Weston & Sampson SM

westonandsampson.com

3955 Faber Place, Suite 300
North Charleston, SC 29405
tel: 843.881.9804

REPORT

April 2021

CITY OF
Charleston
SOUTH CAROLINA

Church Creek Drainage Improvements Storage Analysis

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EXECUTIVE SUMMARY

Figure 1 - Residents kayaking in Hickory Farms during October 2015 historic rain event.

On behalf of the City of Charleston, Weston & Sampson evaluated three improvements to the Church Creek Drainage Basin using the most current ICPR4® model of the basin. The improvements were identified based upon previous recommendations in the 2017 *Evaluation of the Church Creek Drainage Reduction Study* (Church Creek Study) by Weston & Sampson, discussions with the City and residents, as well as existing opportunities for construction and funding. The goal of the study is to determine the extent of the benefits provided to the overall hydraulics of the basin for the identified improvements both as standalone improvements and as combined improvements. The study focused solely on these specified improvements and the results of the modeling efforts were observed, recorded, and analyzed. The results and analysis of the study will assist in prioritizing improvements for design and implementation within the Church Creek Drainage Basin. The following is a detailed list of the scenarios modeled and evaluated in this study:

1. West Ashley Circle (WAC) Storage Facility with Hickory Farms Overland Flow Diversion
2. Mid Basin Storage Facility
    a. Option A: Construct a berm around the existing Crosstowne Church and create a flood bench in the surrounding area of the church property adjacent to Church Creek.
    b. Option B: Create two 200' flood benches one on each side of Church Creek.
    c. Option C: Create a flood bench[1] within the 100-year floodplain of Church Creek between Bees Ferry Rd and the CSX Railroad right-of-way.
3. CSX-Whitfield Channel: Create a new channel next to the existing railroad tracks extending approximately 7,800 LF from the intersection of Church Creek and CSX Railroad to the intersection of Bees Ferry Rd and a tributary of Church Creek known as Planck Channel.
4. Combination of Improvements
    a. WAC and Mid Basin Storage Facilities
    b. WAC Storage Facility and CSX-Whitfield Channel
    c. CSX-Whitfield Channel and Mid Basin Storage
    d. WAC Storage Facility, Mid Basin Storage Facility, and CSX-Whitfield Channel

These scenarios were run using the previously developed and calibrated 2-D ICPR4 model of the Church Creek Drainage Basin, which was updated to include more detailed Light Detection and Ranging

[1] A flood bench or floodplain bench is a restoration technique to construct a low-lying area along a waterway to temporarily store floodwaters.

(LIDAR)[2] information, boundary conditions, stormwater infrastructure, and tidal information as a part of this study. These updates were incorporated to create a more refined model for use in analyzing results for proposed improvements within the Church Creek Basin with a high degree of confidence. Each scenario modeled the hydrologic and hydraulic changes at key locations in the Church Creek Drainage Basin under the tidal conditions and storm events outlined in Table 1.

Table 1 - Modeled Tidal Conditions and Storm Events

Tidal Conditions	1-hr Storm	24-hr Storm	48-hr Storm
MHHW	10%[3]	10%	10%
MHHW + 2.5' SLR	4%	4%	4%
King Tide + 2.5' SLR		2%	2%
		1%	1%

The modeling results were used to analyze the effectiveness of the proposed improvement and help identify improvements that should be considered for implementation. The prioritization is based upon selected scoring criteria and a formula developed by the Weston & Sampson improvement team. The criteria included the reduction of water surface elevations at key nodes throughout the basin, number of positively impacted nodes throughout the basin, decrease in time of water surface elevation above flood stage, potential for the stormwater facility to serve as mixed-use land, and maintainability after construction. The scores of each criterion were totaled and compared for the modeled stormwater improvements during the 10%, 4%, and 1%, 24-hour storms.[4]

After evaluating the results of the model simulations, it was determined that the Mid Basin Storage Facility Option B provides the greatest immediate benefit to the Church Creek Basin. The Mid Basin Storage Facility is predicted to reduce the water surface elevation at peak staging by at least 1.68" during the 1%, 48-hour storm and at most 2.76" during the 10%, 24-hour storm. The West Ashley Circle storage facility will provide some improvement but is not being recommended for implementation due to its diminishing returns. Further investigation into the use of pumps to optimize the benefits of the West Ashley storage facility is necessary before this solution can be considered for implementation.

The CSX-Whitfield Channel improvements are not predicted to provide a positive effect in the mitigation of flooding within the Church Creek Drainage Basin and therefore not recommended for implementation. The water surface elevation during 10% and 4% storm events is predicted to remain the same in post-conditions as in pre-conditions. During the 1% storm events the water surface elevation increased under post-conditions during peak staging at the mid basin and downstream nodes. However, the CSX-

[2] LIDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges to the Earth. These light pulses generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. (National Oceanic and Atmospheric Administration, 2018)

[3] The storm percentage is used to define the recurrence interval for a storm based upon a frequency analysis using statistical techniques to determine the probability of occurrence for a given precipitation event. For example, a 10% storm recurrence interval means there is a 1 in 10 chance that the precipitation during that rain event will be equaled or exceeded in any given year. (Dinicola, 1997)

[4] It should be noted that the preliminary modeling work done in October 2018 associated with the West Ashley Circle Storage Facility utilized 27 acres, a deeper cross section, and tidal surge protection. The depth of the modeled improvement was set below the seasonal high ground water table and the facility was modeled with pumping capabilities to maximize the available storage capacity for storm events. Further, the rain event simulated was comparable to tropical storm Irma, which, at approximately 6" of rainfall over 48-hours was significantly less than the 1%, 24-hour storm.

Whitfield Channel is predicted to be an effective means of conveying flows from the southwestern drainage basin to Church Creek if a pump station were built in the mid-basin area in the future. Detailed descriptions of the overall effort, model results, and analysis of the results are included as part of this report.

It should be noted that the implementation of the Mid Basin Storage Facility will not alone mitigate the flooding experienced in the Church Creek Drainage Basin. This improvement is predicted to reduce the water surface elevation, but additional improvements will need to be studied and implemented to achieve the volume of stormwater relief needed in the basin for flood mitigation.

1.0 IMPROVEMENT BACKGROUND

The drainage basin for Church Creek is located in an area of Charleston known as West Ashley and discharges into the Ashley River. The drainage basin is nearly four miles wide at its widest point and extends from Bees Ferry Road to the north approximately four and a half miles and to the south approximately two miles. It is bounded in the east by the Ashley River and SC Highway 61 (Ashley River Road) and to the west by Glenn McConnell Parkway and grade changes within the basin. This channel drains a 10,000-acre area that has very low elevations throughout. Flows in developed areas of the basin are collected in systems of pipes, ponds, and channels that were installed as development occurred over the years and conveyed to the main channels. In the undeveloped areas, mainly the northern portion of the basin, stormwater is collected via a network of small channels that were constructed as a result of mining and timbering that flow into main conveyance channels. Under significant rain events, the stormwater flow within the drainage basin exceeds the capacity of Church Creek and its conveyance channels, which results in an increased water surface elevation along the main conveyance areas that overflows the channels and Church Creek in many locations. The increased flows also impact outfalls from many of the stormwater ponds and create headwater[5] conditions for drainage in parts of the basin. Due to these hydraulic conditions, the Church Creek Basin has experienced flooding during past storm events involving significant rainfall, tidal events, or both simultaneously.

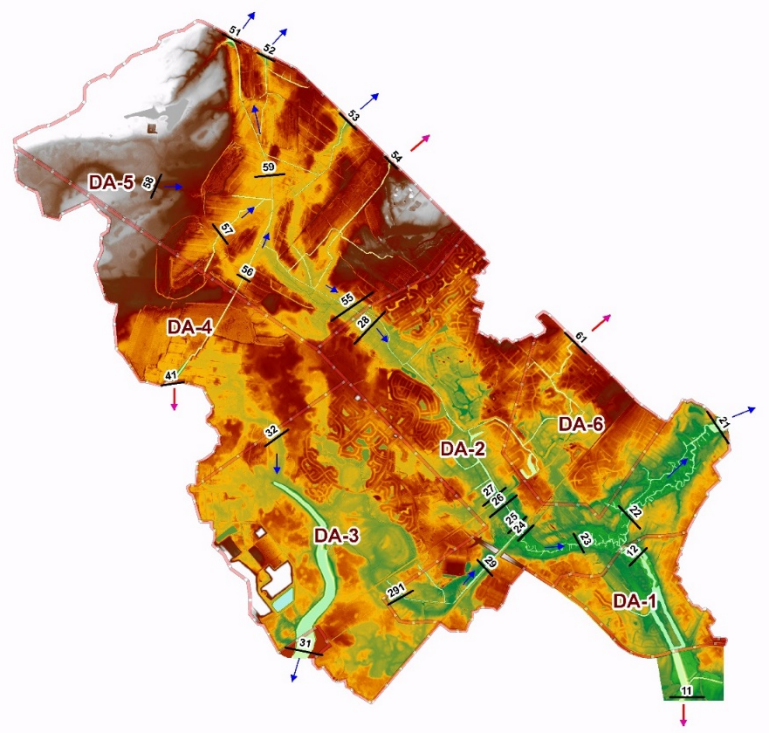

Figure 2 - Image of ICPR4 DEM of Church Creek Drainage Basin with sub-basins labeled.

In 2017, Weston & Sampson was selected by the City of Charleston to evaluate the Church Creek Drainage Basin, identify improvements associated with drainage related assets and to recommend policy strategies to help protect basin capacity, reduce flood levels, and improve flood control in the basin. The scope of work performed by Weston & Sampson was as follows:

- Collect data and review history of the basin
- Perform field inspections of key conveyance elements
- Review the performance of past structural improvements
- Review the accuracy, condition, and performance of the hydraulic model
- Upgrade the hydraulic model to ICPR4

[5] A headwater is an increased depth of water located immediately upstream of a hydraulic structure, such as dam or culvert. Headwater occurs due to a downstream restriction in flow.

- Confirm the calibration of the upgraded hydraulic model
- Review recently proposed improvements (from a study completed by Woolpert in 2001)
- Review performance of recent improvements
- Provide recommendations for additional required improvements to prevent future flooding

Figure 3 - Aerial photo of flooding in Bridgepoint neighborhood following Hurricane Irma, October 2017

The Church Creek Flood Reduction Study was completed by Weston & Sampson in October of 2017 and recommended seven major improvements within the Church Creek Drainage Basin. Since then, Weston & Sampson and the City have refined the improvements based on cost, public input, and magnitude of anticipated benefits. The impacts of these improvements, both independently and in combination, were analyzed. The main focus of the modeling effort was on the changes in water surface elevations at various selected locations, or nodes, throughout the basin during the 10% (10-year) and 4% (25-year) 1-hour storm event and the 10% (10-year), 4% (25-year), 2% (50-year), and 1% (100-year) 24-hour and 48-hour storm events. Boundary conditions with a dynamic tide were set for each storm event as a Mean Higher High Water (MHHW)[6] tidal event, a MHHW with 2.5 feet elev. sea level rise (SLR)[7] tidal event, and a King Tide[8] with 2.5 feet elev. SLR tidal event. The proposed improvements were also modeled using two historical events with known rainfall and tidal conditions: Tropical Storm Irma and the October 2015, 0.1% storm. The City will use the results of this study to determine the viability and cost-effectiveness of future improvements for prioritization purposes.

[6] Mean higher high water is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. (National Oceanic and Atmospheric Association, n.d.)
[7] Global sea level has been rising over the past century, and the rate has increased in recent decades. In the US, almost 40% of the population lives in high-population-density coastal areas like Charleston, South Carolina. (National Oceanic and Atmospheric Association, 2019)
[8] A King Tide is a non-scientific term often used to describe exceptionally high tides. (National Oceanic and Atmospheric Association, 2019)

2.0 OVERVIEW OF MODELED POTENTIAL IMPROVEMENTS

The three selected improvements for study provided storage capacity within the Church Creek Basin in the vicinity of the Bees Ferry Rd and Church Creek crossing. Additional storage in the Church Creek Basin was a recommendation included in the 2017 Church Creek Study and there are currently several large areas of undeveloped property near Bees Ferry Rd and West Ashley Circle that have the potential to serve a portion of the City's stormwater storage needs. The approach Weston & Sampson used for developing the improvements considered a combination of "hard engineering[9]" and "soft engineering[10]" design solutions. The West Ashley Circle Storage Facility with Hickory Farms Diversion Channel, Mid-Basin Storage Facility, and CSX-Whitfield Channel were all developed thoughtfully within the model to create the greatest opportunity for stormwater flows to be managed "offline" from the Church Creek in order to both reduce peak staging and allow the basin recovery time following the storm events.

2.1 Preliminary Site Characterizations

There are common characterizations of the sites due to their proximity to one another. The first is the seasonal high groundwater table. Based upon a geotechnical exploration report shared with Weston & Sampson and prepared by S&ME, Inc. dated February 19, 2018 for the Publix West Ashley, the groundwater table is expected to vary between approximately 1 to 4 feet below the ground surface elevation. In some instances, in very low-lying areas along the CSX-Whitfield channel route, the groundwater table is at the ground surface elevation. The soils present in these locations vary between sand, silty-sand, and clayey-sand with expected infiltration rates of greater than 0.8 inches per hour through sand to less than 0.2 inches per hour through clayey-sand (United States Department of Agriculture, 2014). Finally, as would be expected based upon field, soil, and groundwater observations, at least a portion of each of the sites are characterized as freshwater wetlands. See *Figure 4* for the US Fish and Wildlife Service National Wetlands Inventory map with the proposed improvement areas overlaid. (US Fish and WIldlife Service, 2020)

[9] Hard Engineering solutions are those flood management techniques using artificial structures to control water. These techniques include pump stations, levees, dams, etc. (Hausmann, 2019)

[10] Soft Engineering solutions are those flood management techniques using natural defenses to reduce the effects of flooding. These techniques include erosion prevention, natural barriers, constructed wetlands, etc. (Hausmann, 2019)

Figure 4 - US Fish and Wildlife Service National Wetlands Inventory map with improvement areas shown.

2.2 West Ashley Circle Storage Facility Overview

The West Ashley Circle storage facility can serve to provide a portion of the recommended storage by adding approximately 11 acres of stormwater surface storage to the basin. The location of the West Ashley Circle (WAC) storage facility was identified based upon the property owner's offer to provide the property to the City of Charleston for use in drainage improvements benefiting the basin. The property included in the storage improvement scope is in addition to the property required for the Hickory Farms Overland Flow Diversion improvement, also proposed for donation by the same property owner. The location of this improvement is shown in *Figure 5*. The Hickory Farms Diversion channel would outfall to the West Ashley Circle retention pond, which would then discharge to Church Creek via the Bees Ferry Road stormwater channel.

Figure 5- Location of West Ashley Circle Storage Facility and Hickory Farms Overland Flow Diversion Channel

The WAC storage facility improvement involves clearing approximately 14-acres of trees and vegetation from the northeastern quadrant of the West Ashley Circle and excavating a pond to an elevation of 1' above the existing groundwater table, which is expected to be approximately 4 feet below the surface elevation. The pond would include culverts under the road connecting the influent channel and the pond's outfall. The Hickory Farms Diversion Channel is approximately 1,500 feet in length and 60 feet in width, an area of approximately two acres, and runs southeast to the WAC storage facility. The WAC storage facility is connected to the Bees Ferry Road stormwater channel via dual 36" underground culverts approximately 400 feet in length. The roadside stormwater channel runs parallel to Bees Ferry Road in the northeast direction before discharging into Church Creek.

2.3 Mid-Basin Storage Facility Overview

The City of Charleston proposed evaluating a second storage option in the mid-basin adjacent to Church Creek and in the vicinity of the Crosstowne Church. This proposed improvement was named the Mid-Basin Storage Facility and was intended for storage either on its own or in combination with the WAC storage facility. The area of the Mid Basin storage facility includes three different options for consideration that vary in size and scope; the best option was chosen and used in evaluation of combinations with the WAC Storage Facility and CSX-Whitfield Channel. The locations of all three Mid Basin storage options, Options A, B, and C are shown in *Figure 6*. All three options created additional storage adjacent to Church Creek by providing a large area for water to flow into during storm events.

Option A included creating a berm around the Crosstowne Church for flood protection and lowering the parking and greenspace areas of that property to one foot above the seasonal high ground water table (SHGWT), which varies between 2.5 and 4 feet below the ground elevation. This would allow these areas to remain functional during dry weather and serve as additional storage during wet weather events. Option B created two flood benches 200 feet wide on either side of the Church Creek Channel excavated to the SHGWT between Bees Ferry Road and the CSX Railroad right-of-way. This requires clearing approximately 12 acres of poor value grasses, trees, and shrubs. Option C included a storage area within the 100-year flood plain from Bees Ferry Road to the CSX Railroad right-of-way excavated down to the SHGWT. This option requires clearing over 40 acres of poor value grasses, trees, and shrubs. Once the flood bench for the mid-basin storage is established, the area should be revegetated with native hydrophytic vegetation.

Figure 6- Location of Mid Basin Storage Options A, B, and C

2.4 CSX-Whitfield Channel Overview

In addition to these two storage facilities, a third potential improvement of opportunity presented itself based on a property owner's willingness to work with the City and provide property to accomplish additional storage and conveyance recommended in the 2017 Church Creek Study. The CSX-Whitfield Channel improvement would add approximately 13 acres of additional property for construction of a storage and conveyance facility. This improvement was broken into two phases: Phase 1 included developing 1,200 LF of channel between the Glenn McConnell Parkway and Church Creek adjacent to the existing SCDOT channel and Phase 2 included developing 6,600 LF of channel from Glenn McConnell to Bees Ferry Road following the CSX Railroad right-of-way and existing channel before turning north in the vicinity of Rev Joseph Heyward Rd. The proposed channel in both phases was modeled to be 50-feet wide at the top with the invert elevation spanning from 5 feet elev. at Bees Ferry Road to 1 feet elev. at Church Creek. See *Figure 7* for proposed improvement location.

The CSX-Whitfield Channel was also evaluated as a means of conveyance into a storage facility such as a flood bench or constructed wetlands. This was achieved by lowering the elevation of the low-lying areas along the existing channel. The channel would serve as conveyance into and discharge from the storage facility. This area added approximately 13-acres of storage to the 13-acres provided by the channel itself.

Figure 7- Location of CSX Whitfield Channel, Phase 1 & 2

2.5 Combination Scenarios

The ICPR4 model was also run for various combinations of the proposed improvements to determine the full scope of benefits that the Church Creek Drainage Basin could realize during storm events. The improvements were combined in the model after they had been effectively developed as individual improvements. It is understood that in order to successfully mitigate flooding within the basin, several water management improvements and improvements must be implemented for the aggregate of their individual regional impacts to improve the hydrology[11] and hydraulics[12] of the entire Church Creek Drainage Basin. The combination scenarios are critical to the prioritization of proposed improvements due to the dynamic nature of hydrological flow patterns.

[11] Hydrology is the science that encompasses the occurrence, distribution, movement and properties of the waters. In short, it is the study of how water moves overland and through the hydrologic cycle. (United States Geological Survey, n.d.)

[12] Hydraulics is the study of the mechanical behavior of water in physical systems. In layman terms, it is the study of how water is conveyed through pipes, channels, and other hydraulic structures. (Morris & Wiggert, 1972)

3.0 MODEL BACKGROUND

The modeling for all proposed improvements within the Church Creek Drainage Basin was completed using ICPR4® by Streamline Technologies. ICPR4 is a stormwater modeling program that includes both 1-D hydrology and hydraulics and fully integrated 2-D surface water and groundwater flow with an emphasis on the interactions between surficial aquifer systems, surface water bodies, and rain events (Streamline Technologies, n.d.). The Church Creek Drainage Basin model was upgraded from ICPR3 to ICPR4 as part of the 2017 basin study conducted by Weston & Sampson. Multiple improvements were made to the model during the 2017 upgrade including the following items:

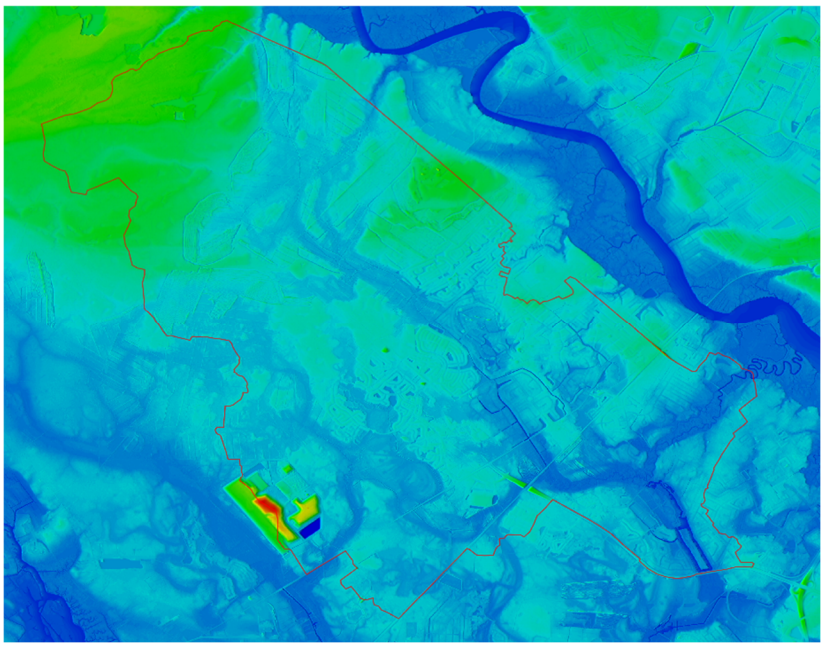

Figure 8 - ICPR4 Digital Elevation Model (DEM) with Church Creek Drainage Basin boundary shown.

- The model datum was updated from NGVD 29[13] to NAVD 88[14]. All elevations included in this report reference NAVD 1988.
- The model boundary area was reviewed using a LIDAR produced ground surface digital elevation model (DEM) based on a 10-foot grid from the SC Department of Natural Resources (SCDNR).
  - This enabled the basin boundary to be determined from overland flow patterns especially in the northern parts of the undeveloped areas between Highway 61 and Rantowles Creek.
  - The update increased the basin area from 8.5 mi^2 in ICPR3 to 15.9 mi^2 in ICPR4, providing a more accurate representation of the hydrological area of the basin.
- The soil in the area was set to Antecedent Moisture Condition[15] (AMC) III, which is representative of relatively wet soils; this change was verified by model calibrations during the October 2015 storm simulation.

[13] The National Geodetic Vertical Datum of 1929 (NGVD 29) is a vertical control datum in the United States by the general mean sea level adjustment in 1929. (National Oceanic and Atmospheric Association, 2018)
[14] The North American Vertical Datum of 1988 (NAVD 88) is the vertical control datum established in 1991 by the minimum-constraint adjustment of the Canadian-Mexican-United States leveling observations. (National Oceanic and Atmospheric Association, 2018)
[15] Antecedent moisture is the relative wetness or dryness of the soils in a watershed. The AMC in modeling accounts for the rainfall predicted to be absorbed in the soil and ensures the hydrology of the drainage basin is accurately represented during a storm event.

As a part of the WAC storage facility, Mid Basin storage facility, and CSX-Whitfield Channel improvements study, the ICPR4 model was improved further. The LIDAR and DEM data used by the model was updated with the most current available data from SCDNR, which included a 2.5' DEM. This helped to improve the breaklines interpolated by the model and provided a more detailed overland flow analysis. Breaklines are an important feature in surface modeling as they define and control surface behavior in terms of smoothness and continuity (ESRI, n.d.). Breaklines directly impact the accuracy and comprehensiveness of the model. The model also included refined information regarding stormwater infrastructure in the Hickory Farms, WAC, and Mid Basin areas as well as the connection of Church Creek from the culvert crossings at the railroad to the saltmarsh.

Finally, tidal boundaries were updated to be a more accurate and realistic representation of what is currently observed and predicted. King tides and sea level rise were also taken into consideration by incorporating both in the tidal boundary conditions for additional model scenarios. The tidal boundary was set to reflect mean higher high water (MHHW) and mean low water (MLW) as recorded by the National Oceanic and Atmospheric Administration (NOAA) at the I-526 Bridge, Ashley River, Gage No. 8665099. The tidal boundary conditions for 2.5 feet of sea level rise and king tide with 2.5 feet of sea level rise were incorporated into the model. The use of 2.5 feet for sea level rise is based upon the City of Charleston's 50-year planning horizon established in the Sea Level Rise Strategy most recently updated in February 2019.

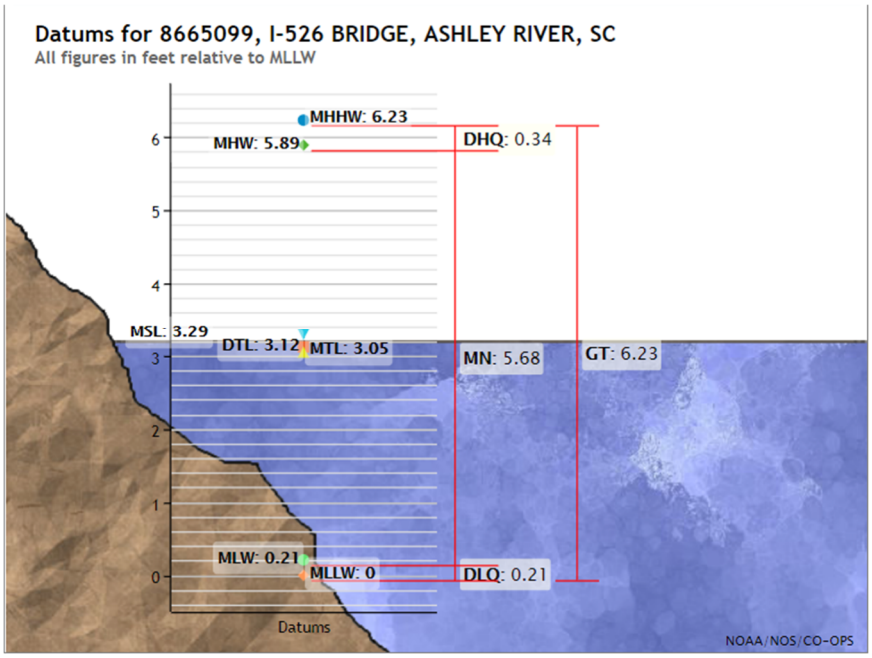

Figure 9 - Water surface elevations for NOAA gage at the I-526 Bridge, Ashley River. Elevations are in feet relative to mean lower low water (MLLW).

The scenarios were run under various combinations of tide conditions, storm events, and historical events which are listed below.

Tide Conditions

Tidal Conditions	WSE (ft. NAVD 88)
Mean Higher High Water	3.09
MHHW with 2.5' SLR	5.59
King Tide with 2.5' SLR	8.09

Storm Events

AEP Storm	Duration (hours)	Inches of Rainfall
10%	1	2.91
	24	6.4
	48	7.35
4%	1	3.42
	24	7.8
	48	8.9
2%	24	8.93
	48	10.2
1%	24	10.0
	48	11.5

Historical Events (Tide and Rainfall)

Historical Event	Observed Tides for Dates Listed (ft. NAVD 88)	Storm Duration	Observed Rainfall (in)	Apprx. AEP Storm Equivalent
Tropical Storm Irma	Highest WSE 7.03' Lowest WSE 2.63'	2000, 9/10/2017 to 2000, 9/14/2017	8.85"	2%
October 2015 Storm Event	Highest WSE 5.47' Lowest WSE 2.7'	0600, 10/1/2015 to 0000, 10/8/2015	17.28"	0.1%

The outputs for all modeled scenarios are found in Appendix B of this report. Model data summaries, analyses, and conclusions are in the sections pertaining to the respective improvement scenarios in the following sections.

4.0 WEST ASHLEY CIRCLE & HICKORY FARMS OVERLAND FLOW DIVERSION

4.1 Background

The West Ashley Circle (WAC) Storage Facility and Hickory Farms Overland Flow Diversion Connection are located north of the intersection of Bees Ferry Road and Glenn McConnell Parkway. The proposed WAC Storage Facility would make use of approximately 11 acres of the northeastern quadrant of the existing West Ashley Circle. The Hickory Farms Overland Flow Diversion Channel is proposed to flow into the WAC Storage Facility from the north, connecting a wetland area near Hickory Farms to the storage facility. A second connection is proposed to flow northeast from the WAC Storage Facility parallel to Bees Ferry Road and connect to the existing drainage easement leading to Church Creek. Historically, this area has experienced significant flooding, especially in the Hickory Farms neighborhood, during large storm events. The goal of the diversion channel and pond is to improve drainage during weather events, decrease the likelihood of flooding in developed, residential areas of the basin—such as Hickory Farms and Hickory Hills—and to provide additional storage during wet-weather events for improved overall basin hydraulics.

Figure 10 - Location of West Ashley Circle Storage Facility and Hickory Farms Overland Flow Diversion Channel

The potential improvement involves excavating the WAC area down to an elevation 1' above the existing groundwater table to provide storage. The groundwater in this area is estimated to be between 3 and 4 feet below the ground elevation. The storage was modeled with 2 feet of freeboard and envisioned as either a pond or constructed wetland. The Hickory Farms Diversion Channel, which flows into the WAC Storage Facility, is approximately 1500 feet long and 60 feet wide and runs southeast from the wetland area before connecting to the storage facility. The connection of the WAC to the Bees Ferry Road Channel was modeled as dual 36" underground culverts approximately 400 feet long. This outfall was modeled without a structure, with the pipe inverts set at 4' NAVD88. The Bees Ferry Road Channel runs parallel with Bees Ferry Road in the northeast direction until it connects with Church Creek.

The ICPR4 model was set-up to include the WAC Storage Facility and Hickory Farms Overland Flow Diversion Connection for select storm events using mean higher high water (MHHW) tide conditions. The scenario storm and tidal conditions are shown in the table below.

Table 2- Modeled Tidal Conditions and Storm Events for West Ashley Circle Storage Facility

Tidal Conditions	24-hr Storm	48-hr Storm
MHHW	10%	10%
	4%	4%
	1%	1%

The water surface elevation was recorded and analyzed at 14 select nodes within the model to determine how the extra storage created by the WAC and Hickory Farms Overland Flow Diversion Channel impacted the water surface elevation, both during and after each storm event. The nodes were selected based on their proximity to the proposed improvement as well as other key elements of the Church Creek basin such as convergences, culverts, and dikes. The results are discussed in the following section.

4.2 Results

4.2.1 Existing Conditions

The hydrograph in *Figure 12* shows the staging at node B020 (N-B020) for the 10% and 1% storm events to be used in comparison to the implementation of the WAC Storage Facility. Node B020 is located north of Bees Ferry Road and is approximately 1,200 feet northeast of the West Ashley Circle, see *Figure 11*. This node was selected because it is directly downstream of the WAC Storage Facility and Hickory Farms Overland Flow Diversion Channel. N-B020 was also a consistent analysis point for the basin. The flood warning stage is the point at which the water surface elevation breaches the lowest elevation in the top of the creek bank near the node of interest and is represented in the hydrograph and labeled “flood stage”. This elevation is the first level at which flooding is experienced when the water surface elevation stages above the channel’s capacity. The lowest road elevation near N-B020 is at 10.2’ and not represented in the hydrograph as it is more than 2 feet above the highest modeled water surface elevation.

Figure 11- Location of N-B020, N-B010, WAC-01, and HFD-02

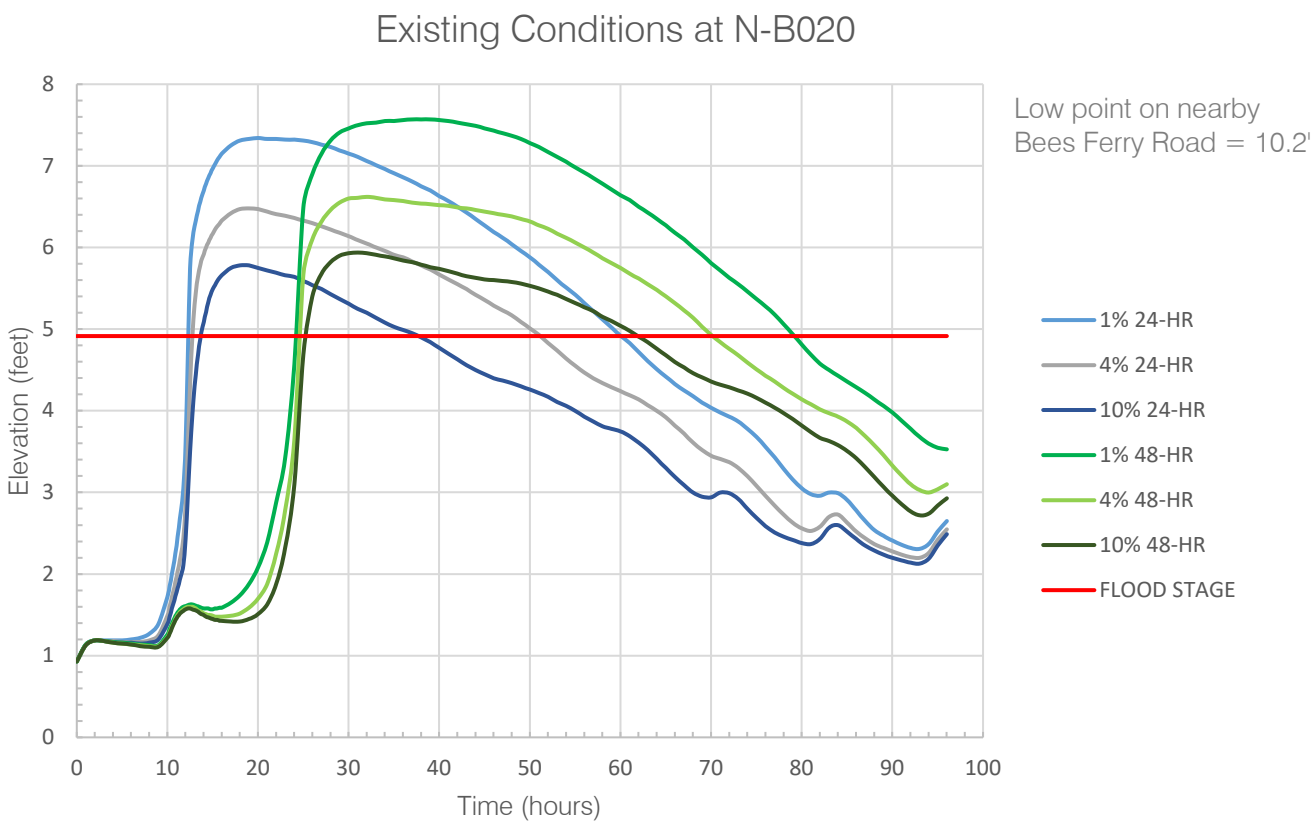

Figure 12- Hydrograph for Existing Conditions at N-B020

4.2.2 Proposed Improvements

The improvements for the WAC Storage Facility are located upstream of node B020 at nodes WAC-01 and HFD-02, see *Figure 11*. HFD-02 resides behind the proposed overflow weir between the wetland area north east of Hickory Farms and the Hickory Farms Overland Flow Diversion Channel. Node B020 resides north of Bees Ferry Road at the end of the Bees Ferry Road Channel. This basin improvement alternative utilizes approximately 11 acres of land to create the storage facility and 2 acres for the Hickory Farms Overland Flow Diversion Channel. The storage generated by the WAC facility decreases the water surface elevation at node B020 by an average of 0.84" throughout all modeled storm events. Optimizations to the outfall may contribute differing results and can be investigated beyond this preliminary observation. This basin improvement alternative also allows for the previously designed Hickory Farms Overland Flow Diversion to be rerouted. See Appendix B for the selected nodes throughout the Church Creek Basin showing the staging with the proposed conditions in comparison to the staging of the existing conditions.

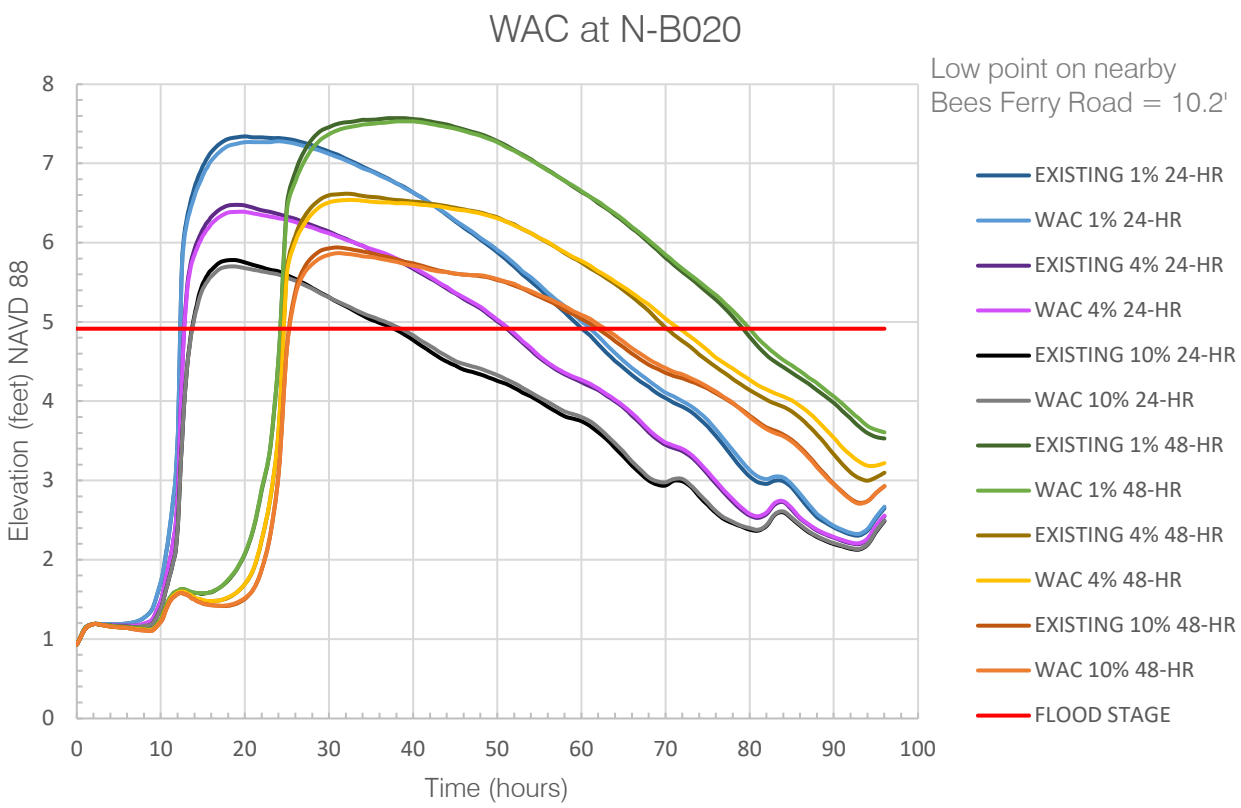

Figure 13- Post-Conditions Model Results for West Ashley Circle Storage Facility at N-B020

Table 3 – Change in Water Surface Elevation Pre- and Post-West Ashley Circle Storage Facility Improvements

Storm	Pre-	Post-	Δ
10% 24-HR	5.79'	5.71'	-0.96"
10% 48-HR	5.94'	5.87'	-0.84"
4% 24-HR	6.48'	6.39'	-1.08"
4% 48-HR	6.62'	6.54'	-0.96"
1% 24-HR	7.34'	7.28'	-0.72"
1% 48-HR	7.57'	7.53'	-0.48"

4.3 Conclusions

Weston & Sampson, based on analysis of the model results, concluded the following:

1. The modeling predicts the West Ashley Circle Storage Facility will have a slight positive impact on the Church Creek Drainage Basin by lowering the peak staging elevation a minimum of 0.48-inches during the 1%, 48-hour storm event and a maximum of 1.08-inches during the 4%, 24-hour storm event. The decrease in the staging elevation is due to the additional storage provided by the West Ashley Circle Storage Facility.
2. The duration of inundation at Node B020 is predicted to not change or increase approximately two hours depending on the storm event. The increase in time for the water surface elevation to decrease below the flood stage elevation is due to an increased time of concentration for the collected runoff to flow into Church Creek from the West Ashley Circle Storage Facility.

5.0 MID BASIN STORAGE

5.1 Background

The proposed Mid Basin Storage facility is along Church Creek adjacent to Crosstowne Church, located at 1941 Bees Ferry Road, between Bees Ferry Road and the CSX Railroad. This improvement arose because of a need to evaluate additional storage locations near Church Creek and determine the potential impacts the storage area would have on overall basin hydraulics. The goal of this improvement is to provide an additional stormwater storage area during weather events to decrease the extent of flooding in developed, residential areas of the basin. Multiple storage options were considered for modeling that varied in size and scope; three options were selected and subsequently modeled. The most practical and beneficial of these options will be modeled in combination with the West Ashley Circle Storage Facility and Hickory Farms Overland Flow Diversion and the CSX-Whitfield Channel.

Figure 14- Location of Mid Basin Storage Options A, B, and C

The ICPR4 model was set-up to include a Mid Basin Storage Facility for the following options:

1. Option A – A storage area was created by building a berm around the Crosstowne Church adjacent to the Church Creek channel for flood protection and modifying the clearings and parking areas to an elevation approximately 1' above the seasonal high ground water table (SHGWT) to allow for additional storage volume. This would allow these areas to remain functional during dry weather and serve as additional storage during wet weather events. The total area of this option is approximately 3.6 acres.
2. Option B – A storage area consisting of a 200' flood bench on either side of the Church Creek Channel down to 1' above the SHGWT. This option covers a total area of approximately 12 acres.
3. Option C – This option includes a storage area that utilizes all available areas adjacent to the Church Creek Channel between Bees Ferry Road, the CSX Railroad, and Glenn McConnell Parkway within the 100-year (1%) floodplain by removing material to an elevation 1' above the SHGWT. This option covers a total area of approximately 40 acres.

All three options created additional storage adjacent to the Church Creek Channel. The options were modeled for select storm events using current mean higher high water (MHHW) tide conditions. The scenario storm and tidal conditions are shown in the table below.

Table 4 - Modeled Tidal Conditions and Storm Events for Mid Basin Storage Facility

Tidal Conditions	24-hr Storm	48-hr Storm
MHHW	10%	10%
	4%	4%
	1%	1%

The water surface elevation was recorded and analyzed at 13 select nodes within the model to determine how the extra storage created by each Mid Basin Storage Facility impacted the water surface elevation for the duration of the storm event. The nodes were selected based on their proximity to the proposed improvement as well as other key elements of the Church Creek basin such as convergences, culverts, and dikes. See Appendix B for a map of these key nodes. The results for all three options are discussed in the following section. All elevations are in NAVD 88.

