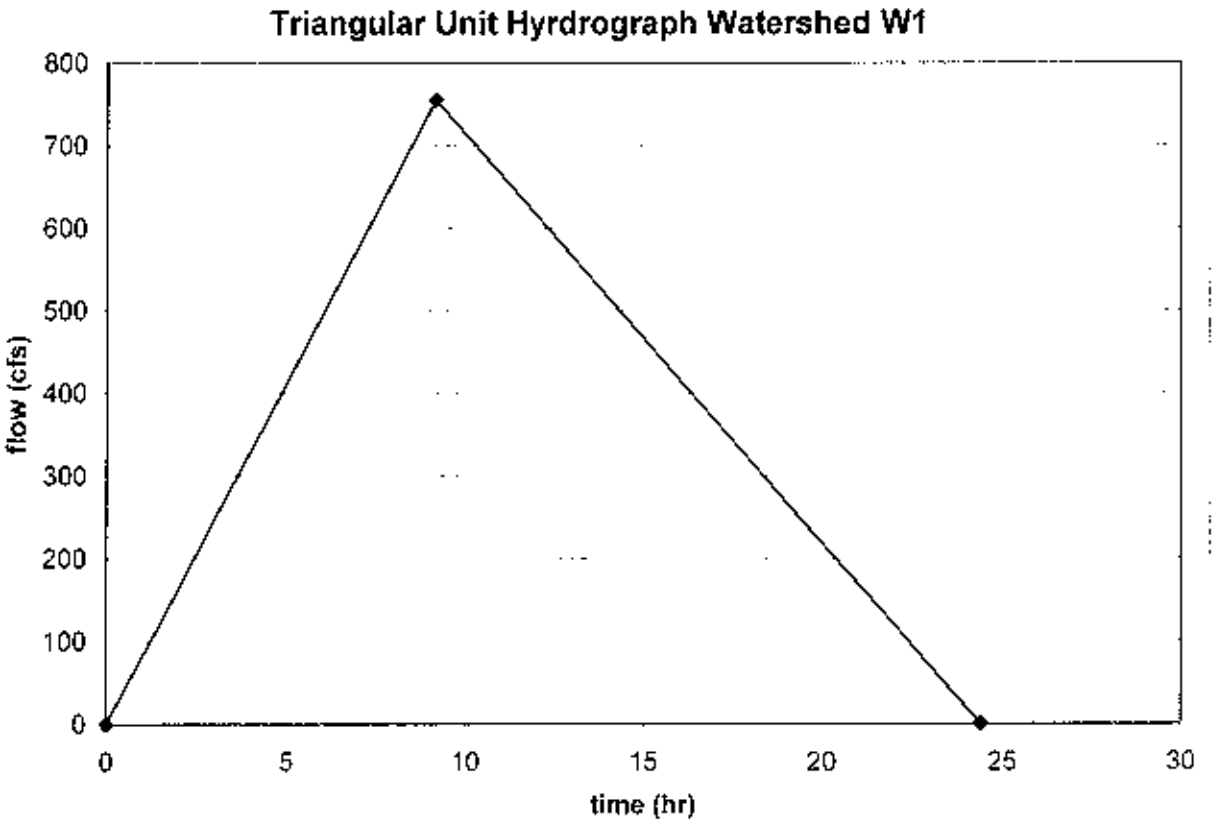
Watershed M6

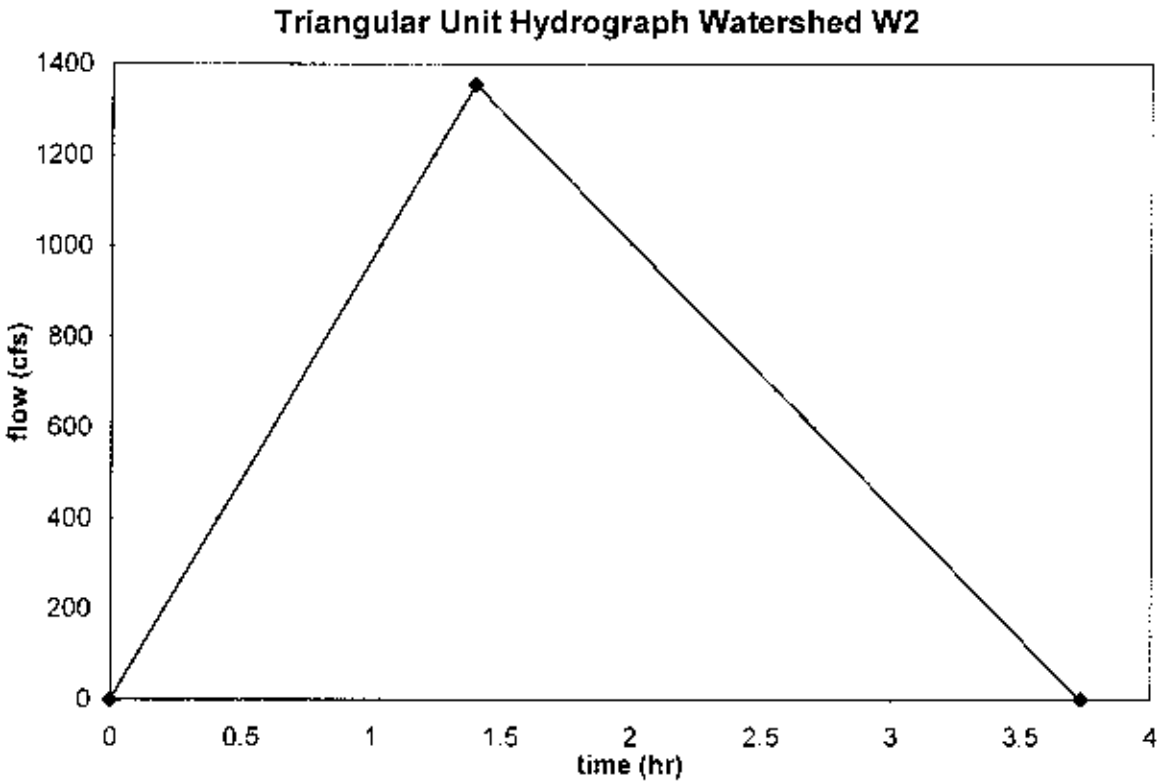
Time (hr)	Flow (cfs)
0	0
18.94	1,513
50.58	0

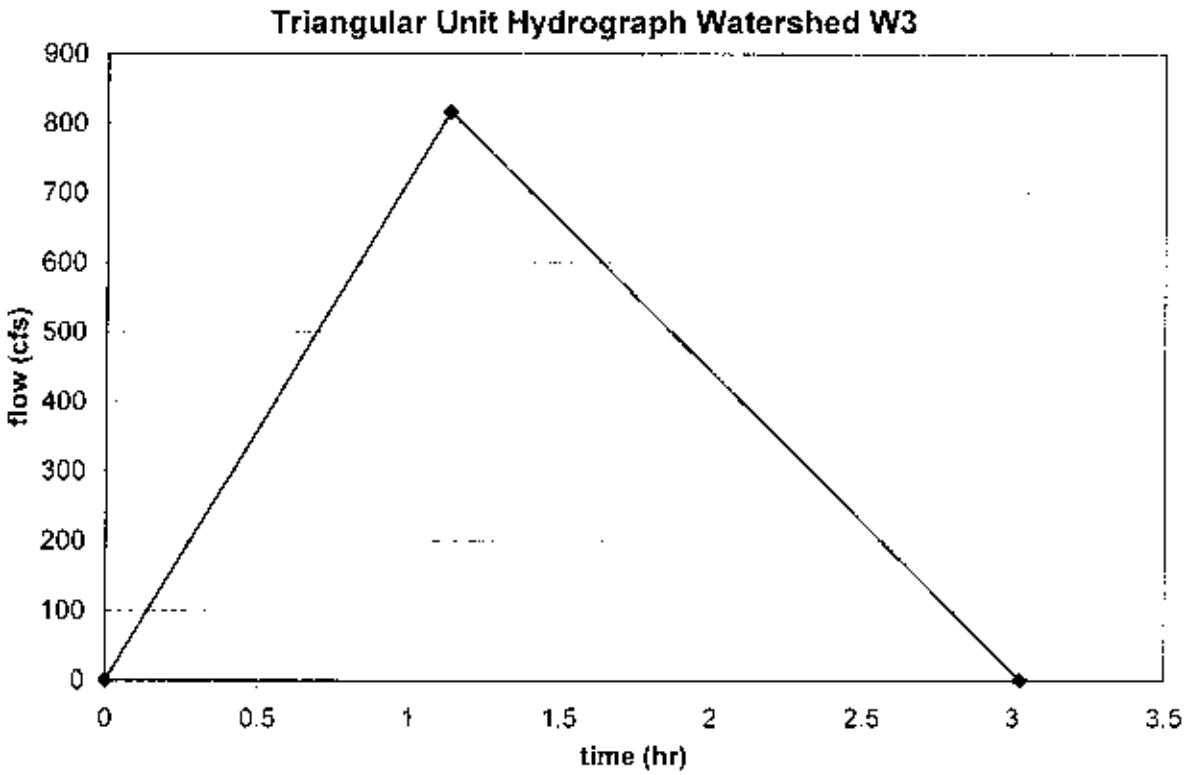

Triangular Unit Hydrograph Watershed E1
2000
1800
1600
1400
1200
1000
800
600
400
200
0
flow (cfs)
0
1
2
3
4
5
6
7
8
9
time (hr)


Triangular Unit Hydrograph Watershed E2
2500
2000
1500
1000
500
0
flow (cfs)
0
2
4
6
8
10
12
time (hr)


Triangular Unit Hydrograph Watershed E3
flow (cfs)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
14
16
time (hr)


Triangular Unit Hyrdrograph Watershed W1
flow (cfs)
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
time (hr)


Triangular Unit Hydrograph Watershed W2
flow (cfs)
1400
1200
1000
800
600
400
200
0
0
0.5
1
1.5
2
2.5
3
3.5
4
time (hr)


Triangular Unit Hydrograph Watershed W3
flow (cfs)
900
800
700
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
3.5
time (hr)

Trail Creek Watershed Study
SCS Type II Distribution
July 11, 2006
IN20040385

R(t) = 0 if P(t) < 0.2S

Watershed E1, S = 8.07, 0.2S = 1.615

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	----
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0	0
0.520	12.48	0.730	1.568	0	0
0.530	12.72	0.750	1.611	0	0
0.540	12.96	0.770	1.654	0.0002	0.0002
0.550	13.20	0.780	1.675	0.0005	0.0003
0.560	13.44	0.800	1.718	0.0013	0.001
0.570	13.68	0.810	1.740	0.0019	0.001
0.580	13.92	0.820	1.761	0.0026	0.001
0.600	14.40	0.835	1.794	0.0039	0.001
0.630	15.12	0.860	1.847	0.0066	0.003
0.650	15.60	0.870	1.869	0.0078	0.001
0.670	16.08	0.880	1.890	0.0091	0.001
0.700	16.80	0.895	1.922	0.0114	0.002
0.720	17.28	0.910	1.955	0.0138	0.002
0.750	18.00	0.920	1.976	0.0156	0.002
0.770	18.48	0.930	1.998	0.0174	0.002
0.800	19.20	0.940	2.019	0.0194	0.002
0.830	19.92	0.950	2.041	0.0214	0.002
0.850	20.40	0.960	2.062	0.0236	0.002
0.870	20.88	0.970	2.084	0.0258	0.002
0.900	21.60	0.980	2.105	0.0282	0.002
0.950	22.80	0.990	2.127	0.0306	0.002
1.000	24.00	1.000	2.148	0.0331	0.003

Watershed E2, S = 8.74, 0.2S = 1 748

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	----
0.040	0.96	0.010	0 021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0	0
0.520	12.48	0.730	1.568	0	0
0.530	12.72	0.750	1.611	0	0
0.540	12.96	0.770	1.654	0	0
0.550	13.20	0.780	1.675	0	0
0.560	13.44	0.800	1.718	0	0
0.570	13.68	0.810	1.740	0	0
0.580	13.92	0.820	1.761	2.04E-05	2.04E-05
0.600	14.40	0.835	1.794	0.0002	0.0002
0.630	15.12	0.860	1.847	0.0011	0.0009
0.650	15.60	0.870	1.869	0.0016	0.0005
0.670	16.08	0.880	1.890	0.0023	0.0006
0.700	16.80	0.895	1.922	0.0034	0.0011
0.720	17.28	0.910	1.955	0.0048	0.0014
0.750	18.00	0.920	1.976	0.0058	0.0010
0.770	18.48	0.930	1.998	0.0069	0.0011
0.800	19.20	0.940	2.019	0.0082	0.0012
0.830	19.92	0.950	2.041	0.0095	0.0013
0.850	20.40	0.960	2.062	0.0109	0.0014
0.870	20.88	0.970	2.084	0.0124	0.0015
0.900	21.60	0.980	2.105	0.0140	0.0016
0.950	22.80	0.990	2.127	0.0157	0.0017
1.000	24.00	1.000	2.148	0.0175	0.0018

Watershed E3, S = 8.98, 0.2S = 1.796

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0	0
0.520	12.48	0.730	1.568	0	0
0.530	12.72	0.750	1.611	0	0
0.540	12.96	0.770	1.654	0	0
0.550	13.20	0.780	1.675	0	0
0.560	13.44	0.800	1.718	0	0
0.570	13.68	0.810	1.740	0	0
0.580	13.92	0.820	1.761	0	0
0.600	14.40	0.835	1.794	0	0
0.630	15.12	0.860	1.847	0.0003	0.0003
0.650	15.60	0.870	1.869	0.0006	0.0003
0.670	16.08	0.880	1.890	0.0010	0.0004
0.700	16.80	0.895	1.922	0.0018	0.0008
0.720	17.28	0.910	1.955	0.0028	0.0010
0.750	18.00	0.920	1.976	0.0035	0.0008
0.770	18.48	0.930	1.998	0.0044	0.0009
0.800	19.20	0.940	2.019	0.0054	0.0010
0.830	19.92	0.950	2.041	0.0065	0.0011
0.850	20.40	0.960	2.062	0.0077	0.0012
0.870	20.88	0.970	2.084	0.0089	0.0013
0.900	21.60	0.980	2.105	0.0103	0.0014
0.950	22.80	0.990	2.127	0.0117	0.0015
1.000	24.00	1.000	2.148	0.0133	0.0015

Watershed W1, S = 5.59, 0.2S = 1.118

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0.0113	0.0113
0.520	12.48	0.730	1.568	0.0335	0.0223
0.530	12.72	0.750	1.611	0.0400	0.0064
0.540	12.96	0.770	1.654	0.0469	0.0069
0.550	13.20	0.780	1.675	0.0505	0.0037
0.560	13.44	0.800	1.718	0.0582	0.0077
0.570	13.68	0.810	1.740	0.0623	0.0040
0.580	13.92	0.820	1.761	0.0664	0.0041
0.600	14.40	0.835	1.794	0.0728	0.0064
0.630	15.12	0.860	1.847	0.0842	0.0113
0.650	15.60	0.870	1.869	0.0889	0.0047
0.670	16.08	0.880	1.890	0.0937	0.0048
0.700	16.80	0.895	1.922	0.1012	0.0075
0.720	17.28	0.910	1.955	0.1089	0.0077
0.750	18.00	0.920	1.976	0.1142	0.0053
0.770	18.48	0.930	1.998	0.1196	0.0054
0.800	19.20	0.940	2.019	0.1251	0.0055
0.830	19.92	0.950	2.041	0.1307	0.0056
0.850	20.40	0.960	2.062	0.1364	0.0057
0.870	20.88	0.970	2.084	0.1422	0.0058
0.900	21.60	0.980	2.105	0.1481	0.0059
0.950	22.80	0.990	2.127	0.1541	0.0060
1.000	24.00	1.000	2.148	0.1603	0.0061

Watershed W2, S = 11.56, 0.2S = 2.312

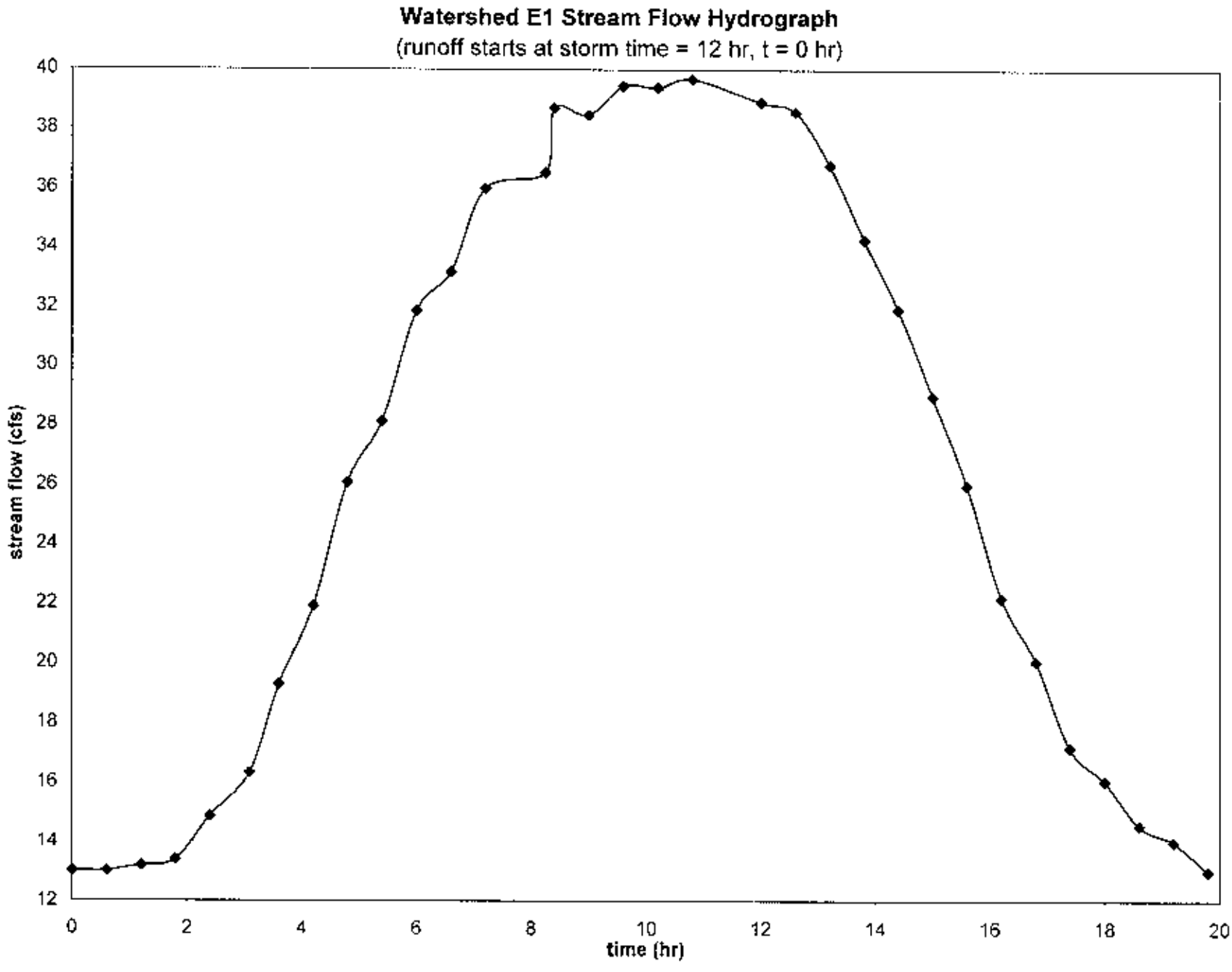
Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0	0
0.520	12.48	0.730	1.568	0	0
0.530	12.72	0.750	1.611	0	0
0.540	12.96	0.770	1.654	0	0
0.550	13.20	0.780	1.675	0	0
0.560	13.44	0.800	1.718	0	0
0.570	13.68	0.810	1.740	0	0
0.580	13.92	0.820	1.761	0	0
0.600	14.40	0.835	1.794	0	0
0.630	15.12	0.860	1.847	0	0
0.650	15.60	0.870	1.869	0	0
0.670	16.08	0.880	1.890	0	0
0.700	16.80	0.895	1.922	0	0
0.720	17.28	0.910	1.955	0	0
0.750	18.00	0.920	1.976	0	0
0.770	18.48	0.930	1.998	0	0
0.800	19.20	0.940	2.019	0	0
0.830	19.92	0.950	2.041	0	0
0.850	20.40	0.960	2.062	0	0
0.870	20.88	0.970	2.084	0	0
0.900	21.60	0.980	2.105	0	0
0.950	22.80	0.990	2.127	0	0
1.000	24.00	1.000	2.148	0	0

Watershed W3, S = 11.78, 0.2S = 2.356

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0	0
0.520	12.48	0.730	1.568	0	0
0.530	12.72	0.750	1.611	0	0
0.540	12.96	0.770	1.654	0	0
0.550	13.20	0.780	1.675	0	0
0.560	13.44	0.800	1.718	0	0
0.570	13.68	0.810	1.740	0	0
0.580	13.92	0.820	1.761	0	0
0.600	14.40	0.835	1.794	0	0
0.630	15.12	0.860	1.847	0	0
0.650	15.60	0.870	1.869	0	0
0.670	16.08	0.880	1.890	0	0
0.700	16.80	0.895	1.922	0	0
0.720	17.28	0.910	1.955	0	0
0.750	18.00	0.920	1.976	0	0
0.770	18.48	0.930	1.998	0	0
0.800	19.20	0.940	2.019	0	0
0.830	19.92	0.950	2.041	0	0
0.850	20.40	0.960	2.062	0	0
0.870	20.88	0.970	2.084	0	0
0.900	21.60	0.980	2.105	0	0
0.950	22.80	0.990	2.127	0	0
1.000	24.00	1.000	2.148	0	0

Trail Creek Watershed Study
July 12, 2006
IN20040385
Watershed E1 Hydrograph Calculations

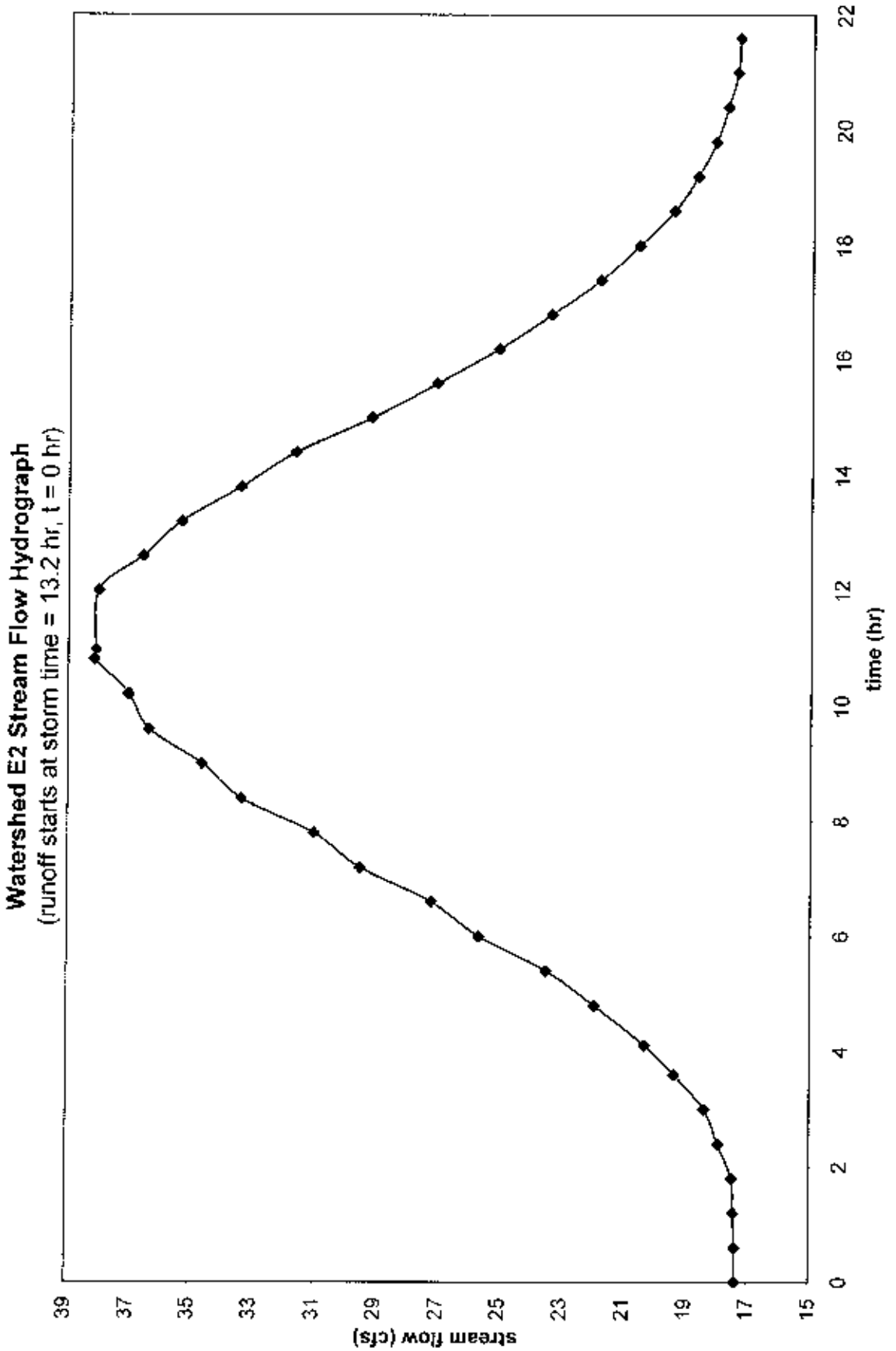
Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (starts at storm time x hr so Time = 0 is Storm Time = 12 hr when runoff											Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12		
		0	0.0005	0.0034	0.0039	0.0036	0.0042	0.0038	0.0042	0.0046	0.0024	0.0025		
0	0.00	0.000											0.000	13.020
0.6	375.15	0.000	0.000										0.000	13.020
1.2	750.29	0.000	0.188	0.000									0.188	13.208
1.8	1125.44	0.000	0.375	0.000									0.375	13.395
2.4	1500.58	0.000	0.563	1.275	0.000								1.838	14.858
3.09	1932.00	0.000	0.750	2.551	0.000								3.301	16.321
3.6	1741.05	0.000	0.966	3.826	1.463	0.000							6.256	19.276
4.2	1516.39	0.000	0.871	5.102	2.926	0.000							8.899	21.919
4.8	1291.74	0.000	0.758	6.569	4.389	1.351	0.000						13.067	26.087
5.4	1067.09	0.000	0.646	5.920	5.852	2.701	0.000						15.119	28.139
6	842.44	0.000	0.534	5.156	7.535	4.052	1.576	0.000					18.851	31.871
6.6	617.79	0.000	0.421	4.392	6.790	5.402	3.151	0.000					20.157	33.177
7.2	393.14	0.000	0.309	3.628	5.914	6.955	4.727	1.426	0.000				22.959	35.979
8.25	0.00	0.000	0.197	2.864	5.038	6.268	6.302	2.851	0.000				23.520	36.540
8.4		0.000	0.000	2.100	4.162	5.459	8.114	4.277	1.576	0.000			25.688	38.708
9			0.000	1.337	3.286	4.650	7.312	5.702	3.151	0.000			25.438	38.458
9.6				0.000	2.409	3.842	6.369	7.342	4.727	1.726	0.000		26.414	39.434
10.2				0.000	1.533	3.033	5.425	6.616	6.302	3.451	0.000		26.361	39.381
10.8					0.000	2.224	4.482	5.762	8.114	5.177	0.900	0.000	26.660	39.680
12					0.000	1.415	3.538	4.909	7.312	6.903	1.801	0.000	25.878	38.898
12.6						0.000	2.595	4.055	6.369	8.887	2.701	0.938	25.545	38.565
13.2						0.000	1.651	3.201	5.425	8.009	3.601	1.876	23.764	36.784
13.8							0.000	2.348	4.482	6.975	4.637	2.814	21.255	34.275
14.4							0.000	1.494	3.538	5.942	4.179	3.751	18.904	31.924
15								0.000	2.595	4.909	3.639	4.830	15.973	28.993
15.6								0.000	1.651	3.875	3.100	4.353	12.979	25.999
16.2									0.000	2.842	2.561	3.791	9.194	22.214
16.8									0.000	1.808	2.022	3.229	7.060	20.080
17.4										0.000	1.483	2.668	4.150	17.170
18										0.000	0.944	2.106	3.050	16.070
18.6											0.000	1.544	1.544	14.564
19.2											0.000	0.983	0.983	14.003
19.8												0.000	0.000	13.020
												SUM =	**435.368**	**865.028**


Watershed E1 Stream Flow Hydrograph
(runoff starts at storm time = 12 hr, t = 0 hr)
stream flow (cfs)
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
0
2
4
6
8
10
12
14
16
18
20
time (hr)

Trail Creek Watershed Study
July 12, 2006
IN20040385
Watershed E2 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 13.2 hr)										Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8		
		0	0.0002	0.0014	0.0018	0.0024	0.0024	0.0027	0.0031	0.0017	0.0018		
0.0	0.00	0.000										0.000	17.390
0.6	283.36	0.000	0.000									0.000	17.390
1.2	566.72	0.000	0.057	0.000								0.057	17.447
1.8	850.07	0.000	0.113	0.000								0.113	17.503
2.4	1133.43	0.000	0.170	0.397	0.000							0.567	17.957
3.0	1416.79	0.000	0.227	0.793	0.000							1.020	18.410
3.6	1700.15	0.000	0.283	1.190	0.510	0.000						1.984	19.374
4.11	1941.00	0.000	0.340	1.587	1.020	0.000						2.947	20.337
4.8	1745.77	0.000	0.388	1.984	1.530	0.680	0.000					4.582	21.972
5.4	1576.00	0.000	0.349	2.380	2.040	1.360	0.000					6.130	23.520
6.0	1406.24	0.000	0.315	2.717	2.550	2.040	0.680	0.000				8.303	25.693
6.6	1236.47	0.000	0.281	2.444	3.060	2.720	1.360	0.000				9.866	27.256
7.2	1066.70	0.000	0.247	2.206	3.494	3.400	2.040	0.765	0.000			12.153	29.543
7.8	896.94	0.000	0.213	1.969	3.142	4.080	2.720	1.530	0.000			13.655	31.045
8.4	727.17	0.000	0.179	1.731	2.837	4.658	3.400	2.295	0.878	0.000		15.980	33.370
9.0	557.40	0.000	0.145	1.493	2.531	4.190	4.080	3.060	1.757	0.000		17.257	34.647
9.6	387.64	0.000	0.111	1.256	2.226	3.782	4.658	3.825	2.635	0.482	0.000	18.976	36.366
10.2	217.87	0.000	0.078	1.018	1.920	3.375	4.190	4.590	3.514	0.963	0.000	19.648	37.038
10.8	48.10	0.000	0.044	0.780	1.614	2.968	3.782	5.241	4.392	1.445	0.510	20.776	38.166
10.97	0.00	0.000	0.010	0.543	1.309	2.560	3.375	4.714	5.270	1.927	1.020	20.727	38.117
12.0			0.000	0.305	1.003	2.153	2.968	4.255	6.017	2.409	1.530	20.639	38.029
12.6			0.000	0.067	0.698	1.745	2.560	3.797	5.412	2.890	2.040	19.210	36.600
13.2				0.000	0.392	1.338	2.153	3.338	4.886	3.300	2.550	17.957	35.347
13.8				0.000	0.087	0.930	1.745	2.880	4.359	2.968	3.060	16.030	33.420
14.4					0.000	0.523	1.338	2.422	3.833	2.679	3.494	14.288	31.678
15.0					0.000	0.115	0.930	1.963	3.307	2.391	3.142	11.849	29.239
15.6						0.000	0.523	1.505	2.781	2.102	2.837	9.747	27.137
16.2						0.000	0.115	1.047	2.254	1.813	2.531	7.761	25.151
16.8							0.000	0.588	1.728	1.525	2.226	6.067	23.457

