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Geolocation and Analysis of FEMA FIS Discharge Data

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Project and Presentation Overview

- Geolocated 7,400 discharge points
 - In collaboration with FEMA, USGS
 - Some analysis of overlap with USGS stream gages
 - Conducted initial post-compilation data analysis
 - Only flood sources with detailed flood studies
- Today's focus
 - Data of interest and how points were geolocated
 - Initial data interpretations
 - Next steps

Background

- FEMA has published thousands of discharges in its Flood Insurance Studies (FISs) via Summary of Discharge tables

TABLE 3- SUMMARY OF DISCHARGES - continued

| <u>FLOODING SOURCE AND LOCATION</u> | <u>DRAINAGE AREA (sq. miles)</u> | <u>PEAK DISCHARGES (cfs)</u> <u>% ANNUAL CHANCE</u> | | | |
|--|--|--|--|--|--|
| | | <u>10-Percent Annual Chance</u> | <u>2-Percent Annual Chance</u> | <u>1-Percent Annual Chance</u> | <u>0.2-Percent Annual Chance</u> |
| JONES HOLLOW Approximately 0.53 mile upstream of confluence with South River | 5.15 | 850 | * | 2,300 | 3,800 |
| LEWIS CREEK 100 feet west of Commerce Road and | 15.2 | 7,830 | 13,000 | 15,300 | 21,100 |

- Spatial capture of such points historically not required
 - With implementation of updated FIS specifications in 2013, data may be captured and included in FEMA’s National Flood Hazard Layer (NFHL)

Background (Cont'd)

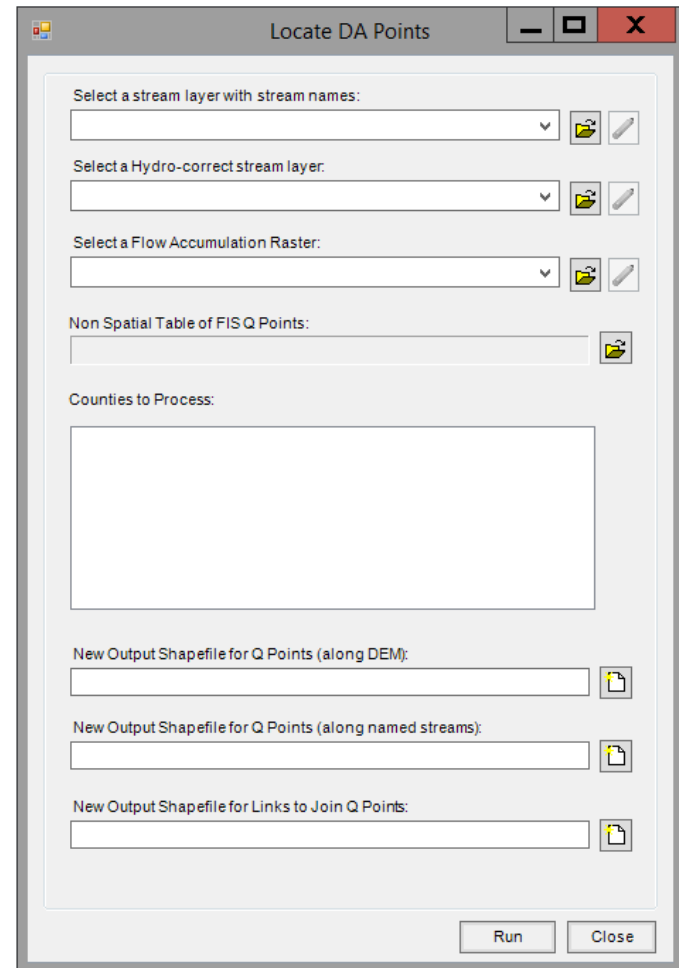
- Primary, secondary NFHL datasets
 - S_NODES
 - L_SUMMARY_DISCHARGES
 - S_SUBBASINS
 - S_GAGE
 - L_SOURCE_CIT
- Basic Approach
 - Transcribe FIS data
 - Geolocate points
 - Intermediary, final database locations
 - Create sub-basins
 - Identify gage analyses (via Coordinated Needs Management Strategy [CNMS]), extract points for S_GAGE
 - Compile and format data in NFHL format
 - Compile “FIS error list” based on identified potential errors

Data Transcription

- Extract historic data into database
 - PDF (text extractable or not), Word, Excel
 - Effective or pending/preliminary data if in progress
 - Input for L_SUMMARY_DISCHARGES table
- First reviews
 - Several algorithms in database environment to look for anomalies (mistranscriptions and FIS errors)
 - Drainage area/discharge relationships
 - Discharge relationships
 - Missing, repeated information

