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SAUQUOIT CREEK DRAINAGE STUDY
FINDINGS OF 2019 HALLOWEEN STORM – HYDRAULIC MODELING

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FINDINGS OF 2019 HALLOWEEN STORM – HYDRAULIC MODELING

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This report summarizes the additional findings of the two-dimensional hydraulic modeling for the Village of Whitesboro, NY for the 2019 Halloween storm event in conjunction with the memorandum dated March 31, 2020, "*Preliminary Findings of Halloween Storm 2019-Hydraulic Modeling,*" included in this report as Appendix A.

1.1 Introduction

The Village of Whitesboro, NY has experienced multiple flood events in the past five years, with the most recent storm event occurring on October 31, 2019. This event was particularly intense, causing damage to multiple residential foundations resulting in orders of condemnation.

The Sauquoit Creek Basin Intermunicipal Commission (SCBIC), in partnership with Oneida County, is seeking to better understand why the October 2019 storm event resulted in extensive damage to a subset of residential properties (some of which have not experienced damage in prior storm events), and how targeted mitigation efforts could benefit the community by reducing flood risk and repetitive loss.

The analysis focused on an area in the Village of Whitesboro generally bounded by the CSX railroad tracks, Sauquoit Creek, Oriskany Boulevard, Victory Parkway, Main Street, and Mohawk Street. The project area is shown in Figure 1.

Figure 1. Village of Whitesboro – Flood Risk Assessment Survey Area

1.2 Survey

To further understand the type and magnitude of impacts in terms of hydraulic forces, velocities and inundation depths and duration, the two-dimensional depth averaged model used in the preliminary study dated February 31, 2020 was enhanced by incorporating field survey data. Specifically, Prudent Engineering LLP, in March 2020 collected the First Floor Elevation (FFE), Lowest Adjacent Grade (LAG), Lowest Point of Entry (LPE) and roadway centerline survey points of each building within the significantly flooded area between Oriskany Boulevard and the Railroad Bridge crossing of Sauquoit Creek.

1.3 Topography

The additional survey data was incorporated into the 2-meter LiDAR Digital Elevation Model (DEM) surface that was downloaded from "http://www.orthos.dhses.ny.gov" collected in 2008. The building's LPE, LAG and FFE elevations were stamped into the DEM using the building footprints, based on ortho imagery collected in 2017 by New York State Office of Information Technology Services. This allows the hydraulics simulation to depict more accurate flow patterns, flow constrictions through the two adjacent buildings, velocities, and depths around the buildings. The hydraulics model now simulates inundation that occurred above the FFE. These type of simulation results can show the buildings that may be critically impacted by flooding.

1.4 Regulations

According to Code of Federal Regulation 44 CFR 60.6 (c), a residential building may be issued a permit to floodproof the basement only if it can be shown that the maximum flood depth and velocities will be less than five feet, and five feet per second (fps), respectively. Therefore, this study will help to identify buildings that may meet these criteria.

Additionally, according to the FEMA 480 document, flood depths of two feet or more may float a four-wheel vehicle and drag it along in the current. While this study did not evaluate this criteria directly, observations of velocities were made to suggest areas where vehicle-to-building impacts may have weakened the structural integrity of the buildings, even though the buildings are exposed to depths and velocities less than five feet and five fps, respectively.

A sudden high erosion, due to the peak velocity, could also impact the structural integrity of building foundations. Therefore, this study also helps to identify where such high-velocity zones may exist.

1.5 2D Hydrodynamic Model Calibration

The survey collection was able to locate and collect a high-water mark near 33 Sauquoit Street. The high-water mark was measured to be at elevation 415.8 ft, NAVD 88. The 2D model was calibrated by adjusting ground roughness to match the measured high-water mark near the above-mentioned property. The calibrated roughness map is shown below (Figure 2) with corresponding Manning's roughness values.

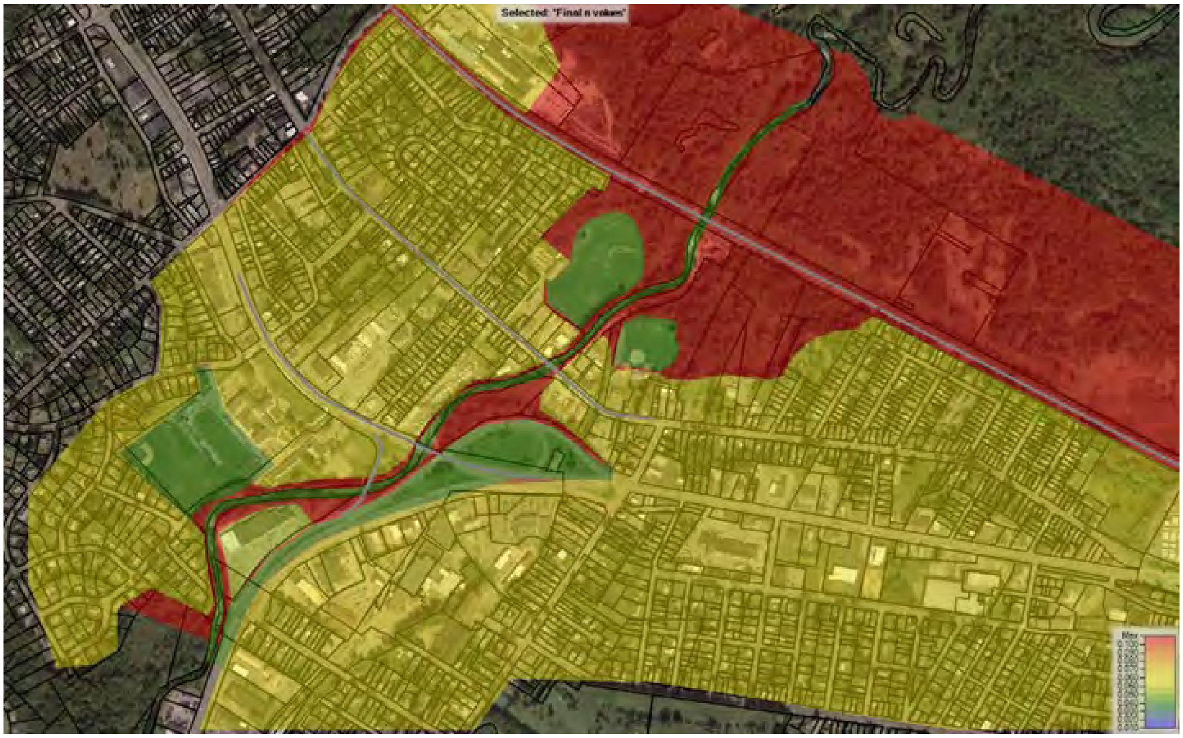

Figure 2. Calibrated Manning's n for the 2d Model

Modeling indicated that the initial out-of-bank flooding begins as water stages upstream of the railroad crossing. Over the course of approximately 3.5 hrs. (215 minutes), approximately 75% of the overland area bordered by Oriskany Boulevard, Mohawk Street and CSX railroad were inundated to the peak depth (Figure 3). After which, from the peak it took approximately 25 hours for flooding to recede in the primarily residential area (Figure 4) and then another 49 hours (74 hours since the peak) to completely drain all overland flooding (Figure 5).

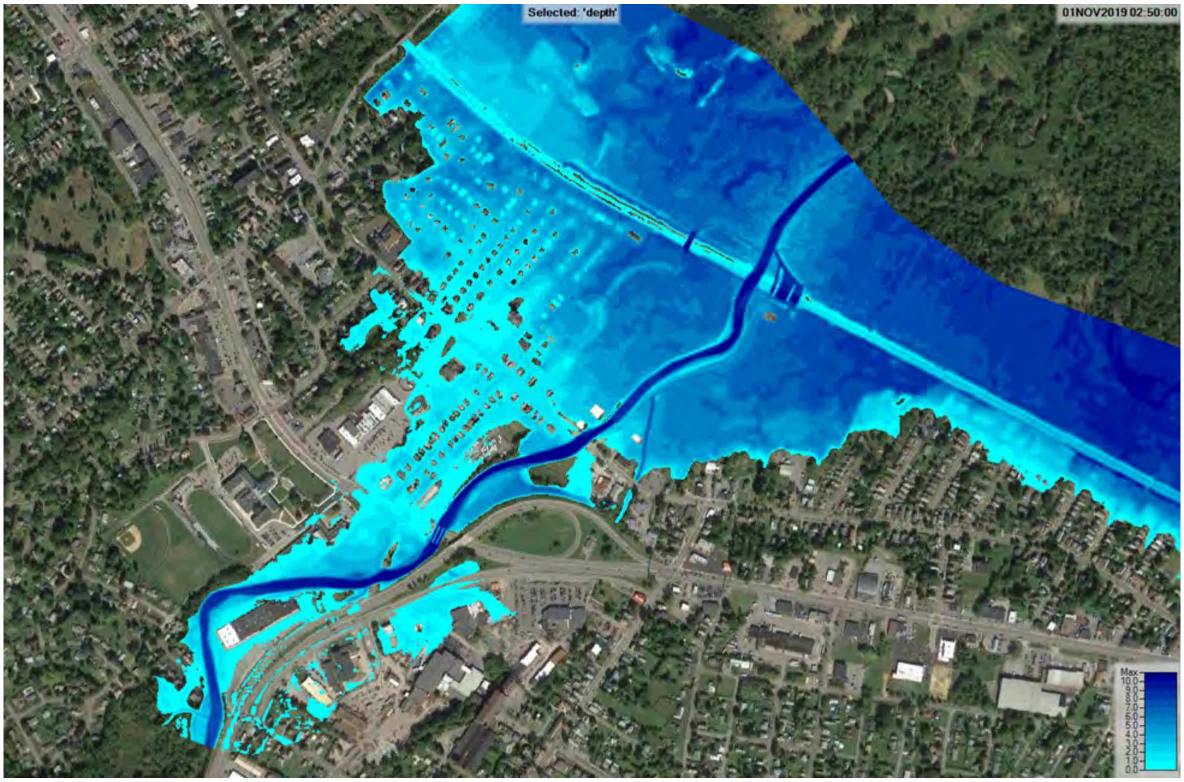

Figure 3. Sauquoit Creek - Peak flood during the 2019 Halloween Storm

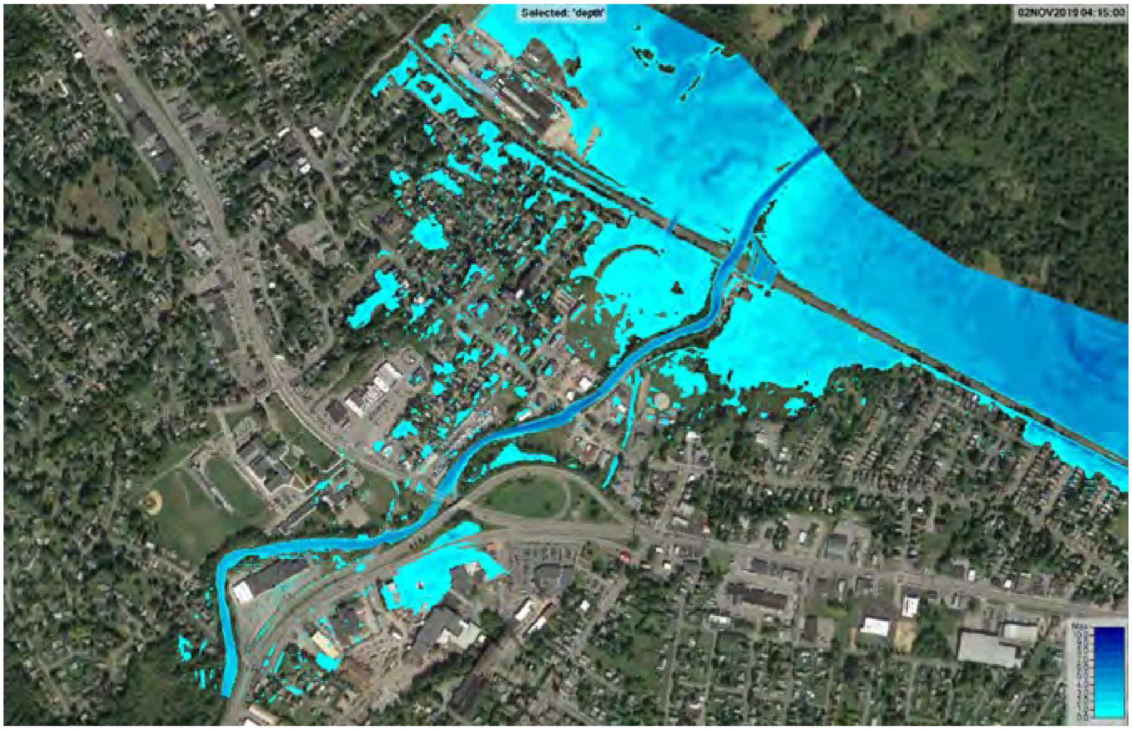

Figure 4. Sauquoit Creek - 25 hours after the peak flood during the 2019 Halloween Storm

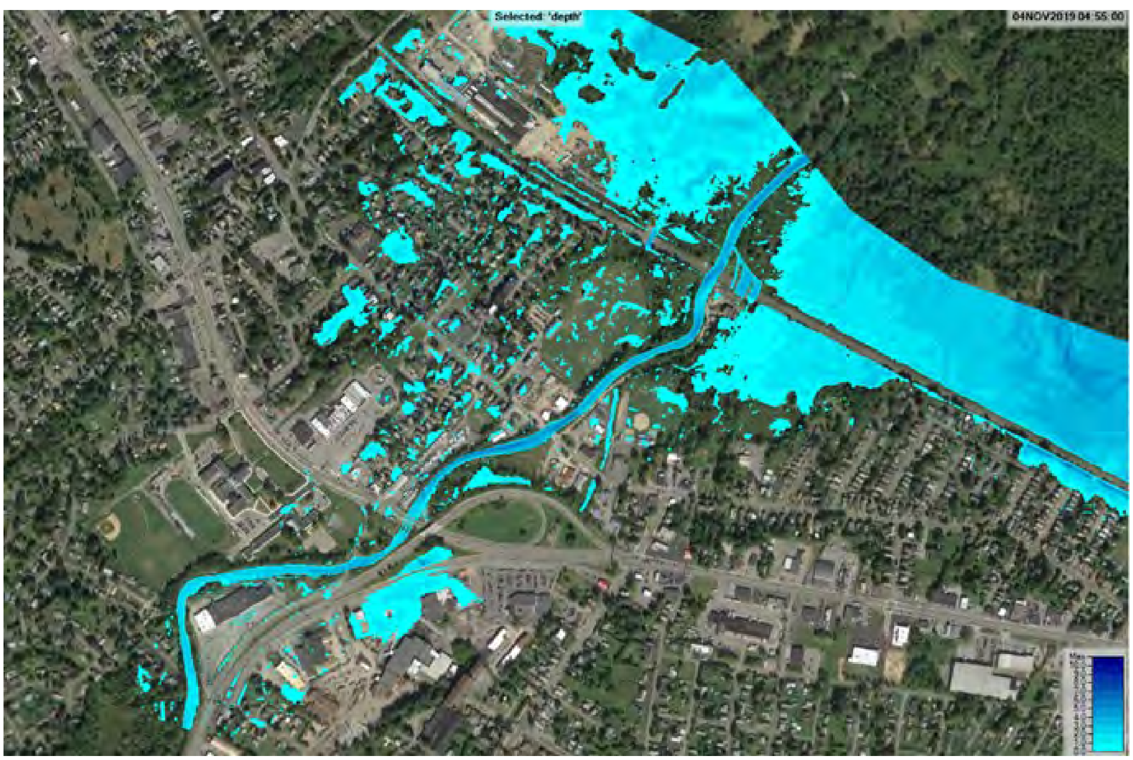

Figure 5. Sauquoit Creek - 74 hours after the peak flood during the 2019 Halloween Storm

Figure 6 shows the number of residential buildings whose first-floor elevations were completely under water during the event. Approximately 67 residential buildings were potentially critically impacted by inundation of their FFE, and / or basement. Approximately, 114 buildings were not flooded to the FFE, however their parcels were inundated to various depths, which could have weakened their foundations.

Figure 6. Inundated Buildings at the peak of the Halloween Storm

To understand the velocities and their directions, the modeling software allows the user to visualize the pattern by displaying a series of “flow trace” lines. These lines are depicted in white on the following images. These lines indicate the direction of flow at each point during the storm. Figure 7 and Figure 8 show the development of flooding into the floodplain between Oriskany Boulevard. and the railroad crossing. Specifically, Figure 7 shows that overland flooding begins between Main Street and the railroad crossing in the vicinity of the proposed floodplain bench (Mauro parcel). As the storm continues to develop, Figure 8 shows how flooding starts to enter at Sauquoit St. and Ellis Avenue, and how overland flooding begins to develop at two additional locations, near the Whitesboro Elementary School onto Gardner Street and behind the Whitesboro Veterans of WWII building.

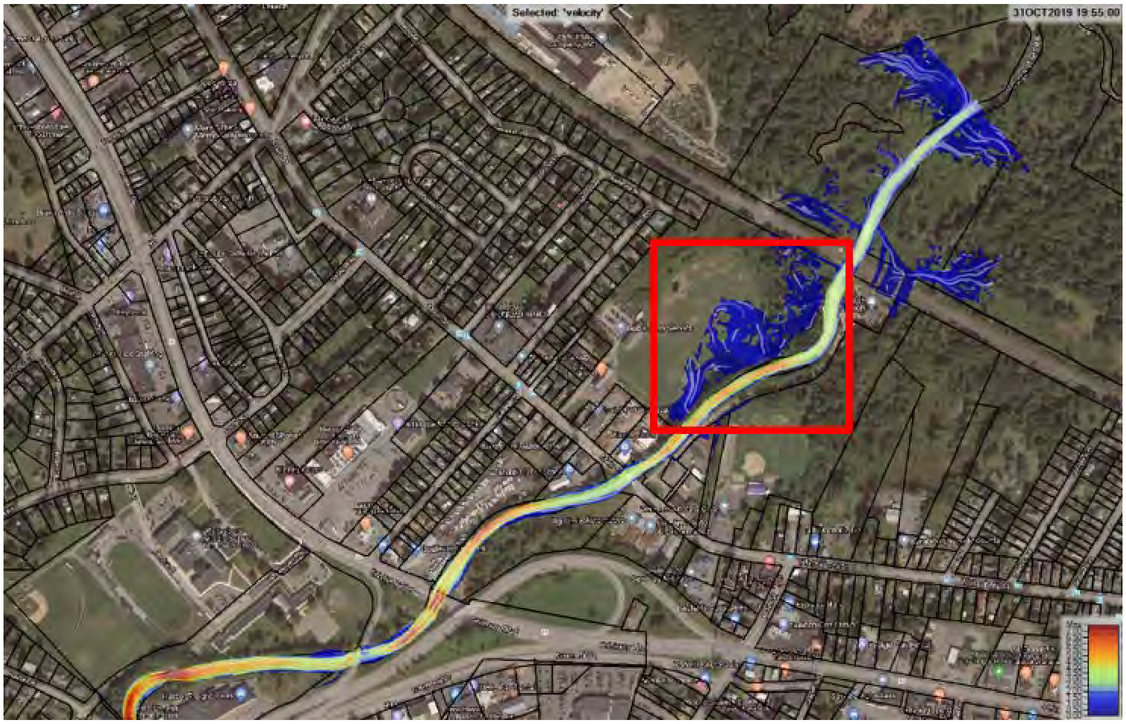

Figure 7. Flood development – (between Main Street and the railroad crossing)

Figure 8. Flood development (Sauquoit Street and Ellis Avenue)

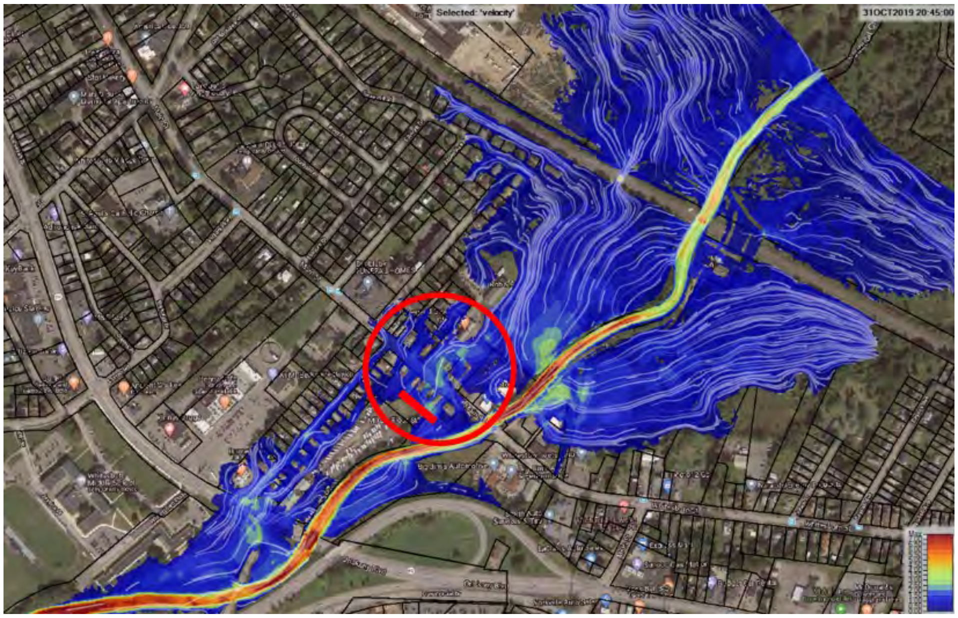

Figure 9. Flood development (Whitesboro Middle School / Main Street area)

In Figure 9 the model shows flooding beginning to concentrate at the Whitesboro Middle Schools parking lot and flow down Gardner Street towards Main Street The figure also depicts how flow begins to concentrate at the northern end of the Boulevard Trailer property about 880-feet downstream from the Oriskany Boulevard bridge. Floodwater then passes over Main Street inundating the residential neighborhoods on both sides of the Main Street roadway (Circled in Figure 9). The maximum velocity and the maximum depths located at the thick red line drawn on Figure 9 is above 3 fps and above 2.5 feet. The flood water then continues to flow into the lower areas adjacent to the railroad embankment.

