Watsonville Sloughs Hydrology Study

Modeling Tools Workshop

January 9, 2014

RESOURCE CONSERVATION DISTRICT OF SANTA CRUZ COUNTY

Balance Hydrologics, Inc.®

Modeling Component Agenda

- Orientation to the Modeling Tools Users' Guide
- Model and software overview
- HEC-HMS hydrologic model structure
- GIS data sources, analysis, and management
- Running the HMS model
- Short break
- HEC-RAS hydraulic model structure
- Running the RAS model and scenarios

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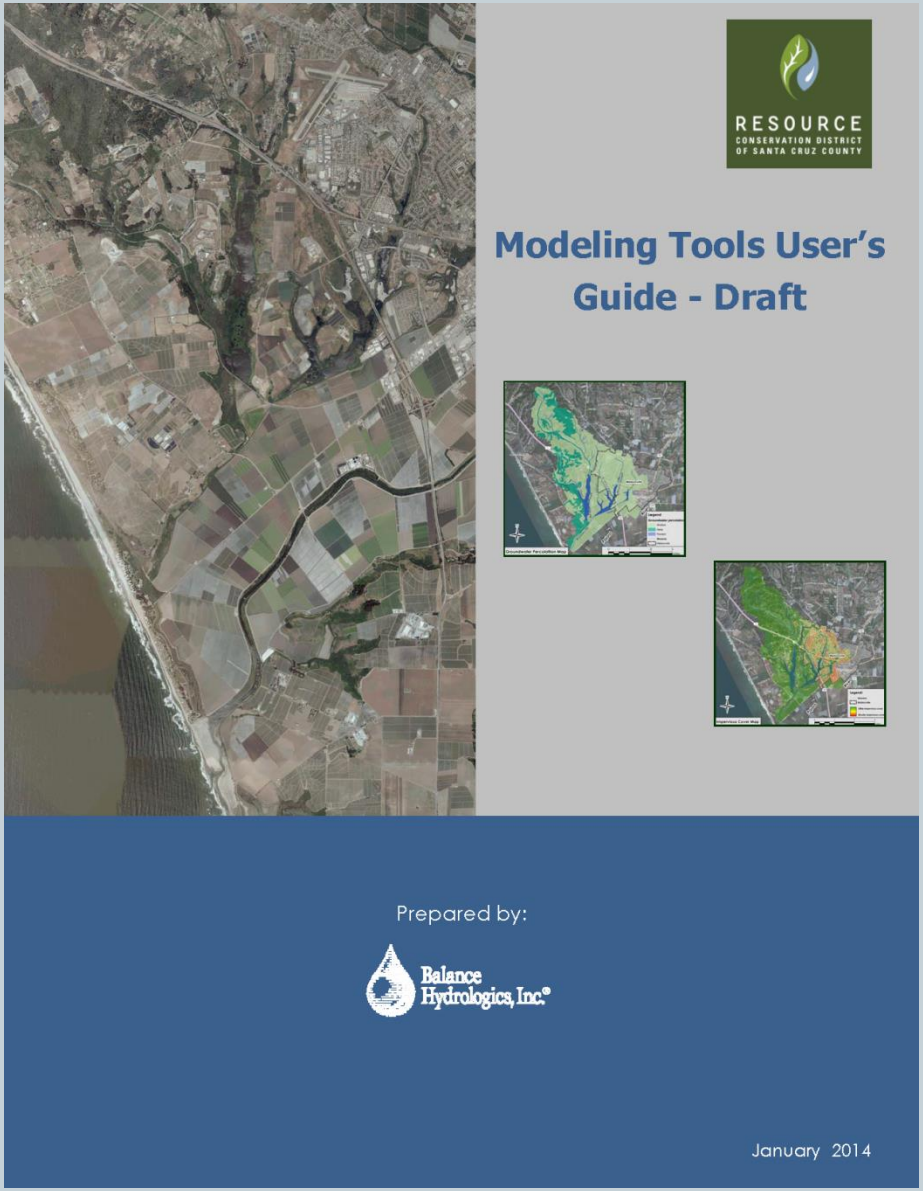
Modeling Tools Users' Guide



The Modeling Tools Users' Guide

- Step wise "cookbook" for getting started
- Covers all key modeling tools
- Outlines a consistent file naming and management structure
- Provides a base for tracking model improvements and changes

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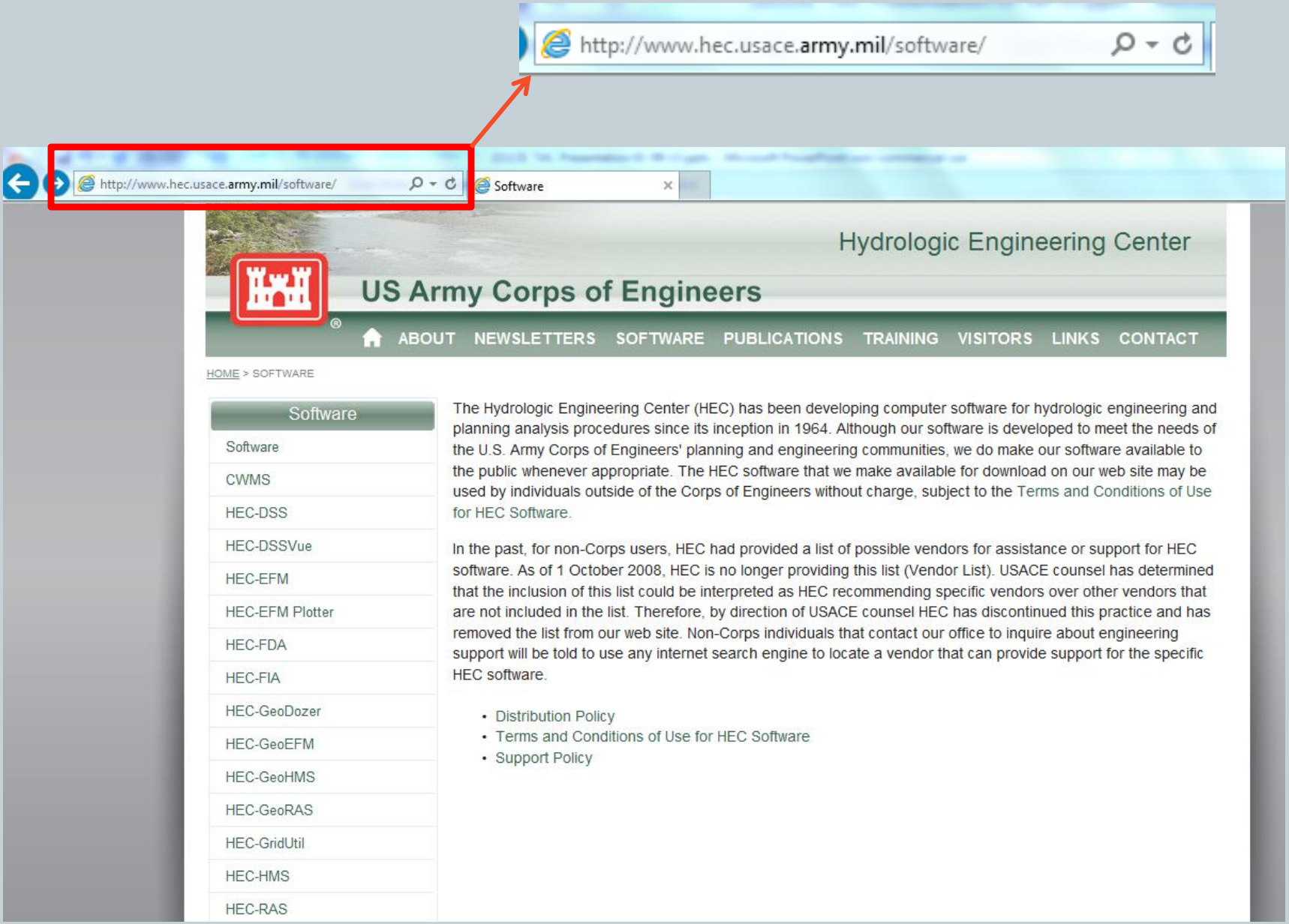
Model and Software Overview

- Explicit goal of using readily available software
- Data management and transfer
  - Microsoft Excel
- Spatial data management
  - ESRI ArcGIS
  - Autodesk AutoCADD Civil 3D
- Modeling and output management
  - HEC-HMS for hydrology
  - HEC-RAS for hydraulics
  - HEC-DSSVue for modeling data management

The Modeling Go-To Website



- Watershed Characteristics
- Climate

- Water levels
- Flow rates

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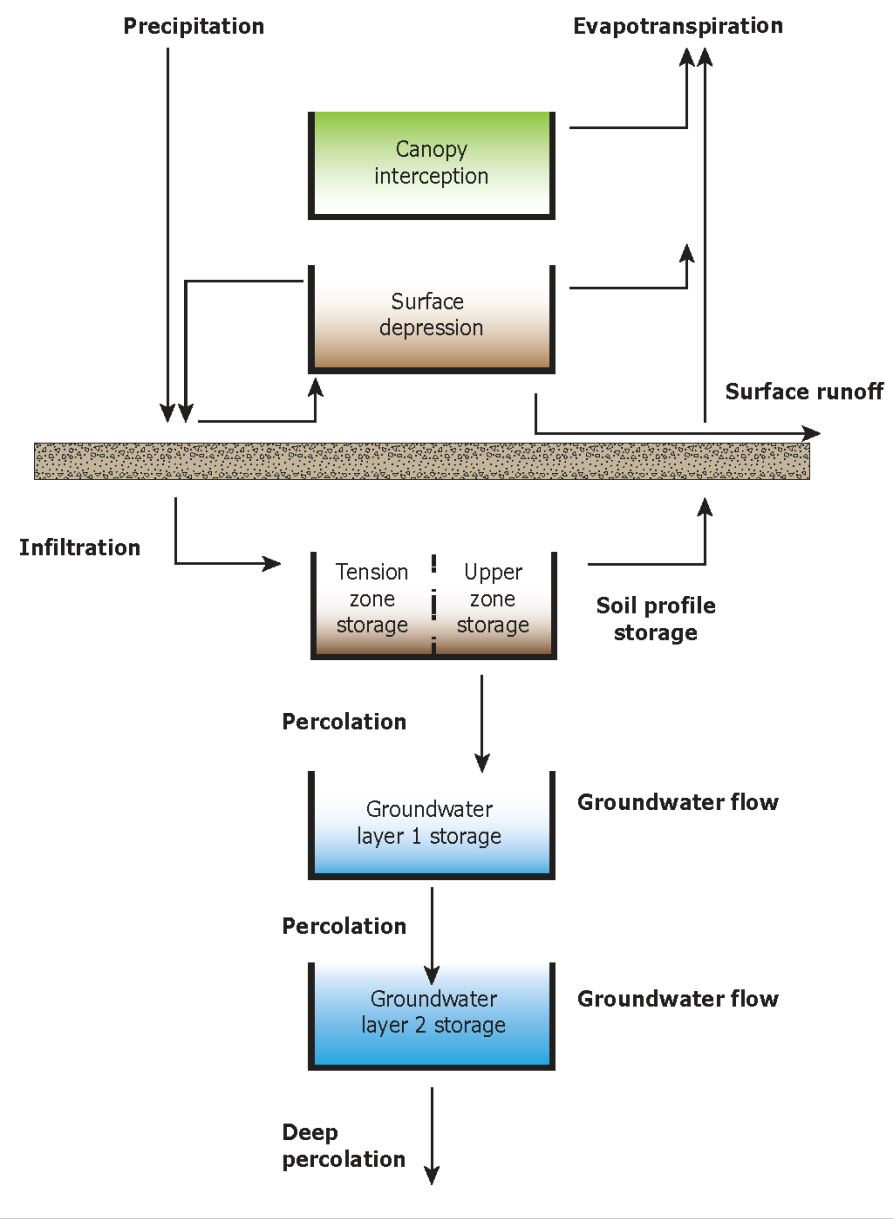
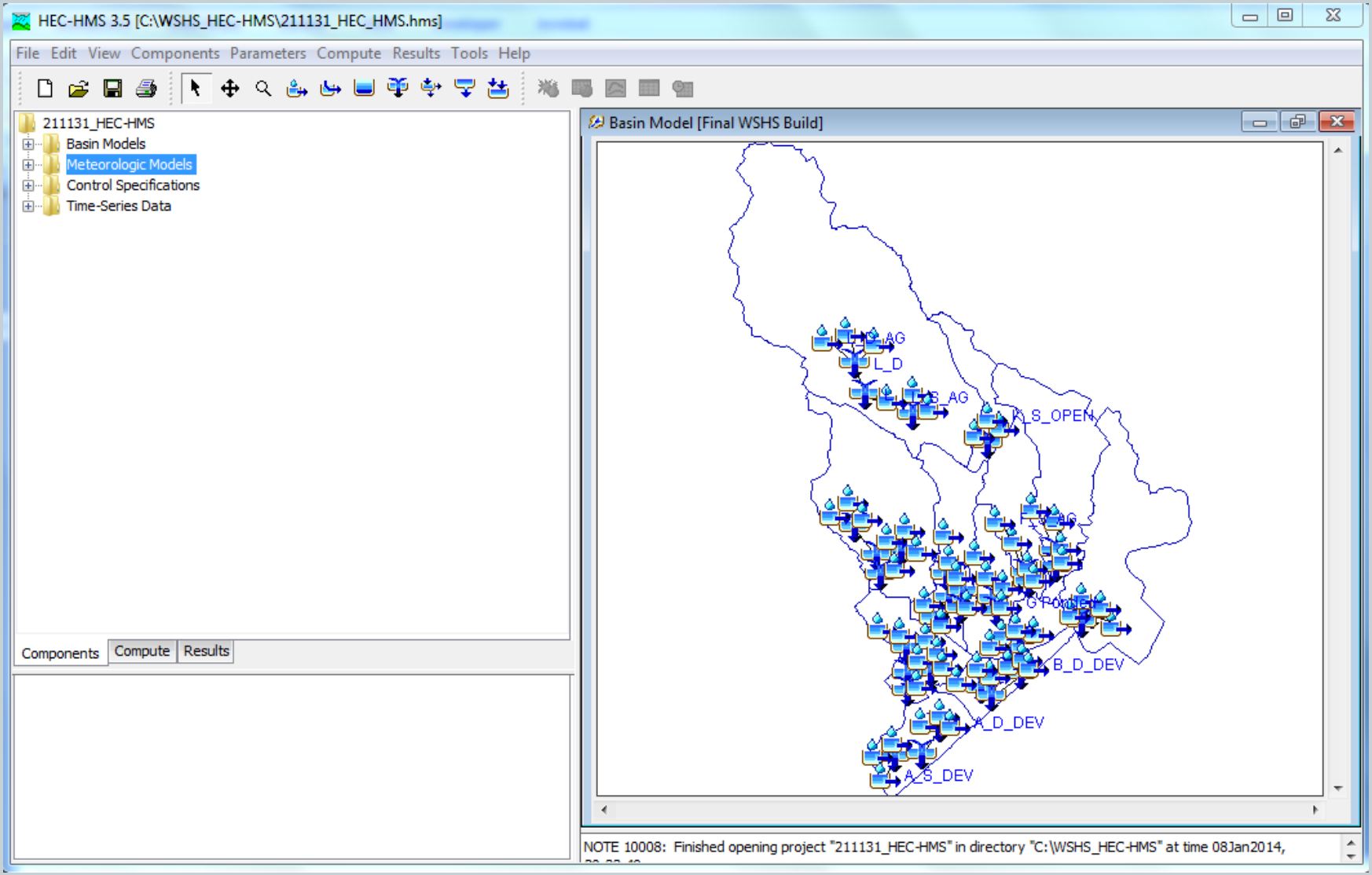
HEC-HMS Model Structure


Precipitation
Evapotranspiration
Canopy interception
Surface depression
Surface runoff
Infiltration
Tension zone storage
Upper zone storage
Soil profile storage
Percolation
Groundwater layer 1 storage
Groundwater flow
Percolation
Groundwater layer 2 storage
Groundwater flow
Deep percolation


HEC-HMS 3.5 [C:\WSHS_HEC-HMS\211131_HEC_HMS.hms]
File Edit View Components Parameters Compute Results Tools Help
211131_HEC-HMS
Basin Models
Meteorologic Models
Control Specifications
Time-Series Data
Components
Compute
Results
Basin Model [Final WSHS Build]
AG
L_D
S_AG
S_OPEN
B_D_DEV
A_D_DEV
A_S_DEV
NOTE 10008: Finished opening project "211131_HEC-HMS" in directory "C:\WSHS_HEC-HMS" at time 08Jan2014,

