District of Columbia

Water and Sewer Authority

Mail-out on

Potomac Interceptor Flow Capacity Assessment

For:

Blue Plains IMA Negotiating Team

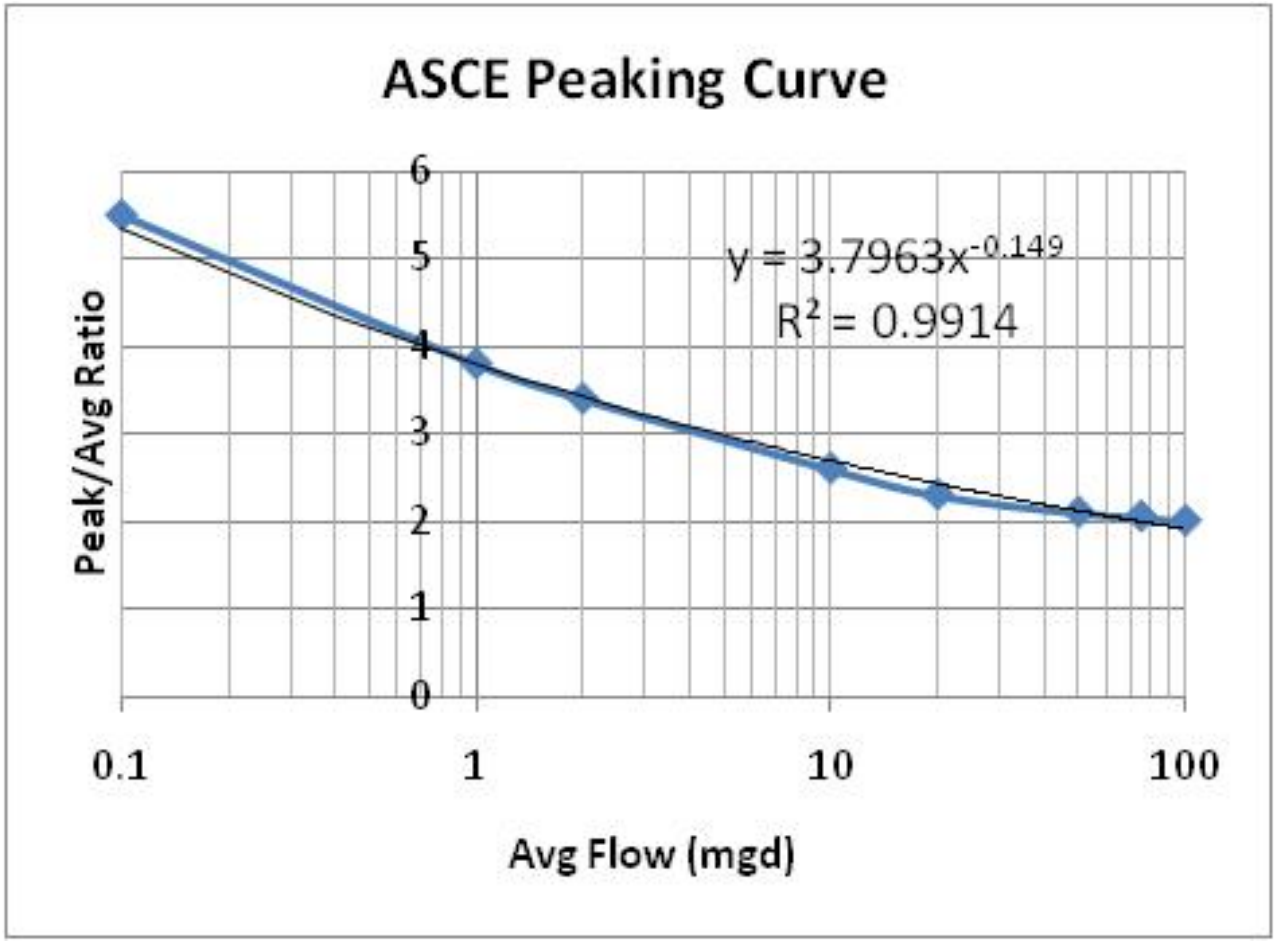
Operating Agency Work Group

March 26, 2010

Outline

- ASCE peaking factor vs. average flow
- Review of historical WSSC & Fairfax peaks to PI
- Overflow records for PI
- Timing of Peak Flows Delivered to PI
- Conclusions
- Options for Peak flow Limits

ASCE and Others Have Developed Peaking Factor vs. Avg Flow Curves



Source: *Gravity Sanitary Sewer Design*, ASCE, 1982, Page 40

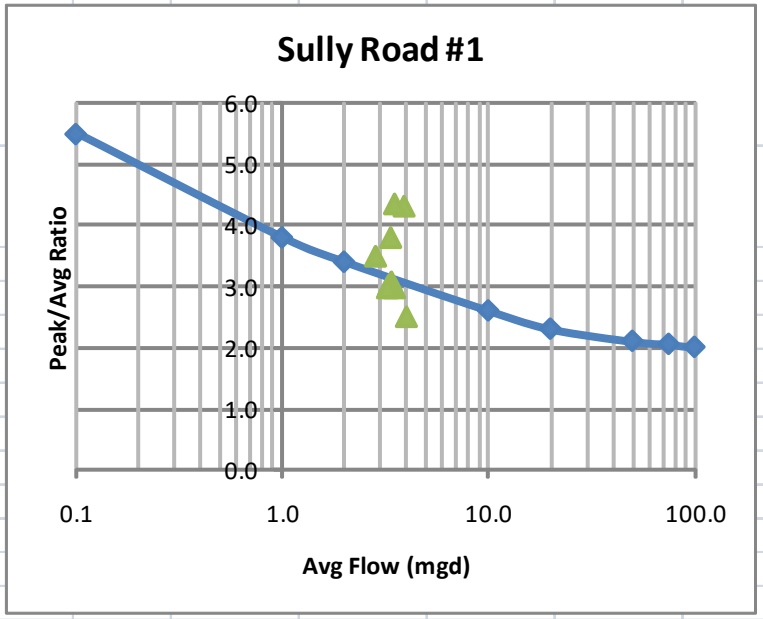
Review of Historical WSSC & Fairfax Peaks to PI

- Reason for review:
  - We had been focusing on the max observed peak for each point of connection
  - Concerned about accuracy of using one data point
  - Better to look at range of data

