Intended for
Sauquoit Creek Basin Intermunicipal Commission

Document type
Draft Report v.1.0

Date
July 2020

RAMBOLL - SAUQUOIT CREEK DRAINAGE STUDY
ALTERNATIVE DESIGN

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Project name	**Sauquoit Creek Drainage Study**
Project no.	**20908.74959**
Recipient	**Sauquoit Creek Basin Intermunicipal Commission**
Document type	**Report**
Version	**1**
Date	**July 10, 2020**
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RAMBOLL - SAUQUOIT CREEK DRAINAGE STUDY ALTERNATIVE DESIGN ANALYSIS

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CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

APPENDICES

1. ALTERNATIVE DESIGN ANALYSIS

This report summarizes the results and discussions of several alternative mitigation strategies to reduce the flooding risk through the residential community in Sauquoit Creek's floodplain. Each alterative was studied in unsteady state two-dimensional hydrodynamic modeling and the outcome evaluated for the 2019 November storm (Halloween Storm in 2019) hydrograph. This report can also be considered as a follow up report to the previously submitted study titled *Sauquoit Creek Drainage Study-Findings of 2019 Halloween Storm - Hydraulic Modeling* dated May 11, 2020 and submitted to the Sauquoit Creek Basin Intermunicipal Commission.

1.1 Introduction

The report submitted to the Sauquoit Creek Basin Intermunicipal Commission, dated May 11, 2020 includes the 2D hydraulics modelling of the evolution of 2019 Halloween storm through the communities. Impacts of hydrodynamic and hydrostatic forces on houses and building were evaluated and included in the report. The model was developed utilizing the observed flow hydrograph, associate with the USGS 01339060-gauge station data, for the Halloween 2019 Storm (between 31-OCT-2019 15:00:00 and 01:NOV-2019 15:00:00 with the peak at 31-OCT-2019 22:28:00). The 2D hydrodynamic model was calibrated to reproduce the high-water mark observed near the residential property at No. 33 Sauquoit Street. The topography for the 2D simulations included a 2-meter LiDAR Digital Elevation Model (DEM) surface collected in 2008 that was downloaded from http://www.orthos.dhses.ny.gov, and the survey collected of the First Floor Elevations (FFE), Lowest Adjacent Grades (LAG), Lowest Point of Entry (LPE) and roadway centerline survey points of each building within the community in February 28, 2020 by Prudent Engineering LLP. The channel bathymetry was corrected from the hydro-flattened DEM using the 2017 surveyed cross sections along the Sauquoit Creek from Prudent Engineering LLP.

The alternatives for this study (discussed in this report) were developed by adding geometric changes to the computational topography to gain hydraulic changes that will result in reduced flooding depths (stage) and reduced resident times, by reducing the backwater effects due to existing capacities of the infrastructures, and the shape of the overland area, including undeveloped and developed areas.

Each alternative does not represent a final design, but is intended to be an indication of how each would impact the communities. Further analyses, with more attention to detail of the design and the benefit to cost ratio, is required to fully evaluate selected alternatives.

Each alterative is added incrementally in addition to the already proposed flood bench at CSX (Phase II project at CSX) in the Village of Whitesboro, NY. Benefit is defined as a reduction in water level (stage) at three representative locations; 1. At the front yard of Whitesboro Middle School, 2. At Gardner Street, and 3. At Dunham Place. These locations were selected to represent the change in topography, overland slope, and locations of past repetitive losses. By looking at the alternatives impact in these locations, one can evaluate if the benefit is effective only locally, in the vicinity of the alternative, or more generally in all three locations. The water

level comparison for each alternative considered in this report at the above three locations are also presented in 11- by 17-inch plots for better clearance in Appendix A.
A rough order of magnitude cost estimate for each proposed alternative is also presented.

1.2 Alternatives

All the topographic modifications considered in this study is shown in Figure 1. An Alternative is defined as one of, or a combination of, several modifications. All modifications are stamped onto the topography in addition to the current Phase II project at CSX.

Rough order of magnitude (ROM) cost estimates were prepared for each modification which are aggregated to arrive at the ROM for each alternative. In order to reflect current construction market conditions, a semi-analogous cost estimating procedure was used by considering costs of a recently completed, similar scope construction project performed in Upstate New York. Phase I of the Sauquoit Creek Channel and Floodplain Restoration Project in Whitestown, NY contained many elements similar to those found in the proposed mitigation alternatives; namely floodplain benches and associated stabilization measures. Where recent construction cost data was not readily available, RSMeans CostWorks 2019 was used to determine accurate and timely information (RSMeans Data Online 2019).

The summary of the cost for each individual modification shown in Figure 1 is tabulated in Table 2. The detailed cost calculation for each modification is attached to this report as Appendix B.

A summary of technical information of the proposed modifications along with the existing condition information is given in Table 1.

Table 1. Summary of Technical Details of the Modifications

Modification Number	Modification Name	Existing Technical Details	Proposed Technical Details
1	Approved proposed condition	None	Five 4-ft diameter cylindrical culverts
2	Oriskany Boulevard Bridge widening	Three 20-ft wide by 10-ft high openings	One 200-ft wide by 10-ft high opening PR. width – 200 ft
3	Oriskany flood bench	Ground elevation varies between EL 416 to EL 423	Proposed average EL 410
4	Tahan's plaza flood bench – EL 417	Tahan's Plaza building and the existing ground elevation varies between EL 423 to EL 427	Removed plaza building and average flood bench EL 417
5	Main Street Bridge widening	One 62-ft wide by 6-ft high opening	One 250-ft wide by 6-ft high opening
6	CSX 2nd flood bench – EL 408 & El 409	15 houses total and the soccer field	Two elevation flood benches with EL 409 and EL 408
7	Downstream retention pond	None	Five additional 4-ft diameter cylindrical culverts
8	Flood wall near Whitesboro Middle School	None	Flood wall top EL 425 for length of 1721 ft

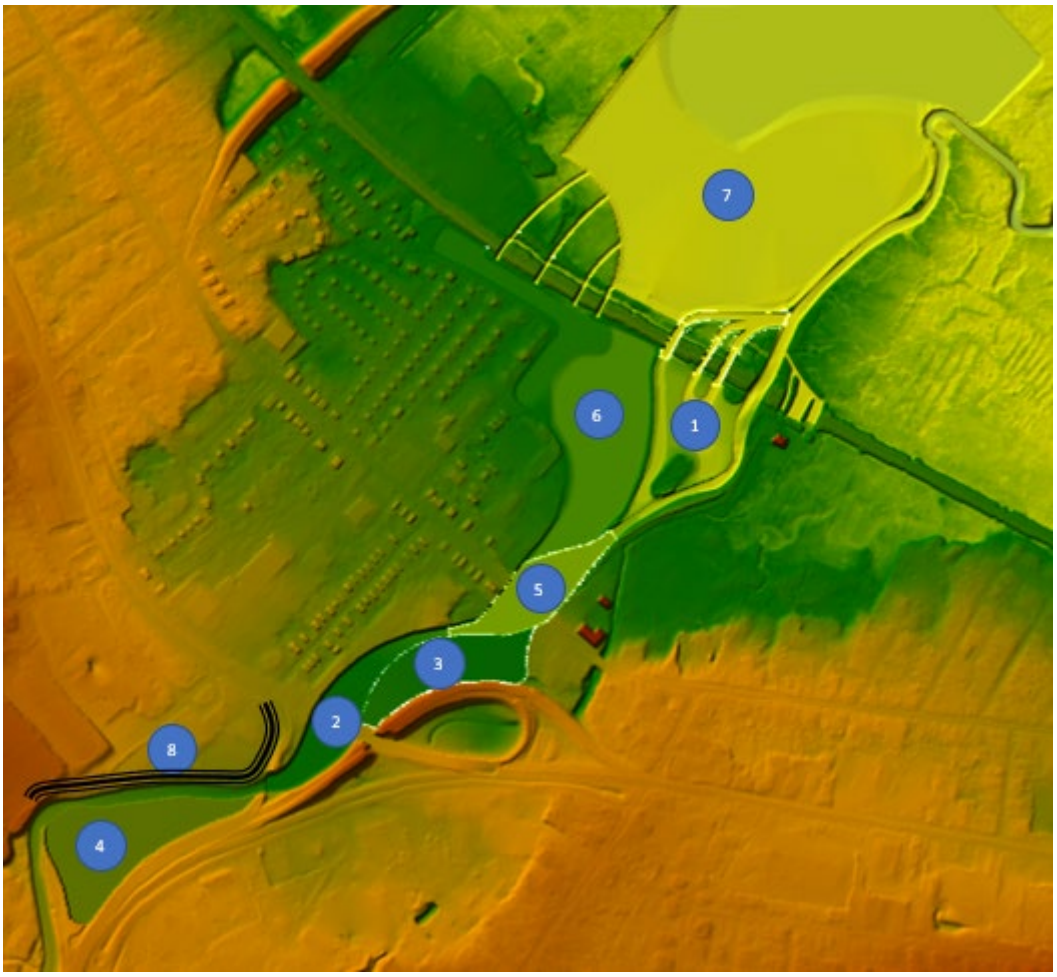


Figure 1. Proposed Modifications to the Sauquoit Creek Floodplain

Table 2. Summary of Cost of Construction of Modifications

Whitesboro Inundation Study Town of Whitestown, NY		
Modification #	**Item/Description**	**Total Project Cost**
2	Oriskany Boulevard Bridge widening	***$10,629,000***
3	Oriskany Boulevard flood bench	***$2,794,000***
4	Tahan's plaza flood bench	***$16,992,000***
5	Main Street Bridge widening	***$7,274,000***
6	CSX flood bench #2	***$8,477,000***
7	CSX downstream retention	***$29,686,000***
8	Floodwall	***$1,590,000***

1.2.1 Alternative-1 (ALT-1) – Oriskany Boulevard Bridge Widening

The existing Oriskany Boulevard Bridge consists of two stone piers. These piers are remnants from the old Erie Canal aqueduct structure that were repurposed into the current bridge. The current conveyance through this bridge is approximately equivalent to three 20-ft by 10-ft concrete box culverts, 60 ft long. The presence of the piers adds additional roughness when flowing at full capacity. This contributes to backwater (e.g. rise in water elevation upstream of the bridge) that propagates upstream leading to overflow at the Whitesboro Middle School onto the ball field and continuing down Gardner Street. In this alternative, a clear span bridge was tested with a width of 200 ft. Figure 2 below depicts the existing and proposed bridge widenings.

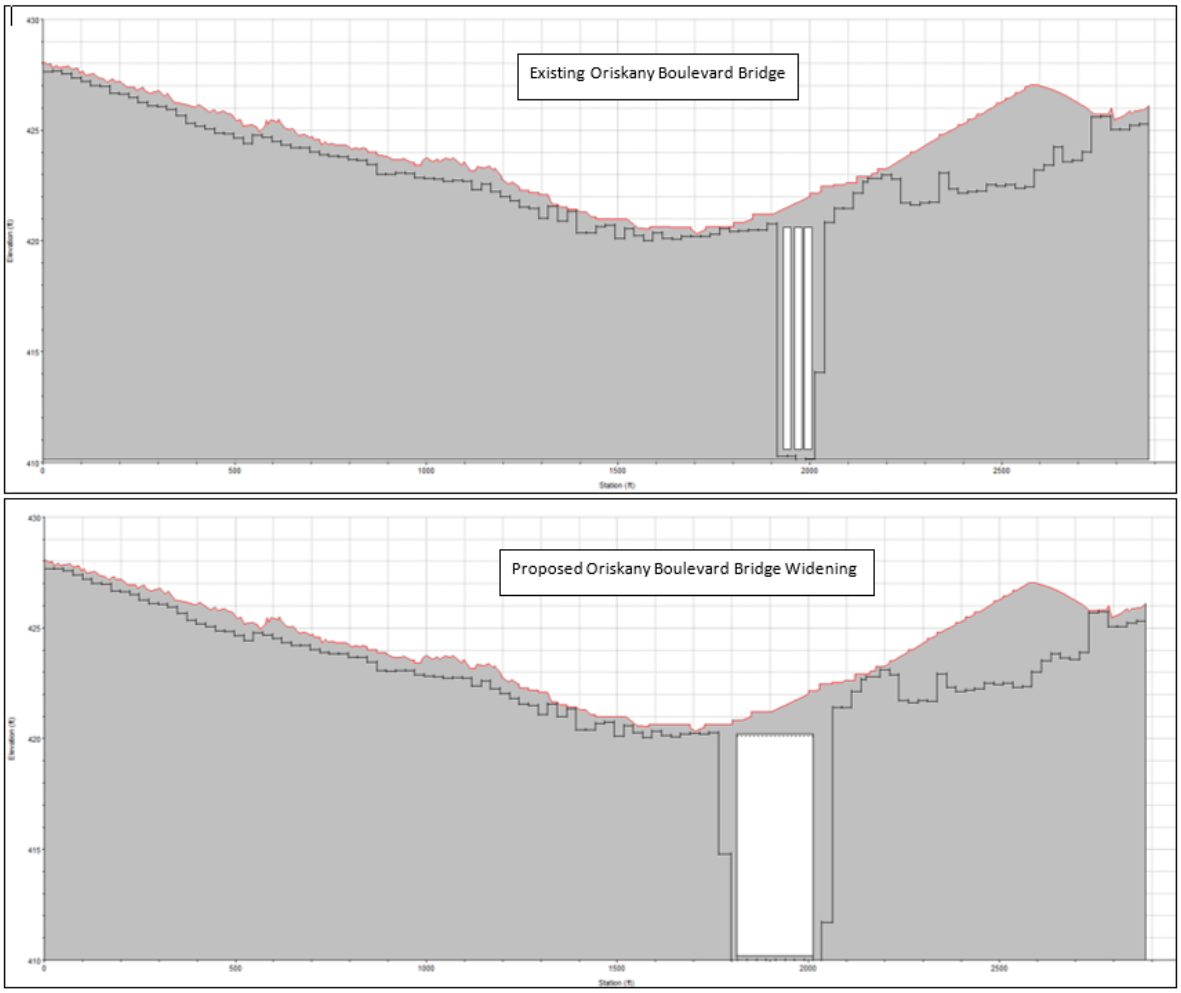


Figure 2. Existing and Proposed Oriskany Boulevard Bridge

Figure 3 depicts the 2D velocity and the inundation at the beginning of the overland flooding for the existing bridge opening with the addition of the Phase II Flood Bench project (left figure) and ALT-1(right figure). Results for both cases were extracted at the same time (31-October 2019 20:20:00), when flood waters first started to inundate the left overbank.

Figure 4 depicts the spreading of the flood overland at the peak of the flood hydrograph for the existing system (left figure) and for the ALT-1 (right figure).

Figure 4 demonstrates that widening the Oriskany Boulevard bridge reduces the delay in flow downstream therefore reducing backwater effects. Also, the bridge widening would reduce the flood area, depth and velocity of flooding within the marked area (dashed red square and white circle). Note, that velocities are shown via a color graduated scale where red is high velocity, and blue is low velocity. An important observation, is the reduction of velocities on Gardner Street. High velocities contribute to structural damage to structures and landscaping.

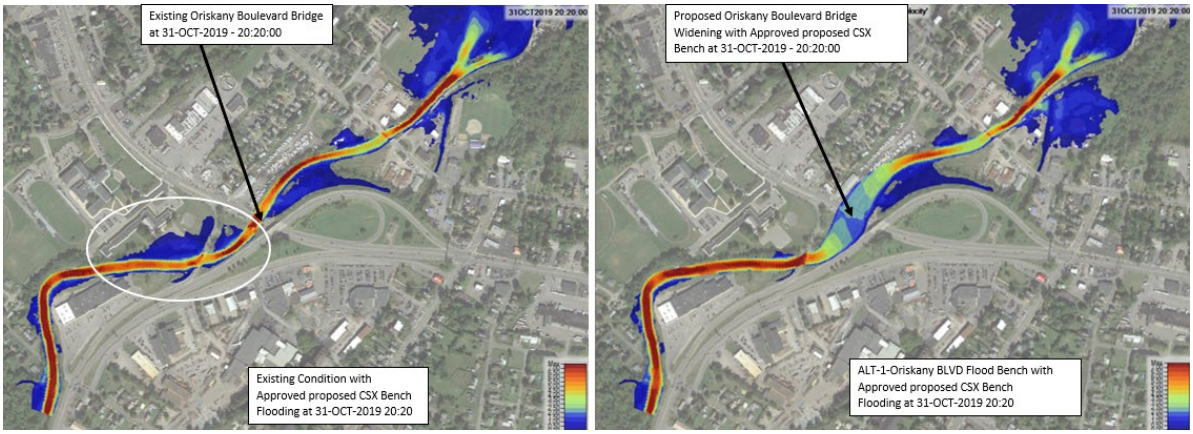


Figure 3. Comparison of Flood Initiation - ALT-1 at 31-October 2019 20:20:00

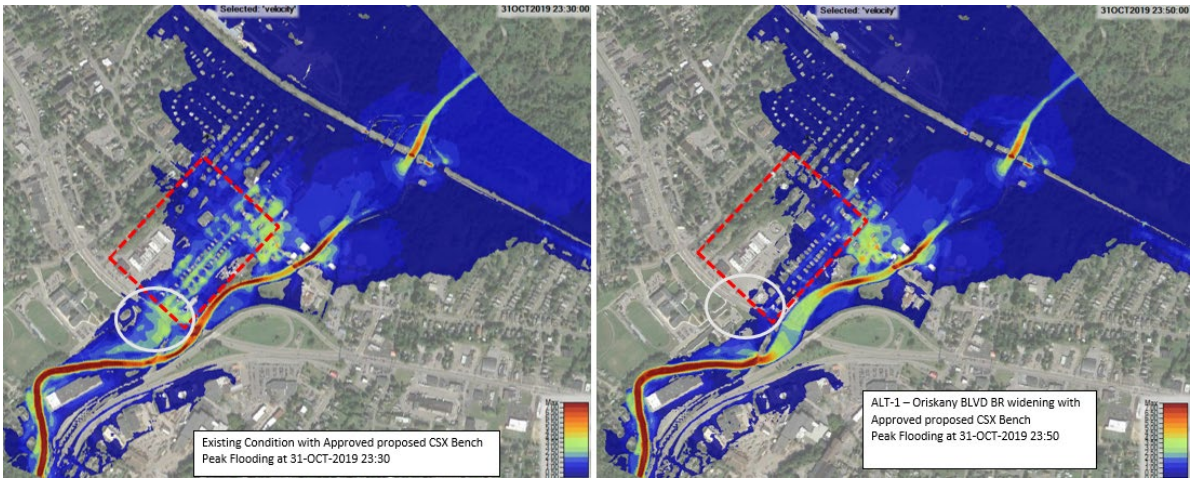


Figure 4. Comparison of Peak velocity (and Flooding Spread) - ALT-1

In conclusion, ALT-1 depicts a reduction in peak water level at Whitesboro Middle School front yard (Location A) and in Gardner Street (Location B) as seen in Figure 5.