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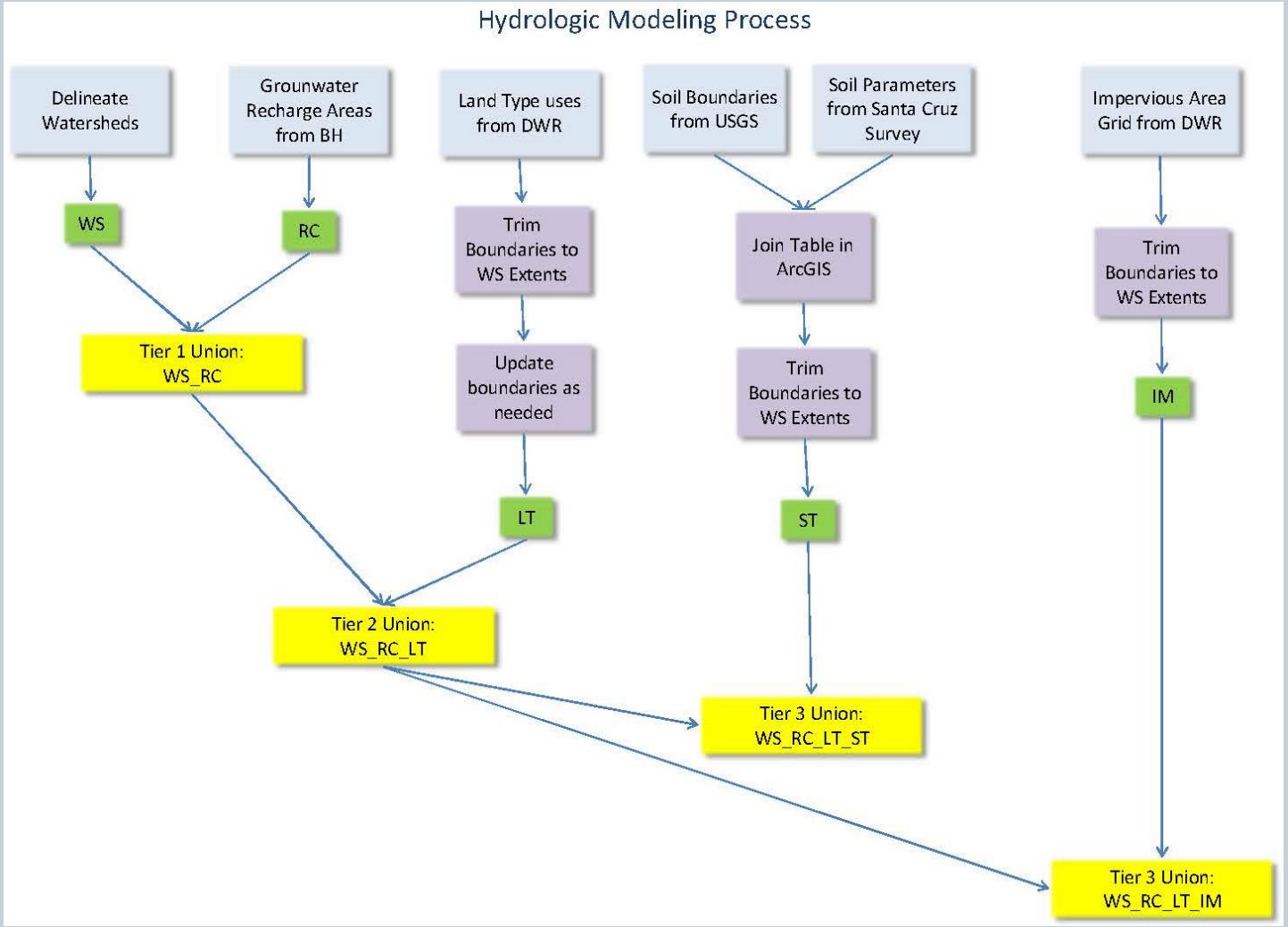
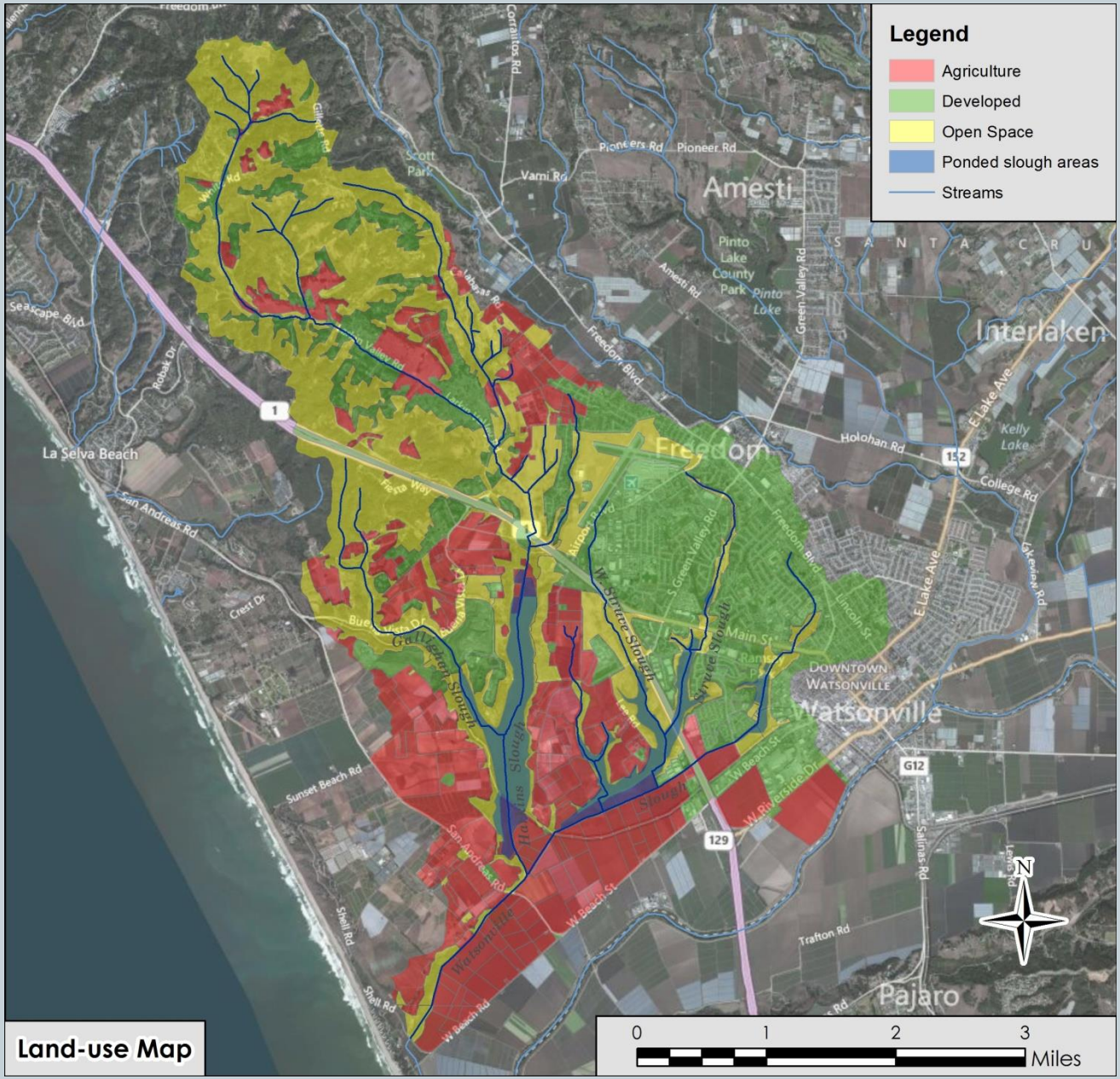
GIS Data Sources, Analysis, & Management

Data Hierarchy



GIS Data and Shape Files



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
20	Transposed Values (Alphabetical)								Adjustment Factors						For Import - Soil Accounting Parameters					
21	NAME	AREA	SOIL STORAGE	TENSION STORAGE	PERC	INFIL	Imp		S	T	P	Inf	Imp		Initial Soil Storage	Initial GW1 Storage	Initial GW2 Storage	Max Infiltration	Impervious	Soil Storage
22		*(ac)*	*(in)*	*(in)*	*(in/hr)*	*(in/hr)*	*(%)*								*(%)*	*(%)*	*(%)*	*(in/hr)*	*(%)*	*(in)*
23	A-D-A	119.2	18.3	5.2	6.0	6.0	8.2		1	1	1	1	1		5.464	0.000	0.000	5.999	8.2	18.300
24	A-D-D	0.0	18.3	5.2	6.0	6.0	0.0		1	1	1	1	1		0.000	0.000	0.000	5.998	0.0	18.300
25	A-D-O	27.4	18.3	5.2	6.0	6.0	2.5		1	1	1	1	1		0.000	0.000	0.000	5.997	2.5	18.300
26	A-S-A	348.2	18.6	8.7	0.1	0.1	2.2		1	1	1	1	1		5.376	0.000	0.000	0.060	2.2	18.600
27	A-S-D	1.1	18.6	8.7	0.1	0.1	34.2		1	1	1	1	1		0.000	0.000	0.000	0.060	34.2	18.600
28	A-S-O	38.9	18.6	8.7	0.1	0.1	0.7		1	1	1	1	1		0.000	0.000	0.000	0.063	0.7	18.600
29	B-D-A	9.9	18.3	5.2	6.0	6.0	22.9		1	1	1	1	1		5.464	0.000	0.000	5.998	22.9	18.300
30	B-D-D	0.4	18.3	5.2	6.0	6.0	30.5		1	1	1	1	1		0.000	0.000	0.000	6.000	30.5	18.300
31	B-D-O	5.4	18.3	5.2	6.0	6.0	5.8		1	1	1	1	1		0.000	0.000	0.000	5.988	5.8	18.301
32	B-S-A	350.0	18.6	8.7	0.1	0.1	3.8		1	1	1	1	1		5.376	0.000	0.000	0.060	3.8	18.600
33	B-S-D	21.9	18.6	8.7	0.1	0.1	72.4		1	1	1	1	1		0.000	0.000	0.000	0.060	72.4	18.600
34	B-S-O	0.4	18.6	8.6	0.2	0.2	11.9		1	1	1	1	1		0.000	0.000	0.000	0.155	11.9	18.595
35	C-S-A	262.3	18.6	9.0	0.0	0.3	4.6		1	1	1	1	1		5.371	0.000	0.000	0.271	4.6	18.617
36	C-S-D	36.6	18.7	9.1	0.0	0.3	69.7		1	1	1	1	1		0.000	0.000	0.000	0.275	69.7	18.676
37	C-S-O	20.2	16.0	7.7	0.0	0.3	17.1		1	1	1	1	1		0.000	0.000	0.000	0.318	17.1	16.023

WS	MAP	Adjustment	Area
			(acres)
CIMIS 129	17.9	--	
A	20.5	1.13	535
B	21.0	1.15	388
C	21.4	1.16	409
D	22.2	1.19	1,469
E	22.7	1.21	1,136
F	22.3	1.20	607
G	22.1	1.19	356
H	21.7	1.17	564
I	21.8	1.18	746
J	24.3	1.26	1,533
K	23.5	1.24	382
L	26.9	1.34	3,742
Total	23.9	1.25	

Prism Precipitation Normals 1981-2010

In/year Station

23.17 Watsonville Airport (from grid at intersection of runways)

23.62 Cimis 111

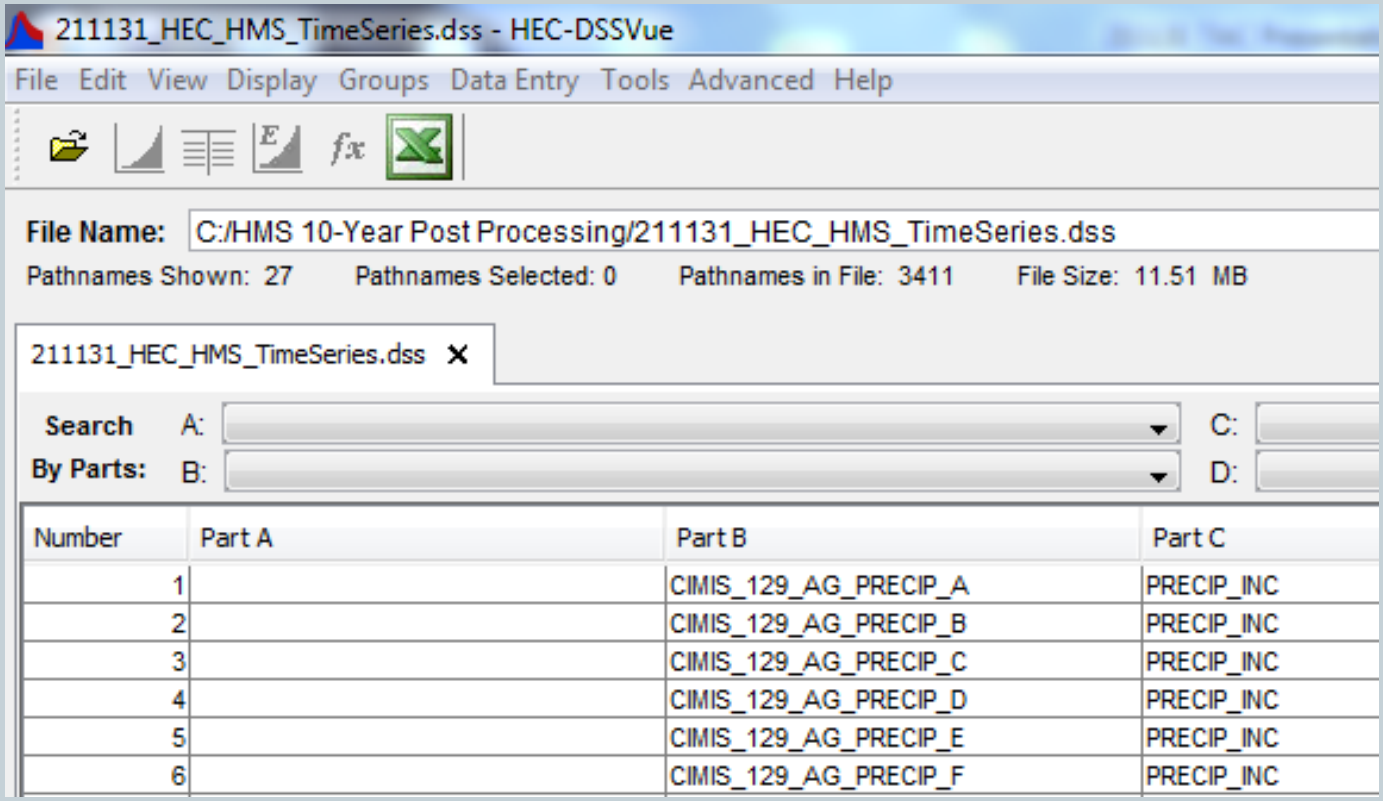
21.62 Cimis 129

23.27 Cimis 209

23.50 Watsonville Water

Note that these values were adjusted in July 2013 QA/QC backcheck

Updated then to Prism 1981 to 2010 data 800 m gridded precip


211131_HEC_HMS_TimeSeries.dss - HEC-DSSVue
File Edit View Display Groups Data Entry Tools Advanced Help
File Name: C:/HMS 10-Year Post Processing/211131_HEC_HMS_TimeSeries.dss
Pathnames Shown: 27 Pathnames Selected: 0 Pathnames in File: 3411 File Size: 11.51 MB
211131_HEC_HMS_TimeSeries.dss
Search By Parts: A: B: C: D:
Number Part A Part B Part C
1 CIMIS_129_AG_PRECIP_A PRECIP_INC
2 CIMIS_129_AG_PRECIP_B PRECIP_INC
3 CIMIS_129_AG_PRECIP_C PRECIP_INC
4 CIMIS_129_AG_PRECIP_D PRECIP_INC
5 CIMIS_129_AG_PRECIP_E PRECIP_INC
6 CIMIS_129_AG_PRECIP_F PRECIP_INC