Creation of S_NODES Point Layer

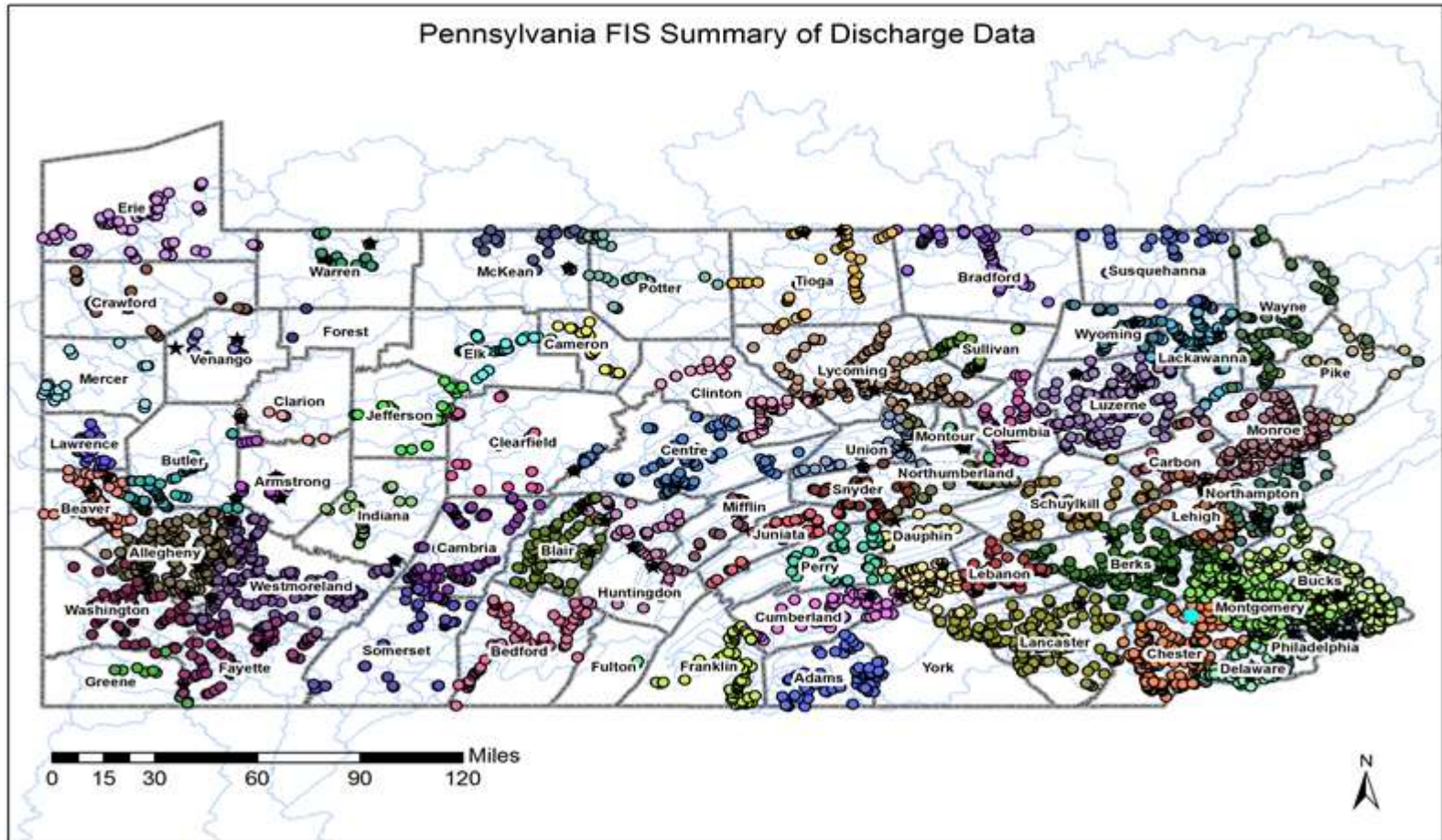
- Leverage transcribed data
- Reverse-place points based on drainage areas (DAs)
 - Use AECOM “Locate DA Points” tool
 - Two output layers – hydro and CNMS
- Review point placement and adjust if needed
 - Location description/ ballpark placement