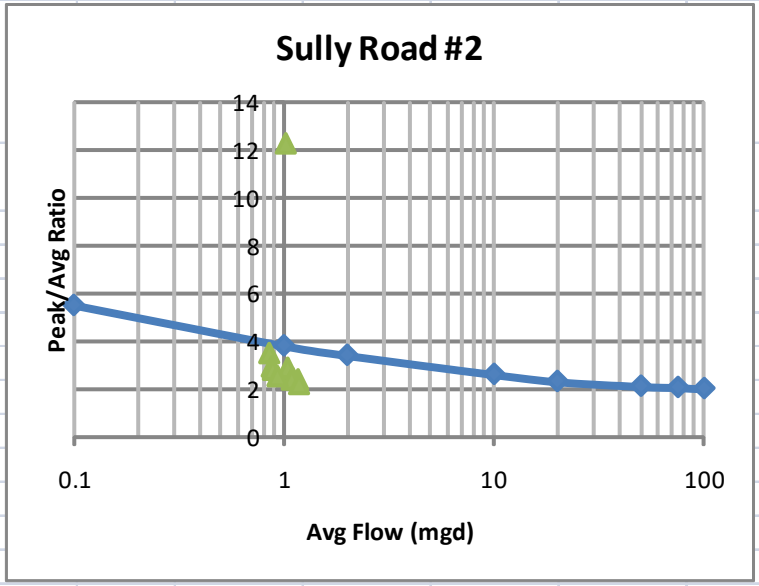
- Reviewed data from Oct 1997 to Dec 2009 and plotted peaks vs. ASCE curve

Fairfax Data – Sully Road #1 and #2

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Sully Road #1	IMA	4.00	9.20	2.3		
	Top 10 Observed					
	May-08	3.9	16.7	4.3		
	Feb-03	3.5	15.2	4.3		
	Jun-06	3.4	12.7	3.8		
	Dec-03	3.5	10.4	3.0		
	May-09	3.4	10.4	3.1		
	Feb-98	3.4	10.3	3.1		
	Dec-09	4.0	10.0	2.5		
	Oct-05	2.8	9.9	3.5		
	Apr-08	3.3	9.9	3.0		
	Jan-03	3.2	9.6	3.0		

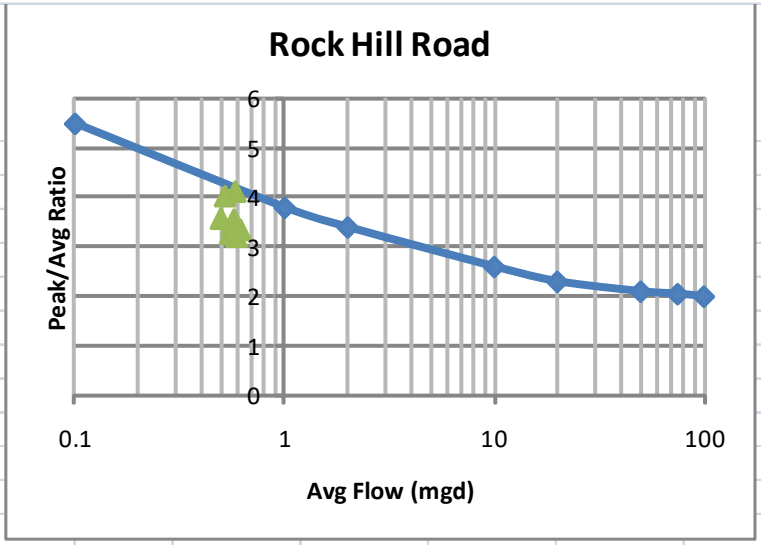


Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Sully Road #2	IMA	1.1	2.10	1.9		
	Top 10 Observed					
	Jun-06	1.0	12.5	12.3		
	Sep-08	1.0	3.0	2.9		
	Jul-04	0.8	3.0	3.5		
	May-09	1.2	2.8	2.4		
	May-08	1.1	2.7	2.5		
	Jul-09	1.1	2.6	2.4		
	Dec-09	1.2	2.6	2.2		
	Feb-03	0.9	2.6	2.9		
	Jul-05	0.9	2.5	2.8		
	Apr-06	0.9	2.3	2.5		

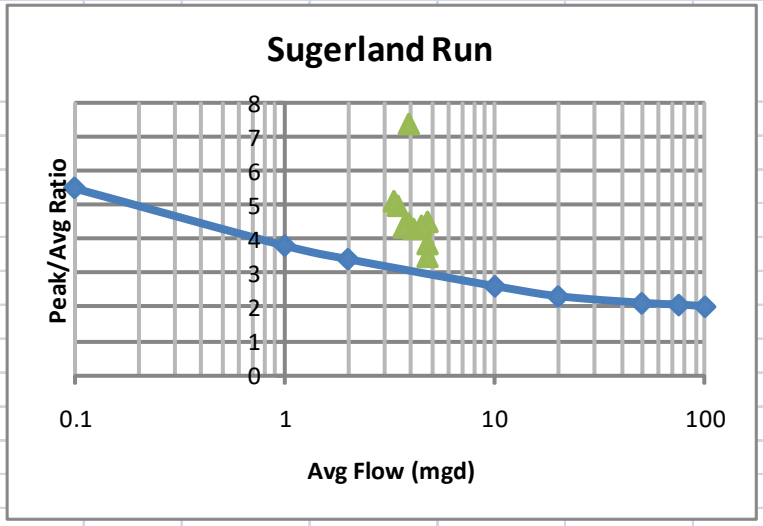


Fairfax Data – Rock Hill Road & Sugerland Run

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Rock Hill Road	IMA	0.90	2.30	2.6		
	Top 10 Observed					
	Feb-03	0.6	2.4	4.1		
	Sep-08	0.5	2.1	4.0		
	Jul-05	0.6	2.1	3.3		
	Jun-06	0.6	2.0	3.5		
	Apr-06	0.6	1.9	3.4		
	Mar-05	0.6	1.9	3.4		
	May-08	0.6	1.9	3.3		
	Oct-05	0.6	1.9	3.2		
	Apr-07	0.6	1.8	3.2		
	Jan-03	0.5	1.8	3.6		

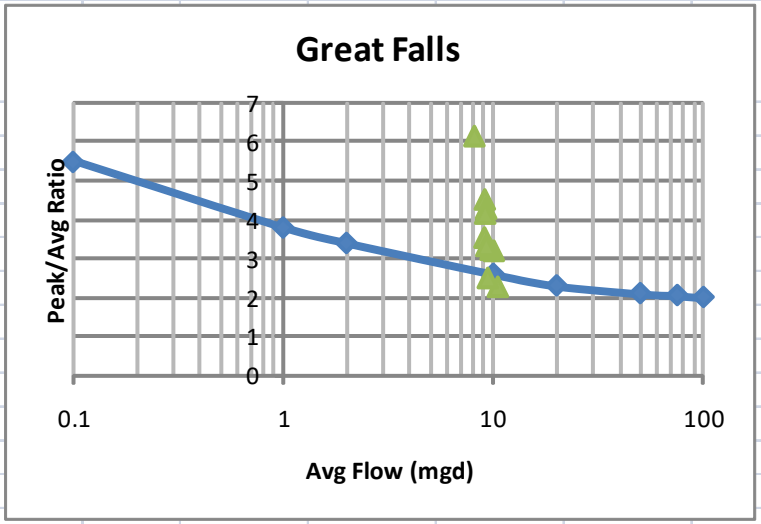


Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Sugerland Run	IMA	4.00	12.00	3.0		
	Top 10 Observed					
	Feb-03	3.9	28.4	7.3		
	May-08	4.8	21.4	4.5		
	Mar-98	4.5	19.5	4.4		
	Feb-98	4.8	18.3	3.8		
	Jan-98	4.1	17.4	4.3		
	Jul-05	3.9	17.2	4.4		
	Jan-03	3.4	17.0	5.0		
	Jun-06	3.3	16.7	5.1		
	Jun-03	4.8	16.5	3.5		
	Sep-03	3.7	15.8	4.3		

