Appendix I.

Evaluation of Two IHNC Basin Hydrology Issues

Appendix I. Evaluation of Two IHNC Basin Hydrology Issues

This Appendix presents an evaluation of two key IHNC Basin hydrologic issues in support of Part IV:

I. Seabrook and IHNC Surge Barrier Overtopping Hazard and Impact on IHNC Basin SWL Hazard.
II. Diversion of IHNC Basin Surge into the Central Wetlands.

I. <u>Seabrook and IHNC Surge Barrier Overtopping Hazard and Impact on IHNC Basin SWL Hazard</u>

The Supplement, *Hurricane Surge Hazard Primer*, notes that NFIP surge hazard estimates should be redone for purposes of comprehensive surge risk management. Part I (Sections 2.2 and 4.3) described the *partial* revision of NFIP 100- and 500-yr exterior surge hazard and levee overtopping Q50 and Q90 estimates at 20 HSDRRS locations to address several priority issues presented in Appendix C (*Four Priority Issues with the USACE Surge Hazard and HSDRRS Overtopping Analysis*).

Partial revisions have been examined for the exterior 100- and 500-yr SWL50, SWLσ, and overtopping Q50 and Q90 for the IHNC and Seabrook Surge Barriers in a manner similar to the 20 levee locations. The USACE 2014 *DER* specified design elevations for the 9,400-ft IHNC and 2,000-ft Seabrook Surge Barriers at 25 to 26 and 16 ft NAVD88. For purposes of this Report the full length of each barrier was represented by a single design condition. Since both Barriers are floodwalls and were designed for 2057 conditions (with 1.5 ft of RSLR), partial revisions are provided for both 2007 and 2057 estimates. The latter are then used to provide a basis for a partial revision of IHNC Basin *2057* 100-yr SWL50, SWLσ, and 500-yr SWL50.

Seabrook Barrier 100-yr Overtopping

- The exterior 100-yr SWL50 is increased by 0.9 ft to correct for FORTRAN code issues, from 9.3 to 10.2 ft NAVD88 for 2007 and from 10.8 to 11.7 ft NAVD88 for 2057. With a 16.0 ft design elevation this reduces the Seabrook Barrier 100-yr SWL50 freeboard from 6.7 to 5.8 ft and from 5.2 to 4.3 ft for 2007 and 2057 (13 and 17 percent). [Note, the 0.9 ft increase is similar to those described for reaches NO01 and NE01 in Section 2.2.Tables 2.1.]
- The exterior 100-yr SWLσ is increased to 25 percent, consistent with a reasonably conservative approach to all sources of SWL uncertainty—or 2.6 and 2.9 ft for 2007 and 2057. The *DER* 100-yr SWLσ was 0.8 ft. The 100-yr SWL90 increases to 13.5 and 15.4 ft NAVD88 for 2007 and 2057.

  The revised 100-yr 2057 Q50 and Q90 for the Seabrook Surge Barrier increase from 0.004 and 0.015 cfs/ft to 0.03 and 1.4 cfs/ft. The increase was recomputed using the revised 100-yr SWL50 and SWLσ, the Franco and Franco equation (Figure I-1) and revised Monte Carlo analysis for floodwall overtopping uncertainty (see Table I-1 for a list of the Monte Carlo inputs.). Over the 2,000 ft barrier the revised Q50 and Q90 correspond to 4.1 and 236 acre-ft/hour. For a 3,700 acre Basin surface area this equates to 0.01 and 0.77 inches of additional depth for each hour of overtopping at this peak rate.

  Note that estimating the actual 100-yr cumulative overtopping volume (a V50 and V90) requires developing an inflow time-series corresponding to the surge hydrograph, and integrating the inflow time-series. This is beyond the requirements of this Report. The Q50 and Q90 provide sufficient information to develop a working assumption for revised 100-yr Basin SWL50 and SWL90.

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Table VI-5-13
Overtopping Formula by Franco and Franco (1999)

Impermeable and permeable vertical walls. Non-breaking, oblique, long- and short-crested waves.

$$\frac{q}{\sqrt{gH_s^3}} = 0.082 \exp\left(-3.0\frac{R_c}{H_s}\frac{1}{\gamma_\beta \gamma_s}\right) \qquad (VI-5-28)$$

Uncertainty: Standard deviation of factor 3.0 = 0.26 (see Figure VI-5-16).

Figure I-1 Franco and Franco Overtopping Equation (USACE Coastal Engineering Manual 2006)

Table I-1 Overtopping Monte Carlo Analysis Inputs

	Seabrook					**IHNC**			
	100-yr			**500-yr**		**100-yr**		**500-yr**	
	DER 2057*	2007	2057	2007	2057	2007	2057	2007	2057
Inputs									
Toe	2.8	2.8	2.8	2.8	2.8	0.0	0.0	0.0	0.0
Crown	16.0	16.0	16.0	16.0	16.0	25.5	25.0	25.5	25.0
γS	0.75	0.75	0.75	0.75	0.75	0.9	0.9	0.9	0.9
SWL50	10.8	10.2	11.7	13.3	14.8	19.2	20.7	22.9	24.4
σ	0.8	2.6	2.9	3.3	3.7	4.8	5.2	5.7	6.1
SWL90	11.8	13.5	15.4	17.6	19.5	25.3	27.3	30.2	32.2
SWL50 Depth	8.0	7.4	8.9	10.5	12.0	19.2	20.7	22.9	24.4
Hs	3.2	3.0	3.6	4.2	4.8	7.7	8.3	9.2	9.8
HS σ	0.3	0.3	0.4	0.4	0.5	0.8	0.8	0.9	1.0
TP	6.4	6.4	6.4	6.4	6.4	8.1	8.1	8.1	8.1
TP σ	1.2	1.2	1.2	1.2	1.2	1.6	1.6	1.6	1.6
Results									
Determ	0.004	0.001	0.02	0.31	0.8	0.6	2.0	5.0	11.5
q50	0.004	0.001	0.03	0.3	0.8	0.6	1.8	4.0	7.5
q90	0.02	0.1	1.4	9.5	18.2	6.5	16.0	45.1	85.3
DERq50	0.004								
DERq90	0.02								

*DER 2057 Seabrook inputs were re-run as a check.

- The revised 2007 100-yr Q50 and Q90—without the 1.5 ft of RSLR—were also computed for comparison. These were not presented in the *DER* since the design is based on the 2057 100-yr SWL. As would be expected, the 2007 100-yr Q50 and Q90 are lower, at 0.001 and 0.1 cfs/ft.

The increases in revised versus *DER* 2057 100-yr Q50 and Q90 reflect the nonlinear effect of increasing SWL50 and SWLσ (see Section 4.3 of Part I). However, while the revised Seabrook Barrier 2057 100-yr Q50 and Q90 increased substantially above the design limits, the above estimates of peak 100-yr overflow volumes indicate that overtopping total volumes—over the duration of a surge event—would be negligible relative to the Basin storage capacity.

IHNC Barrier 100-yr Overtopping

- An increase in the exterior 100-yr SWL50 of 0.4 ft to correct for FORTRAN code issues, from 18.8 to 19.2 ft NAVD88 for 2007 and from 20.3 to 20.7 ft NAVD88 for 2057. Using a 25.0 ft design elevation this reduces the IHNC Barrier 100-yr SWL50 freeboard for 2007 and 2057 from 6.2 to 5.8 ft and from 4.7 to 4.3 ft (6 and 9 percent). [Note, the 0.4 ft increase is similar to those described for reach SB11 in Section 2.2.Tables 2.1.]
- An increase in the exterior 100-yr SWLσ to 25 percent, consistent with a reasonably conservative approach to all sources of SWL uncertainty—or 4.8 and 5.2 ft for 2007 and 2057. The *DER* 100-yr SWLσ was 1.0 ft. The 100-yr SWL90 increases to 25.3 and 27.3 ft NAVD88 for 2007 and 2057.
- The revised 100-yr 2057 Q50 and Q90 for the IHNC Barrier are 1.8 and 16.0 cfs/ft. The DER does not include estimates of the 100-yr Q50 and Q90, nor are these rates identified in *the IHNC Basin System Analysis Report* (USACE 2013). The increase was recomputed using the revised 100-yr SWL50 and SWLσ, and analysis for floodwall overtopping uncertainty. Over the 9,400 ft barrier the revised Q50 and Q90 correspond to 1,406 and 12,430 acre-ft/hour. For the 3,700 acre Basin surface area this equates to 0.38 ft and 3.4 ft of additional depth for each hour of overtopping at this rate.
- The 2007 100-yr Q50 and Q90 are much lower, at 0.6 and 6.5 cfs/ft—corresponding to 0.13 and 1.36 ft for each hour of overtopping at these rates.

Discounting uncertainty, the revised 2007 IHNC Barrier 100-yr Q50 rate—at 0.13 ft of Basin rise for each hour of peak overtopping—indicates that the 100-yr overtopping volume from the IHNC Barrier is also *currently* minor relative to the Basin storage capacity. Total added volume is likely to be less than one foot. However, uncertainty with the IHNC Barrier 2007 100-yr overtopping indicates that inflow exceeding two feet of Basin storage is very possible. With 2057 reduction of 100-yr SWL50 freeboard to 4.3 ft, higher 100-yr Q50—at 0.38 ft of Basin rise for each hour of peak overtopping—will raise the Basin 100-yr SWL50. Finally, if uncertainty and future RSLR are both considered, 100-yr overtopping from the IHNC Barrier could produce several feet of rise in Basin SWL.

IHNC Basin 100-yr SWL

A complete re-estimate of the IHNC Basin 100-yr SWL and SWLσ requires a complex joint probability analysis combining an updated estimate of overflow hazard at the IHNC and Seabrook Barriers (the latter might not be negligible following a thorough updating of the exterior surge hazard analysis), the direct rainfall and local pump station discharge probabilities, and interior wind setup conditions. This re-estimate is beyond the scope of this Report but is strongly recommended for local comprehensive risk management purposes. For this Report, partially revised estimates for ***2057*** 100-yr SWL50 and SWLσ are 8.0 ft NAVD88 and 2.0 ft (consistent with a SWLσ of 25 percent)—rather than 6.6 ft NAVD88 and 0.8 ft per the 2014 *DER*. A partially revised estimate for 2057 100-yr SWL90 is 10.6 ft NAVD88.

Seabrook Barrier 500-yr Overtopping

- An increase in the exterior 500-yr SWL50 of 0.9 ft to correct for FORTRAN code issues, from 12.4 to 13.3 ft NAVD88 for 2007 and from 13.9 to 14.8 ft NAVD88 for 2057. With a 16.0 ft design elevation this reduces the Seabrook Barrier 500-yr SWL50 freeboard from 3.6 to 2.7 ft and from 2.1 to 1.2 ft for 2007 and 2057 (25 and 33 percent).
- An increase in the exterior 500-yr SWLσ to 25 percent, consistent with a reasonably conservative approach to all sources of SWL uncertainty—or 3.33 and 3.7 ft for 2007 and 2057. The 500-yr SWL90 increases to 17.6 and 19.5 ft NAVD88 for 2007 and 2057.
- The revised 500-yr 2057 Q50 and Q90 for the Seabrook Surge Barrier increase to 0.8 and 18.2 cfs/ft . Over the 2,000 ft barrier the revised Q50 and Q90 correspond to 136 and 3,001 acre-ft/hour. For the 3,700 acre Basin surface area this equates to 0.44 in and 0.81 ft of additional depth for each hour of overtopping at this peak rate.
- The revised 2007 100-yr Q50 and Q90—without the 1.5 ft of RSLR—were lower, at 0.313 and 9.51 cfs/ft—corresponding to 0.17 in and 0.42 ft for each hour of overtopping at these rates.

IHNC Barrier 500-yr Overtopping

- An increase in the exterior 500-yr SWL50 of 0.4 ft to correct for FORTRAN code issues, from 22.5 to 22.9 ft NAVD88 for 2007 and from 24.0 to 24.4 ft NAVD88 for 2057. Using a 25.0 ft design elevation this reduces the IHNC Barrier 500-yr SWL50 freeboard from 2.5 to 2.1 ft and from 1.0 to 0.6 ft for 2007 and 2057 (16 and 40 percent).
- An increase in the exterior 500-yr SWLσ to 25 percent, consistent with a reasonably conservative approach to all sources of SWL uncertainty—or 5.7 and 6.1 ft for 2007 and 2057. The 500-yr SWL90 increases to 30.2 and 32.2 ft NAVD88 for 2007 and 2057.
- The revised 500-yr 2057 Q50 and Q90 for the IHNC Barrier increase to 7.5 and 85.3 cfs/ft. Over the 9,400 ft barrier the revised Q50 and Q90 correspond to 5,803 and 66,266 acre-ft/hour. For the 3,700 acre Basin surface area this equates to 1.57 ft and 17.9 ft of additional depth for each hour of overtopping at this rate. This depth for the Q90 inflow assumes that the overtopping volume is contained within the IHNC Basin with a sufficiently higher perimeter. With current IHNC Basin perimeter elevations the Q90 would actually overtop into all three polder and not reach 17.9 ft in Basin. Without overtopping and breaching the Basin holds about 18,000 acre-ft—thus over 48,000 acre-ft would flow into the adjacent polders. The 48,000 acre-ft could be reduced by 3,700 acre-ft for every extra foot of increase in IHNC Basin storage.
- The 2007 500-yr Q50 and Q90 are lower, at 3.97 and 45.12 cfs/ft—corresponding to 0.83 and 9.47 ft for each hour of overtopping at these rates.