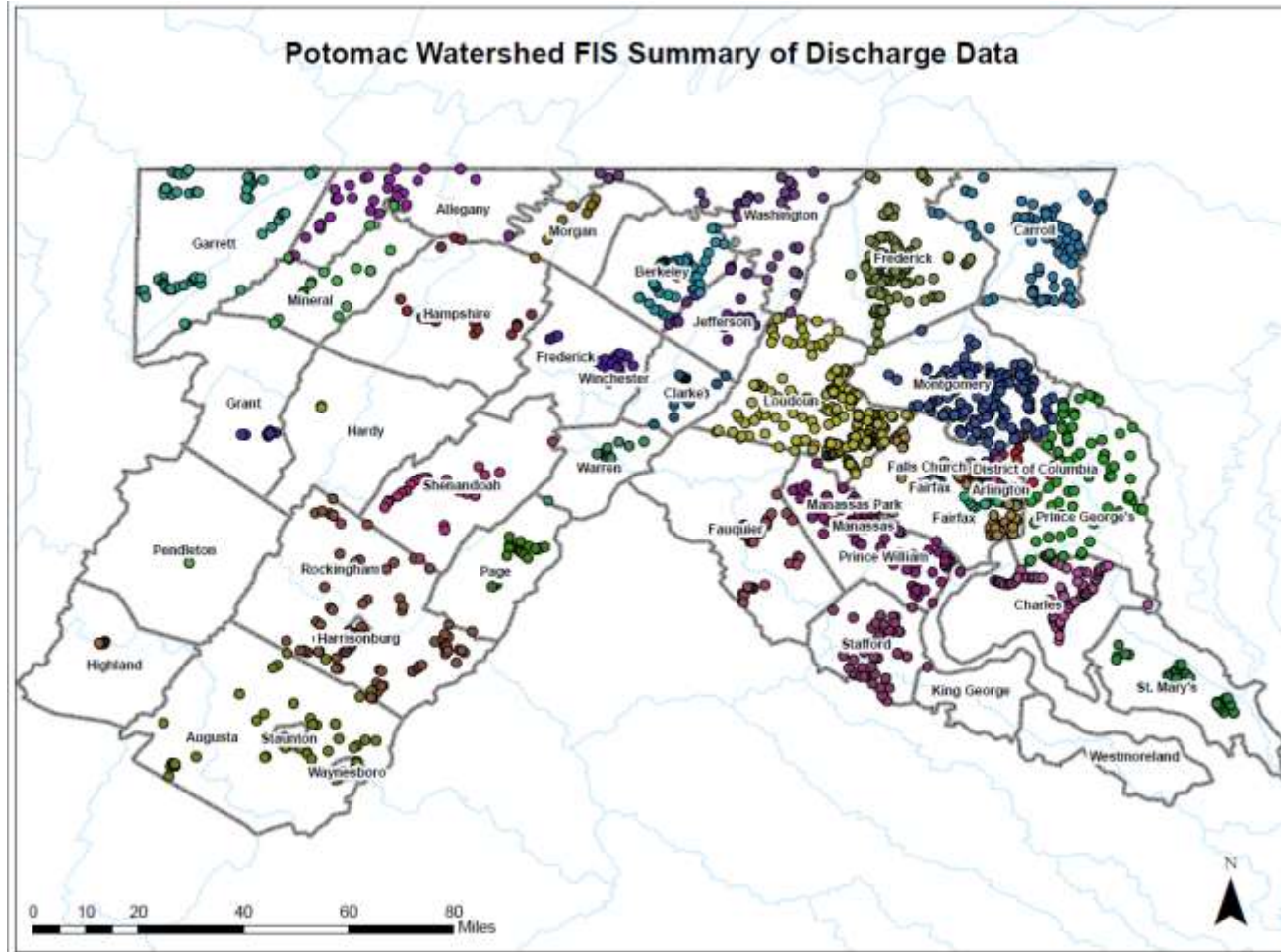
S_NODES - Review Point Placement

- Points don't always plot accurately
 - Data resolution, stream configuration differences, FIS errors, and limitation of tool
 - Coarser large-scale hydro-enforced datasets
 - In general, initial placement is good to excellent
- Visual review of plotted points
 - Using location description to verify “ballpark”
 - Manually adjust as needed
 - Points don't always fall within expected geography!
 - Enhanced investigations
 - Some set practices
 - “At confluence”

PA FIS Discharge Points (5,541 Points)



Potomac Watershed FIS Discharge Points (1,854 Points)