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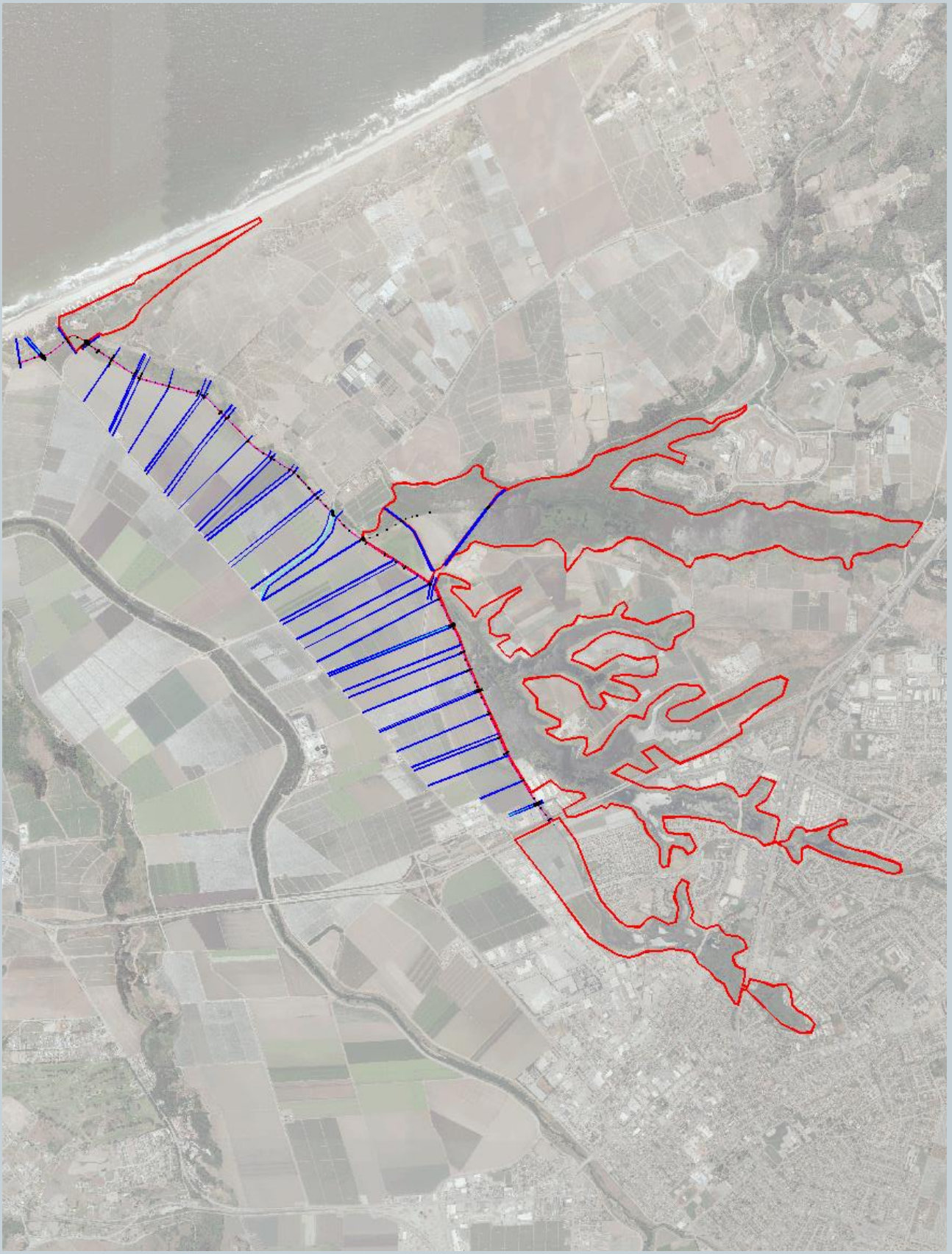
HEC-RAS Model Structure

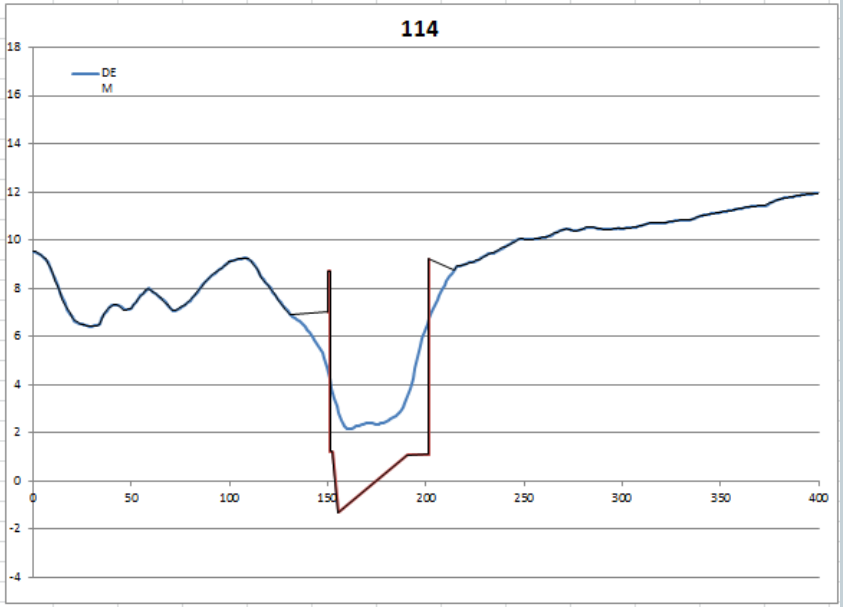


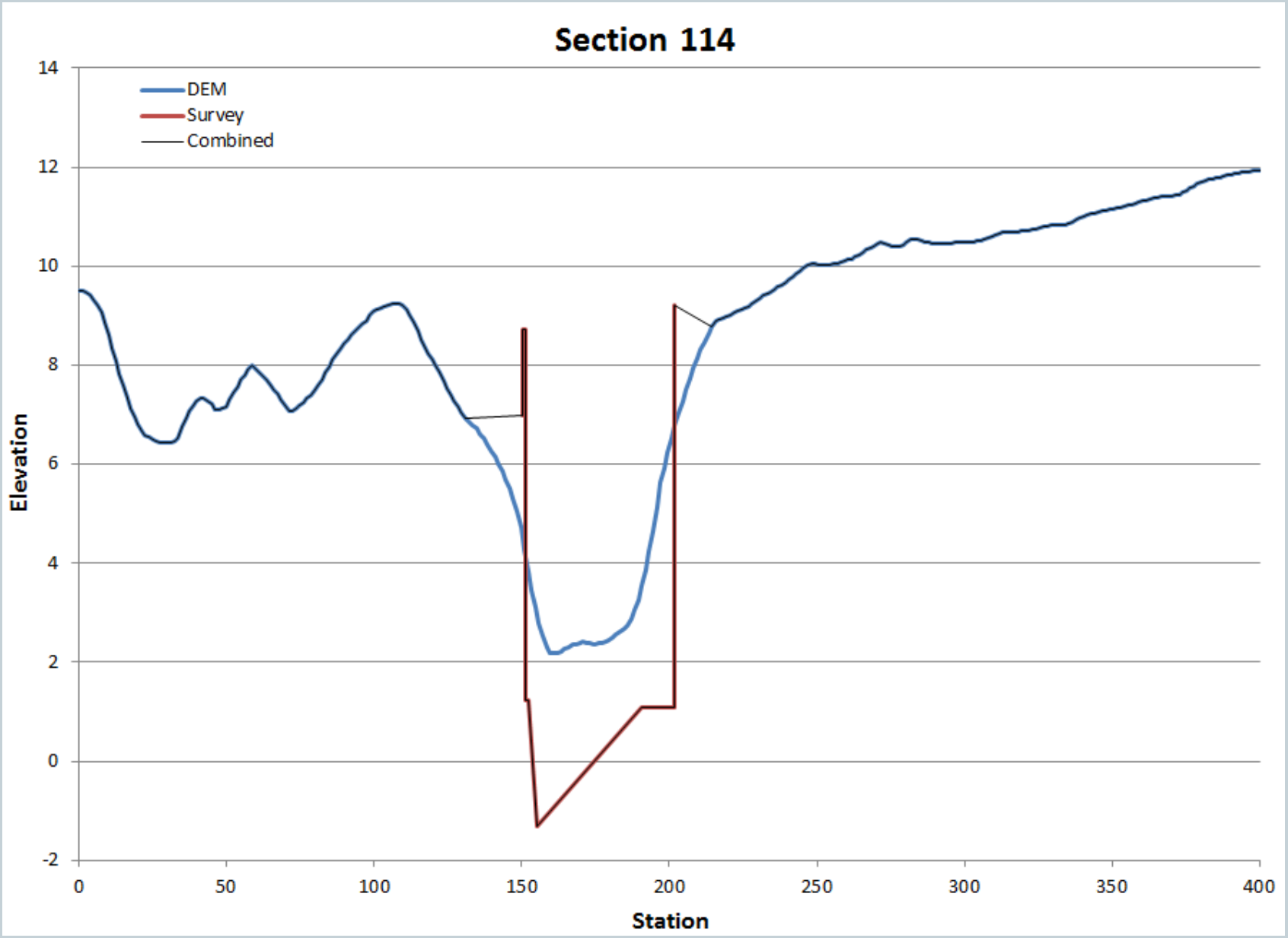
Work Map Preparation

Work Map – Up Close

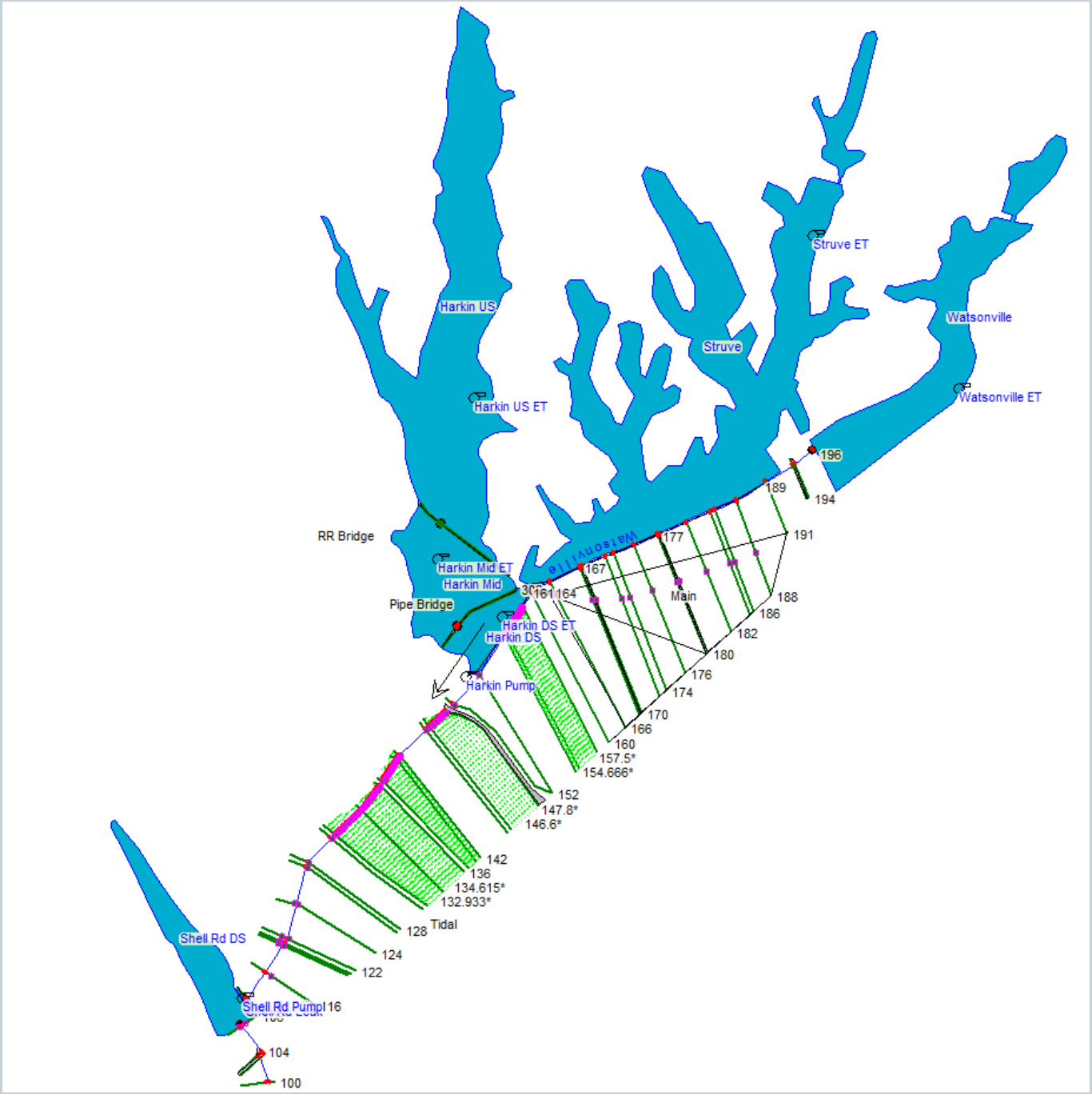
Cross-Section Generation

	Location		DEM Section Data				Survey Section		Combined	
	X	Y	X	Y	Elevation	Distance (Total	Station	Elev	Station	Elev
3	6176128.24	1778218.30	6176128.24	1778218	9.51	0	150.18	7	0.00	9.51
4	6175826.66	1778615.43	6176127.49	1778219	9.51	1.247	150.18	8.72	1.25	9.51
5			6176126.73	1778220	9.473	2.493	151.18	8.72	2.49	9.47
6			6176125.98	1778221	9.41	3.74	151.18	1.23	3.74	9.41
7			6176125.22	1778222	9.322	4.986	152.45	1.23	4.99	9.32
8			6176124.47	1778223	9.208	6.233	155.39	-1.31	6.23	9.21
9			6176123.72	1778224	9.069	7.48	190.42	1.09	7.48	9.07
10			6176122.96	1778225	8.879	8.726	201.09	1.1	8.73	8.88
11			6176122.21	1778226	8.607	9.973	201.5	1.1	9.97	8.61
12			6176121.45	1778227	8.341	11.219	201.5	9.22	11.22	8.34
13			6176120.7	1778228	8.081	12.466			12.47	8.08
14			6176119.95	1778229	7.829	13.713			13.71	7.83
15			6176119.19	1778230	7.583	14.959			14.96	7.58
16			6176118.44	1778231	7.343	16.206			16.21	7.34
17			6176117.68	1778232	7.134	17.452			17.45	7.13
18			6176116.93	1778233	6.964	18.699			18.70	6.96
19			6176116.18	1778234	6.799	19.945			19.95	6.80
20			6176115.42	1778235	6.655	21.192			21.19	6.66
21			6176114.67	1778236	6.592	22.439			22.44	6.59
22			6176113.91	1778237	6.539	23.685			23.69	6.54
23			6176113.16	1778238	6.497	24.932			24.93	6.50
24			6176112.41	1778239	6.465	26.178			26.18	6.47
25			6176111.65	1778240	6.443	27.425			27.43	6.44
26			6176110.9	1778241	6.431	28.672			28.67	6.43
27			6176110.15	1778242	6.429	29.918			29.92	6.43
28			6176109.39	1778243	6.437	31.165			31.17	6.44
29			6176108.64	1778244	6.456	32.411			32.41	6.46
30			6176107.88	1778245	6.514	33.658			33.66	6.51
31			6176107.13	1778246	6.742	34.905			34.91	6.74
32			6176106.38	1778247	6.933	36.151			36.15	6.93
33			6176105.62	1778248	7.086	37.398			37.40	7.09
34			6176104.87	1778249	7.202	38.644			38.64	7.20
35			6176104.11	1778250	7.28	39.891			39.89	7.28
36			6176103.36	1778251	7.32	41.138			41.14	7.32
37			6176102.61	1778252	7.322	42.384			42.38	7.32
38			6176101.85	1778253	7.286	43.631			43.63	7.29
39			6176101.1	1778254	7.213	44.877			44.88	7.21
40			6176100.34	1778255	7.107	46.124			46.12	7.11
41			6176099.59	1778256	7.105	47.371			47.37	7.11
42			6176098.84	1778257	7.124	48.617			48.62	7.12
43			6176098.08	1778258	7.164	49.864			49.86	7.16
44			6176097.33	1778259	7.304	51.11			51.11	7.30
45			6176096.57	1778260	7.445	52.357			52.36	7.45
46			6176095.82	1778261	7.576	53.603			53.60	7.58
47			6176095.07	1778262	7.695	54.85			54.85	7.70
48			6176094.31	1778263	7.803	56.097			56.10	7.80
49			6176093.56	1778264	7.901	57.343			57.34	7.90
50			6176092.8	1778265	7.987	58.59			58.59	7.99
51			6176092.05	1778266	7.927	59.836			59.84	7.93
52			6176091.3	1778267	7.855	61.083			61.08	7.86
53			6176090.54	1778268	7.778	62.33			62.33	7.78
54			6176089.79	1778269	7.695	63.576			63.58	7.70
55			6176089.03	1778270	7.607	64.823			64.82	7.61
56			6176088.28	1778271	7.514	66.069			66.07	7.51
57			6176087.53	1778272	7.408	67.316			67.32	7.41
58			6176086.77	1778273	7.297	68.563			68.56	7.30



