

Monsoon Flooding 2013: City of Flagstaff

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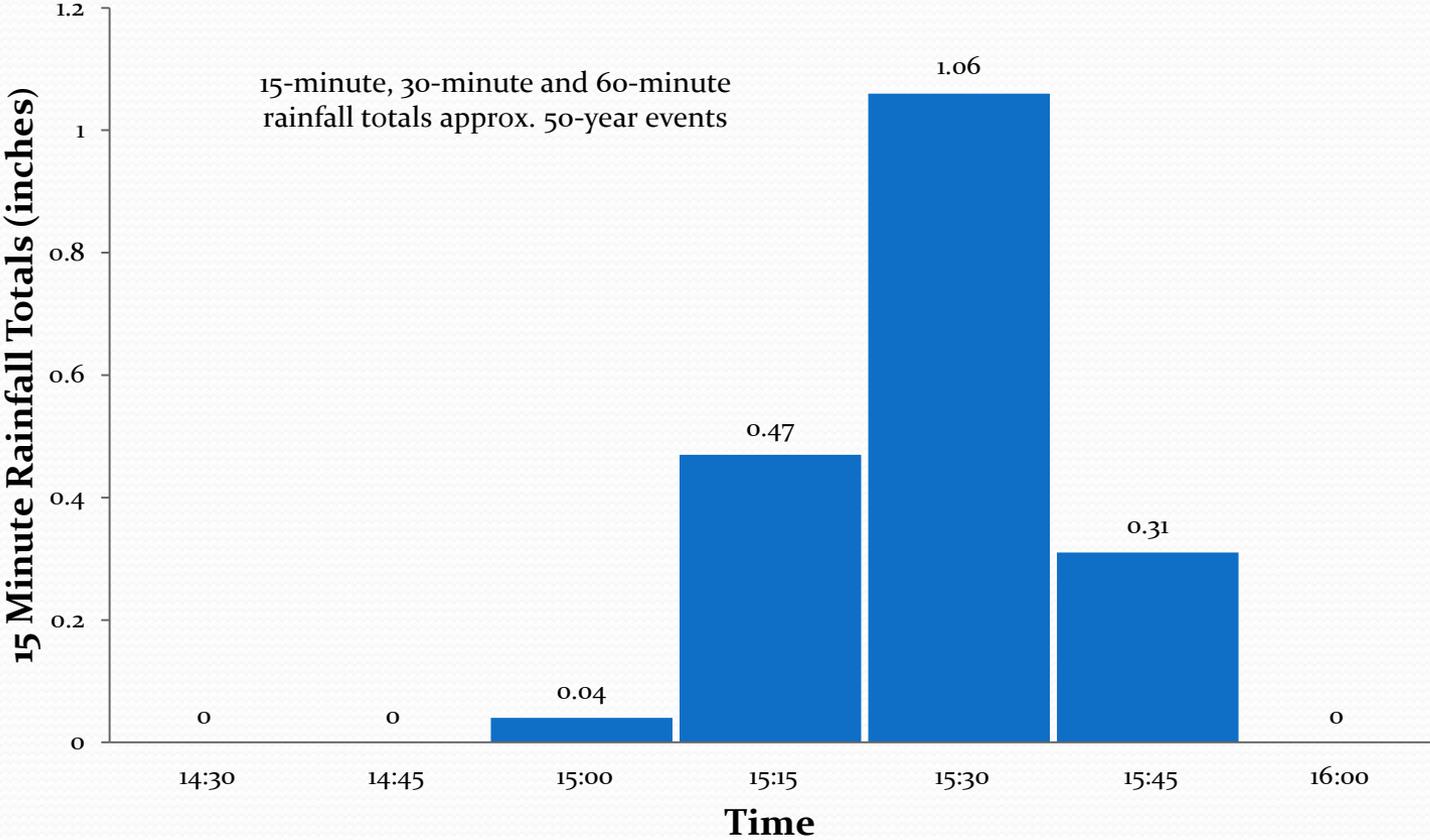