5.2 Results

5.2.1 Existing Conditions

Figure 16 shows the staging at node B020 (N-B020) for the 10%, 4%, and 1% storm events to be used in comparison to the Mid Basin storage facility options discussed below. Node B020 is located north of Bees Ferry Road and is approximately 500 feet northwest of Crosstowne Church, see *Figure 15*. This node was selected to determine the effectiveness of the Mid Basin Storage Facility alternatives in reducing headwater impacts in the Church Creek Channel. The flood warning stage is the point at which the water surface elevation breaches the lowest elevation in the top of the creek bank near the node of interest and is represented in the hydrograph. This elevation is the first level at which flooding is experienced when the water surface elevation stages above the channel's capacity. The nearest road elevation to N-B020 is at 10.2' and not represented in the hydrograph as it is more than 2 feet above the highest modeled water surface elevation.

Figure 15 - Location of N-B020 and N-B010

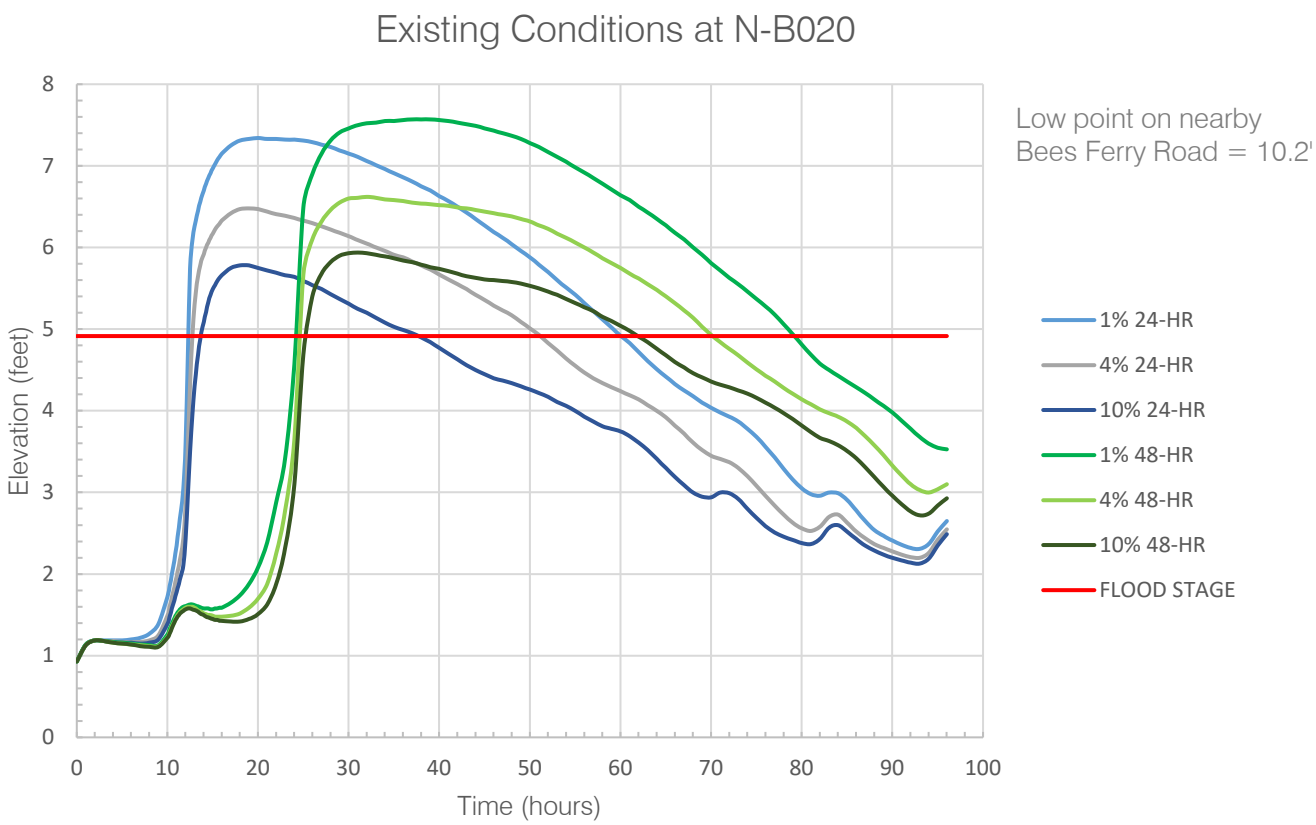

Figure 16 - Hydrograph of Existing Conditions at N-B020

5.2.2 Proposed Improvements

1.1.1. Option A

The improvements for Mid Basin Storage Option A are located near node B010 (N-B010) which resides just south of Bees Ferry Road and north of Crosstowne Church. This option utilizes less than four acres of land and berms the existing church to mitigate flood damage to the building. In the immediate upstream area, at N-B020, there is a predicted decrease of approximately 0.8 to 1.2 inches during peak staging for all modeled storm events. N-A120, which is upstream of B020, is predicted to experience little to no impact by implementing Option A. N-B160, which is upstream of B020, sees a decrease of 0.96 to 0.60 inches. See Appendix B for the selected node results throughout the Church Creek Basin showing the staging with the proposed improvements in comparison to the staging of the existing conditions.

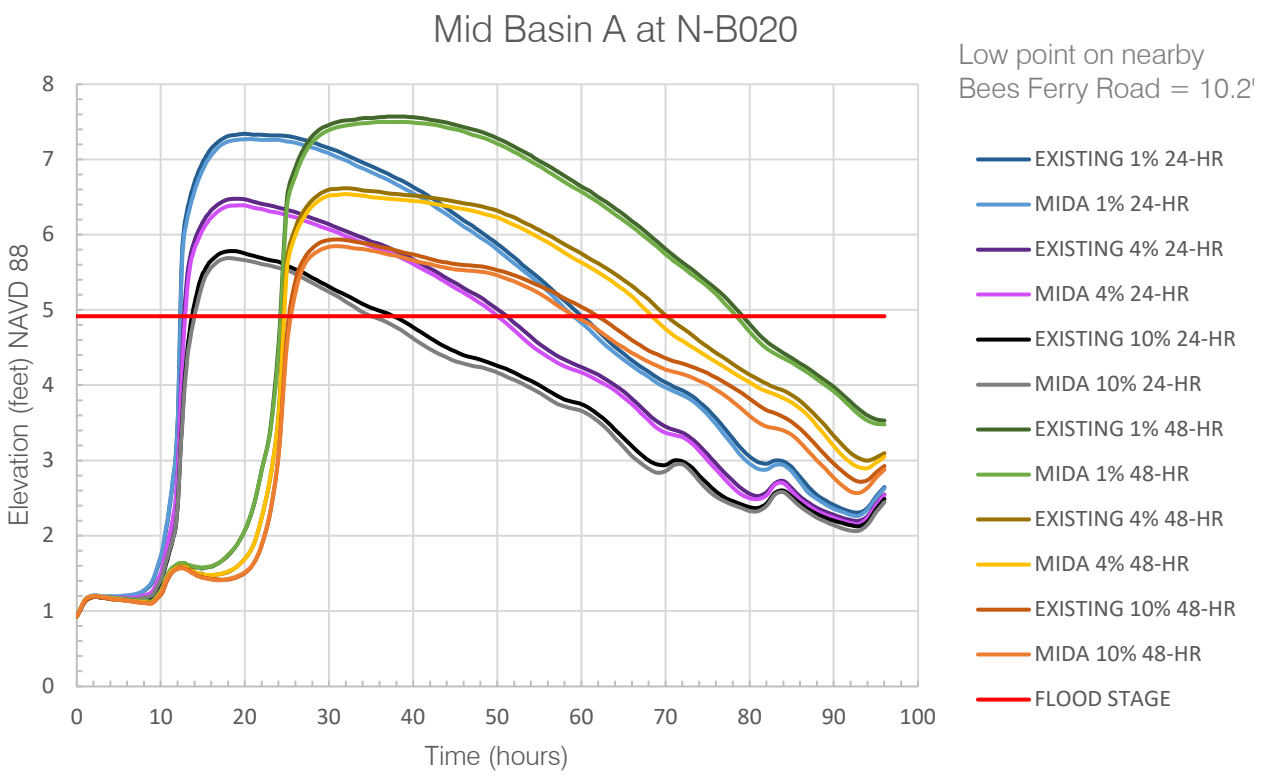

Figure 17 - Hydrograph of Post-Conditions Model Results for Mid-Basin Storage Facility Option A

Table 5 - Change in water surface elevation at Pre- and Post-Improvements at N-B020 for Mid-Basin Storage Facility Option A

Storm	Pre-	Post-	WSE Δ	Duration of Flooding Δ
10% 24-HR	5.79'	5.69'	1.20"	-2 hrs
10% 48-HR	5.94'	5.85'	1.08"	-3 hrs
4% 24-HR	6.48'	6.39'	1.08"	-1 hr
4% 48-HR	6.62'	6.54'	0.96"	-2 hrs
1% 24-HR	7.34'	7.27'	0.84"	-1 hr
1% 48-HR	7.57'	7.50'	0.84"	-1 hr

1.1.2. Option B

The improvements associated with Option B are also located near Node B010, which resides just south of Bees Ferry Road and north of Crosstowne Church and makes use of an area approximately three-times the size of Option A. For model simplicity and available nearby land, this area was modeled as a 200' flood bench on either side of the Church Creek Channel, thus totaling a 400' flood bench extending from Bees Ferry Road to the CSX Railroad. As in Option A, N-B020 was evaluated during the modeling and is represented in *Figure 18.* Node B020 is located immediately upstream of the proposed improvements and provides a better representation over Node B010 of the Mid Basin Storage Facility impacts during storm events. Option B provides an average decrease of approximately 1.8- to 2.1-inches in peak staging for all modeled storm events. This option provides the greatest decrease in

overall water surface elevation per acre of land utilized. See Appendix B for the selected node results showing the staging after the proposed improvements in comparison to the staging of the existing conditions.

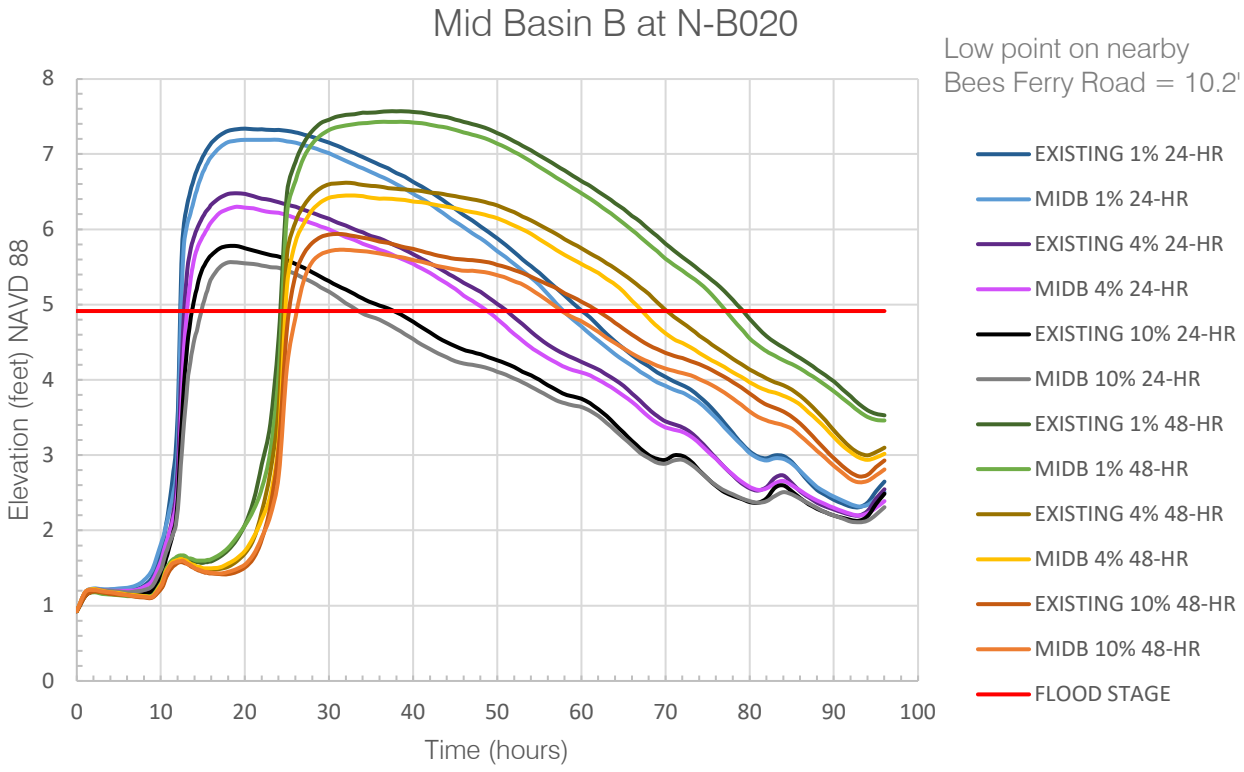

Figure 18 - Hydrograph of Post-Conditions Model Results for Mid-Basin Storage Facility Option B

Table 6 - Change in water surface elevation at Pre- and Post-Improvements at N-B020 for Mid-Basin Storage Facility Option B

Storm	Pre-	Post-	WSE Δ	Duration of Flooding Δ
10% 24-HR	5.79'	5.56'	-2.76"	-4 hrs
10% 48-HR	5.94'	5.73'	-2.52"	-5 hrs
4% 24-HR	6.48'	6.30'	-2.16"	-3 hrs
4% 48-HR	6.62'	6.45'	-2.04"	-3 hrs
1% 24-HR	7.34'	7.19'	-1.80"	-3 hrs
1% 48-HR	7.57'	7.43'	-1.68"	-3 hrs

1.1.3. Option C

Located at N-B010, Option C makes use of approximately 40 acres of land in the vicinity of Crosstowne Church north of the railroad tracks and south of Bees Ferry Road. The results of implementing Option C decrease the peak staging at the immediate upstream node, N-B020, by an average of 3.56" for all modeled storm events. As seen in *Figure 19*, the peak staging is not met until a later time and takes longer to drawdown or lower the water surface elevation. This elongation of the hydrograph is due to the

increased time of concentration caused by the perimeter shape of the flood bench. It should also be noted that the area of Option C is more than three times larger than Option B and is absorbing runoff from areas across the basin. See Appendix B for the selected node results showing the water surface elevation staging after the proposed improvements in comparison to the water surface elevation staging of the existing conditions. This option is the best in decreasing the overall staging.

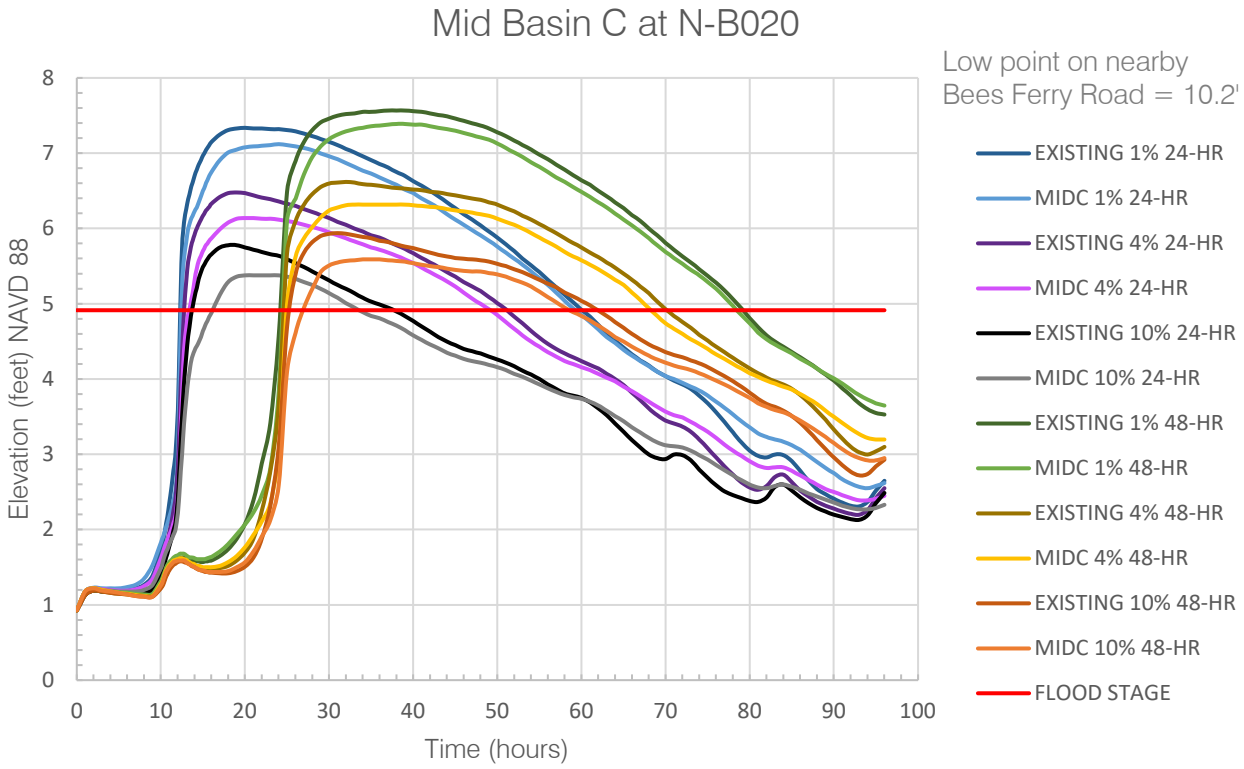

Figure 19 - Hydrograph of Post-Conditions Model Results for Mid-Basin Storage Facility Option C

Table 7 - Change in water surface elevation at Pre- and Post-Improvements at N-B020 for Mid-Basin Storage Facility Option C

Storm	Pre-	Post-	WSE Δ	Duration of Flooding Δ
10% 24-HR	5.79'	5.39'	-4.80"	-4 hrs
10% 48-HR	5.94'	5.59'	-4.20"	-3 hrs
4% 24-HR	6.48'	6.15'	-3.96"	-2 hrs
4% 48-HR	6.62'	6.32'	-3.60"	-2 hrs
1% 24-HR	7.34'	7.12'	-2.64"	<-1 hr
1% 48-HR	7.57'	7.39'	-2.16"	<-1 hr

5.2.3 Comparison of Proposed Improvements

The figures and tables in the preceding subsections provide a comparison of the staging impacts of Options A, B, and C to the existing conditions. The model predicts Option B will have a 114% decrease in water surface elevation during the 1% 24-hour storm over Option A with an increase of land area of approximately 233%. The predicted lowering of the water surface elevation from Option B to Option C

during the 1%, 24-hour storm is nearly 47% for approximately 233% increase in land used. While Option C has the greatest impact to the water surface elevation, compared to Option B it has a lower impact to the length of time the Church Creek is above flood elevations as shown in Table 8. Mid-Basin Option A is predicted to be the least impactful of the three options.

Table 8 - Total Change in Time WSE is Above Flood Elevation at N-B020

At N-B020		Difference (hr) between Pre- and Post-Improvement for Time Above Flood Stage*		
Storm Event		Mid Basin A	Mid Basin B	Mid Basin C
24-HR	10%	-2	-4	-4
	4%	-3	-3	-2
	1%	-1	-3	<-1
48-HR	10%	-2	-5	-3
	4%	-1	-3	-2
	1%	-1	-3	<-1

**Time above flood stage refers to the length of time the water surface elevation exceeds the capacity of the stormwater facility and begins to flood until it recovers to an elevation at or below the flood stage.*

5.3 Conclusions

Weston & Sampson, based on analysis of the model results, concluded the following:

1. The creation of additional storage capacity in an area immediately adjacent to Church Creek is predicted to reduce the water surface elevation and areas of inundation upstream of the storage facility. The impact is logarithmically regressive to the volume of storage created.
2. Of the three Mid-Basin Storage Facility options evaluated, Option B modeled the greatest impact to the peak staging level per acre of storage.
3. Option C provides the greatest reduction of water surface elevation at peak staging with a reduction of 4.8" during the 10%, 24-hour storm and 2.64" during the 1%, 24-hour storm at Node B020. However, the period of time the water surface is above flood levels at Node A120 (downstream of the Mid-Basin Storage Facility) increases by three to four hours depending on the storm event, see Table 9.

Table 9 - Total Change in Time WSE is Above Flood Elevation at N-A120

At N-A120		Difference (hr) between Pre- and Post-Improvement for Time Above Flood Stage*		
Storm Event		Mid Basin A	Mid Basin B	Mid Basin C
24-HR	10%	-1	<-1	+2
	4%	-1	0	+4
	1%	<-1	<-1	+3

6.0 CSX-WHITFIELD CHANNEL

6.1 Background

The proposed CSX-Whitfield Channel is planned to follow the CSX railroad right-of-way and SCDOT channel that cross under Glenn McConnell Parkway south of Bees Ferry Road. The CSX-Whitfield Channel improvements arose because of the property owner's desire to transfer responsibility to the City of Charleston for maintaining the channel. The CSX-Whitfield Channel improvement would add approximately 13 acres of additional property for construction of a conveyance and storage facility. This improvement was broken into two phases: Phase I includes developing 1,200 LF of channel between the Glenn McConnell Parkway and the Church Creek Channel adjacent to the existing SCDOT channel and CSX Railroad right-of-way and Phase II includes developing an additional 6,600 LF of channel from Glenn McConnell Parkway along the railroad right-of-way and then turning north towards Bees Ferry Road, also adjacent to the existing SCDOT channel. The proposed channel in both phases is 50' wide.

The ICPR4 model incorporates the CSX-Whitfield Channel for the following scenarios:

1. Phase I – Approximately 1,200 LF of 50' wide channel is installed north of the CSX railroad right-of-way northeast of Glenn McConnell Parkway adjacent to the existing SCDOT Drainage Channel. The channel connects to Church Creek just upstream of the creek crossing under the CSX railroad right-of-way via multiple culverts.
2. Phase II – Approximately 6,600 LF of 50' wide channel is installed north of the CSX railroad right-of-way southwest of Glenn McConnell Parkway. This section of the channel connects to Phase I before merging the proposed channel with the existing channel crossing under Glenn McConnell Parkway. The proposed channel splits from the existing SCDOT channel south of Glenn McConnell Parkway and continues to the southside of Bees Ferry Road at the existing Planck channel.
3. Storage Facility – Approximately 13-acres of low-lying land below 6 ft elevation and immediately adjacent to the CSX-Whitfield Channel was benched to an elevation of 2 ft and connected to the channel. This model scenario was intended to simulate the addition of either a flood bench or constructed wetlands as added storage. The scenario was run with and without downstream controls.

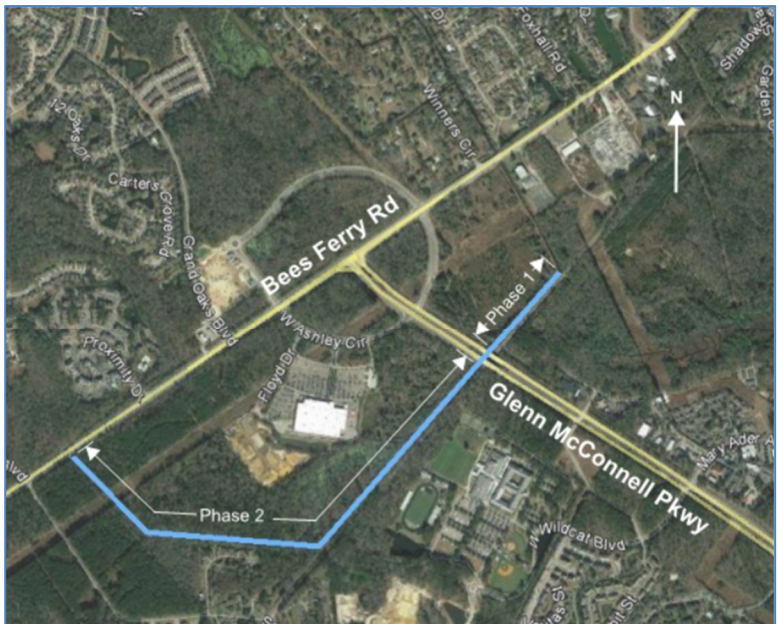

Figure 20 - Location of CSX-Whitfield Channel Phases I and II

The implementation of both phases creates additional conveyance to the Church Creek Channel and provides additional capacity for stormwater flowing out of the southwest area of the basin. The phases

were modeled for select storm events using mean higher high water (MHHW) tide condition of 3.09 feet elevation NAVD 88. The storm events and tidal conditions modeled are shown in Table 10.

Table 10 - Modeled Tidal Conditions and Storm Events for CSX-Whitfield Channel

Tidal Conditions	24-hr Storm	48-hr Storm
MHHW	10%	10%
	4%	4%
	1%	1%

The water surface elevation was recorded and analyzed at 13 select nodes within the model to determine how the extra storage created by the various options is predicted to impact the water surface elevation for the duration of the storm event. The nodes were selected based on their proximity to the proposed improvement as well as other key elements of the Church Creek basin such as convergences, culverts, and dikes. The results for all three options are discussed in the following section.

6.2 Results

6.2.1 Existing Conditions

The hydraulics of the proposed improvement area consist of an existing SCDOT stormwater conveyance channel extending southeast from Bees Ferry Road along Sanders Road and turning east towards the CSX Railroad before turning northeast paralleling the CSX Railroad to the Church Creek Channel. It currently directs the flow from the southwest subbasin to the main channel of Church Creek. In most storm conditions, this drainage ditch overtops and contributes to a flooded timber/swamp environment that acts as a tributary to Church Creek.

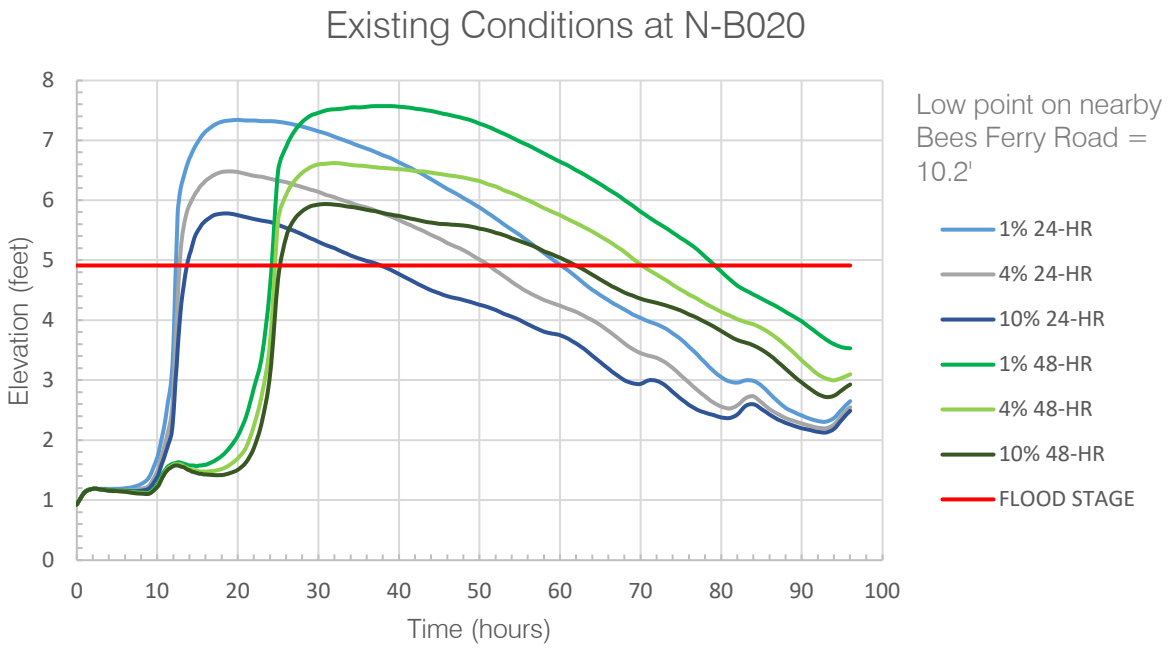

Figure 21 - Hydrograph for existing conditions at Node B020.

6.2.2 Proposed Improvements

The proposed CSX – Whitfield Channel was modeled to include a total of 7,800 LF of new channel and maintenance access adjacent to the existing SCDOT stormwater channel. This channel cross section is planned to be 50-feet wide at the top of bank and 14-feet wide at the bottom, with 25-feet of maintenance access raised to the top of bank elevation. This channel flows parallel to the existing channel until joining with the existing channel to cross beneath Glenn McConnell Parkway. On the downstream side of Glenn McConnell Parkway, the channel would flow into a separate proposed channel. The design of this channel is beyond the scope of this report.

These improvements were proposed to create additional storage by adding a defined conveyance channel and improve hydraulics along the CSX Railroad right-of-way conveyance channel. Pipes from the adjacent low-lying areas were modeled to be directed under the dike/access road to provide relief of any water that collects outside of the channel limits and prevent divided hydrological areas.

This improvement was modeled first as Phase 1 only, which included 1,200 LF of channel, with maintenance access adjacent to the channel, with an outfall into Church Creek. The improvement was then modeled with Phase 2 encompassing the entire improvement as described above. The connection to Church Creek consisted of the existing channel connection and the proposed outfall for Phase 1. The outfall was modeled with a 36-inch pipe through a weir with flap gate installed for single-direction-flow out of the channel.

The CSX-Whitfield Channel when modeled as Phase 1 alone, provided little impact on the basin; it did not increase nor decrease peak staging elevations or length of inundation in the mid basin area. This lack of change was believed to be due, in part, to the existing conditions within the Phase 1 improvement area where there are wetlands and flooded timbers.

While modeling the CSX-Whitfield Channel with Phase 2, Weston & Sampson worked through trial and error to optimize the outfall of the channel to provide storage within the Church Creek Drainage Basin rather than conveyance alone. The outfall was originally modeled with a 36-inch pipe through a weir with flap gate installed for single-direction-flow out of the channel. The model predicts this outfall will have a net zero impact in the mid basin area during the 10% and 4% AEP storms and cause the water surface elevation to increase during peak staging in the 1% storms; see the hydrograph in *Figure 22*. It was necessary to rethink the outfall to improve the impacts in the mid basin area.

During the modeling of the CSX-Whitfield Channel combined with the West Ashley Circle Storage Facility, an outfall was inserted with dual 48" pipes allowing for free flow in both directions. The hypothesis was that allowing Church Creek to flow into the CSX-Whitfield Channel during times of peak staging would help reduce headwaters impacting the mid-basin area. The results of this combined improvement were less impactful than the West Ashley Circle Storage Facility results as a standalone improvement. The difference in the WAC Storage Facility model results and the combination with the CSX-Whitfield Channel were due to the conveyance of water through the proposed channel too quickly. The flows from the southwestern subbasin negatively impacted Church Creek and did not provide any headwater relief.

During the CSX-Whitfield Channel and Mid Basin Option B combined scenario modeling, the outfall was modeled using a weir set above the peak water surface elevation with a 12-inch diameter pipe with flap gate set at the invert of the channel. This outfall configuration predicted better results than the two

previously modeled, however, it too is predicted to increase the water surface elevation during 1% storms. While reviewing the hydraulic grade line of the CSX-Whitfield Channel and Church Creek, shown in *Figure 23*, it was found that the water surface elevation within the channel was higher than in Church Creek. This difference in elevation created a higher head condition on the upstream side of the outfall and proved that the channel was predicted to negatively impact Church Creek.

Due to the CSX-Whitfield Channel modeling results for Phase I and Phase II, the storage facility scenario was developed in the belief that providing the channel flow a means to slow down and spread out would reduce the negative impacts downstream at Church Creek. The flood bench concept was added to the model and run for the 4% and 1% AEP, 240-hour storm events. The results were the same as for the Phase II scenarios—the water surface elevation increased in the Church Creek channel. A weir structure was added to the storage facility outfall to further control the flows. This too proved unsuccessful and resulted in an increased water surface elevation in the Church Creek channel. No further attempts were made to improve the channel and storage facility scenario.

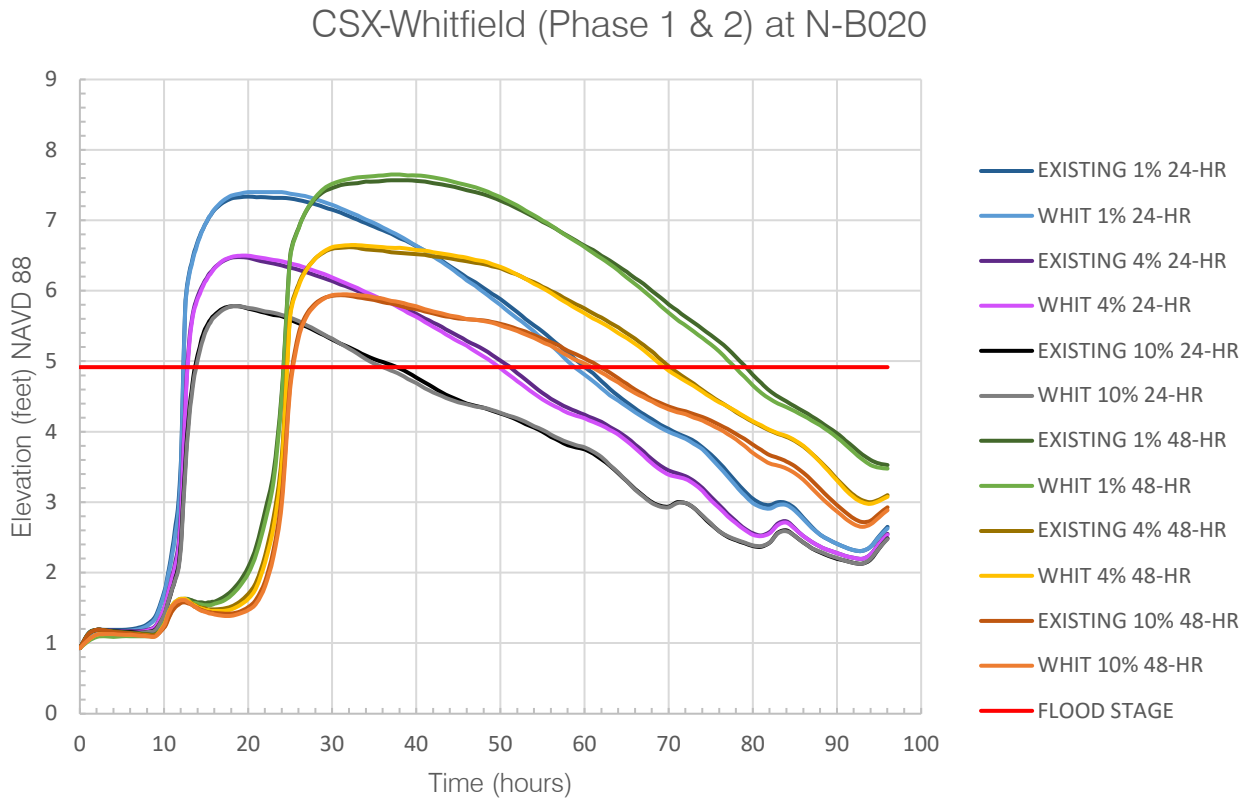

Figure 22 - Hydrograph for CSX-Whitfield Channel at Node B020.

Table 11 - Change in water surface elevation at Pre- and Post-Improvements at N-B020 for CSX-Whitfield Channel Phase 1 & 2

Storm	Pre-	Post-	Δ
10% 24-HR	5.79'	5.78'	-0.12"
10% 48-HR	5.94'	5.95'	0.12"
4% 24-HR	6.48'	6.50'	0.24"
4% 48-HR	6.62'	6.65'	0.36"
1% 24-HR	7.34'	7.40'	0.72"
1% 48-HR	7.57'	7.65'	0.96"

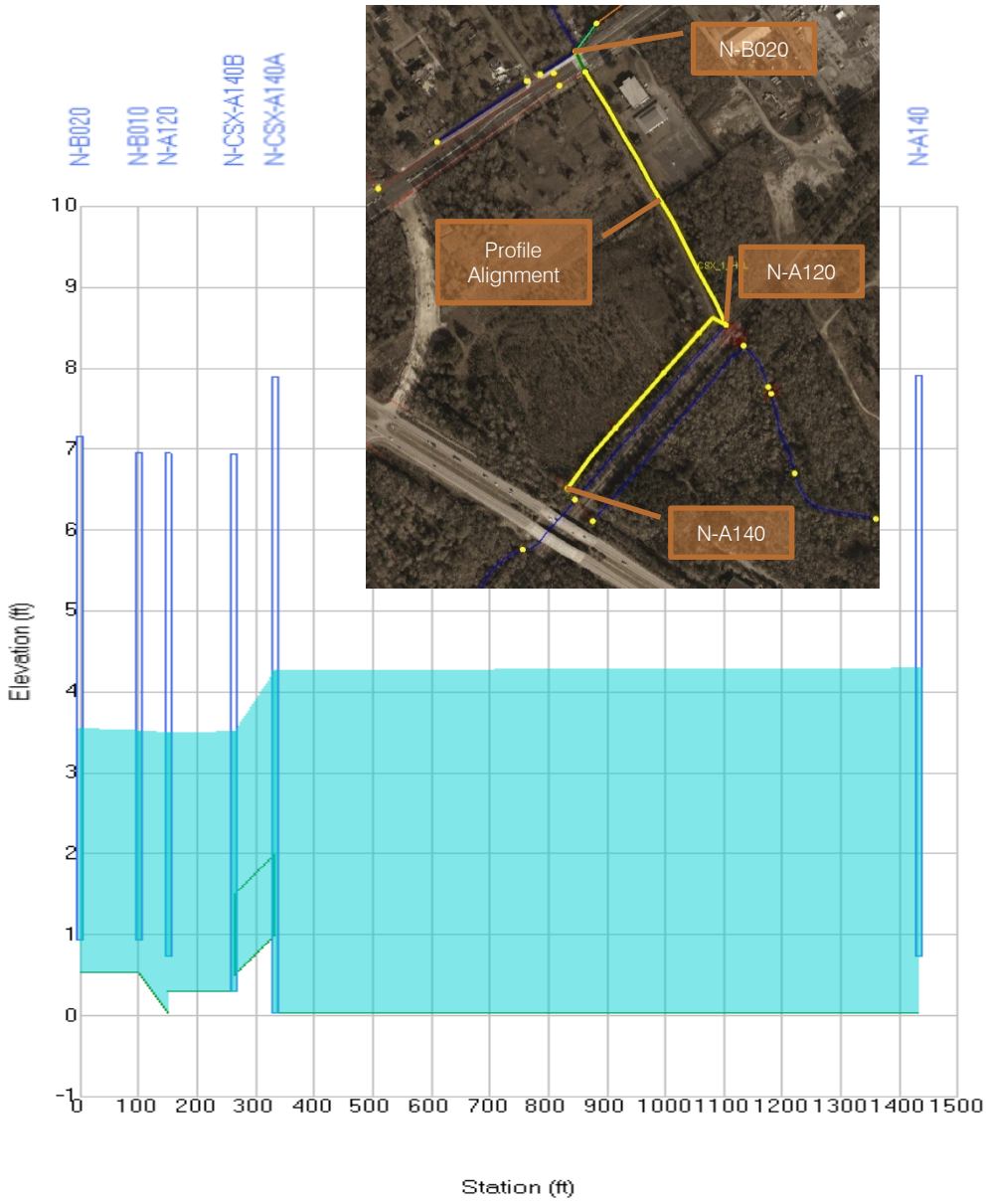

Figure 23 - Hydraulic Grade Line for CSX-Whitfield Channel Outfall at Church Creek during 1% AEP modeled storm

6.3 Conclusions

Weston & Sampson, based on analysis of the model results, concluded the following:

1. The proposed CSX-Whitfield channel is predicted to convey flows to Church Creek effectively and reduce inundation in portions of the southwest subbasin upstream of the channel.
2. The conveyance of stormwater is predicted to have a negative impact on Church Creek by increasing the peak staging elevation and lengthening the period of inundation in the mid basin areas.
3. Despite modeling efforts to control and slow down the flow of water in the conveyance channel, the CSX-Whitfield channel improvement is predicted to increase both the volume of flow in Church Creek and speed with which stormwater is conveyed to Church Creek.
4. Modeling further upstream of the CSX-Whitfield Channel was outside the scope of this improvement, however, based upon the results of our modeling it is suspected that the western basin conveyance upstream of Bees Ferry Rd may be worth additional study. Any further studies should analyze in more detail the hydraulic and hydrologic flow patterns between the western basin and Church Creek and if controls within the western basin could provide flood mitigation in the mid basin.

7.0 COMBINED IMPROVEMENTS

7.1 Background

Following the development and modeling of proposed improvements as individual improvements, Weston & Sampson combined the improvements into scenarios to determine the cumulative effects that the improvements may have within the basin. The intent of these combination runs was to assist the City in prioritizing improvements for design that are predicted to provide the greatest improvements to stormwater management within the Church Creek Drainage Basin. The proposed improvements run concurrently in the ICPR4 model were the West Ashley Circle (WAC) Storage Facility, the selected Mid Basin Storage Facility (Option B), and the CSX-Whitfield Channel. The combinations of scenarios modeled are listed below, and the results and impacts to the Church Creek Basin are discussed within the following subsections.

1. Selected Mid Basin Storage Facility & WAC Storage Facility
2. Selected Mid Basin Storage Facility & CSX-Whitfield Channel
3. WAC Storage Facility & CSX-Whitfield Channel
4. WAC Storage Facility & CSX-Whitfield Channel & Selected Mid Basin Storage Facility

All scenario combinations were run for select storm events using current mean higher high water (MHHW) tide conditions. The scenario conditions are shown in the table below.

Table 12 - Modeled Tidal Conditions and Storm Events for Combined Improvement Scenarios

Tidal Conditions	24-hr Storm	48-hr Storm
MHHW	10%	10%
	4%	4%
	1%	1%

The water surface elevation was recorded and analyzed at select nodes within the model to determine how the extra storage created by the various options will impact the water surface elevation for the duration of the storm event. The nodes were selected based on their proximity to the proposed improvements as well as other key elements of the Church Creek Basin such as convergences, culverts, and dikes. The results are discussed in the following sections. All elevations are in NAVD 88.