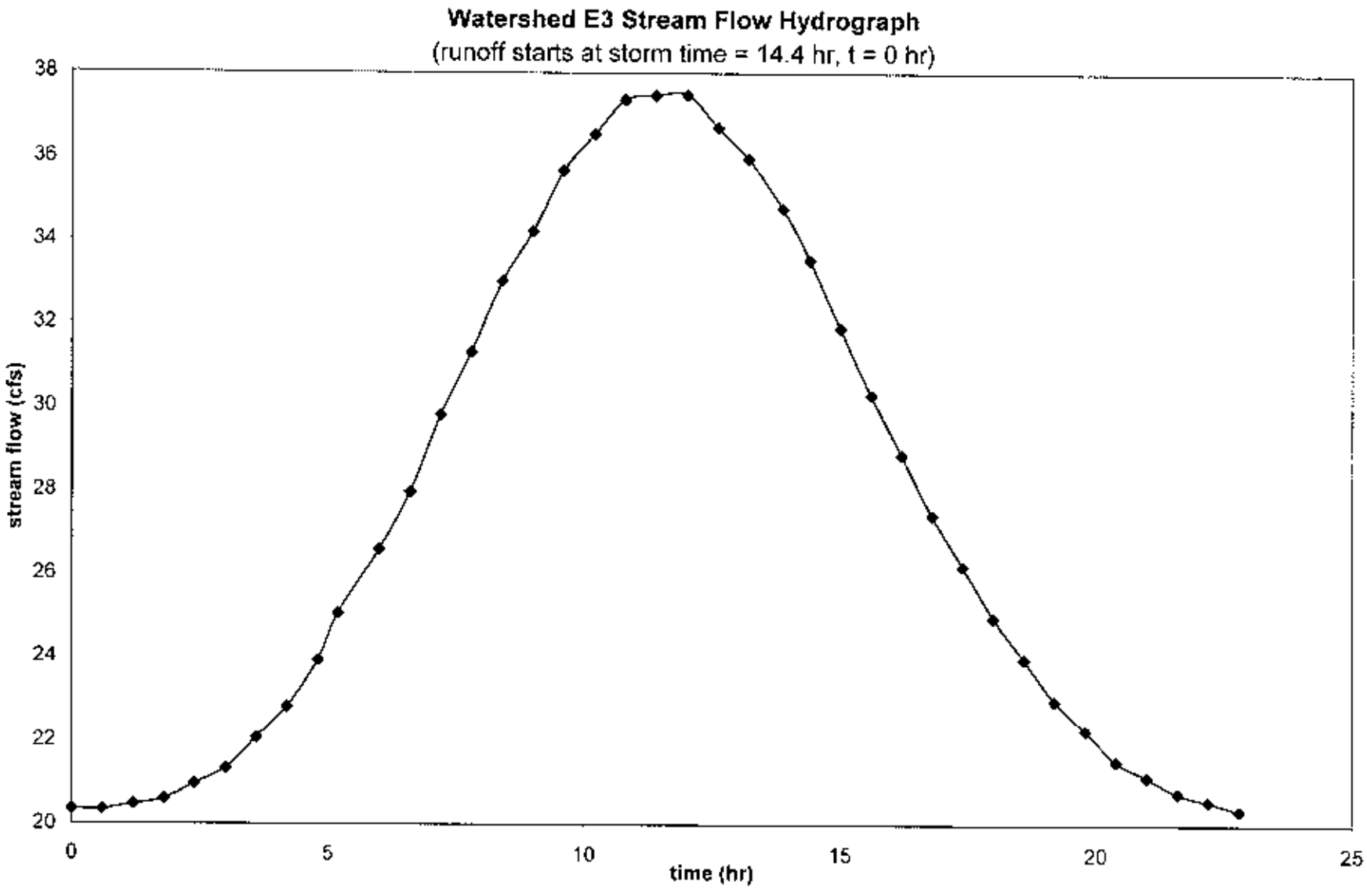
17.4							0.000	0.130	1.202	1.236	1.920	4.488	21.878
18.0								0.000	0.675	0.948	1.614	3.237	20.627
18.6								0.000	0.149	0.659	1.309	2.117	19.507
19.2									0.000	0.370	1.003	1.374	18.764
19.8									0.000	0.082	0.698	0.780	18.170
20.4										0.000	0.392	0.392	17.782
21.0										0.000	0.087	0.087	17.477
21.6											0.000	0.000	17.390
											SUM =	310.762	954.192


Watershed E2 Stream Flow Hydrograph
(runoff starts at storm time = 13.2 hr, t = 0 hr)
stream flow (cfs)
39
37
35
33
31
29
27
25
23
21
19
17
15
0
2
4
6
8
10
12
14
16
18
20
22
time (hr)

Trail Creek Watershed Study
July 12, 2006
IN20040385
Watershed E3 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 14.4 hr)									Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0 0	1.2 0.0006	2.4 0.0012	3.6 0.0017	4.8 0.0019	6 0.0023	7.2 0.0026	8.4 0.0014	9.6 0.0016		
0	0	0.000									0.000	20.350
0.6	207.75	0.000	0.000								0.000	20.350
1.2	415.49	0.000	0.125	0.000							0.125	20.475
1.8	623.24	0.000	0.249	0.000							0.249	20.599
2.4	830.98	0.000	0.374	0.249	0.000						0.623	20.973
3.0	1038.73	0.000	0.499	0.499	0.000						0.997	21.347
3.6	1246.47	0.000	0.623	0.748	0.353	0.000					1.724	22.074
4.2	1454.22	0.000	0.748	0.997	0.706	0.000					2.451	22.801
4.8	1661.97	0.000	0.873	1.246	1.060	0.395	0.000				3.573	23.923
5.19	1797.00	0.000	0.997	1.496	1.413	0.789	0.000				4.695	25.045
6.0	1629.31	0.000	1.078	1.745	1.766	1.184	0.478	0.000			6.251	26.601
6.6	1505.09	0.000	0.978	1.994	2.119	1.579	0.956	0.000			7.625	27.975
7.2	1380.87	0.000	0.903	2.156	2.472	1.974	1.433	0.540	0.000		9.479	29.829
7.8	1256.66	0.000	0.829	1.955	2.825	2.368	1.911	1.080	0.000		10.969	31.319
8.4	1132.44	0.000	0.754	1.806	3.055	2.763	2.389	1.620	0.291	0.000	12.678	33.028
9.0	1008.22	0.000	0.679	1.657	2.770	3.158	2.867	2.161	0.582	0.000	13.873	34.223
9.6	884.01	0.000	0.605	1.508	2.559	3.414	3.345	2.701	0.873	0.332	15.336	35.686
10.2	759.79	0.000	0.530	1.359	2.347	3.096	3.823	3.241	1.163	0.665	16.224	36.574
10.8	635.57	0.000	0.456	1.210	2.136	2.860	4.133	3.781	1.454	0.997	17.027	37.377
11.4	511.36	0.000	0.381	1.061	1.926	2.624	3.747	4.321	1.745	1.330	17.134	37.484
12.0	387.14	0.000	0.307	0.912	1.714	2.388	3.462	4.672	2.036	1.662	17.152	37.502
12.6	262.93	0.000	0.232	0.763	1.503	2.152	3.176	4.236	2.327	1.994	16.383	36.733
13.2	138.71	0.000	0.158	0.614	1.292	1.916	2.890	3.913	2.516	2.327	15.625	35.975
13.87	0.00	0.000	0.083	0.465	1.080	1.680	2.605	3.590	2.281	2.659	14.443	34.793
14.4			0.000	0.316	0.869	1.444	2.319	3.267	2.107	2.875	13.197	33.547
15.0			0.000	0.166	0.658	1.208	2.033	2.944	1.933	2.607	11.550	31.900
15.6				0.000	0.447	0.972	1.748	2.621	1.759	2.408	9.955	30.305
16.2				0.000	0.236	0.736	1.462	2.298	1.585	2.209	8.526	28.876
16.8					0.000	0.500	1.176	1.975	1.412	2.011	7.073	27.423

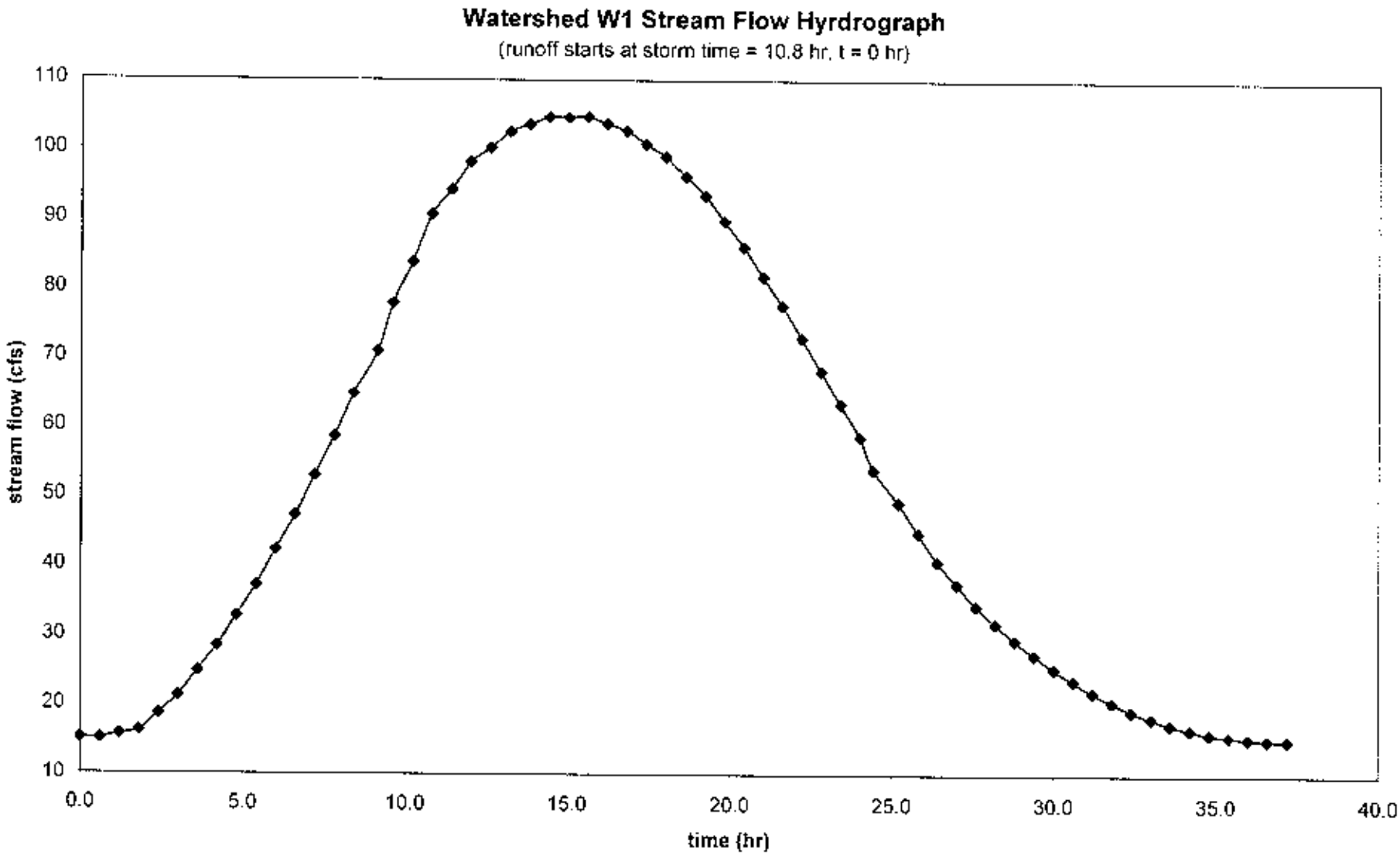
17.4					0.000	0.264	0.890	1.652	1.238	1.812	5.856	26.206
18.0						0.000	0.605	1.330	1.064	1.613	4.611	24.961
18.6						0.000	0.319	1.007	0.890	1.414	3.630	23.980
19.2							0.000	0.684	0.716	1.216	2.615	22.965
19.8							0.000	0.361	0.542	1.017	1.920	22.270
20.4								0.000	0.368	0.818	1.186	21.536
21.0								0.000	0.194	0.619	0.814	21.164
21.6									0.000	0.421	0.421	20.771
22.2									0.000	0.222	0.222	20.572
22.8										0.000	0.000	20.350
										SUM =	**276.214**	**1069.864**


Watershed E3 Stream Flow Hydrograph
(runoff starts at storm time = 14.4 hr, t = 0 hr)
stream flow (cfs)
38
36
34
32
30
28
26
24
22
20
0
5
10
15
20
25
time (hr)

Trail Creek Watershed Study
July 12, 2006
IN20040385
Watershed W1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 10.8 hr)												Storm Hydrograph (cfs)	Stream Flow Hyrdrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2		
		0	0.0113	0.0392	0.0223	0.0161	0.0123	0.013	0.0109	0.0113	0.0117	0.006	0.0062		
0.0	0.00	0.000												0.000	15.050
0.6	49.56	0.000	0.000											0.000	15.050
1.2	99.12	0.000	0.560	0.000										0.560	15.610
1.8	148.69	0.000	1.120	0.000										1.120	16.170
2.4	198.25	0.000	1.680	1.943	0.000									3.623	18.673
3.0	247.81	0.000	2.240	3.886	0.000									6.126	21.176
3.6	297.37	0.000	2.800	5.829	1.105	0.000								9.734	24.784
4.2	346.94	0.000	3.360	7.771	2.210	0.000								13.342	28.392
4.8	396.50	0.000	3.920	9.714	3.316	0.798	0.000							17.748	32.798
5.4	446.06	0.000	4.480	11.657	4.421	1.596	0.000							22.154	37.204
6.0	495.62	0.000	5.040	13.600	5.526	2.394	0.610	0.000						27.170	42.220
6.6	545.19	0.000	5.601	15.543	6.631	3.192	1.219	0.000						32.186	47.236
7.2	594.75	0.000	6.161	17.486	7.737	3.990	1.829	0.644	0.000					37.846	52.896
7.8	644.31	0.000	6.721	19.428	8.842	4.788	2.438	1.289	0.000					43.506	58.556
8.4	693.87	0.000	7.281	21.371	9.947	5.586	3.048	1.933	0.540	0.000				49.706	64.756
9.14	755.00	0.000	7.841	23.314	11.052	6.384	3.658	2.577	1.080	0.000				55.906	70.956
9.6	732.26	0.000	8.531	25.257	12.158	7.182	4.267	3.222	1.621	0.560	0.000			62.797	77.847
10.2	702.59	0.000	8.275	27.200	13.263	7.980	4.877	3.866	2.161	1.120	0.000			68.741	83.791
10.8	672.92	0.000	7.939	29.596	14.368	8.777	5.487	4.510	2.701	1.680	0.580	0.000		75.639	90.689
11.4	643.26	0.000	7.604	28.704	15.473	9.575	6.096	5.154	3.241	2.240	1.160	0.000		79.249	94.299
12.0	613.59	0.000	7.269	27.542	16.836	10.373	6.706	5.799	3.782	2.800	1.740	0.297	0.000	83.144	98.194
12.6	583.93	0.000	6.934	26.379	16.329	11.171	7.315	6.443	4.322	3.360	2.320	0.595	0.000	85.168	100.218
13.2	554.26	0.000	6.598	25.216	15.668	12.155	7.925	7.087	4.862	3.920	2.899	0.892	0.307	87.531	102.581
13.8	524.59	0.000	6.263	24.053	15.006	11.789	8.535	7.732	5.402	4.480	3.479	1.189	0.615	88.544	103.594
14.4	494.93	0.000	5.928	22.890	14.345	11.312	9.286	8.376	5.943	5.040	4.059	1.487	0.922	89.588	104.638
15.0	465.26	0.000	5.593	21.727	13.683	10.834	9.007	9.020	6.483	5.601	4.639	1.784	1.229	89.600	104.650
15.6	435.60	0.000	5.257	20.564	13.022	10.356	8.642	9.815	7.023	6.161	5.219	2.082	1.536	89.677	104.727
16.2	405.93	0.000	4.922	19.401	12.360	9.879	8.277	9.519	7.563	6.721	5.799	2.379	1.844	88.664	103.714
16.8	376.26	0.000	4.587	18.238	11.698	9.401	7.912	9.134	8.229	7.281	6.379	2.676	2.151	87.687	102.737

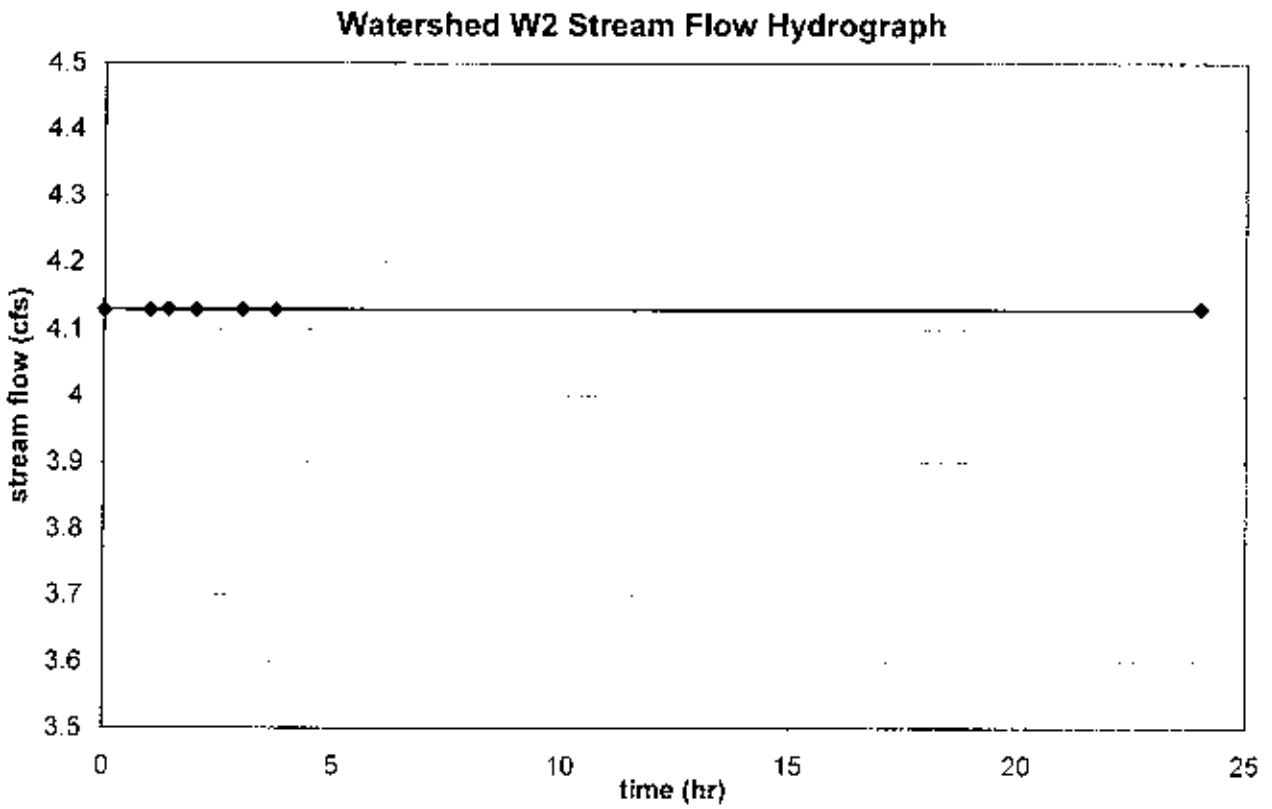
17.4	346.60	0.000	4.252	17.075	11.037	8.924	7.547	8.748	7.982	7.841	6.959	2.974	2.458	85.796	100.846
18.0	316.93	0.000	3.917	15.912	10.375	8.446	7.182	8.362	7.658	8.531	7.538	3.271	2.766	83.960	99.010
18.6	287.27	0.000	3.581	14.750	9.714	7.968	6.817	7.977	7.335	8.275	8.118	3.568	3.073	81.176	96.226
19.2	257.60	0.000	3.246	13.587	9.052	7.491	6.453	7.591	7.012	7.939	8.833	3.866	3.380	78.450	93.500
19.8	227.93	0.000	2.911	12.424	8.391	7.013	6.088	7.205	6.688	7.604	8.567	4.163	3.687	74.742	89.792
20.4	198.27	0.000	2.576	11.261	7.729	6.535	5.723	6.820	6.365	7.269	8.220	4.530	3.995	71.022	86.072
21.0	168.60	0.000	2.240	10.098	7.068	6.058	5.358	6.434	6.041	6.934	7.873	4.394	4.302	66.800	81.850
21.6	138.94	0.000	1.905	8.935	6.406	5.580	4.993	6.048	5.718	6.598	7.526	4.216	4.681	62.607	77.657
22.2	109.27	0.000	1.570	7.772	5.744	5.103	4.628	5.663	5.395	6.263	7.179	4.038	4.540	57.894	72.944
22.8	79.60	0.000	1.235	6.609	5.083	4.625	4.263	5.277	5.071	5.928	6.832	3.860	4.356	53.139	68.189
23.4	49.94	0.000	0.900	5.446	4.421	4.147	3.898	4.891	4.748	5.593	6.485	3.682	4.172	48.383	63.433
24.0	20.27	0.000	0.564	4.283	3.760	3.670	3.533	4.506	4.425	5.257	6.138	3.504	3.988	43.628	58.678
24.41	0.00	0.000	0.229	3.120	3.098	3.192	3.168	4.120	4.101	4.922	5.791	3.326	3.804	38.873	53.923
25.2			0.000	1.958	2.437	2.714	2.804	3.734	3.778	4.587	5.444	3.148	3.620	34.223	49.273
25.8			0.000	0.795	1.775	2.237	2.439	3.349	3.455	4.252	5.096	2.970	3.436	29.803	44.853
26.4				0.000	1.114	1.759	2.074	2.963	3.131	3.917	4.749	2.792	3.252	25.751	40.801
27.0				0.000	0.452	1.282	1.709	2.577	2.808	3.581	4.402	2.614	3.069	22.494	37.544
27.6					0.000	0.804	1.344	2.192	2.484	3.246	4.055	2.436	2.885	19.446	34.496
28.2					0.000	0.326	0.979	1.806	2.161	2.911	3.708	2.258	2.701	16.850	31.900
28.8						0.000	0.614	1.421	1.838	2.576	3.361	2.080	2.517	14.406	29.456
29.4						0.000	0.249	1.035	1.514	2.240	3.014	1.902	2.333	12.287	27.337
30.0							0.000	0.649	1.191	1.905	2.667	1.724	2.149	10.285	25.335
30.6							0.000	0.264	0.868	1.570	2.320	1.546	1.965	8.532	23.582
31.2								0.000	0.544	1.235	1.973	1.368	1.781	6.900	21.950
31.8								0.000	0.221	0.900	1.626	1.190	1.597	5.533	20.583
32.4									0.000	0.564	1.278	1.012	1.413	4.268	19.318
33.0									0.000	0.229	0.931	0.834	1.229	3.223	18.273
33.6										0.000	0.584	0.656	1.045	2.285	17.335
34.2										0.000	0.237	0.478	0.861	1.576	16.626
34.8											0.000	0.300	0.677	0.977	16.027
35.4											0.000	0.122	0.494	0.615	15.665
36.0												0.000	0.310	0.310	15.360
36.6												0.000	0.126	0.126	15.176
37.2													0.000	0.000	15.050
													SUM =	**2463.114**	**3411.264**


Watershed W1 Stream Flow Hyrdrograph
(runoff starts at storm time = 10.8 hr, t = 0 hr)
stream flow (cfs)
110
100
90
80
70
60
50
40
30
20
10
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
time (hr)

Trail Creek Watershed Study
July 12, 2006
IN20040385
Watershed W2 Hydrograph Calculations

**There is no run off in this watershed and therefore no storm hydrograph. The stream hydrograph for for the storm is simply the base flow of the stream.*

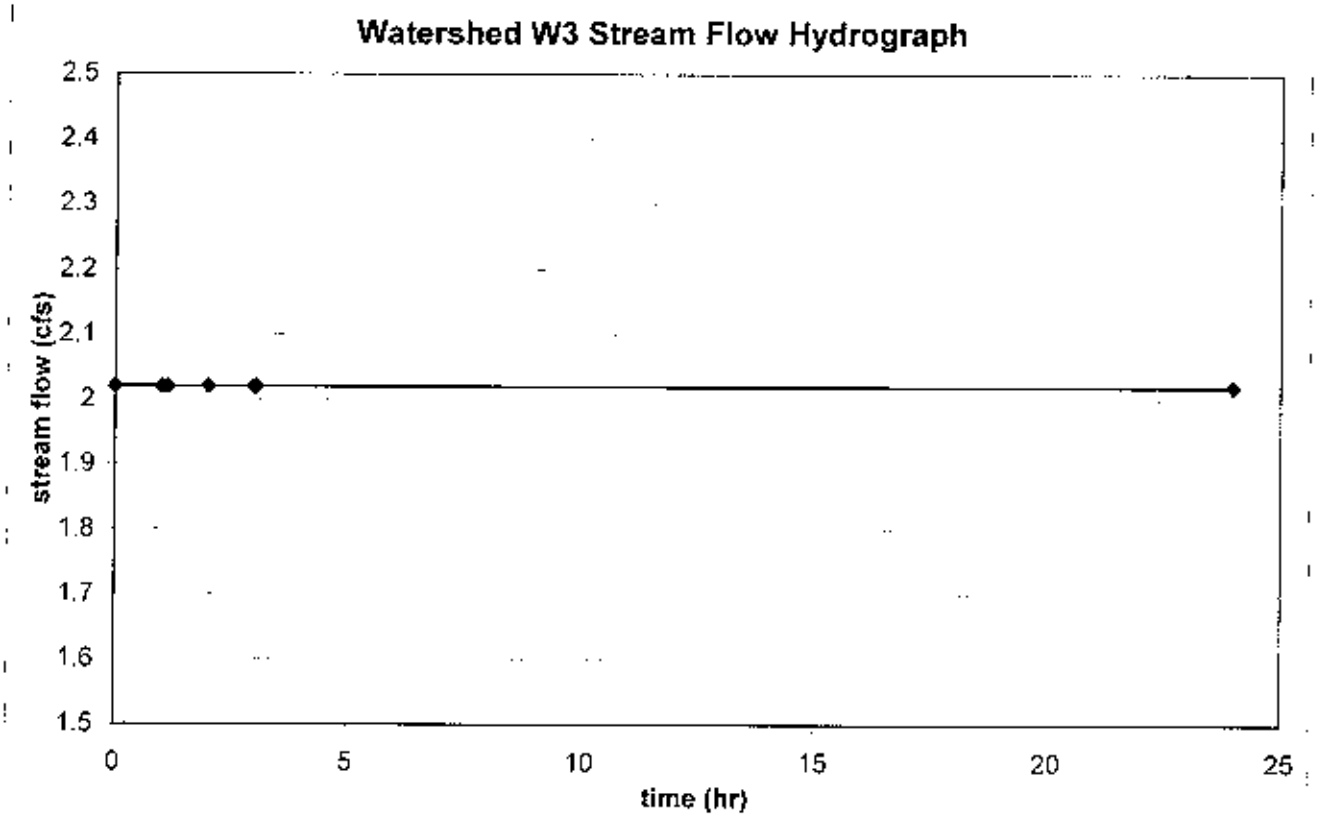
Time (hr)	Unit Hydrograph (cfs)	Storm Hydrograph (cfs)	Stream Hydrograph (cfs)
0	0.00	0	4.13
1	967.86	0	4.13
1.4	1355.00	0	4.13
2	1006.07	0	4.13
3	424.53	0	4.13
3.73	0.00	0	4.13
24		0	4.13



Trail Creek Watershed Study
July 12, 2006
IN20040385
Watershed W3 Hydrograph Calculations

**There is no run off in this watershed and therefore no storm hydrograph. The stream hydrograph for for the storm is simply the base flow of the stream.*

Time (hr)	Unit Hydrograph (cfs)	Storm Hydrograph (cfs)	Stream Hydrograph (cfs)
0	0.00	0	2.02
1	723.01	0	2.02
1.13	817.00	0	2.02
2	442.90	0	2.02
3	12.90	0	2.02
3.03	0.00	0	2.02
24		0	2.02



From HEC-1 Manual:

(1) $t_t = \frac{L}{3600V}$, t_t = travel time, V = velocity from Fig. 3.3.5

(2) $t_c = 2t_{tr}$, t_c = time of concentration

(3) $q_p = \frac{484 A_m Q'}{t_p}$ (4) $t_p = \frac{L_c}{2} + L = \frac{L_c}{2} + 0.6t_c$

t_p = time to peak, hr A_m = area, mi²

q_p = peak flow rate Q' = runoff, in

See attached sheet for [illegible]

$Q' = 2''$ [illegible]

See [illegible] to determine Unit [illegible] [illegible]

Unit Hydrograph Check

$V = 1'' \times 645.33 = 59.22 \times 645.33 = 38216.44$ cfs-hr

$V_{UH} = \Delta D \sum_{i=1}^{n} q_i = (22.68\,min)(\frac{[illegible]}{2})(\frac{hr}{60\,min}) = 71254.78$ cfs-hr

Try Triangular Unit Hydrograph:

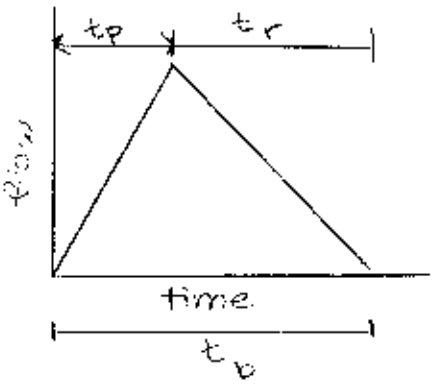
(5) $t_b = 2.67\,t_p$

(6) $t_r = 1.67\,t_p$

t_p = time to peak

t_b = base time

t_r = recession time



NOT TO SCALE

Unit Hydrograph Check

$V_{UH} = 38216.44$ cfs-hr

$V_{UH} = \frac{1}{2}(18.94)(1[illegible]) + \frac{1}{2}(31.62)(1[illegible]) = 38[illegible]$ cfs-hr

Triangular UH is [illegible]. Therefore, OK.

Linear [illegible] since they are through [illegible] ; $y = mx + c$

$c = 0$ [illegible] for [illegible]

[illegible]

[illegible]

E1

$m_1 = \frac{[illegible]}{[illegible]} = 685.843$; $y = 685.843x$

$m_2 = \frac{0 - [illegible]}{2.86 - 3.09} = -374.4186$; $y = -374.4186x + b$; $y = -374.4186x + 3082.5$

$0 = -374.4186(8.23) + b$

$b = 3082.5$

E6

$m_1 = \frac{[illegible] - 0}{4.11 - 0} = 472.8672$; $y = 472.8672x$

$m_2 = \frac{0 - [illegible]}{10.9 - [illegible]} = -282.[illegible]$; $y = -282.945x + b$; $y = -282.945x + 3103.707$

$0 = -282.945(10.97) + b$

$b = 3103.707$

E3

$m_1 = \frac{1792 - 0}{5.19 - 0} = 346.8788$; $y = 346.8788x$

$m_2 = \frac{0 - [illegible]}{13.87 - [illegible]} = -207.0876$; $y = -207.0876x + b$; $y = -207.0876x + 2871.4728$

$0 = -207.0876(13.87) + b$

$b = 2871.4728$

W1

$m_1 = \frac{[illegible] - 0}{9.14 - 0} = 86.[illegible]$; $y = 86.[illegible]x$

$m_2 = \frac{0 - 765}{24.41 - 9.14} = -49.4434$; $y = -49.4434x + b$; $y = -49.4434x + 1206.9134$

$0 = -49.4434(24.41) + b$

$b = 1206.9134$

W6

$m_1 = \frac{1326 - 0}{1.4 - 0} = 967.8571$; $y = 967.8571x$

$m_2 = \frac{0 - 125}{3.13 - 1.4} = -581.[illegible]$; $y = -581.[illegible]x + b$; $y = -581.[illegible]x + 2169.1632$

$0 = -581.[illegible](3.13) + b$

$b = 2169.1632$

(a) 3

$m_1 = \frac{837-0}{1.13-0} = 740.[illegible]$; $y = 740.0082$

$m_2 = \frac{0-837}{[illegible]-1.13} = -420$; $y = -420x + b$; $y = -420x + 1308.9$

$0 = -420(3.11) + b$

$b = 1308.9$

(b) 1

$m_1 = \frac{3000-0}{7.30-0} = 410.[illegible]$; $y = 410.3836x$

$m_2 = \frac{0-3000}{19.66-7.30} = -242.5808$; $y = -242.5808x + b$; $y = -242.5808x + 4767.0903$

$0 = -242.5808(19.66) + b$

$b = 4767.0903$

(c) 6

$m_1 = \frac{2337-0}{11.39-0} = 205.5409$; $y = 205.5409x$

$m_2 = \frac{0-2337}{30.37-[illegible]} = -123$; $y = -123x + b$; $y = -123x + 3735.81$

$0 = -123(30.37) + b$

$b = 3735.81$

M3

$m_1 = \frac{624-0}{16.50-0} = 103.0303$; $y = 103.0303x$

$m_2 = \frac{0-624}{43.[illegible]-[illegible]} = -62.0059$; $y = -62.0059x + b$; $y = -62.0059x + 2708.4177$

$0 = -62.0059(43.[illegible]) + b$

$b = 2708.4177$

M4

$m_1 = \frac{1[illegible]2-0}{17.10-0} = 95.0247$; $y = 95.0247x$

$m_2 = \frac{0-1[illegible]8}{45.62-17.10} = -57.0882$; $y = -57.0882x + b$; $y = -57.0882x + [illegible]$

$0 = -57.0882(45.62) + b$

$b = 2602.[illegible]$

M15

$m_1 = \frac{[illegible]}{17.71-0} = 89.441$; $y = [illegible]x$

$m_2 = \frac{0-1584}{[illegible]} = -53.[illegible]$; $y = -53.5497x + b$; $y = -53.5497x - [illegible]$

$0 = -53.5497([illegible]) + b$

$b = 8536.[illegible]$

M10

$m_1 = \frac{1513-0}{18.[illegible]-0} = 79.8132$; $y = 79.8132x$

$m_2 = \frac{0-1513}{[illegible]} = -47.8196$; $y = -47.8196x + [illegible]$

$0 = -47.8196([illegible]) + b$

$b = 0418.6351$

1. File: P:/IN6204/0385/C. Calcs_Data/Studies and Background Information/Drainage Calcs/Land Use For Drainage Calcs Hogan Calcs.XLS

Land Use Type – from Fred/Jim Data

Acres – [illegible] acres in land use in the given watershed calculated in Fred/Jim

A, B, C, D – Curve numbers for each soil type A, B based on the land use designation. Assumptions are for [illegible] attached Table 3.3.2 from [illegible] the [illegible]

2. File: P:/IN6204/0385/C. Calcs_Data/Studies and Background Information/Drainage Calcs/Soil Type.XLS

Map Symbol – from Fred/Jim Data

Total [illegible] acres of soil in the given watershed calculated in Fred/Jim

Type – Soil [illegible]

Percentage – Percentage of each soil type A-D in the watershed

3. File: P/IN6204/0385/C. Calcs_Data/Studies and Background Information/Base + Peak Flow.XLS

Values were obtained from [illegible] spreadsheet [illegible]. No calculations performed on this sheet.