More detailed assessment of regional exterior 500-yr SWLσ might support lower estimates, and hence low Q90 values, especially given major surge-response changes when surges approach the crowns of NO East and St. Bernard reaches east of the IHNC Barrier.

IHNC Basin 500-yr SWL

A partially revised estimate for the 2057 500-yr SWL50 is 11 ft NAVD88—rather than 8.9 ft NAVD88 per the 2014 *DER*.

II. Diversion of IHNC Basin Surge into the Central Wetlands

A one-dimensional dynamic routing analysis was performed for the diversion of surge from the IHNC Basin to the Central Wetlands via the Bayou Bienvenue Sector Gate. The analysis was performed with HEC-RAS v4.1.0. This model domain included 14 channels shown on Figure I-1:

- The IHNC—from the Lock to Seabrook Surge Barrier.
- The GIWW—from the IHNC Surge Barrier to the IHNC.
- Bayou Bienvenue (from the Orleans Pump Station No. 5 to GIWW.
- Four Central Wetland Channels west of Paris Rd—from 40 Arpent Levee/Floodwall to Bayou Bienvenue—CW6, CW7, CW8, and CW9.
- A Pipeline Canal in the Central Wetland east of Paris Rd paralleling the HSDRRS—from far eastern end of HSDRRS to Bayou Bienvenue just inside the Sector Gate.
- Bayou Dupre—from Violet to the Pipeline Canal).
- Three Central Wetland Channels between Paris Rd and Bayou Dupre—from the 40 Arpent Levee/Floodwall; one to Bayou Bienvenue—CW1—and two to the Pipeline Canal—CW2 and CW3.
- Two Central Wetland Channels east of Bayou Dupre—both from the 40 Arpent Levee/Floodwall; one to Bayou Dupre—CW4—and one to the Pipeline Canal—CW5.

IHNC, GIWW, and Central Wetlands features were delineated using Google Earth imagery. Topography and bathymetry were obtained from available LIDAR DEMs and navigation charts. The Central Wetlands LIDAR DEM is depicted in Figure I-2.

The storage and conveyance capacity and frictional energy dissipation of the IHNC Basin and Central Wetlands channels were represented with numerous cross sections. Central Wetland channel thalwegs were assumed to be a few feet and were sloped slightly downstream to enhance flow stability. A few areas of high elevation, such as along the HSDRRS, were not represented in the cross sections. Some typical cross sections are presented in Figure I-4. Twenty (20) storage areas—shown on Figure I-3—were employed to represent large open areas with likely very flat gradients. The storage areas were connected to channels—and in some cases each other—as indicated in the imagery and DEM.

Three in-line structures were included in the model.

- The Bayou Bienveue Sector Gate.
- The Paris Rd Bridge at Bayou Bienvenue.
- Seabrook Surge Barrier Gate.

The Bayou Bienvenue Sector Gate and Paris Rd Bridge are shown in Figure I-5.

The HEC-RAS model was used to simulate transient conditions during surge scenarios—i.e., time-varying flow inputs and gate opening/closure. Transient surge scenarios were modeled with:

- 96-hr total simulation periods.
- The primary flow input for surge scenarios at the head of the GIWW channel—the IHNC Surge Barrier—to represent overtopping.

Figure I-1. Model Channels

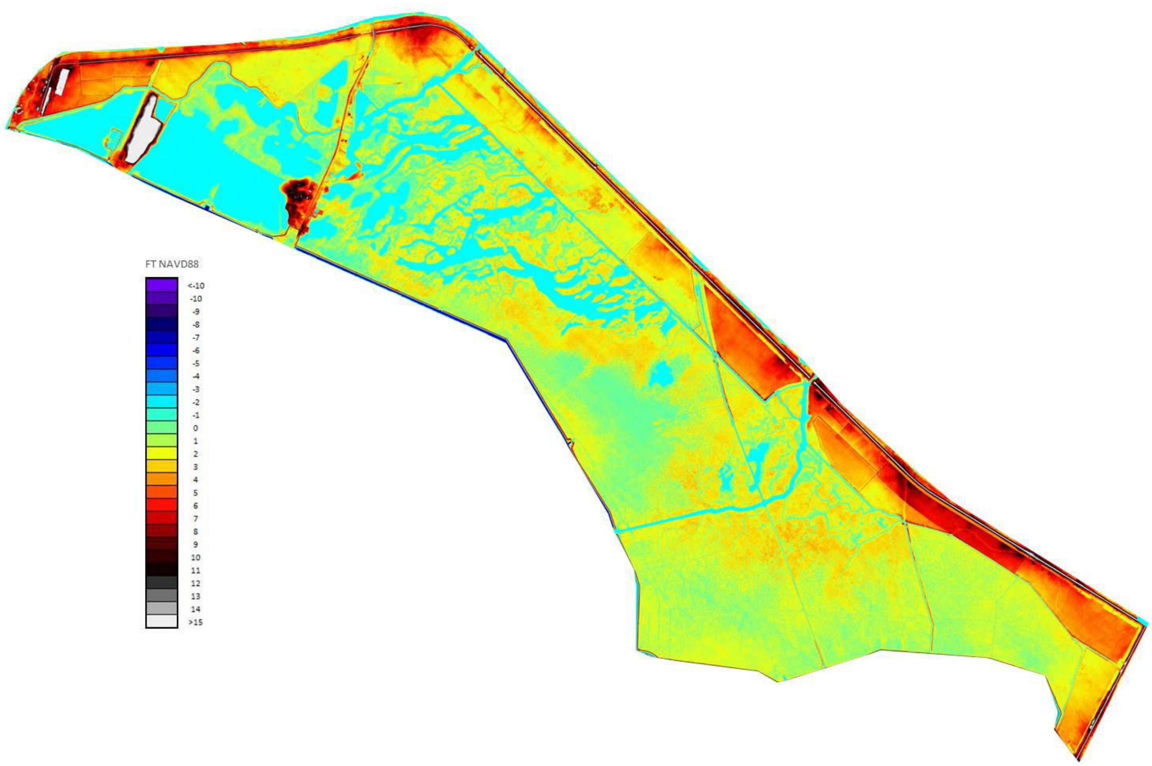


Figure I-2. Central Wetlands LIDAR DEM

U.S. Geological Survey, EAARL Coastal Topography--Central Wetlands, Louisiana, 2010, 2012

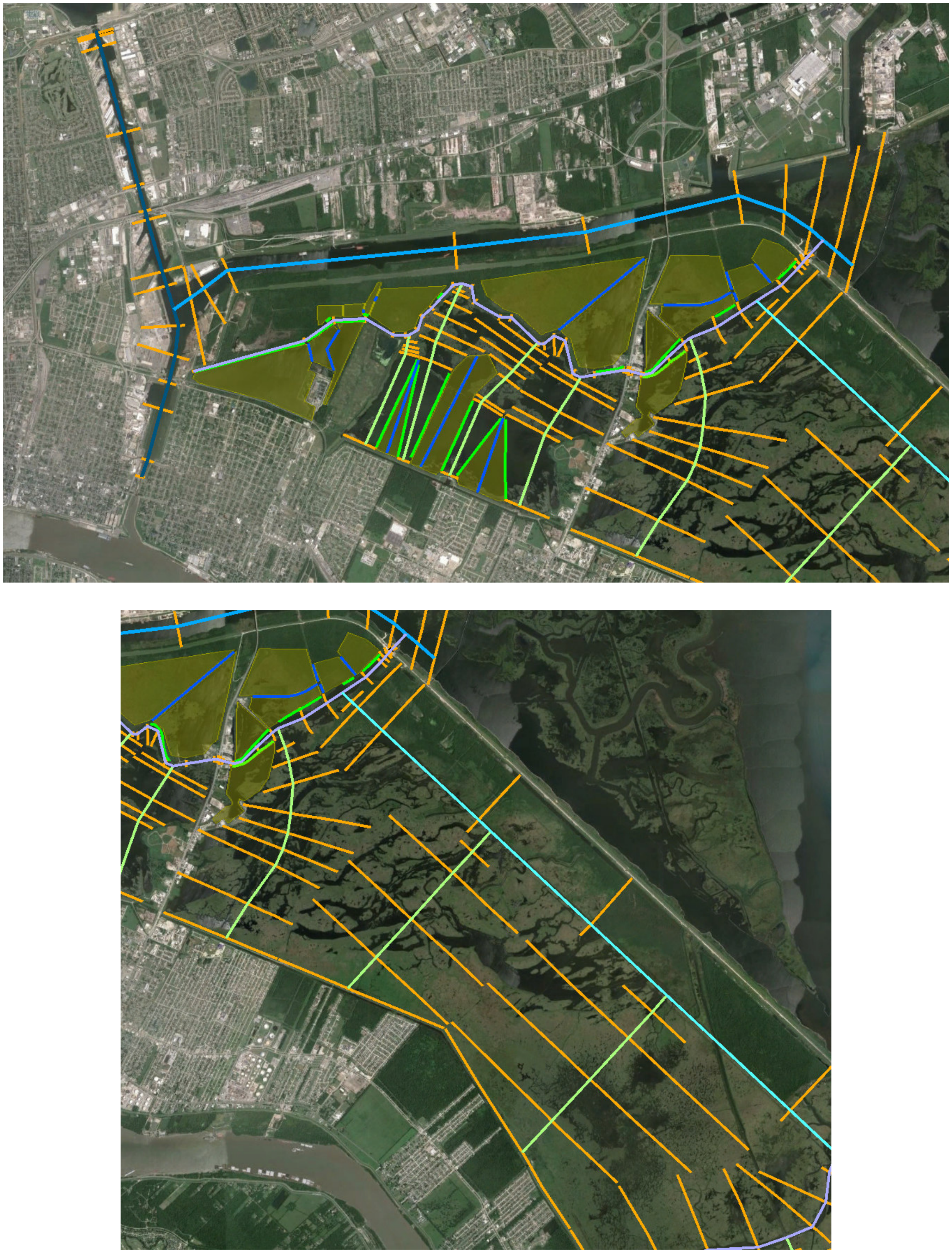
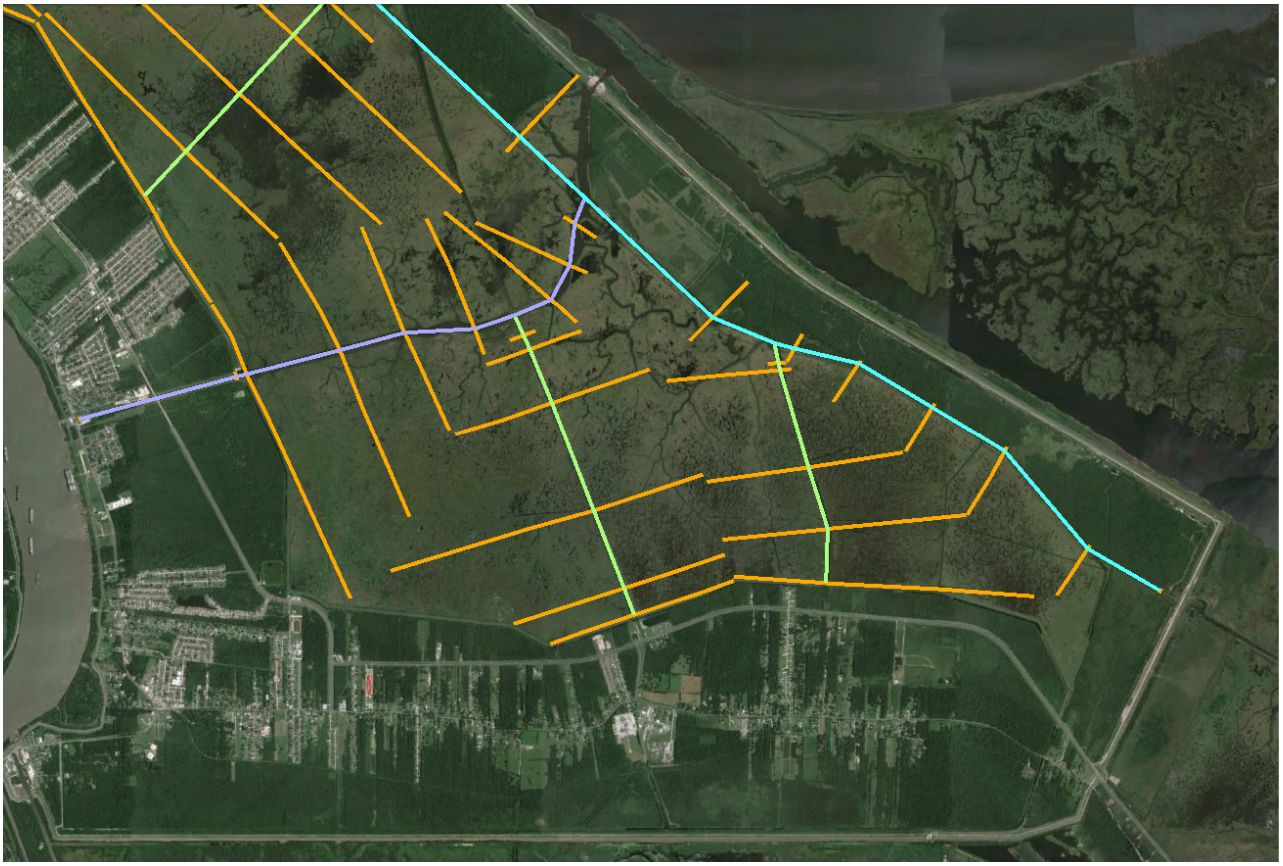
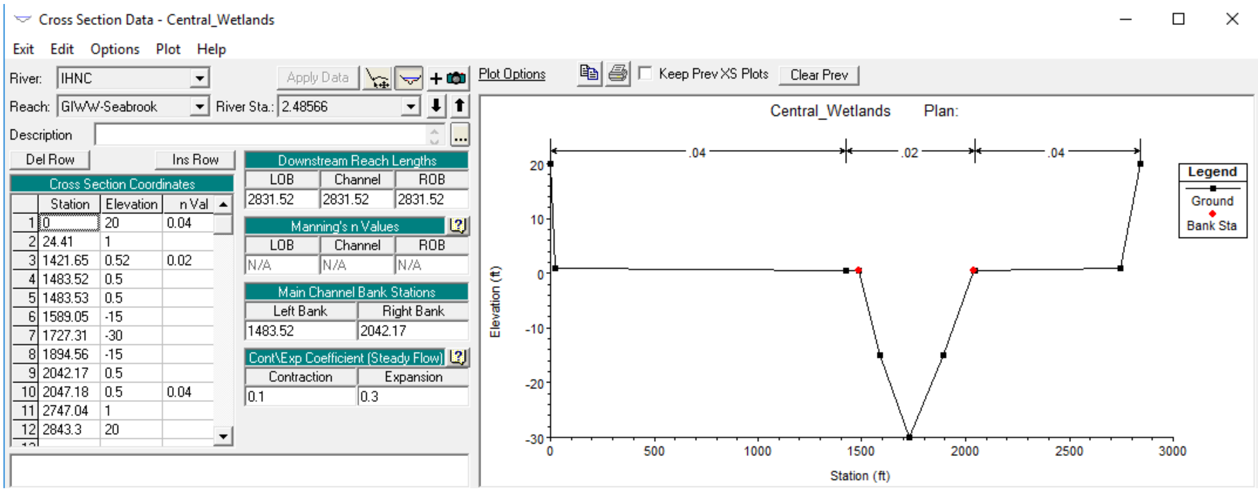