S_SUBBASIN Creation

- Use USGS StreamStats 'Batch Processing Tool' to delineate basins
 - Points must snap to USGS stream raster
 - Second DA check
- USGS data include:
 - Drainage basin shapefile (used for S_SUBBASIN)
 - Peak discharge rates (used for initial assessment)

The screenshot shows the 'StreamStats Batch Processing Tool' web interface. At the top, it says 'StreamStats Version 3.0'. Below that, there's a header 'StreamStats Batch Processing Tool'. A paragraph of text explains the tool's purpose: 'This tool produces shapefiles that contain the delineated basins, basin characteristics, and flow statistics for multiple sites requested at the points of interest will likely need to be edited in GIS so that they are coincident with the stream grid used by StreamStats for delineation and download the stream grid for your area of interest. The number of points in the shapefile generally should not exceed 200. Insert the interest below. The batch process will delineate the drainage areas and if checked, will compute basin characteristics, and/or estimate flow statistics for the selected points. The user will be notified by email where to pick up the results when they are done.' Below this text are several input fields: 'Local ID Field:' with a text box, 'State Abbrev:' with a dropdown menu, and 'Enter email Address for completion notification:' with a text box. There are three radio buttons: 'Delineate', 'Compute Basin Chars', and 'Compute Flow Stats'. Below these are two large empty text boxes. At the bottom, there's a section titled 'Select the # files to upload a shapefile' with four file selection buttons: '.SHP file', '.DBF file', '.PRJ file', and '.SHX file'. Each button has a 'Choose File' link and the text 'No file chosen'. There are also 'Help' and 'Submit to Queue' buttons.

