GISHYDRO: Developing Discharges and Watershed Parameters

A Case Study with Baltimore City Watersheds

by

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Baltimore City Watershed Study

- Conducted for City of Baltimore, MD
- Cooperating Technical Partner (CTP) agreement with FEMA
- H&H Analysis reviewed & approved by USACE

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Scope

- The scope involved detailed H&H analysis of four major streams in the City and the remaining streams were studied by approximate analysis (Zone A)
  - Gywnns' Falls, including Maiden's Choice Run
  - Jones Falls
  - Herring Run & Tributary to Herring Run

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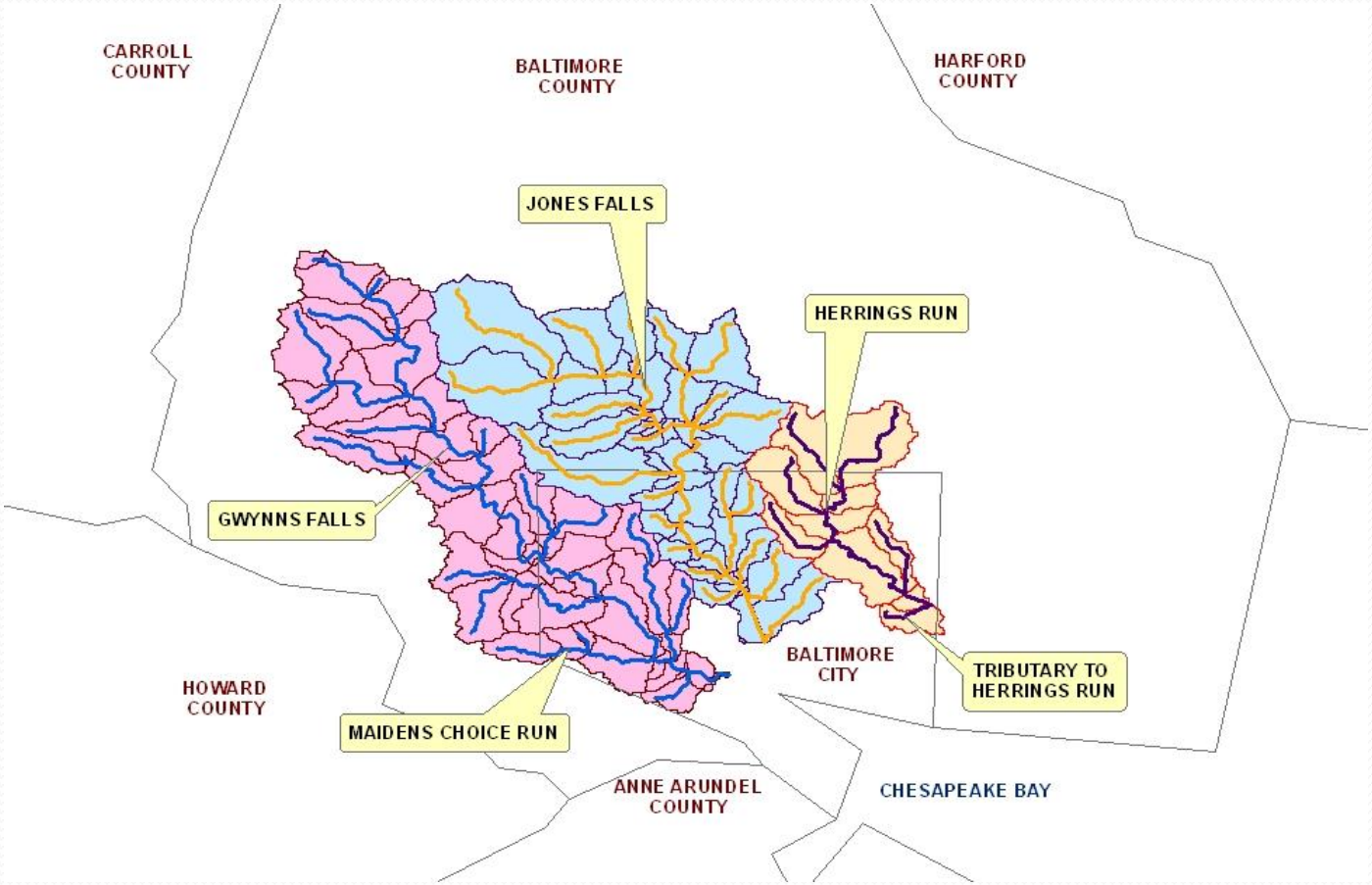
Location of the Study Area



