

# Comparing handbook curve number values to measured data

Laura Chap, PE, CFM

# Curve Number Method

Estimates runoff from rainfall events

# Development of the CN method

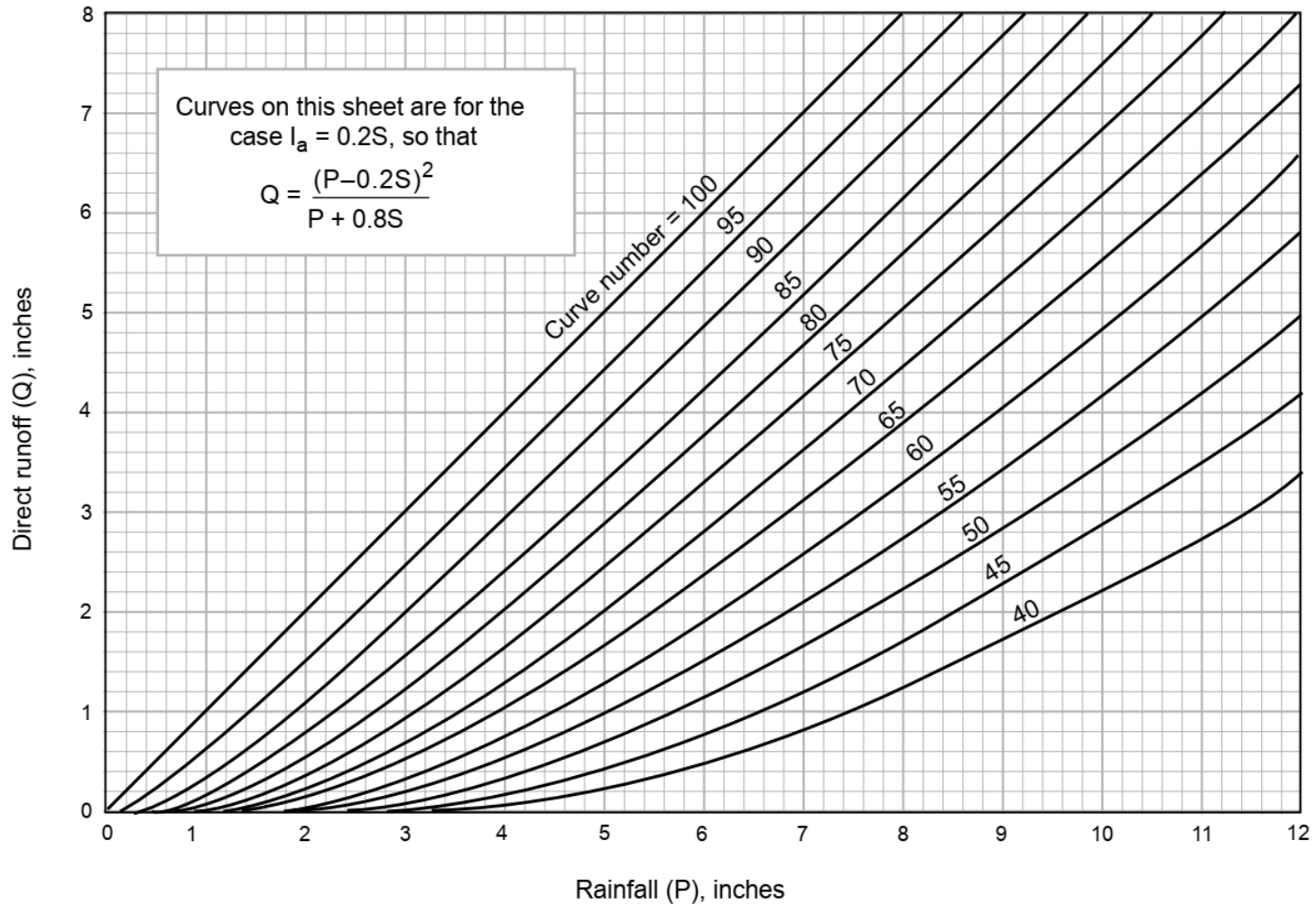
- USDA – Soil Conservation Service
- PL-566: Small Watershed and Flood Control Act of 1954
- National Engineering Handbook Section 4
- Limited review and documentation

ASCE, 2009 and Helms, 1988

**Table 2-2a** Runoff curve numbers for urban areas <sup>1/</sup>

Cover description	Average percent impervious area <sup>2/</sup>	Curve numbers for hydrologic soil group			
		A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) <sup>3/</sup> :					
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; curbs and storm sewers (excluding right-of-way) .....					
		98	98	98	98
Paved; open ditches (including right-of-way) .....					
		83	89	92	93
Gravel (including right-of-way) .....					
		76	85	89	91
Dirt (including right-of-way) .....					
		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) <sup>4/</sup> .....					
		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) .....					
		96	96	96	96
Urban districts:					
Commercial and business .....					
	85	89	92	94	95
Industrial .....					
	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses) .....					
	65	77	85	90	92
1/4 acre .....					
	38	61	75	83	87
1/3 acre .....					
	30	57	72	81	86
1/2 acre .....					
	25	54	70	80	85
1 acre .....					
	20	51	68	79	84
2 acres .....					
	12	46	65	77	82

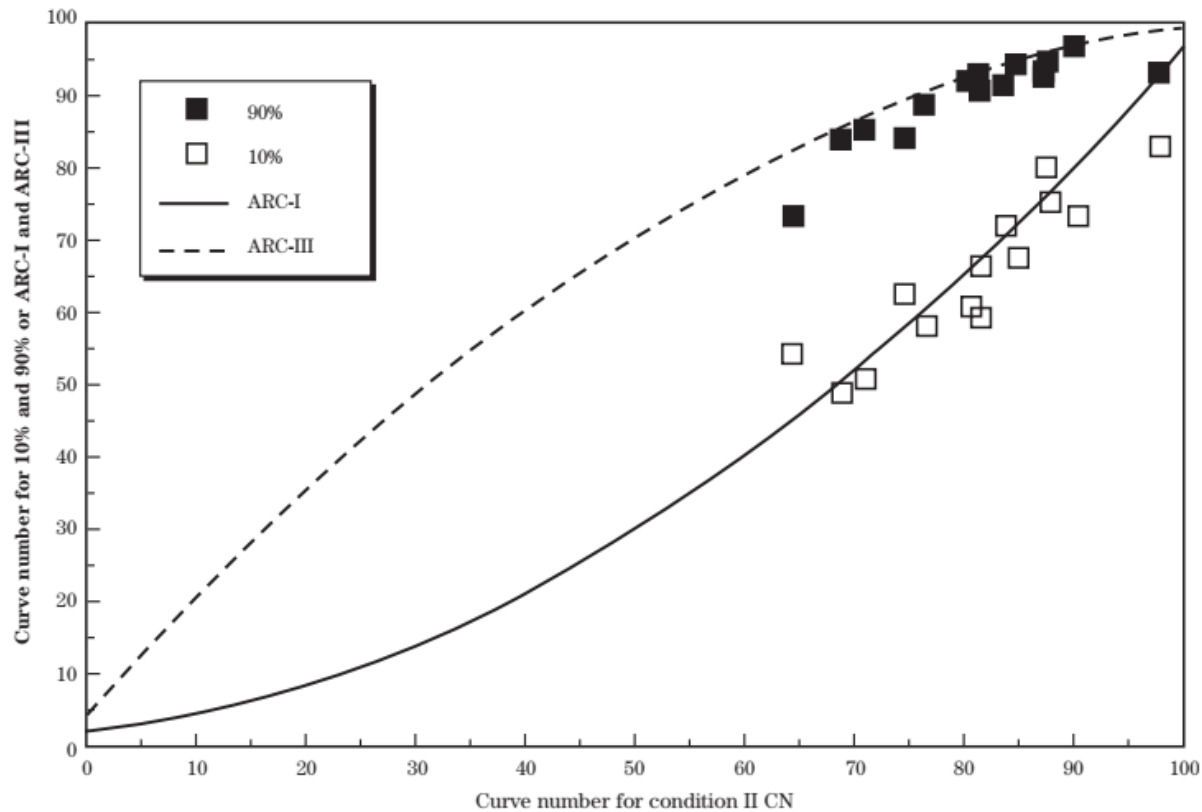
• (F)