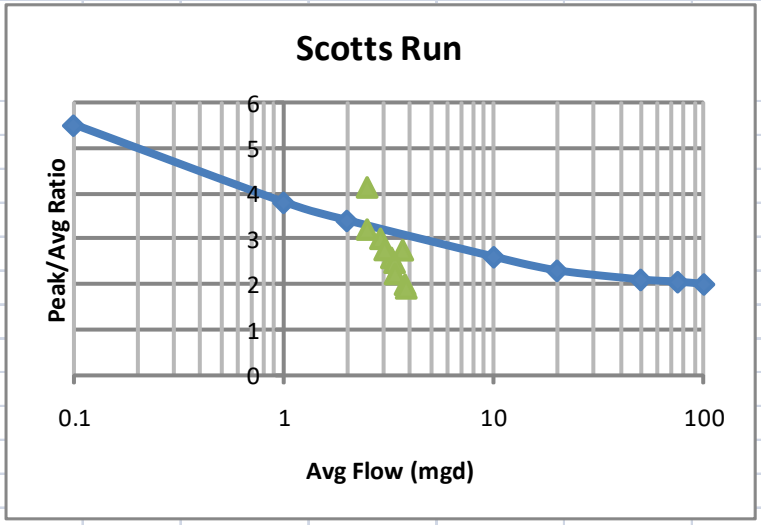


Fairfax Data – Great Falls & Scotts Run

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Great Falls	IMA	8.70	22.50	2.6		
	Top 10 Observed					
	Aug-01	8.0	49.3	6.1		
	Jun-06	9.0	40.7	4.5		
	Sep-08	9.2	39.2	4.3		
	Jun-01	9.1	37.7	4.2		
	Jun-03	10.0	31.9	3.2		
	May-01	9.0	31.8	3.5		
	Feb-03	9.6	31.1	3.2		
	Sep-03	9.2	30.5	3.3		
	Dec-09	10.4	23.8	2.3		
	Dec-03	9.3	23.4	2.5		

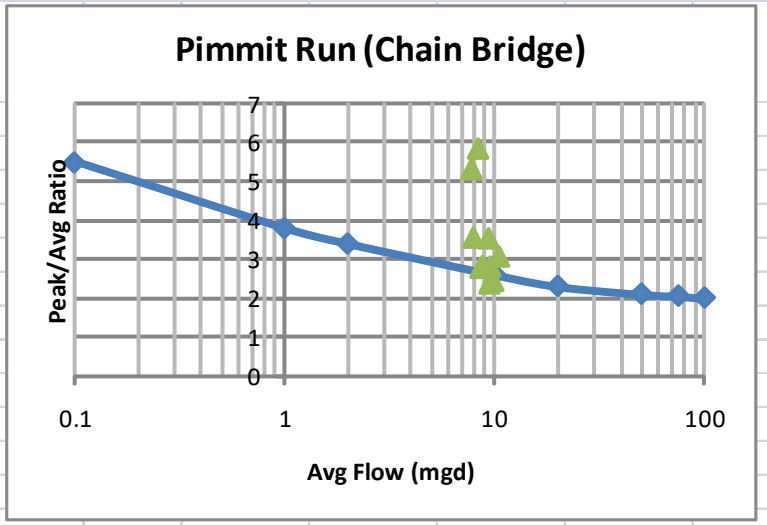


Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Scotts Run	IMA	2.90	9.40	3.2		
	Top 10 Observed					
	Sep-08	2.5	10.2	4.1		
	Aug-01	3.6	10.0	2.7		
	Jun-06	2.9	8.6	3.0		
	May-98	3.2	8.3	2.6		
	Dec-98	3.3	8.2	2.5		
	Feb-03	3.0	8.2	2.7		
	Jul-04	2.5	7.9	3.2		
	Jul-03	3.4	7.4	2.2		
	May-99	3.7	7.4	2.0		
	Jun-99	3.8	7.2	1.9		



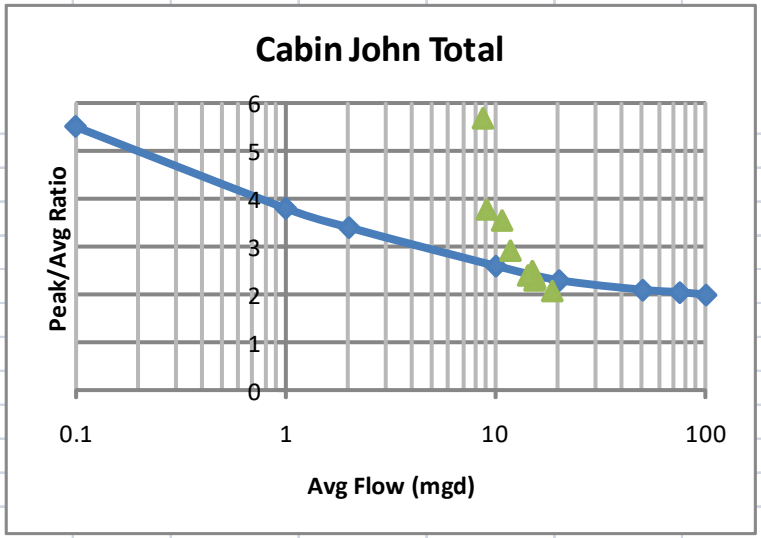
Fairfax Data – Pimmit Run (Chain Bridge)

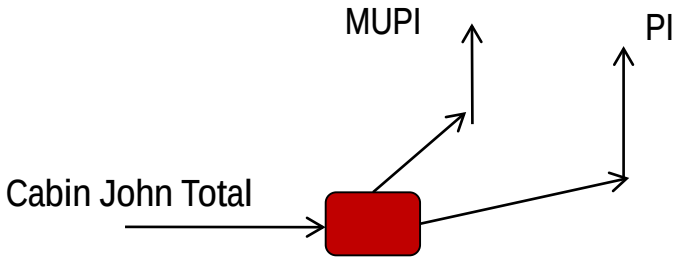
Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio		
Pimmit Run (Chain Bridge)	IMA	9.40	23.60	2.5		
	Top 10 Observed					
	Sep-08	8.3	48.6	5.9		
	Jun-06	7.7	41.1	5.3		
	Nov-06	9.3	33.0	3.5		
	May-08	10.5	32.0	3.1		
	Jul-04	7.9	27.9	3.6		
	Jun-08	9.5	26.6	2.8		
	Mar-05	8.7	24.6	2.8		
	Apr-07	9.8	23.9	2.4		
	Mar-08	8.5	23.6	2.8		
	Apr-05	9.4	22.2	2.4		