Figure I-3. Model Features

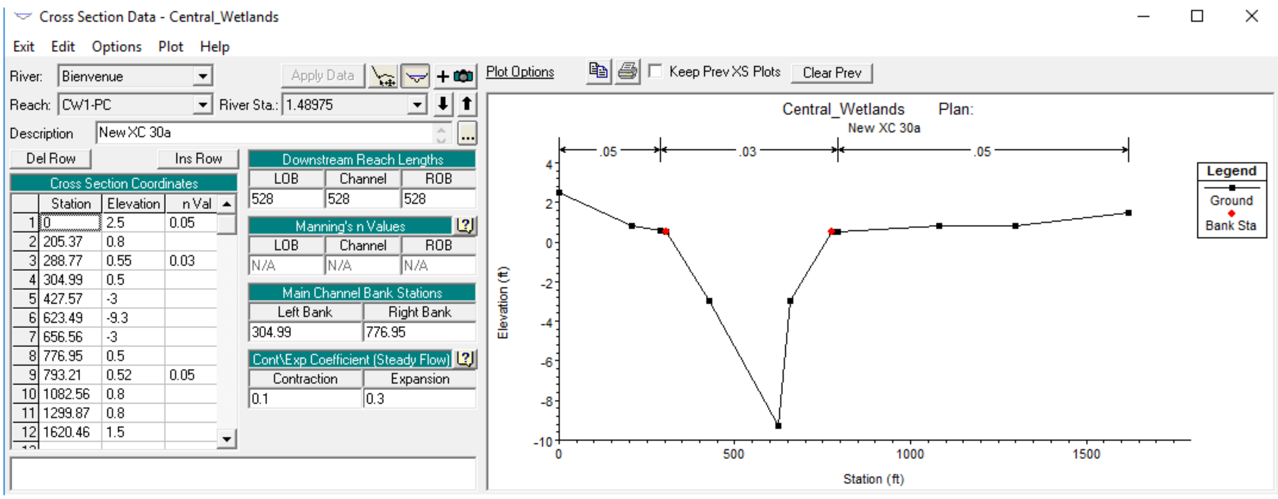


Central Wetlands Channel—Pale Green
Cross Sections—Orange
Storage Areas—Olive Green
Linear Structures—Bright Green (connect channels to storage areas)
Storage Area Connectors—Dark Blue (connect storage areas)

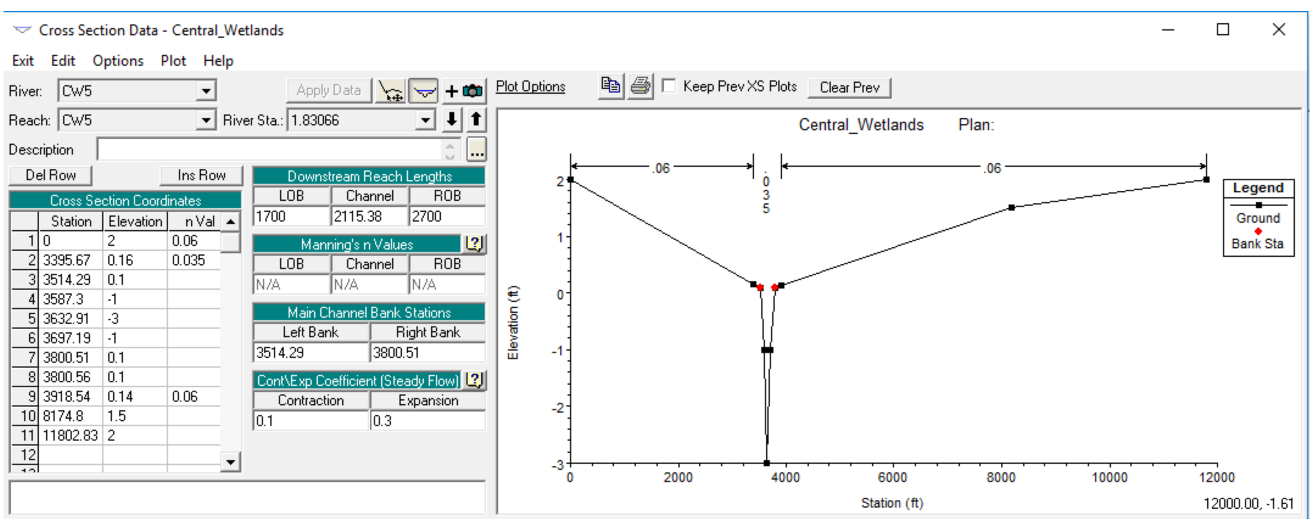
Figure I-3. Model Features



a. IHNC north of GIWW

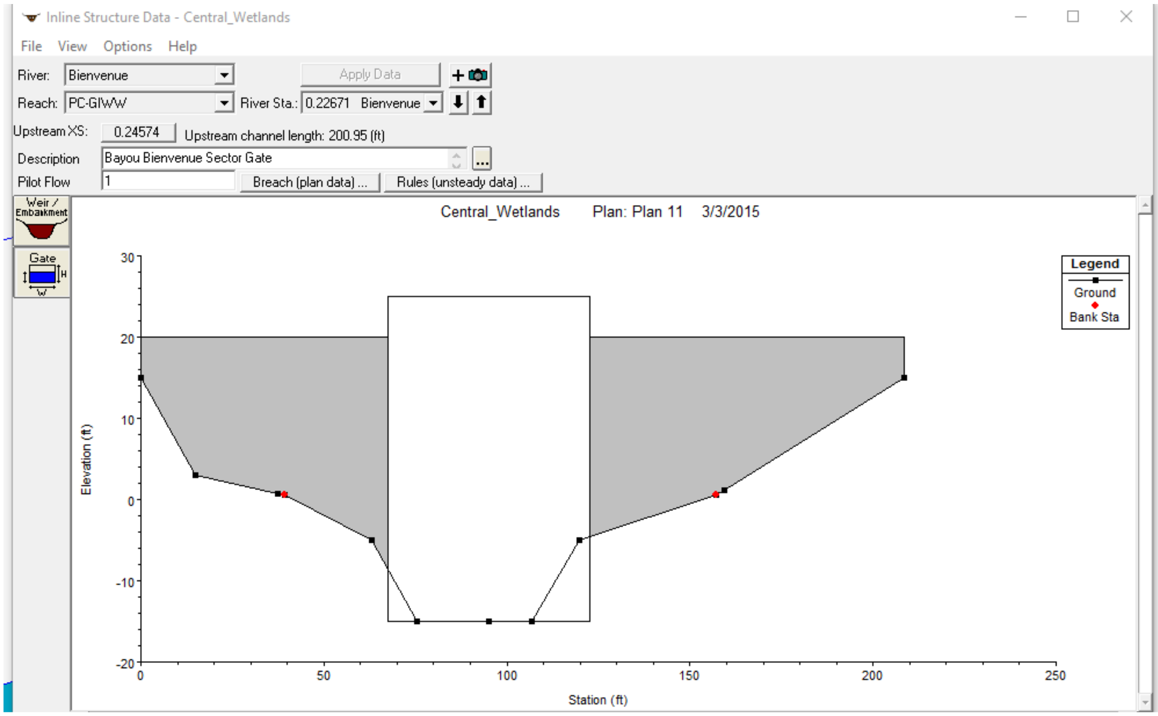


b. Bayou Bienvenue between CW1 and Pipeline Canal

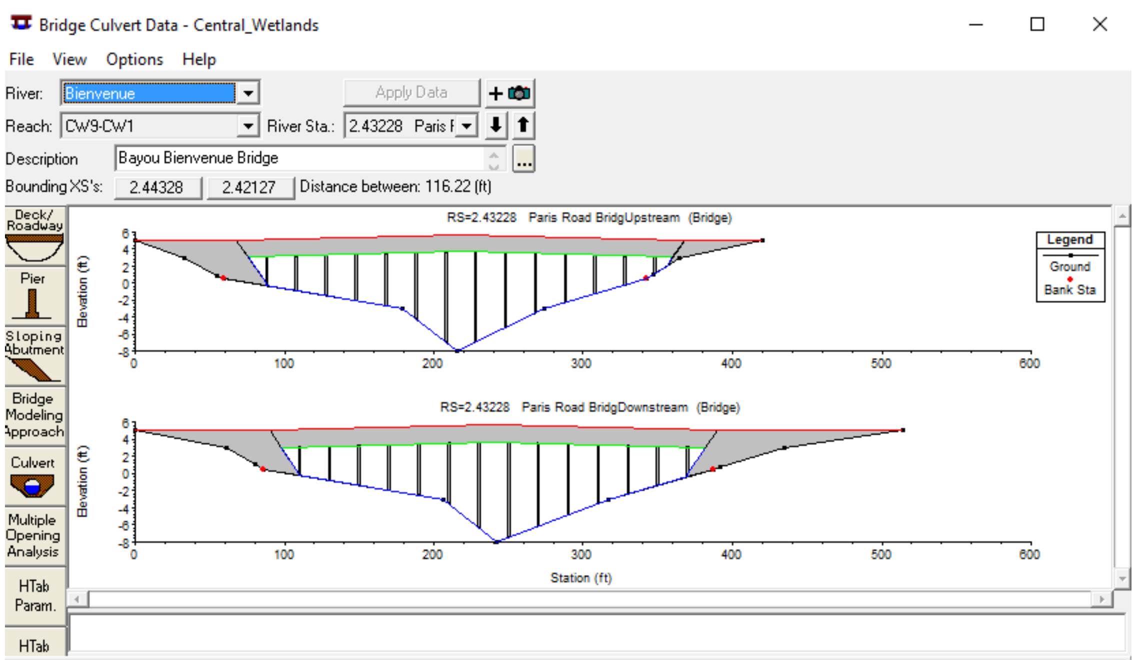


c. Head of CW5

Figure I-4. Sample Cross Sections



a. Bayou Bienvenue Sector Gate



b. Bayou Bienvenue Bridge at Paris Rd

Figure I-5. Bayou Bienvenue Sector Gate and Paris Rd Bridge

- Secondary flows input to the other 13 channels to represent time-varying discharges from five IHNC Basin and eight Central Wetlands pump stations as well as the time-varying direct rainfall into the IHNC Basin and Central Wetlands.
- Bayou Bienvenue Sector Gate starting open and closing at 8 hours.
- Over the first 36 hours as follows:
  - downstream stage in Lake Pontchartrain starts at 0.5 and rises to 1.4 ft NAVDD88.
  - the GIWW inflow begins at 30 cfs and ramping up to 3,000 cfs.
  - the 13 secondary inflows are steady with direct rainfall at 0.03-in/hr and pump stations at 4% of capacity.
  - a steady state run for the boundary conditions at 36 hours provide initial conditions.
- 13 secondary inflows ramping-up after 36 hours, peaking at 68 hours with direct rainfall at 1 in/hr and pump station capacity at 100 percent. These inflows then declined, returning to the initial rates at 84 hours. The total direct rainfall over the simulation is about 12 inches.
- GIWW inflow closed at 36 hours and Seabrook Gate closed and outflow restricted to a trickle flow at 44 hours.
- Primary surge inflow starting at 68 hours, peaking at 70 hours, and finishing by 84 hours.
- Lake Pontchartrain downstream stage rises to 9.2 ft NAVD88 at 72 hours.