NRCS, 1986

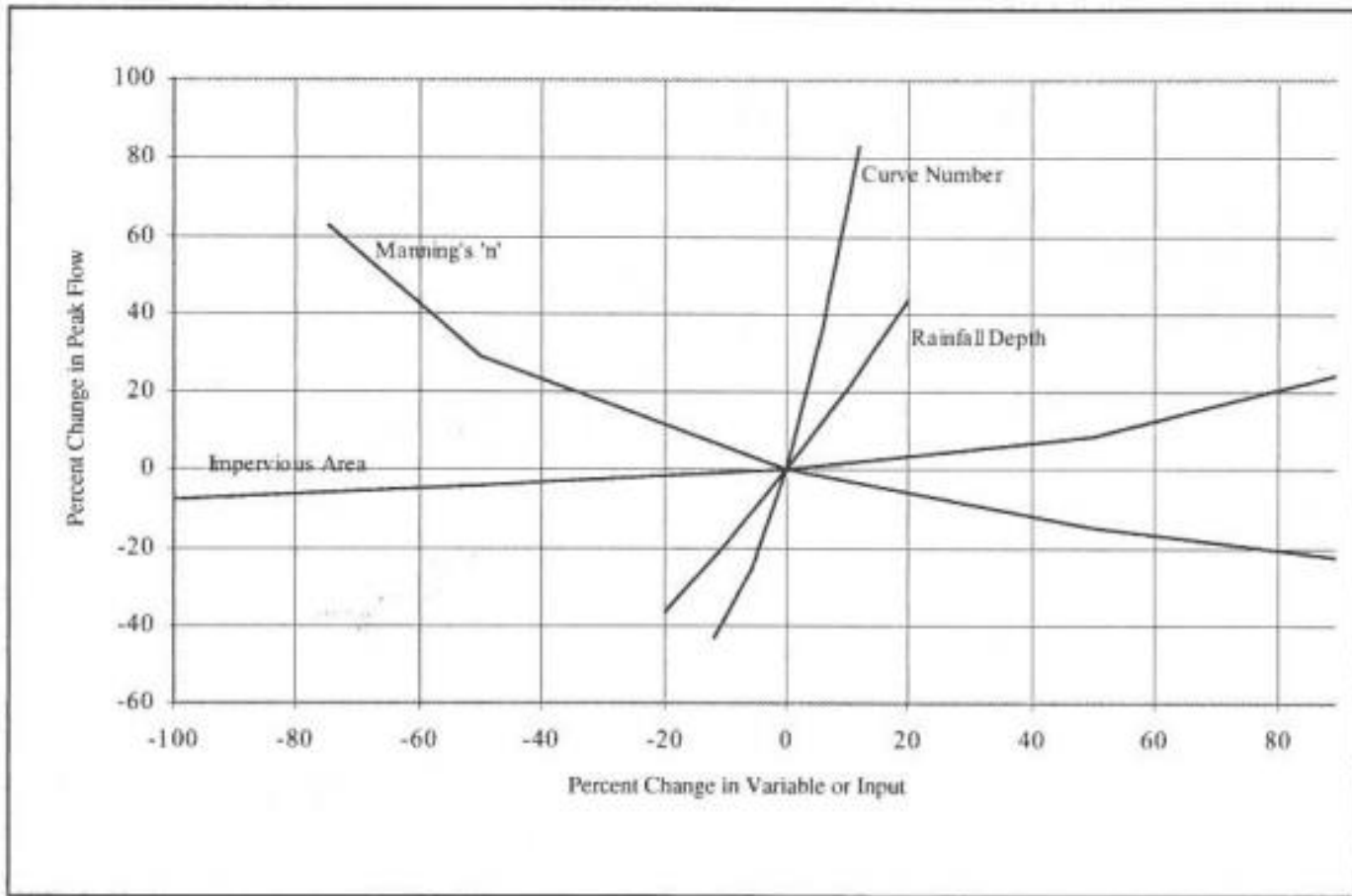
# Variability

**Figure 10-4** Comparison of 10 and 90 percent extremes with ARC I and ARC III values from table 10-1 (adapted from Hjelmfelt 1991)