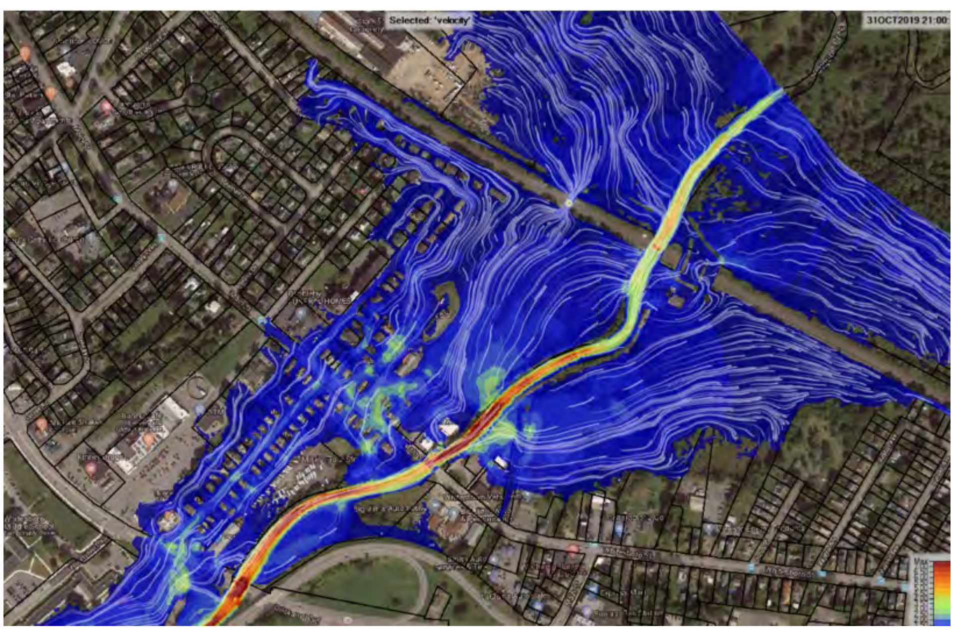

Figure 10. Flooding evolution (1)

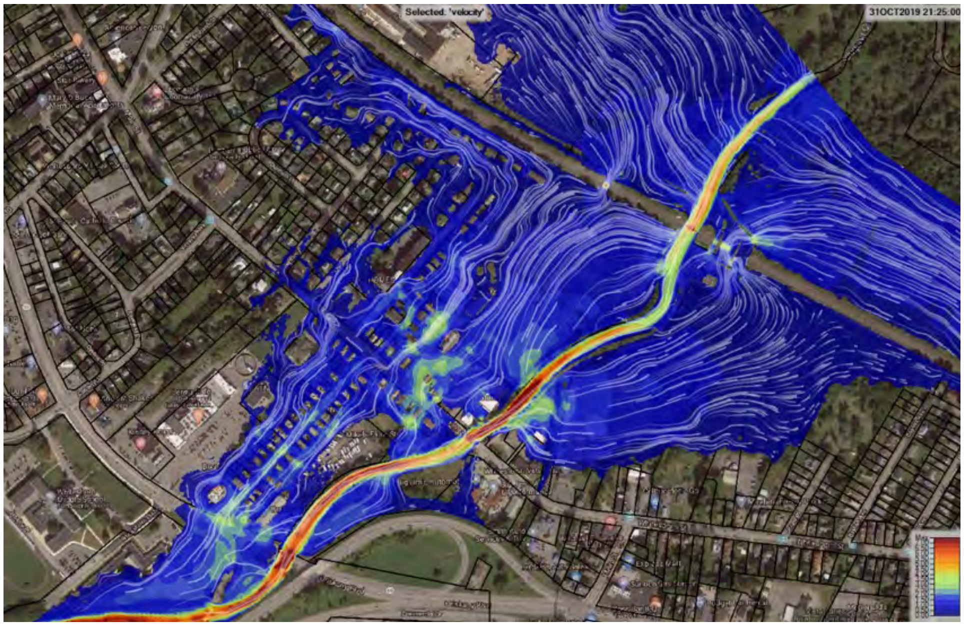

Figure 11. Flooding evolution (2)

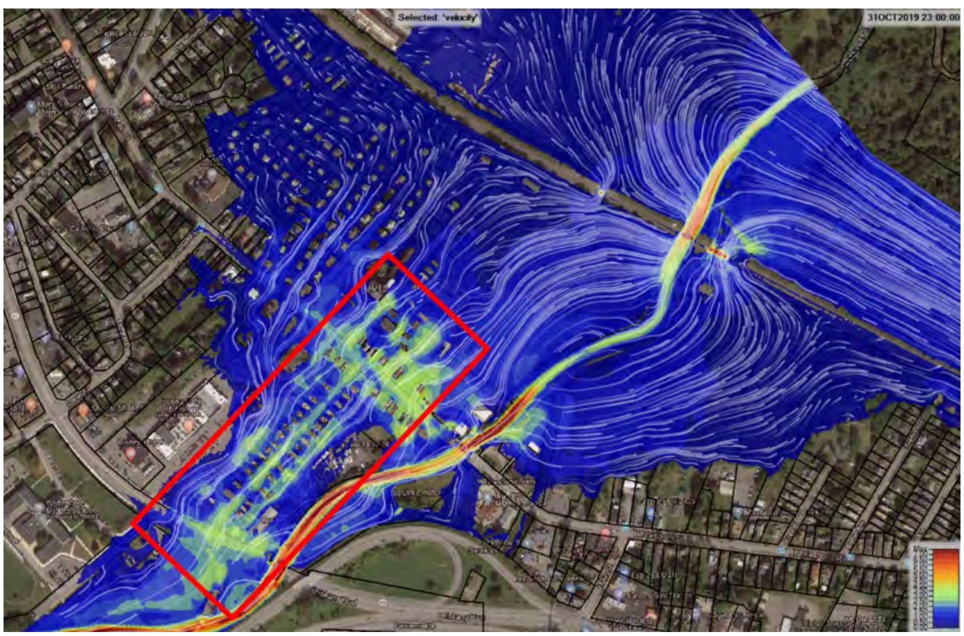

Figure 12. Flooding evolution (3)

Figures 10 through 12 show the flooding evolution in the left floodplain between the Main Street Bridge crossing and the railroad crossing of the Sauquoit Creek. Figure 11 and Figure 12 show the peak velocity and the peak depth contours during the storm. In Figure 12, the neighborhoods that are under high velocity during the storm are marked with a rectangle. The streamlines indicate the direction of flow. The color shading shows the relative intensity of the velocity field.

A majority of residential buildings are concentrated towards the Northwestern side of the left floodplain of Sauquoit Creek near or within Dunham Place, Wind Place and Ellmore Place. Figures 10 through 12 shows the leading edge of the flood wave travel along Sauquoit Street and enter Dunham Place, Wind Place and Ellmore Place, and shows low velocities during the peak event. Figure 13 shows that the peak depth occurs 40 minutes after the peak velocity occurred.

Figure 13. Sauquoit Creek Maximum Flood Depth during the 2019 Halloween Storm

Figures 14 through 16 (enlarged plan views included in Appendix C) depict areas that were significantly inundated. The shades of blue color depict different levels (water depths) of inundation of building's FFEs and adjacent ground. A color legend is included to help understand the degree of water depths. A darker blue represents a higher water depth and a lighter blue represents a shallower water depth. The land parcels with their addresses are also shown in the background with some transparency to read and identify the details of inundation better.

From Figure 14, one can determine that for the neighborhoods of Dunham and Wind Place, most houses are flooded by more than two feet of water. Modeling also shows approximately 16 properties in this neighborhood that have their FFE fully submerged. The remaining may not have been subject to first floor flooding; however, each is subject to potential hydrostatic pressure from the depth of floodwater, potentially weakening the foundations structural integrity.

Specifically, house numbers 7, 9, 10, 12, and 14 Wind Place, 19 Dunham Place, 24, 26, 28 and 36 Sauquoit Street yards are flooded by more than four feet of water. Additionally, 1 ,2 and 4 Dunham and 1, 3, 5, 6 and 8 Wind Place, and 21, 22, 23, 24, 25 and 26 Ellmore Drive yards are flooded by up to three feet of water. The majority of the Ellmore Drive and Albert Drive towards Sauquoit Street are also submerged by similar amounts.

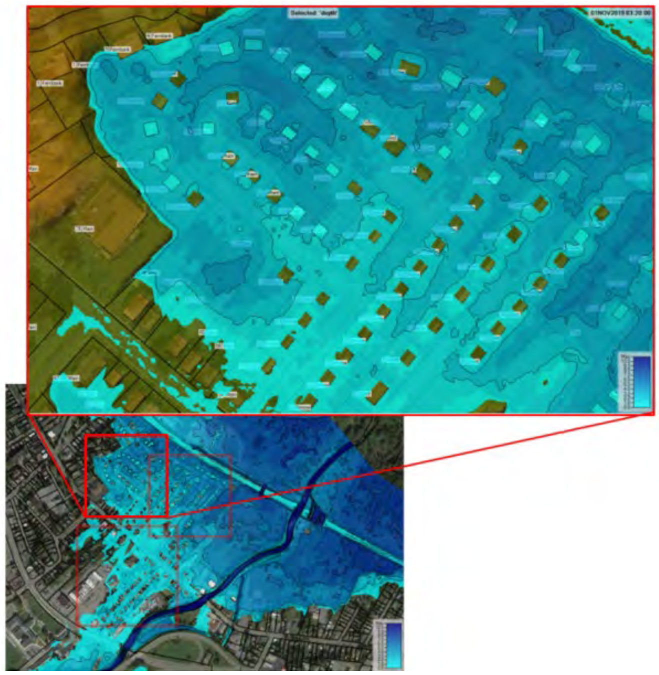

Figure 14. Inundated buildings at the peak of the 2019 Halloween Storm

Continuing along each street, house numbers 10 through 16, and 18, 19, and 20 Ellmore Drive house yards are submerged by approximately two feet of water. The effects of buoyancy and hydrostatic pressure from the flood water surrounding each of these structures, may have adversely affected the foundation of each.

Figure 15 shows that all the FFE on Sauquoit Street along the railroad embankment are under greater than three feet of water. Ellis and Albert Avenues are fully inundated by more than four feet, with the deepest inundation at the intersection with Sauquoit Street House numbers 31 through 40 Ellis Avenue, with the exception of 35 Ellis Avenue yards are submerged by more than four feet of water, with more than two feet of water above their FFE. Rob’s Auto Service’s yard is under more than four feet of water, which poses an eminent threat of buoyancy if vehicles were stored in the yard prior to the flood. However, the maximum velocity in this area during the peak of the flood remains under one foot per second, which reduces the danger of dragging potential floating vehicles into adjacent buildings. Finally, 15, 16, 20 and 22 Ellis Avenue yards are under more than 2.5 feet of water, including approximately a half of a foot above the FFE.

In Figure 16 the flooding mainly within the Gardner and Main Street neighborhoods are shown. The yards in these neighborhoods experienced a flood depth of less than 1.5 foot.

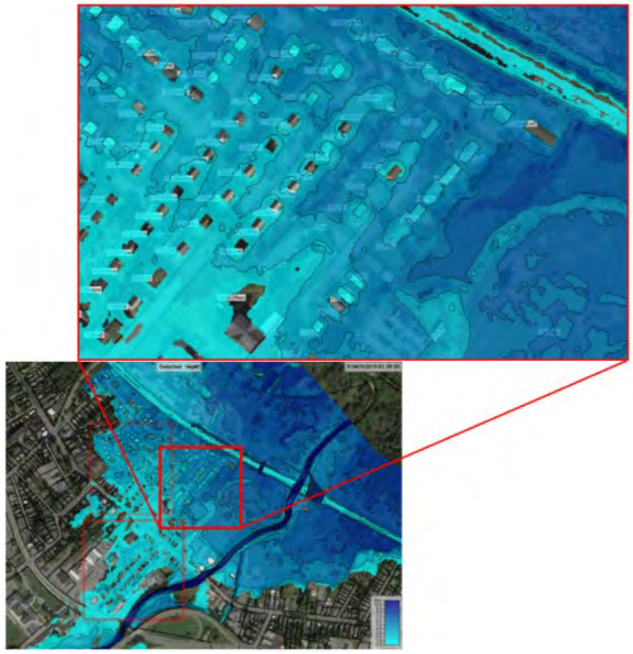

Figure 15. Inundated buildings at the peak of the 2019 Halloween Storm

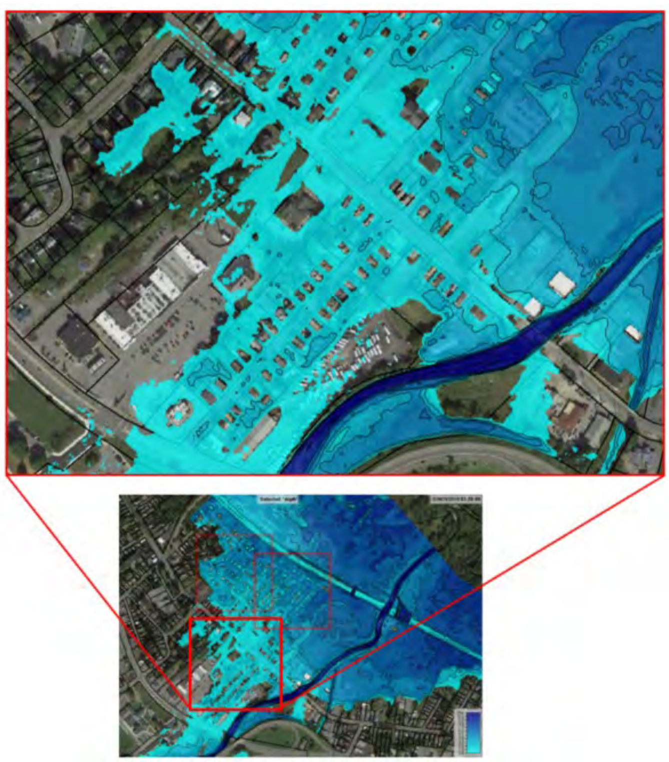

Figure 16. Inundated buildings at the peak of the 2019 Halloween Storm

1.5.1 Flood Depth Profiles

Another perspective important to understanding the severity of the impacts caused by this storm event are the flood depth profiles through the houses within the various neighborhoods in this area. These profiles show water depth above the FFE as well as the water depth against the walls and foundation as compared to the adjacent terrain. From these, the potential hydrostatic forces imposed on each house may be assessed.

The potential severity of the damage due to hydrostatic forces depends on the difference in water depths across the wall. For instance, in a basement that was not flooded, and which was subject to flooding up to the first-floor elevation, the difference would be measured from the LAG to the FFE (e.g. if the FFE was 415.6 ft., and the LAG was 410.6 ft., the difference would be 5 ft.).

Flood depth residence time is also equally important as the hydrostatic pressure force in understanding which structures may be subject to greater damage than others. The greater the residence time of the flood water the greater potential for weakening of the foundation either from pressure force or from saturation of the soil. This could ultimately reduce the loss of soil cohesion resulting in settling. Weakening of the foundation can also occur from prolonged buoyancy force acting on the structure through the saturated soil. Therefore, the potential for damages is a combination of direct hydrostatic pressure, residence flood time, depth of inundation, buoyancy forces along with the age of the structure.

Profile plots were produced in each neighborhood, drawn through the houses at peak flood stage to aid in the analysis (Refer to Figures 17 - 40). The profile line is shown in magenta color on the plan view (left side) with the stationing that corresponds to the profile plot shown on to the right side. The corresponding houses are shown as rectangular bars, with the top of the bar representing the FFE, along with the maximum water level observed during the storm. Several structures suffered substantial foundation damage during this storm event and were condemned until repairs could be completed. For these structures, profiles across all four sides of houses (along a longitudinal and a lateral direction across each house) were developed to help to understand the cause of the damage.

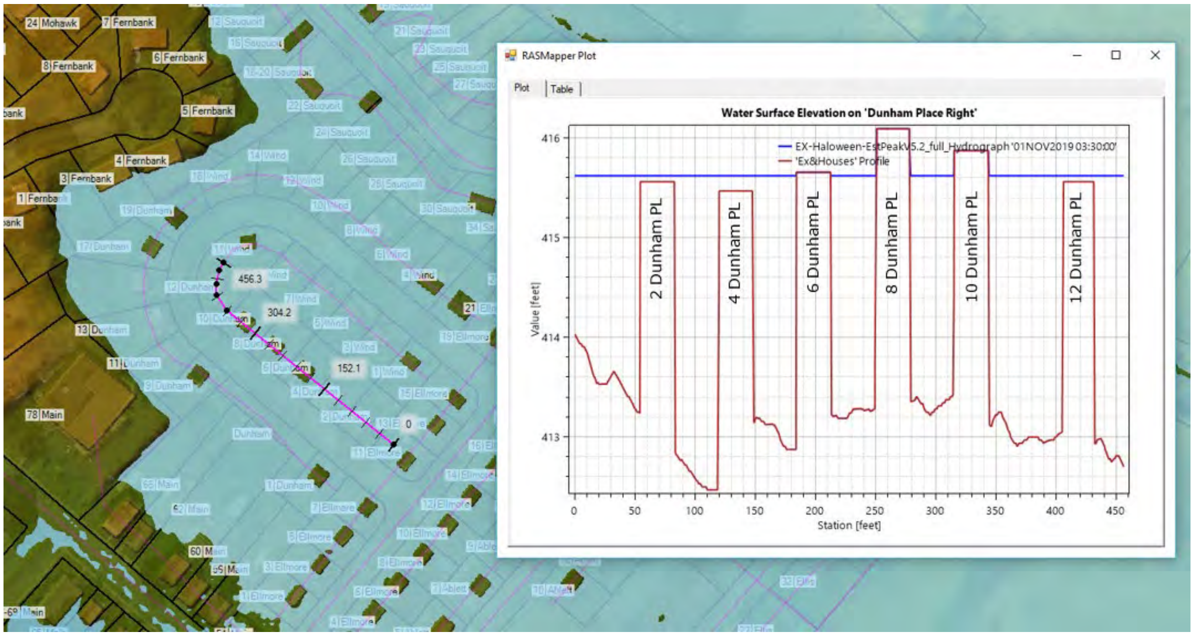

Figure 17. Dunham Place (Right Side)

For Reference, Figure 18 begins with 1 Dunham Place on the far left. Figure 19 is the profile for this address in the lateral direction. The potential hydrostatic force differential on all four sides are significant even though the FFE of the house was not fully inundated.