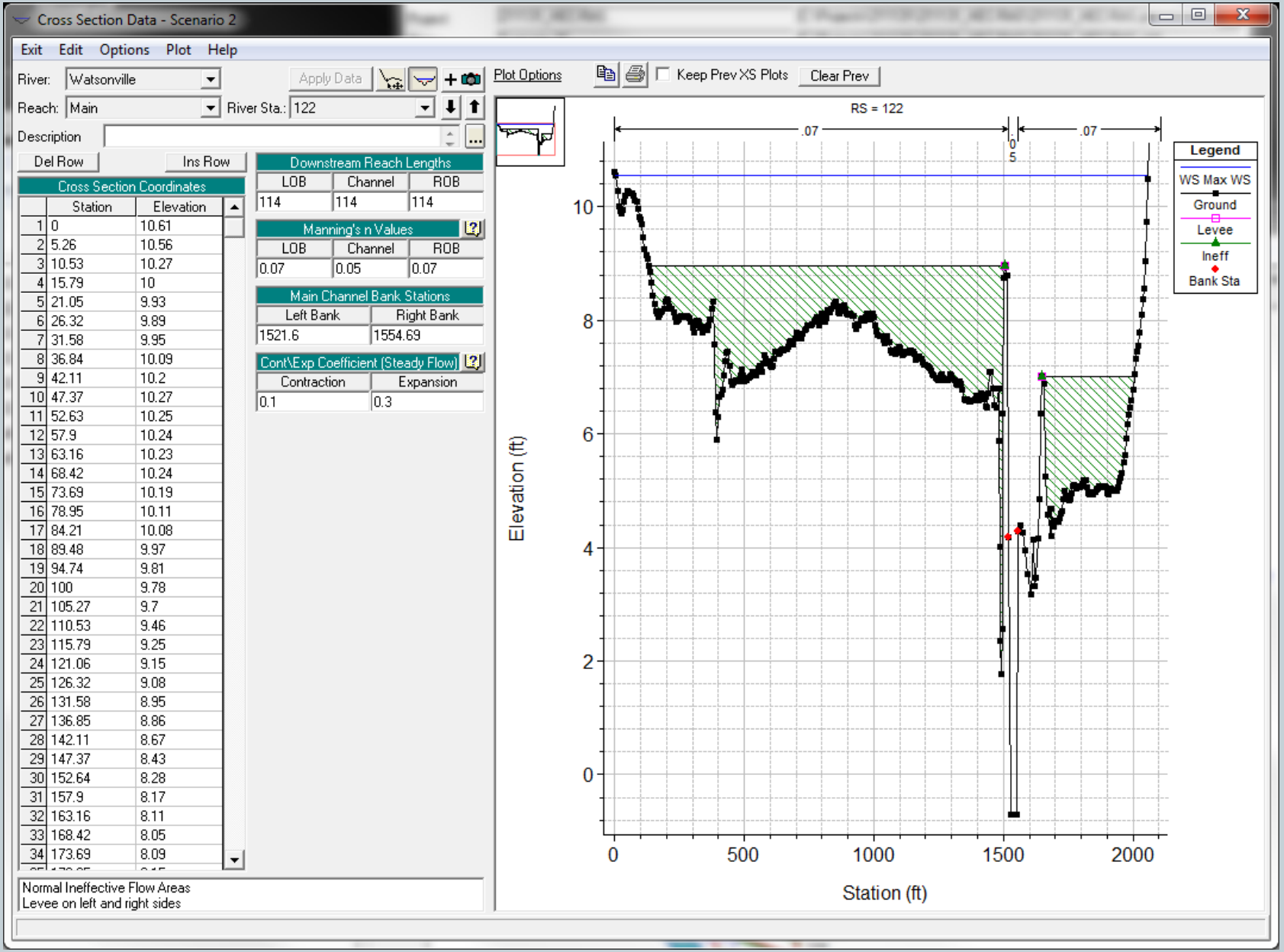


Advantage of Ground Survey



Moving It All into HEC-RAS

Cross-Section Editor - Heart of the Geometry



Channel Roughness – Important and Challenging

Plan - Roughness Change Factors

Roughness Factor Data

Set: riv: Watsonville rch:Main rs:162 to 154

Add | Copy | Delete

River: Watsonville

Reach: Main

Upstream Riv Sta: 162

Downstream Riv Sta: 154

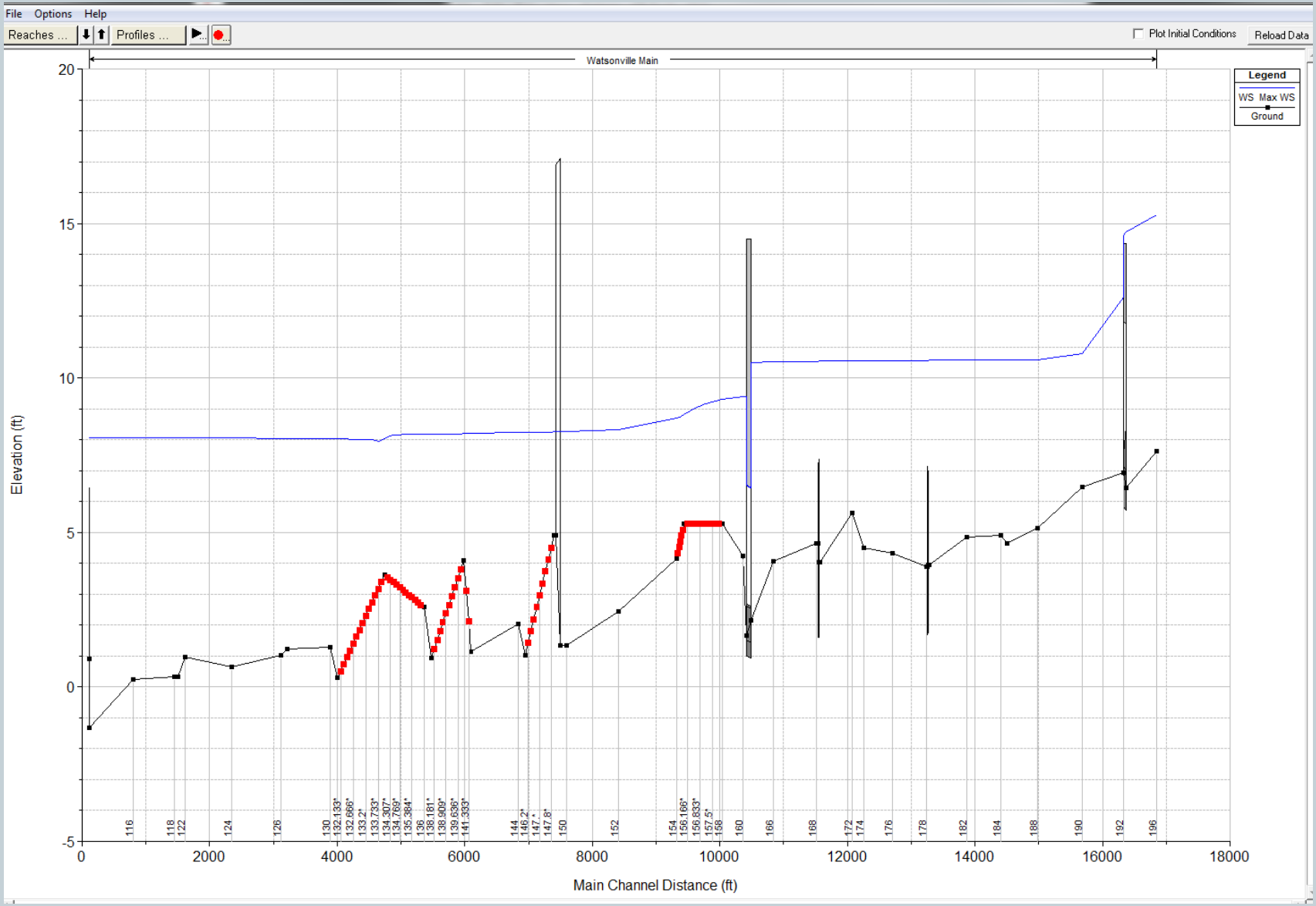
Auto-Generate Flow Column

Uniform Spacing ... | Exponentially Increasing ...

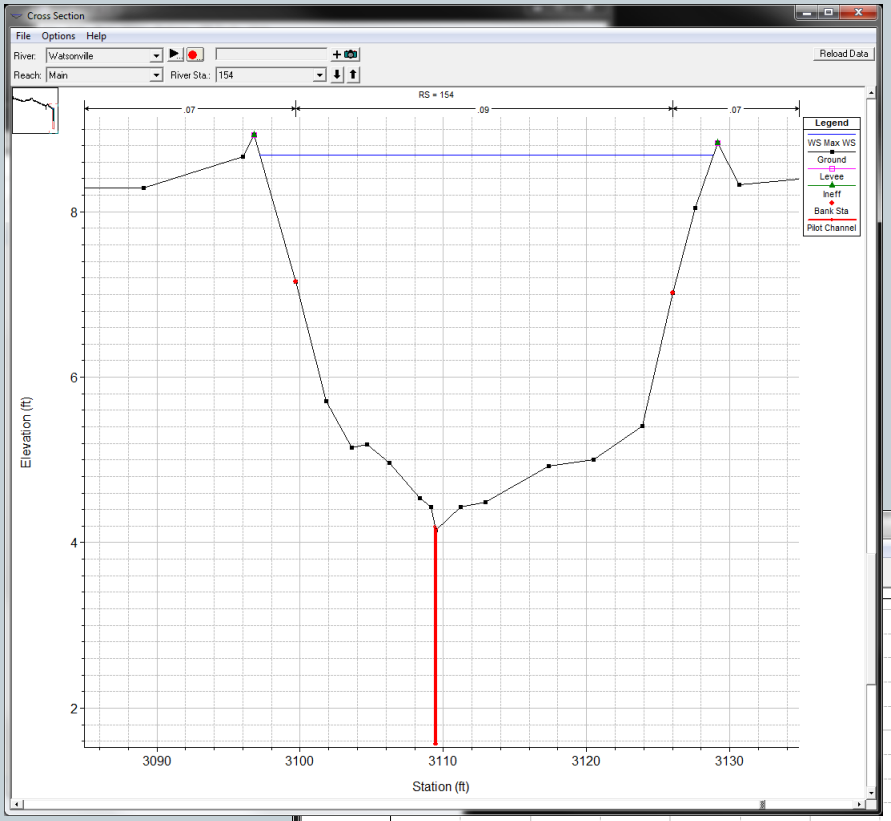
	Flow	Roughness Factor
1	0.	20.
2	5.	8.
3	10.	3.
4	100.	1.
5	1000.	1.
6		
7		
8		
9		
10		
11		
12		
13		

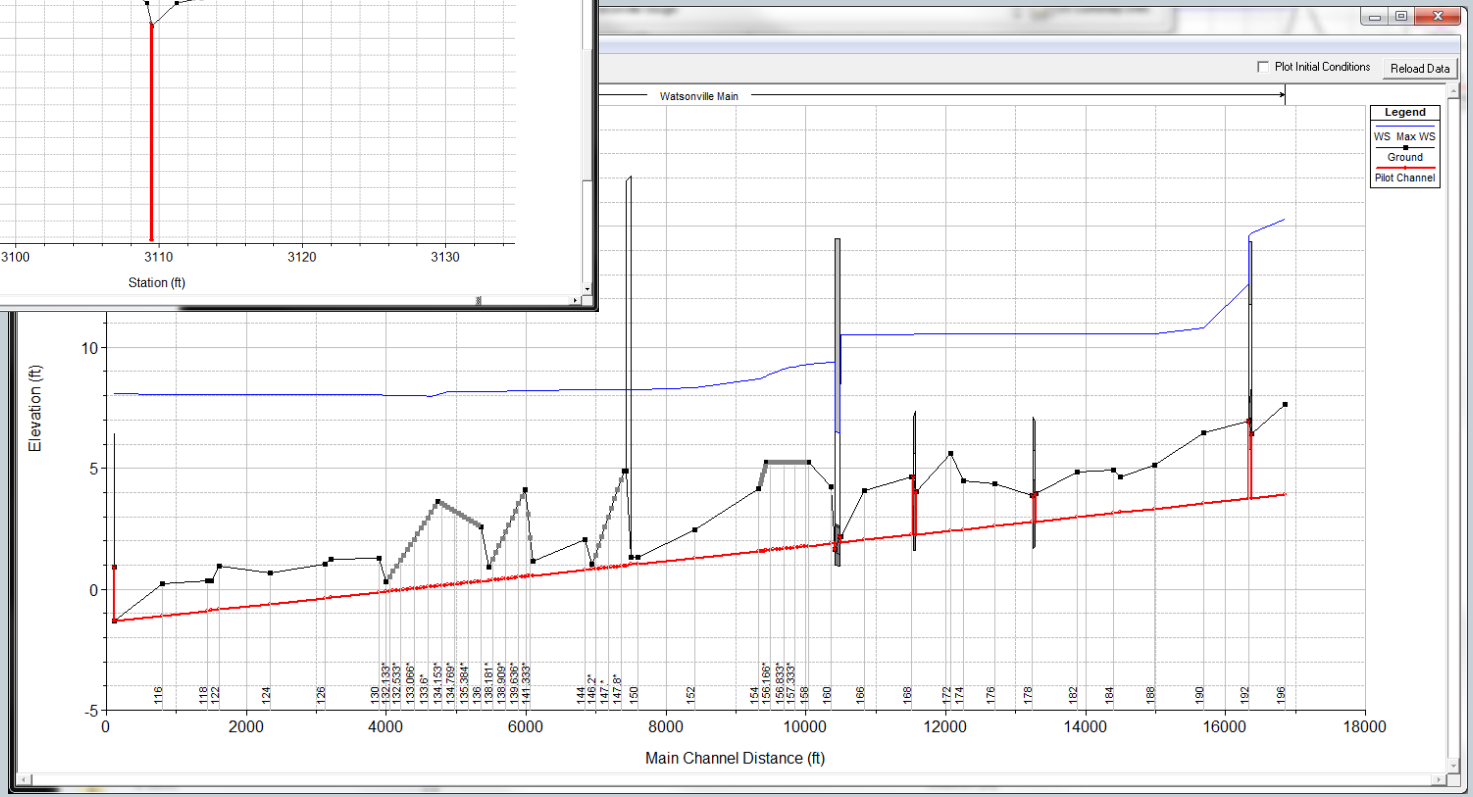
OK | Cancel

Cross-Section Interpolation

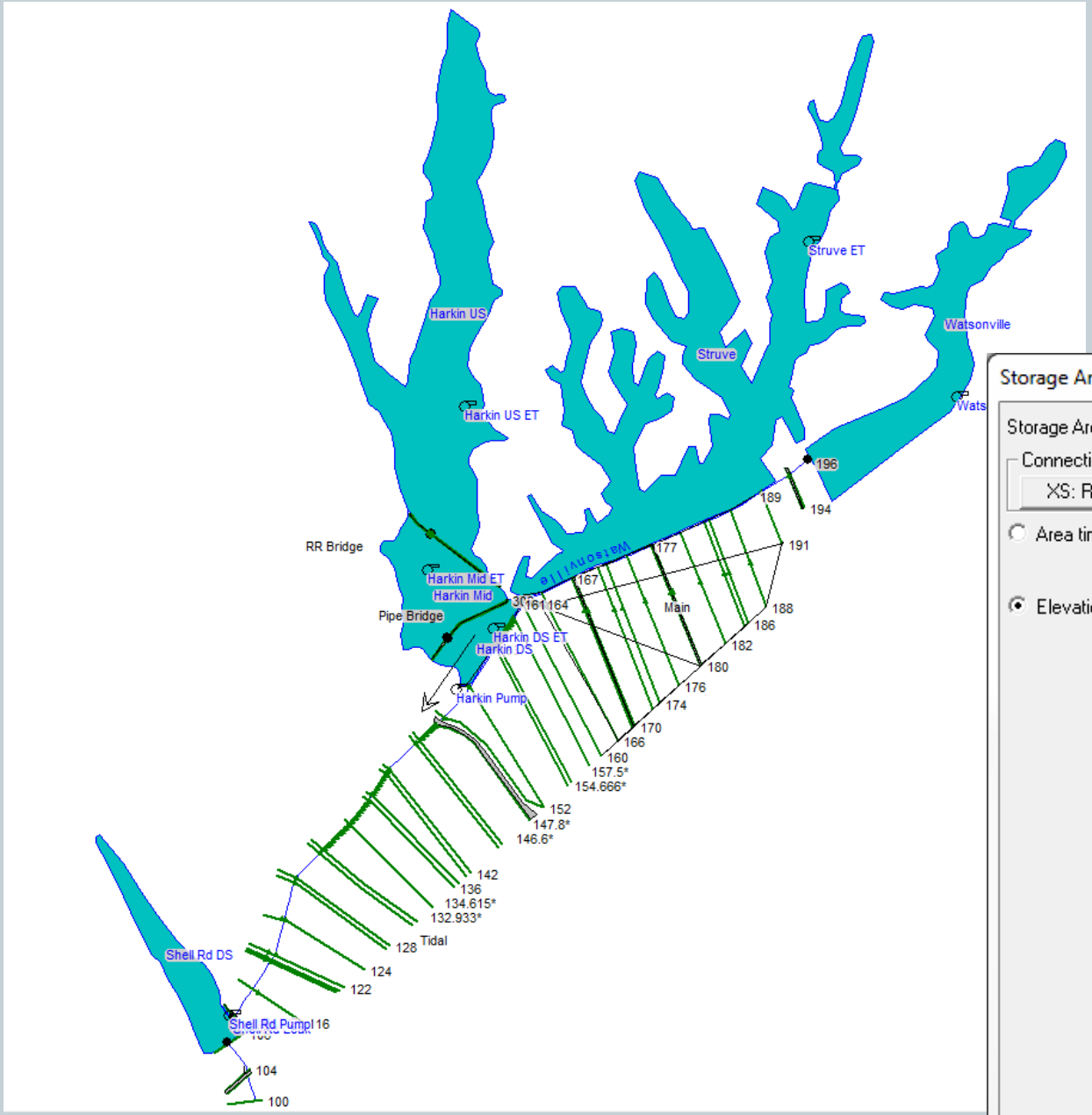


Model Stability - Pilot Channels





Storage Areas



Storage Area Editor

Storage Area: Harkin US

Connections and References to this Storage Area

XS: RS=406 | Pump: Harkin US ET (to)