7.2 Results

7.2.1 Mid Basin Storage Facility & West Ashley Circle Storage Facility

Mid Basin Storage Option B was selected as the most favorable of the three Mid Basin storage options because it created the greatest positive impact in relation to the amount of land the improvement required. Option B also allowed for the completion of the CSX-Whitfield Channel while retaining the usefulness of the land west of Church Creek and east of Glenn McConnell Parkway. This scenario combination was run with the Hickory Farms Overland Flow Diversion Channel flowing into the WAC storage facility, which then connects to Church Creek via modifications to the Bees Ferry Road drainage channel. The roadside channel flows into Church Creek and the 12-acre flood bench between Bees Ferry Road and the CSX Railroad right-of-way, as allotted by Mid Basin Option B, before flowing through the culvert under the railroad right-of-way, see *Figure 24*.

The results of this scenario at Node B020 are represented in Table 13 and *Figure 25*. Node B020 is directly downstream of the West Ashley Circle Storage Facility and just upstream of the Mid Basin Storage facility improvements. It provides a consistent reference point to compare the effects of both scenarios individually and in combination. The model predicts measurable improvements to the Church Creek Drainage Basin when installed together. The overall impacts include a predicted reduction of the water surface elevation of 2.17 inches during the 1%, 48-hour storm and 3.24 inches during both the 10%, 48-hour and 4% 24-hour storms. During the 10% storms, the most impactful results are yielded by the Mid Basin Storage Facility as evidenced by the 1.8-inch increase in reduction of the water surface elevation over the resulting decrease for the West Ashley Circle Storage Facility. The combination of the two improvements during the 1%, 24-hour storms provides the greatest impact over those predicted for the improvements individually. See Table 13 for comparisons of the resulting water surface elevation reductions predicted for the individual and combined storage improvements.

Figure 24 - Location of Combined West Ashley Circle & Mid-Basin Storage Facilities

Table 13 - Maximum calculated change in water surface elevation for West Ashley Circle and Mid-Basin Storage improvements at N-B020

Storm	Pre-	Post-	Combination Δ	WAC Δ	Mid Basin Δ
10% 24-HR	*5.79'*	*5.57'*	*-3.36"*	*-0.96"*	*-2.76"*
10% 48-HR	*5.94'*	*5.67'*	*-3.24"*	*-0.84"*	*-2.52"*
4% 24-HR	*6.48'*	*6.21'*	*-3.24"*	*-1.08"*	*-2.16"*
4% 48-HR	*6.62'*	*6.37'*	*-3.00"*	*-0.96"*	*-2.04"*
1% 24-HR	*7.34'*	*7.13'*	*-2.52"*	*-0.72"*	*-1.80"*
1% 48-HR	*7.57'*	*7.39'*	*-2.16"*	*-0.48"*	*-1.68"*

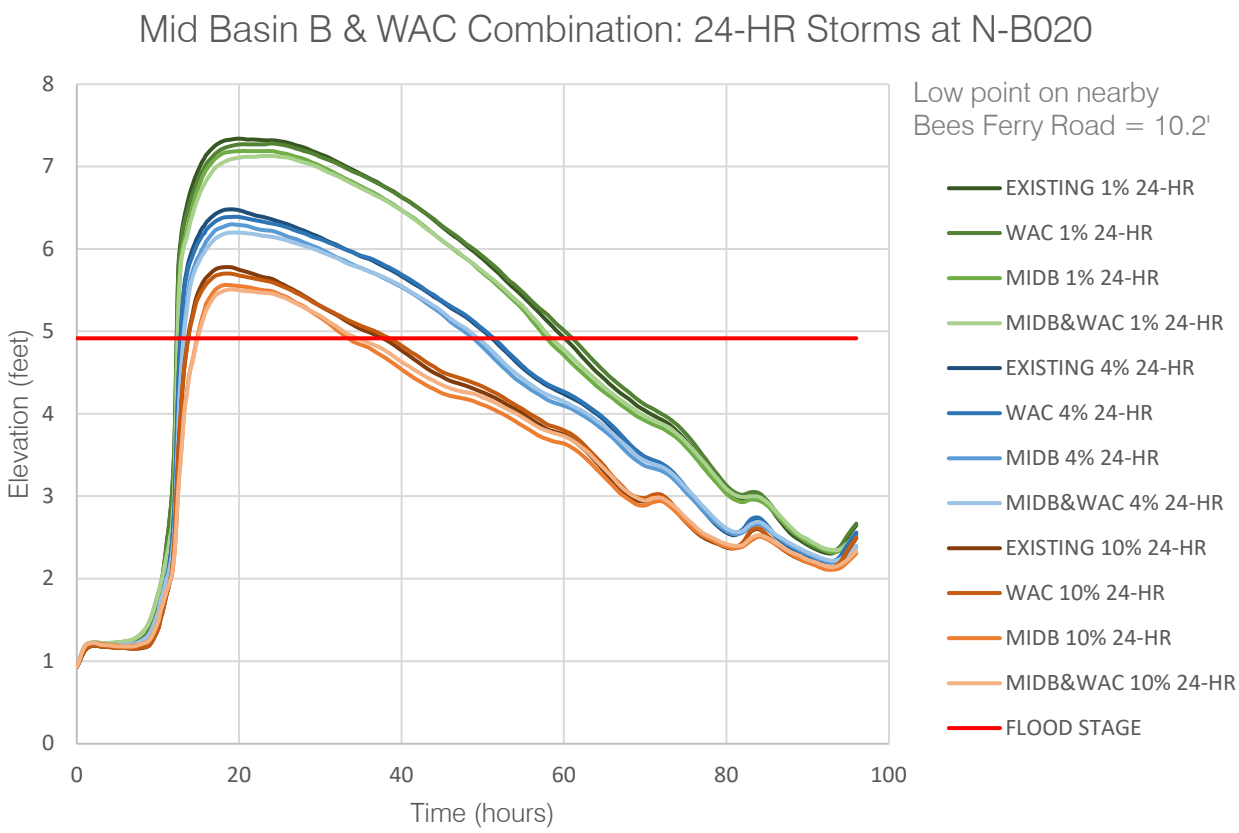

Figure 25 - Post-Conditions Model Results for Combined West Ashley Circle & Mid-Basin Storage Facilities

7.2.2 *Mid Basin Storage Facility & CSX-Whitfield Channel*

The combination of Mid Basin Storage Facility and CSX-Whitfield Channel was modeled with the existing SCDOT channel discharging directly into Church Creek at its current location; the Mid Basin Storage Facility as the flood bench originally developed in the individual improvement scenario; and the CSX-Whitfield Channel with a modified outfall location discharging into the Mid Basin Storage Facility along the alignment originally developed in the individual improvement. The outfall for the CSX-Whitfield Channel was modeled using a weir set above the peak water surface elevation with a 12-inch diameter pipe with flap gate set at the invert of the channel.

Figure 26 - Location of Combined Mid-Basin Storage Facility & CSX-Whitfield Channel

As shown in *Figure 27*, the CSX-Whitfield Channel and Mid Basin Storage Facility combined do not provide improvements to the Church Creek Drainage Basin water surface elevation in comparison to the Mid Basin Storage Facility. The Mid Basin Storage Facility clearly mitigates the negative impacts observed in the model for the CSX-Whitfield Channel improvements but the combination of the two does not improve or alter the hydraulics of the Church Creek Drainage Basin.

Table 14 - Maximum calculated change in water surface elevation for CSX-Whitfield and Mid-Basin Storage improvements at N-B020

Storm	Pre-	Post-	Combination Δ	CSX-Whitfield Δ	Mid Basin Δ
10% 24-HR	*5.79'*	*5.60'*	*-2.28"*	*-0.12"*	*-2.76"*
10% 48-HR	*5.94'*	*5.76'*	*-2.16"*	*0.12"*	*-2.52"*
4% 24-HR	*6.48'*	*6.30'*	*-2.16"*	*0.24"*	*-2.16"*
4% 48-HR	*6.62'*	*6.44'*	*-2.16"*	*0.36"*	*-2.04"*
1% 24-HR	*7.34'*	*7.16'*	*-2.16"*	*0.72"*	*-1.80"*
1% 48-HR	*7.57'*	*7.39'*	*-2.16"*	*0.96"*	*-1.68"*

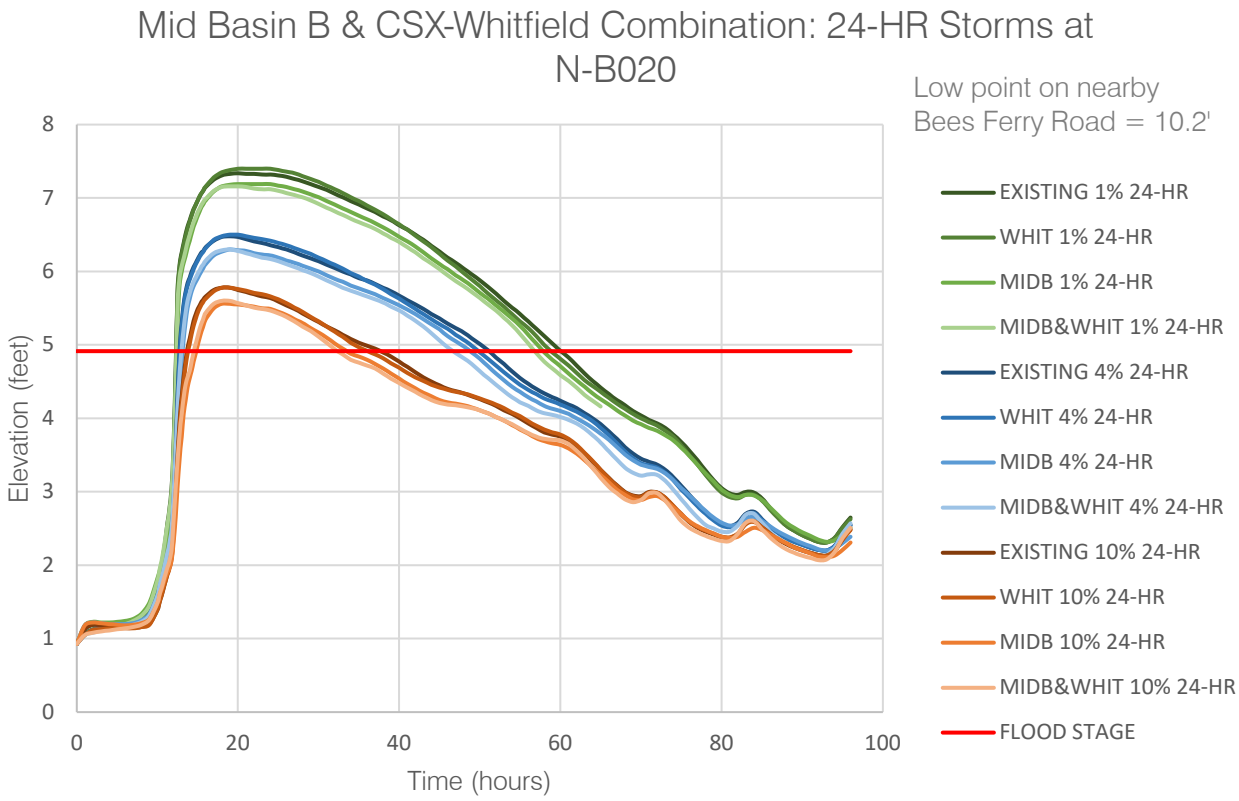

Figure 27 - Hydrograph at Node B020 for Mid Basin Storage Facility & CSX-Whitfield Channel combined.

7.2.3 *West Ashley Circle Storage Facility & CSX-Whitfield Channel*

The West Ashley Circle Storage Facility and CSX-Whitfield Channel combined scenarios were modeled together as they were originally incorporated into the model for the individual improvement scenarios. The CSX-Whitfield Channel outfall was modified to allow free flow in both directions.

The results of the West Ashley Circle Storage Facility with CSX-Whitfield predict that there will not be any improvements provided to the Church Creek Drainage Basin. The combined scenarios provide a negative impact to the Church Creek Drainage Basin compared to the predicted results of the West Ashley Circle Storage Facility as an individual improvement.

Figure 28 - Location of Combined West Ashley Circle Storage Facility & CSX-Whitfield Channel

Table 15 - Maximum calculated change in water surface elevation for West Ashley Circle and CSX-Whitfield improvements at N-B020

Storm	Pre-	Post-	Combination Δ	CSX-Whitfield Δ	WAC Δ
10% 24-HR	*5.79'*	*5.75'*	*-0.48"*	*-0.12"*	*-0.96"*
10% 48-HR	*5.94'*	*5.92'*	*-0.24"*	*0.12"*	*-0.84"*
4% 24-HR	*6.48'*	*6.45'*	*-0.36"*	*0.24"*	*-1.08"*
4% 48-HR	*6.62'*	*6.60'*	*-0.24"*	*0.36"*	*-0.96"*
1% 24-HR	*7.34'*	*7.35'*	*-0.12"*	*0.72"*	*-0.72"*
1% 48-HR	*7.57'*	*7.61'*	*-0.48"*	*0.96"*	*-0.48"*

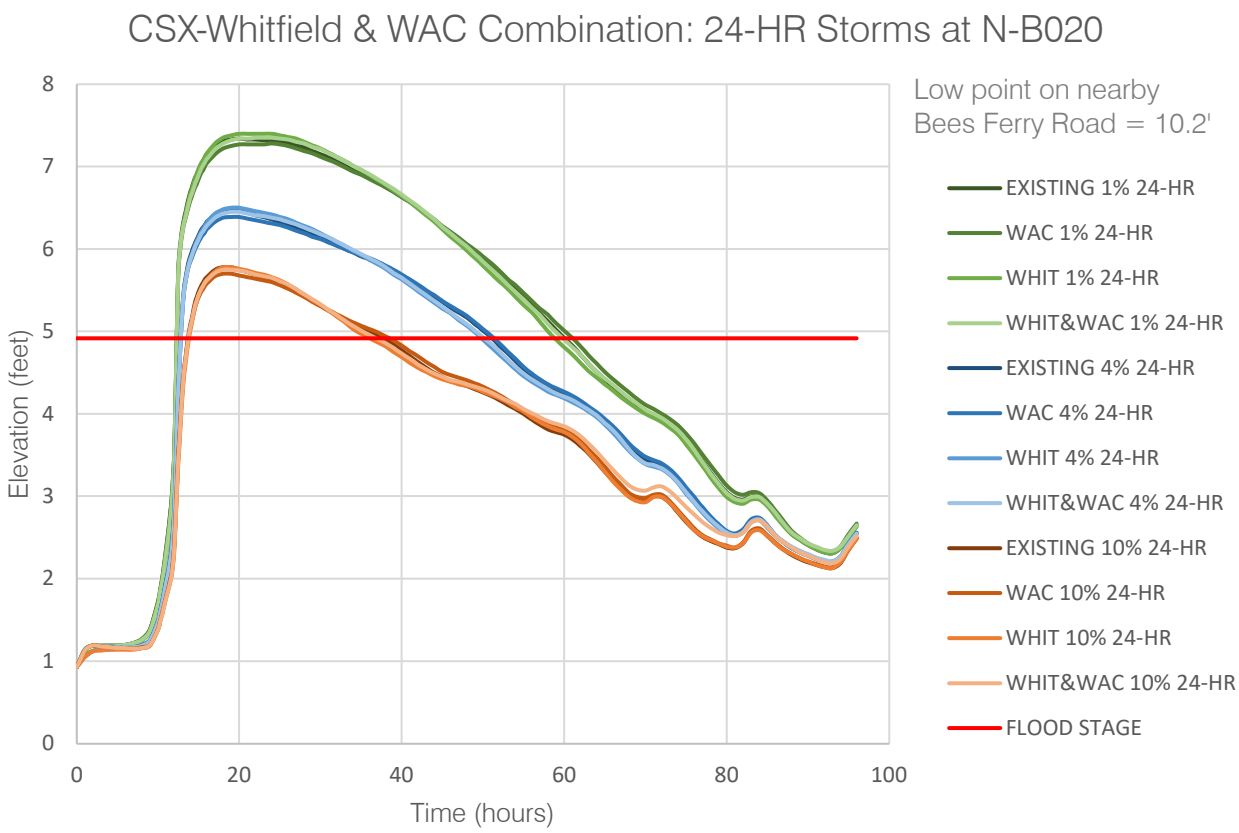

Figure 29 - Hydrograph at Node B020 for CSX-Whitfield Channel & West Ashley Circle Storage Facility combined scenario

7.2.4 Selected Mid Basin Storage Facility & WAC Storage Facility & CSX-Whitfield Channel

The Mid Basin Storage Facility Option B and West Ashley Storage Facility were modeled in the combined scenario the same as in the individual scenarios. The CSX-Whitfield Channel was modeled with a weir and 12-inch pipe at the outfall as was included in the CSX-Whitfield Channel and Mid Basin Storage Facility combined scenarios. Further, the CSX-Whitfield Channel was set to discharge into the Mid Basin Storage Facility and two upstream hydraulic structures were included with the intention of slowing down the conveyance and providing the desired relief to the mid basin area.

The results of the combined Mid Basin and West Ashley Circle Storage Facilities and CSX-Whitfield Channel predicted improved water surface elevations in Church Creek over the West Ashley Circle Storage Facility and CSX-Whitfield Channel individual scenarios for all storms. However, when compared to the Mid Basin Storage Facility individual scenario, the combined scenario is predicted to have a greater reduced water surface elevation during the 10%, 24- and 48-hour storms and the 4%, 48-hour storm; during all other storms, the combined scenario is predicted to not reduce the water surface elevation as much as the Mid Basin Storage Facility individual scenario.

Table 16 - Maximum calculated change in water surface elevation for West Ashley Circle, Mid Basin, and CSX-Whitfield improvements at N-B020

Storm	Pre-	Post-	Combination Δ	WAC Δ	Mid Basin Δ	CSX-Whitfield Δ
10% 24-HR	5.79'	5.48'	-3.72"	-0.96"	-2.76"	-0.12"
10% 48-HR	5.94'	5.66'	-3.36"	-0.84"	-2.52"	0.12"
4% 24-HR	6.48'	6.23'	-3.00"	-1.08"	-2.16"	0.24"
4% 48-HR	6.62'	6.4'	-2.64"	-0.96"	-2.04"	0.36"
1% 24-HR	7.34'	7.17'	-2.04"	-0.72"	-1.80"	0.72"
1% 48-HR	7.57'	7.43'	-1.68"	-0.48"	-1.68"	0.96"

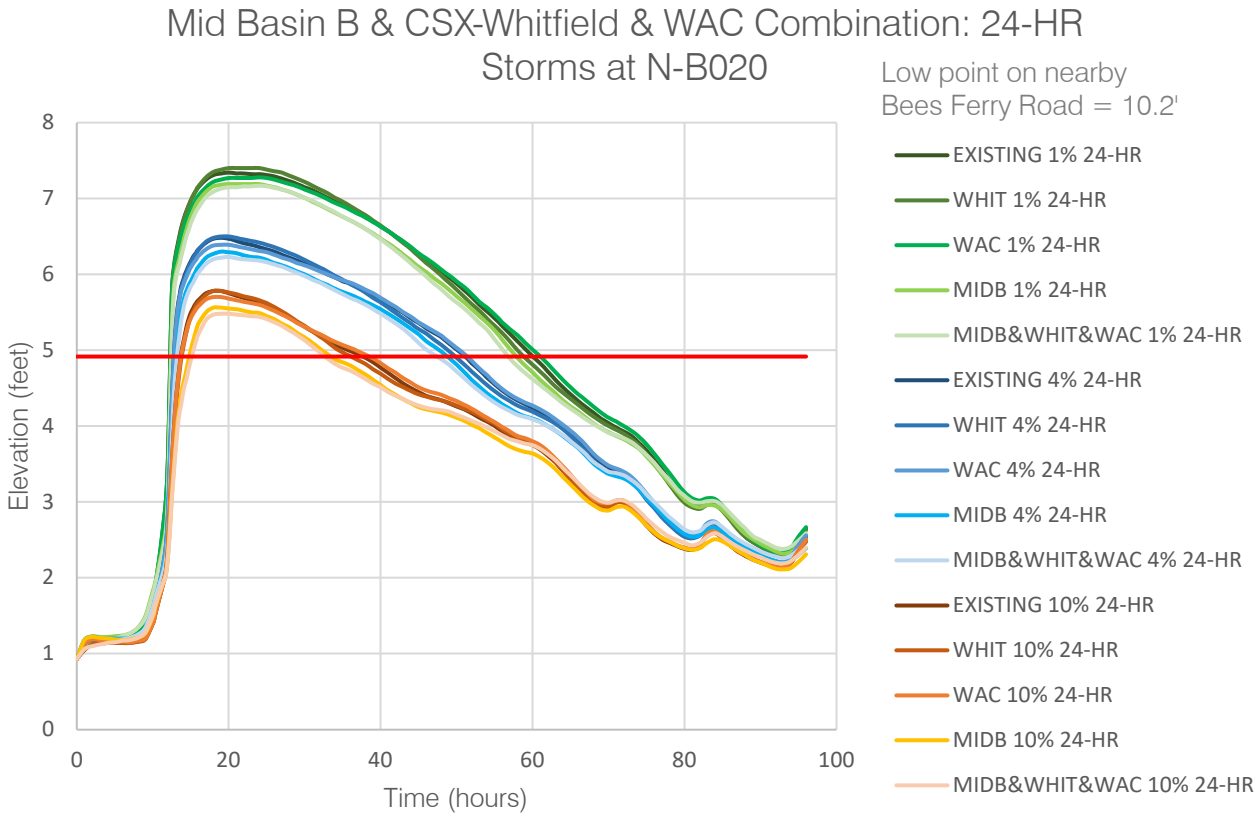

Figure 30 - Hydrograph at Node B020 for CSX-Whitfield Channel, Mid-Basin and West Ashley Circle Storage Facilities

7.2.5 *Overall Comparison of Combined Scenarios*

The Church Creek Drainage Basin model predicts there will be positive impacts to the peak staging and period of inundation for Church Creek by implementing combinations of improvements. The most beneficial set of improvements are the West Ashley Circle and Mid Basin Storage Facilities. These two improvements combined are predicted to net a greater decrease in the peak staging elevation during the 1% storms than other improvements and will decrease the period of inundation experienced in the mid basin area. Combinations including the CSX-Whitfield Channel are not predicted to improve the peak staging elevation, however, the greatest reduction of inundation time is predicted for the

combination of West Ashley Circle Storage Facility, Mid Basin Storage Facility, and CSX-Whitfield Channel. See Tables 17 and 18 for detailed data for the change in water surface elevation and the period of inundation; a negative number indicates a net decrease and a positive number indicates a net increase.

Table 17 - Total increase or decrease of water surface elevation at Node B020 during peak staging.

At N-B020		Maximum Δ in Water Surface Elevation (in) between Pre- and Post-Improvement								
Storm Event		Mid Basin A	Mid Basin B	Mid Basin C	WAC	CSX-Whit.	Mid - WAC	Mid - Whit	WAC - Whit.	Mid - WAC - Whit.
24-HR	10%	-1.20	-2.76	-4.80	-0.96	-0.12	-3.36	-2.28	-0.48	-3.72
	4%	-1.08	-2.16	-3.96	-1.08	0.24	-3.24	-2.16	-0.36	-3.00
	1%	-0.84	-1.80	-2.64	-0.72	0.72	-2.52	-2.16	0.12	-2.04
48-HR	10%	-1.08	-2.52	-4.20	-0.84	0.12	-3.24	-2.16	-0.24	-3.36
	4%	-0.96	-2.04	-3.60	-0.96	0.36	-3.00	-2.16	-0.24	-2.64
	1%	-0.84	-1.68	-2.16	-0.48	0.96	-2.16	-2.16	-0.48	-1.68

Table 18 - Total increase or decrease of inundation period at Node B020.

At N-B020		Difference (hr) between Pre- and Post-Improvement for Recovery Time								
Storm Event		Mid Basin A	Mid Basin B	Mid Basin C	WAC	CSX-Whit.	Mid - WAC	Mid - Whit	WAC - Whit.	Mid - WAC - Whit.
24-HR	10%	-2	-4	-4	1	-2	-3	-5	-1	-6
	4%	-3	-3	-2	1	-2	-1	-4	-1	-4
	1%	-1	-3	<-1	1	-2	-1	-3	0	-4
48-HR	10%	-2	-5	-3	1	-1	-3	-5	-1	-6
	4%	-1	-3	-2	2	-1	-1	-3	0	-4
	1%	-1	-3	<-1	1	-2	-1	-3	-1	-3

8.0 CONCLUSIONS AND RECOMMENDATIONS

Through the modeling efforts, specific conclusions were drawn about both the effectiveness of the proposed improvements and the affects the implementation of those improvements are predicted to have on the Church Creek Drainage Basin. From those conclusions Weston & Sampson developed recommendations for the City to consider moving forward for both stormwater capital improvements and additional improvement types that should be explored further.

Weston & Sampson also developed a prioritization tool to score and identify recommended improvements. The prioritization tool used specific criterion for evaluating the effectiveness of the stormwater improvements and a formula developed by the improvement team. The results for all model scenarios were entered into the formula and assigned a prioritization score. Those prioritization scores were compared, and the highest scoring improvements recommended for implementation. The prioritization score formula is as follows:

$$Prioritization\ Score = \frac{10 \times (\sum pWSE_{max} - \sum nWSE_{max})}{A} + pN_0 + \Delta t + U + M$$

where,
A = area of improvement extents in acres
$\sum pWSE_{max}$ = Sum of the maximum positive water surface elevation changes
$\sum nWSE_{max}$ = Sum of the maximum negative water surface elevation changes
pN_0 = Net number of positively impacted nodes (∑pN - ∑nN, sum of positively impacted nodes minus the sum of negatively impacted nodes)
Δt = Total change in time (hours) the water surface elevation is above flood stage
U = Potential for beneficial use beyond stormwater storage/conveyance
M = Maintainability after construction

The beneficial use and maintainability scores were assigned on a 0 to 5 scale designated by specific criteria. The beneficial use scoring criteria are as follows:

0 = No additional benefits.
1 = Provides little to no additional benefits and is not easily implemented.
2 = Provides additional benefits but is not easily implemented.
3 = Provides additional benefits and can be implemented.
4 = Provides mixed use benefits and can be implemented.
5 = Provides mixed use benefits and is easily implemented.

The maintainability scoring criteria are as follows:

0 = Substantial maintenance required and very difficult to access.
1 = Difficult to maintain due to lack of access.
2 = Substantial amount of maintenance required.
3 = Requires some maintenance and has easy access.
4 = Minimal maintenance, easy to maintain and easy access.
5 = Little to no maintenance required after initial construction.

The complete tables for the prioritization scores for the 10%, 4%, and 1%, 24-hour storms can be found in Appendix E. The Mid Basin Storage Facility is the only stormwater improvement recommended, with Option B being the most highly prioritized, followed by Option C and lastly Option A. The West Ashley Circle Storage Facility and combinations including the West Ashley Circle Storage Facility are not

recommended for implementation due to the diminishing returns on improvements for flooding and increase of inundation times. The CSX-Whitfield Channel and combinations with the CSX-Whitfield Channel were not recommended for implementation as it has not been found to function as storage. Further description can be found in section 8.1.1 and 8.1.2.

8.1 Conclusions

8.1.1 West Ashley Circle and Mid Basin Storage Facilities

During the modeling of the West Ashley Circle and the Mid Basin Storage Facilities it was apparent that the location of the storage facility is key to its effectiveness. The Mid Basin Storage Facility is predicted to provide a greater reduction in the WSE at peak staging than the West Ashley Circle Storage Facility despite their similar sizes and capacities. The difference in improvements is significant enough that when the hydrographs of the individual and combined scenarios during the 10%, 24-hour storm are compared, the decrease in staging expected for the Mid Basin Storage Facility is more than twice that of the West Ashley Circle Storage Facility and the composite of Mid Basin and WAC storage facilities only nets an additional 0.6 inches compared to the Mid Basin Storage Facility alone, an approximate 21% increase.

The differences between the West Ashley Circle and Mid Basin Storage Facility impacts are due to the location of the storage. The West Ashley Circle Storage Facility was modeled to receive flows from the immediately surrounding areas of West Ashley Circle. These areas, while inundated with water during storm events, are not a major source of flow to the Church Creek. The Mid Basin Storage Facility location in comparison provides immediate relief at a point in the creek that is immediately downstream of the convergence for Bees Ferry Rd drainage and the main Church Creek channel. The flood bench allows the creek to swell in that area and reduce the tailwater effects further upstream. The larger the area that can be excavated to form a flood bench, the greater the impact will be to the water surface elevation.

Finally, Weston & Sampson analyzed the duration of inundation by comparing the ground elevation of the channel immediately adjacent to the selected nodes with the hydrograph. The length of time the water surface elevation spent above the elevation of the surrounding ground surface is predicted to decrease by two to four hours for the Mid Basin Storage Facility while it is predicted to increase by one to two hours for the West Ashley Circle Storage Facility. Further, the combination of the West Ashley Circle and Mid Basin Storage Facilities is predicted to decrease the period of inundation by one to three hours. The increase in the inundation time for the West Ashley Circle Storage Facility is due to its distance from the Church Creek channel which increases the time of concentration for the outfall flows. Therefore, due to diminishing returns and increase of inundation times at multiple nodes, the West Ashley Circle Storage Facility or any combinations including the West Ashley Storage Facility are not recommended as part of this study.

8.1.2 CSX-Whitfield Channel

The CSX-Whitfield Channel was modeled several different ways as each method of development used in the model proved to be less beneficial than desired. The model predicts that the CSX-Whitfield channel has no positive impact on the Church Creek Drainage Basin as a whole and during 1% storms it is predicted to have a negative impact on the peak staging elevation. The modeling attempts included two-way flow at the outfall to allow Church Creek to flow into the channel as well as flap gates at the outfall to provide one-way flow out of the channel. Both proved to be unsuccessful because the volume of flow reaching the outfall of the CSX-Whitfield channel is predicted to stage higher than the creek itself. Further the peak flow is predicted to reach the outfall of the CSX-Whitfield channel at approximately the

same rate Church Creek peaks during a storm event thus adding stormwater to the creek at a time it is most critical to remove and hold flow. The channel was also modeled with an adjacent storage facility and control structures to help slow down the hydraulics of the channel; these proved successful in slowing down the water, but not enough to counter the negative impacts to Church Creek. Therefore, the CSX-Whitfield Channel and any combination including the CSX-Whitfield Channel are not recommended as part of this study. Further modeling, which was beyond the scope of this study, may include retaining the water in an area of wetlands behind the existing WalMart and directing the flow out the southwest portion of the basin away from Church Creek.

8.2 Recommendations

Based upon the conclusions Weston & Sampson deduced during the study, recommendations were developed for the City's consideration. These recommendations are based on discussions between Weston & Sampson and City staff regarding the goals for mitigating flooding within the Church Creek Drainage Basin.

The following is recommended by Weston & Sampson.

1. The Mid-Basin Storage Facility Option B is recommended to be considered for design. The flood bench as modeled is predicted to provide a measurable benefit within the mid basin area of Church Creek. During design and land acquisition negotiations, the modeled storage facility should be further refined to determine to what extent additional positive impacts could be realized by increasing the area of the flood benches. Lastly, this improvement also has the potential benefit of creating multi-use land if the design explores the opportunities for incorporating recreational areas, thoughtfully planned walkways, and educational placards. The flood bench could function as a green space incorporating flood-resilient landscaping and walkways or as a constructed wetland incorporating linear park features and select vegetative species.
2. The West Ashley Circle Storage Facility is not recommended to be considered for design as proposed. Further study of the facility that includes a pumping system to reduce the water surface elevation ahead of large storm events and the use of a control structure to retain the stormwater for longer periods of time may produce some benefit downstream, however, due to its position in the basin, it is not expected to yield significant results. Preliminary calculations show that the pond could hold approximately 3.5 million gallons per foot. The pumping capacity would be dictated by the number of feet and period of time desired for pumping ahead of the storm. Table 19 shows the flow rate in gallons per minute (gpm) required for variable volumes and time frames. The table cells shaded gray are flow rates that should not be considered for this application. If a pumping system is selected, care and consideration should be given to designing the discharge infrastructure to ensure adequate dissipation of energy and distribution of flow so as not to negatively impact the downstream receiving ditches and channels. Preliminary modeling showed that by lowering the WAC Storage Facility water surface elevation by two feet, the effect at Node-B020 was a peak staging of 6.33' during the 4% AEP, 24-hour storm and 7.25' during the 1% AEP, 24-hour storm. The difference between the peak water surface elevation with and without staging down the WAC Storage Facility two feet is approximately 3/4" and 3/8" for the 4% and 1% AEP storms, respectively.

Table 19 - West Ashley Circle Storage Facility pumping capacities based on volume and time

Pumping Capacity in gpm Required for WSE Reduction for Periods of Time					
WSE Reduction	6 hours	8 hours	12 hours	18 hours	24 hours
1 foot	9,955	7,467	4,978	3,319	2,489
2 feet	19,911	14,933	9,955	6,637	4,978
3 feet	29,865	22,401	14,934	9,955	7,467

3. The CSX-Whitfield Channel is not recommended to be considered for design at this time. The channel is predicted to not be useful for storage and in fact has a negative impact on the Church Creek water surface elevation during significant storm events. The CSX-Whitfield Channel could, however, serve well as a means of conveying stormwater to the southwest portions of the drainage basin from the mid-basin area. Further study and modeling, including modeling of the drainage basins west of the Church Creek Basin, would be required.
4. It is recommended that the City continue to look for storage opportunities within proximity of Church Creek and its main conveyance channels. Providing water with a place to go during significant rain events will continue to help reduce the level of flooding experienced by property owners within the drainage basin. The convergence of waters at the mid basin area should be slowed to the greatest extent possible especially in areas north of Bees Ferry Road.
5. It is recommended that the City continue to study and improve the hydrology and hydraulics of the Church Creek Drainage Basin by following low impact water management principles: slow it down, spread it out, let it soak in, and store it. Once all effective and environmentally sustainable water management improvements have been incorporated into the Church Creek Drainage Basin, “hard engineering” solutions, like a stormwater pump station, should be considered and studied.

9.0 REFERENCES

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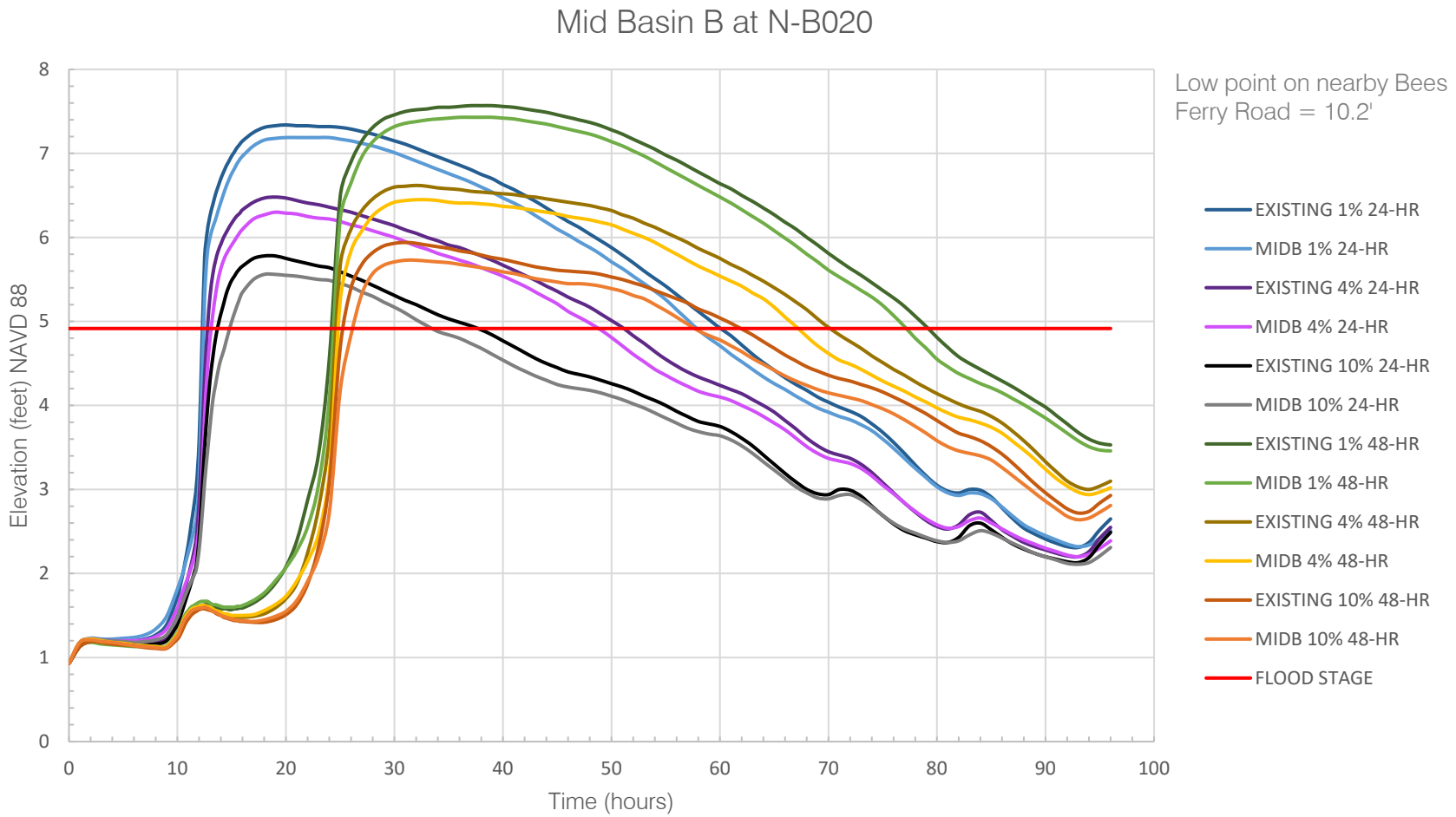
APPENDIX A

Hydrographs for N-A120, N-B020, & N-B160


Mid Basin B at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet) NAVD 88
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
MIDB 1% 24-HR
EXISTING 4% 24-HR
MIDB 4% 24-HR
EXISTING 10% 24-HR
MIDB 10% 24-HR
EXISTING 1% 48-HR
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EXISTING 4% 48-HR
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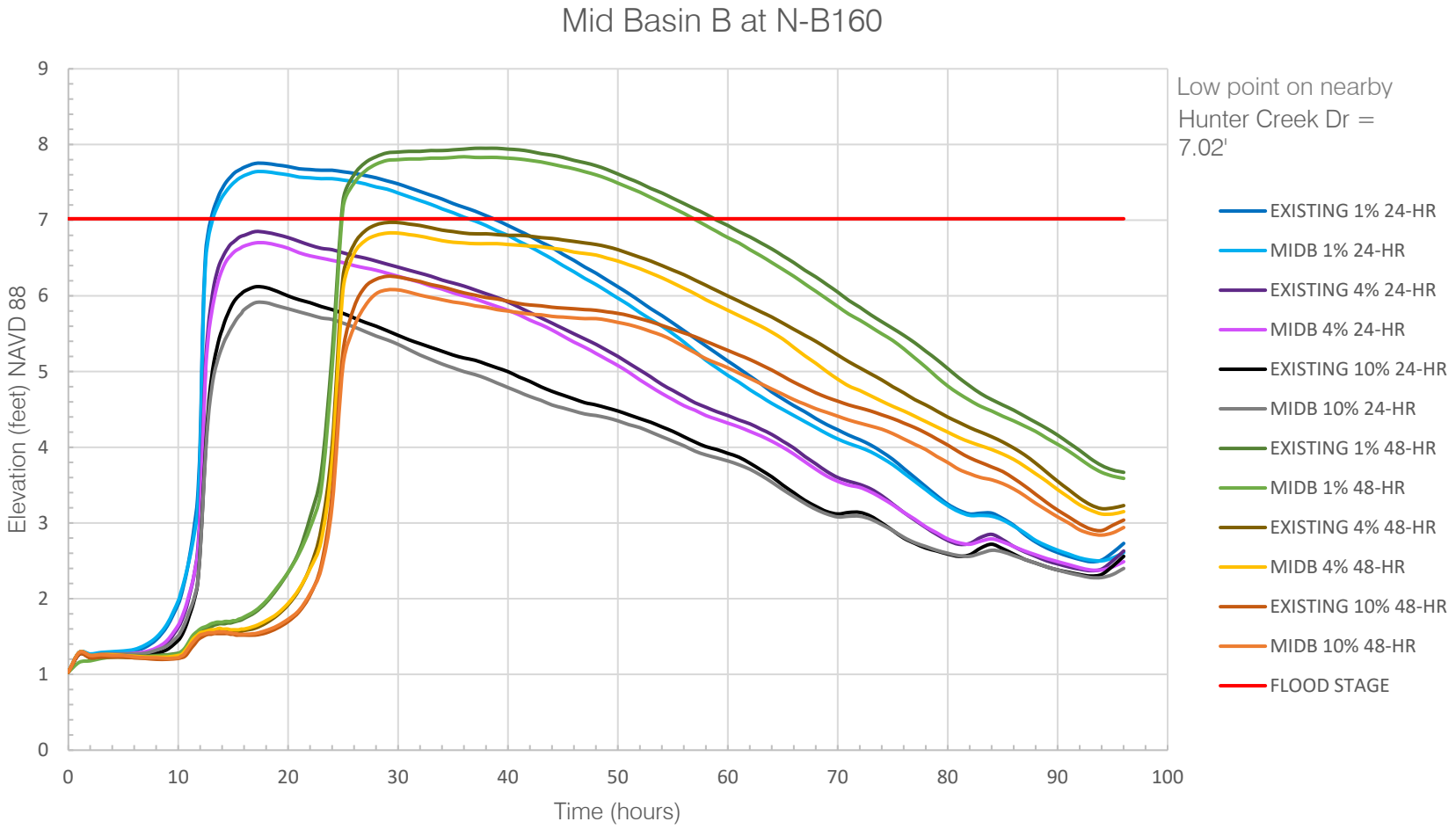
MIDB 10% 48-HR
FLOOD STAGE