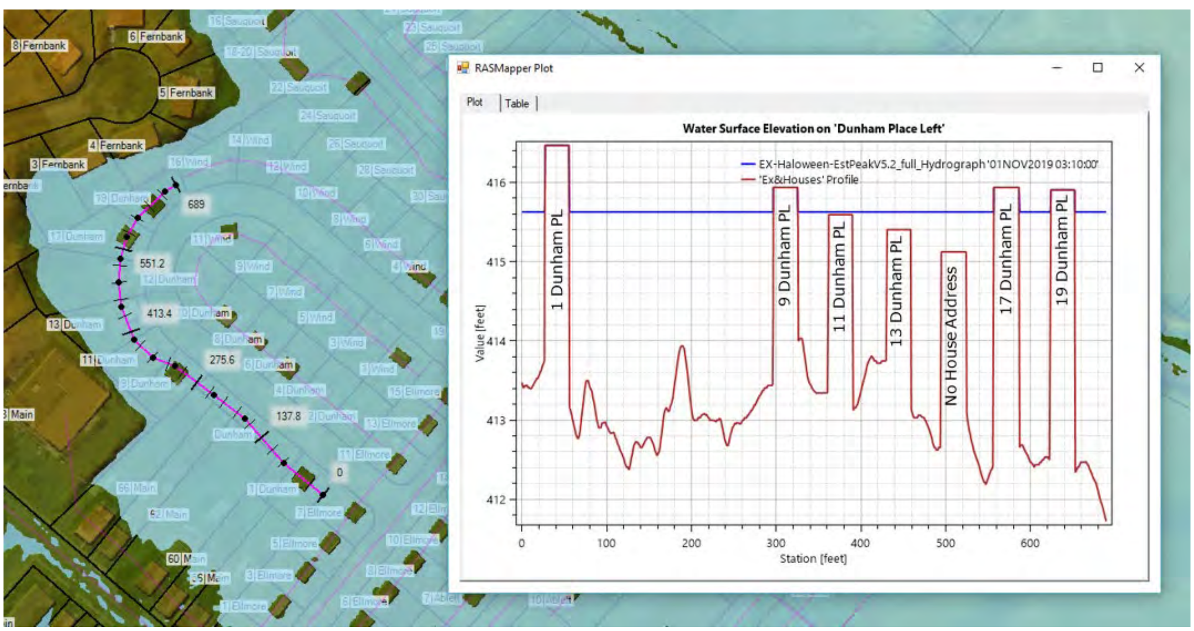

Figure 18. Dunham Place (Left Side)

Moving next to 9 Dunham Place (2nd house on Figure 18), again the potential hydrostatic force in longitudinal direction is significant even though the FFE of the house was not fully inundated. A lateral direction is not considered for this house since the pressure differential in the longitudinal direction alone is significant on the house.

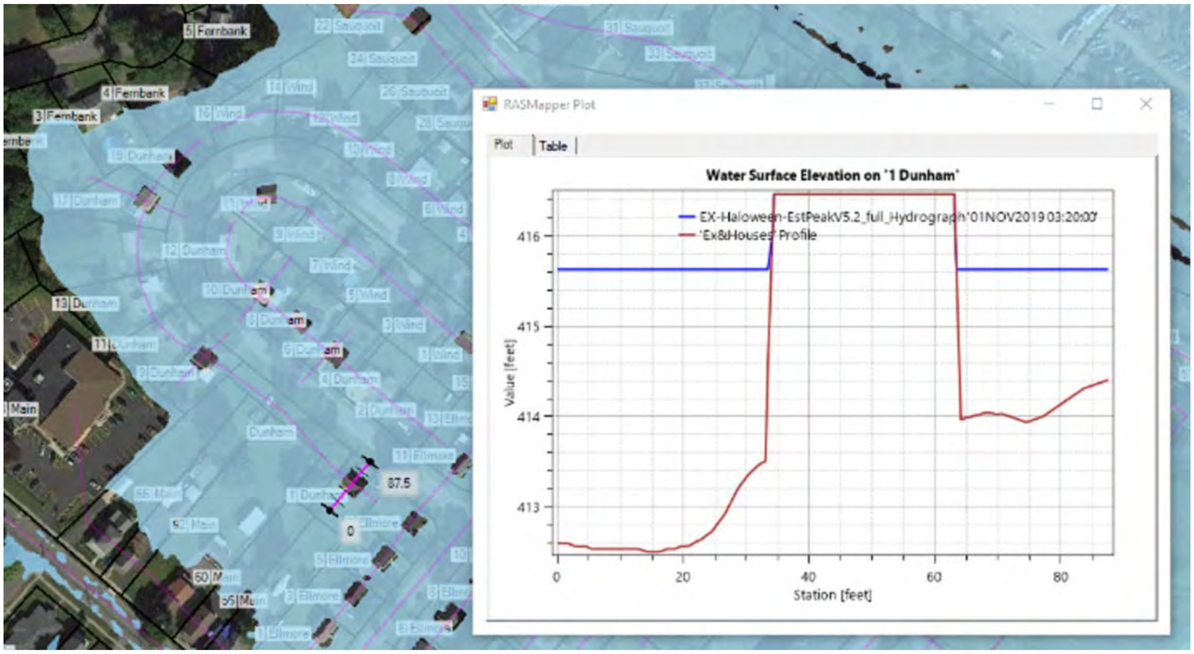

Figure 19. House Address: 1 Dunham Place

Next, 6 Dunham Place, Figure 17, (3rd house), experienced smaller potential hydrostatic forces, but shows a large potential hydrostatic force when examining Figure 20, the lateral profile. A similar observation is seen for 10 and 17 Dunham Place houses (Refer to Figures 21 and 22).

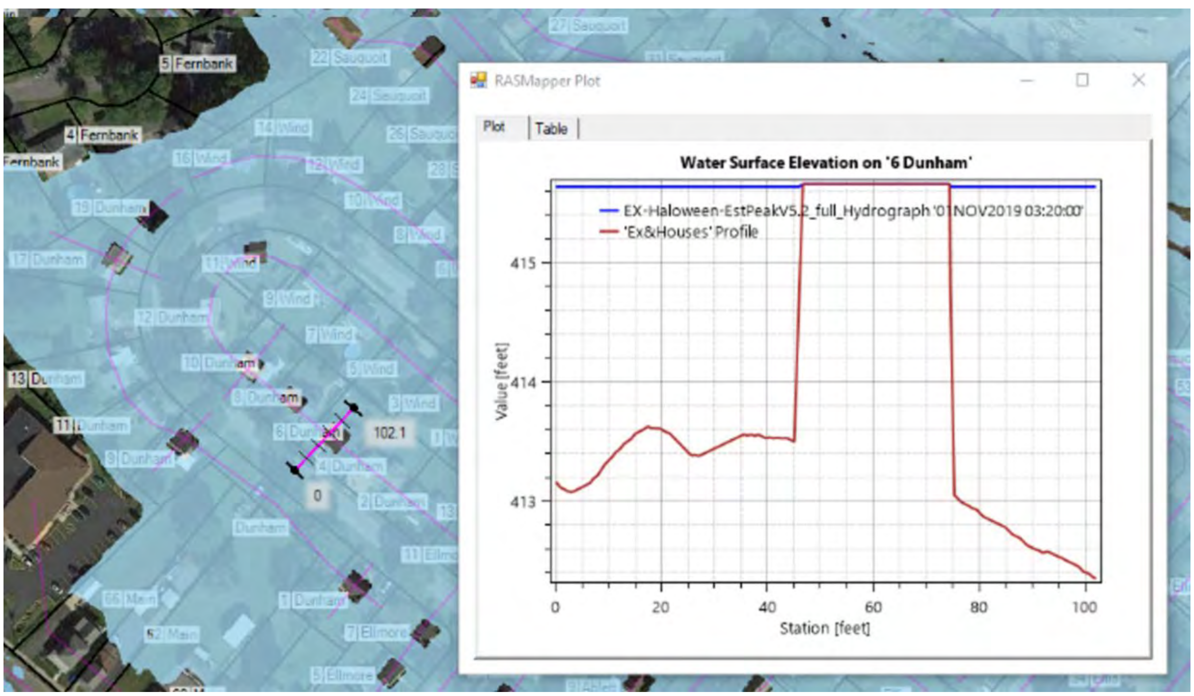

Figure 20. House Address: 6 Dunham Place

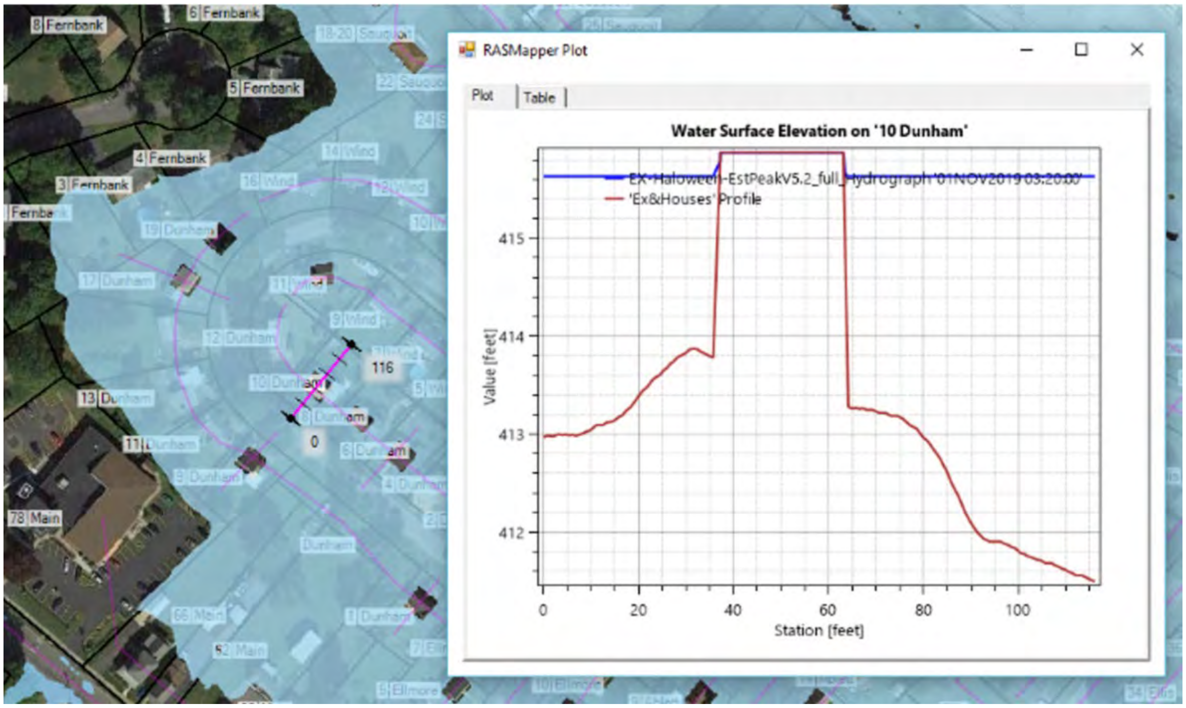

Figure 21. House Address: 10 Dunham Place

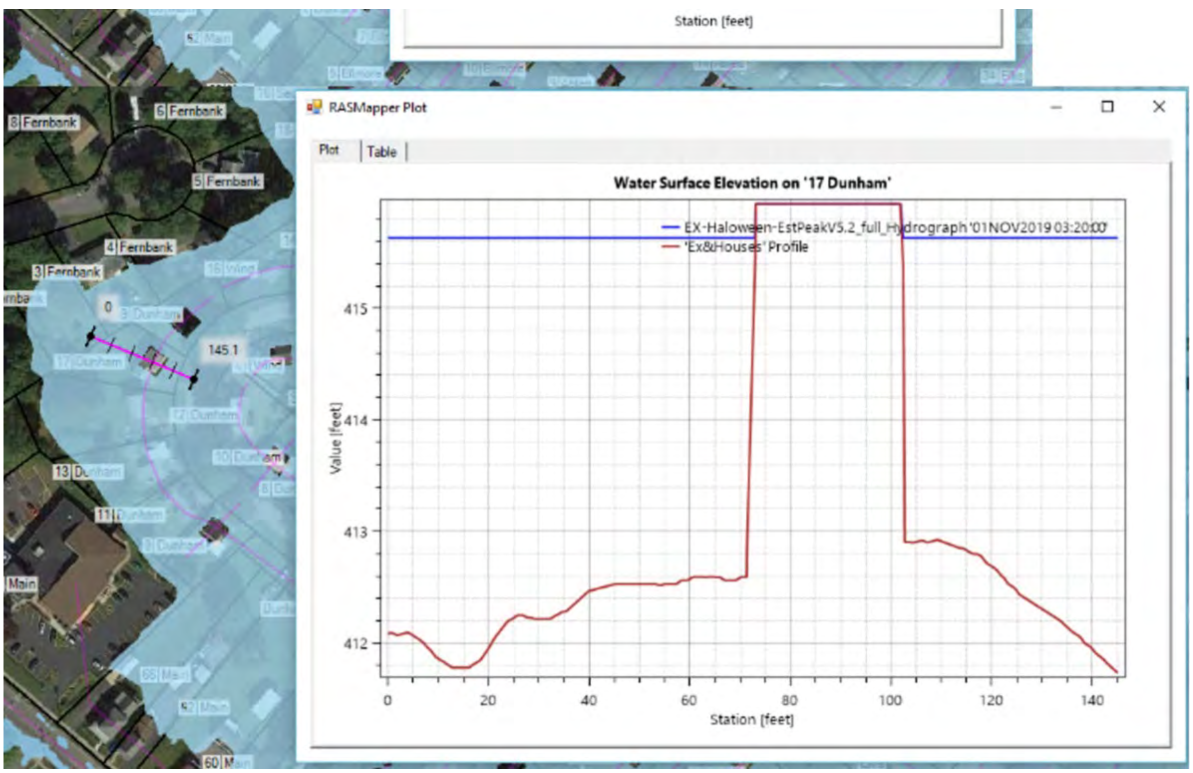

Figure 22. House Address: 17 Dunham Place

Wind Place house numbers 5, 7, 8, 11 and 14 were also condemned as a result of the flood damage caused by this storm event. As per the simulation; the profile views on Figures 23 and 24 indicate that the first floors of these houses were significantly inundated with several feet of water and experienced a prolonged flood resident time. This could have contributed to potential hydrostatic pressure differential which could also have weakened their structural integrity.

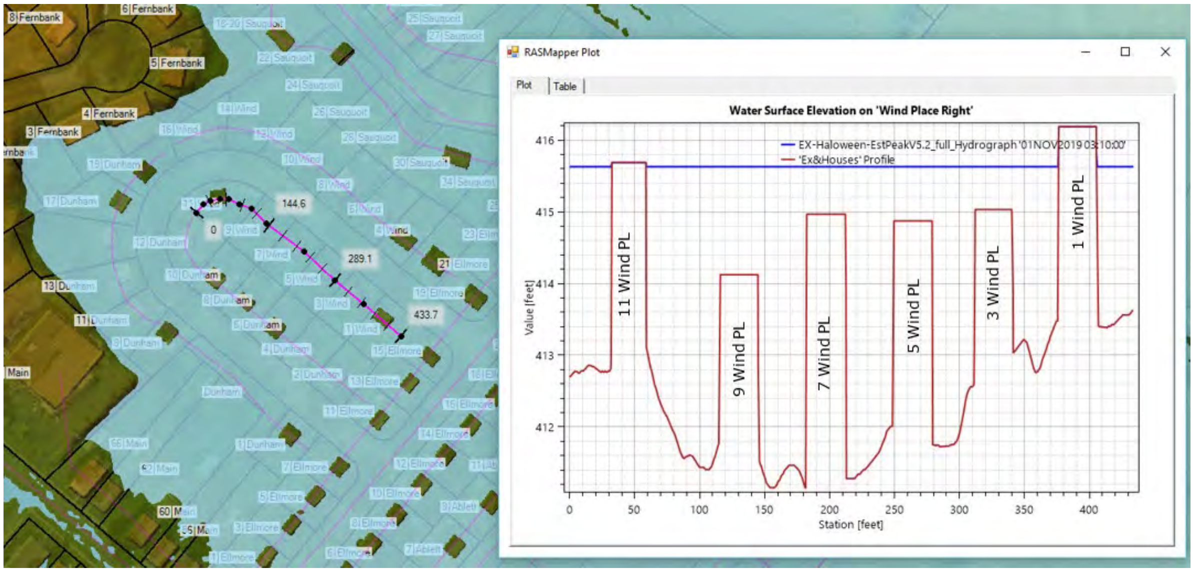

Figure 23. Wind Place (Right Side)

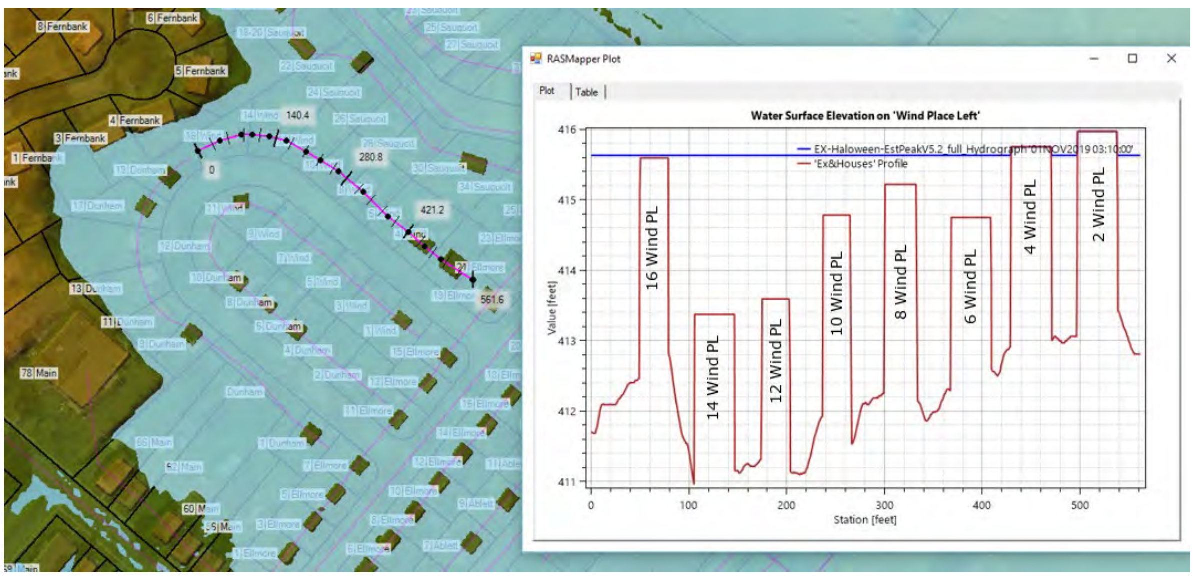

Figure 24. Wind Place (Left Side)

