US Army Corps of Engineers®

Piat Place & Harding Ditch

Flood Hazard Analysis

(Floodplain Management Services - FPMS)

Appendix A - Hydraulics and Hydrology

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1.0 Project Area

This appendix examines the hydrologic and hydraulic conditions related to localized flooding in the study area and possible opportunities to reduce the flood inundation risk to structures and property. The portion of the study area referred to in this study as Piat Place is bordered by N 58th Street to the west, Summit Avenue to the north, Harding Ditch to the east, and Whispering Willow Lake to the south. The Piat Place portion of the study area is at the north end of the study area outlined in dashed red lines in Figure 1. Within this area, the area approximately north of Laura Ave is within the City of East St. Louis, and the area south of Laura Ave is in the City of Cahokia Heights.

The portion of Harding Ditch within the study area extends from its confluence with Schoenberger Creek to the north to the south pump station at Prairie Du Pont creek to the south. The extents of the hydraulic model will cover most of Harding Ditch and its larger tributaries. The Harding Ditch portion of the study area is identified with a solid red polygon in Figure 1.

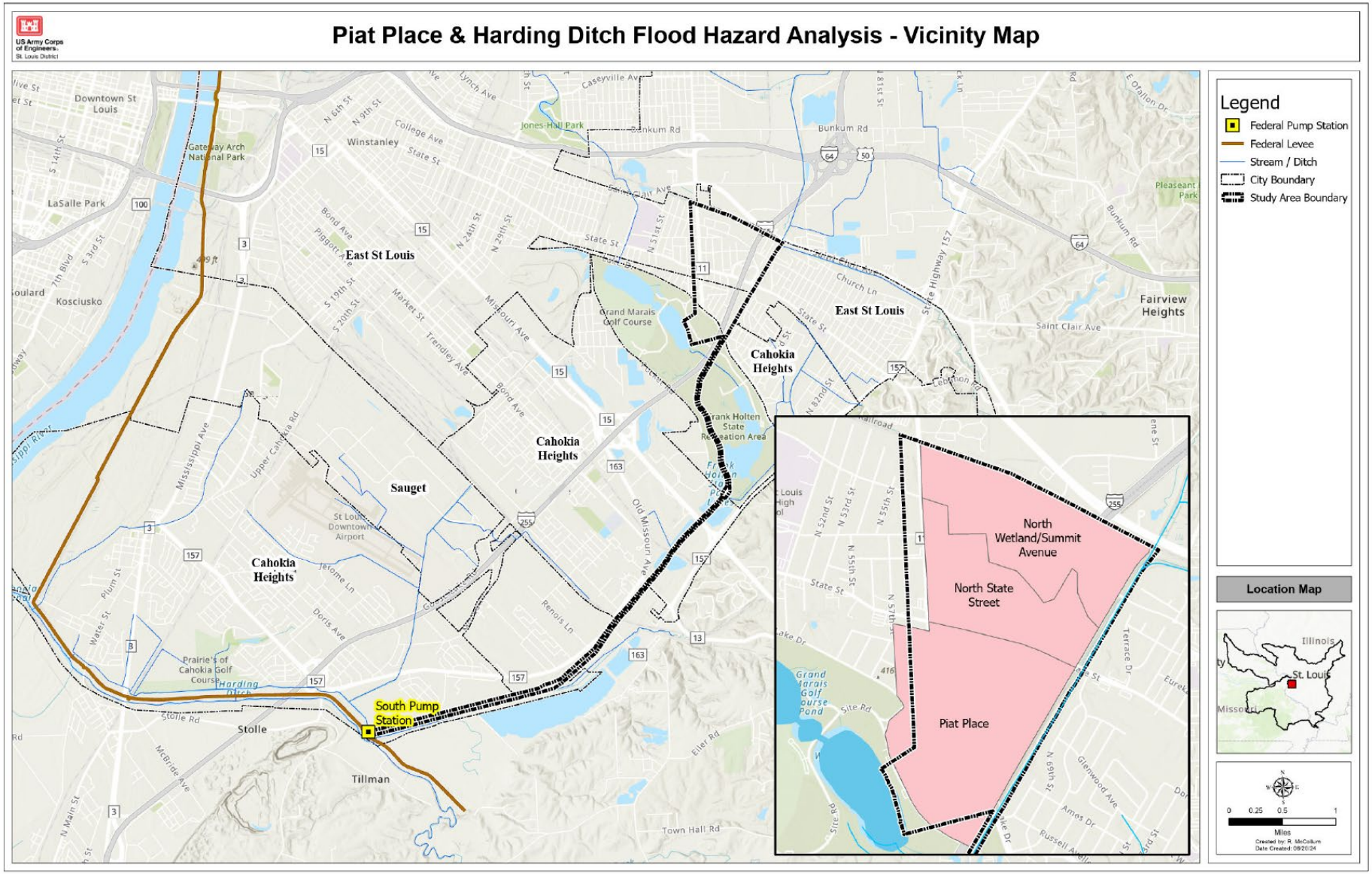

Figure 1. Study Area Boundary Map

Many of the residential structures in the study area are repeatedly at risk of inundation during regular precipitation events. The purpose of this report is to provide the cities of Cahokia Heights and East St. Louis with sufficient information to make informed decisions regarding future flood risk management activities within the study area.

1.1 Study Scope

The scope of this report is to provide the cities of Cahokia Heights and East St. Louis with an evaluation of flood prone areas within the study area, conduct engineering analysis of structural alternatives to reduce flood risk, and present the findings and conceptual cost estimates to assist the cities with reducing long-term flood risk. The evaluations in this report take into consideration local hydraulics and existing site conditions.

PCSWMM and HEC-RAS models were created of the storm sewers, ditches, and floodplains. For the Piat Place portion of the study area, USACE relied on a storm sewer survey conducted by IDNR.

New Harding Ditch channel cross sections were gathered by USACE for the areas between Schoenberger Creek and the South pump station. Comparing channel conditions in the 2012 Harding Ditch model to the new surveyed cross sections, the effects of change in the channel conditions were determined.

1.2 Flood Hazard Areas – Piat Place Portion of Study Area

The flood hazard areas in the Piat Place portion of the study area that are addressed in this report are shown in Figure 2. The areas of documented flooding shown in blue, purple, and orange, are based on information gathered from local residents by HeartLands Conservancy (HeartLands Conservancy, 2024). The specific problems identified by the IDNR storm sewer survey and by this hydraulic analysis are shown in Figure 3. The corrective actions detailed in this appendix focus on addressing these issues.

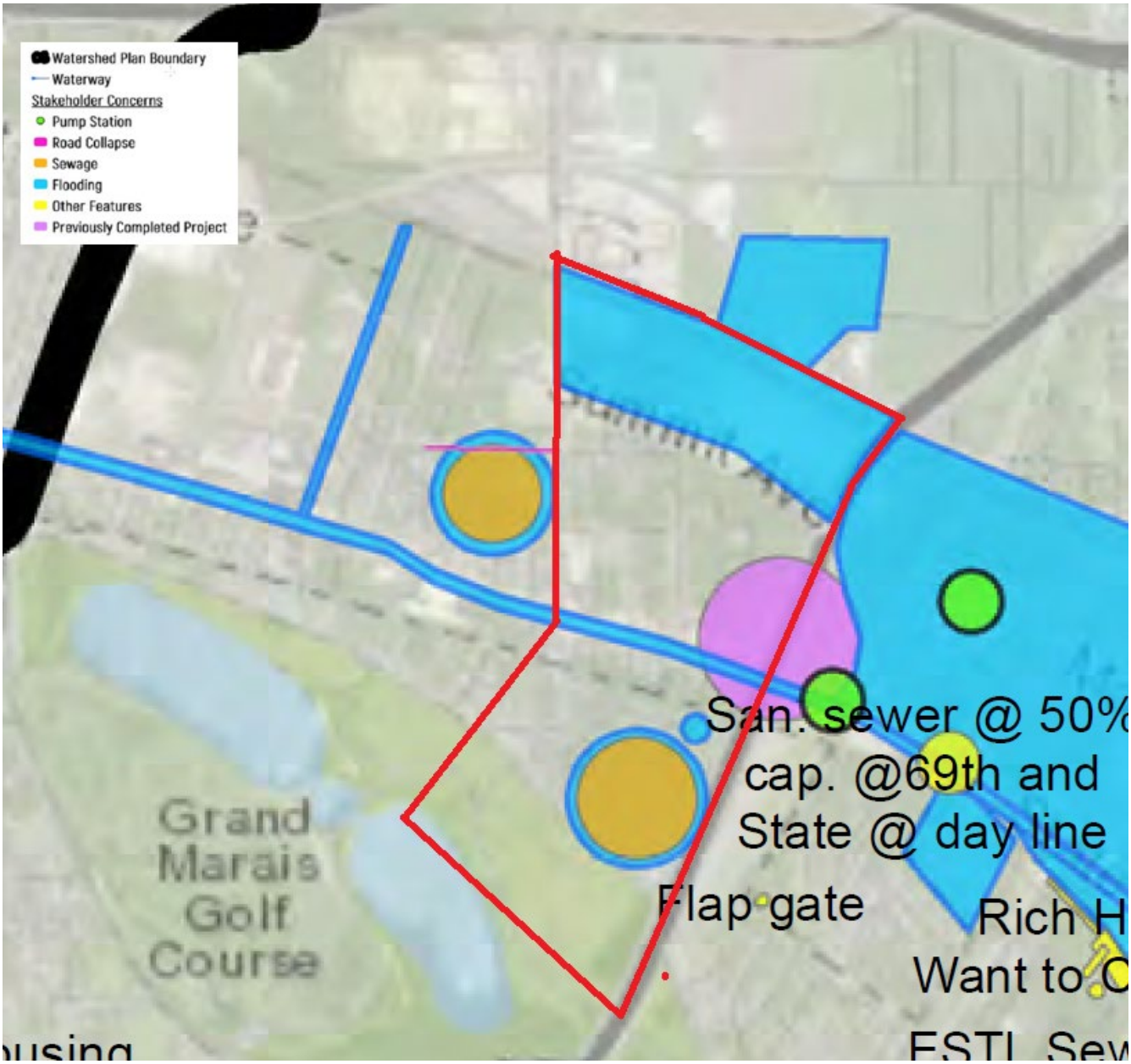

Figure 2. Study Flood Hazard Area with Approximate Study Area Modeling Extents (red). Image from HeartLands Conservancy. Image will be updated prior to final report.

