Update on Regional Hydrologic Investigations

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2016 UDFCD Annual Seminar April 5, 2016


EVENING POST
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OCTOBER 3, 1936
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Typical Municipal Criteria:

Flood Channels:

- Freeboard: 1-2 feet

Detention Basins:

- May only include ½ WQCV (or EURV) in 100-Year Volume
- Freeboard: 1 foot

Channel Freeboard

- 1’ of freeboard ≈ 140% increase in capacity
- 2’ of freeboard ≈ 190% increase in capacity

100-Year Channel Becomes?

- 1’ of freeboard ≈ 500-year channel
- 2’ of freeboard ≈ 1,000-year channel

Freeboard is a Safety Factor

Detention Freeboard

- ½ WQCV & 1’ freeboard ≈ 140% increase
- ½ EURV & 1’ freeboard ≈ 160% increase

100-Year Detention Becomes?

- ½ WQCV & 1’ of freeboard ≈ 500-year storage
- ½ EURV & 2’ of freeboard ≈ 1,000-year storage

Conservativism vs. Accuracy

Hydraulics:

- We want to be conservative
- i.e., safety factor to hedge uncertainty

Hydrology:

- We want to be accurate
- i.e., right, based on known events

Conditional Letters of Map Revision (CLOMRs) based on Hydrology

3 Methods:

1. Statistical extrapolation of gage data
2. Regression equations
3. Rainfall—runoff models

Conditional Letters of Map Revision (CLOMRs) based on Hydrology: Partners

South Platte River

- Adams County
- Arapahoe County
- Brighton
- Columbine Valley
- Commerce City
- Denver
- Douglas County
- Englewood
- Fort Lupton
- Jefferson County
- Littleton
- Sheridan
- Thornton
- Weld County