However, the water level in Dunham Place (Location C), is increased approximately 0.3 ft at the peak of the flood. Since this general behavior is seen in other alternatives, a general explanation for the water level increase in "Location C" is provided under section 1.3 of this report.

The total construction cost for ALT-1 is $10.6 million.

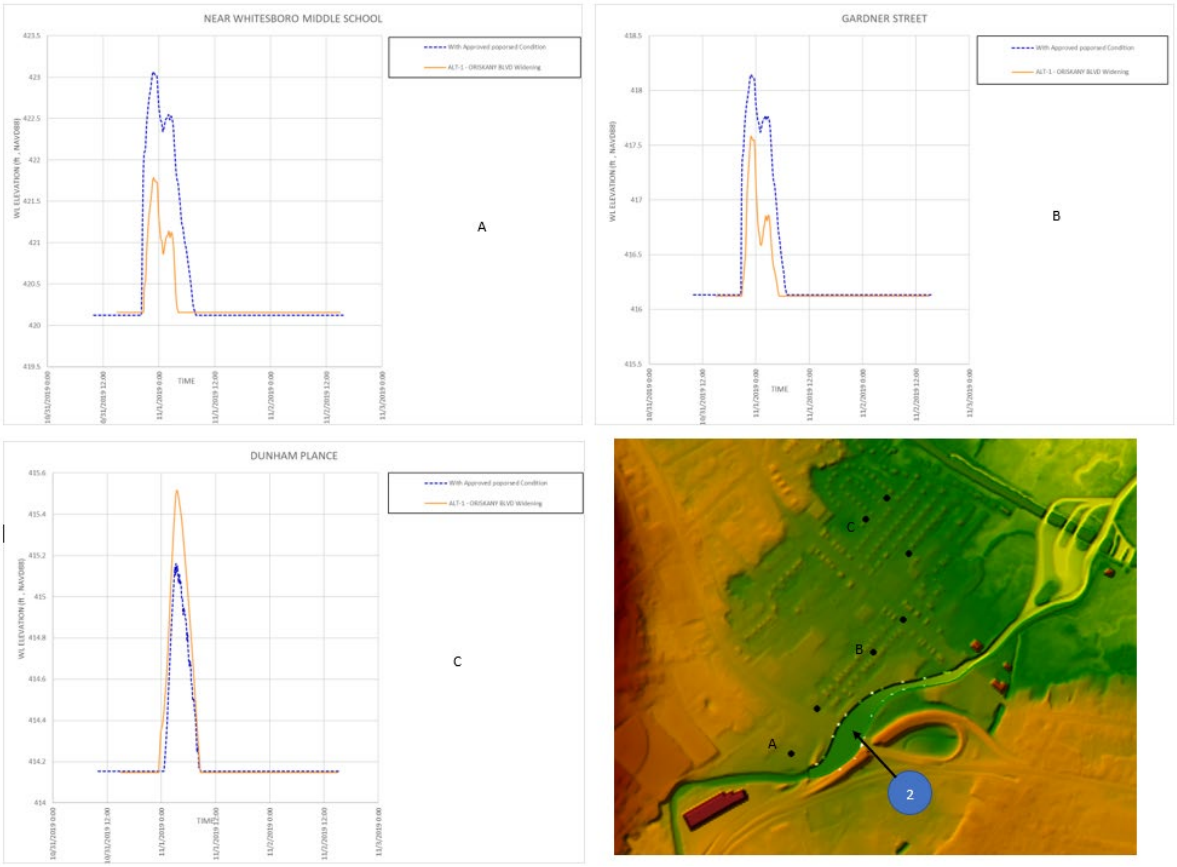


Figure 5. Water Level Comparison for ALT-1

1.2.2 Alternative-2 (ALT-2) – Floodplain Bench Immediately Downstream of Oriskany Boulevard Bridge

Alternative-2 consists of a flood bench immediate downstream and on the right overbank of the Oriskany Boulevard bridge. The approximate area of this proposed flood bench is 2,424 sq.ft and currently exists as unused wooded land. The existing terrain elevations of this area according to the LiDAR data varies from EL 423 in the north-eastern end, to EL 416 in the south-western end. A flood bench elevation of 410 ft was tested with a slight slope away from the bridge and cross-wise towards the creek to support better drainage (gravity flow). The purpose of the bench is to temporarily store flood-surged waters.

Figure 6 depicts the flood stage for the existing and proposed ALT-2 conditions on 31-October 2019 at 20:20:00. This initial inundation for both cases looks very similar, suggesting the effect of the flood bench alone is insignificant regarding flood width (overland inundated area).

Figure 7 depicts a velocity map at the maximum inundation for both existing and ALT-2 conditions. Significant velocity reduction is observed, immediately adjacent to the bench in this alternative. Reduction in velocity contributes to a reduction in head cutting of the stream, reducing the suspended sediment load transferred downstream.

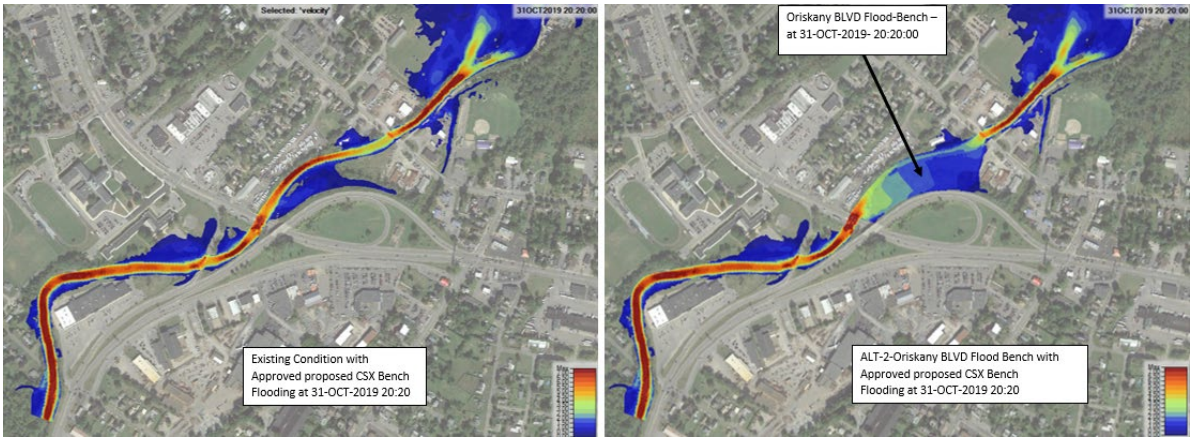


Figure 6. Comparison of Velocities at Flood Initiation Exiting and ALT-2 on 31-October 2019 20:20:00

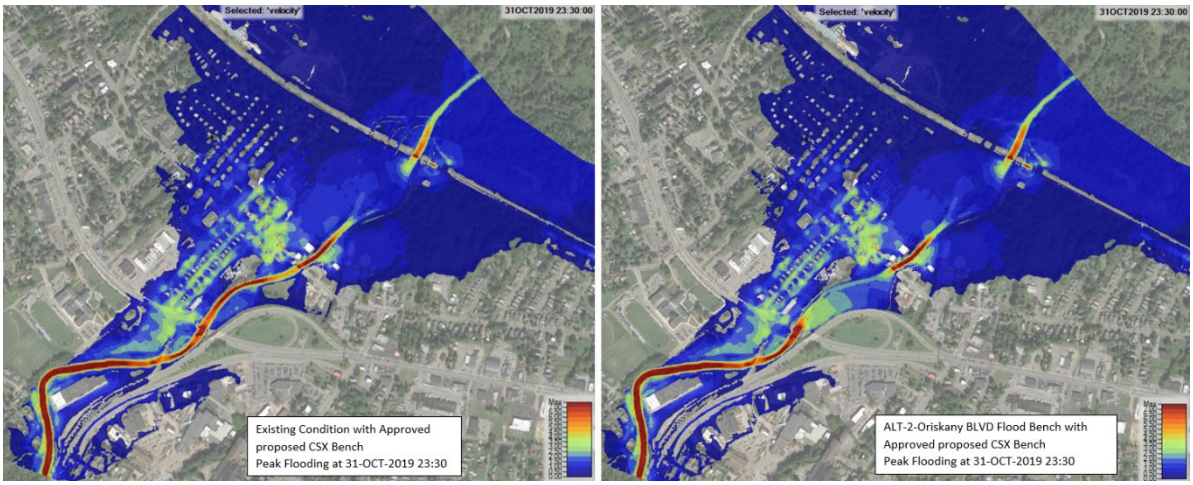


Figure 7. Comparison of Peak Velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-2

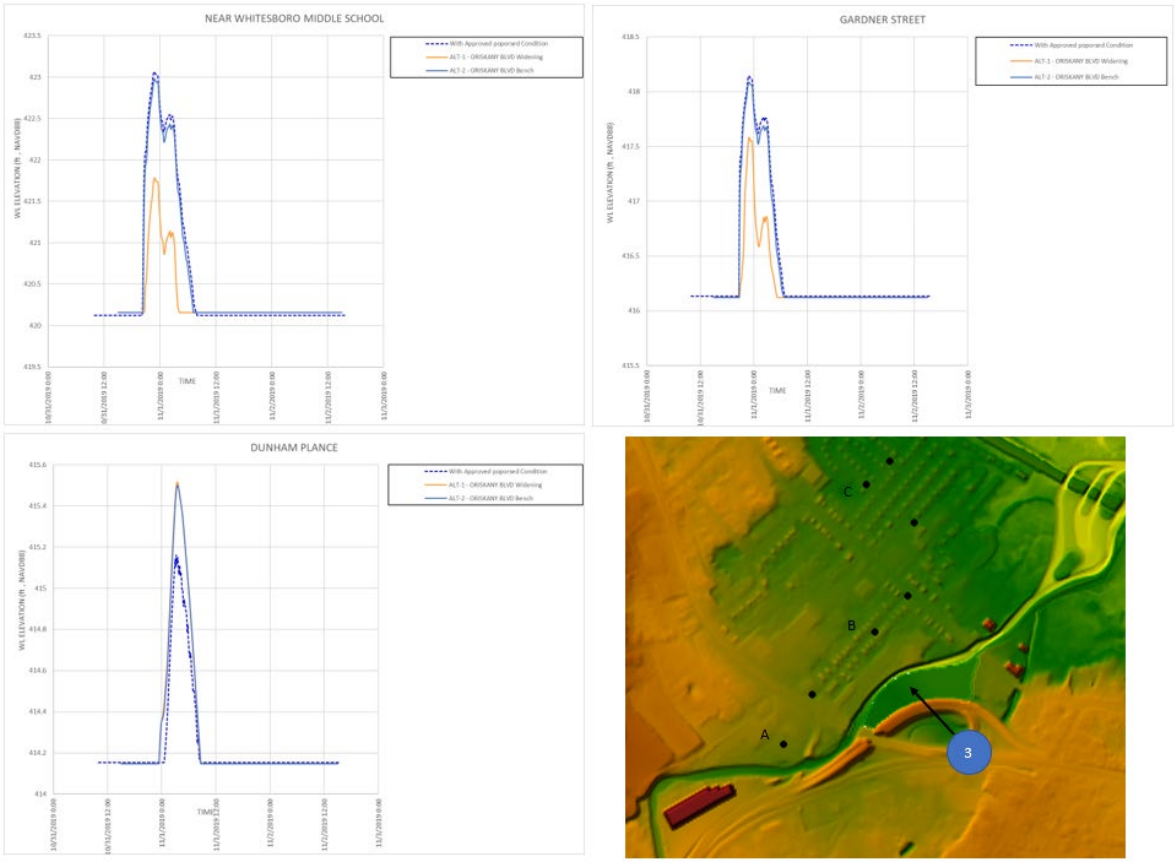


Figure 8. Water Level Comparison for ALT-2

Figure 8 compares the water levels at Whitesboro Middle School front yard (Location A), a location at Gardner Street (Location B), and at Dunham Place (Location C) of the existing, ALT-1, and ALT-2 conditions. The plots show that the flood bench alone provides approximately 0.3 ft. increase in peak flood stage, at Dunham Place, for the 2019 Halloween storm. However, at Gardner Street and the Whitesboro Middle School, the bench provides little to no benefit. Flood benches typically provide benefit in the immediate area, so the reduction at Dunham Place is unexpected as it is further away from this flood bench and should be evaluated further. Previous studies, e.g. the *Sauquoit Creek Channel and Floodplain Restoration Project, Lower Sauquoit Creek Engineering Report* dated November 2018 by OBG, indicates that the bench would potentially reduce the 1% annual chance event by up to 1.2 ft in the immediate overbank (e.g. Boulevard Trailer).

The total construction cost for ALT-2 is $2.8 million

1.2.3 Alternative-3 (ALT-3) – Alternative 1 and 2 Combined

ALT-3 consists of both the Oriskany Boulevard Bridge widening and the floodplain bench immediately downstream of Oriskany Boulevard bridge. Figure 9 depicts the initiation of flooding onto the left floodplain for both existing conditions, and with ALT-3 (right figure) at the same time during the Halloween storm (31-October 2019 20:20:00). Comparing the plots, it is

observed that with ALT-3, the flooding at the Whitesboro Middle School is reduced. In other words, these alternatives delay the development of backwater at the Oriskany Boulevard Bridge.

Figure 10 depicts a velocity map at the maximum inundation for both existing conditions and ALT-3. (Peak inundation was reached at two different times for the two cases.) The two boxes in Figure 10 highlight the areas that are affected positively (e.g. reducing the inundation through this alternative). The in-channel and overland high velocities observed in the existing conditions will also be reduced through this alternative.

Alternative-2 did not show significant improvements in the water level reductions. However, by combining the Oriskany Boulevard bridge widening and the Oriskany boulevard flood bench a positive reduction in flood stage and velocities will occur along Gardner Street.

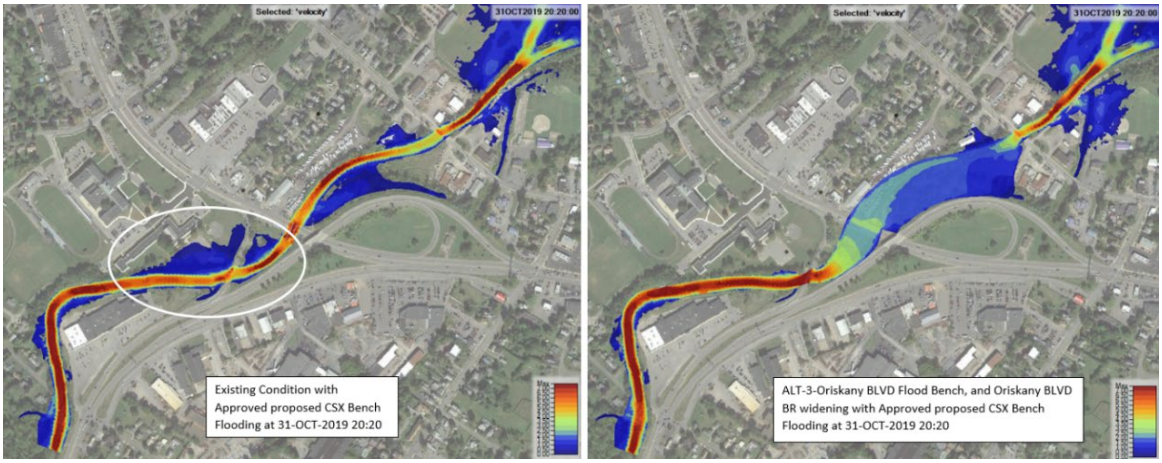


Figure 9. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-3 at 31-October 2019 20:20:00

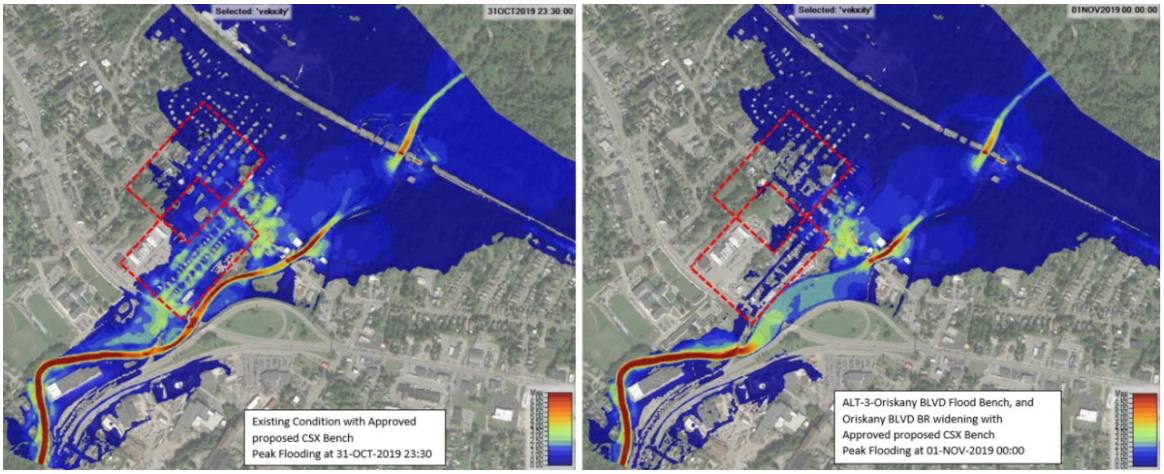


Figure 10. Comparison of Peak velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-3

Figure 11 depicts water levels at the three observation points previously mentioned. The plots indicate that ALT-3 has the greatest impact at the Whitesboro Middle School and along Gardner Street, with limited to no impact at Dunham Place. Again, the plots confirm that ALT-3 provides more benefit to the Whitesboro Middle School and in the Gardner Street area more than either ALT-1 or ALT-2 alone.