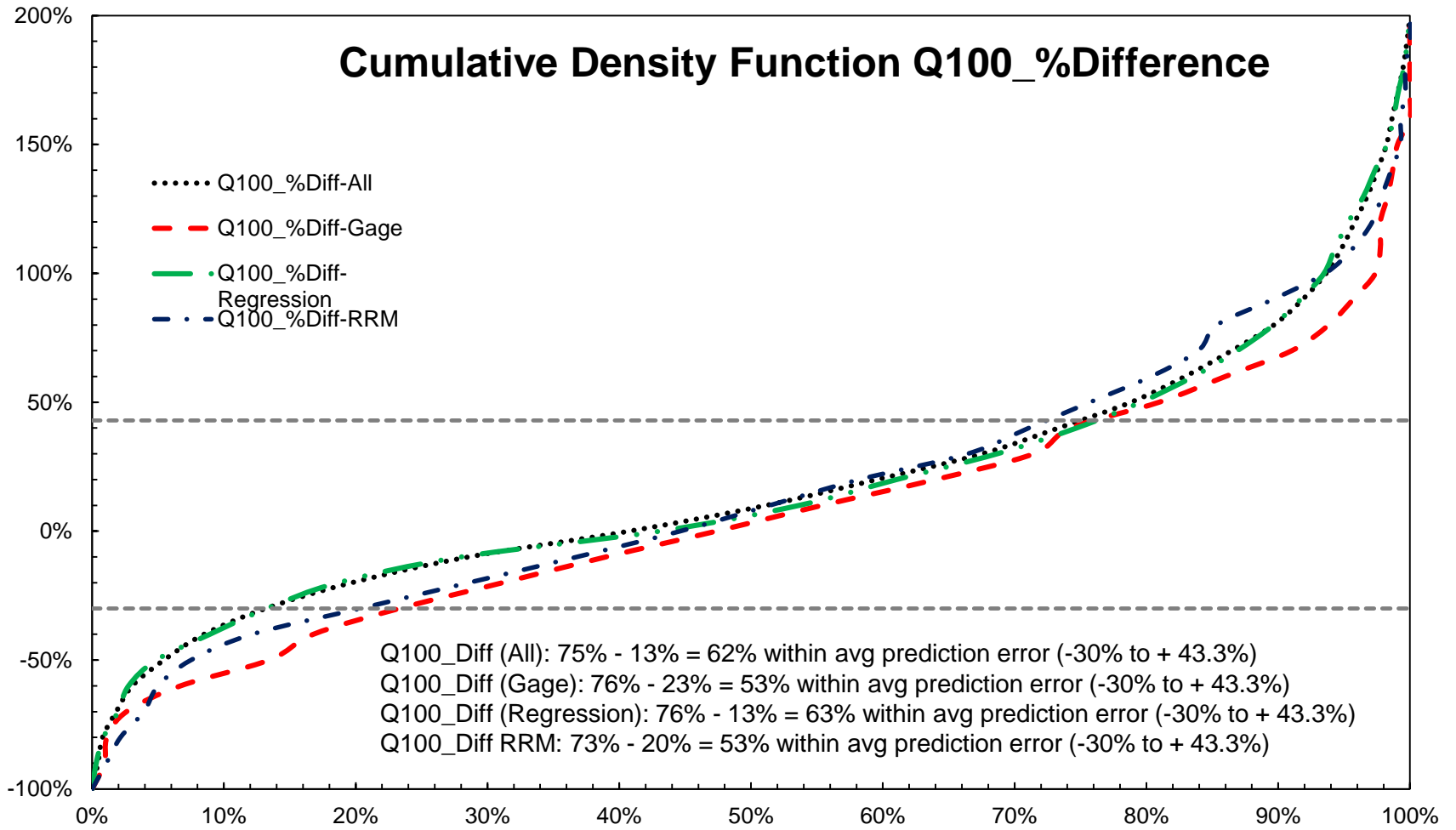
Final Review and Potential FIS Errors

- StreamStats DAs compare FIS DAs
 - Flagged for additional investigation when...
 - If DA < 1 mi² AND error is > 50%, check
 - If DA =< 10 mi² AND error is > 20%, check
 - If DA > 10 mi² AND error is > 10%, check
 - If flagged but correct, left per FIS location description and noted as potential FIS error
- FIS Error Report
 - Unexpected, flagged DAs
 - Misspellings, invalid references, missing data
 - Organized by county FIS, to be corrected as other planned updates are funded