The above transient boundary conditions produced pre-storm IHNC Basin and Central Wetlands SWLs of roughly 2.5 and 1.7 ft NAVD88 at 48 hours, and 3.0 and 2.1 ft NAVD88 at 64 hours. Without primary surge inflow the IHNC Basin Peak SWL reached about 5.0 ft NAVD88. Three primary surge inflow scenarios were simulated to produce peak IHNC Basin SWLs of roughly 6, 9, and 12 ft NAVD88 Without-Diversion. Simulations were then run With-Diversion by re-opening the Bayou Bienvenue Sector Gate at 48 hours. Table I-2 presents the transient boundary conditions used in the three scenarios.

Peak conditions for these three scenarios—Without and With Diversion—are shown in Table I-3. The GIWW inflow and stage hydrographs, and hydrographs for the head of Bayou Bienvenue, Bayou Bienvenue east of Paris Rd (between the Pipeline Canal and CW1), and the heads of Bayou Dupre and the Pipeline Canal for all three scenarios, Without and With Diversion, are given Figures I-6, I-7, and I-8.

The dynamic routing analysis indicates that early re-opening of the Bayou Bienvenue Sector Gate provides a major reduction of IHNC Basin peak SWL—by 2.6, 4.4, and 5.9 ft in these three scenarios—which indicates significant surge risk reduction for the IHNC Basin. The analysis also indicates that diversions with early re-opening could have much lower peak velocities at the Bayou Bienvenue Sector Gate than indicated by the USACE's 2014 initial analysis, implying that associated operational and structural concerns may be moderated.

Without-Diversion, the highest peak SWLs in the Central Wetlands occur at the channel heads concurrent with peaking inflows. These peaks are relatively unaffected by diversion. Under all three scenarios, SWLs peaked near 7.5 ft NAVD88 at the head of both Bayou Bienvenue and Bayou Dupre both Without- and With-Diversion. At the head of the Pipeline Canal at the far eastern end of the Central Wetlands peak SWL rose by 0.3 ft in Scenario 3 With-Diversion.

The diversion raised interior Central Wetlands peak SWL more noticeably. For Scenario 3 the peak SWL in Bayou Bienvenue east of Paris Rd increased 1.75 ft With-Diversion, to near 5 ft NAVD88.

Table I-2. Boundary Conditions (Hour 0 to 96, 2 hour increments)

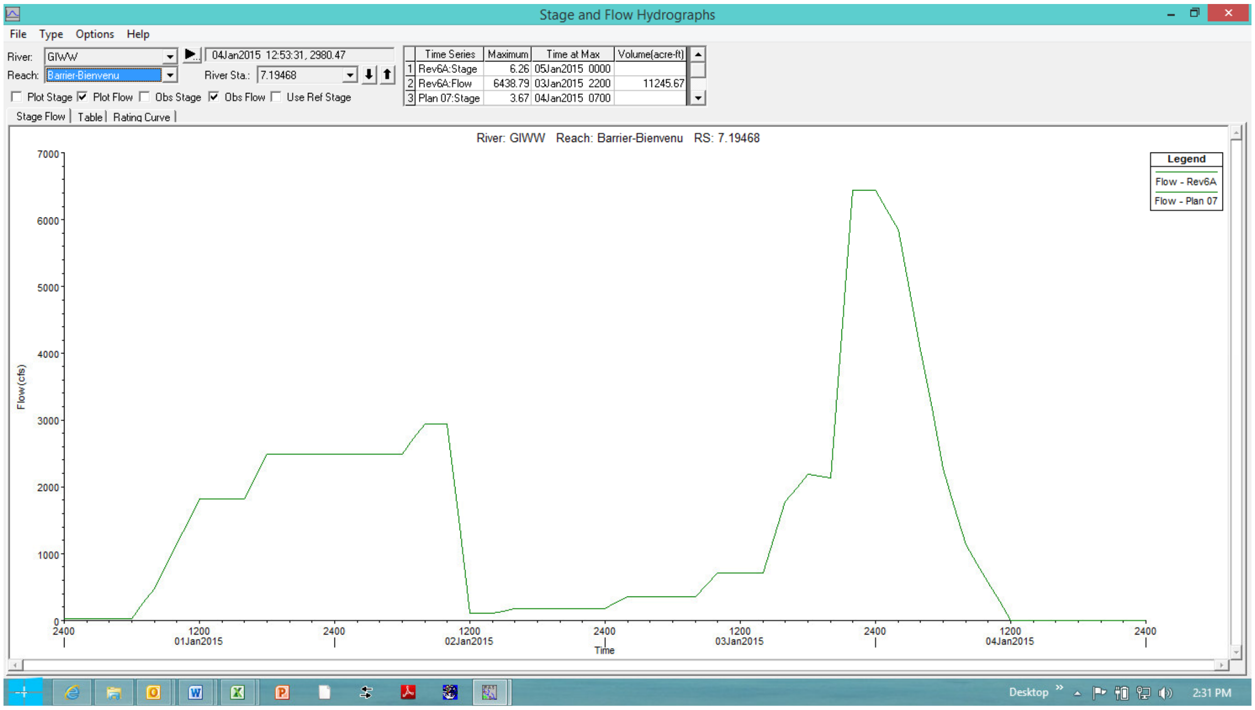
IHNC GIWW-Seabrook	Bienvenue	Dupre Violet-	IHNC Lock	Pipeline Canal	GIWW Barrier Inflow	Total GIWW Barrier Inflow	Total GIWW Barrier Inflow
DS Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary
Stage	Flow	Flow	Flow	Flow	Flow	Flow	Flow
ALL	ALL	ALL	ALL	ALL	Scenario 1	Scenario 2	Scenario 3
0.5	221.97	133.60	196.15	151.25	30.96	30.96	30.96
0.5	221.97	133.60	196.15	151.25	30.96	30.96	30.96
0.5	221.97	133.60	196.15	151.25	30.96	30.96	30.96
0.6	221.97	133.60	196.15	151.25	30.96	30.96	30.96
0.6	221.97	133.60	196.15	151.25	475.40	475.40	475.40
0.6	221.97	133.60	196.15	151.25	1146.95	1146.95	1146.95
0.6	221.97	133.60	196.15	151.25	1818.50	1818.50	1818.50
0.7	221.97	133.60	196.15	151.25	1818.50	1818.50	1818.50
0.7	221.97	133.60	196.15	151.25	1818.50	1818.50	1818.50
0.7	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
0.8	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
0.8	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
0.9	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
0.9	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
1.0	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
1.1	221.97	133.60	196.15	151.25	2490.05	2490.05	2490.05
1.2	221.97	133.60	196.15	151.25	2937.75	2937.75	2937.75
1.4	221.97	133.60	196.15	151.25	2937.75	2937.75	2937.75
1.6	221.97	133.60	196.15	151.25	106.96	106.96	106.96
1.8	221.97	133.60	196.15	151.25	106.96	106.96	106.96
2.0	369.95	222.66	326.92	252.08	178.26	178.26	178.26
2.2	369.95	222.66	326.92	252.08	178.26	178.26	178.26
2.4	369.95	222.66	326.92	252.08	178.26	178.26	178.26
2.6	369.95	222.66	326.92	252.08	178.26	178.26	178.26
2.8	369.95	222.66	326.92	252.08	178.26	178.26	178.26
3.0	739.90	445.32	653.84	504.17	356.52	356.52	356.52
3.5	739.90	445.32	653.84	504.17	356.52	356.52	356.52
4.0	739.90	445.32	653.84	504.17	356.52	356.52	356.52
4.5	739.90	445.32	653.84	504.17	356.52	356.52	356.52
5.0	1479.80	890.63	1307.68	1008.33	713.04	713.04	713.04
5.6	1479.80	890.63	1307.68	1008.33	713.04	713.04	713.04
6.2	1479.80	890.63	1307.68	1008.33	713.04	713.04	713.04
6.8	3247.50	2094.58	2515.21	2520.83	1778.23	2119.31	2460.39
7.4	3247.50	2094.58	2515.21	2520.83	2185.64	3440.76	4695.87
8.0	6495.00	4189.17	5030.42	5041.67	2132.78	6000.00	12000.00
8.6	3247.50	2094.58	2515.21	2520.83	6438.79	17236.05	28033.30
9.2	3247.50	2094.58	2515.21	2520.83	6438.79	17236.05	28033.30
9.2	1479.80	890.63	1307.68	1008.33	5855.52	17392.89	28930.27
8.2	1479.80	890.63	1307.68	1008.33	4064.72	11584.35	19103.99
7.2	1479.80	890.63	1307.68	1008.33	2273.92	5775.81	9277.70
6.7	739.90	445.32	653.84	504.17	1136.96	2887.90	4638.85
6.2	369.95	222.66	326.92	252.08	568.48	1443.95	2319.42
5.7	221.97	133.60	196.15	151.25	0.00	0.00	0.00
5.2	221.97	133.60	196.15	151.25	0.00	0.00	0.00
5.0	221.97	133.60	196.15	151.25	0.00	0.00	0.00
4.8	221.97	133.60	196.15	151.25	0.00	0.00	0.00
4.6	221.97	133.60	196.15	151.25	0.00	0.00	0.00
4.4	221.97	133.60	196.15	151.25	0.00	0.00	0.00
4.2	221.97	133.60	196.15	151.25	0.00	0.00	0.00

Table I-2. Boundary Condition (Hour 0 to 96, 2 hour increments)

CW1	CW2	CW3	CW4	CW5	CW6	CW7	CW8	CW9
US Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary	US Boundary
Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow
ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL	ALL
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
140.88	177.07	213.19	100.83	100.83	15.13	25.21	182.36	59.79
140.88	177.07	213.19	100.83	100.83	15.13	25.21	182.36	59.79
140.88	177.07	213.19	100.83	100.83	15.13	25.21	182.36	59.79
140.88	177.07	213.19	100.83	100.83	15.13	25.21	182.36	59.79
140.88	177.07	213.19	100.83	100.83	15.13	25.21	182.36	59.79
281.75	354.13	426.38	201.67	201.67	30.25	50.42	364.72	119.58
281.75	354.13	426.38	201.67	201.67	30.25	50.42	364.72	119.58
281.75	354.13	426.38	201.67	201.67	30.25	50.42	364.72	119.58
281.75	354.13	426.38	201.67	201.67	30.25	50.42	364.72	119.58
563.50	708.26	852.77	403.33	403.33	60.50	100.83	729.43	239.17
563.50	708.26	852.77	403.33	403.33	60.50	100.83	729.43	239.17
563.50	708.26	852.77	403.33	403.33	60.50	100.83	729.43	239.17
1308.75	1567.25	1882.92	1008.33	1008.33	151.25	252.08	1374.58	527.92
1308.75	1567.25	1882.92	1008.33	1008.33	151.25	252.08	1374.58	527.92
2617.50	3134.50	3765.83	2016.67	2016.67	302.50	504.17	2749.17	1055.83
1308.75	1567.25	1882.92	1008.33	1008.33	151.25	252.08	1374.58	527.92
1308.75	1567.25	1882.92	1008.33	1008.33	151.25	252.08	1374.58	527.92
563.50	708.26	852.77	403.33	403.33	60.50	100.83	729.43	239.17
563.50	708.26	852.77	403.33	403.33	60.50	100.83	729.43	239.17
563.50	708.26	852.77	403.33	403.33	60.50	100.83	729.43	239.17
281.75	354.13	426.38	201.67	201.67	30.25	50.42	364.72	119.58
140.88	177.07	213.19	100.83	100.83	15.13	25.21	182.36	59.79
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88
84.53	106.24	127.92	60.50	60.50	9.08	15.13	109.42	35.88