This observation confirms that the Oriskany Boulevard bridge widening reduces the back-water effect and lowers the inundation levels near the Whitesboro Middle School, while adding a flood bench immediately downstream of the Oriskany Boulevard bridge further reduces water levels in the Gardner Street residential area. Therefore, only the combination of the bridge widening and flood bench together delivers the full benefit of lowering the water levels in the Whitesboro Middle School (Location A) by approximately 1.5 ft, and in the Gardner Street residential area (Location B) by approximately 1.2 ft.

However, the water level in Dunham Place (Location C), is increased by approximately 0.35 ft at the peak flood. Since this behavior is seen in other alternatives, a general explanation for the water level increase is provided under section 1.3 of this report.

The total construction cost for ALT-3 is $13.4 million.

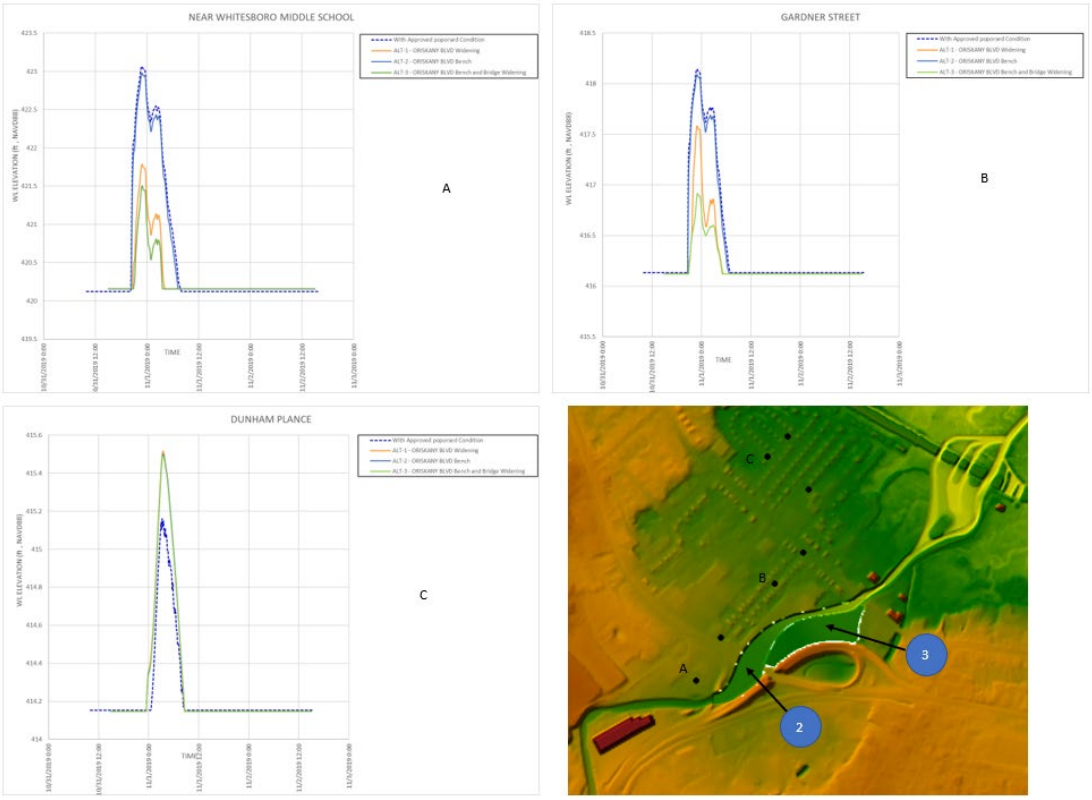


Figure 11. Water Level Comparison with ALT-3, ALT-2, ALT-1, and Approved Proposed Bench

1.2.4 Alternative 4 (ALT-4) – Flood Bench at Tahan's Plaza

ALT-4 consists of a flood bench at the Tahan's plaza as shown in the Figure 14. This alternative was originally proposed in the *Sauquoit Creek Channel and Floodplain Restoration Project, Lower Sauquoit Creek Engineering Report* dated November 2018 by OBG. The alternative would include the demolition of the existing building, terrain gradation to EL 417, (approx. 7-9 ft depth of excavation), with the installation of a series of pools and riffles in Sauquoit Creek. Figure 12 depicts the initiation of flooding onto the left floodplain of Sauquoit Creek for both existing conditions, and with ALT-4 (right figure) at the same time during the storm (31-October 2019 20:20:00).

Figure 13 depicts velocities at the maximum inundation for both existing conditions, and ALT-4 cases (right figure), and Figure 14 depicts the water level comparison through the community at Whitesboro Middle School (Location A), at Gardner Street (Location B) and at Dunham Place (Location C). Both Figure 13 and Figure 14 indicate limited reduction in flood water levels with ALT-4. This is supported by the conclusion in the November 2018 Engineering Report, which indicated that a flood bench at Tahan's plaza would reduce flooding across Commercial Boulevard and in the vicinity of the Hubbell Galvanizing and Hippos Billiards area.

The total construction cost for ALT-4 is $17.0 million. This cost does not include a land acquisition.

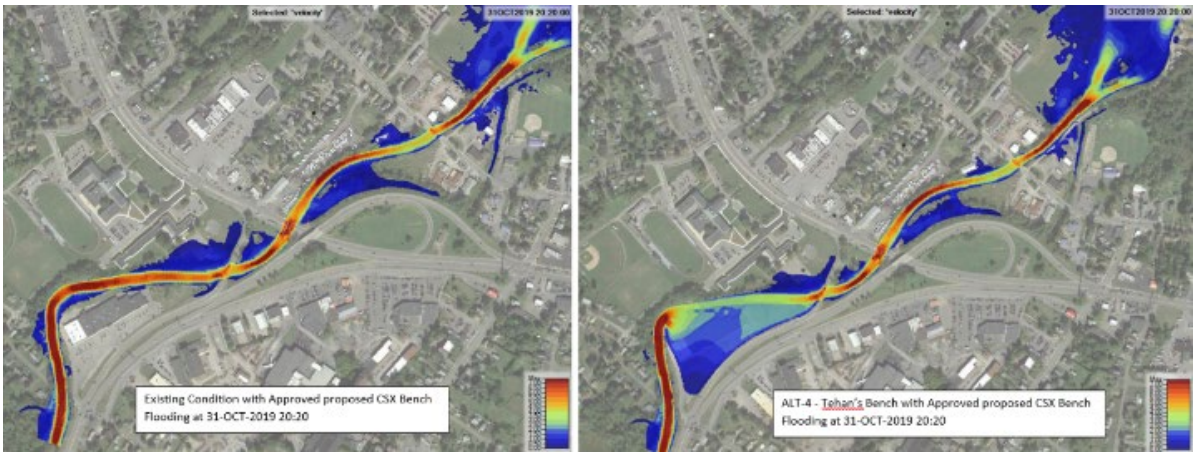


Figure 12. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-4 at 31-October 2019 20:20:00

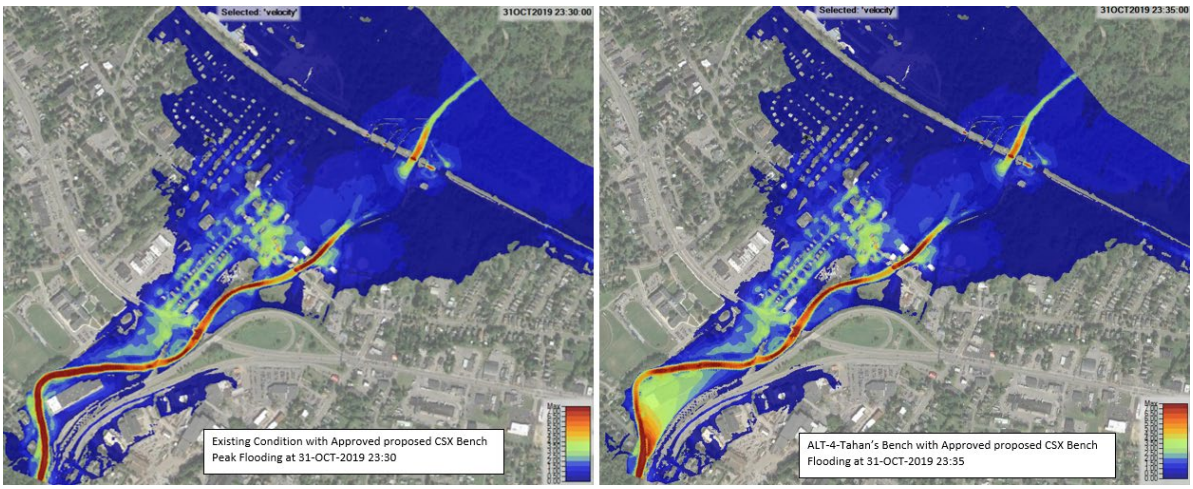


Figure 13. Comparison of Peak Velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-4

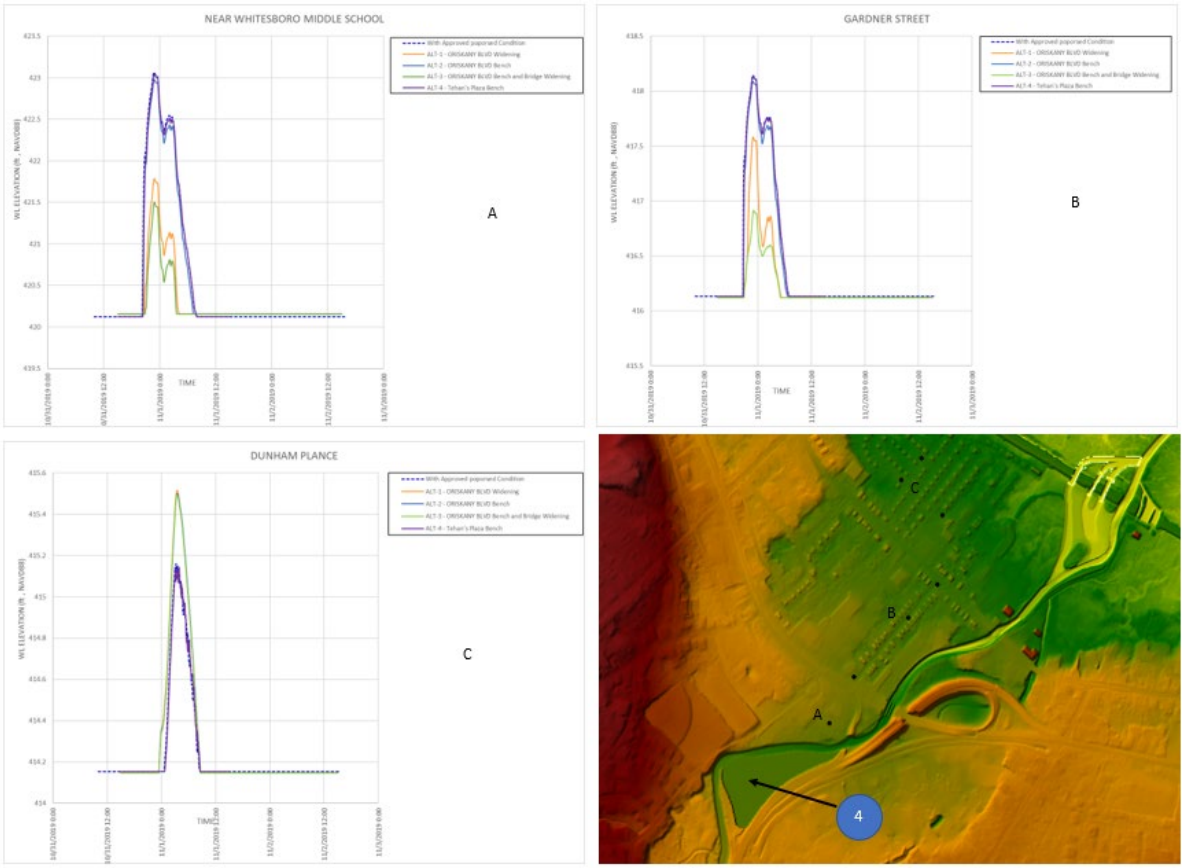


Figure 14. Water Level Comparison with ALT-4, ALT-3, to ALT-1, and Approved Proposed Bench

1.2.5 Alternative-5 (ALT-5) – Alternative 3 and 4 Combined

ALT-5 consists of combination of Tahan's plaza flood bench (ALT-4) with the Oriskany Boulevard Bridge widening and the flood bench immediately downstream, of Oriskany Boulevard Bridge (ALT-3). Figure 15 depicts flooding on to the left floodplain of Sauquoit Creek for both existing conditions, and with the ALT-5 (right figure) concurrently during the Halloween storm (31-October 2019 20:20:00).

Figure 16 depicts velocities at the maximum inundation for both existing conditions, and ALT-5 cases. The peak inundation is reached at two different times for the two cases. The two boxes (dashed red) in the Figure 16 depicts the area where velocities are reduced as a result of ALT-5.

Figure 17 depicts peak flood stage and a reduction in water levels at Locations A and B. However, ALT-5 depicts a slight increase in water levels compared to ALT-3. This may be due to the increased back water effects at the Main Street bridge with the increased conveyance in the creek from the flood benches and bridge widening. The circled area (white circle) on Figure 16, depicts higher velocities in ALT-5 compared to the existing system on the left figure, indicating the significance of the back water effects at Main Street bridge.

The water level in Dunham Place (Location C), is increased by approximately 0.5 ft at the peak flood compared to the existing . Since this behavior results from other alternatives, a general explanation for the water level increase is provided under Section 1.3 of this report.

The total construction cost for ALT-5 is $30.4 million.