Area times depth method Area (acres):

Min Elev:

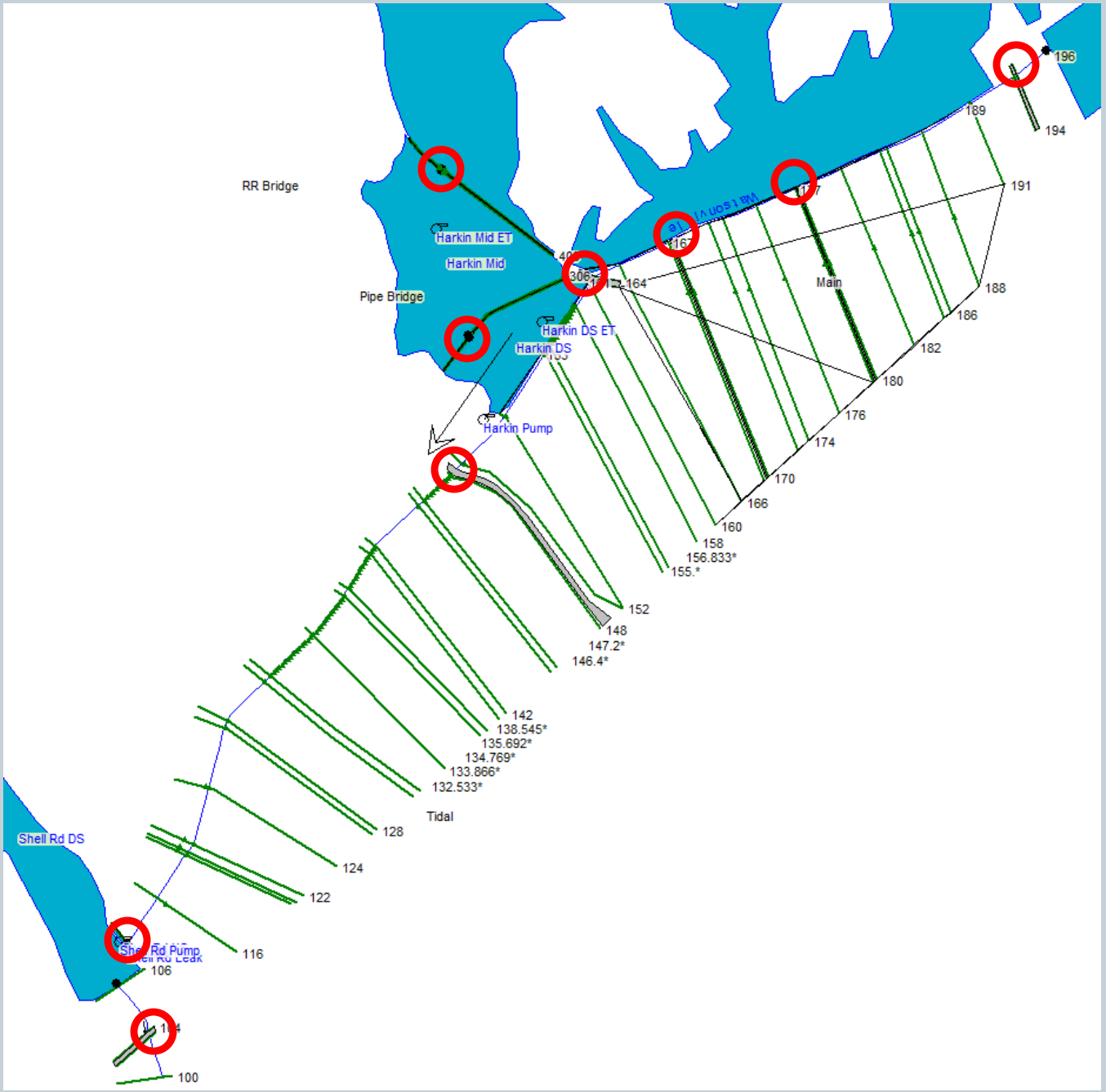
Elevation versus Volume Curve

Elevation Volume Curve
First elevation must have zero volume

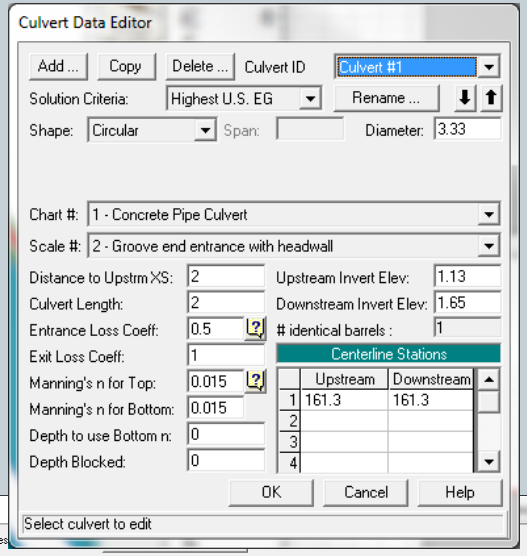
	Elevation	Volume (acre-ft)
1	-2.	0.
2	0.	1.
3	2.	8.6
4	4.	69.6
5	5.	192.5
6	6.	400.
7	8.	877.9
8	10.	1403.4
9	12.	1956.4
10	14.	2529.8
11	16.	3121.4
12		
13		
14		
15		
16		

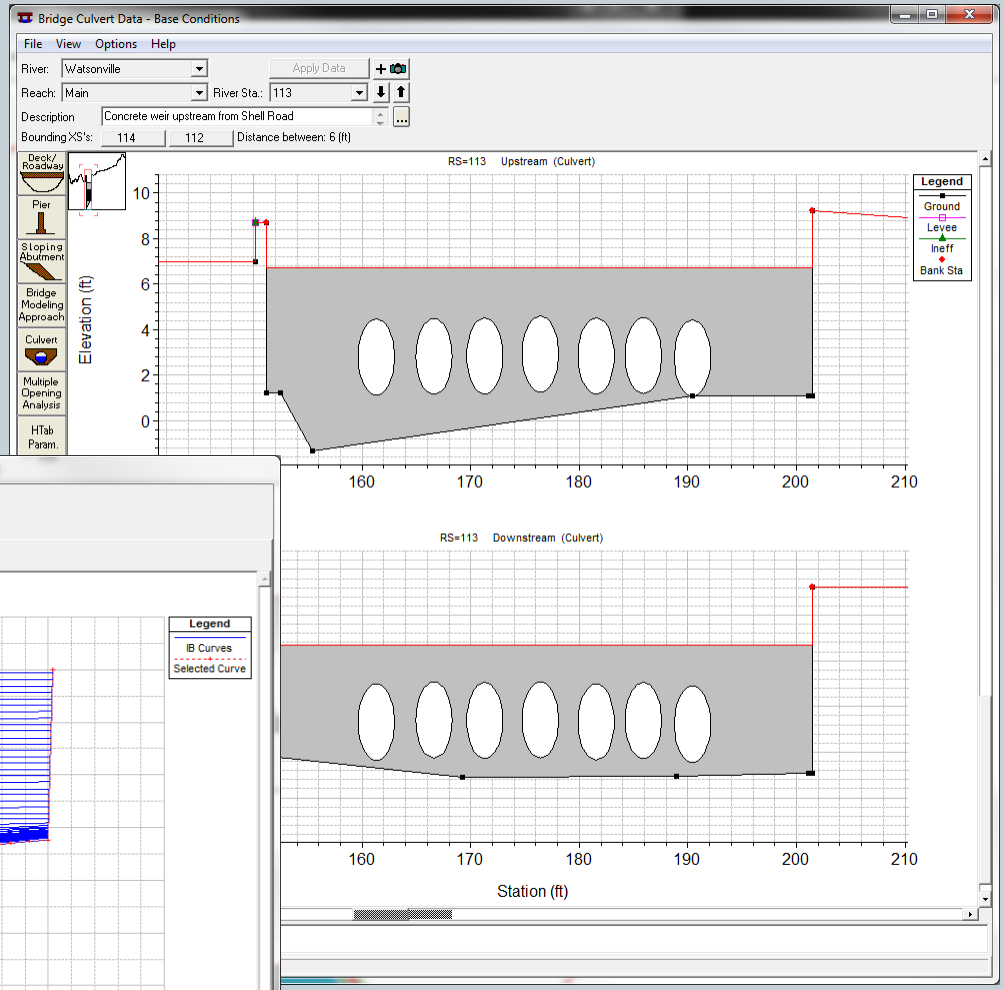
Plot Vol-Elev ... OK Cancel

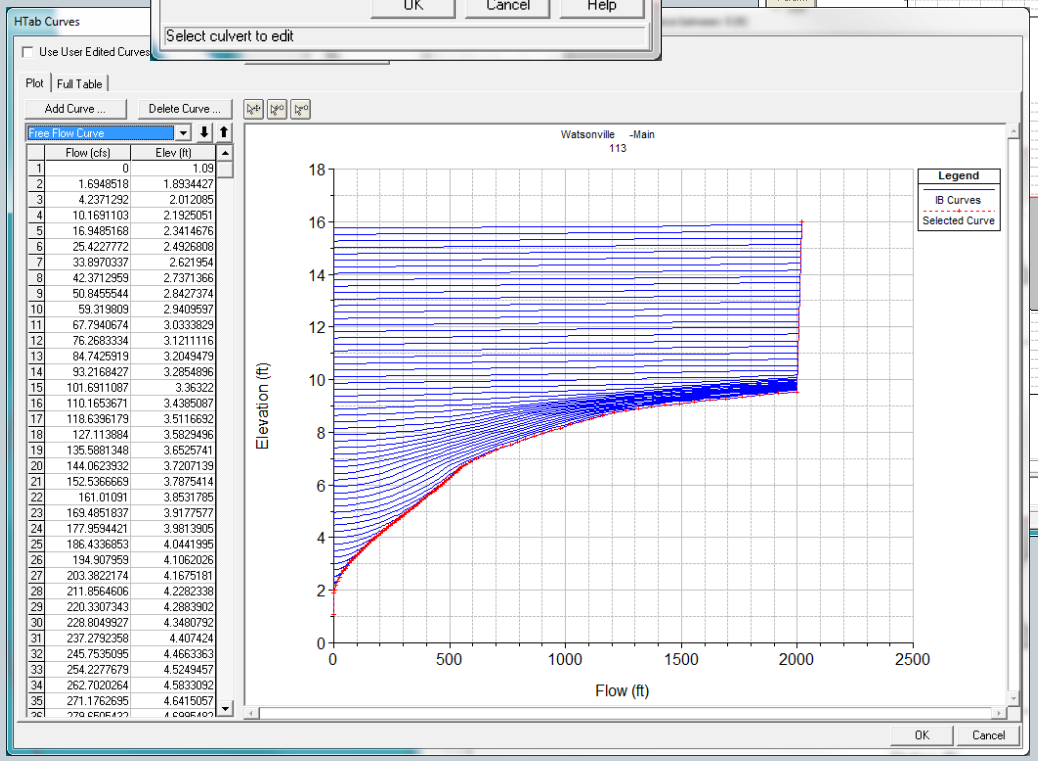
Structures – Lots of Different Flavors



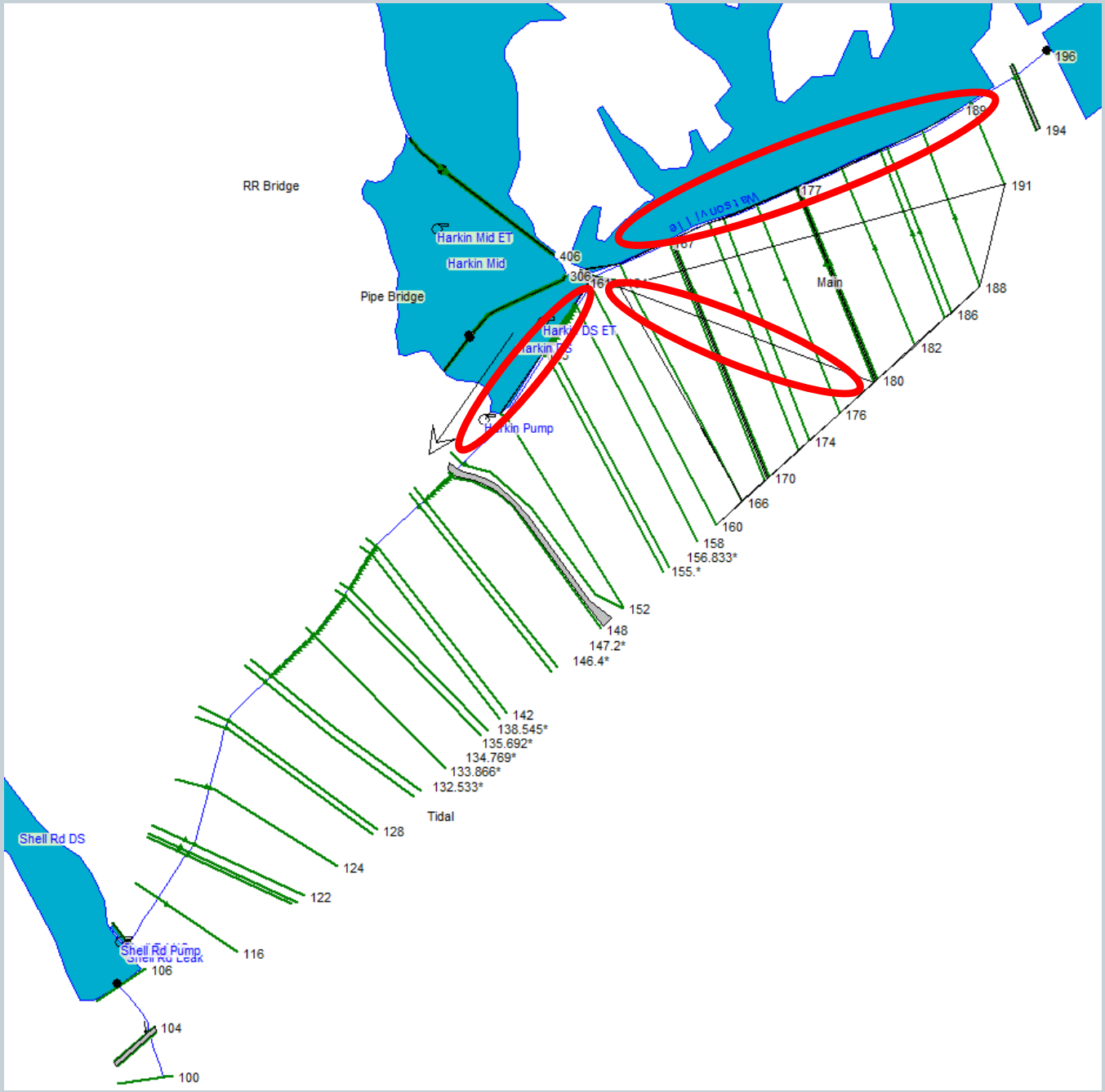
Structure Editors and the All Important HTab



