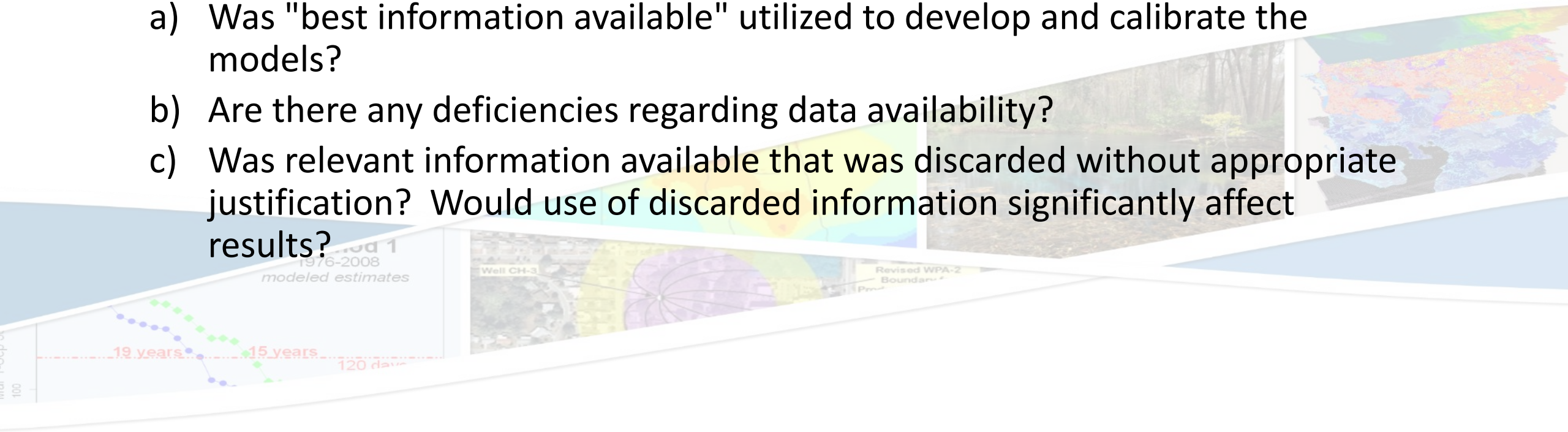
Wekiva River Hydrology and Hydraulics Modeling Review

St. Johns River Water Management District

10/23/2018

Required Questions

1. Assess the adequacy and appropriateness of the data used in model development and calibration.
   a) Was "best information available" utilized to develop and calibrate the models?
   b) Are there any deficiencies regarding data availability?
   c) Was relevant information available that was discarded without appropriate justification? Would use of discarded information significantly affect results?



Required Questions

2. Assess the validity, defensibility and appropriateness of the model development, and calibration.

a) Determine if the model is appropriate, defensible, and valid, given the District's MFLs approach.

b) Evaluate the validity and appropriateness of all assumptions used in the model development and calibration.
   - Are the assumptions reasonable and consistent given the "best information available"?
   - Is there information available that could have been used to eliminate any of the assumptions? Could the use of this additional information substantially change the models results?

c) Review model input and output data including but not limited to:
   - Model elevations vs collected data to verify same datum used consistently;
   - Flow/stage plots to look for model instabilities;
   - Output file for model warnings (full flow channels, flooded nodes, etc.);
   - Continuity error and convergence data;
   - Water budget to check for reasonableness;
   - Values assigned to model parameters to check for reasonableness;
   - Appropriateness of boundary conditions including spring flows and river stages used in model inputs; and
   - Review of the methodologies used to:
     a) Develop boundary conditions including spring flows; and
     b) Incorporate HSPF output in HEC-RAS models.

d) Development of an independent water budget will be included in this subtask

Q1 -- Assess the adequacy and appropriateness of the data used in model development and calibration

a) Was "best information available" utilized to develop and calibrate the models?
   - Climate data from NOAA disaggregated from daily (ideally hourly observed would be used if available)
   - Daily flow data from USGS
   - Channel cross sections surveyed by the District
   - Basin map is well discretized
   - Land cover map is well defined

b) Are there any deficiencies regarding data availability?
   - The best available data was used.
   - Data was processed using standard engineering principles.
   - Spring data was not available daily so statistical models were used to complete time series.
   - Rainfall data was processed using standard engineering techniques; hourly rain data would have been preferred but not available.

c) Was relevant information available that was discarded without appropriate justification? Would use of discarded information significantly affect results?

   Relevant information was not discarded.

Q2 -- Assess the validity, defensibility and appropriateness of the model development, and calibration

a) Determine if the model is appropriate, defensible, and valid, given the District's MFLs approach.

b) Evaluate the validity and appropriateness of all assumptions used in the model development and calibration.

- Are the assumptions reasonable and consistent given the "best information available"?
- Is there information available that could have been used to eliminate any of the assumptions? Could the use of this additional information substantially change the models results?

A thorough review of the HSPF and HEC-RAS models was performed to address these questions.

Modeling Strategy

- Two principle components
  - Hydrology – HSPF
  - Hydraulics – HEC-RAS
- Well accepted and supported public domain models (EPA, USGS)
- These models are regularly applied for MFL development in SJRWMD as well as many other WMDs

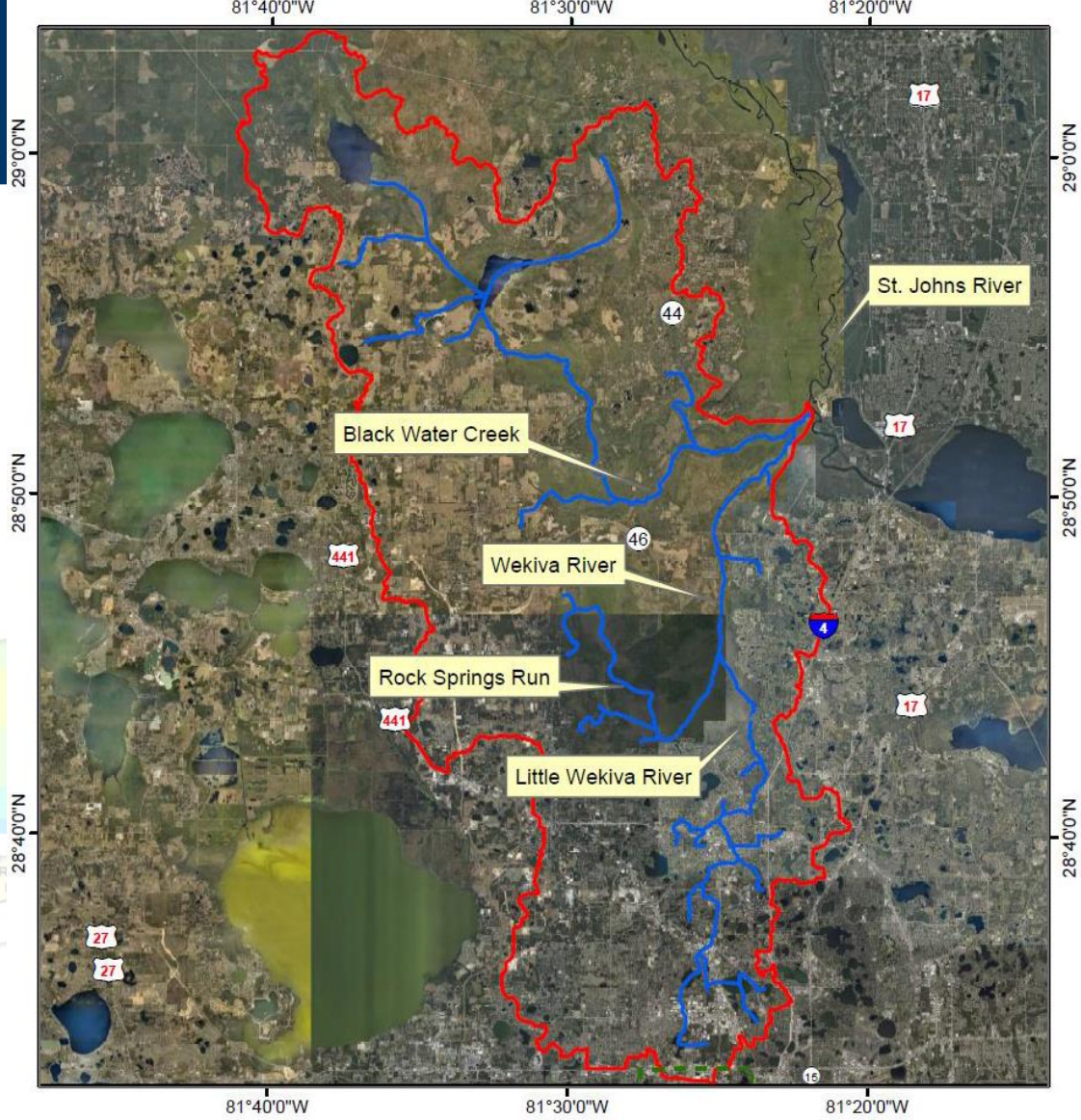


Figure 1. Location of Wekiva River Watershed

0 3.25 6.5 Miles

Legend

- Watershed Boundary
- Stream Network
- County Boundary

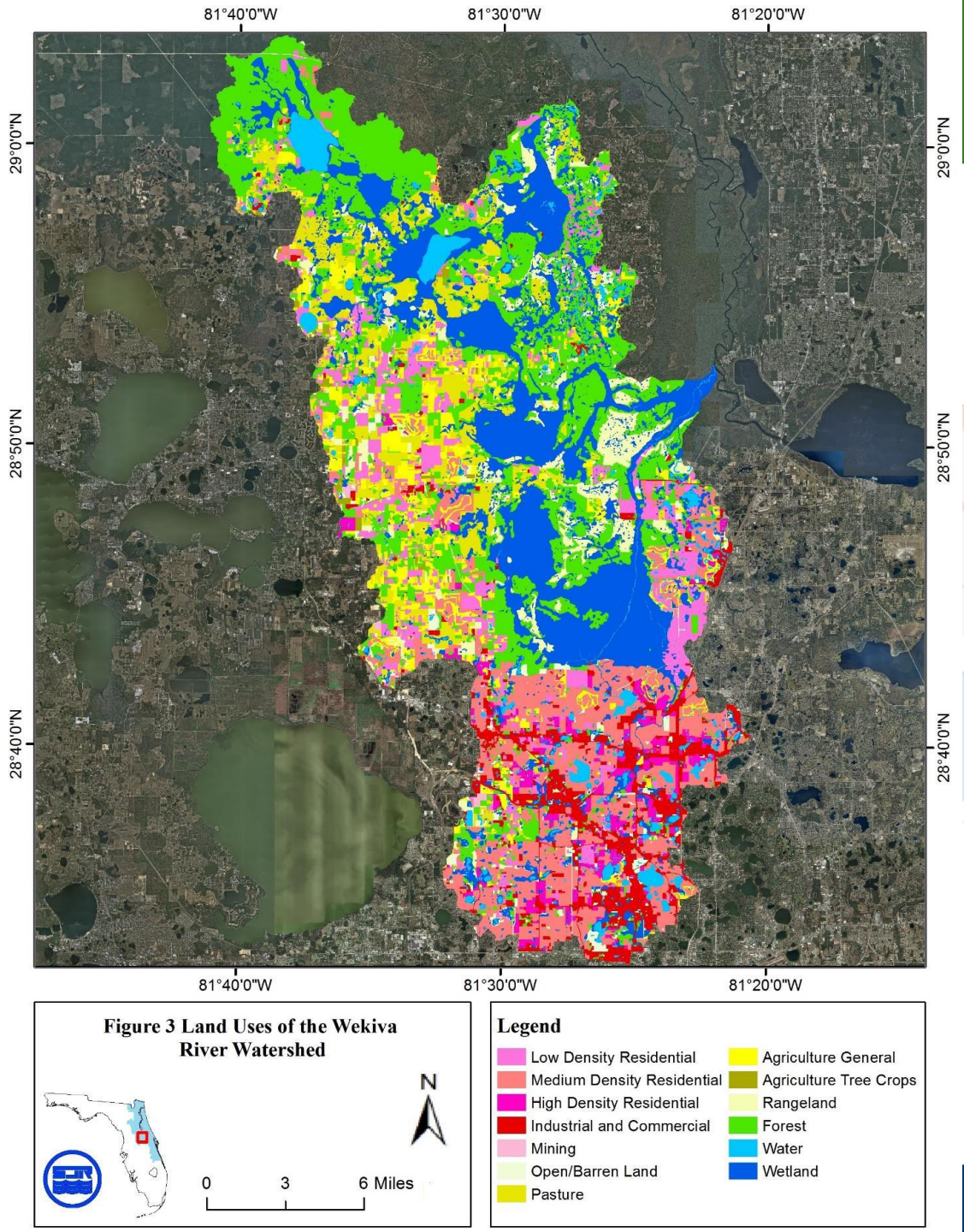
HSPF Model Review

- 3 separate models
  - Black Water Creek
  - Little Wekiva River
  - Wekiva River
- All models are hourly
- Calibration Period 2001-2016
- Each basin is discretized into land segments
- PEST was used to optimize parameters in:
  - PWAT-PARM2
  - PWAT-PARM3
  - PWAT-PARM4
- Land use codes that correspond to HSPF segments should be described in the documentation. (14 shown in document; 17 in models); Add LU codes to Table 1. (FOR versus FORR; Table 1 should be rectified with UCIs)

ID	LUCode	Description
21	LDR	Low Density Residential
22	MDR	Medium Density Residential
23	HDR	High Density Residential
24	IND	Industrial Commercial
25	MIN	Mining
26	OPE	Open Land
27	PAS	Pasture
28	AGR	Agricultural General
29	AGT	Agricultural Tree Crop
30	RAN	Rangeland
31	FOR	Forest
32	WAT	Water
33	RWET	Riparian Wetland
34	FORR	Forested
35	NRWET	Nonriparian Weland
36	IRR	Irrigated
37	IPAS	Irrigated Pasture

Basin Land Cover

- Very stark difference in land cover
  - Urban land use to the south
  - Rural and agriculture to the north
- Urban land cover impervious fraction (DCIA)
  - Among 13 land uses, four urban land uses (low density residential, medium density residential, high density residential, and industrial/commercial) are assumed to have impervious areas. The impervious percentages for these land uses are 5, 10, 35 and 50, respectively



Spring Flows

- Handled as external time series
  - Gaps filled with statistical analysis
- Almost 30 springs routed to reaches in HSPF model
- Spring flows also used in HEC-RAS model
- Additional details regarding the scaling of “Step 3” springs should be added to the Appendix documentation: observed flow in each spring, ratio, and date of observations.