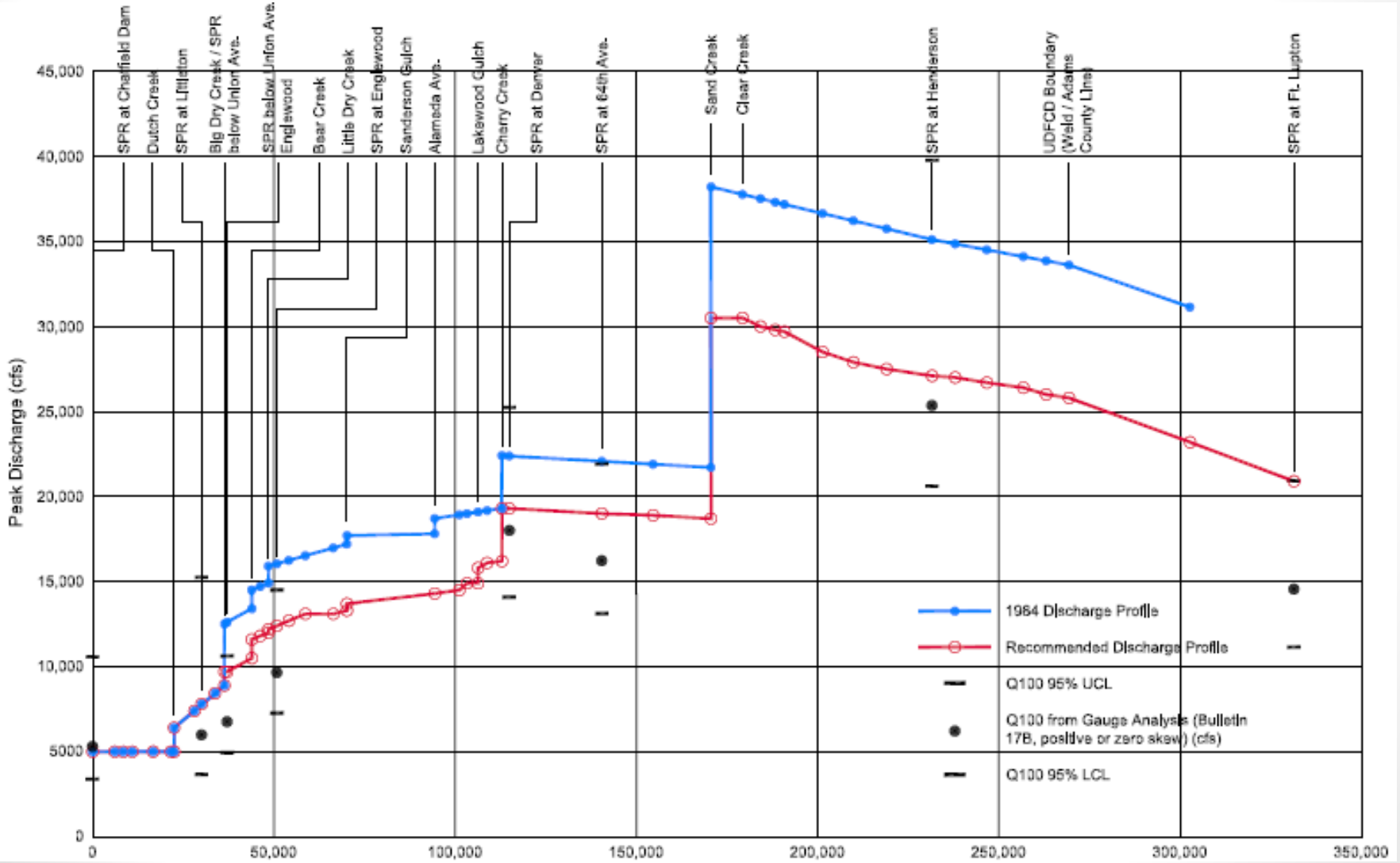
Clear Creek

- Adams County
- Arvada
- Denver
- Golden
- Jefferson County
- Wheat Ridge

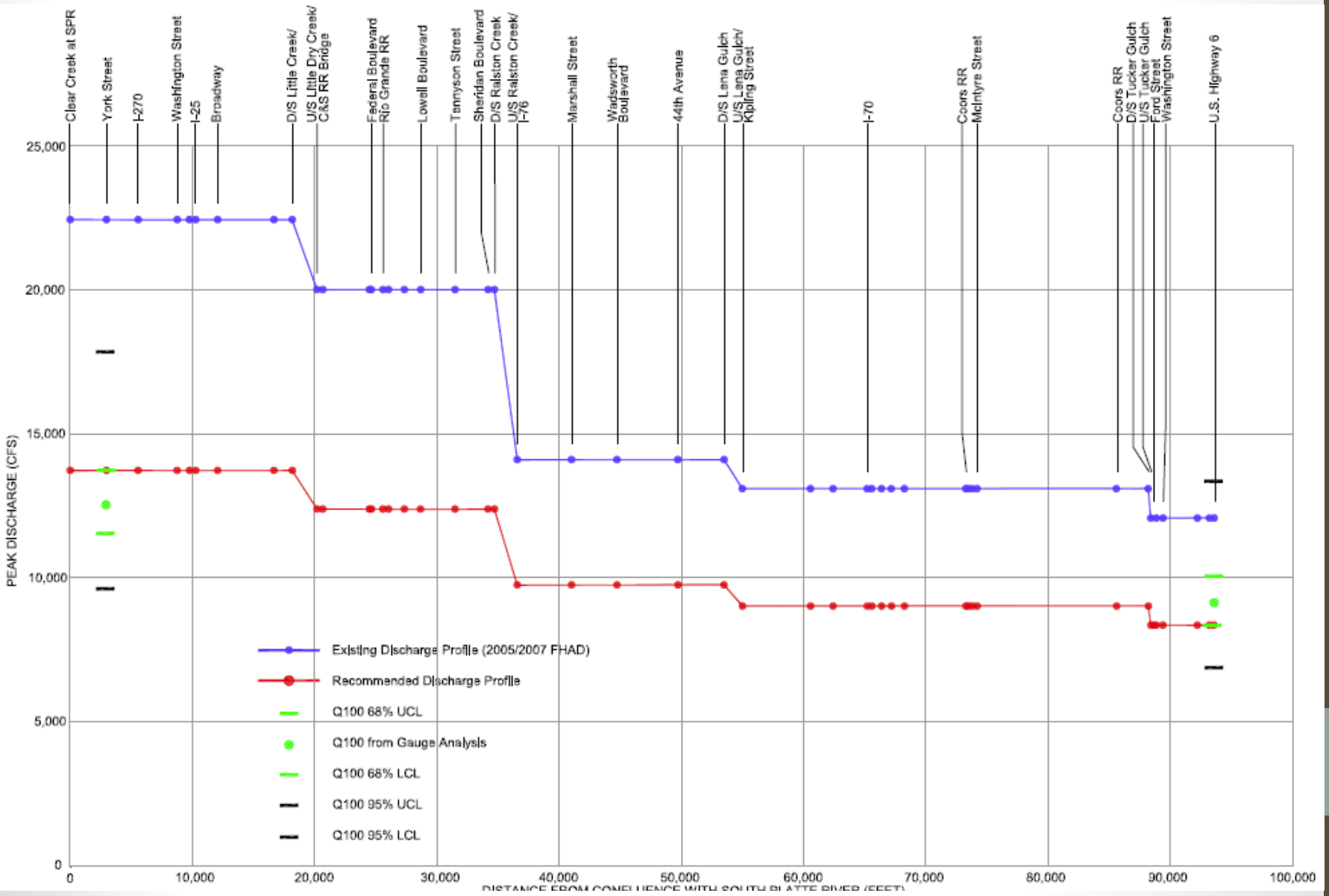
Both

- CWCB
- FEMA
- USGS

South Platte River CLOMR



Clear Creek CLOMR

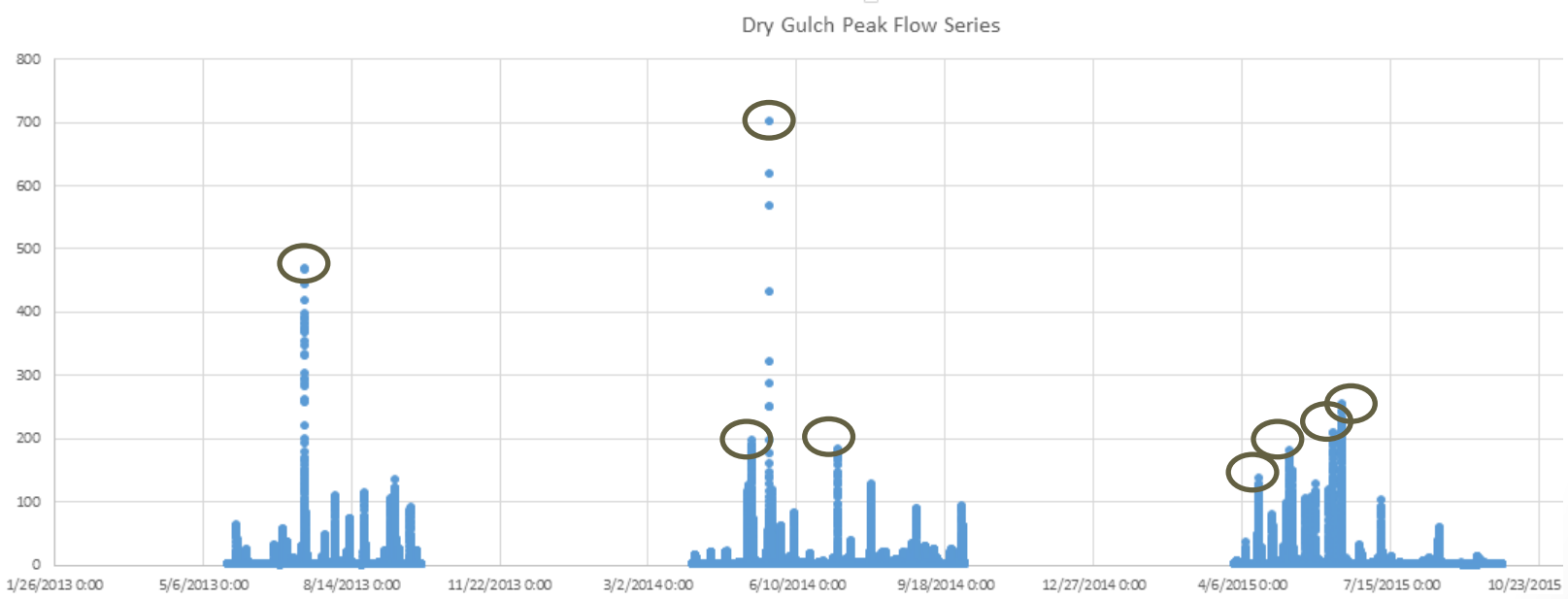


CUHP Update (Year's Progress)

- 10 basins were tested using GARR Rainfall Developed by Rainvieux.
- Each analysis compared:
  - Larger CUHP Basins,
  - Smaller basins averaging 100 acres,
  - New calibrated Cp and Ct values,
  - Testing the effects of Routing.
- This resulted in over 60 storms being analyzed between 2013 and 2015 for each scenario creating more than 240 comparisons.
- Data was paired down based on correlation between rainfall, runoff, and some were eliminated by obvious gage recording errors.
- Paired down data results in 41 data sets to date of ***Selected Data***.