NRCS, 2004

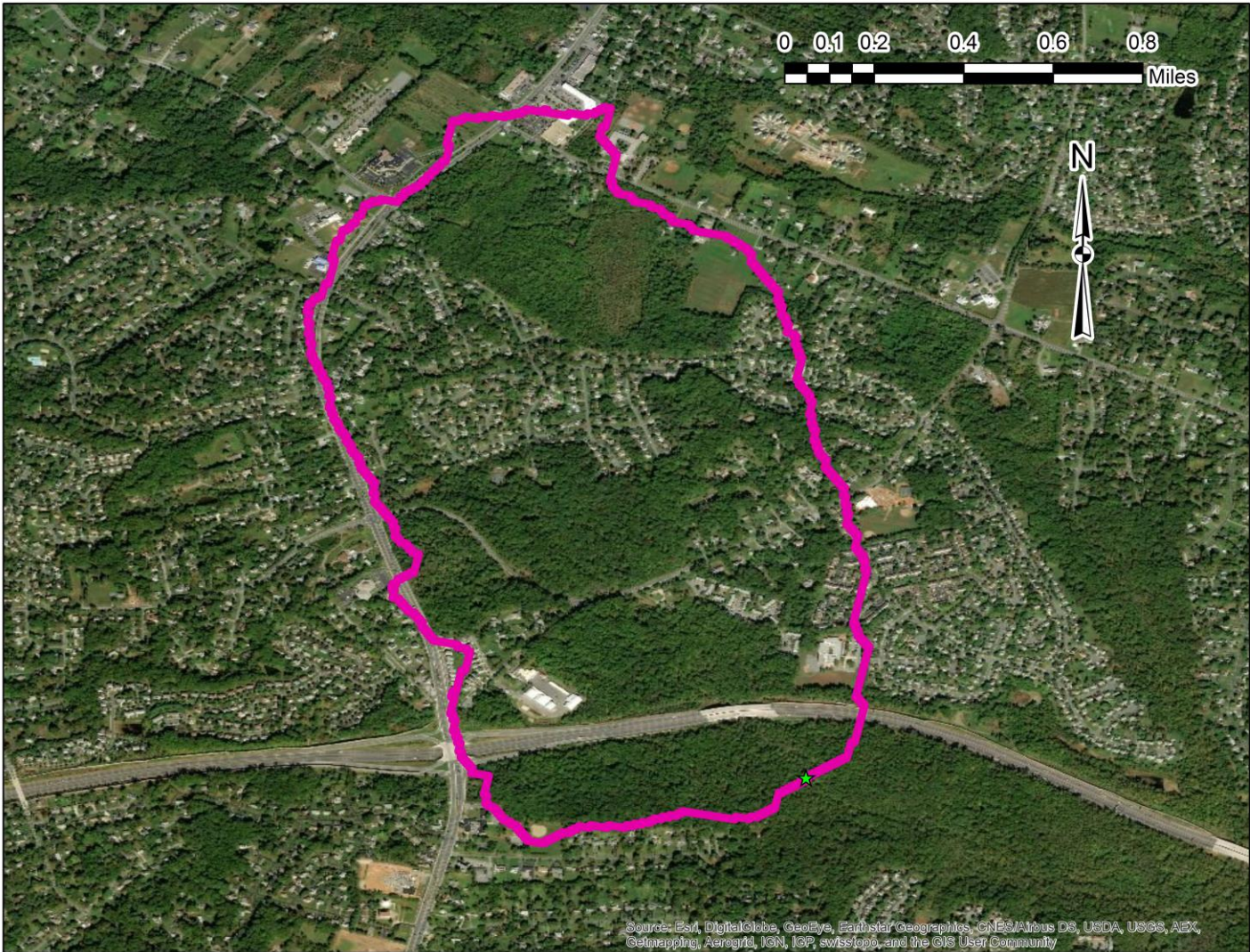
# Sensitivity

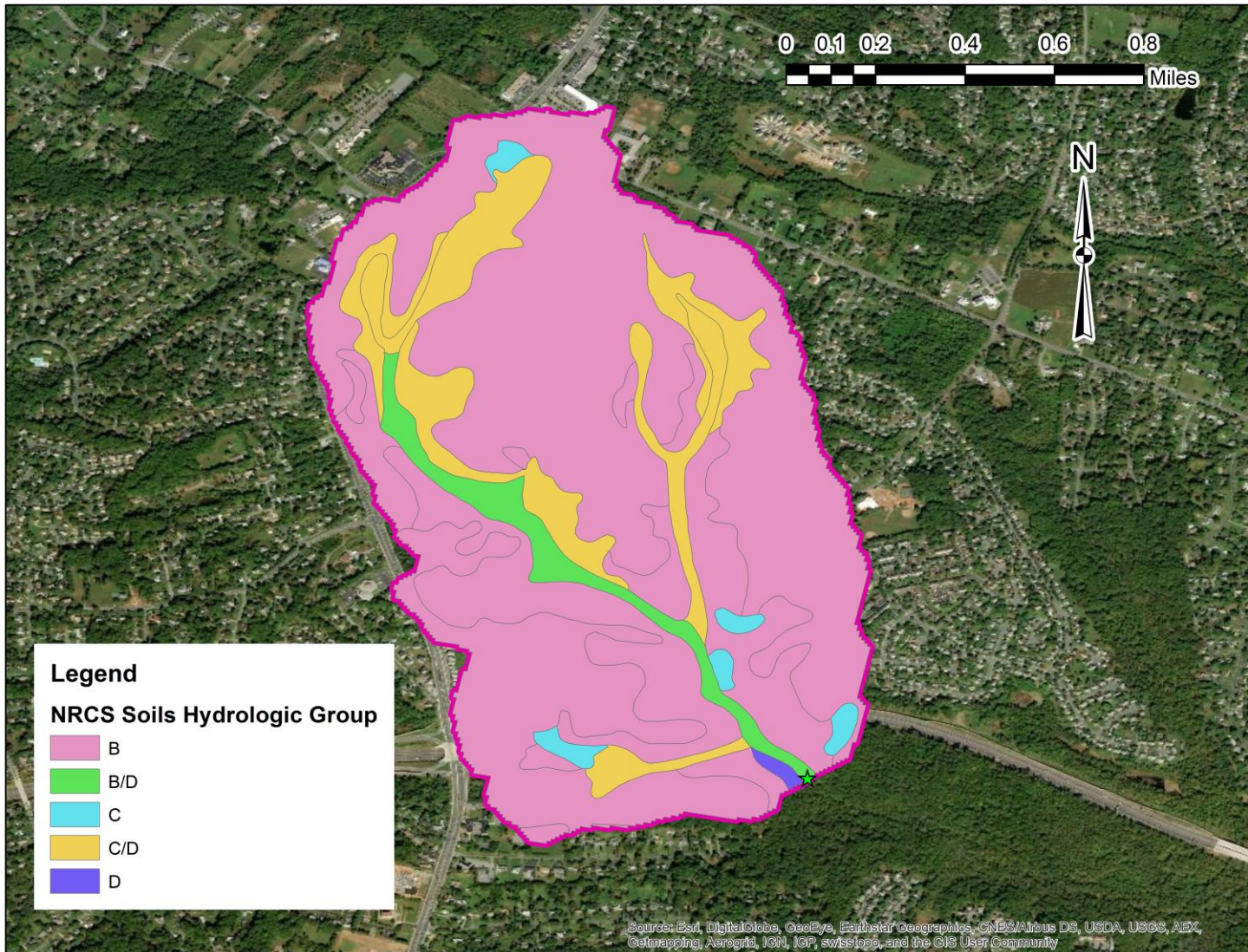


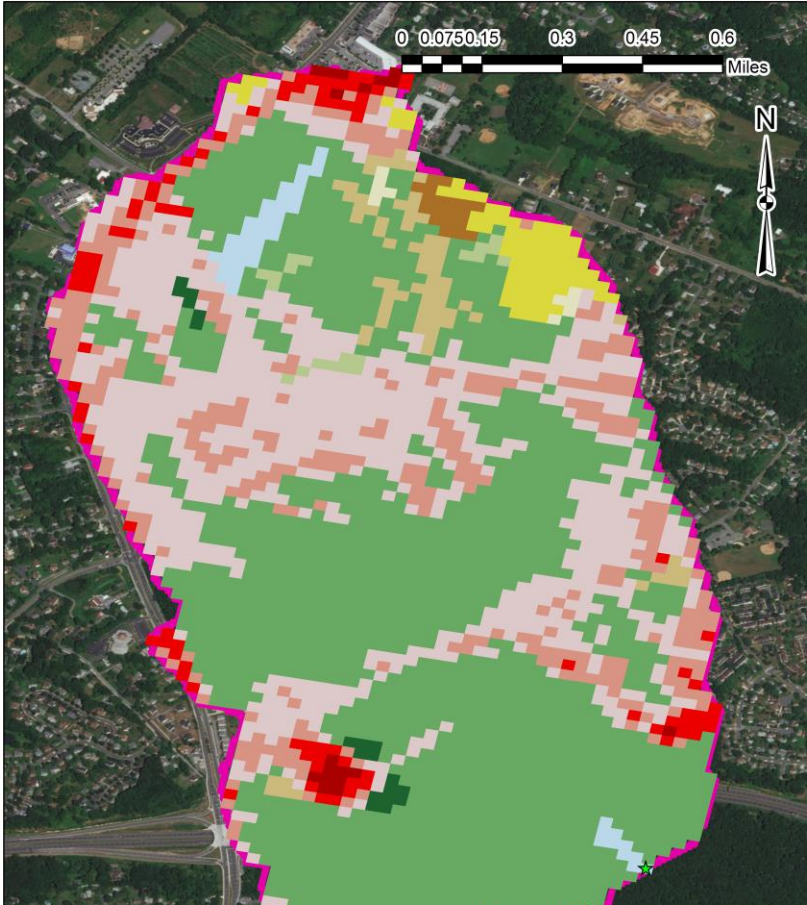
ASCE, 2009

# Sample sites

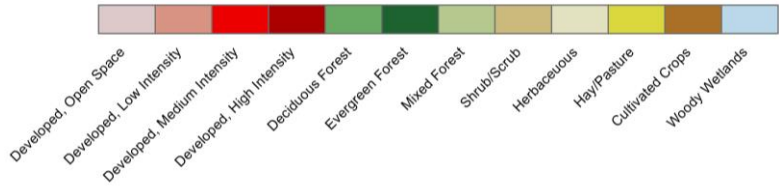








**Legend**

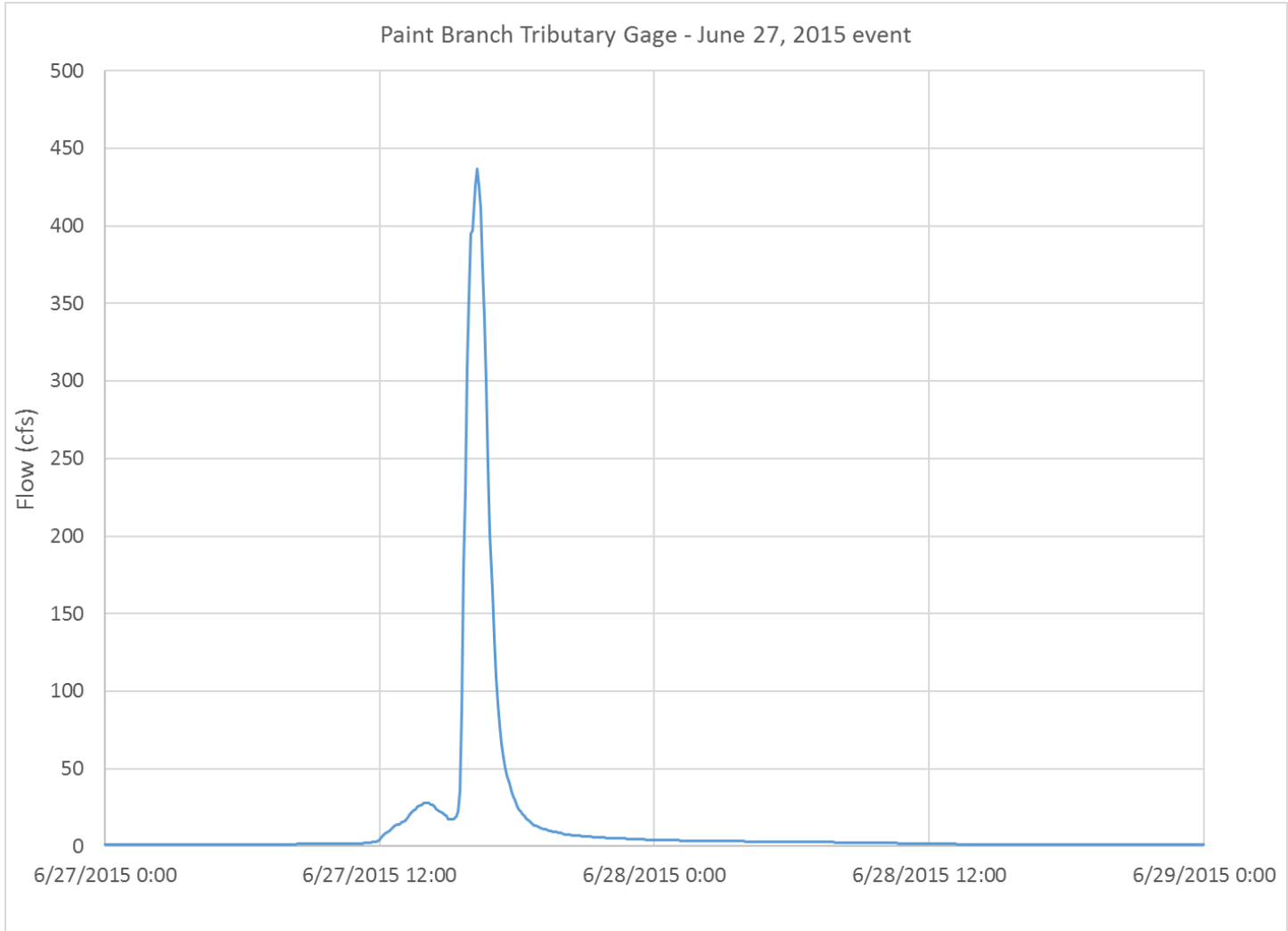


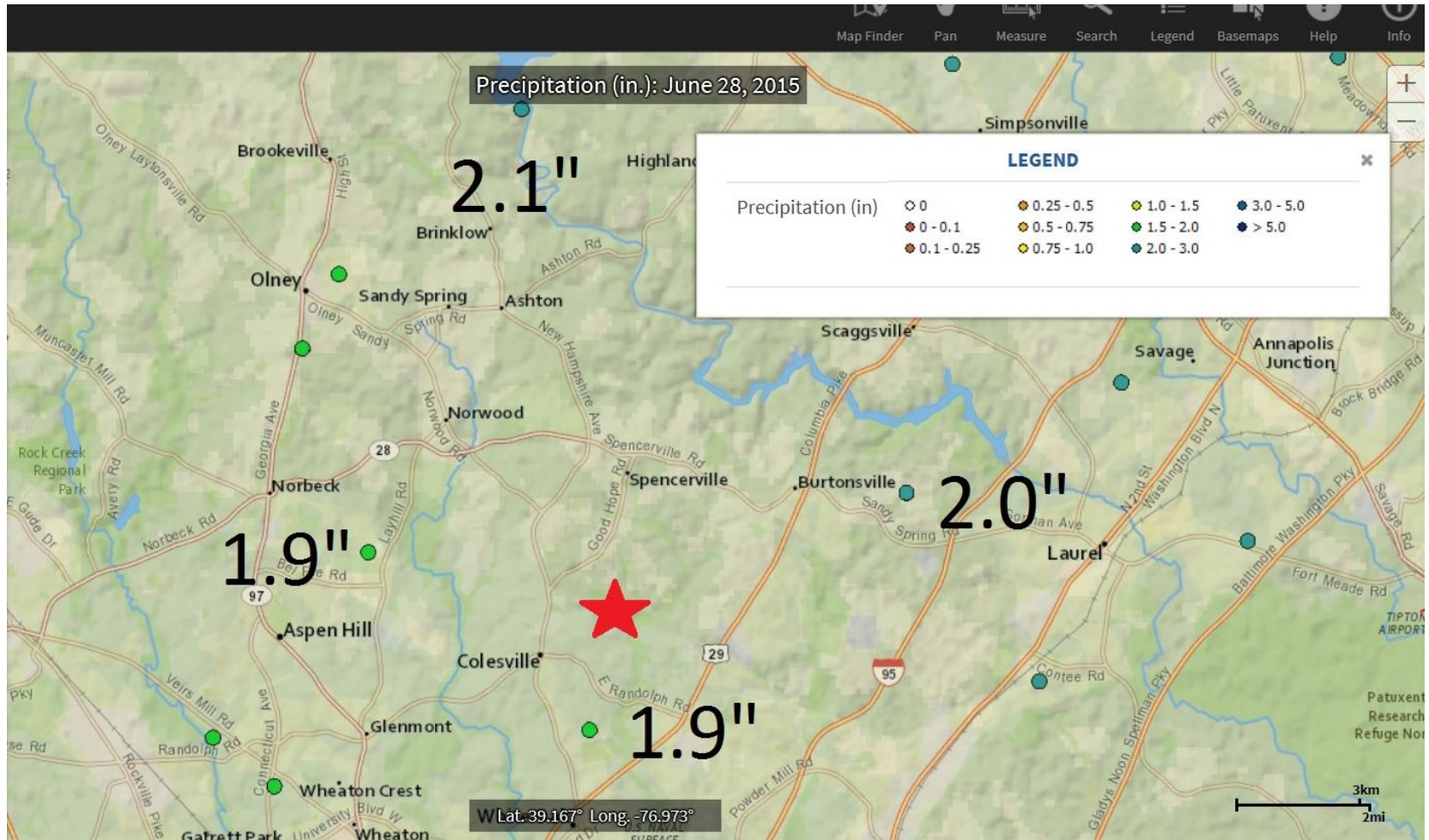