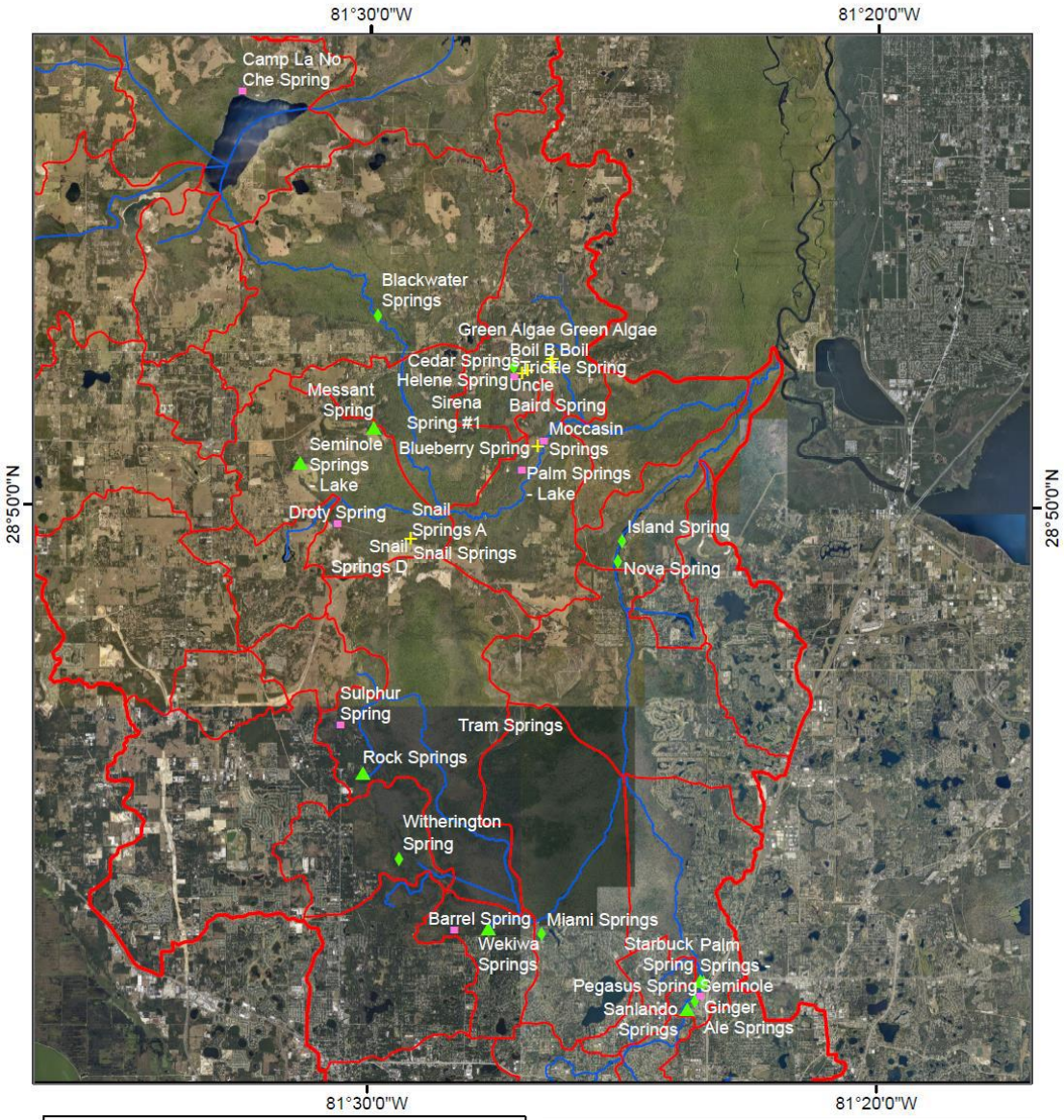
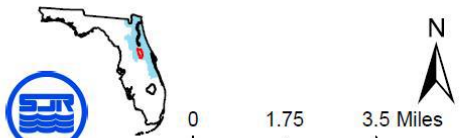


Figure 9. Location of Springs



Springs, By Magnitude

- 2 (10 to 100 cfs)
- 3 (1 to 10 cfs)
- 4 (0.223 cfs to 1 cfs)
- 5 (0.0223 cfs to 0.223 cfs)
- 6 (0.0022 cfs to 0.0223 cfs)
- Measurement not available
- Subwatershed
- Stream Network

HSPF Calibration

- Good spatial coverage of observed flow data
- No errors generated in HSPF output
- PEST was utilized to adjust some of the model parameters Parm2, Parm3, Parm4)
- The document should itemize the optimized parameters, the ranges specified in the PEST control file, and the file optimized parameter

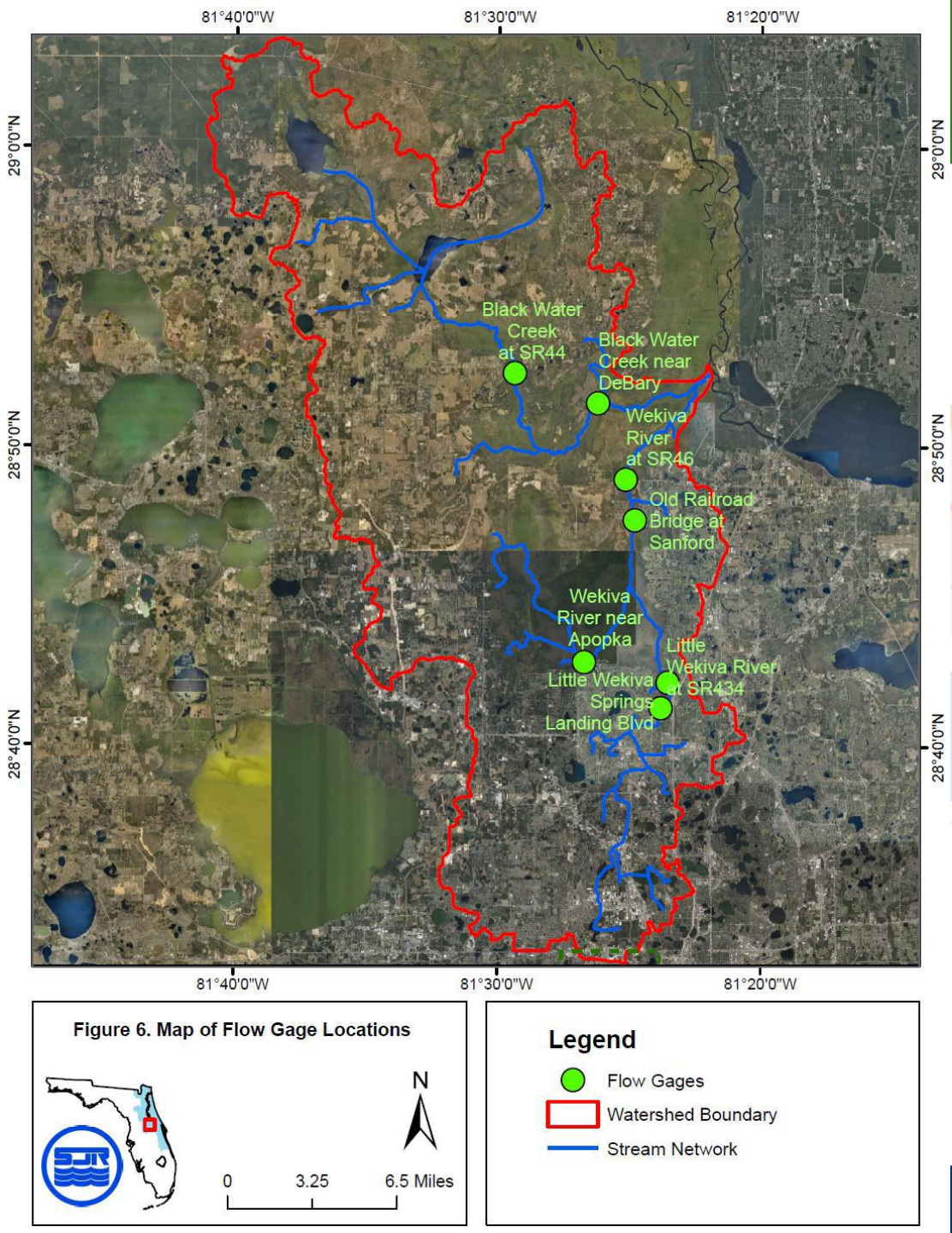


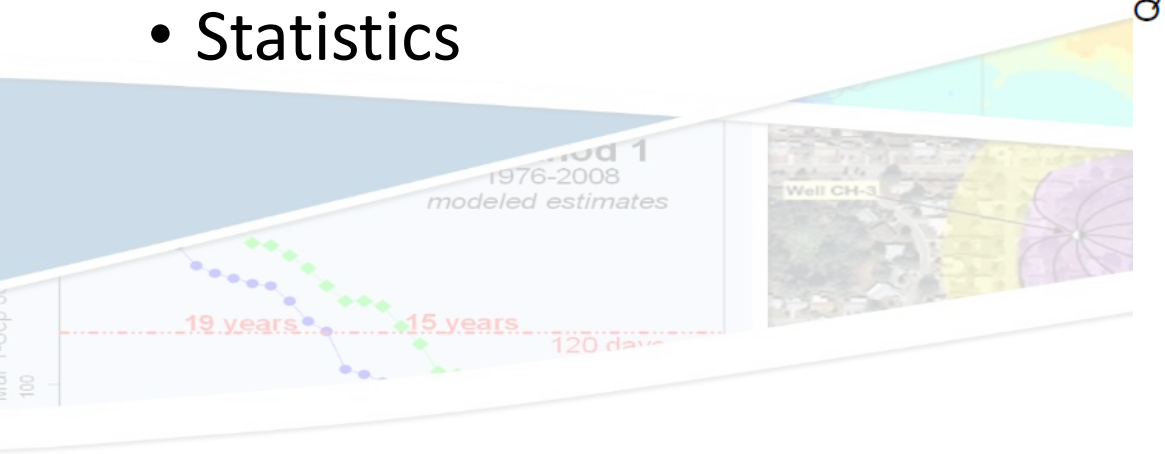
Table 4 Calibration Locations

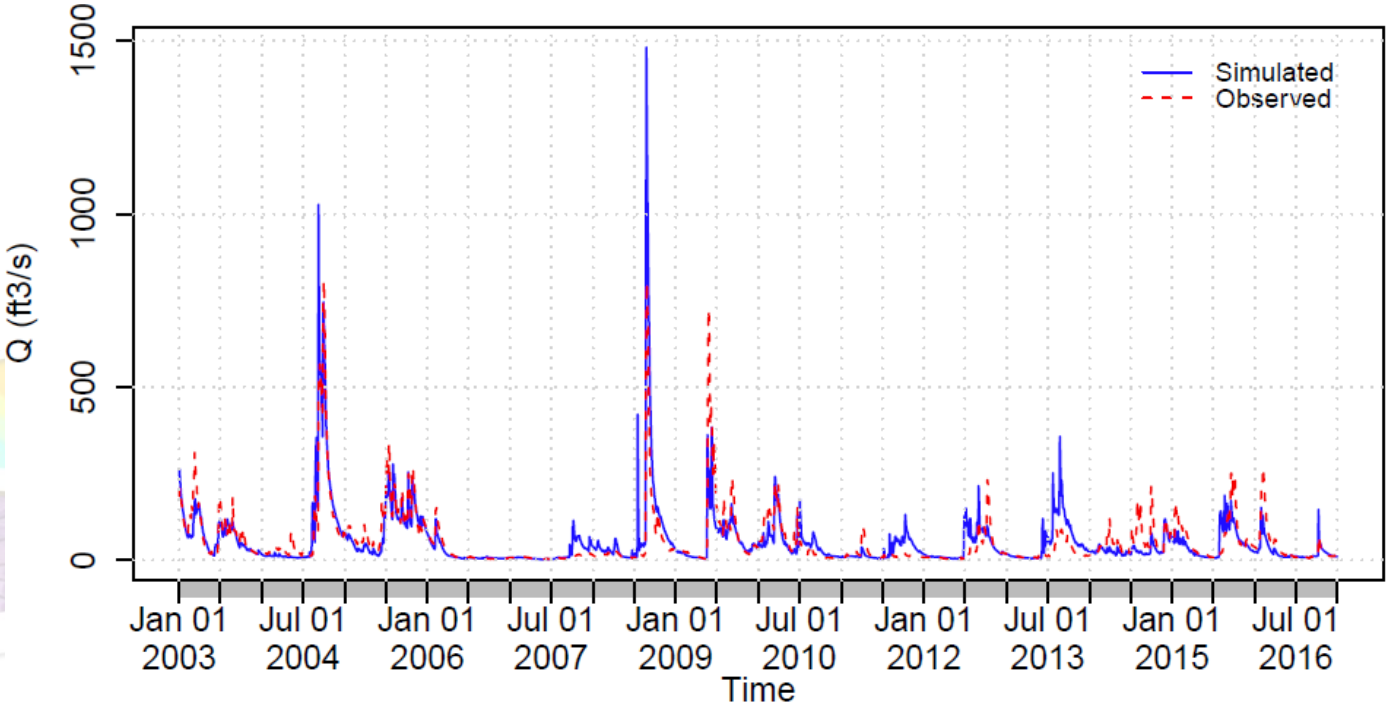
- Table 4 of the documentation should utilize the published station names:

1. Little Wekiva River at SR434 (SR434) should reference Little Wekiva River near Altamonte Springs (SR 434) [USGS 02234990]
2. Wekiva River near Apopka (near Apopka) should reference Wekiva River at Apopka [SJRWMD 09522138]
3. Wekiva River at SR46 (SR46) should reference Wekiva River near Sanford, FL (SR46) [USGS 02235000]

HSPF Calibration

- Daily flow hydrograph
- Monthly hydrograph
- Scatter plot
- Flow duration curve
- Statistics





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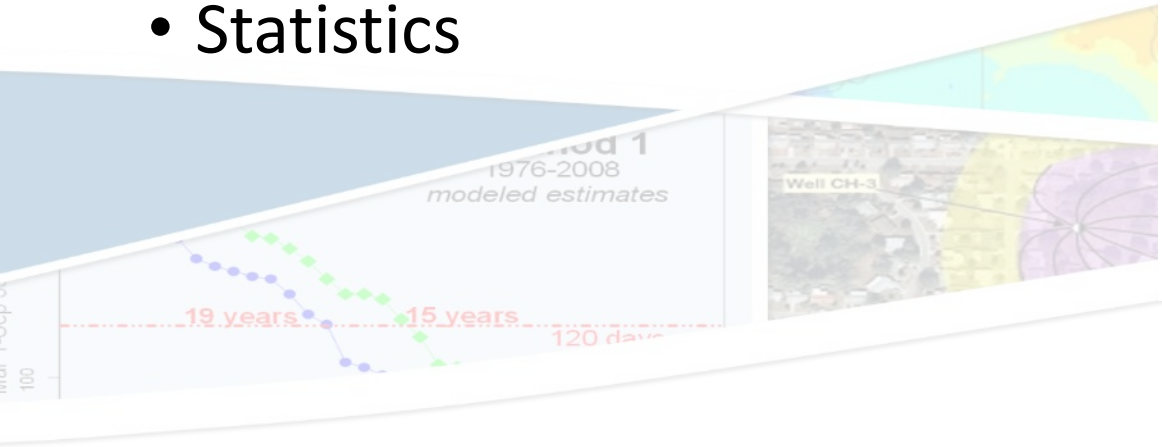

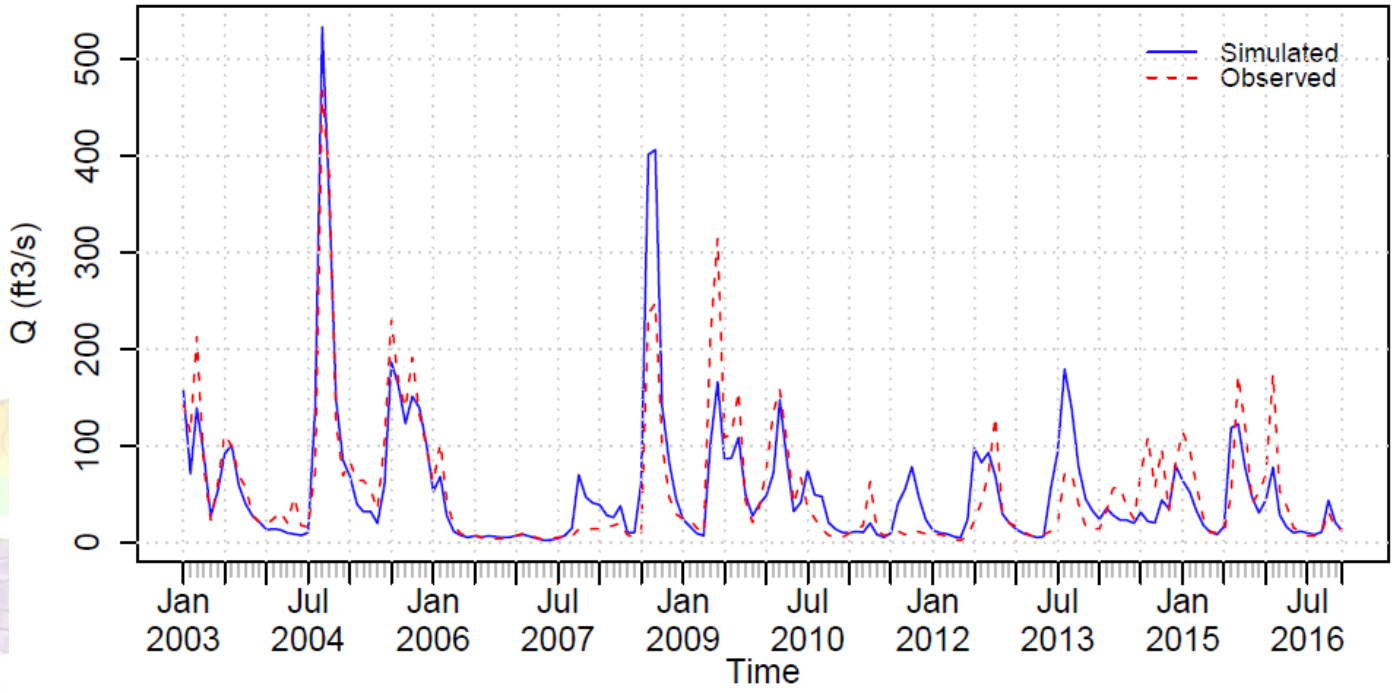

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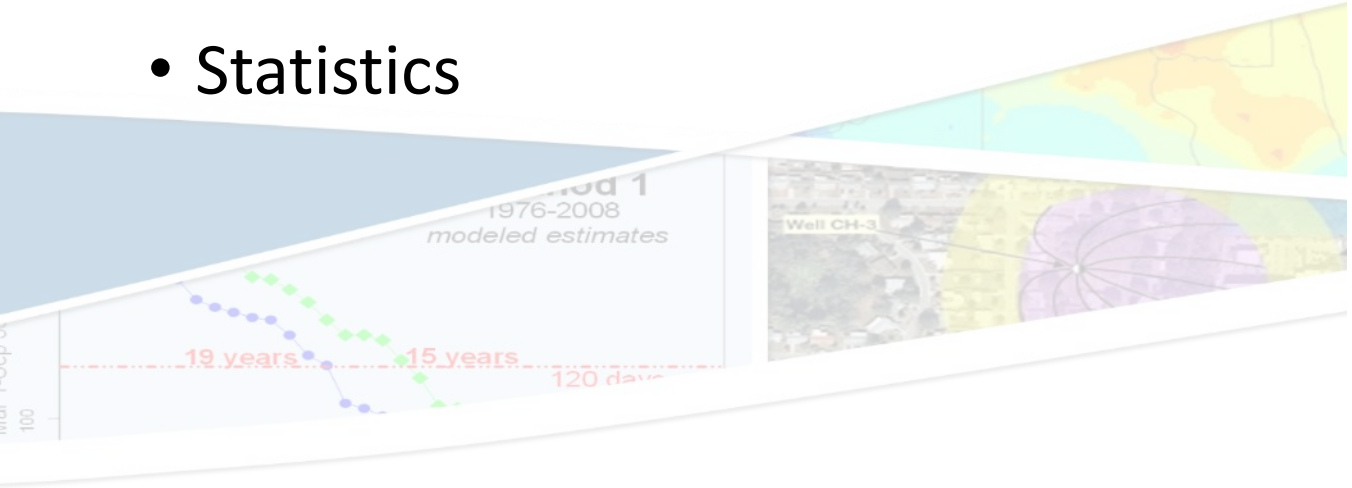
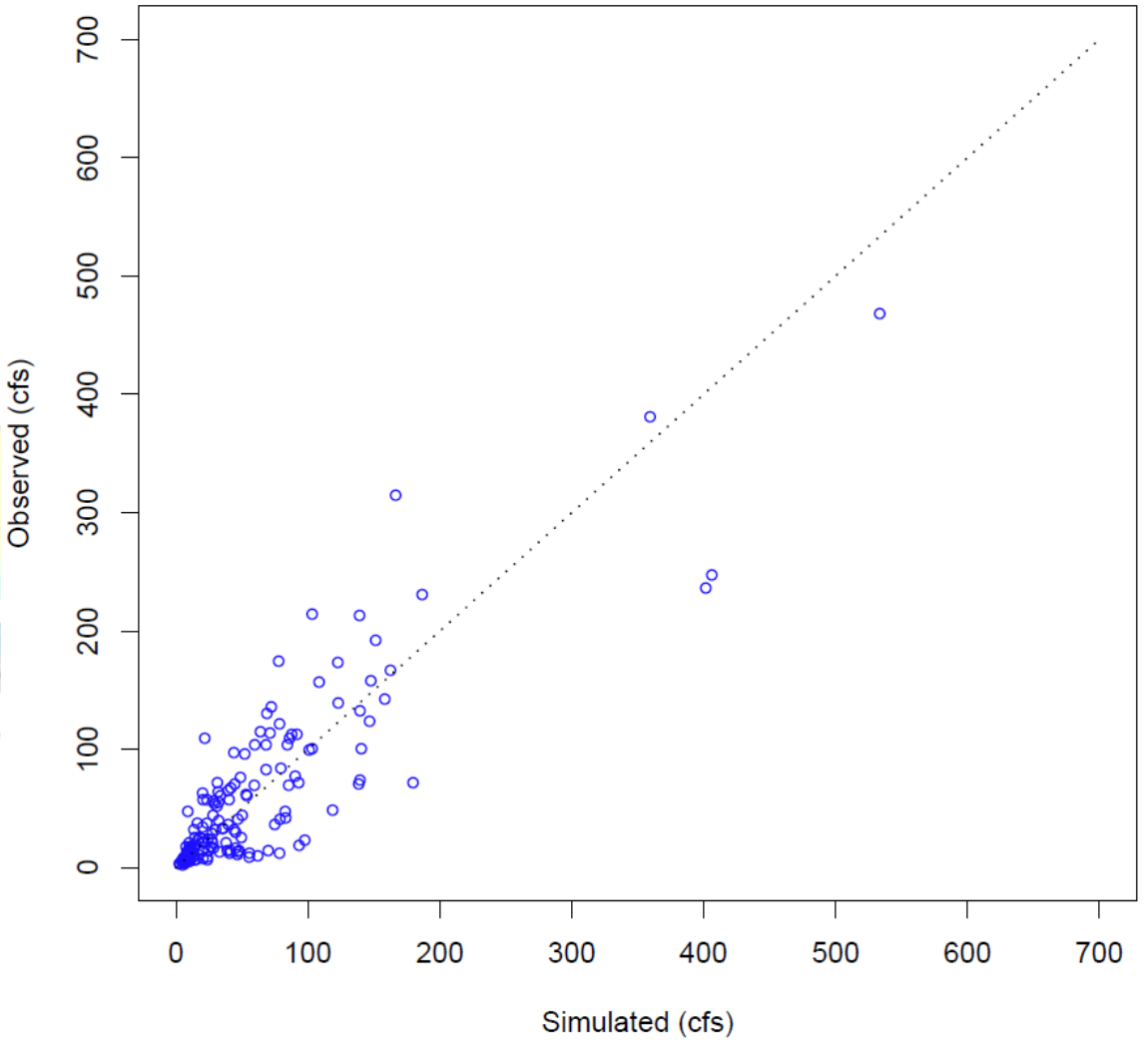




HSPF Calibration

- Daily flow hydrograph
- Monthly hydrograph
- Scatter plot
- Flow duration curve
- Statistics

- Cumulative volume should also be included to examine the overall conservation of mass

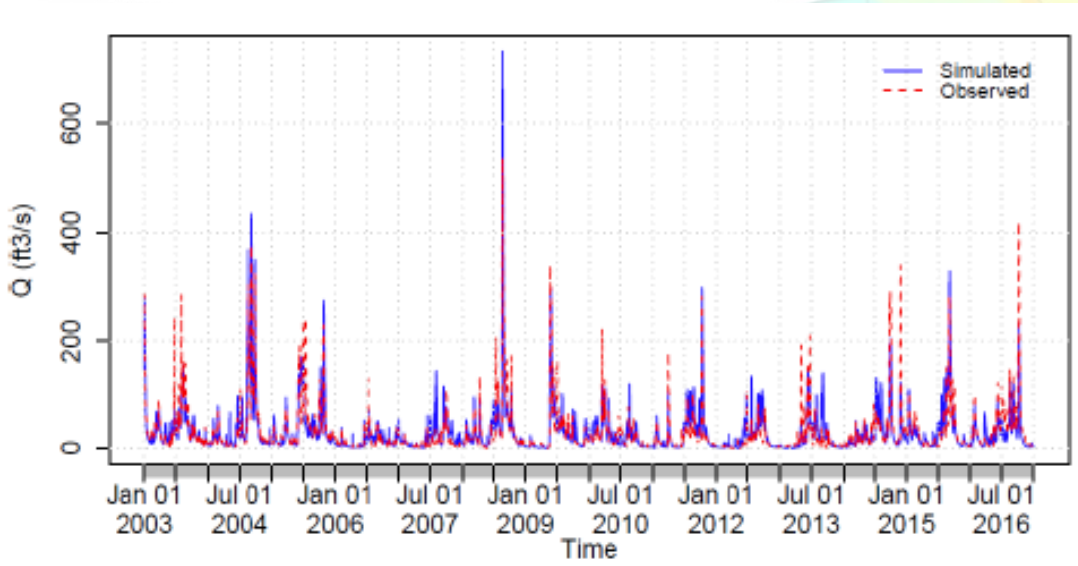
Table 11 Results of performance analysis