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Choice of Hydrologic Methodology

HEC-HMS/ GISHYDRO

- Jones Falls
- Gwynns Falls (includes Maidens' Choice Run)

GISHydro Regression Equations

- Herring Run
- Tributary to Herring Run

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GISHYDRO 2000

- A GIS-based program for performing hydrologic analysis
  - Developed by State Highway Administration in cooperation with UMD
- Arc-view based platform, and it consists of large database of hydrologic layers.
  - Complete databases for DEM, Land use, and soils data for Maryland.
  - Develops stream network, watershed boundaries
- Computes peak discharges
  - USGS regional regression equations
  - Fixed Region Equations
- TR-20 input data generation
  - Sub-basin development
  - Curve Number, Tc, reservoir/ reach routing

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Herrings Run and Tributary

- Herring Run
  - Originates near Towson
  - Flows Southerly direction
  - Joins Black River and into Chesapeake Bay
- Tributary to Herrings' Run
  - Flows easterly direction
  - Less than 1 sq. mi.
  - Joins Herrings Run near mouth

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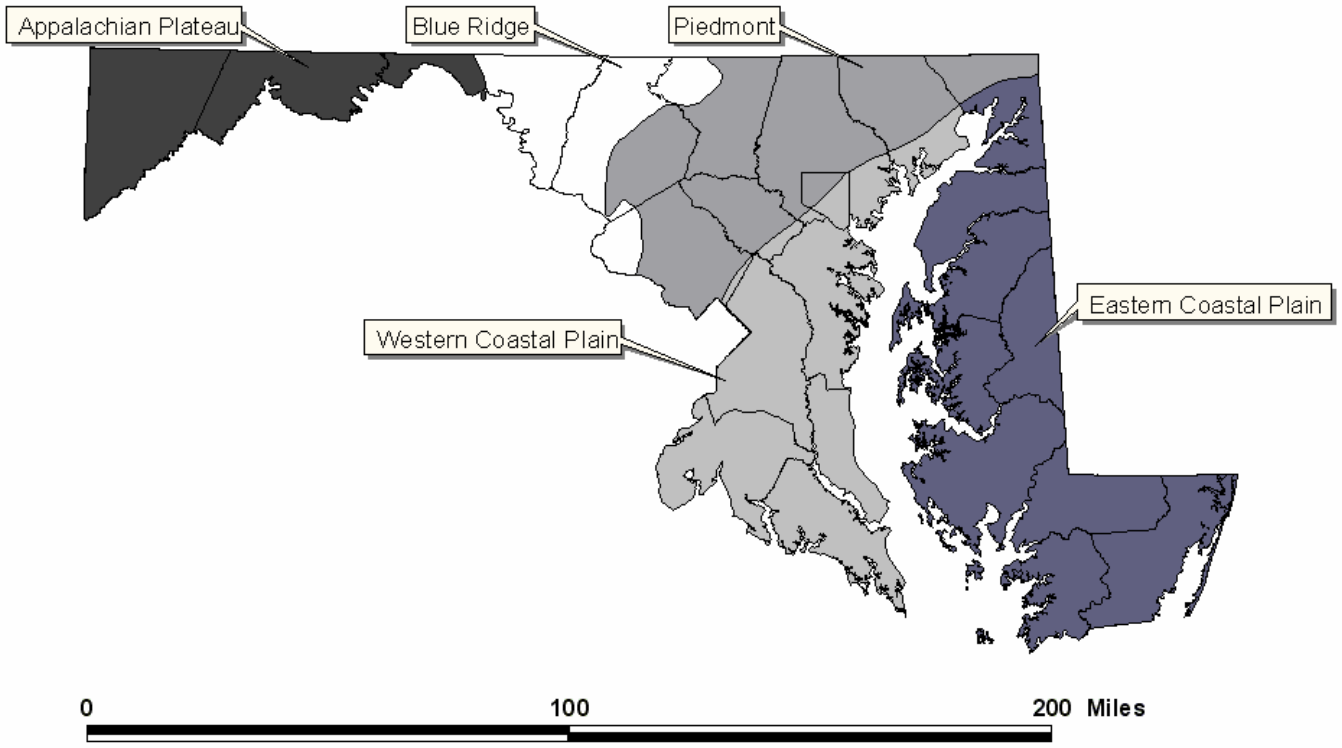
Fixed Region Equations