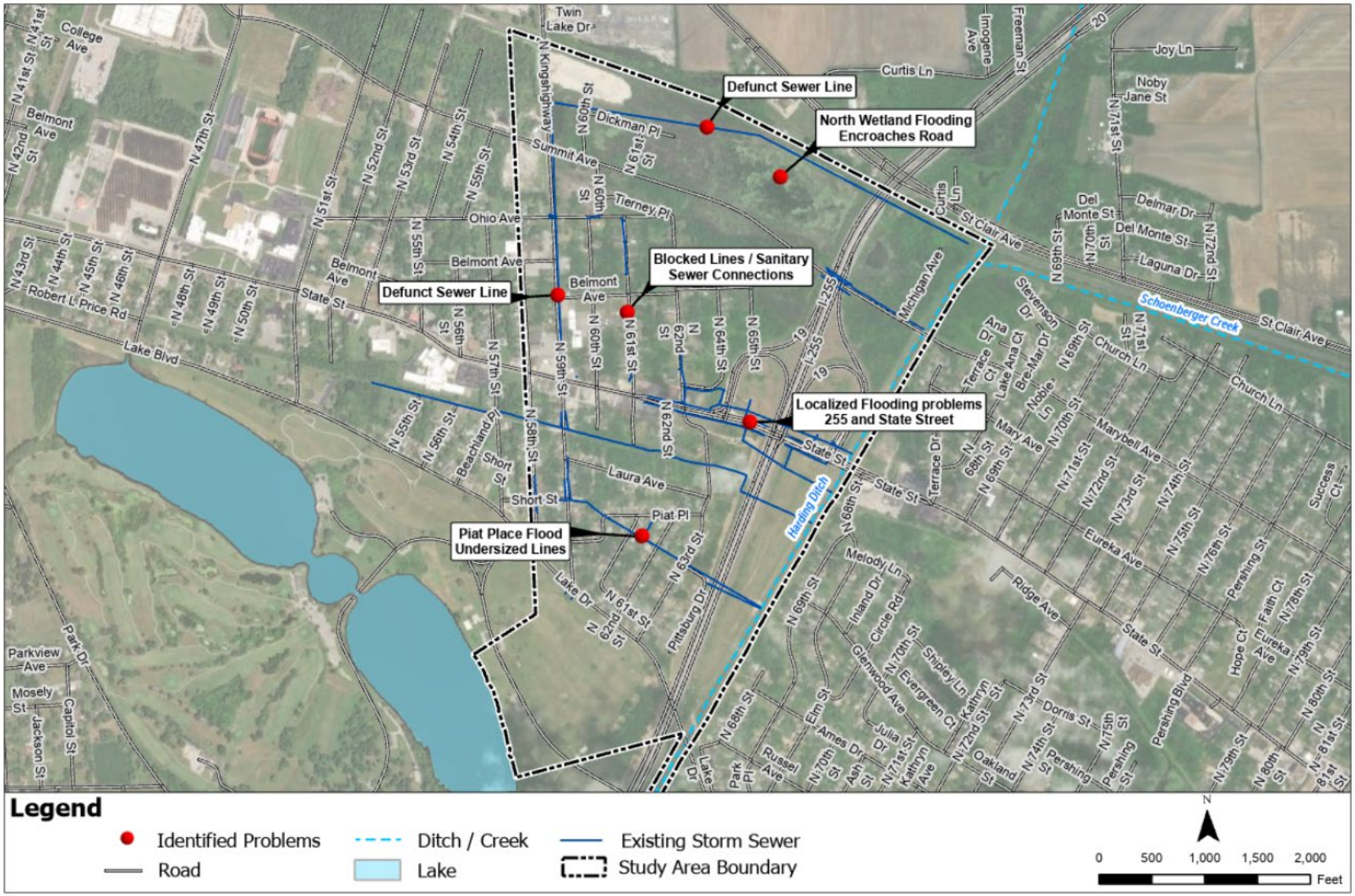

Figure 3. Problem Areas Identified by Hydraulic Modeling in this Study

2.0 Existing Storm Sewer System – Piat Place Portion of the Study Area

Information and data about the existing storm sewer system were identified from a 2023 IDNR storm sewer survey, PCSWMM modeling of the storm sewer system (see Section 7.0), issues identified by residents in the HeartLands Conservancy map, field observations, input from partner organizations including the cities of East St. Louis and Cahokia Heights, and conversations with residents in the project area during a site visit.

In 2023, IDNR collected data from the storm sewer system/inlets in the study area and identified the condition of the inlets, elevation of inverts and rim levels, and pipe sizes with direction and material type. The information was organized in an ArcGIS geodatabase showing pictures, survey notes, and survey shots.

The current state of the storm sewer systems is poor. Several inlets are filled with silt and trash. Several are damaged and do not properly drain the contributing area leaving standing water. Several areas do not drain into their intended inlet due to changes in the roadway or land surface. These inlet conditions do not provide adequate drainage and leave water ponded in the roadways and ditches. Several pipes have adverse slopes, probably due to settlement over time, which further restricts drainage in the network. The ditches in several areas along the roadside are discontinuous. Either due to settlement or landowners regrading yards, most ditches do not drain as originally conceived. As a result, standing water can be seen throughout the drainage area.

The wetland area north and south of Summit Avenue has ditches and culverts connecting the wetlands. There are ditches alongside Summit Avenue and a culvert that allows flow under the Interstate 255 overpass. Once east of Interstate 255, the area drains to a culvert into Harding Ditch. The north wetland area does not have a clear path to drain into Harding Ditch. Ditches along Kingshighway that drain into the wetland have culverts blocked leaving standing water. From field observation it was noted that the culvert under Interstate 255 is 75% blocked (Figure 4). The only true path under Interstate 255 is next to Summit Avenue on the highway embankment. It was also noted that the culvert that drains the wetlands into Harding Ditch east of Interstate 255 does not have a flap gate on it.

Several lines along Kingshighway drain to the non-functional Wedgewood pump station. The location of the old pump station is just south of the Metrolink tracks west of Harding Ditch. The mainline to the pump station drains through the north wetland and as a result the lines along Kingshighway are full of water. Standing water was also found on some of the lines on streets east of Kingshighway, however, connectivity to this mainline could not be determined, only suspected. It is also suspected that some of these lines drain into the sanitary sewer system.

The area directly south of State Street is mainly drained by a ditch that parallels Ridge Avenue. The ditch turns and runs along Interstate 255 before entering a culvert that drains to Harding Ditch. South of that is the storm sewer system that drains the Piat Place neighborhood. The main line that drains this watershed follows Short Street, then enters a ditch before emptying into a pipe network that transects the Piat Place neighborhood. This Piat Place mainline goes under Interstate 255 and into Harding Ditch. A functioning flap gate prevents backup from Harding Ditch into the Piat Place neighborhood.

Illustrations of the storm sewer pipe network and ditches north and south of State Street are shown in Figure 5 and 6.

The Piat Place portion of the study area contains an existing storm sewer network for drainage which primarily drains under Interstate 255 into Harding Ditch. Flap gates are employed to restrict backwater from Harding Ditch. Poor drainage in the Piat Place neighborhood is a regular problem. The streets are regularly inundated with several feet of water and flood water has entered multiple residents on Piat Place. Undersized conduits do not drain as originally intended. Some work has been done to alleviate this; a pump diverting water into the sanitary sewer system was installed at inlet 1018 in the Piat Place neighborhood. However, it is not expected to fully remove the flood risk to the structures.

Figure 4. Blocked Culvert Under I-255 Adjacent to Summit Avenue Wetlands (Photo: USACE, March 2024)

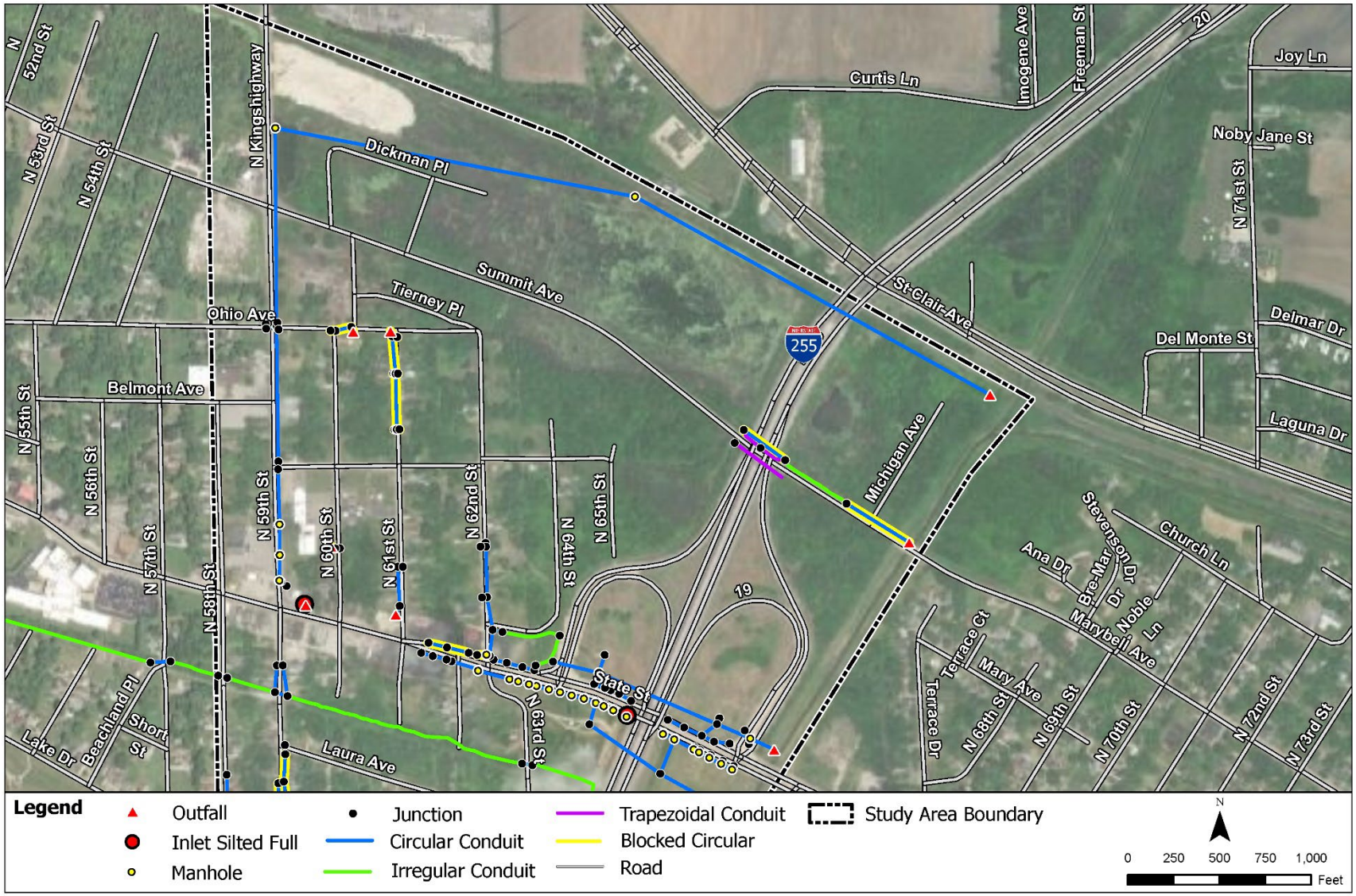

Figure 5. Drainage and Storm Sewer Infrastructure North of State Street

Figure 6. Drainage and Storm Sewer Infrastructure South of State Street

3.0 Hydrologic Modeling

The hydrology and hydraulic modeling analysis relied primarily on PCSWMM version 7.5 to capture the flood levels and discharges associated with the localized flooding. PCSWMM is a modeling software package that relies on the SWMM engine to compute discharges and water levels in storm sewer networks. PCSWMM also has the capability to simulate both 1D and 2D river and overland flow hydraulics. In this project the hydraulics of the study area storm sewer system, ditches, and floodplain are examined.