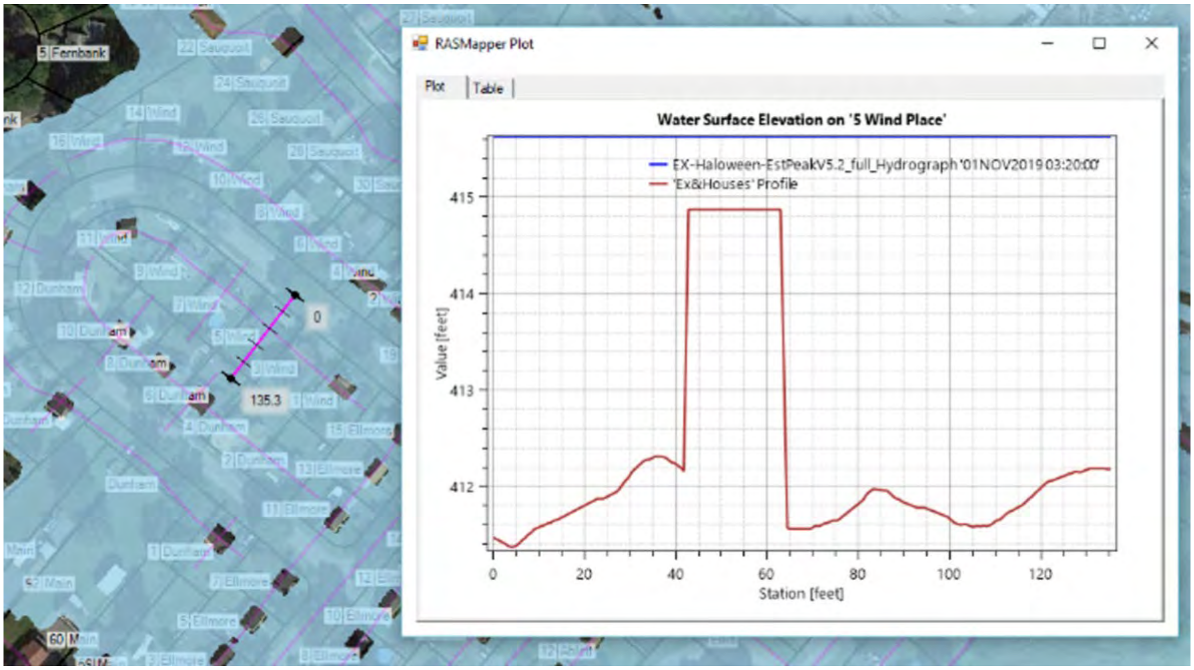

Figure 25. House Address: 5 Wind Place

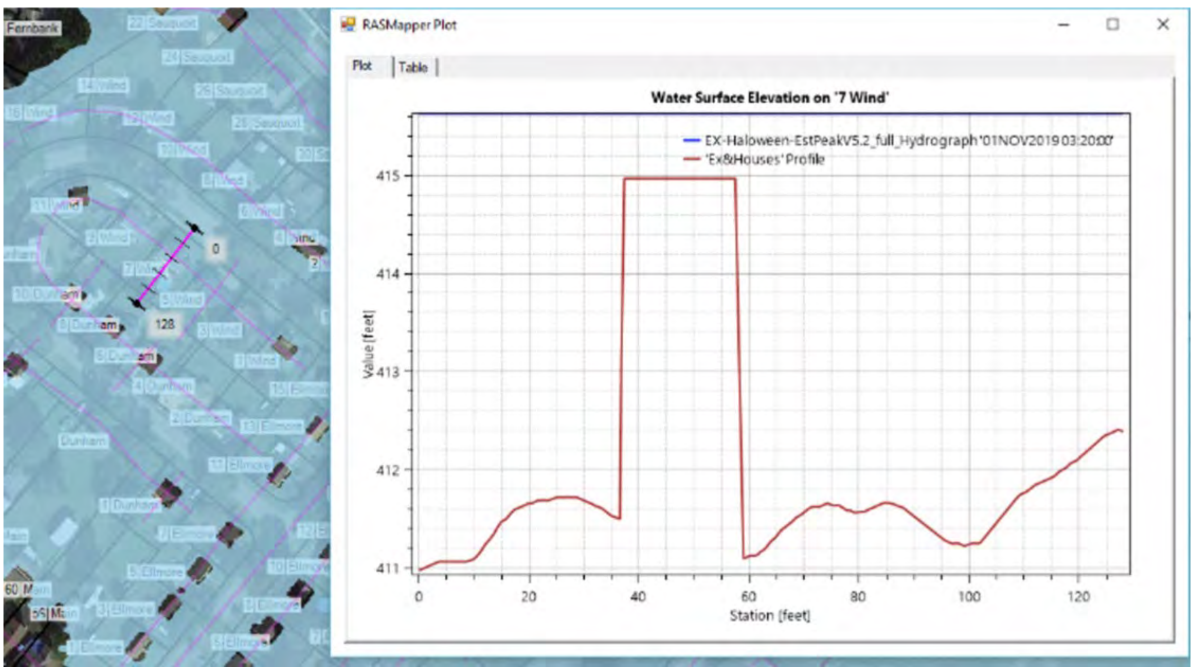

Figure 26. House Address: 7 Wind Place

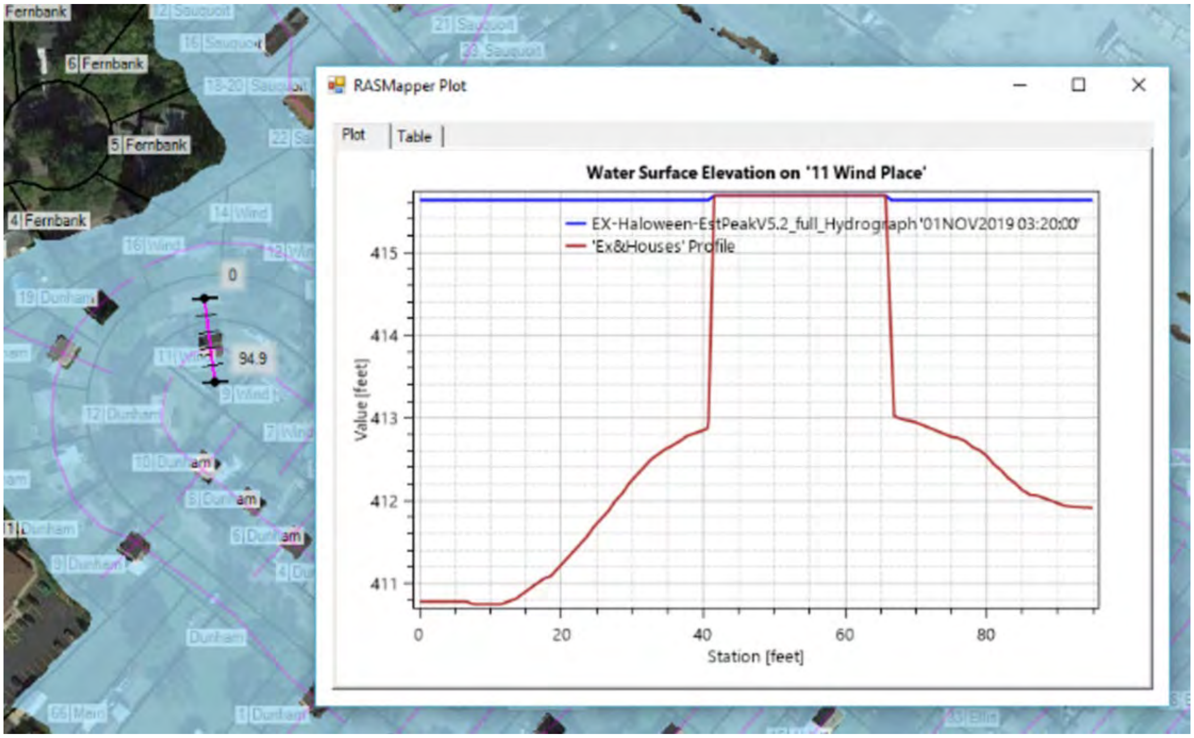

Figure 27. House Address: 11 Wind Place

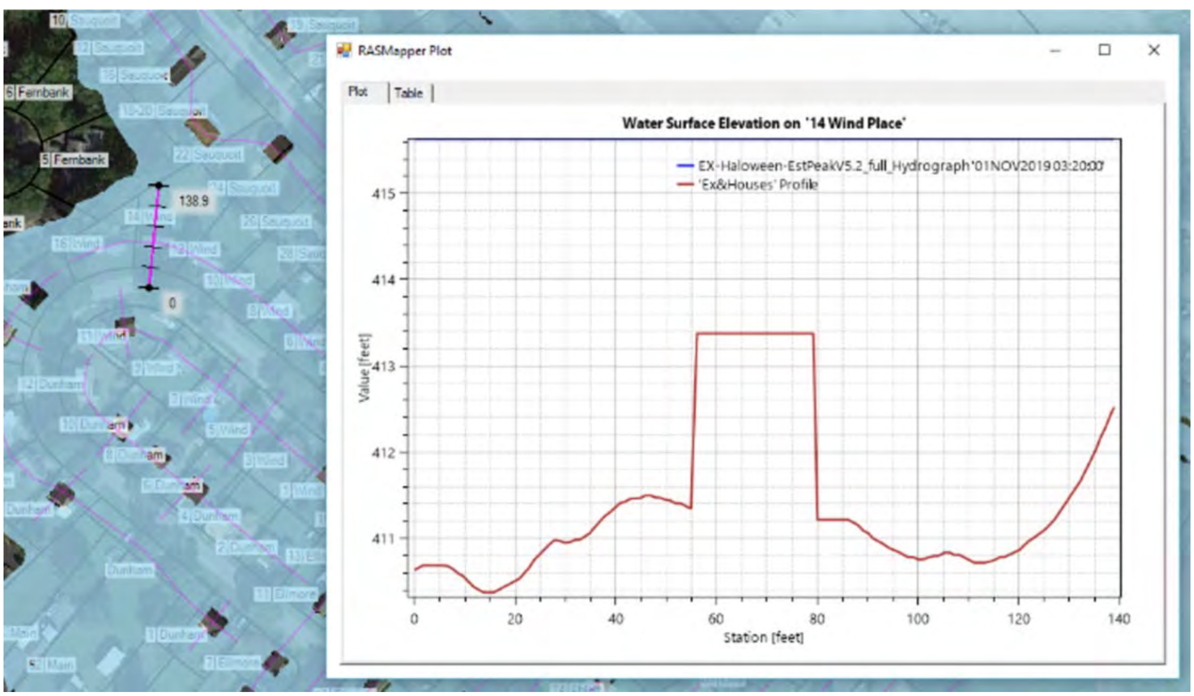

Figure 28. House Address: 14 Wind Place

A summary table (Appendix B) for all the neighborhoods that experienced similar flooding during the 2019 Halloween storm, with the possible influencing factors on structural integrity, is presented along with the longitudinal profiles through the impacted neighborhoods. Figure 29 through Figure 40 show the Water Level longitudinal profile plots for Sauquoit Street, Ellmore Drive, Albert Avenue, Ellis Avenue, Main Street and Gardner Street, respectively.

The profile plot helps to depict the degree of potential hydrostatic pressure difference and the level of FFE inundation for these houses. An average flood residence time for each street representing a neighborhood is also summarized to show the degree of soil saturation, and to quantitively illustrate the longevity of buoyancy effects on the buildings. The Appendix B summary table provides insight into potential for future storm event vulnerability within the study area from an event of similar magnitude, duration, and intensity.

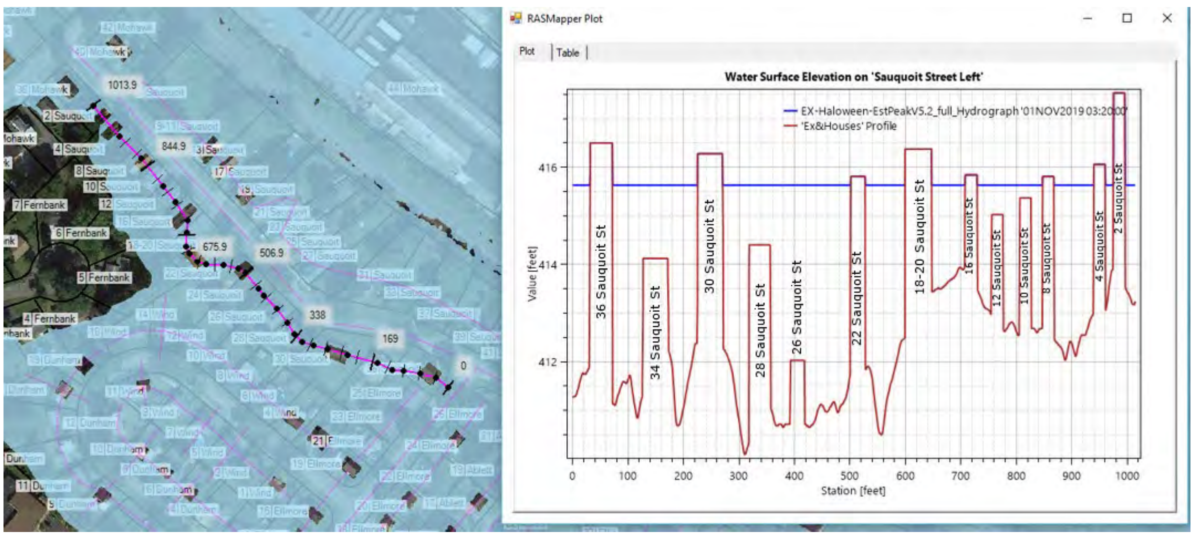

Figure 29. Sauquoit Street (Left Side)

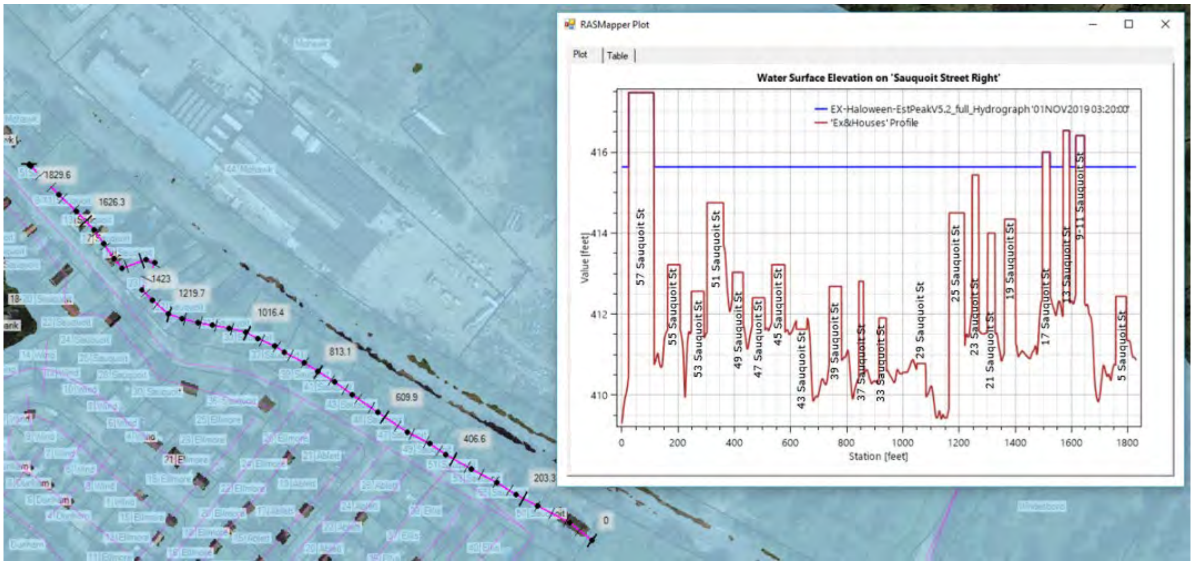

Figure 30. Sauquoit Street (Right Side)

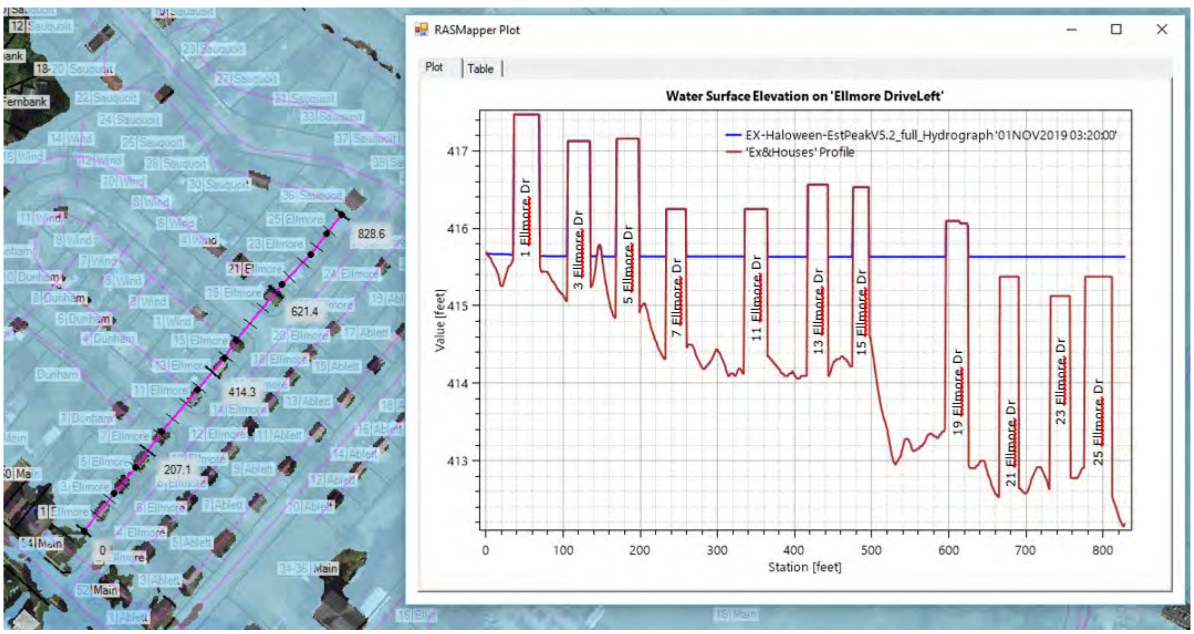

Figure 31. Elmore Drive (Left Side)

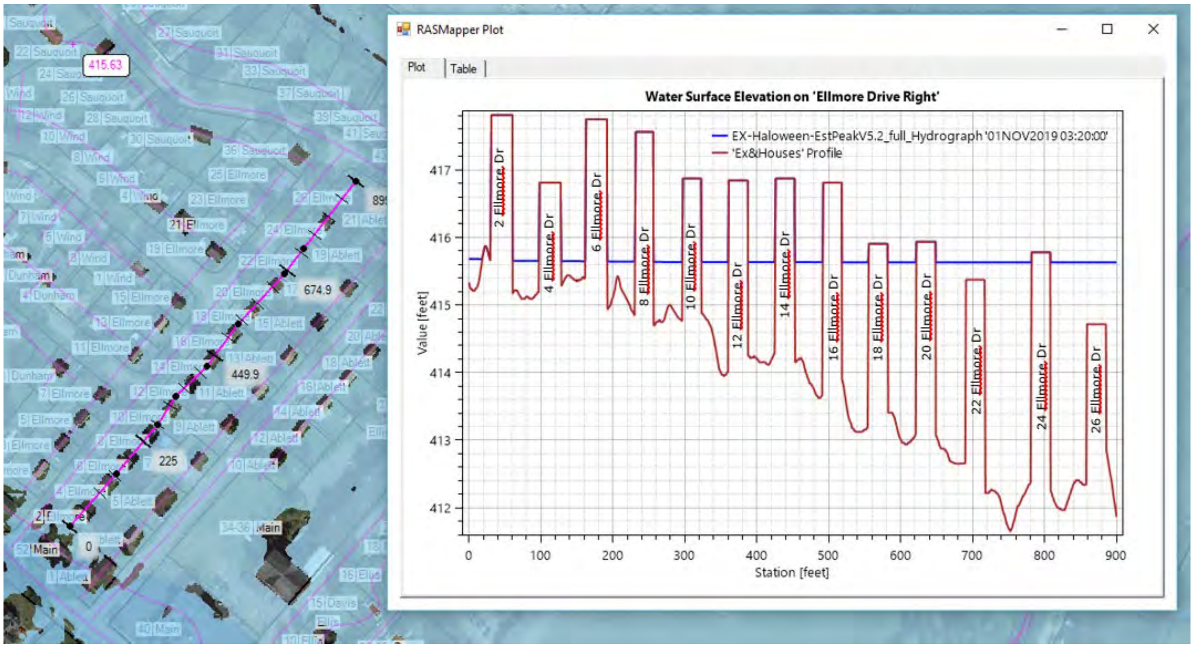

Figure 32. Elmore Drive (Right Side)

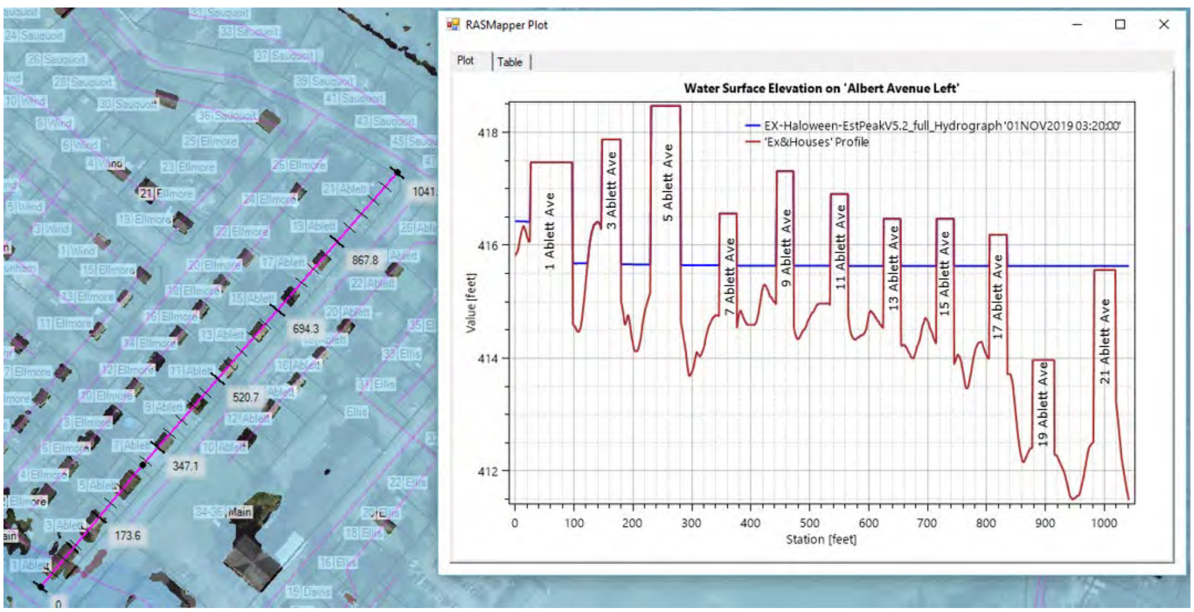

Figure 33. Albert Avenue (Left Side)