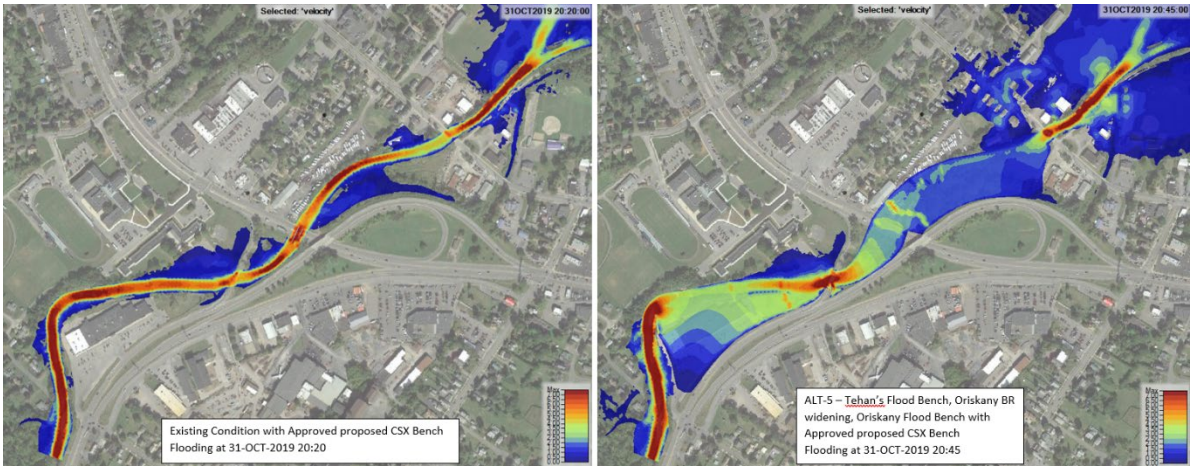


Figure 15. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-5 at 31-October 2019 20:20:00

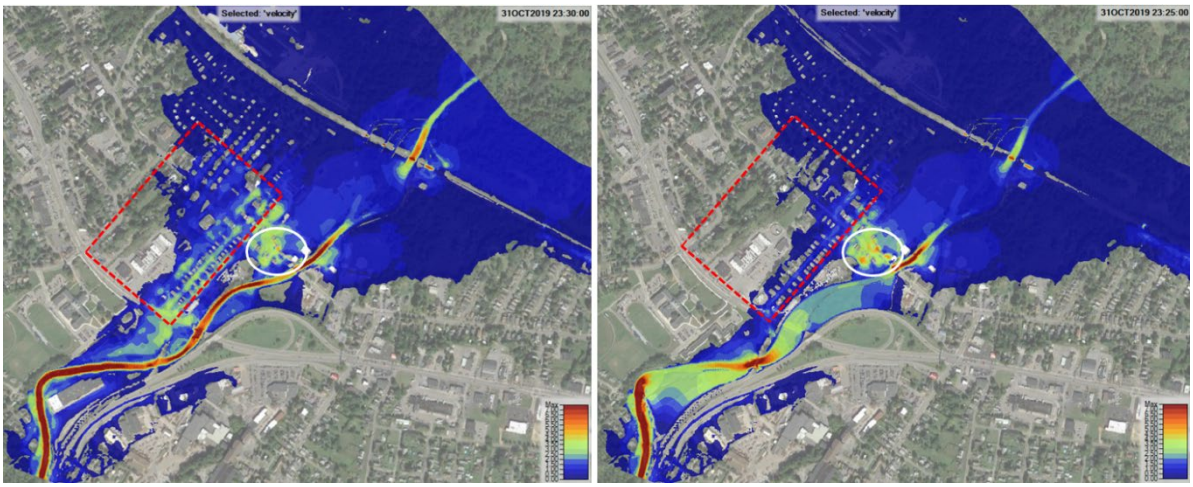


Figure 16. Comparison of Peak velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-5

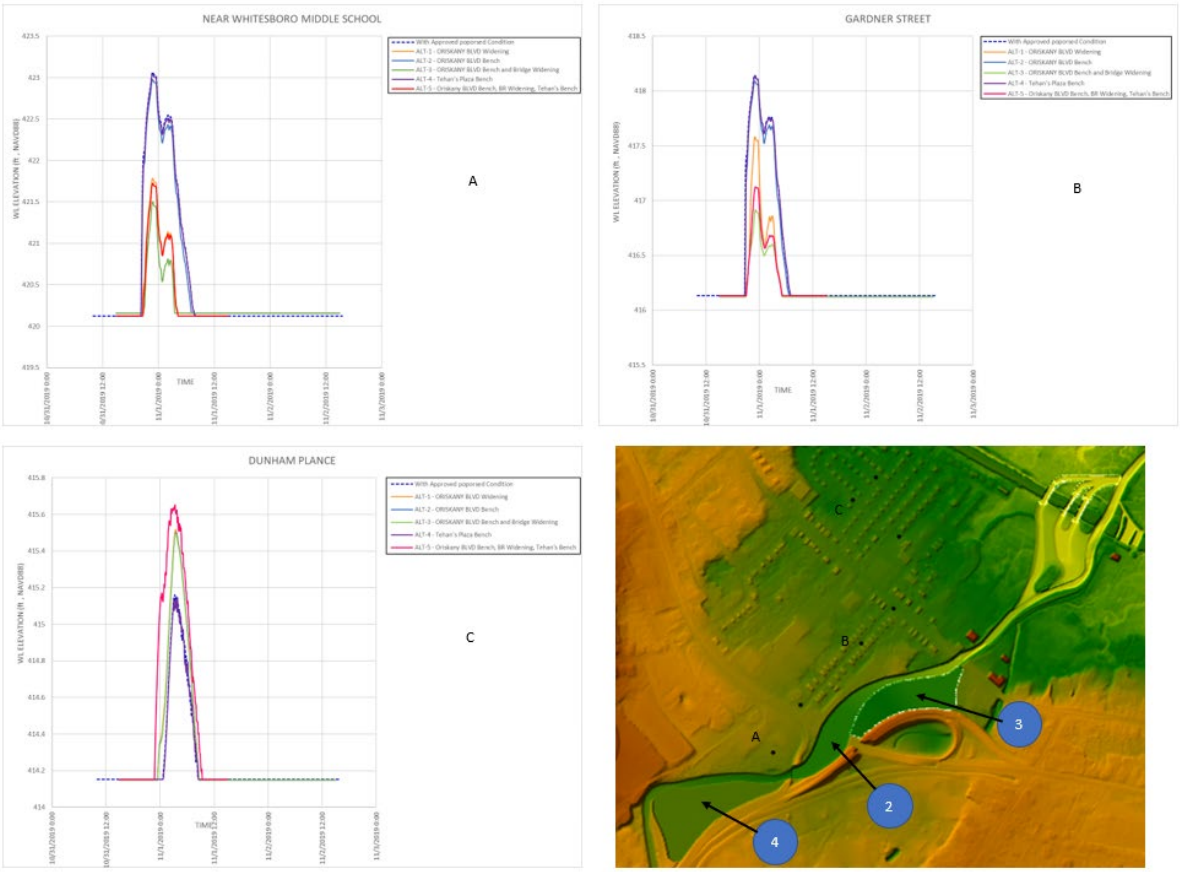


Figure 17. Water Level Comparison for ALT-5 with ALT-1 to ALT-4

1.2.6 Alternative-6 (ALT-6) – Main Street Bridge Widening

ALT-6 considers only the widening of the Main Street bridge, in the Village of Whitesboro, NY. Previously in ALT-5, it was observed that the addition of more flood benches increases the downstream conveyance of the creek creating more back water at the Main Street bridge. Therefore, ALT-6 looks at only the effects of widening the Main Street bridge.

The existing bridge opening is approximately 62-ft by 6-ft. This alternative tested the widest possible opening size of 250-ft by 6-ft, increasing capacity by approximately four times the existing capacity. It is recognized that this width would require at least one center pier. Figure 20 depicts the resultant water level of this alternative. Widening of the Main Street bridge alone provides only minor flood stage reductions in the Village of Whitesboro.

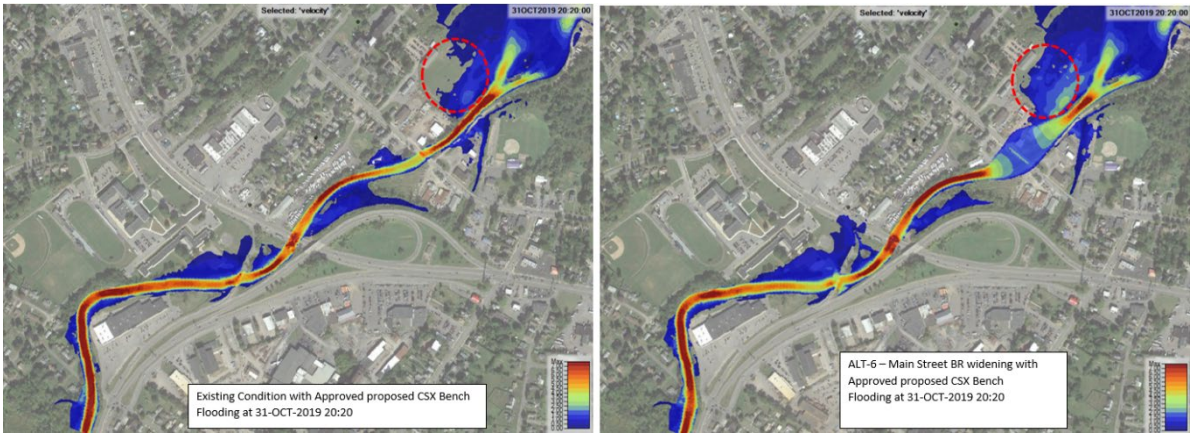


Figure 18. Comparison of Velocities at Flood Initiation with Existing Conditions and ALT-6 at 31-October 2019 20:20:00

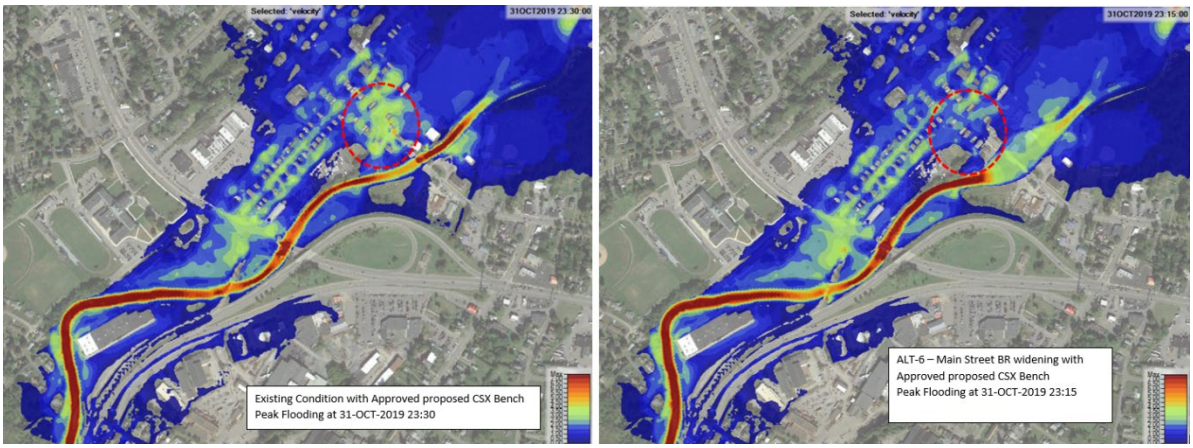


Figure 19. Comparison of Peak Velocity (and Flooding Spread) between Existing Conditions and ALT-6

Figure 18 depicts the initial spreading of the flood surge with and without the Main Street bridge widening. Due to the increase conveyance through the Main Street bridge widening, more water is conveyed to downstream of the bridge resulting in flooding of the sports field on the left overbank near the approved CSX flood bench. This area is circled (red dashed line) in Figure 18.

Figure 19 compares the velocity and the spread of the flood at its peak. The circled area in Figure 19 indicates a reduction in peak velocities in the vicinity of approximately seven houses by implementing the Main Street bridge widening.

Water level comparison in Figure 20 indicated no reduction in water levels throughout the Village by widening the Main Street bridge alone.

The total construction cost for ALT-6 is $7.3 million.

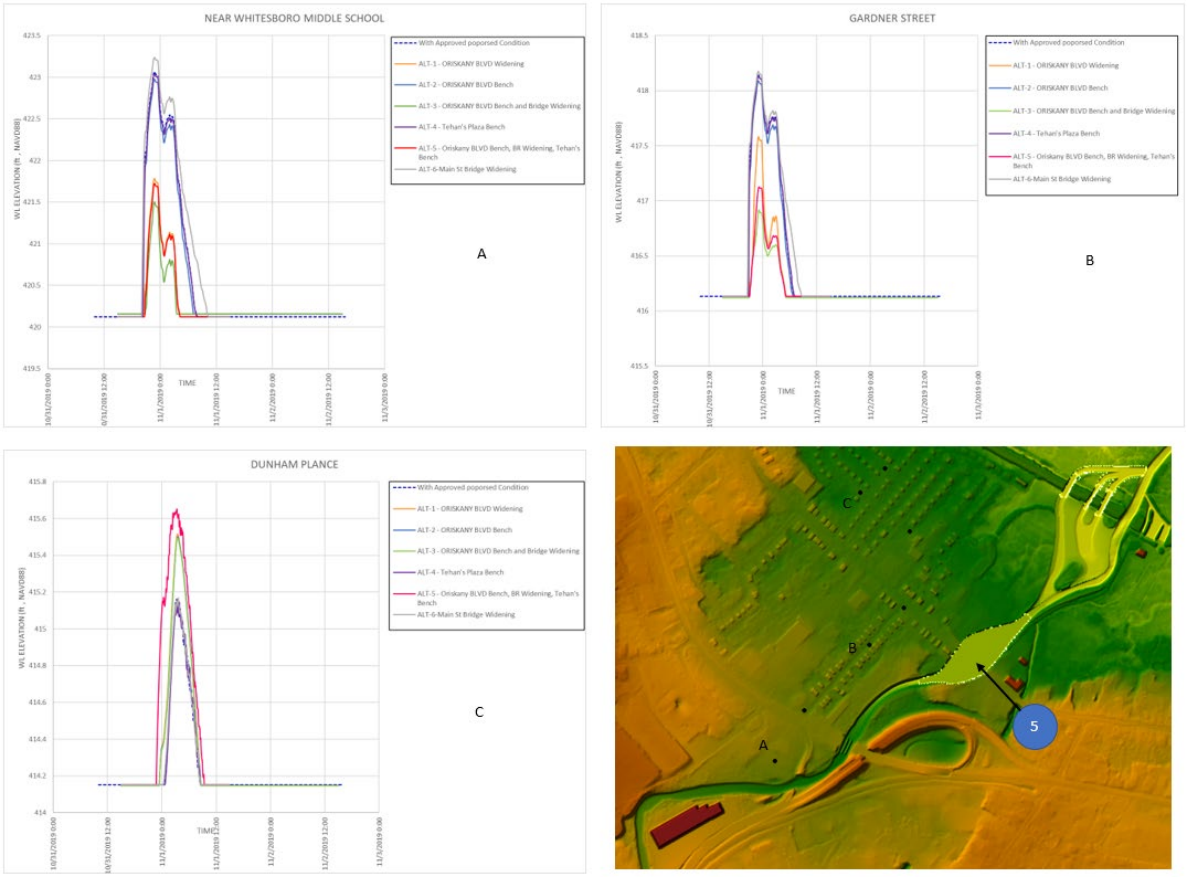


Figure 20. Water Level Comparison with ALT-6, ALT-5, to ALT-1, and Approved Proposed Bench

1.2.7 Alternative-7 (ALT-7) – Alternative 6 and 5 Combined

ALT-7 consists of a combination of the Main Street bridge widening (ALT-6), and Tahan's flood bench with the Oriskany Boulevard bridge widening and floodplain bench immediately downstream of Oriskany Boulevard (ALT-5). Figure 21 depicts the initiation of flooding onto the left floodplain of Sauquoit Creek for both existing conditions (left figure) and with the ALT-7 (right figure) concurrently during the Halloween storm (at 31-October 2019 20:20:00).

Figure 22 depicts velocities at the maximum inundation for both existing conditions and ALT-7 cases. The peak inundation in the domain reached at two different times for the two cases indicating the positive effects of ALT-7. The two boxes (dashed red) in the Figure 22 depicts the area that is affected positively by this alternative. A significant number of houses on Gardner Street and Main Street are removed from the flooding with ALT-7.

A water level comparison in Figure 23 depicts an overall reduction in water levels through the village, and depicts the best reduction in water at Locations A and B compared to the previously considered alternatives (ALT-1 to ALT-6).

The water level in Dunham Place (Location C), is increased by approximately 0.4 ft at the peak flood compared to the existing system. Since this behavior results from other alternatives, a general explanation for the water level increase is provided under Section 1.3 of this report.

The total construction cost for ALT-7 is $37.7 million.