An additional modeling software, HEC-RAS version 6.5, was used to assess the hydraulic conditions in Harding Ditch. The USACE Hydraulic Engineering Centers River Analysis System (HEC-RAS) is software that allows performance of one-dimensional steady flow hydraulics; one- and two-dimensional unsteady flow river hydraulics calculations; quasi-unsteady and full unsteady flow sediment transport-mobile bed modeling; water temperature analysis; and generalized water quality modeling (nutrient fate and transport). This is the preferred software package of the USACE Hydrology and Hydraulics Community of Practice.

An existing 1D model of the Metro East levee district, previously constructed in 2012, was used in the modeling of Harding Ditch. It was reduced to only capture Harding Ditch south of Interstate 64 down to the South pump station. Harding Ditch cross sections were updated from a USACE 2024 channel survey.

HEC-RAS simulation results of Harding Ditch and Whispering Willow Lake were used as boundary conditions to the Piat Place study area PCSWMM models. Both models used a frequency storm duration of 24-hours.

As stated in Section 1.2 of the main report, storm events and their resultant inundation will be referred to by Annual Exceedance Probability (AEP) in this report. For example, a storm event with a 1% AEP would have a 1% chance of occurring in a given year. Additionally, in the past, storm events have often been described by their “return period”, or the estimated average length of time between storm events of a similar magnitude. A 1% AEP event would have been referred to as having a 100-year return period or being a 100-year event. This terminology is no longer used because it falsely conveys a sense of time and lowers public risk perceptions.

3.1 Existing Conditions Model - PCSWMM

One 1D/2D composite PCSWMM model was created of the Piat Place project area existing conditions. The 10%, 4%, and 1% AEP storm events were simulated by the existing conditions model.

Illustration of the existing model geometry is shown in Figures 7 and 8 for the watersheds north and south of State Street. In the figures, watersheds are delineated in light green, inlets or manholes are blue, conduits are yellow, ditches are dark green, trapezoidal channels are blue, and the outfalls are red.

Figure 7. PCSWMM Existing Conditions Model - North of State Street

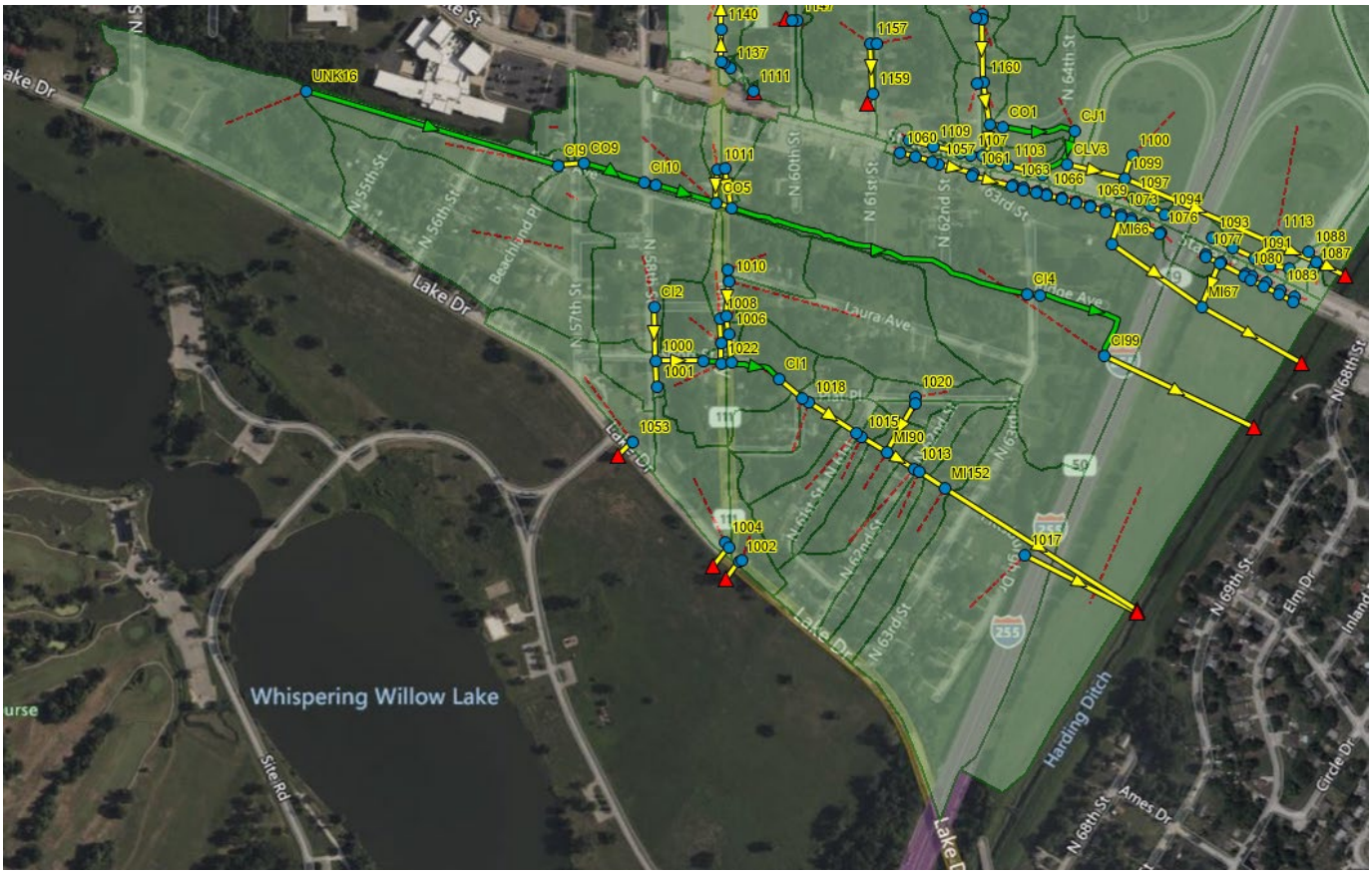

Figure 8. PCSWMM Existing Condition Model - South of State Street

Whispering Willow Lake and Harding Ditch were the downstream boundaries in the PCSWMM watershed models. For the outfalls, HEC-RAS simulation results of Harding Ditch and Whispering Willow Lake were used as stage time series boundary conditions in the PCSWMM models. In the simulations, both models used a frequency storm duration of 24 hours.

The tributary areas of the models were determined by subdividing the USGS watershed boundaries based upon DEM data provided by the USGS (2019). The sub-watersheds were determined for every inlet represented in the model. Parameters such as width and slope were estimated from the terrain to reflect the watershed existing conditions.

SCS Curve Numbers were used to approximate infiltration parameters. A Curve Number grid of the project area was created from a composite of the Illinois Soil Survey Geographic Database (SSURGO) and 2019 National Land Cover Database (NLCD). Curve Numbers were determined for each land cover type and hydrologic soil grouping combination. Upon import to PCSWMM, Curve Numbers were adjusted to give more weight to the infiltration of the pervious areas in the watershed. Curve numbers were set to a maximum of approximately 85. Percent imperviousness was computed using the 2019 NLCD urban imperviousness products. Watershed surface roughness was estimated from the NLCD land cover type corresponding to the Manning's n-value ranges published in the HEC-RAS Hydraulic Reference Manual.

Depression storage was set to a minimum of 0.2 and a maximum of 0.5 inches for impervious areas. Pervious area depression storage was set to a minimum of 0.4 and a maximum of 0.85 inches.

Depression storage was determined using aerial photos and field surveys. High depression storage coefficients account for the discontinuous flow through ditches and wetlands and for the fact that in numerous instances the ground surface does not drain directly to sewer inlets. The more standing water in the subbasin, the higher the depression storage coefficient.

Conduits and junctions were added to model sewer connectivity. Parameters such as inverts, rim elevations, and conduit offsets were taken from an IDNR field survey (2022). For lines and junctions not captured in the field survey, inverts were interpolated between junctions with IDNR surveyed information. Unknown inlet or manhole rim elevations were taken from the DEM data. Conduit lengths were computed from geo-referenced pipe and inlet locations. Manning's n-values for the various conduit types are shown in Table 1. For inlet blockages, the downstream pipe diameter was reduced to 0.1 feet for complete inlet blockage. The pipe diameters were adjusted from their estimated full size according to the percent of inlet/pipe blockage reported in the IDNR survey.

Table 1. Sewer Conduit Manning's n-value

Material	Manning's n-value
Reinforced Concrete Pipe (RCP)	0.017
Corrugated Metal Pipe (CMP)	0.035
Vitrified Clay Pipe (VCP)	0.017
Ductile Iron (DIP)	0.023
PVC	0.015

The models created for this study were constructed as 2D representations of the watershed drainage. The benefit of a 2D model is that overland flow and inundation from surcharge at the inlets can be visualized and surface flow computationally routed. Steps taken in the assembly of the 2D components started with importation of the USGS DEM covering the project area. 2D area bounding layers were created that defined a mesh with a 20-foot grid cell size.

Ditches were modeled as 1D irregular channels. For the 1D models, the cross sections covered the channel and overbank. For the 2D models, the cross sections were truncated to the back stations to not double account for channel storage in the overbank.

In creating a 2D model, grid cell points are first generated covering the surface of the watershed. The layout of the points takes into account the stream centerlines and boundary layer definition. In the regions between the 20-foot grid cells, additional cell points were added to better define the surface. This was done by enforcing edge lines for the high terrain and road boundaries. Once completed, a 2D hexagonal cell mesh of junctions and conduits was created where the elevation for the cell/junction points were taken from the DEM. Downstream outfall boundary connections to the 2D junction/conduit configuration are defined and the 2D junction configuration is connected using orifices to link the 2D cells to the 1D inlets (bottom orifice technique).

3.2 Existing Conditions Model – HEC-RAS

A 1D/2D composite unsteady flow HEC-RAS model was created of Harding Ditch from Schoenberger Creek downstream to the South pump station. The model was cut from a USACE-built model of the MESD levee district interior drainage system completed in 2012. 1D channel and storage areas define

the majority of Harding Ditch. The 2D extents cover the areas around Canal 1 and the north overbank near the South pump station. An illustration of the Harding Ditch portion of the model geometry is shown in Figures 9 and 10.