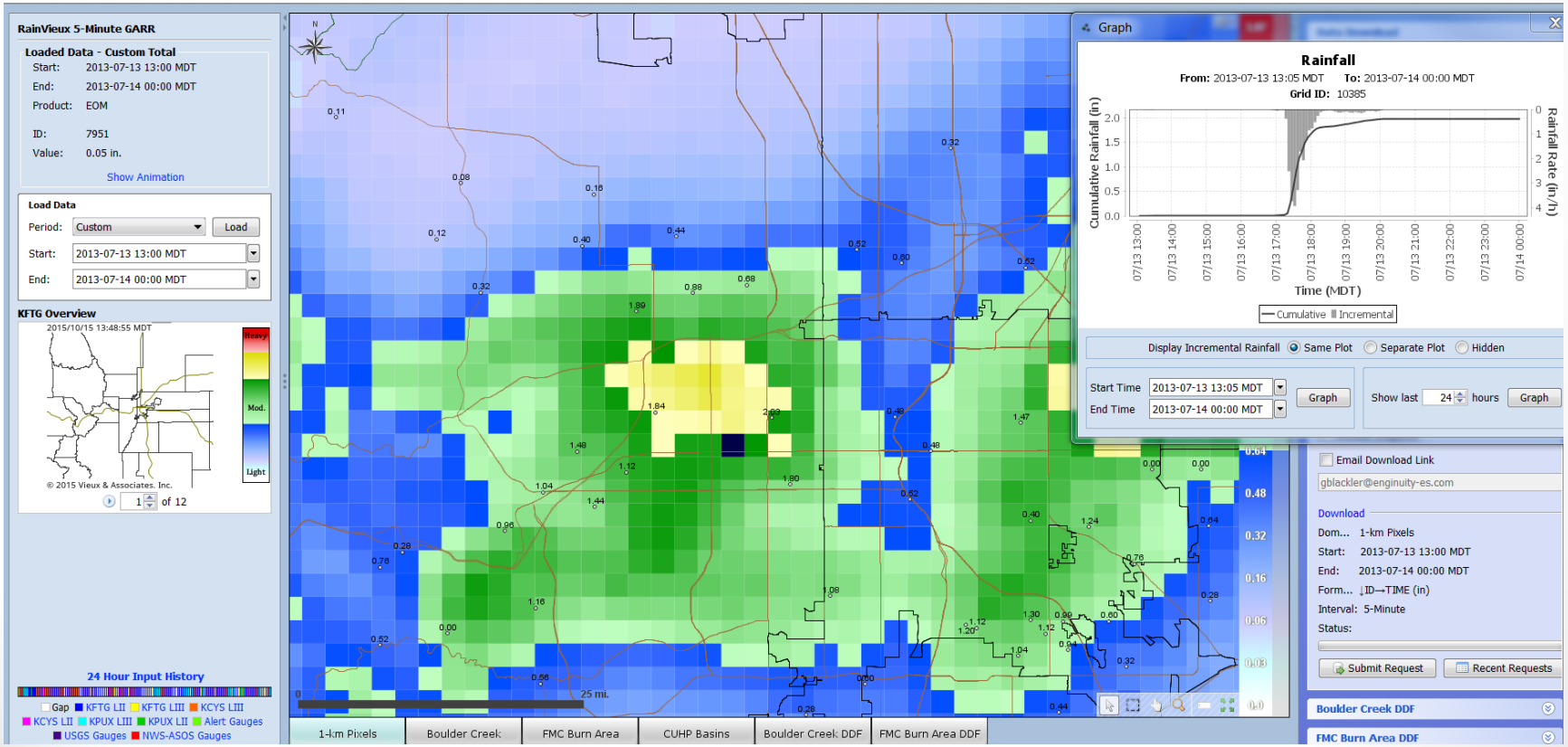
Calibration Process

1. Select Recorded Flows of Interest



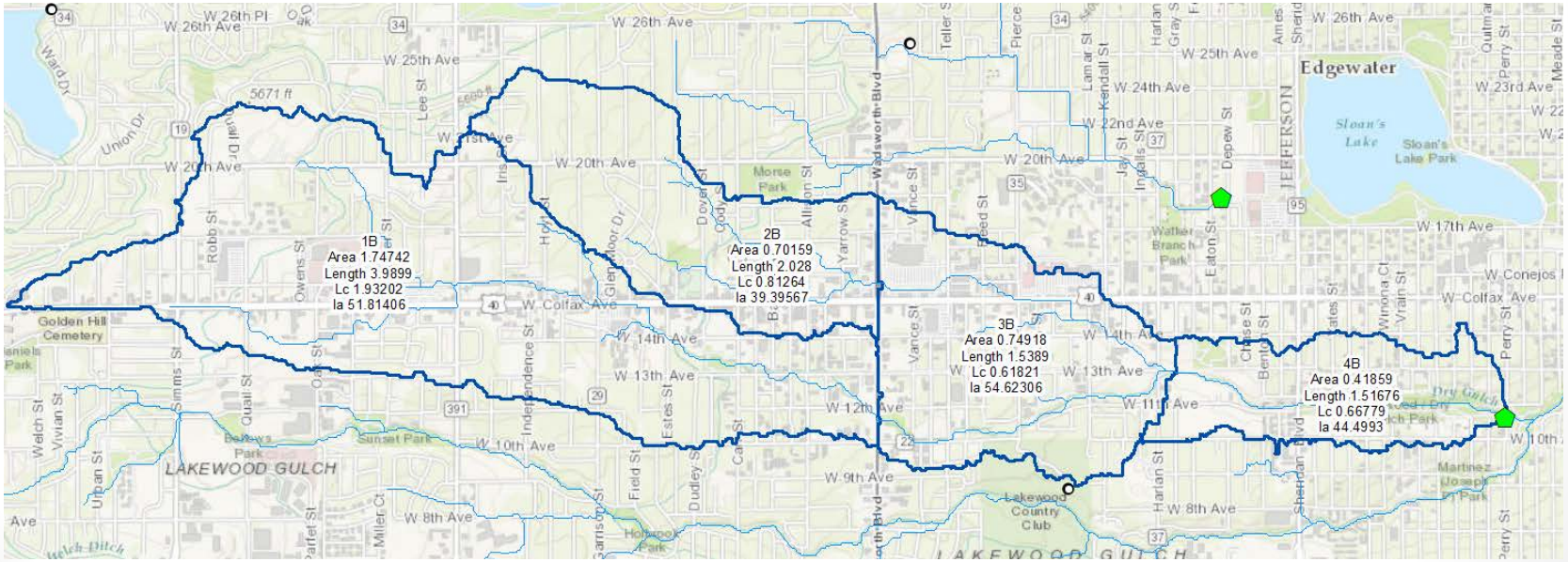
Calibration Process

2. Compare GARR Rainfall with Selected Flows



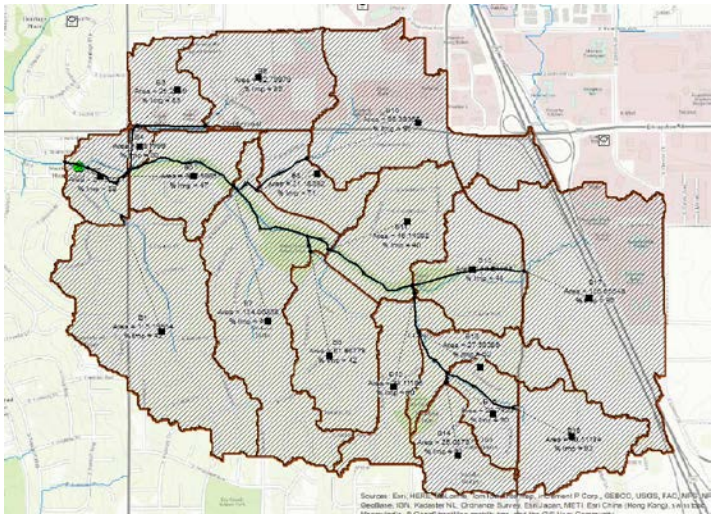
Calibration Process

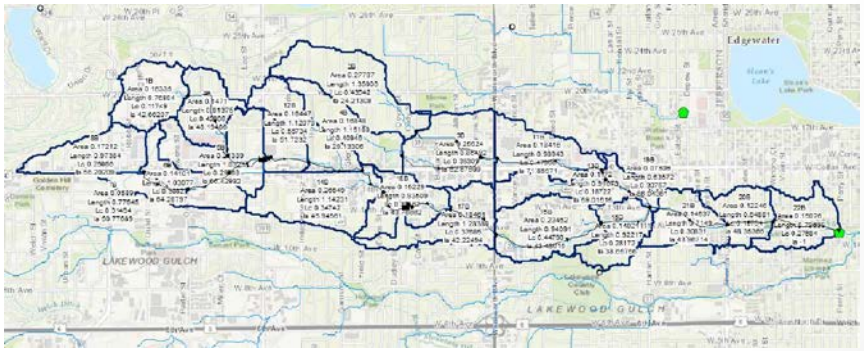
3. Develop Single Basin Model
   - Develop basins that are not greater than 5 square miles and are within reasonable shapes (L^2/A)