Statistics		Black Water Creek		Little Wekiva River		Wekiva River		
		SR44	Near Debary	SR434	SLB	Near Apopka	Old Railroad (RR)	SR46
Daily	RMSE	50.97	73.53	27.01	34.00	29.17	69.63	76.68
	R^2	0.69	0.64	0.69	0.76	0.50	0.73	0.69
	PBIAS %	-1.00	-1.10	-0.40	-6.90	0.00	4.80	-0.30
	high10%	-3.41	1.46	-4.29	-15.02	-6.91	-1.52	-3.99
	low50%	11.76	0.90	-1.26	9.99	0.53	9.28	4.28
	NSE	0.63	0.53	0.67	0.76	0.45	0.71	0.67
	RSR	0.60	0.69	0.57	0.49	0.74	0.54	0.58
Monthly	RMSE	37.24	54.50	15.14	22.50	24.62	47.27	54.36
	R^2	0.75	0.70	0.79	0.82	*0.45**	0.77	0.72
	PBIAS %	-1.30	-1.20	-0.50	-6.60	0.10	4.80	-0.30
	NSE	0.72	0.65	0.79	0.80	*0.34**	0.74	0.70
	RSR	0.53	0.59	0.46	0.44	*0.81**	0.51	0.54

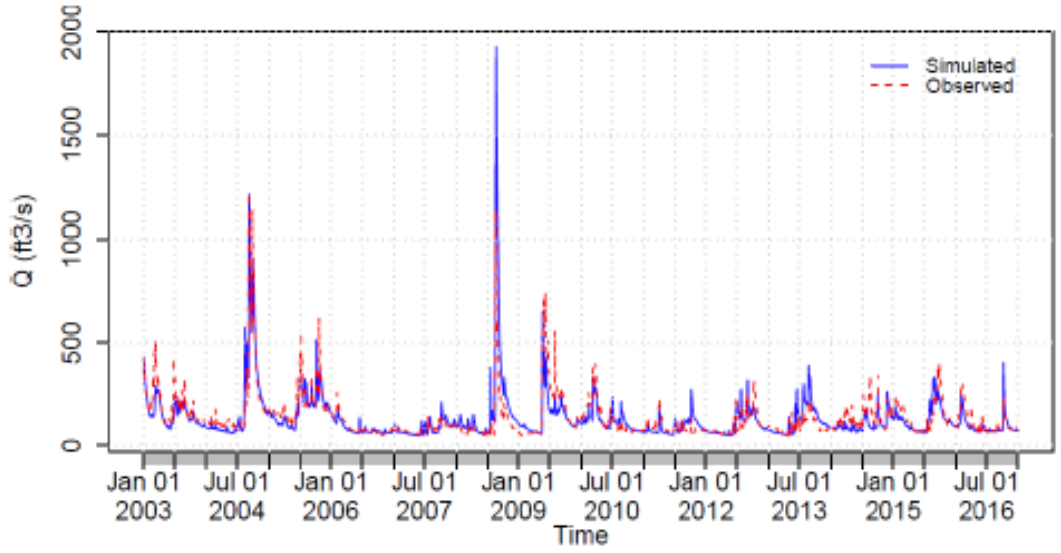
Simulated (cfs)

Flow/Stage Plots for Examination of Model Instabilities

- HSPF model datum is not explicitly stated in the documentation. Please add a statement specifying the model datum in the report. Examination of the UCI files shows that a correction (STCOR) was applied to shift F-table stages but the model datum is unclear.
- No model instabilities were noted based on the hydrographs presented in the documentation.



(a) Daily observed and simulated flow at SR434 gage (USGS 02234990) in Little Wekiva River



(a) Daily observed and simulated flow at Near Debary gage in Black Water Creek at Near Debary gage (SJRWMD 30143084) in Black Water Creek

Initial Conditions/Parameter Reasonableness

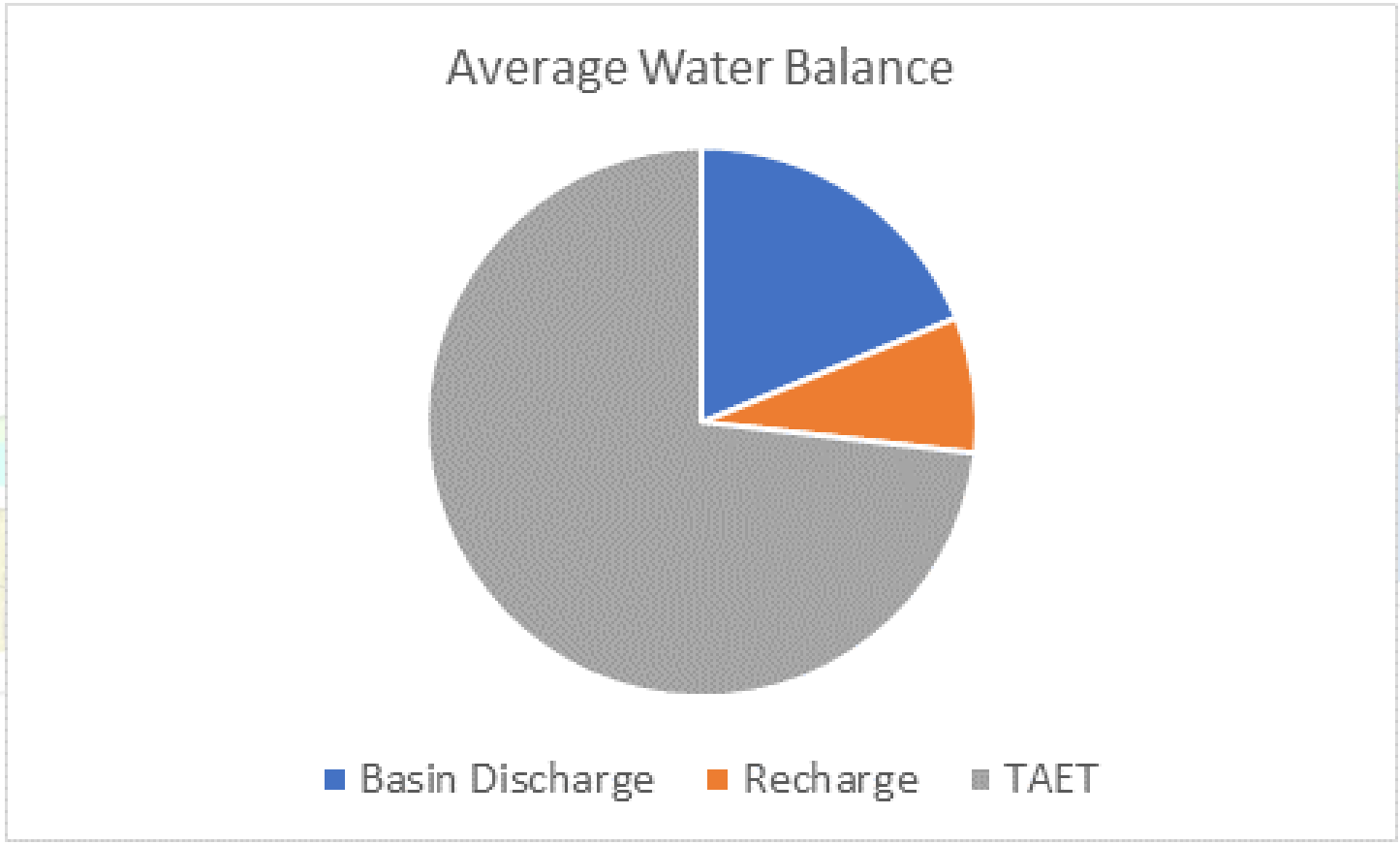
- Initial conditions can impact the simulated results for a short period of time (ranging from days to months).
- There are inconsistencies with respect to the relative moisture levels at the start of the simulation.
- LZS is initialized at 6.4 inches for all simulations.
- LZSN ranges from .5 to 7.5 inches.
- Initial LZRAT would vary from almost 13 to just below 1.

- RETSC (retention storage capacity) is set to 0.1-inches for all impervious land segments.

Water Budget Check- Black Water Creek

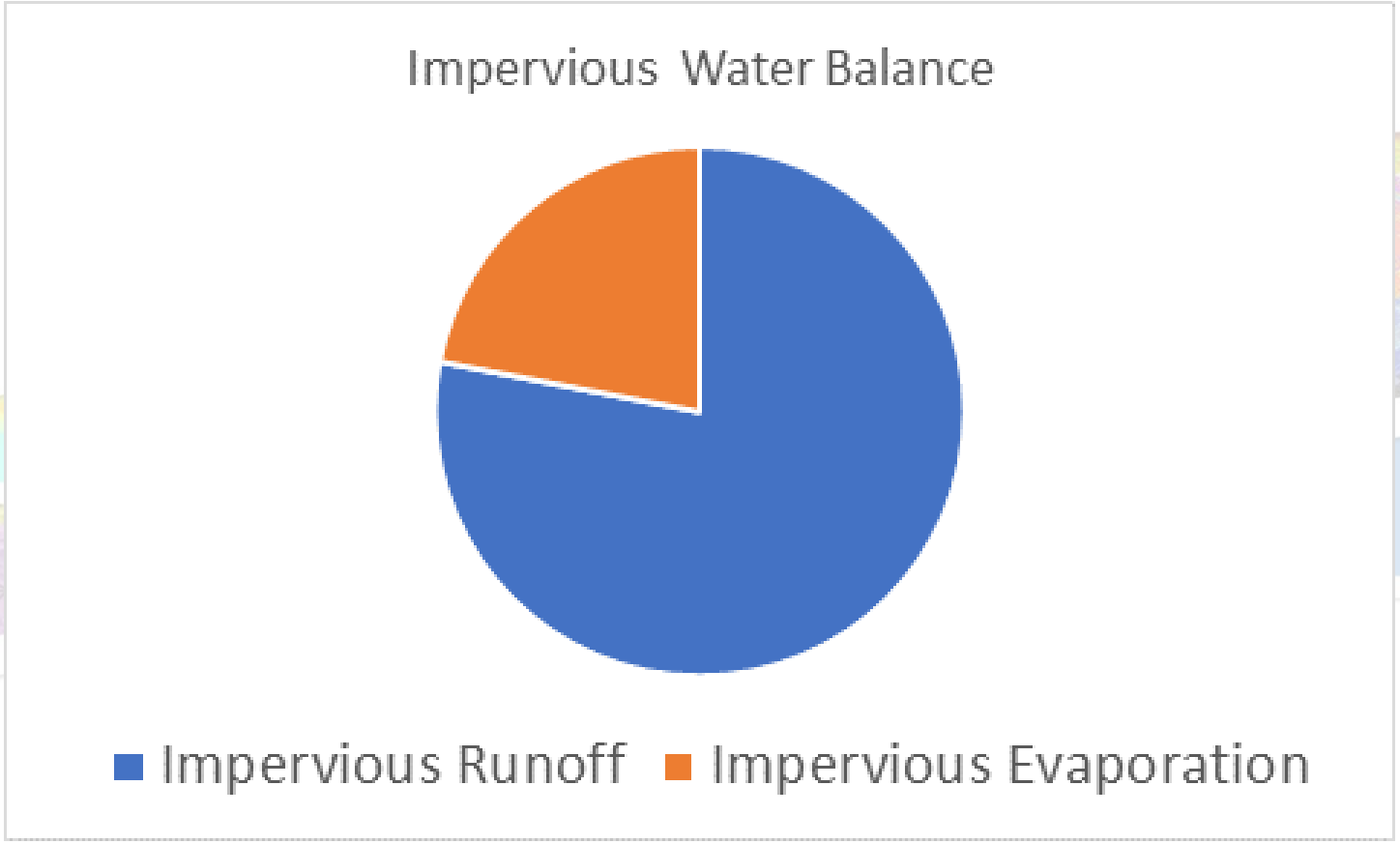
Water Balance Term	Annual Average, inches
Rainfall	51.4
Basin Discharge	9.8
Recharge	4.2
TAET	38.2
Difference	0.8

Conclusion: the average basin water balance appears reasonable.



Impervious Water Budget Check- Black Water Creek

Water Balance Term	Annual Average, inches
Rainfall	51.9
Impervious Runoff	40.5
Impervious Evaporation	11.4
Difference	0.0



HEC-RAS Model Review

- The domain includes Rock Springs Run, Wekiwa Springs Run, Little Wekiva River downstream of SR64, and the Wekiva River from the junction with Rock Springs Run to the Lower Wekiva River gauge.

- Datum for cross sections is noted as NAVD88, but the model datum is not explicitly stated in the documentation. Please add a statement specifying the model datum as NAVD88 at the beginning of Section 4 (or another appropriate location).

Q2 -- Assess the validity, defensibility and appropriateness of the model development, and calibration

a) Determine if the model is appropriate, defensible, and valid, given the District's MFLs approach.
   a) The models are appropriate, defensible, and valid
   b) The model codes are popular and well accepted

b) Evaluate the validity and appropriateness of all assumptions used in the model development and calibration.
   - Are the assumptions reasonable and consistent given the "best information available"?
   - Is there information available that could have been used to eliminate any of the assumptions? Could the use of this additional information substantially change the models results?

The best information available was used to develop and calibrate the models. Subsequent slides focus on detailed review of the HEC-RAS model.