WSSC Data – Cabin John Total

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio	WSSC Model 2-yr Peak	WSSC Model 10-yr Peak
Cabin John Total	IMA	11.00	48.30	4.4	NA	57.50
	Top 10 Observed					
	Sep-08	8.8	50.1	5.7		
	Dec-03	18.9	39.2	2.1		
	Oct-99	10.9	38.6	3.5		
	May-08	15.2	37.8	2.5		
	Dec-09	15.4	37.3	2.4		
	Mar-98	15.7	36.7	2.3		
	Apr-05	15.5	35.7	2.3		
	Oct-05	11.9	34.8	2.9		
	Mar-05	14.5	34.8	2.4		
	Jan-98	9.2	34.7	3.8		

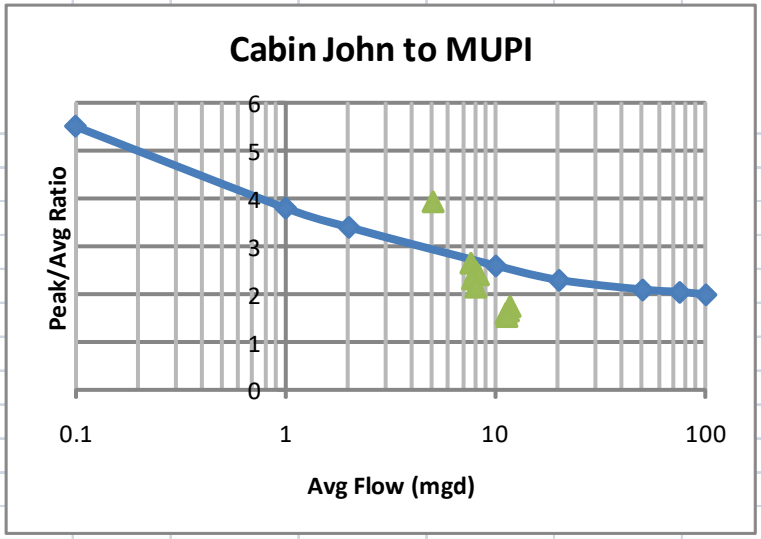




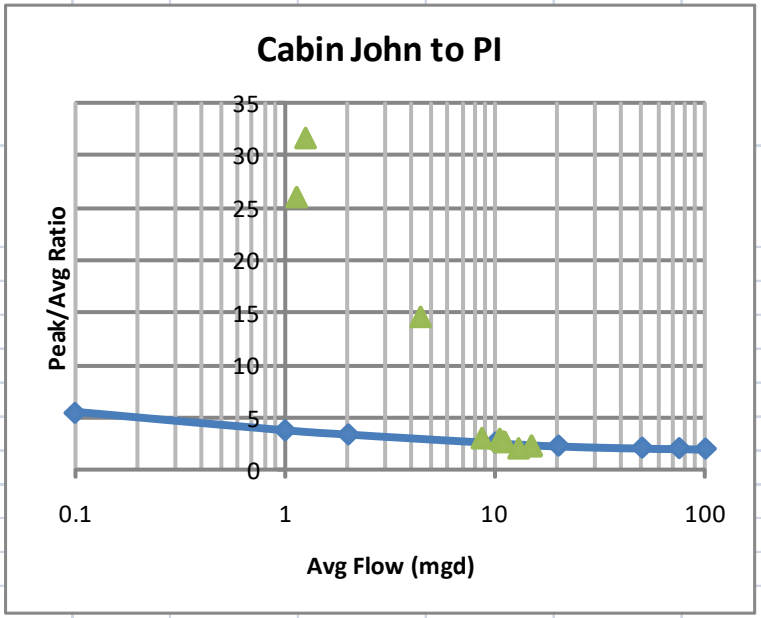
WSSC Data – Cabin John to MUPI and PI

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio	WSSC Model 2-yr Peak	WSSC Model 10-yr Peak
Cabin John 1 to MUPI	IMA	10.30	23.30	2.3	NA	13.40
	Top 10 Observed					
	Mar-05	11.698	20.450	1.7		
	Sep-08	7.663	20.300	2.6		
	Oct-99	5.097	20.000	3.9		
	Nov-99	8.072	20.000	2.5		
	Jan-09	8.312	20.000	2.4		
	Jan-05	11.495	19.050	1.7		
	Feb-09	7.796	18.100	2.3		
	Dec-04	11.196	17.970	1.6		
	Dec-09	11.300	17.400	1.5		
	Jun-06	8.078	17.380	2.2		

Note: Alot of missing data - not representative

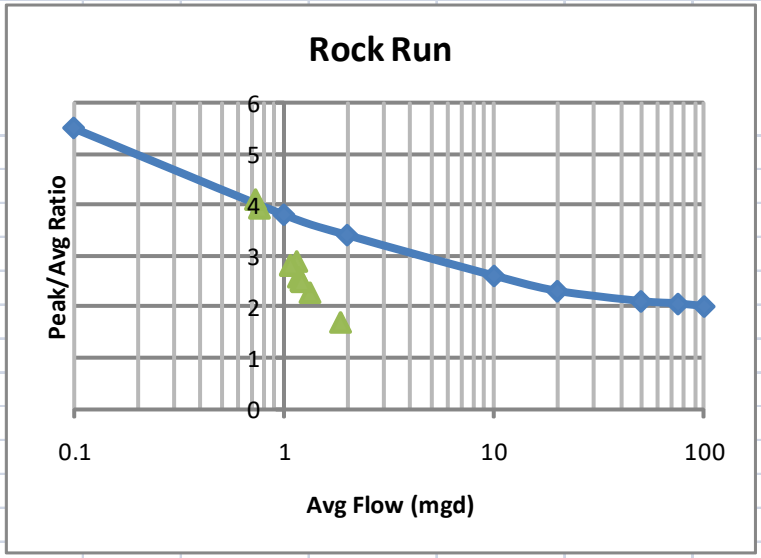


Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio	WSSC Model 2-yr Peak	WSSC Model 10-yr Peak
Cabin John 2 to PI	IMA	0.70	25.00	35.7	32.3	44.10
	Top 10 Observed					
	Feb-03	4.4	64.4	14.5		
	Feb-02	1.3	40.0	31.5		
	Mar-98	14.9	33.3	2.2		
	Jun-03	14.8	32.2	2.2		
	Sep-99	10.5	30.3	2.9		
	Sep-08	1.2	29.8	25.9		
	Apr-99	11.1	28.7	2.6		
	May-99	10.9	28.7	2.6		
	Jan-98	8.7	25.5	2.9		
	Feb-98	12.9	25.5	2.0		