Table 1-3. Surge Scenarios Evaluating Diversion Option with Dynamic Routing Analysis

Scenario	Peak SWL ft NAVD88				
	IHNC Basin	Head of Bayou Bienvenue	Bayou Bienvenue Between Pipeline Canal and CW1	Head of Bayou Dupre	Head of Pipeline Canal
1. IHNC Surge Barrier Peak Overtopping Rate 0.7 cfs/ft					
Without-Diversion	6.2	7.35	3.20	7.55	3.98
With-Diversion	3.6	7.43	3.63	7.49	3.98
Difference	-2.6	+0.08	+0.43	-0.06	0.0
Bayou Bienvenue Sector Gate Re-Opened Velocity, 3.1ft/s					
2. IHNC Surge Barrier Peak Overtopping Rate 1.8 cfs/ft					
Without-Diversion	9.3	7.36	3.20	7.55	3.98
With-Diversion	4.9	7.43	4.31	7.49	3.99
Difference	-4.4	+0.07	+1.11	-0.06	+0.01
Bayou Bienvenue Sector Gate Re-Opened Velocity, 7.1 ft/s					
3. IHNC Surge Barrier Peak Overtopping Rate 3.1 cfs/ft					
Without-Diversion	12.5	7.35	3.21	7.55	3.98
With-Diversion	6.6	7.42	4.96	7.49	4.30
Difference	-5.9	+0.07	+1.75	-0.06	+0.32
Bayou Bienvenue Sector Gate Re-Opened Velocity, 9.8 ft/s					



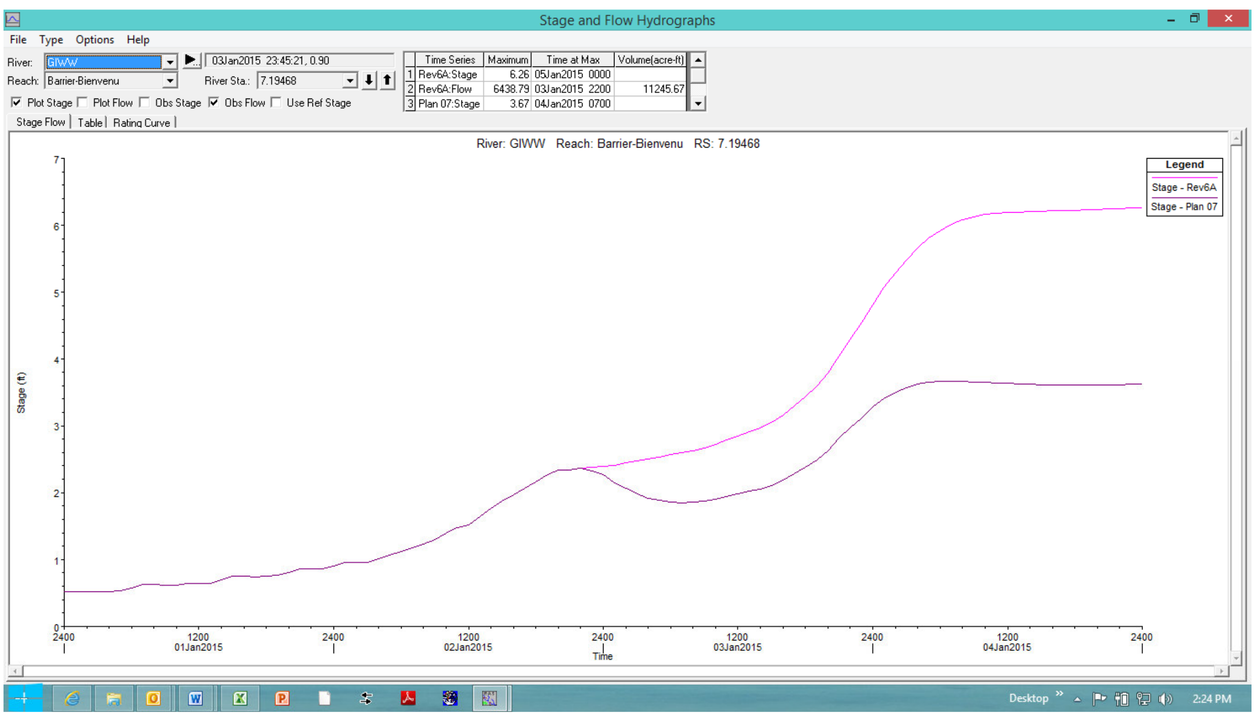
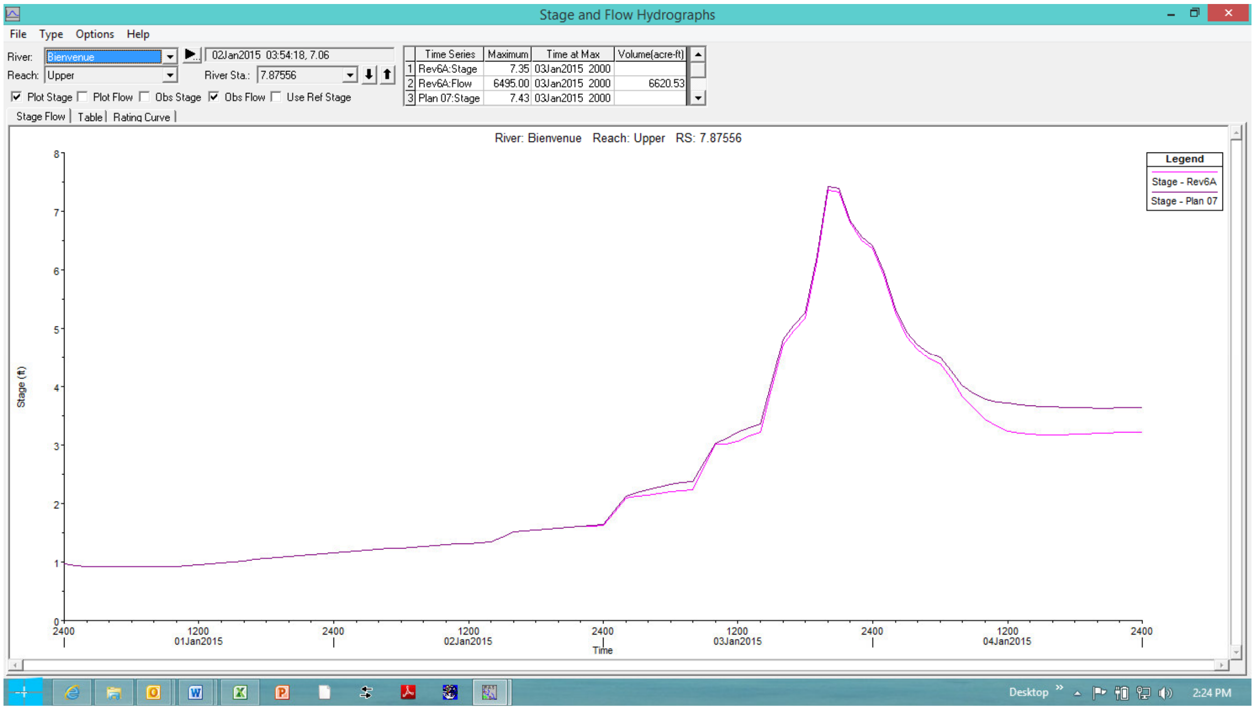


Figure I-6. Hydrographs for Scenario 1



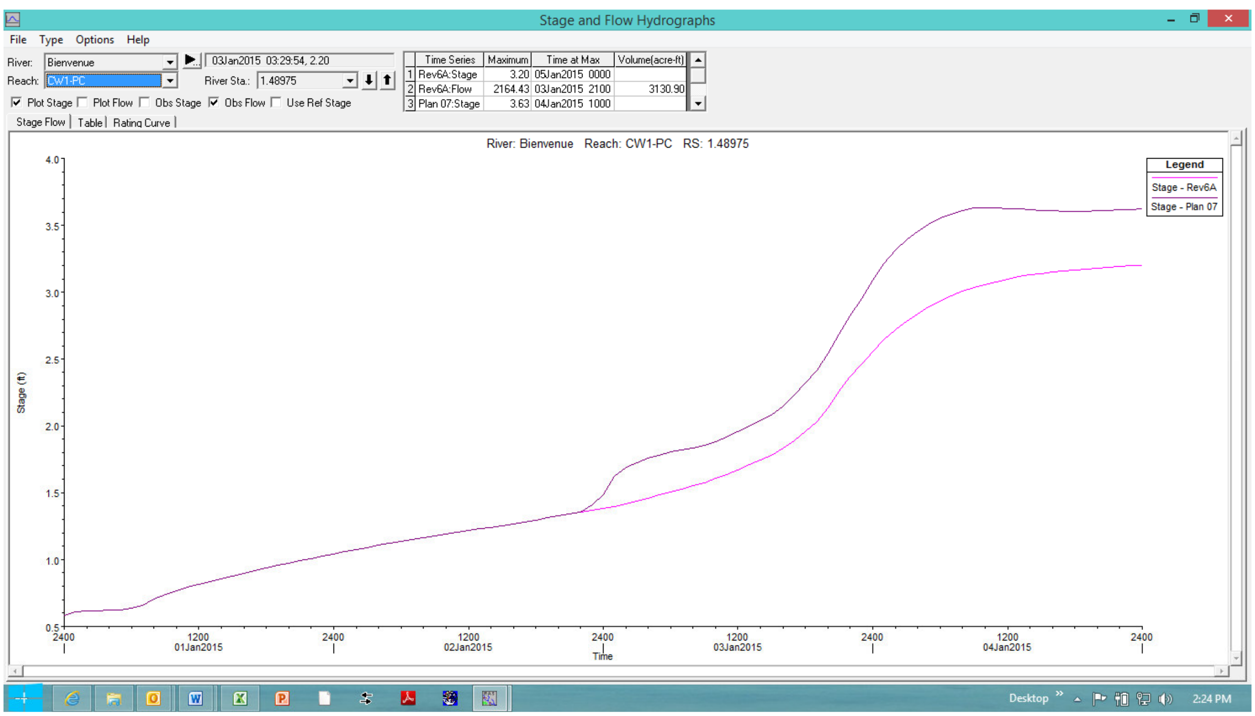
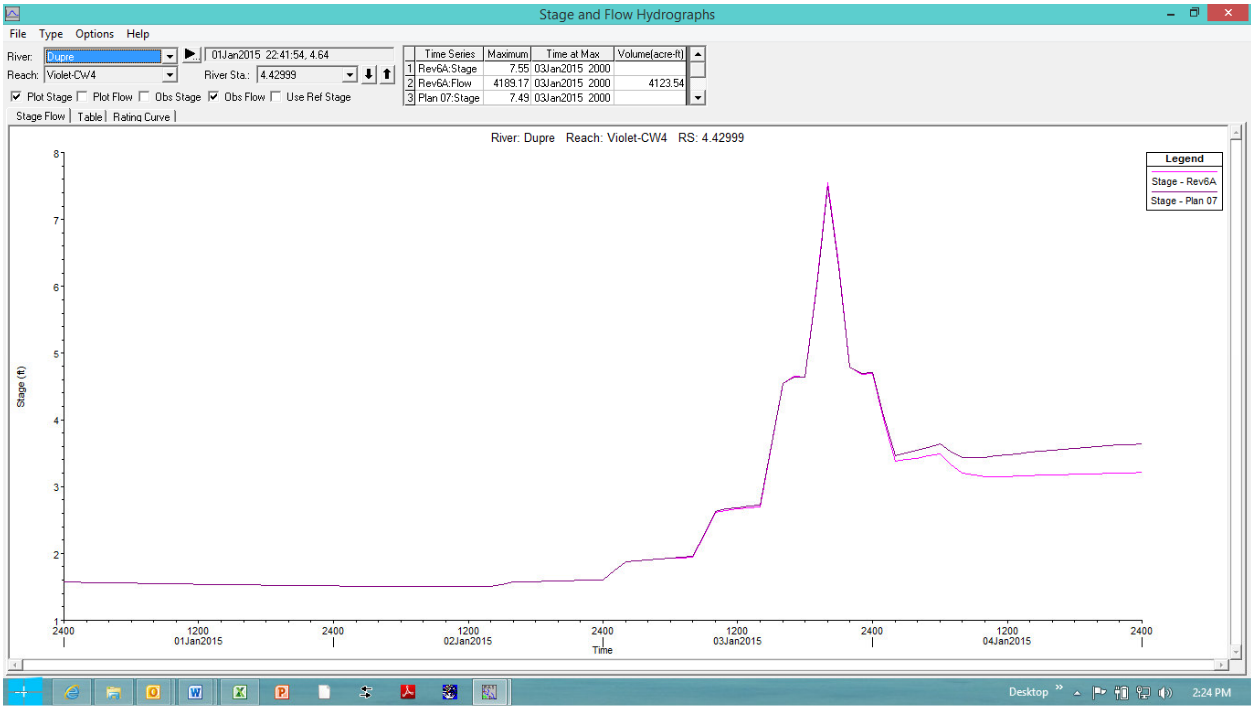