Calibration Process

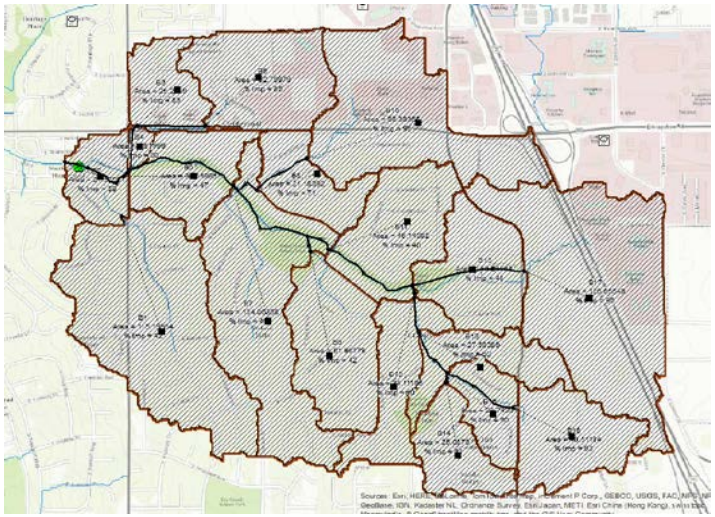
4. Review MDP / OSP Small Basin Model
   - If model needs re-developed, develop a new small basin model averaging 100 acres per UDFCD Standards.

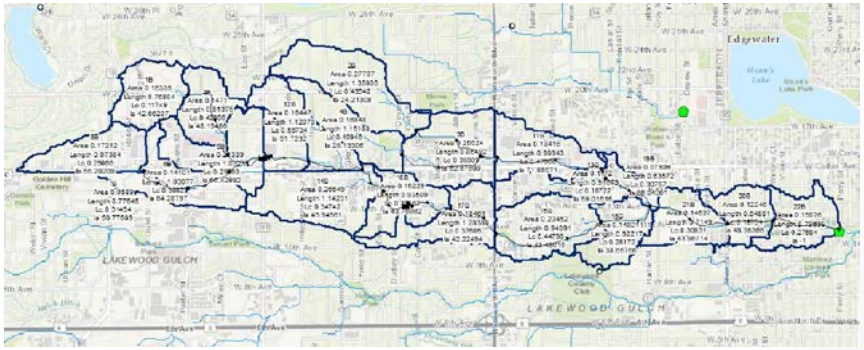




Calibration Process

5. Develop a Dynamic Model from MDP / OSP Kinematic Wave Model to compare Routing Sensitivity





Calibration Process

6. Run CUHP Models and Selected Storms for the Following:
   1. Single / Large Basin Analysis
   2. MDP / OSP Small Basins
   3. MDP / OSP Small Basins with Adjusted Cp and Ct

This workbook is developed as part of the 2015 CUHP Calibration Efforts and is for testing only.

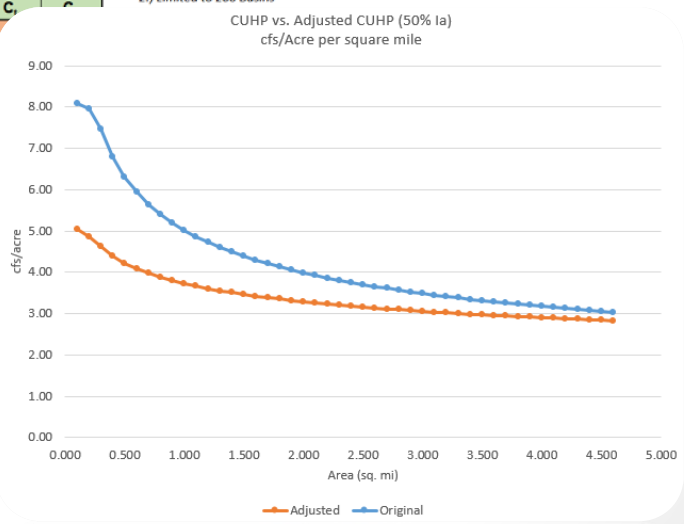
Developed by: Gerald Blackler, PhD, PE - Enginuity Engineering Solutions

Paste the Input for CUHP Below

Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	C_T Override	C_p
3B	3B	Storm9	0.1471	0.42808	0.81375	0.014812193	48.19486	0.089061	0.
14B	14B	Storm9	0.26649	0.34742	1.14231	0.018120104	45.94561	0.090164	0.
12B	12B	Storm9	0.16447	0.55734	1.12078	0.021365169	51.7232	0.087398	0.
10B	10B	Storm9	0.0837	0.19186	0.60443	0.030228419	62.65416	0.082768	0.
2B	2B	Storm9	0.27787	0.43542	1.35006	0.018103356	24.21308	0.105247	0.
4B	4B	Storm9	0.16848	0.40946	1.15188	0.021649759	29.13306	0.100263	0.
18B	18B	Storm9	0.15229	0.39062	0.93509	0.016409127	43.76662	0.091264	0.
17B	17B	Storm9	0.18461	0.37685	1.28388	0.014976517	42.22494	0.092062	0.
9B	9B	Storm9	0.25524	0.35309	0.86492	0.01175528	62.67699	0.082759	0.
13B	13B	Storm9	0.1172	0.18722	0.91679	0.01387642	59.01515	0.084222	0.
11B	11B	Storm9	0.18416	0.47956	0.98943	0.013124674	71.89571	0.079469	0.
16B	16B	Storm9	0.23452	0.44798	0.94091	0.013650259	43.48615	0.091408	0.
15B	15B	Storm9	0.14021	0.28172	0.92217	0.010462811	38.65756	0.093778	0.
19B	19B	Storm9	0.07309	0.30757	0.63572	0.014517653	66.04361	0.081493	0.
21B	21B	Storm9	0.14537	0.30831	0.7149	0.015375034	30	0.0995	0.
20B	20B	Storm9	0.12246	0.19754	0.64881	0.025871886	32	0.097872	0.
22B	22B	Storm9	0.15076	0.27584	0.78639	0.022907174	35	0.095775	0.