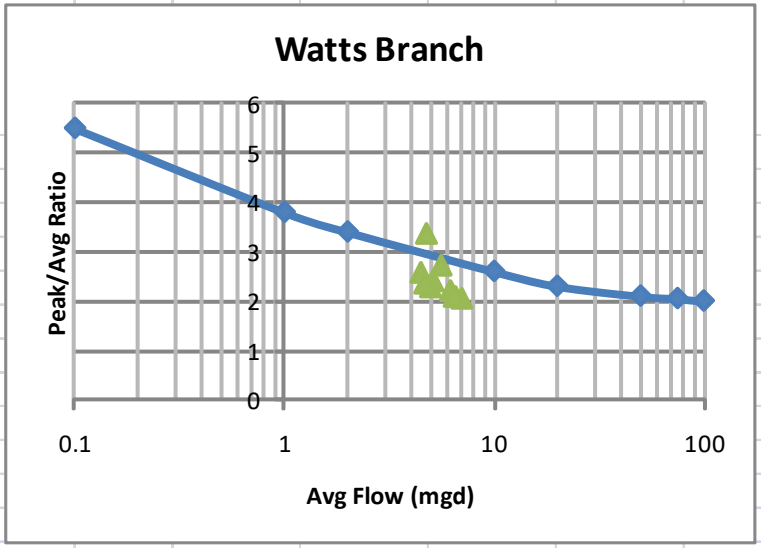


WSSC Data – Rock Run & Watts Branch

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio	WSSC Model 2-yr Peak	WSSC Model 10-yr Peak
Rock Run	IMA	0.90	3.70	4.1	4.4	5.60
	Top 10 Observed					
	May-08	1.2	3.3	2.9		
	Feb-08	1.9	3.1	1.7		
	Nov-97	0.8	3.0	3.9		
	Mar-98	1.2	3.0	2.6		
	May-98	1.1	3.0	2.8		
	Aug-01	0.7	3.0	4.1		
	Jul-03	1.2	3.0	2.5		
	Sep-03	1.3	3.0	2.3		
	Feb-04	1.2	3.0	2.5		
	Mar-05	1.1	3.0	2.8		

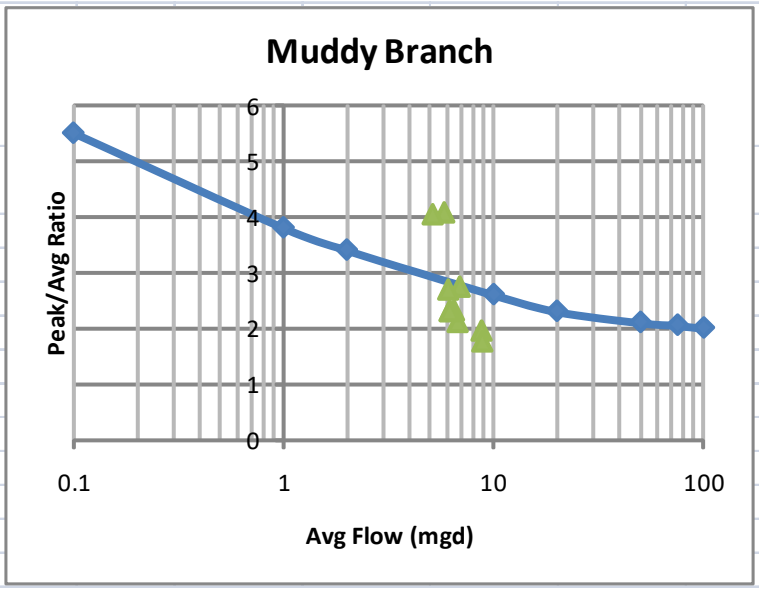


Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio	WSSC Model 2-yr Peak	WSSC Model 10-yr Peak
Watts Branch	IMA	4.50	14.20	3.2	12.4	16.50
	Top 10 Observed					
	Jun-06	4.7	16.0	3.4		
	Sep-08	5.6	15.2	2.7		
	Dec-09	7.0	14.4	2.1		
	May-08	6.5	13.7	2.1		
	Aug-09	6.2	13.7	2.2		
	May-09	6.4	13.5	2.1		
	Apr-05	5.1	12.4	2.4		
	Jul-04	4.5	11.6	2.6		
	Nov-06	5.0	11.4	2.3		
	Oct-05	4.7	11.1	2.4		



WSSC Data – Muddy Branch

Loc.	Item	Annual Avg (mgd)	Peak (mgd)	Peak/ Avg Ratio	WSSC Model 2-yr Peak	WSSC Model 10-yr Peak
Muddy Branch	IMA	15.5	40.30	2.6	22.80	28.30
	Top 10 Observed					
	Nov-08	5.8	23.7	4.1		
	Mar-05	5.1	20.7	4.1		
	Apr-07	6.9	18.9	2.7		
	Dec-09	8.8	17.2	2.0		
	Jan-05	6.1	16.3	2.7		
	May-09	8.9	15.6	1.8		
	Sep-08	6.5	15.0	2.3		
	Oct-06	6.2	14.2	2.3		
	Jun-06	6.7	14.2	2.1		
	Nov-06	6.2	14.2	2.3		



Peaks after summer 2004 plotted (after flow reduction due to Seneca)

Conclusions Regarding Historical WSSC & Fairfax Peaks to PI

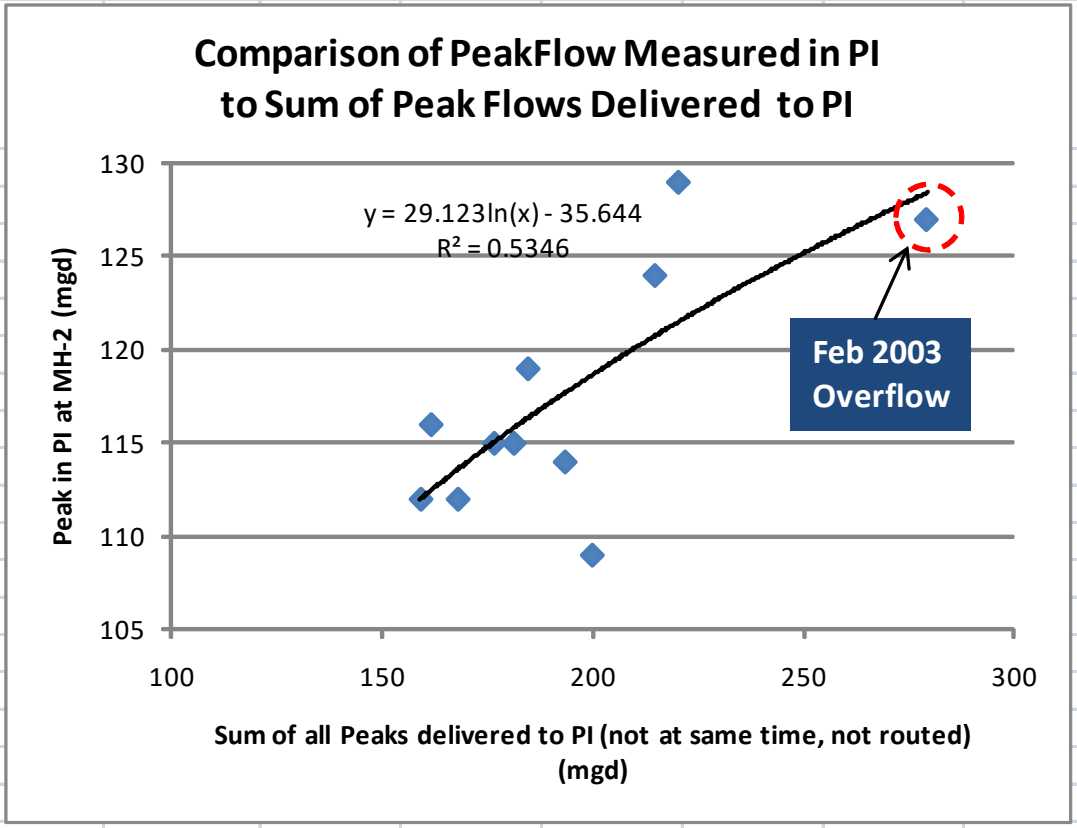
- WSSC sheds with high peaks compared to average flow:
  - Cabin John to PI
  - Muddy Branch
- Fairfax sheds with high peaks compared to average flow:
  - Sully Road #1
  - Great Falls
  - Sugerland Run
  - Pimmit Run (Chain Bridge)