The downstream boundary on Harding Ditch is the South pump station. It has a gravity outfall culvert and pump connection to Prairie du Pont Creek. In the model, HEC-RAS rules govern the operations of the pumps depending on Mississippi River discharge and the computed river stage at St. Louis. Stages at the St. Louis gage on the Mississippi River exceeding 21.5 feet prevent outflow through the culvert at the pump station and the rules set the pump to operate. For stages less than 21.5 feet the rules turn the pump off and flow ensues through the culverts.

Inflow into the model at the upstream reach boundaries is set as flow hydrographs. For the 1D and 2D storage areas, inflow hydrographs have been added to account for the interior runoff. Specific to the 2D areas, inflow boundary points were area weighted and were set along the main tributaries within the storage area. The inflow hydrographs were computed using the HEC-HMS model of MESD created as part of the 2012 modeling effort.

Lateral structures were employed to define the connection between the channel and storage areas. Storage area connections were used to define the 1D connectivity between storage areas, as well as define bridges and culverts in the 2D areas. These lateral structures and storage area connections were geo-referenced in the updated model so that lateral structures and storage area connection weir elevations could be extracted from the terrain. Levee culverts at the various locations along Harding Ditch were captured in the 2024 USACE field survey and defined in the lateral structures as culverts. Culvert and bridge dimensions defined by storage area connections in the 2D area were captured by field survey. Flap gate information was also captured in the field survey and the culverts were defined with one directional flow where they existed. Culvert definition for the 1D storage area to storage area connections were preserved from the 2012 MESD model.

In the 2D areas, breaklines were created to delineate streams, embankments, and roads. Ditch cross sections identified in the field survey were imported into HEC-RAS as a 1D channel. The 1D channel was then burned into the 2D terrain to produce more accurate flow routing in the channels.

To adequately capture rainfall runoff response from the entirety of the MESD HEC-HMS model watershed (which includes not only Harding Ditch but also Cahokia Canal), a 72-hour duration storm event was selected and used for the HEC-RAS model frequency event simulations of the Harding Ditch portion of the study area.

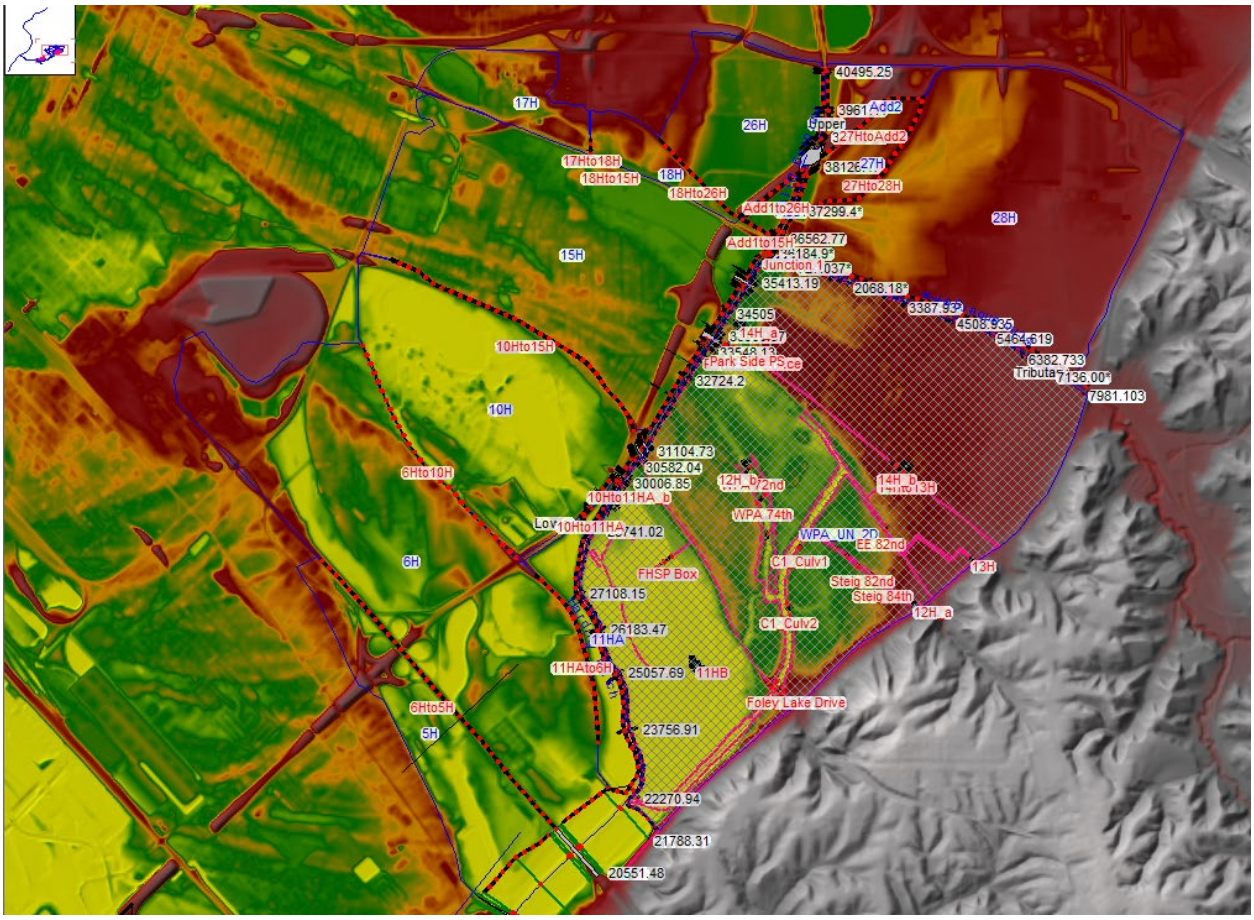

Figure 9. HEC-RAS Geometry Covering Harding Ditch Upstream to Canal 1 (North)

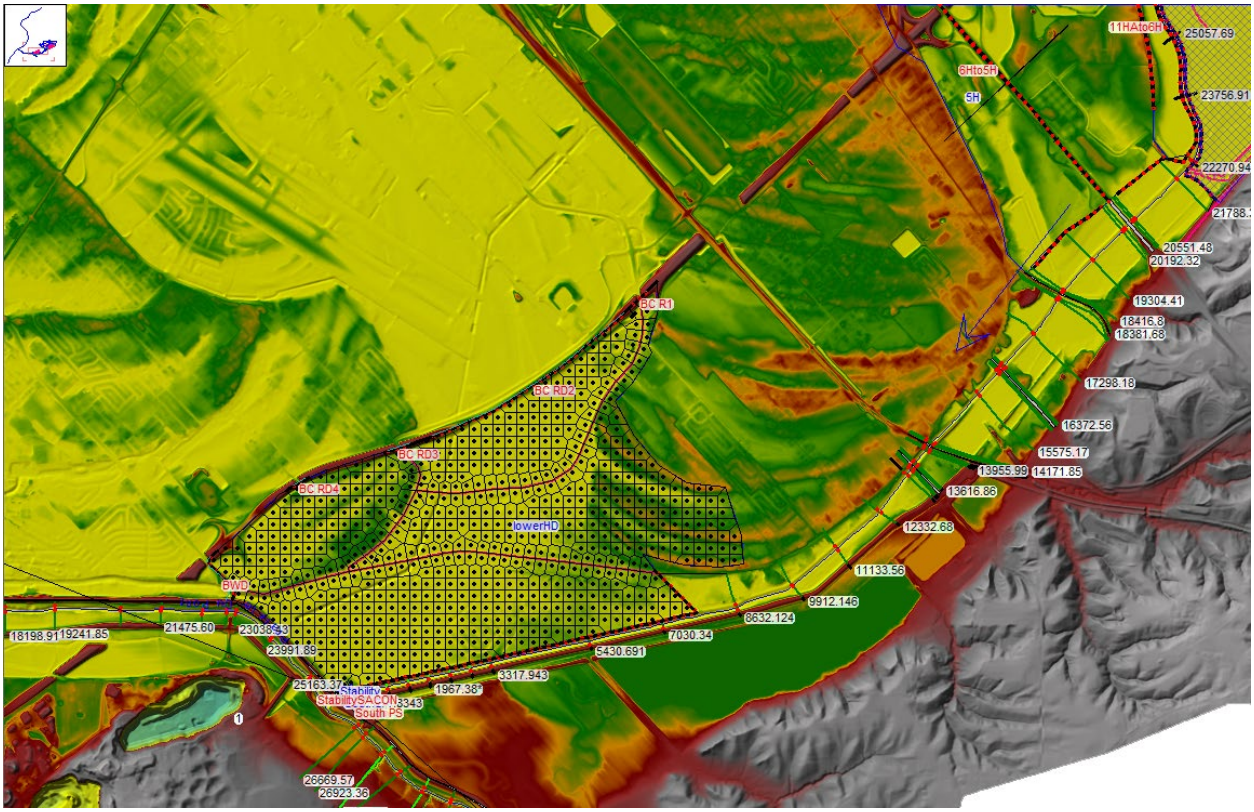

Figure 10. HEC-RAS Geometry Covering Harding Ditch from Canal 1 to the South Pump Station (South)

3.3 Design Considerations for the Storm Sewer Systems

There is no specific guidance for storm sewer design for USACE projects. Each local municipality in which projects may be located has its own requirements, but these do not directly govern federal projects. Where applicable, federal projects try to adhere to local requirements. Designs in this study aim to exceed the storm water design regulations for St. Clair County, Illinois. The regulations regarding storm water management for St. Clair County, Illinois was found at: https://www.co.st-clair.il.us/webdocuments/CountyCode/Stormwater%20Control%20Code.txt

The discussion on page 11 of the St. Clair County, Illinois stormwater regulations states that a minor drainage system is "that portion of a drainage system designed for the convenience of the public. It consists of street gutters, storm sewers, small open channels, and swales and, where man-made, is to be designed to handle the 10-year runoff event." Page 22 discusses drainage system design and evaluation. It states when evaluating existing conditions and designing a drainage system the design shall provide capacity to pass the 50% AEP 24-hour peak flow rate in the minor drainage system and an overflow path for flows in excess of the design capacity. Regarding positive drainage, all developments will pass the 1% AEP 24-hour flow at a stage of at least one foot below all structure foundation grades in the vicinity of the flow path.

Since it is not clear whether to design the new sewer modifications to the 50% AEP or 10% AEP storm event, the 10% AEP 24-hour duration storm event is used for the base design of drainage modifications for this project. Most municipalities nationwide tend to require that the 10% AEP storm event be used in the design of sewer systems.

Because of the lack of structure foundation elevation information, the resulting 1% AEP storm event inundation for the project will only be shown for the measures in each respective section of the pipe network. This can be compared to the existing 1% AEP event flood inundation. The resulting inundation will show the residual flood risk to structures with an overall reduction in damages.