4. File: P/IN6204/0385/C. Calcs_Data/Studies and [illegible] Base Flow Estimates.XLS

$$\text{Area}(mi^2) = \text{Area}(ac) \times \frac{43560\ ft^2}{ac} \times \left(\frac{mi}{5280\ ft}\right)^2$$

$$= (893.6\ ac)\left(\frac{43560\ ft^2}{ac}\right)\left(\frac{mi}{5280\ ft}\right)^2 = 12.33\ mi^2$$

$$\text{Annual Runoff}(ft^3) = 18.85'' \times \text{Area}(mi^2) \times \frac{1\ ft}{12''} \times \left(\frac{5280\ ft}{mi}\right)^2$$

$$= (18.85'')(12.33\ mi^2)\left(\frac{1\ ft}{12''}\right)\left(\frac{5280\ ft}{mi}\right)^2 = 540,125,000\ ft^3$$

- 18.85" is the annual runoff in Mississippi and was assumed to apply to the entire watershed

$$\text{Annual Flow}(cfs) = \frac{\text{Annual Runoff}(ft^3)}{31,536,000\ s} = 17.13\ cfs$$

- There are 31,536,000 seconds in a year

$$\text{Base Flow} = 0.76 \times \text{Annual Flow}$$

$$= 0.76(17.13)$$

$$= 13.02\ cfs$$

[illegible] P:\1N600\0322\C. Calcs_Data\Studies and Background Information\ [illegible] Hydrograph Calculations.xls

Sheet: Hydrograph Calculations

[illegible]

Beginning Ending Elevation [illegible]

Slope = (Beginning − Ending) / Travel Length

= (9.05 − 6.2) / [illegible] = [illegible]

Velocity = [illegible] / [illegible]

[illegible] under Bowman Estimate [illegible]

Time of Concentration = L / 3600V = [illegible] / 1.6 fps = 4.64 hr

$\Delta D = 0.133\, t_c = (0.133)(4.64\ hr) = 0.62\ hr$

Time to Peak $= \frac{\Delta D}{2} + 0.6\, t_c = \frac{0.62}{2} + 0.6(4.64) = 3.01\ hr$

Peak Flow $= 484 \times A_m \times \frac{Q'}{t_p} = (484)\frac{[illegible]}{3.01} = 1932\ cfs$

Base time $= 2.67\, t_p = 2.67(3.01) = 8.03\ hr$

Recession time $= 1.67\, t_p = 1.67(3.01) = 5.16\ hr$

$Q' = 1''$ (minimum depth for [illegible] generation)

Sheet: Triangular Unit Hydrograph Calculations

t_p, q_p, $t_{p/2}$, t_r – from [illegible] spreadsheet

Unit [illegible] – main points at $t=0$, $t=t_p$, & $t=t_b$ [illegible] slope [illegible] [illegible]

Sheet: SCS Type II Distribution

Time/Total Time – ratio from attached Soil Conservation Service Type II Storm Distribution sheet

Time (hr) = (24 hr)(Time/Total Time) = (24)(0.040) = 0.96 hr

- Looking at 1 yr, 24 hr storm → duration is 24 hr

Rainfall/Total Rainfall – ratio from same sheet as Time/Total Time

Cumulative Rainfall (in) = (2.48")(Rainfall/Total Rainfall)

= (2.48)(0.010) = 0.025"

- 2.48" & S values are from separate rainfall [illegible]

Cumulative Runoff = Q if P(t) < 0.25 [illegible] : Cumulative Depth

$$= \frac{(P(t) - 0.25)^2}{(P(t) + 0.85)}$$

$$= \frac{(1.64 - 0.25)^2}{1.64 + 0.85} = 0.0005''$$

Incremental Runoff = Current Runoff − Cumulative Runoff

$$= 0.0005 - 0.0000 = 0.0005''$$

Sheet: Watershed [illegible]

- See attached [illegible] for calculations. Sample calcs shown here

Peak Time = [illegible]

[illegible] =

$0.0005'' \times 1125.44$ [illegible]

[illegible] $\times 375.15$ = [illegible]

Storm Runoff = 0. − 0. [illegible] − [illegible] = 1.832 cfs

Total [illegible] = [illegible] + [illegible]

= 1.832 + 13.026 = 14.858 cfs

Trail Creek Watershed Study
REVISED Calculated Flows
IN20040385
July 19, 2006

**Watershed	Base Flow (cfs)		Peak Flow (cfs)		*With WWTP Flows (cfs) Base Flow (cfs)		*With WWTP Flows (cfs) Peak Flow (cfs)	
	Original	Revised	Original	Revised	Original	Revised	Original	Revised
E1	13.02	----	39.68	----	----	----	----	----
E2	17.39	----	38.17	----	----	----	----	----
E3	20.35	----	37.50	----	----	----	----	----
W1	15.05	----	104.73	----	----	----	----	----
W2	4.13	----	4.13	----	----	----	----	----
W3	2.02	----	2.02	----	----	----	----	----
M1	48.49	----	139.29	----	----	----	----	----
M2	57.95	57.94	151.59	184.07	----	----	----	----
M3	60.43	60.42	127.87	165.28	----	----	----	----
M4	60.71	60.70	125.97	164.24	----	----	----	----
M5	61.18	62.17	126.35	169.71	72.01	73.00	144.92	188.28
M6	62.50	62.53	141.06	181.22	73.33	73.36	159.63	199.79

*WWTP located between M4 and M5. Average daily flow is +/- 7 MGD (10.83 cfs) and peak wet weather flows are +/- 12 MGD (18.57 cfs).
Equations for Stream Flow when WWTP flow is added:

Base Flow + 10.83 cfs = Base Stream Flow w/WWTP cfs
Peak Flow + 18.57 cfs = Peak Stream Flow w/WWTP cfs

**Only flows for Watersheds M2, M3, M4, M5, & M6 have been revised. Base flow changed +/- 0.01 cfs with the exception of M5, which cahnged 1 cfs. Peak flow changed +/- 40 cfs.

Change in flows due to July 18, 2006 revisions (Revised - Original = Change in Flow, cfs)

Watershed	Base Δ	Peak Δ
M2	-0.01	32.48
M3	-0.01	37.41
M4	-0.01	38.27
M5	0.99	43.36
M6	0.03	40.16

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M2 - Watershed M1
Curve Number & Runoff Check for Michigan City

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1114.31	1537.21	1480.24	86.94	1513.62

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M2-M1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	740.57	12.92%	143.93	198.56	191.20	11.23
Developed Agriculture Row Crop	798.92	13.93%	155.27	214.20	206.26	12.11
Developed Non-Vegetated	142.71	2.49%	27.74	38.26	36.84	2.16
Developed Urban High Density	465.32	8.12%	90.44	124.76	120.14	7.06
Developed Urban Low Density	904.11	15.77%	175.72	242.41	233.42	13.71
Palustrine Forest Deciduous	535.97	9.35%	104.17	143.70	138.38	8.13
Palustrine Herbaceous Deciduous	16.29	0.28%	3.17	4.37	4.21	0.25
Palustrine Shrubland Deciduous	0.00	0.00%	0.00	0.00	0.00	0.00
Terrestrial Forest Deciduous	1890.75	32.98%	367.47	506.94	488.15	28.67
Terrestrial Forest Evergreen	0.07	0.00%	0.01	0.02	0.02	0.00
Terrestrial Forest Mixed	2.87	0.05%	0.56	0.77	0.74	0.04
Terrestrial Shrubland Deciduous	93.19	1.63%	18.11	24.99	24.06	1.41
Terrestrial Woodland Deciduous	118.11	2.06%	22.95	31.67	30.49	1.79
Unclassified Cloud/Shadow	0.00	0.00%	0.00	0.00	0.00	0.00
Water	24.52	0.43%	4.77	6.57	6.33	0.37
TOTAL	5733.41	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	7052.71	13700.50	15104.74	943.31	36801.25
Developed Agriculture Row Crop	7608.40	14779.96	16294.85	1017.63	39700.84
Developed Non-Vegetated	2468.53	3520.17	3463.40	205.58	9657.67
Developed Urban High Density	8048.88	11477.84	11292.74	670.32	31489.77
Developed Urban Low Density	8961.62	16483.61	18440.37	1151.62	45037.22
Palustrine Forest Deciduous	2604.20	7903.59	9686.31	625.80	20819.90
Palustrine Herbaceous Deciduous	79.17	240.27	294.47	19.02	632.93
Palustrine Shrubland Deciduous	0.00	0.00	0.00	0.00	0.00
Terrestrial Forest Deciduous	9186.87	27881.58	34170.53	2207.66	73446.63
Terrestrial Forest Evergreen	0.33	0.99	1.22	0.08	2.61
Terrestrial Forest Mixed	25.11	50.80	57.07	3.61	136.60
Terrestrial Shrubland Deciduous	543.35	1449.16	1708.22	110.22	3810.95
Terrestrial Woodland Deciduous	573.86	1741.63	2134.47	137.90	4587.87
Unclassified Cloud/Shadow	0.00	0.00	0.00	0.00	0.00
Water	343.14	539.12	550.79	33.09	1466.15

Total Sum:	267590.40
Total Acres:	4219.79
Composite Number:	63.41
Flow Rate (cfs):	

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M2 - Watershed M1
Curve Number & Runoff Check for Michigan City

Base Flow

Watershed	Area (ac)	Area (mi^2)	Annual Runoff (ft^3)	Annual Flow (cfs)	Base Flow (cfs)
M5-M1	5733.41	8.96	392,311,699	12.44	9.45

Hydrograph Calculations

Watershed	Travel Length, L (ft)	Beginning Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	*Velocity, v (ft/s)	Area, A_m (mi^2)	Time of Concentr-ation, t_c (hr)	ΔD (hr)	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M2-M1	24,100	695	590	0.004	0.8	8.96	8.37	1.11	5.58	777	14.89	9.31

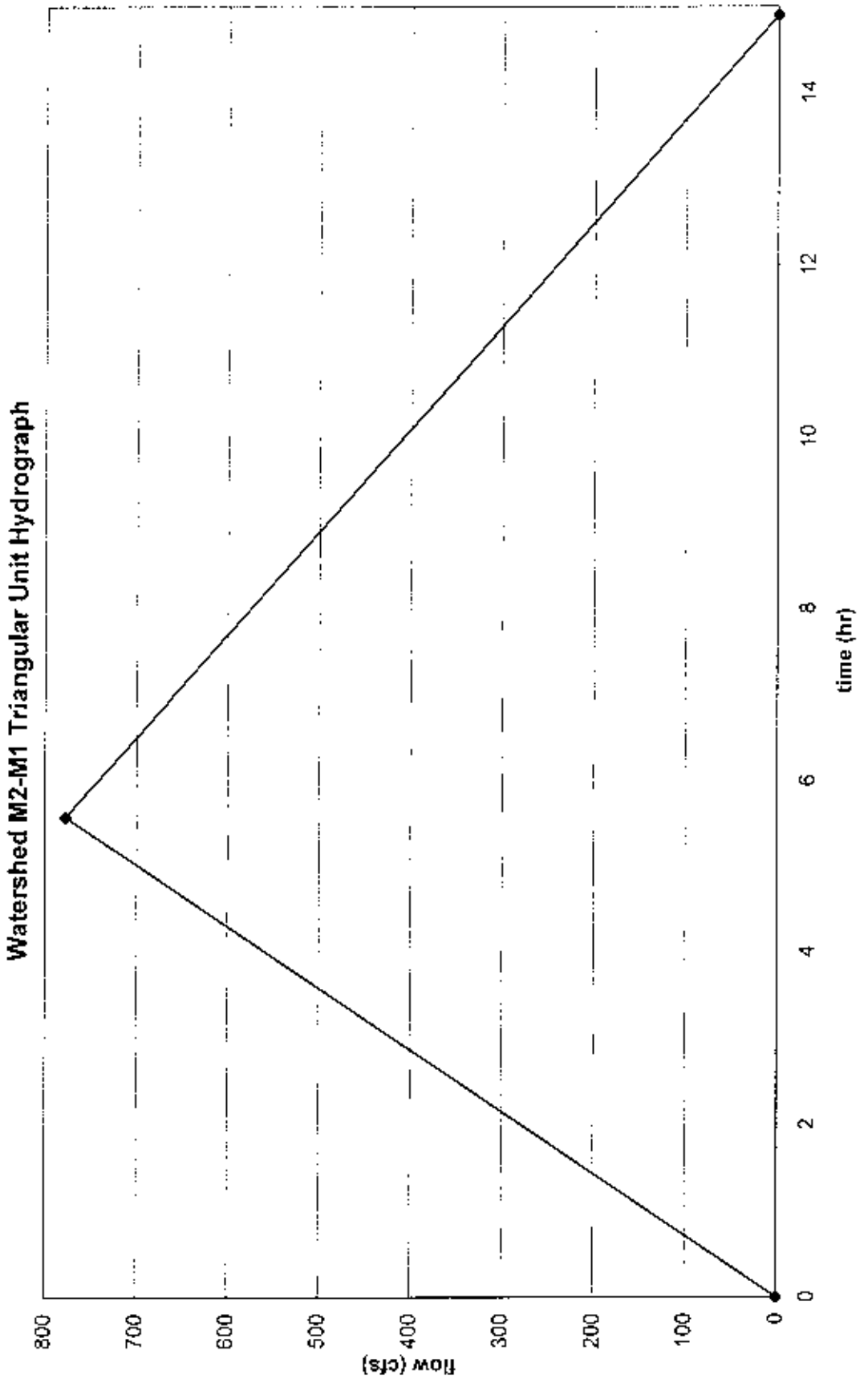
*Any watershed with a slop less than 0.005 has a velocity less than 1 ft/s. It was assumed that slope = 0.004 has a velocity of 0.8 ft/s and slope = 0.002 has a velocity of 0.5 ft/s.

Unit Hydrograph Calculations

Watershed	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M2-M1	5.58	777	14.89	9.31

Watershed M2-M1

Time (hr)	Flow (cfs)
0	0
5.58	777
14.89	0


Watershed M2-M1 Triangular Unit Hydrograph
flow (cfs)
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
14
time (hr)

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M2 - Watershed M1
SCS Type II Distribution

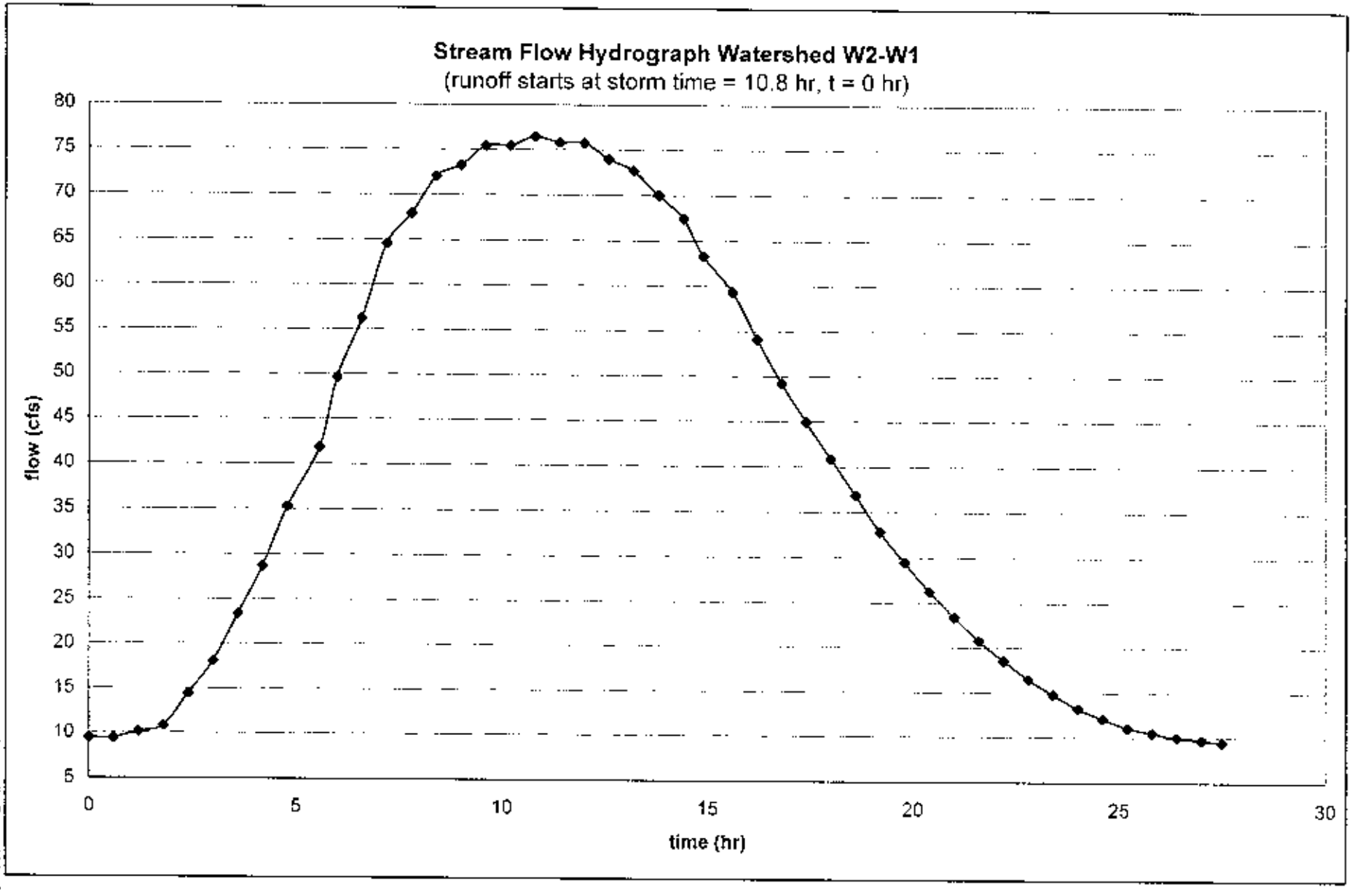
Watershed M2-M1, S = 5.77, 0.2S = 1.154

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0.0081	0.0081
0.520	12.48	0.730	1.568	0.0277	0.0196
0.530	12.72	0.750	1.611	0.0335	0.0058
0.540	12.96	0.770	1.654	0.0399	0.0063
0.550	13.20	0.780	1.675	0.0432	0.0034
0.560	13.44	0.800	1.718	0.0503	0.0071
0.570	13.68	0.810	1.740	0.0540	0.0037
0.580	13.92	0.820	1.761	0.0578	0.0038
0.600	14.40	0.835	1.794	0.0638	0.0060
0.630	15.12	0.860	1.847	0.0744	0.0105
0.650	15.60	0.870	1.869	0.0788	0.0044
0.670	16.08	0.880	1.890	0.0833	0.0045
0.700	16.80	0.895	1.922	0.0903	0.0070
0.720	17.28	0.910	1.955	0.0976	0.0073
0.750	18.00	0.920	1.976	0.1025	0.0050
0.770	18.48	0.930	1.998	0.1076	0.0051
0.800	19.20	0.940	2.019	0.1128	0.0052
0.830	19.92	0.950	2.041	0.1181	0.0053
0.850	20.40	0.960	2.062	0.1235	0.0054
0.870	20.88	0.970	2.084	0.1290	0.0055
0.900	21.60	0.980	2.105	0.1346	0.0056
0.950	22.80	0.990	2.127	0.1403	0.0057
1.000	24.00	1.000	2.148	0.1461	0.0058

Trail Creek Watershed Study
July 18, 2006
IN20040385
Watershed M2-M1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 10.8 hr)												Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2		
		0	0.0081	0.0351	0.0206	0.015	0.0115	0.0122	0.0103	0.0107	0.0111	0.0057	0.0058		
0	0.00	0.000												0.000	9.450
0.6	83.55	0.000	0.000											0.000	9.450
1.2	167.10	0.000	0.677	0.000										0.677	10.127
1.8	250.65	0.000	1.353	0.000										1.353	10.803
2.4	334.19	0.000	2.030	2.933	0.000									4.963	14.413
3.0	417.74	0.000	2.707	5.865	0.000									8.572	18.022
3.6	501.29	0.000	3.384	8.798	1.721	0.000								13.902	23.352
4.2	584.84	0.000	4.060	11.730	3.442	0.000								19.233	28.683
4.8	668.39	0.000	4.737	14.663	5.163	1.253	0.000							25.816	35.266
5.58	777.00	0.000	5.414	17.595	6.884	2.506	0.000							32.400	41.850
6.0	741.95	0.000	6.294	20.528	8.605	3.760	0.961	0.000						40.148	49.598
6.6	691.87	0.000	6.010	23.460	10.327	5.013	1.922	0.000						46.731	56.181
7.2	641.80	0.000	5.604	27.273	12.048	6.266	2.882	1.019	0.000					55.092	64.542
7.8	591.72	0.000	5.199	26.042	13.769	7.519	3.843	2.039	0.000					58.411	67.861
8.4	541.65	0.000	4.793	24.285	16.006	8.773	4.804	3.058	0.861	0.000				62.579	72.029
9.0	491.57	0.000	4.387	22.527	15.284	10.026	5.765	4.077	1.721	0.000				63.787	73.237
9.6	441.50	0.000	3.982	20.769	14.253	11.655	6.726	5.096	2.582	0.894	0.000			65.956	75.406
10.2	391.42	0.000	3.576	19.012	13.221	11.129	7.686	6.116	3.442	1.788	0.000			65.970	75.420
10.8	341.35	0.000	3.171	17.254	12.189	10.378	8.935	7.135	4.303	2.682	0.927	0.000		66.975	76.425
11.4	291.27	0.000	2.765	15.497	11.158	9.627	8.532	8.154	5.163	3.576	1.855	0.000		66.327	75.777
12.0	241.20	0.000	2.359	13.739	10.126	8.876	7.957	9.479	6.024	4.470	2.782	0.476	0.000	66.288	75.738
12.6	191.12	0.000	1.954	11.981	9.095	8.125	7.381	9.052	6.884	5.364	3.710	0.952	0.000	64.497	73.947
13.2	141.05	0.000	1.548	10.224	8.063	7.374	6.805	8.441	8.003	6.258	4.637	1.429	0.485	63.265	72.715
13.8	90.97	0.000	1.142	8.466	7.032	6.622	6.229	7.830	7.642	7.152	5.564	1.905	0.969	60.554	70.004
14.4	40.89	0.000	0.737	6.708	6.000	5.871	5.653	7.219	7.126	8.314	6.492	2.381	1.454	57.955	67.405
14.89	0.00	0.000	0.331	4.951	4.969	5.120	5.077	6.608	6.611	7.939	7.419	2.857	1.938	53.820	63.270
15.6			0.000	3.193	3.937	4.369	4.501	5.997	6.095	7.403	8.625	3.334	2.423	49.877	59.327
16.2			0.000	1.435	2.906	3.618	3.925	5.386	5.579	6.867	8.236	3.810	2.907	44.670	54.120
16.8				0.000	1.874	2.867	3.350	4.775	5.063	6.331	7.680	4.429	3.392	39.761	49.211

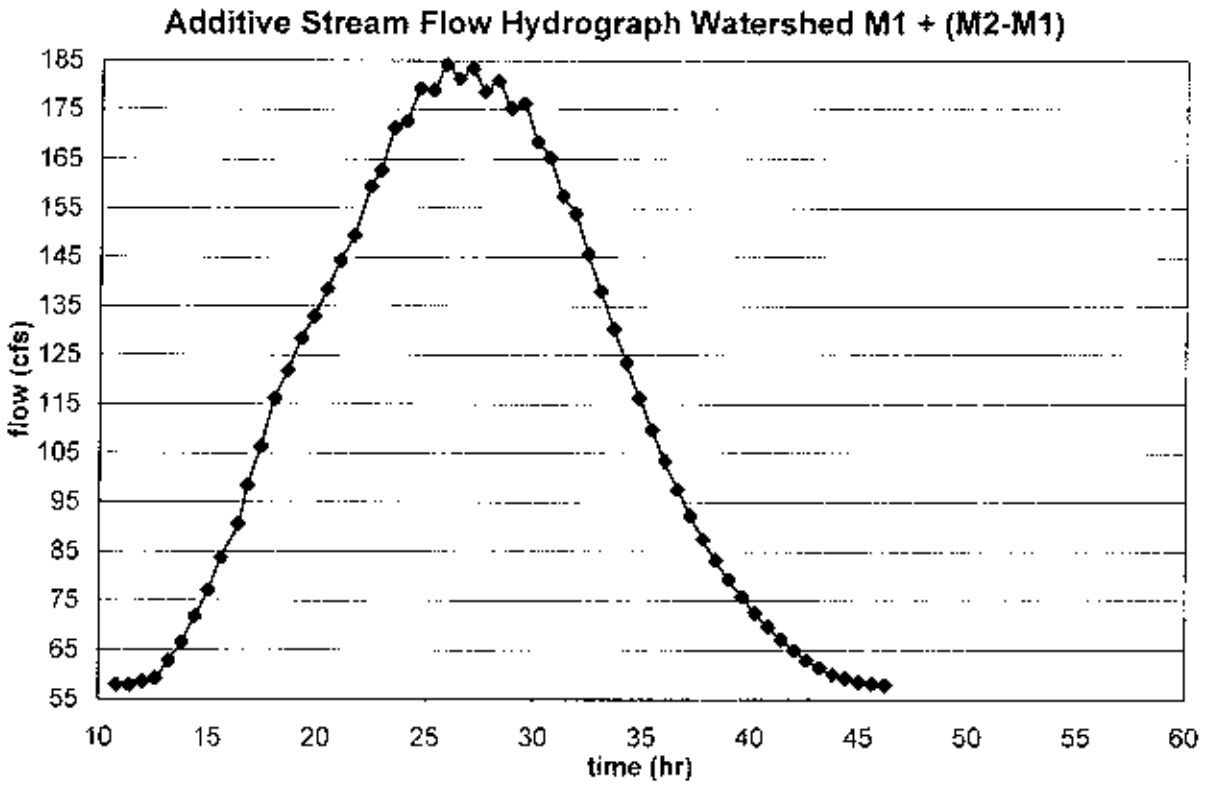
17.4				0.000	0.842	2.116	2.774	4.164	4.647	5.796	7.124	4.229	3.877	35.469	44.919
18.0					0.000	1.365	2.198	3.554	4.032	5.260	6.568	3.944	4.507	31.426	40.876
18.6					0.000	0.613	1.622	2.943	3.516	4.724	6.012	3.658	4.303	27.392	36.842
19.2						0.000	1.046	2.332	3.000	4.188	5.456	3.373	4.013	23.408	32.858
19.8						0.000	0.470	1.721	2.484	3.652	4.901	3.087	3.722	20.038	29.488
20.4							0.000	1.110	1.969	3.117	4.345	2.802	3.432	16.774	26.224
21.0							0.000	0.499	1.453	2.581	3.789	2.517	3.142	13.979	23.429
21.6								0.000	0.937	2.045	3.233	2.231	2.851	11.297	20.747
22.2								0.000	0.421	1.509	2.677	1.946	2.561	9.114	18.564
22.8									0.000	0.973	2.121	1.660	2.270	7.025	16.475
23.4									0.000	0.438	1.566	1.375	1.980	5.358	14.808
24.0										0.000	1.010	1.089	1.689	3.789	13.239
24.6										0.000	0.454	0.804	1.399	2.657	12.107
25.2											0.000	0.519	1.108	1.627	11.077
25.8											0.000	0.233	0.818	1.051	10.501
26.4												0.000	0.528	0.528	9.978
27.0												0.000	0.237	0.237	9.687
27.49													0.000	0.000	9.450
													SUM =	**1410.750**	**1854.900**


Stream Flow Hydrograph Watershed W2-W1
(runoff starts at storm time = 10.8 hr, t = 0 hr)
flow (cfs)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
time (hr)

Trail Creek Watershed Study
Additive Stream Flow Hydrograph
Watershed M1 + (M2-M1)
July 18, 2006
IN20040385

Storm Time (hr)	M1 Time (hr)	M1 Time Actual (hr)	Stream Flow from M1 (cfs)	M2-M1 Time (hr)	Stream Flow M2-M1 (cfs)	Sum (cfs) M1 + (M2-M1)
10.8	0		48.490	0	9.450	57.940
11.4	0		48.490	0.6	9.450	57.940
12.0	0		48.490	1.2	10.127	58.617
12.6	0.6		48.490	1.8	10.803	59.293
13.2	1.2		48.490	2.4	14.413	62.903
13.8	1.8		48.490	3.0	18.022	66.512
14.4	2.4		48.490	3.6	23.352	71.842
15.0	3.0	0.0	48.490	4.2	28.683	77.173
15.6	3.6	0.6	48.490	4.8	35.266	83.756
16.2	4.2	1.2	48.736			
16.38	4.38			5.58	41.850	90.586
16.8	4.8	1.8	48.982	6.0	49.598	98.580
17.4	5.4	2.4	50.287	6.6	56.181	106.468
18.0	6.0	3.0	51.592	7.2	64.542	116.134
18.6	6.6	3.6	53.980	7.8	67.861	121.841
19.2	7.2	4.2	56.368	8.4	72.029	128.397
19.8	7.8	4.8	59.741	9.0	73.237	132.979
20.4	8.4	5.4	63.114	9.6	75.406	138.520
21.0	9.0	6.0	68.905	10.2	75.420	144.325
21.6	9.6	6.6	73.017	10.8	76.425	149.442
22.2	10.2	7.2		11.4	75.777	
22.36	10.36	7.36	83.666	11.56		159.442
22.8	10.8	7.8	87.055	12.0	75.738	162.794
23.4	11.4	8.4	97.312	12.6	73.947	171.260
24.0	12.0	9.0	99.974	13.2	72.715	172.689
24.6	12.6	9.6	109.321	13.8	70.004	179.325
25.2	13.2	10.2	111.611	14.4	67.405	179.016
25.69	13.69			14.89	63.270	
25.8	13.8	10.8	120.799	15.0		184.070
26.4	14.4	11.4	121.935	15.6	59.327	181.261
27.0	15.0	12.0	129.320	16.2	54.120	183.439
27.6	15.6	12.6	129.483	16.8	49.211	178.694
28.2	16.2	13.2	135.920	17.4	44.919	180.839
28.8	16.8	13.8	134.293	18.0	40.876	175.169
29.4	17.4	14.4	139.286	18.6	36.842	176.128
30.0	18.0	15.0	135.711	19.2	32.858	168.569
30.6	18.6	15.6	135.840	19.8	29.488	165.328
31.2	19.2	16.2	131.229	20.4	26.224	157.453
31.8	19.8	16.8	130.475	21.0	23.429	153.904
32.4	20.4	17.4	124.893	21.6	20.747	145.640
33.0	21.0	18.0	119.515	22.2	18.564	138.079
33.6	21.6	18.6	113.928	22.8	16.475	130.404
34.2	22.2	19.2	108.554	23.4	14.808	123.362
34.66	22.66	19.66	103.074	23.86		

34.8	22.8			24.0	13.239	116.312
35.4	23.4	20.4	97.628	24.6	12.107	109.735
36.0	24.0	21.0	92.295	25.2	11.077	103.372
36.6	24.6	21.6	87.110	25.8	10.501	97.611
37.2	25.2	22.2	82.411	26.4	9.978	92.388
37.8	25.8	22.8	77.863	27.0	9.687	87.550
38.4	26.4	23.4	73.811	27.49	9.450	83.261
39.0	27.0	24.0	69.898	27.49	9.450	79.348
39.6	27.6	24.6	66.436	27.49	9.450	75.886
40.2	28.2	25.2	63.132	27.49	9.450	72.582
40.8	28.8	25.8	60.348	27.49	9.450	69.798
41.4	29.4	26.4	57.704	27.49	9.450	67.154
42.0	30.0	27.0	55.524	27.49	9.450	64.974
42.6	30.6	27.6	53.502	27.49	9.450	62.952
43.2	31.2	28.2	51.999	27.49	9.450	61.449
43.8	31.8	28.8	50.665	27.49	9.450	60.115
44.4	32.4	29.4	49.884	27.49	9.450	59.334
45.0	33.0	30.0	49.193	27.49	9.450	58.643
45.6	33.6	30.6	48.795	27.49	9.450	58.245
46.2	34.2	31.2	48.490	27.49	9.450	57.940



Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M3 - Watershed M1
Curve Number & Runoff Check for Michigan City

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1861.33	1991.41	1539.33	113.3	1731.32

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M3-M1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	887.72	12.27%	228.31	244.27	188.81	13.90
Developed Agriculture Row Crop	1044.14	14.43%	268.54	287.30	222.08	16.35
Developed Non-Vegetated	161.44	2.23%	41.52	44.42	34.34	2.53
Developed Urban High Density	535.32	7.40%	137.68	147.30	113.86	8.38
Developed Urban Low Density	976.98	13.50%	251.27	268.83	207.80	15.29
Palustrine Forest Deciduous	762.13	10.53%	196.01	209.71	162.10	11.93
Palustrine Herbaceous Deciduous	17.12	0.24%	4.40	4.71	3.64	0.27
Palustrine Shrubland Deciduous	0.00	0.00%	0.00	0.00	0.00	0.00
Terrestrial Forest Deciduous	2603.87	35.98%	669.68	716.48	553.83	40.76
Terrestrial Forest Evergreen	0.02	0.00%	0.01	0.01	0.01	0.00
Terrestrial Forest Mixed	2.94	0.04%	0.76	0.81	0.63	0.05
Terrestrial Shrubland Deciduous	97.53	1.35%	25.08	26.84	20.74	1.53
Terrestrial Woodland Deciduous	123.96	1.71%	31.88	34.11	26.37	1.94
Unclassified Cloud/Shadow	0.00	0.00%	0.00	0.00	0.00	0.00
Water	24.11	0.33%	6.20	6.63	5.13	0.38
TOTAL	7237.28	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	11187.22	16854.37	14916.31	1167.38	44125.28
Developed Agriculture Row Crop	13158.34	19824.01	17544.48	1373.06	51899.90
Developed Non-Vegetated	3695.21	4086.72	3227.64	240.09	11249.67
Developed Urban High Density	12253.21	13551.43	10702.77	796.14	37303.54
Developed Urban Low Density	12814.58	18280.18	16416.09	1284.75	48795.62
Palustrine Forest Deciduous	4900.25	11533.95	11347.09	918.70	28700.00
Palustrine Herbaceous Deciduous	110.06	259.05	254.85	20.63	644.60
Palustrine Shrubland Deciduous	0.00	0.00	0.00	0.00	0.00
Terrestrial Forest Deciduous	16741.97	39406.39	38767.97	3138.80	98055.13
Terrestrial Forest Evergreen	0.16	0.37	0.37	0.03	0.93
Terrestrial Forest Mixed	34.03	53.40	48.16	3.82	139.42
Terrestrial Shrubland Deciduous	752.51	1556.53	1472.85	119.10	3900.99
Terrestrial Woodland Deciduous	797.04	1876.04	1845.65	149.43	4668.16
Unclassified Cloud/Shadow	0.00	0.00	0.00	0.00	0.00
Water	446.42	543.96	446.11	33.59	1470.08