Figure I-6. Hydrographs for Scenario 1



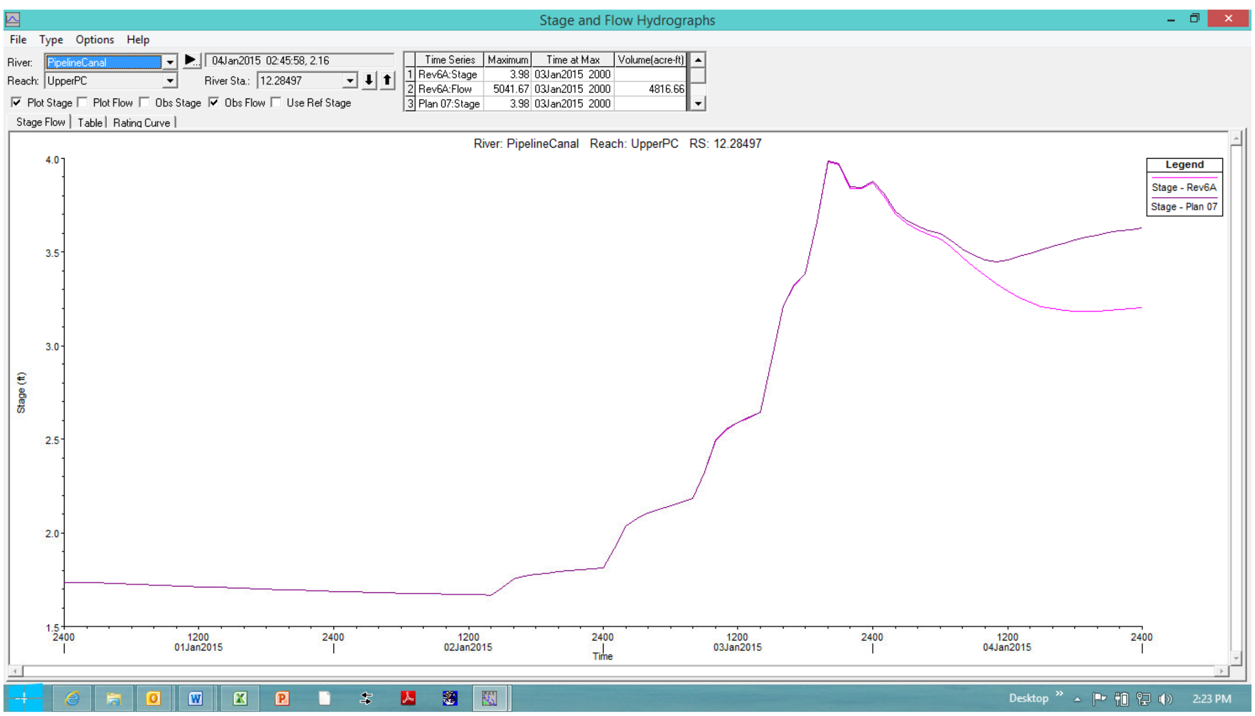
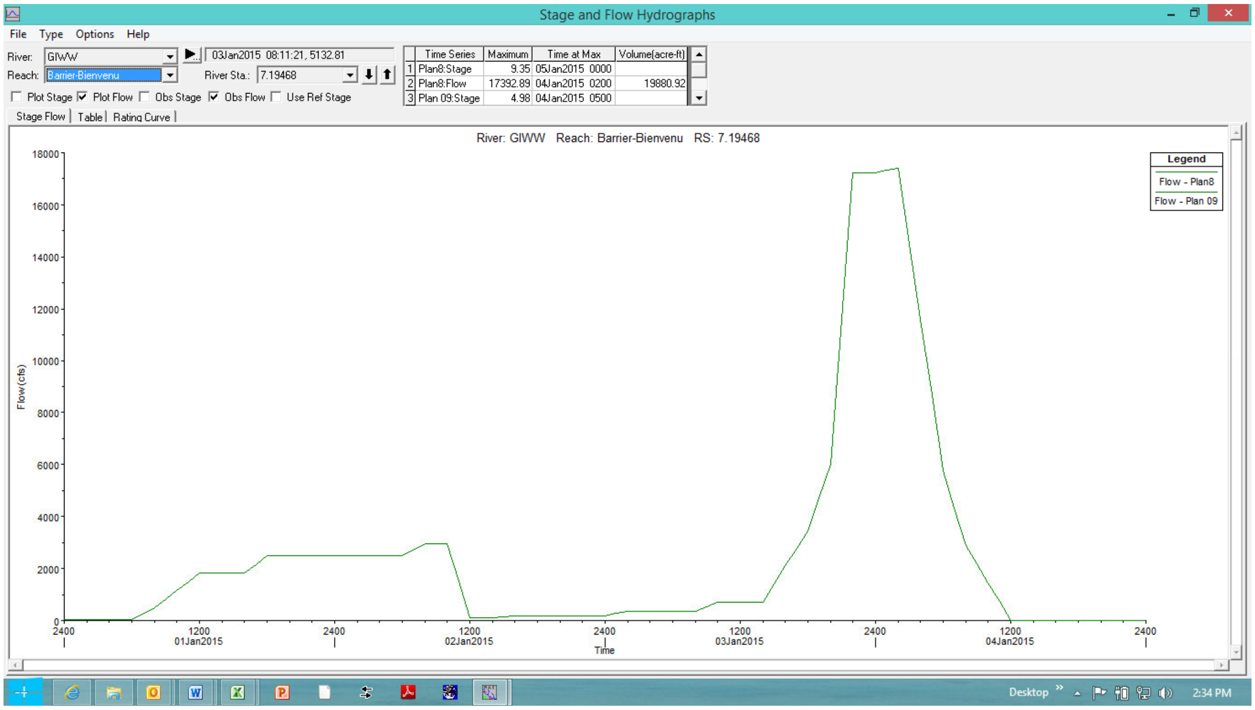


Figure I-6. Hydrographs for Scenario 1



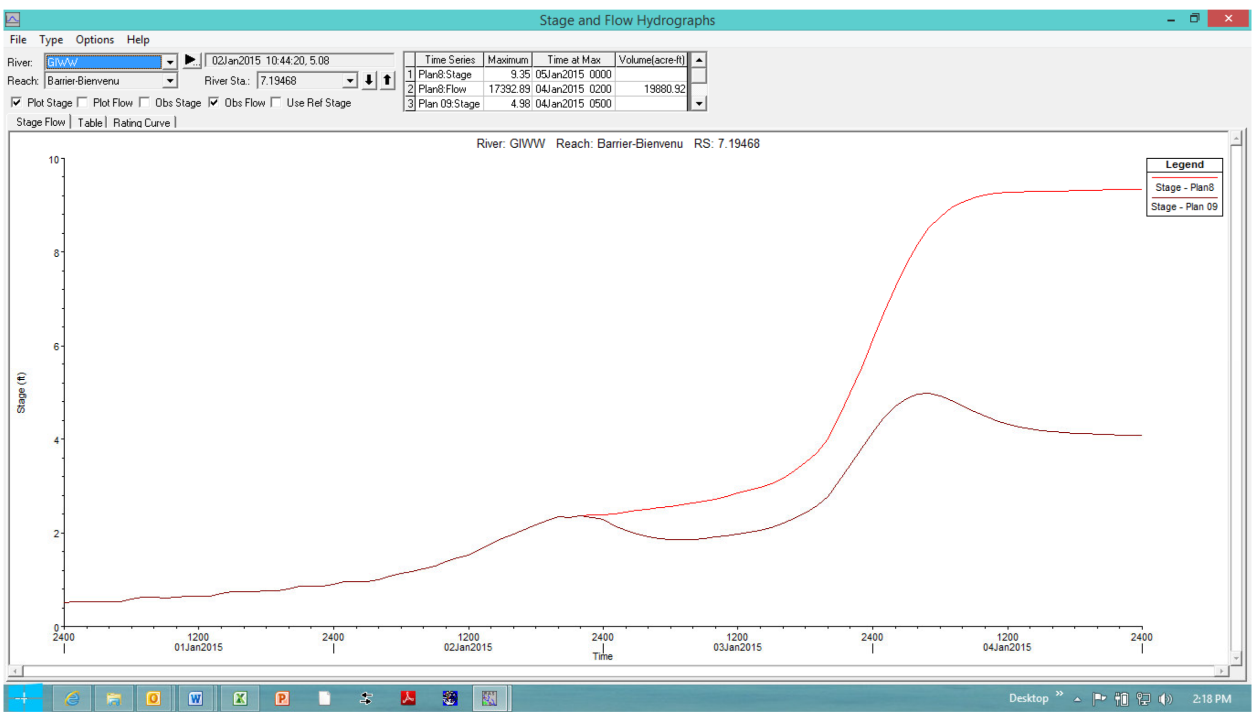
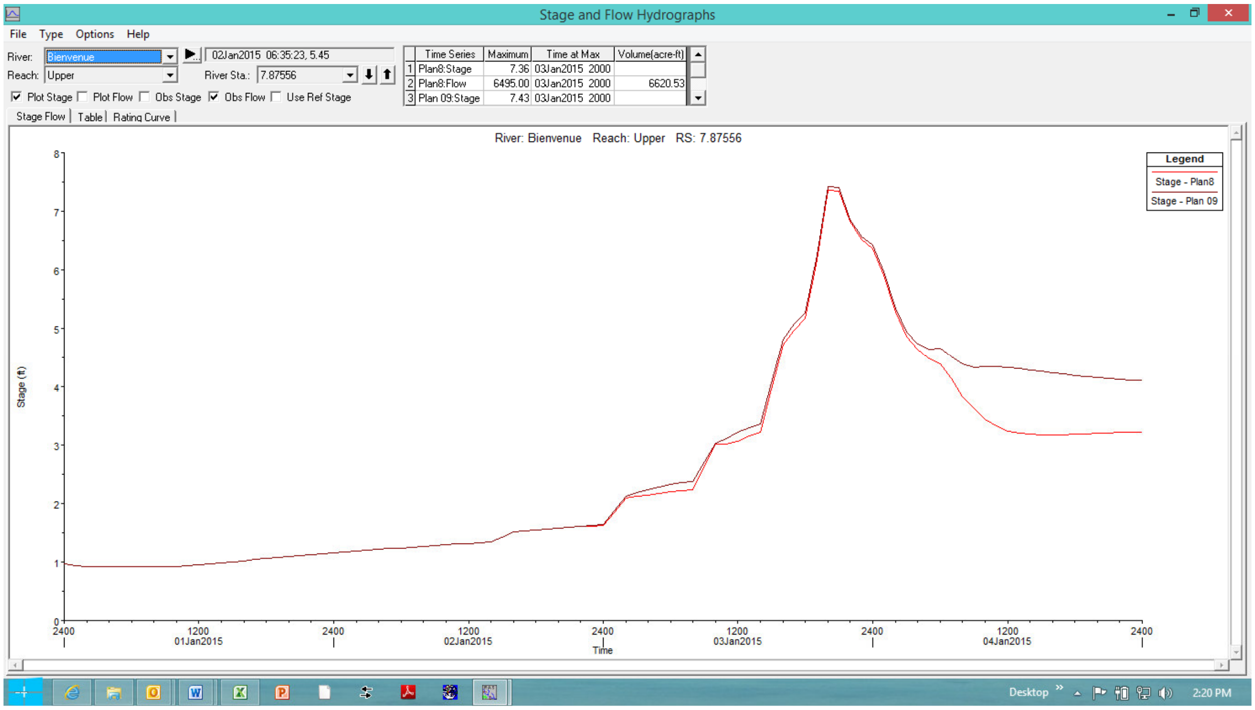