3.4 Frequency Design Precipitation

This analysis assumed that a 24-hour duration storm event is sufficient to capture the full effects of flooding in the Piat Place portion of the study area. Also, a 72-hour duration storm event is sufficient to capture the full effects of flooding in the Harding Ditch HEC-RAS model. For the entire study area, the assumed storm duration is greater than the time of concentrations for the modeled watersheds. Depth data for various 24-hour and 72-hour duration rainfall events was gathered for East St. Louis, IL from the Nation Oceanic and Atmospheric Administration Atlas 14 online at https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html. Table 2 shows the 24-hour duration rainfall depths used in the PCSWMM analysis. Table 3 shows the 72-hour duration rainfall depths used in generating inflow into the Harding Ditch HEC-RAS model. Both tables are based upon return period and AEP.

Table 2. NOAA Atlas 14 24-hour duration rainfall depth for East St. Louis, IL

Storm Event	Depth (inches)
10% AEP	4.52
4% AEP	5.56
1% AEP	7.64

Table 3. NOAA Atlas 14 72-hour duration rainfall depth for East St. Louis, IL

Storm Event	Depth (inches)
10% AEP	5.59
4% AEP	6.85
1% AEP	9.38

3.5 Proposed Conditions Modeling

Following creation of the existing conditions PCSWMM models, copies were modified to generate models for evaluating proposed conditions for the measures and alternatives described in Section 4.0. Each proposed condition model focused on modifications in different sections of the sewer system. Modifications such as increasing the pipeline size, correcting an adverse sloped pipe, or re-routing a sewer inlet to another sewer line were some of those examined. Regarding changes in some of the sewer system pipes, sewer inverts are adjusted to yield more fall in a line or properly sloped where adverse sloped pipes existed. When channeling an inlet to another network trunkline, inlets are assumed to be replaced in a manner that assures adequate drainage to the downstream junction.

New storm sewer systems in the Piat Place portion of the study area that would drain to Harding Ditch require pump stations to move water into the ditch. The current storm sewer system lacks pump

stations which creates problems when water backs up from Harding Ditch. Coincidence of severe storm events outside of Harding Ditch are not independent of high Harding Ditch stages. Also, there is not a lot of elevation relief in the sewer system and water does not have any space to back up. The flood risk is further compounded since a lot of the storm sewer system is undersized.

For the new pump stations, wet wells were set to have a constant area of 1,000 ft^2. In the PCSWMM models, storage nodes defined the wells, and outlet PCSWMM features were used with constant discharge rating curves to mimic pump operation. The pump station has a 10% AEP design capacity meaning the pump station rating is set to equal the 10% AEP peak discharge from the network. The benefit of this configuration in the model is that it adequately captures the pump station backup induced during the 1% AEP storm event.

In the Harding Ditch analysis, one of the first steps was to update Harding Ditch with the most recent channel survey. The technique for doing this involved organizing the survey points into cross sections and snapping them to straight lines. These adjusted points were converted to 3D line features using the ArcGIS route tool and checked for consistency in review of the station/elevation tables generated from the lines. The 3D line features in ArcGIS Pro were imported into HEC-RAS using RAS-Mapper. The new cross section geometry utilized the same river alignment as the base model. Utilizing the Feature Import tool, the 3D lines were imported in with their z-component and m-component from the 3D polyline shape file. With the survey data in a HEC-RAS geometry, the survey cross sections were then merged with the 2012 HEC-RAS model cross sections.

For channel changes, new channel dimensions were driven into the 1D cross sections using the Channel Design/Modification Editor. For the design capacity changes to the South pump station, additional pumps were added with similar configurations to the 2012 HEC-RAS model pump group definition.

4.0 Measures and Alternatives

Measures were identified to address various problems observed in the existing models; these were then organized into alternative plans (alternatives). The alternatives are organized by geographic location in the study area.

North of Summit Avenue:

- Alternative 1 – Summit A (Limited Flood Risk Reduction) (Figure 11)
    - Raise low sections of Summit Avenue.
- Alternative 2 – Summit B (Maximum Flood Risk Reduction) (Figure 12)
    - Install culverts to drain undrained areas west of wetland. Add or replace existing culverts.
    - Put culverts in Summit Avenue under the Interstate 255 overpass to pass more water from west to east at that location.
    - Re-establish ditch flow.
    - Increase size of culvert into Harding Ditch and add a small 30 cubic feet per second pump station with gravity outfall.

North of State Street:

Alternative 3 – State Street A (Limited Flood Risk Reduction) (

- Figure 13)
    - Fix and replace broken or blocked storm sewer inlets.
    - Replace undersized storm sewer lines.
    - Run new storm sewer line down westbound lane of State Street. This includes picking up drainage from existing sections. Add additional lines to new pump station.
    - Add 100 cubic feet per second pump station that captures the drainage and directs it into Harding Ditch.
- Alternative 4 – State Street B (Maximum Flood Risk Reduction) (Figure 14)
    - Fix and replace broken or blocked inlets.
    - Replace undersized storm sewer lines.
    - Run new storm sewer line down westbound lane of State Street. This includes picking up drainage from existing sections. Add additional lines to new pump station.
    - Add new storm sewer lines that pick up drainage from the non-functional sewer line to the Wedgwood pump station (Kingshighway).
    - Add new storm sewer lines to drain 60th and 61st Street to the south. This includes separating storm sewer from the sanitary sewer system.
    - Add 175 cubic feet per second pump station that captures the drainage and directs it into Harding Ditch.

Piat Place Neighborhood:

- Alternative 5 – Piat A (Intermediate Flood Risk Reduction A – South Ditch) (Figure 15)
    - Fix and replace broken or blocked storm sewer inlets.
    - Replace undersized storm sewer lines.
    - Replace ditches with storm sewer line fed by area inlets.
    - New main storm sewer line south to Whispering Willow Lake down 62nd Street. Reverse line east of 62nd Street.
    - Add ditch through Frank Holten State Park (FHSP) field to channel water from Piat Place into Whispering Willow Lake. This includes culverts under roadway to lake.
- Alternative 6 – (Intermediate Flood Risk Reduction B – East Under Highway) (Figure 16)
    - Fix and replace broken or blocked storm sewer inlets.
    - Replace undersized storm sewer lines.
    - Replace ditches with storm sewer line fed by area inlets.
    - Bore main storm sewer line east under Interstate 255 that discharges to pump station.
    - Install pump station that discharges drainage into Harding Ditch. Pump station capacity of 110 cubic feet per second.
- Alternative 7 – Piat C (Maximum Flood Risk Reduction) (Figure 17)
    - Fix and replace broken or blocked storm sewer inlets.
    - Replace undersized storm sewer lines.
    - Replace ditches with storm sewer line fed by area inlets.
    - New main storm sewer line south to Whispering Willow Lake down 62nd Street. Reverse line east of 62nd Street.
    - Create wetland in FHSP field to store water from Piat Place that empties into Whispering Willow Lake. This includes culverts under roadway to lake.

Harding Ditch:

- Alternative 8 – Harding A (Limited Flood Risk Reduction) (Figure 18)
    - Dredge to deepen and widen Harding Ditch from Schoenberger Creek to south pump station.
- Alternative 9 – Harding B (Intermediate Flood Risk Reduction) (Figure 18)
    - Dredge to deepen and widen Harding Ditch from Schoenberger Creek to south pump station.
    - Add one additional pump to south pump station (131.5 cfs).
- Alternative 10 – Harding C (Maximum Flood Risk Reduction) (Figure 18)
    - Dredge to deepen and widen Harding Ditch from Schoenberger Creek to south pump station.
    - Add two additional pumps to south pump station (131.5 cfs each).

As noted next to each alternative name, Figures 11 through 20 show the alternatives. In the figures, the conduits and storm inlets are color coded. For the junctions, storm inlets are black, and manholes are yellow. For the conduits, blue signifies lines sizes to be increased, red lines remain unchanged, purple are new arch type conduits, green are new or existing ditches, and yellow lines are conduits to be cleaned out. Note that some of the lines that have their sizes increased are currently blocked. Tables located in Annex 1 detail the proposed pipe size and invert changes for the alternatives.

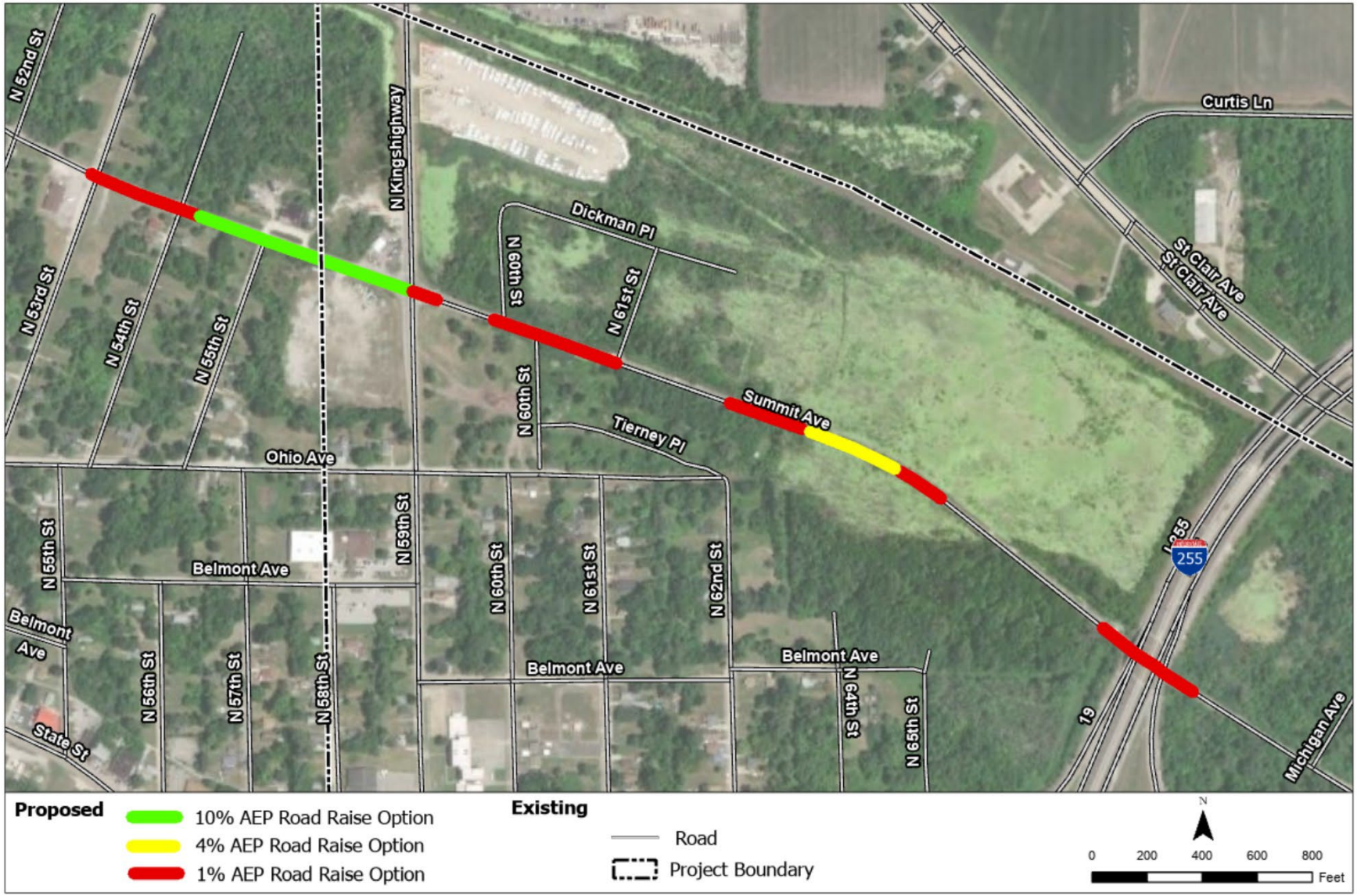

Figure 11. Alternative 1: Summit A (Limited Flood Risk Reduction)