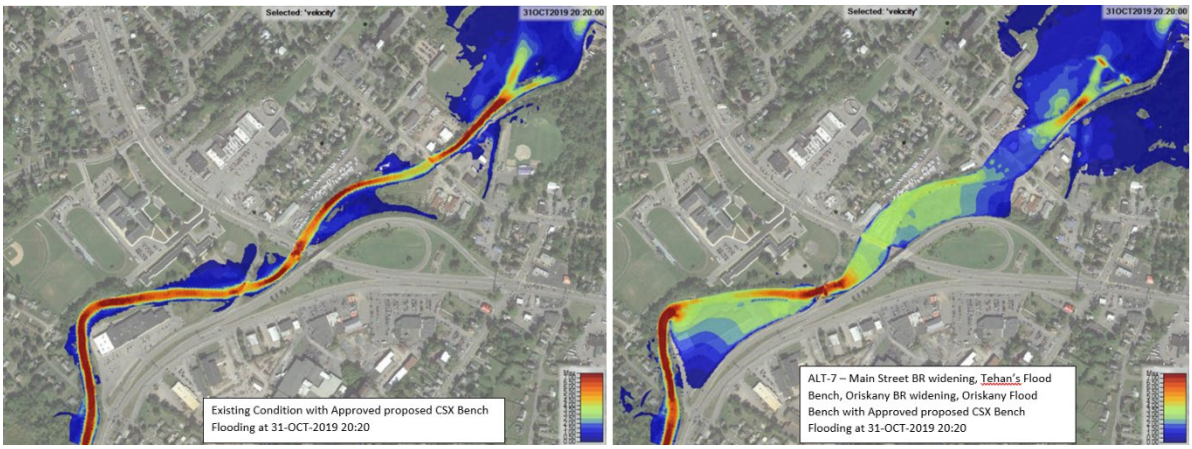


Figure 21. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-7 at 31-October 2019 20:20:00

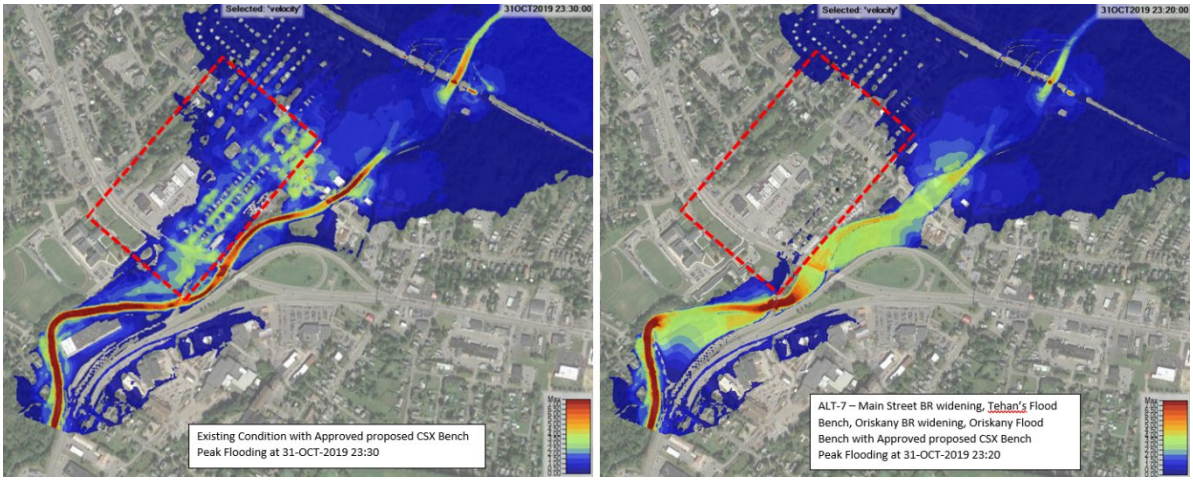


Figure 22. Comparison of Peak velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-7

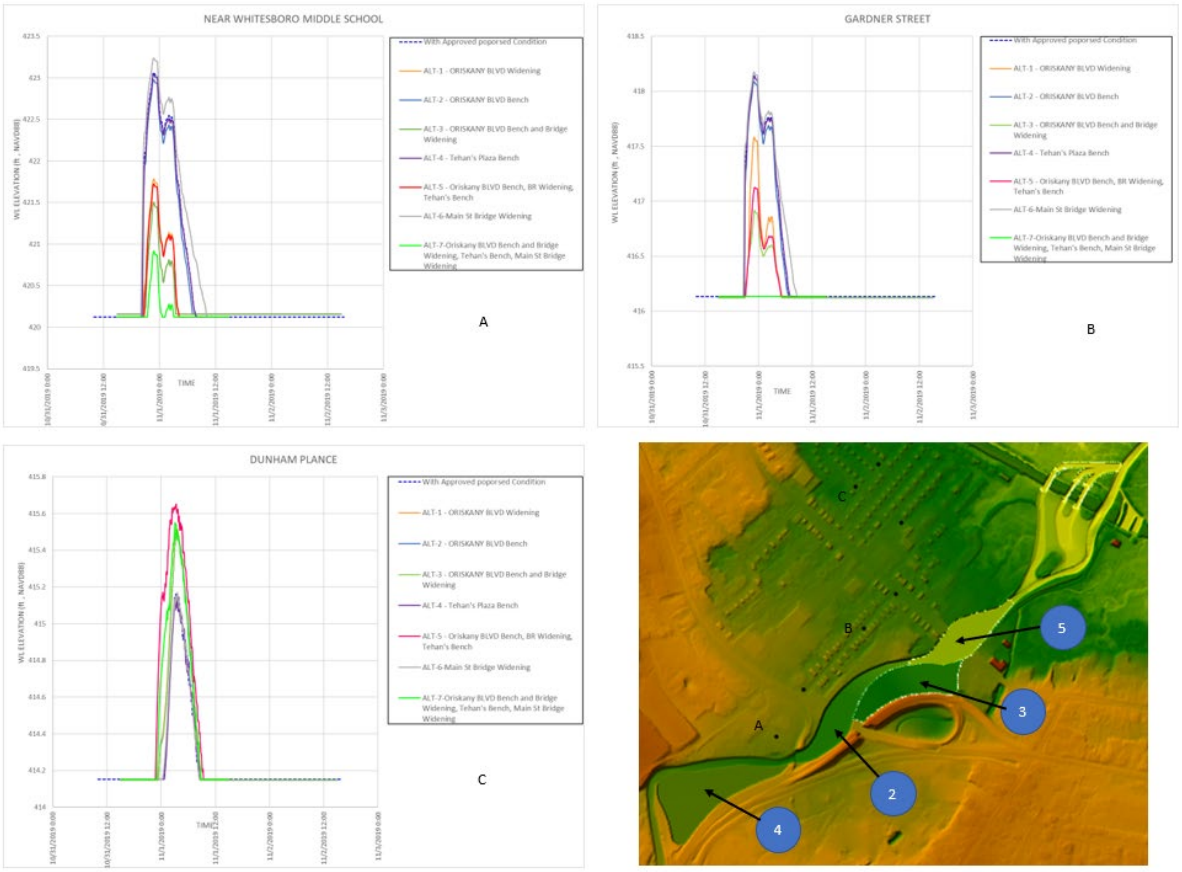


Figure 23. Water Level Comparison with ALT-7, ALT-6, to ALT-1, and Approved Proposed Bench

1.2.8 Alternative-8 (ALT-8) – Enlargement of Phase II CSX Flood Bench

ALT-8 considers an enlargement of the Phase II flood bench upstream of the CSX railroad embankment. Two grading elevations; EL 408 along the Sauquoit Street and EL 409 within the sports field, were considered. The alternative would include the acquisition of approximately 15 houses along Sauquoit Street. Also, an additional four, 4-ft diameter culverts would be installed under the CSX railroad embankment, as shown in Figure 26, to better drain flood waters under the railroad embankment.

Figure 24 depicts the initiation of flooding onto the left floodplain of Sauquoit Creek for both existing conditions (left figure) and with the ALT-8 (right figure) at the same time during the Halloween storm (31-October 2019 20:20:00).

Figure 25 depicts velocities at the maximum inundation for both existing conditions and ALT-8 cases. The peak inundation in the domain was reached at two different times for the two cases. The maximum inundation plot for ALT-8 indicated that enlarging the bench alone, will not markedly decrease water level through the community.

A water level comparison in Figure 26 also depicts a minor overall reduction in water levels through the community, except at Location C in Dunham Place. However, the reduction in water levels in Dunham Place for drainage culverts present is negligible.

The total construction cost for ALT-8 is $8.5 million.

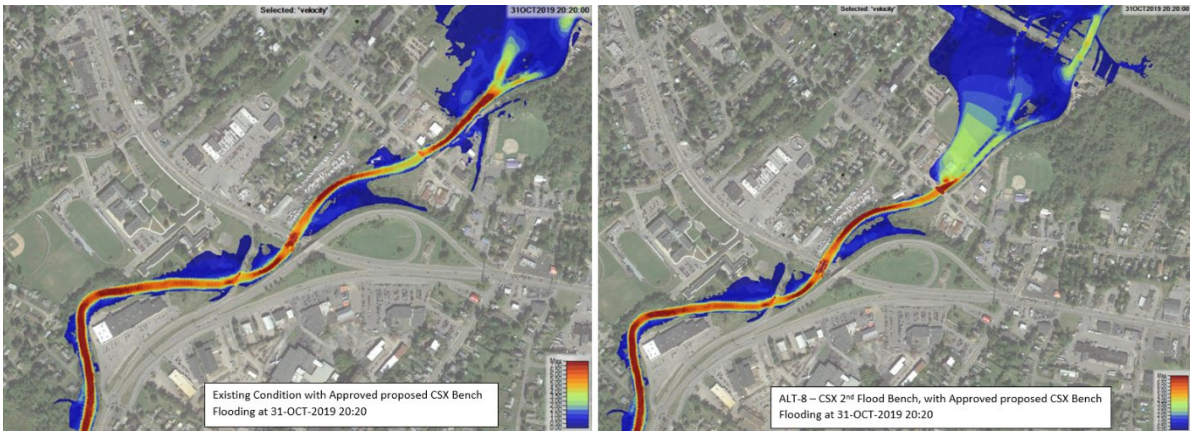


Figure 24. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-8 at 31-October 2019 20:20:00

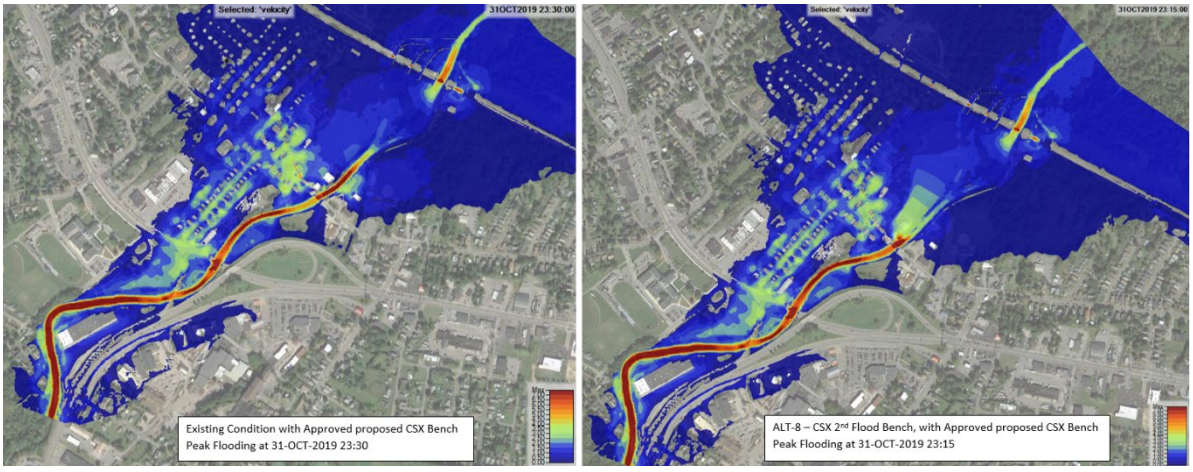


Figure 25. Comparison of Peak Velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-8

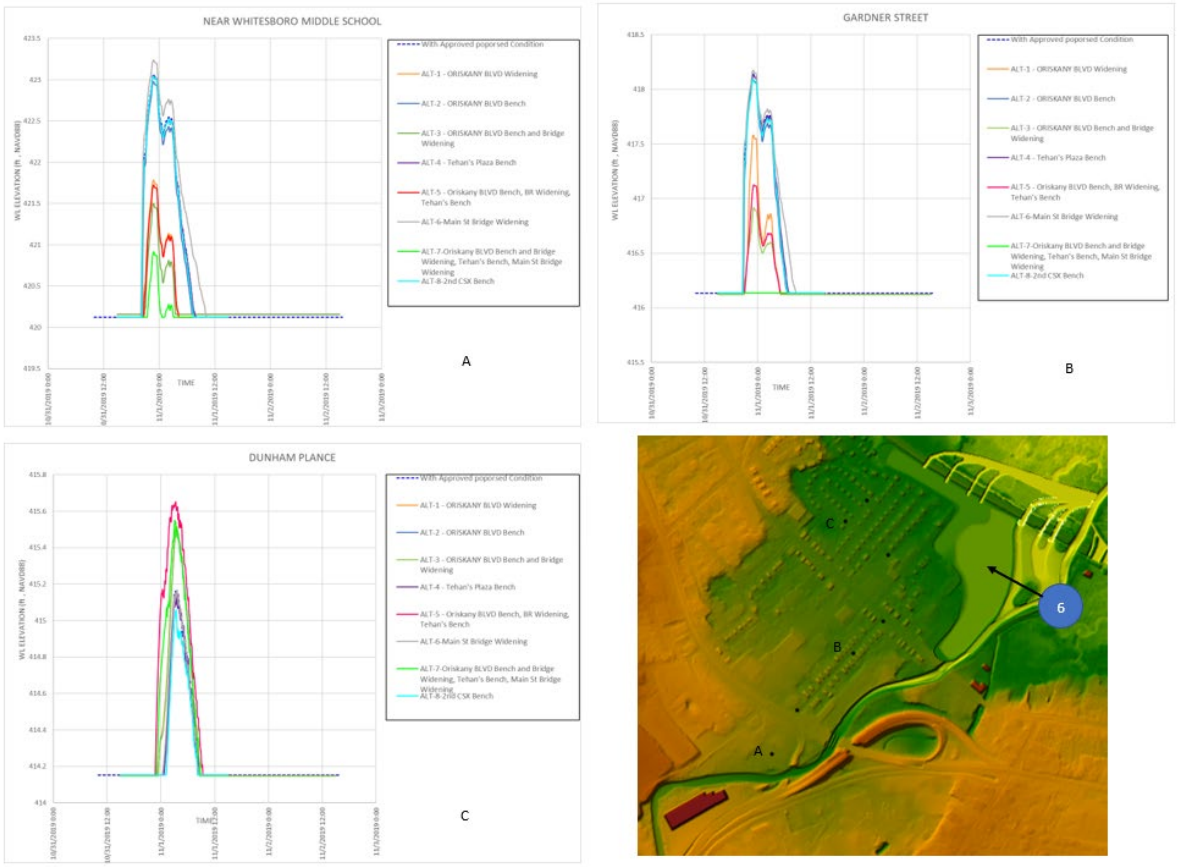


Figure 26. Water Level Comparison with ALT-8, ALT-7, to ALT-1, and Approved Proposed Bench

1.2.9 Alternative-9 (ALT-9) – Alternative 7 and 8 Combined

ALT-9 consists of a combination of enlarging the Phase II floodplain bench (ALT-8) with the Main Street bridge widening, Tahan's flood bench, Oriskany Boulevard bridge widening and a floodplain bench immediately downstream of Oriskany Boulevard (ALT-7). Figure 27 depicts the initiation of flooding onto the left floodplain of Sauquoit Creek for existing conditions (on the left) and with the ALT-7 (on the right) at the same time during the Halloween storm (31-October 2019 20:20:00).

Figure 28 depicts velocities at the maximum inundation for both existing conditions and ALT-9 cases. The peak inundation in the domain is reached at two different times for the two cases. The two boxes (dashed red) in the Figure 28 depicts the area that is affected positively by reducing the inundation from this alternative. A significant number of houses in Gardner Street and Main Street experience significant reductions in flood exposure with ALT-9. The high velocities experienced by the residents in Main Street, Ellmore Drive, Ablett and Ellis Avenues are also reduced, removing possible velocity impacts on the buildings.

A water level comparison in Figure 29 depicts an overall reduction in water levels through the community, and depicts the best reduction in water at Locations A and B compared to the previously considered alternatives from ALT-1 to ALT-8.

The water level in Dunham Place (Location C), is still increased in about 0.4 ft at the peak flood compared to the existing system. Since this behavior results from other alternatives, a general explanation for the water level increase is provided under Section 1.3 of this report.

The total construction cost for ALT-9 is $46.2 million.

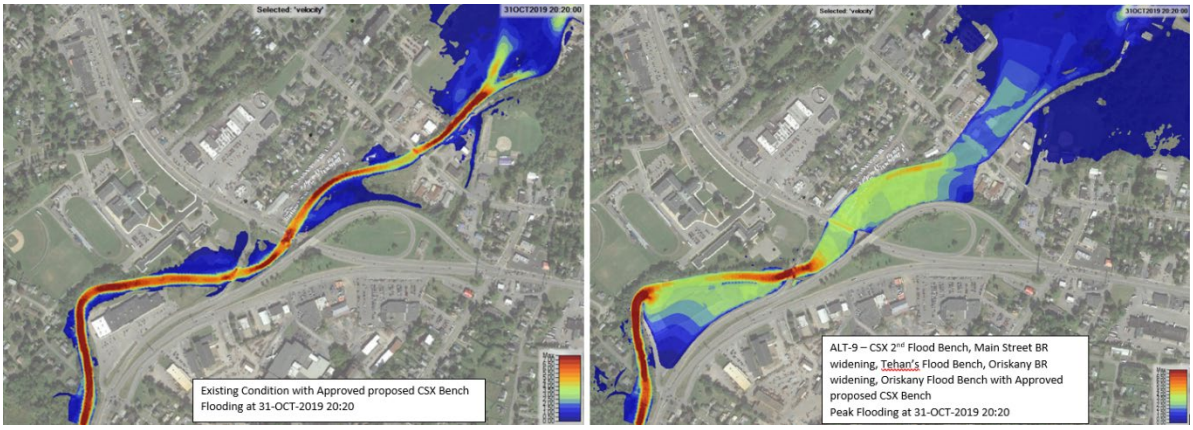


Figure 27. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-9 at 31-October 2019 20:20:00

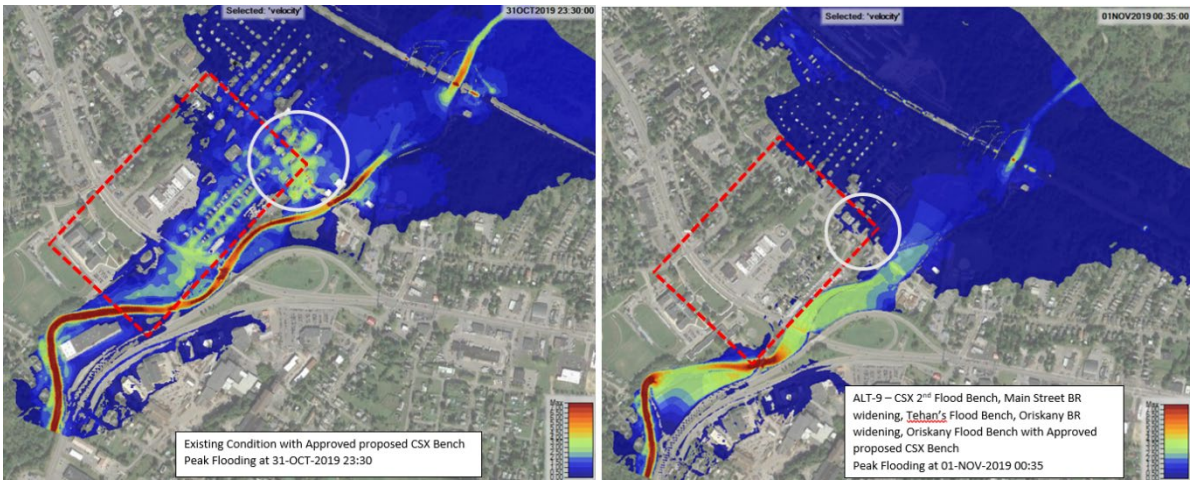


Figure 28. Comparison of Peak Velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-9