Total Sum:	330953.30
Total Acres:	5505.96
Composite Number:	60.11
Flow Rate (cfs):	

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M3 - Watershed M1
Curve Number & Runoff Check for Michigan City

Base Flow

Watershed	Area (ac)	Area (mi^2)	Annual Runoff (ft^3)	Annual Flow (cfs)	Base Flow (cfs)
M3-M1	7237.28	11.31	495,214,503	15.70	11.93

Hydrograph Calculations

Watershed	Travel Length, L (ft)	Beginning Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	*Velocity, v (ft/s)	Area, A_m (mi^2)	Time of Concentr-ation, t_c (hr)	ΔD (hr)	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M3-M1	33,362	695	590	0.003	0.6	11.31	15.45	2.05	10 29	532	27.49	17 19

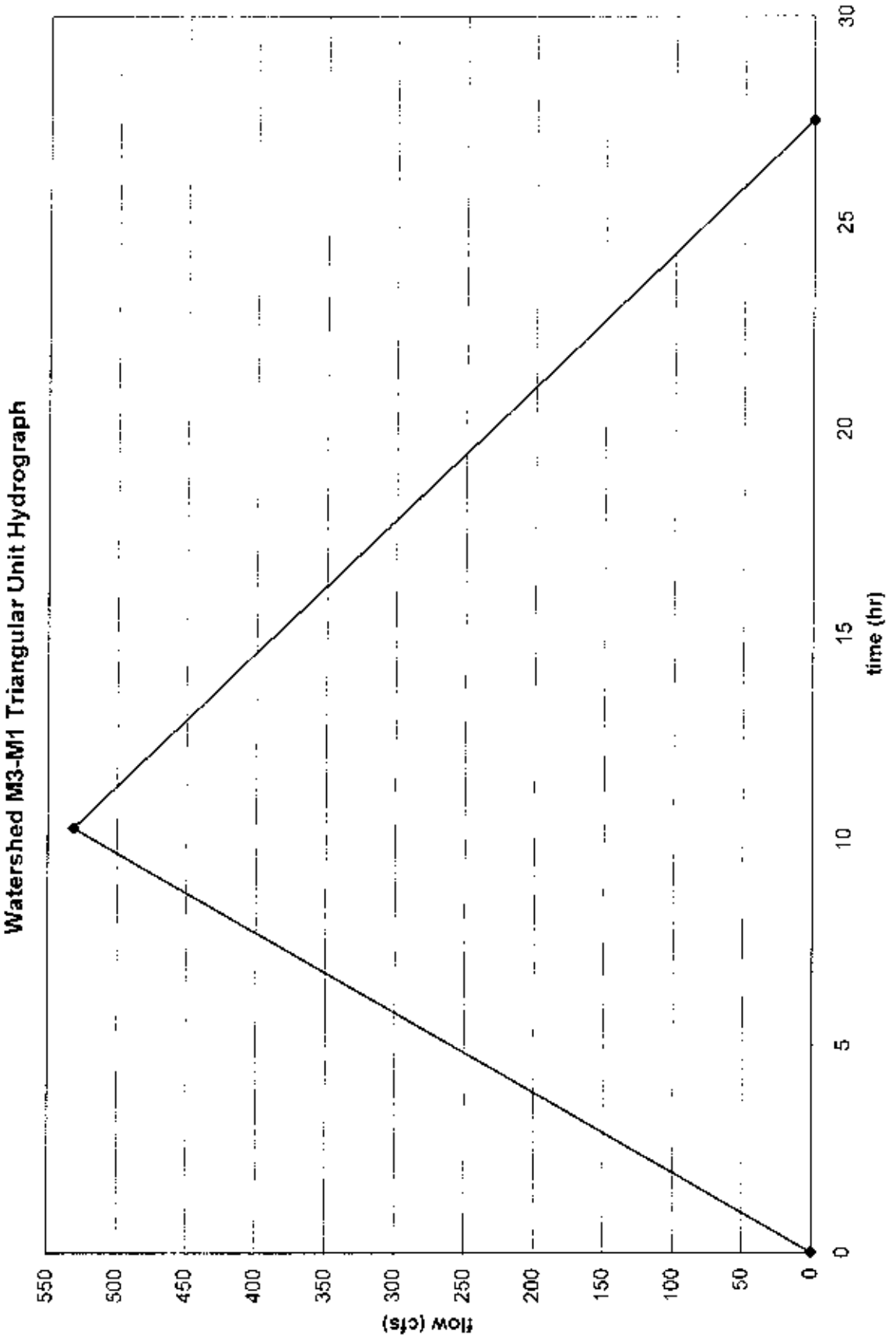
*Any watershed with a slop less than 0.005 has a velocity less than 1 ft/s. It was assumed that slope = 0 004 has a velocity of 0.8 ft/s and slope = 0.002 has a velocity of 0.5 ft/s.

Unit Hydrograph Calculations

Watershed	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M3-M1	10.29	532	27.49	17.19

Watershed M3-M1

Time (hr)	Flow (cfs)
0	0
10.29	532
27.49	0


Watershed M3-M1 Triangular Unit Hydrograph
flow (cfs)
550
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
time (hr)

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M3 - Watershed M1
SCS Type II Distribution

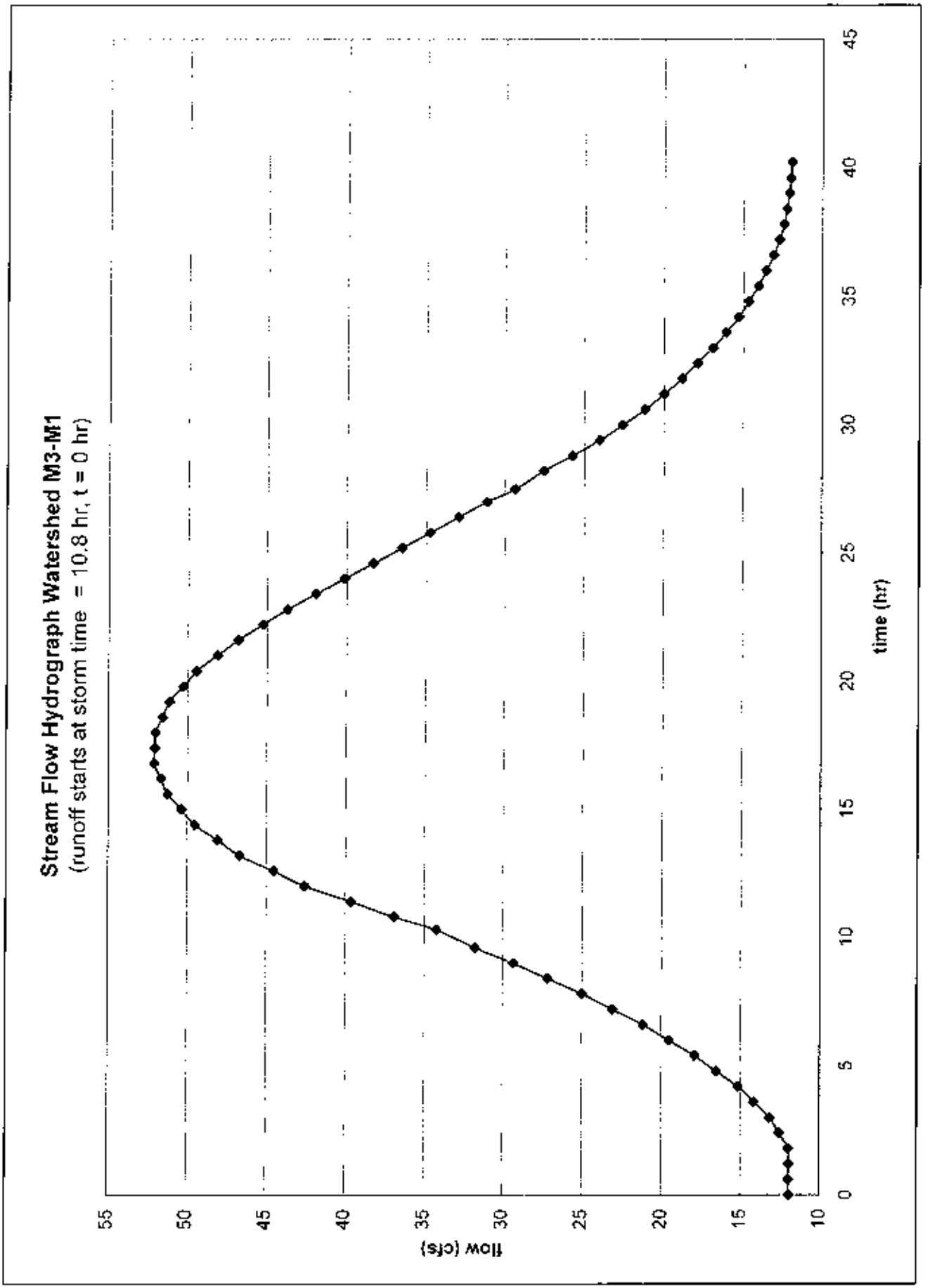
Watershed M3-M1, S = 6.64, 0.2S = 1.327

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0.0004	0.0004
0.520	12.48	0.730	1.568	0.0091	0.0087
0.530	12.72	0.750	1.611	0.0125	0.0034
0.540	12.96	0.770	1.654	0.0165	0.0040
0.550	13.20	0.780	1.675	0.0187	0.0022
0.560	13.44	0.800	1.718	0.0234	0.0047
0.570	13.68	0.810	1.740	0.0260	0.0026
0.580	13.92	0.820	1.761	0.0287	0.0027
0.600	14.40	0.835	1.794	0.0329	0.0043
0.630	15.12	0.860	1.847	0.0406	0.0077
0.650	15.60	0.870	1.869	0.0439	0.0033
0.670	16.08	0.880	1.890	0.0473	0.0034
0.700	16.80	0.895	1.922	0.0526	0.0053
0.720	17.28	0.910	1.955	0.0582	0.0056
0.750	18.00	0.920	1.976	0.0621	0.0039
0.770	18.48	0.930	1.998	0.0660	0.0040
0.800	19.20	0.940	2.019	0.0701	0.0041
0.830	19.92	0.950	2.041	0.0743	0.0042
0.850	20.40	0.960	2.062	0.0786	0.0043
0.870	20.88	0.970	2.084	0.0830	0.0044
0.900	21.60	0.980	2.105	0.0875	0.0045
0.950	22.80	0.990	2.127	0.0922	0.0046
1.000	24.00	1.000	2.148	0.0969	0.0047

Trail Creek Watershed Study
July 18, 2006
IN20040385
Watershed M3-M1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 10.8 hr)												Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2		
		0	0.0004	0.0183	0.0142	0.011	0.0087	0.0095	0.008	0.0085	0.0089	0.0047	0.0047		
0	0.00	0.000												0.000	11.930
0.6	31.02	0.000	0.000											0.000	11.930
1.2	62.04	0.000	0.012	0.000										0.012	11.942
1.8	93.06	0.000	0.025	0.000										0.025	11.955
2.4	124.08	0.000	0.037	0.568	0.000									0.605	12.535
3.0	155.10	0.000	0.050	1.135	0.000									1.185	13.115
3.6	186.12	0.000	0.062	1.703	0.440	0.000								2.206	14.136
4.2	217.14	0.000	0.074	2.271	0.881	0.000								3.226	15.156
4.8	248.16	0.000	0.087	2.838	1.321	0.341	0.000							4.588	16.518
5.4	279.18	0.000	0.099	3.406	1.762	0.682	0.000							5.950	17.880
6.0	310.20	0.000	0.112	3.974	2.202	1.024	0.270	0.000						7.581	19.511
6.6	341.22	0.000	0.124	4.541	2.643	1.365	0.540	0.000						9.213	21.143
7.2	372.25	0.000	0.136	5.109	3.083	1.706	0.810	0.295	0.000					11.139	23.069
7.8	403.27	0.000	0.149	5.677	3.524	2.047	1.080	0.589	0.000					13.066	24.996
8.4	434.29	0.000	0.161	6.244	3.964	2.389	1.349	0.884	0.248	0.000				15.240	27.170
9.0	465.31	0.000	0.174	6.812	4.405	2.730	1.619	1.179	0.496	0.000				17.415	29.345
9.6	496.33	0.000	0.186	7.380	4.845	3.071	1.889	1.473	0.744	0.264	0.000			19.853	31.783
10.29	532.00	0.000	0.199	7.947	5.286	3.412	2.159	1.768	0.993	0.527	0.000			22.291	34.221
10.8	516.23	0.000	0.213	8.515	5.726	3.753	2.429	2.063	1.241	0.791	0.276	0.000		25.007	36.937
11.4	497.67	0.000	0.206	9.083	6.167	4.095	2.699	2.358	1.489	1.055	0.552	0.000		27.703	39.633
12.0	479.11	0.000	0.199	9.736	6.607	4.436	2.969	2.652	1.737	1.318	0.828	0.146	0.000	30.628	42.558
12.6	460.55	0.000	0.192	9.447	7.048	4.777	3.239	2.947	1.985	1.582	1.104	0.292	0.000	32.612	44.542
13.2	441.99	0.000	0.184	9.107	7.554	5.118	3.508	3.242	2.233	1.846	1.380	0.437	0.146	34.757	46.687
13.8	423.43	0.000	0.177	8.768	7.330	5.460	3.778	3.536	2.482	2.109	1.656	0.583	0.292	36.171	48.101
14.4	404.88	0.000	0.169	8.428	7.067	5.852	4.048	3.831	2.730	2.373	1.933	0.729	0.437	37.597	49.527
15.0	386.32	0.000	0.162	8.088	6.803	5.678	4.318	4.126	2.978	2.637	2.209	0.875	0.583	38.457	50.387
15.6	367.76	0.000	0.155	7.749	6.540	5.474	4.628	4.420	3.226	2.900	2.485	1.021	0.729	39.327	51.257
16.2	349.20	0.000	0.147	7.409	6.276	5.270	4.491	4.715	3.474	3.164	2.761	1.166	0.875	39.749	51.679
16.8	330.64	0.000	0.140	7.070	6.013	5.066	4.330	5.054	3.722	3.428	3.037	1.312	1.021	40.192	52.122
17.4	312.09	0.000	0.132	6.730	5.749	4.862	4.168	4.904	3.971	3.691	3.313	1.458	1.166	40.145	52.075
18.0	293.53	0.000	0.125	6.390	5.486	4.658	4.007	4.728	4.256	3.955	3.589	1.604	1.312	40.109	52.039
18.6	274.97	0.000	0.117	6.051	5.222	4.454	3.845	4.552	4.130	4.219	3.865	1.750	1.458	39.662	51.592

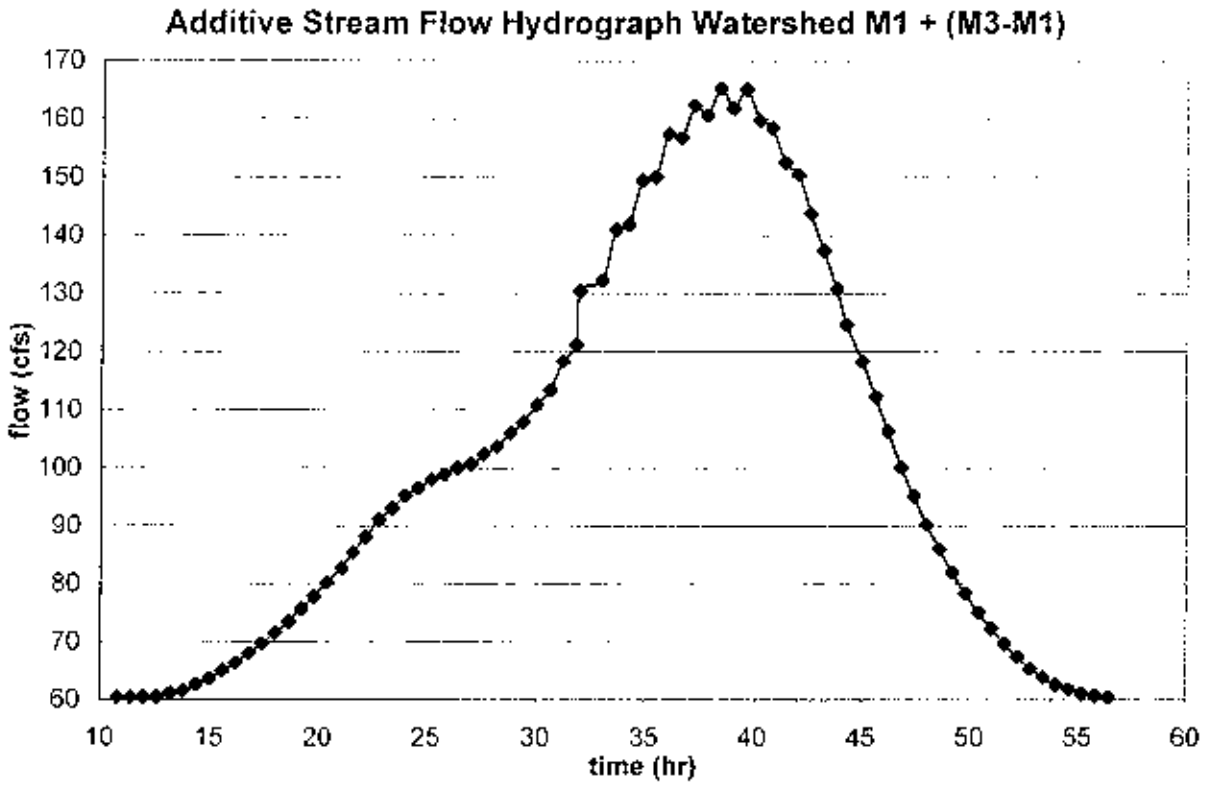
19.2	256.41	0.000	0.110	5.711	4.959	4.250	3.684	4.375	3.981	4.522	4.141	1.895	1.604	39.232	51.162
19.8	237.85	0.000	0.103	5.372	4.695	4.045	3.522	4.199	3.833	4.388	4.417	2.041	1.750	38.365	50.295
20.4	219.30	0.000	0.095	5.032	4.432	3.841	3.361	4.023	3.684	4.230	4.735	2.187	1.895	37.515	49.445
21.0	200.74	0.000	0.088	4.692	4.168	3.637	3.200	3.846	3.536	4.072	4.594	2.333	2.041	36.208	48.138
21.6	182.18	0.000	0.080	4.353	3.905	3.433	3.038	3.670	3.387	3.915	4.429	2.500	2.187	34.897	46.827
22.2	163.62	0.000	0.073	4.013	3.641	3.229	2.877	3.494	3.239	3.757	4.264	2.426	2.333	33.345	45.275
22.8	145.06	0.000	0.065	3.673	3.378	3.025	2.715	3.317	3.091	3.599	4.099	2.339	2.500	31.802	43.732
23.4	126.50	0.000	0.058	3.334	3.114	2.821	2.554	3.141	2.942	3.441	3.934	2.252	2.426	30.017	41.947
24.0	107.95	0.000	0.051	2.994	2.850	2.616	2.392	2.965	2.794	3.284	3.769	2.165	2.339	28.218	40.148
24.6	89.39	0.000	0.043	2.655	2.587	2.412	2.231	2.789	2.645	3.126	3.603	2.077	2.252	26.420	38.350
25.2	70.83	0.000	0.036	2.315	2.323	2.208	2.069	2.612	2.497	2.968	3.438	1.990	2.165	24.622	36.552
25.8	52.27	0.000	0.028	1.975	2.060	2.004	1.908	2.436	2.348	2.810	3.273	1.903	2.077	22.823	34.753
26.4	33.71	0.000	0.021	1.636	1.796	1.800	1.746	2.260	2.200	2.653	3.108	1.816	1.990	21.025	32.955
27.0	15.16	0.000	0.013	1.296	1.533	1.596	1.585	2.083	2.051	2.495	2.943	1.728	1.903	19.227	31.157
27.49	0.00	0.000	0.006	0.957	1.269	1.392	1.424	1.907	1.903	2.337	2.778	1.641	1.816	17.429	29.359
28.2			0.000	0.617	1.006	1.187	1.262	1.731	1.754	2.179	2.612	1.554	1.728	15.632	27.562
28.8			0.000	0.277	0.742	0.983	1.101	1.554	1.606	2.022	2.447	1.467	1.641	13.841	25.771
29.4				0.000	0.479	0.779	0.939	1.378	1.457	1.864	2.282	1.380	1.554	12.112	24.042
30.0				0.000	0.215	0.575	0.778	1.202	1.309	1.706	2.117	1.292	1.467	10.661	22.591
30.6					0.000	0.371	0.616	1.025	1.161	1.549	1.952	1.205	1.380	9.258	21.188
31.2					0.000	0.167	0.455	0.849	1.012	1.391	1.787	1.118	1.292	8.070	20.000
31.8						0.000	0.293	0.673	0.864	1.233	1.621	1.031	1.205	6.920	18.850
32.4						0.000	0.132	0.497	0.715	1.075	1.456	0.943	1.118	5.936	17.866
33.0							0.000	0.320	0.567	0.918	1.291	0.856	1.031	4.982	16.912
33.6							0.000	0.144	0.418	0.760	1.126	0.769	0.943	4.160	16.090
34.2								0.000	0.270	0.602	0.961	0.682	0.856	3.371	15.301
34.8								0.000	0.121	0.444	0.796	0.595	0.769	2.725	14.655
35.4									0.000	0.287	0.630	0.507	0.682	2.106	14.036
36.0									0.000	0.129	0.465	0.420	0.595	1.609	13.539
36.6										0.000	0.300	0.333	0.507	1.140	13.070
37.2										0.000	0.135	0.246	0.420	0.801	12.731
37.8											0.000	0.158	0.333	0.491	12.421
38.4											0.000	0.071	0.246	0.317	12.247
39.0												0.000	0.158	0.158	12.088
39.6												0.000	0.071	0.071	12.001
40.2													0.000	0.000	11.930
													SUM =	1181.222	1992.462


Stream Flow Hydrograph Watershed M3-M1
(runoff starts at storm time = 10.8 hr, t = 0 hr)
flow (cfs)
55
50
45
40
35
30
25
20
15
10
0
5
10
15
20
25
30
35
40
45
time (hr)

Trail Creek Watershed Study
Additive Stream Flow Hydrograph
Watershed M1 + (M3-M1)
July 18, 2006
IN20040385

Storm Time (hr)	M1 Time (hr)	M1 Time Actual (hr)	Stream Flow from M1 (cfs)	M3-M1 Time (hr)	Stream Flow M3-M1 (cfs)	Sum (cfs) M1 + (M3-M1)
10.8	0		48.490	0	11.930	60.420
11.4	0		48.490	0.6	11.930	60.420
12.0	0		48.490	1.2	11.942	60.432
12.6	0.6		48.490	1.8	11.955	60.445
13.2	1.2		48.490	2.4	12.535	61.025
13.8	1.8		48.490	3.0	13.115	61.605
14.4	2.4		48.490	3.6	14.136	62.626
15.0	3.0		48.490	4.2	15.156	63.646
15.6	3.6		48.490	4.8	16.518	65.008
16.2	4.2		48.490	5.4	17.880	66.370
16.8	4.8		48.490	6.0	19.511	68.001
17.4	5.4		48.490	6.6	21.143	69.633
18.0	6.0		48.490	7.2	23.069	71.559
18.6	6.6		48.490	7.8	24.996	73.486
19.2	7.2		48.490	8.4	27.170	75.660
19.8	7.8		48.490	9.0	29.345	77.835
20.4	8.4		48.490	9.6	31.783	80.273
21.0	9.0		48.490	10.2		
21.09	9.09			10.29	34.221	82.711
21.6	9.6		48.490	10.8	36.937	85.427
22.2	10.2		48.490	11.4	39.633	88.123
22.8	10.8		48.490	12.0	42.558	91.048
23.4	11.4		48.490	12.6	44.542	93.032
24.0	12.0		48.490	13.2	46.687	95.177
24.6	12.6		48.490	13.8	48.101	96.591
25.2	13.2	0	48.490	14.4	49.527	98.017
25.8	13.8	0.6	48.490	15.0	50.387	98.877
26.4	14.4	1.2	48.736	15.6	51.257	99.993
27.0	15.0	1.8	48.982	16.2	51.679	100.662
27.6	15.6	2.4	50.287	16.8	52.122	102.409
28.2	16.2	3.0	51.592	17.4	52.075	103.667
28.8	16.8	3.6	53.980	18.0	52.039	106.020
29.4	17.4	4.2	56.368	18.6	51.592	107.960
30.0	18.0	4.8	59.741	19.2	51.162	110.903
30.6	18.6	5.4	63.114	19.8	50.295	113.409
31.2	19.2	6.0	68.905	20.4	49.445	118.350
31.8	19.8	6.6	73.017	21.0	48.138	121.154
32.4	20.4	7.2		21.6	46.827	
31.96	19.96	7.36	83.666			130.493
33.0	21.0	7.8	87.055	22.2	45.275	132.331
33.6	21.6	8.4	97.312	22.8	43.732	141.044
34.2	22.2	9.0	99.974	23.4	41.947	141.920
34.8	22.8	9.6	109.321	24.0	40.148	149.469
35.4	23.4	10.2	111.611	24.6	38.350	149.961

36.0	24.0	10.8	120.799	25.2	36.552	157.351
36.6	24.6	11.4	121.935	25.8	34.753	156.688
37.2	25.2	12 0	129.320	26.4	32.955	162 275
37.8	25.8	12 6	129.483	27.0	31 157	160.640
38.29	26.29			27.49	29.359	
38.4	26.4	13.2	135.920	27.6		165.279
39.0	27 0	13.8	134.293	28.2	27.562	161.855
39.6	27.6	14.4	139.286	28.8	25.771	165.057
40.2	28.2	15 0	135.711	29.4	24.042	159.753
40.8	28.8	15.6	135.840	30.0	22.591	158 431
41.4	29 4	16.2	131.229	30.6	21.188	152.417
42 0	30.0	16.8	130.475	31.2	20.000	150.475
42.6	30.6	17.4	124.893	31.8	18.850	143.743
43.2	31.2	18.0	119.515	32.4	17.866	137.381
43.8	31.8	18.6	113.928	33.0	16.912	130.841
44.4	32.4	19.2		33.6	16.090	
44.26	32.26	19.66	108.554			124.644
45.0	33.0	19.8	103.074	34.2	15 301	118.374
45.6	33.6	20.4	97.628	34.8	14.655	112.283
46.2	34.2	21.0	92.295	35.4	14.036	106.331
46.8	34.8	21.6	87.110	36.0	13.070	100.180
47.4	35.4	22.2	82.411	36.6	12.731	95.141
48.0	36.0	22.8	77.863	37.2	12.421	90.284
48.6	36.6	23.4	73.811	37.8	12.247	86.058
49.2	37.2	24.0	69.898	38.4	12.088	81 986
49.8	37.8	24.6	66.436	39.0	12.001	78.437
50.4	38.4	25.2	63.132	39.6	11.930	75.062
51.0	39.0	25.8	60.348	40.2	11.930	72.278
51.6	39.6	26.4	57.704	40.8	11.930	69.634
52.2	40.2	27.0	55.524	41.4	11.930	67.454
52.8	40.8	27.6	53.502	42.0	11.930	65.432
53.4	41.4	28.2	51.999	42.6	11.930	63.929
54.0	42.0	28.8	50.665	43.2	11.930	62.595
54.6	42.6	29.4	49.884	43.8	11.930	61.814
55.2	43.2	30.0	49.193	44.4	11.930	61.123
55.8	43.8	30.6	48.795	45.0	11.930	60.725
56.4	44.4	31.2	48.490	45.6	11.930	60.420


Additive Stream Flow Hydrograph Watershed M1 + (M3-M1)
flow (cfs)
170
160
150
140
130
120
110
100
90
80
70
60
10
15
20
25
30
35
40
45
50
55
60
time (hr)

IN20040385 Trail Creek Watershed
July 18, 2006
Watershed M4 - Watershed M1
Curve Number & Runoff Check for Michigan City

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1924.1	2002.68	1544.45	113.39	1817.41

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M4-M1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	888.89	12.01%	231.06	240.49	185.47	13.62
Developed Agriculture Row Crop	1052.71	14.22%	273.64	284.82	219.65	16.13
Developed Non-Vegetated	165.73	2.24%	43.08	44.84	34.58	2.54
Developed Urban High Density	568.55	7.68%	147.79	153.82	118.63	8.71
Developed Urban Low Density	994.03	13.43%	258.39	268.94	207.40	15.23
Palustrine Forest Deciduous	781.85	10.56%	203.23	211.53	163.13	11.98
Palustrine Herbaceous Deciduous	17.12	0.23%	4.45	4.63	3.57	0.26
Palustrine Shrubland Deciduous	0.00	0.00%	0.00	0.00	0.00	0.00
Palustrine Woodland Deciduous	1.53	0.02%	0.40	0.41	0.32	0.02
Terrestrial Forest Deciduous	2676.15	36.15%	695.64	724.05	558.38	40.99
Terrestrial Forest Evergreen	0.03	0.00%	0.01	0.01	0.01	0.00
Terrestrial Forest Mixed	2.87	0.04%	0.75	0.78	0.60	0.04
Terrestrial Shrubland Deciduous	97.75	1.32%	25.41	26.45	20.40	1.50
Terrestrial Woodland Deciduous	123.98	1.67%	32.23	33.54	25.87	1.90
Unclassified Cloud/Shadow	0.29	0.00%	0.07	0.08	0.06	0.00
Water	30.63	0.41%	7.96	8.29	6.39	0.47
TOTAL	7402.09	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Palustrine Woodland Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	11321.79	16594.04	14651.84	1143.79	43711.46
Developed Agriculture Row Crop	13408.38	19652.29	17352.16	1354.59	51767.42
Developed Non-Vegetated	3834.00	4125.09	3250.39	241.18	11450.66
Developed Urban High Density	13153.23	14151.88	11151.07	827.40	39283.58
Developed Urban Low Density	13177.78	18287.95	16384.96	1279.08	49129.78
Palustrine Forest Deciduous	5080.87	11634.42	11419.38	922.22	29056.90
Palustrine Herbaceous Deciduous	111.25	254.74	250.04	20.19	636.22
Palustrine Shrubland Deciduous	0.00	0.00	0.00	0.00	0.00
Palustrine Woodland Deciduous	9.93	22.75	22.33	1.80	56.81
Terrestrial Forest Deciduous	17390.93	39822.59	39086.53	3156.61	99456.66
Terrestrial Forest Evergreen	0.19	0.44	0.43	0.03	1.10
Terrestrial Forest Mixed	33.59	51.27	46.13	3.65	134.63
Terrestrial Shrubland Deciduous	762.29	1533.95	1448.12	116.80	3861.15
Terrestrial Woodland Deciduous	805.70	1844.94	1810.83	146.24	4607.72
Unclassified Cloud/Shadow	1.87	4.29	4.21	0.34	10.71
Water	573.18	679.45	555.94	41.75	1850.32

Total Sum:	335015.11
Total Acres:	5584.68
Composite Number:	59.99
Flow Rate (cfs):	

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M4 - Watershed M1
Curve Number & Runoff Check for Michigan City

Base Flow

Watershed	Area (ac)	Area (mi^2)	Annual Runoff (ft^3)	Annual Flow (cfs)	Base Flow (cfs)
M5-M1	7402.09	11.57	506,491,819	16.06	12.21

Hydrograph Calculations

Watershed	Travel Length, L (ft)	Beginning Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	*Velocity, v (ft/s)	Area, A_m (mi^2)	Time of Concentr-ation, t_c (hr)	ΔD (hr)	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M4-M1	36,543	695	590	0.003	0.6	11.57	16.92	2.25	11.28	496	30.11	18.83

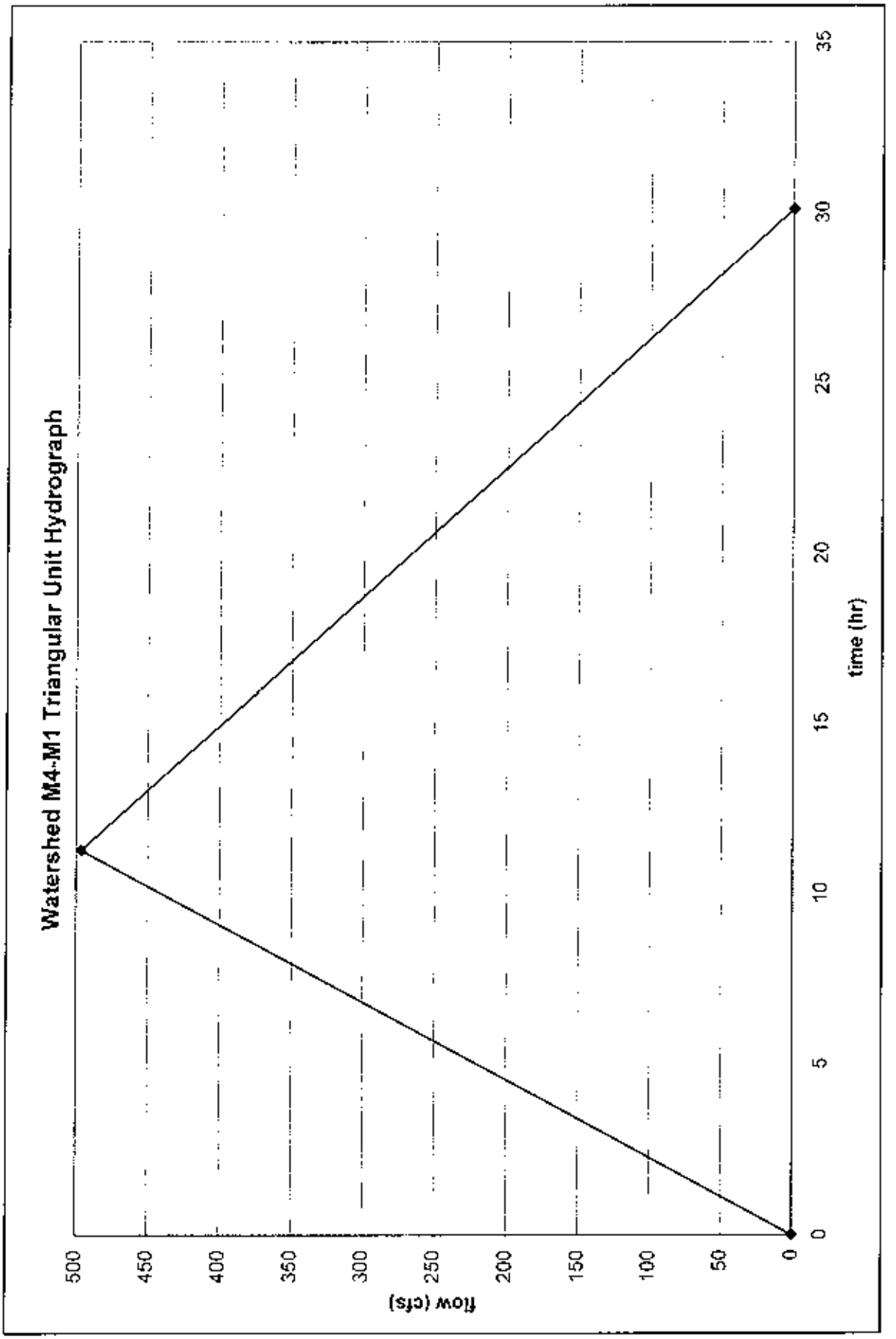
*Any watershed with a slop less than 0.005 has a velocity less than 1 ft/s. It was assumed that slope = 0.004 has a velocity of 0.8 ft/s and slope = 0.002 has a velocity of 0.5 ft/s.