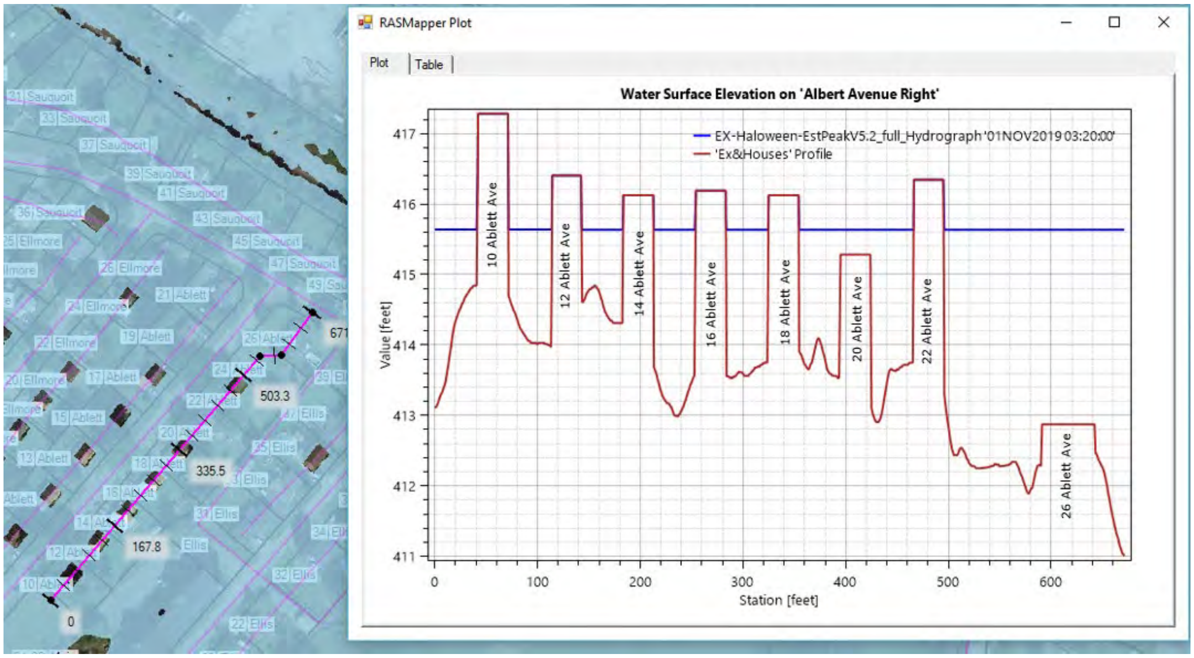

Figure 34. Albert Avenue (Right Side)

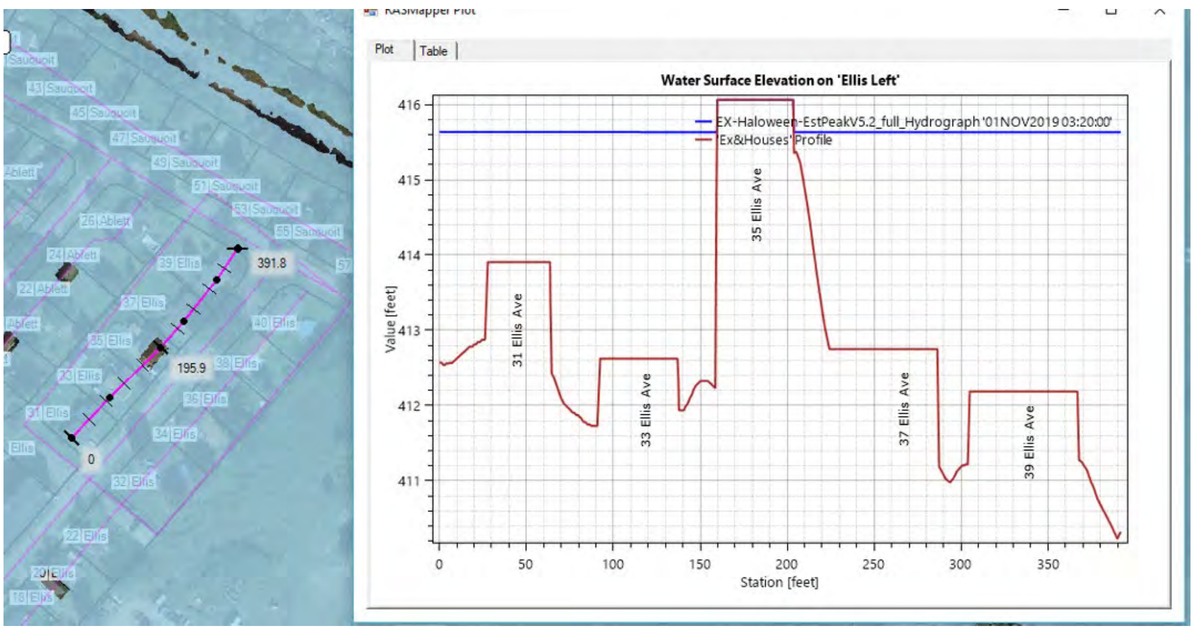

Figure 35. Ellis Avenue (Left Side)

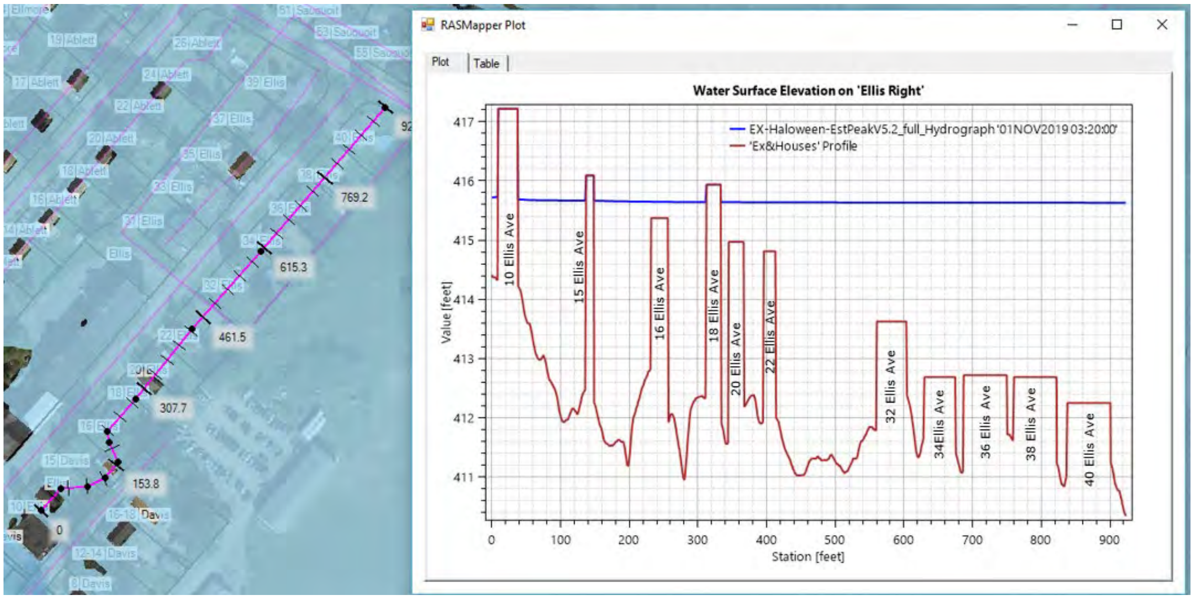

Figure 36. Ellis Avenue (Right Side)

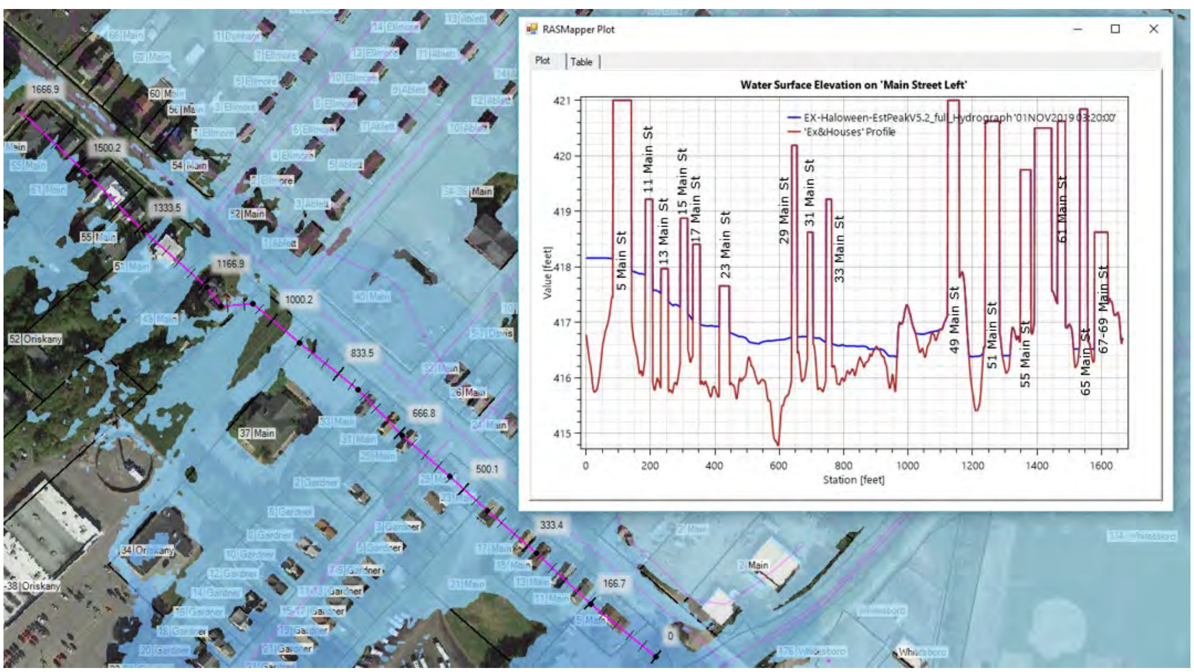

Figure 37. Main Street (Left Side)

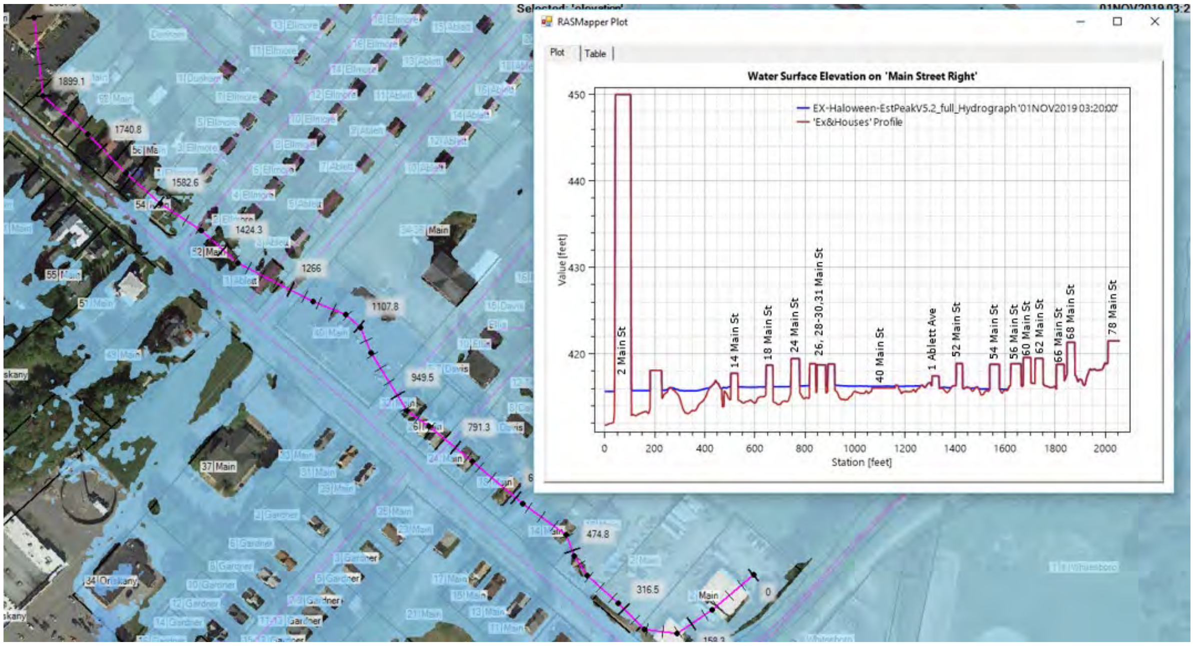

Figure 38. Main Street (Right Side)

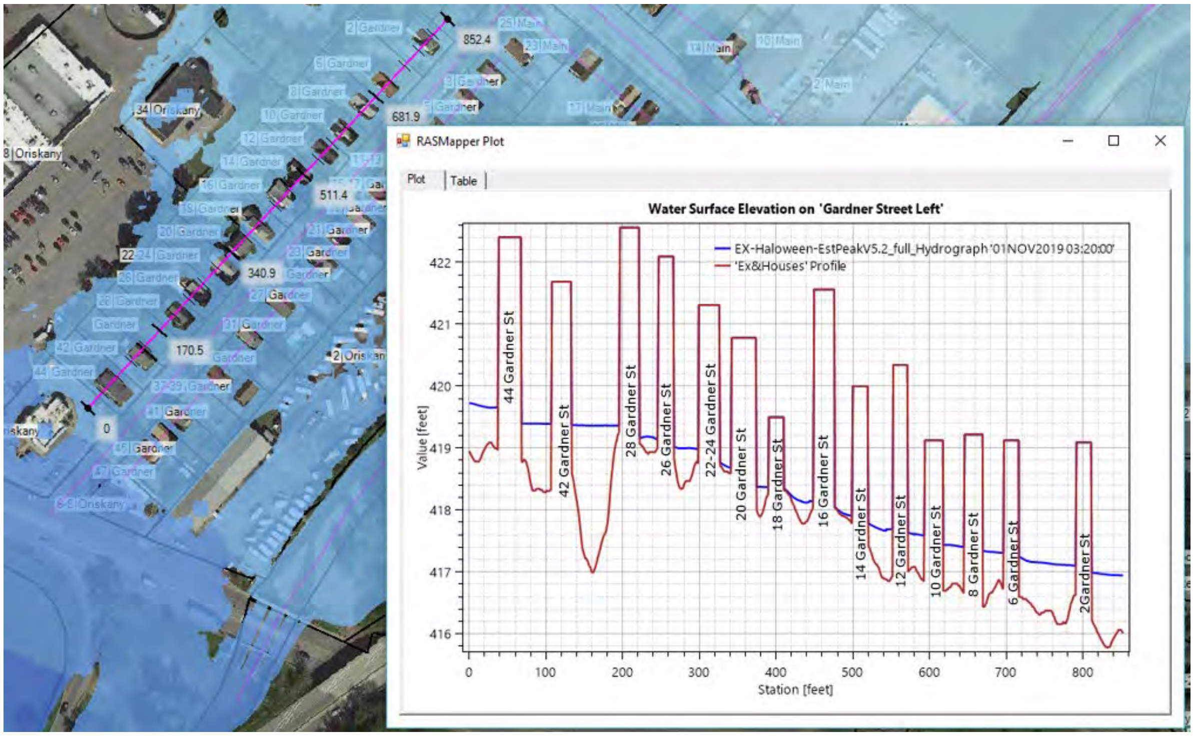

Figure 39. Gardner Street (Left Side)

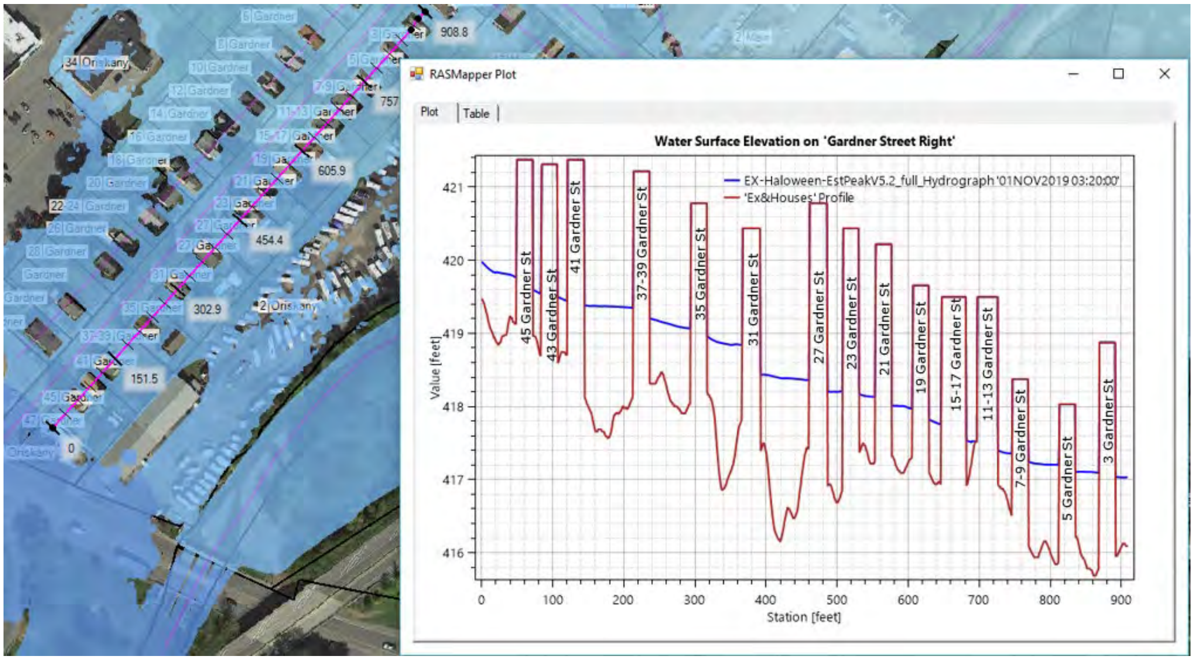

Figure 40. Gardner Street (Right Side)

1.6 Analysis Findings

The summary of the results from the model predictions are shown quantitatively on Table 1 (Appendix B). The analysis was focused on the following factors, that would impose concerns on each of the building's structural integrity.

1.6.1 Level of Inundation of Building First Floor Elevation (FFE)

A completely inundated foundation undergoes uplifting forces caused by buoyancy forces; suffers damages to the interior of the building; absorbs water, and the increased moisture content of the wood or any other material used on the walls makes a temporarily inhabitable and unsafe living condition during a flooding event.

1.6.2 Flood Residence Time

The flood residence time is the time window that flood water remains in contact with the building. This makes the soil that the foundation is built upon highly saturated, which increases internal soil pressure that leads to settlement upon drying. Also, prolonged periods of ponded water increases the erosion potential which in turn weakens the building foundations.

1.6.3 Hydrostatic Pressure Differential

When the two opposite walls of a building have different ground elevations, a resultant hydrostatic force is created on the building walls when the adjacent ground starts to accumulate water. Prolonged periods of the resultant hydrostatic pressure differentials impose horizontal forces on the foundation while the buoyancy effects are also in place on the foundation due to the ponded water surrounding the building. This will cause an even greater structural instability that could result in a collapse of the foundation walls.

1.6.4 Impacting Velocity

While the flood event is advancing, the leading edge of the flood water hit each of the buildings with a certain velocity. As a result, the impact can come directly as a hydrodynamic force, or as an object collision force caused by objects that are being carried along with the flood currents. Significant erosions are also possible that could lead to structural instabilities, and finally result in structural failure.