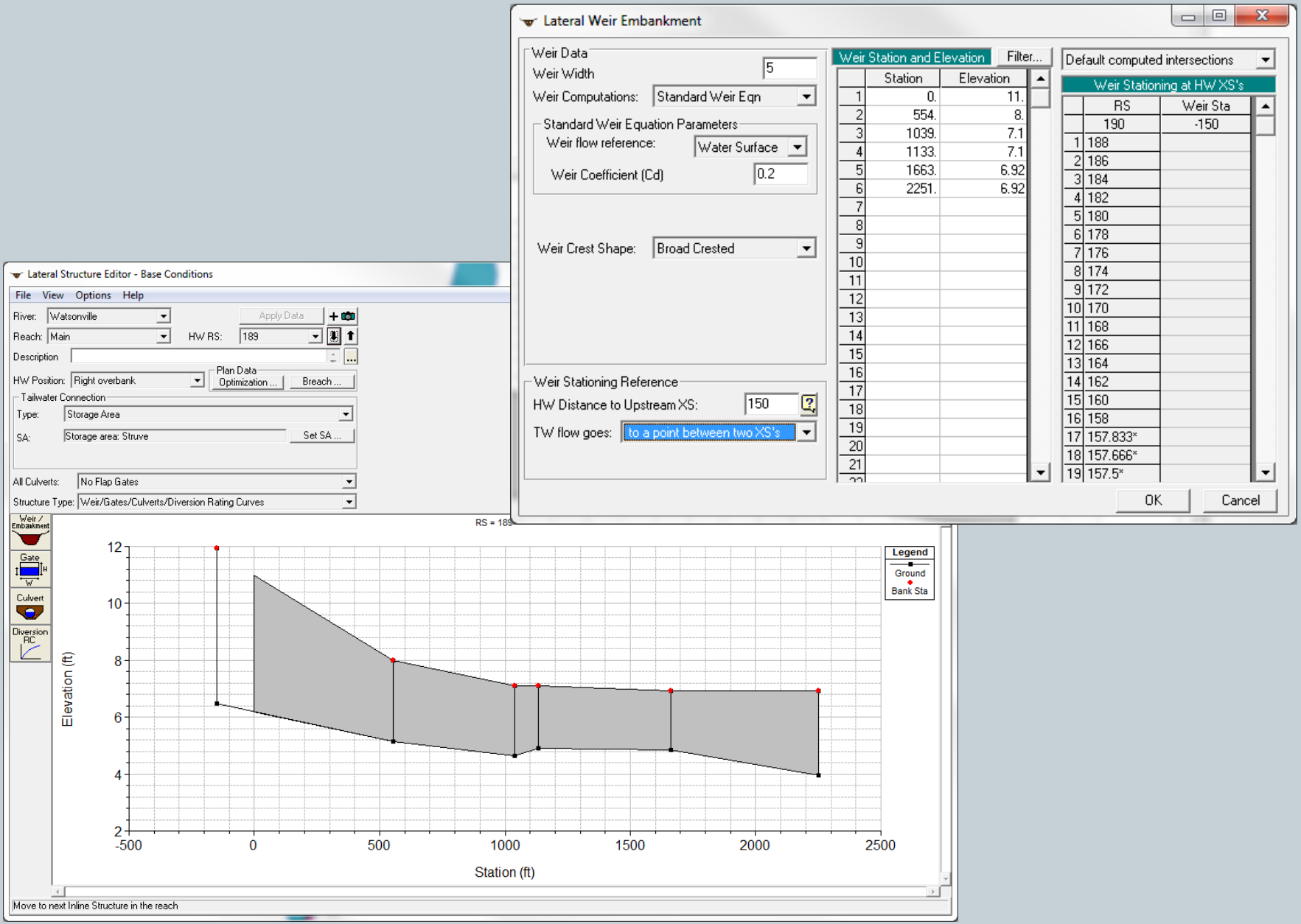




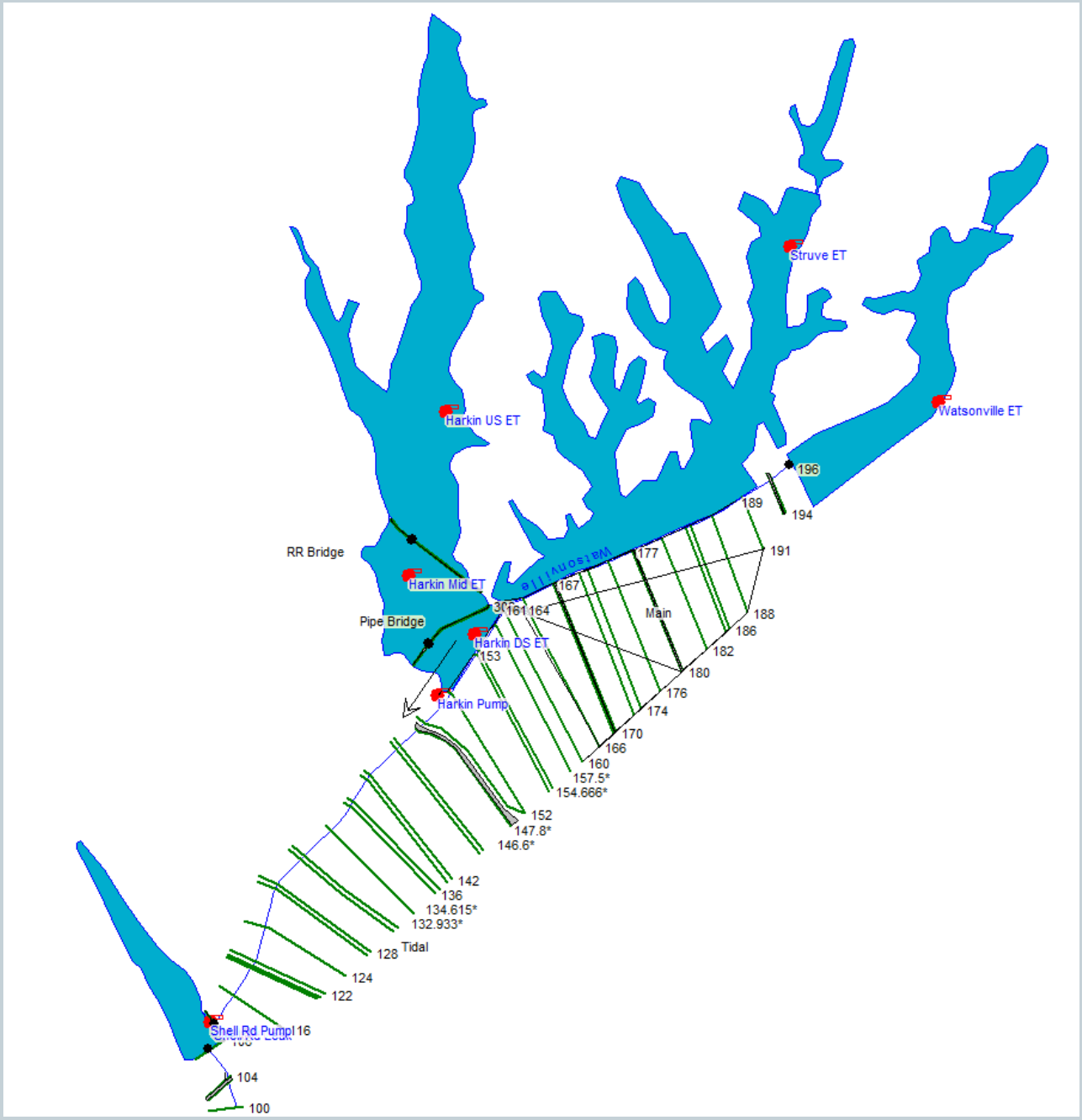
Lateral Weirs – Creating a Sense of Space