Unit Hydrograph Calculations

Watershed	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M4-M1	11.28	496	30.11	18.83

Watershed M4-M1

Time (hr)	Flow (cfs)
0	0
11.28	496
30.11	0


Watershed M4-M1 Triangular Unit Hydrograph
flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
time (hr)

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M4 - Watershed M1
SCS Type II Distribution

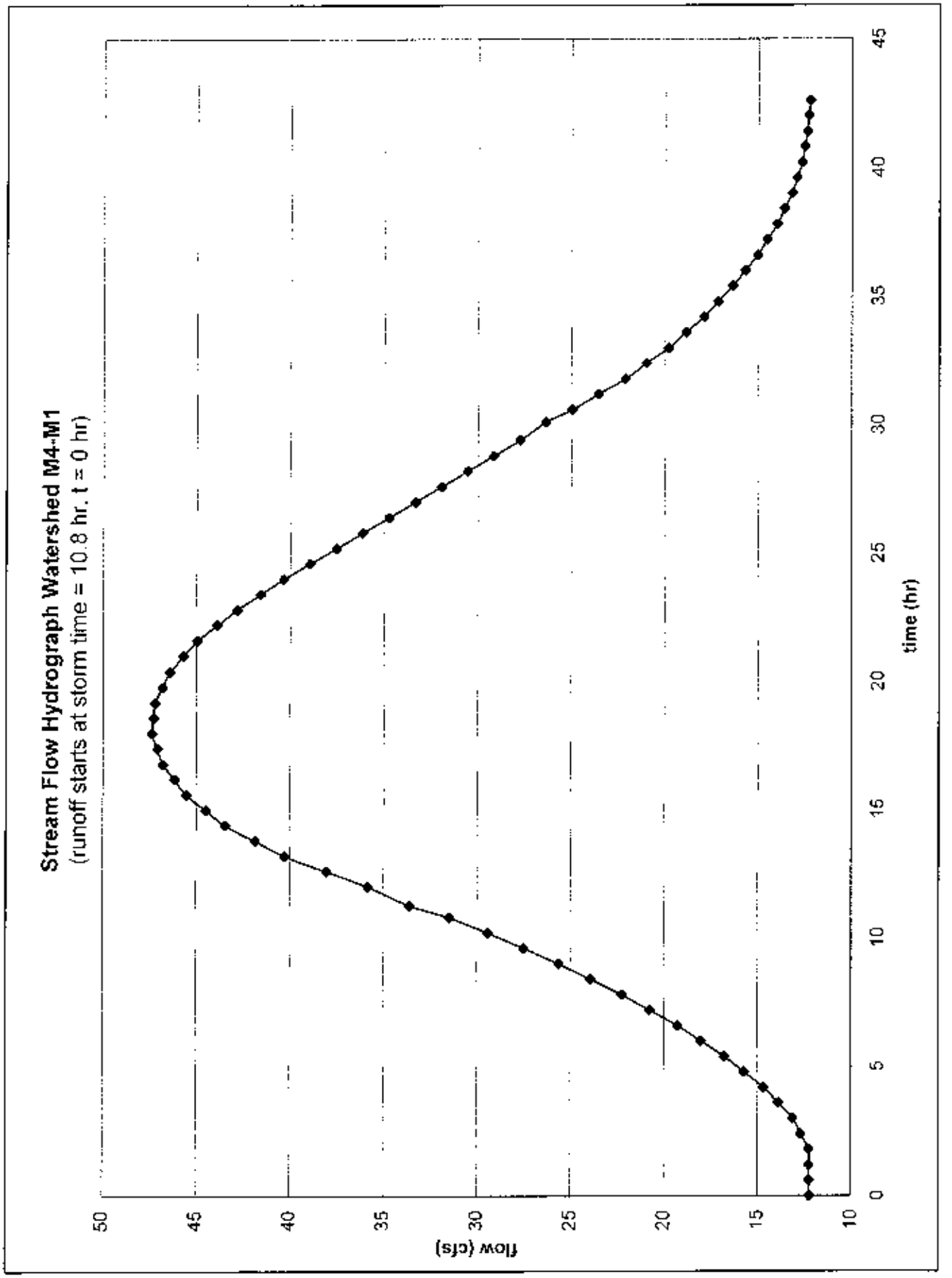
Watershed M4-M1, S = 6.67, 0.2S = 1.334

Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0.0002	0.0002
0.520	12.48	0.730	1.568	0.0079	0.0077
0.530	12.72	0.750	1.611	0.0110	0.0031
0.540	12.96	0.770	1.654	0.0146	0.0036
0.550	13.20	0.780	1.675	0.0166	0.0020
0.560	13.44	0.800	1.718	0.0209	0.0043
0.570	13.68	0.810	1.740	0.0233	0.0023
0.580	13.92	0.820	1.761	0.0257	0.0025
0.600	14.40	0.835	1.794	0.0296	0.0039
0.630	15.12	0.860	1.847	0.0367	0.0071
0.650	15.60	0.870	1.869	0.0397	0.0030
0.670	16.08	0.880	1.890	0.0428	0.0031
0.700	16.80	0.895	1.922	0.0477	0.0049
0.720	17.28	0.910	1.955	0.0528	0.0051
0.750	18.00	0.920	1.976	0.0564	0.0036
0.770	18.48	0.930	1.998	0.0601	0.0037
0.800	19.20	0.940	2.019	0.0638	0.0038
0.830	19.92	0.950	2.041	0.0677	0.0039
0.850	20.40	0.960	2.062	0.0717	0.0040
0.870	20.88	0.970	2.084	0.0757	0.0041
0.900	21.60	0.980	2.105	0.0799	0.0042
0.950	22.80	0.990	2.127	0.0842	0.0043
1.000	24.00	1.000	2.148	0.0885	0.0044

Trail Creek Watershed Study
July 18, 2006
IN20040385
Watershed M4-M1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 10.8 hr)												Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2		
		0	0.0002	0.0164	0.013	0.0101	0.008	0.0087	0.0074	0.0079	0.0082	0.0043	0.0043		
0	0.00	0.000												0.000	12.210
0.6	26.38	0.000	0.000											0.000	12.210
1.2	52.77	0.000	0.005	0.000										0.005	12.215
1.8	79.15	0.000	0.011	0.000										0.011	12.221
2.4	105.53	0.000	0.016	0.433	0.000									0.449	12.659
3.0	131.91	0.000	0.021	0.865	0.000									0.886	13.096
3.6	158.30	0.000	0.026	1.298	0.343	0.000								1.667	13.877
4.2	184.68	0.000	0.032	1.731	0.686	0.000								2.448	14.658
4.8	211.06	0.000	0.037	2.163	1.029	0.266	0.000							3.496	15.706
5.4	237.45	0.000	0.042	2.596	1.372	0.533	0.000							4.543	16.753
6.0	263.83	0.000	0.047	3.029	1.715	0.799	0.211	0.000						5.802	18.012
6.6	290.21	0.000	0.053	3.461	2.058	1.066	0.422	0.000						7.060	19.270
7.2	316.60	0.000	0.058	3.894	2.401	1.332	0.633	0.230	0.000					8.548	20.758
7.8	342.98	0.000	0.063	4.327	2.744	1.599	0.844	0.459	0.000					10.036	22.246
8.4	369.36	0.000	0.069	4.759	3.087	1.865	1.055	0.689	0.195	0.000				11.719	23.929
9.0	395.74	0.000	0.074	5.192	3.430	2.132	1.266	0.918	0.390	0.000				13.403	25.613
9.6	422.13	0.000	0.079	5.625	3.773	2.398	1.477	1.148	0.586	0.208	0.000			15.294	27.504
10.2	448.51	0.000	0.084	6.058	4.116	2.665	1.689	1.377	0.781	0.417	0.000			17.186	29.396
10.8	474.89	0.000	0.090	6.490	4.459	2.931	1.900	1.607	0.976	0.625	0.216	0.000		19.294	31.504
11.28	496.00	0.000	0.095	6.923	4.802	3.198	2.111	1.836	1.171	0.834	0.433	0.000		21.402	33.612
12.0	477.04	0.000	0.099	7.356	5.145	3.464	2.322	2.066	1.367	1.042	0.649	0.113	0.000	23.622	35.832
12.6	461.23	0.000	0.095	7.788	5.488	3.731	2.533	2.295	1.562	1.251	0.865	0.227	0.000	25.835	38.045
13.2	445.43	0.000	0.092	8.134	5.831	3.997	2.744	2.525	1.757	1.459	1.082	0.340	0.113	28.075	40.285
13.8	429.62	0.000	0.089	7.823	6.174	4.263	2.955	2.754	1.952	1.667	1.298	0.454	0.227	29.657	41.867
14.4	413.82	0.000	0.086	7.564	6.448	4.530	3.166	2.984	2.148	1.876	1.514	0.567	0.340	31.223	43.433
15.0	398.01	0.000	0.083	7.305	6.201	4.796	3.377	3.213	2.343	2.084	1.731	0.681	0.454	32.268	44.478
15.6	382.21	0.000	0.080	7.046	5.996	5.010	3.588	3.443	2.538	2.293	1.947	0.794	0.567	33.301	45.511
16.2	366.40	0.000	0.076	6.787	5.791	4.818	3.799	3.673	2.733	2.501	2.163	0.908	0.681	33.929	46.139
16.8	350.60	0.000	0.073	6.527	5.585	4.658	3.968	3.902	2.929	2.710	2.380	1.021	0.794	34.547	46.757
17.4	334.79	0.000	0.070	6.268	5.380	4.499	3.816	4.132	3.124	2.918	2.596	1.134	0.908	34.844	47.054
18.0	318.99	0.000	0.067	6.009	5.174	4.339	3.690	4.315	3.319	3.126	2.812	1.248	1.021	35.121	47.331
18.6	303.19	0.000	0.064	5.750	4.969	4.180	3.563	4.150	3.514	3.335	3.029	1.361	1.134	35.049	47.259
19.2	287.38	0.000	0.061	5.491	4.763	4.020	3.437	4.013	3.670	3.543	3.245	1.475	1.248	34.966	47.176

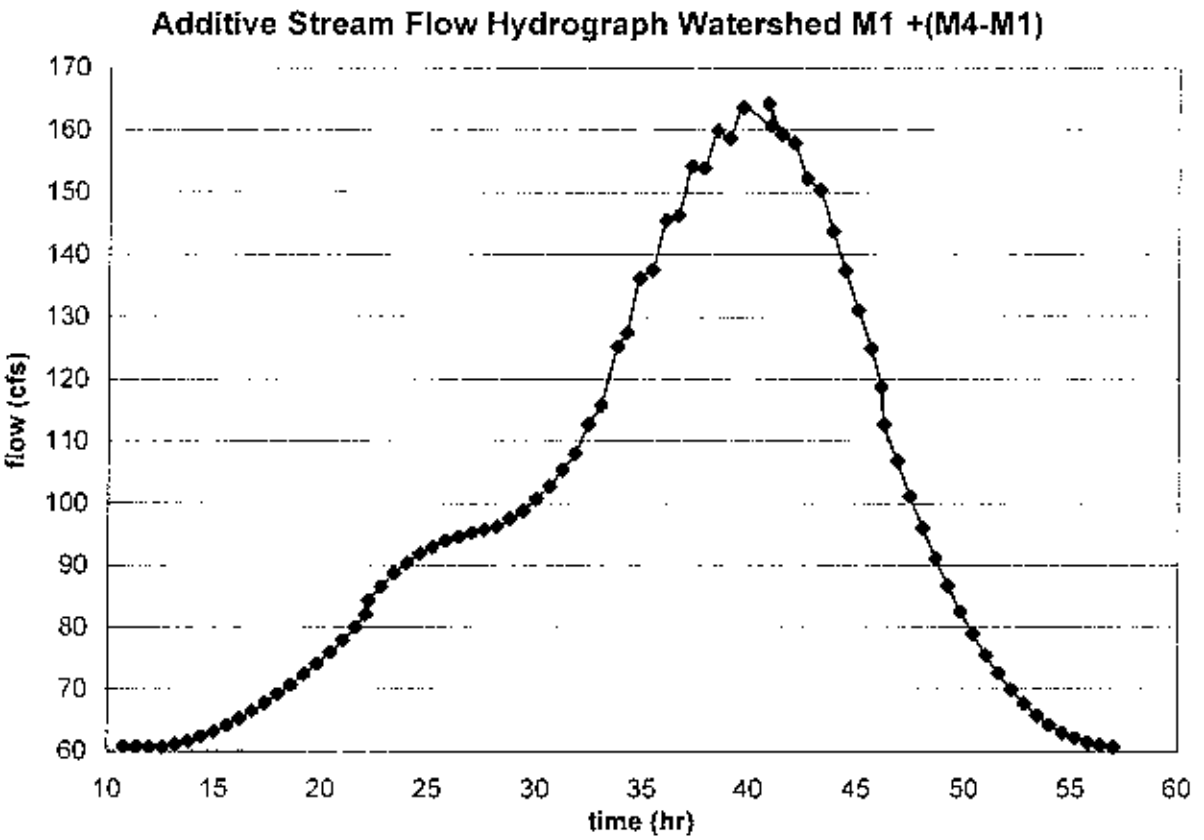
19.8	271.58	0.000	0.057	5.231	4.558	3.860	3.311	3.875	3.530	3.752	3.461	1.588	1.361	34.586	46.796
20.4	255.77	0.000	0.054	4.972	4.352	3.701	3.184	3.738	3.413	3.918	3.678	1.702	1.475	34.187	46.397
21.0	239.97	0.000	0.051	4.713	4.147	3.541	3.058	3.600	3.296	3.769	3.894	1.815	1.588	33.472	45.682
21.6	224.16	0.000	0.048	4.454	3.941	3.381	2.931	3.463	3.179	3.644	4.067	1.929	1.702	32.739	44.949
22.2	208.36	0.000	0.045	4.195	3.736	3.222	2.805	3.325	3.062	3.519	3.912	2.042	1.815	31.677	43.887
22.8	192.55	0.000	0.042	3.935	3.530	3.062	2.678	3.188	2.945	3.394	3.782	2.133	1.929	30.619	42.829
23.4	176.75	0.000	0.039	3.676	3.325	2.903	2.552	3.050	2.828	3.269	3.652	2.051	2.042	29.388	41.598
24.0	160.94	0.000	0.035	3.417	3.120	2.743	2.425	2.913	2.711	3.144	3.523	1.983	2.133	28.148	40.358
24.6	145.14	0.000	0.032	3.158	2.914	2.583	2.299	2.775	2.594	3.019	3.393	1.915	2.051	26.735	38.945
25.2	129.34	0.000	0.029	2.899	2.709	2.424	2.173	2.638	2.477	2.895	3.264	1.847	1.983	25.337	37.547
25.8	113.53	0.000	0.026	2.639	2.503	2.264	2.046	2.500	2.361	2.770	3.134	1.779	1.915	23.938	36.148
26.4	97.73	0.000	0.023	2.380	2.298	2.104	1.920	2.363	2.244	2.645	3.005	1.711	1.847	22.539	34.749
27.0	81.92	0.000	0.020	2.121	2.092	1.945	1.793	2.225	2.127	2.520	2.875	1.643	1.779	21.141	33.351
27.6	66.12	0.000	0.016	1.862	1.887	1.785	1.667	2.088	2.010	2.395	2.745	1.576	1.711	19.742	31.952
28.2	50.31	0.000	0.013	1.603	1.681	1.626	1.540	1.950	1.893	2.270	2.616	1.508	1.643	18.343	30.553
28.8	34.51	0.000	0.010	1.344	1.476	1.466	1.414	1.813	1.776	2.145	2.486	1.440	1.576	16.945	29.155
29.4	18.70	0.000	0.007	1.084	1.270	1.306	1.288	1.675	1.659	2.021	2.357	1.372	1.508	15.546	27.756
30.11	0.00	0.000	0.004	0.825	1.065	1.147	1.161	1.538	1.542	1.896	2.227	1.304	1.440	14.147	26.357
30.6			0.000	0.566	0.860	0.987	1.035	1.400	1.425	1.771	2.097	1.236	1.372	12.748	24.958
31.2			0.000	0.307	0.654	0.827	0.908	1.263	1.308	1.646	1.968	1.168	1.304	11.352	23.562
31.8				0.000	0.449	0.668	0.782	1.125	1.191	1.521	1.838	1.100	1.236	9.909	22.119
32.4				0.000	0.243	0.508	0.655	0.988	1.074	1.396	1.709	1.032	1.168	8.773	20.983
33.0					0.000	0.349	0.529	0.850	0.957	1.271	1.579	0.964	1.100	7.599	19.809
33.6					0.000	0.189	0.403	0.713	0.840	1.147	1.449	0.896	1.032	6.668	18.878
34.2						0.000	0.276	0.575	0.723	1.022	1.320	0.828	0.964	5.708	17.918
34.8						0.000	0.150	0.438	0.606	0.897	1.190	0.760	0.896	4.937	17.147
35.4							0.000	0.300	0.489	0.772	1.061	0.692	0.828	4.142	16.352
36.0							0.000	0.163	0.372	0.647	0.931	0.624	0.760	3.497	15.707
36.6								0.000	0.255	0.522	0.801	0.556	0.692	2.827	15.037
37.2								0.000	0.138	0.397	0.672	0.488	0.624	2.320	14.530
37.8									0.000	0.273	0.542	0.420	0.556	1.791	14.001
38.4									0.000	0.148	0.413	0.352	0.488	1.401	13.611
39.0										0.000	0.283	0.284	0.420	0.988	13.198
39.6										0.000	0.153	0.216	0.352	0.722	12.932
40.2											0.000	0.148	0.284	0.433	12.643
40.8											0.000	0.080	0.216	0.297	12.507
41.4												0.000	0.148	0.148	12.358
42.0												0.000	0.080	0.080	12.290
42.6													0.000	0.000	12.210
													SUM =	1101.256	1980.376


Stream Flow Hydrograph Watershed M4-M1
(runoff starts at storm time = 10.8 hr. t = 0 hr)
flow (cfs)
50
45
40
35
30
25
20
15
10
0
5
10
15
20
25
30
35
40
45
time (hr)

Trail Creek Watershed Study
Additive Stream Flow Hydrograph
Watershed M1 + (M4-M1)
July 18, 2006
IN20040385

Storm Time (hr)	M1 Time (hr)	M1 Time Actual (hr)	Stream Flow from M1 (cfs)	M4-M1 Time (hr)	Stream Flow M4-M1 (cfs)	Sum (cfs) M1 + (M4-M1)
10.8	0		48.490	0	12.210	60.700
11.4	0		48.490	0.6	12.210	60.700
12.0	0		48.490	1.2	12.215	60.705
12.6	0.6		48.490	1.8	12.221	60.711
13.2	1.2		48.490	2.4	12.659	61.149
13.8	1.8		48.490	3.0	13.096	61.586
14.4	2.4		48.490	3.6	13.877	62.367
15.0	3.0		48.490	4.2	14.658	63.148
15.6	3.6		48.490	4.8	15.706	64.196
16.2	4.2		48.490	5.4	16.753	65.243
16.8	4.8		48.490	6.0	18.012	66.502
17.4	5.4		48.490	6.6	19.270	67.760
18.0	6.0		48.490	7.2	20.758	69.248
18.6	6.6		48.490	7.8	22.246	70.736
19.2	7.2		48.490	8.4	23.929	72.419
19.8	7.8		48.490	9.0	25.613	74.103
20.4	8.4		48.490	9.6	27.504	75.994
21.0	9.0		48.490	10.2	29.396	77.886
21.6	9.6		48.490	10.8	31.504	79.994
22.08	10.08		48.490	11.28	33.612	82.102
22.2	10.2		48.490	12.0	35.832	84.322
22.8	10.8		48.490	12.6	38.045	86.535
23.4	11.4		48.490	13.2	40.285	88.775
24.0	12.0		48.490	13.8	41.867	90.357
24.6	12.6		48.490	14.4	43.433	91.923
25.2	13.2		48.490	15.0	44.478	92.968
25.8	13.8		48.490	15.6	45.511	94.001
26.4	14.4	0	48.490	16.2	46.139	94.629
27.0	15.0	0.6	48.490	16.8	46.757	95.247
27.6	15.6	1.2	48.736	17.4	47.054	95.791
28.2	16.2	1.8	48.982	18.0	47.331	96.313
28.8	16.8	2.4	50.287	18.6	47.259	97.546
29.4	17.4	3.0	51.592	19.2	47.176	98.768
30.0	18.0	3.6	53.980	19.8	46.796	100.776
30.6	18.6	4.2	56.368	20.4	46.397	102.765
31.2	19.2	4.8	59.741	21.0	45.682	105.423
31.8	19.8	5.4	63.114	21.6	44.949	108.063
32.4	20.4	6.0	68.905	22.2	43.887	112.792
33.0	21.0	6.6	73.017	22.8	42.829	115.845
33.6	21.6	7.2		23.4	41.598	
33.76	21.76	7.36	83.666			125.263
34.2	22.2	7.8	87.055	24.0	40.358	127.413
34.8	22.8	8.4	97.312	24.6	38.945	136.258
35.4	23.4	9.0	99.974	25.2	37.547	137.521

36.0	24.0	9.6	109.321	25.8	36.148	145.469
36.6	24.6	10.2	111.611	26.4	34.749	146.360
37.2	25 2	10.8	120.799	27.0	33.351	154.150
37.8	25.8	11.4	121.935	27.6	31.952	153 887
38.4	26.4	12.0	129.320	28.2	30.553	159.873
39.0	27.0	12.6	129.483	28.8	29.155	158.637
39.6	27.6	13.2	135.920	29.4	27.756	163.676
40.2	28.2	13.8	134.293			
40.91	28.91			30.11	26.357	160.650
40.8	28.8	14.4	139.286	30.6	24.958	164.244
41.4	29.4	15.0	135.711	31.2	23.562	159.274
42.0	30.0	15.6	135.840	31.8	22.119	157.959
42.6	30.6	16.2	131.229	32.4	20 983	152.212
43.2	31.2	16.8	130.475	33.0	19.809	150.284
43.8	31.8	17.4	124.893	33.6	18.878	143.771
44.4	32.4	18.0	119.515	34.2	17.918	137.432
45.0	33.0	18.6	113.928	34.8	17.147	131.075
45.6	33.6	19.2	108.554	35.4	16.352	124.906
46.06	34.06	19.66	103.074			
46.2	34.2	19.8		36.0	15.707	118.781
46.8	34.8	20.4	97.628	36.6	15.037	112.665
47.4	35.4	21.0	92.295	37.2	14.530	106.825
48.0	36.0	21.6	87.110	37.8	14.001	101.111
48.6	36.6	22.2	82.411	38.4	13.611	96.022
49.2	37.2	22.8	77.863	39.0	13.198	91.060
49.8	37.8	23.4	73.811	39.6	12.932	86.743
50.4	38.4	24.0	69.898	40.2	12.643	82.540
51.0	39.0	24.6	66.436	40.8	12.507	78.942
51.6	39.6	25.2	63.132	41.4	12.358	75.490
52.2	40.2	25.8	60.348	42.0	12.290	72.638
52.8	40.8	26.4	57.704	42.6	12.210	69.914
53.4	41.4	27.0	55.524	43.2	12.210	67.734
54.0	42.0	27.6	53.502	43.8	12.210	65.712
54.6	42.6	28.2	51.999	44.4	12.210	64.209
55.2	43.2	28.8	50.665	45.0	12.210	62.875
55.8	43.8	29.4	49.884	45.6	12.210	62.094
56.4	44.4	30.0	49.193	46.2	12.210	61.403
57.0	45.0	30.6	48.795	46.8	12.210	61.005
57.6	45.6	31.2	48.490	47.4	12.210	60.700


Additive Stream Flow Hydrograph Watershed M1 +(M4-M1)
flow (cfs)
170
160
150
140
130
120
110
100
90
80
70
60
10
15
20
25
30
35
40
45
50
55
60
time (hr)

II:20040385 Trail Creek Watershed
July 18, 2006
Watershed M5 - Watershed M1
Curve Number & Runoff Check for Michigan City

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1941.07	2036.18	1544.58	113.1	2055.44

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M5-M1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	893.55	11.62%	225.51	236.56	179.45	13.14
Developed Agriculture Row Crop	1057.32	13.75%	266.84	279.92	212.34	15.55
Developed Non-Vegetated	168.69	2.19%	42.57	44.66	33.88	2.48
Developed Urban High Density	663.14	8.62%	167.36	175.56	133.17	9.75
Developed Urban Low Density	1108.35	14.41%	279.72	293.43	222.58	16.30
Palustrine Forest Deciduous	782.22	10.17%	197.41	207.09	157.09	11.50
Palustrine Herbaceous Deciduous	16.69	0.22%	4.21	4.42	3.35	0.25
Palustrine Shrubland Deciduous	0.00	0.00%	0.00	0.00	0.00	0.00
Palustrine Woodland Deciduous	3.15	0.04%	0.79	0.83	0.63	0.05
Terrestrial Forest Deciduous	2718.21	35.34%	686.01	719.62	545.88	39.97
Terrestrial Forest Evergreen	0.00	0.00%	0.00	0.00	0.00	0.00
Terrestrial Forest Mixed	2.89	0.04%	0.73	0.77	0.58	0.04
Terrestrial Shrubland Deciduous	97.77	1.27%	24.67	25.88	19.63	1.44
Terrestrial Woodland Deciduous	126.46	1.64%	31.92	33.48	25.40	1.86
Unclassified Cloud/Shadow	0.00	0.00%	0.00	0.00	0.00	0.00
Water	52.77	0.69%	13.32	13.97	10.60	0.78
TOTAL	7691.22	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Palustrine Woodland Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	11049.95	16322.56	14176.22	1103.74	42652.47
Developed Agriculture Row Crop	13075.25	19314.26	16774.53	1306.03	50470.08
Developed Non-Vegetated	3788.96	4108.59	3184.39	235.65	11317.59
Developed Urban High Density	14894.90	16151.41	12518.28	926.39	44490.99
Developed Urban Low Density	14265.76	19953.01	17584.13	1369.07	53171.97
Palustrine Forest Deciduous	4935.30	11389.68	10996.16	885.70	28206.85
Palustrine Herbaceous Deciduous	105.32	243.05	234.65	18.90	601.91
Palustrine Shrubland Deciduous	0.00	0.00	0.00	0.00	0.00
Palustrine Woodland Deciduous	19.87	45.85	44.27	3.57	113.56
Terrestrial Forest Deciduous	17150.19	39579.17	38211.70	3077.81	98018.87
Terrestrial Forest Evergreen	0.00	0.00	0.00	0.00	0.00
Terrestrial Forest Mixed	32.87	50.58	44.76	3.53	131.75
Terrestrial Shrubland Deciduous	740.23	1501.24	1394.04	112.14	3747.65
Terrestrial Woodland Deciduous	797.90	1841.40	1777.78	143.19	4560.27
Unclassified Cloud/Shadow	0.00	0.00	0.00	0.00	0.00
Water	958.95	1145.65	922.04	69.07	3095.70

Total Sum:	340579.66
Total Acres:	5635.78
Composite Number:	60.43
Flow Rate (cfs):	

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M5 - Watershed M1
Curve Number & Runoff Check for Michigan City

Base Flow

Watershed	Area (ac)	Area (mi^2)	Annual Runoff (ft^3)	Annual Flow (cfs)	Base Flow (cfs)
M5-M1	7691.22	12.02	526,275,820	16.69	12.68

Hydrograph Calculations

Watershed	Travel Length, L (ft)	Beginning Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	*Velocity, v (ft/s)	Area, A_m (mi^2)	Time of Concentr-ation, t_c (hr)	ΔD (hr)	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M5-M1	39,200	695	585	0.003	0.6	12.02	18.15	2.41	12.10	481	32.30	20.20

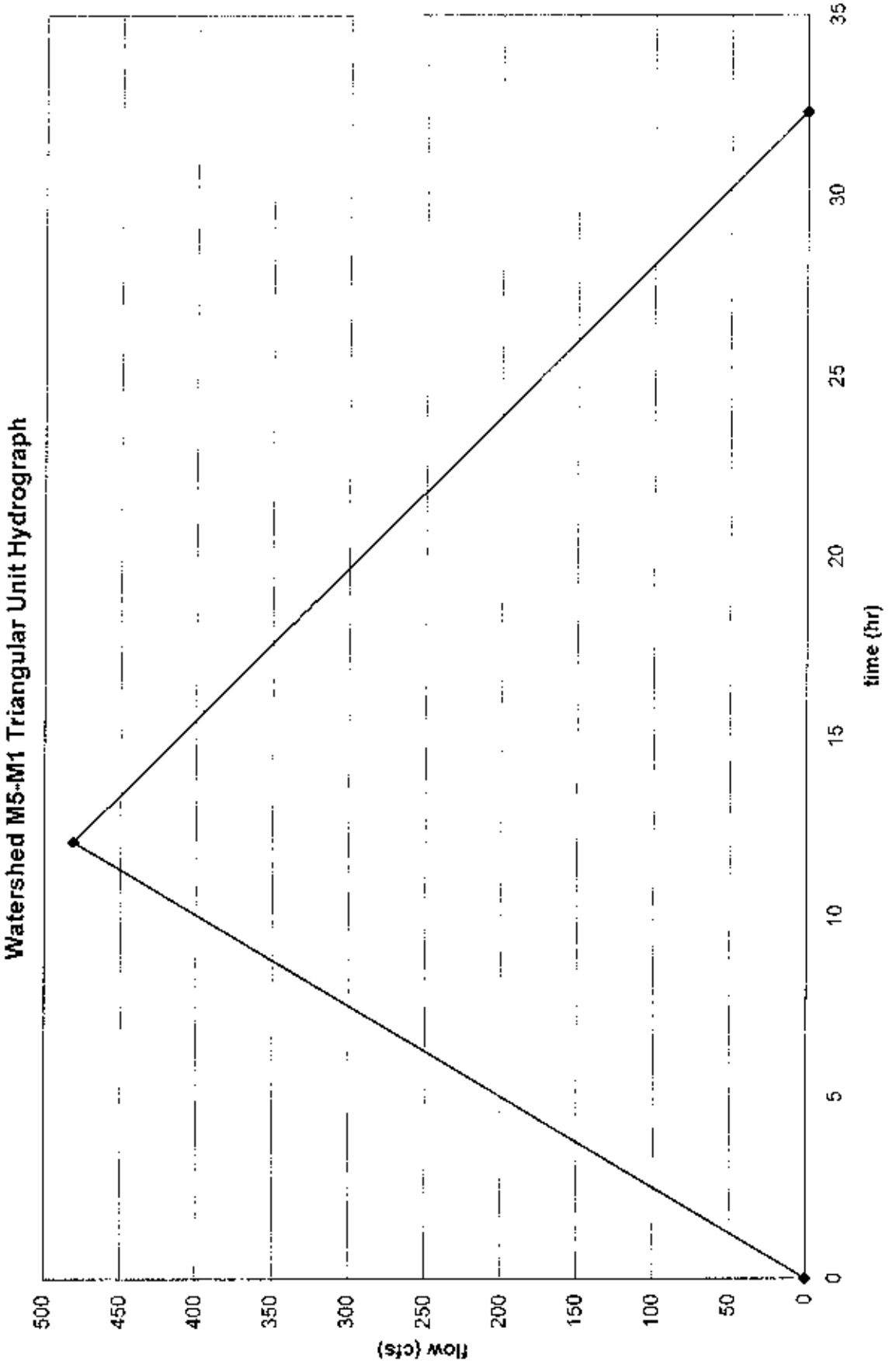
*Any watershed with a slop less than 0.005 has a velocity less than 1 ft/s. It was assumed that slope = 0.004 has a velocity of 0.8 ft/s and slope = 0.002 has a velocity of 0.5 ft/s.