- Developed by MD State Highway Administration in collaboration with University of Maryland
- Recommended for ungaged MD watersheds
- Supersedes 1996 USGS Equations
- Accepted for Flood Insurance Studies
- Applicable for Urban watersheds
- Five Hydrologic Regions: Appalachian Plateau, Blue Ridge, Piedmont, Western Coastal Plain, Eastern Coastal Plain

Hydrologic Regions



Source: GISHydro Manual

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Herrings Run

- Piedmont Region
- Drainage Area
- Percentage imperviousness
- Discharges by GISHYDRO
  - Select the discharge locations
  - Watershed parameters and discharges computed
  - Time saved on collecting topographic and land use information

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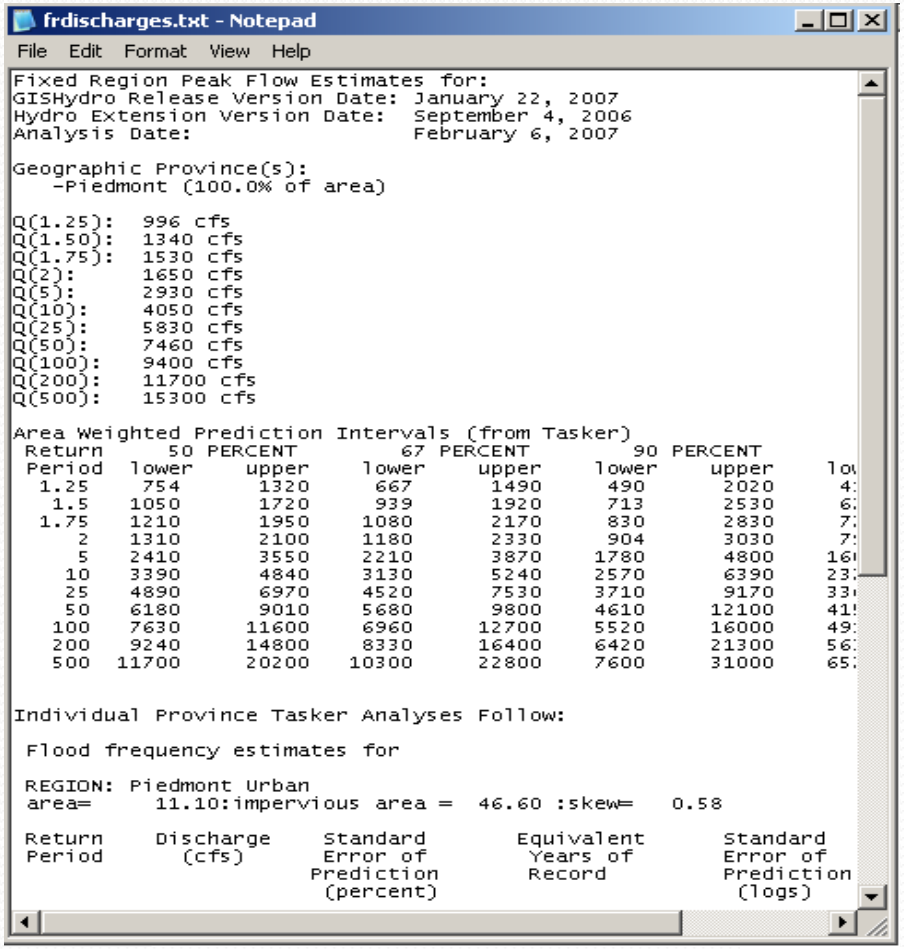
Herrings Run: Sample Output