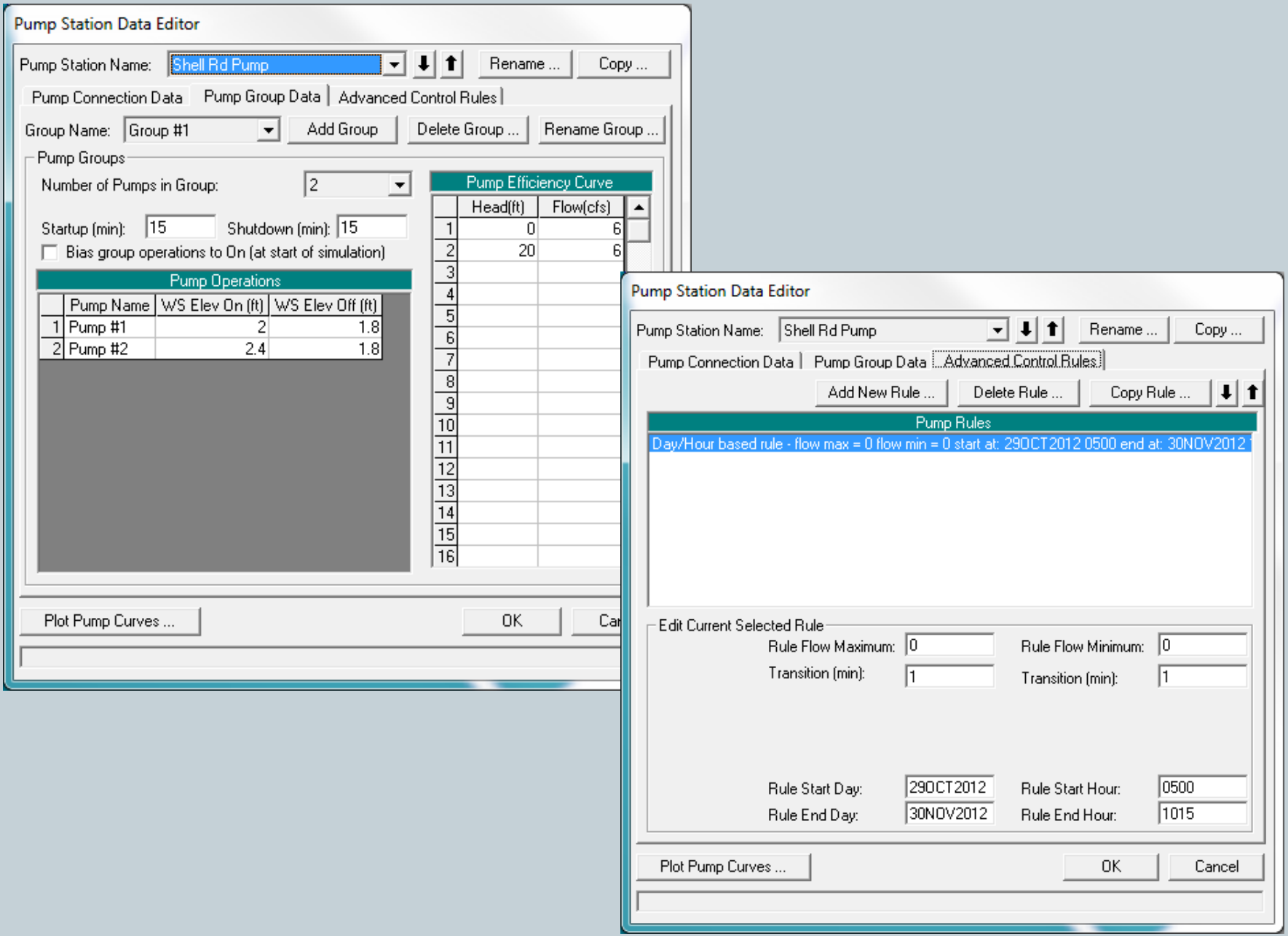
Lateral Weir Editor



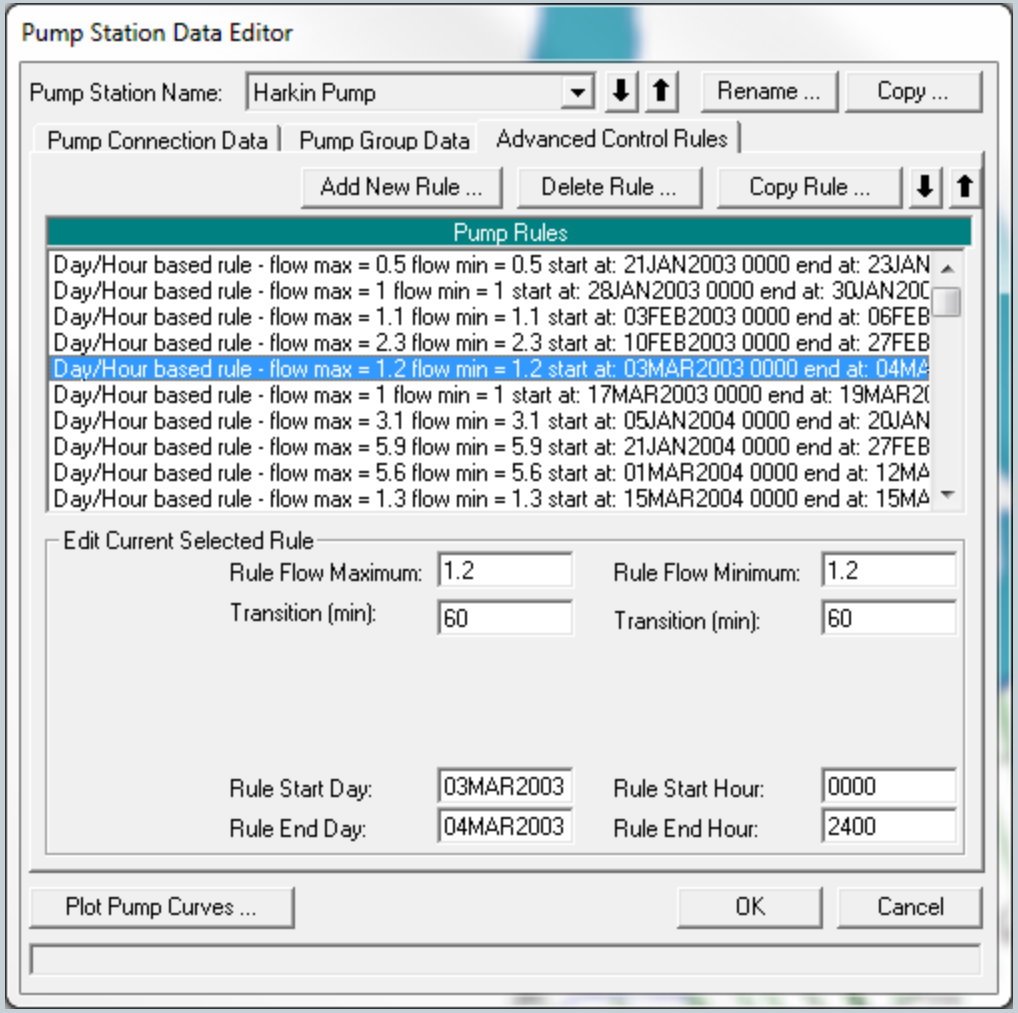
Pumps – Some Real + Some Simulated

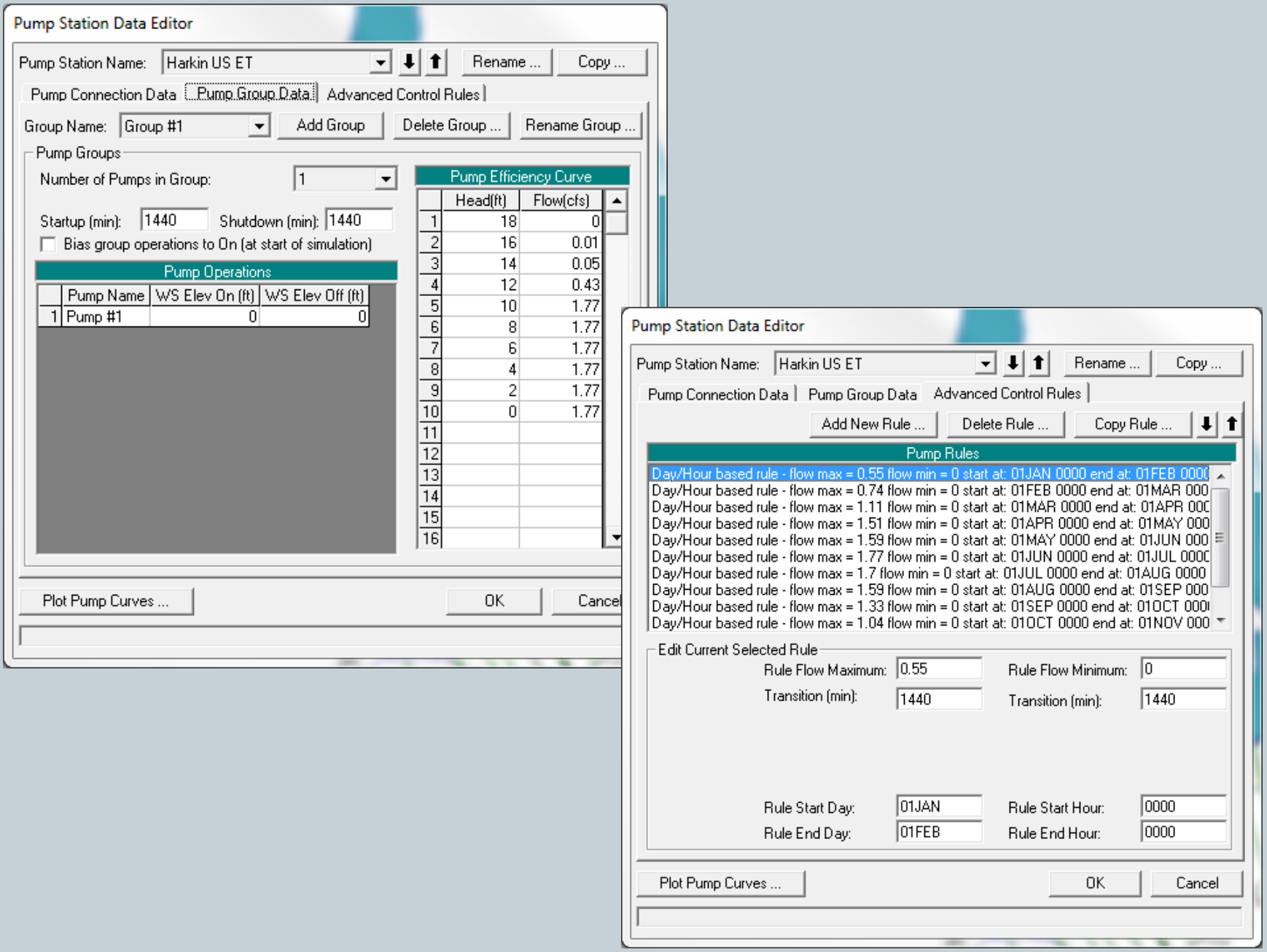


Shell Road – Your Basic Pump Configuration

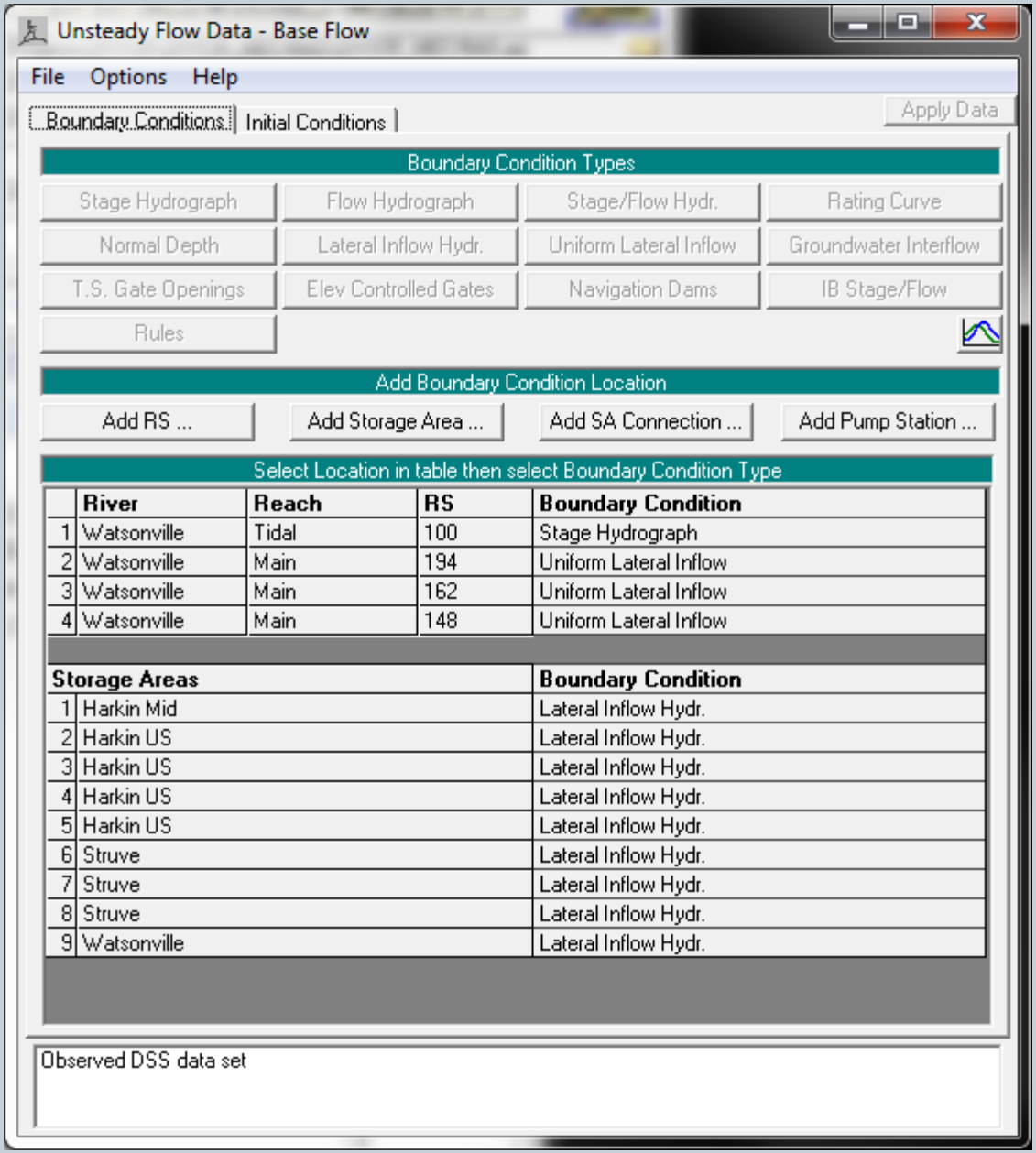


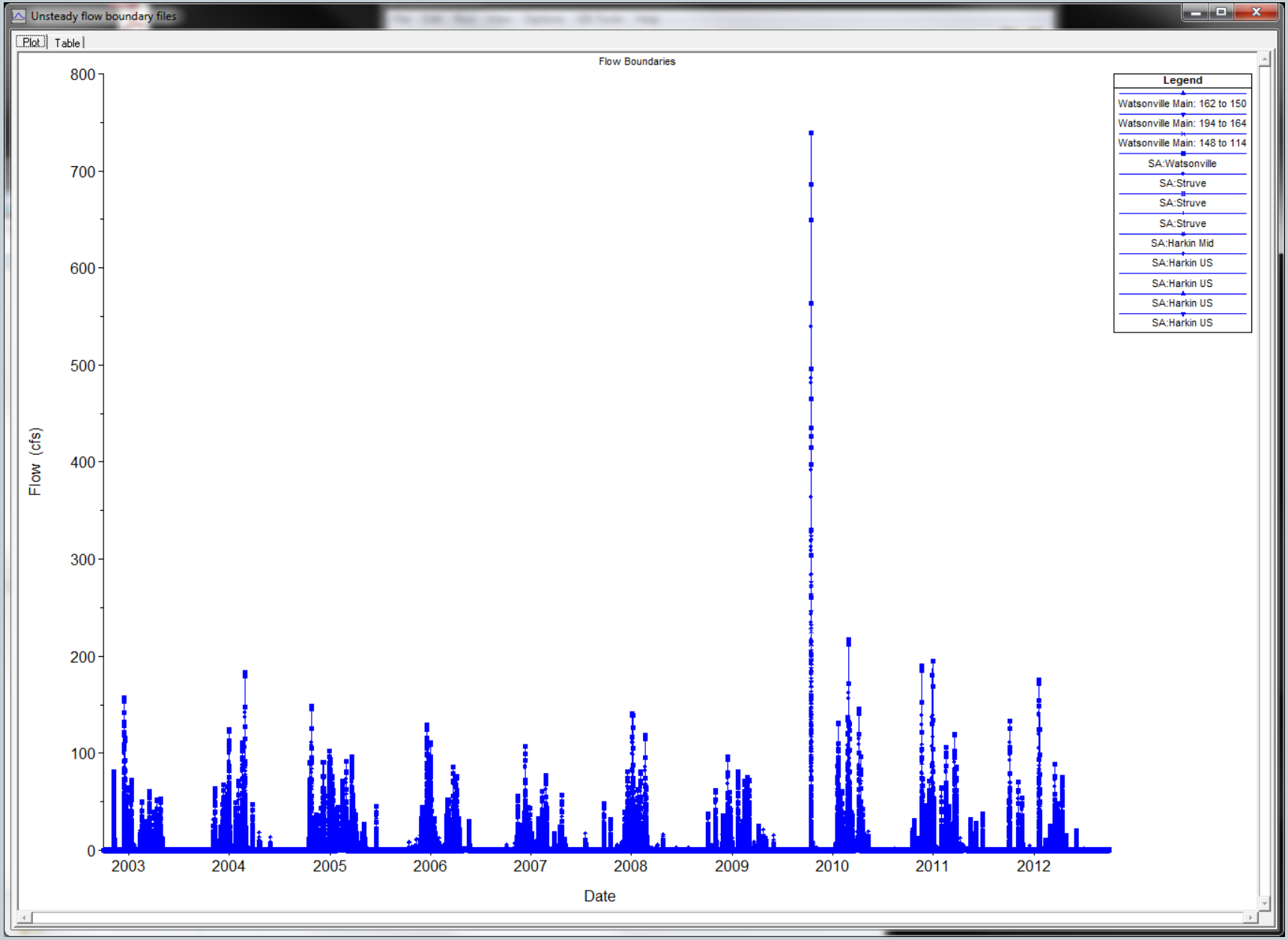
Harkins Slough – Pump Rules




Pump Station Data Editor
Pump Station Name: Harkin US ET
Rename ...
Copy ...
Pump Connection Data
Pump Group Data
Advanced Control Rules
Group Name: Group #1
Add Group
Delete Group ...
Rename Group ...
Pump Groups
Number of Pumps in Group: 1
Startup (min): 1440
Shutdown (min): 1440
Bias group operations to On (at start of simulation)
Pump Operations
Pump Name | WS Elev On (ft) | WS Elev Off (ft)
1 | Pump #1 | 0 | 0
Pump Efficiency Curve
Head(ft) | Flow(cfs)
1 | 18 | 0
2 | 16 | 0.01
3 | 14 | 0.05
4 | 12 | 0.43
5 | 10 | 1.77
6 | 8 | 1.77
7 | 6 | 1.77
8 | 4 | 1.77
9 | 2 | 1.77
10 | 0 | 1.77
11
12
13
14
15
16
Plot Pump Curves ...
OK
Cancel
Pump Station Data Editor
Pump Station Name: Harkin US ET
Rename ...
Copy ...
Pump Connection Data
Pump Group Data
Advanced Control Rules
Add New Rule ...
Delete Rule ...
Copy Rule ...
Pump Rules
Day/Hour based rule - flow max = 0.55 flow min = 0 start at: 01JAN 0000 end at: 01FEB 0000
Day/Hour based rule - flow max = 0.74 flow min = 0 start at: 01FEB 0000 end at: 01MAR 000
Day/Hour based rule - flow max = 1.11 flow min = 0 start at: 01MAR 0000 end at: 01APR 000
Day/Hour based rule - flow max = 1.51 flow min = 0 start at: 01APR 0000 end at: 01MAY 000
Day/Hour based rule - flow max = 1.59 flow min = 0 start at: 01MAY 0000 end at: 01JUN 000
Day/Hour based rule - flow max = 1.77 flow min = 0 start at: 01JUN 0000 end at: 01JUL 000
Day/Hour based rule - flow max = 1.7 flow min = 0 start at: 01JUL 0000 end at: 01AUG 0000
Day/Hour based rule - flow max = 1.59 flow min = 0 start at: 01AUG 0000 end at: 01SEP 000
Day/Hour based rule - flow max = 1.33 flow min = 0 start at: 01SEP 0000 end at: 01OCT 000
Day/Hour based rule - flow max = 1.04 flow min = 0 start at: 01OCT 0000 end at: 01NOV 000
Edit Current Selected Rule
Rule Flow Maximum: 0.55
Rule Flow Minimum: 0
Transition (min): 1440
Transition (min): 1440
Rule Start Day: 01JAN
Rule Start Hour: 0000
Rule End Day: 01FEB
Rule End Hour: 0000
Plot Pump Curves ...
OK
Cancel