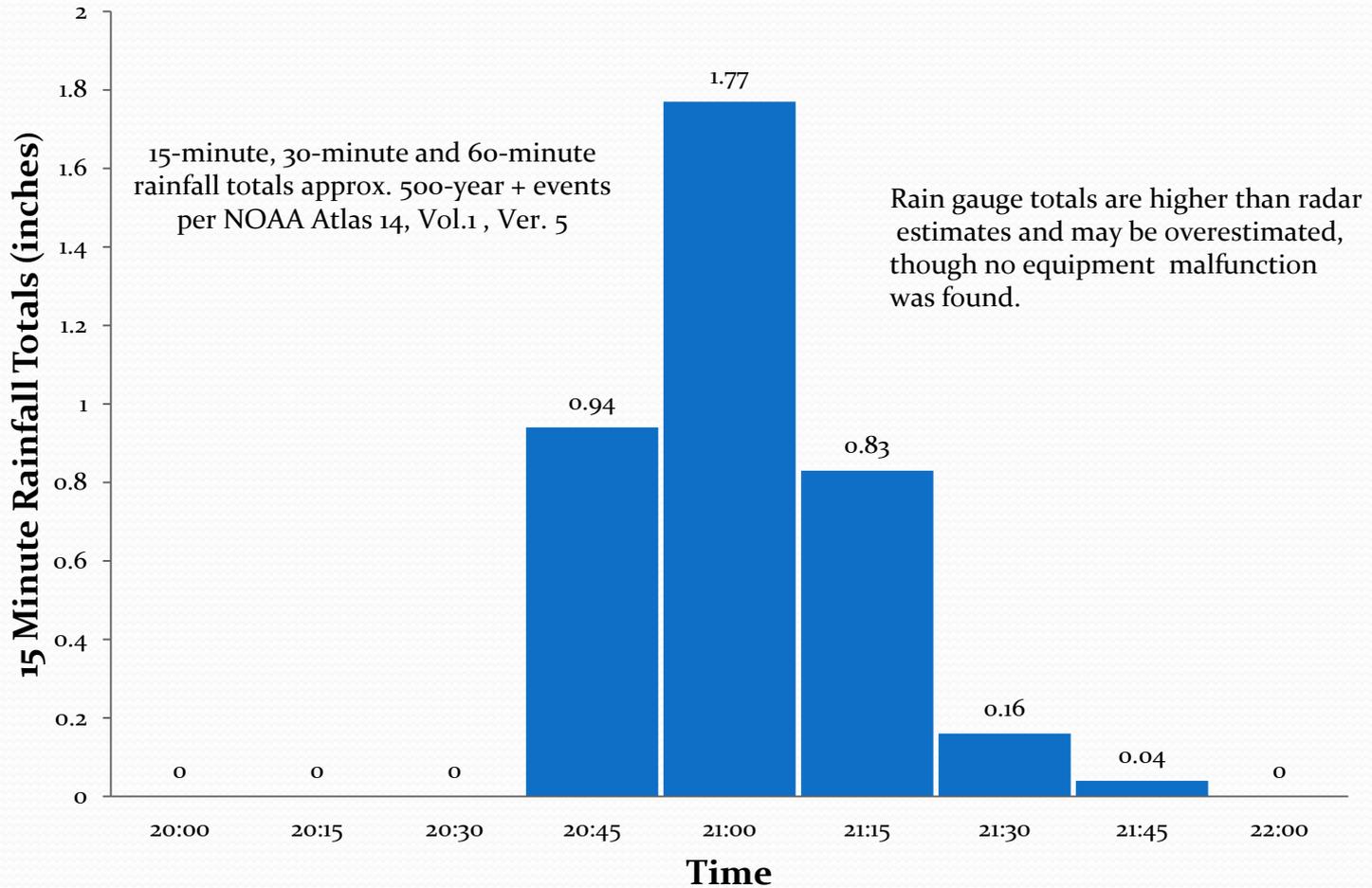
Monsoon Summary

- One of the wettest monsoon on record at most locations.
- Intensity of July storms unprecedented: gages recorded 100 and 500 year rainfall in some locations.
- About 70 flooded structures throughout City, mostly as the result of 3 rainfall events. Likely highest # of flooded structures recorded in Flagstaff.