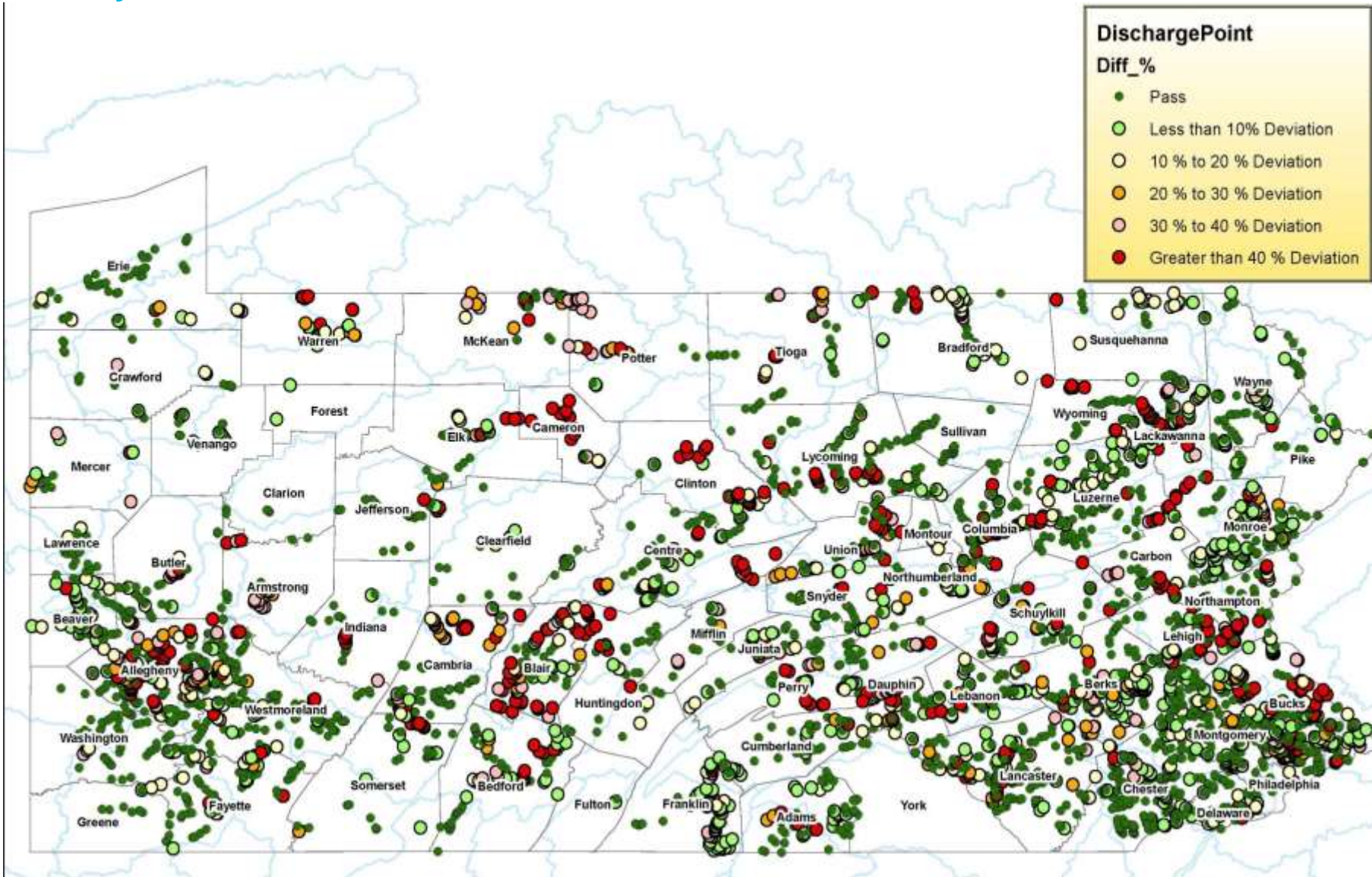
Data Analytics – Needs Assessment

- Conducted initial review of potential discharge validity in PA using USGS-derived peak flows
 - Derived original study approach from CNMS
 - Regression (42%)
 - Gage Analysis (11%)
 - Rainfall Runoff Model (6%)
 - Other or Unknown (41%)
- Expected range between -30% and +43% given regression equation average prediction error
 - Falling outside range does not mean error!

Cumulative Density Plot



Q_{100-yr} Comparison Map



Drainage Area Influence

- In general, the percentage of points that fall within tolerance increases slightly as drainage area difference between FIS and USGS decreases

| Draianage Area Difference Tolerance | Total Discharge Points | Points Within Prediction Error | Passing Rate |
|-------------------------------------|------------------------|--------------------------------|--------------|
| ±36% | 4828 | 3014 | 62.42% |
| ±10% | 4192 | 2652 | 63.26% |
| ±5% | 3640 | 2321 | 63.76% |
| ±1% | 2050 | 1316 | 64.19% |

- The percentage of points that fall within tolerance was greatest amongst discharge points with drainage areas in between 10 mi² and 100 mi²

| Draianage Area Range (mi ²) | Total Discharge Points | Points Within Prediction Error | Passing Rate |
|---|------------------------|--------------------------------|--------------|
| <1 | 280 | 157 | 56.07% |
| 1 to 10 | 1970 | 1144 | 58.07% |
| 10 to 100 | 1783 | 1226 | 68.76% |
| >100 | 802 | 491 | 61.22% |

Further Investigation

- Lehigh HUC-8 Watershed
 - Ongoing FEMA Discovery project
 - 223 total discharge points
 - 57% in expected range (95 points are outside of tolerance)
 - 43% valid when out of expected range

| Status | Total Points | CNMS Status | |
|-----------------------|--------------|-------------|------------|
| | | Valid | Unverified |
| In Expected Range | 128 | 81 | 47 |
| Out of Expected Range | 95 | 41 | 54 |

Further Investigation (Cont'd)

- Investigated the hydrologic method applied to each flooding source per FIS
 - Generally, newer studies tended to be within the tolerance
 - Older studies and methods had sporadic results

| County | STREAM | Method | P or F |
|--------|-----------------------------|---|--------|
| BERKS | LITTLE LEHIGH CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Pass |
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| BERKS | LITTLE LEHIGH CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Pass |
| BERKS | SWABIA CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Fail |
| BERKS | TOAD CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Pass |
| BERKS | TOAD CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Pass |
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| BERKS | TOAD CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Fail |
| BERKS | TRIBUTARY A TO SWABIA CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Fail |
| BERKS | TRIBUTARY B TO SWABIA CREEK | Reginal Regression Equation developed in USGS Water_resources Investigation 82-21, 1982 | Fail |

Potential Reasons for Difference

- Different hydrology methods
 - Regression, Gage, Rainfall Runoff, Rational Method, Others
- Currency of study
 - Republication of older studies (1970s et al)
 - Availability of additional gage record
- Other factors
 - Land Use
 - Urbanization
 - Mining
 - Karst

Next Steps

- Data loaded to NFHL as FISs are updated
 - Cost-efficiency for FEMA
- Remaining Region III data to be compiled in 2017
- Further pilot applications and use
 - Evaluating use for needs assessment during Discovery meetings to be held summer 2017
 - Discuss applications with CNMS team
 - Further refinement of data analysis approach
 - Similar to Lehigh watershed, focus on one county
 - Additional stratification of analysis, other data inputs to further refine assessment



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