Overflow Records for PI

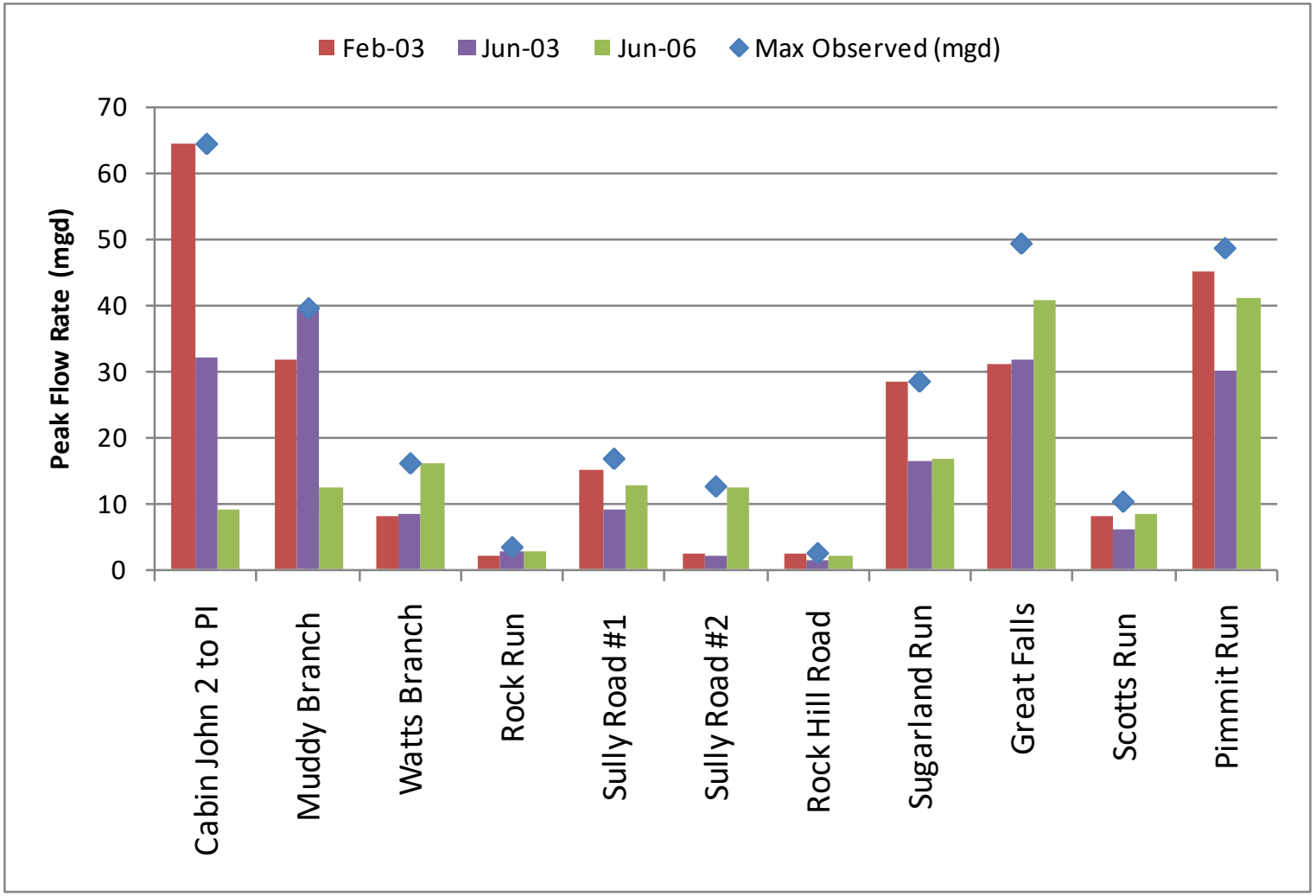
- One overflow recorded on PI
  - Feb 22-23, 2003 – combined rain & snowmelt
  - Reported at MH 9, 11, 12, 1991 and 3013
  - Rainfall was between a 2 and 5 yr storm, but snowmelt substantially exacerbated conditions
  - Peak flow at MH#2 measured to be 127 mgd
  - Modeling at the time did not predict an overflow would occur
  - Overflows mostly on section with bolted MHs
  - Bolted manholes reportedly did not perform properly

Peaks Delivered to PI Versus Peaks Observed in PI at MH-2

Date	Sum of All Peaks Delivered to PI (mgd)	Peak in PI at MH-2	Notes
Sep-99	184.6	119.0	
Aug-01	199.8	109.0	
Jan-03	176.5	115.0	
Feb-03	279.3	127.0	Overflow
Mar-03	181.2	115.0	
May-03	193.4	114.0	
Jun-03	220.3	129.0	No Overflow
Feb-04	161.5	116.0	
Apr-05	167.9	112.0	
Oct-05	159.1	112.0	
Jun-06	214.7	124.0	



Actual Rain Storms have been Variable Enough so that All Sewer Sheds Do Not Deliver Max Peaks



Published Rainfall Reductions due to Area do not Reflect Experience in PI Watershed