July 2, 2013 Rainfall at Frances Short Pond



July 20, 2013 Rainfall at Clay Avenue Det. Basin



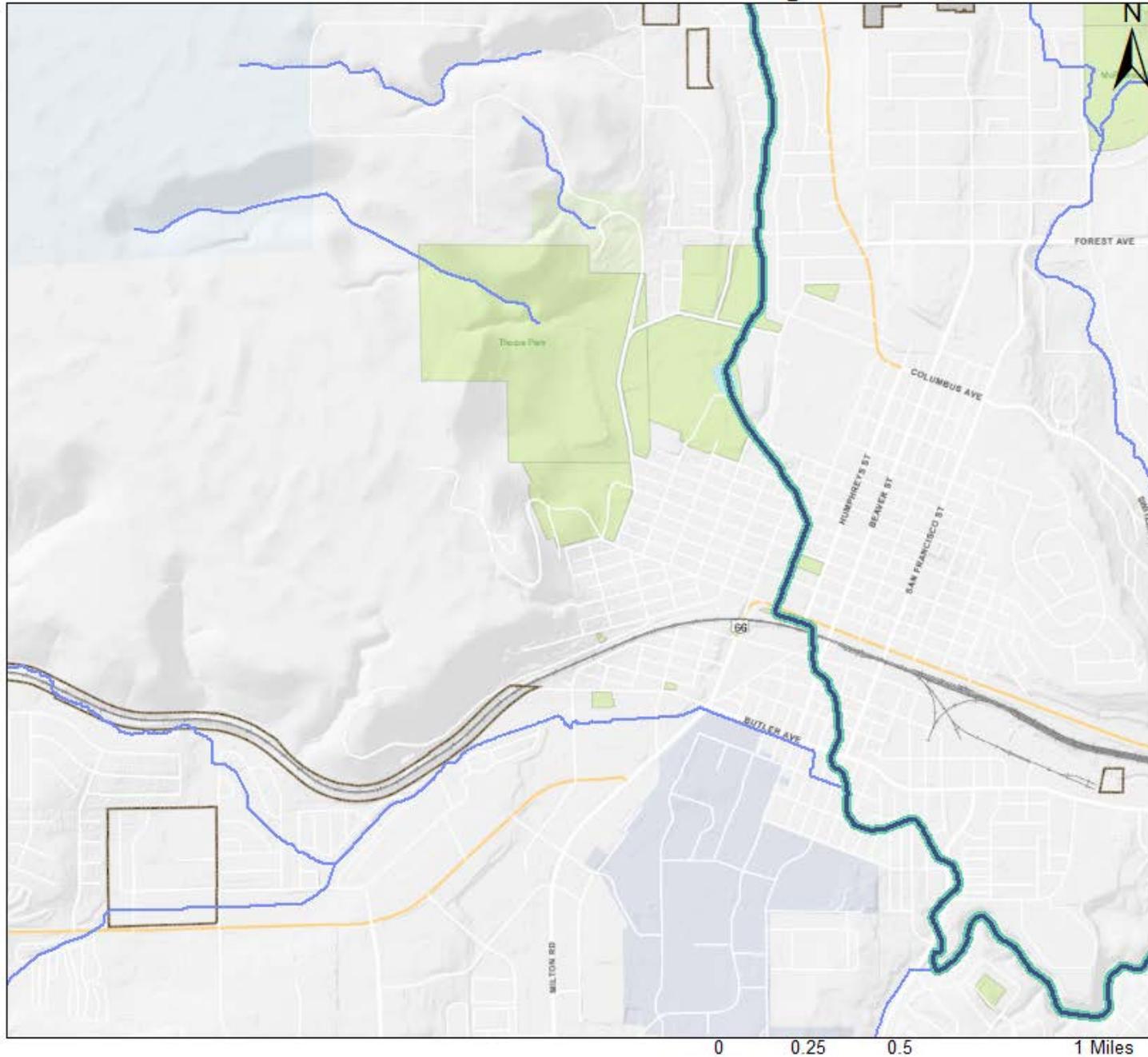




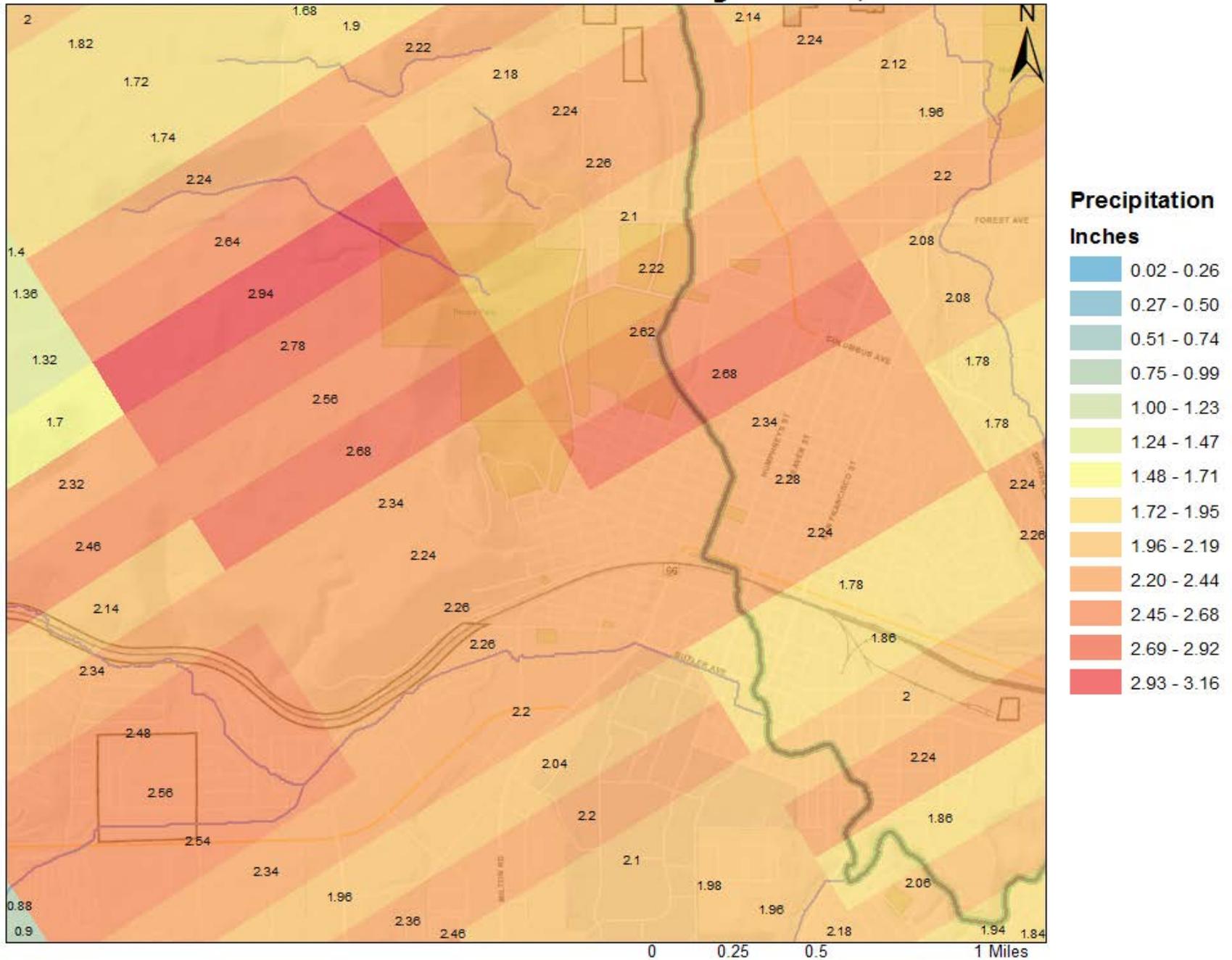




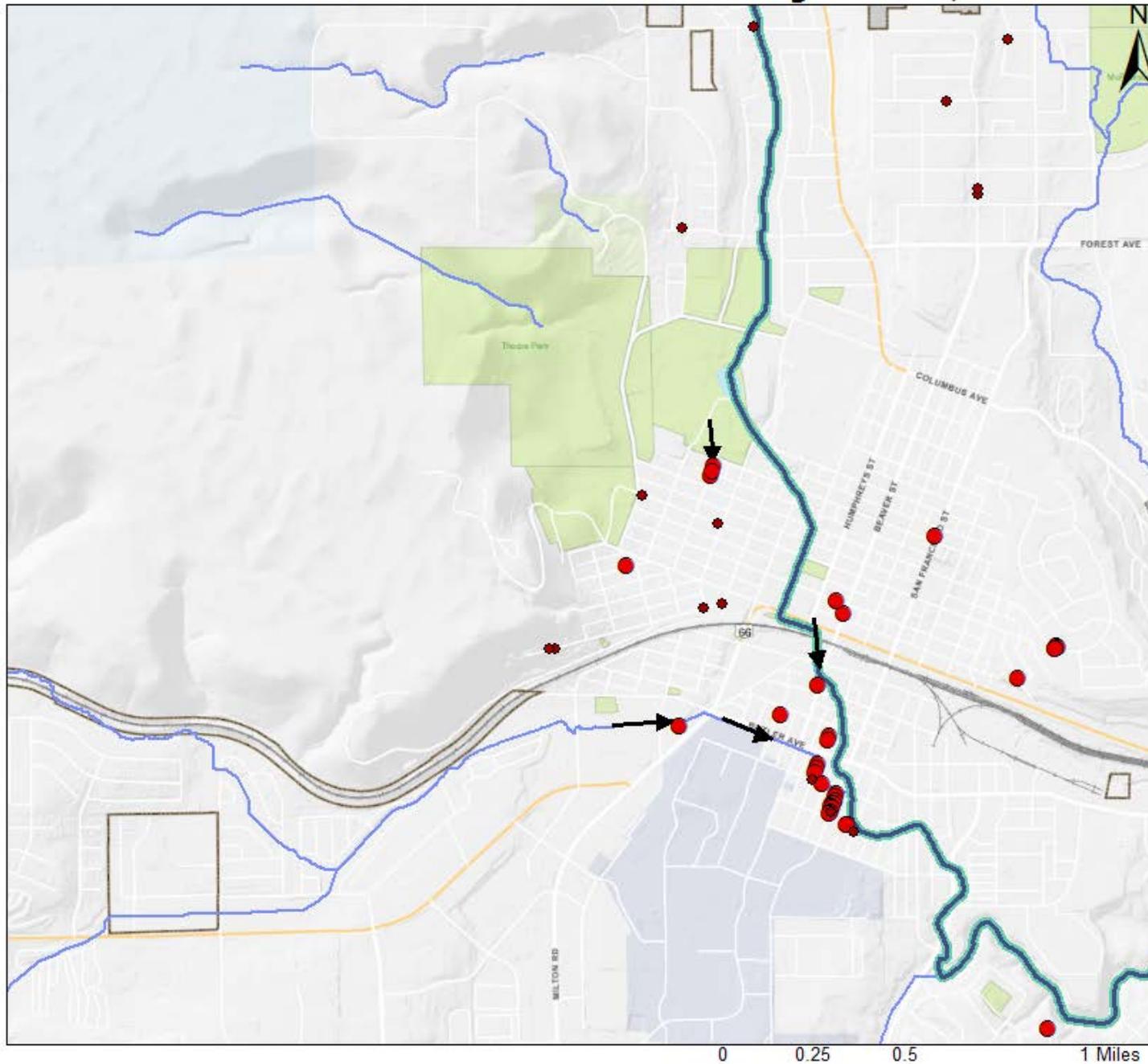