Unit Hydrograph Calculations

Watershed	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M5-M1	12.10	481	32.30	20.20

Watershed M5-M1

Time (hr)	Flow (cfs)
0	0
12.10	481
32.30	0


Watershed M5-M1 Triangular Unit Hydrograph
flow (cfs)
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
time (hr)

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M5 - Watershed M1
SCS Type II Distribution

Watershed M5-M1, S = 6.55, 0.2S = 1.31

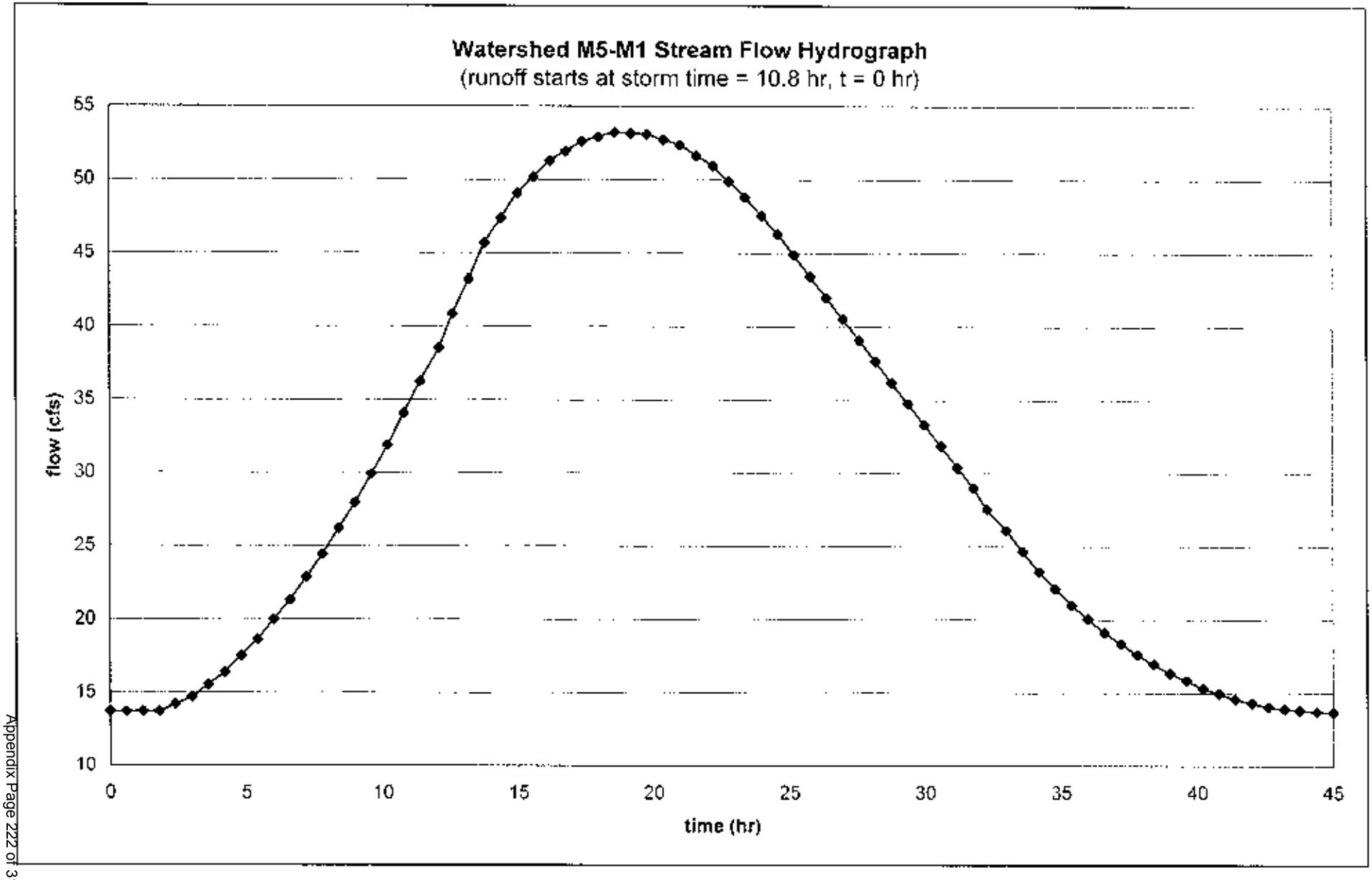
Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0.0007	0.0007
0.520	12.48	0.730	1.568	0.0105	0.0098
0.530	12.72	0.750	1.611	0.0141	0.0037
0.540	12.96	0.770	1.654	0.0184	0.0042
0.550	13.20	0.780	1.675	0.0206	0.0023
0.560	13.44	0.800	1.718	0.0256	0.0050
0.570	13.68	0.810	1.740	0.0283	0.0027
0.580	13.92	0.820	1.761	0.0311	0.0028
0.600	14.40	0.835	1.794	0.0355	0.0044
0.630	15.12	0.860	1.847	0.0435	0.0080
0.650	15.60	0.870	1.869	0.0469	0.0034
0.670	16.08	0.880	1.890	0.0504	0.0035
0.700	16.80	0.895	1.922	0.0559	0.0055
0.720	17.28	0.910	1.955	0.0616	0.0057
0.750	18.00	0.920	1.976	0.0656	0.0040
0.770	18.48	0.930	1.998	0.0696	0.0041
0.800	19.20	0.940	2.019	0.0738	0.0042
0.830	19.92	0.950	2.041	0.0781	0.0043
0.850	20.40	0.960	2.062	0.0825	0.0044
0.870	20.88	0.970	2.084	0.0870	0.0045
0.900	21.60	0.980	2.105	0.0916	0.0046
0.950	22.80	0.990	2.127	0.0964	0.0047
1.000	24.00	1.000	2.148	0.1012	0.0048

Trail Creek Watershed Study
July 18, 2006
IN20040385
Watershed M5-M1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 10.8 hr)												Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2		
		0	0.0007	0.0199	0.0149	0.0114	0.009	0.0097	0.0082	0.0087	0.0091	0.0048	0.0048		
0	0.00	0.000												0.000	13.680
0.6	23.85	0.000	0.000											0.000	13.680
1.2	47.70	0.000	0.017	0.000										0.017	13.697
1.8	71.55	0.000	0.033	0.000										0.033	13.713
2.4	95.41	0.000	0.050	0.475	0.000									0.525	14.205
3.0	119.26	0.000	0.067	0.949	0.000									1.016	14.696
3.6	143.11	0.000	0.083	1.424	0.355	0.000								1.863	15.543
4.2	166.96	0.000	0.100	1.899	0.711	0.000								2.710	16.390
4.8	190.81	0.000	0.117	2.373	1.066	0.272	0.000							3.828	17.508
5.4	214.66	0.000	0.134	2.848	1.422	0.544	0.000							4.947	18.627
6.0	238.51	0.000	0.150	3.322	1.777	0.816	0.215	0.000						6.280	19.960
6.6	262.36	0.000	0.167	3.797	2.132	1.088	0.429	0.000						7.613	21.293
7.2	286.22	0.000	0.184	4.272	2.488	1.360	0.644	0.231	0.000					9.178	22.858
7.8	310.07	0.000	0.200	4.746	2.843	1.631	0.859	0.463	0.000					10.743	24.423
8.4	333.92	0.000	0.217	5.221	3.198	1.903	1.073	0.694	0.196	0.000				12.503	26.183
9.0	357.77	0.000	0.234	5.696	3.554	2.175	1.288	0.925	0.391	0.000				14.263	27.943
9.6	381.62	0.000	0.250	6.170	3.909	2.447	1.503	1.157	0.587	0.208	0.000			16.231	29.911
10.2	405.47	0.000	0.267	6.645	4.265	2.719	1.717	1.388	0.782	0.415	0.000			18.199	31.879
10.8	429.32	0.000	0.284	7.120	4.620	2.991	1.932	1.620	0.978	0.623	0.217	0.000		20.383	34.063
11.4	453.17	0.000	0.301	7.594	4.975	3.263	2.147	1.851	1.173	0.830	0.434	0.000		22.568	36.248
12.10	481.00	0.000	0.317	8.069	5.331	3.535	2.361	2.082	1.369	1.038	0.651	0.114	0.000	24.867	38.547
12.6	469.09	0.000	0.337	8.544	5.686	3.807	2.576	2.314	1.565	1.245	0.868	0.229	0.000	27.169	40.849
13.2	454.81	0.000	0.328	9.018	6.042	4.079	2.791	2.545	1.760	1.453	1.085	0.343	0.114	29.558	43.238
13.8	440.52	0.000	0.318	9.572	6.397	4.350	3.005	2.776	1.956	1.660	1.302	0.458	0.229	32.024	45.704
14.4	426.23	0.000	0.308	9.335	6.752	4.622	3.220	3.008	2.151	1.868	1.519	0.572	0.343	33.700	47.380
15.0	411.95	0.000	0.298	9.051	7.167	4.894	3.435	3.239	2.347	2.075	1.736	0.687	0.458	35.387	49.067
15.6	397.66	0.000	0.288	8.766	6.989	5.166	3.649	3.470	2.543	2.283	1.953	0.801	0.572	36.482	50.162
16.2	383.37	0.000	0.278	8.482	6.777	5.483	3.864	3.702	2.738	2.490	2.170	0.916	0.687	37.587	51.267
16.8	369.08	0.000	0.268	8.198	6.564	5.348	4.079	3.933	2.934	2.698	2.388	1.030	0.801	38.240	51.920

17.4	354.80	0.000	0.258	7.913	6.351	5.185	4.329	4.164	3.129	2.905	2.605	1.145	0.916	38.901	52.581
18.0	340.51	0.000	0.248	7.629	6.138	5.022	4.222	4.396	3.325	3.113	2.822	1.259	1.030	39.204	52.884
18.6	326.22	0.000	0.238	7.345	5.925	4.859	4.093	4.666	3.520	3.320	3.039	1.374	1.145	39.524	53.204
19.2	311.94	0.000	0.228	7.060	5.712	4.696	3.965	4.550	3.716	3.528	3.256	1.488	1.259	39.459	53.139
19.8	297.65	0.000	0.218	6.776	5.499	4.533	3.836	4.412	3.944	3.735	3.473	1.603	1.374	39.404	53.084
20.4	283.36	0.000	0.208	6.492	5.286	4.370	3.708	4.273	3.847	3.943	3.690	1.717	1.488	39.022	52.702
21.0	269.07	0.000	0.198	6.208	5.074	4.208	3.579	4.134	3.729	4.185	3.907	1.832	1.603	38.656	52.336
21.6	254.79	0.000	0.188	5.923	4.861	4.045	3.450	3.996	3.612	4.081	4.124	1.946	1.717	37.944	51.624
22.2	240.50	0.000	0.178	5.639	4.648	3.882	3.322	3.857	3.495	3.957	4.377	2.061	1.832	37.247	50.927
22.8	226.21	0.000	0.168	5.355	4.435	3.719	3.193	3.719	3.378	3.833	4.269	2.175	1.946	36.189	49.869
23.4	211.93	0.000	0.158	5.070	4.222	3.556	3.065	3.580	3.261	3.708	4.139	2.309	2.061	35.129	48.809
24.0	197.64	0.000	0.148	4.786	4.009	3.393	2.936	3.442	3.144	3.584	4.009	2.252	2.175	33.877	47.557
24.6	183.35	0.000	0.138	4.502	3.796	3.230	2.807	3.303	3.026	3.460	3.879	2.183	2.309	32.634	46.314
25.2	169.06	0.000	0.128	4.217	3.583	3.067	2.679	3.164	2.909	3.335	3.749	2.114	2.252	31.199	44.879
25.8	154.78	0.000	0.118	3.933	3.371	2.905	2.550	3.026	2.792	3.211	3.619	2.046	2.183	29.753	43.433
26.4	140.49	0.000	0.108	3.649	3.158	2.742	2.422	2.887	2.675	3.087	3.489	1.977	2.114	28.308	41.988
27.0	126.20	0.000	0.098	3.364	2.945	2.579	2.293	2.749	2.558	2.962	3.359	1.909	2.046	26.862	40.542
27.6	111.92	0.000	0.088	3.080	2.732	2.416	2.164	2.610	2.441	2.838	3.229	1.840	1.977	25.416	39.096
28.2	97.63	0.000	0.078	2.796	2.519	2.253	2.036	2.471	2.324	2.714	3.099	1.772	1.909	23.970	37.650
28.8	83.34	0.000	0.068	2.511	2.306	2.090	1.907	2.333	2.206	2.590	2.969	1.703	1.840	22.524	36.204
29.4	69.05	0.000	0.058	2.227	2.093	1.927	1.779	2.194	2.089	2.465	2.839	1.634	1.772	21.078	34.758
30.0	54.77	0.000	0.048	1.943	1.880	1.764	1.650	2.056	1.972	2.341	2.709	1.566	1.703	19.632	33.312
30.6	40.48	0.000	0.038	1.658	1.668	1.602	1.522	1.917	1.855	2.217	2.579	1.497	1.634	18.187	31.867
31.2	26.19	0.000	0.028	1.374	1.455	1.439	1.393	1.779	1.738	2.092	2.449	1.429	1.566	16.741	30.421
31.8	11.91	0.000	0.018	1.090	1.242	1.276	1.264	1.640	1.621	1.968	2.319	1.360	1.497	15.295	28.975
32.3	0.00	0.000	0.008	0.806	1.029	1.113	1.136	1.501	1.503	1.844	2.189	1.292	1.429	13.849	27.529
33.0			0.000	0.521	0.816	0.950	1.007	1.363	1.386	1.719	2.059	1.223	1.360	12.405	26.085
33.6			0.000	0.237	0.603	0.787	0.879	1.224	1.269	1.595	1.929	1.154	1.292	10.969	24.649
34.2				0.000	0.390	0.624	0.750	1.086	1.152	1.471	1.799	1.086	1.223	9.580	23.260
34.8				0.000	0.177	0.461	0.621	0.947	1.035	1.347	1.668	1.017	1.154	8.429	22.109
35.4					0.000	0.299	0.493	0.808	0.918	1.222	1.538	0.949	1.086	7.313	20.993
36.0					0.000	0.136	0.364	0.670	0.801	1.098	1.408	0.880	1.017	6.374	20.054
36.6						0.000	0.236	0.531	0.683	0.974	1.278	0.812	0.949	5.463	19.143
37.2						0.000	0.107	0.393	0.566	0.849	1.148	0.743	0.880	4.687	18.367
37.8							0.000	0.254	0.449	0.725	1.018	0.674	0.812	3.933	17.613
38.4							0.000	0.115	0.332	0.601	0.888	0.606	0.743	3.285	16.965
39.0								0.000	0.215	0.476	0.758	0.537	0.674	2.661	16.341

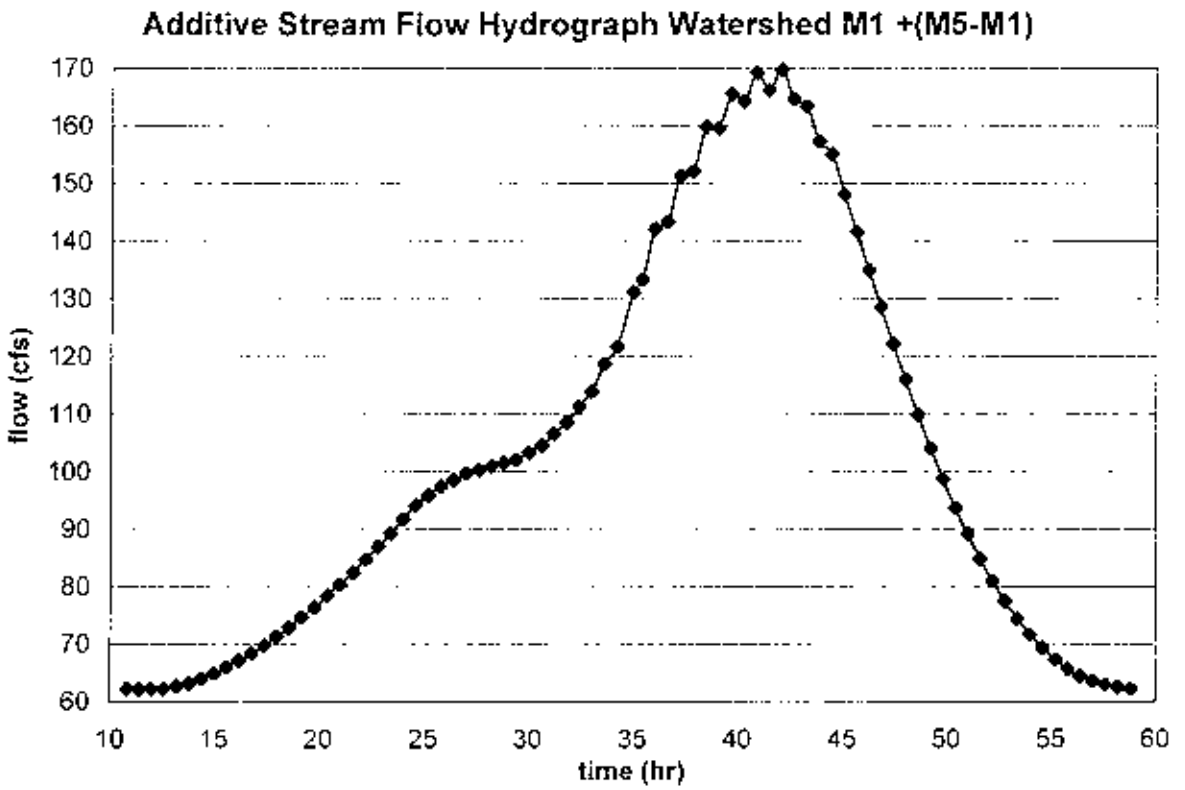
39.6								0.000	0.098	0.352	0.628	0.469	0.606	2.153	15.833
40.2									0.000	0.228	0.498	0.400	0.537	1.663	15.343
40.8									0.000	0.104	0.368	0.331	0.469	1.272	14.952
41.4										0.000	0.238	0.263	0.400	0.901	14.581
42.0										0.000	0.108	0.194	0.331	0.634	14.314
42.6											0.000	0.126	0.263	0.389	14.069
43.2											0.000	0.057	0.194	0.251	13.931
43.75												0.000	0.126	0.126	13.806
44.4												0.000	0.057	0.057	13.737
45.0													0.000	0.000	13.680
													SUM =	1310.462	2350.142


Watershed M5-M1 Stream Flow Hydrograph
(runoff starts at storm time = 10.8 hr, t = 0 hr)
flow (cfs)
55
50
45
40
35
30
25
20
15
10
0
5
10
15
20
25
30
35
40
45
time (hr)

Trail Creek Watershed Study
Additive Stream Flow Hydrograph
Watershed M1 + (M5-M1)
July 18, 2006
IN20040385

Storm Time (hr)	M1 Time (hr)	M1 Time Actual (hr)	Stream Flow from M1 (cfs)	M5-M1 Time (hr)	Stream Flow M5-M1 (cfs)	Sum (cfs) M1 + (M5-M1)
10.8	0		48.490	0	13.680	62.170
11.4	0		48.490	0.6	13.680	62.170
12.0	0		48.490	1.2	13.697	62.187
12.6	0.6		48.490	1.8	13.713	62.203
13.2	1.2		48.490	2.4	14.205	62.695
13.8	1.8		48.490	3.0	14.696	63.186
14.4	2.4		48.490	3.6	15.543	64.033
15.0	3.0		48.490	4.2	16.390	64.880
15.6	3.6		48.490	4.8	17.508	65.998
16.2	4.2		48.490	5.4	18.627	67.117
16.8	4.8		48.490	6.0	19.960	68.450
17.4	5.4		48.490	6.6	21.293	69.783
18.0	6.0		48.490	7.2	22.858	71.348
18.6	6.6		48.490	7.8	24.423	72.913
19.2	7.2		48.490	8.4	26.183	74.673
19.8	7.8		48.490	9.0	27.943	76.433
20.4	8.4		48.490	9.6	29.911	78.401
21.0	9.0		48.490	10.2	31.879	80.369
21.6	9.6		48.490	10.8	34.063	82.553
22.2	10.2		48.490	11.4	36.248	84.738
22.8	10.8		48.490	12.10	38.547	87.037
23.4	11.4		48.490	12.6	40.849	89.339
24.0	12.0		48.490	13.2	43.238	91.728
24.6	12.6		48.490	13.8	45.704	94.194
25.2	13.2		48.490	14.4	47.380	95.870
25.8	13.8		48.490	15.0	49.067	97.557
26.4	14.4		48.490	15.6	50.162	98.652
27.0	15.0		48.490	16.2	51.267	99.757
27.6	15.6	0	48.490	16.8	51.920	100.410
28.2	16.2	0.6	48.490	17.4	52.581	101.071
28.8	16.8	1.2	48.736	18.0	52.884	101.620
29.4	17.4	1.8	48.982	18.6	53.204	102.187
30.0	18.0	2.4	50.287	19.2	53.139	103.426
30.6	18.6	3.0	51.592	19.8	53.084	104.676
31.2	19.2	3.6	53.980	20.4	52.702	106.682
31.8	19.8	4.2	56.368	21.0	52.336	108.704
32.4	20.4	4.8	59.741	21.6	51.624	111.365
33.0	21.0	5.4	63.114	22.2	50.927	114.041
33.6	21.6	6.0	68.905	22.8	49.869	118.774
34.2	22.2	6.6	73.017	23.4	48.809	121.826
34.8	22.8	7.2			47.557	
34.96	23.0	7.36	83.666	24.0		131.223
35.4	23.4	7.8	87.055	24.6	46.314	133.369
36.0	24.0	8.4	97.312	25.2	44.879	142.192

36.6	24.6	9.0	99.974	25.8	43.433	143.407
37.2	25.2	9.6	109.321	26.4	41.988	151.309
37.8	25.8	10.2	111.611	27.0	40.542	152.152
38.4	26.4	10.8	120.799	27.6	39.096	159.895
39.0	27.0	11.4	121.935	28.2	37.650	159.585
39.6	27.6	12.0	129.320	28.8	36.204	165.524
40.2	28.2	12.6	129.483	29.4	34.758	164.241
40.8	28.8	13.2	135.920	30.0	33.312	169.233
41.4	29.4	13.8	134.293	30.6	31.867	166.159
42.0	30.0	14.4	139.286	31.2	30.421	169.707
42.6	30.6	15.0	135.711	31.8	28.975	164.686
43.10				32.3	27.529	
43.20	31.2	15.6	135.840			163.368
43.80	31.8	16.2	131.229	33.0	26.085	157.314
44.4	32.4	16.8	130.475	33.6	24.649	155.124
45.0	33.0	17.4	124.893	34.2	23.260	148.153
45.6	33.6	18.0	119.515	34.8	22.109	141.623
46.2	34.2	18.6	113.928	35.4	20.993	134.921
46.8	34.8	19.2	108.554	36.0	20.054	128.608
47.26	35.26	19.66	103.074			
47.4	35.4	19.8		36.6	19.143	122.217
48.0	36.0	20.4	97.628	37.2	18.367	115.995
48.6	36.6	21.0	92.295	37.8	17.613	109.908
49.2	37.2	21.6	87.110	38.4	16.965	104.075
49.8	37.8	22.2	82.411	39.0	16.341	98.752
50.4	38.4	22.8	77.863	39.6	15.833	93.695
51.0	39.0	23.4	73.811	40.2	15.343	89.155
51.6	39.6	24.0	69.898	40.8	14.952	84.850
52.2	40.2	24.6	66.436	41.4	14.581	81.017
52.8	40.8	25.2	63.132	42.0	14.314	77.446
53.4	41.4	25.8	60.348	42.6	14.069	74.416
54.0	42.0	26.4	57.704	43.2	13.931	71.636
54.6	42.6	27.0	55.524	43.75	13.806	69.330
55.2	43.2	27.6	53.502	44.4	13.737	67.239
55.8	43.8	28.2	51.999	45.0	13.680	65.679
56.4	44.4	28.8	50.665	45.6	13.680	64.345
57.0	45.0	29.4	49.884	46.2	13.680	63.564
57.6	45.6	30.0	49.193	46.8	13.680	62.873
58.2	46.2	30.6	48.795	47.4	13.680	62.475
58.8	46.8	31.2	48.490	48.0	13.680	62.170


Additive Stream Flow Hydrograph Watershed M1 +(M5-M1)
flow (cfs)
170
160
150
140
130
120
110
100
90
80
70
60
10
15
20
25
30
35
40
45
50
55
60
time (hr)

IN20040385 Trail Creek Watershed
July 18, 2006
Watershed M6 - Watershed M1
Curve Number & Runoff Check for Michigan City

Acres of Each Soil Type in Watershed

A	B	C	D	Null
1949.3	2071.26	1543.21	112.96	2837.8

Acres of Given Land Use for Each Soil Type

Land Use Type	Acres	% of M6-M1	A (ac)	B (ac)	C (ac)	D (ac)
Developed Agriculture Pasture/Grassland	892.58	10.48%	204.32	217.11	161.76	11.84
Developed Agriculture Row Crop	1062.06	12.47%	243.12	258.33	192.47	14.09
Developed Non-Vegetated	170.10	2.00%	38.94	41.37	30.83	2.26
Developed Urban High Density	1200.98	14.10%	274.92	292.12	217.65	15.93
Developed Urban Low Density	1347.48	15.82%	308.46	327.76	244.20	17.87
Palustrine Forest Deciduous	781.84	9.18%	178.98	190.17	141.69	10.37
Palustrine Herbaceous Deciduous	16.84	0.20%	3.85	4.10	3.05	0.22
Palustrine Shrubland Deciduous	0.00	0.00%	0.00	0.00	0.00	0.00
Palustrine Woodland Deciduous	3.15	0.04%	0.72	0.77	0.57	0.04
Terrestrial Forest Deciduous	2741.68	32.20%	627.61	666.88	496.86	36.37
Terrestrial Forest Evergreen	0.00	0.00%	0.00	0.00	0.00	0.00
Terrestrial Forest Mixed	2.90	0.03%	0.66	0.71	0.53	0.04
Terrestrial Shrubland Deciduous	97.84	1.15%	22.40	23.80	17.73	1.30
Terrestrial Woodland Deciduous	126.32	1.48%	28.92	30.73	22.89	1.68
Unclassified Cloud/Shadow	0.00	0.00%	0.00	0.00	0.00	0.00
Water	71.64	0.84%	16.40	17.43	12.98	0.95
TOTAL	8515.40	100.00%				

Curve Number for Each Land Use

Land Use Type	A	B	C	D
Developed Agriculture Pasture/Grassland	49	69	79	84
Developed Agriculture Row Crop	49	69	79	84
Developed Non-Vegetated	89	92	94	95
Developed Urban High Density	89	92	94	95
Developed Urban Low Density	51	68	79	84
Palustrine Forest Deciduous	25	55	70	77
Palustrine Herbaceous Deciduous	25	55	70	77
Palustrine Shrubland Deciduous	30	58	71	78
Palustrine Woodland Deciduous	25	55	70	77
Terrestrial Forest Deciduous	25	55	70	77
Terrestrial Forest Evergreen	25	55	70	77
Terrestrial Forest Mixed	45	66	77	83
Terrestrial Shrubland Deciduous	30	58	71	78
Terrestrial Woodland Deciduous	25	55	70	77
Unclassified Cloud/Shadow	25	55	70	77
Water	72	82	87	89

Curve Number x Acres of Land Use for Each Soil Type

Land Use Type	A (ac)	B (ac)	C (ac)	D (ac)	Sums
Developed Agriculture Pasture/Grassland	10011.86	14980.41	12778.86	994.59	38765.73
Developed Agriculture Row Crop	11912.91	17824.89	15205.31	1183.44	46126.56
Developed Non-Vegetated	3465.52	3806.47	2897.69	214.36	10384.04
Developed Urban High Density	24468.02	26875.26	20458.94	1513.49	73315.70
Developed Urban Low Density	15731.40	22287.54	19291.71	1501.49	58812.15
Palustrine Forest Deciduous	4474.39	10459.55	9918.33	798.60	25650.87
Palustrine Herbaceous Deciduous	96.37	225.28	213.62	17.20	552.47
Palustrine Shrubland Deciduous	0.00	0.00	0.00	0.00	0.00
Palustrine Woodland Deciduous	18.02	42.13	39.95	3.22	103.32
Terrestrial Forest Deciduous	15690.25	36678.25	34780.38	2800.44	89949.32
Terrestrial Forest Evergreen	0.00	0.01	0.01	0.00	0.02
Terrestrial Forest Mixed	29.88	46.57	40.48	3.19	120.13
Terrestrial Shrubland Deciduous	671.88	1380.23	1258.85	101.23	3412.19
Terrestrial Woodland Deciduous	722.90	1689.88	1602.44	129.02	4144.23
Unclassified Cloud/Shadow	0.00	0.00	0.00	0.00	0.00
Water	1180.74	1428.87	1129.50	84.58	3823.68

Total Sum:	355160.42
Total Acres:	5677.60
Composite Number:	62.55
Flow Rate:	

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M6 - Watershed M1
Curve Number & Runoff Check for Michigan City

Base Flow

Watershed	Area (ac)	Area (mi^2)	Annual Runoff (ft^3)	Annual Flow (cfs)	Base Flow (cfs)
M6-M1	8515.40	13.31	582,670,503	18.48	14.04

Hydrograph Calculations

Watershed	Travel Length, L (ft)	Beginning Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	*Velocity, v (ft/s)	Area, A_m (mi^2)	Time of Concentr-ation, t_c (hr)	ΔD (hr)	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M6-M1	44,251	695	585	0.002	0.5	13.31	24.58	3.27	16.39	393	43.75	27.36

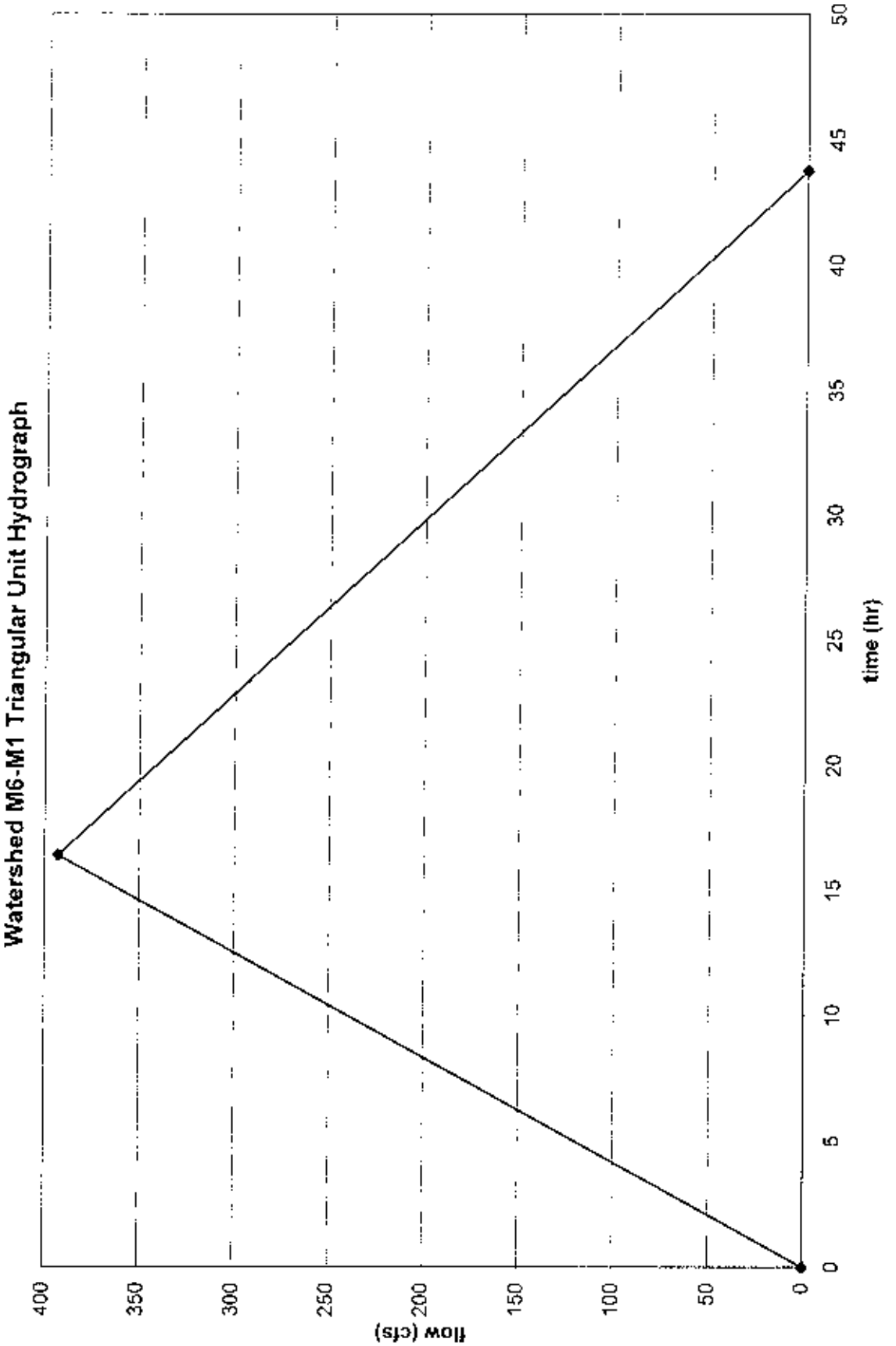
*Any watershed with a slop less than 0.005 has a velocity less than 1 ft/s. It was assumed that slope = 0.004 has a velocity of 0.8 ft/s and slope = 0.002 has a velocity of 0.5 ft/s.