Q2 -- Assess the validity, defensibility and appropriateness of the model development, and calibration

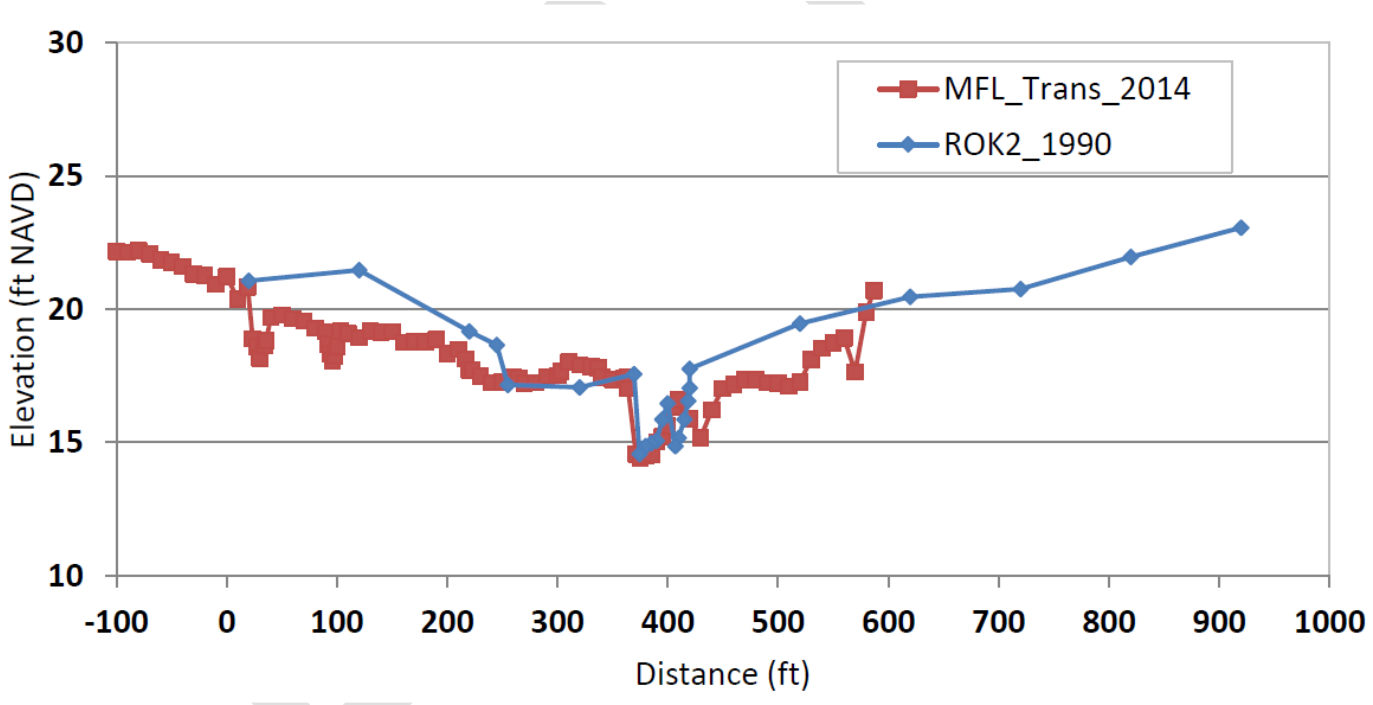
c) Review model input and output data including but not limited to:

- Model elevations vs collected data to verify same datum used consistently;
- Flow/stage plots to look for model instabilities;
- Output file for model warnings (full flow channels, flooded nodes, etc.);
- Continuity error and convergence data;
- Water budget to check for reasonableness;
- Values assigned to model parameters to check for reasonableness;
- Appropriateness of boundary conditions including spring flows and river stages used in model inputs; and
- Review of the methodologies used to:
    a) Develop boundary conditions including spring flows; and
    b) Incorporate HSPF output in HEC-RAS models.

The above items were included in the in-depth review.

Cross sections

- Good density of cross sections
- Good density of ground shots



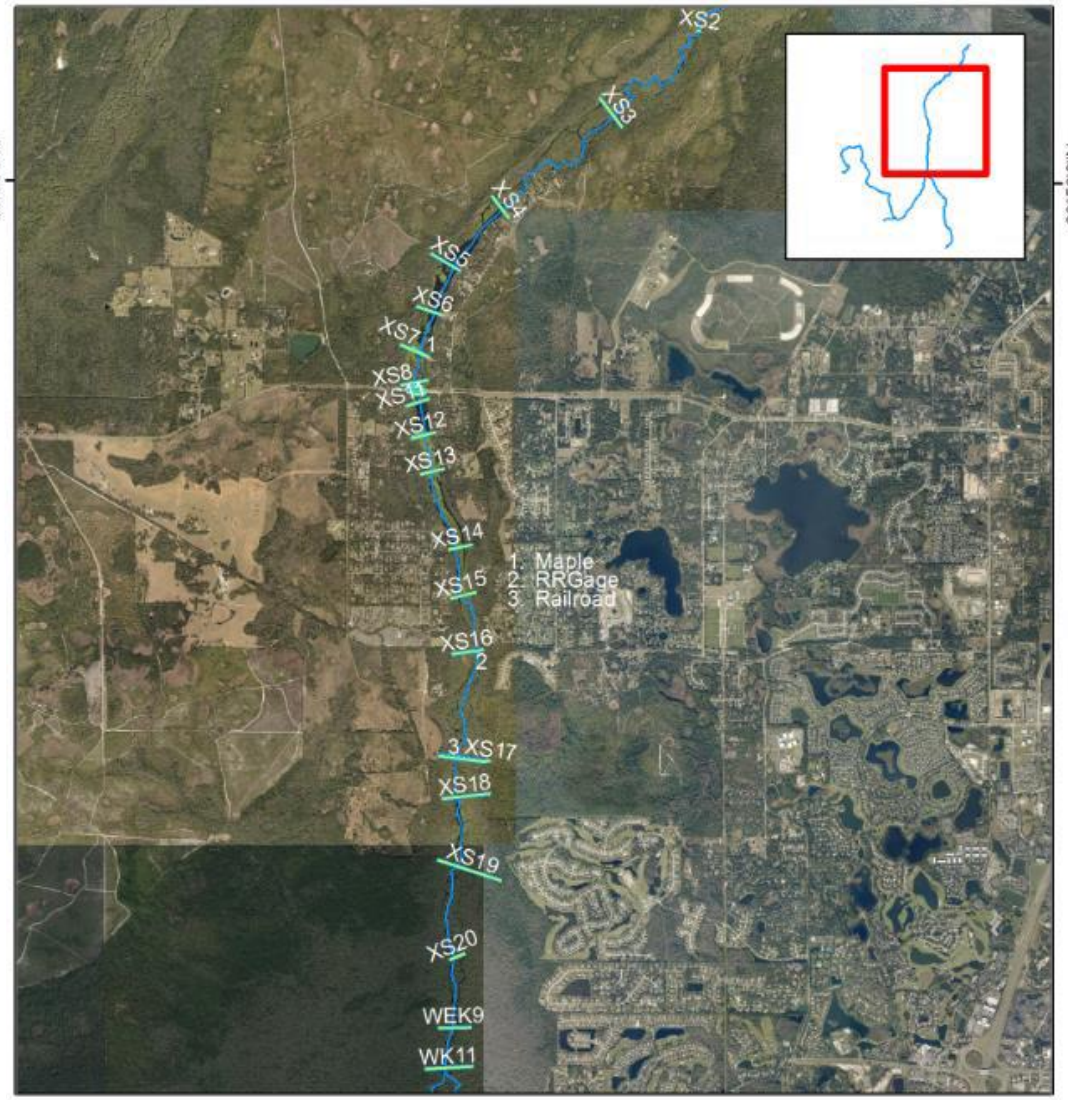
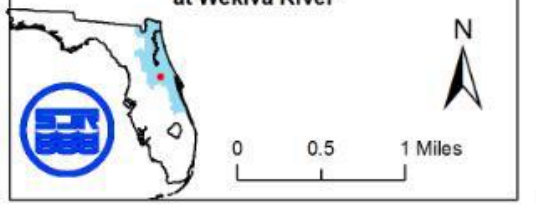
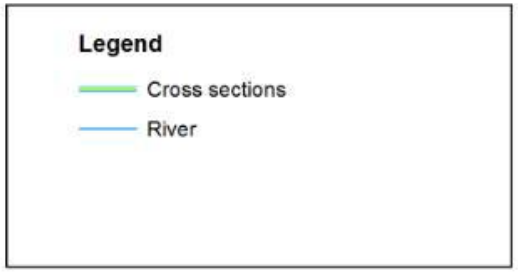
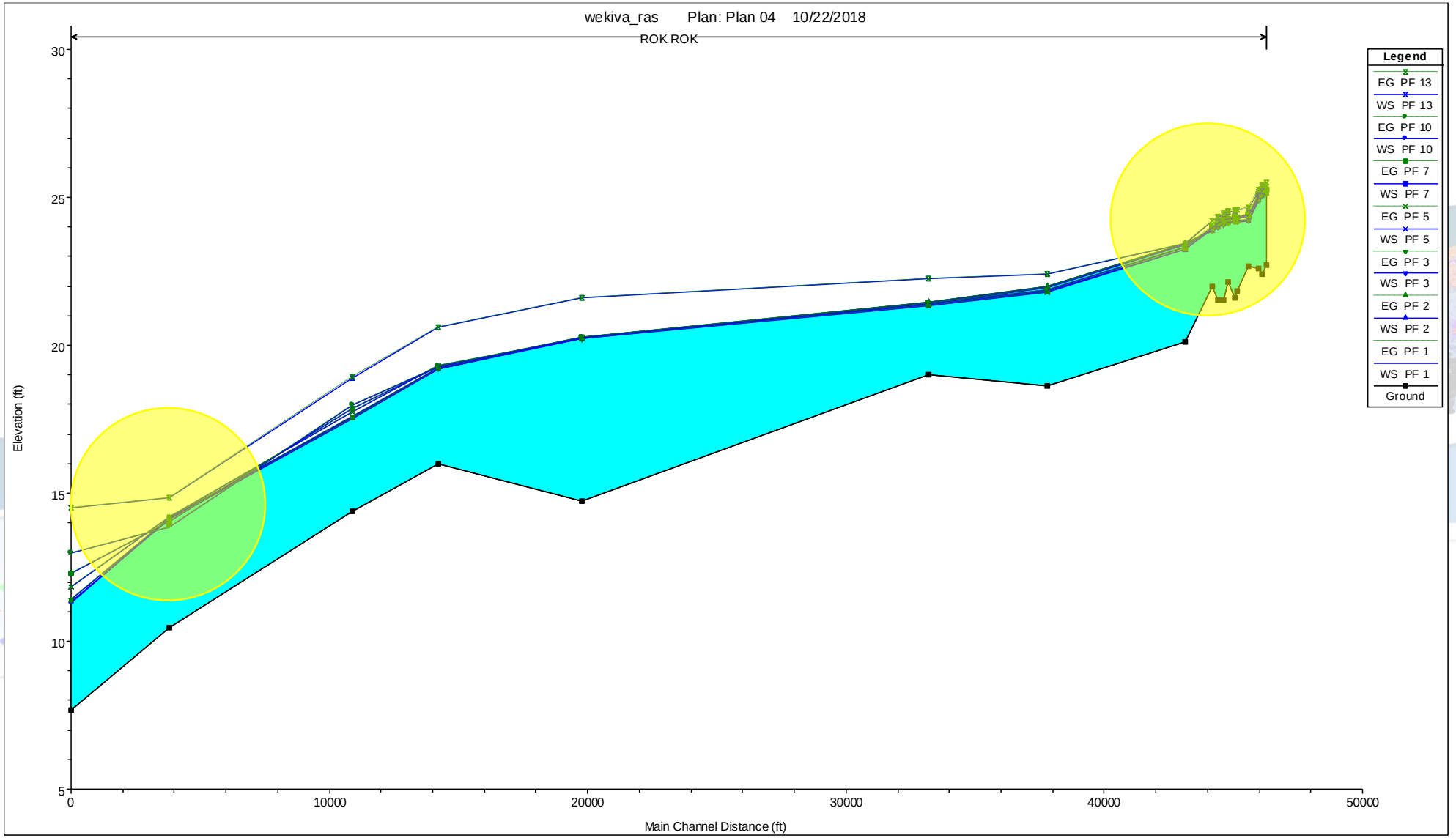