Mid Basin B at N-B160
Elevation (feet) NAVD 88
Time (hours)
0
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2
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6
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10
20
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40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 24-HR
MIDB 1% 24-HR
EXISTING 4% 24-HR
MIDB 4% 24-HR
EXISTING 10% 24-HR
MIDB 10% 24-HR
EXISTING 1% 48-HR
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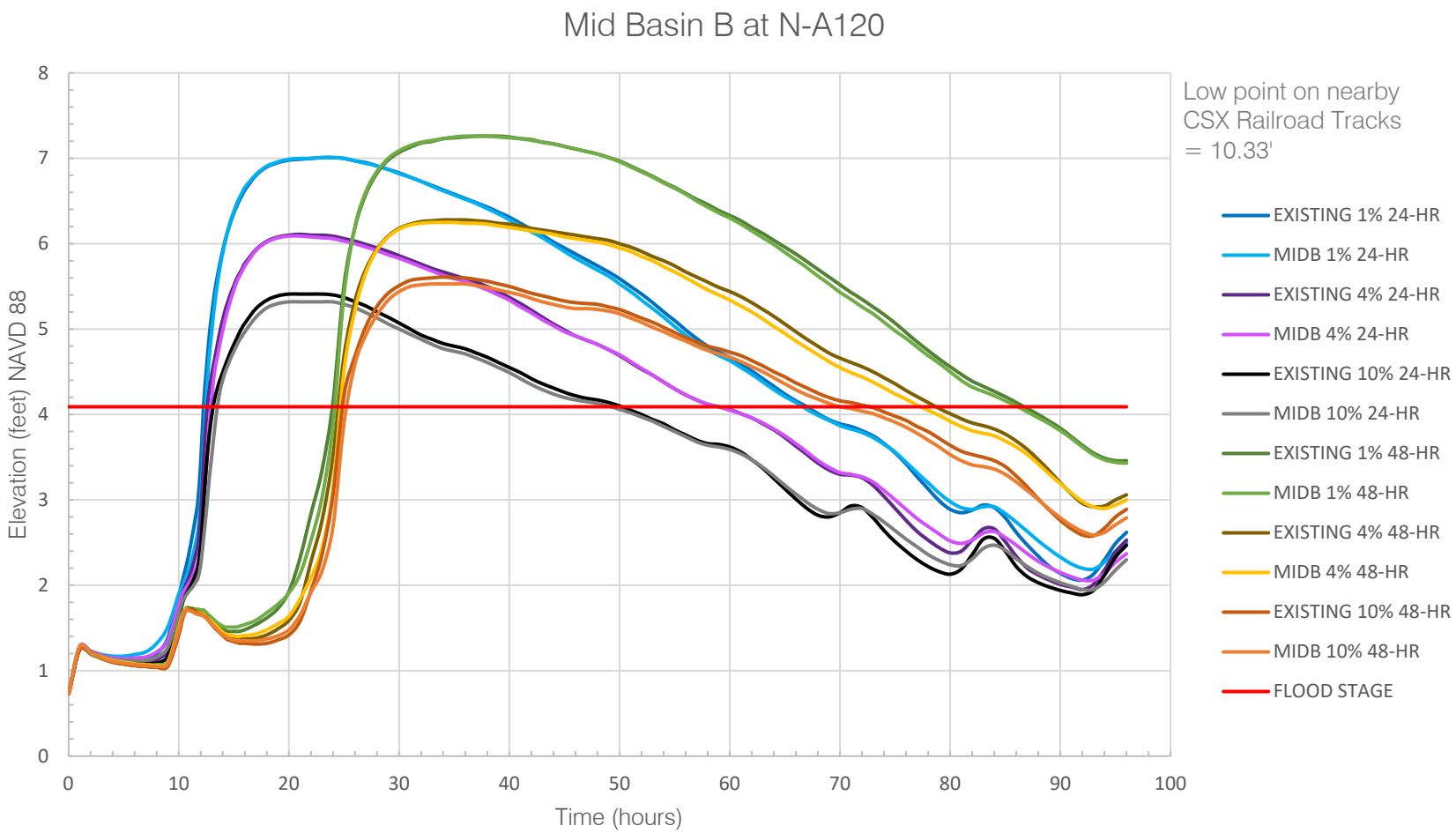
MIDB 10% 48-HR
FLOOD STAGE


Mid Basin B at N-A120
Elevation (feet) NAVD 88
Time (hours)
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7
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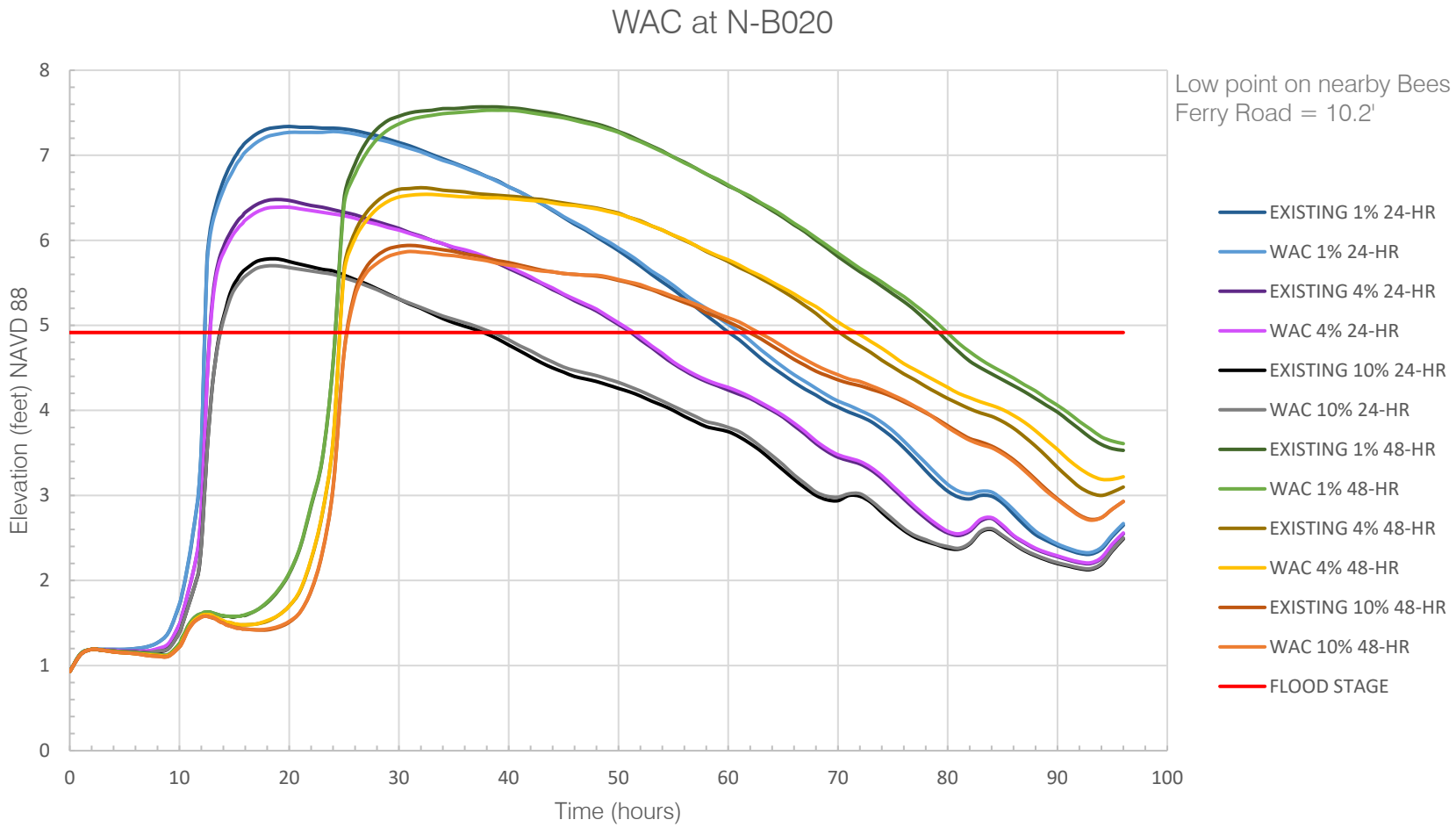
60
70
80
90
100
Low point on nearby
CSX Railroad Tracks
= 10.33'
EXISTING 1% 24-HR
MIDB 1% 24-HR
EXISTING 4% 24-HR
MIDB 4% 24-HR
EXISTING 10% 24-HR
MIDB 10% 24-HR
EXISTING 1% 48-HR
MIDB 1% 48-HR
EXISTING 4% 48-HR
MIDB 4% 48-HR
EXISTING 10% 48-HR
MIDB 10% 48-HR
FLOOD STAGE


WAC at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet) NAVD 88
Time (hours)
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5
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30
40
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60
70
80
90
100
EXISTING 1% 24-HR
WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
EXISTING 1% 48-HR
WAC 1% 48-HR
EXISTING 4% 48-HR
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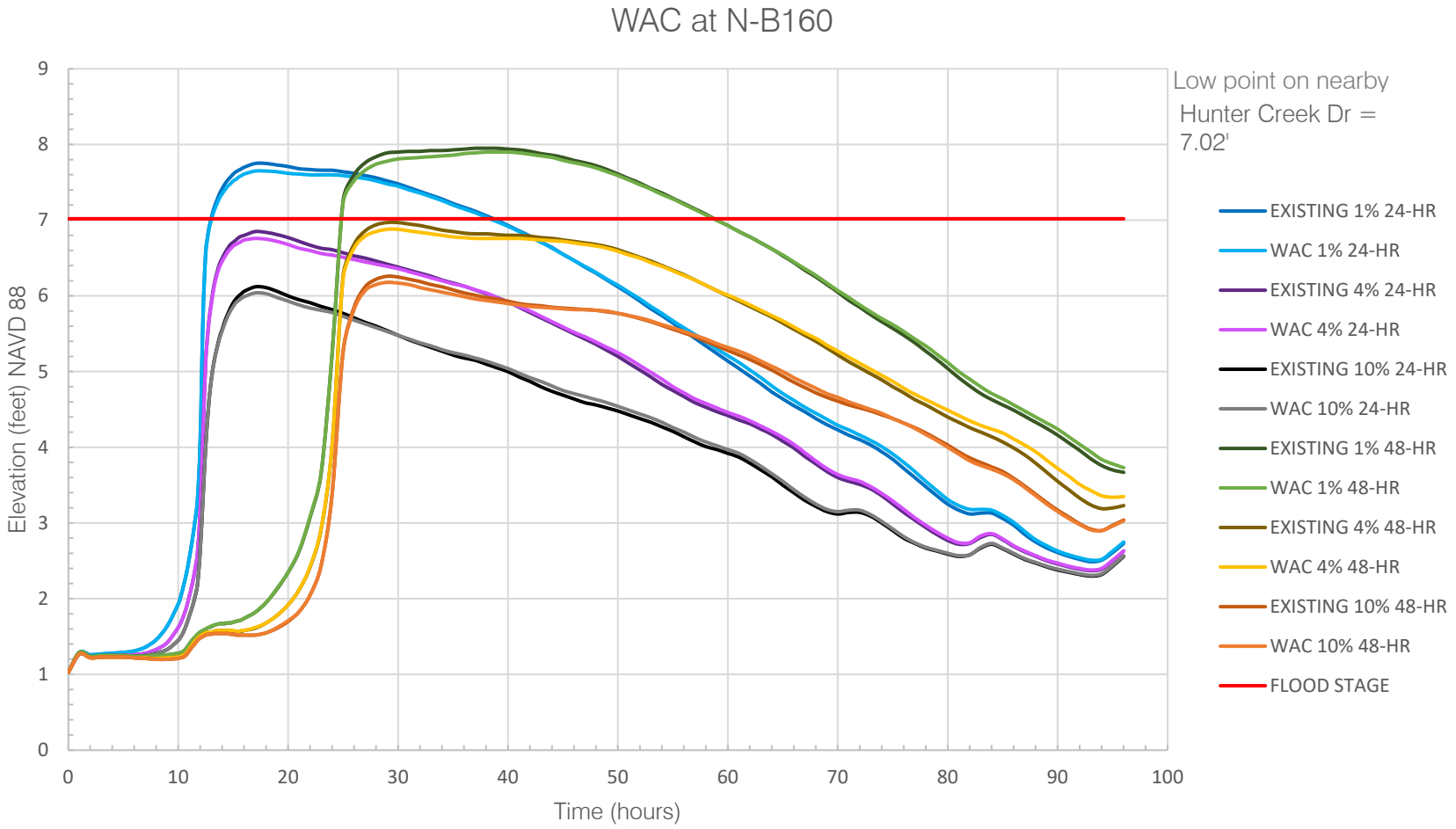
EXISTING 10% 48-HR
WAC 10% 48-HR
FLOOD STAGE


WAC at N-B160
Low point on nearby Hunter Creek Dr = 7.02'
Elevation (feet) NAVD 88
Time (hours)
0
1
2
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4
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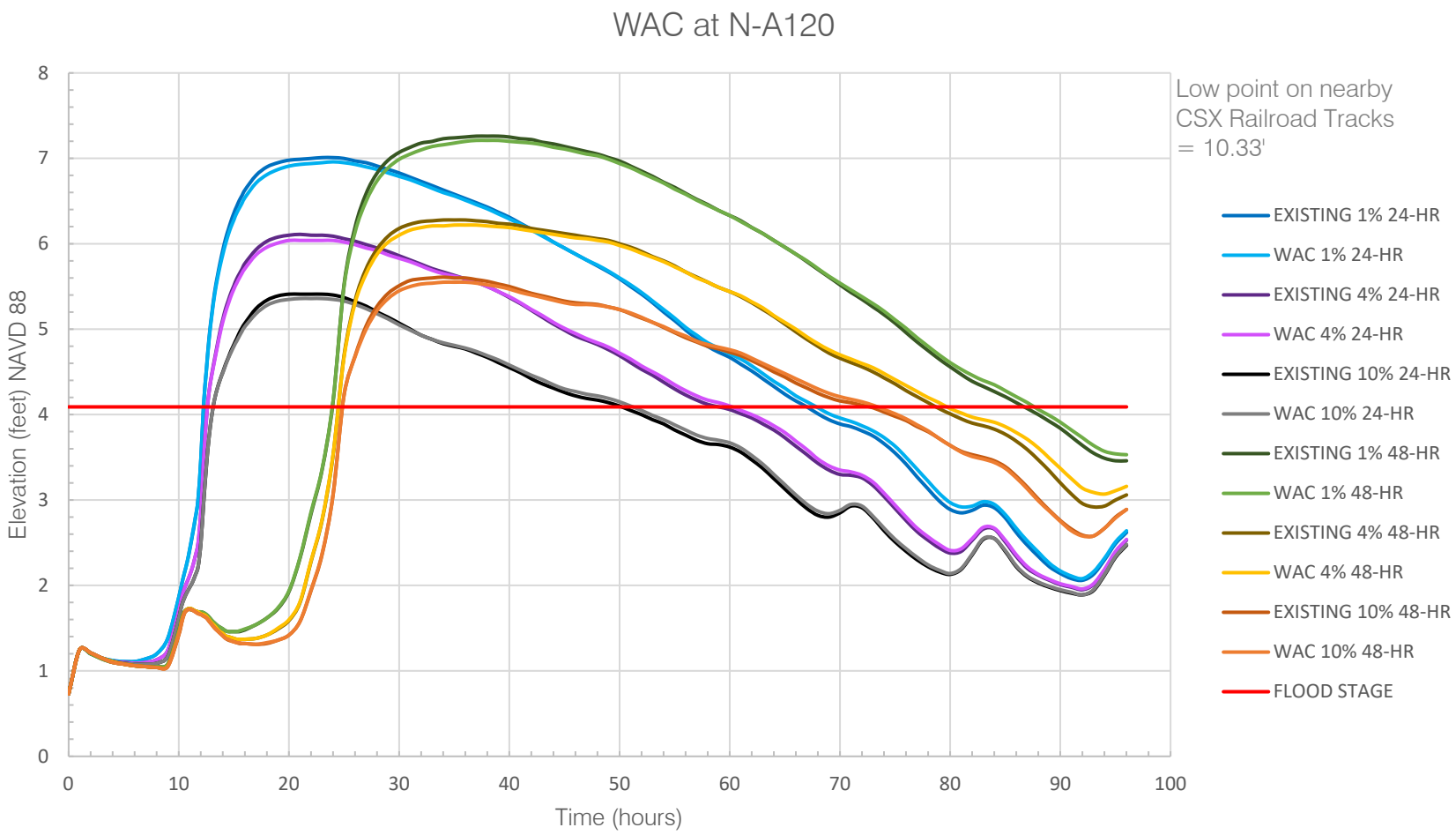
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
EXISTING 1% 48-HR
WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
FLOOD STAGE


WAC at N-A120
Elevation (feet) NAVD 88
Time (hours)
0
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8
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10
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30
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70
80
90
100
Low point on nearby
CSX Railroad Tracks
= 10.33'
EXISTING 1% 24-HR
WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
EXISTING 1% 48-HR
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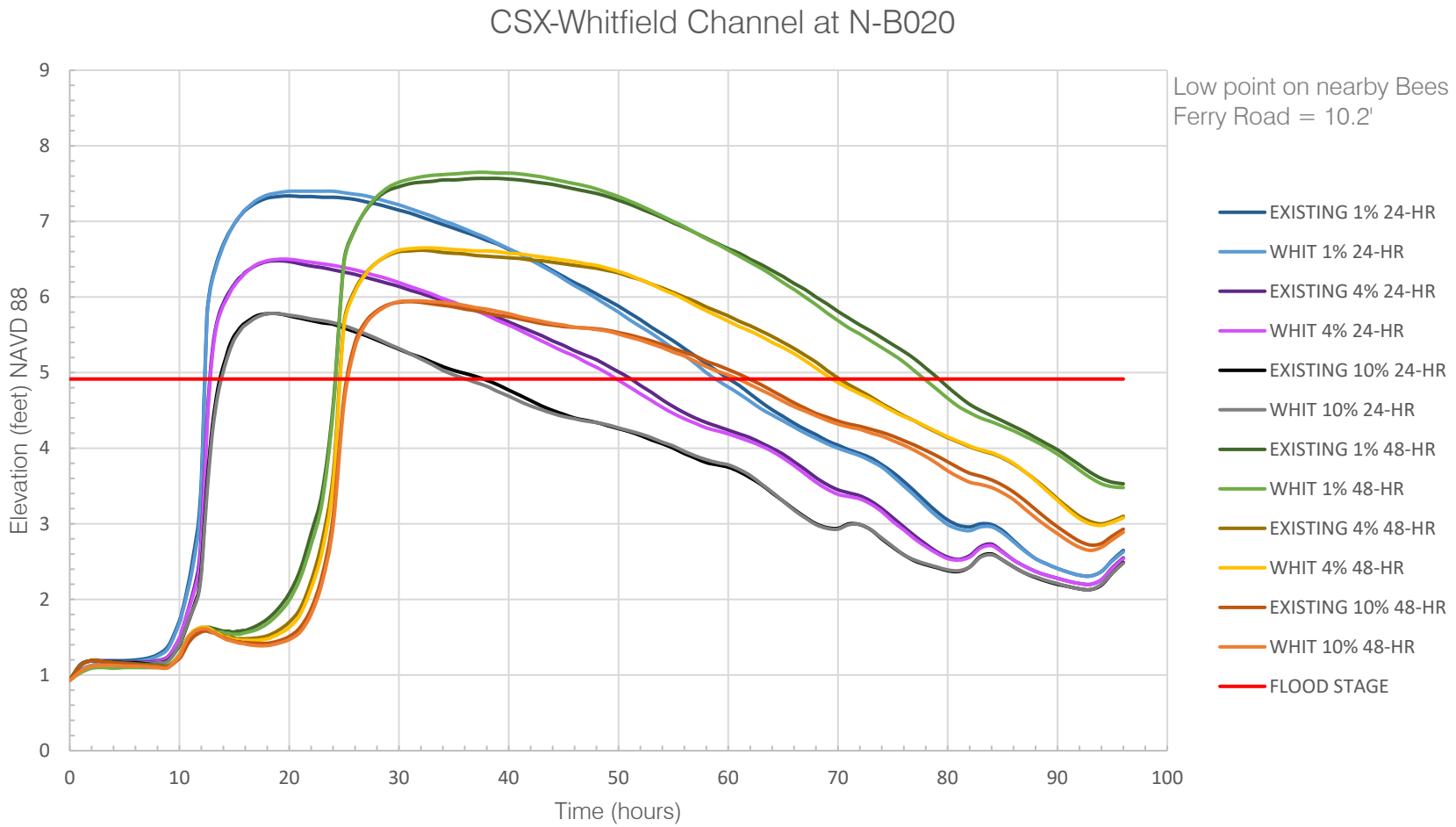
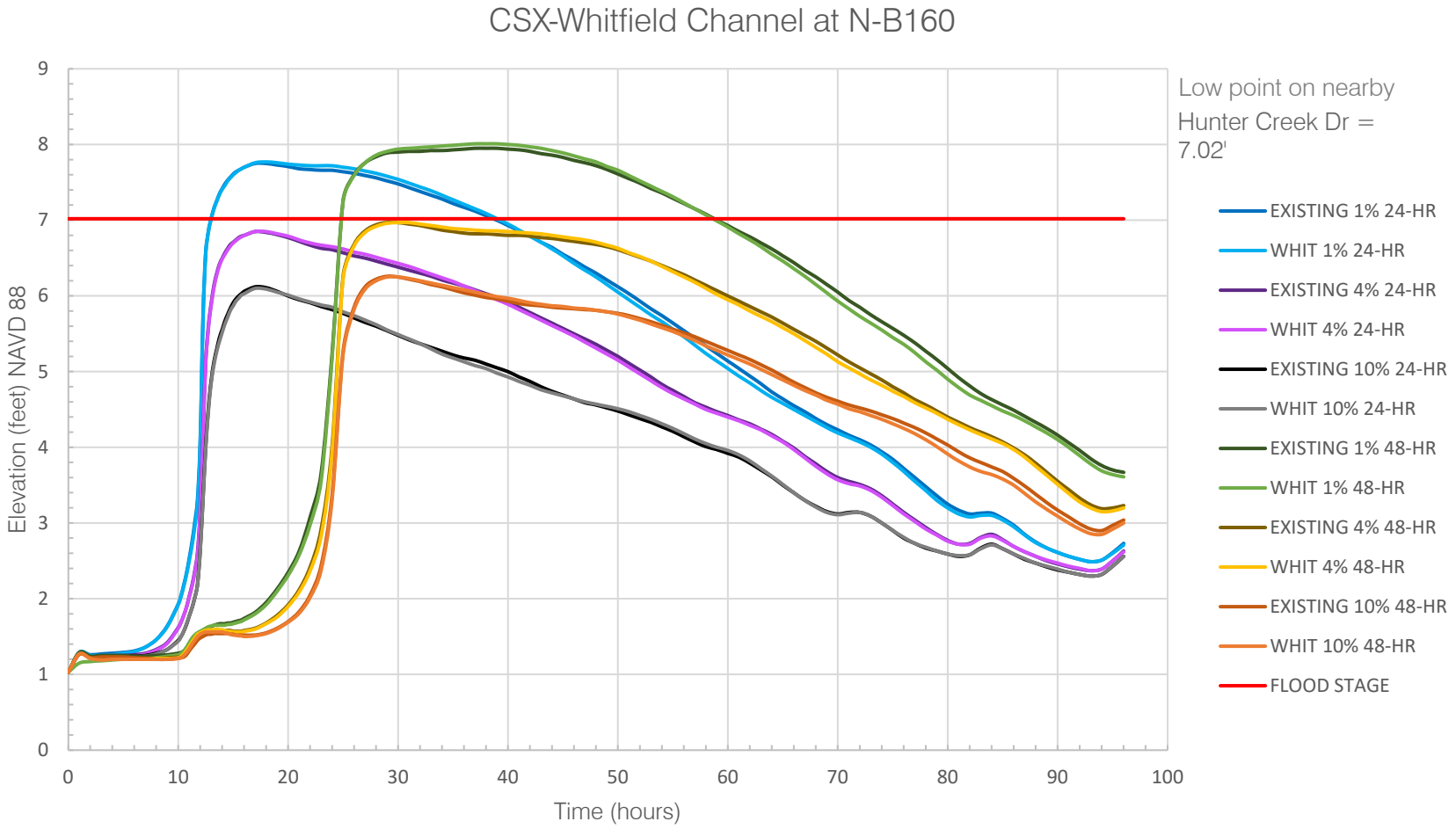
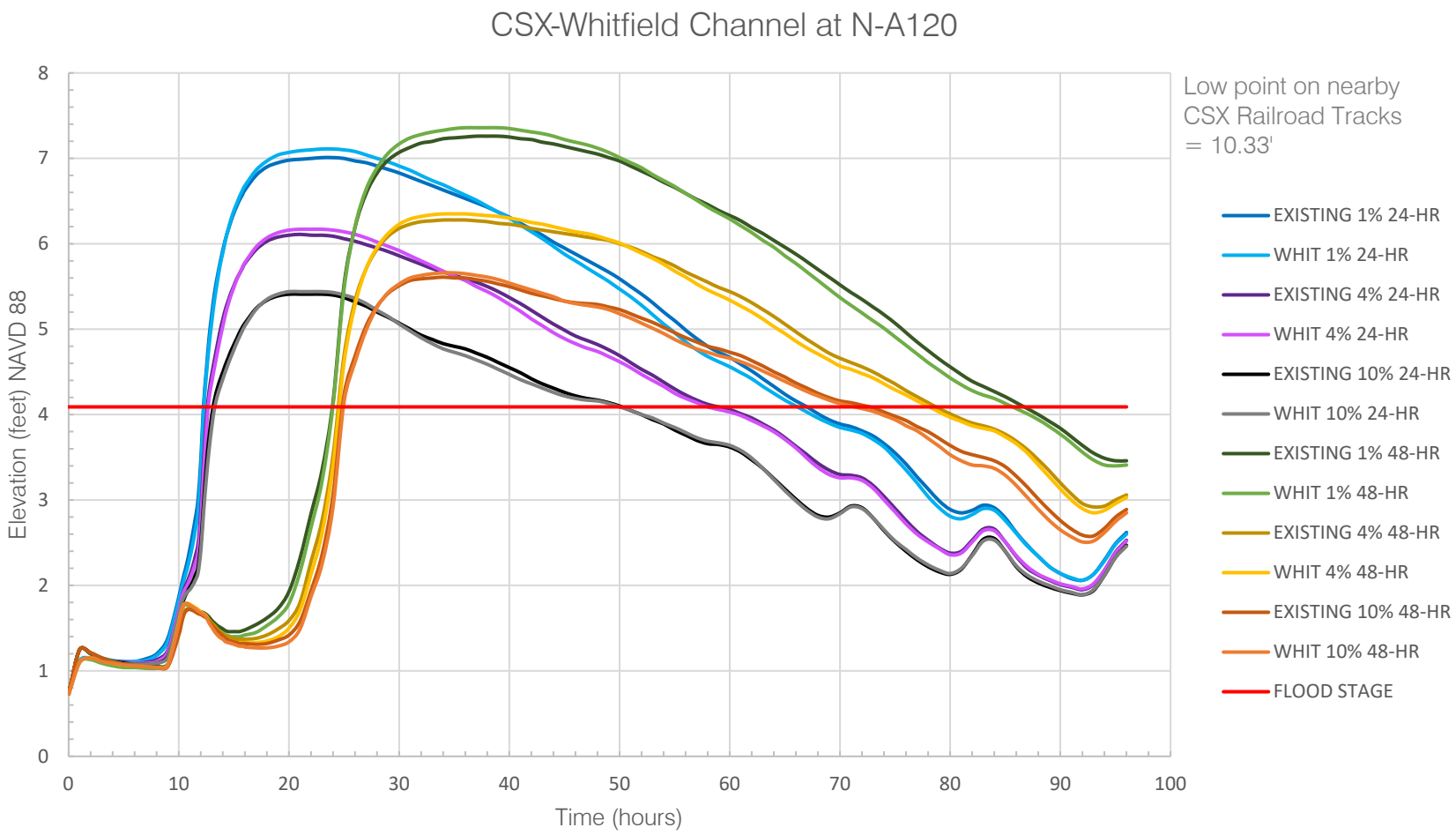
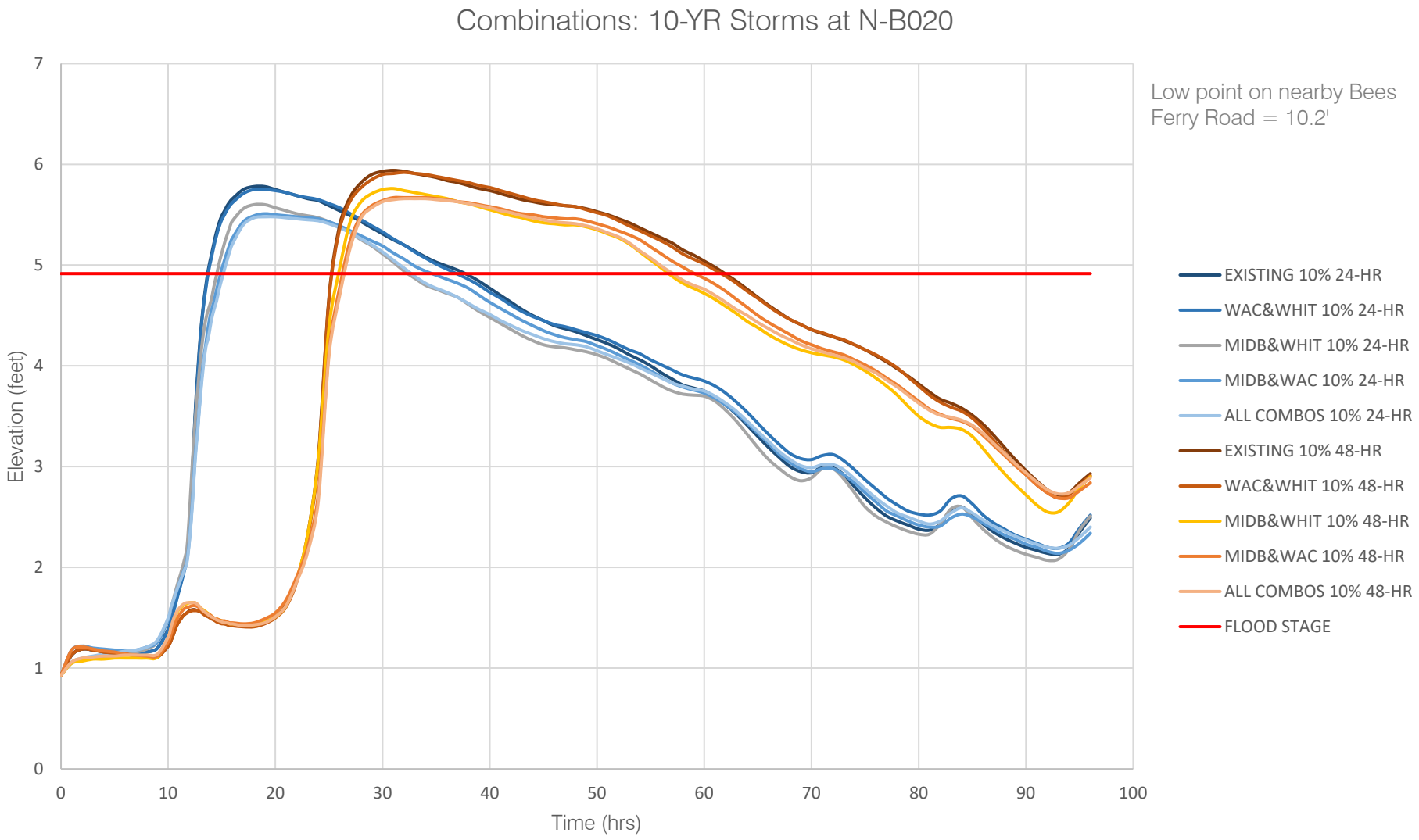
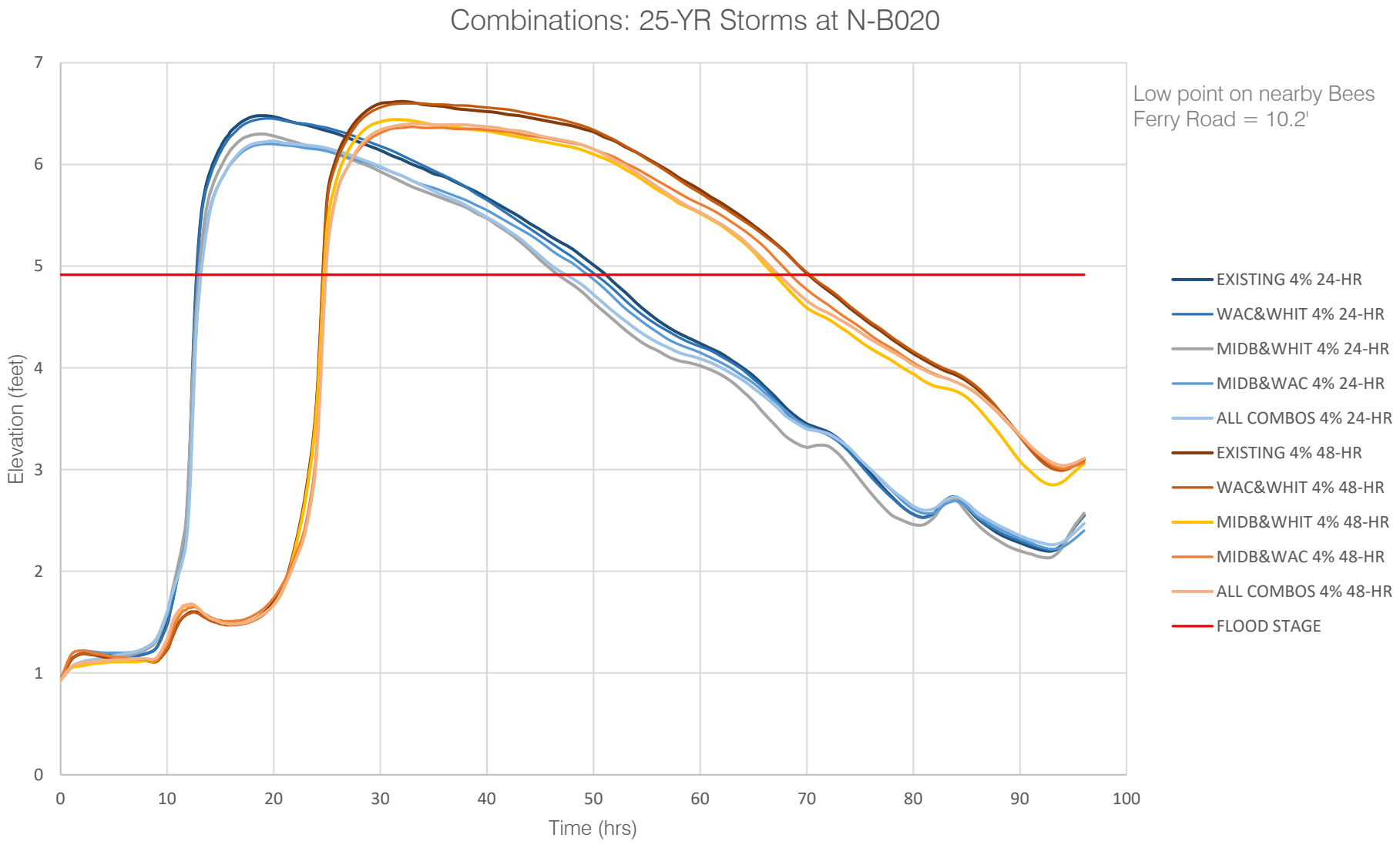
EXISTING 4% 48-HR
WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
FLOOD STAGE

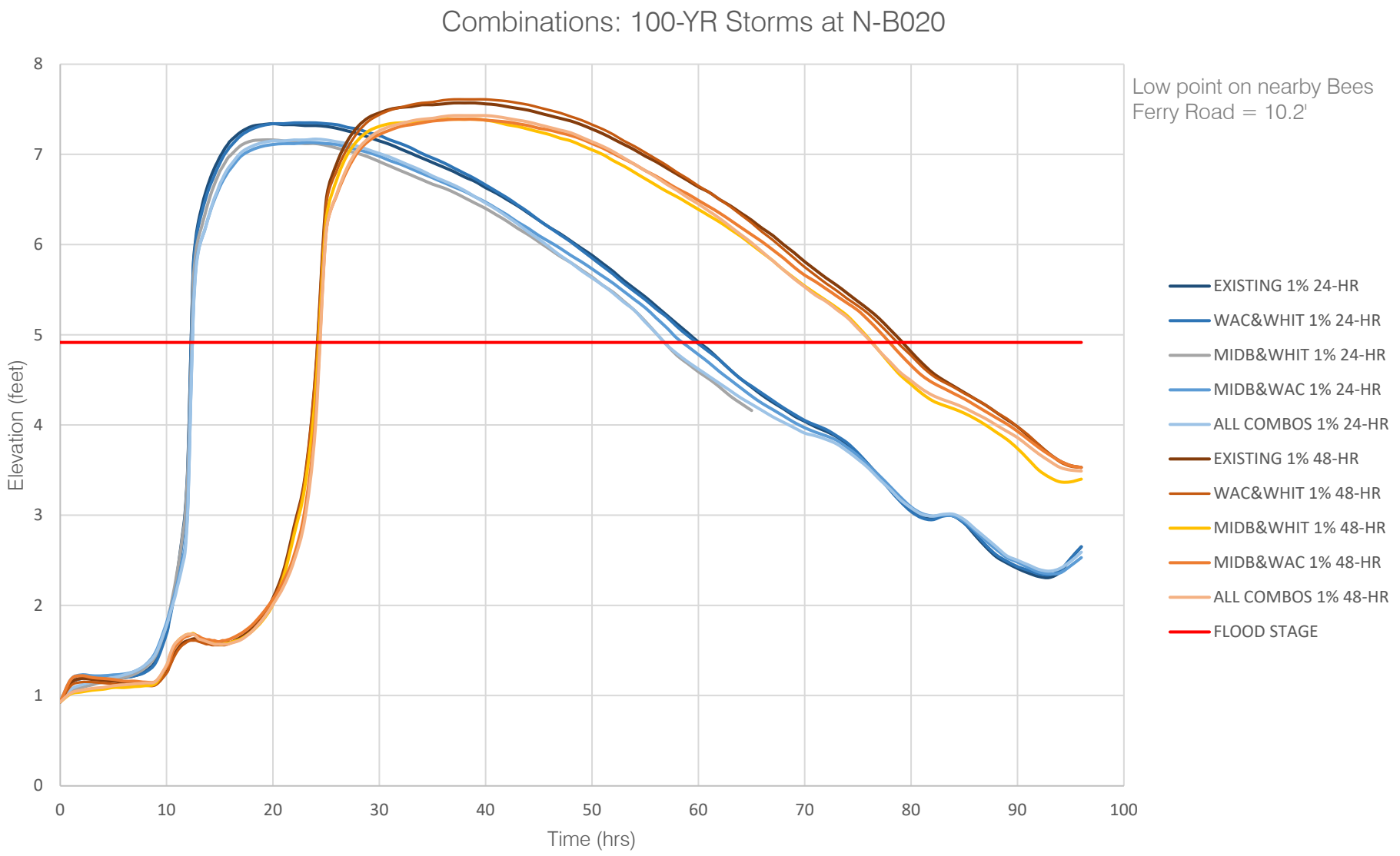

CSX-Whitfield Channel at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet) NAVD 88
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WHIT 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
EXISTING 1% 48-HR
WHIT 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
FLOOD STAGE

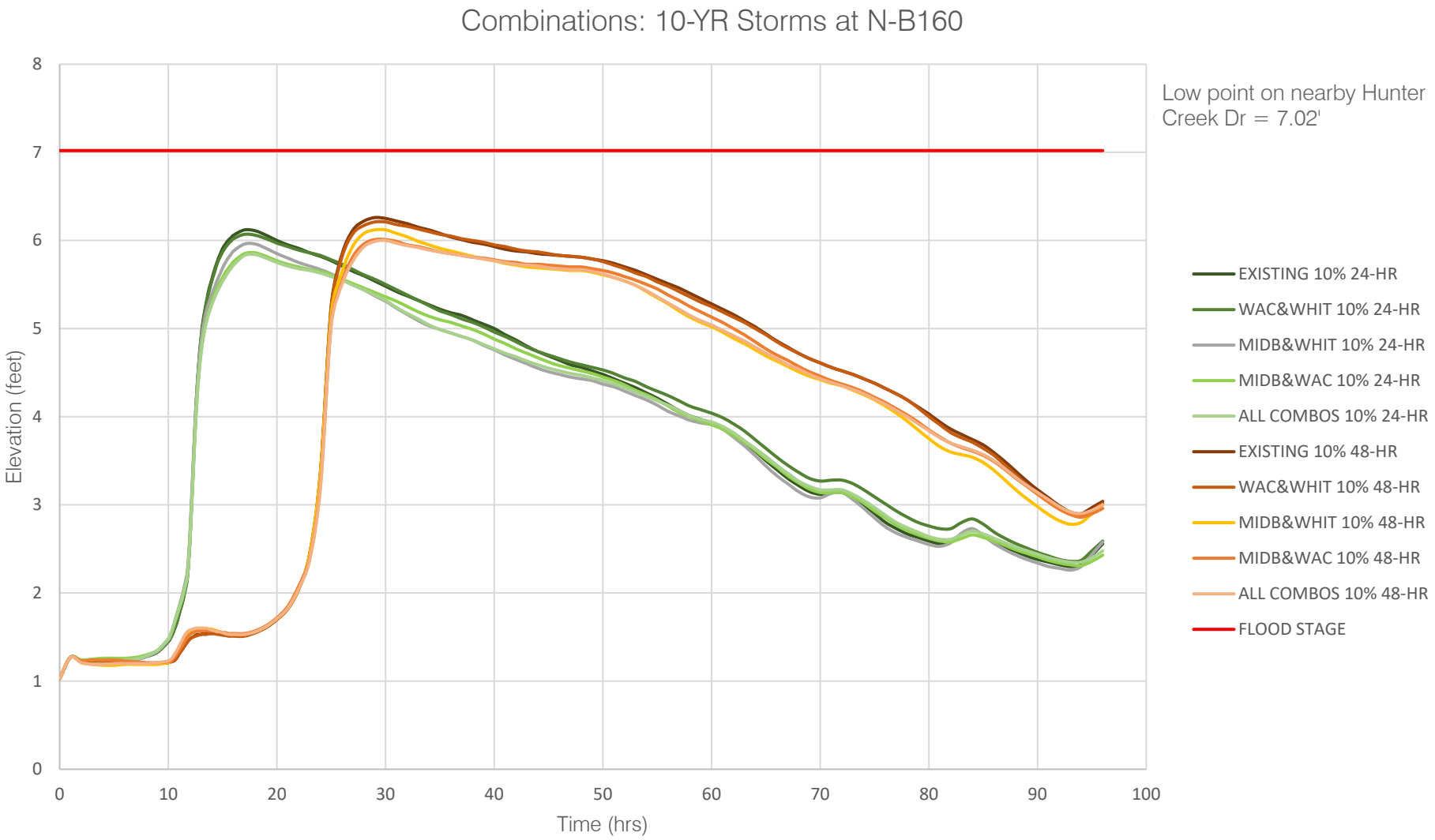

CSX-Whitfield Channel at N-B160
Elevation (feet) NAVD 88
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 24-HR
WHIT 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
EXISTING 1% 48-HR
WHIT 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
FLOOD STAGE