Only a 10% reduction in rainfall for large areas

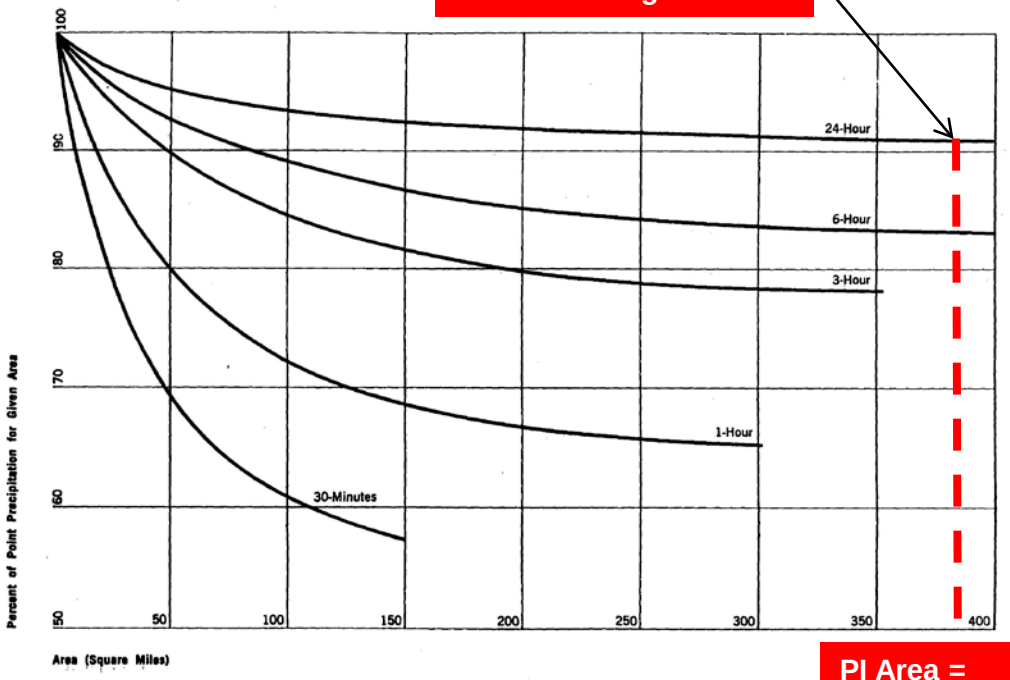
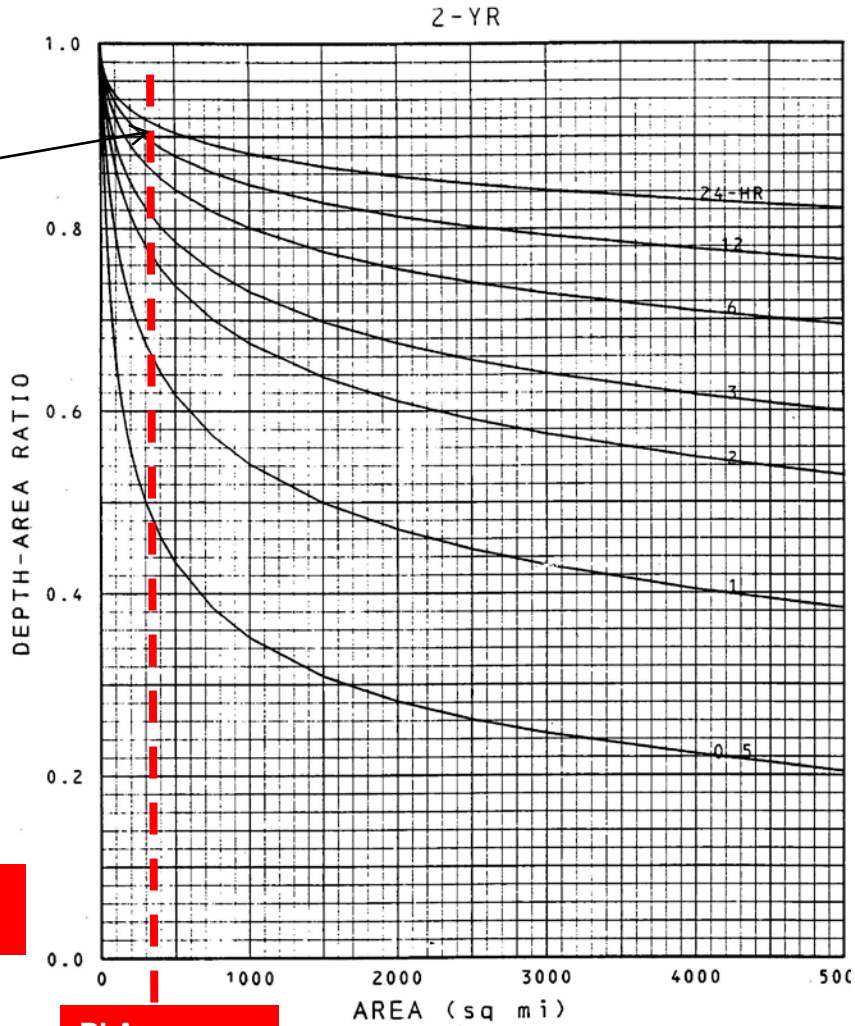


Figure 1-1.--Depth-area ratios, from Miller et al. (1973).

PI Area = 385 sq mi ±



PI Area = 385 sq mi ±

Figure 6-6.--Same as figure 6-1, to 5000 mi^2.

Source: ***NOAA Technical Report NWS 24: A Methodology for Point to Area Frequency Ratios*****, National Weather Service, Feb. 1980**

Modeling Findings

- Ran numerous modeling scenarios with peak limits as follows:

Run	Rainfall	Peak Limits	Sum of peaks to PI	PI Overflow?
1	Uniform 10-yr storm, de-rated to 90% per NOAA	Set at IMA limits	199.8 mgd	No
2	Uniform 10-yr storm, de-rated to 90% per NOAA	WSSC - per CDM 10 yr storm Fairfax - per regression, up observed peaks	298 mgd	Yes
5, 6 & 7	Uniform 10-yr storm, de-rated to 90% per NOAA	Various combinations of peak flow reductions	224 to 277 mgd	Yes
8	Uniform 10-yr storm, de-rated to 50% (approx equivalent to a uniform 2 yr storm)	None – peaks per regression predictions	200 mgd	No

Conclusions

- Peak flows significantly exceed current IMA transmission limits during major storms
- Rain is variable enough so that not all sewer sheds will deliver peak flow during any particular rain event. Actual rain is more variable geographically and temporally than suggested by NOAA data
- Modeling would predict overflows if peaks marginally exceed IMA transmission limits
  - Assumes rain happens over whole sewer shed, but this is not borne out by historical actual data
- 1 overflow identified on PI – when peaks delivered to sewer = 279 mgd
- Overflows have not occurred when peaks delivered to PI = 220 mgd
- Reasonable approach is to limit sum of peaks from all users to 220 to 240 mgd, based on past experience
- If overflows occur, provide language in IMA allowing WASA to identify reason and require peak flow reductions as necessary

Option 1 - Potential Peak Limits (No Fairfax Additional Flow)