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Fixed Region Peak Flow Estimates for:
GISHydro Release Version Date: January 22, 2007
Hydro Extension Version Date:  September 4, 2006
Analysis Date:                 February 6, 2007

Geographic Province(s):
   -Piedmont (100.0% of area)

Q(1.25):   996 cfs
Q(1.50):   1340 cfs
Q(1.75):   1530 cfs
Q(2):      1650 cfs
Q(5):      2930 cfs
Q(10):     4050 cfs
Q(25):     5830 cfs
Q(50):     7460 cfs
Q(100):    9400 cfs
Q(200):    11700 cfs
Q(500):    15300 cfs

Area Weighted Prediction Intervals (from Tasker)
 Return      50 PERCENT          67 PERCENT          90 PERCENT
 Period   lower    upper      lower    upper      lower    upper     lo
   1.25     754     1320        667     1490        490     2020      4
    1.5    1050     1720        939     1920        713     2530      6
   1.75    1210     1950       1080     2170        830     2830      7
      2    1310     2100       1180     2330        904     3030      7
      5    2410     3550       2210     3870       1780     4800     16
     10    3390     4840       3130     5240       2570     6390     23
     25    4890     6970       4520     7530       3710     9170     33
     50    6180     9010       5680     9800       4610    12100     41
    100    7630    11600       6960    12700       5520    16000     49
    200    9240    14800       8330    16400       6420    21300     56
    500   11700    20200      10300    22800       7600    31000     65

Individual Province Tasker Analyses Follow:

 Flood frequency estimates for

 REGION: Piedmont Urban
 area=     11.10:impervious area =  46.60 :skew=   0.58

 Return     Discharge     Standard       Equivalent      Standard
 Period       (cfs)       Error of        Years of       Error of
                         Prediction       Record        Prediction
                          (percent)                       (logs)
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Watershed Modeling -GISHYDRO

- GISHYDRO generates watershed parameters
  - Watershed and sub-basin boundaries
  - Drainage Areas, Time of concentration, and curve numbers, lag time.
  - Reach routing parameters suitable for TR-20.
  - Develops necessary input data for TR-20 model
- Data used in HEC-HMS model

Jones Falls/ Gwynns Falls

- Watershed Development
- Parameter Development
- Developing HEC-HMS Input Dataset
- Calibrating the HEC-HMS model
- Developing Peak discharges

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HEC-HMS Model Development

- Delineate Watershed and sub-basins using GISHYDRO
- GISHYDRO- Time of concentration, curve number, reach-routing parameters computed by GISHYDRO
- Watershed parameters incorporated into HEC-HMS dataset

Parameters used in HMS

- Sub-basins
  - SCS Curve Number used as loss method
- Reaches connecting the junctions
  - Muskingum-Cunge reach routing used
  - Cross-sections from GIShydro
- Areas, curve numbers, initial abstraction, & impervious cover obtained from GISHYDRO