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero, GeoMapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community



# Comparing CN for subdivision area

Method	IC	CN (Type B soils)
TR-55 Table value from 1/3 acre lots	30%	72
NLCD Impervious Cover	19%	68
NLCD Land Use	0-49%	72
Measured impervious	38%	75





Rainfall	Runoff depth for curve number of—										
	40	45	50	55	60	65	70	75	80	85	90
	inches										
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.10	5.27	.46
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53

Paint Branch Trib drainage area: Weighted CN = 69

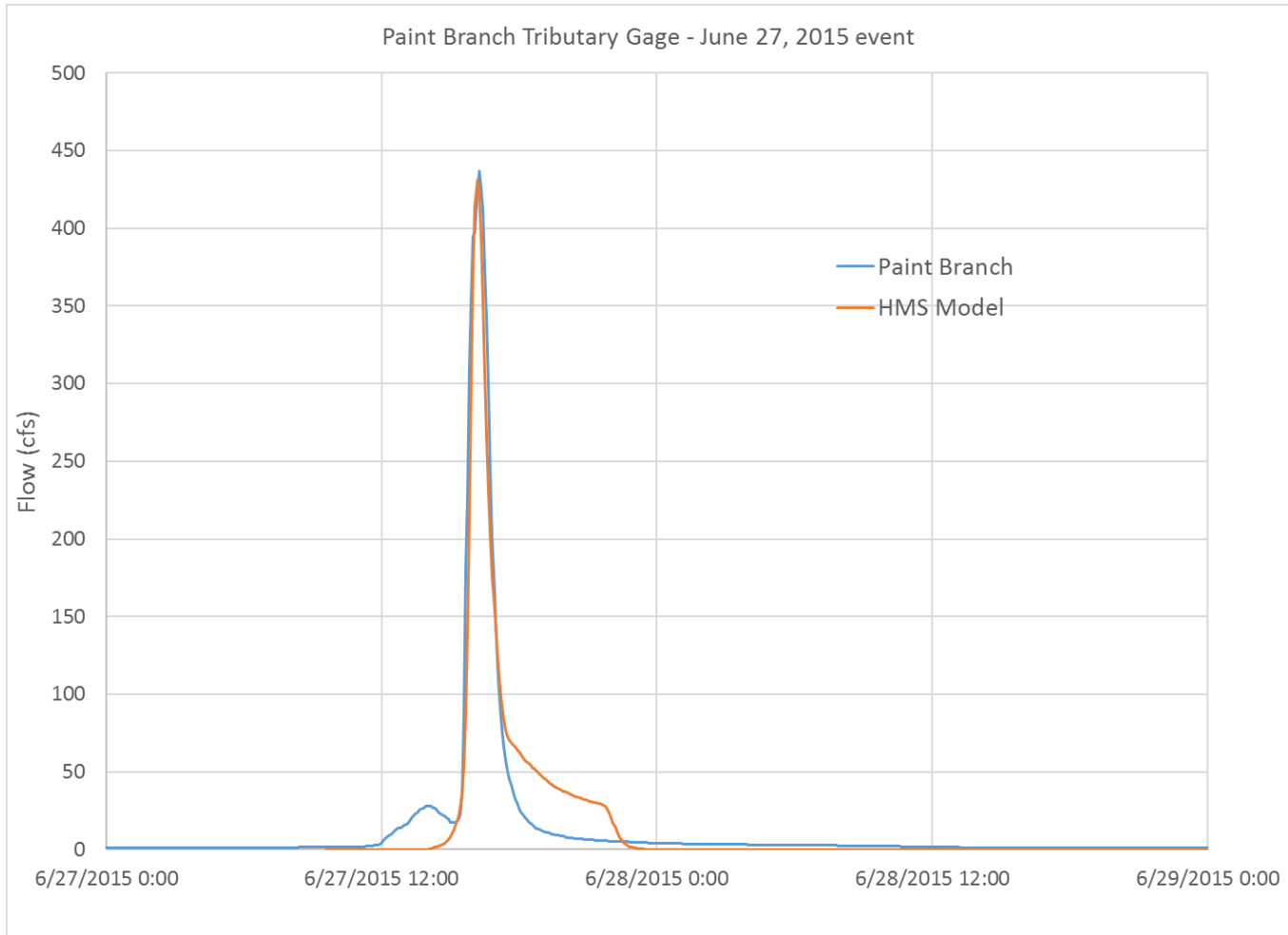
Estimated rainfall for June 27, 2015 storm: 2 inches