Figure I-7. Hydrographs for Scenario 2



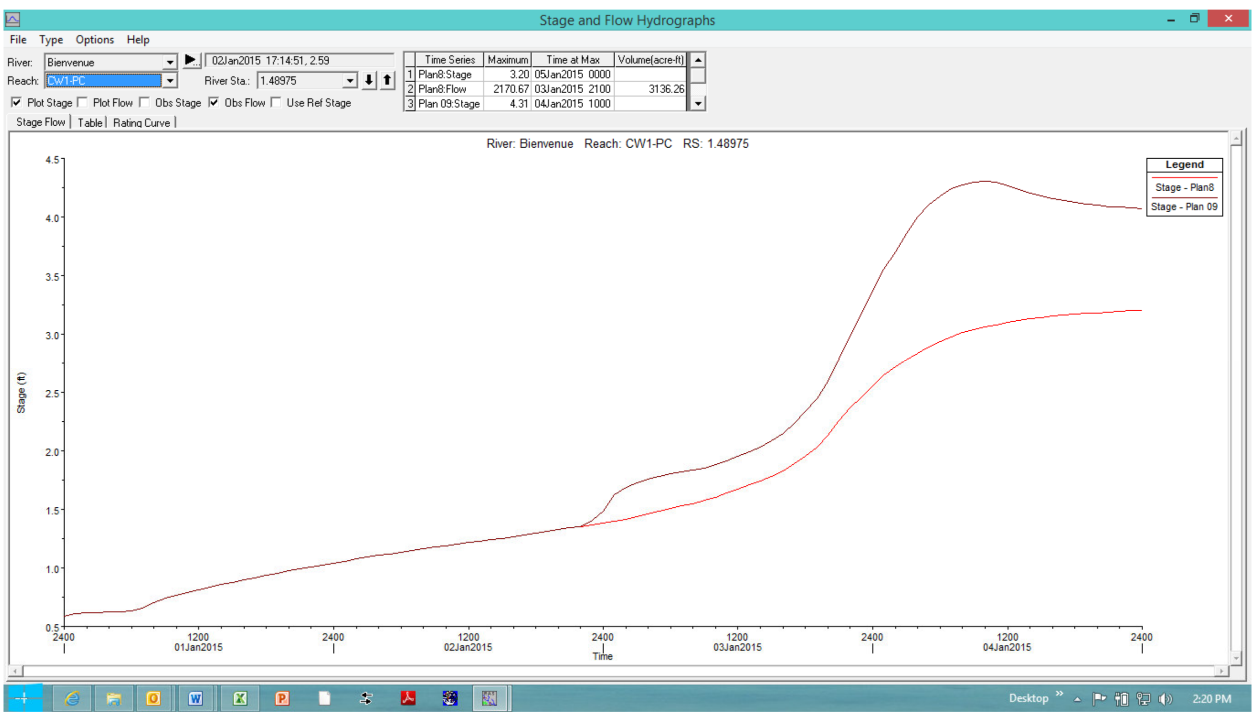
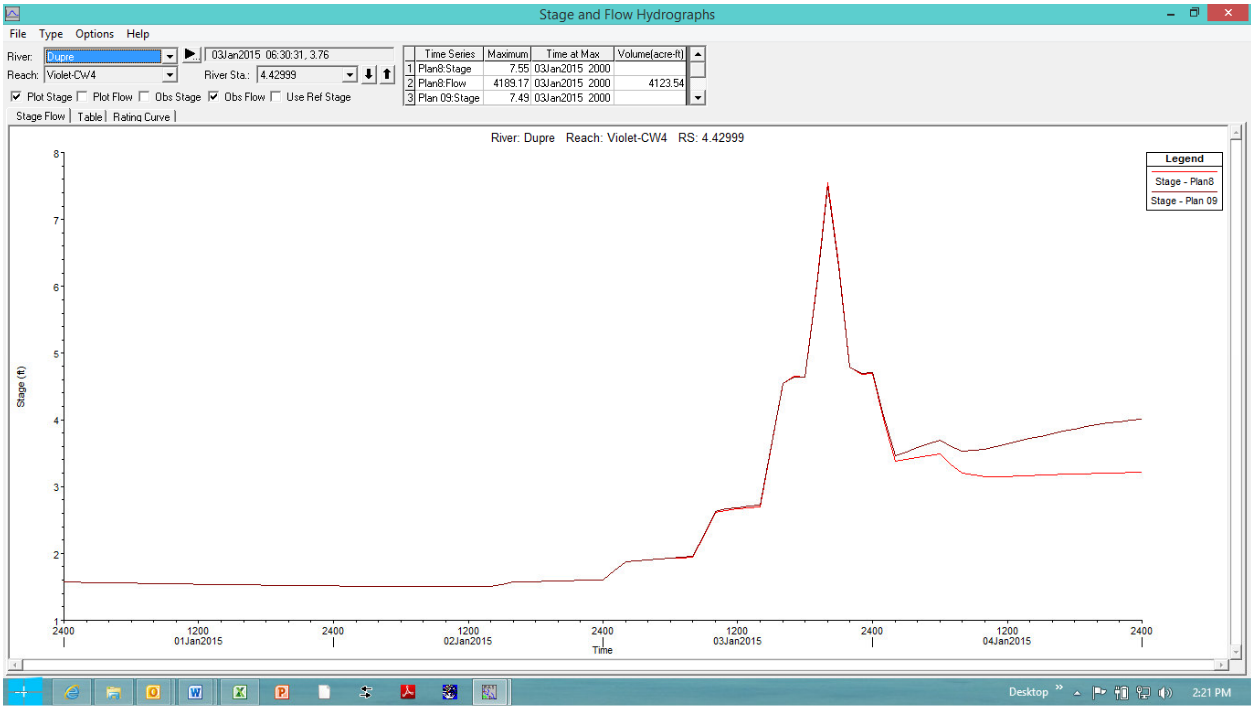


Figure I-7. Hydrographs for Scenario 2



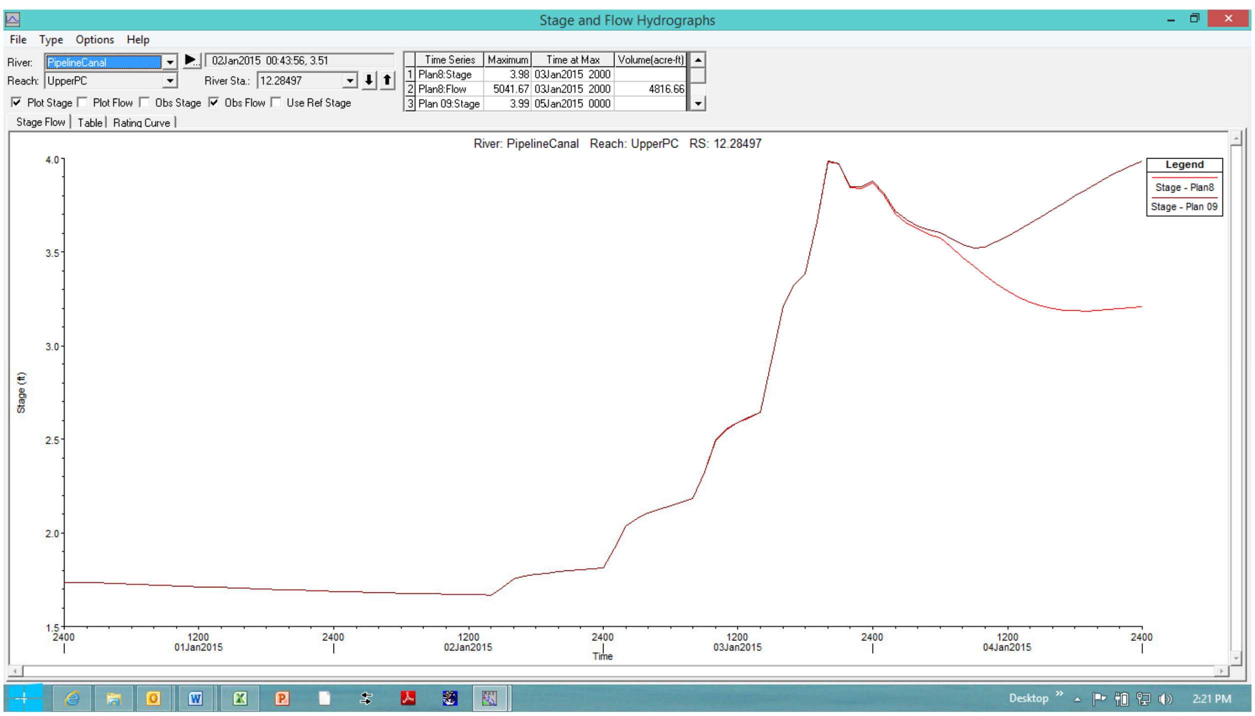
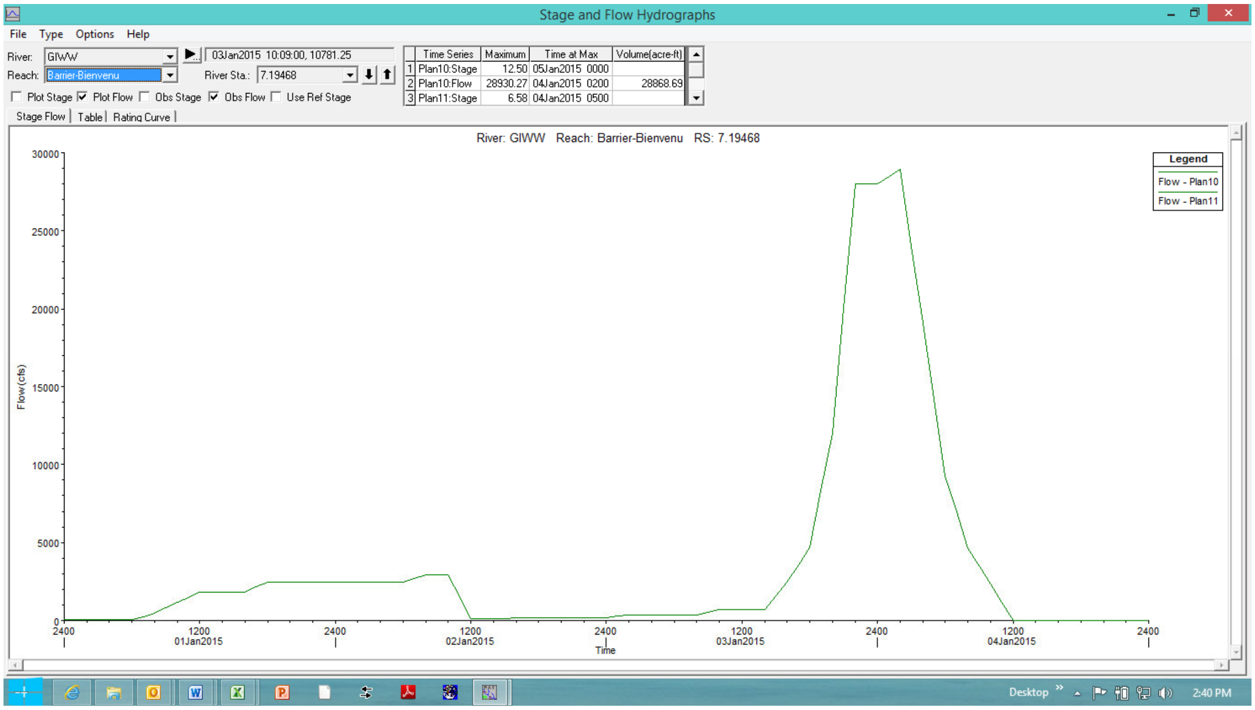