Storm Event: July 2nd, 2013



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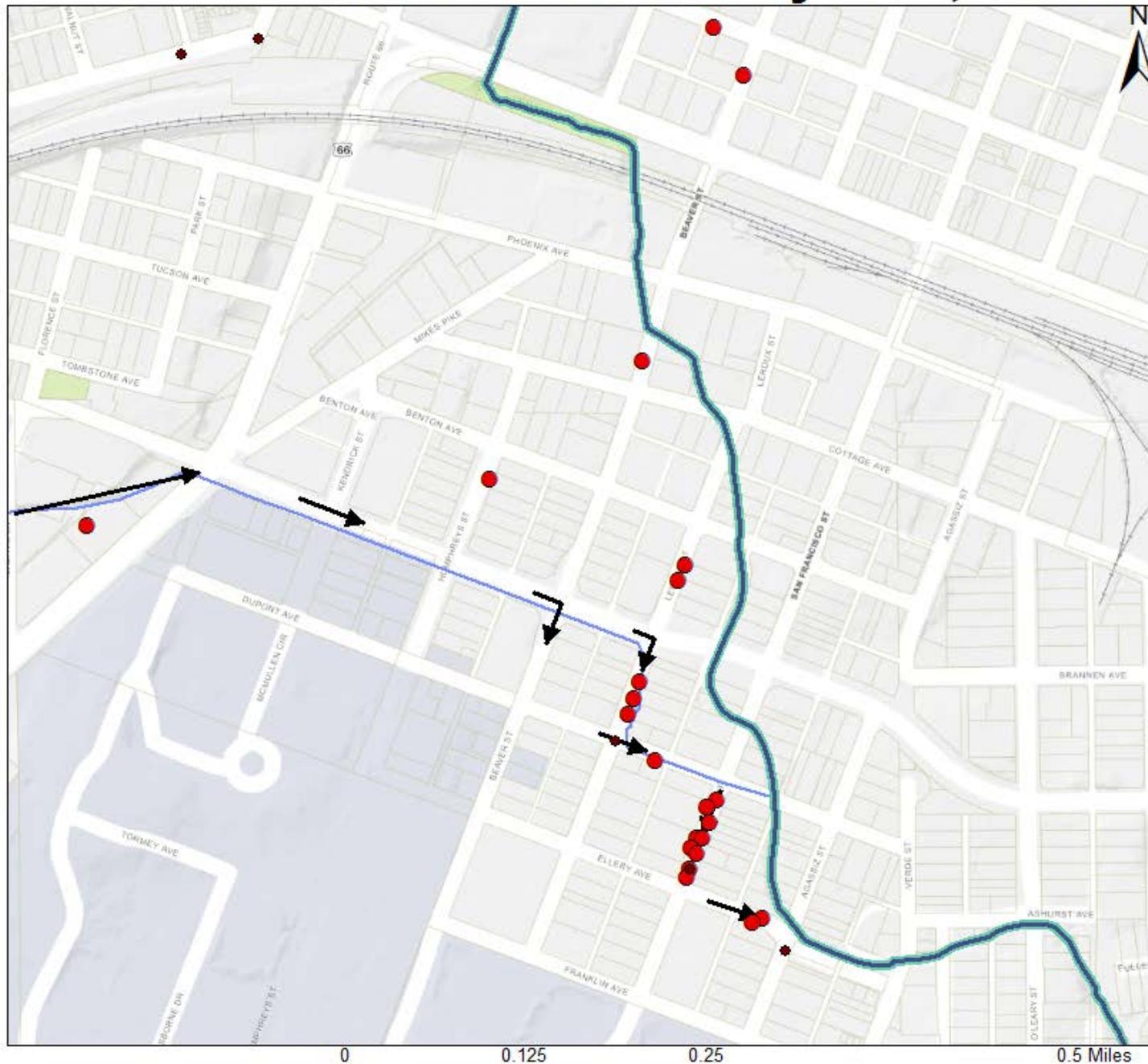
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Flood Complaints