Figure 11. Location of Cross Sections at Wekiva River





Continuity Issues



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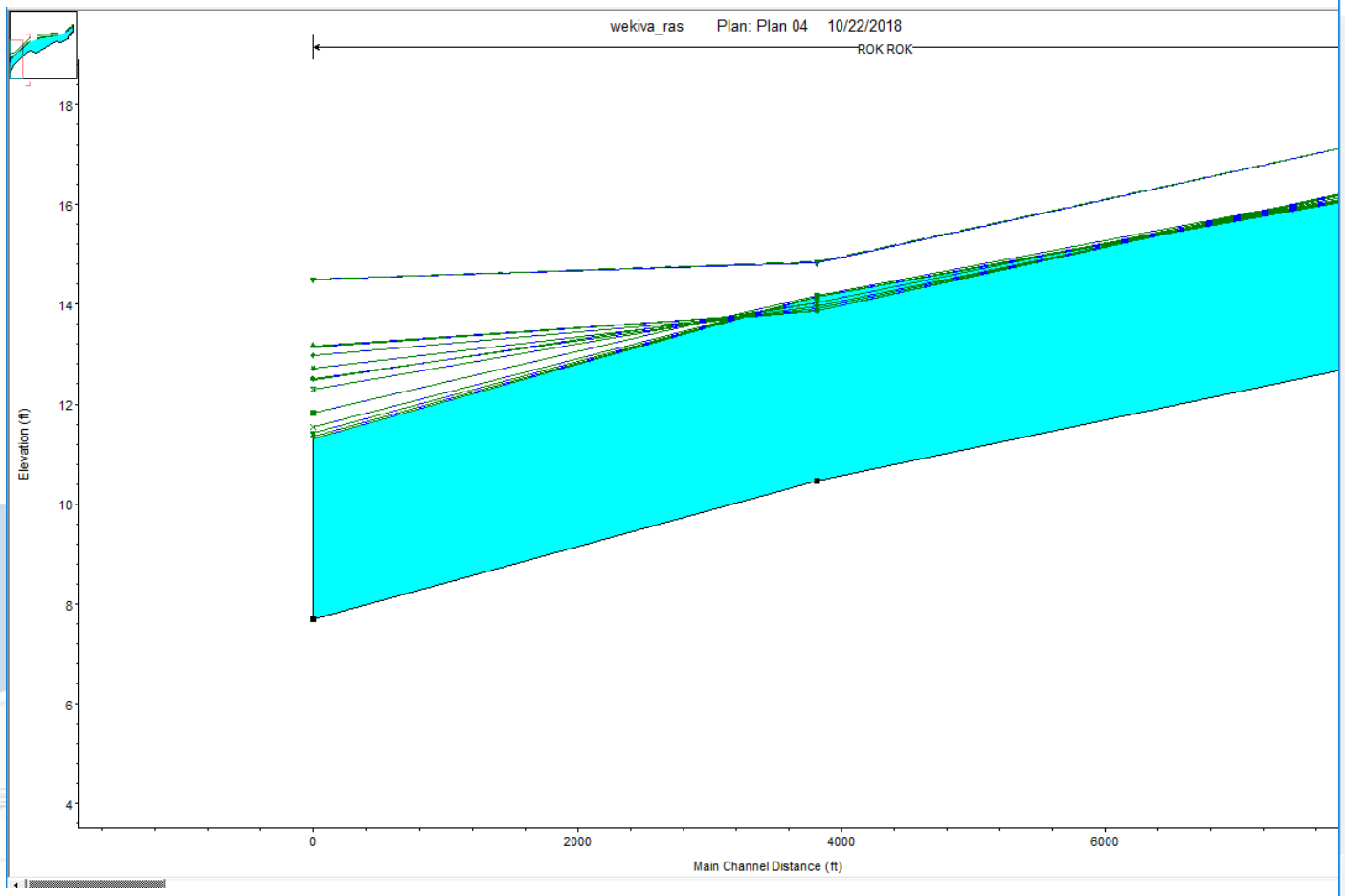


Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W (ft)
ROK	126.88 ROK2	PF 9	72.93	14.40	17.95	
ROK	126.88 ROK2	PF 10	73.43	14.40	17.97	
ROK	126.88 ROK2	PF 11	79.49	14.40	18.03	
ROK	126.88 ROK2	PF 12	72.45	14.40	17.97	
ROK	126.88 ROK2	PF 13	244.78	14.40	18.91	
ROK	56.34 ROK1	PF 1	48.06	10.47	14.15	
ROK	56.34 ROK1	PF 2	47.05	10.47	14.14	
ROK	56.34 ROK1	PF 3	50.04	10.47	14.16	
ROK	56.34 ROK1	PF 4	50.91	10.47	14.15	
ROK	56.34 ROK1	PF 5	67.01	10.47	14.18	
ROK	56.34 ROK1	PF 6	60.87	10.47	13.96	
ROK	56.34 ROK1	PF 7	71.45	10.47	14.04	
ROK	56.34 ROK1	PF 8	68.89	10.47	14.04	
ROK	56.34 ROK1	PF 9	72.93	10.47	13.91	
ROK	56.34 ROK1	PF 10	73.43	10.47	13.86	
ROK	56.34 ROK1	PF 11	79.49	10.47	13.86	
ROK	56.34 ROK1	PF 12	72.45	10.47	13.86	
ROK	56.34 ROK1	PF 13	244.78	10.47	14.84	
ROK	18.17 WK16	PF 1	52.63	7.68	11.31	
ROK	18.17 WK16	PF 2	54.45	7.68	11.35	
ROK	18.17 WK16	PF 3	56.24	7.68	11.42	

Flow Profiles

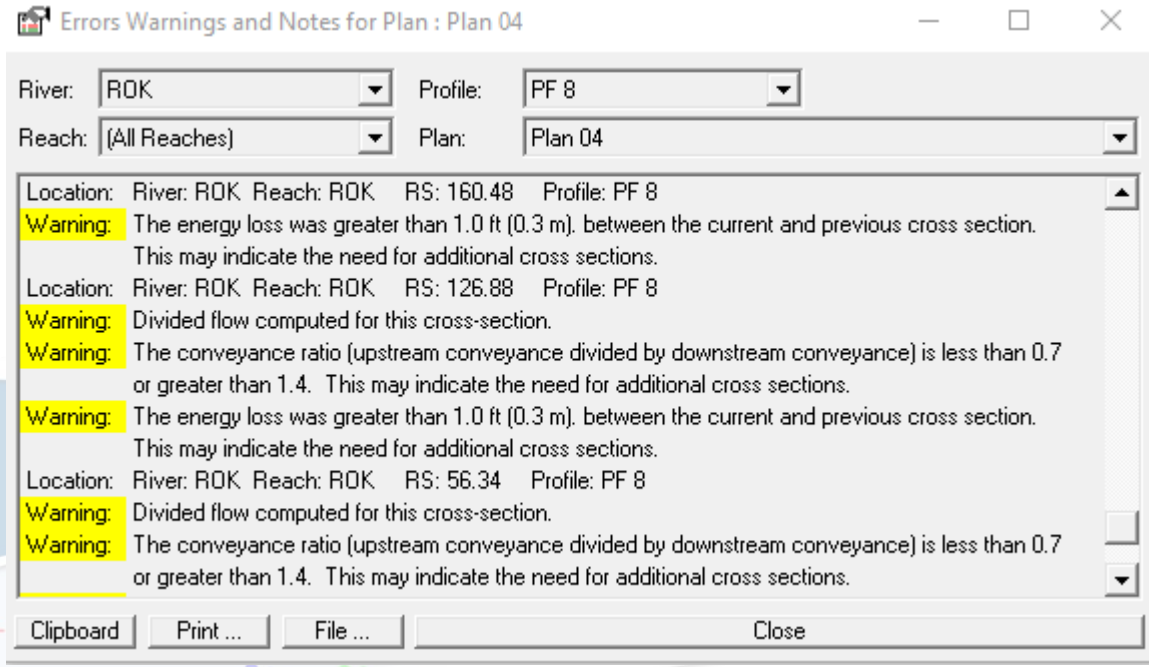
Table 13 Flow profiles for steady state simulation

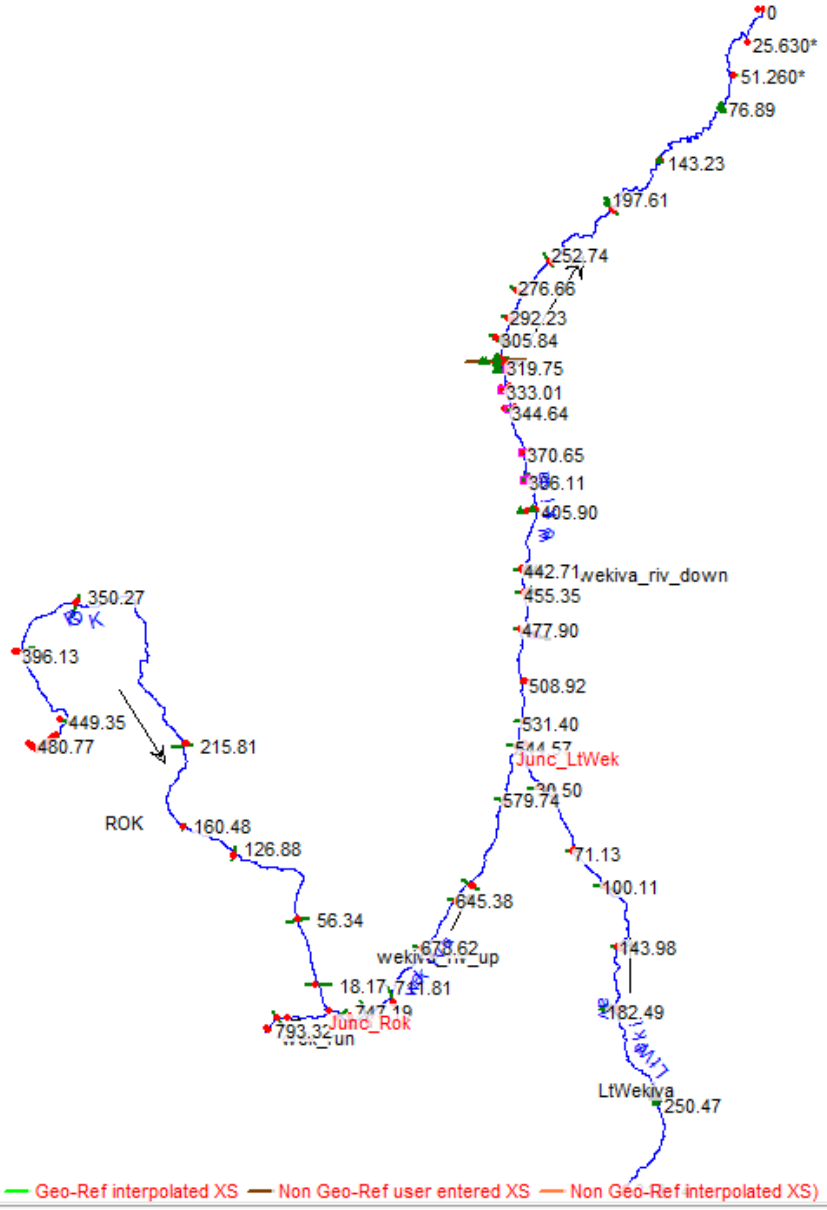
Stream	XS	RS	PF 1	PF 2	PF 3	PF 4	PF 5	PF 6	PF 7	PF 8	PF 9	PF 10	PF 11	PF 12	PF 13
Little Wekiva	SR434	312.14	0.9	0.4	5.3	14.1	20.5	44.8	80.3	64.8	279.0	295.0	340.0	269.0	536.0
	SLB	245.69	29.1	29.5	36.0	47.5	57.3	99.9	113.6	112.3	320.2	345.1	382.7	327.3	576.7
	Sabol	182.49	29.3	29.7	36.2	47.9	58.1	118.5	114.8	113.8	326.6	354.8	398.6	333.1	640.0
	WK18	30.50	29.1	30.1	34.7	51.6	62.7	140.1	216.3	140.0	319.5	384.4	433.2	448.6	1020.7
Rock Springs Run	Rock Springs	480.77	46.8	46.0	48.1	48.8	56.1	50.6	56.8	58.2	59.0	59.1	56.8	59.1	72.3
	ROK5	350.27	46.8	46.0	48.1	49.1	58.2	53.9	60.4	61.2	66.4	65.4	69.4	65.1	118.0
	ROK4	215.81	48.1	47.1	50.0	50.9	67.0	60.9	71.5	68.9	72.9	73.4	79.5	72.5	244.8
	WK16	18.17	52.6	54.5	56.2	58.7	72.6	118.3	84.4	119.1	135.4	162.7	173.0	184.5	421.9
Wekiwa Run	WekSpr6	793.32	50.5	50.2	52.2	54.4	63.3	59.5	65.1	55.0	58.9	60.0	57.3	59.4	58.0
Wekiva River	WEK12	747.19	103.6	105.1	108.9	113.8	137.9	187.4	152.0	176.3	196.3	227.8	237.3	246.1	529.1
	WEK10	579.74	109.2	114.1	116.3	120.9	136.5	260.4	196.5	274.2	254.1	311.5	348.6	363.4	546.8
	WK11	544.57	138.3	144.2	151.0	172.5	199.2	400.5	412.8	414.2	573.7	695.8	781.8	812.0	1567.5
	XS19	477.90	134.5	139.0	148.0	180.4	210.9	381.7	451.0	456.6	644.0	771.6	900.7	897.7	1713.0
	XS15	386.11	149.5	153.5	163.4	196.4	226.5	398.6	469.1	473.9	662.3	789.8	919.3	915.9	1732.9
	XS12	333.01	150.0	155.0	164.0	196.0	225.0	407.0	467.0	479.0	665.0	797.0	922.0	927.0	1740.0
	XS2	143.23	164.1	169.5	178.6	235.9	259.2	395.5	520.6	552.9	662.2	837.0	896.8	992.4	1896.4
	Black Water Creek	25.63	192.3	196.8	213.1	291.6	336.5	496.7	799.6	674.1	976.3	1149.2	1327.2	1309.7	3142.0

Model Elevations vs Collected Data

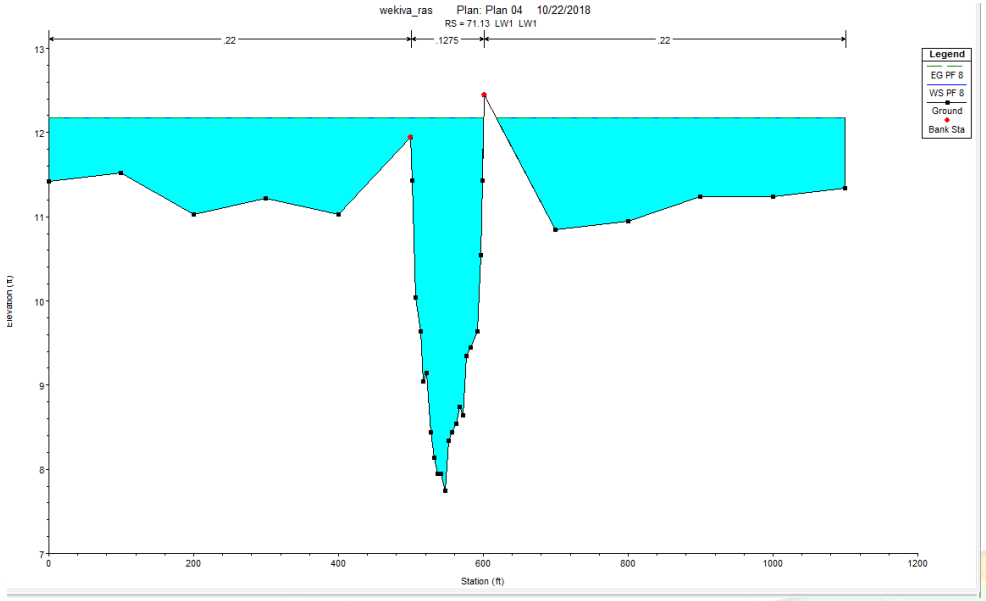
- The following water level elevations in Table 14 were verified as ft NAVD88 via USGS or SJRWMD data web sites:
- PF8 12/4/2014
  - SJRWMD 340785151 Rock Springs Run ROK2 17.68 ft NAVD88
  - SJRWMD 00330830 Rock Springs at Apopka 24.93 ft NAVD88
  - SJRWMD 09512135 Wekiva River at Old Railroad Bridge at Sanford 9.58 ft NAVD88
  - SJRWMD 00371831 Wekiwa Springs at Altamonte Springs 12.81 ft NAVD88
  - USGS 02234990 Little Wekiva River near Altamonte Springs, FL 23.6 ft NAVD88
  - USGS 02235000 Wekiva River near Sanford, FL 7.49 ft NAVD88
- PF6 8/27/2012
  - SJRWMD 09522138 Wekiva River at Apopka 12.62 ft NAVD88
- PF 11 5/22/2009
  - SJRWMD 09502132 Little Wekiva River at Springs Landing 19.66 ft NAVD88
- Conclusion: the correct datum was used for model calibration data.