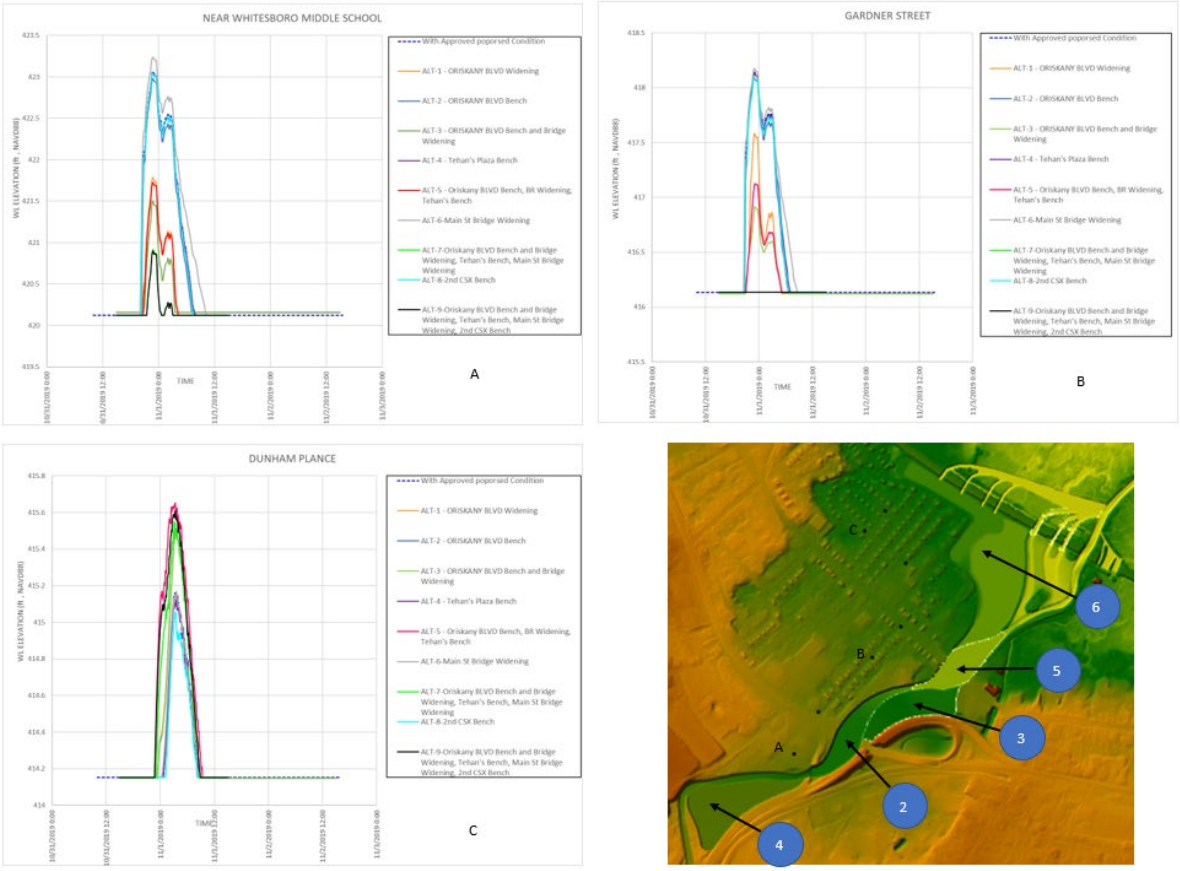


Figure 29. Water Level Comparison with ALT-9, ALT-8, to ALT-1, and Approved Proposed Bench

1.2.10 Alternative-10 (ALT-10) – Alternative 9 with Retention Pond North of the CSX Railroad Crossing

ALT-10 consists of combination of a retention pond north of the CSX railroad crossing, enlarging the Phase II flood bench, Main Street bridge widening, Tahan's flood bench with the Oriskany Boulevard bridge widening and a floodplain bench immediately downstream of Oriskany Boulevard (ALT-9). The retention pond would reduce ponding downstream of the railroad crossing, allowing the full capacity of the additional culverts to drain flood waters from the Village of Whitesboro in the vicinity of Dunham and Wind Places.

Figure 30 depicts the initiation of flooding onto the left floodplain of Sauquoit Creek existing conditions (left figure) and with the ALT-10 (right figure) at the same time during the Halloween storm (31-October 2019 20:20:00).

Figure 31 depicts velocities at the maximum inundation for both existing conditions and ALT-10 cases. The peak inundation in the domain reached at two different times for the two cases. The two boxes (dashed red) in Figure 28 depicts the area that is affected positively by reduced flood inundation. A significant number of houses in Gardner Street, Main Street, Ellmore Drive,Ablett and Ellis Avenues experience none or reduced flood inundations with ALT-10.

Figure 32 depicts the comparison of ALT-9 (without the downstream retention area) add ALT-10 (with the downstream retention area). The figure depicts a significant amount of residential homes in the community are not contained within peak flood area.

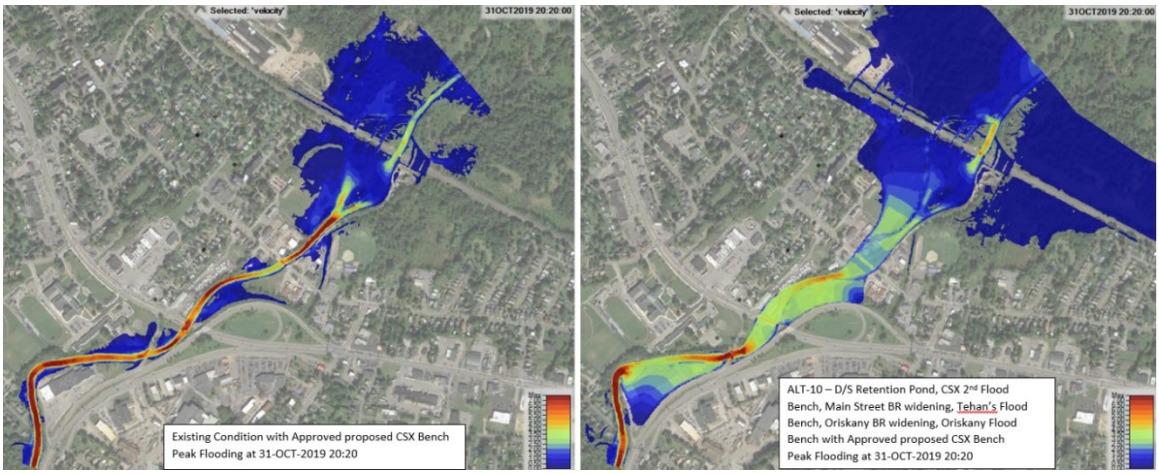


Figure 30. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-10 at 31-October 2019 20:20:00

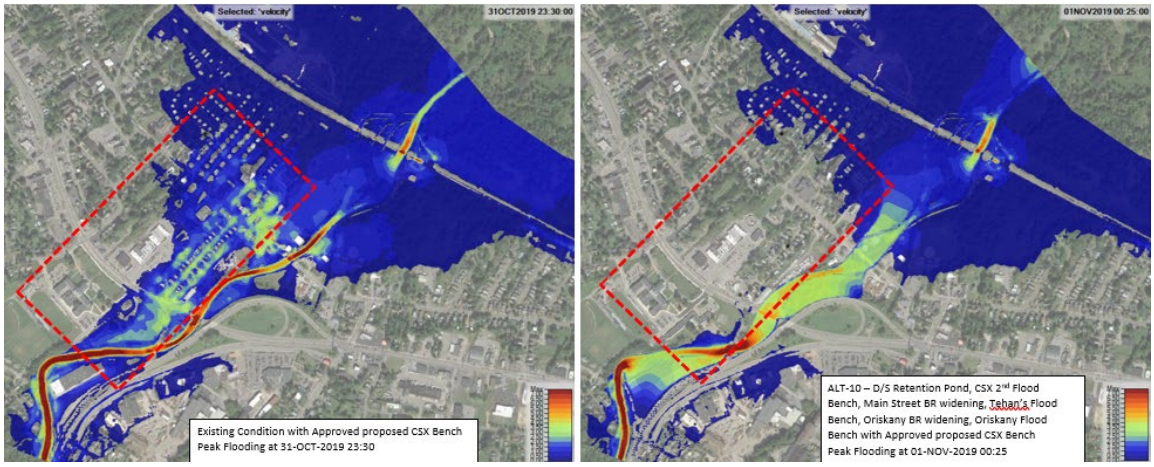


Figure 31. Comparison of Peak Velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-10

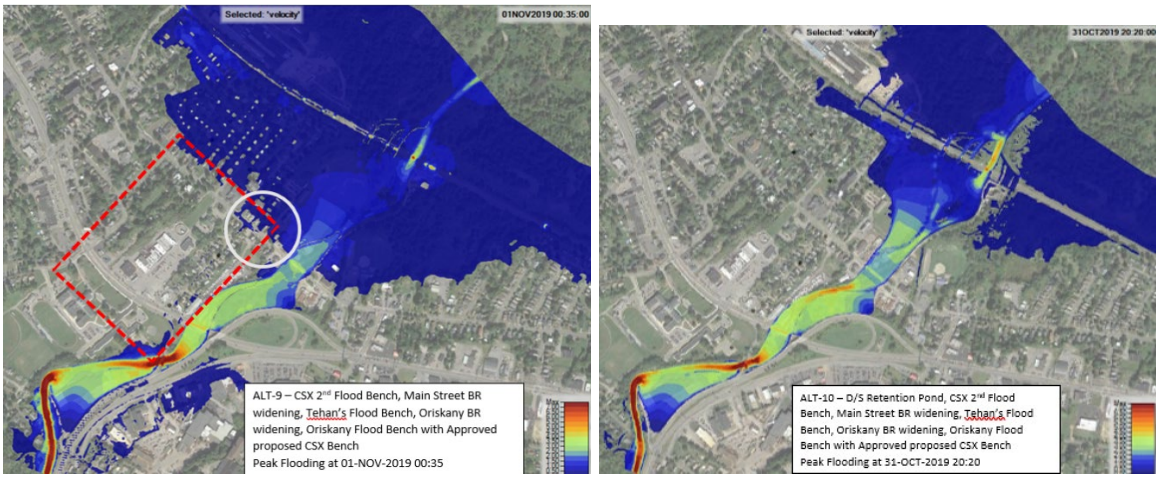


Figure 32. Comparison of Peak velocity (and Flooding) with and without the Downstream Retention Pond

A water level comparison in Figure 33 depicts an overall reduction in water levels through the most of the community, and depicts the best reduction in water at Locations A and B and also in C compared to the previously considered alternatives from ALT-1 to ALT-9.

The water level in Dunham Place (Location C) is still increased by approximately 0.01 ft at the peak flood compared to the existing system.

The total construction cost for ALT-10 is $75.9 million.

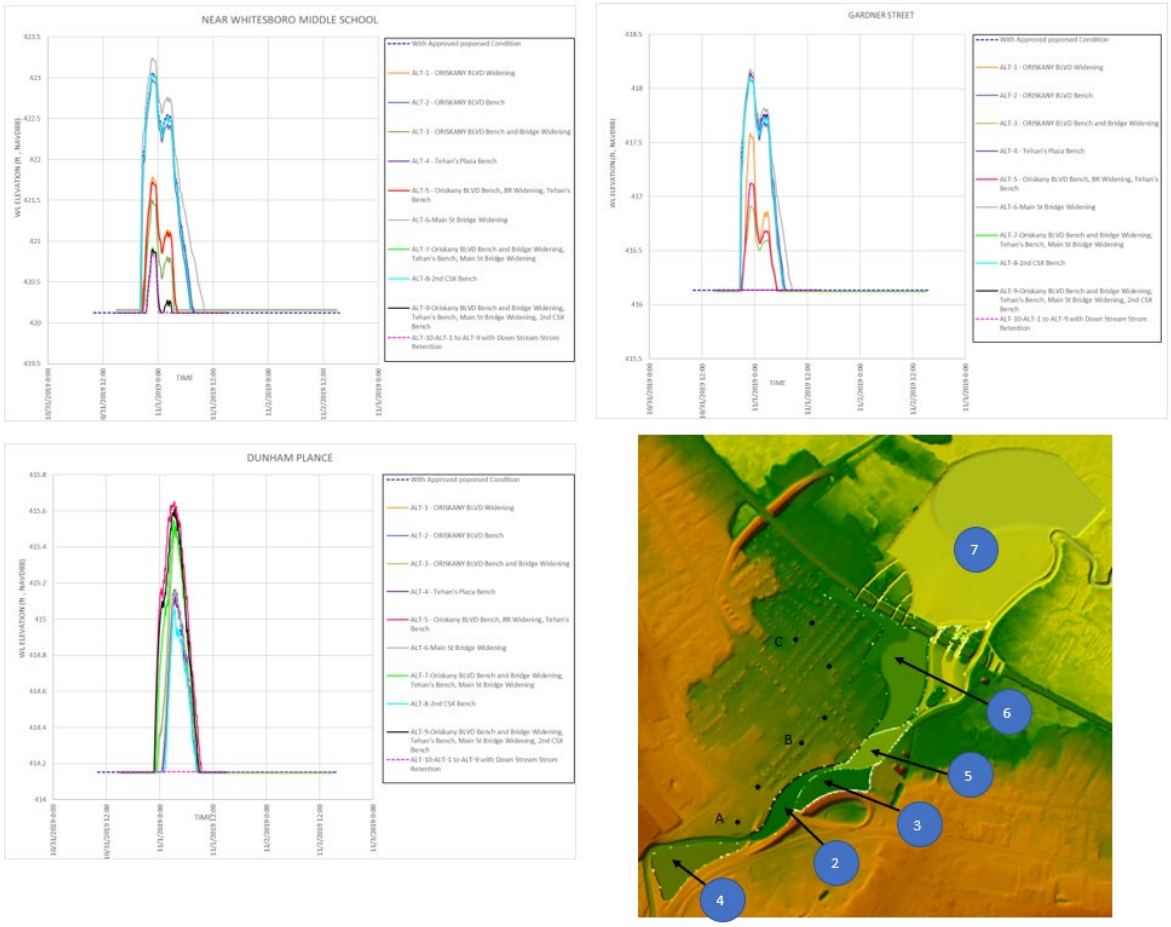


Figure 33. Water Level Comparison with ALT-10, ALT-9, to ALT-1, and Approved Proposed Bench

1.2.11 Alternative-11 (ALT-11) – Alternative 2 and 3 Combined with a Flood Wall at Whitesboro Middle School

ALT-11 consists of a combination of the Oriskany Boulevard bridge widening (ALT-2), the floodplain bench immediately downstream of Oriskany Boulevard Bridge, and a 1,720 foot-long floodwall along the left floodplain near the Whitesboro Middle School's front yard. The top elevation of the floodwall was set at EL 425 based on the existing conditions resulting from the Halloween storm. The floodwall would begin at the entrance to the Whitestown plaza and parallel the on-ramp from Oriskany Boulevard to Route 5A, and then follow the left overbank on the south border of the Whitesboro Middle School front yard to higher elevations.

Figure 34 depicts the initiation of flooding onto the left floodplain of Sauquoit Creek for both the existing system (left figure) and with the ALT-11 (right figure) concurrently during the Halloween storm (31-October 2019 20:20:00).

Figure 35 depicts velocities at the maximum inundation for both existing conditions and ALT-11 cases. The peak inundation within the domain was reached at two different times for the two cases. The two boxes (dashed red) in Figure 35 depicts the area that is affected positively by reducing the inundation. A significant number of houses in Gardner Street and Main Street would experience no or reduced flood inundations with ALT-11. In addition, the floodwall proved to be a full protection to the Whitesboro Middle School from flooding. However, the white circled area in Figure 35 depicts a higher velocity zone compared with the existing system with Phase II project at CSX for several homes along Main Street next to the Main Street bridge. If this alternative was constructed, attention and study would be needed to minimize any damages from the high velocity impacts.