- No Structure Flooded
- Flooded Structure
- Direction of Flow

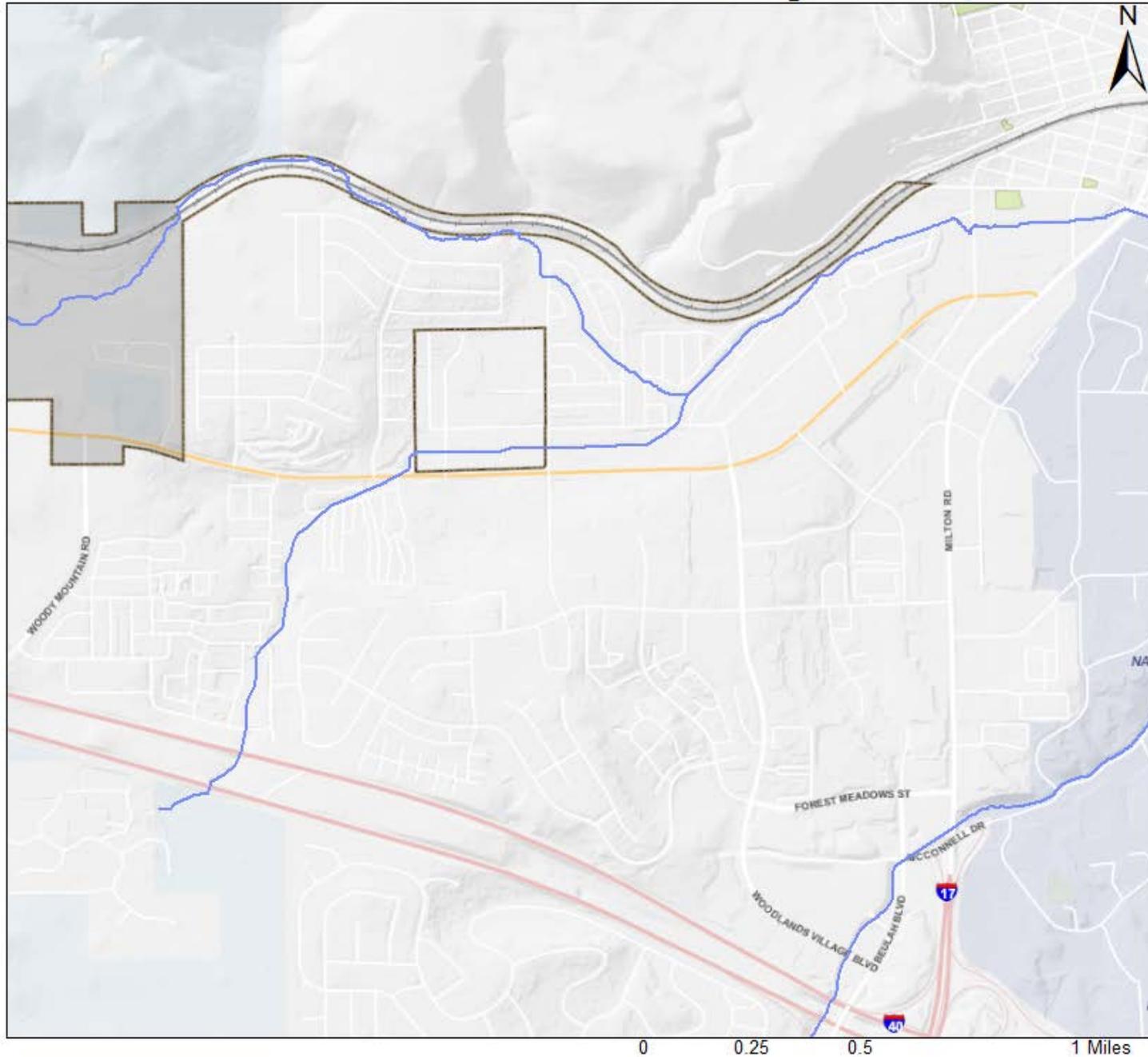
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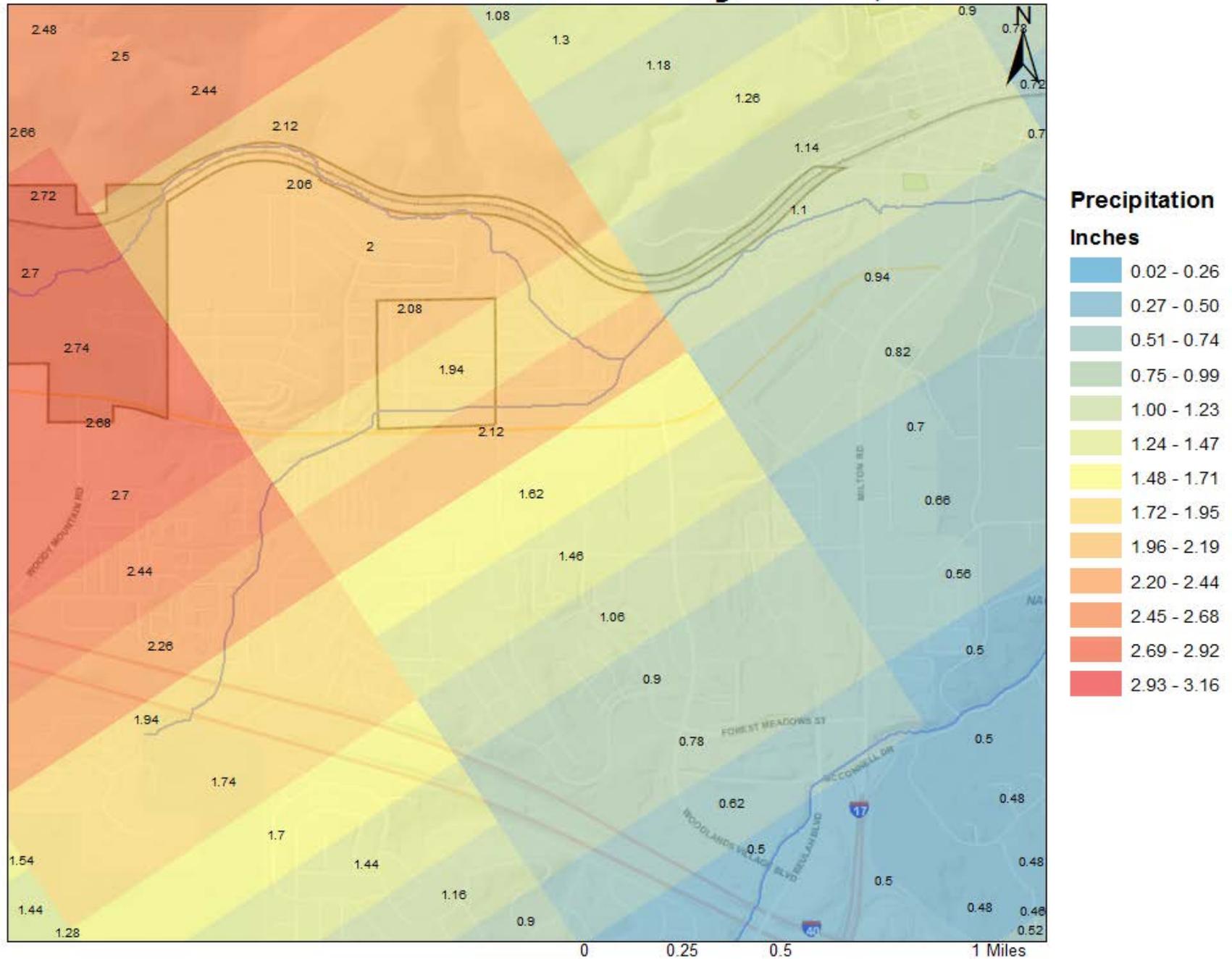
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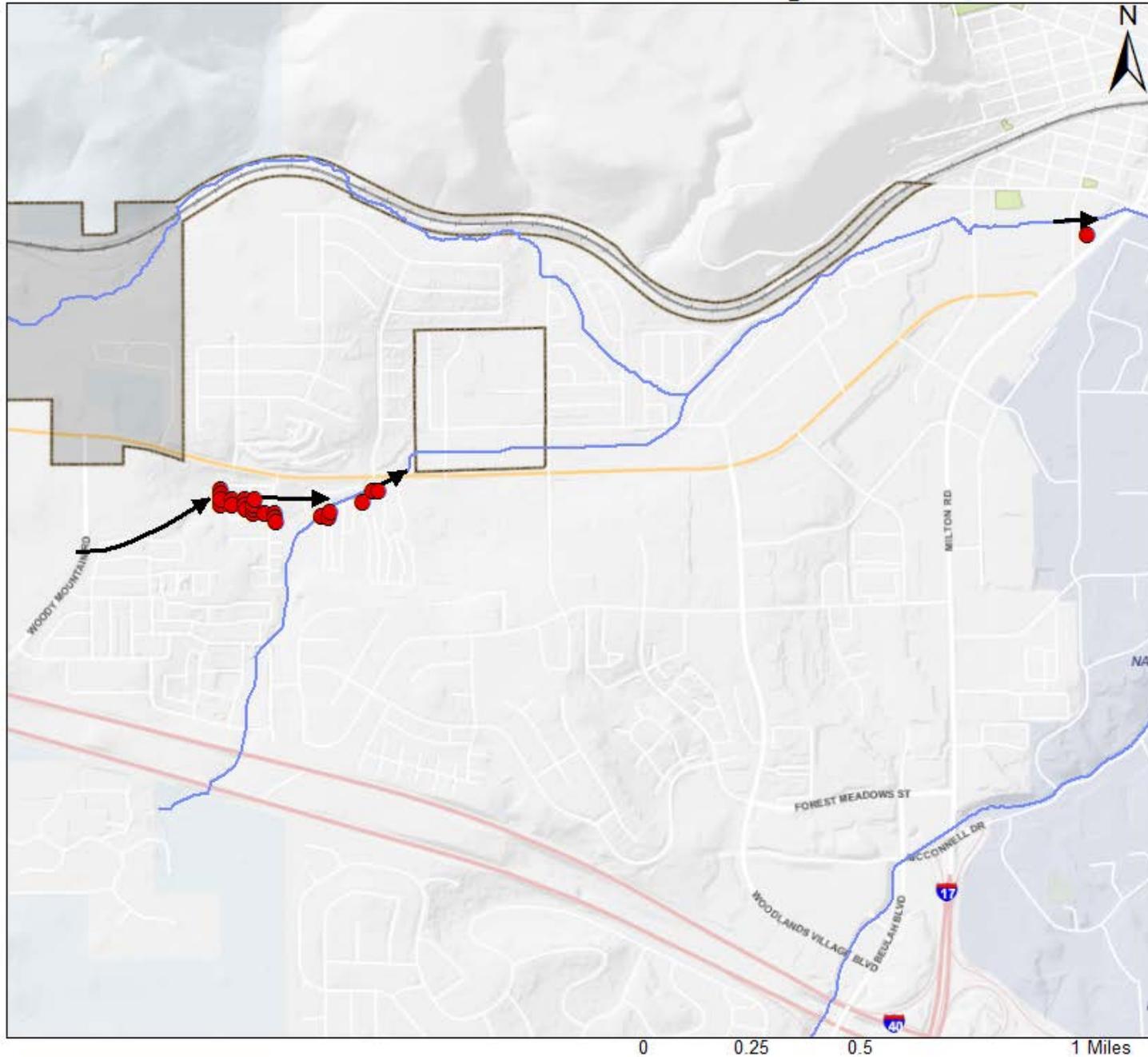
Storm Event: July 20th, 2013