Unit Hydrograph Calculations

Watershed	Time to Peak, t_p (hr)	Peak Flow, q_p (cfs)	Base Time, t_b (hr)	Recession Time, t_r (hr)
M6-M1	16.39	393	43.75	27.36

Watershed M6-M1

Time (hr)	Flow (cfs)
0	0
16.39	393
43.75	0


Watershed M6-M1 Triangular Unit Hydrograph
flow (cfs)
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
time (hr)

Trail Creek Watershed
July 18, 2006
IN20040385
Watershed M6 - Watershed M1
SCS Type II Distribution

Watershed M6-M1, S = 5.99, 0.2S = 1.20

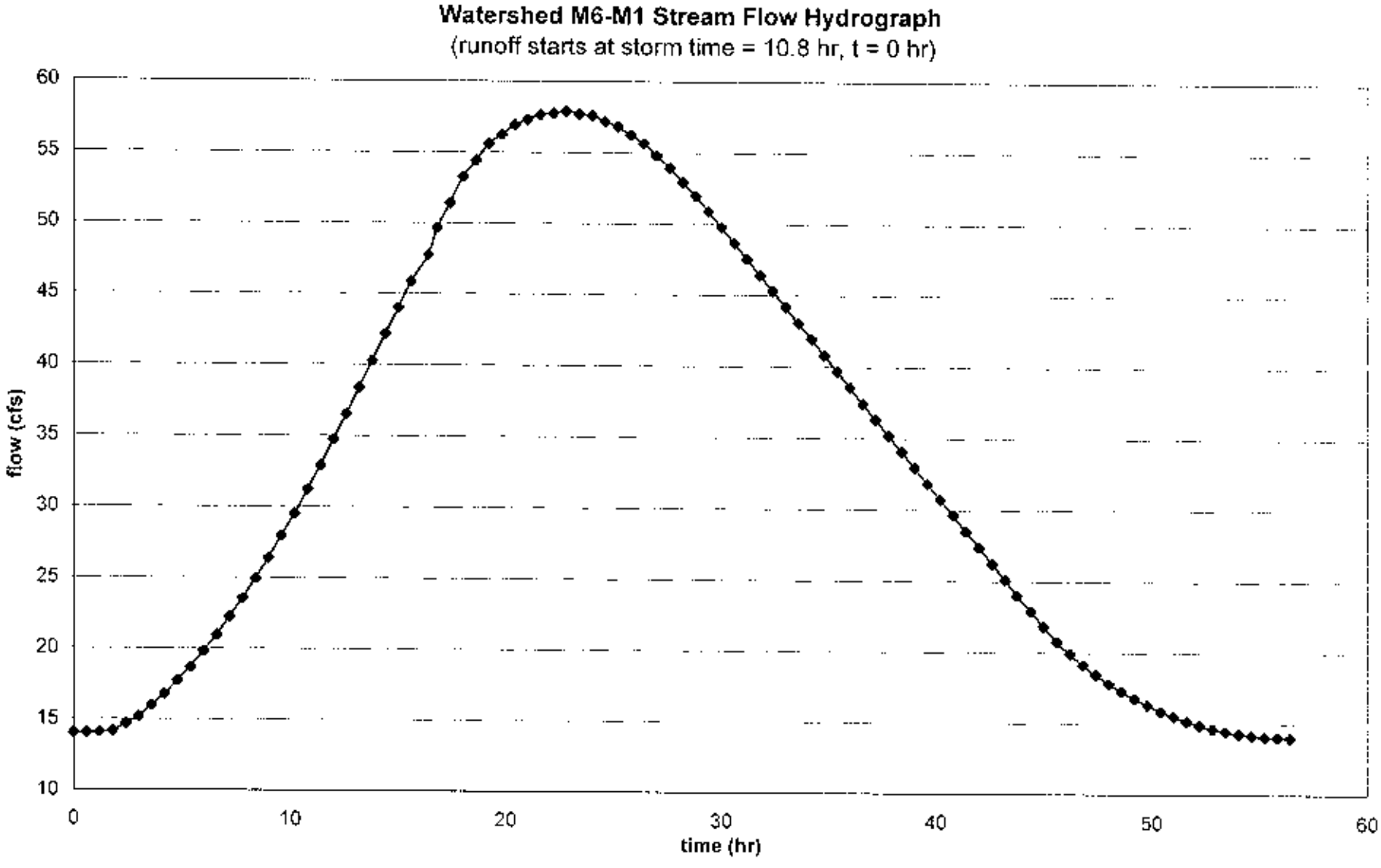
Time/Total Time	Time (hr)	Rainfall/Total Rainfall	Cummulative Depth (in)	Cummulative Runoff (in)	Incremental Runoff (in)
0.000	0.00	0.000	0.000	0	0
0.040	0.96	0.010	0.021	0	0
0.100	2.40	0.025	0.054	0	0
0.150	3.60	0.040	0.086	0	0
0.200	4.80	0.060	0.129	0	0
0.250	6.00	0.080	0.172	0	0
0.300	7.20	0.100	0.215	0	0
0.330	7.92	0.120	0.258	0	0
0.350	8.40	0.130	0.279	0	0
0.380	9.12	0.150	0.322	0	0
0.400	9.60	0.165	0.354	0	0
0.420	10.08	0.190	0.408	0	0
0.430	10.32	0.200	0.430	0	0
0.440	10.56	0.210	0.451	0	0
0.450	10.80	0.220	0.473	0	0
0.460	11.04	0.230	0.494	0	0
0.470	11.28	0.260	0.558	0	0
0.480	11.52	0.300	0.644	0	0
0.485	11.64	0.340	0.730	0	0
0.487	11.69	0.370	0.795	0	0
0.490	11.76	0.500	1.074	0	0
0.500	12.00	0.640	1.375	0.0051	0.0051
0.520	12.48	0.730	1.568	0.0215	0.0165
0.530	12.72	0.750	1.611	0.0266	0.0051
0.540	12.96	0.770	1.654	0.0323	0.0056
0.550	13.20	0.780	1.675	0.0352	0.0030
0.560	13.44	0.800	1.718	0.0416	0.0064
0.570	13.68	0.810	1.740	0.0450	0.0034
0.580	13.92	0.820	1.761	0.0484	0.0035
0.600	14.40	0.835	1.794	0.0539	0.0054
0.630	15.12	0.860	1.847	0.0635	0.0096
0.650	15.60	0.870	1.869	0.0675	0.0041
0.670	16.08	0.880	1.890	0.0717	0.0042
0.700	16.80	0.895	1.922	0.0782	0.0065
0.720	17.28	0.910	1.955	0.0849	0.0067
0.750	18.00	0.920	1.976	0.0895	0.0046
0.770	18.48	0.930	1.998	0.0942	0.0047
0.800	19.20	0.940	2.019	0.0990	0.0048
0.830	19.92	0.950	2.041	0.1039	0.0049
0.850	20.40	0.960	2.062	0.1089	0.0050
0.870	20.88	0.970	2.084	0.1141	0.0051
0.900	21.60	0.980	2.105	0.1193	0.0052
0.950	22.80	0.990	2.127	0.1246	0.0053
1.000	24.00	1.000	2.148	0.1300	0.0054

Trail Creek Watershed Study
July 18, 2006
IN20040385
Watershed M6-M1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 10.8 hr)												Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2		
		0	0.0051	0.0301	0.0187	0.0136	0.0107	0.0113	0.0095	0.0099	0.0104	0.0053	0.0054		
0	0.00	0.000												0.000	14.040
0.6	14.39	0.000	0.000											0.000	14.040
1.2	28.77	0.000	0.073	0.000										0.073	14.113
1.8	43.16	0.000	0.147	0.000										0.147	14.187
2.4	57.55	0.000	0.220	0.433	0.000									0.653	14.693
3.0	71.93	0.000	0.293	0.866	0.000									1.160	15.200
3.6	86.32	0.000	0.367	1.299	0.269	0.000								1.935	15.975
4.2	100.71	0.000	0.440	1.732	0.538	0.000								2.710	16.750
4.8	115.09	0.000	0.514	2.165	0.807	0.196	0.000							3.682	17.722
5.4	129.48	0.000	0.587	2.598	1.076	0.391	0.000							4.653	18.693
6.0	143.87	0.000	0.660	3.031	1.345	0.587	0.154	0.000						5.778	19.818
6.6	158.25	0.000	0.734	3.464	1.614	0.783	0.308	0.000						6.903	20.943
7.2	172.64	0.000	0.807	3.897	1.883	0.978	0.462	0.163	0.000					8.190	22.230
7.8	187.03	0.000	0.880	4.330	2.152	1.174	0.616	0.325	0.000					9.478	23.518
8.4	201.42	0.000	0.954	4.763	2.421	1.370	0.770	0.488	0.137	0.000				10.902	24.942
9.0	215.80	0.000	1.027	5.197	2.690	1.565	0.924	0.650	0.273	0.000				12.327	26.367
9.6	230.19	0.000	1.101	5.630	2.959	1.761	1.078	0.813	0.410	0.142	0.000			13.893	27.933
10.2	244.58	0.000	1.174	6.063	3.228	1.957	1.232	0.975	0.547	0.285	0.000			15.460	29.500
10.8	258.96	0.000	1.247	6.496	3.497	2.152	1.385	1.138	0.683	0.427	0.150	0.000		17.176	31.216
11.4	273.35	0.000	1.321	6.929	3.766	2.348	1.539	1.301	0.820	0.570	0.299	0.000		18.893	32.933
12.0	287.74	0.000	1.394	7.362	4.035	2.544	1.693	1.463	0.957	0.712	0.449	0.076	0.000	20.685	34.725
12.6	302.12	0.000	1.467	7.795	4.305	2.739	1.847	1.626	1.093	0.855	0.598	0.153	0.000	22.478	36.518
13.2	316.51	0.000	1.541	8.228	4.574	2.935	2.001	1.788	1.230	0.997	0.748	0.229	0.078	24.348	38.388
13.8	330.90	0.000	1.614	8.661	4.843	3.131	2.155	1.951	1.367	1.139	0.898	0.305	0.155	26.219	40.259
14.4	345.28	0.000	1.688	9.094	5.112	3.326	2.309	2.113	1.503	1.282	1.047	0.381	0.233	28.089	42.129
15.0	359.67	0.000	1.761	9.527	5.381	3.522	2.463	2.276	1.640	1.424	1.197	0.458	0.311	29.959	43.999
15.6	374.06	0.000	1.834	9.960	5.650	3.718	2.617	2.439	1.777	1.567	1.347	0.534	0.388	31.829	45.869
16.39	393.00	0.000	1.908	10.393	5.919	3.913	2.771	2.601	1.913	1.709	1.496	0.610	0.466	33.700	47.740
16.8	387.11	0.000	2.004	10.826	6.188	4.109	2.925	2.764	2.050	1.852	1.646	0.686	0.544	35.593	49.633

17.4	378.49	0.000	1.974	11.259	6.457	4.305	3.079	2.926	2.187	1.994	1.795	0.763	0.622	37.360	51.400
18.0	369.87	0.000	1.930	11.829	6.726	4.500	3.233	3.089	2.323	2.136	1.945	0.839	0.699	39.250	53.290
18.6	361.25	0.000	1.886	11.652	6.995	4.696	3.387	3.251	2.460	2.279	2.095	0.915	0.777	40.393	54.433
19.2	352.64	0.000	1.842	11.393	7.349	4.892	3.541	3.414	2.597	2.421	2.244	0.991	0.855	41 538	55.578
19.8	344.02	0.000	1.798	11.133	7.239	5.087	3.695	3.577	2.733	2.564	2.394	1.068	0.932	42.220	56.260
20.4	335.40	0.000	1.754	10.874	7.078	5.345	3.848	3.739	2.870	2.706	2.544	1.144	1 010	42.912	56.952
21.0	326.78	0.000	1.711	10.614	6.917	5.265	4.002	3.902	3.007	2.849	2.693	1.220	1 088	43.267	57.307
21.6	318.16	0.000	1.667	10.355	6.755	5.147	4.205	4.064	3.144	2.991	2.843	1.296	1 165	43.633	57 673
22.2	309.54	0.000	1.623	10.096	6.594	5.030	4.142	4 227	3.280	3.133	2.992	1.373	1.243	43.733	57 773
22.8	300.93	0.000	1.579	9.836	6.433	4.913	4.050	4.441	3.417	3.276	3.142	1 449	1.321	43.856	57.896
23.4	292.31	0.000	1.535	9.577	6.272	4.796	3.958	4.374	3.554	3 418	3.292	1.525	1 398	43.698	57.738
24.0	283.69	0.000	1.491	9.317	6.111	4 679	3.865	4.277	3 733	3.561	3.441	1 601	1 476	43.553	57 593
24.6	275.07	0.000	1.447	9.058	5.950	4.561	3.773	4.180	3 678	3.703	3.591	1.678	1.554	43.171	57 211
25.2	266.45	0.000	1.403	8.798	5.788	4.444	3.681	4.082	3.596	3.891	3.741	1 754	1.631	42.809	56 849
25.8	257.83	0.000	1.359	8.539	5.627	4.327	3.589	3.985	3.514	3.832	3.890	1.830	1.709	42.201	56.241
26.4	249.22	0.000	1.315	8.280	5.466	4.210	3.497	3.887	3.432	3.747	4.087	1.906	1.787	41.614	55.654
27.0	240.60	0.000	1.271	8.020	5.305	4.093	3.404	3.790	3.350	3.662	4.026	1.983	1.865	40.768	54.808
27.6	231.98	0.000	1.227	7.761	5.144	3.975	3.312	3.693	3.268	3.576	3.936	2.083	1.942	39.918	53.958
28.2	223.36	0.000	1.183	7.501	4.983	3.858	3.220	3.595	3.186	3.491	3.847	2.052	2.020	38.936	52.976
28.8	214.74	0.000	1.139	7.242	4.821	3.741	3.128	3.498	3.104	3.406	3.757	2.006	2.122	37.965	52.005
29.4	206.12	0.000	1.095	6.983	4.660	3.624	3.035	3.400	3.023	3.320	3.667	1.960	2.090	36.859	50.899
30.0	197.51	0.000	1.051	6.723	4.499	3.507	2.943	3.303	2.941	3.235	3.578	1.915	2.044	35.738	49.778
30.6	188.89	0.000	1.007	6.464	4.338	3.389	2.851	3.206	2.859	3.150	3.488	1.869	1.997	34.618	48.658
31.2	180.27	0.000	0.963	6.204	4.177	3.272	2.759	3.108	2.777	3.064	3.399	1.823	1.951	33.498	47.538
31.8	171.65	0.000	0.919	5.945	4.016	3.155	2.667	3.011	2.695	2.979	3.309	1.778	1.904	32.377	46.417
32.4	163.03	0.000	0.875	5.685	3.855	3.038	2.574	2.914	2.613	2.894	3.219	1.732	1.858	31.257	45.297
33.0	154.41	0.000	0.831	5.426	3.693	2.920	2.482	2.816	2.531	2.809	3.130	1.686	1.811	30.137	44 177
33.6	145.79	0.000	0.788	5 167	3.532	2.803	2.390	2.719	2.449	2.723	3.040	1 641	1 765	29 016	43.056
34.2	137 18	0.000	0 744	4.907	3.371	2.686	2.298	2.621	2.368	2.638	2.950	1.595	1.718	27.896	41.936
34.8	128.56	0.000	0.700	4.648	3.210	2.569	2.206	2.524	2.286	2.553	2.861	1.549	1.672	26.775	40.815
35.4	119.94	0.000	0.656	4.388	3.049	2.452	2.113	2.427	2.204	2.467	2.771	1.504	1.625	25.655	39.695
36.0	111.32	0.000	0.612	4.129	2.888	2.334	2.021	2.329	2.122	2.382	2.681	1.458	1.578	24.535	38.575
36.6	102.70	0.000	0.568	3.870	2.726	2.217	1.929	2.232	2.040	2.297	2.592	1 412	1 532	23.414	37.454
37.2	94.08	0.000	0.524	3.610	2.565	2.100	1.837	2.134	1.958	2.211	2.502	1.367	1 485	22.294	36.334
37.8	85.47	0.000	0.480	3.351	2.404	1.983	1.744	2.037	1.876	2.126	2.413	1.321	1.439	21.173	35.213
38.4	76.85	0.000	0.436	3.091	2.243	1.866	1.652	1.940	1.794	2.041	2.323	1.275	1.392	20.053	34.093
39.0	68.23	0.000	0.392	2.832	2.082	1.748	1.560	1.842	1.713	1.955	2.233	1.229	1.346	18.933	32.973

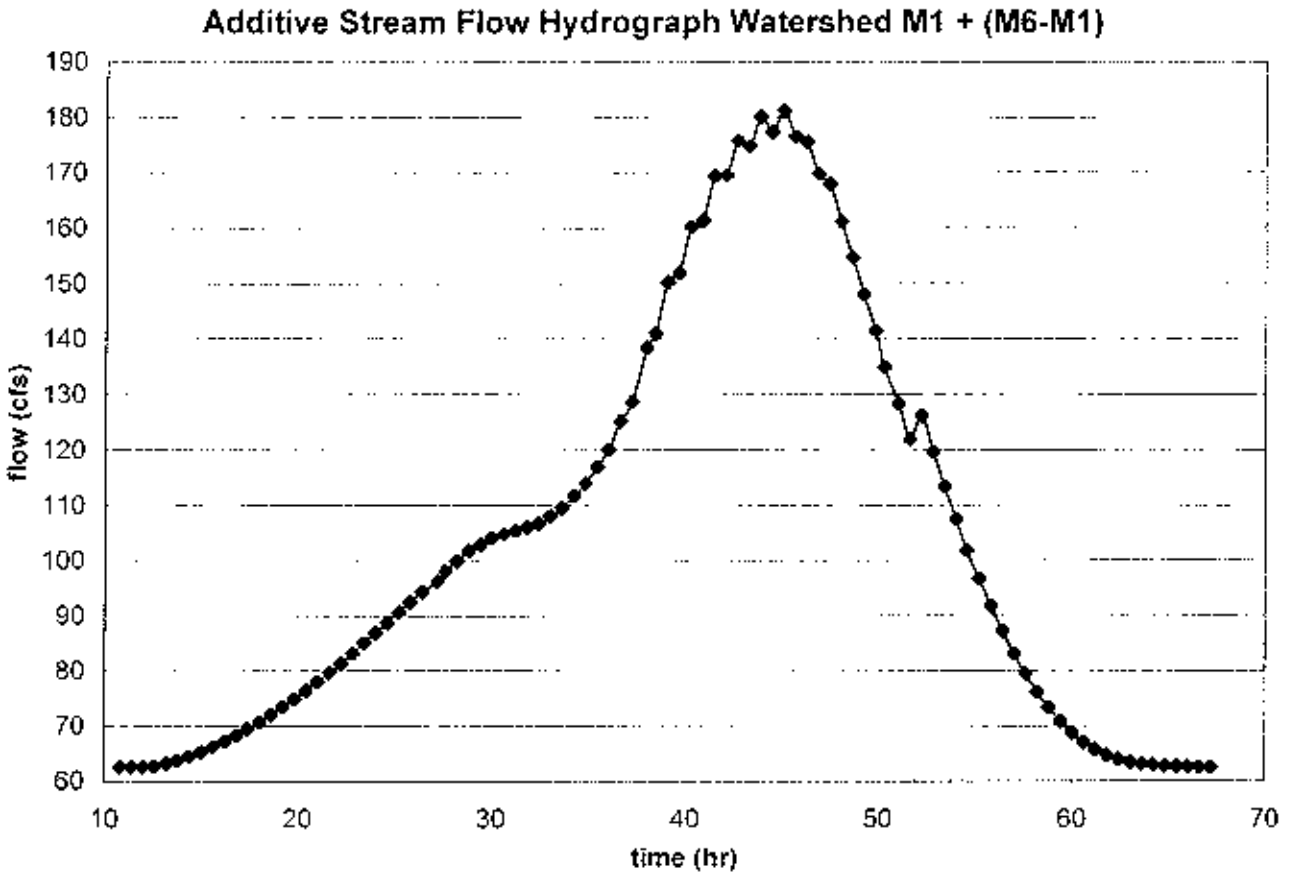
39.6	59.61	0.000	0.348	2.573	1.921	1.631	1.468	1.745	1.631	1.870	2.144	1.184	1.299	17.812	31.852
40.2	50.99	0.000	0.304	2.313	1.759	1.514	1.376	1.647	1.549	1.785	2.054	1.138	1.253	16.692	30.732
40.8	42.37	0.000	0.260	2.054	1.598	1.397	1.283	1.550	1.467	1.699	1.964	1.092	1.206	15.571	29.611
41.4	33.76	0.000	0.216	1.794	1.437	1.280	1.191	1.453	1.385	1.614	1.875	1.047	1.160	14.451	28.491
42.0	25.14	0.000	0.172	1.535	1.276	1.162	1.099	1.355	1.303	1.529	1.785	1.001	1.113	13.331	27.371
42.6	16.52	0.000	0.128	1.275	1.115	1.045	1.007	1.258	1.221	1.443	1.696	0.955	1.067	12.210	26.250
43.2	7.90	0.000	0.084	1.016	0.954	0.928	0.914	1.161	1.139	1.358	1.606	0.910	1.020	11.090	25.130
43.75	0.00	0.000	0.040	0.757	0.792	0.811	0.822	1.063	1.058	1.273	1.516	0.864	0.973	9.969	24.009
44.4			0.000	0.497	0.631	0.693	0.730	0.966	0.976	1.187	1.427	0.818	0.927	8.853	22.893
45.0			0.000	0.238	0.470	0.576	0.638	0.868	0.894	1.102	1.337	0.773	0.880	7.776	21.816
45.6				0.000	0.309	0.459	0.546	0.771	0.812	1.017	1.247	0.727	0.834	6.721	20.761
46.2				0.000	0.148	0.342	0.453	0.674	0.730	0.931	1.158	0.681	0.787	5.904	19.944
46.8					0.000	0.225	0.361	0.576	0.648	0.846	1.068	0.636	0.741	5.101	19.141
47.4					0.000	0.107	0.269	0.479	0.566	0.761	0.978	0.590	0.694	4.445	18.485
48.0						0.000	0.177	0.381	0.484	0.675	0.889	0.544	0.648	3.799	17.839
48.6						0.000	0.085	0.284	0.403	0.590	0.799	0.499	0.601	3.260	17.300
49.2							0.000	0.187	0.321	0.505	0.710	0.453	0.555	2.729	16.769
49.8							0.000	0.089	0.239	0.420	0.620	0.407	0.508	2.283	16.323
50.4								0.000	0.157	0.334	0.530	0.362	0.462	1.845	15.885
51.0								0.000	0.075	0.249	0.441	0.316	0.415	1.496	15.536
51.6									0.000	0.164	0.351	0.270	0.368	1.153	15.193
52.2									0.000	0.078	0.261	0.225	0.322	0.886	14.926
52.8										0.000	0.172	0.179	0.275	0.626	14.666
53.4										0.000	0.082	0.133	0.229	0.444	14.484
54.0											0.000	0.088	0.182	0.270	14.310
54.6											0.000	0.042	0.136	0.178	14.218
55.2												0.000	0.089	0.089	14.129
55.8												0.000	0.043	0.043	14.083
56.4													0.000	0.000	14.040
													SUM =	1862.964	3196.764


Watershed M6-M1 Stream Flow Hydrograph
(runoff starts at storm time = 10.8 hr, t = 0 hr)
flow (cfs)
time (hr)
60
55
50
45
40
35
30
25
20
15
10
0
10
20
30
40
50
60

Trail Creek Watershed Study
Additive Stream Flow Hydrograph
Watershed M1 + (M6-M1)
July 18, 2006
IN20040385

Storm Time (hr)	M1 Time (hr)	M1 Time Actual (hr)	Stream Flow from M1 (cfs)	M6-M1 Time (hr)	Stream Flow M6-M1 (cfs)	Sum (cfs) M1 + (M6-M1)
10.8	0.0		48.490	0	14.040	62.530
11.4	0.0		48.490	0.6	14.040	62.530
12.0	0.0		48.490	1.2	14.113	62.603
12.6	0.6		48.490	1.8	14.187	62.677
13.2	1.2		48.490	2.4	14.693	63.183
13.8	1.8		48.490	3.0	15.200	63.690
14.4	2.4		48.490	3.6	15.975	64.465
15.0	3.0		48.490	4.2	16.750	65.240
15.6	3.6		48.490	4.8	17.722	66.212
16.2	4.2		48.490	5.4	18.693	67.183
16.8	4.8		48.490	6.0	19.818	68.308
17.4	5.4		48.490	6.6	20.943	69.433
18.0	6.0		48.490	7.2	22.230	70.720
18.6	6.6		48.490	7.8	23.518	72.008
19.2	7.2		48.490	8.4	24.942	73.432
19.8	7.8		48.490	9.0	26.367	74.857
20.4	8.4		48.490	9.6	27.933	76.423
21.0	9.0		48.490	10.2	29.500	77.990
21.6	9.6		48.490	10.8	31.216	79.706
22.2	10.2		48.490	11.4	32.933	81.423
22.8	10.8		48.490	12.0	34.725	83.215
23.4	11.4		48.490	12.6	36.518	85.008
24.0	12.0		48.490	13.2	38.388	86.878
24.6	12.6		48.490	13.8	40.259	88.749
25.2	13.2		48.490	14.4	42.129	90.619
25.8	13.8		48.490	15.0	43.999	92.489
26.4	14.4		48.490	15.6	45.869	94.359
27.19	15.19		48.490	16.39	47.740	96.230
27.6	15.6		48.490	16.8	49.633	98.123
28.2	16.2		48.490	17.4	51.400	99.890
28.8	16.8		48.490	18.0	53.290	101.780
29.4	17.4		48.490	18.6	54.433	102.923
30.0	18.0		48.490	19.2	55.578	104.068
30.6	18.6	0.0	48.490	19.8	56.260	104.750
31.2	19.2	0.6	48.490	20.4	56.952	105.442
31.8	19.8	1.2	48.736	21.0	57.307	106.043
32.4	20.4	1.8	48.982	21.6	57.673	106.655
33.0	21.0	2.4	50.287	22.2	57.773	108.060
33.6	21.6	3.0	51.592	22.8	57.896	109.488
34.2	22.2	3.6	53.980	23.4	57.738	111.718
34.8	22.8	4.2	56.368	24.0	57.593	113.961
35.4	23.4	4.8	59.741	24.6	57.211	116.953
36.0	24.0	5.4	63.114	25.2	56.849	119.963
36.6	24.6	6.0	68.905	25.8	56.241	125.146
37.2	25.2	6.6	73.017	26.4	55.654	128.670
37.8	25.8	7.2		27.0	54.808	
37.96	25.96	7.36	83.666			138.473

38.4	26.4	7.8	87.055	27.6	53.958	141.013
39.0	27.0	8.4	97.312	28.2	52.976	150 289
39.6	27.6	9.0	99.974	28.8	52.005	151.978
40.2	28.2	9.6	109.321	29.4	50.899	160.220
40.8	28.8	10.2	111.611	30.0	49.778	161.389
41.4	29.4	10.8	120.799	30 6	48.658	169.458
42.0	30.0	11.4	121.935	31.2	47.538	169.473
42.6	30.6	12.0	129 320	31 8	46.417	175.737
43.2	31.2	12.6	129.483	32.4	45.297	174.780
43.8	31.8	13.2	135.920	33 0	44.177	180 097
44 4	32.4	13.8	134.293	33.6	43 056	177.349
45.0	33.0	14.4	139.286	34.2	41.936	181.222
45.6	33.6	15.0	135.711	34.8	40.815	176.527
46.2	34 2	15.6	135.840	35 4	39.695	175.535
46.8	34.8	16.2	131.229	36.0	38.575	169.804
47.4	35.4	16.8	130.475	36.6	37.454	167.929
48.0	36.0	17.4	124.893	37.2	36.334	161.226
48.6	36.6	18.0	119.515	37.8	35.213	154.728
49.2	37.2	18.6	113.928	38.4	34.093	148.021
49.8	37.8	19.2	108.554	39.0	32.973	141.527
50.26	38.26	19.66	103.074			
50.4	38.4	19.8		39.6	31.852	134.926
51.0	39.0	20.4	97.628	40.2	30.732	128.360
51.6	39.6	21.0	92.295	40.8	29.611	121.907
52.2	40.2	21.6	97.628	41.4	28.491	126.119
52.8	40.8	22.2	92.295	42.0	27.371	119.666
53.4	41.4	22.8	87.110	42.6	26.250	113.360
54.0	42.0	23.4	82.411	43 2	25.130	107.541
54.55				43.75	24.009	
54.6	66.6	24.0	77.863			101.872
55.2	43.2	24.6	73.811	44.4	22.893	96.704
55.8	43.8	25.2	69.898	45.0	21.816	91.714
56.4	44.4	25.8	66.436	45.6	20.761	87.197
57.0	45.0	26.4	63.132	46.2	19.944	83.076
57.6	45.6	27.0	60.348	46.8	19.141	79.488
58.2	46.2	27.6	57.704	47.4	18.485	76.189
58.8	46.8	28.2	55.524	48.0	17.839	73.363
59.4	47.4	28.8	53.502	48.6	17.300	70.802
60.0	48.0	29.4	51.999	49.2	16.769	68.768
60.6	48.6	30.0	50.665	49.8	16.323	66.988
61.2	49.2	30.6	49.884	50.4	15.885	65.769
61.8	49.8	31.2	49.193	51.0	15.536	64.728
62.4	50.4	31.8	48.795	51.6	15.193	63.988
63.0	51.0	32.4	48.490	52.2	14.926	63.416
63.6	51.6	33.0	48.490	52.8	14.666	63.156
64.2	52.2	33.6	48.490	53.4	14.484	62.974
64.8	52.8	34.2	48.490	54.0	14.310	62.800
65.4	53.4	34.8	48.490	54.6	14.218	62.708
66.0	54.0	35.4	48.490	55.2	14.129	62.619
66.6	54.6	36.0	48.490	55.8	14.083	62.573
67.2	55.2	36.6	48.490	56.4	14.040	62.530


Additive Stream Flow Hydrograph Watershed M1 + (M6-M1)
flow (cfs)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
10
20
30
40
50
60
70
time (hr)

Curve Number for the Mg-M1 area: 66.52

[illegible]

$S = \frac{1000}{66.52} - 10 = 5.99$

$0.85 = 1.60$

$Q_a = \frac{(6.42 - 0.2(5.99))^2}{6.42 + 0.8(5.99)} = 0.13''$

Triangular Unit Hydrograph $y = mx + b$

Mg - M1

$m_1 = \frac{[illegible]}{[illegible]} = [illegible]$; $y = [illegible]$

$m_2 = \frac{[illegible]}{[illegible]} = -14.364$; $y = -14.364x + b$; $y = -14.364x + [illegible]$

$0 = -14.364(2.78) + 0$

$b = [illegible]$

Base Flow at M1 = Base Flow [illegible] + Ex Mg-M1

= 48.49 + 14.04

= 62.53 cfs

Peak Flow M1: t = 14.4 hr

storm t = 14.4 + 12 = 26.4 hr

Peak Flow M1-M1: t = 26.2 hr

storm t = 26.2 + 12 = 38.2 hr

Time for flow to reach M1:

d = 8.82 - 4.28 = 4.54 = 33760 LF

Elev = 102 - 52 = 50'

$S = \frac{50}{33760} = 0.0015$ ft/ft

V = 0.6 fps (Bennett)

$t = \frac{d}{V} = \frac{[illegible]}{0.6} = (67440)\left(\frac{min}{[illegible]}\right)\left(\frac{hr}{60 min}\right) = 18.73$ hr

M1 peak flow occurs at storm t = [illegible] = 45.13 hr (45 hr)

CN = 69.3

P(t) = 6.18"

$S = \frac{1000}{69.3} - 10 = 6.55$

0.6S = 1.81

$R(t) = \frac{(6.18 - 0.6[illegible])^2}{6.18 + 0.4(6.55)} = 0.0[illegible]$

[illegible]

$Q = \frac{481 - 0}{10.10 - 0} = [illegible]$ 39.766 X

$m_a = \frac{[illegible]}{[illegible]} = [illegible]$; [illegible]

Q = [illegible]

c = 759.[illegible]

Base flow at MS = Base flow at [illegible] + [illegible]

= 48.49 + 12.68

= 61.17 cfs

Peak flow [illegible] = [illegible] hr

[illegible] = 14.4 + 12 = [illegible] hr

Peak flow [illegible] : t = 18.8 hr

[illegible] = [illegible] + 12 = 30 hr

Time for [illegible] to peak MS

d = 7653 - 4812 = [illegible]

[illegible] 305 - [illegible] = [illegible]

$S = \frac{[illegible]}{[illegible]} = 0.000704$

V = 0.5 [illegible]