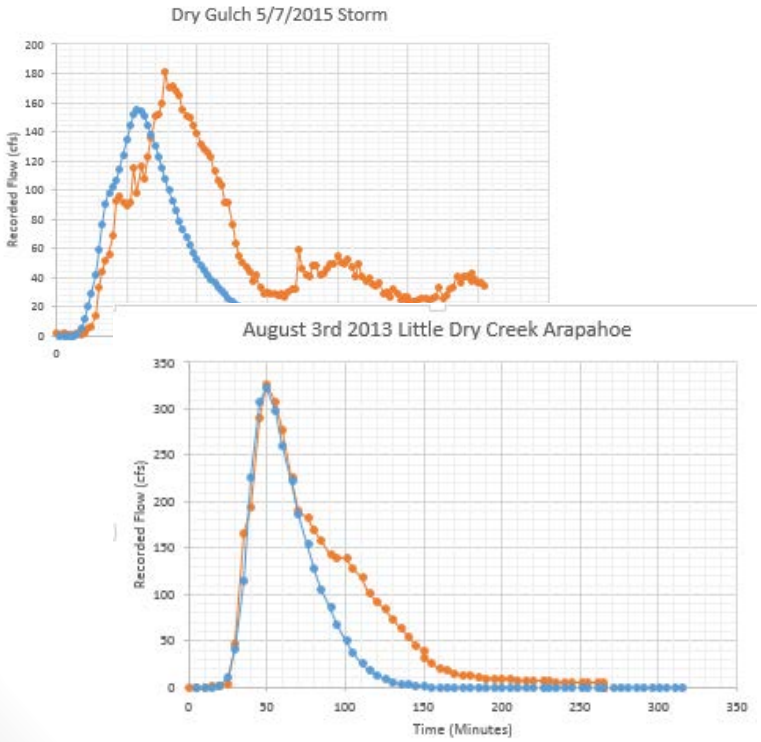
Notes:
1.) After first run check effective impervious values in CUHP and re-compute Cp and Ct if they are significantly different than the percent impervious used.