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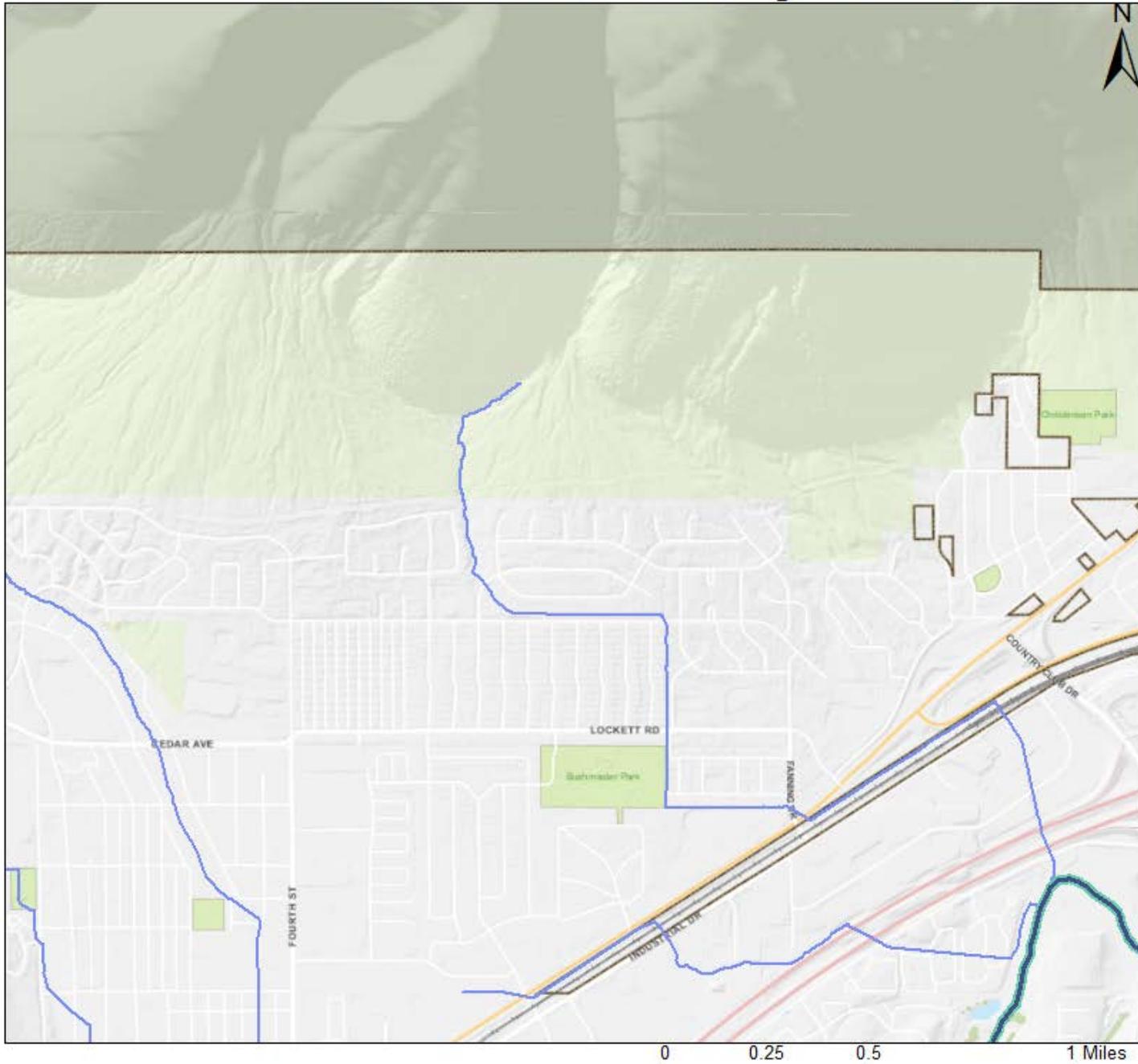
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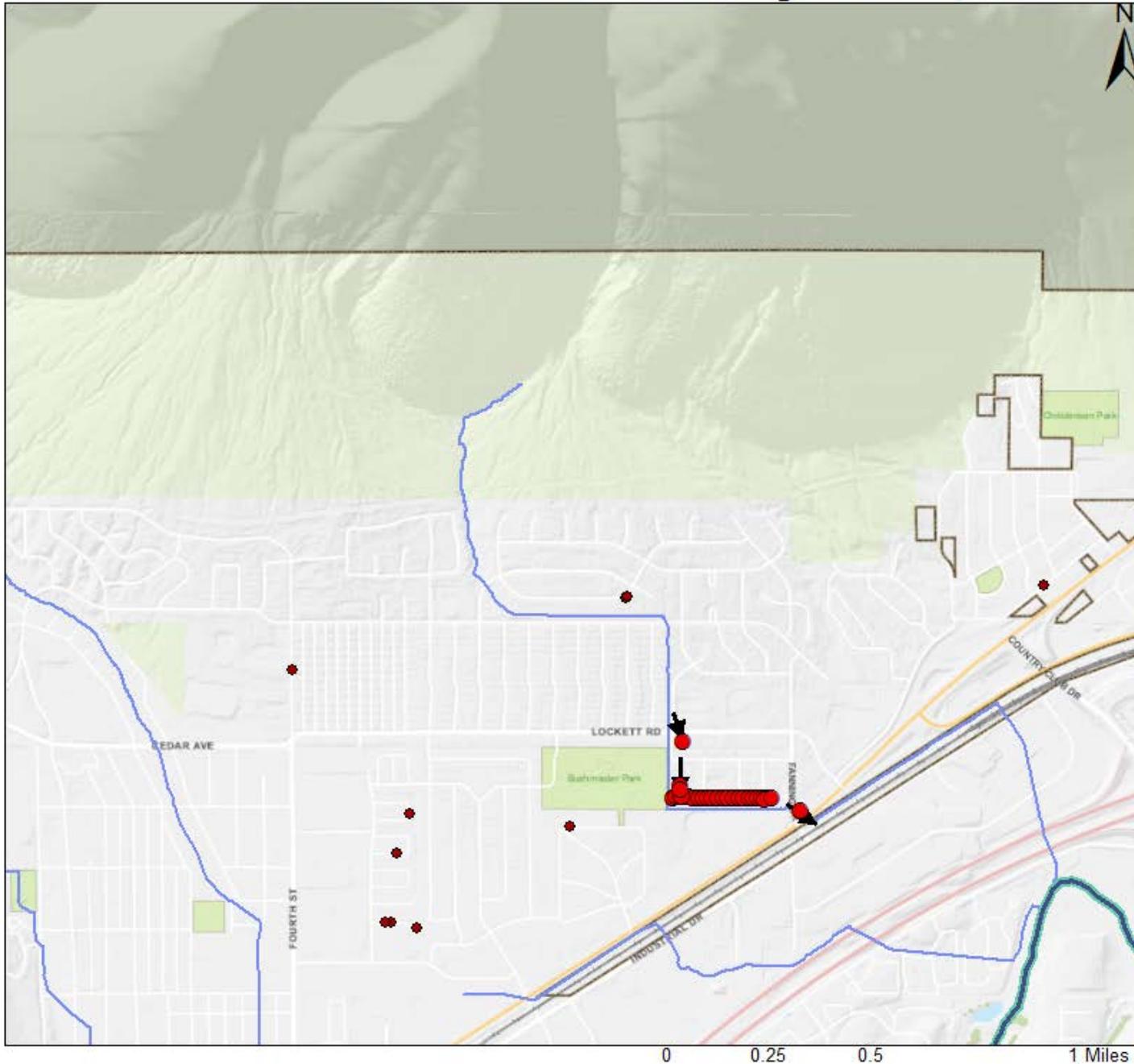
Flood Complaints