1.6.5 The Age of the Building

A newly built house is more resilient to a novel flood event because of structural codes implemented according to the latest floodplain regulations, and low deterioration of structural members and materials compared to a house built 50 years ago or more.

Table 1 (Appendix B) summarizes a quantitative analysis of all of the above factors except the age of the buildings. The analysis was performed based on the 2D hydrodynamic modeling of the 2019 November Halloween Storm. All the FFEs of the buildings in Dunham Place, Wind Place, Sauquoit Street, Ellmore Drive, Albert Avenue and Ellis Avenue were included in the analysis. A hydrostatic pressure differential potential was identified when a 0.2 feet or more difference of adjacent ground on opposite sides of the building existed. This difference was observed in the longitudinal direction along the road, and in the lateral direction in certain buildings, especially when the differential in longitudinal direction was not identified. The first flood elevation (FFE) was also observed and labelled if they experienced a 0.5 feet of water depths above the FFE or not. The buildings that experienced FFE water depths above half a foot were highlighted in dark red color and highlighted in light red color if the FFE experienced less than half a foot of water in Table 1. The velocity impacts on each neighborhood driveway was measured (from the numerical model) and listed noting if they were below or above an average velocity within a roadway. Figure 11 shows the fully developed velocity contours during the peak event of the flood.

The rows highlighted in yellow color in Table 1 indicate the houses that were identified as condemned buildings by the Town of Whitesboro. These condemned buildings satisfied at least one or more impacting factors listed above, such as higher residence time, a hydrostatic pressure differential or a significant first floor flooding.

For example, the houses at number 1 and 9 Dunham Place did not flood the FFE. However, they experienced a varying hydrostatic pressure differential on walls for 14 hours, which can lead to foundational or structural damages. Therefore, if only with inundation maps of the surrounding water depths were used to assess structural damage of these buildings, condemnation based on structural failure may not have been justified. In conclusion, the finding in Table 1 should be applied along with the latest inundation maps to perform a full assessment of vulnerabilities that could lead to a condemnation of a building due to flooding.

In order to determine which buildings are vulnerable, the age of the house from its original build year or the year of any major structural renovation was determined as key information to review along with the model findings. A photo log of the damaged houses during or after the storm along with photos showing the flooding, are also informative to evaluate the damage as well as the hydrodynamic modeling and Table 1 findings.

2. NEXT STEPS

As a next step, Ramboll will use the proposed flood bench topography and run a future scenario of a similar storm hydrograph with the knowledge gained from the analysis performed for this drainage study for the purpose of comparing the impacts to this study area. A flood wall alternative at the lowest points along the left bank of Sauquoit Creek at locations shown in Figure 6 and Figure 7 can be tested to evaluate the potential impact. Increasing the culvert capacity at the railroad abutment with additional culverts can also be tested to evaluate the potential impacts with the existing conditions. The first proposed flood bench in the vicinity of the sports field near the railroad crossing is shown in Figure 41.

Figure 41. Proposed Flood Bench near the Railroad Crossing of Sauquoit Creek

APPENDIX A
SAUQUOIT CREEK DRAINAGE STUDY - PRELIMINARY RESULTS MEMO

WATER

MEMO

Project name	**Sauquoit Creek Drainage Study**
Project no.	**74959**
Client	**Sauquoit Creek Intermunicipal Basin Commission**
Memo no.	**1**
Version	**1**
To	**Dave Glen, Commissioner & Kristin Campbell**
From	**Shaun Gannon P.E., D.WRE, P.H., CFM, PMP**
Copy to	**Thomas Snow, NYSDEC**
Prepared by	**Shaun B. Gannon**
Checked by	**N/A**
Approved by	**N/A**

1 Preliminary Finding of Halloween 2019 Storm – Hydraulic Modeling

Date March 31, 2020

This memorandum summaries the initial finding of the two-dimensional hydraulic modeling for the Village of Whitesboro, NY for the Halloween 2019 storm event.

To better understand the flow patterns and flooding caused by the Halloween 2019 flood event, Ramboll has developed a two-dimensional depth averaged model for a portion of the Village of Whitesboro, NY (Village) as shown in the attached map. The model was developed by incorporating the best publicly available Digital Elevation Model Data (DEM) with field survey of the First Floor Elevation (FFE), Lowest Adjacent Grade (LAG), Lowest Point of Entry (LPE) and roadway centerline survey points. Elevations of the FFE for each building within the study area (see map) were used to create three-dimensional polygons (rectangles protruding from the DEM) to better understand the flow pattern, velocities and forces experienced by each structure. Next, the Halloween 2019 storm event hydrograph, recorded at USGS stream gage No. 01339060. Located upstream of Joe Tahan's furniture in the Town of Whitestown, NY (Town) were input and the model executed. The model was then calibrated to surveyed high water marks along Sauquoit Street in the Village.

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The preliminary results show multiple home being inundated above the FFE within the study area. Of the approximate 250 structures surveyed, approximately 67 were inundated at or above their FFE during the event. According to the model, the highest concentration of inundated homes occurred along Sauquoit Street, Ellis Ave and Dunham & Wind Place. Following are several figures and plots which depict the preliminary model results which help to understand the vulnerability of different portions of the study area.

Ellis Ave

Figure 1 below shows the preliminary model flood inundation limits within the Village of Whitesboro, NY for the Halloween 2019 event along with a reference line on Ellis Ave (magenta line with stationing). Figure 2 shows the preliminary profile of the ground elevation and the model results along this reference line. Through observation of Figure 1, it is apparent that all of the structures along Ellis Ave were subject to potential inundation by the event. Observation of Figure 2 shows that, Ellis Ave slopes away from Main St. toward Sauquoit Street and at the intersection of Ellis Ave and Sauquoit Street the preliminary modeling shows approximately flood depth of feet above ground level. This suggest that structures closer to Sauquoit St. may have suffered greater inundation than those closer to Main St.

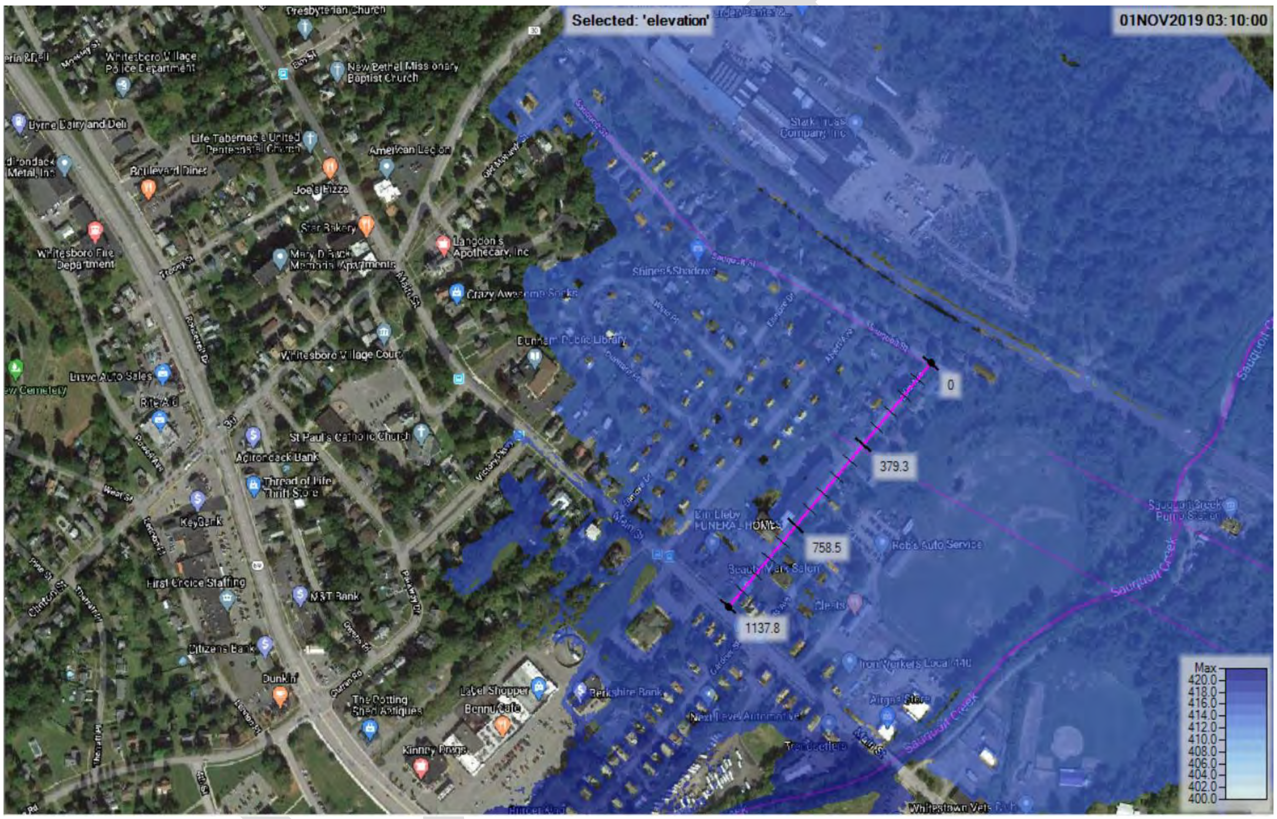


Figure 1: Ellis Ave Reference Line

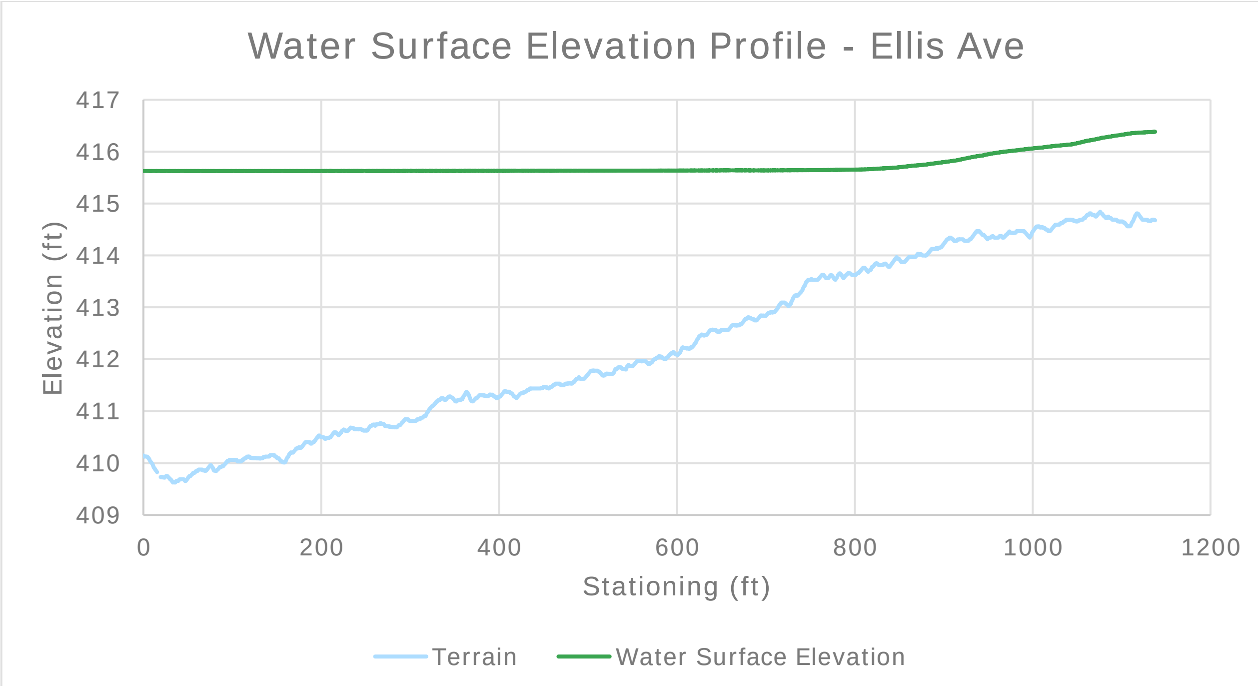


Figure 2: Ellis Ave Profile Plot

Ablett Ave

Figure 3 below shows the preliminary model flood inundation limits within the Village of Whitesboro, NY for the Halloween 2019 event along with a reference line on Ablett Ave (magenta line with stationing). Figure 4 shows the preliminary profile of the ground elevation and the model results along this reference line. Through observation of Figure 3, structures close to the intersection with Sauquoit St. were potentially inundated by the event. Observation of Figure 4 shows that, Ablett Ave slopes away from Main St. toward Sauquoit Street and at the intersection of Ablett Ave and Sauquoit Street the preliminary modeling shows approximately flood depth of feet above ground level. This suggest that structures closer to Sauquoit St. may have suffered greater inundation than those closer to Main St.

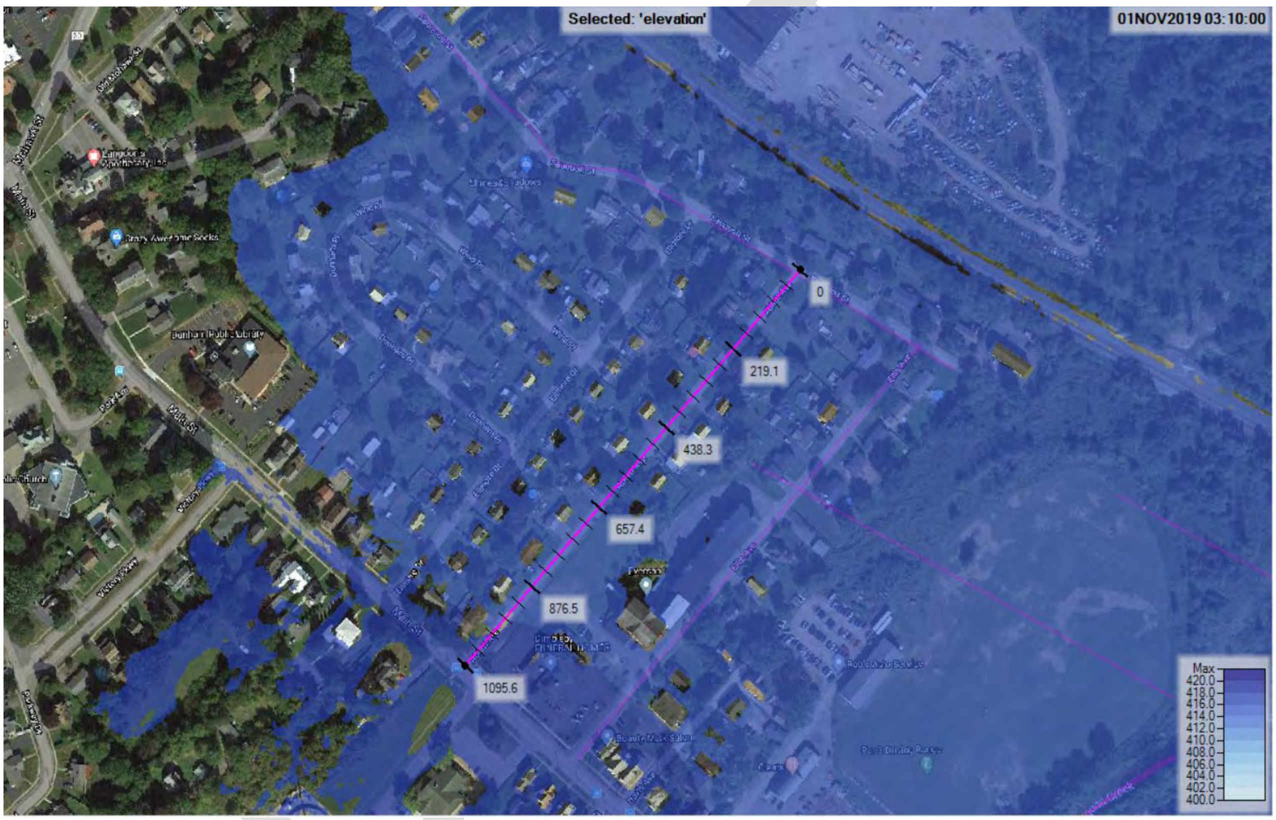


Figure 3: Ablett Ave Reference Line

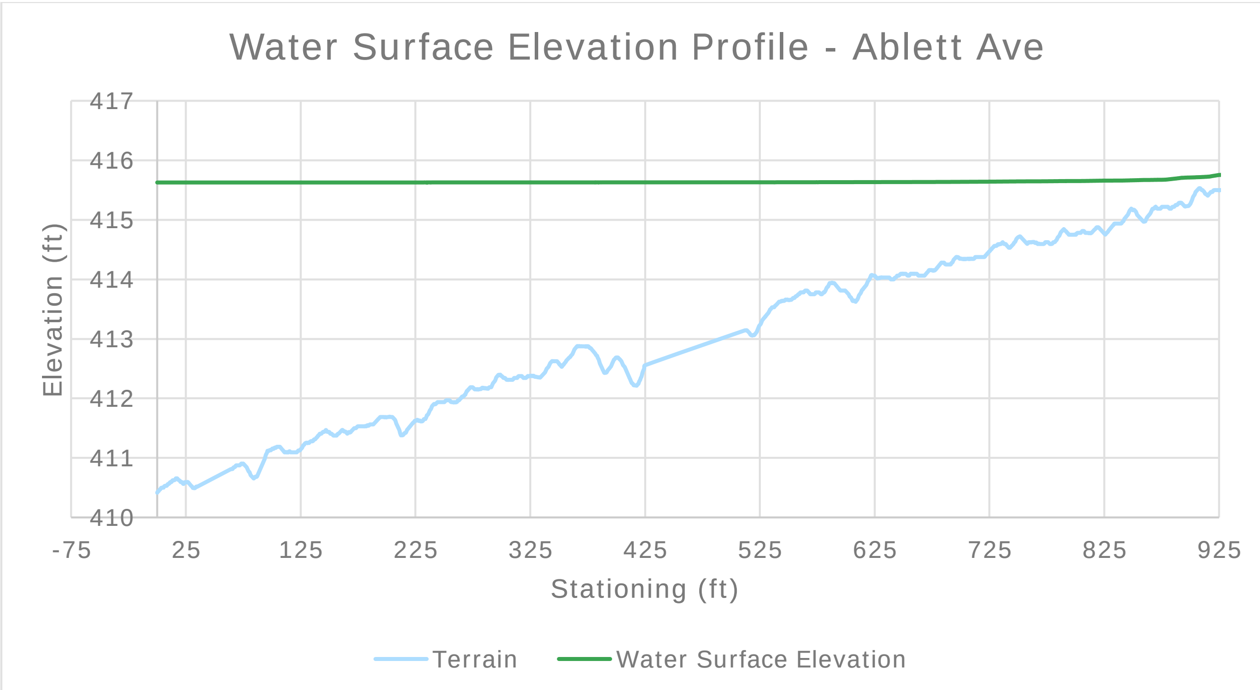


Figure 4: Ablett Ave Profile Plot

Ellmore Drive

Figure 5 below shows the preliminary model flood inundation limits within the Village of Whitesboro, NY for the Halloween 2019 event along with a reference line on Ellmore Drive (magenta line with stationing). Figure 6 shows the preliminary profile of the ground elevation and the model results along this reference line. Through observation of Figure 5, structures close to the intersection with Sauquoit St. were potentially inundated by the event. Observation of Figure 6 shows that, Ellmore Ave slopes away from Main St. toward Sauquoit Street and at the intersection of Ellmore Ave and Sauquoit Street the preliminary modeling shows approximately flood depth of feet above ground level. This suggest that structures closer to Sauquoit St. may have suffered greater inundation than those closer to Main St.