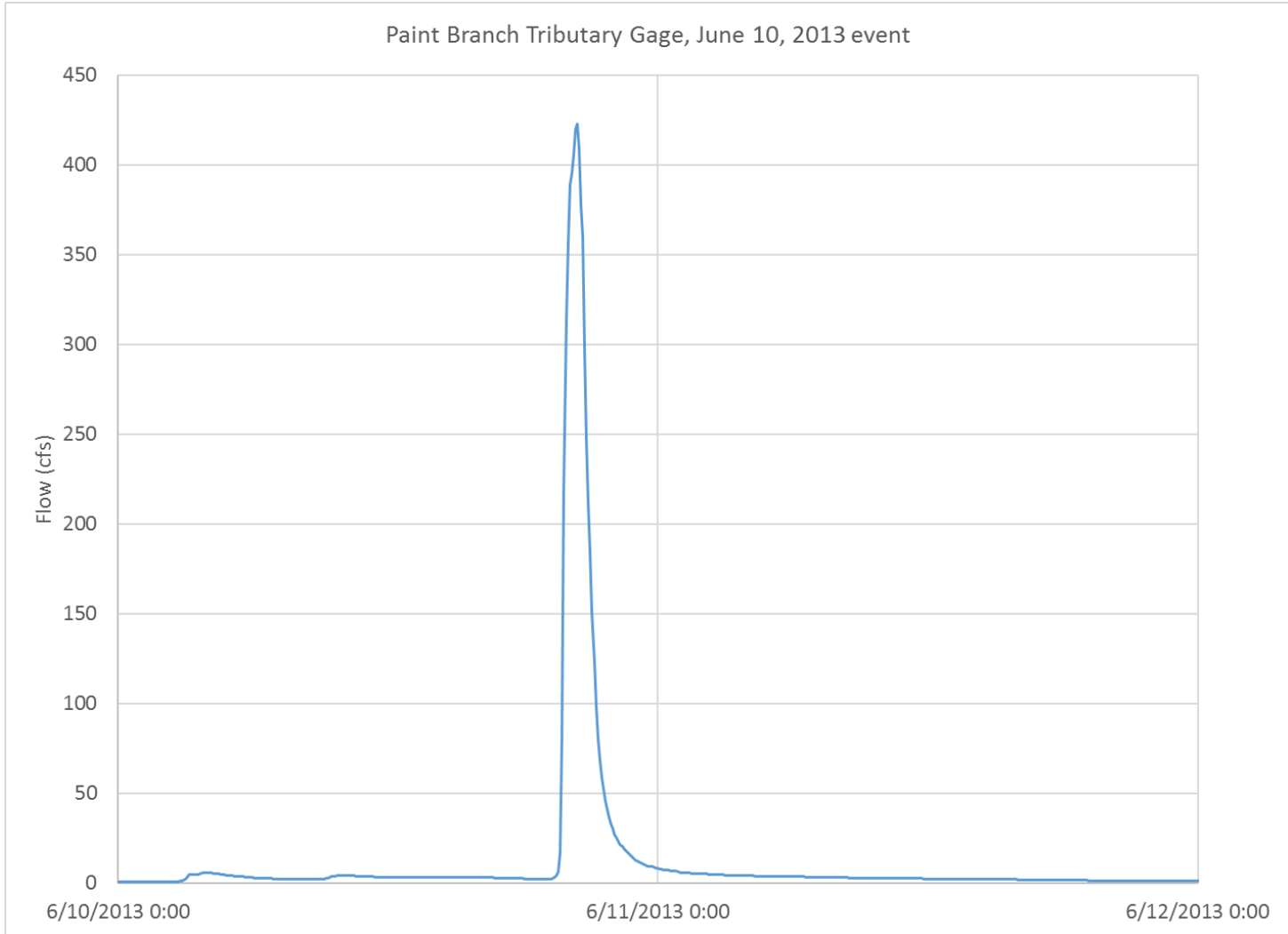
Runoff from June 27, 2015 storm: 0.93 inch

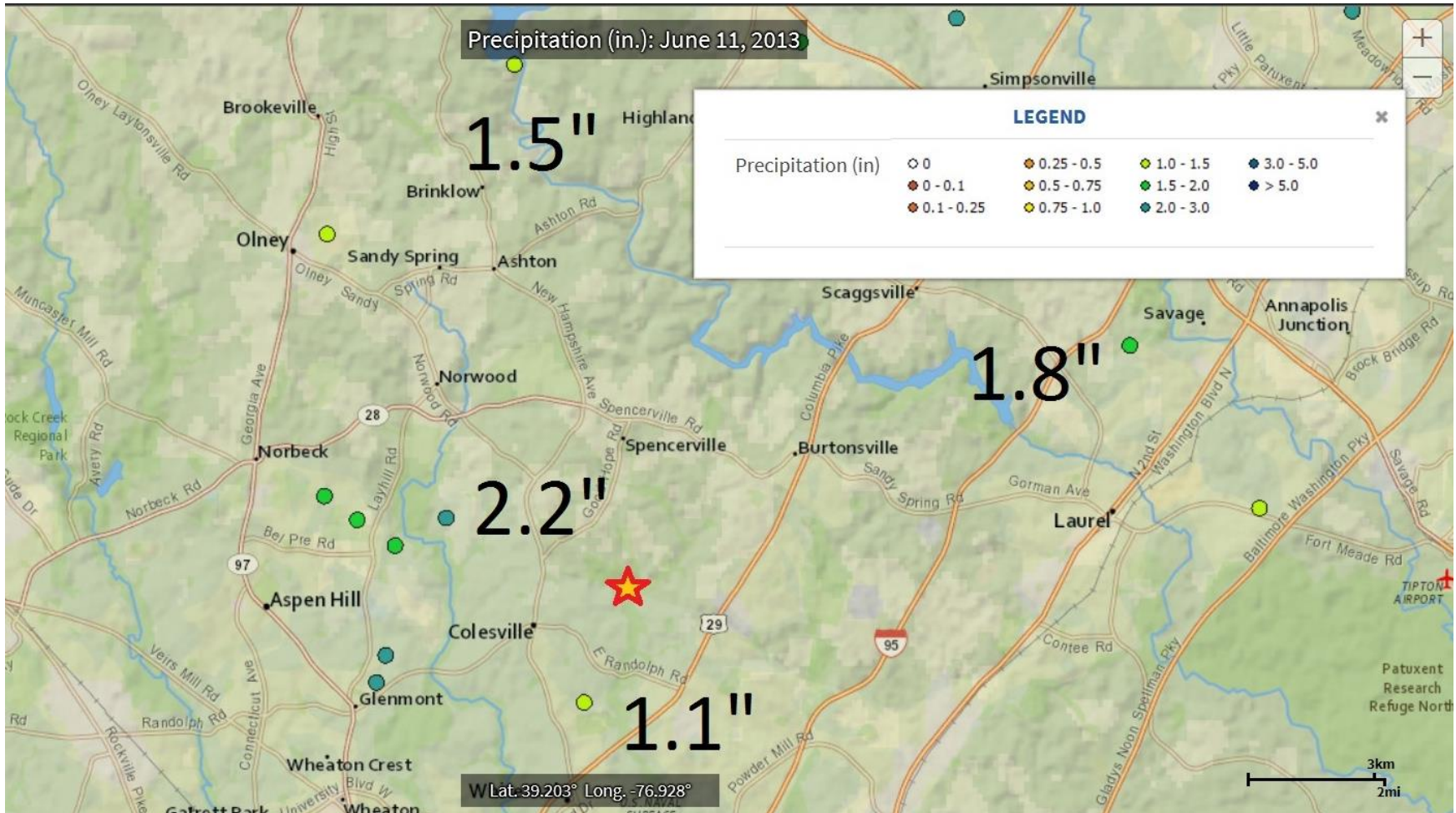
Actual CN = 87.2

NRCS, 1986









Rainfall	Runoff depth for curve number of—											
	40	45	50	55	60	65	70	75	80	85	90	95
	inches											
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.10	5.27	.46	.74
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96