- Flooded Structure
- Direction of Flow

Storm Event: July 25th, 2013



Storm Event: July 25th, 2013



Waterline Road Flooding July 21st

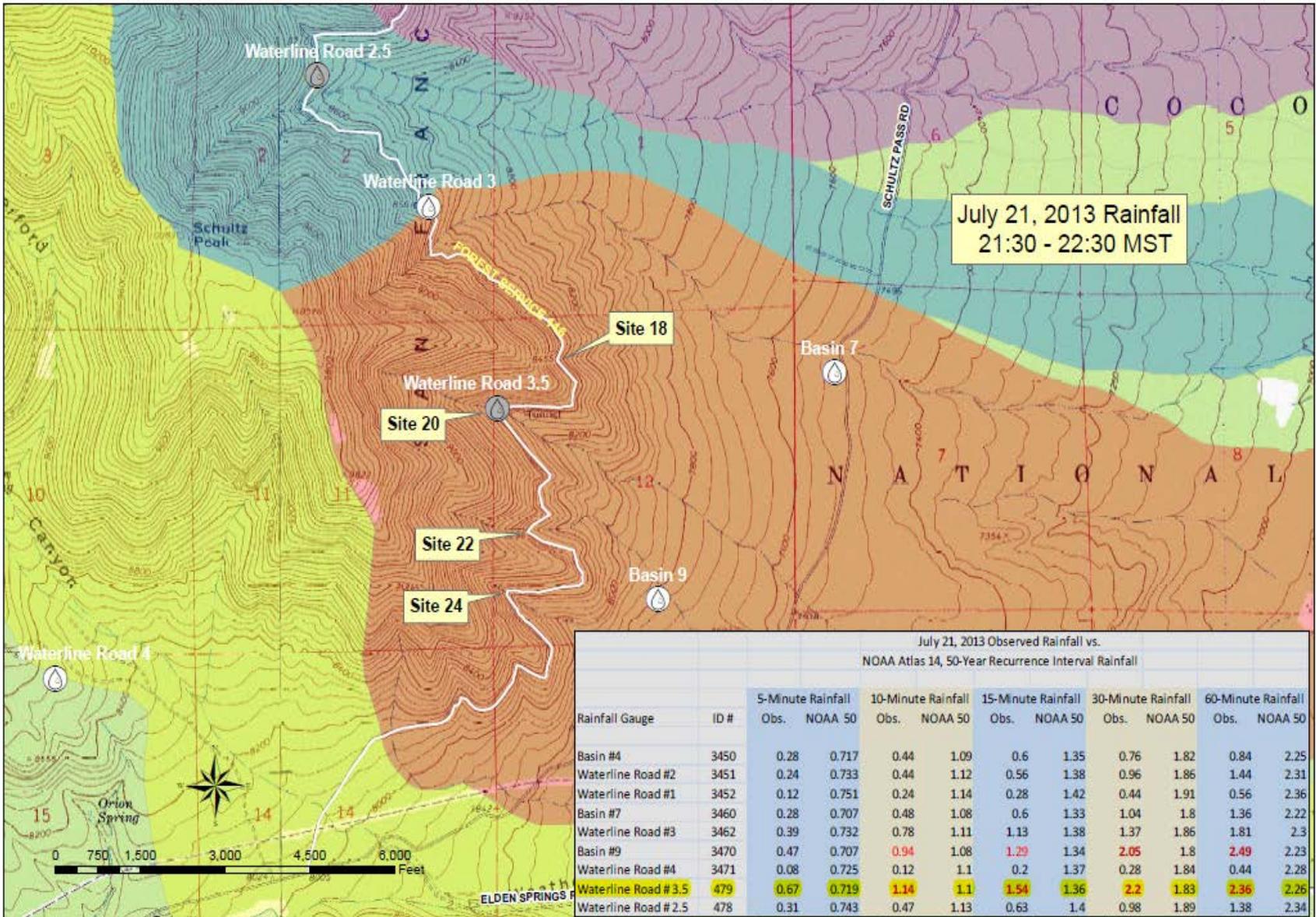
- Event estimated between 50 and 100 year flood.
- Debris flows
- Structure failure