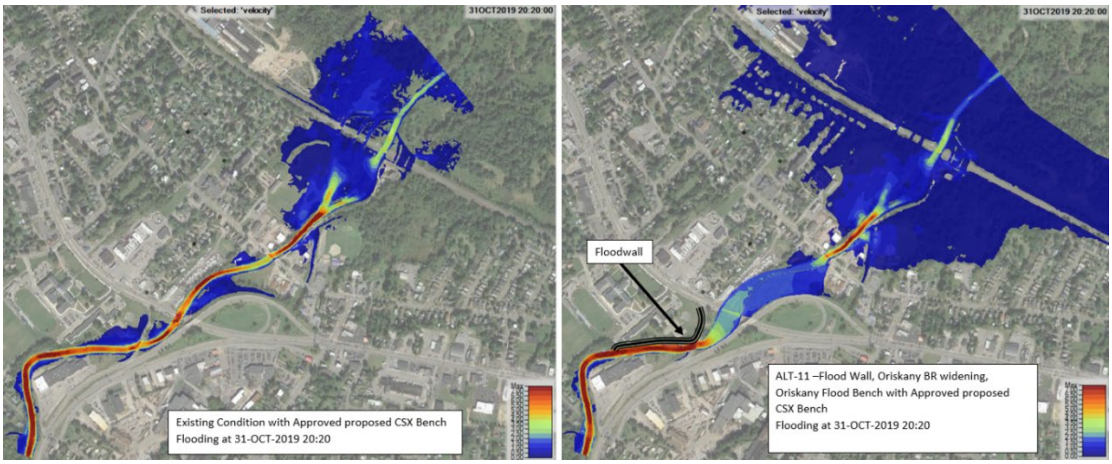


Figure 34. Comparison of Velocities at Flood Initiation with Existing (with approved CSX Flood Bench) and ALT-11 at 31-October 2019 20:20:00

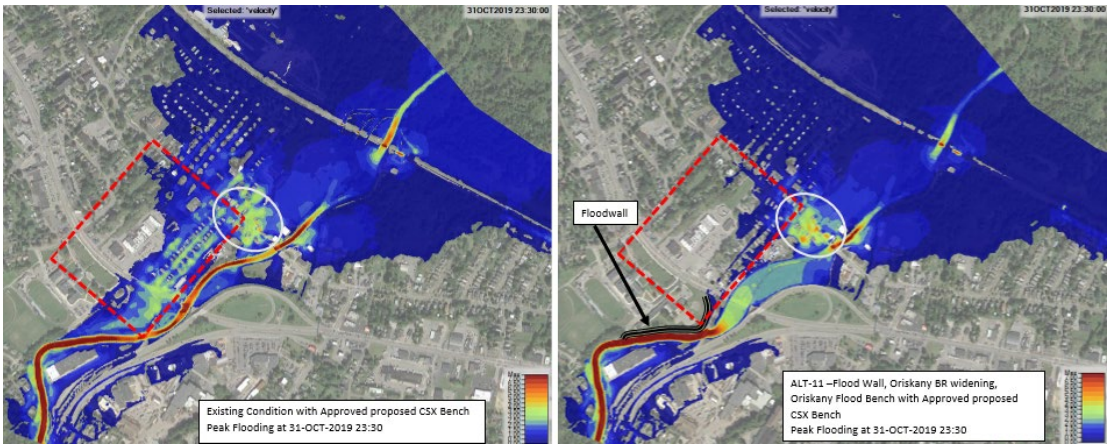


Figure 35. Comparison of Peak Velocity (and Flooding Spread) between Existing (with approved CSX Flood Bench) and ALT-11

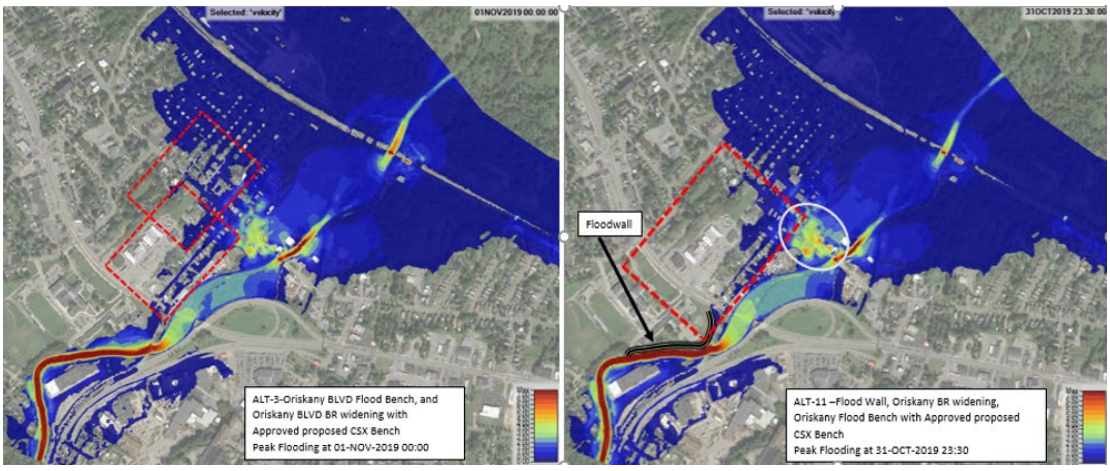


Figure 36.Comparison of Peak Velocity (and Flooding Spread) with ALT-3 (without floodwall) and ALT-11 (with floodwall)

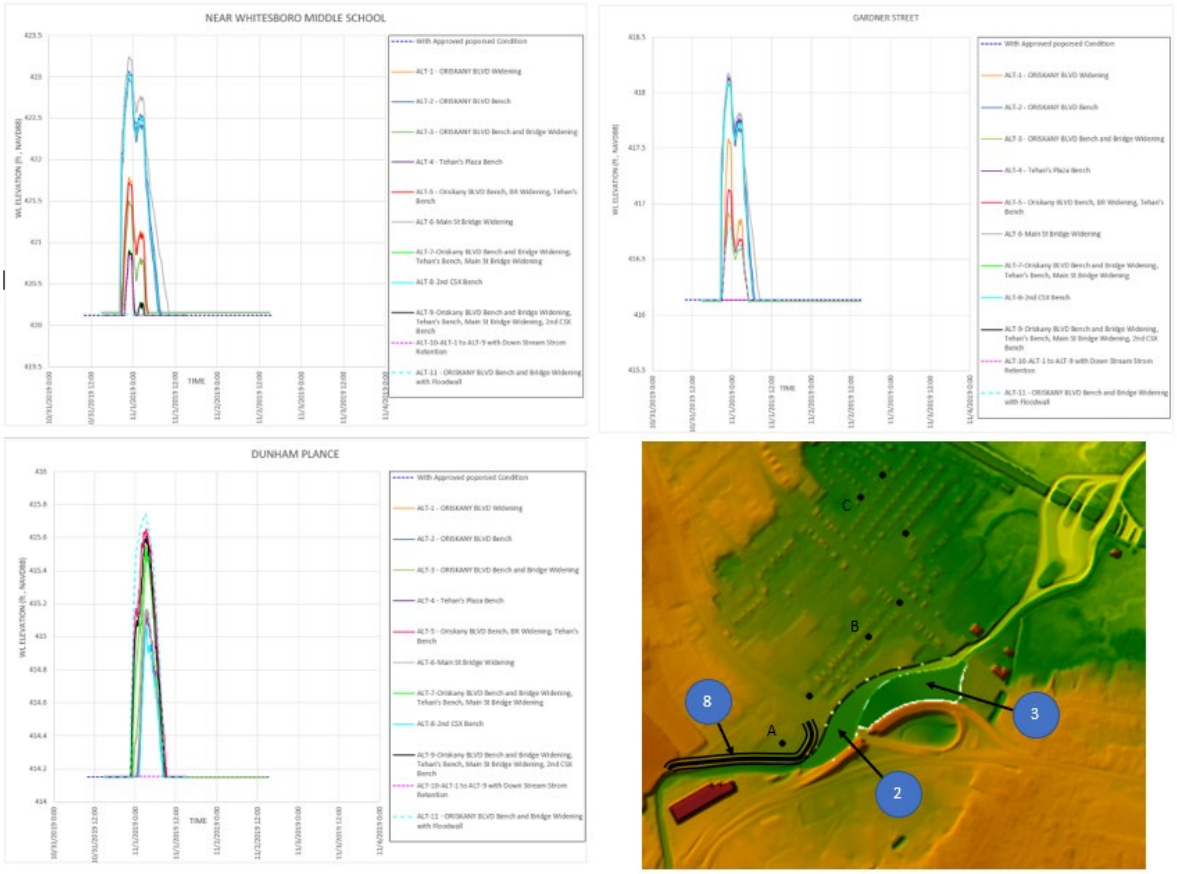


Figure 37. Water Level Comparison with ALT-11, ALT-10, to ALT-1, and Approved Proposed Bench

Figure 36 depicts the comparison of adding the Oriskany Boulevard bridge widening and the Oriskany Boulevard flood bench [does not include the floodwall (ALT-3)] and ALT-11 with the floodwall. In summary, the addition of the floodwall results in the Whitesboro Middle School being completely protected from flood waters. But there is an increased potential for velocity impacts to the neighborhood depicted in the white circle of Figure 36.

A water level comparison in Figure 37 depicts an overall reduction in water levels through most of the community, and depicts reduction in water at Locations A and B, but not at Location C.

The water level at Dunham Place (Location C), is still increased by approximately 0.5 ft at the peak flood compared to the existing system. Since this behavior results in most of the other alternatives, a general explanation for the water level increase is provided under Section 1.3 of this report.

The total construction cost for ALT-11 is $15.0 million.

1.3 General Remarks

This study conducted several 2D hydrodynamic simulations to investigate various flood reduction mitigation alternatives, for the storm experienced during Halloween 2019. These alternatives consisted of one or more topographical modifications to the current floodplain terrain such as flood benches, bridge widenings, and / or floodwalls.

A flood bench temporarily stores surged flood water in a safe area within an irrigation system and releases the stored water back to the system when the surge recedes. Flood benches activate only when the water level in the main channel (in the vicinity of the flood bench) increases and operates as part of the river network. Therefore, flood benches can prevent overland flooding by lowering the water levels below the bank levels, by temporarily holding water within the flood bench, provided that the flood bench has adequate storage capacity.

Bridge openings, that do not convey the larger storm event flows, can often create backwater swellings in a river increasing the water levels upstream of the bridge. Therefore, when riverbanks are low, these backwater effects can overflow onto the lower grounds of the dry floodplains. The backwater effects can be minimized by allowing more flow to pass through the bridge by widening the bridge opening.

If a flood bench is constructed along with the widening of a bridge, during a flood surge, as the water levels rise higher, the flood benches get activated, temporarily storing flood waters, and behave as part of the river system. The widened bridge opening can pass the increased flow without restrictions with no backwater impacts. Suddenly the conveyance of the creek is increased, and the system can now pass a higher capacity of flow.

All the alternatives considered in this study were associated with an increase in conveyance through the Sauquoit Creek during a flood surge compared to the existing conditions. With the increased conveyance capacity, the creek can now pass more flow through the system during a flood surge. Without any adequate draining at the railroad bridge crossing the additional water that conveyed to downstream will start to accumulate within the downstream community increasing the flood water levels in Dunham and Wind Place neighborhoods. Therefore, a small water level rise in the Dunham and Wind Place neighborhoods were observed, even though the flood benches and bridge widenings associated in water level reductions in upstream on the creek and locally to the modifications.

1.4 Major Findings

The terrain downstream of the CSX railroad embankment (e.g. the Mohawk River floodplain) is basically flat. Floodwater requires slope (gravity) to move through a creek system. As the Sauquoit Creek approaches the Village of Whitesboro and enters the Mohawk River floodplain below the CSX embankment, the slope flattens rapidly, which is the major contributor to the extent and depth of flooding below Oriskany Boulevard. The benefits of alternatives that provide only additional storage are limited when viewed at Location C, Dunham Place and its nearby neighborhoods. Alternatives that reduce backwater at road crossings have immediate impacts on the adjacent areas (e.g. Whitesboro Middle School), but may have adverse impacts at Location C.

When considering alternatives further, it is important to remember the NYSDEC and USACE permit requirements as independent review. This means that a project cannot rely on a future project to achieve its functionality, e.g. flood stage reduction. As this report demonstrates, the most benefit is achieved by combination of two or more alternatives, which have higher construction cost estimates. The commission, municipalities, County, State and Federal partners will need to work together closely in order to plan and execute the most effective mitigation alternatives as they relate to cost and complexity.

Throughout all the alternatives, the Tahan's floodplain bench and the Oriskany Boulevard flood benches alone did not work to significantly lower the flood water levels. However, when combined with other alternatives, they enhance and contribute to flood stage reductions at the three observation areas.

Table 3 summarizes the benefits and associated costs involved in the above described alternatives. The benefit is countified by measuring the water level reductions at Locations A, B and C compared to the conditions with the Phase II approved project at CSX. However, there are also the additional benefits of reduction of higher velocity zones, and reduction in overall inundation areas as well, on top of the local water level reductions.