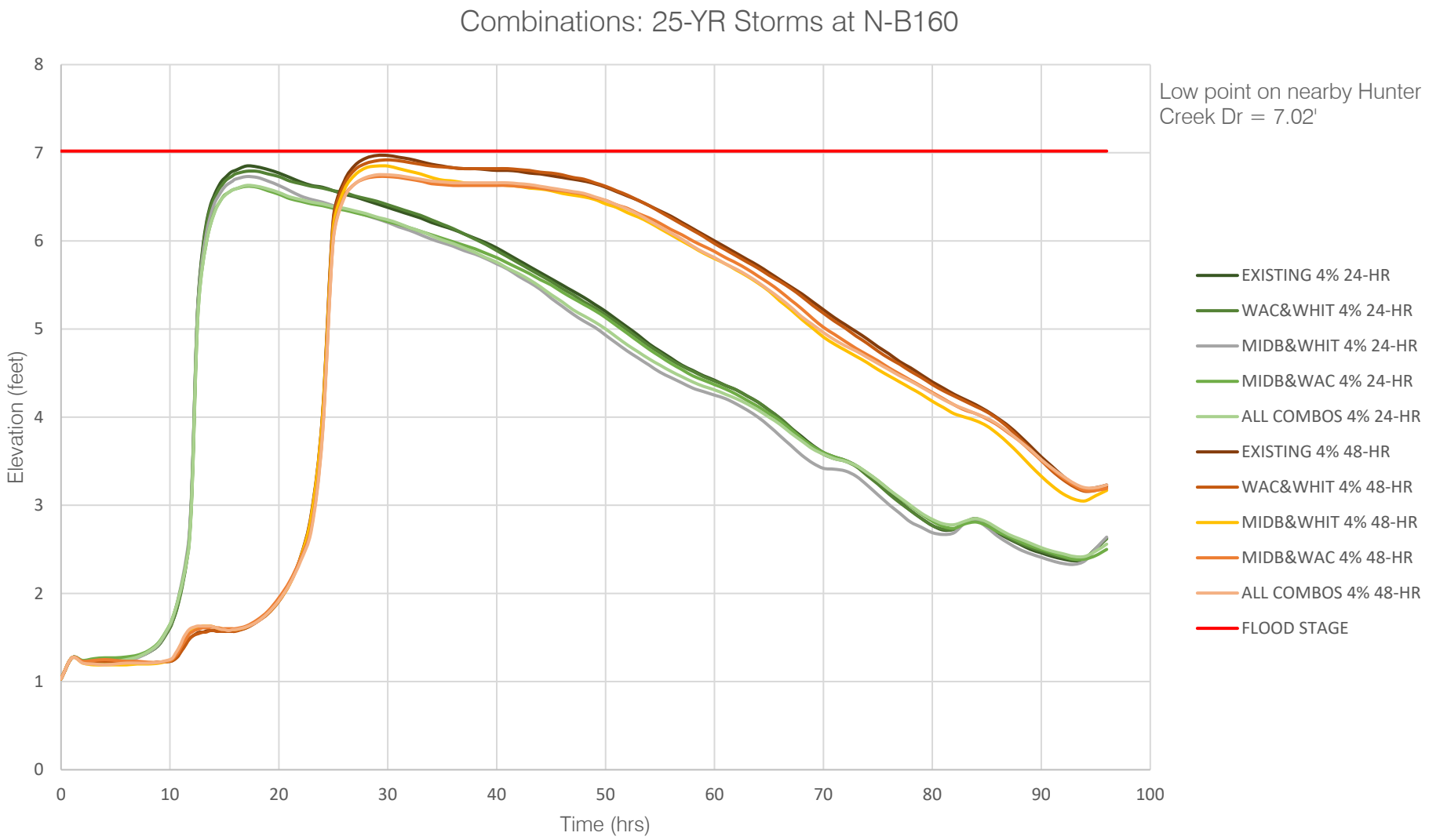

CSX-Whitfield Channel at N-A120
Elevation (feet) NAVD 88
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby
CSX Railroad Tracks
= 10.33'
EXISTING 1% 24-HR
WHIT 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
EXISTING 1% 48-HR
WHIT 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
FLOOD STAGE

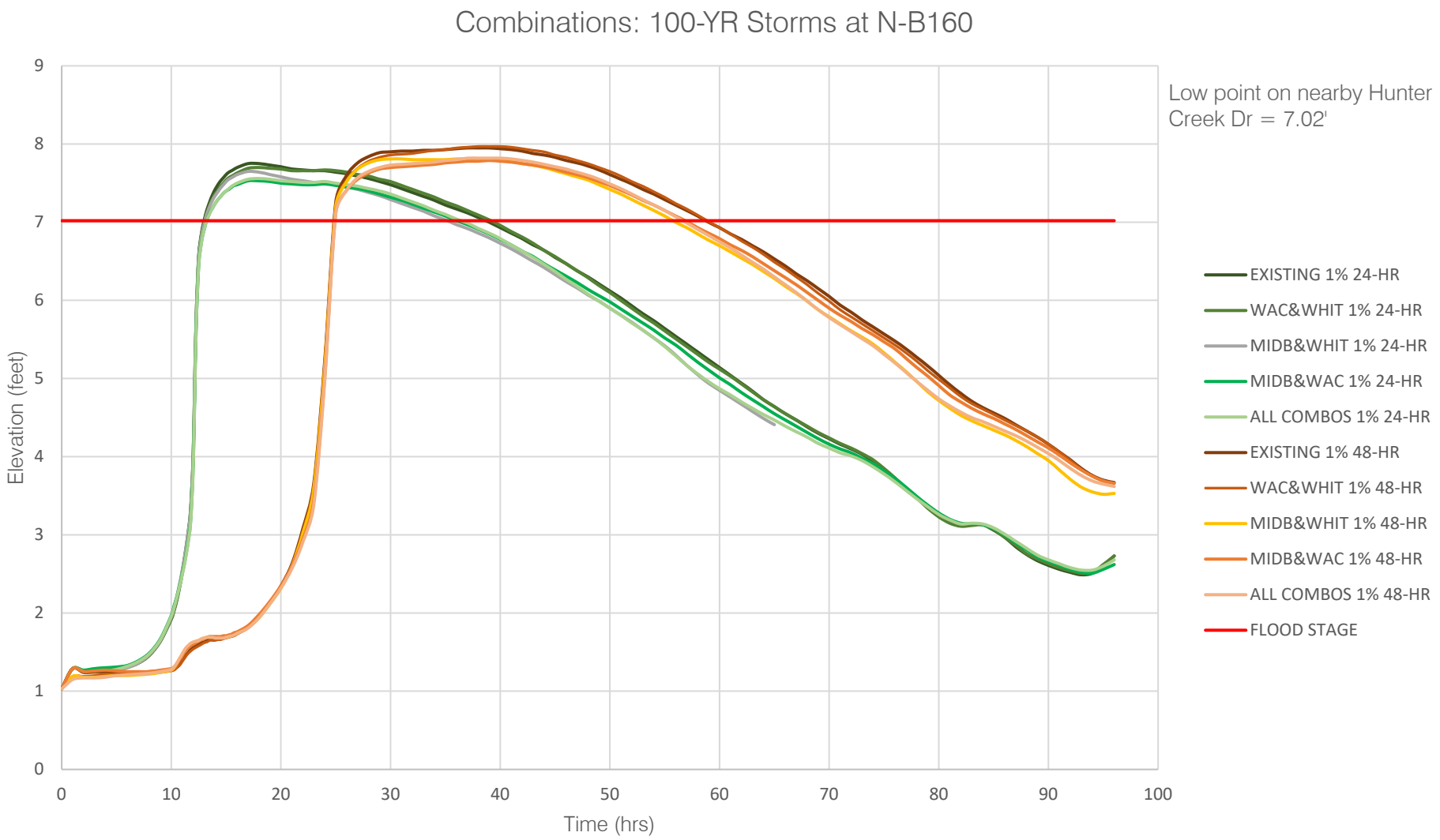

Combinations: 10-YR Storms at N-B020
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Bees Ferry Road = 10.2'
EXISTING 10% 24-HR
WAC&WHIT 10% 24-HR
MIDB&WHIT 10% 24-HR
MIDB&WAC 10% 24-HR
ALL COMBOS 10% 24-HR
EXISTING 10% 48-HR
WAC&WHIT 10% 48-HR
MIDB&WHIT 10% 48-HR
MIDB&WAC 10% 48-HR
ALL COMBOS 10% 48-HR
FLOOD STAGE

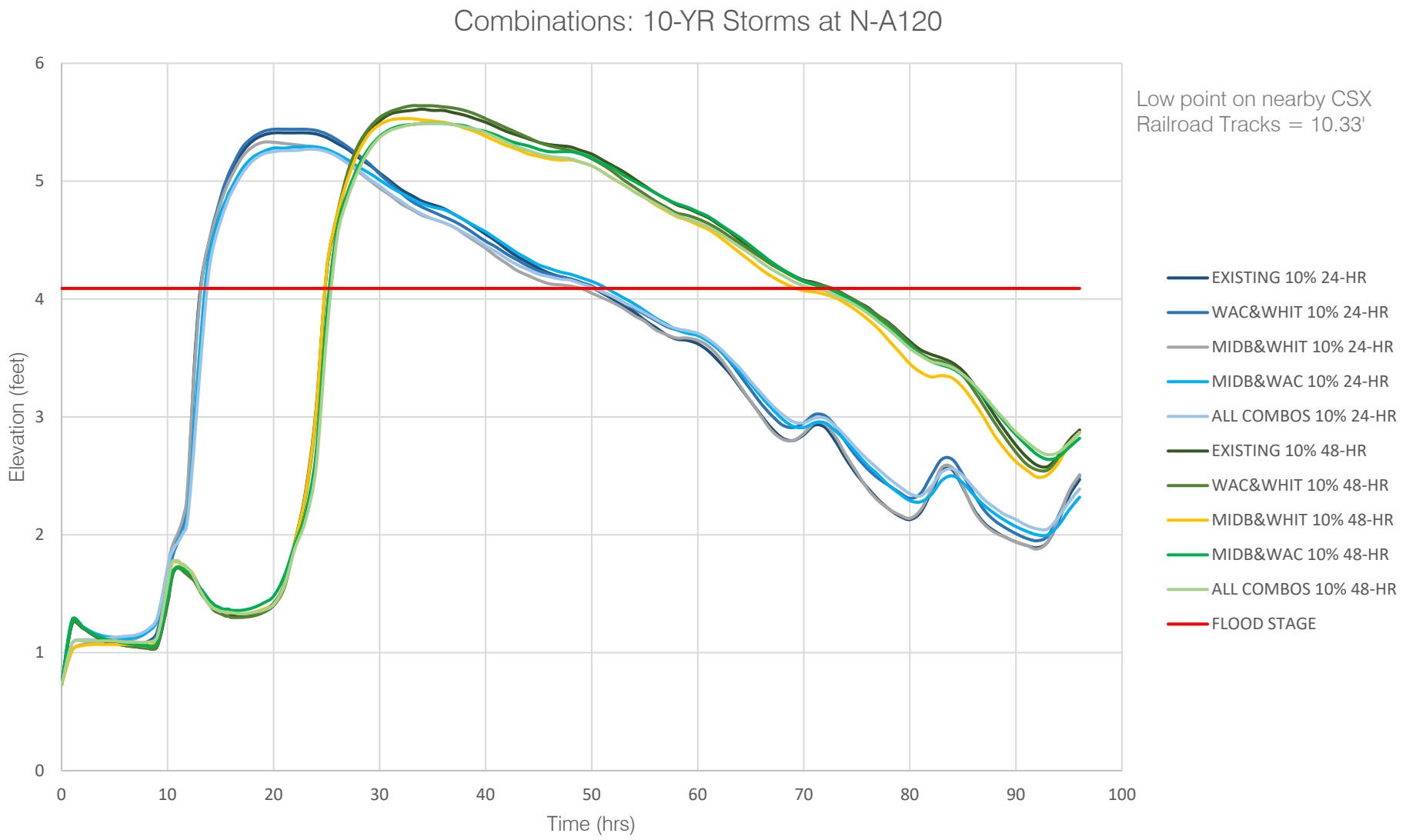

Combinations: 25-YR Storms at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100
EXISTING 4% 24-HR
WAC&WHIT 4% 24-HR
MIDB&WHIT 4% 24-HR
MIDB&WAC 4% 24-HR
ALL COMBOS 4% 24-HR
EXISTING 4% 48-HR
WAC&WHIT 4% 48-HR
MIDB&WHIT 4% 48-HR
MIDB&WAC 4% 48-HR
ALL COMBOS 4% 48-HR
FLOOD STAGE

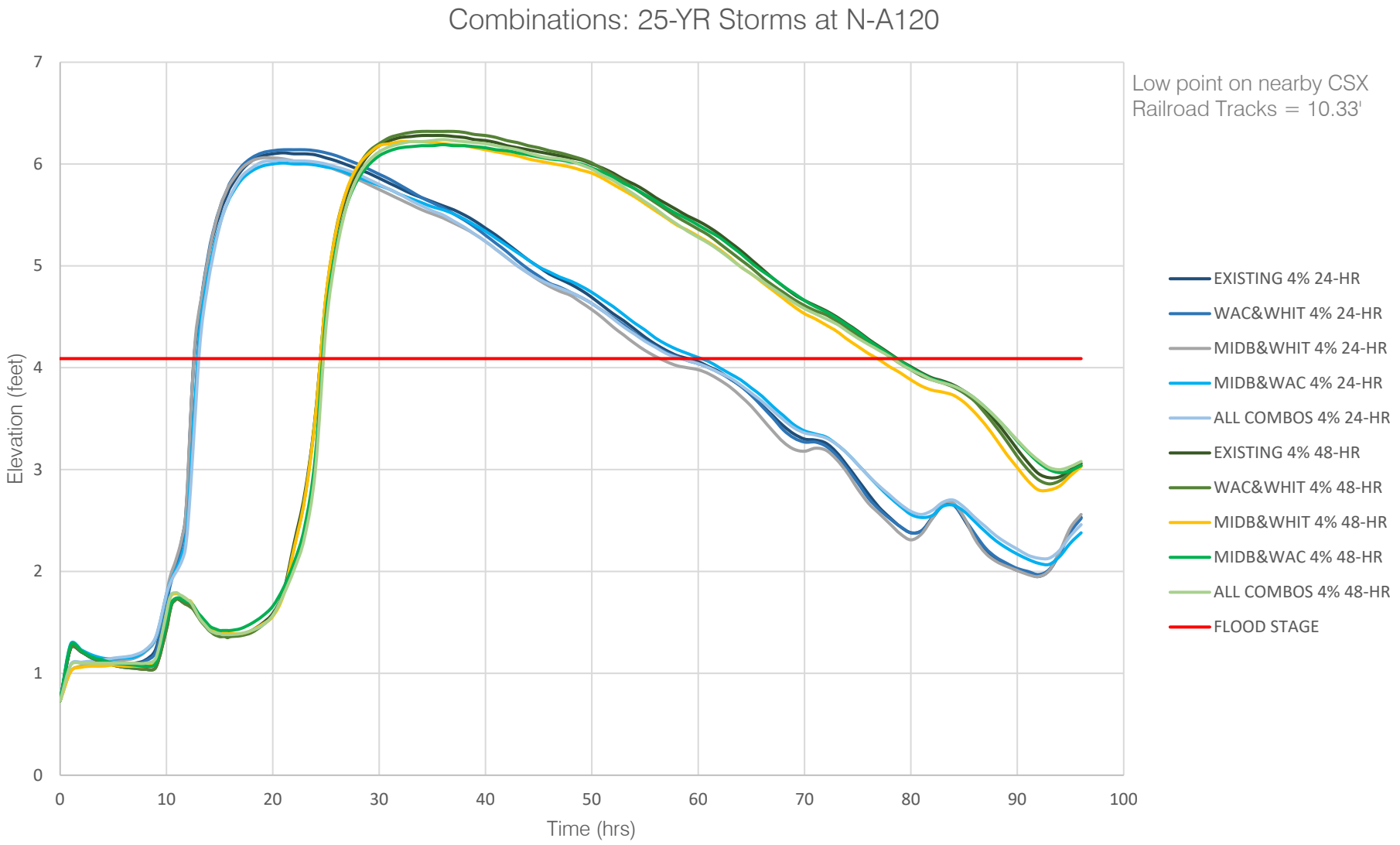

Combinations: 100-YR Storms at N-B020
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Bees Ferry Road = 10.2'
EXISTING 1% 24-HR
WAC&WHIT 1% 24-HR
MIDB&WHIT 1% 24-HR
MIDB&WAC 1% 24-HR
ALL COMBOS 1% 24-HR
EXISTING 1% 48-HR
WAC&WHIT 1% 48-HR
MIDB&WHIT 1% 48-HR
MIDB&WAC 1% 48-HR
ALL COMBOS 1% 48-HR
FLOOD STAGE

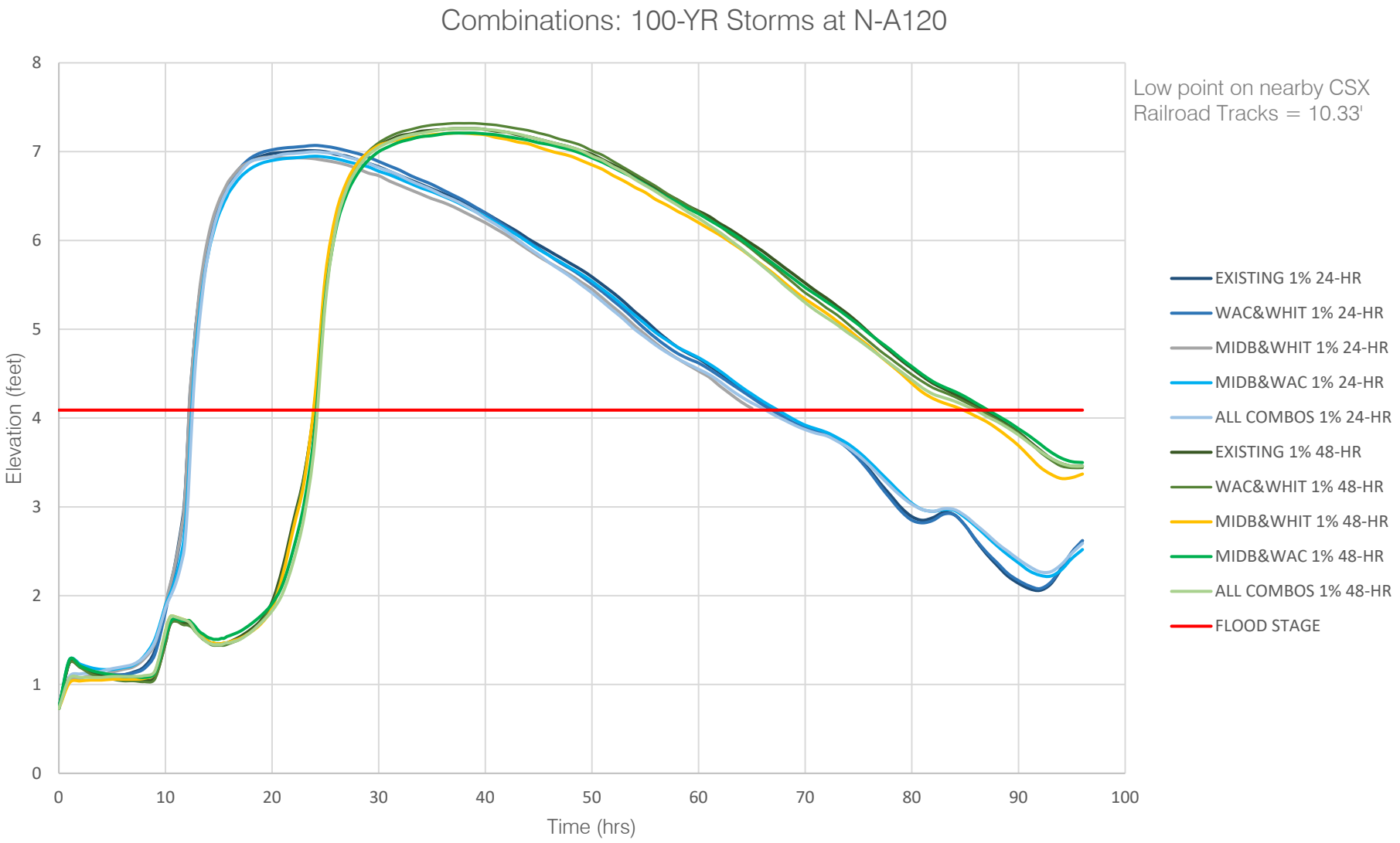

Combinations: 10-YR Storms at N-B160
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 10% 24-HR
WAC&WHIT 10% 24-HR
MIDB&WHIT 10% 24-HR
MIDB&WAC 10% 24-HR
ALL COMBOS 10% 24-HR
EXISTING 10% 48-HR
WAC&WHIT 10% 48-HR
MIDB&WHIT 10% 48-HR
MIDB&WAC 10% 48-HR
ALL COMBOS 10% 48-HR
FLOOD STAGE

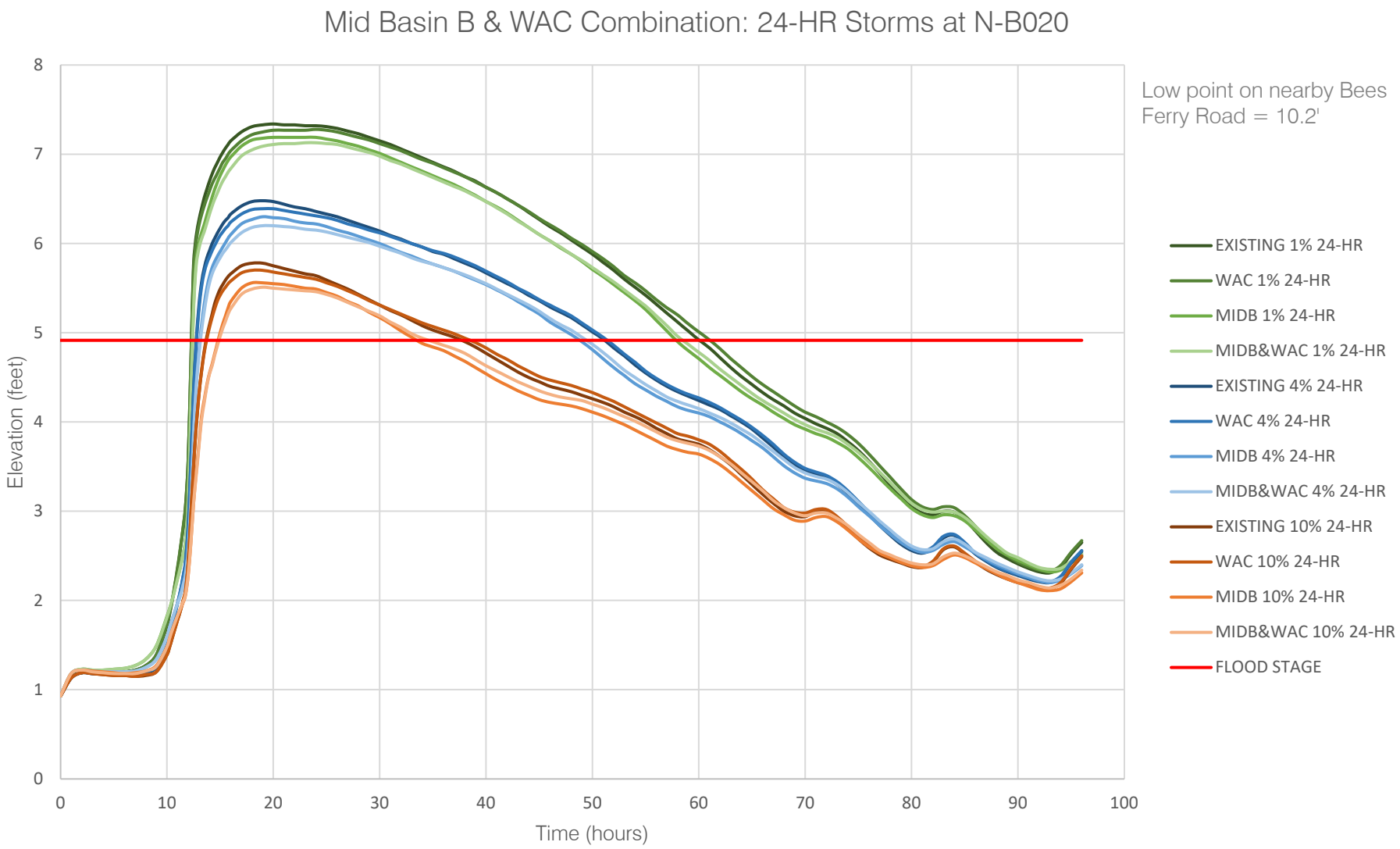

Combinations: 25-YR Storms at N-B160
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 4% 24-HR
WAC&WHIT 4% 24-HR
MIDB&WHIT 4% 24-HR
MIDB&WAC 4% 24-HR
ALL COMBOS 4% 24-HR
EXISTING 4% 48-HR
WAC&WHIT 4% 48-HR
MIDB&WHIT 4% 48-HR
MIDB&WAC 4% 48-HR
ALL COMBOS 4% 48-HR
FLOOD STAGE

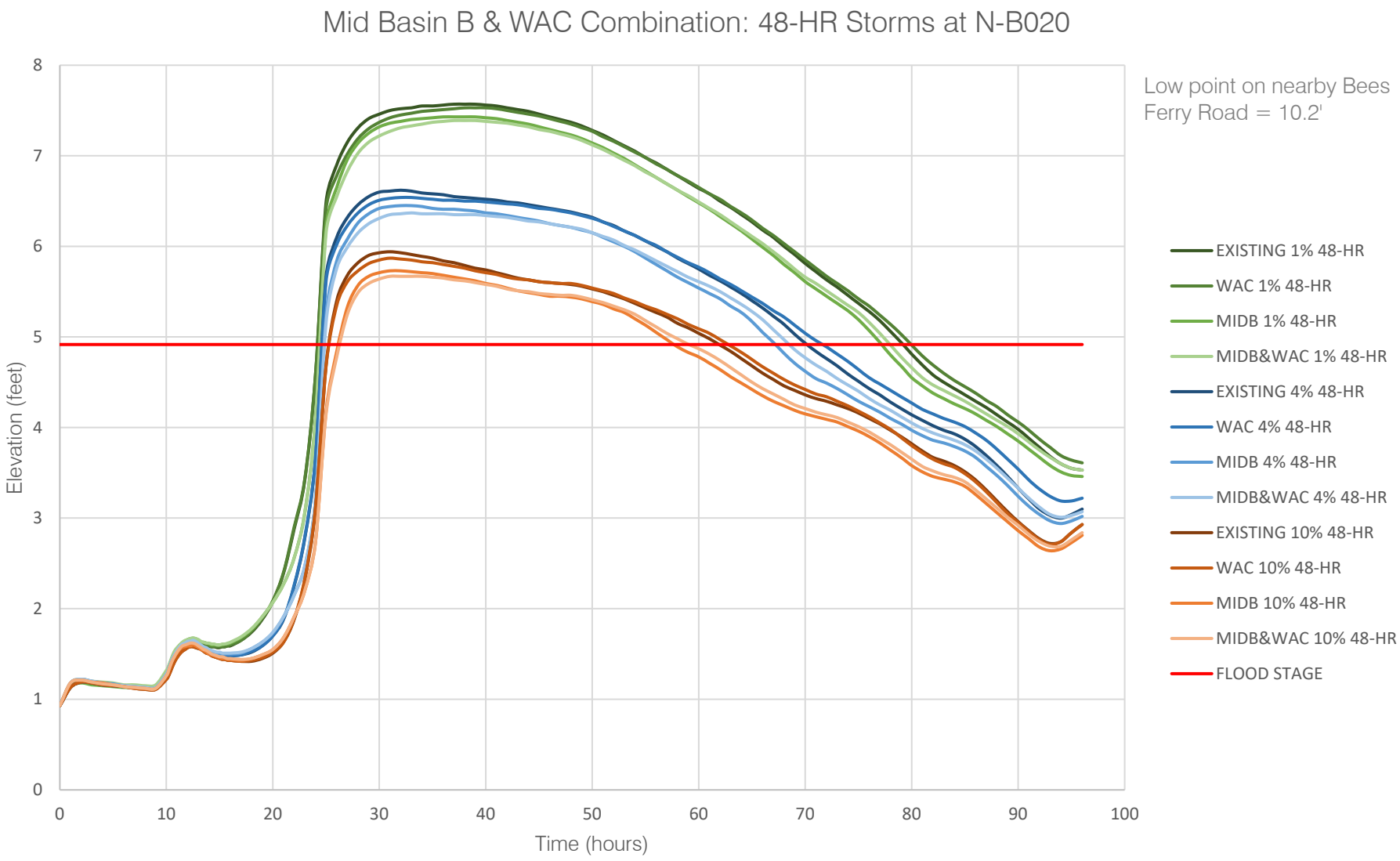

Combinations: 100-YR Storms at N-B160
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 24-HR
WAC&WHIT 1% 24-HR
MIDB&WHIT 1% 24-HR
MIDB&WAC 1% 24-HR
ALL COMBOS 1% 24-HR
EXISTING 1% 48-HR
WAC&WHIT 1% 48-HR
MIDB&WHIT 1% 48-HR
MIDB&WAC 1% 48-HR
ALL COMBOS 1% 48-HR
FLOOD STAGE


Combinations: 10-YR Storms at N-A120
Low point on nearby CSX Railroad Tracks = 10.33'
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80
90
100
EXISTING 10% 24-HR
WAC&WHIT 10% 24-HR
MIDB&WHIT 10% 24-HR
MIDB&WAC 10% 24-HR
ALL COMBOS 10% 24-HR
EXISTING 10% 48-HR
WAC&WHIT 10% 48-HR
MIDB&WHIT 10% 48-HR
MIDB&WAC 10% 48-HR
ALL COMBOS 10% 48-HR
FLOOD STAGE

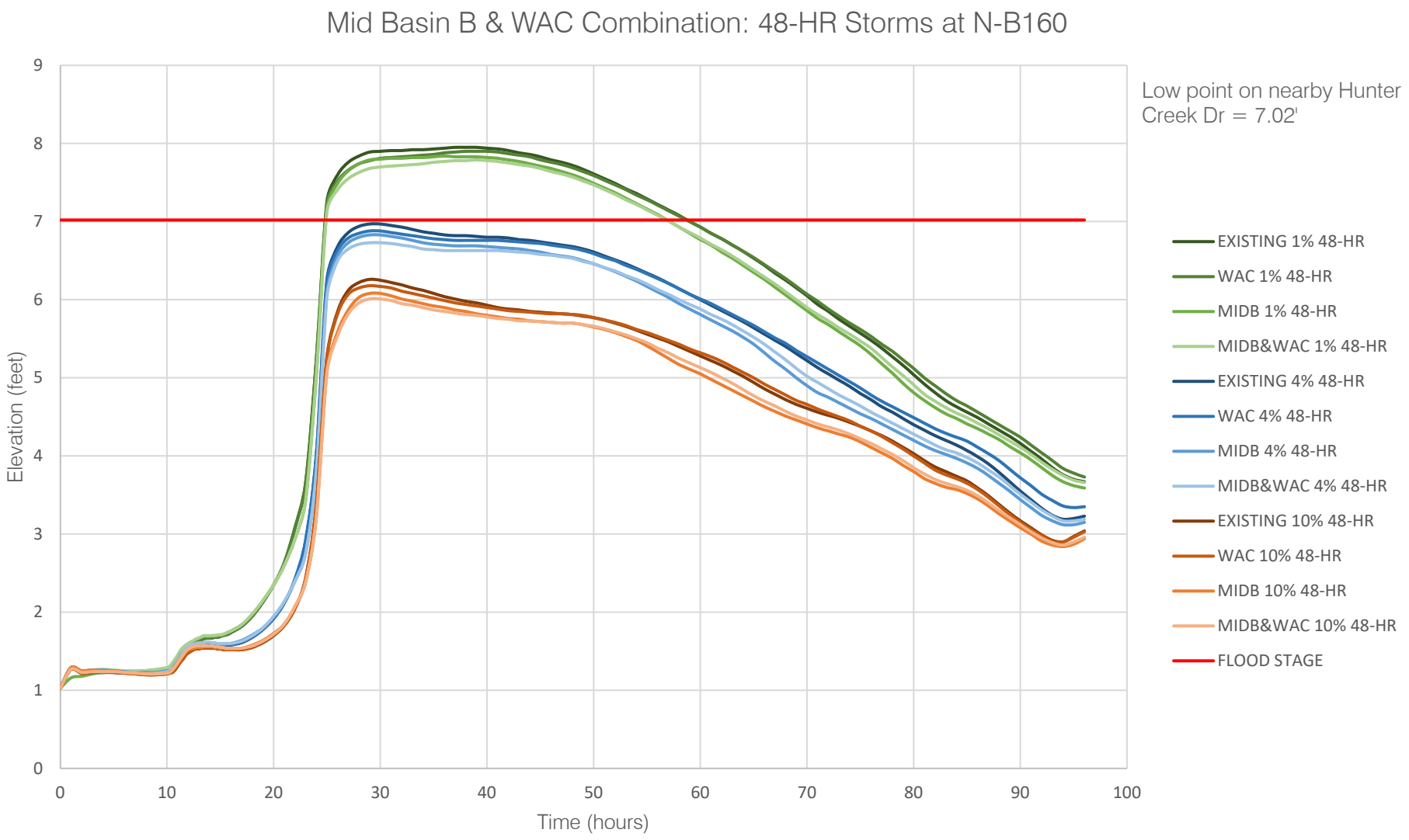

Combinations: 25-YR Storms at N-A120
Low point on nearby CSX Railroad Tracks = 10.33'
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
100
EXISTING 4% 24-HR
WAC&WHIT 4% 24-HR
MIDB&WHIT 4% 24-HR
MIDB&WAC 4% 24-HR
ALL COMBOS 4% 24-HR
EXISTING 4% 48-HR
WAC&WHIT 4% 48-HR
MIDB&WHIT 4% 48-HR
MIDB&WAC 4% 48-HR
ALL COMBOS 4% 48-HR
FLOOD STAGE

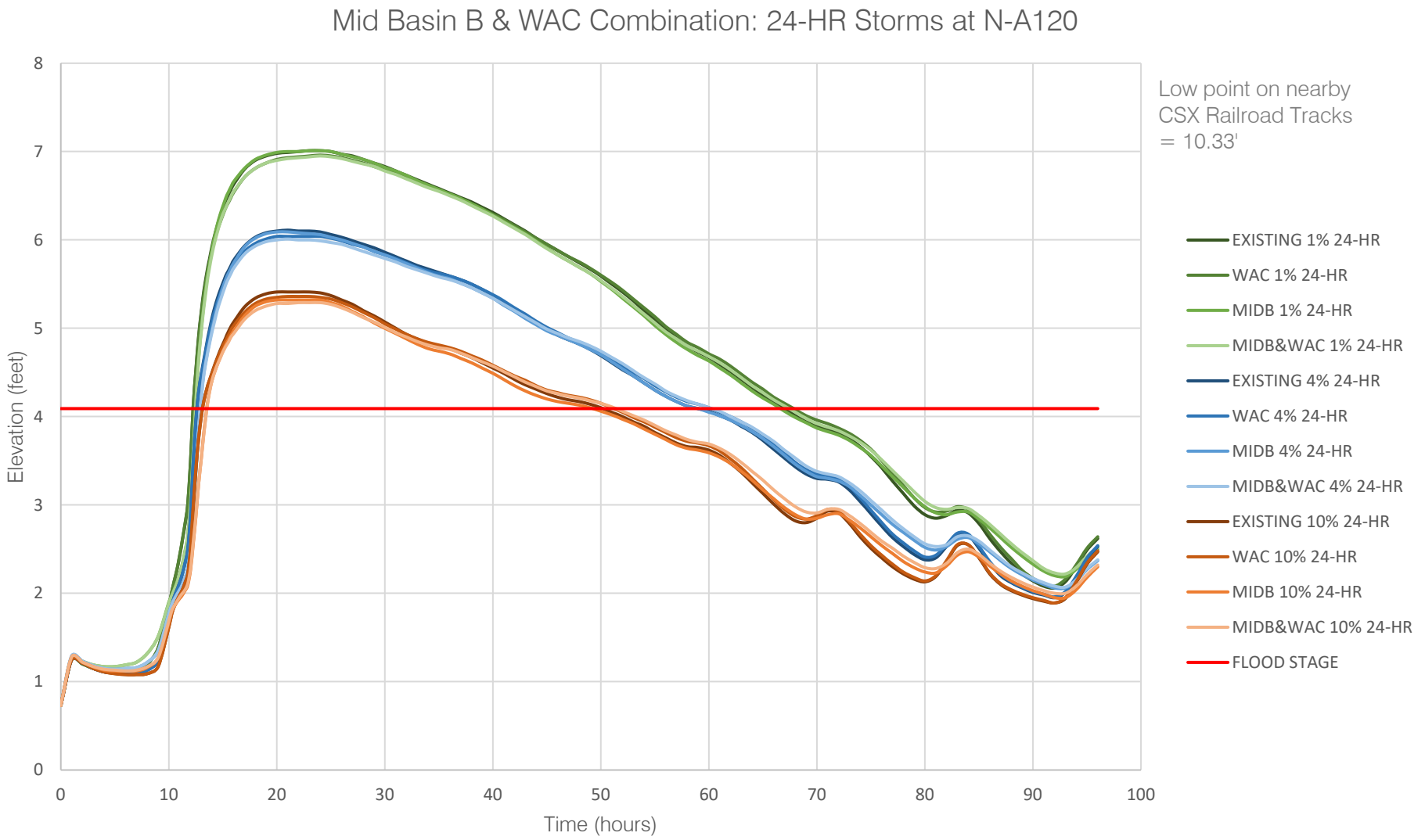

Combinations: 100-YR Storms at N-A120
Low point on nearby CSX Railroad Tracks = 10.33'
Elevation (feet)
Time (hrs)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WAC&WHIT 1% 24-HR
MIDB&WHIT 1% 24-HR
MIDB&WAC 1% 24-HR
ALL COMBOS 1% 24-HR
EXISTING 1% 48-HR
WAC&WHIT 1% 48-HR
MIDB&WHIT 1% 48-HR
MIDB&WAC 1% 48-HR
ALL COMBOS 1% 48-HR
FLOOD STAGE

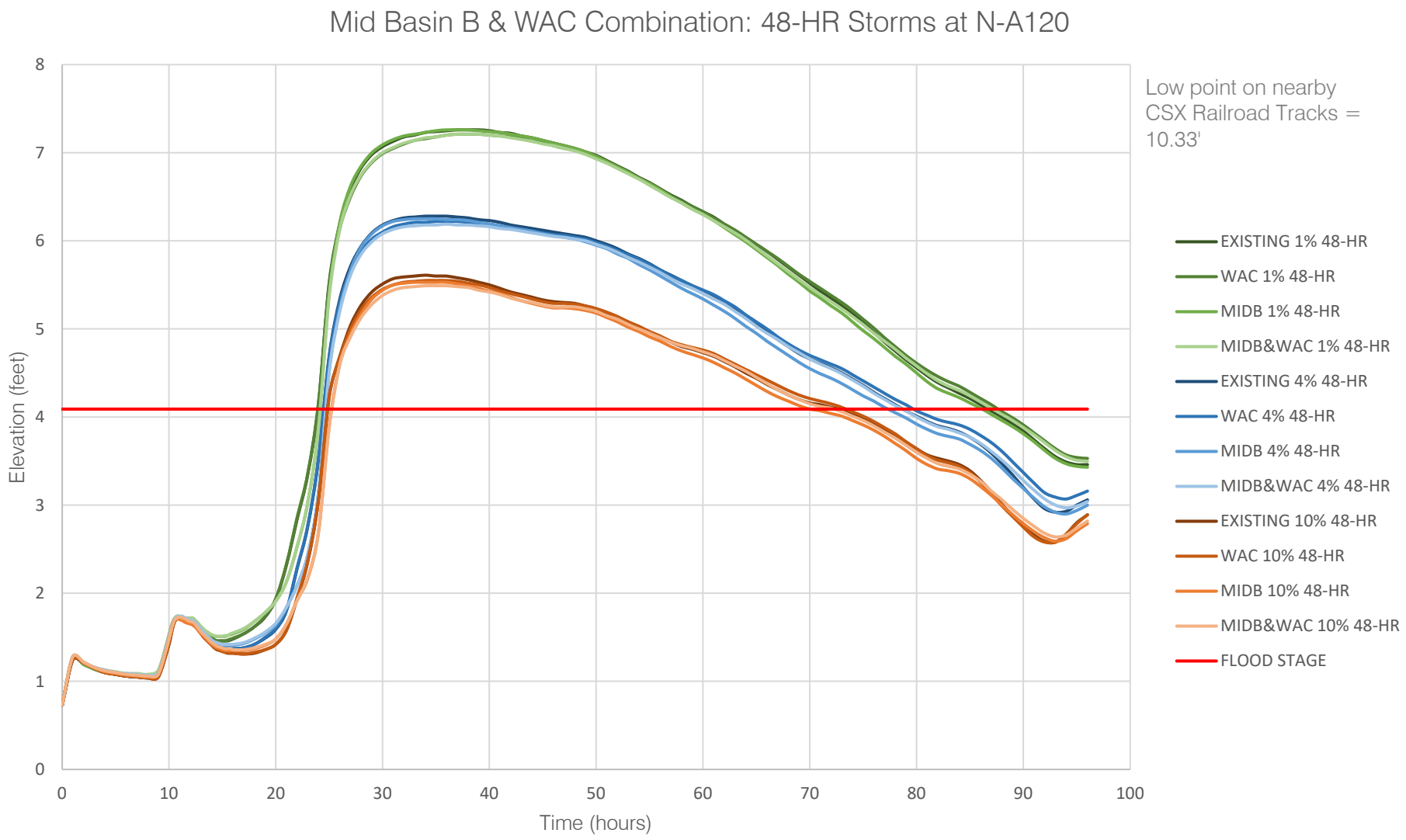

Mid Basin B & WAC Combination: 24-HR Storms at N-B020
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Bees Ferry Road = 10.2'
EXISTING 1% 24-HR
WAC 1% 24-HR
MIDB 1% 24-HR
MIDB&WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
MIDB 4% 24-HR
MIDB&WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
MIDB 10% 24-HR
MIDB&WAC 10% 24-HR
FLOOD STAGE