Figure I-7. Hydrographs for Scenario 2



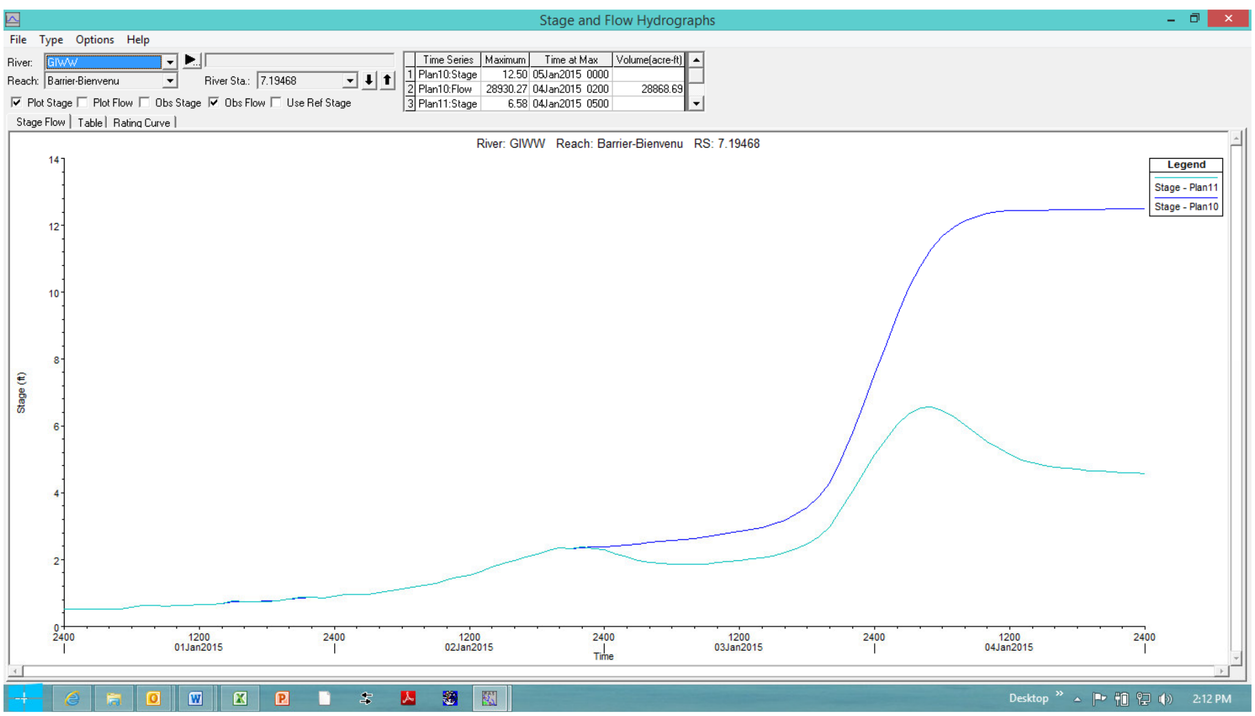
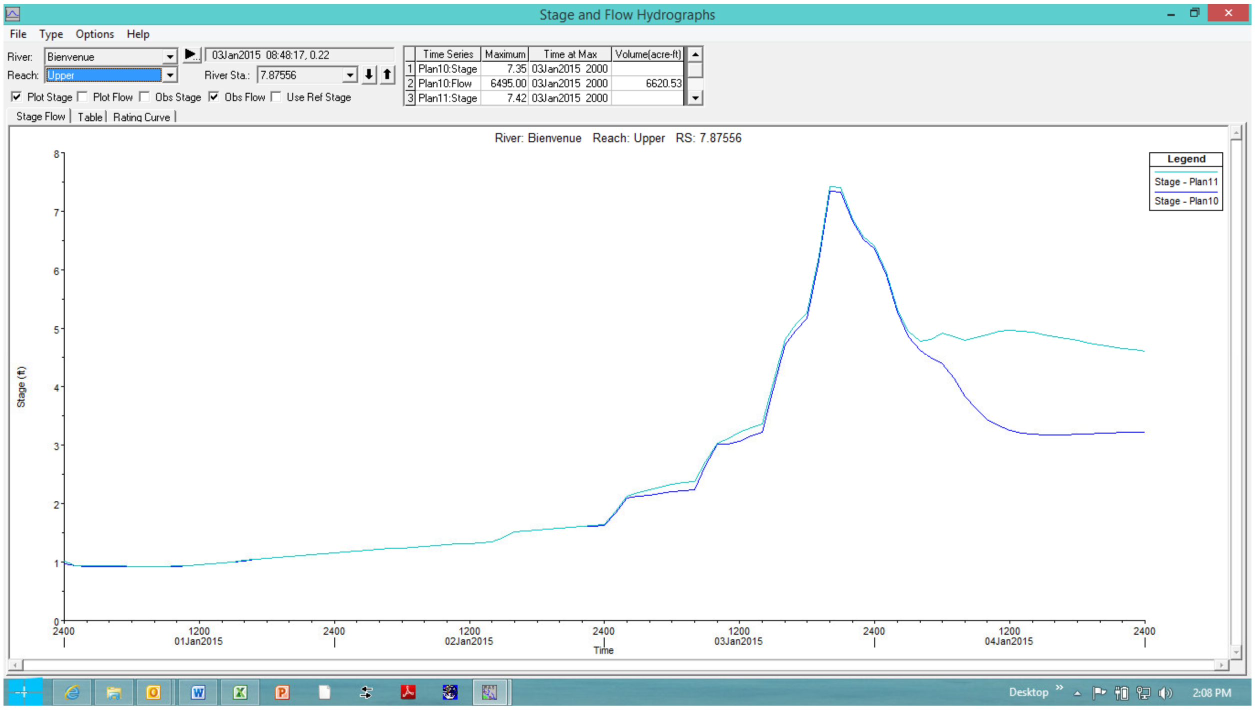


Figure I-8. Hydrographs for Scenario 3



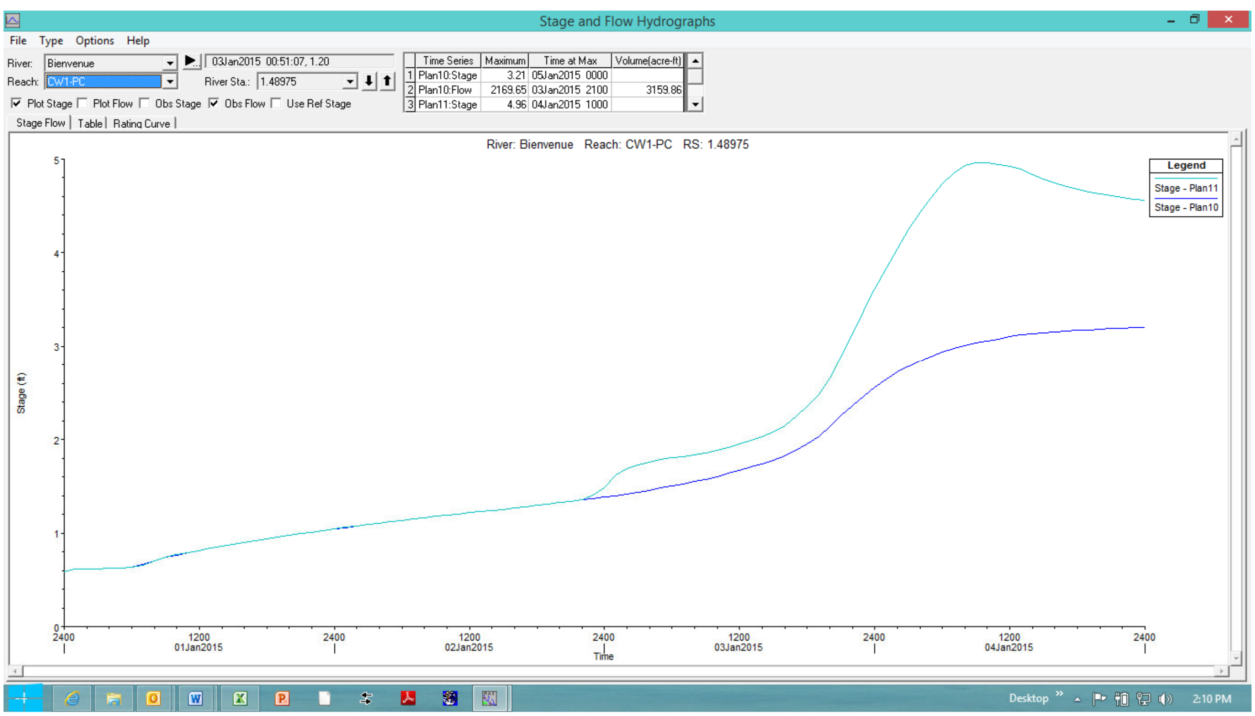
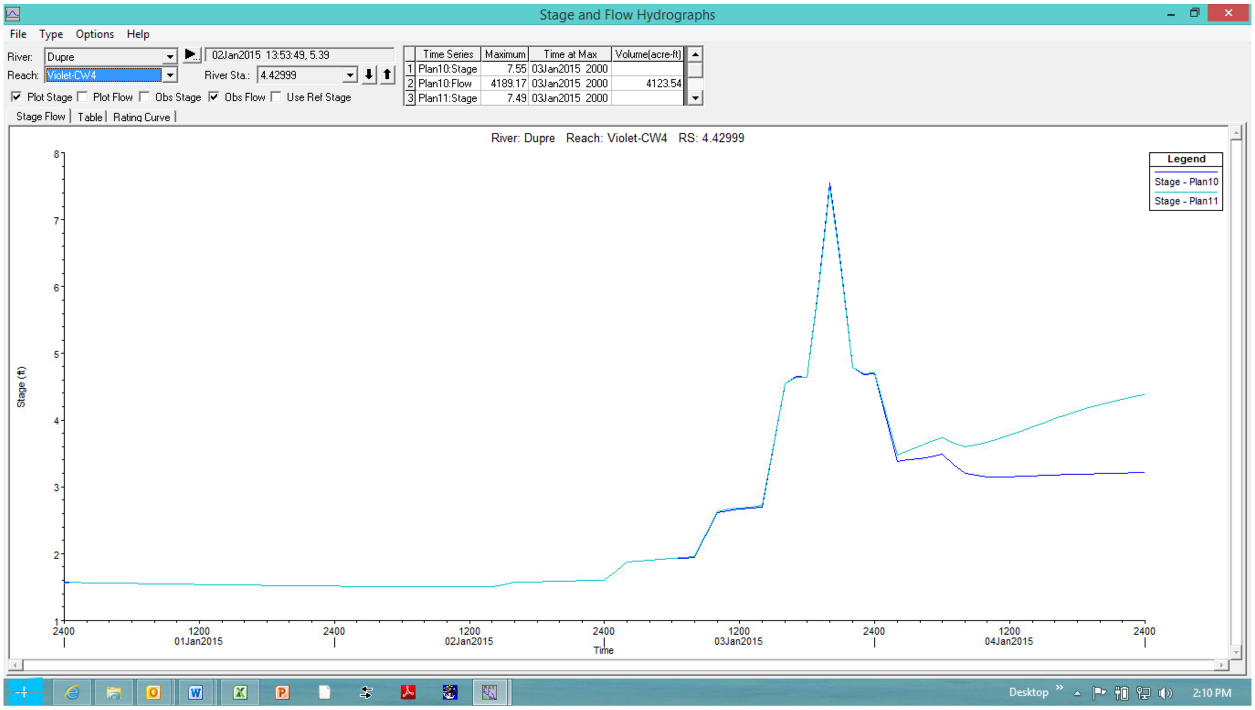


Figure I-8. Hydrographs for Scenario 3



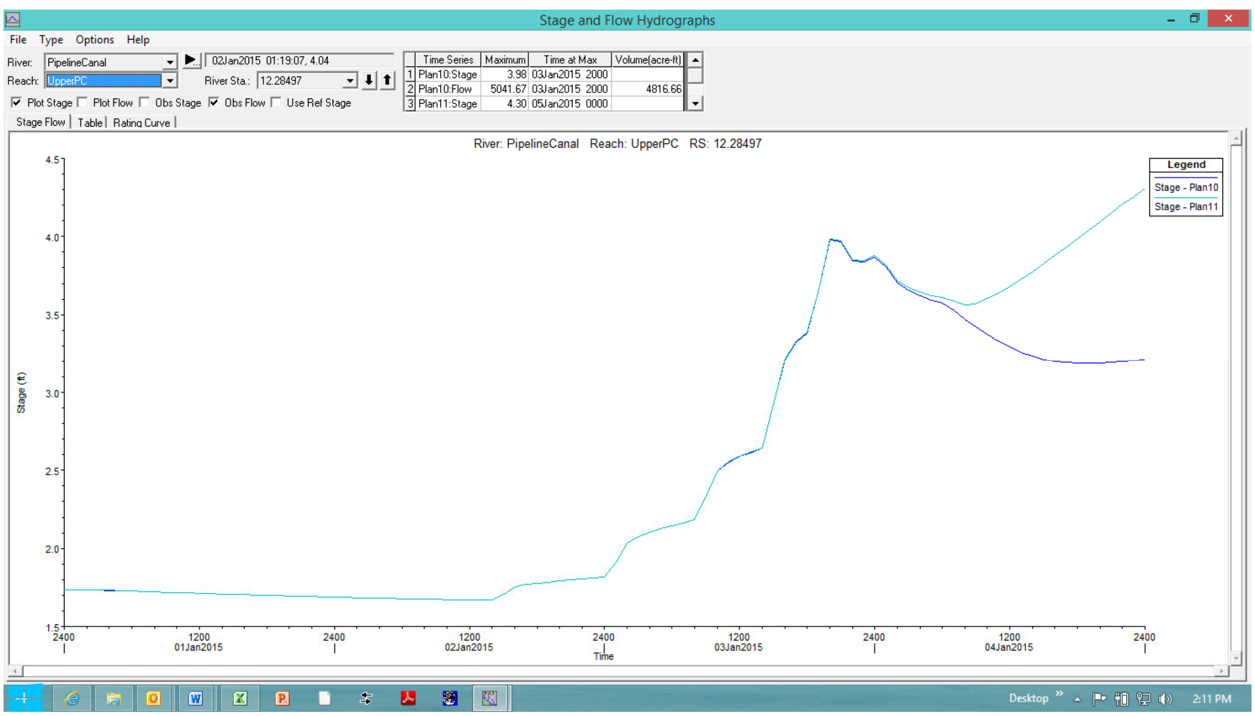


Figure I-8. Hydrographs for Scenario 3