$t = \frac{d}{V} = \frac{[illegible]}{0.5} = [illegible] \frac{[illegible]}{[illegible]} = 15.[illegible]$ hr

[illegible] = 26.4 - 15.[illegible] = 40.16 hr [illegible]

CN = 59.99

P(E) = 6.48"

$S = \frac{1000}{CN} - 10 = 6.67$

0.2S = 1.334

$R(t) = \frac{P(t) - 0.2S}{P(t) + 0.8S} = 0.084$"

[illegible] $y = mx + c$

$m_1 = \frac{[illegible] - 0}{[illegible]} = [illegible]$; $y = 43.9[illegible]x$

$m_2 = \frac{[illegible]}{[illegible]} = -[illegible]$; $y = -[illegible]x + c$; $y = -[illegible]x + [illegible]$

$c = [illegible]$

Base Flow at M4 [illegible] = Base Flow at M4 - M1

= 48.49 + 12.2

= 60.70 cfs

Peak Flow M1 t = 14.4 hr

storm t = 14.4 + 12 = 26.4 hr

Peak Flow M4 - M1 t = 18.0 hr

storm t = 18.0 + 10.8 = 28.8 hr

Time for M1 to reach M4

$d = 73[illegible] = 8574$ LF

$L_{flow} = 600 - 590 = 10$

$S = [illegible] = 0.000583$

V = 0.5 ft/s (assumed)

$t = \frac{d}{V} = \frac{8574}{0.5} = 17148 \text{ s} \left(\frac{hr}{3600 \text{ s}}\right) = 14.30 \text{ hr}$

M1 peak flow [illegible] storm t = 26.4 + 14.30 = 40.7 hr (40.8)

CN = 60.11 P(24) = 3.48

S = [illegible] − [illegible] = 6.64

0.2S = 1.32

R(t) = [illegible] = 0.09

Triangular Unit Hydrograph

m_1 = [illegible] 51,700 ; q = [illegible]

m_6 = [illegible] = 30.[illegible] ; q = [illegible] ; q = [illegible]

b = [illegible]

Base Flow at M3 = Base Flow at M1 + Base Flow from M1-M3

= 48.29 + 11.93

= 60.42 cfs

Peak Flow M1 ; t = 14.4 hr

storm t = [illegible] + 2 = [illegible] hr

Peak Flow M1-M3 ; t = 16.8 hr

storm t = 16.8 + 10.8 = 27.6 hr

Time for M1 to reach M3:

d = 10693 − 4813 = 5880

Delay = 2.75 − 5.90 = 15'

s = 15/5880 = 0.003 ft/ft

v = 0.5 ft/s (assumed)

t = d/v = 5880 LF / 0.5 ft/s = (11760 s)(1 hr / 3600 s) = 12.33 hr (10.[illegible] hr)

M1 varying start of storm t = 18 + 10.6 = 28.6 hr

peak = 28.6 + 10.4 = 39 hr

CN = 63.41 P(1) = 2.148

$S = \frac{1000}{63.41} - 10 = 5.77$

0.2S = 1.154

$R_a = \frac{2.148 - 0.2(1.154)}{2.148 + 0.8(1.154)} = 0.146$

Triangular Unit Hydrograph

$m_1 = \frac{[illegible]}{5.58-0} = 130.8412$; $y = 130.8412x$

$m_2 = \frac{[illegible]}{4.87-[illegible]} = -83.4586$; $y = [illegible]$; $y = -83.4586x + [illegible]$

$b = [illegible]$

Base Flow at M2 = Base Flow at M1 + Base Flow to M1-M2
= 48.47 + 9.45
= [illegible] cfs

Peak Flow M1 t = 14.4 hr
storm t = [illegible] hr

Peak Flow M2 t = 10.8 hr
storm t = 10.8 + 0.8 = 6.6 hr

Time from M1 to peak M2:

$\lambda = 6.6 - 48.33 = 1382.12$ ft

Leb = 600 - 585 = 15'

$S = \frac{15}{1382.12} = 0.0011$

V = 1.6 ft/s

$t = \frac{d}{V} = \frac{1382}{1.6} = (1000 ft)\left(\frac{hr}{3600 s}\right) = 2.84$ hr (3 hr)

M1 values are at storm t = 12 + 3 = 15 hr
peak = 15 + 14.4 = [illegible] hr

WUTP Flow

[illegible] = 10.82 cfs

[illegible] = 8.57 cfs

Base Flow + WUTP Flow = Base Flow with WUTP included (base WUTP)
Peak Flow + WUTP Flow = Peak Stream Flow w/WUTP included (peak WUTP)

60.17 + 10.82 = 70.99 cfs
[illegible] + 18.57 = 182.87 cfs

Sample Calc [illegible]

P:/INAROU/[illegible] Data/[illegible]
Drainage Calcs/[illegible] ← Used for sample calc
[illegible]

[illegible]

Land Use Type – from Arcview data
Acres – [illegible]
[illegible]
[illegible] = [illegible] × 0.[illegible] = [illegible] cfs

[illegible] – Acres of [illegible]
Ex [illegible] → [illegible] = [illegible]

Curve Numbers for [illegible] – Curve numbers for [illegible] Assumptions for open land are based on [illegible] from the HEC-[illegible] Manual. A street is also [illegible] assumption [illegible]

[illegible] × [illegible]
[illegible] = [illegible] for Acres [illegible] × Curve Number for [illegible]
= 143.[illegible] × 40 = [illegible] cfs
Sums = sum of [illegible]
= [illegible] – 13700.50 + 15104.71 + 943.[illegible] = [illegible]
Total [illegible] – Sums Column
Total Acres = [illegible] from Acres [illegible] Column [illegible] Type – Null acres
[illegible] = [illegible] 40[illegible]

Long-term Runoff = Total Sum / Total Area = 267590.10 / 680.79 = 0.39

Sheet: Mid-Mt calcs cont.

Base Flow

Area 2: from Mid-Mt calcs

Area mi^2 = Area (ac) × 43560 ft²/ac / (5280 ft/mi)²

= 8.88 ac × (43560 ft²/ac) / (5280 ft/mi)² = 8.76 mi²

Annual Runoff = 8.88 (from mi²) × 1 ft × (5280 ft/mi)²

= (8.88 ft)(8.76 mi²)(1 ft/12 in)(5280 ft/mi)² = [illegible]

• 18.88" is the annual runoff in inches over the area + was calculated in [illegible] for the entire Mid-Mt watershed

Annual Flow (cfs) = Annual runoff (in) / [illegible] = 398,311,679 / 31,536,000 = 12.63 cfs

Base Flow = 0.76 × Annual Flow

= 0.76 × 12.63 = 9.59 cfs

• There are 31,536,000 s in 1 year

• The [illegible] equal 9.88 [illegible] for [illegible] of annual flow to base flow [illegible] Flow [illegible] 9.59.

• 76% [illegible]

Hydrologic Calculations

[illegible] Hydrograph [illegible]

Beginning, Ending [illegible] Hydrograph

Slope = [illegible] / [illegible] = (795 − 620)' / 2400 LF = 0.204

Velocity = [illegible] = [illegible] from [illegible] spreadsheet [illegible]

Area [illegible] from [illegible] table

Time of Concentration, t_c = L / 3600V = 24100 ft / (3600 × 0.8 ft/s) = 8.37 hr

Lag Time = 0.132 (8.37) = 1.11 hr

t_p = Lag / 0.6 = 1.11 / 0.6 + (0.6)(8.37) = 5.58 hr

$q_p = 484 \times A_m \times \frac{Q}{t_p} = \frac{[illegible]}{5.58\ hr} = 777\ cfs$

Q = [illegible] inches for unit hydrograph

$t_b = 2.67\, t_p = 2.67 \times 5.58 = 14.89\ hr$

$t_r = 1.67\, t_p = 1.67 \times (5.58) = 9.31\ hr$

Unit Hydrograph Calculation read from hydrograph [illegible]
Watershed Model — point [illegible]

Sheet: SCS Type II

Time from Three-point [illegible] Soil Conservation Curve Type II
[illegible]

Time (hr) = [illegible] Time/lag Time = [illegible] hr

• Looking at the inner storm duration is 24 hr
[illegible]
Cumulative Rainfall = (0.42)(Total Rainfall)
= (6.148)(0.42) = 2.582

• Initial + Continuing are from [illegible]
[illegible] = 0 [illegible], PE = Cumulative Rainfall
= $\frac{PE - [illegible]}{[illegible]}$ [illegible]

Incremental Rainfall = Cumulative Rainfall − Cumulative [illegible] n-1
= 2.582 − 2.[illegible] = [illegible]

Sheet: Ma-Mi

See attached chart as shown [illegible], Sample Calcs show [illegible]
Rise Time = 2.4 hr
Unit Hydrograph = [illegible]
(0.008)(250.66) = 2.020 [illegible]
(0.09[illegible])(250.66) = [illegible] [illegible]
Storm Hydrograph = 0 + 2.020 + [illegible]
Stream Flow Hydrograph = Storm Hydrograph − Base Flow
= [illegible] − 2.420 = 14.473 cfs

Sheet: Mi+(Ma-Mi)

Storm time = hr since the storm has started
Mi time − Mi [illegible] since the storm [illegible] so the
[illegible] time runoff reaches [illegible] Mi
(Storm time − lag time

If time actual = time that runoff has reached M6. There is a lag of [illegible] hours to reach from M6.
= M6 runoff start time − [illegible]

= 10 − 2 = 8 hr

Stream flow from M1 − M1 stream flow hydrograph.

M2-M1 time = time of runoff from M2-M1 which starts at storm time = 10 hr

Stream flow M2-M1 → from M2-M1 hydrograph

Sum M1+(M2-M1) = Stream flow M1 + Stream flow M2-M1
= 42.420 + 10.127 = 52.547 cfs

Add the stream flow hydrograph

Table 3.3.3
Runoff Curve Numbers for Urban Areas (SCS, 1986)

Cover Type and Hydrologic Condition		Curve Numbers for Hydrologic Soil Group			
		A	B	C	D
Undeveloped Areas					
Cultivated Land					
Without conservation treatment		72	81	88	91
With conservation treatment		62	71	78	81
Pasture or range land					
Poor condition		68	79	86	89
Good condition		39	61	74	80
Meadow					
Good condition		30	58	71	78
Wood or forest land					
Thin stand, poor cover, no mulch		45	66	77	83
Good cover		25	55	70	77
Fully developed urban areas (with established vegetation)					
Open space (lawns, parks, golf courses, cemeteries)					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved curb and storm sewers (excluding right-of-way)		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89
Urban Districts					
Commercial and business	(85% impervious)	89	92	94	95
Industrial (72% impervious)		81	88	91	93
Residential					
1/8 acre or less, townhouses	(65% impervious)	77	85	90	92
1/4 acre	(38% impervious)	61	75	83	87
1/3 acre	(30% impervious)	57	72	81	86
1/2 acre	(25% impervious)	54	70	80	85
1 acre	(20% impervious)	51	68	79	84
2 acre		46	65	77	82
Developing Urban Areas					
Newly graded areas (no vegetation)		77	86	91	94

Table 3.3.4
Runoff Curve Numbers for Agricultural Lands (SCS, 1986)

Cover Type and Hydrologic Condition	Curve Numbers for Hydrologic Soil Group			
	A	B	C	D
Pasture, grassland, or range with continous forage for grazing				
Poor	68	79	86	89
Fair	49	69	79	84
Good	39	61	74	80
Meadow with continuous grass, protected from grazing and generally mowed for hay	30	58	71	78
Brush/brush-weed-grass mixture with brush being the major element				
Poor	48	67	77	83
Fair	35	56	70	77
Good	30	48	65	73
Woods and grass combination (orchard or tree farm)				
Poor	57	73	82	86
Fair	43	65	76	82
Good	32	58	72	79
Woods				
Poor	45	66	77	83
Fair	36	60	73	79
Good	30	55	70	77
Farmsteads	59	74	82	86

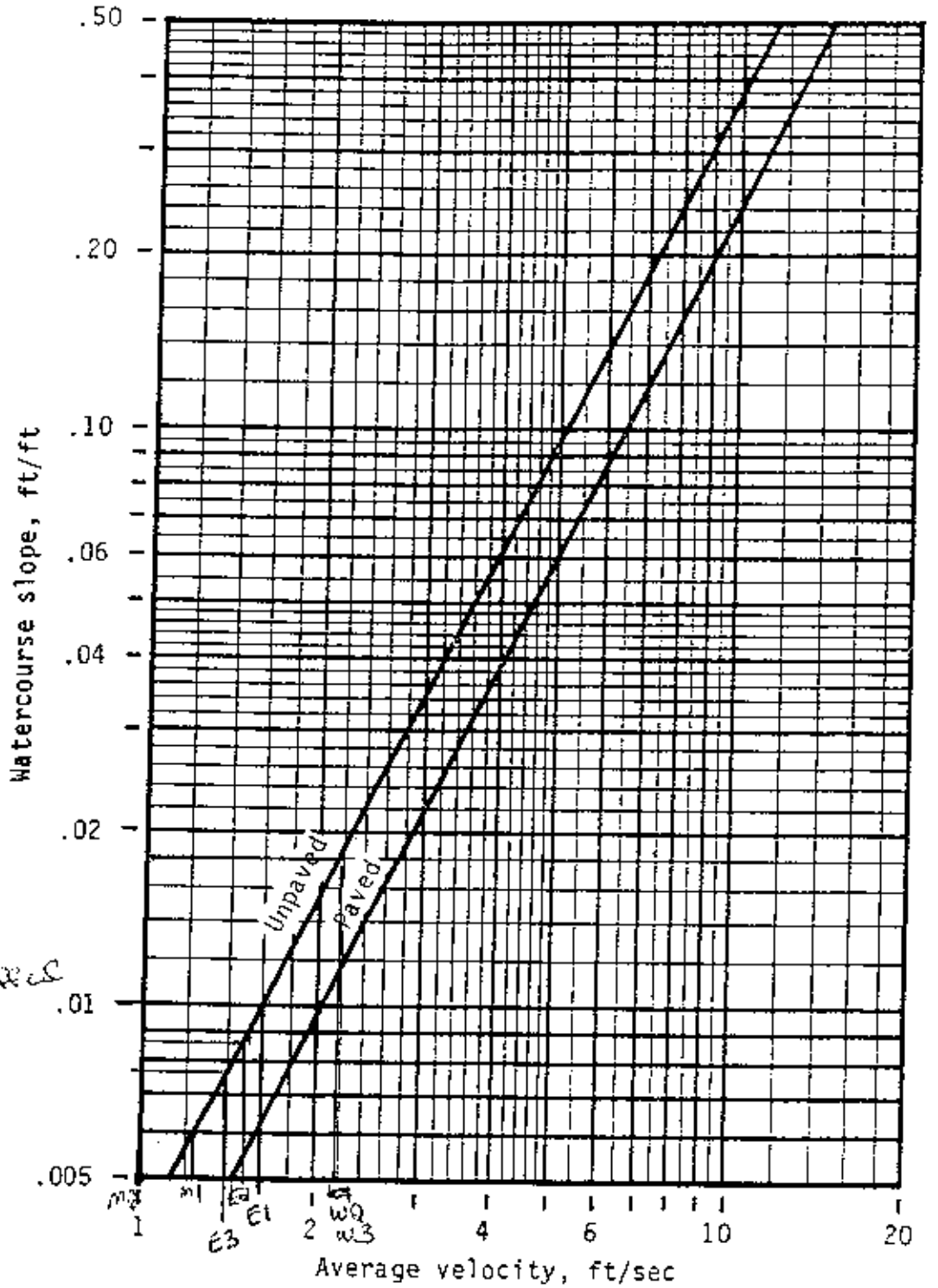
The curve number method may also be used in determining the time distribution of the runoff. In this manual, the CN method is used in conjunction with the synthetic dimensionless and triangular unit hydrograph methods to determine the storm hydrograph. The procedure used in this operation is outlined below.

1. Determine the basin curve number.

2. Given the rainfall depth and storm duration, determine the time distribution of the rainfall This distribution can be the SCS Type II or Huff Distributions discussed in Chapter 2.

Watershed Land Use Types and the Corresponding Cover Type Assumptions for Curve Number Calculations

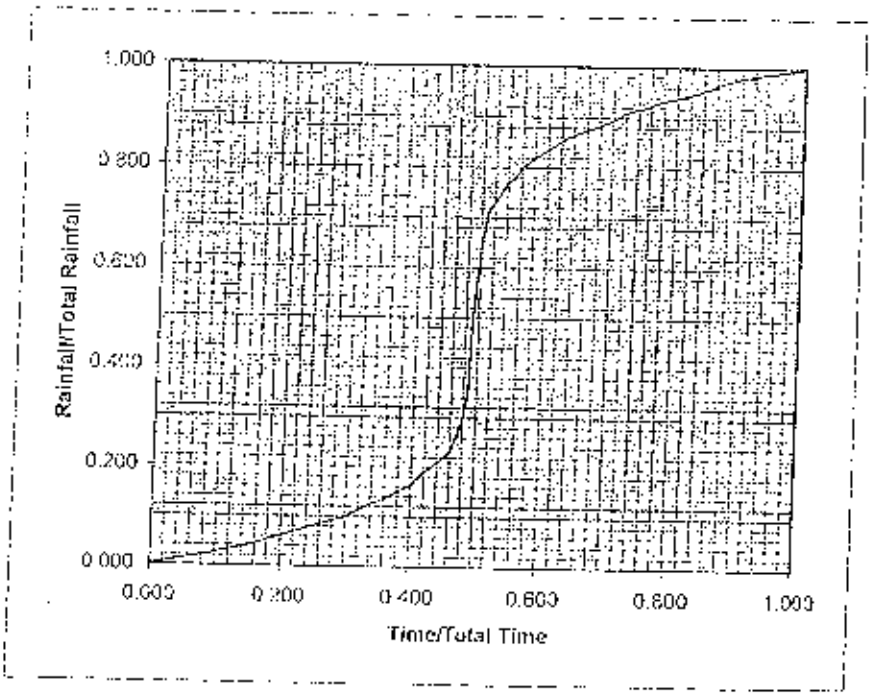
Developed Agriculture Pasture/Grassland	Pasture, grassland, or range with continuous forage for grazing
Developed Agriculture Row Crop	Pasture, grassland, or range with continuous forage for grazing
Developed Non-Vegetated	Urban: Commercial and Business
Developed Urban High Density	Urban: Commercial and Business
Developed Urban Low Density	Residential: 1 acre
Palustrine Forest Deciduous	Wood or Forest Land: good cover
Palustrine Herbaceous Deciduous	Wood or Forest Land: good cover
Palustrine Shrubland Deciduous	Meadow
Palustrine Woodland Deciduous	Wood or Forest Land: good cover
Terrestrial Forest Deciduous	Wood or Forest Land: good cover
Terrestrial Forest Evergreen	Wood or Forest Land: good cover
Terrestrial Forest Mixed	Wood or Forest Land: thin stand
Terrestrial Shrubland Deciduous	Meadow
Terrestrial Woodland Deciduous	Wood or Forest Land: good cover
Unclassified Cloud/Shadow	Highest % (Wood or Forest for E1)
Water	Dirt



· assume all unpaved
- W1, M3-M10 off of chart

Figure 3.4.5
Average Velocities for Estimating Travel Time (SCS, 1986)

Soil Conservation Service Type II Storm Distribution



Time/Total Time	Rainfall/Total Rainfall	Time/Total Time	Rainfall/Total Rainfall
0.000	0.000	0.520	0.730
0.040	0.010	0.530	0.750
0.100	0.025	0.540	0.770
0.150	0.040	0.550	0.790
0.200	0.060	0.560	0.800
0.250	0.080	0.570	0.810
0.300	0.100	0.580	0.820
0.330	0.120	0.600	0.835
0.350	0.130	0.630	0.850
0.380	0.150	0.650	0.870
0.400	0.165	0.670	0.880
0.420	0.190	0.700	0.895
0.430	0.200	0.720	0.910
0.440	0.210	0.750	0.920
0.450	0.220	0.770	0.930
0.460	0.230	0.800	0.940
0.470	0.260	0.830	0.950
0.480	0.300	0.850	0.960
0.485	0.340	0.870	0.970
0.487	0.370	0.900	0.980
0.490	0.500	0.950	0.990
0.500	0.640	1.000	1.000

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IN20040385
Watershed E1 Hydrograph Calculations

0.0005 x 375.15
0.0005 x 750.29
0.0034 x 375.15
0.0034 x 750.29

interval = 1.2 hr

Σ accyslow storm flow + base flow

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (starts at storm time x hr so Time = 0 is Storm Time = 12 hr when runoff											Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12		
		0	0.0005	0.0034	0.0039	0.0036	0.0042	0.0038	0.0042	0.0046	0.0024	0.0025		
0	0.00	0.000											0.000	13.020
0.6	375.15	0.000	0.000										0.000	13.020
1.2	750.29	0.000	0.188	0.000									0.188	13.208
1.8	1125.44	0.000	0.375	0.000									0.375	13.395
2.4	1500.58	0.000	0.563	1.275	0.000								1.838	14.858
3.09	1932.00	0.000	0.750	2.551	0.000								3.301	16.321
3.6	1741.05	0.000	0.966	3.826	1.463	0.000							6.256	19.276
4.2	1516.39	0.000	0.871	5.102	2.926	0.000							8.899	21.919
4.8	1291.74	0.000	0.758	6.569	4.389	1.351	0.000						13.067	26.087
5.4	1067.09	0.000	0.646	5.920	5.852	2.701	0.000						15.119	28.139
6	842.44	0.000	0.534	5.156	7.535	4.052	1.576	0.000					18.851	31.871
6.6	617.79	0.000	0.421	4.392	6.790	5.402	3.151	0.000					20.157	33.177
7.2	393.14	0.000	0.309	3.628	5.914	6.955	4.727	1.426	0.000				22.959	35.979
8.25	0.00	0.000	0.197	2.864	5.038	6.268	6.302	2.851	0.000				23.520	36.540
8.4		0.000	0.000	2.100	4.162	5.459	8.114	4.277	1.576	0.000			25.688	38.708
9			0.000	1.337	3.286	4.650	7.312	5.702	3.151	0.000			25.438	38.458
9.6				0.000	2.409	3.842	6.369	7.342	4.727	1.726	0.000		26.414	39.434
10.2				0.000	1.533	3.033	5.425	6.616	6.302	3.451	0.000		26.361	39.381
10.8					0.000	2.224	4.482	5.762	8.114	5.177	0.900	0.000	26.660	39.680
12					0.000	1.415	3.538	4.909	7.312	6.903	1.801	0.000	25.878	38.898
12.6			0.0034	x 393.14		0.000	2.595	4.055	6.369	8.887	2.701	0.938	25.545	38.565
13.2						0.000	1.651	3.201	5.425	8.009	3.601	1.876	23.764	36.784
13.8							0.000	2.348	4.482	6.975	4.637	2.814	21.255	34.275
14.4							0.000	1.494	3.538	5.942	4.179	3.751	18.904	31.924
15								0.000	2.595	4.909	3.639	4.830	15.973	28.993
15.6								0.000	1.651	3.875	3.100	4.353	12.979	25.999
16.2									0.000	2.842	2.561	3.791	9.194	22.214
16.8									0.000	1.808	2.022	3.229	7.060	20.080
17.4										0.000	1.483	2.668	4.150	17.170
18										0.000	0.944	2.106	3.050	16.070
18.6											0.000	1.544	1.544	14.564
19.2											0.000	0.983	0.983	14.003
19.8												0.000	0.000	13.020
												SUM =	435.368	865.028

12 hr into storm when runoff starts

interval is 1.2 hr

end of 24 hr storm

interval is 1.2 hr is constant
interval is needed

peak flow

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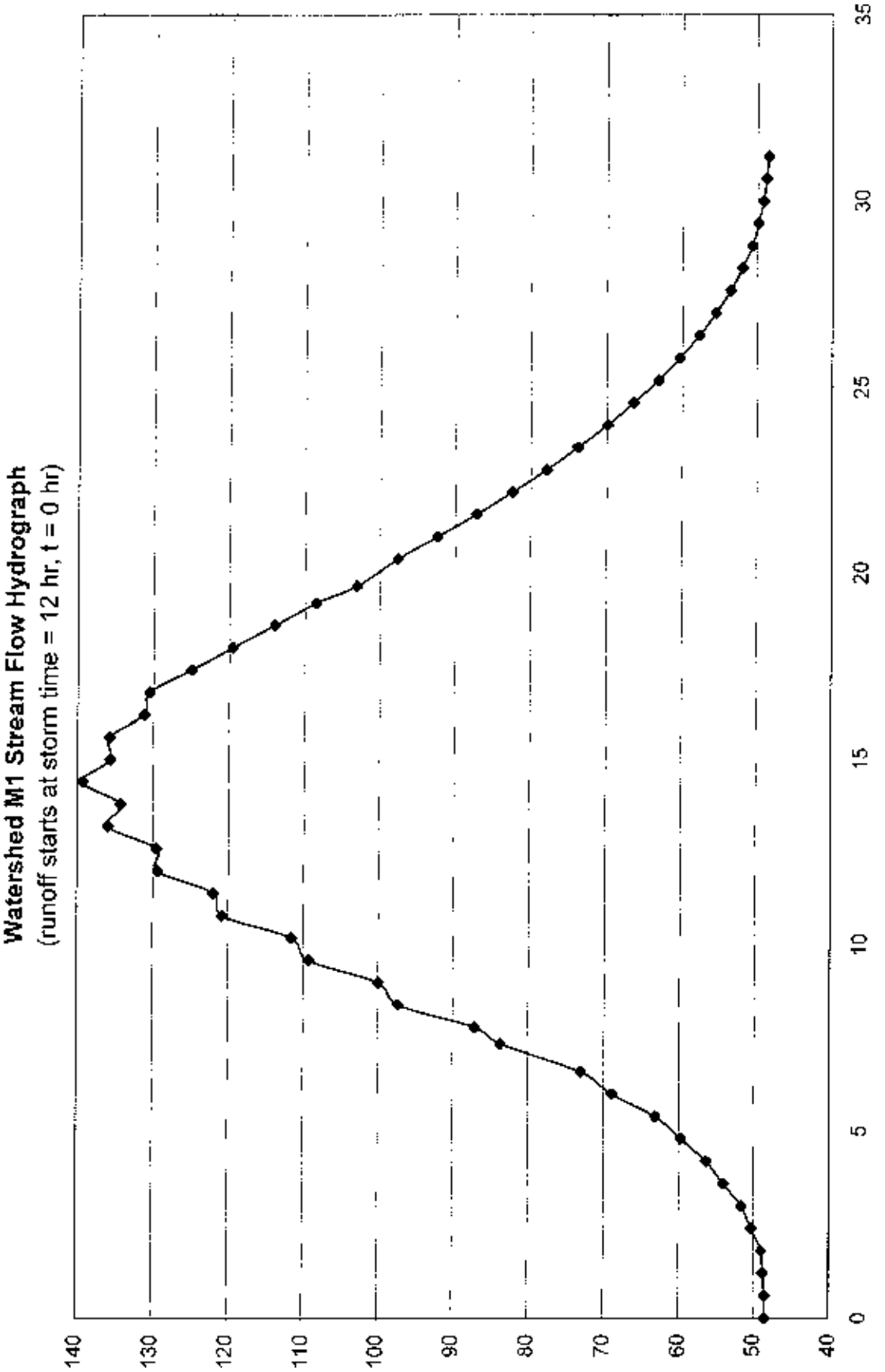
Watershed M1 Hydrograph Calculations

Time (hr)	Unit Hydrograph (cfs)	Excess Precipitation (in) (Time = 0 is when runoff starts at 12 hr)											Storm Hydrograph (cfs)	Stream Flow Hydrograph (cfs)
		0	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12		
		0	0.001	0.0043	0.0044	0.004	0.0046	0.0041	0.0046	0.0049	0.0026	0.0027		
0	0.00	0.000											0.000	48.490
0.6	246.20	0.000	0.000										0.000	48.490
1.2	492.39	0.000	0.246	0.000									0.246	48.736
1.8	738.59	0.000	0.492	0.000									0.492	48.982
2.4	984.78	0.000	0.739	1.059	0.000								1.797	50.287
3.0	1230.98	0.000	0.985	2.117	0.000								3.102	51.592
3.6	1477.17	0.000	1.231	3.176	1.083	0.000							5.490	53.980
4.2	1723.37	0.000	1.477	4.235	2.167	0.000							7.878	56.368
4.8	1969.57	0.000	1.723	5.293	3.250	0.985	0.000						11.251	59.741
5.4	3501.24	0.000	1.970	6.352	4.333	1.970	0.000						14.624	63.114
6.0	3353.92	0.000	3.501	7.410	5.416	2.954	1.133	0.000					20.415	68.905
6.6	3206.60	0.000	3.354	8.469	6.500	3.939	2.265	0.000					24.527	73.017
7.36	3020.00	0.000	3.207	15.055	7.583	4.924	3.398	1.009	0.000				35.176	83.666
7.8	2911.97	0.000	3.020	14.422	8.666	5.909	4.530	2.019	0.000				38.565	87.055
8.4	2764.65	0.000	2.912	13.788	15.405	6.893	5.663	3.028	1.133	0.000			48.822	97.312
9.0	2617.33	0.000	2.765	12.986	14.757	7.878	6.795	4.038	2.265	0.000			51.484	99.974
9.6	2470.02	0.000	2.617	12.521	14.109	14.005	7.928	5.047	3.398	1.206	0.000		60.831	109.321
10.2	2322.70	0.000	2.470	11.888	13.288	13.416	9.060	6.056	4.530	2.413	0.000		63.121	111.611
10.8	2175.38	0.000	2.323	11.255	12.813	12.826	16.106	7.066	5.663	3.619	0.640	0.000	72.309	120.799
11.4	2028.07	0.000	2.175	10.621	12.164	12.080	15.428	8.075	6.795	4.825	1.280	0.000	73.445	121.935
12.0	1880.75	0.000	2.028	9.988	11.516	11.648	14.750	14.355	7.928	6.032	1.920	0.665	80.830	129.320
12.6	1733.43	0.000	1.881	9.354	10.868	11.059	13.892	13.751	9.060	7.238	2.560	1.329	80.993	129.483
13.2	1586.11	0.000	1.733	8.721	10.220	10.469	13.395	13.147	16.106	8.445	3.201	1.994	87.430	135.920
13.8	1438.80	0.000	1.586	8.087	9.572	9.880	12.717	12.382	15.428	9.651	3.841	2.659	85.803	134.293
14.4	1291.48	0.000	1.439	7.454	8.923	9.291	12.040	11.939	14.750	17.156	4.481	3.324	90.796	139.286
15.0	1144.16	0.000	1.291	6.820	8.275	8.702	11.362	11.335	13.892	16.434	5.121	3.988	87.221	135.711
15.6	996.85	0.000	1.144	6.187	7.627	8.112	10.684	10.731	13.395	15.712	9.103	4.653	87.350	135.840
16.2	849.53	0.000	0.997	5.553	6.979	7.523	10.007	10.127	12.717	14.798	8.720	5.318	82.739	131.229
16.8	702.21	0.000	0.850	4.920	6.331	6.934	9.329	9.523	12.040	14.269	8.337	9.453	81.985	130.475

17.4	554.89	0.000	0.702	4.286	5.683	6.344	8.651	8.919	11.362	13.547	7.852	9.056	76.403	124.893
18.0	407.58	0.000	0.555	3.653	5.034	5.755	7.974	8.315	10.684	12.825	7.571	8.658	71.025	119.515
18.6	260.26	0.000	0.408	3.020	4.386	5.166	7.296	7.711	10.007	12.103	7.188	8.154	65.438	113.928
19.2	112.94	0.000	0.260	2.386	3.738	4.577	6.618	7.107	9.329	11.381	6.805	7.862	60.064	108.554
19.66	0.00	0.000	0.113	1.753	3.090	3.987	5.941	6.503	8.651	10.659	6.422	7.465	54.584	103.074
20.4			0.000	1.119	2.442	3.398	5.263	5.899	7.974	9.938	6.039	7.067	49.138	97.628
21.0			0.000	0.486	1.793	2.809	4.585	5.295	7.296	9.216	5.656	6.669	43.805	92.295
21.6				0.000	1.145	2.220	3.908	4.691	6.618	8.494	5.273	6.271	38.620	87.110
22.2				0.000	0.497	1.630	3.230	4.087	5.941	7.772	4.890	5.874	33.921	82.411
22.8					0.000	1.041	2.553	3.483	5.263	7.050	4.507	5.476	29.373	77.863
23.4					0.000	0.452	1.875	2.879	4.585	6.328	4.124	5.078	25.321	73.811
24.0						0.000	1.197	2.275	3.908	5.606	3.741	4.680	21.408	69.898
24.6						0.000	0.520	1.671	3.230	4.885	3.358	4.283	17.946	66.436
25.2							0.000	1.067	2.553	4.163	2.975	3.885	14.642	63.132
25.8							0.000	0.463	1.875	3.441	2.592	3.487	11.858	60.348
26.4								0.000	1.197	2.719	2.209	3.089	9.214	57.704
27.0								0.000	0.520	1.997	1.826	2.691	7.034	55.524
27.6									0.000	1.275	1.443	2.294	5.012	53.502
28.2									0.000	0.553	1.060	1.896	3.509	51.999
28.8										0.000	0.677	1.498	2.175	50.665
29.4										0.000	0.294	1.100	1.394	49.884
30.0											0.000	0.703	0.703	49.193
30.6											0.000	0.305	0.305	48.795
31.2												0.000	0.000	48.490
												SUM =	**1941.614**	**4511.584**


Watershed M1 Stream Flow Hydrograph
(runoff starts at storm time = 12 hr, t = 0 hr)
140
130
120
110
100
90
80
70
60
50
40
0
5
10
15
20
25
30
35