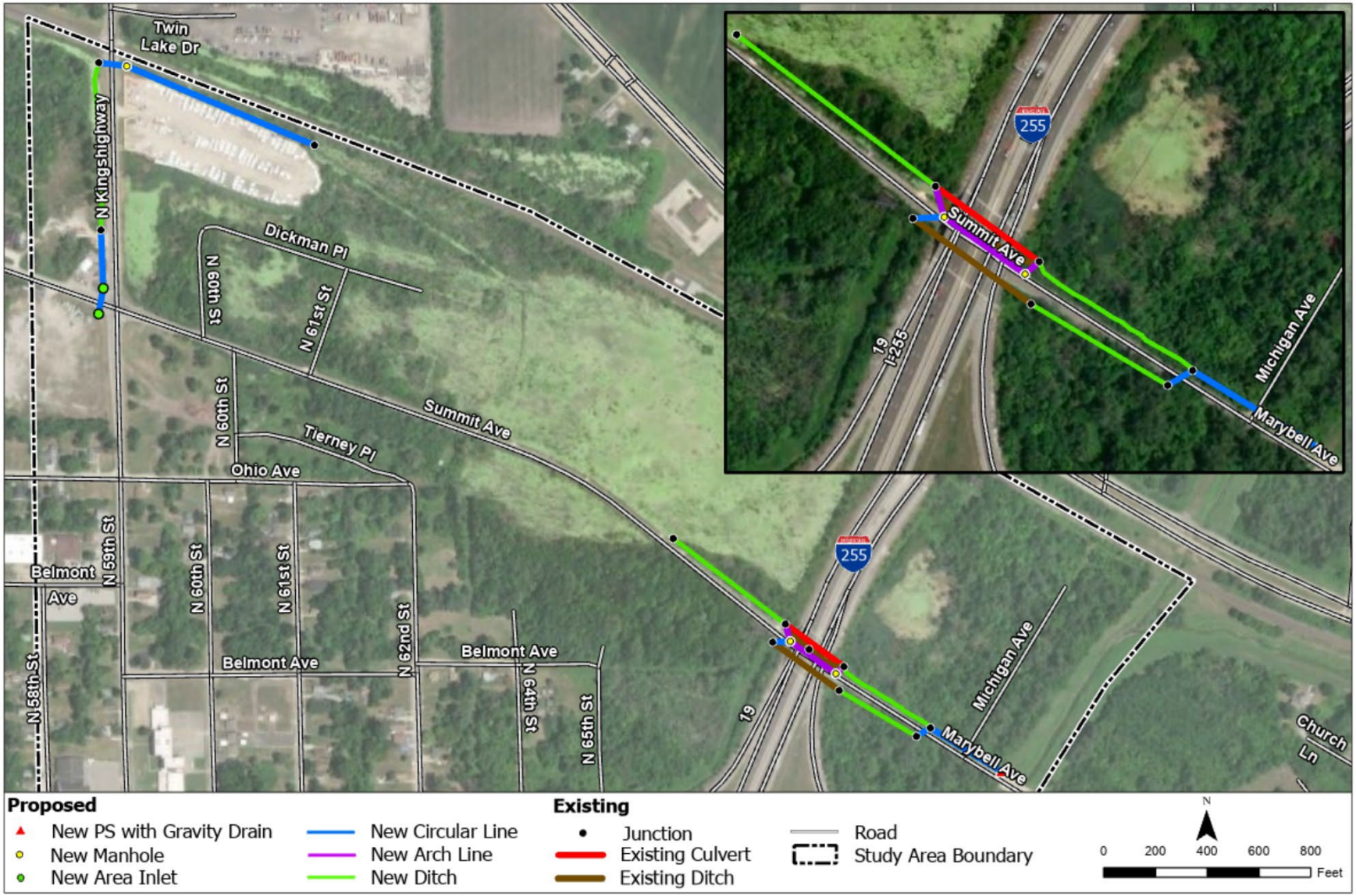

Figure 12. Alternative 2: Summit B (Maximum Flood Risk Reduction)

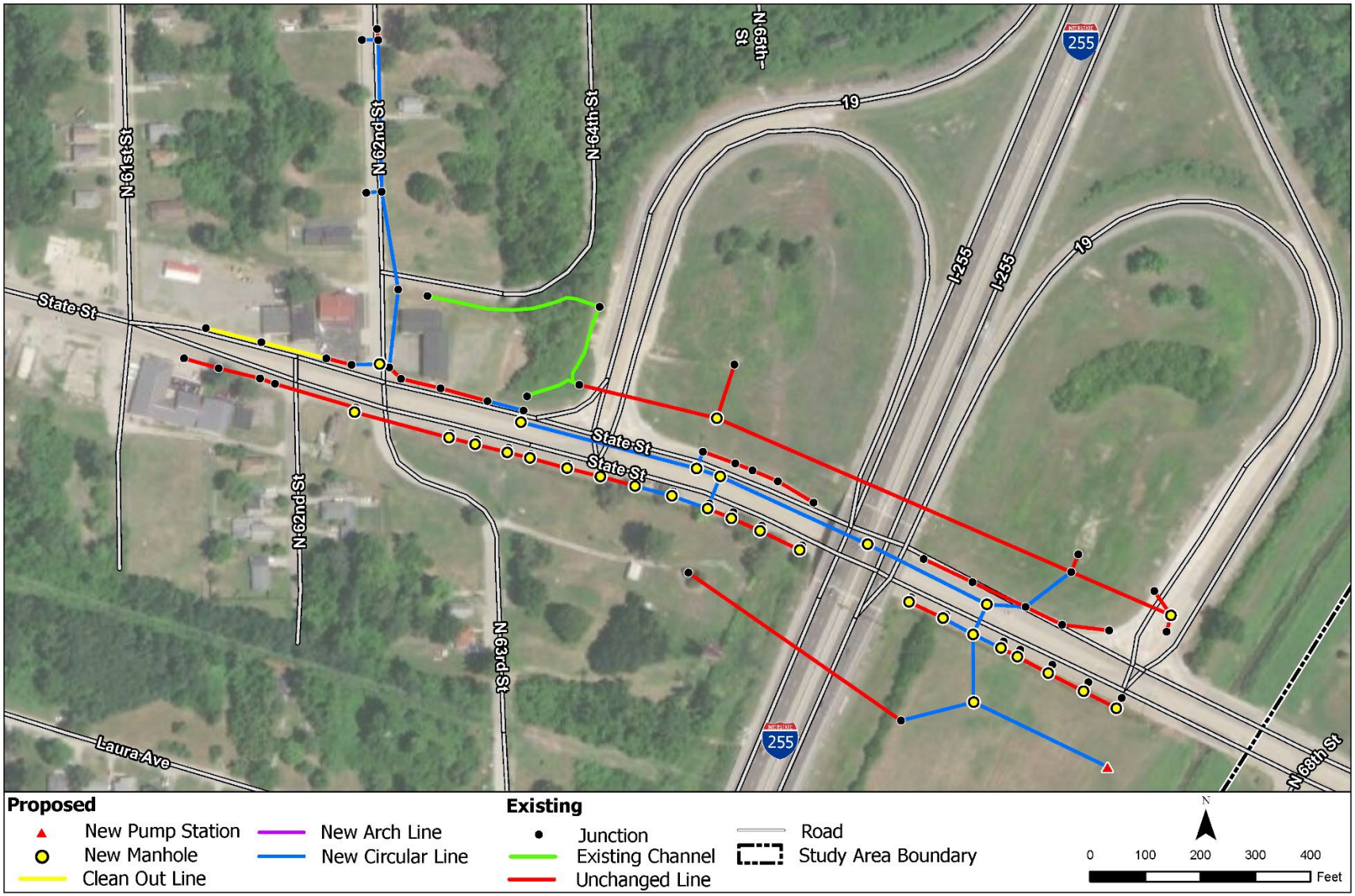

Figure 13. Alternative 3: State Street A (Limited Flood Risk Reduction)

Figure 14. Alternative 4: State Street B (Maximum Flood Risk Reduction)

Figure 15. Alternative 5: Piat A (Intermediate Flood Risk Reduction A – South Ditch)