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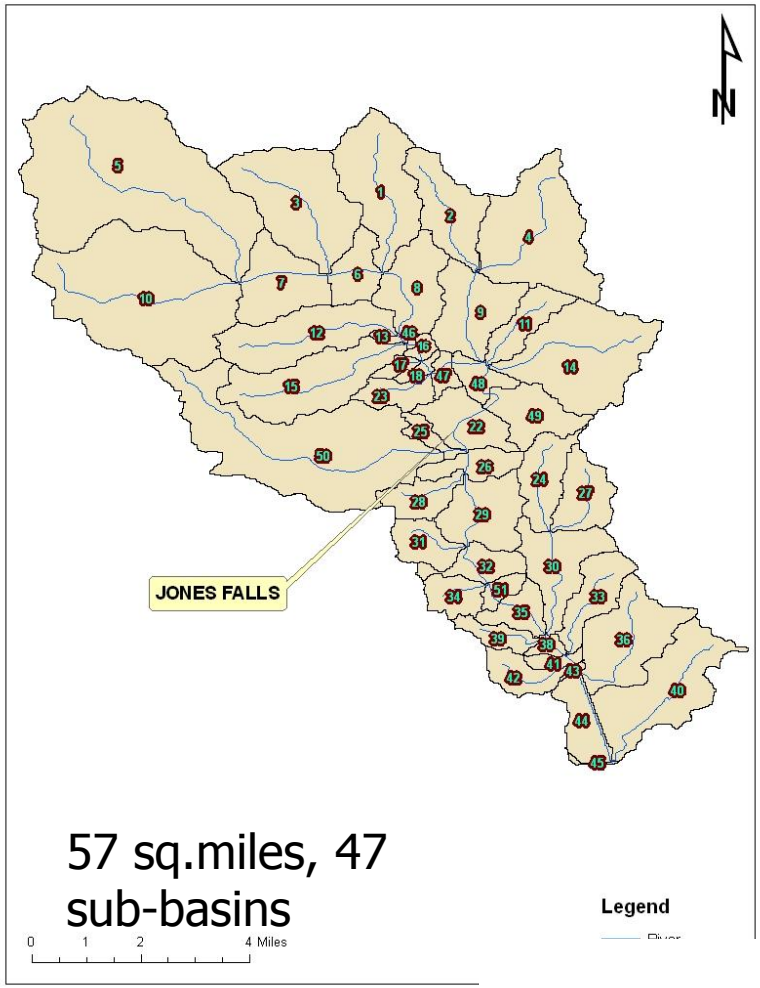
Subwatersheds –Gywnns Falls

Subwatersheds- Jones Falls



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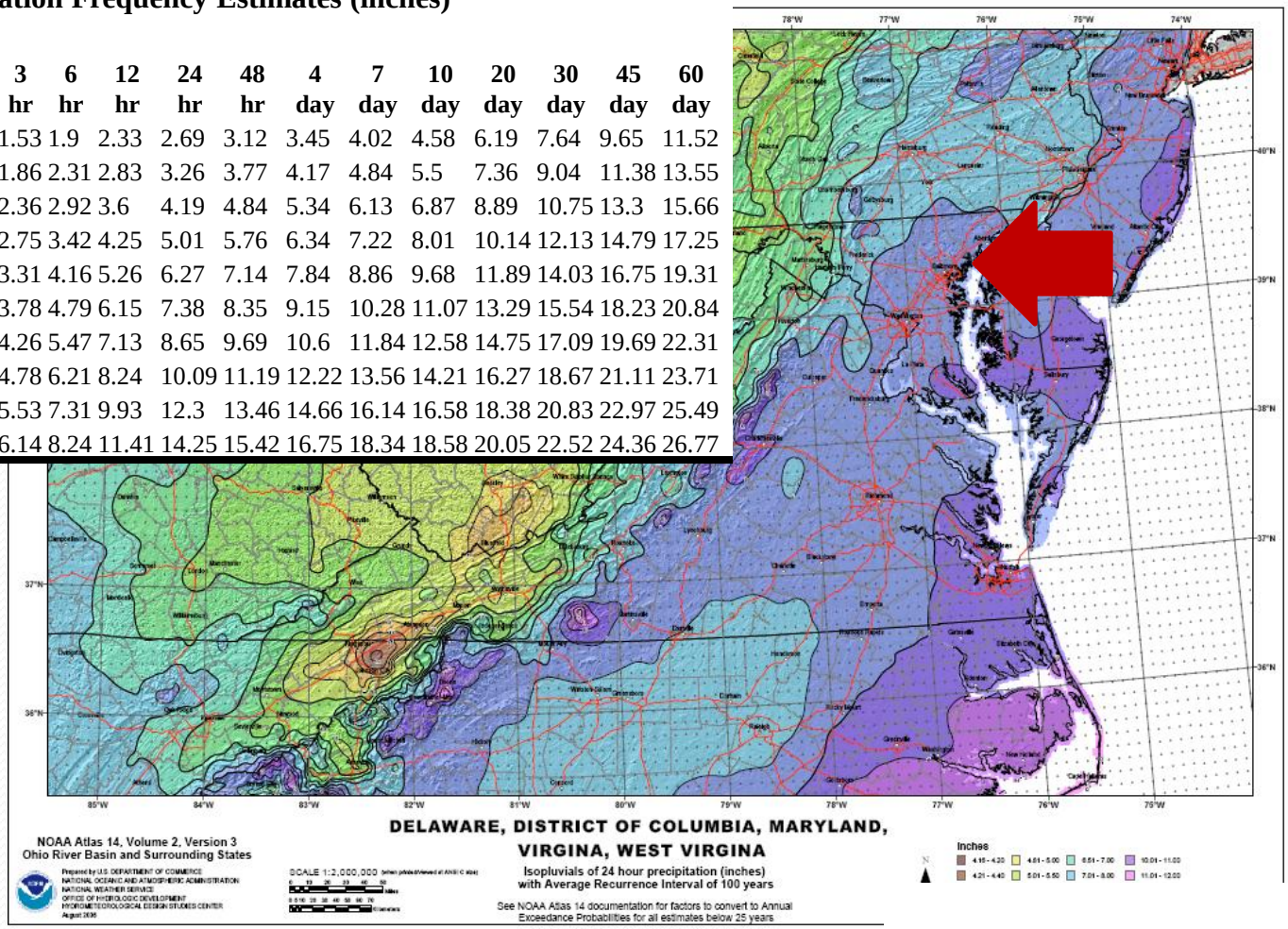
Rainfall from Atlas 14