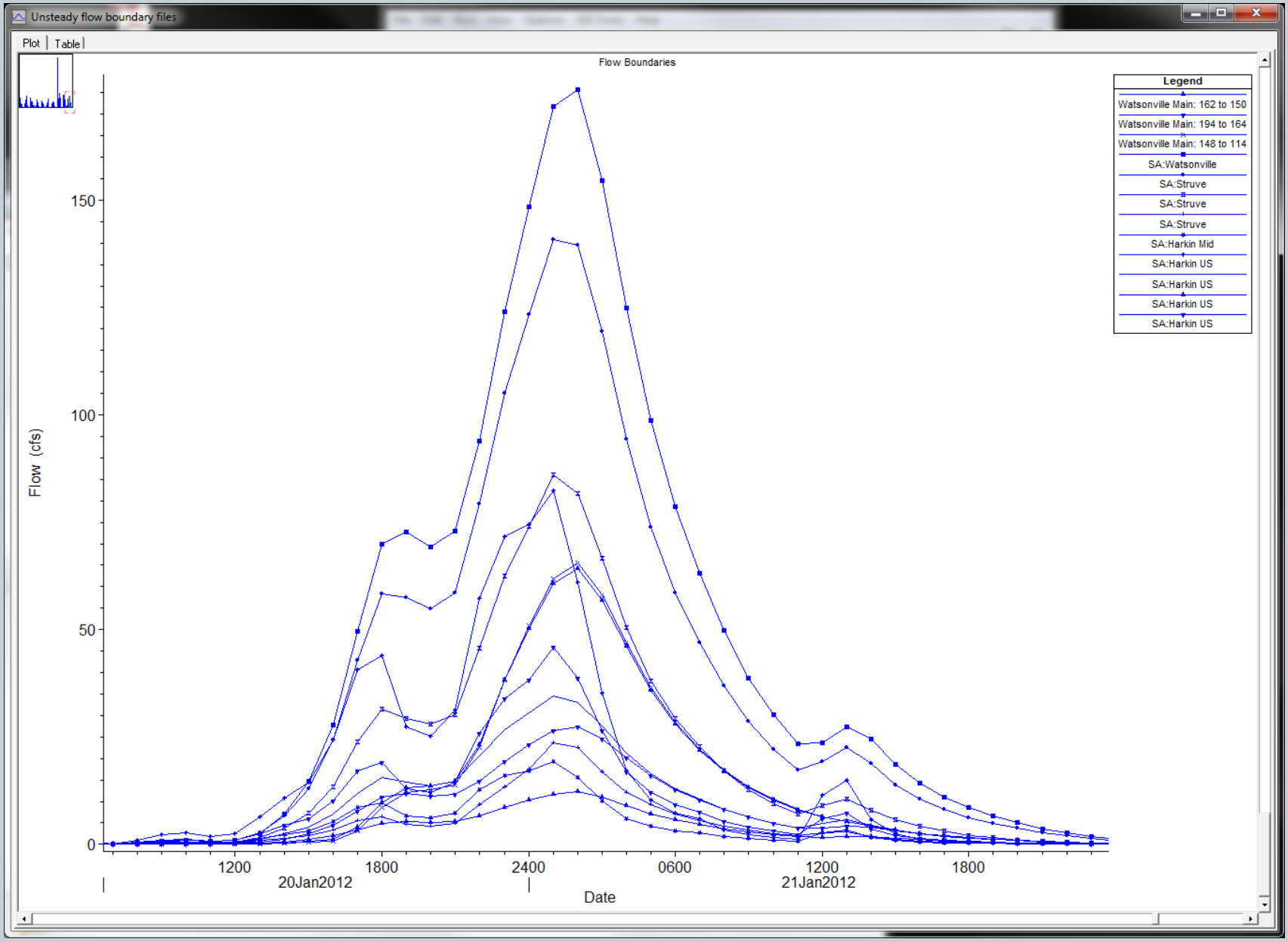
Unsteady Flow Run Editor

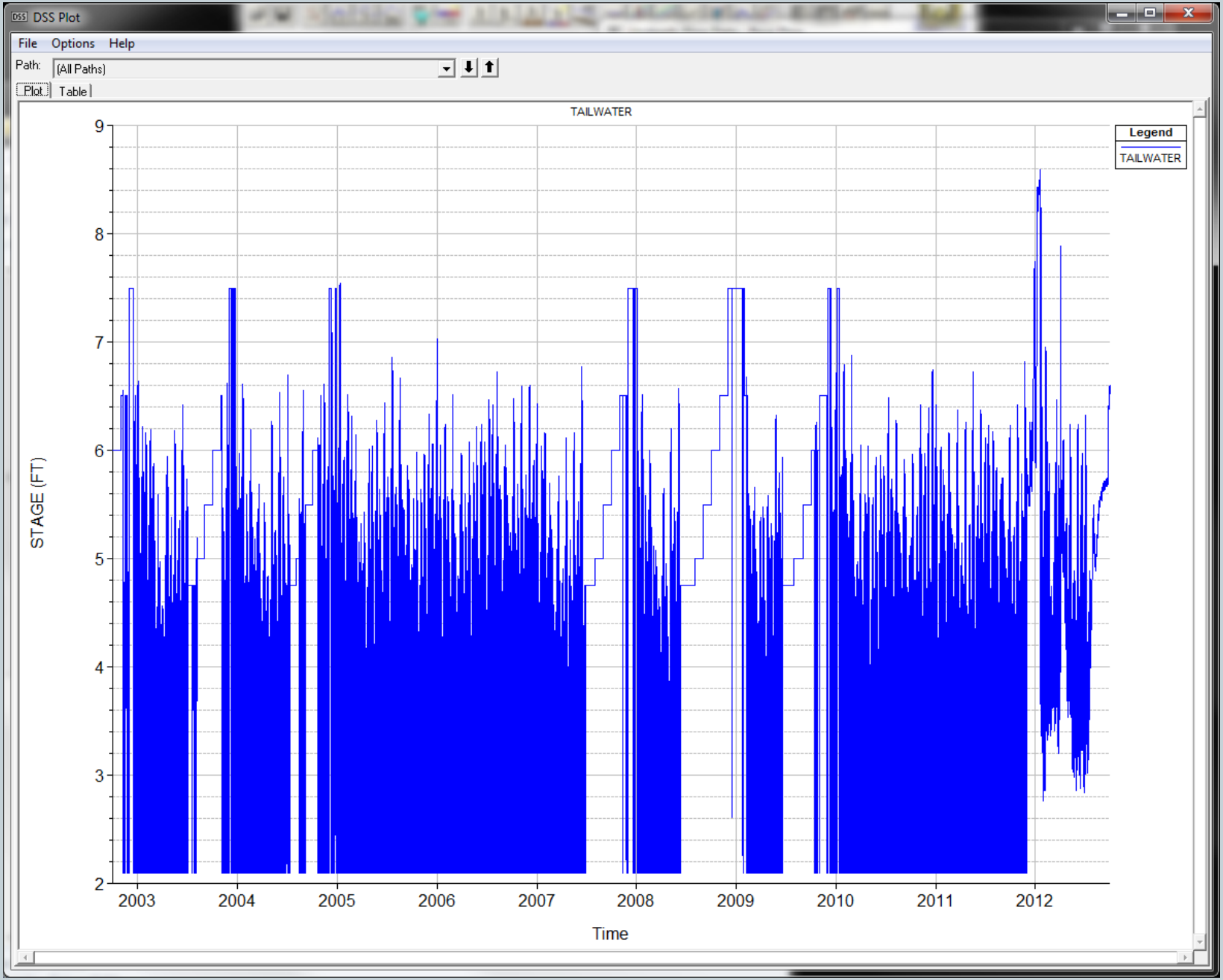




Boundary Conditions – Inflow Hydrographs

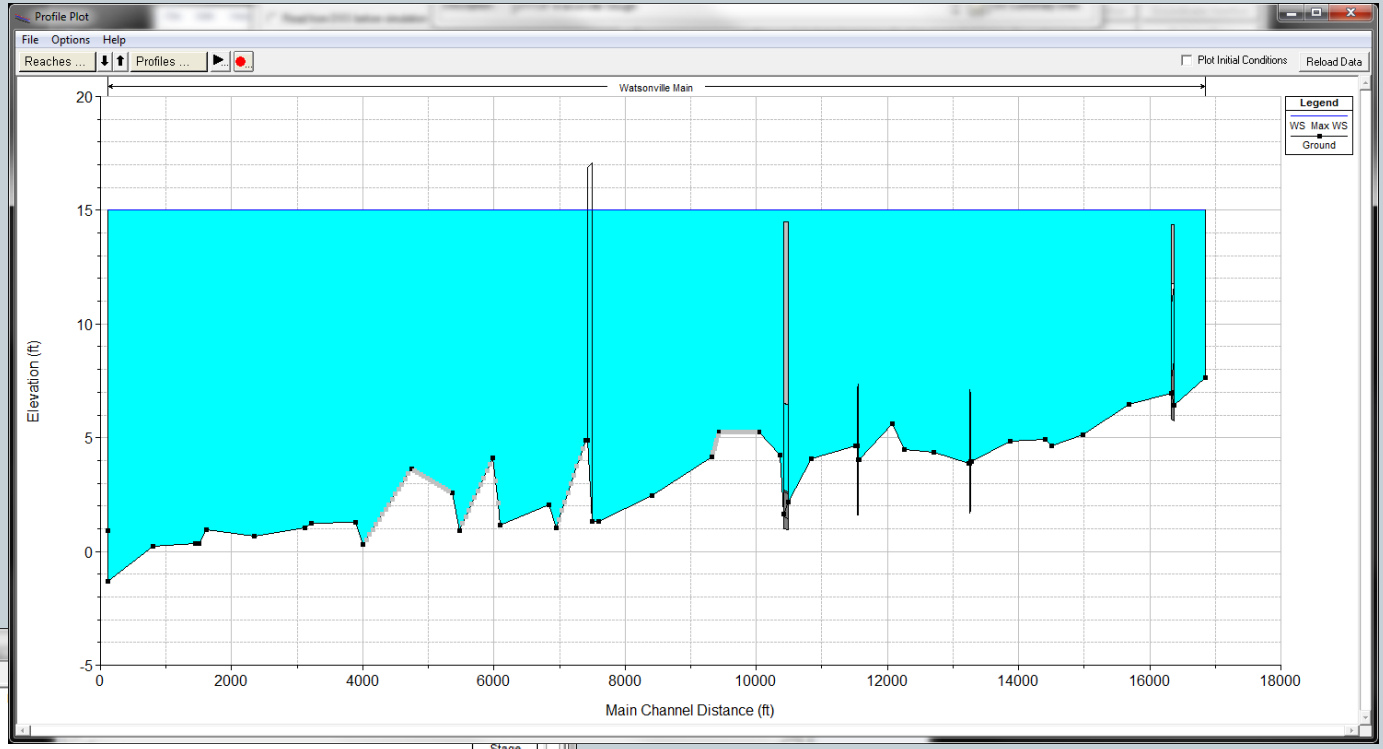
Inflow Hydrographs in Detail

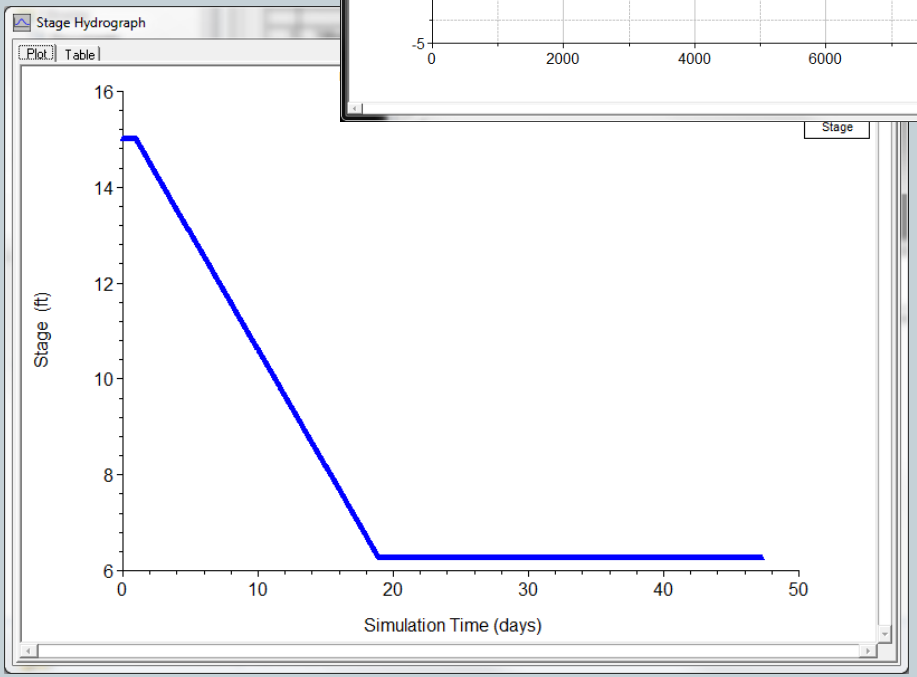




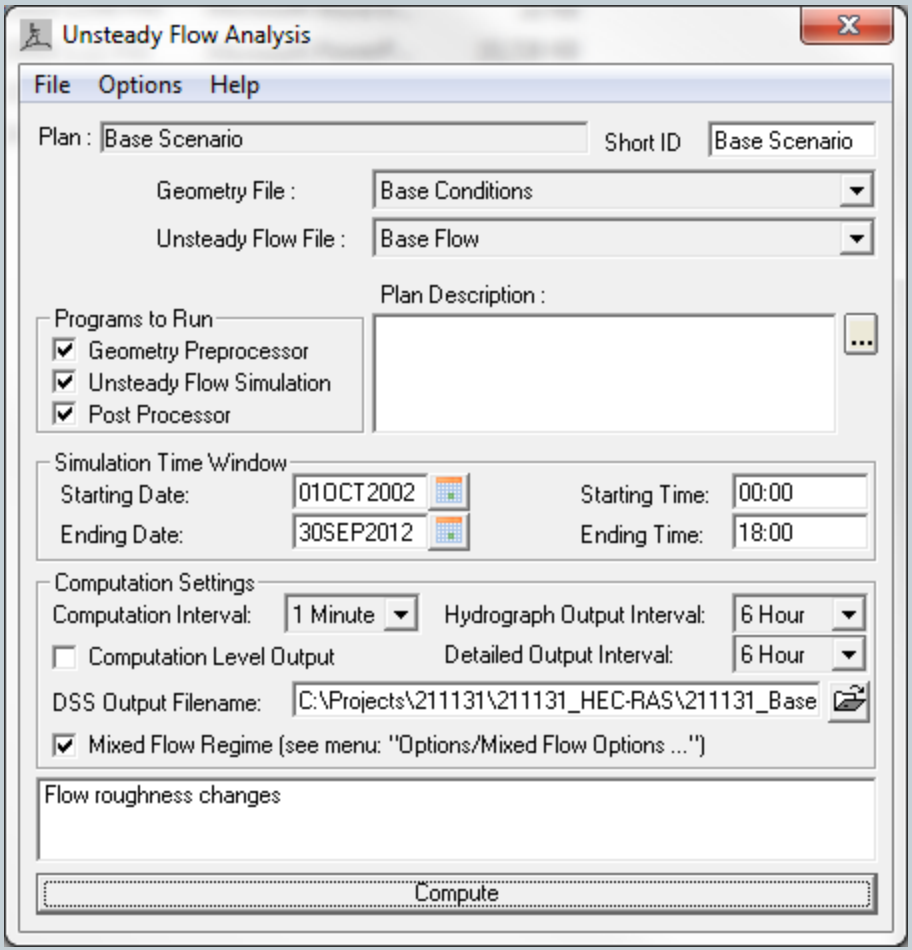
Boundary Conditions - Tailwater

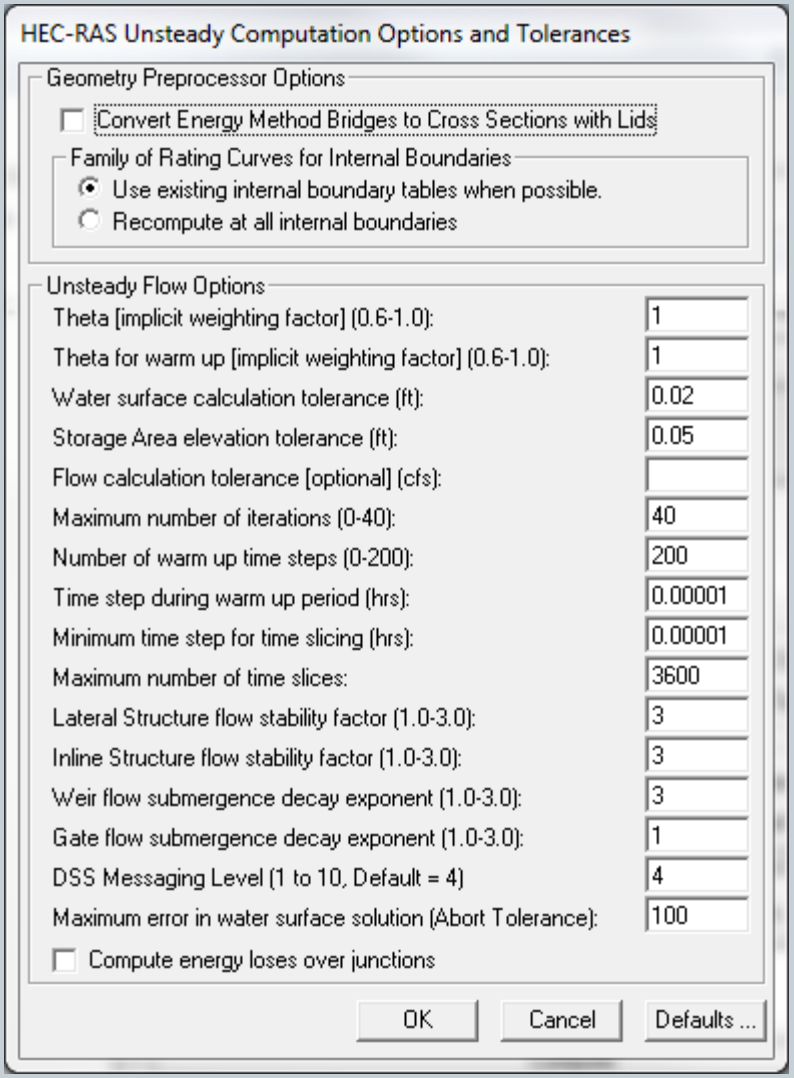
Initial Conditions – "Hot Start"





Unsteady Computation Options and Controls



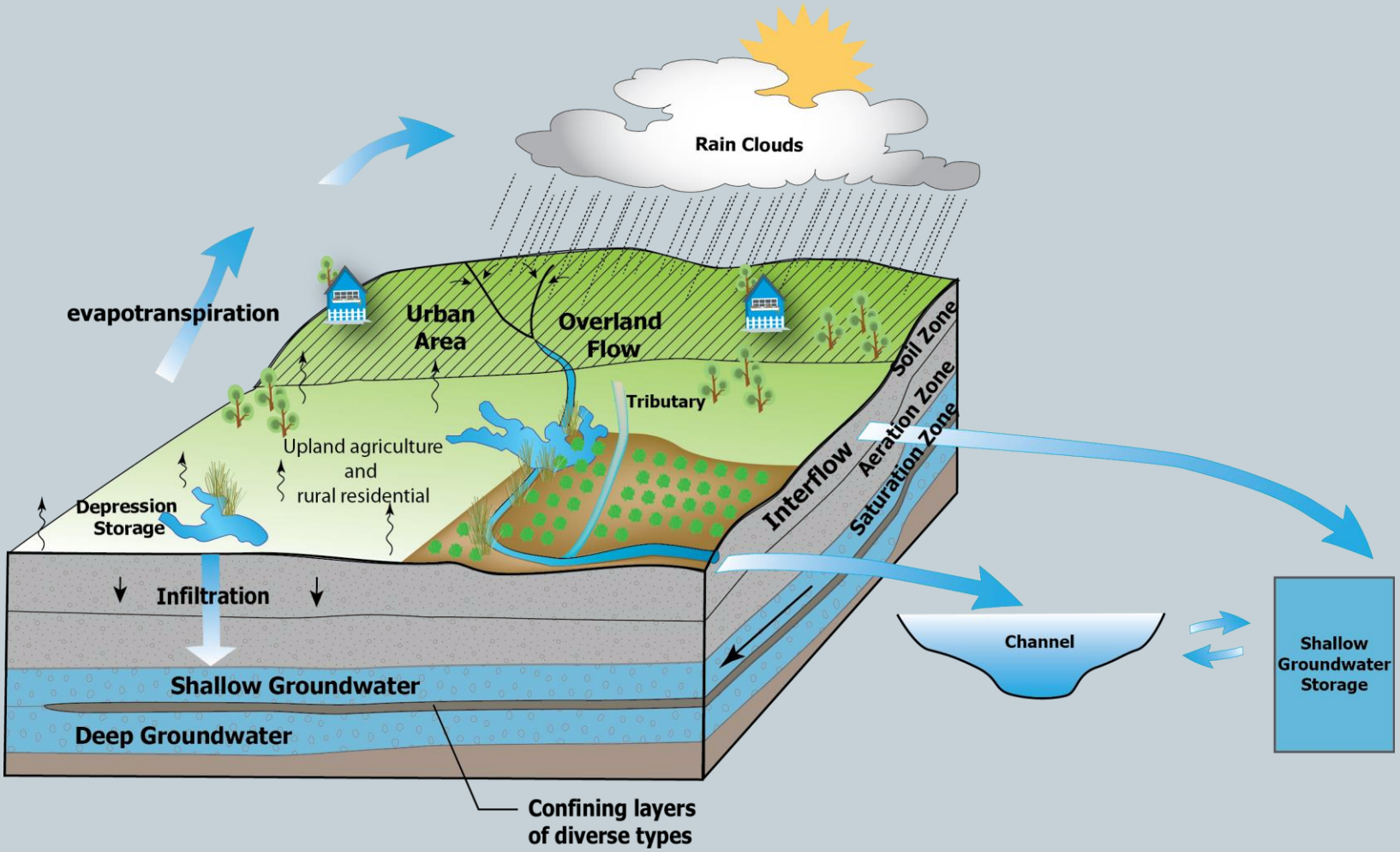


Photos – Watsonville Slough D/S from San Andreas

- Watershed areas at selected stations:
  - Harkins Slough at Buena Vista 2,720 acres
  - Watsonville Slough at Highway 1 1,470 acres
  - Gallighan Slough 1,240 acres
  - East Struve at Main 840 acres
  - West Struve at High School 380 acres
  - Harkins Slough Tributary at Manfre 250 acres

PHOTOS – WATSONVILLE SLOUGH D/S FROM R.R.

Hydrologic Modeling Overview



The Bigger Picture