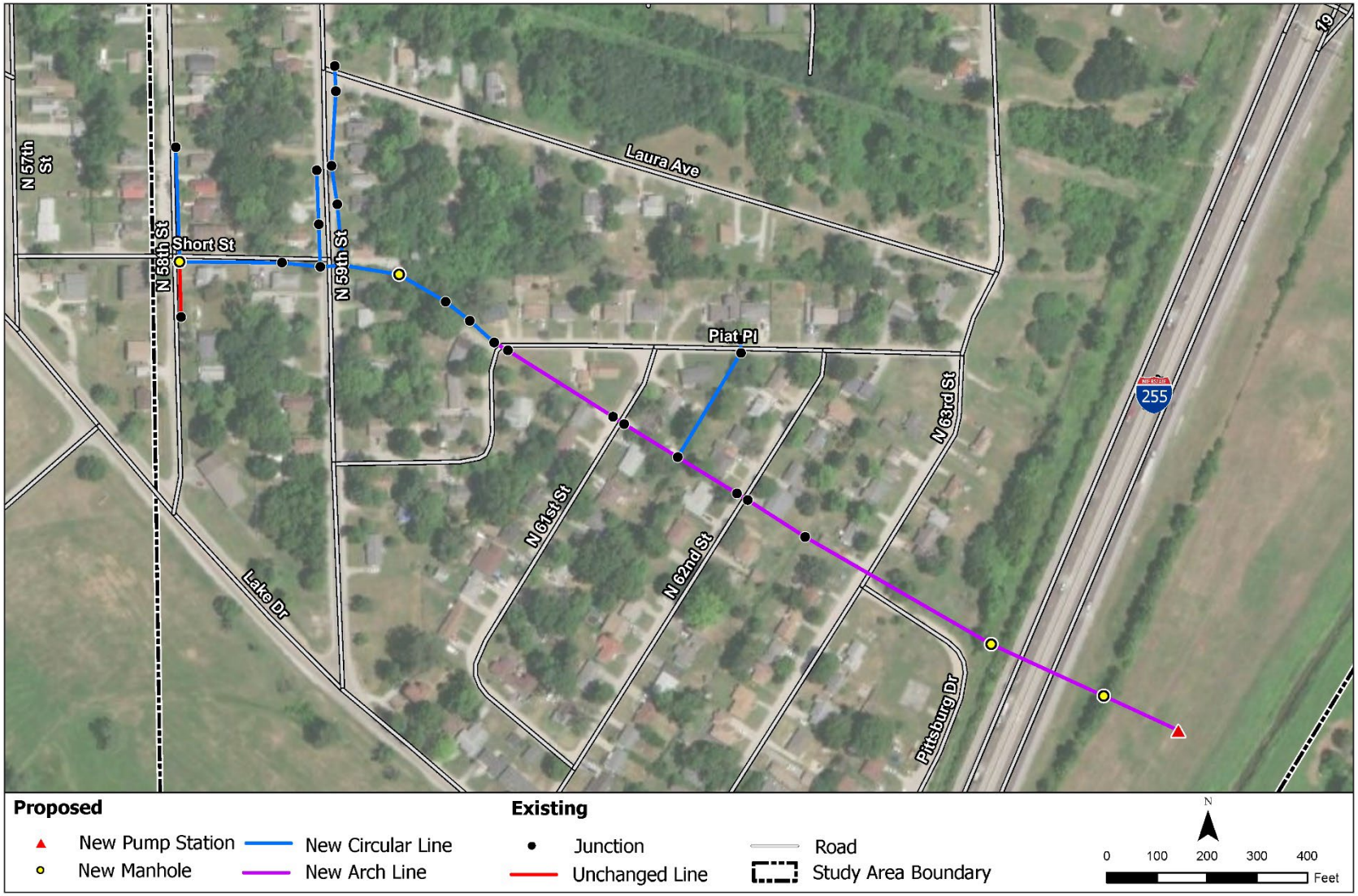

Figure 16. Alternative 6: Piat B (Intermediate Flood Risk Reduction B – East Under Highway)

Figure 17. Alternative 7: Piat C (Maximum Flood Risk Reduction)

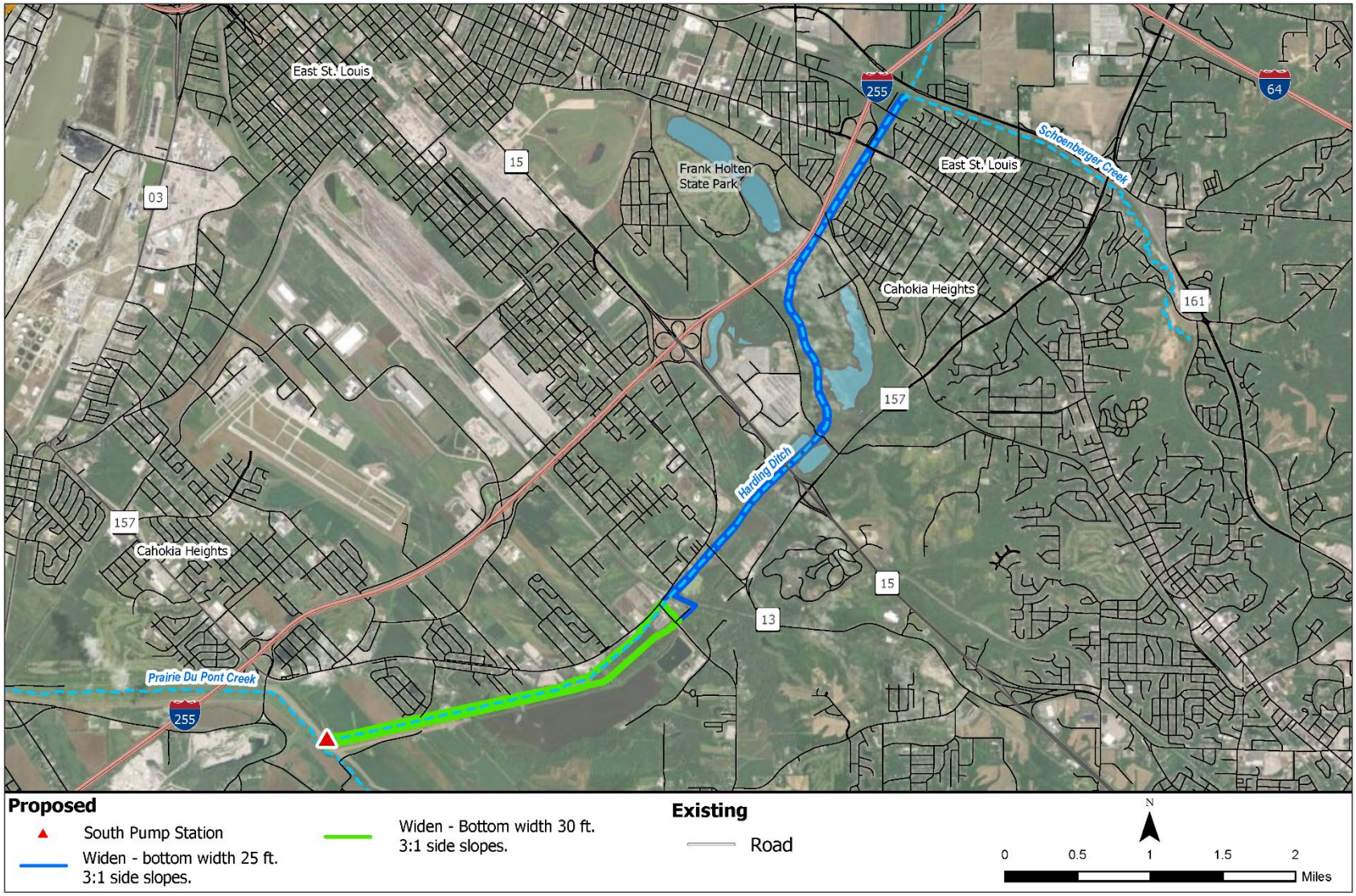

Figure 18. Alternative 8: Harding A (Limited Flood Risk Reduction), Harding B (Intermediate Flood Risk Reduction), and Harding C (Maximum Flood Risk Reduction)

4.1 Analysis of Piat Place Portion of Study Area

To analyze the alternatives discussed in Section 4.0, the models were manipulated to represent the future changes. The manner in which the changes were made is discussed in Section 3.5. The focus of the model results is shown in terms of simulated water surface level and resulting inundation.

4.1.1 Existing Condition Inundation

Illustrations showing the 10%, 4%, and 1% AEP storm event inundation for existing conditions are shown in Figures 19 through 24. In the illustrations, the darker the inundation color, the higher the depth of water.

As seen in the figures, flooding occurs throughout the watersheds during a 10% AEP storm event. The sewer lines surcharge at the storm inlets inundating the area around them. This indicates that the existing sewer and ditch networks are inadequate to drain the watersheds. The primary problem areas in the Piat Place portion of the study area are the north area wetland waters encroaching on Summit Avenue, drainage around the State Street/Interstate 255 interchange, and the Piat Place neighborhood flooding.

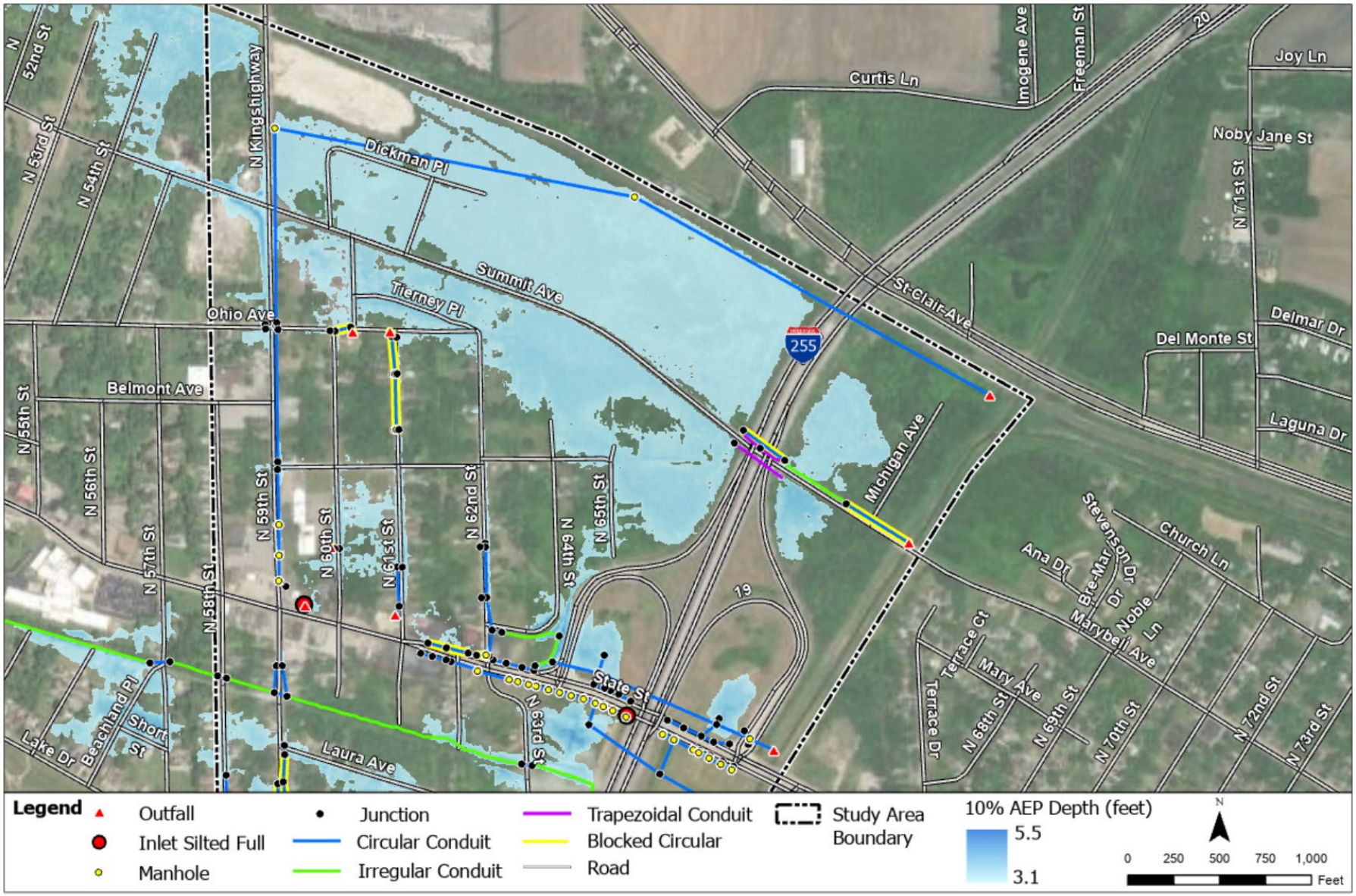

Figure 19. Piat Place Portion of Study Area Existing Conditions Inundation, North of State Street – 10% AEP storm event