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.35	0.55	0.69	0.95	1.18	1.42	1.53	1.9	2.33	2.69	3.12	3.45	4.02	4.58	6.19	7.64	9.65	11.52
2	0.41	0.66	0.83	1.15	1.45	1.73	1.86	2.31	2.83	3.26	3.77	4.17	4.84	5.5	7.36	9.04	11.38	13.55
5	0.49	0.79	1	1.42	1.82	2.19	2.36	2.92	3.6	4.19	4.84	5.34	6.13	6.87	8.89	10.75	13.3	15.66
10	0.55	0.88	1.11	1.61	2.1	2.54	2.75	3.42	4.25	5.01	5.76	6.34	7.22	8.01	10.14	12.13	14.79	17.25
25	0.62	0.99	1.26	1.86	2.48	3.04	3.31	4.16	5.26	6.27	7.14	7.84	8.86	9.68	11.89	14.03	16.75	19.31
50	0.67	1.07	1.36	2.05	2.77	3.44	3.78	4.79	6.15	7.38	8.35	9.15	10.28	11.07	13.29	15.54	18.23	20.84
100	0.73	1.15	1.46	2.23	3.08	3.87	4.26	5.47	7.13	8.65	9.69	10.6	11.84	12.58	14.75	17.09	19.69	22.31
200	0.78	1.23	1.55	2.41	3.38	4.32	4.78	6.21	8.24	10.09	11.19	12.22	13.56	14.21	16.27	18.67	21.11	23.71
500	0.84	1.32	1.67	2.65	3.8	4.95	5.53	7.31	9.93	12.3	13.46	14.66	16.14	16.58	18.38	20.83	22.97	25.49
1000	0.89	1.39	1.75	2.83	4.13	5.46	6.14	8.24	11.41	14.25	15.42	16.75	18.34	18.58	20.05	22.52	24.36	26.77



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Frequencies

- Discharges were computed for 10,50, 100 and 500 yr flood events
- In addition, 2004 flood event was also used to check the results obtained