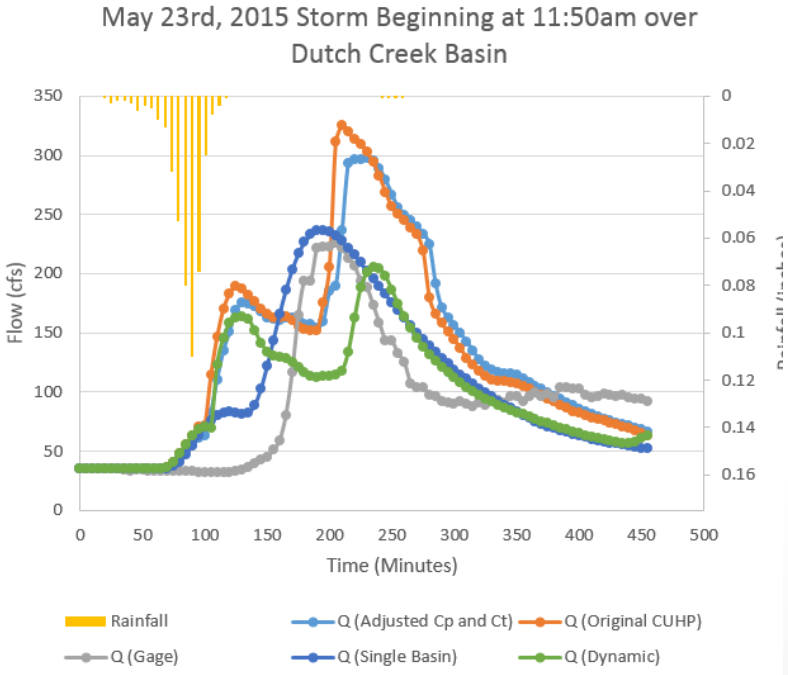
2.) Limited to 200 Basins



Calibration Process

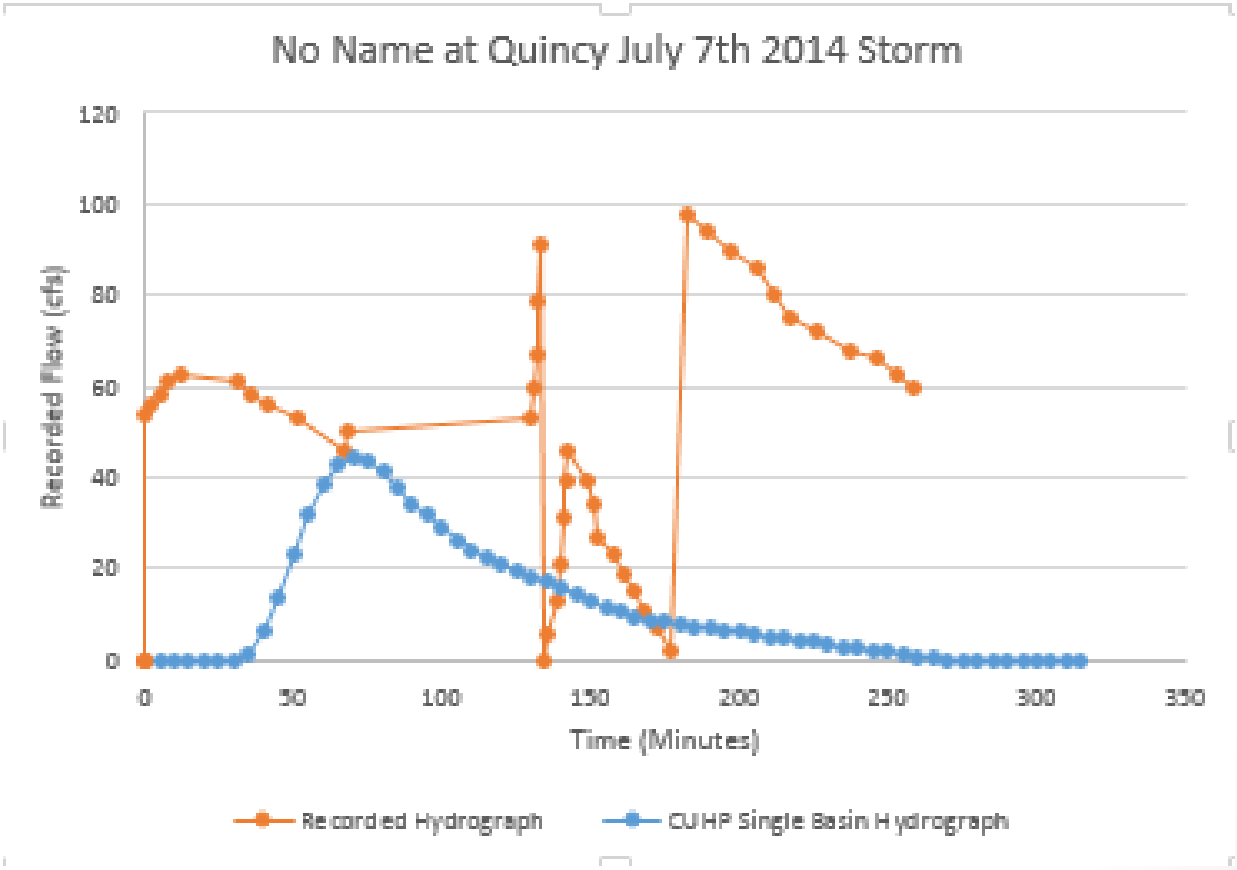
7. Compare Computed Peak Flows with Recorded Flows





Calibration Process

8. Review Recorded Data for Consistency, Eliminate Bad Data



Preliminary Results

- Even with the large amount of gauges available, only six (6) so far were considered viable:
  - Period of record with GARR
  - Location and placement of gauge (Example, ponds)

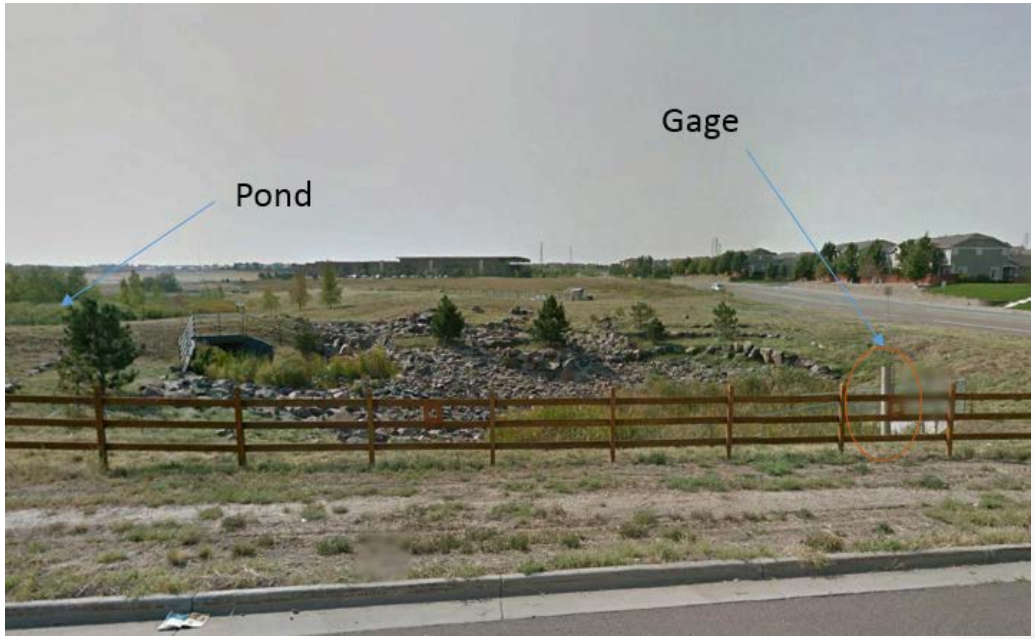
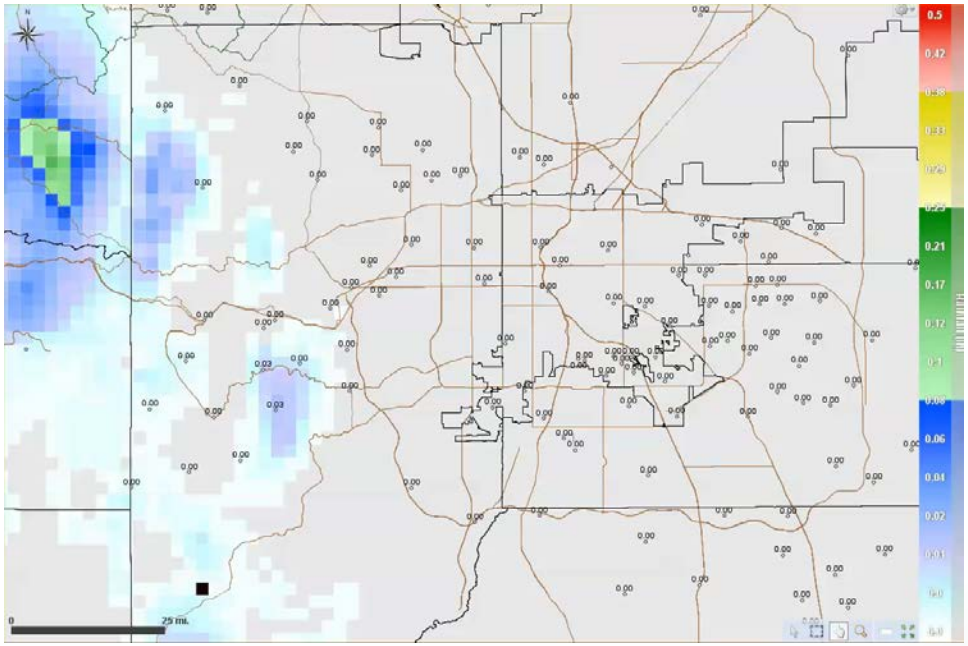