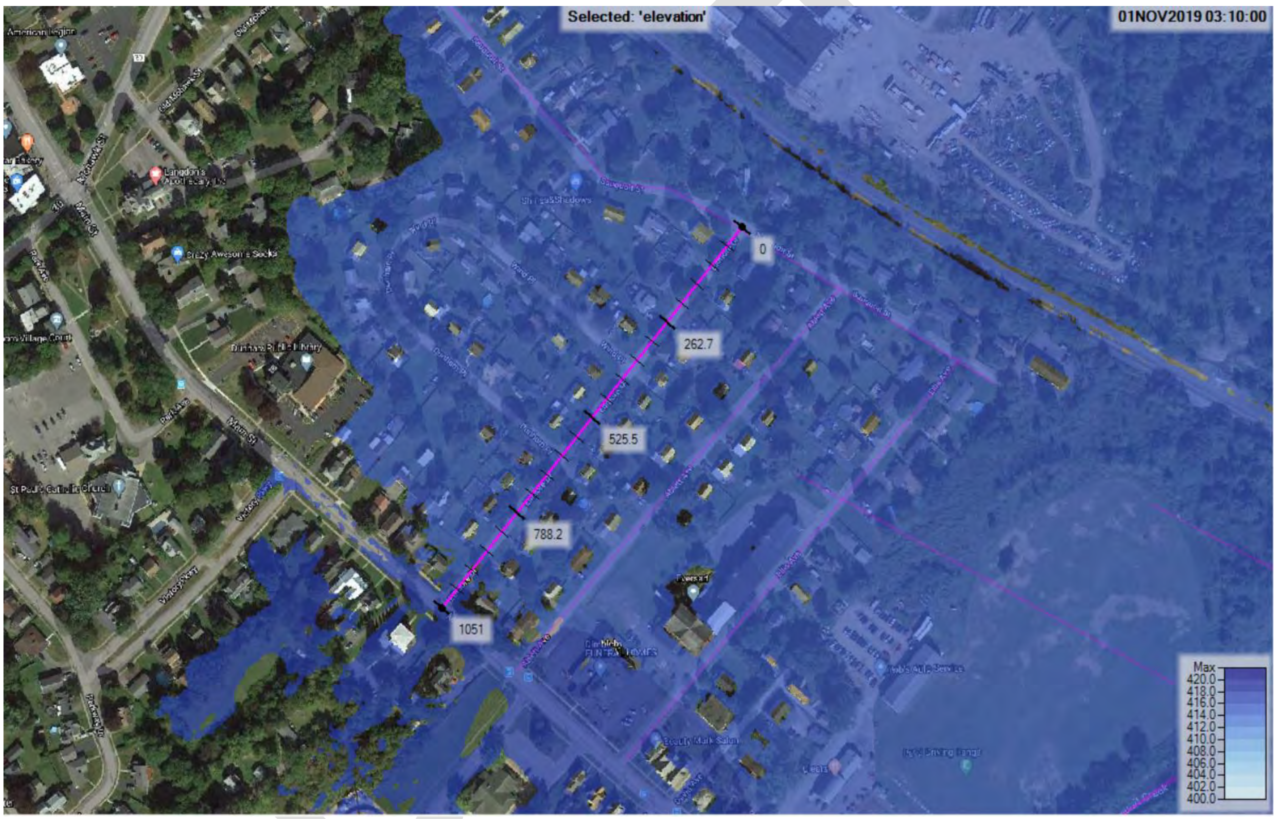


Figure 5: Ellmore Drive Reference Line

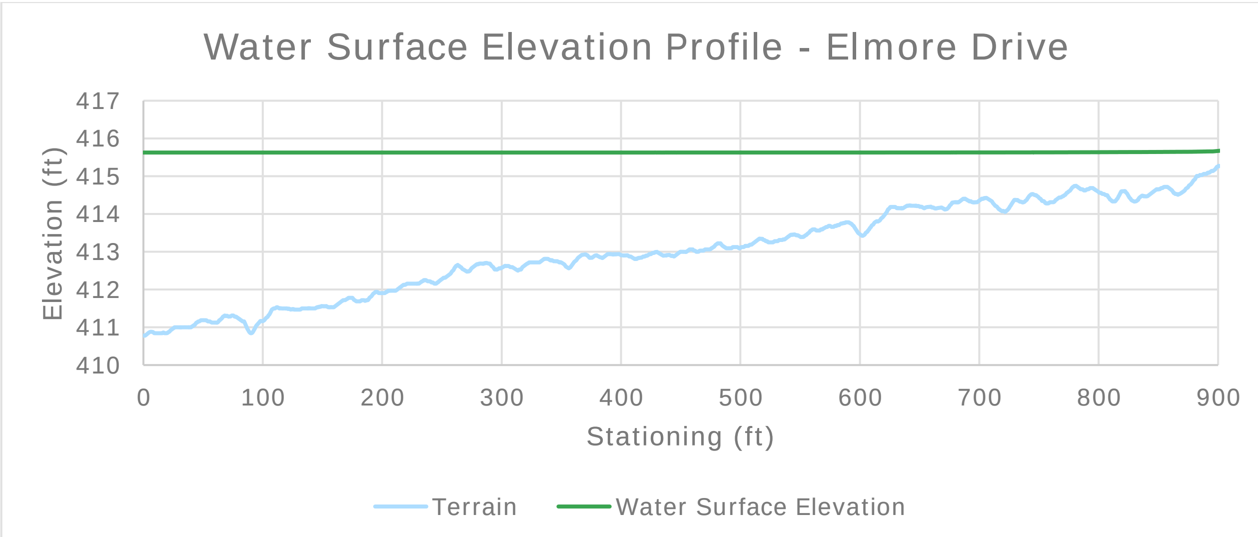


Figure 6: Ellmore Drive Profile Plot

Dunham and Winn Place

Figure 7 below shows the preliminary model flood inundation limits within the Village of Whitesboro, NY for the Halloween 2019 event along with a reference line cut through the neighborhood of Dunham and Winn Place (magenta line with stationing). Figure 8 shows the preliminary profile of the ground elevation and the model results along this reference line. Through observation of Figure 7, it can be observed that structures along both Dunham and Winn Place potentially inundated by the event. Observation of Figure 8 shows that, were show that structures along Dunham Place were potentially subject to over 2 feet of inundation while those along Winn Place were podetial subject to over 3 feet of inundation. This suggest that structures closer to Sauquoit St. may have suffered greater inundation than those closer to Main St.

Figure 7: Dunham and Winn Place Reference Line

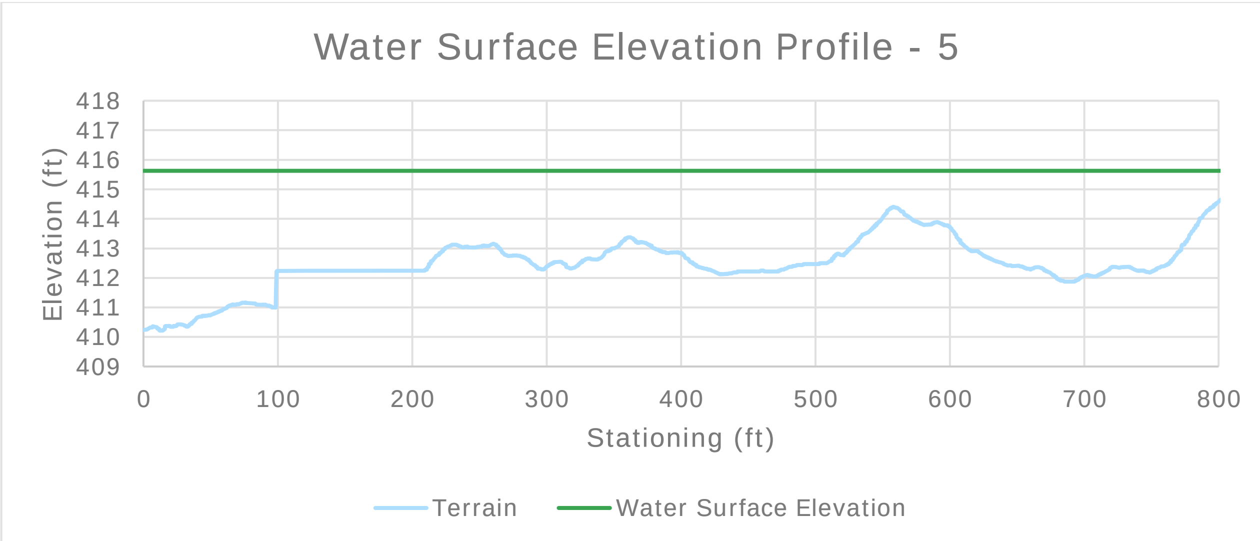


Figure 8: Profile Perpendicular to Dunham and Winn Place

Sauquoit Street

Figure 9 below shows the preliminary model flood inundation limits within the Village of Whitesboro, NY for the Halloween 2019 event along with a reference line on Sauquoit St (magenta line with stationing). Figure 10 shows the preliminary profile of the ground elevation and the model results along this reference line. Through observation of Figure 9, all structures along the street were potentially inundated by the event. Observation of Figure 10 shows that, Sauquoit St. slopes gradually away from Old Mohawk St. towards Ellis Ave. with potential flood depths ranging from 5.5 ft t0 over 6 ft at the intersection of Sauquoit and Ellis. This suggest that structures closer to Ellis St. may have suffered greater inundation than those closer to Old Mohawk St.

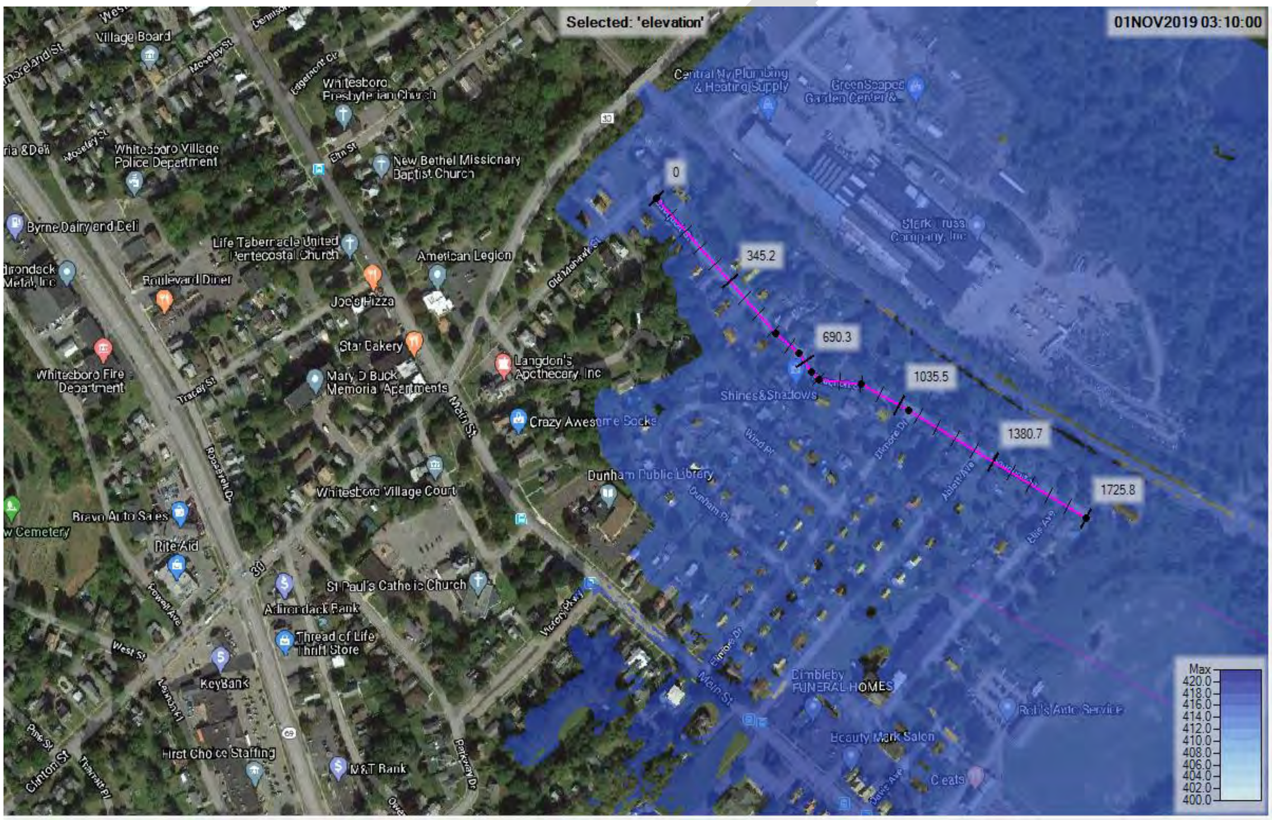


Figure 9: Sauquoit Creek Reference Line

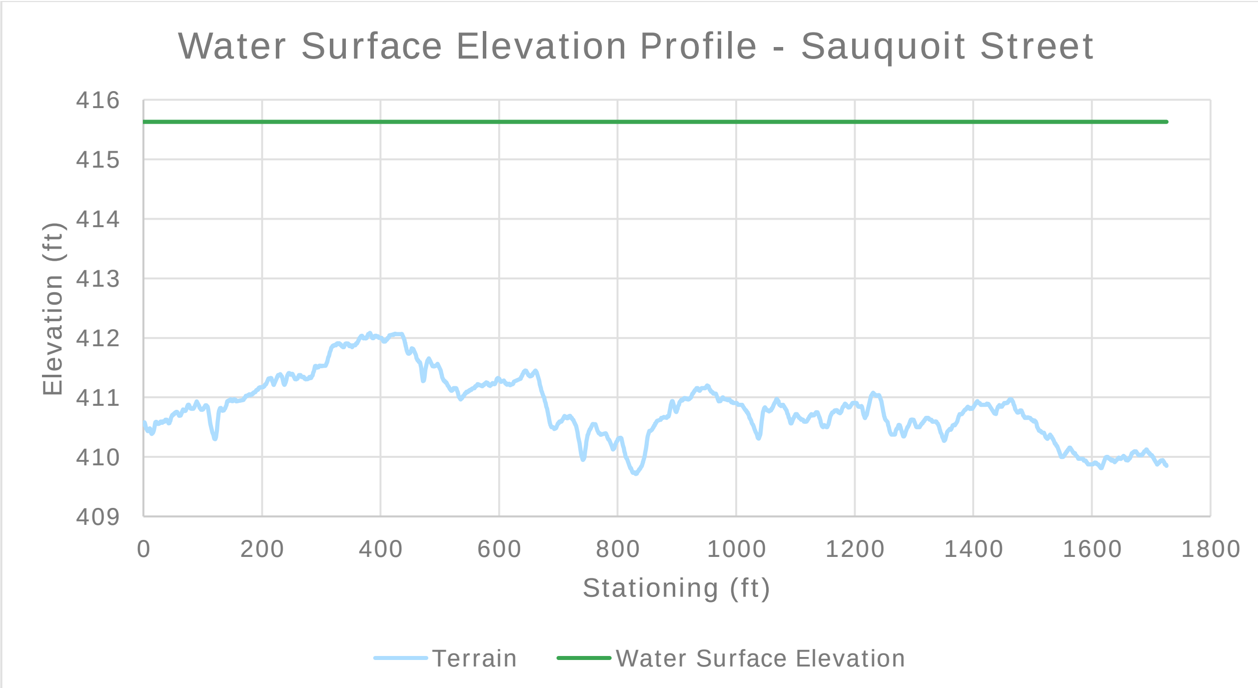


Figure 10: Sauquoit Street Profile Plot

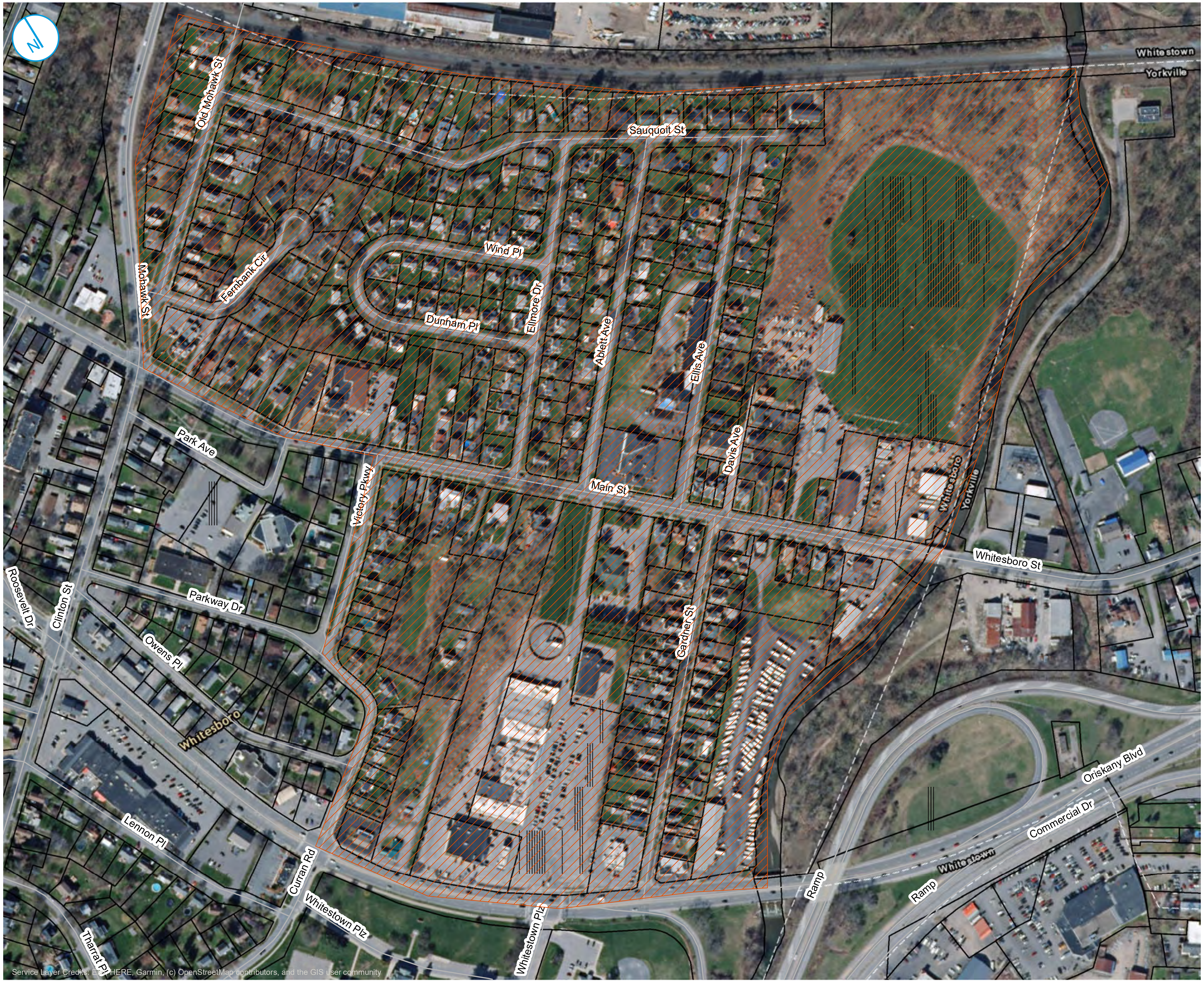
2 Next Steps

The results of the preliminary model are useful to begin to understand the depths of inundation experienced by the various residences and businesses within the study area. Just as important to understanding the extend of the flood, it is important to understand why various structures were flooded or additionally damaged. During the Halloween 2019 event, several locations suffered structural damage to the foundations, which must be evaluated further.

In the next phase of our study, Ramboll will compare the FFE, LAG, LPE for each structure with the study area. In doing so, we can better determine of flooding was a result of structural failure of the foundation, a low entry point such as a below or at ground window well or door, depth of flooding above the FFE, etc. Such observations can be used by the Commission, County and State to help determine the appropriate flood mitigation measure for each structure. Additionally, by observing the time lapse inundation of the study area, emergency management may be able to better target actives to protect the health and safety within the area.

3 Conclusions

The preliminary modeling provides useful insight into how the Halloween 2019 storm impacted the study area. Initial results suggest which structures are at a higher risk than others. To better understand the risk and potential mitigation measures, additional analysis and observations are required. In the coming weeks, Ramboll will perform this work and provide an additional memorandum to the Commission.



0 200 400 Feet

VILLAGE OF WHITESBORO
FLOOD RISK ASSESSMENT
SURVEY AREA

Village of Whitesboro
Oneida County
New York

FIGURE 01

O'BRIEN & GERE ENGINEERS, INC.
A RAMBOLL COMPANY

RAMBOLL

PROJECT: 169000XXXX | DATED: 11/20/2019 | DESIGNER: WHITTABE

I:\Whitestown-T.20969\BD\WhitesboroFloodMapping\SurveyArea.mxd

3/31/2020 5:31 PM

C:\Users\HASTINRM\OneDrive - Ramboll\Documents\70923 - Sauquoit Creek - Phase II\Drainage_Study_Figure.dwg

N

WHITESBORO, NY
FIRST FLOOR ELEVATIONS

0 75 150 300 Feet
1:1800.0036

APRIL 1, 2020

O'BRIEN & GERE ENGINEERS, INC.