	Existing IMA			Observed Peak Range		New IMA			Peak Based on ASCE
	Ann. Avg (mgd)	Peak (mgd)	Peak/ Avg	Worst (mgd)	Typical Range	Ann. Avg (mgd)	Peak (mgd)	Peak/ Avg	
WSSC									
Cabin John Total (1)									
Cabin John 1 to MUPI	10.30	23.30	2.3			10.30	15.00	1.5	2.7
Cabin John 2 to PI	0.70	25.00	35.7	64.4	30 to 40	0.70	33.00	47.1	4.0
Muddy Branch	15.50	40.30	2.6	23.3	16 to 20	15.50	28.00	1.8	2.5
Watts Branch	4.50	14.20	3.2	16.0	13 to 16	4.50	16.50	3.7	3.0
Rock Run	0.90	3.70	4.1	3.3	3.0	0.90	5.60	6.2	3.9
Total to PI	**21.60**	**83.2**	**3.9**	**107.0**	**71.0**	**21.60**	**83.1**	**3.8**	**2.4**
Total to PI & UPI	31.90	106.5	3.3			31.90	98.1	3.1	2.3
Fairfax									
Sully Road #1	4.00	9.20	2.3	16.7	10 to 15	4.00	14.00	3.5	3.1
Sully Road #2	1.10	2.10	1.9	12.5	2 to 3	1.10	3.00	2.7	3.7
Rock Hill Road	0.90	2.40	2.7	2.4	1.9 to 2.1	0.90	2.40	2.7	3.9
Sugarland Run (2)	4.00	12.00	3.0	28.4	17 to 22	4.00	14.00	3.5	3.1
Great Falls(3)	8.70	22.50	2.6	49.3	30 to 40	8.70	30.00	3.4	2.8
Scotts Run	2.90	9.40	3.2	10.2	8 to 10	2.90	10.20	3.5	3.2
Pimmit Run	9.40	23.60	2.5	48.6	25 to 41	9.40	35.00	3.7	2.7
Total	**31.00**	**81.20**	**2.6**	**168.10**	**114.5**	**31.00**	**108.60**	**3.5**	**2.3**
LCSA	13.1	31.9			31.9	13.1	31.9		
Dulles + small users	1.5	3.5			3.5	1.5	3.5		
Total	**67.2**	**199.8**			**220.90**	**67**	**227.1**		

Rationale:
Set peaking factors in proportion to average flow

Option 2 - Potential Peak Limits (With 9.5 mgd Additional Fairfax Flow)

	Existing IMA			Observed Peak Range		New IMA			
	Ann. Avg (mgd)	Peak (mgd)	Peak/ Avg	Worst (mgd)	Typical Range	Ann. Avg (mgd)	Peak (mgd)	Peak/ Avg	Peak Based on ASCE
WSSC									
Cabin John Total (1)									
Cabin John 1 to MUPI	10.30	23.30	2.3			10.30	15.00	1.5	2.7
Cabin John 2 to PI	0.70	25.00	35.7	64.4	30 to 40	0.70	31.00	44.3	4.0
Muddy Branch	15.50	40.30	2.6	23.3	16 to 20	15.50	28.30	1.8	2.5
Watts Branch	4.50	14.20	3.2	16.0	13 to 16	4.50	16.50	3.7	3.0
Rock Run	0.90	3.70	4.1	3.3	3.0	0.90	5.60	6.2	3.9
Total to PI	**21.60**	**83.2**	**3.9**	**107.0**	**71.0**	**21.60**	**81.4**	**3.8**	**2.4**
Total to PI & UPI	31.90	106.5	3.3			31.90	96.4	3.0	2.3
Fairfax									
Sully Road #1	4.00	9.20	2.3	16.7	10 to 15	4.0	14.00	3.5	3.1
Sully Road #2	1.10	2.10	1.9	12.5	2 to 3	2.0	3.00	1.5	3.4
Rock Hill Road	0.90	2.40	2.7	2.4	1.9 to 2.1	0.5	2.40	4.8	4.2
Sugarland Run (2)	4.00	12.00	3.0	28.4	17 to 22	7.00	20.00	2.9	2.8
Great Falls(3)	8.70	22.50	2.6	49.3	30 to 40	15.0	35.00	2.3	2.5
Scotts Run	2.90	9.40	3.2	10.2	8 to 10	5.0	10.20	2.0	3.0
Pimmit Run	9.40	23.60	2.5	48.6	25 to 41	7.0	35.00	5.0	2.8
Total	**31.00**	**81.20**	**2.6**	**168.10**	**114.5**	**40.47**	**119.60**	**3.0**	**2.2**
LCSA	13.1	31.9			31.9	13.1	31.9		
Dulles + small users	1.5	3.5			3.5	1.5	3.5		
Total	**67.2**	**199.8**			**220.90**	**77**	**236.4**		

Rationale:

- Since WSSC is not adding flow, leave overall peak unchanged
- Allow Fairfax peaks to increase since additional flow is being added

Option 3 - Potential Peak Limits (With 9.5 mgd Additional Fairfax Flow)

	Existing IMA			Observed Peak Range		New IMA			
	Ann. Avg (mgd)	Peak (mgd)	Peak/ Avg	Worst (mgd)	Typical Range	Ann. Avg (mgd)	Peak (mgd)	Peak/ Avg	Peak Based on ASCE
WSSC									
Cabin John Total (1)									
Cabin John 1 to MUPI	10.30	23.30	2.3			10.30	15.00	1.5	2.7
Cabin John 2 to PI	0.70	25.00	35.7	64.4	30 to 40	0.70	31.00	44.3	4.0
Muddy Branch	15.50	40.30	2.6	23.3	16 to 20	15.50	20.00	1.3	2.5
Watts Branch	4.50	14.20	3.2	16.0	13 to 16	4.50	16.50	3.7	3.0
Rock Run	0.90	3.70	4.1	3.3	3.0	0.90	5.60	6.2	3.9
Total to PI	**21.60**	**83.2**	**3.9**	**107.0**	**71.0**	**21.60**	**73.1**	**3.4**	**2.4**
Total to PI & UPI	31.90	106.5	3.3			31.90	88.1	2.8	2.3
Fairfax									
Sully Road #1	4.00	9.20	2.3	16.7	10 to 15	4.0	14.00	3.5	3.1
Sully Road #2	1.10	2.10	1.9	12.5	2 to 3	2.0	3.00	1.5	3.4
Rock Hill Road	0.90	2.40	2.7	2.4	1.9 to 2.1	0.5	2.40	4.8	4.2
Sugarland Run (2)	4.00	12.00	3.0	28.4	17 to 22	7.00	20.00	2.9	2.8
Great Falls(3)	8.70	22.50	2.6	49.3	30 to 40	15.0	35.00	2.3	2.5
Scotts Run	2.90	9.40	3.2	10.2	8 to 10	5.0	10.20	2.0	3.0
Pimmit Run	9.40	23.60	2.5	48.6	25 to 41	7.0	40.00	5.7	2.8
Total	**31.00**	**81.20**	**2.6**	**168.10**	**114.5**	**40.47**	**124.60**	**3.1**	**2.2**
LCSA	13.1	31.9			31.9	13.1	31.9		
Dulles + small users	1.5	3.5			3.5	1.5	3.5		
Total	**67.2**	**199.8**			**220.90**	**77**	**233.1**		

Rationale:

Set peaks in proportion to average annual flow to PI

Suggested Next Steps

- Do users propose changing annual average flow allocations to PI? Examples:
  - Fairfax request for 6 to 9.5 mgd?
  - WSSC
    - Cabin John to PI allocation is 0.7 mgd, but it has averaged about 3 mgd over past 5 years
- Agree on peaks by point of connection to PI so sum of peaks does not exceed 220-240 mgd
- Consider long term metering for PI
  - Add meters near MH 7 or 18 (surcharge area)
  - Consider long term rain gage network
  - Given enough data, would allow developing a ‘real-world’ 10 year storm