Paint Branch Watershed: Computed CN = 69

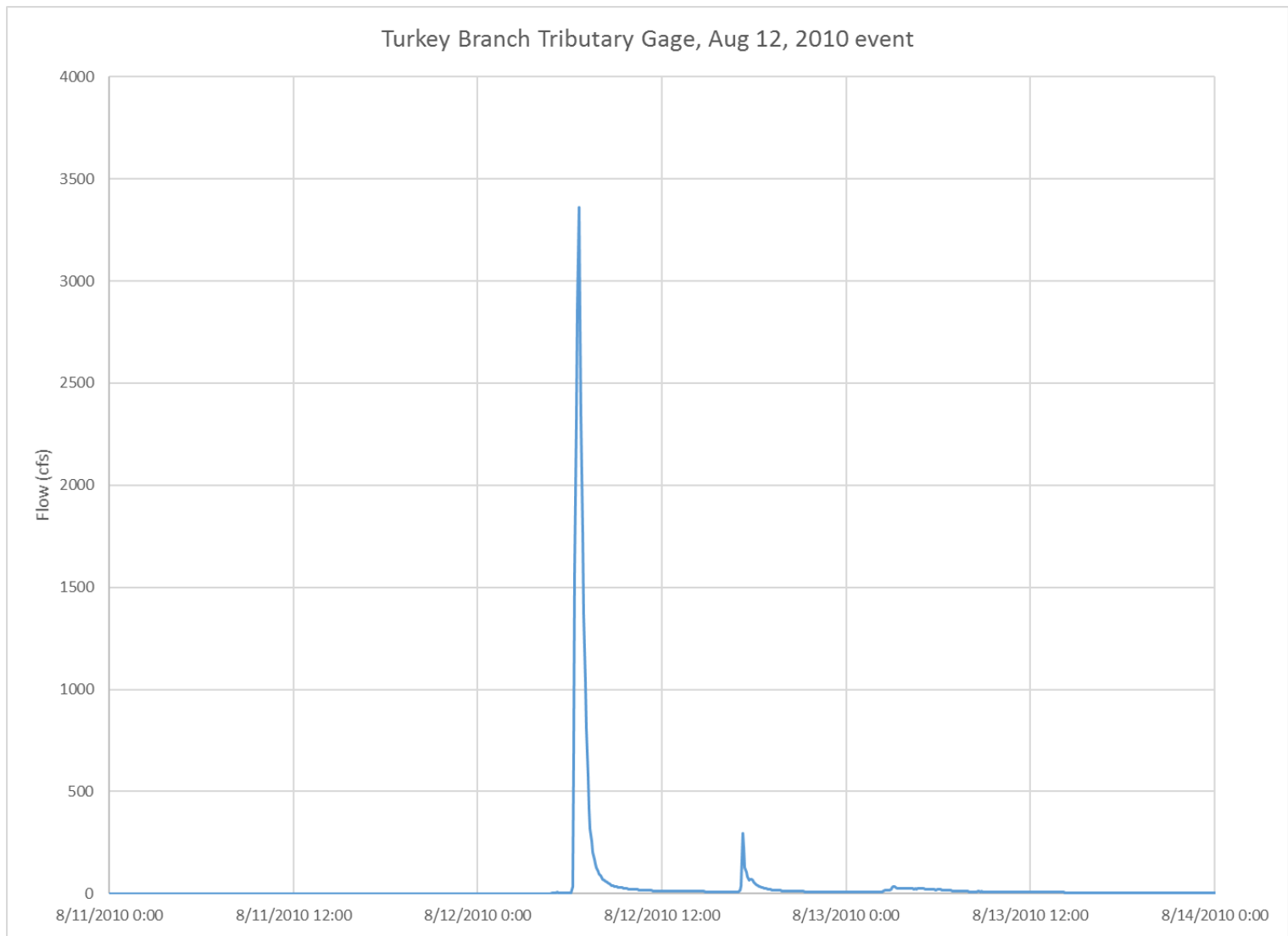
Estimated rainfall for June 10, 2013 storm: 1.1-2.2”

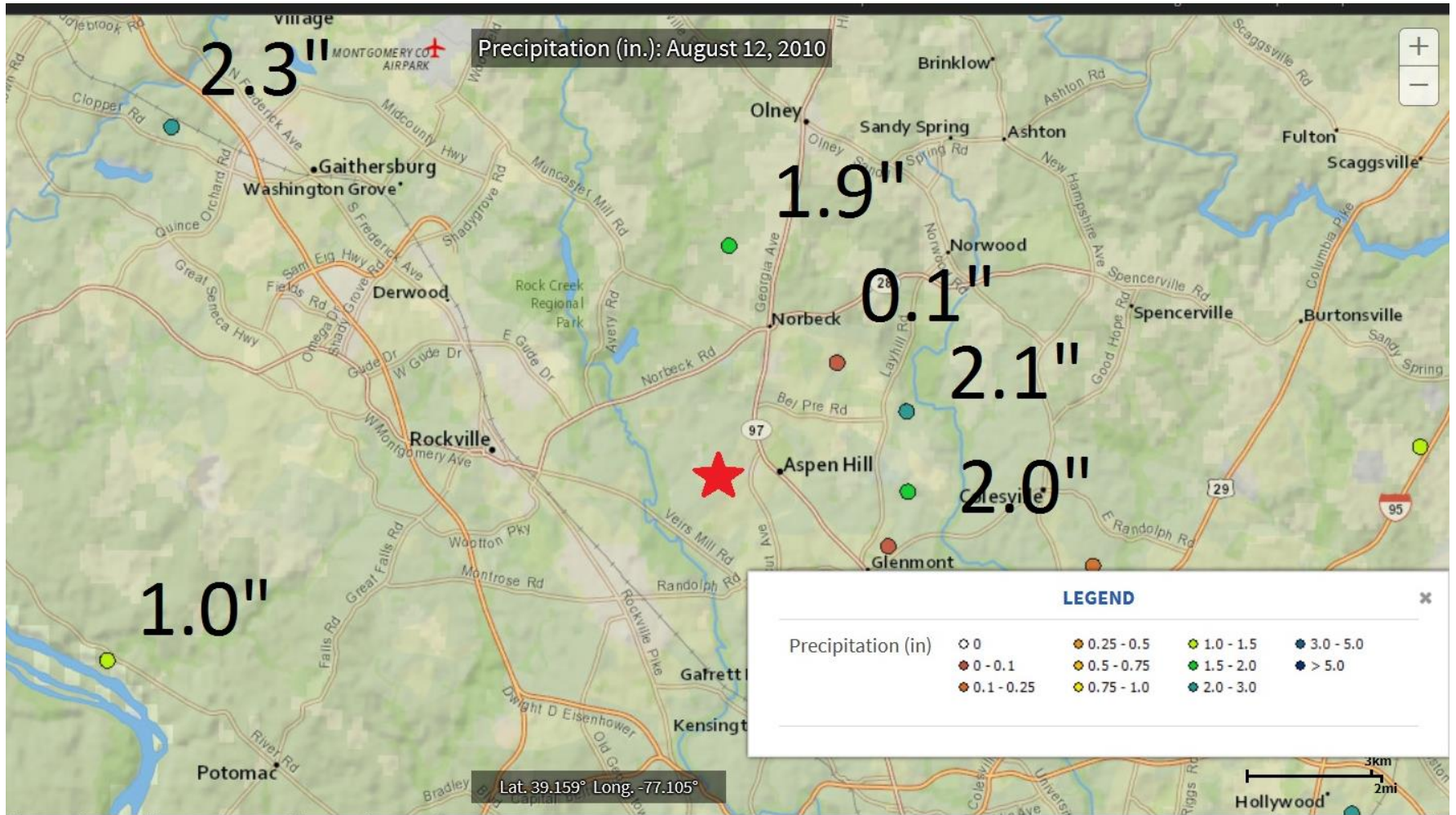
Runoff from June 10, 2013 storm: 0.81 inch