July 21, 2013 Rainfall
21:30 - 22:30 MST

July 21, 2013 Observed Rainfall vs.
NOAA Atlas 14, 50-Year Recurrence Interval Rainfall

Rainfall Gauge	ID #	5-Minute Rainfall		10-Minute Rainfall		15-Minute Rainfall		30-Minute Rainfall		60-Minute Rainfall	
		Obs.	NOAA 50	Obs.	NOAA 50	Obs.	NOAA 50	Obs.	NOAA 50	Obs.	NOAA 50
Basin #4	3450	0.28	0.717	0.44	1.09	0.6	1.35	0.76	1.82	0.84	2.25
Waterline Road #2	3451	0.24	0.733	0.44	1.12	0.56	1.38	0.96	1.86	1.44	2.31
Waterline Road #1	3452	0.12	0.751	0.24	1.14	0.28	1.42	0.44	1.91	0.56	2.36
Basin #7	3460	0.28	0.707	0.48	1.08	0.6	1.33	1.04	1.8	1.36	2.22
Waterline Road #3	3462	0.39	0.732	0.78	1.11	1.13	1.38	1.37	1.86	1.81	2.3
Basin #9	3470	0.47	0.707	0.94	1.08	1.29	1.34	2.05	1.8	2.49	2.23
Waterline Road #4	3471	0.08	0.725	0.12	1.1	0.2	1.37	0.28	1.84	0.44	2.28
Waterline Road # 3.5	479	0.67	0.719	1.14	1.1	1.54	1.36	2.2	1.83	2.36	2.26
Waterline Road # 2.5	478	0.31	0.743	0.47	1.13	0.63	1.4	0.98	1.89	1.38	2.34





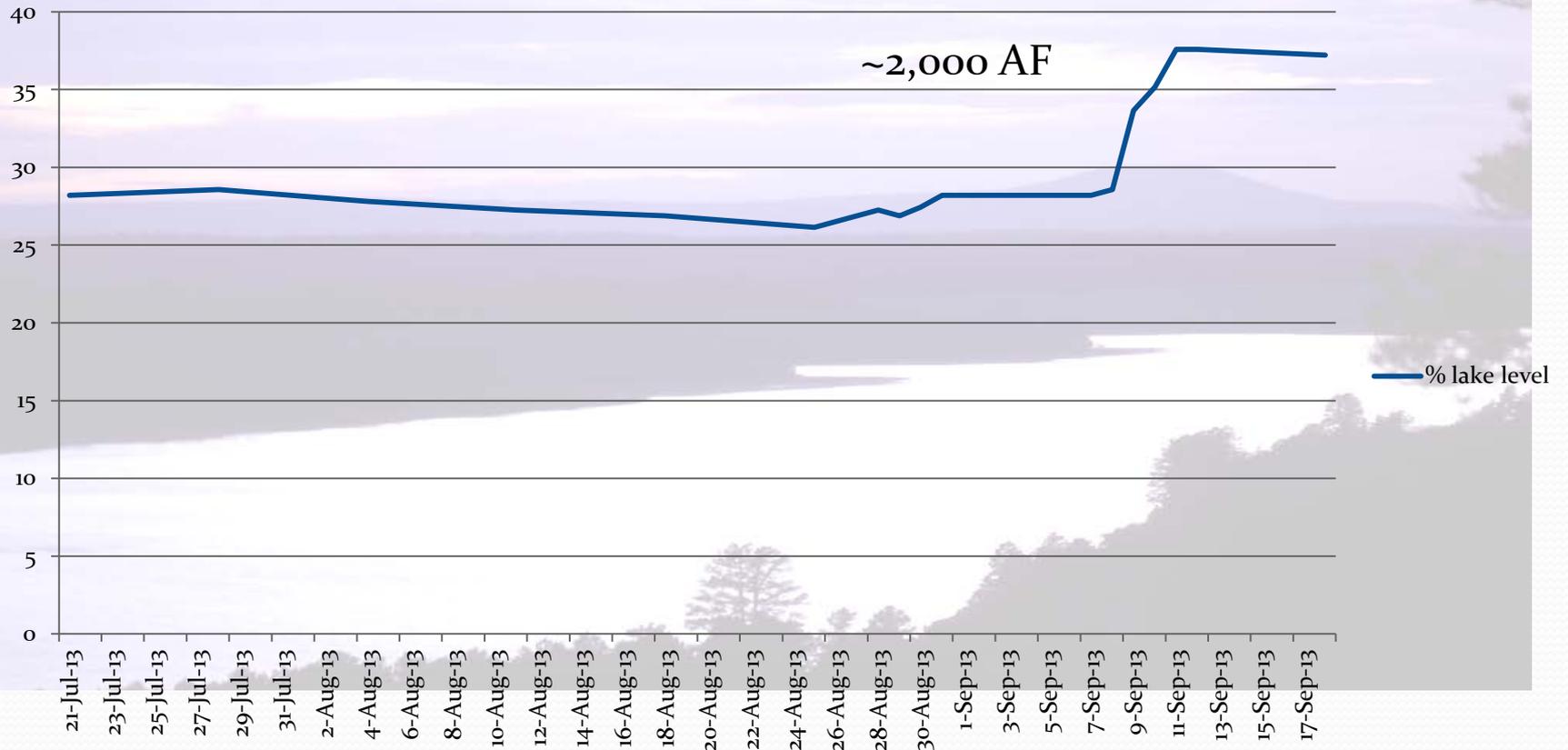


Lake Mary



- Unprecedented rise in W.S.E. in early September of 12%.
- Saturated soil condition in watershed.

Summer 2013 Monsoon vs % lake level



Summary

Lessons learned?

- Unusually wet and intense monsoon
- Older infrastructure under-designed.
- Consider frequency of flooding in development of capital programs: not delineated floodplains (or what *could* happen).
- City drainage capital improvement program underfunded.
- Maintenance is critical, but not always effective.