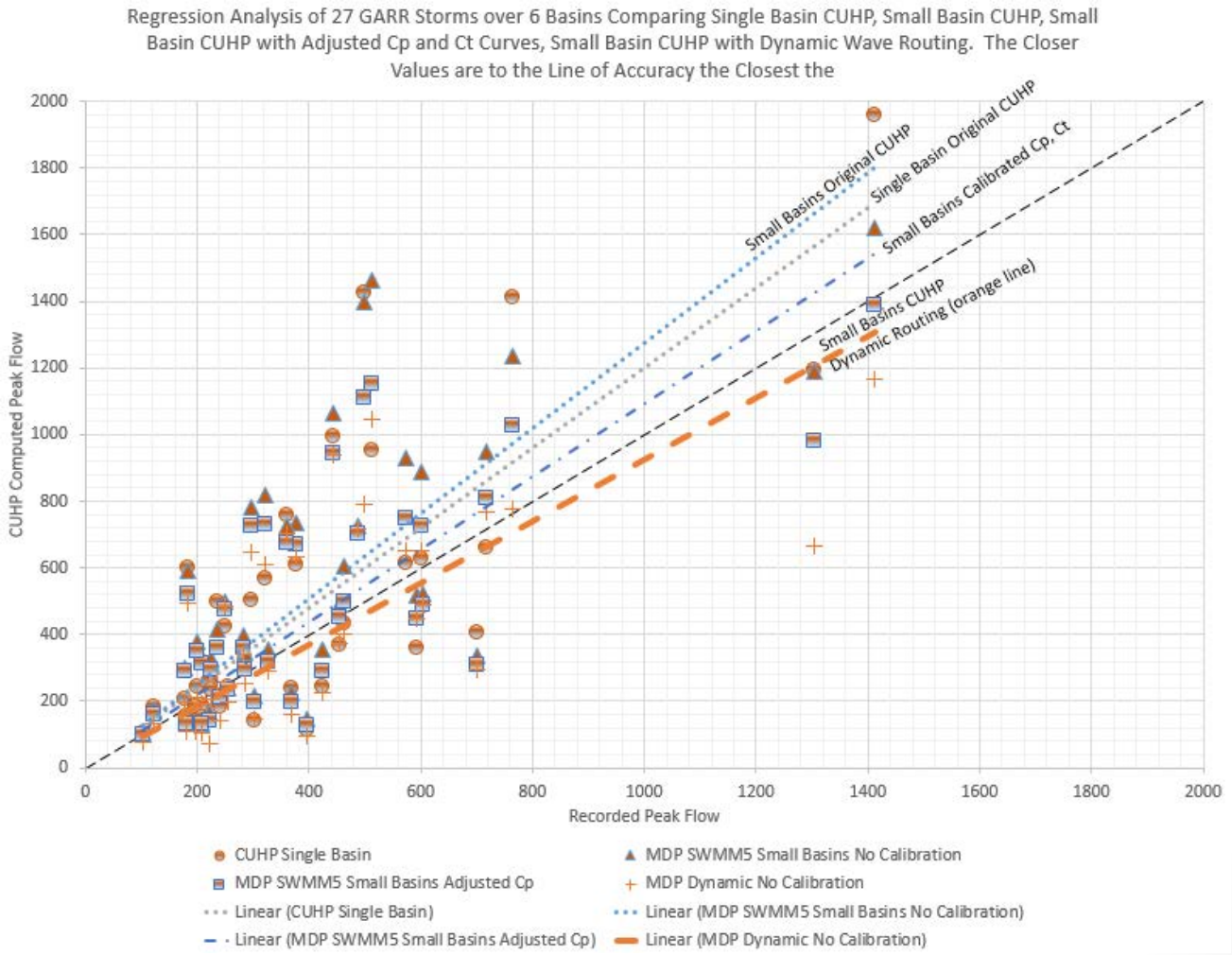
Image of Gauge Location for No Name at Quincy Drainageway

Preliminary Results

- Large deviation of data:
  - Can sometimes be a gauge reading or measurement error
  - GARR reduces rainfall error, but storms still move more dynamically than 1 or 2 hyetographs can represent.



Preliminary Results



Ongoing Work

- Currently Testing a few Recommendations and Hypotheses with storm frequency.
- General Findings:
  - The original calibration of CUHP produced a good product that is unique and specific to Denver.
  - Re-examination of CUHP did not produce any startling results (Good Job Ben!).
  - The usage of small basins in our MDP process does appear to increase flows when compared to the gauges.
- What to expect:
  - No major decisions have been made at this time.
  - It is likely that there will be some modifications, how big or small those are is still being decided.