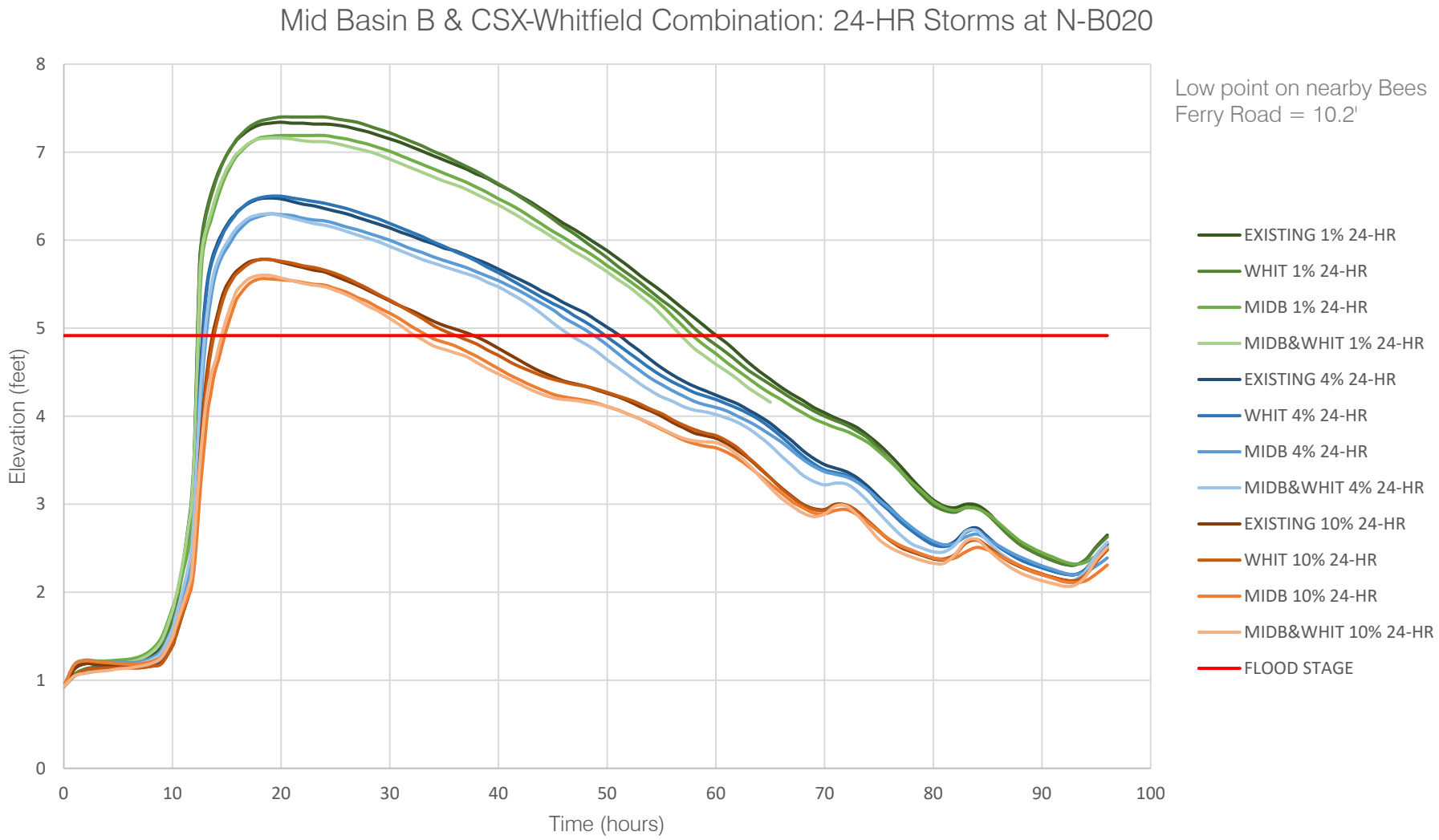

Mid Basin B & WAC Combination: 48-HR Storms at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 48-HR
WAC 1% 48-HR
MIDB 1% 48-HR
MIDB&WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
MIDB 4% 48-HR
MIDB&WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
MIDB 10% 48-HR
MIDB&WAC 10% 48-HR
FLOOD STAGE

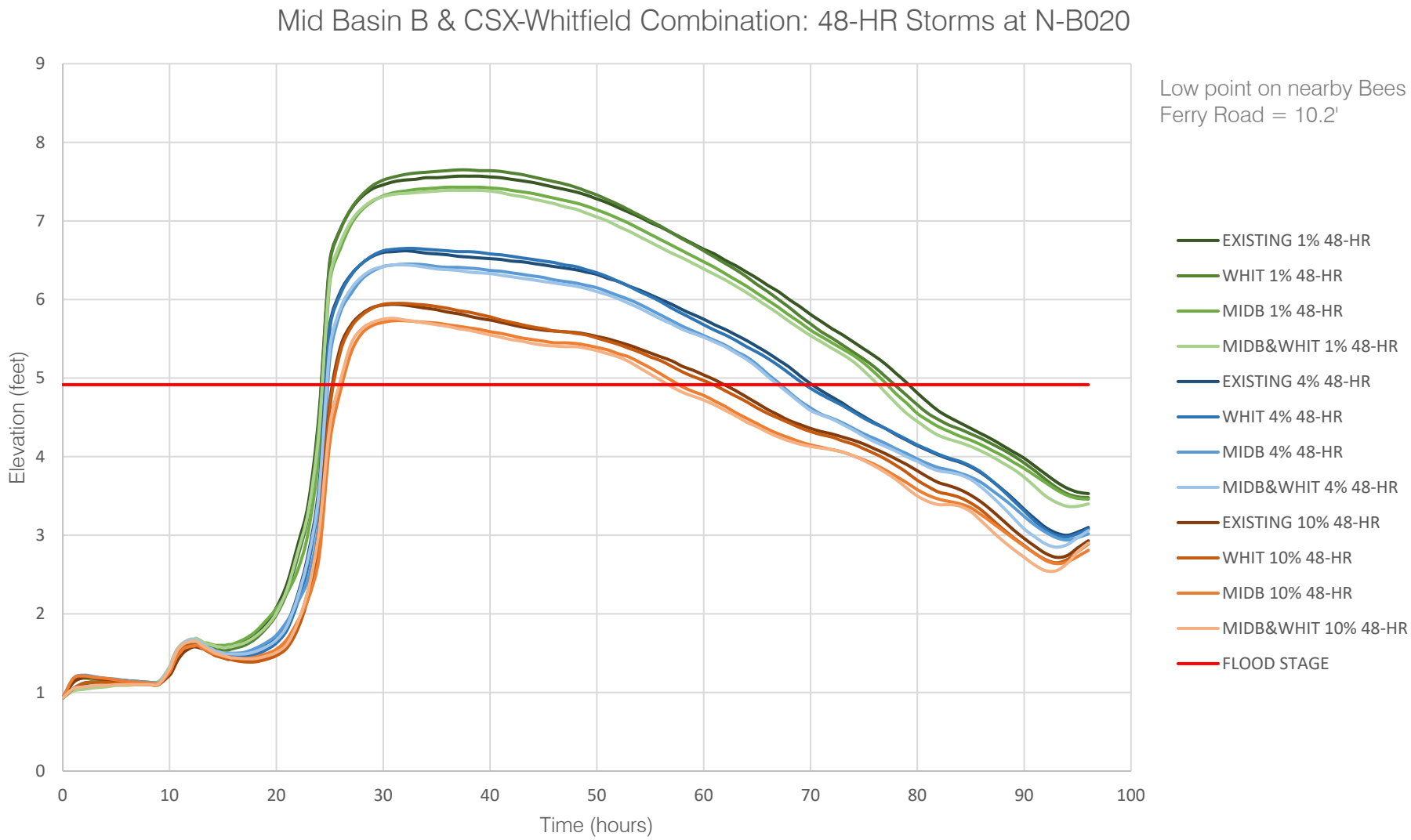

Mid Basin B & WAC Combination: 24-HR Storms at N-B160
Low point on nearby Hunter Creek Dr = 7.02'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WAC 1% 24-HR
MIDB 1% 24-HR
MIDB&WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
MIDB 4% 24-HR
MIDB&WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
MIDB 10% 24-HR
MIDB&WAC 10% 24-HR
FLOOD STAGE

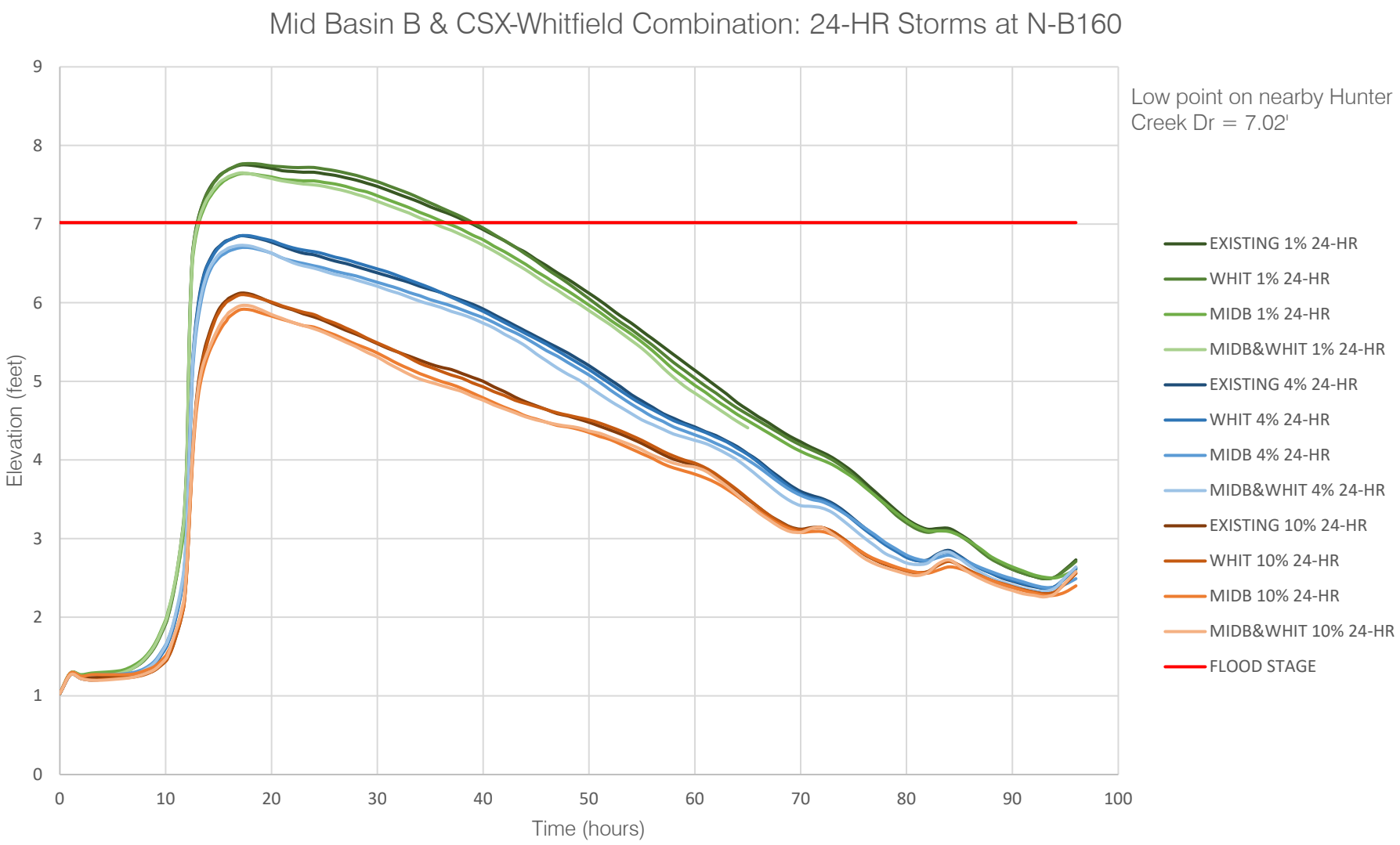

Mid Basin B & WAC Combination: 48-HR Storms at N-B160
Low point on nearby Hunter Creek Dr = 7.02'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 48-HR
WAC 1% 48-HR
MIDB 1% 48-HR
MIDB&WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
MIDB 4% 48-HR
MIDB&WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
MIDB 10% 48-HR
MIDB&WAC 10% 48-HR
FLOOD STAGE

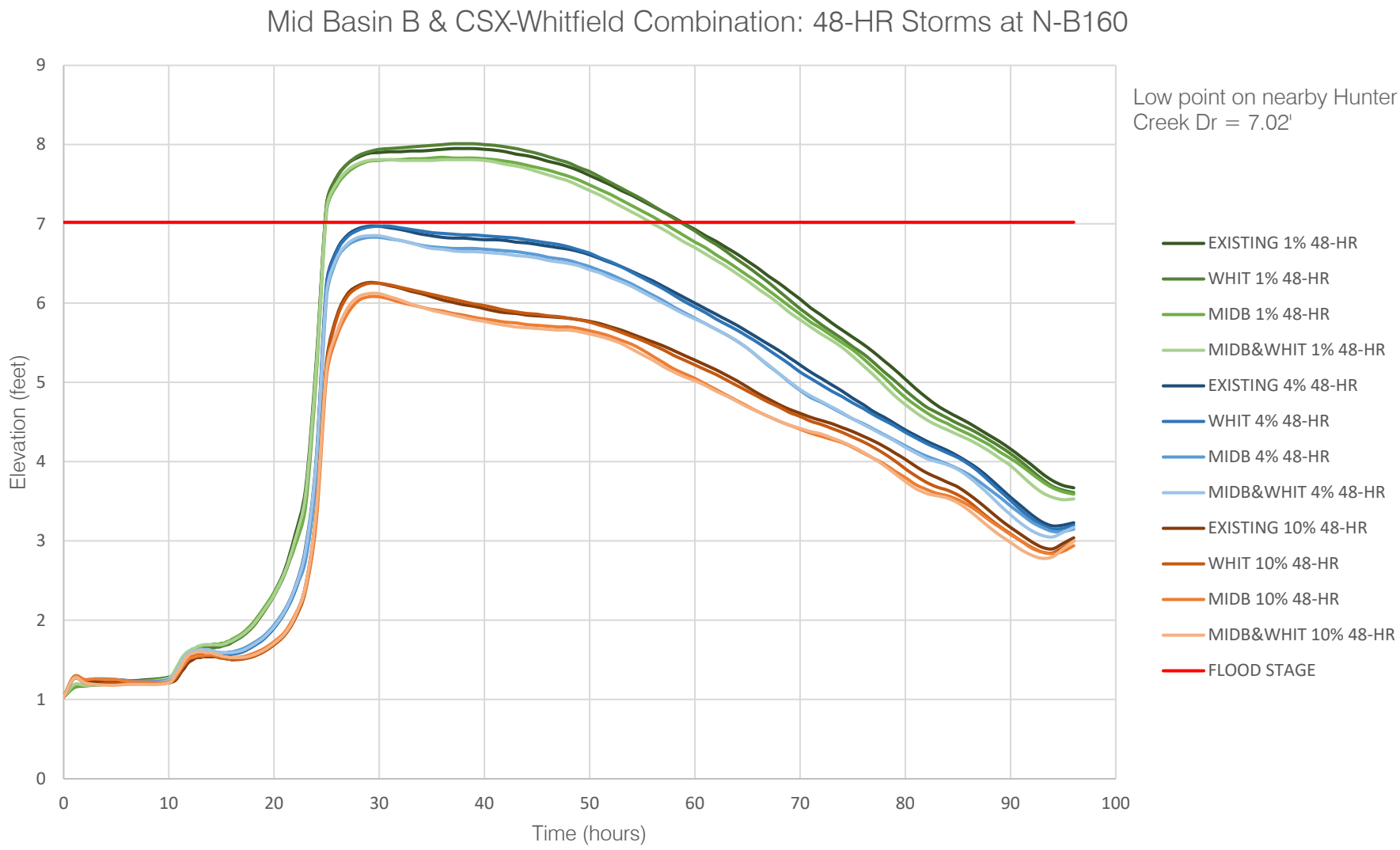

Mid Basin B & WAC Combination: 24-HR Storms at N-A120
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby CSX Railroad Tracks = 10.33'
EXISTING 1% 24-HR
WAC 1% 24-HR
MIDB 1% 24-HR
MIDB&WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
MIDB 4% 24-HR
MIDB&WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
MIDB 10% 24-HR
MIDB&WAC 10% 24-HR
FLOOD STAGE

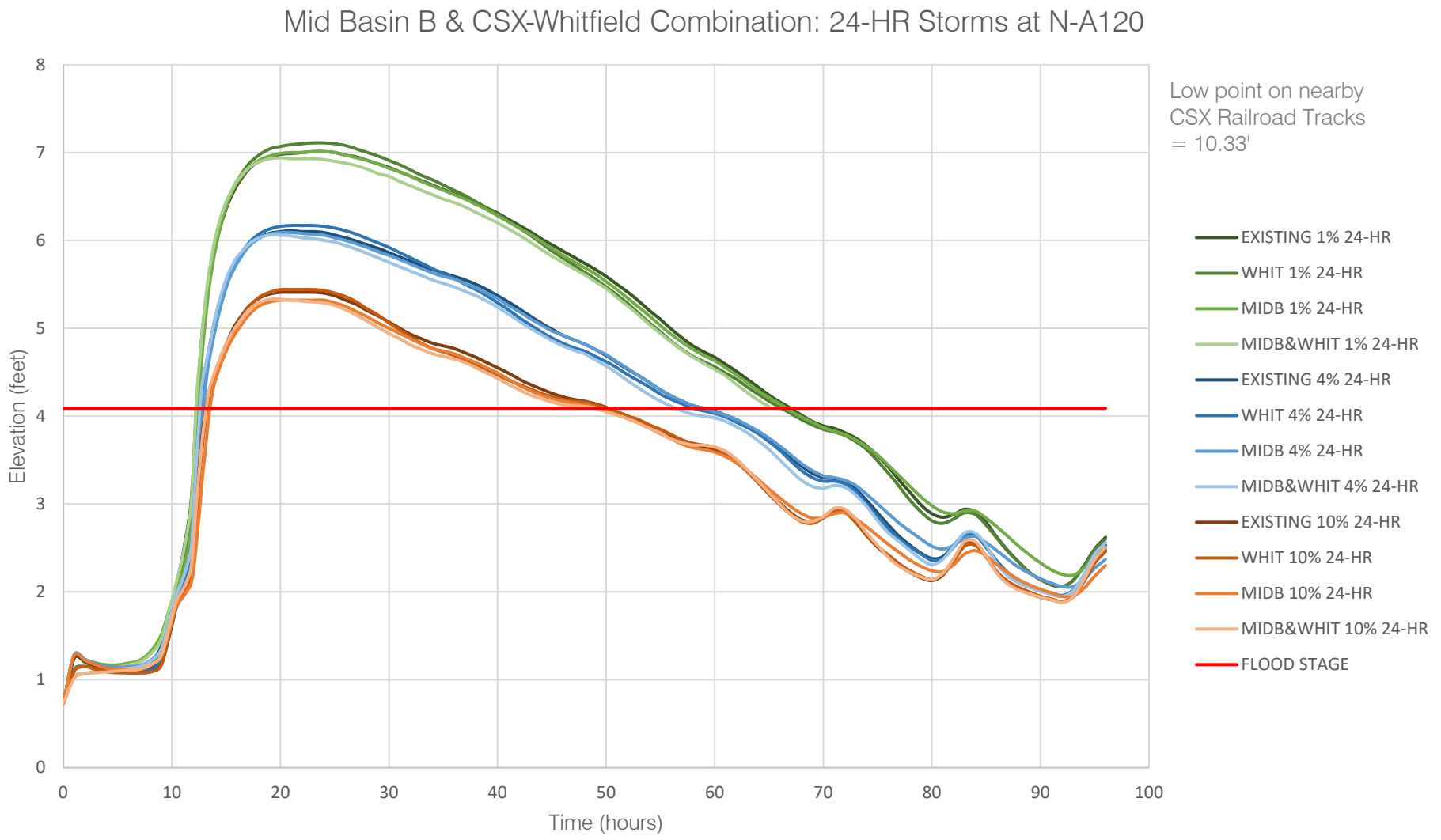

Mid Basin B & WAC Combination: 48-HR Storms at N-A120
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby CSX Railroad Tracks = 10.33'
EXISTING 1% 48-HR
WAC 1% 48-HR
MIDB 1% 48-HR
MIDB&WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
MIDB 4% 48-HR
MIDB&WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
MIDB 10% 48-HR
MIDB&WAC 10% 48-HR
FLOOD STAGE

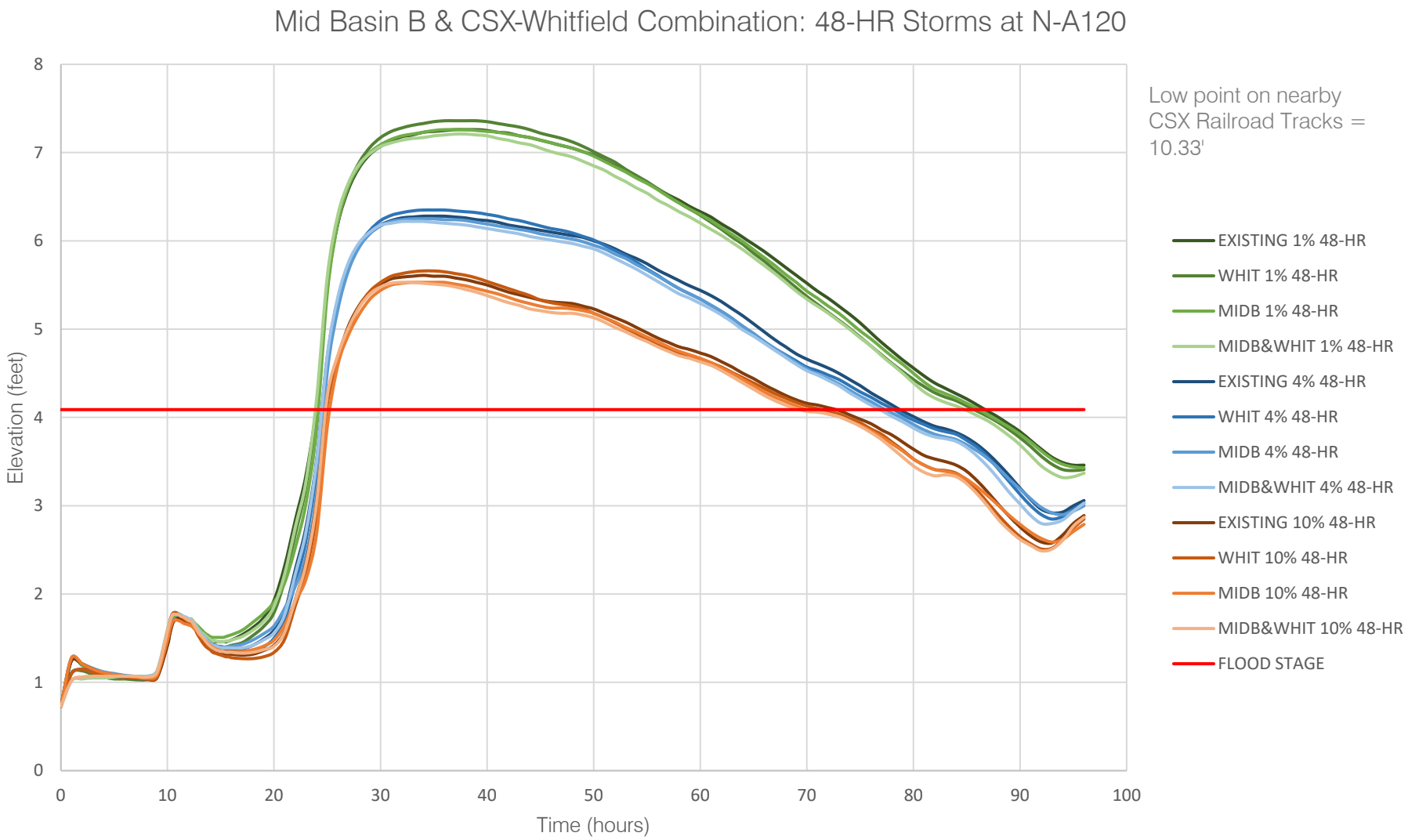

Mid Basin B & CSX-Whitfield Combination: 24-HR Storms at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WHIT 1% 24-HR
MIDB 1% 24-HR
MIDB&WHIT 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
MIDB 4% 24-HR
MIDB&WHIT 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
MIDB 10% 24-HR
MIDB&WHIT 10% 24-HR
FLOOD STAGE

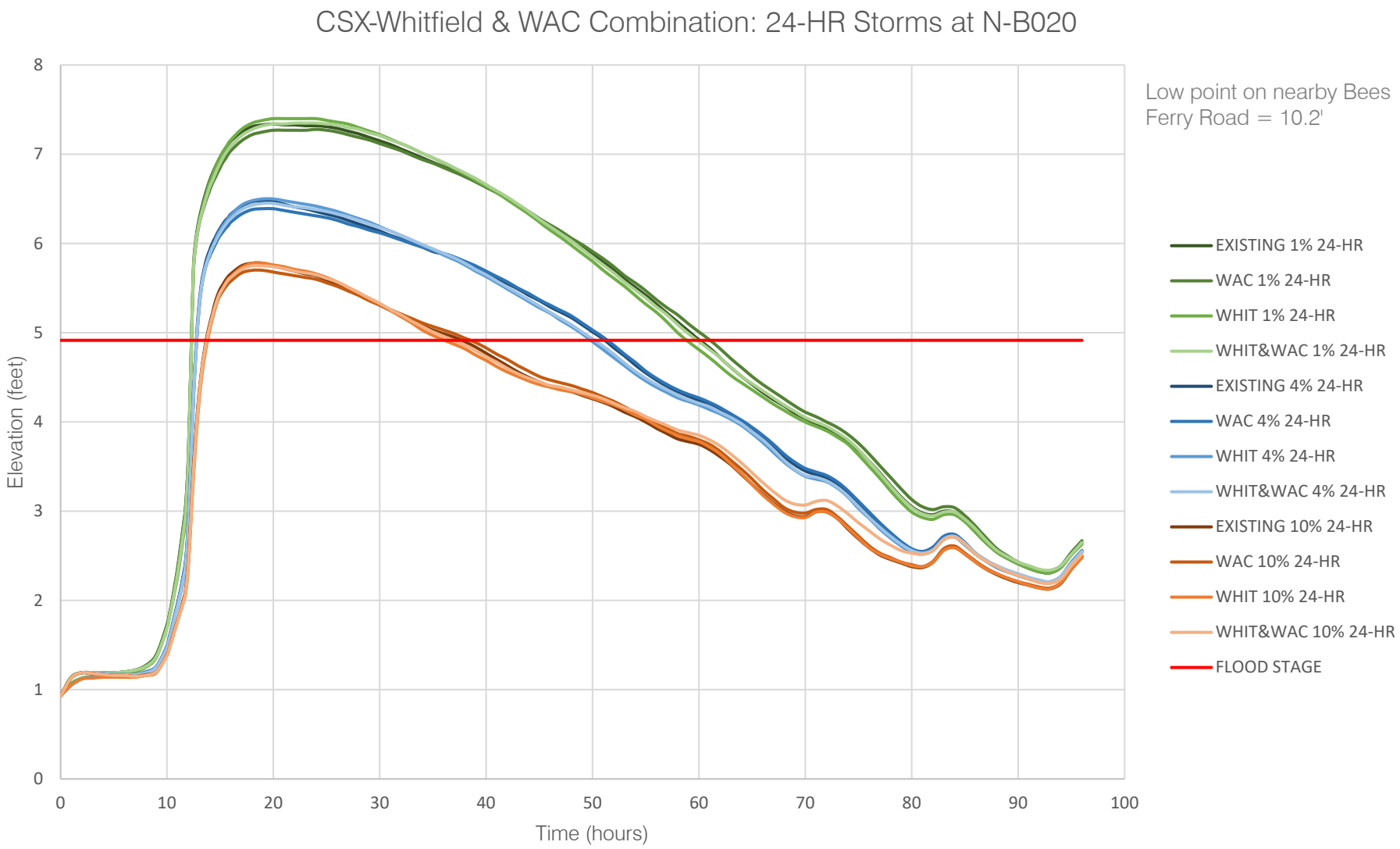

Mid Basin B & CSX-Whitfield Combination: 48-HR Storms at N-B020
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Bees Ferry Road = 10.2'
EXISTING 1% 48-HR
WHIT 1% 48-HR
MIDB 1% 48-HR
MIDB&WHIT 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
MIDB 4% 48-HR
MIDB&WHIT 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
MIDB 10% 48-HR
MIDB&WHIT 10% 48-HR
FLOOD STAGE

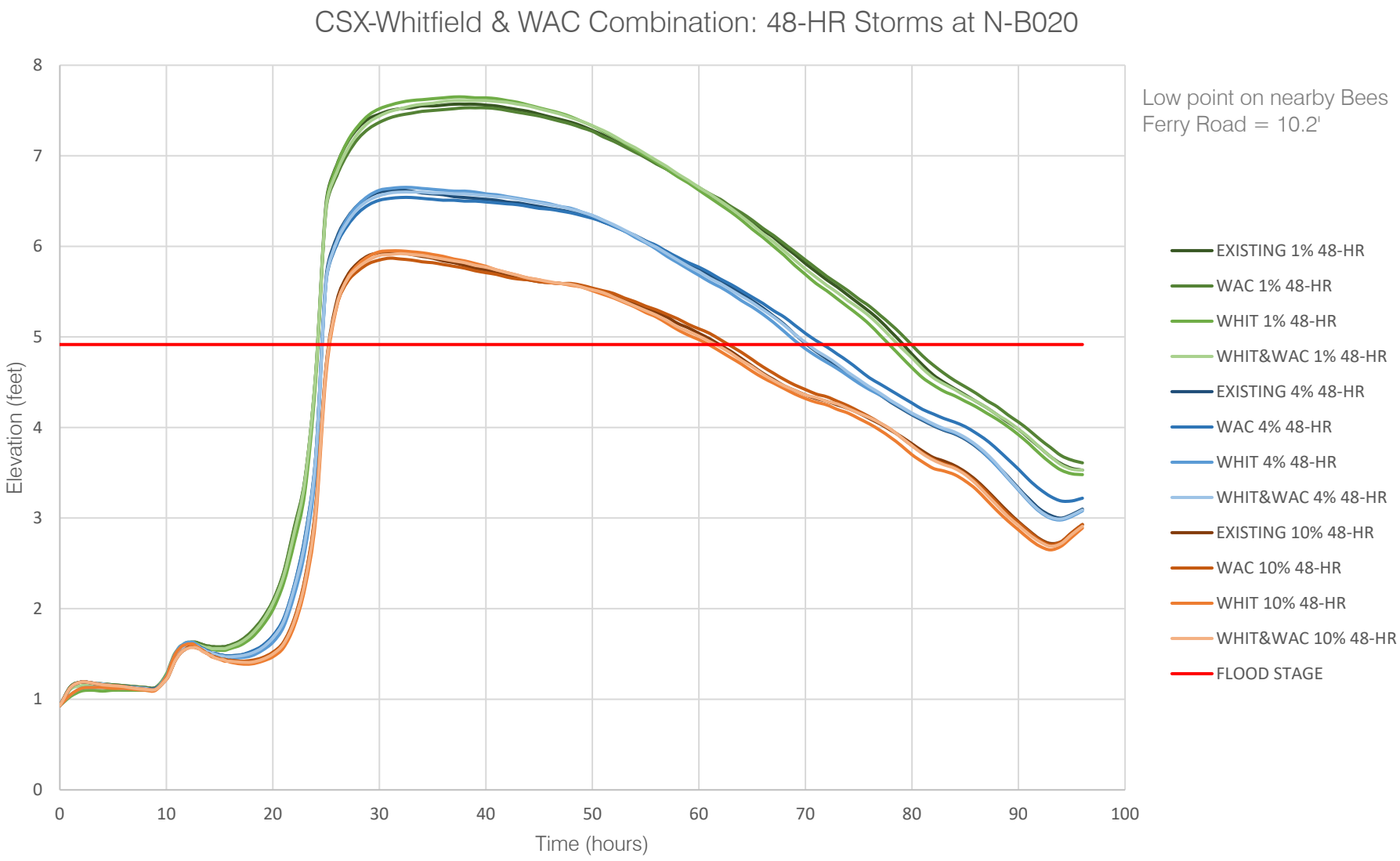

Mid Basin B & CSX-Whitfield Combination: 24-HR Storms at N-B160
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 24-HR
WHIT 1% 24-HR
MIDB 1% 24-HR
MIDB&WHIT 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
MIDB 4% 24-HR
MIDB&WHIT 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
MIDB 10% 24-HR
MIDB&WHIT 10% 24-HR
FLOOD STAGE

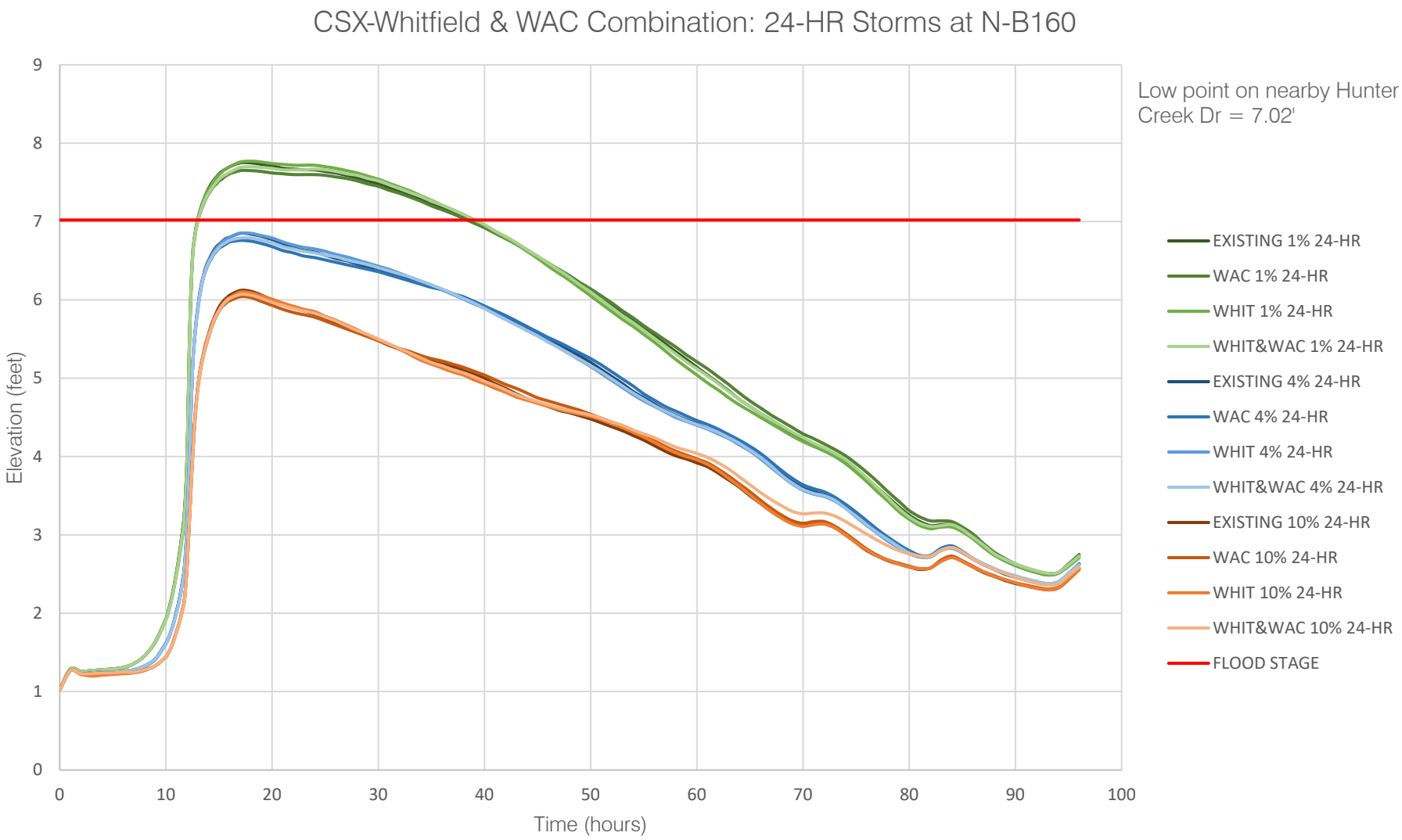

Mid Basin B & CSX-Whitfield Combination: 48-HR Storms at N-B160
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 48-HR
WHIT 1% 48-HR
MIDB 1% 48-HR
MIDB&WHIT 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
MIDB 4% 48-HR
MIDB&WHIT 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
MIDB 10% 48-HR
MIDB&WHIT 10% 48-HR
FLOOD STAGE


Mid Basin B & CSX-Whitfield Combination: 24-HR Storms at N-A120
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby CSX Railroad Tracks = 10.33'
EXISTING 1% 24-HR
WHIT 1% 24-HR
MIDB 1% 24-HR
MIDB&WHIT 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
MIDB 4% 24-HR
MIDB&WHIT 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
MIDB 10% 24-HR
MIDB&WHIT 10% 24-HR
FLOOD STAGE

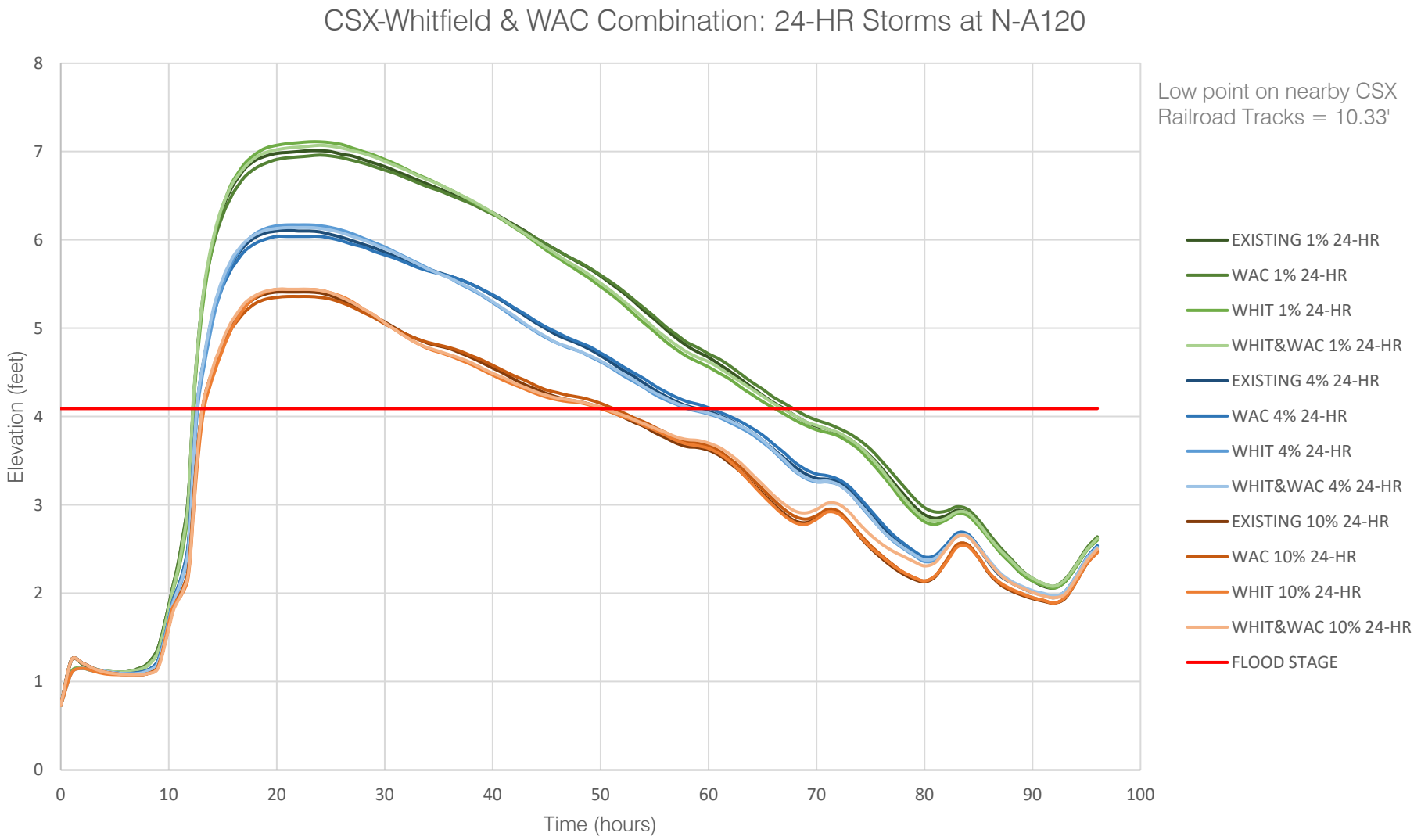

Mid Basin B & CSX-Whitfield Combination: 48-HR Storms at N-A120
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby CSX Railroad Tracks = 10.33'
EXISTING 1% 48-HR
WHIT 1% 48-HR
MIDB 1% 48-HR
MIDB&WHIT 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
MIDB 4% 48-HR
MIDB&WHIT 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
MIDB 10% 48-HR
MIDB&WHIT 10% 48-HR
FLOOD STAGE