APPENDIX B
SUMMARY OF HYDRAULICS FINDINGS

Appendix B

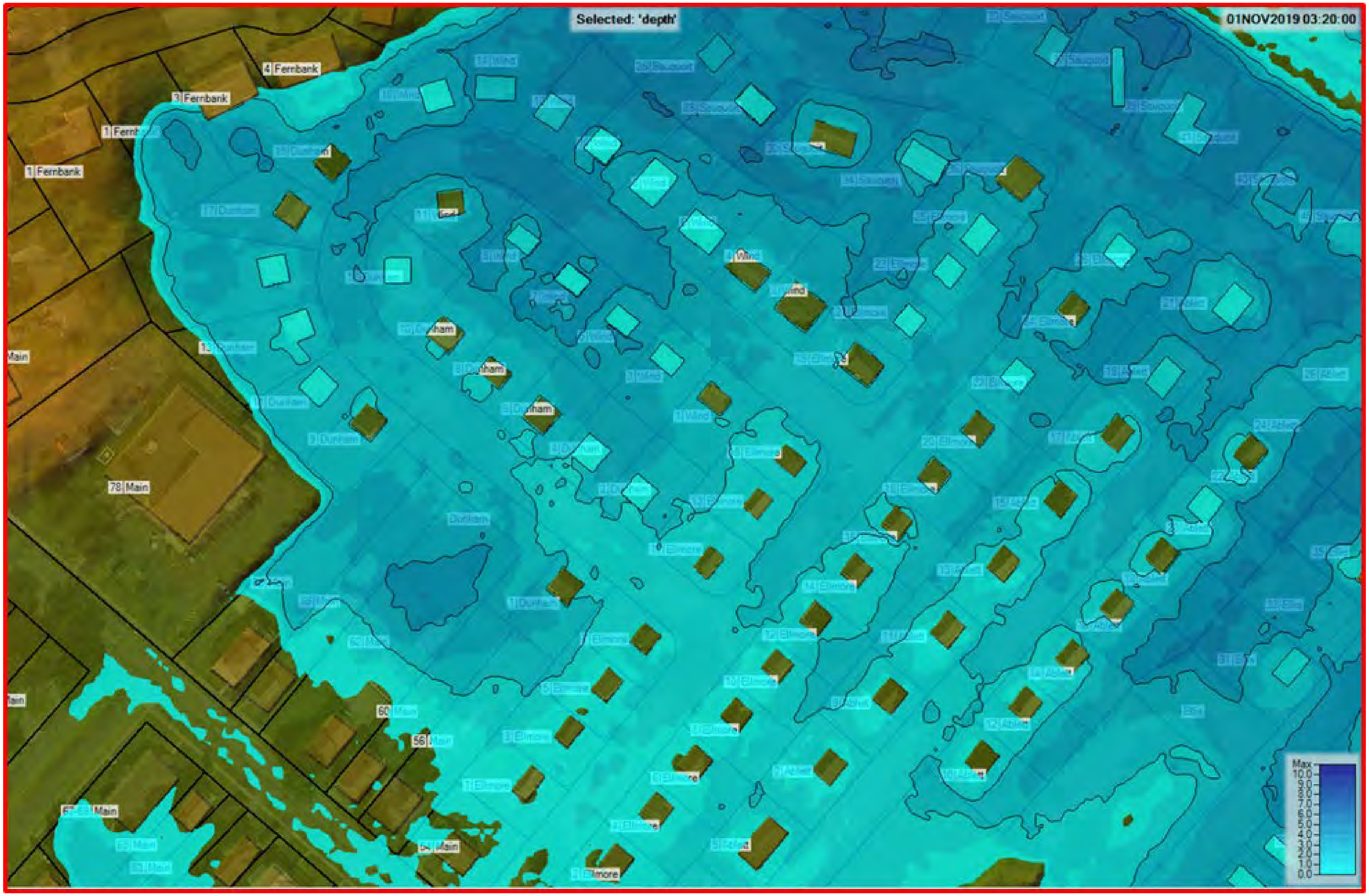
Table 1. Summary of Hydraulics Findings

House #	Street	City	Flood Residance Time	Hydrostatic Pressure Diffrential Potential (more than 0.2 ft diff)		FFE Completely Inundated		Velocity Impact
				Longitudinal	Lateral	> 0.5 ft	< 0.5 ft	
1	Dunham Place	Whitesboro	14 hours	Y		N		
9	Dunham Place	Whitesboro	14 hours	Y		N		
11	Dunham Place	Whitesboro	14 hours	N	N	Y	N	
13	Dunham Place	Whitesboro	14 hours	Y		Y	N	
	Dunham Place	Whitesboro	14 hours	Y		Y	Y	
17	Dunham Place	Whitesboro	14 hours	Y		N		
19	Dunham Place	Whitesboro	14 hours	Y		N		Less than 1 fps
2	Dunham Place	Whitesboro	14 hours	Y		N		
4	Dunham Place	Whitesboro	14 hours	Y		N		
6	Dunham Place	Whitesboro	14 hours	Y		N		
8	Dunham Place	Whitesboro	14 hours	N	Y	N		
10	Dunham Place	Whitesboro	14 hours	Y		N		
12	Dunham Place	Whitesboro	14 hours	N	Y	N		
2	Wind Place	Whitesboro	23 hours	Y		N		
4	Wind Place	Whitesboro	23 hours	N	N	N		
6	Wind Place	Whitesboro	23 hours	Y		Y	Y	
8	Wind Place	Whitesboro	23 hours	N	Y	Y	Y	
10	Wind Place	Whitesboro	23 hours	Y		Y	Y	
12	Wind Place	Whitesboro	23 hours	N	Y	Y	Y	
14	Wind Place	Whitesboro	23 hours	N	N	Y	Y	
16	Wind Place	Whitesboro	23 hours	Y		Y	Y	Less than 0.5 fps
1	Wind Place	Whitesboro	23 hours	Y		N		
3	Wind Place	Whitesboro	23 hours	Y		Y	Y	
5	Wind Place	Whitesboro	23 hours	N	Y	Y	Y	
7	Wind Place	Whitesboro	23 hours	Y		Y	Y	
9	Wind Place	Whitesboro	23 hours	Y		Y	Y	
11	Wind Place	Whitesboro	23 hours	N	N	N	N	
5	Sauquoit Street	Whitesboro	22 hours	Y		Y	N	
9	Sauquoit Street	Whitesboro	22 hours	NO FFE		N		
13	Sauquoit Street	Whitesboro	22 hours	N	Y	N		
17	Sauquoit Street	Whitesboro	22 hours	N	Y	N		
19	Sauquoit Street	Whitesboro	22 hours	Y		Y	Y	
21	Sauquoit Street	Whitesboro	22 hours	N	Y	Y	Y	
23	Sauquoit Street	Whitesboro	22 hours	N	Y	Y		
25	Sauquoit Street	Whitesboro	22 hours	N	Y	Y	Y	
27	Sauquoit Street	Whitesboro	22 hours	Y		Y	Y	
	Sauquoit Street	Whitesboro	22 hours	NO FFE				
31	Sauquoit Street	Whitesboro	22 hours	N	Y	Y	Y	
33	Sauquoit Street	Whitesboro	22 hours	Y		Y	Y	
37	Sauquoit Street	Whitesboro	22 hours	Y		Y	Y	
39	Sauquoit Street	Whitesboro	24 hours	NO FFE		Y	Y	
41	Sauquoit Street	Whitesboro	24 hours	N	Y	Y	Y	
43	Sauquoit Street	Whitesboro	24 hours	Y		Y	Y	
45	Sauquoit Street	Whitesboro	24 hours	Y		Y	Y	
47	Sauquoit Street	Whitesboro	24 hours	Y		Y	Y	
49	Sauquoit Street	Whitesboro	24 hours	Y		Y	Y	Less thann 0.5 fps
51	Sauquoit Street	Whitesboro	24 hours	Y		Y	Y	
53	Sauquoit Street	Whitesboro	24 hours	N	Y	Y	Y	
55	Sauquoit Street	Whitesboro	24 hours	N	Y	Y	Y	
57	Sauquoit Street	Whitesboro	24 hours	Y		N	N	
36	Sauquoit Street	Whitesboro	25 Hours	Y		N		
34	Sauquoit Street	Whitesboro	25 Hours	N	Y	Y	Y	
30	Sauquoit Street	Whitesboro	25 Hours	Y		N		
28	Sauquoit Street	Whitesboro	25 Hours	Y		Y	Y	
26	Sauquoit Street	Whitesboro	25 Hours	N	Y	Y	Y	
24	Sauquoit Street	Whitesboro	25 Hours	Y		N		
22	Sauquoit Street	Whitesboro	25 Hours	Y		N		
18-20	Sauquoit Street	Whitesboro	25 Hours	N	Y	N		
16	Sauquoit Street	Whitesboro	25 Hours	N	Y	Y	N	
12	Sauquoit Street	Whitesboro	25 Hours	N	Y	Y	N	
10	Sauquoit Street	Whitesboro	25 Hours	N	Y	N		
8	Sauquoit Street	Whitesboro	25 Hours	NO FFE		N		
4	Sauquoit Street	Whitesboro	25 Hours	Y		N		
2	Sauquoit Street	Whitesboro	25 Hours	Y		N		
1	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
3	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
5	Ellmore Drive	Whitesboro	14 hours	N	Y	N		

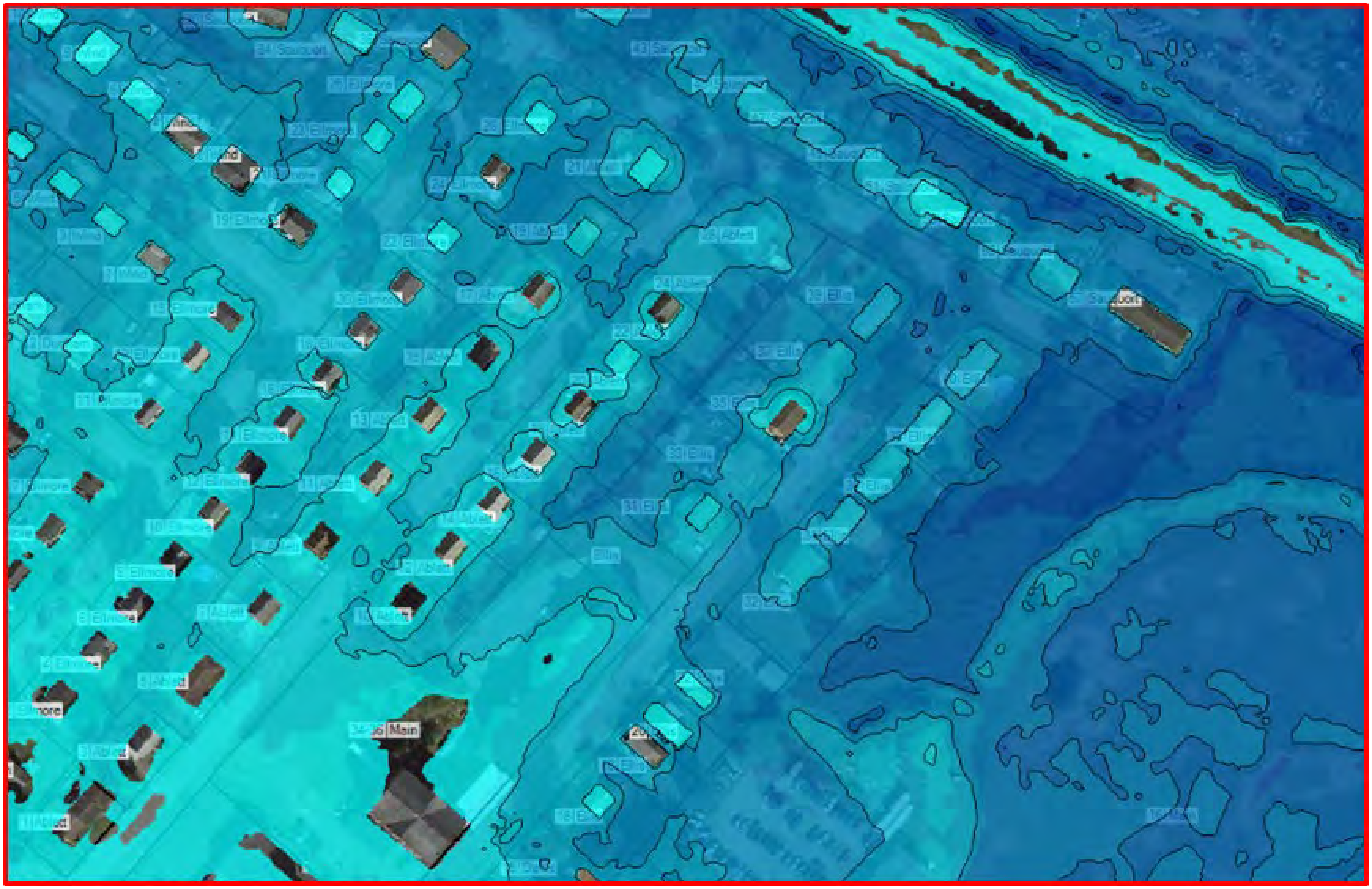
Table 1. Summary of Hydraulics Findings

House #	Street	City	Flood Residance Time	Hydrostatic Pressure Diffrential Potential (more than 0.2 ft diff)		FFE Completely Inundated		Velocity Impact
				Longitudinal	Lateral	> 0.5 ft	< 0.5 ft	
7	Ellmore Drive	Whitesboro	14 hours	N	Y	N		0.5 to 1.2 fps
11	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
13	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
15	Ellmore Drive	Whitesboro	14 hours	Y		N		
19	Ellmore Drive	Whitesboro	14 hours	Y		N		
21	Ellmore Drive	Whitesboro	14 hours	N	Y	Y		
23	Ellmore Drive	Whitesboro	14 hours	N	Y	Y	Y	
25	Ellmore Drive	Whitesboro	14 hours	Y		Y		
2	Ellmore Drive	Whitesboro	14 hours	Y		N		
4	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
6	Ellmore Drive	Whitesboro	14 hours	Y		N		
8	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
10	Ellmore Drive	Whitesboro	14 hours	Y		N		
12	Ellmore Drive	Whitesboro	14 hours	Y		N		
14	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
16	Ellmore Drive	Whitesboro	14 hours	Y		N		
18	Ellmore Drive	Whitesboro	14 hours	Y		N		
20	Ellmore Drive	Whitesboro	14 hours	N	Y	N		
22	Ellmore Drive	Whitesboro	14 hours	Y		Y	N	
24	Ellmore Drive	Whitesboro	14 hours	Y		N		
26	Ellmore Drive	Whitesboro	14 hours	Y		Y	Y	
1	Ablett Avenue	Whitesboro	25 Hours	Y		N		0.5 to 1.0 fps
3	Ablett Avenue	Whitesboro	25 Hours	Y		N		
5	Ablett Avenue	Whitesboro	25 Hours	Y		N		
7	Ablett Avenue	Whitesboro	25 Hours	N	Y	N		
9	Ablett Avenue	Whitesboro	25 Hours	Y		N		
11	Ablett Avenue	Whitesboro	25 Hours	Y		N		
13	Ablett Avenue	Whitesboro	25 Hours	N	Y	N		
15	Ablett Avenue	Whitesboro	25 Hours	N	Y	N		
17	Ablett Avenue	Whitesboro	25 Hours	N	Y	N		
19	Ablett Avenue	Whitesboro	25 Hours	Y		Y	Y	
21	Ablett Avenue	Whitesboro	25 Hours	Y		Y		
10	Ablett Avenue	Whitesboro	25 Hours	Y		N		
12	Ablett Avenue	Whitesboro	25 Hours	Y		N		
14	Ablett Avenue	Whitesboro	25 Hours	Y		N		
16	Ablett Avenue	Whitesboro	25 Hours	Y		N		
18	Ablett Avenue	Whitesboro	25 Hours	N	Y	N		
20	Ablett Avenue	Whitesboro	25 Hours	Y		N		
22	Ablett Avenue	Whitesboro	25 Hours	Y		Y	N	
24	Ablett Avenue	Whitesboro	25 Hours	Y		N		
26	Ablett Avenue	Whitesboro	25 Hours	No data		N		
31	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	Less than 0.5 fps
33	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
35	Ellis Avenue	Whitesboro	30 Hours	Y		N		
37	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
39	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
10	Ellis Avenue	Whitesboro	30 Hours	Y		N		
15	Davis Avenue	Whitesboro	30 Hours	Y		N		
16	Davis Avenue	Whitesboro	30 Hours	Y		Y	N	
18	Ellis Avenue	Whitesboro	30 Hours	Y		N		
20	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
22	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
32	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
34	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
36	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
38	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	
40	Ellis Avenue	Whitesboro	30 Hours	Y		Y	Y	

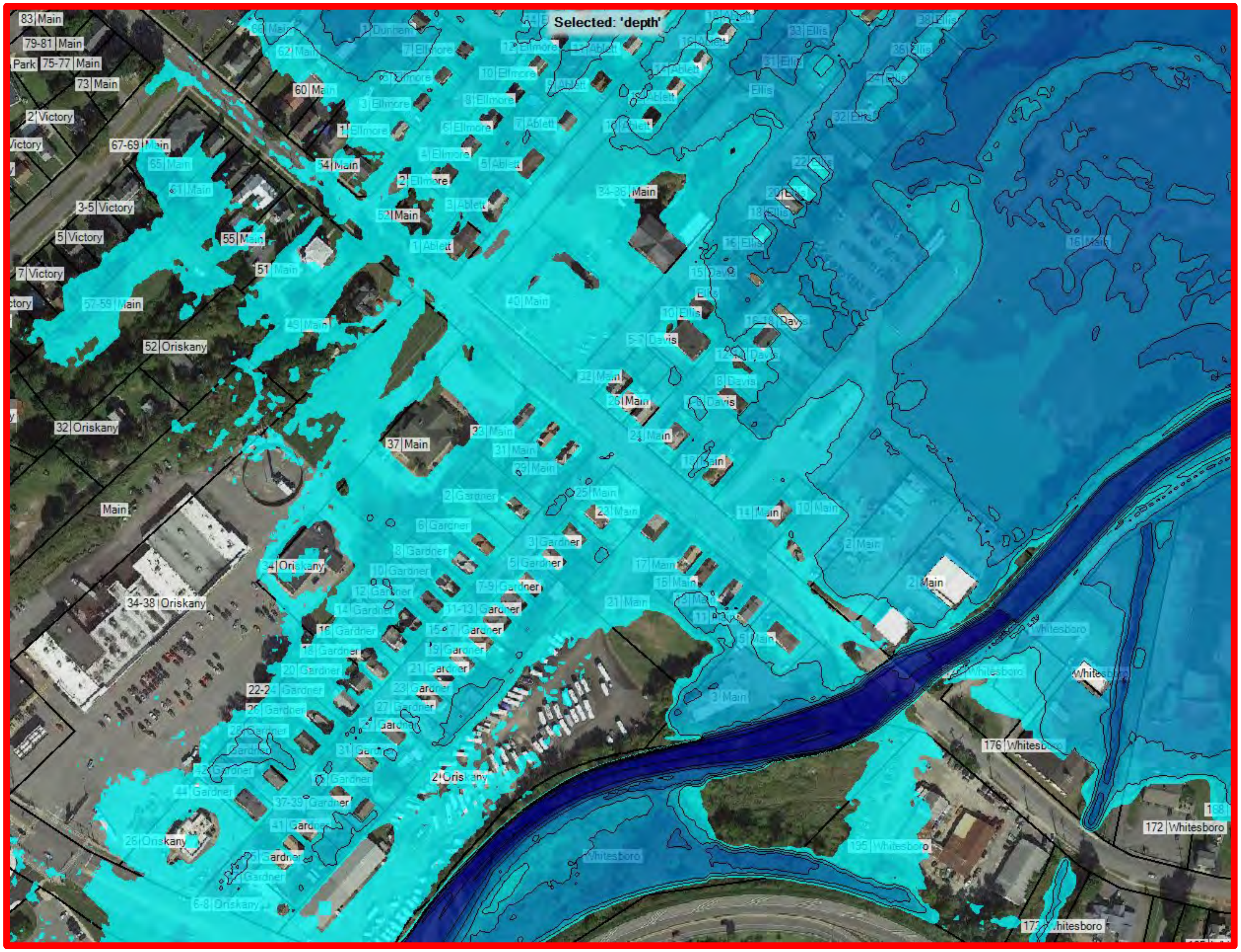
APPENDIX C
ENLARGED PLAN VIEW FIGURES



Enlarged view Figure 13 1



Enlarged view Figure 14 2



Enlarged view Figure 15 3