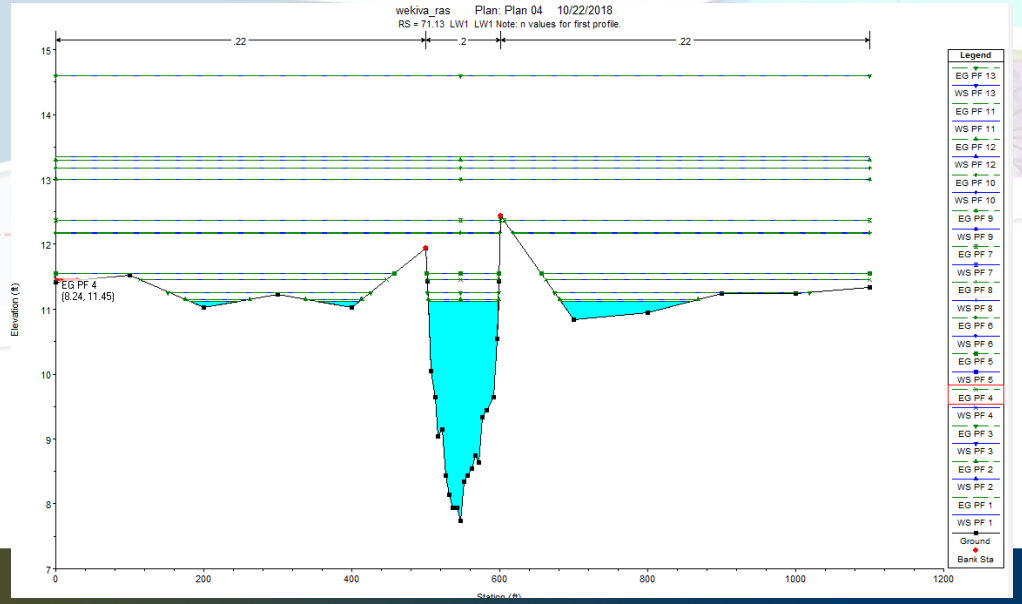
Output File for Model Warnings





Output File for Model Warnings





Errors Warnings and Notes for Plan : Plan 04

River: LtWekiva Profile: PF 8

Reach: (All Reaches) Plan: Plan 04

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
Location:	River: LtWekiva Reach: LtWekiva RS: 182.49 Profile: PF 8
Warning:	Divided flow computed for this cross-section.
Warning:	The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
Location:	River: LtWekiva Reach: LtWekiva RS: 143.98 Profile: PF 8
Warning:	The cross-section end points had to be extended vertically for the computed water surface.
Location:	River: LtWekiva Reach: LtWekiva RS: 100.11 Profile: PF 8
Warning:	Divided flow computed for this cross-section.
Warning:	The cross-section end points had to be extended vertically for the computed water surface.
Location:	River: LtWekiva Reach: LtWekiva RS: 71.13 Profile: PF 8
Warning:	Divided flow computed for this cross-section.
Warning:	The cross-section end points had to be extended vertically for the computed water surface.
Warning:	The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Location:	River: LtWekiva Reach: LtWekiva RS: 30.50 Profile: PF 8

Clipboard Print ... File ... Close

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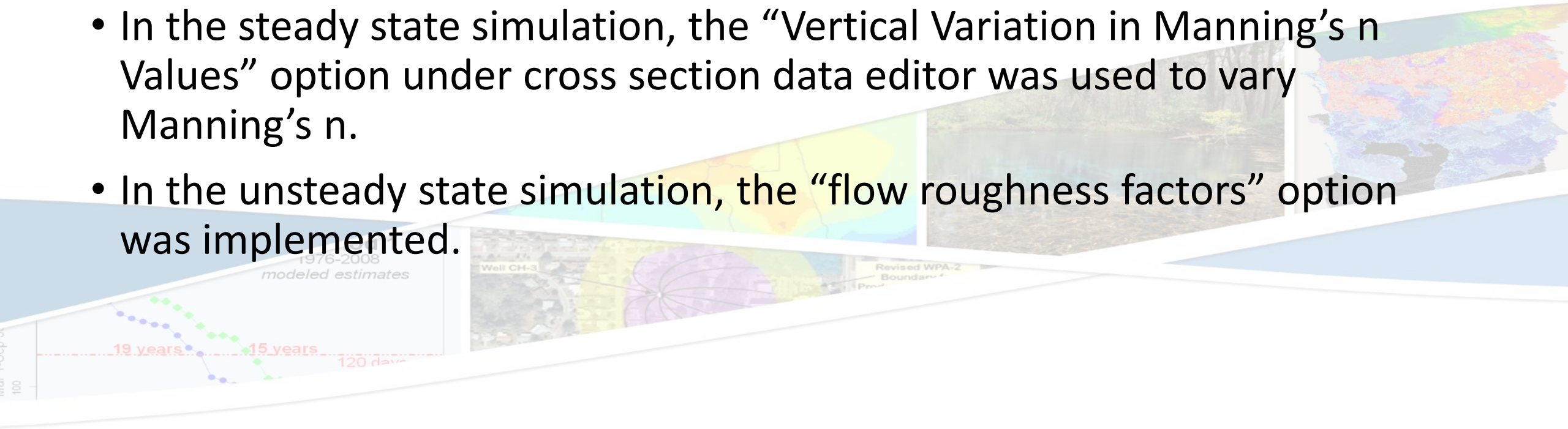
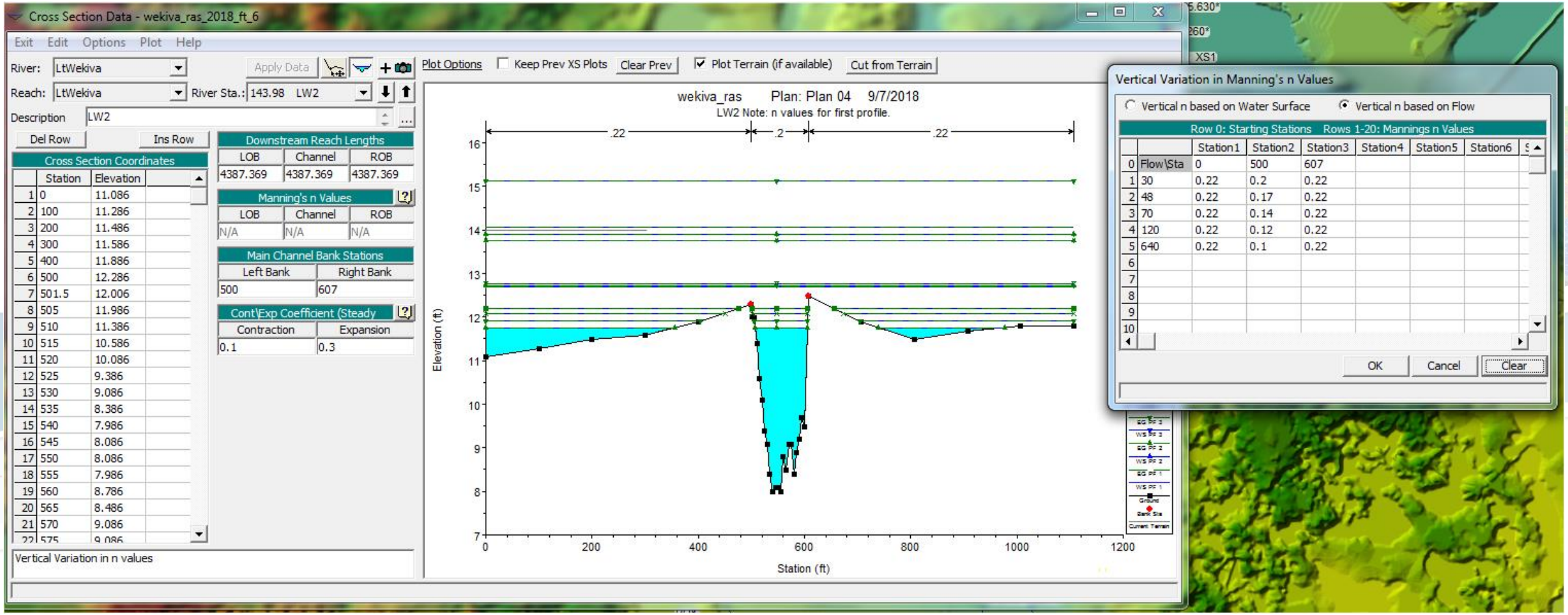
Reasonableness of Model Parameter Values

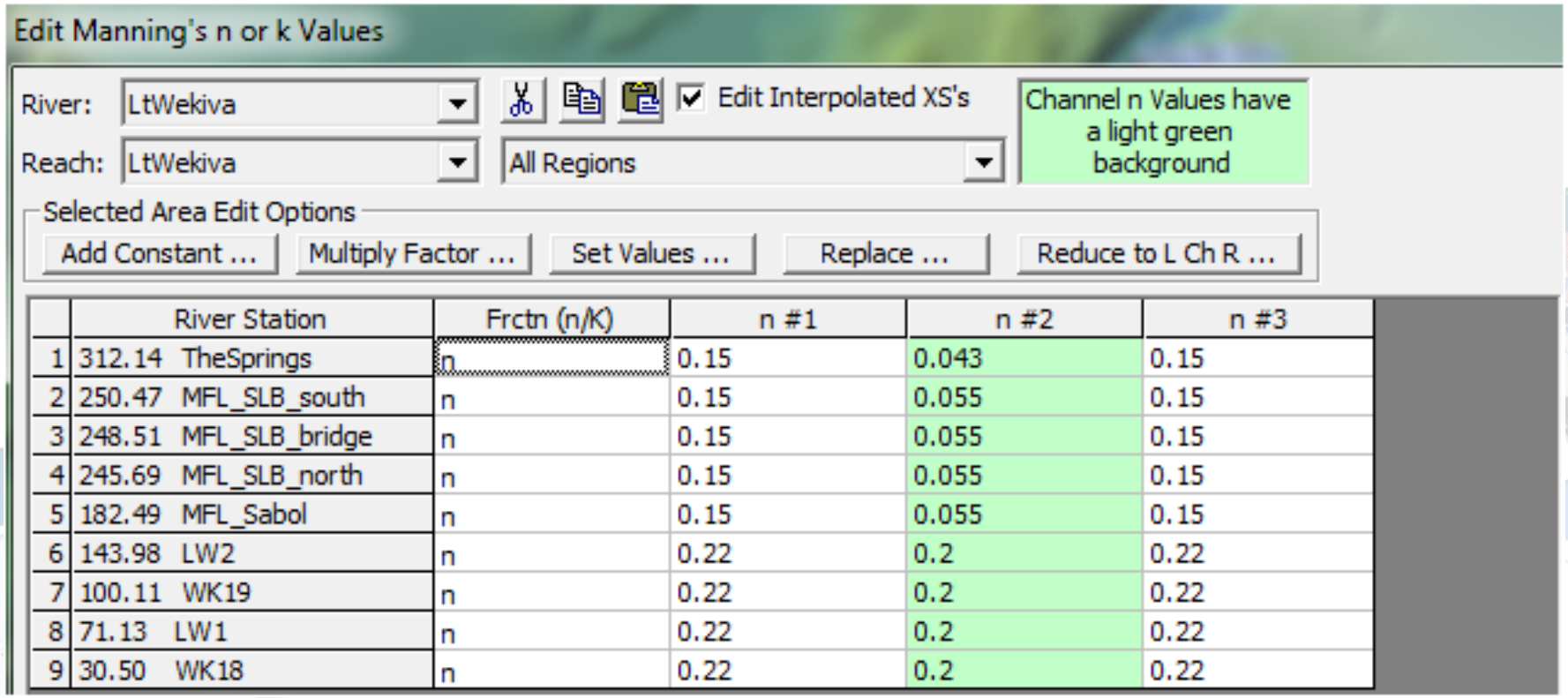
- Manning's n was varied with respect to flow to simulate low to high flow regimes for both steady and unsteady simulation.
- In the steady state simulation, the "Vertical Variation in Manning's n Values" option under cross section data editor was used to vary Manning's n.
- In the unsteady state simulation, the "flow roughness factors" option was implemented.