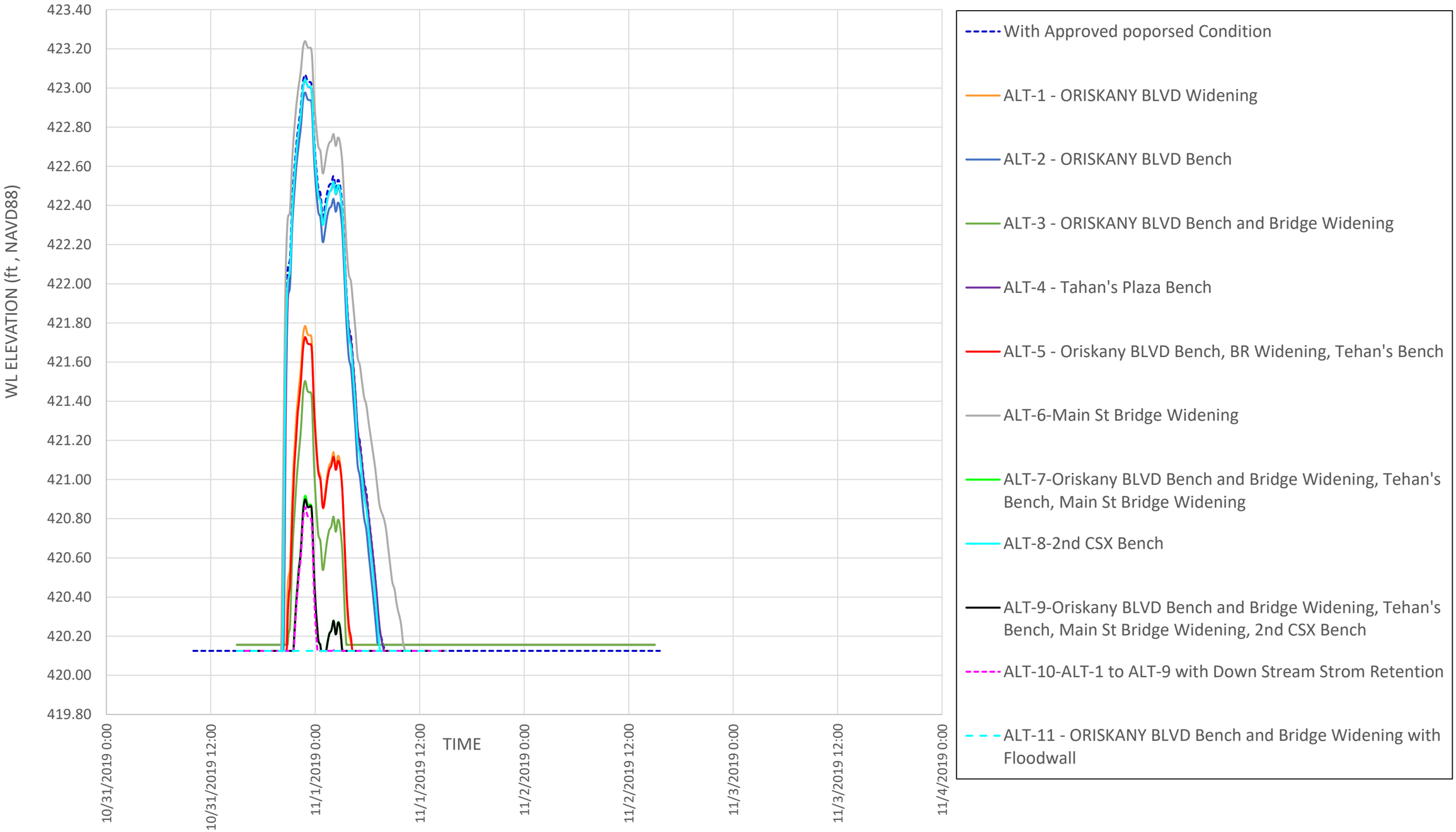
Table 3. Cost and Benefits

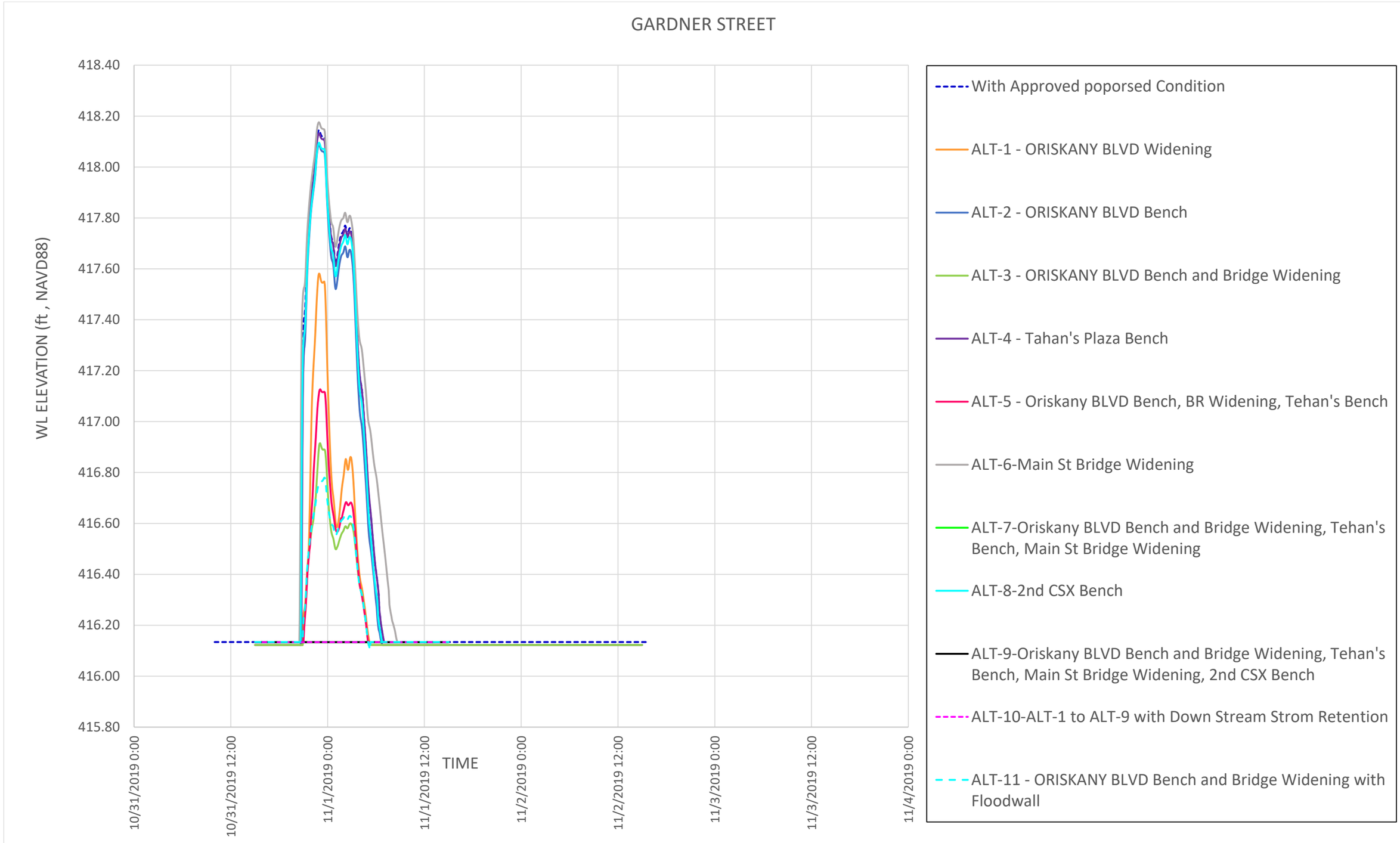
ALTERNATIVE	COST of Construction in Million Dollars	Benefit Compared to Approved Phase II Project (feet)			Total Benefit
		A	B	C	A+B+C
1	10.6	1.25	0.58	-0.37	1.46
2	2.8	0.08	0.06	-0.37	-0.23
3	13.4	1.55	1.25	-0.35	2.44
4	17.0	0.05	0.00	0.01	0.06
5	30.4	1.35	1.02	-0.51	1.87
6	7.3	-0.15	-0.04	0.00	-0.19
7	37.7	2.15	2.00	-0.41	3.74
8	8.5	0.00	0.06	0.08	0.14
9	46.2	2.19	2.00	-0.45	3.74
10	75.9	2.20	2.00	-0.01	4.19
11	15.0	2.93	1.38	-0.59	3.71

A positive benefit is measured as a water level reduction compared to the Phase II approved project conditions. A negative benefit is a water level increase from the current conditions. The total benefit is taken as an addition of benefits at all the Locations, A, B and C. According to Table 3, ALT-11, ALT-10, ALT-9 and ALT-7 show higher benefits.

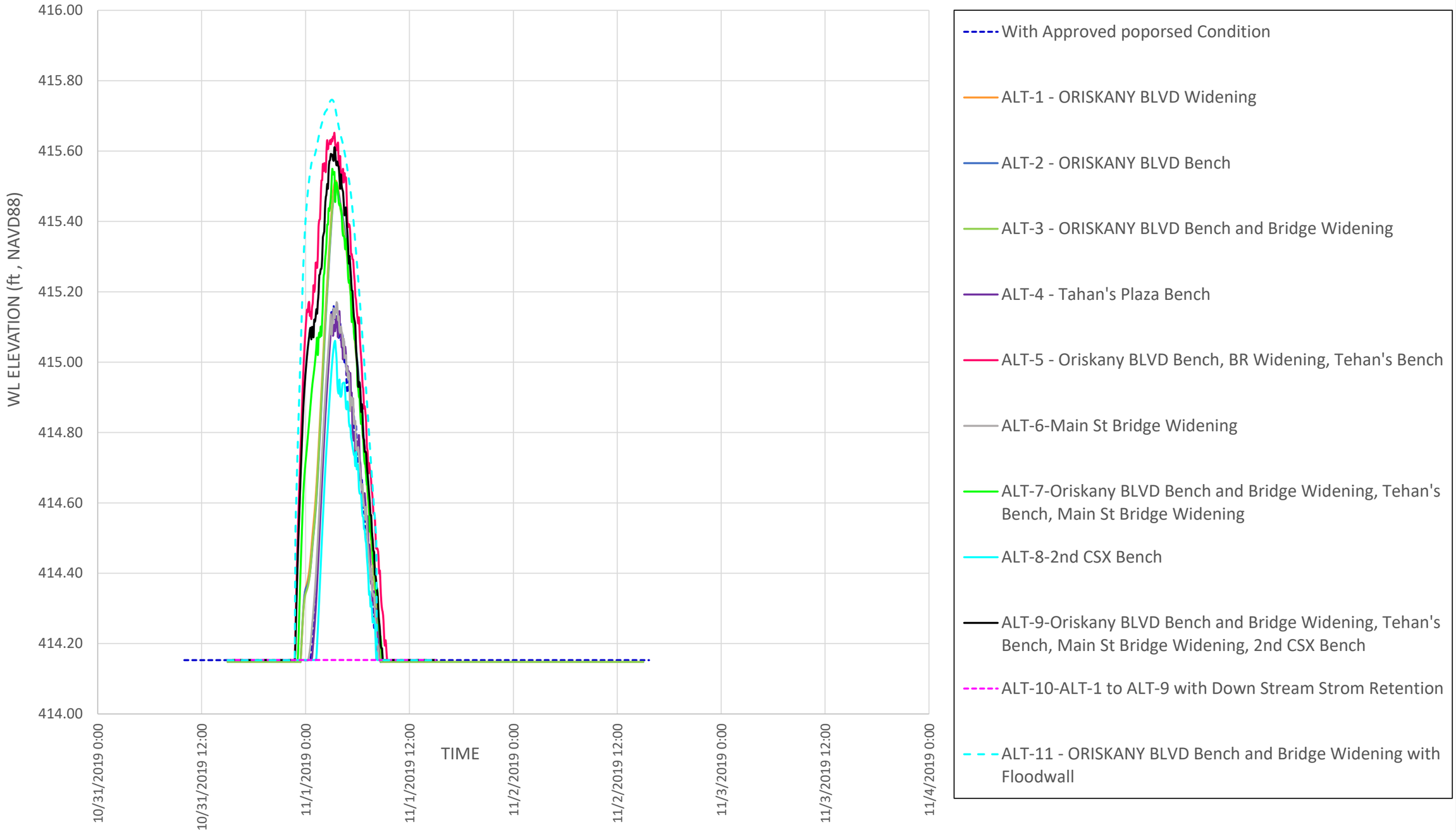
APPENDIX A
WATER LEVELS

NEAR WHITESBORO MIDDLE SCHOOL




GARDNER STREET
WL ELEVATION (ft , NAVD88)
418.40
418.20
418.00
417.80
417.60
417.40
417.20
417.00
416.80
416.60
416.40
416.20
416.00
415.80
10/31/2019 0:00
10/31/2019 12:00
11/1/2019 0:00
11/1/2019 12:00
11/2/2019 0:00
11/2/2019 12:00
11/3/2019 0:00
11/3/2019 12:00
11/4/2019 0:00
TIME
With Approved poporsed Condition
ALT-1 - ORISKANY BLVD Widening
ALT-2 - ORISKANY BLVD Bench
ALT-3 - ORISKANY BLVD Bench and Bridge Widening
ALT-4 - Tahan's Plaza Bench
ALT-5 - Oriskany BLVD Bench, BR Widening, Tehan's Bench
ALT-6-Main St Bridge Widening
ALT-7-Oriskany BLVD Bench and Bridge Widening, Tehan's Bench, Main St Bridge Widening
ALT-8-2nd CSX Bench
ALT-9-Oriskany BLVD Bench and Bridge Widening, Tehan's Bench, Main St Bridge Widening, 2nd CSX Bench
ALT-10-ALT-1 to ALT-9 with Down Stream Strom Retention
ALT-11 - ORISKANY BLVD Bench and Bridge Widening with Floodwall

DUNHAM PLANCE



APPENDIX B
ALTERNATIVES COST ESTIMATES

Appendix B

O'Brien & Gere

Project:	Whitesboro Inundation Study
Owner:	Town of Whitestown
County:	Oneida
Municipality:	Whitesboro
Last Update:	6/29/2020
QA/QC Completed:	

Total project costs rounded up to nearest ten thousand

Whitesboro Inundation Study
Town of Whitestown, NY

Item/Description		Total Project Cost
Modification #	Description	
2	Oriskany Boulevard Bridge Widening	$ 10,629,000
3	Oriskany Boulevard Flood Bench	$ 2,794,000
4	Tehan Plaza Flood Bench	$ 16,992,000
5	Main Street Bridge Widening	$ 7,274,000
6	CSX Bench #2	$ 8,477,000
7	CSX Downstream Retention	$ 29,686,000
8	Flood Wall	$ 1,590,000

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 2 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
Oriskany Boulevard Bridge Widening				
Removal of bridge				***$ 1,331,772***
Removal of bridge	6,224	SF	$ 57	$ 354,768
Hauling - machine loaded - 8 CY truck	1,383	CY	$40	$ 55,324
Excavation	45,909	CY	$20	$ 918,180
Construction Entrance	1	EA	$3,500	$ 3,500
Installation of new bridge				***$ 4,447,000***
New bridge, steel, over water	13,400	SF	$ 330	$ 4,422,000
Maintenance & Protection of Traffic	1	ELOC	$ 25,000	$ 25,000
Pavement Restoration				***$ 167,236***
1 1/2" thickness asphaltic top course	2,644	SY	$8	$ 21,284
2" thickness asphaltic binder course	2,644	SY	$10	$ 26,308
4" thickness asphaltic base course	2,644	SY	$18	$ 48,782
12" thickness type 2 subbase	881	CY	$77	$ 67,863
Pavement striping - yellow - 4"	1,000	LF	$1	$ 1,000
Pavement striping - white - 4"	2,000	LF	$1	$ 2,000
Construction Cost Subtotal				**$ 5,946,009**
Mobilization	10%			$ 595,000
Total Estimated Construction Cost				**$ 6,541,000**
Engineering, Legal, and Administrative	25%			$ 1,635,000
Contingency	30%			$ 2,453,000
Total Estimated Project Cost				**$ 10,629,000**

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 3 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
Oriskany Boulevard Flood Bench				
Formation of flood bench				***$ 1,521,860***
Strip and stockpile topsoil		SY		
Excavation	51,718	CY	$ 20	$ 1,034,360
Clearing/Grubbing	5	AC	$ 16,000	$ 76,000
Seeding and/or planting	5	AC	$ 69,650	$ 331,000
Temporary sediment and erosion control	1,100	LF	$ 70	$ 77,000
Construction Entrance	1	EA	$3,500	$ 3,500
Land acquisition	5	AC	$3,500	***$ 16,625***
Maintenance & Protection of Traffic	1	LS	$25,000	***$ 25,000***
Construction Cost Subtotal				**$ 1,563,485**
Mobilization	10%			$ 156,000
Total Estimated Construction Cost				**$ 1,719,000**
Engineering, Legal, and Administrative	25%			$ 430,000
Contingency	30%			$ 645,000
Total Estimated Project Cost				**$ 2,794,000**

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 4 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
Tehan Plaza Flood Bench				
Formation of flood bench				***$ 6,481,200***
Excavation	280,435	CY	$ 20	$ 5,608,700
Clearing/Grubbing	1	AC	$ 16,000	$ 16,000
Building demolition	72,000	SF	$ 4	$ 288,000
Seeding and/or planting	7	AC	$ 69,650	$ 488,000
Temporary sediment and erosion control	1,100	LF	$ 70	$ 77,000
Construction Entrance	1	EA	$3,500	$ 3,500
Land acquisition	1	LS	$3,000,000	***$ 3,000,000***
Maintenance & Protection of Traffic	1	LS	$25,000	***$ 25,000***
Construction Cost Subtotal				**$ 9,506,200**
Mobilization	10%			$ 951,000
Total Estimated Construction Cost				**$ 10,457,000**
Engineering, Legal, and Administrative	25%			$ 2,614,000
Contingency	30%			$ 3,921,000
Total Estimated Project Cost				**$ 16,992,000**

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 5 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
Main Street Bridge Widening				
Removal of bridge				***$ 1,032,861***
Removal of bridge	4,541	SF	$ 57	$ 258,837
Hauling - machine loaded - 8 CY truck	1,009	CY	$40	$ 40,364
Excavation	36,508	CY	$20	$ 730,160
Construction Entrance	1	EA	$3,500	$ 3,500
Installation of new bridge				***$ 2,912,500***
New bridge, steel, over water	8,750	SF	$ 330	$ 2,887,500
Maintenance & Protection of Traffic	1	ELOC	$ 25,000	$ 25,000
Pavement Restoration				***$ 123,755***
1 1/2" thickness asphaltic top course	1,944	SY	$8	$ 15,649
2" thickness asphaltic binder course	1,944	SY	$10	$ 19,343
4" thickness asphaltic base course	1,944	SY	$18	$ 35,867
12" thickness type 2 subbase	648	CY	$77	$ 49,896
Pavement striping - yellow - 4"	1,000	LF	$1	$ 1,000
Pavement striping - white - 4"	2,000	LF	$1	$ 2,000
Construction Cost Subtotal				**$ 4,069,116**
Mobilization	10%			$ 407,000
Total Estimated Construction Cost				**$ 4,476,000**
Engineering, Legal, and Administrative	25%			$ 1,119,000
Contingency	30%			$ 1,679,000
Total Estimated Project Cost				**$ 7,274,000**

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 6 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
CSX Bench #2				
Formation of flood bench				***$ 2,917,810***
Excavation	60,540	CY	$ 20	$ 1,210,800
Clearing/Grubbing	4	AC	$ 16,000	$ 64,000
Building demolition	18	EA	$ 25,000	$ 450,000
Seeding and/or planting	17	AC	$ 69,650	$ 1,184,000
Silt Fence	1,450	LF	$ 4	$ 5,510
Construction Entrance	1	EA	$3,500	$ 3,500
Property acquisition	1	LS	$1,800,000	***$ 1,800,000***
Maintenance & Protection of Traffic	1	LS	$25,000	***$ 25,000***
Construction Cost Subtotal				**$ 4,742,810**
Mobilization	10%			$ 474,000
Total Estimated Construction Cost				**$ 5,217,000**
Engineering, Legal, and Administrative	25%			$ 1,304,000
Contingency	30%			$ 1,956,000
Total Estimated Project Cost				**$ 8,477,000**

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 7 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
CSX Downstream Retention				
Formation of flood bench				***$ 15,057,160***
Excavation	453,433	CY	$ 20	$ 9,068,660
Clearing/Grubbing	68	AC	$ 16,000	$ 1,088,000
Seeding and/or planting	68	AC	$ 69,650	$ 4,736,000
Temporary sediment and erosion control	2,300	LF	$ 70	$ 161,000
Construction Entrance	1	EA	$3,500	$ 3,500
Culvert Installation				***$ 1,286,798***
Pipe jacking	900	LF	$874.22	$ 786,798
Jacking pits	1	LS	$500,000.00	$ 500,000
Property acquisition	68	AC	$3,500	***$ 238,000***
Maintenance & Protection of Traffic	1	LS	$25,000	***$ 25,000***
Construction Cost Subtotal				**$ 16,606,958**
Mobilization	10%			$ 1,661,000
Total Estimated Construction Cost				**$ 18,268,000**
Engineering, Legal, and Administrative	25%			$ 4,567,000
Contingency	30%			$ 6,851,000
Total Estimated Project Cost				**$ 29,686,000**

Project: Whitesboro Inundation Study
Owner: Town of Whitestown
County: Oneida
Municipality: Whitesboro
Last Update: 6/29/2020
QA/QC Completed: 1/0/1900

Modification 8 - PROJECT COST ESTIMATE

Item/Description	Qty	Units	Unit Cost	Amount
Flood Wall				
Formation of flood wall				***$ 863,500***
Concrete flood wall	1,720	LF	$ 500	$ 860,000
Construction Entrance	1	EA	$3,500	$ 3,500
Maintenance & Protection of Traffic	1	LS	$25,000	***$ 25,000***
Construction Cost Subtotal				**$ 888,500**
Mobilization	10%			$ 89,000
Total Estimated Construction Cost				**$ 978,000**
Engineering, Legal, and Administrative	25%			$ 245,000
Contingency	30%			$ 367,000
Total Estimated Project Cost				**$ 1,590,000**