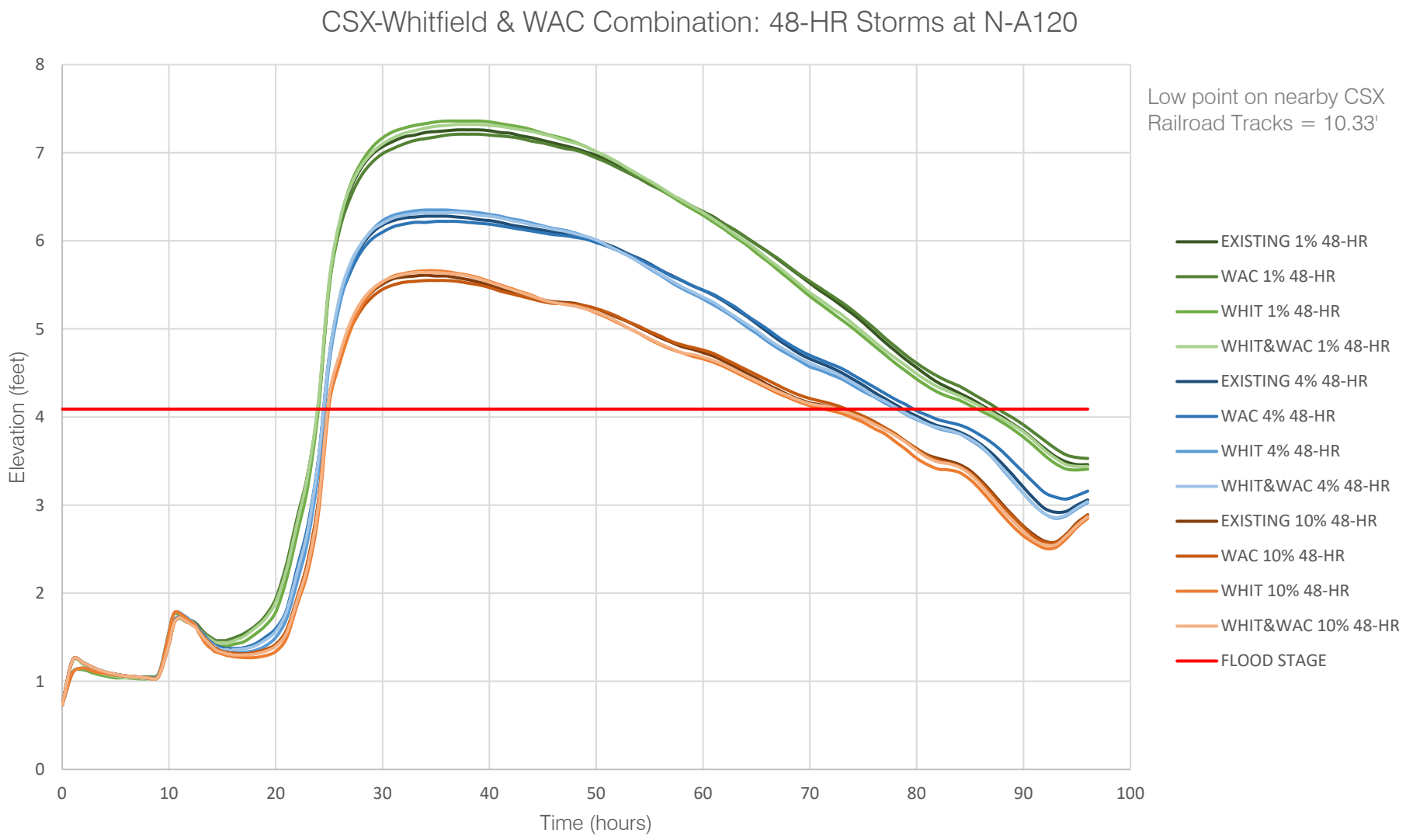

CSX-Whitfield & WAC Combination: 24-HR Storms at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WAC 1% 24-HR
WHIT 1% 24-HR
WHIT&WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
WHIT 4% 24-HR
WHIT&WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
WHIT 10% 24-HR
WHIT&WAC 10% 24-HR
FLOOD STAGE

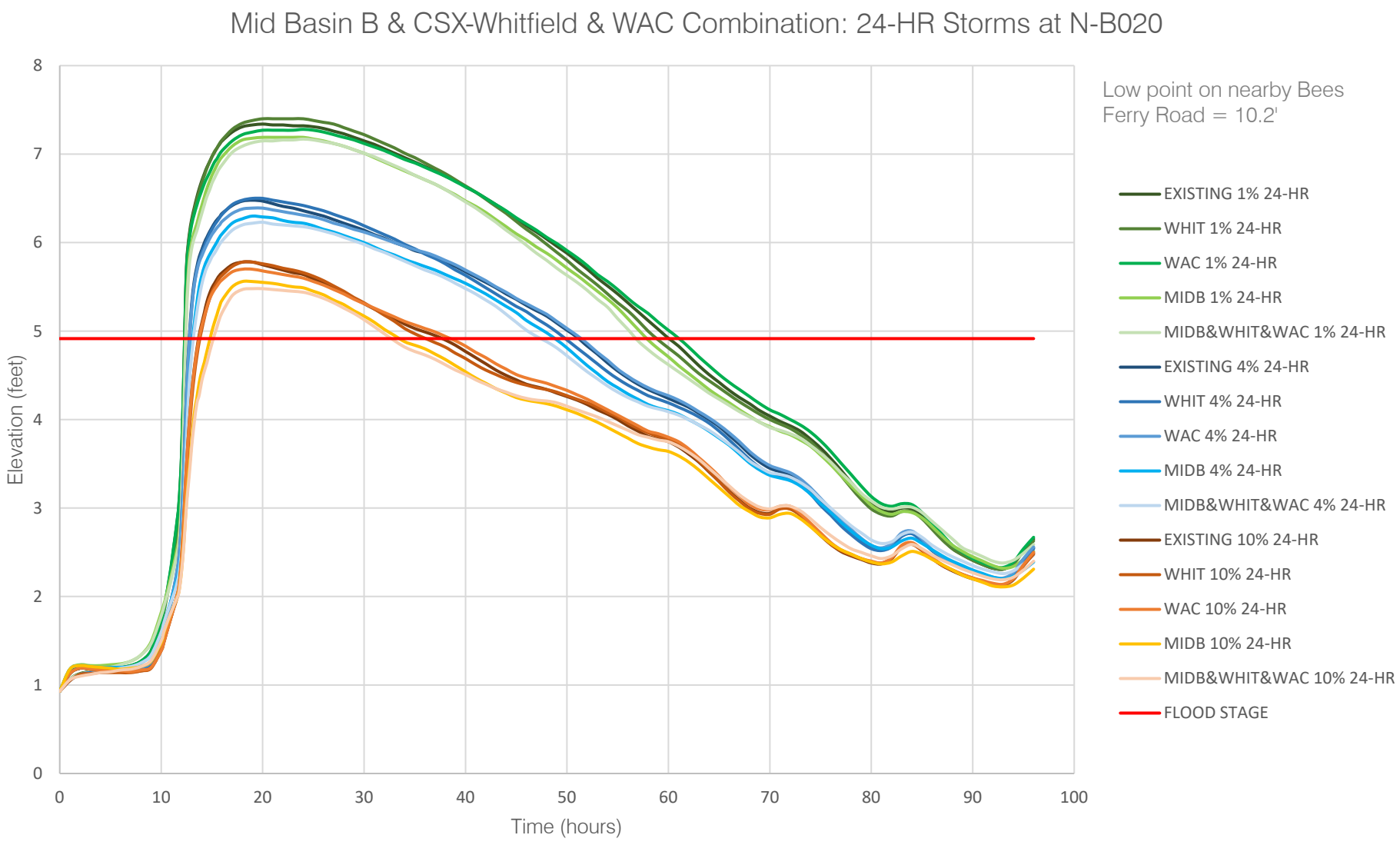

CSX-Whitfield & WAC Combination: 48-HR Storms at N-B020
Low point on nearby Bees Ferry Road = 10.2'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 48-HR
WAC 1% 48-HR
WHIT 1% 48-HR
WHIT&WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
WHIT 4% 48-HR
WHIT&WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
WHIT 10% 48-HR
WHIT&WAC 10% 48-HR
FLOOD STAGE

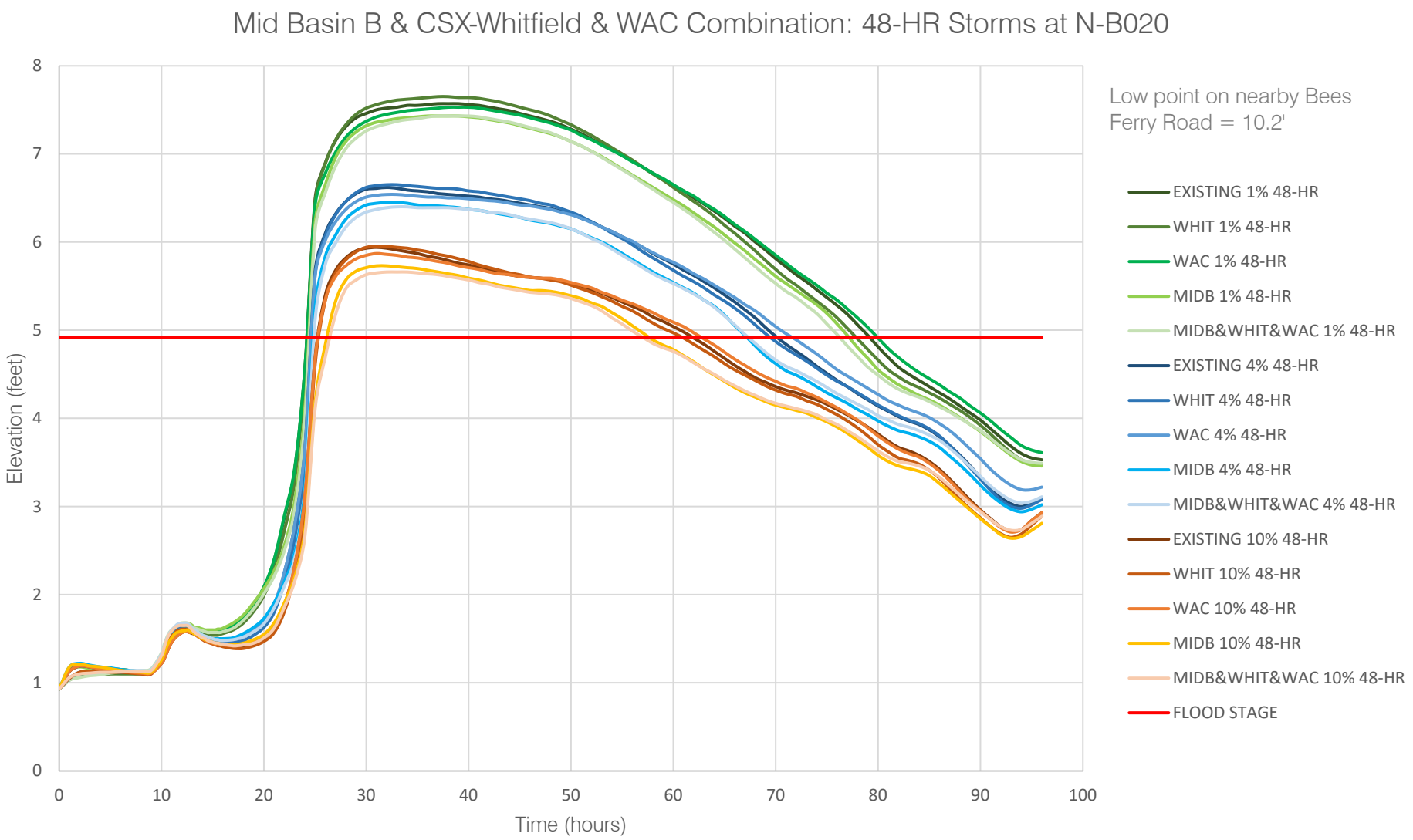

CSX-Whitfield & WAC Combination: 24-HR Storms at N-B160
Low point on nearby Hunter Creek Dr = 7.02'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WAC 1% 24-HR
WHIT 1% 24-HR
WHIT&WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
WHIT 4% 24-HR
WHIT&WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
WHIT 10% 24-HR
WHIT&WAC 10% 24-HR
FLOOD STAGE

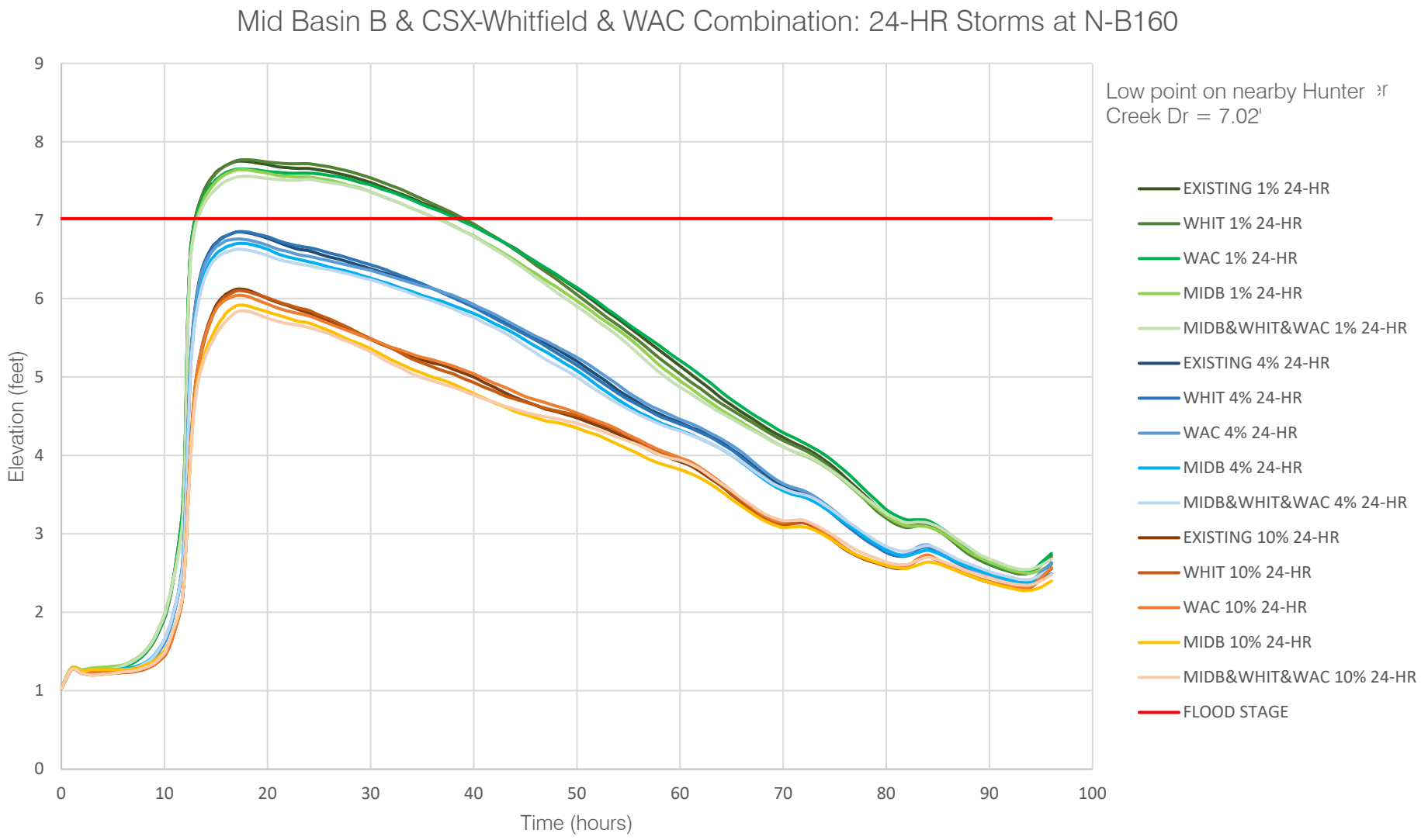

CSX-Whitfield & WAC Combination: 48-HR Storms at N-B160
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 48-HR
WAC 1% 48-HR
WHIT 1% 48-HR
WHIT&WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
WHIT 4% 48-HR
WHIT&WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
WHIT 10% 48-HR
WHIT&WAC 10% 48-HR
FLOOD STAGE

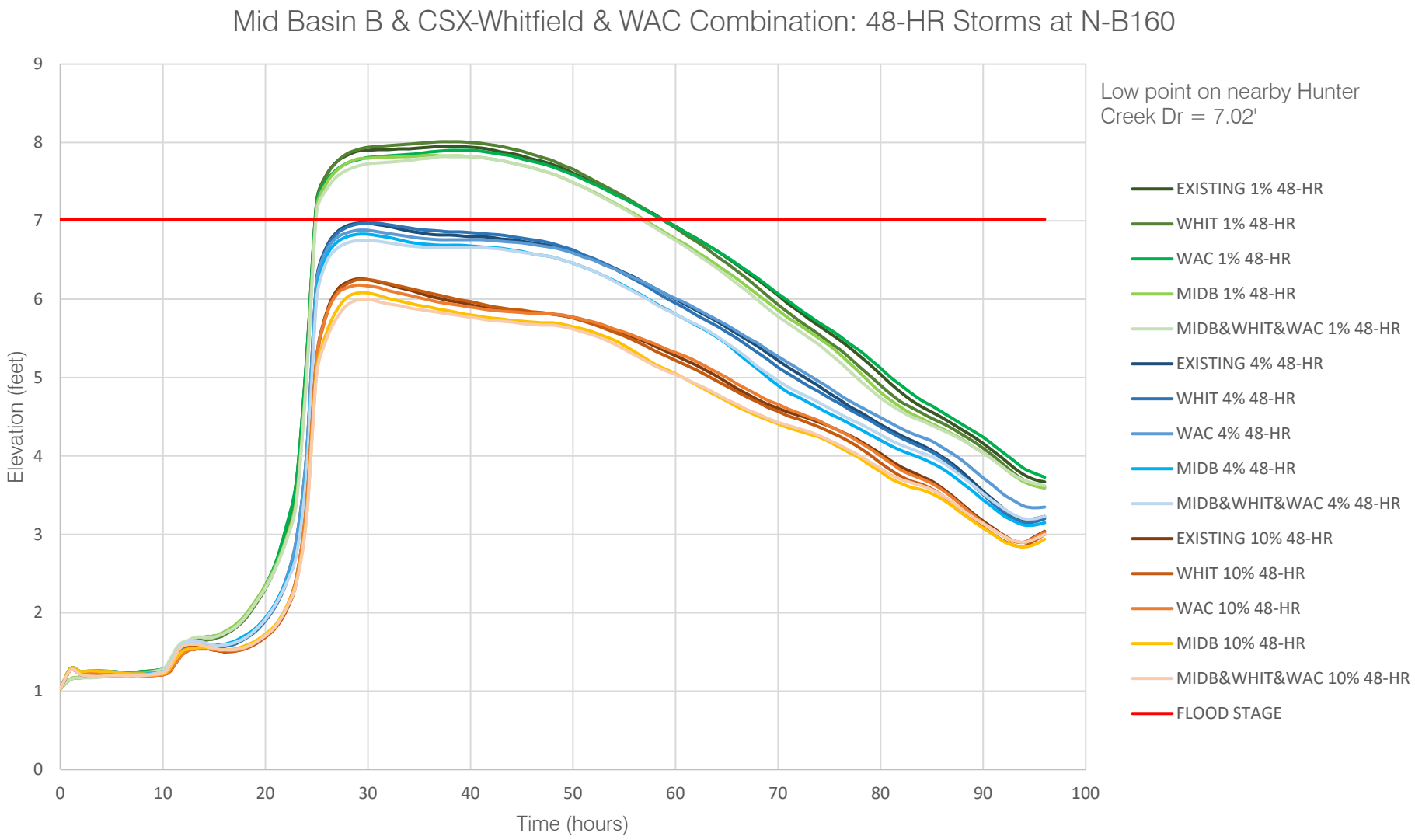

CSX-Whitfield & WAC Combination: 24-HR Storms at N-A120
Low point on nearby CSX Railroad Tracks = 10.33'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WAC 1% 24-HR
WHIT 1% 24-HR
WHIT&WAC 1% 24-HR
EXISTING 4% 24-HR
WAC 4% 24-HR
WHIT 4% 24-HR
WHIT&WAC 4% 24-HR
EXISTING 10% 24-HR
WAC 10% 24-HR
WHIT 10% 24-HR
WHIT&WAC 10% 24-HR
FLOOD STAGE

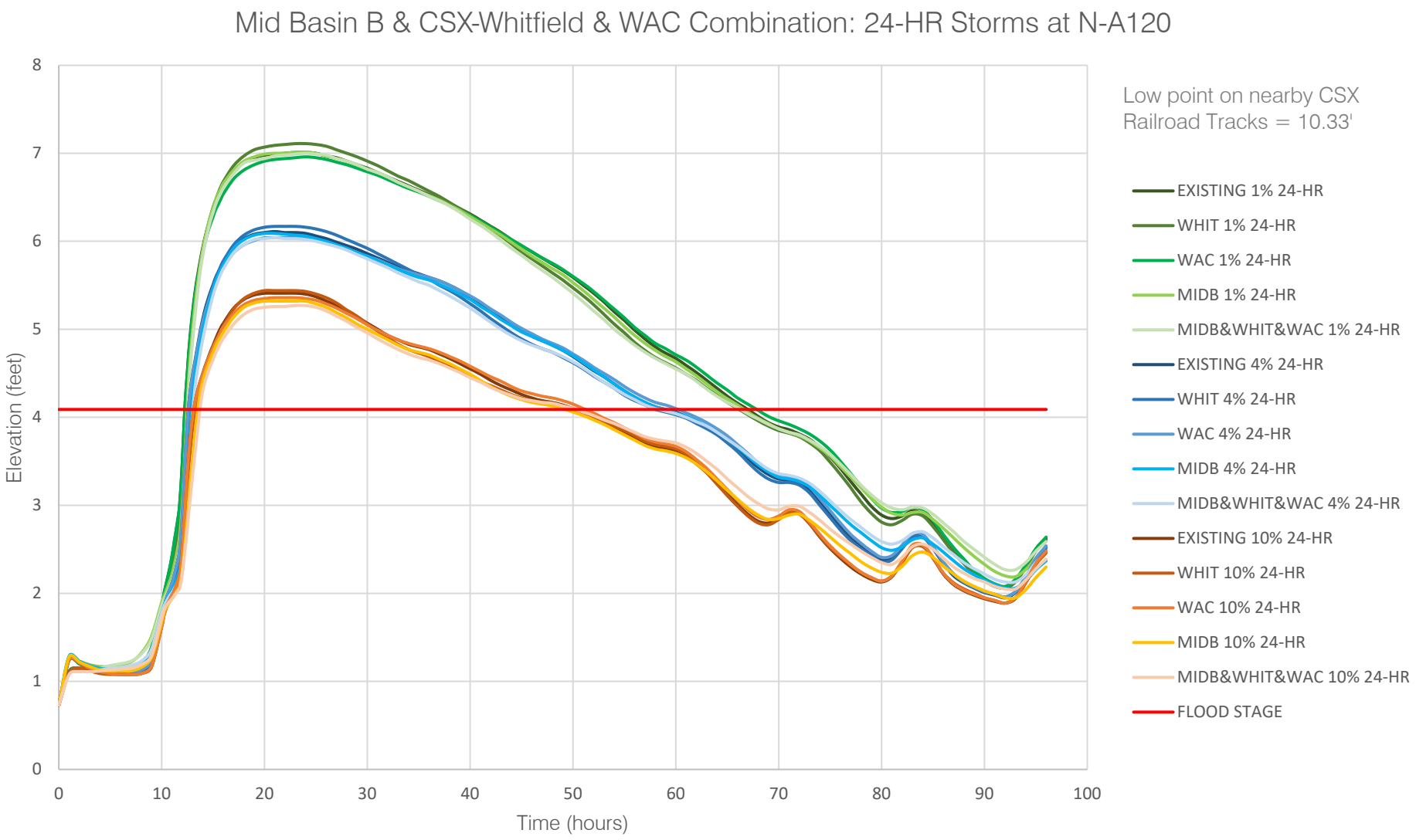

CSX-Whitfield & WAC Combination: 48-HR Storms at N-A120
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby CSX Railroad Tracks = 10.33'
EXISTING 1% 48-HR
WAC 1% 48-HR
WHIT 1% 48-HR
WHIT&WAC 1% 48-HR
EXISTING 4% 48-HR
WAC 4% 48-HR
WHIT 4% 48-HR
WHIT&WAC 4% 48-HR
EXISTING 10% 48-HR
WAC 10% 48-HR
WHIT 10% 48-HR
WHIT&WAC 10% 48-HR
FLOOD STAGE

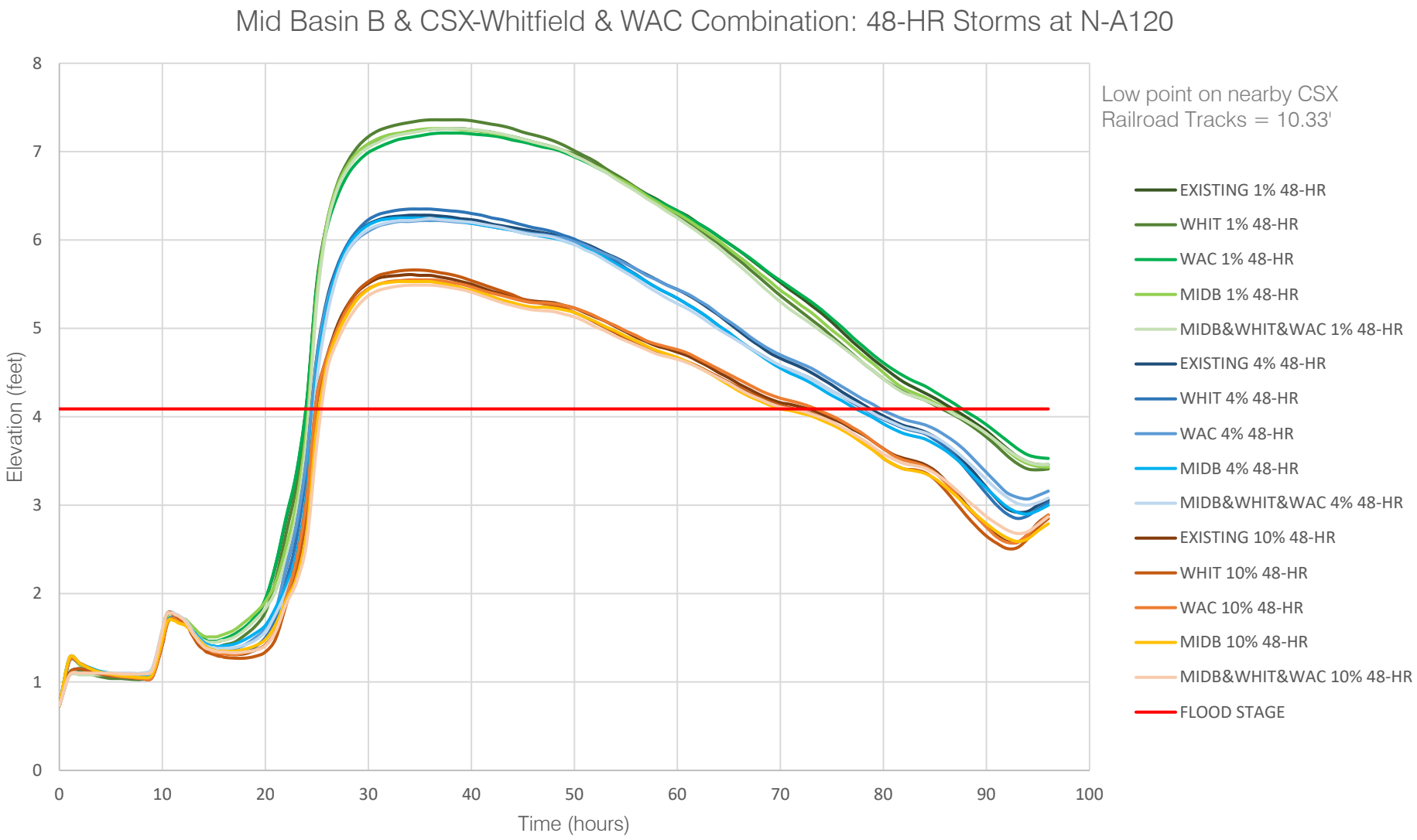

Mid Basin B & CSX-Whitfield & WAC Combination: 24-HR Storms at N-B020
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Bees Ferry Road = 10.2'
EXISTING 1% 24-HR
WHIT 1% 24-HR
WAC 1% 24-HR
MIDB 1% 24-HR
MIDB&WHIT&WAC 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
WAC 4% 24-HR
MIDB 4% 24-HR
MIDB&WHIT&WAC 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
WAC 10% 24-HR
MIDB 10% 24-HR
MIDB&WHIT&WAC 10% 24-HR
FLOOD STAGE


Mid Basin B & CSX-Whitfield & WAC Combination: 48-HR Storms at N-B020
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Bees Ferry Road = 10.2'
EXISTING 1% 48-HR
WHIT 1% 48-HR
WAC 1% 48-HR
MIDB 1% 48-HR
MIDB&WHIT&WAC 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
WAC 4% 48-HR
MIDB 4% 48-HR
MIDB&WHIT&WAC 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
WAC 10% 48-HR
MIDB 10% 48-HR
MIDB&WHIT&WAC 10% 48-HR
FLOOD STAGE


Mid Basin B & CSX-Whitfield & WAC Combination: 24-HR Storms at N-B160
Low point on nearby Hunter
Creek Dr = 7.02'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 24-HR
WHIT 1% 24-HR
WAC 1% 24-HR
MIDB 1% 24-HR
MIDB&WHIT&WAC 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
WAC 4% 24-HR
MIDB 4% 24-HR
MIDB&WHIT&WAC 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
WAC 10% 24-HR
MIDB 10% 24-HR
MIDB&WHIT&WAC 10% 24-HR
FLOOD STAGE


Mid Basin B & CSX-Whitfield & WAC Combination: 48-HR Storms at N-B160
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby Hunter Creek Dr = 7.02'
EXISTING 1% 48-HR
WHIT 1% 48-HR
WAC 1% 48-HR
MIDB 1% 48-HR
MIDB&WHIT&WAC 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
WAC 4% 48-HR
MIDB 4% 48-HR
MIDB&WHIT&WAC 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
WAC 10% 48-HR
MIDB 10% 48-HR
MIDB&WHIT&WAC 10% 48-HR
FLOOD STAGE


Mid Basin B & CSX-Whitfield & WAC Combination: 24-HR Storms at N-A120
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
Low point on nearby CSX Railroad Tracks = 10.33'
EXISTING 1% 24-HR
WHIT 1% 24-HR
WAC 1% 24-HR
MIDB 1% 24-HR
MIDB&WHIT&WAC 1% 24-HR
EXISTING 4% 24-HR
WHIT 4% 24-HR
WAC 4% 24-HR
MIDB 4% 24-HR
MIDB&WHIT&WAC 4% 24-HR
EXISTING 10% 24-HR
WHIT 10% 24-HR
WAC 10% 24-HR
MIDB 10% 24-HR
MIDB&WHIT&WAC 10% 24-HR
FLOOD STAGE


Mid Basin B & CSX-Whitfield & WAC Combination: 48-HR Storms at N-A120
Low point on nearby CSX Railroad Tracks = 10.33'
Elevation (feet)
Time (hours)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
EXISTING 1% 48-HR
WHIT 1% 48-HR
WAC 1% 48-HR
MIDB 1% 48-HR
MIDB&WHIT&WAC 1% 48-HR
EXISTING 4% 48-HR
WHIT 4% 48-HR
WAC 4% 48-HR
MIDB 4% 48-HR
MIDB&WHIT&WAC 4% 48-HR
EXISTING 10% 48-HR
WHIT 10% 48-HR
WAC 10% 48-HR
MIDB 10% 48-HR
MIDB&WHIT&WAC 10% 48-HR
FLOOD STAGE

APPENDIX B

Model Output by Node

Mid Basin Option A All-Node Maximum Conditions *					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.64	0.12
	10% 48-HR		3.83	3.83	0.00
	4% 24-HR		4.21	4.21	0.00
	4% 48-HR		4.37	4.39	-0.24
	1% 24-HR		5.00	5	0.00
	1% 48-HR		5.20	5.21	-0.12
N-0530	10% 24-HR	3.00	3.85	3.59	3.12
	10% 48-HR		3.78	3.79	-0.12
	4% 24-HR		4.16	4.16	0.00
	4% 48-HR		4.33	4.34	-0.12
	1% 24-HR		4.95	4.95	0.00
	1% 48-HR		5.15	5.15	0.00
N-A120	10% 24-HR	4.09	5.41	5.38	0.36
	10% 48-HR		5.61	5.58	0.36
	4% 24-HR		6.11	6.11	0.00
	4% 48-HR		6.28	6.27	0.12
	1% 24-HR		7.01	7.01	0.00
	1% 48-HR		7.26	7.27	-0.12
N-A160	10% 24-HR	7.91	6.72	6.69	0.36
	10% 48-HR		6.89	6.68	2.52
	4% 24-HR		7.32	7.31	0.12
	4% 48-HR		7.45	7.43	0.24
	1% 24-HR		8.05	8.05	0.00
	1% 48-HR		8.25	8.25	0.00
N-A200	10% 24-HR	7.72	6.10	6.1	0.00
	10% 48-HR		5.87	5.86	0.12
	4% 24-HR		6.30	6.3	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.21	0.12
N-B010	10% 24-HR	4.86	5.60	5.49	1.32
	10% 48-HR		5.77	5.67	1.20
	4% 24-HR		6.3	6.21	1.08
	4% 48-HR		6.46	6.37	1.08
	1% 24-HR		7.19	7.11	0.96
	1% 48-HR		7.45	7.37	0.96
N-B020	10% 24-HR	4.91	5.79	5.69	1.20
	10% 48-HR		5.94	5.85	1.08
	4% 24-HR		6.48	6.39	1.08
	4% 48-HR		6.62	6.54	0.96
	1% 24-HR		7.34	7.27	0.84
	1% 48-HR		7.57	7.5	0.84
N-B160	10% 24-HR	7.02	6.12	6.04	0.96
	10% 48-HR		6.26	6.19	0.84
	4% 24-HR		6.85	6.78	0.84
	4% 48-HR		6.97	6.91	0.72
	1% 24-HR		7.75	7.7	0.60
	1% 48-HR		7.95	7.9	0.60
N-C080	10% 24-HR	10.87	8.82	8.8	0.24
	10% 48-HR		8.83	8.81	0.24
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.34	0.12
	1% 24-HR		9.98	9.99	-0.12
	1% 48-HR		9.96	9.95	0.12
N-C110	10% 24-HR	9.03	9.03	9	0.36
	10% 48-HR		9.05	9.02	0.36
	4% 24-HR		9.72	9.72	0.00
	4% 48-HR		9.70	9.67	0.36
	1% 24-HR		10.63	10.67	-0.48
	1% 48-HR		10.66	10.65	0.12
N-D055	10% 24-HR	7.54	7.48	7.48	0.00
	10% 48-HR		7.60	7.59	0.12
	4% 24-HR		8.17	8.15	0.24
	4% 48-HR		8.51	8.49	0.24
	1% 24-HR		9.24	9.22	0.24
	1% 48-HR		9.40	9.39	0.12
N-E010	10% 24-HR	7.03	9.41	9.4	0.12
	10% 48-HR		9.80	9.79	0.12
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.28	0.12
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11	0.00
N-G020	10% 24-HR	9.14	7.76	7.75	0.12
	10% 48-HR		7.90	7.88	0.24
	4% 24-HR		8.29	8.28	0.12
	4% 48-HR		8.43	8.42	0.12
	1% 24-HR		9.07	9.06	0.12
	1% 48-HR		9.25	9.24	0.12

*Results for scenario modeled with Mean Higher High Water tidal condition

Mid Basin Option B All-Node Maximum Conditions*					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.61	0.48
	10% 48-HR		3.83	3.79	0.48
	4% 24-HR		4.21	4.18	0.36
	4% 48-HR		4.37	4.36	0.12
	1% 24-HR		5.00	4.99	0.12
	1% 48-HR		5.20	5.19	0.12
N-0530	10% 24-HR	3.00	3.85	3.55	3.60
	10% 48-HR		3.78	3.75	0.36
	4% 24-HR		4.16	4.14	0.24
	4% 48-HR		4.33	4.32	0.12
	1% 24-HR		4.95	4.94	0.12
	1% 48-HR		5.15	5.14	0.12
N-A120	10% 24-HR	4.09	5.41	5.33	0.96
	10% 48-HR		5.61	5.53	0.96
	4% 24-HR		6.11	6.09	0.24
	4% 48-HR		6.28	6.25	0.36
	1% 24-HR		7.01	7.01	0.00
	1% 48-HR		7.26	7.26	0.00
N-A160	10% 24-HR	7.91	6.72	6.67	0.60
	10% 48-HR		6.89	6.85	0.48
	4% 24-HR		7.32	7.3	0.24
	4% 48-HR		7.45	7.42	0.36
	1% 24-HR		8.05	8.05	0.00
	1% 48-HR		8.25	8.25	0.00
N-A200	10% 24-HR	7.72	6.10	6.1	0.00
	10% 48-HR		5.87	5.86	0.12
	4% 24-HR		6.30	6.3	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.35	3.00
	10% 48-HR		5.77	5.56	2.52
	4% 24-HR		6.3	6.11	2.28
	4% 48-HR		6.46	6.28	2.16
	1% 24-HR		7.19	7.03	1.92
	1% 48-HR		7.45	7.29	1.92
N-B020	10% 24-HR	4.91	5.79	5.56	2.76
	10% 48-HR		5.94	5.73	2.52
	4% 24-HR		6.48	6.3	2.16
	4% 48-HR		6.62	6.45	2.04
	1% 24-HR		7.34	7.19	1.80
	1% 48-HR		7.57	7.43	1.68
N-B160	10% 24-HR	7.02	6.12	5.92	2.40
	10% 48-HR		6.26	6.08	2.16
	4% 24-HR		6.85	6.7	1.80
	4% 48-HR		6.97	6.83	1.68
	1% 24-HR		7.75	7.64	1.32
	1% 48-HR		7.95	7.84	1.32
N-C080	10% 24-HR	10.87	8.82	8.8	0.24
	10% 48-HR		8.83	8.81	0.24
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.34	0.12
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.95	0.12
N-C110	10% 24-HR	9.03	9.03	9	0.36
	10% 48-HR		9.05	9.02	0.36
	4% 24-HR		9.72	9.71	0.12
	4% 48-HR		9.70	9.68	0.24
	1% 24-HR		10.63	10.64	-0.12
	1% 48-HR		10.66	10.65	0.12
N-D055	10% 24-HR	7.54	7.48	7.45	0.36
	10% 48-HR		7.60	7.58	0.24
	4% 24-HR		8.17	8.13	0.48
	4% 48-HR		8.51	8.48	0.36
	1% 24-HR		9.24	9.21	0.36
	1% 48-HR		9.40	9.38	0.24
N-E010	10% 24-HR	7.03	9.41	9.4	0.12
	10% 48-HR		9.80	9.8	0.00
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.28	0.12
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.01	-0.12
N-G020	10% 24-HR	9.14	7.76	7.74	0.24
	10% 48-HR		7.90	7.88	0.24
	4% 24-HR		8.29	8.28	0.12
	4% 48-HR		8.43	8.42	0.12
	1% 24-HR		9.07	9.06	0.12
	1% 48-HR		9.25	9.24	0.12

*Results for scenario modeled with Mean Higher High Water tidal condition

Mid Basin Option C All-Node Maximum Conditions*					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.52	1.56
	10% 48-HR		3.83	3.69	1.68
	4% 24-HR		4.21	4.06	1.80
	4% 48-HR		4.37	4.25	1.44
	1% 24-HR		5.00	4.89	1.32
	1% 48-HR		5.20	5.10	1.20
N-0530	10% 24-HR	3.00	3.85	3.42	5.16
	10% 48-HR		3.78	3.64	1.68
	4% 24-HR		4.16	4.01	1.80
	4% 48-HR		4.33	4.21	1.44
	1% 24-HR		4.95	4.83	1.44
	1% 48-HR		5.15	5.05	1.20
N-A120	10% 24-HR	4.09	5.41	5.20	2.52
	10% 48-HR		5.61	5.43	2.16
	4% 24-HR		6.11	5.96	1.80
	4% 48-HR		6.28	6.15	1.56
	1% 24-HR		7.01	6.94	0.84
	1% 48-HR		7.26	7.21	0.60
N-A160	10% 24-HR	7.91	6.72	6.61	1.32
	10% 48-HR		6.89	6.79	1.20
	4% 24-HR		7.32	7.25	0.84
	4% 48-HR		7.45	7.37	0.96
	1% 24-HR		8.05	7.98	0.84
	1% 48-HR		8.25	8.17	0.96
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.86	0.12
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.21	0.12
N-B010	10% 24-HR	4.86	5.60	5.22	4.56
	10% 48-HR		5.77	5.45	3.84
	4% 24-HR		6.3	5.98	3.84
	4% 48-HR		6.46	6.17	3.48
	1% 24-HR		7.19	6.96	2.76
	1% 48-HR		7.45	7.24	2.52
N-B020	10% 24-HR	4.91	5.79	5.39	4.80
	10% 48-HR		5.94	5.59	4.20
	4% 24-HR		6.48	6.15	3.96
	4% 48-HR		6.62	6.32	3.60
	1% 24-HR		7.34	7.12	2.64
	1% 48-HR		7.57	7.39	2.16
N-B160	10% 24-HR	7.02	6.12	5.70	5.04
	10% 48-HR		6.26	5.91	4.20
	4% 24-HR		6.85	6.57	3.36
	4% 48-HR		6.97	6.69	3.36
	1% 24-HR		7.75	7.53	2.64
	1% 48-HR		7.95	7.79	1.92
N-C080	10% 24-HR	10.87	8.82	8.80	0.24
	10% 48-HR		8.83	8.82	0.12
	4% 24-HR		9.39	9.40	-0.12
	4% 48-HR		9.35	9.34	0.12
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.96	0.00
N-C110	10% 24-HR	9.03	9.03	9.00	0.36
	10% 48-HR		9.05	9.03	0.24
	4% 24-HR		9.72	9.72	0.00
	4% 48-HR		9.70	9.67	0.36
	1% 24-HR		10.63	10.64	-0.12
	1% 48-HR		10.66	10.66	0.00
N-D055	10% 24-HR	7.54	7.48	7.42	0.72
	10% 48-HR		7.60	7.57	0.36
	4% 24-HR		8.17	8.10	0.84
	4% 48-HR		8.51	8.47	0.48
	1% 24-HR		9.24	9.20	0.48
	1% 48-HR		9.40	9.37	0.36
N-E010	10% 24-HR	7.03	9.41	9.39	0.24
	10% 48-HR		9.80	9.79	0.12
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.28	0.12
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.00	0.00
N-G020	10% 24-HR	9.14	7.76	7.74	0.24
	10% 48-HR		7.90	7.87	0.36
	4% 24-HR		8.29	8.26	0.36
	4% 48-HR		8.43	8.40	0.36
	1% 24-HR		9.07	9.04	0.36
	1% 48-HR		9.25	9.21	0.48