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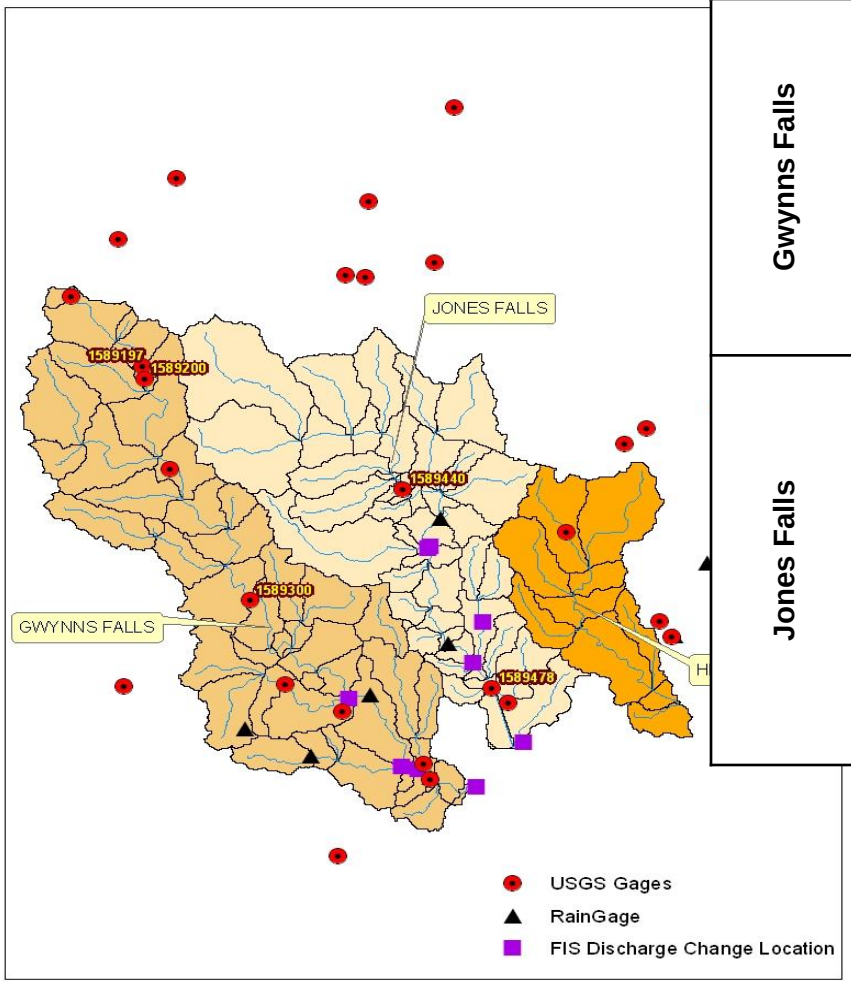
USGS gages used for Calibration



Streams	USGS Gage ID	Gage Description	Drainage Area (Sq.Mi)	From	To	No. of Years
Gwynns Falls	1589180	Glyndon	0.32	8/26/1999	7/8/2005	7
	1589197	Near Delight	4.23	7/22/1999	7/8/2005	7
	1589200	Owings Mills	4.9	9/2/1959	9/26/1975	17
	1589300	Villa Nova	32.5	7/21/1956	7/7/2004	41
	1589352	Baltimore-Washington Blvd.	65.9	8/26/1999	6/25/2006	8
Jones Falls	1589440	Jones Falls at Sorrento, MD	25.2	1/25/1958	1/14/2005	40
	1589478	Jones Falls at MD Ave in Baltimore, MD	58.3	6/25/1981	7/7/2004	7
	1589480	Jones Falls Near Mouth in Baltimore, MD	60.4	6/25/1981	6/27/1982	2

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Calibration for 2004 flood event

- Using the ppt recorded at the gages, simulated hydrograph was generated using the input parameters.
- Observed hydrograph was generated at gage locations using the gage records obtained from www.usgs.gov
- The simulated and observed hydrographs were plotted and compared against to check the simulated results