Manning's n


Cross Section Data - wekiva_ras_2018_ft_6
Exit Edit Options Plot Help
River: LtWekiva
Reach: LtWekiva
River Sta.: 143.98 LW2
Description LW2
Apply Data
Plot Options
Keep Prev XS Plots
Clear Prev
Plot Terrain (if available)
Cut from Terrain
Del Row
Ins Row
Cross Section Coordinates
Station Elevation
1 0 11.086
2 100 11.286
3 200 11.486
4 300 11.586
5 400 11.886
6 500 12.286
7 501.5 12.006
8 505 11.986
9 510 11.386
10 515 10.586
11 520 10.086
12 525 9.386
13 530 9.086
14 535 8.386
15 540 7.986
16 545 8.086
17 550 8.086
18 555 7.986
19 560 8.786
20 565 8.486
21 570 9.086
22 575 9.086
Downstream Reach Lengths
LOB Channel ROB
4387.369 4387.369 4387.369
Manning's n Values
LOB Channel ROB
N/A N/A N/A
Main Channel Bank Stations
Left Bank Right Bank
500 607
Cont\Exp Coefficient (Steady
Contraction Expansion
0.1 0.3
Vertical Variation in n values
wekiva_ras Plan: Plan 04 9/7/2018
LW2 Note: n values for first profile.
.22
.2
.22
Elevation (ft)
Station (ft)
Vertical Variation in Manning's n Values
Vertical n based on Water Surface
Vertical n based on Flow
Row 0: Starting Stations Rows 1-20: Mannings n Values
Station1 Station2 Station3 Station4 Station5 Station6
0 Flow\Sta 0 500 607
1 30 0.22 0.2 0.22
2 48 0.22 0.17 0.22
3 70 0.22 0.14 0.22
4 120 0.22 0.12 0.22
5 640 0.22 0.1 0.22
OK
Cancel
Clear

Manning's n- Variation Along the Channel



	River Station	Frctn (n/K)	n #1	n #2	n #3
1	312.14 TheSprings	n	0.15	0.043	0.15
2	250.47 MFL_SLB_south	n	0.15	0.055	0.15
3	248.51 MFL_SLB_bridge	n	0.15	0.055	0.15
4	245.69 MFL_SLB_north	n	0.15	0.055	0.15
5	182.49 MFL_Sabol	n	0.15	0.055	0.15
6	143.98 LW2	n	0.22	0.2	0.22
7	100.11 WK19	n	0.22	0.2	0.22
8	71.13 LW1	n	0.22	0.2	0.22
9	30.50 WK18	n	0.22	0.2	0.22

Manning's n- Variation Along the Channel

Edit Manning's n or k Values

River: ROK | Edit Interpolated XS's | Channel n Values have a light green background

Reach: (All Reaches) | All Regions

Selected Area Edit Options

Add Constant ... | Multiply Factor ... | Set Values ... | Replace ... | Reduce to L Ch R ...

	Reach	River Station	Frctn (n/K)	n #1	n #2	n #3
1	ROK	480.77 RokSpr02	n	0.15	0.04	0.15
2	ROK	479.28 RokSpr03	n	0.15	0.04	0.15
3	ROK	477.83 RokSpr04	n	0.15	0.04	0.15
4	ROK	473.86 RokSpr05	n	0.15	0.04	0.15
5	ROK	469.5 RokSpr08	n	0.15	0.04	0.15
6	ROK	468.64 RokSpr09	n	0.15	0.04	0.15
7	ROK	466.21 RokSpr11	n	0.15	0.04	0.15
8	ROK	464.28 RokSpr12	n	0.15	0.04	0.15
9	ROK	462.31 RokSpr13	n	0.15	0.04	0.15
10	ROK	459.92 RokSpr14	n	0.15	0.04	0.15
11	ROK	449.35 ROK7	n	0.18	0.04	0.18
12	ROK	396.13 ROK6	n	0.18	0.2	0.18
13	ROK	350.27 ROK5	n	0.18	0.2	0.18
14	ROK	215.81 ROK4	n	0.18	0.2	0.18
15	ROK	160.48 ROK3	n	0.18	0.2	0.18
16	ROK	126.88 ROK2	n	0.18	0.2	0.18
17	ROK	56.34 ROK1	n	0.18	0.2	0.18
18	ROK	18.17 WK16	n	0.18	0.2	0.18

River: wekiva | Edit Interpolated XS's | Channel n Values have a light green background

Reach: (All Reaches) | All Regions

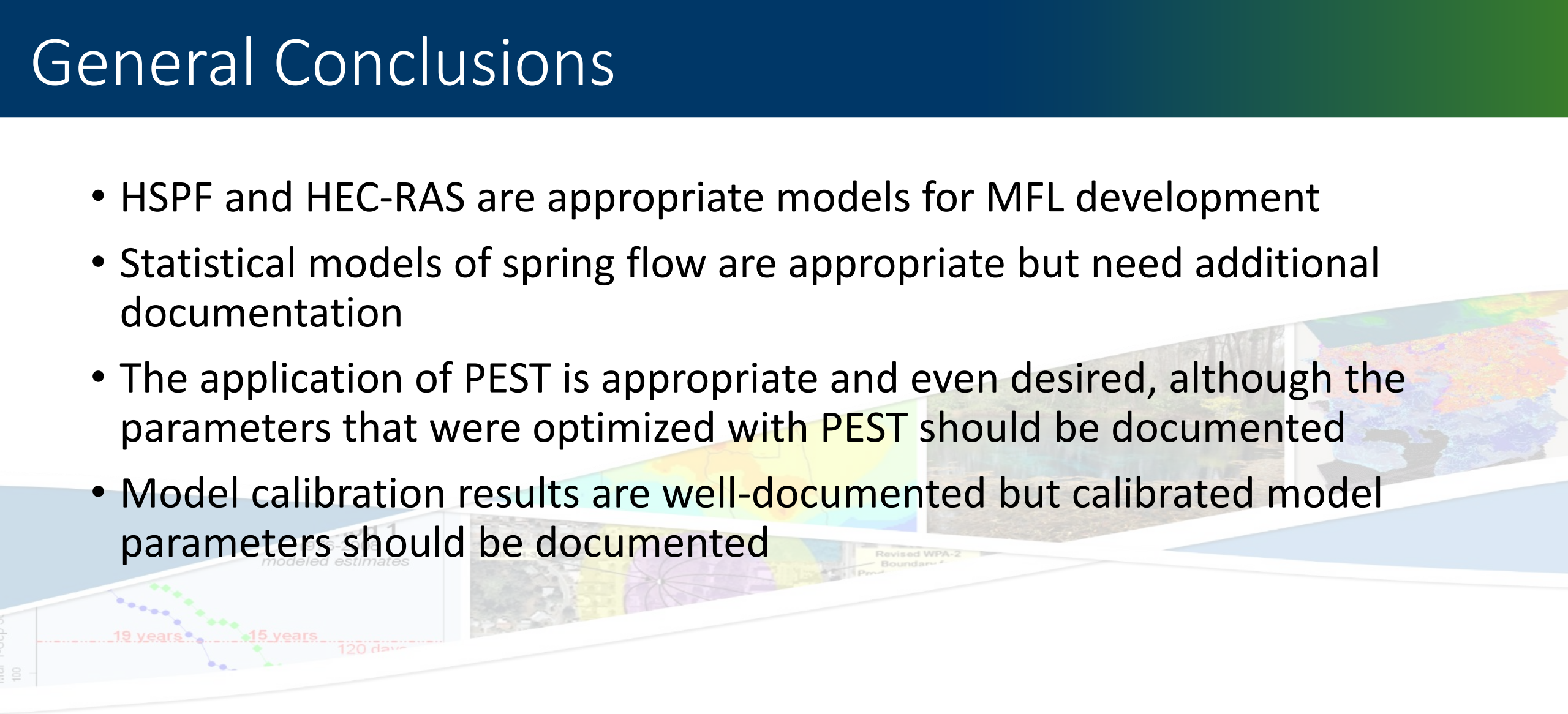
Selected Area Edit Options

Add Constant ... | Multiply Factor ... | Set Values ... | Replace ... | Reduce to L Ch R ...

	Reach	River Station	Frctn (n/K)	n #1	n #2	n #3	n #4	n #5	n #6
1	wek_run	793.32 WekSpr6	n	0.22	0.17	0.22	0.17	0.22	
2	wek_run	785.19 WEK13	n	0.22	0.2	0.22			
3	wek_run	779.51 WK17	n	0.22	0.2	0.22			
4	wekiva_riv_up	747.19 WEK12	n	0.22	0.2	0.22			
5	wekiva_riv_up	739.30	n	0.22	0.17	0.22			
6	wekiva_riv_up	739	Bridge						
7	wekiva_riv_up	738.80	n	0.22	0.17	0.22			
8	wekiva_riv_up	729.66 WK15	n	0.22	0.17	0.22			
9	wekiva_riv_up	711.81 WK14	n	0.22	0.17	0.22			
10	wekiva_riv_up	678.62 WEK11	n	0.22	0.2	0.22			
11	wekiva_riv_up	645.38 MFL_Swamp	n	0.22	0.2	0.22			
12	wekiva_riv_up	632.67 WK12	n	0.22	0.2	0.22			
13	wekiva_riv_up	579.74 WEK10	n	0.22	0.2	0.22			
14	wekiva_riv_down	544.57 WK11	n	0.22	0.2	0.22			
15	wekiva_riv_down	531.40 WEK9-copy of WK1	n	0.22	0.2	0.22			
16	wekiva_riv_down	508.92 XS20	n	0.22	0.2	0.22			
17	wekiva_riv_down	477.90 XS19	n	0.22	0.2	0.22			
18	wekiva_riv_down	455.35 XS18	n	0.22	0.2	0.22			
19	wekiva_riv_down	442.71 MFL_RailRoad	n	0.22	0.2	0.22			
20	wekiva_riv_down	442.46 XS17	n	0.22	0.2	0.22			
21	wekiva_riv_down	405.90 MFL_RailRoadGage	n	0.22	0.2	0.22			
22	wekiva_riv_down	405.81 XS16	n	0.22	0.2	0.22			
23	wekiva_riv_down	386.11 XS15	n	0.22	0.2	0.22			
24	wekiva_riv_down	370.65 XS14	n	0.22	0.2	0.22			
25	wekiva_riv_down	344.64 XS13	n	0.22	0.2	0.22			
26	wekiva_riv_down	333.01 XS12	n	0.22	0.2	0.22			
27	wekiva_riv_down	332.58 MFL_Flats	n	0.22	0.2	0.22			
28	wekiva_riv_down	322.22 XS11	n	0.22	0.2	0.22			
29	wekiva_riv_down	319.75 MFL_SR46E	n	0.22	0.2	0.22			
30	wekiva_riv_down	318.86 XS10	n	0.22	0.22	0.2	0.22		
31	wekiva_riv_down	318.81 MFL_SR46B	n	0.22	0.2	0.22			
32	wekiva_riv_down	318.50	Bridge						
33	wekiva_riv_down	318.19 MFL_SR46A	n	0.22	0.2	0.22			
34	wekiva_riv_down	318.03 XS9	n	0.22	0.2	0.22			
35	wekiva_riv_down	317.25 MFL_SR46F	n	0.22	0.2	0.22			
36	wekiva_riv_down	315.81 XS8	n	0.22	0.2	0.22			
37	wekiva_riv_down	305.84 XS7	n	0.22	0.22	0.2	0.22	0.22	
38	wekiva_riv_down	305.54 MFL_Maple	n	0.22	0.22	0.2	0.22	0.22	0.22
39	wekiva_riv_down	292.23 XS6	n	0.22	0.22	0.2	0.22		
40	wekiva_riv_down	276.66 XS5	n	0.22	0.2	0.22			
41	wekiva_riv_down	252.74 XS4	n	0.22	0.22	0.22	0.2	0.22	
42	wekiva_riv_down	197.61 XS3	n	0.22	0.22	0.22	0.2	0.22	
43	wekiva_riv_down	143.23 XS2	n	0.22	0.2	0.22			
44	wekiva_riv_down	76.89 XS1	n	0.22	0.2	0.22			
45	wekiva_riv_down	51.260*	n	0.22	0.2	0.22			
46	wekiva_riv_down	25.630*	n	0.22	0.2	0.22			
47	wekiva_riv_down	0 LoWek	n	0.22	0.2	0.22			

General Conclusions

- HSPF and HEC-RAS are appropriate models for MFL development
- Statistical models of spring flow are appropriate but need additional documentation
- The application of PEST is appropriate and even desired, although the parameters that were optimized with PEST should be documented
- Model calibration results are well-documented but calibrated model parameters should be documented



Conclusions: Model Review of HSPF

- Water balance from the models is reasonable, wetland AET are reasonable.
- Calibration is adequate for MFL development.
- Initial conditions could be corrected for relative moisture; corrections would have little impact on long term results.
- Water balance should be documented.
- Impervious retention storage seems low; impervious ET reflects low RETSC.
- Impervious fractions are high but BMP and routing water to wetlands is appropriate.

Conclusions: Model Review of HEC-RAS

- Model appears to reproduce observed stages.
- Cross-sections should be extended where necessary.
- Mannings n table shows fairly high channel friction factors that reflect the vegetation present in the channel.
- Flow profiles cross over but reflect the defined flows. Flow profiles should be corrected for hysteresis to prevent cross overs.