*Results for scenario modeled with Mean Higher High Water tidal condition

WAC & Hickory Farms Channel All-Node Maximum Conditions*					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.63	0.24
	10% 48-HR		3.83	3.80	0.36
	4% 24-HR		4.21	4.17	0.48
	4% 48-HR		4.37	4.34	0.36
	1% 24-HR		5.00	4.95	0.60
	1% 48-HR		5.20	5.16	0.48
N-0530	10% 24-HR	3.00	3.85	3.55	3.60
	10% 48-HR		3.78	3.75	0.36
	4% 24-HR		4.16	4.13	0.36
	4% 48-HR		4.33	4.30	0.36
	1% 24-HR		4.95	4.90	0.60
	1% 48-HR		5.15	5.11	0.48
N-A120	10% 24-HR	4.09	5.41	5.36	0.60
	10% 48-HR		5.61	5.55	0.72
	4% 24-HR		6.11	6.04	0.84
	4% 48-HR		6.28	6.22	0.72
	1% 24-HR		7.01	6.96	0.60
	1% 48-HR		7.26	7.21	0.60
N-A160	10% 24-HR	7.91	6.72	6.70	0.24
	10% 48-HR		6.89	6.87	0.24
	4% 24-HR		7.32	7.30	0.24
	4% 48-HR		7.45	7.43	0.24
	1% 24-HR		8.05	8.03	0.24
	1% 48-HR		8.25	8.22	0.36
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.53	0.84
	10% 48-HR		5.77	5.70	0.84
	4% 24-HR		6.3	6.23	0.84
	4% 48-HR		6.46	6.39	0.84
	1% 24-HR		7.19	7.14	0.60
	1% 48-HR		7.45	7.40	0.60
N-B020	10% 24-HR	4.91	5.79	5.71	0.96
	10% 48-HR		5.94	5.87	0.84
	4% 24-HR		6.48	6.39	1.08
	4% 48-HR		6.62	6.54	0.96
	1% 24-HR		7.34	7.28	0.72
	1% 48-HR		7.57	7.53	0.48
N-B160	10% 24-HR	7.02	6.12	6.04	0.96
	10% 48-HR		6.26	6.18	0.96
	4% 24-HR		6.85	6.76	1.08
	4% 48-HR		6.97	6.88	1.08
	1% 24-HR		7.75	7.66	1.08
	1% 48-HR		7.95	7.90	0.60
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.36	-0.12
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.95	0.12
N-C110	10% 24-HR	9.03	9.03	9.04	-0.12
	10% 48-HR		9.05	9.05	0.00
	4% 24-HR		9.72	9.71	0.12
	4% 48-HR		9.70	9.71	-0.12
	1% 24-HR		10.63	10.63	0.00
	1% 48-HR		10.66	10.65	0.12
N-D055	10% 24-HR	7.54	7.48	7.47	0.12
	10% 48-HR		7.60	7.59	0.12
	4% 24-HR		8.17	8.15	0.24
	4% 48-HR		8.51	8.50	0.12
	1% 24-HR		9.24	9.22	0.24
	1% 48-HR		9.40	9.39	0.12
N-E010	10% 24-HR	7.03	9.41	9.41	0.00
	10% 48-HR		9.80	9.81	-0.12
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.00	0.00
N-G020	10% 24-HR	9.14	7.76	7.75	0.12
	10% 48-HR		7.90	7.89	0.12
	4% 24-HR		8.29	8.29	0.00
	4% 48-HR		8.43	8.43	0.00
	1% 24-HR		9.07	9.06	0.12
	1% 48-HR		9.25	9.24	0.12

*Results for scenario modeled with Mean Higher High Water tidal condition

CSX-Whitfield Channel (Phase 1) All-Node Maximum Conditions *					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.65	0.00
	10% 48-HR		3.83	3.83	0.00
	4% 24-HR		4.21	4.21	0.00
	4% 48-HR		4.37	4.38	-0.12
	1% 24-HR		5.00	5.00	0.00
	1% 48-HR		5.20	5.20	0.00
N-0530	10% 24-HR	3.00	3.85	3.59	3.12
	10% 48-HR		3.78	3.79	-0.12
	4% 24-HR		4.16	4.17	-0.12
	4% 48-HR		4.33	4.33	0.00
	1% 24-HR		4.95	4.95	0.00
	1% 48-HR		5.15	5.15	0.00
N-A120	10% 24-HR	4.09	5.41	5.42	-0.12
	10% 48-HR		5.61	5.61	0.00
	4% 24-HR		6.11	6.11	0.00
	4% 48-HR		6.28	6.28	0.00
	1% 24-HR		7.01	7.02	-0.12
	1% 48-HR		7.26	7.27	-0.12
N-A160	10% 24-HR	7.91	6.72	6.72	0.00
	10% 48-HR		6.89	6.90	-0.12
	4% 24-HR		7.32	7.32	0.00
	4% 48-HR		7.45	7.46	-0.12
	1% 24-HR		8.05	8.04	0.12
	1% 48-HR		8.25	8.24	0.12
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.61	-0.12
	10% 48-HR		5.77	5.78	-0.12
	4% 24-HR		6.3	6.30	0.00
	4% 48-HR		6.46	6.46	0.00
	1% 24-HR		7.19	7.20	-0.12
	1% 48-HR		7.45	7.46	-0.12
N-B020	10% 24-HR	4.91	5.79	5.79	0.00
	10% 48-HR		5.94	5.95	-0.12
	4% 24-HR		6.48	6.48	0.00
	4% 48-HR		6.62	6.62	0.00
	1% 24-HR		7.34	7.34	0.00
	1% 48-HR		7.57	7.58	-0.12
N-B160	10% 24-HR	7.02	6.12	6.12	0.00
	10% 48-HR		6.26	6.27	-0.12
	4% 24-HR		6.85	6.85	0.00
	4% 48-HR		6.97	6.98	-0.12
	1% 24-HR		7.75	7.75	0.00
	1% 48-HR		7.95	7.96	-0.12
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.35	0.00
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.95	0.12
N-C110	10% 24-HR	9.03	9.03	9.04	-0.12
	10% 48-HR		9.05	9.05	0.00
	4% 24-HR		9.72	9.71	0.12
	4% 48-HR		9.70	9.71	-0.12
	1% 24-HR		10.63	10.63	0.00
	1% 48-HR		10.66	10.65	0.12
N-D055	10% 24-HR	7.54	7.48	7.49	-0.12
	10% 48-HR		7.60	7.60	0.00
	4% 24-HR		8.17	8.17	0.00
	4% 48-HR		8.51	8.51	0.00
	1% 24-HR		9.24	9.23	0.12
	1% 48-HR		9.40	9.40	0.00
N-E010	10% 24-HR	7.03	9.41	9.41	0.00
	10% 48-HR		9.80	9.80	0.00
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.01	-0.12
N-G020	10% 24-HR	9.14	7.76	7.76	0.00
	10% 48-HR		7.90	7.90	0.00
	4% 24-HR		8.29	8.30	-0.12
	4% 48-HR		8.43	8.44	-0.12
	1% 24-HR		9.07	9.07	0.00
	1% 48-HR		9.25	9.25	0.00

*Results for scenario modeled with Mean Higher High Water tidal condition

CSX-Whitfield Channel (Phase 1 & 2) All-Node Maximum Conditions*					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.65	0.00
	10% 48-HR		3.83	3.84	-0.12
	4% 24-HR		4.21	4.25	-0.48
	4% 48-HR		4.37	4.42	-0.60
	1% 24-HR		5.00	5.06	-0.72
	1% 48-HR		5.20	5.26	-0.72
N-0530	10% 24-HR	3.00	3.85	3.59	3.12
	10% 48-HR		3.78	3.80	-0.24
	4% 24-HR		4.16	4.20	-0.48
	4% 48-HR		4.33	4.37	-0.48
	1% 24-HR		4.95	5.01	-0.72
	1% 48-HR		5.15	5.21	-0.72
N-A120	10% 24-HR	4.09	5.41	5.44	-0.36
	10% 48-HR		5.61	5.66	-0.60
	4% 24-HR		6.11	6.17	-0.72
	4% 48-HR		6.28	6.35	-0.84
	1% 24-HR		7.01	7.11	-1.20
	1% 48-HR		7.26	7.36	-1.20
N-A160	10% 24-HR	7.91	6.72	6.20	6.24
	10% 48-HR		6.89	6.43	5.52
	4% 24-HR		7.32	6.93	4.68
	4% 48-HR		7.45	7.09	4.32
	1% 24-HR		8.05	7.74	3.72
	1% 48-HR		8.25	7.94	3.72
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.61	-0.12
	10% 48-HR		5.77	5.80	-0.36
	4% 24-HR		6.3	6.35	-0.60
	4% 48-HR		6.46	6.51	-0.60
	1% 24-HR		7.19	7.28	-1.08
	1% 48-HR		7.45	7.54	-1.08
N-B020	10% 24-HR	4.91	5.79	5.78	0.12
	10% 48-HR		5.94	5.95	-0.12
	4% 24-HR		6.48	6.50	-0.24
	4% 48-HR		6.62	6.65	-0.36
	1% 24-HR		7.34	7.40	-0.72
	1% 48-HR		7.57	7.65	-0.96
N-B160	10% 24-HR	7.02	6.12	6.10	0.24
	10% 48-HR		6.26	6.25	0.12
	4% 24-HR		6.85	6.85	0.00
	4% 48-HR		6.97	6.97	0.00
	1% 24-HR		7.75	7.77	-0.24
	1% 48-HR		7.95	8.01	-0.72
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.35	0.00
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.95	0.12
N-C110	10% 24-HR	9.03	9.03	9.04	-0.12
	10% 48-HR		9.05	9.06	-0.12
	4% 24-HR		9.72	9.71	0.12
	4% 48-HR		9.70	9.70	0.00
	1% 24-HR		10.63	10.64	-0.12
	1% 48-HR		10.66	10.65	0.12
N-D055	10% 24-HR	7.54	7.48	7.48	0.00
	10% 48-HR		7.60	7.59	0.12
	4% 24-HR		8.17	8.17	0.00
	4% 48-HR		8.51	8.52	-0.12
	1% 24-HR		9.24	9.24	0.00
	1% 48-HR		9.40	9.41	-0.12
N-E010	10% 24-HR	7.03	9.41	9.41	0.00
	10% 48-HR		9.80	9.81	-0.12
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.01	-0.12
N-G020	10% 24-HR	9.14	7.76	7.24	6.24
	10% 48-HR		7.90	7.31	7.08
	4% 24-HR		8.29	7.61	8.16
	4% 48-HR		8.43	7.73	8.40
	1% 24-HR		9.07	8.38	8.28
	1% 48-HR		9.25	8.59	7.92

*Results for scenario modeled with Mean Higher High Water tidal condition

Combination: WAC & Mid Basin Option B All-Node Maximum Conditions *					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.59	0.72
	10% 48-HR		3.83	3.76	0.84
	4% 24-HR		4.21	4.14	0.84
	4% 48-HR		4.37	4.31	0.72
	1% 24-HR		5.00	4.94	0.72
	1% 48-HR		5.20	5.16	0.48
N-0530	10% 24-HR	3.00	3.85	3.51	4.08
	10% 48-HR		3.78	3.71	0.84
	4% 24-HR		4.16	4.10	0.72
	4% 48-HR		4.33	4.27	0.72
	1% 24-HR		4.95	4.89	0.72
	1% 48-HR		5.15	5.10	0.60
N-A120	10% 24-HR	4.09	5.41	5.29	1.44
	10% 48-HR		5.61	5.50	1.32
	4% 24-HR		6.11	6.01	1.20
	4% 48-HR		6.28	6.19	1.08
	1% 24-HR		7.01	6.95	0.72
	1% 48-HR		7.26	7.21	0.60
N-A160	10% 24-HR	7.91	6.72	6.67	0.60
	10% 48-HR		6.89	6.85	0.48
	4% 24-HR		7.32	7.29	0.36
	4% 48-HR		7.45	7.42	0.36
	1% 24-HR		8.05	8.02	0.36
	1% 48-HR		8.25	8.22	0.36
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.32	3.36
	10% 48-HR		5.77	5.52	3.00
	4% 24-HR		6.3	6.03	3.24
	4% 48-HR		6.46	6.21	3.00
	1% 24-HR		7.19	6.97	2.64
	1% 48-HR		7.45	7.24	2.52
N-B020	10% 24-HR	4.91	5.79	5.51	3.36
	10% 48-HR		5.94	5.67	3.24
	4% 24-HR		6.48	6.21	3.24
	4% 48-HR		6.62	6.37	3.00
	1% 24-HR		7.34	7.13	2.52
	1% 48-HR		7.57	7.39	2.16
N-B160	10% 24-HR	7.02	6.12	5.86	3.12
	10% 48-HR		6.26	6.02	2.88
	4% 24-HR		6.85	6.62	2.76
	4% 48-HR		6.97	6.74	2.76
	1% 24-HR		7.75	7.53	2.64
	1% 48-HR		7.95	7.79	1.92
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.35	0.00
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.96	0.00
N-C110	10% 24-HR	9.03	9.03	9.04	-0.12
	10% 48-HR		9.05	9.06	-0.12
	4% 24-HR		9.72	9.70	0.24
	4% 48-HR		9.70	9.70	0.00
	1% 24-HR		10.63	10.64	-0.12
	1% 48-HR		10.66	10.68	-0.24
N-D055	10% 24-HR	7.54	7.48	7.44	0.48
	10% 48-HR		7.60	7.57	0.36
	4% 24-HR		8.17	8.11	0.72
	4% 48-HR		8.51	8.47	0.48
	1% 24-HR		9.24	9.20	0.48
	1% 48-HR		9.40	9.37	0.36
N-E010	10% 24-HR	7.03	9.41	9.43	-0.24
	10% 48-HR		9.80	9.80	0.00
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.00	0.00
N-G020	10% 24-HR	9.14	7.76	7.75	0.12
	10% 48-HR		7.90	7.88	0.24
	4% 24-HR		8.29	8.29	0.00
	4% 48-HR		8.43	8.43	0.00
	1% 24-HR		9.07	9.06	0.12
	1% 48-HR		9.25	9.24	0.12

*Results for scenario modeled with Mean Higher High Water tidal condition

Combination: CSX-Whitfield & Mid Basin Option B All-Node Maximum Conditions *					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.65	0.00
	10% 48-HR		3.83	3.84	-0.12
	4% 24-HR		4.21	4.24	-0.36
	4% 48-HR		4.37	4.41	-0.48
	1% 24-HR		5.00	5.03	-0.36
	1% 48-HR		5.20	5.23	-0.36
N-0530	10% 24-HR	3.00	3.85	3.59	3.12
	10% 48-HR		3.78	3.79	-0.12
	4% 24-HR		4.16	4.19	-0.36
	4% 48-HR		4.33	4.36	-0.36
	1% 24-HR		4.95	4.98	-0.36
	1% 48-HR		5.15	5.18	-0.36
N-A120	10% 24-HR	4.09	5.41	5.34	0.84
	10% 48-HR		5.61	5.53	0.96
	4% 24-HR		6.11	6.07	0.48
	4% 48-HR		6.28	6.23	0.60
	1% 24-HR		7.01	6.95	0.72
	1% 48-HR		7.26	7.21	0.60
N-A160	10% 24-HR	7.91	6.72	6.75	-0.36
	10% 48-HR		6.89	6.94	-0.60
	4% 24-HR		7.32	7.38	-0.72
	4% 48-HR		7.45	7.54	-1.08
	1% 24-HR		8.05	8.22	-2.04
	1% 48-HR		8.25	8.38	-1.56
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.36	2.88
	10% 48-HR		5.77	5.56	2.52
	4% 24-HR		6.3	6.09	2.52
	4% 48-HR		6.46	6.25	2.52
	1% 24-HR		7.19	6.96	2.76
	1% 48-HR		7.45	7.24	2.52
N-B020	10% 24-HR	4.91	5.79	5.60	2.28
	10% 48-HR		5.94	5.76	2.16
	4% 24-HR		6.48	6.30	2.16
	4% 48-HR		6.62	6.44	2.16
	1% 24-HR		7.34	7.16	2.16
	1% 48-HR		7.57	7.39	2.16
N-B160	10% 24-HR	7.02	6.12	5.97	1.80
	10% 48-HR		6.26	6.12	1.68
	4% 24-HR		6.85	6.73	1.44
	4% 48-HR		6.97	6.85	1.44
	1% 24-HR		7.75	7.65	1.20
	1% 48-HR		7.95	7.81	1.68
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.40	-0.12
	4% 48-HR		9.35	9.35	0.00
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.96	0.00
N-C110	10% 24-HR	9.03	9.03	9.04	-0.12
	10% 48-HR		9.05	9.06	-0.12
	4% 24-HR		9.72	9.73	-0.12
	4% 48-HR		9.70	9.70	0.00
	1% 24-HR		10.63	10.64	-0.12
	1% 48-HR		10.66	10.66	0.00
N-D055	10% 24-HR	7.54	7.48	7.45	0.36
	10% 48-HR		7.60	7.57	0.36
	4% 24-HR		8.17	8.14	0.36
	4% 48-HR		8.51	8.47	0.48
	1% 24-HR		9.24	9.21	0.36
	1% 48-HR		9.40	9.38	0.24
N-E010	10% 24-HR	7.03	9.41	9.41	0.00
	10% 48-HR		9.80	9.80	0.00
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.01	-0.12
N-G020	10% 24-HR	9.14	7.76	7.34	5.04
	10% 48-HR		7.90	7.49	4.92
	4% 24-HR		8.29	7.92	4.44
	4% 48-HR		8.43	8.07	4.32
	1% 24-HR		9.07	8.75	3.84
	1% 48-HR		9.25	8.94	3.72

*Results for scenario modeled with Mean Higher High Water tidal condition

Combination: CSX-Whitfield & WAC All-Node Maximum Conditions *					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.66	-0.12
	10% 48-HR		3.83	3.84	-0.12
	4% 24-HR		4.21	4.23	-0.24
	4% 48-HR		4.37	4.40	-0.36
	1% 24-HR		5.00	5.03	-0.36
	1% 48-HR		5.20	5.23	-0.36
N-0530	10% 24-HR	3.00	3.85	3.59	3.12
	10% 48-HR		3.78	3.79	-0.12
	4% 24-HR		4.16	4.18	-0.24
	4% 48-HR		4.33	4.35	-0.24
	1% 24-HR		4.95	4.98	-0.36
	1% 48-HR		5.15	5.17	-0.24
N-A120	10% 24-HR	4.09	5.41	5.44	-0.36
	10% 48-HR		5.61	5.64	-0.36
	4% 24-HR		6.11	6.14	-0.36
	4% 48-HR		6.28	6.32	-0.48
	1% 24-HR		7.01	7.07	-0.72
	1% 48-HR		7.26	7.32	-0.72
N-A160	10% 24-HR	7.91	6.72	6.22	6.00
	10% 48-HR		6.89	6.45	5.28
	4% 24-HR		7.32	6.97	4.20
	4% 48-HR		7.45	7.12	3.96
	1% 24-HR		8.05	7.77	3.36
	1% 48-HR		8.25	7.97	3.36
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.23	-0.12
N-B010	10% 24-HR	4.86	5.60	5.59	0.12
	10% 48-HR		5.77	5.78	-0.12
	4% 24-HR		6.3	6.30	0.00
	4% 48-HR		6.46	6.47	-0.12
	1% 24-HR		7.19	7.23	-0.48
	1% 48-HR		7.45	7.50	-0.60
N-B020	10% 24-HR	4.91	5.79	5.75	0.48
	10% 48-HR		5.94	5.92	0.24
	4% 24-HR		6.48	6.45	0.36
	4% 48-HR		6.62	6.60	0.24
	1% 24-HR		7.34	7.35	-0.12
	1% 48-HR		7.57	7.61	-0.48
N-B160	10% 24-HR	7.02	6.12	6.07	0.60
	10% 48-HR		6.26	6.21	0.60
	4% 24-HR		6.85	6.79	0.72
	4% 48-HR		6.97	6.92	0.60
	1% 24-HR		7.75	7.70	0.60
	1% 48-HR		7.95	7.97	-0.24
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.35	0.00
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.96	0.00
N-C110	10% 24-HR	9.03	9.03	9.03	0.00
	10% 48-HR		9.05	9.06	-0.12
	4% 24-HR		9.72	9.71	0.12
	4% 48-HR		9.70	9.70	0.00
	1% 24-HR		10.63	10.64	-0.12
	1% 48-HR		10.66	10.66	0.00
N-D055	10% 24-HR	7.54	7.48	7.48	0.00
	10% 48-HR		7.60	7.59	0.12
	4% 24-HR		8.17	8.16	0.12
	4% 48-HR		8.51	8.51	0.00
	1% 24-HR		9.24	9.23	0.12
	1% 48-HR		9.40	9.40	0.00
N-E010	10% 24-HR	7.03	9.41	9.41	0.00
	10% 48-HR		9.80	9.81	-0.12
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.01	-0.12
N-G020	10% 24-HR	9.14	7.76	7.29	5.64
	10% 48-HR		7.90	7.39	6.12
	4% 24-HR		8.29	7.77	6.24
	4% 48-HR		8.43	7.89	6.48
	1% 24-HR		9.07	8.54	6.36
	1% 48-HR		9.25	8.73	6.24

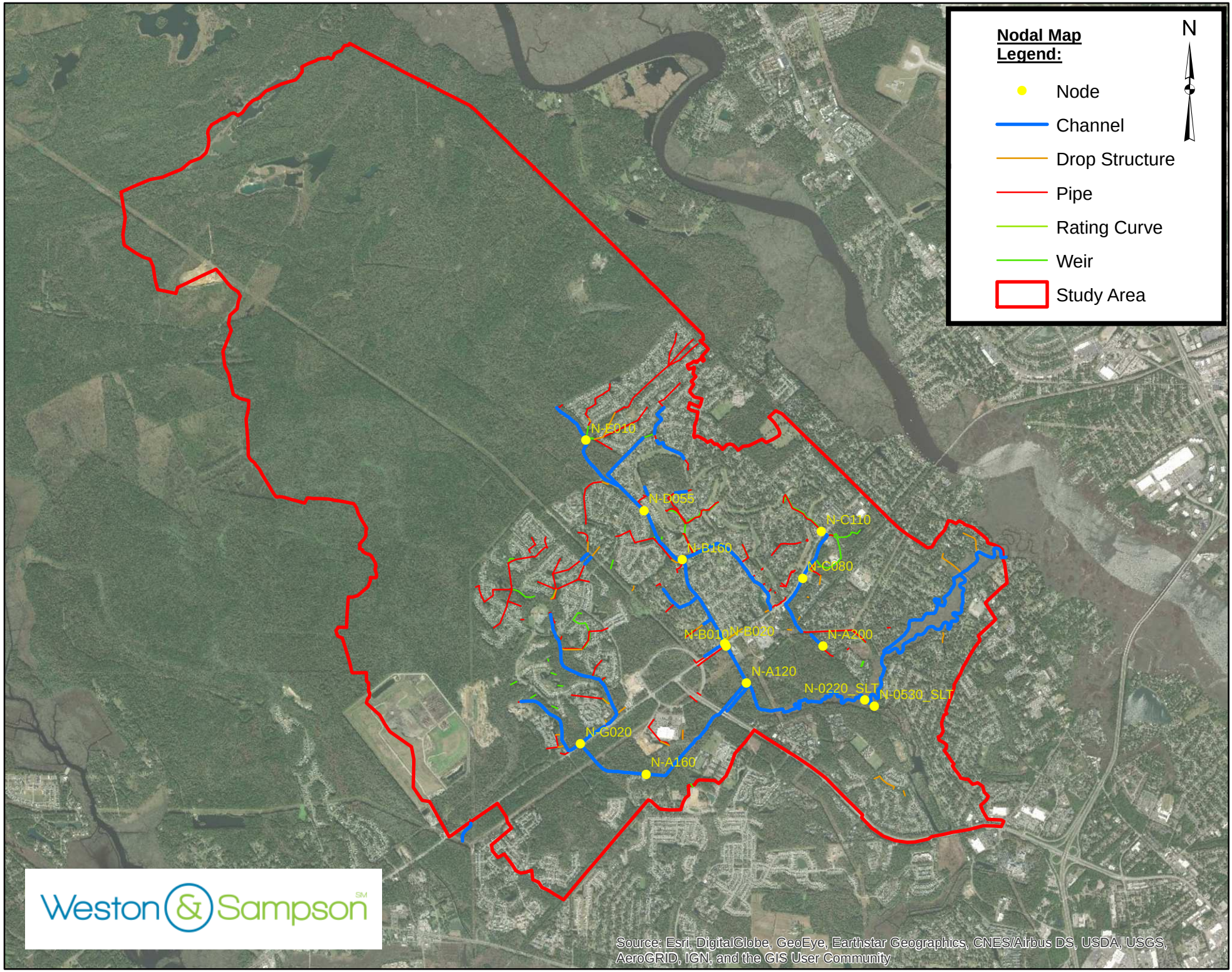
*Results for scenario modeled with Mean Higher High Water tidal condition

Combination: Mid Basin B & CSX-Whitfield & WAC All-Node Maximum Conditions*					
Node Name	Simulation	Warning Stage (ft)	Existing Stage (ft)	Proposed Stage (ft)	Δ (in) Exist-Prop
N-0220	10% 24-HR	3.00	3.65	3.59	0.72
	10% 48-HR		3.83	3.77	0.72
	4% 24-HR		4.21	4.18	0.36
	4% 48-HR		4.37	4.35	0.24
	1% 24-HR		5.00	5.00	0.00
	1% 48-HR		5.20	5.20	0.00
N-0530	10% 24-HR	3.00	3.85	3.50	4.20
	10% 48-HR		3.78	3.72	0.72
	4% 24-HR		4.16	4.13	0.36
	4% 48-HR		4.33	4.31	0.24
	1% 24-HR		4.95	4.95	0.00
	1% 48-HR		5.15	5.14	0.12
N-A120	10% 24-HR	4.09	5.41	5.28	1.56
	10% 48-HR		5.61	5.50	1.32
	4% 24-HR		6.11	6.04	0.84
	4% 48-HR		6.28	6.24	0.48
	1% 24-HR		7.01	7.02	-0.12
	1% 48-HR		7.26	7.26	0.00
N-A160	10% 24-HR	7.91	6.72	6.39	3.96
	10% 48-HR		6.89	6.62	3.24
	4% 24-HR		7.32	7.09	2.76
	4% 48-HR		7.45	7.24	2.52
	1% 24-HR		8.05	7.88	2.04
	1% 48-HR		8.25	8.07	2.16
N-A200	10% 24-HR	7.72	6.10	6.10	0.00
	10% 48-HR		5.87	5.87	0.00
	4% 24-HR		6.30	6.30	0.00
	4% 48-HR		5.97	5.97	0.00
	1% 24-HR		6.54	6.54	0.00
	1% 48-HR		6.22	6.22	0.00
N-B010	10% 24-HR	4.86	5.60	5.30	3.60
	10% 48-HR		5.77	5.52	3.00
	4% 24-HR		6.3	6.06	2.88
	4% 48-HR		6.46	6.25	2.52
	1% 24-HR		7.19	7.02	2.04
	1% 48-HR		7.45	7.29	1.92
N-B020	10% 24-HR	4.91	5.79	5.48	3.72
	10% 48-HR		5.94	5.66	3.36
	4% 24-HR		6.48	6.23	3.00
	4% 48-HR		6.62	6.40	2.64
	1% 24-HR		7.34	7.17	2.04
	1% 48-HR		7.57	7.43	1.68
N-B160	10% 24-HR	7.02	6.12	5.84	3.36
	10% 48-HR		6.26	6.00	3.12
	4% 24-HR		6.85	6.63	2.64
	4% 48-HR		6.97	6.75	2.64
	1% 24-HR		7.75	7.56	2.28
	1% 48-HR		7.95	7.82	1.56
N-C080	10% 24-HR	10.87	8.82	8.82	0.00
	10% 48-HR		8.83	8.83	0.00
	4% 24-HR		9.39	9.39	0.00
	4% 48-HR		9.35	9.35	0.00
	1% 24-HR		9.98	9.98	0.00
	1% 48-HR		9.96	9.95	0.12
N-C110	10% 24-HR	9.03	9.03	9.03	0.00
	10% 48-HR		9.05	9.05	0.00
	4% 24-HR		9.72	9.71	0.12
	4% 48-HR		9.70	9.71	-0.12
	1% 24-HR		10.63	10.63	0.00
	1% 48-HR		10.66	10.65	0.12
N-D055	10% 24-HR	7.54	7.48	7.43	0.60
	10% 48-HR		7.60	7.57	0.36
	4% 24-HR		8.17	8.11	0.72
	4% 48-HR		8.51	8.48	0.36
	1% 24-HR		9.24	9.21	0.36
	1% 48-HR		9.40	9.38	0.24
N-E010	10% 24-HR	7.03	9.41	9.41	0.00
	10% 48-HR		9.80	9.80	0.00
	4% 24-HR		10.03	10.03	0.00
	4% 48-HR		10.29	10.29	0.00
	1% 24-HR		10.83	10.82	0.12
	1% 48-HR		11.00	11.00	0.00
N-G020	10% 24-HR	9.14	7.76	7.41	4.20
	10% 48-HR		7.90	7.51	4.68
	4% 24-HR		8.29	7.87	5.04
	4% 48-HR		8.43	7.99	5.28
	1% 24-HR		9.07	8.63	5.28
	1% 48-HR		9.25	8.81	5.28

*Results for scenario modeled with Mean Higher High Water tidal condition

APPENDIX C

Key Basin Node Map


Nodal Map
Legend:
Node
Channel
Drop Structure
Pipe
Rating Curve
Weir
Study Area
N
N-E010
N-D055
N-C110
N-B160
N-C080
N-B010
N-B020
N-A200
N-A120
N-0220_SLT
N-0530_SLT
N-G020
N-A160
Weston & Sampson
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

APPENDIX D

Flood Inundation Maps

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

- Option A: Flood levels above 8"
- Existing: Flood levels above 8"
- Study Area

N

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson℠

0 2,250 4,500 9,000 13,500 18,000 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

- Mid-Basin Storage: Flood levels above 8"
- Existing: Flood levels above 8"
- Study Area

N

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson SM

0 2,250 4,500 9,000 13,500 18,000 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

- Option C: Flood levels above 8"
- Existing: Flood levels above 8"
- Study Area

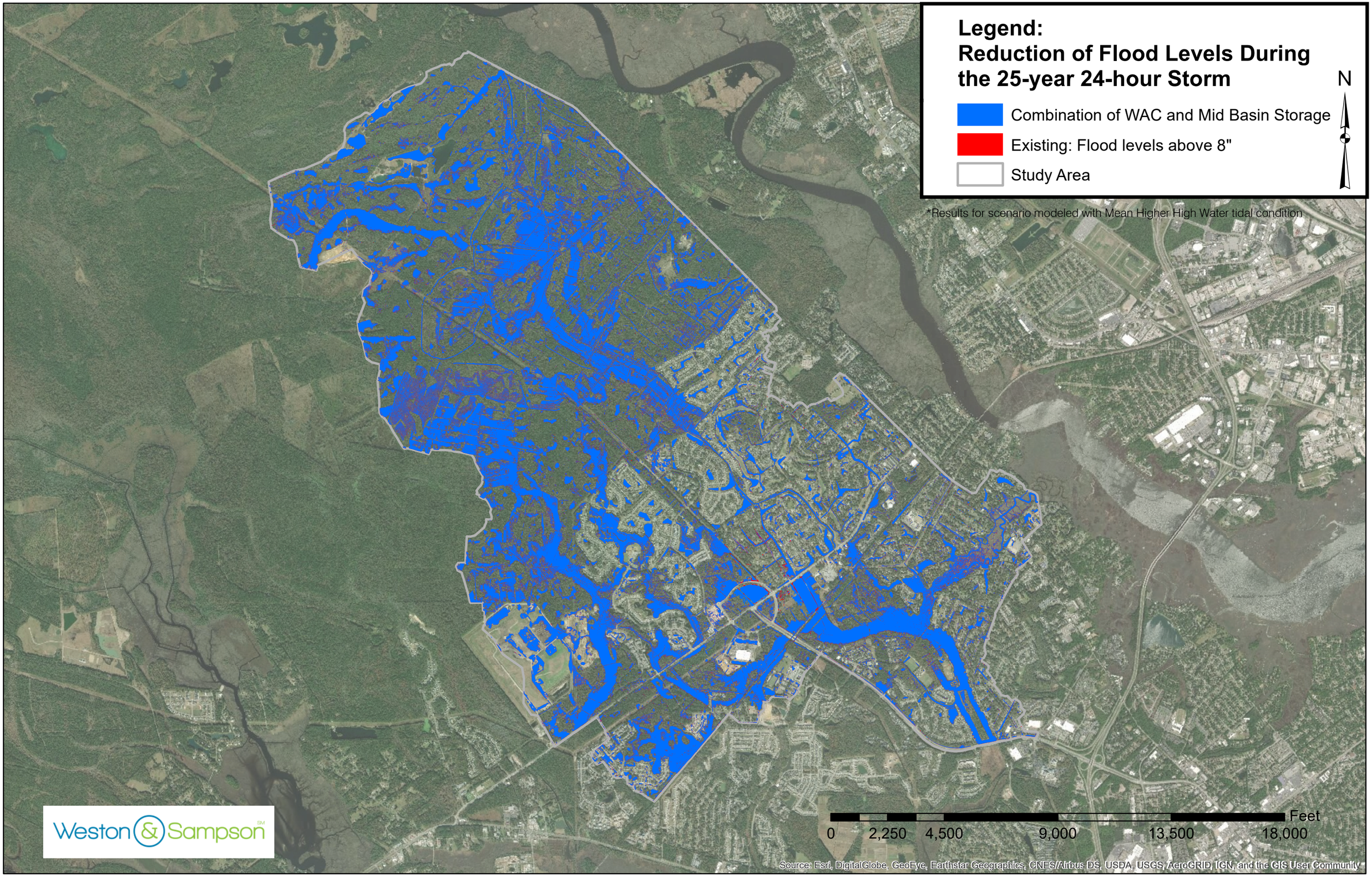
N

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson

0 2,250 4,500 9,000 13,500 18,000 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm
N
Combination of WAC and Mid Basin Storage
Existing: Flood levels above 8"
Study Area
*Results for scenario modeled with Mean Higher High Water tidal condition
Weston & Sampson
Feet
0
2,250
4,500
9,000
13,500
18,000
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

- Combination of WAC, Mid Basin Storage and Whitfield Channel
- Existing: Flood levels above 8"
- Study Area

N

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson℠

0 2,250 4,500 9,000 13,500 18,000 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

N

WAC Storage Facility Flood Levels above 8"

Existing: Flood levels above 8"

Study Area

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson SM

Feet

0 2,250 4,500 9,000 13,500 18,000

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

Combination: Whitfield Channel and Mid Basin Storage

Existing: Flood levels above 8"

Study Area

N

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson SM

Feet
0 2,250 4,500 9,000 13,500 18,000

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend:
Reduction of Flood Levels During the 25-year 24-hour Storm

- Combination Whitfield Channel and WAC
- Existing: Flood levels above 8"
- Study Area

N

*Results for scenario modeled with Mean Higher High Water tidal condition

Weston & Sampson℠

0 2,250 4,500 9,000 13,500 18,000 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

APPENDIX E

Conceptual Elevation Plans

Conceptual Elevation Plan

Legend

Elevation

High : 25

Low : -1

Hickory Farms
Overland Flow
Diversion Channel

West Ashley Circle
Storage Facility

Mid-Basin
Storage

CSX-Whitfield
Channel Phase 1

CSX-Whitfield
Channel Phase 2

0 325 650 1,300 1,950 2,600 3,250
Feet

APPENDIX F

Prioritization Tool Results

100-yr 24-hr Event											
Proposed improvement	Area (ac) of the proposed improvement	Sum of the maximum positive water surface elevation change (in) across 13 key basin nodes.	Sum of the maximum negative water surface elevation change (in) across 13 key basin nodes.	Net positive water surface elevation change (in) across 13 key basin nodes multiplied by a factor of 10.	1.Net positive water surface elevation change (in) per unit of area (ac) multiplied by a factor of 10.	2.Number of net positively impacted nodes of of the 13 key basin nodes.*	3.Decrease in time (hr) spent above the flood evelavtion at N-B020.	4.Potential for beneficial use beyond stormwater storage/conveyance (0-5).	5.Maintainability of improvement after construction (0-5).	Sum of 1-5.	Sum of 1-5 as a whole number.
Mid Basin A	3.6	2.88	0.6	22.80	6.33	4	0	4	3	17.33	**17**
Mid Basin B	12	5.88	0.12	57.60	4.80	7	2	5	4	22.80	**23**
Mid Basin C	40	13.44	0.12	133.20	3.33	9	0	4	4	20.33	**20**
WAC (&Hic Farms)	16	4.92	0	49.20	3.08	10	-1	4	3	19.08	**19**
CSX-Whitfield	13	12.12	4.8	73.20	5.63	-4	2	0	2	5.63	**6**
Mid-WAC	28	11.04	0.12	109.20	3.90	9	1	5	4	22.90	**23**
Mid-Whit	25	11.16	2.88	82.80	3.31	3	3	5	3	17.31	**17**
WAC-Whit	29	10.56	2.16	84.00	2.90	-1	0	4	2	7.90	**8**
Mid-WAC-Whit	41	14.16	0.12	140.4	3.42	6	4	5	3	21.42	**21**

25-yr 24-hr Event											
Proposed improvement	Area (ac) of the proposed improvement	Sum of the maximum positive water surface elevation change (in) across 13 key basin nodes.	Sum of the maximum negative water surface elevation change (in) across 13 key basin nodes.	Net positive water surface elevation change (in) across 13 key basin nodes multiplied by a factor of 10.	1.Net positive water surface elevation change (in) per unit of area (ac) multiplied by a factor of 10.	2.Number of net positively impacted nodes of of the 13 key basin nodes.*	3.Decrease in time (hr) spent above the flood evelavtion at N-B020.	4.Potential for beneficial use beyond stormwater storage/conveyance (0-5).	5.Maintainability of improvement after construction (0-5).	Sum of 1-5.	Sum of 1-5 as a whole number.
Mid Basin A	3.6	3.48	0	34.80	9.67	6	1	4	3	23.67	**24**
Mid Basin B	12	8.04	0	80.40	6.70	10	2	5	4	27.70	**28**
Mid Basin C	40	18.6	0.12	184.80	4.62	9	1	4	4	22.62	**23**
WAC (&Hic Farms)	16	5.28	0	52.80	3.30	9	-1	4	3	18.30	**18**
CSX-Whitfield	13	12.96	2.52	104.40	8.03	-2	2	0	2	10.03	**10**
Mid-WAC	28	13.32	0	133.20	4.76	9	1	5	4	23.76	**24**
Mid-Whit	25	11.4	1.68	97.20	3.89	1	4	5	3	16.89	**17**
WAC-Whit	29	11.76	0.84	109.20	3.77	3	1	4	2	13.77	**14**
Mid-WAC-Whit	41	18.72	0	187.2	4.57	10	4	5	3	26.57	**27**

10-yr 24-hr Event											
Proposed improvement	Area (ac) of the proposed improvement	Sum of the maximum positive water surface elevation change (in) across 13 key basin nodes.	Sum of the maximum negative water surface elevation change (in) across 13 key basin nodes.	Net positive water surface elevation change (in) across 13 key basin nodes multiplied by a factor of 10.	1.Net positive water surface elevation change (in) per unit of area (ac) multiplied by a factor of 10.	2.Number of net positively impacted nodes of of the 13 key basin nodes.*	3.Decrease in time (hr) spent above the flood evelavtion at N-B020.	4.Potential for beneficial use beyond stormwater storage/conveyance (0-5).	5.Maintainability of improvement after construction (0-5).	Sum of 1-5.	Sum of 1-5 as a whole number.
Mid Basin A	3.6	8.28	0	82.80	23.00	11	2	4	3	43.00	**43**
Mid Basin B	12	15.12	0	151.20	12.60	12	4	5	4	37.60	**38**
Mid Basin C	40	26.76	0	267.60	6.69	12	4	4	4	30.69	**31**
WAC (&Hic Farms)	16	7.68	0.12	75.60	4.73	8	-1	4	3	18.73	**19**
CSX-Whitfield	13	15.96	0.6	153.60	11.82	2	2	0	2	17.82	**18**
Mid-WAC	28	17.28	0.36	169.20	6.04	7	3	5	4	25.04	**25**
Mid-Whit	25	16.32	0.48	158.40	6.34	5	5	5	3	24.34	**24**
WAC-Whit	29	15.96	0.48	154.80	5.34	4	1	4	2	16.34	**16**
Mid-WAC-Whit	41	25.92	0	259.2	6.32	8	6	5	3	28.32	**28**

*Nodes with zero impact were not included in the count.

BENEFICIAL USE

0 = No additional benefits.
1 = Provides little to no additional benefits and is not easily implemented.
2 = Provides additional benefits but is not easily implemented.
3 = Provides additional benefits and can be implemented.
4 = Provides mixed use benefits and can be implemented.
5 = Provides mixed use benefits and is easily implemented.

MAINTAINABILITY

0 = Substantial maintenance required and very difficult to access.
1 = Difficult to maintain due to lack of access.
2 = Substantial amount of manitenance required.
3 = Requires some maintenance and has easy access.
4 = Minimal maintenance, easy to maintain and easy access.
5 = Little to no maintenance required after initial construction.