Actual CN is between 86 and 95

NRCS, 1986







Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.10	5.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27

Turkey Branch Watershed: Computed CN = 75

Estimated rainfall for Aug 12, 2010 storm: 2.0"

Runoff from Aug 12, 2010 storm: 1.17 inch

Actual CN = 91

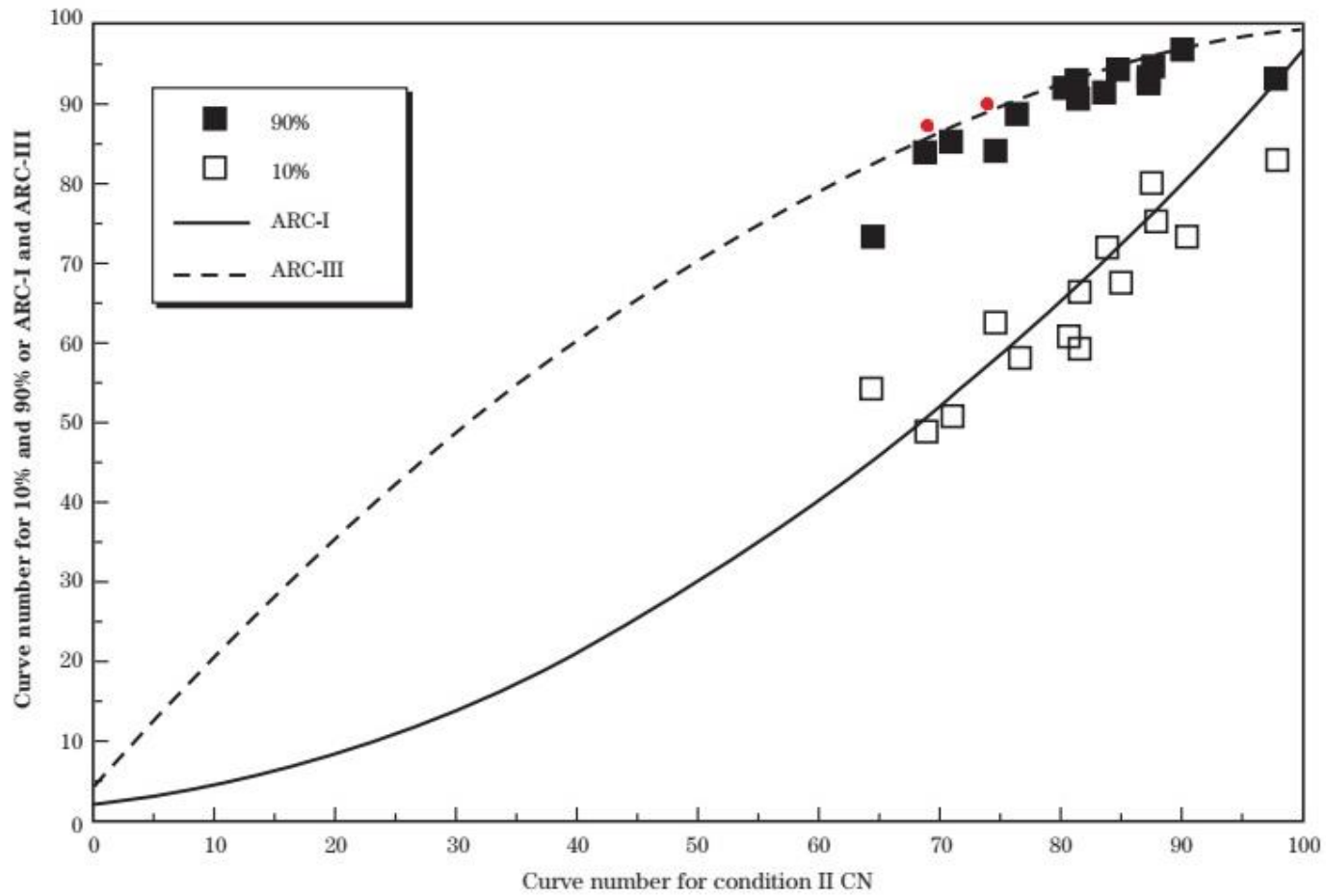
NRCS, 1986



# Summary

	Computed CN	Actual CN
Paint Branch Trib, June 2015	69	87
Paint Branch Trib, June 2013	69	85-95
Turkey Branch, August 2010	75	91

**Figure 10-4** Comparison of 10 and 90 percent extremes with ARC I and ARC III values from table 10-1 (adapted from Hjelmfelt 1991)



## Questions?

Contact:

[laura.chap@atkinsglobal.com](mailto:laura.chap@atkinsglobal.com)

# References

ASCE, 2009. Curve number hydrology: State of the practice. American Society of Civil Engineers.

Helms, Douglas, 1988. Legacy of the flood control act of 1936. Available at [https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/about/history/?cid=nrcs143\\_010953](https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/about/history/?cid=nrcs143_010953)

NOAA, 2018. Daily summaries map. <https://gis.ncdc.noaa.gov/maps/ncei/summaries/daily>

NRCS, 1986. Urban hydrology for small watersheds, TR-55. U.S. Department of Agriculture Natural Resources Conservation Service.

NRCS, 2004. National Engineering Handbook, Part 630 Hydrology, Chapter 10, Estimation of Direct Runoff from Storm Rainfall

USGS, 2014. 2011 National Land Cover Database.

USGS, 2018. USGS Water Data for the Nation. Available at <https://waterdata.usgs.gov/nwis>