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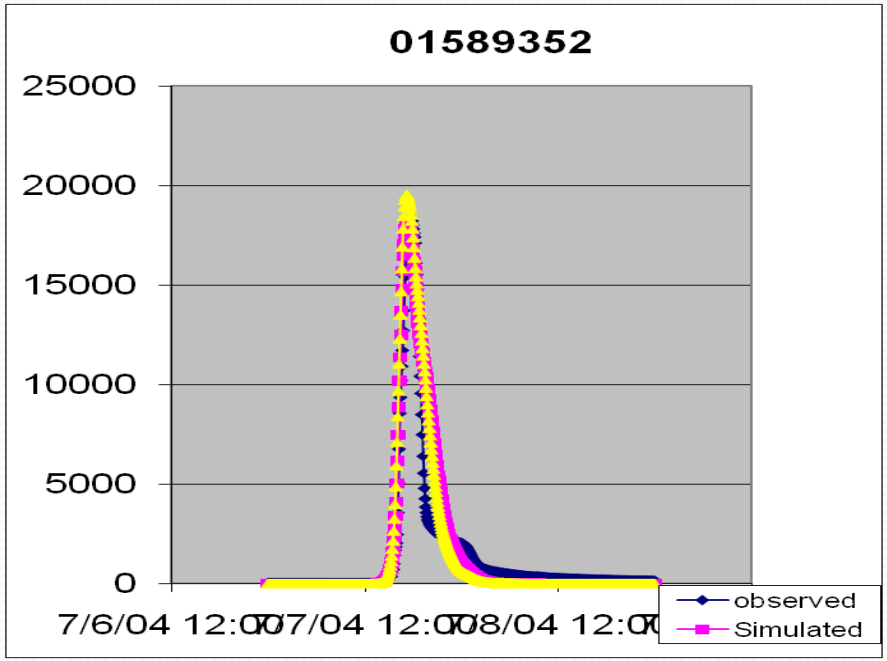
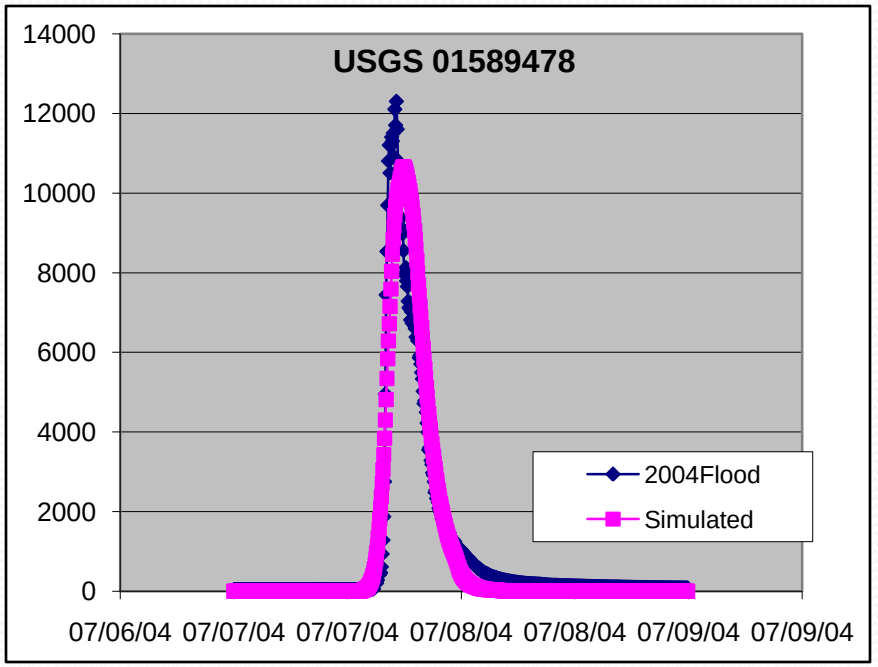
Results of calibration

Gywnns Falls
USGS 01589352, At Washington Blvd



Jones Falls
USGS 01589478, at Maryland Ave



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Summary

- GISHYDRO
  - Includes Basic Datasets necessary for discharge development
  - Fixed Regions Equations applicable to urban watersheds
  - Ease of developing TR-20 model
  - Watershed parameters can be transferred to other watershed models

Summary

- GIS HYDRO Wish List
  - Discharges computed one by one, Discharge locations taken from a shapefile and computations done at the same time.
  - Moving to Arc GIS platform would be useful.
  - Option to incorporate more recent data sets that those in-built in GISHYDRO

Questions??