Figure 20. Piat Place Portion of Study Area Existing Conditions Inundation, South of State Street – 10% AEP storm event

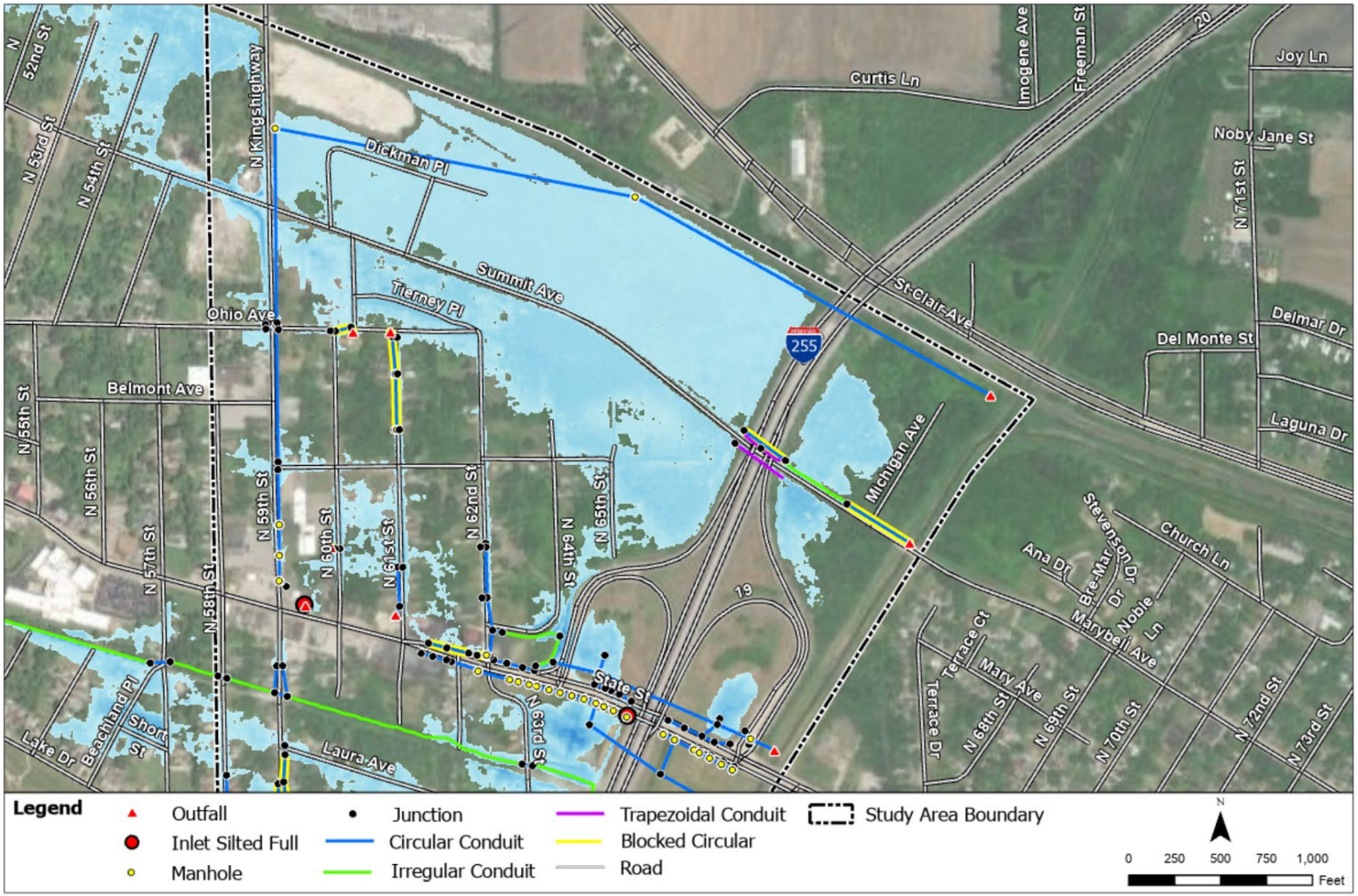

Figure 21. Piat Place Portion of Study Area Existing Conditions Inundation, North of State Street – 4% AEP storm event

Figure 22. Piat Place Portion of Study Area Existing Conditions Inundation, South of State Street – 4% AEP storm event

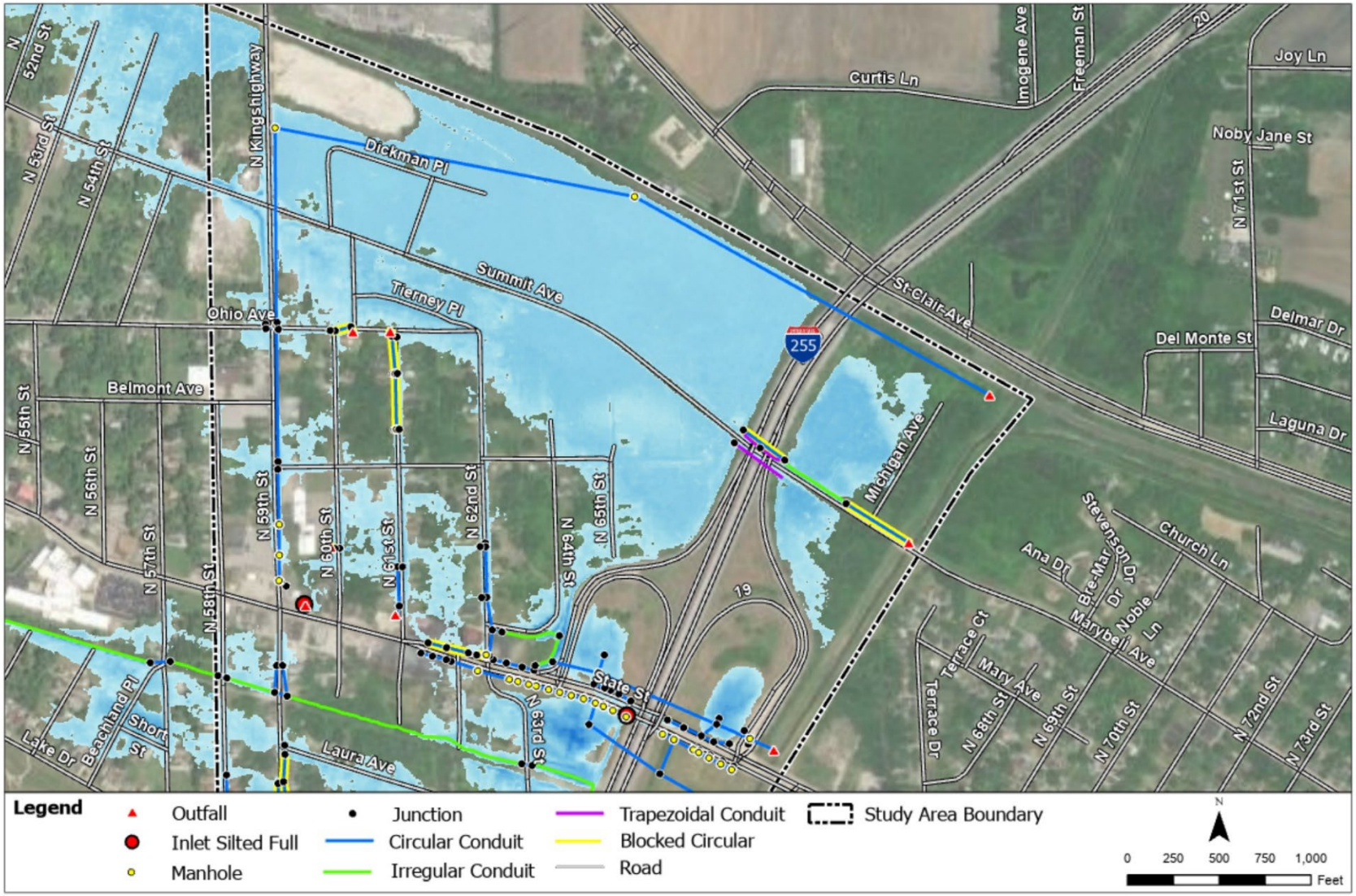

Figure 23. Piat Place Portion of Study Area Existing Conditions Inundation, North of State Street – 1% AEP event

Figure 24. Piat Place Portion of Study Area Existing Conditions Inundation, South of State Street – 1% AEP event

4.1.2 Summit Ave Alternatives Analysis

The 10% AEP storm event inundation for Alternatives 1 and 2 are shown in Figure 25 and Figure 26, respectively.

The 1% AEP storm event inundation for Alternatives 1 and 2 are shown in Figure 27 and Figure 28, respectively.

For Alternative 1, options on the degree of road raise for Summit Avenue were provided, dependent on which flood frequency water level the road is raised to. Table 4 shows the raise elevations for the various sections of road that are inundated. The computed level of raise is 0.25 feet above the actual computed water surface rounded to the nearest 0.1 feet. For the quantities and costs in this study, a road raise to the 1% AEP elevation was developed.

Table 4. Summit Avenue Road Raise Elevations

Section of Summit Ave	10% AEP Raise (Feet NAVD 88)	4% AEP Raise (Feet NAVD 88)	1% AEP Raise (Feet NAVD 88)
Under Interstate 255	-	-	413.0
Interstate 255 West to Kingshighway	-	412.7	413.0
Kingshighway to the West	413.8	413.9	414.0

For Alternative 2, measures include installing or replacing culverts around Kingshighway capturing drainage of the parcels west of Kingshighway, re-establishing ditches at the entrance and exit of the wetland between Kingshighway and Interstate 255, installing a culvert/storm sewer under the Interstate 255, and adding a 30 cubic feet per second pump station with gravity outfall at the Harding Ditch wetland drain point. The reduction in water surface levels in the wetland area between Interstate 255 and Kingshighway is approximately 0.2 feet for the 10% AEP storm event and 0.5 feet for the 1% AEP storm event. Also, roadway flooding at Summit Avenue and Kingshighway is eliminated.

When stages are high in Harding Ditch, the north wetland area is unable to drain. To mitigate this, Alternative 2 includes a pump station at the culvert that drains the north wetland into Harding Ditch. Without it, there is no reduction in water level during the frequency storm events. The degree of reduction is determined by the capacity of the pump station. A sensitivity analysis would yield the optimum capacity for a target water surface level reduction. For Alternative 2, the goal was to alleviate the roadway flooding during the 10% AEP storm event.

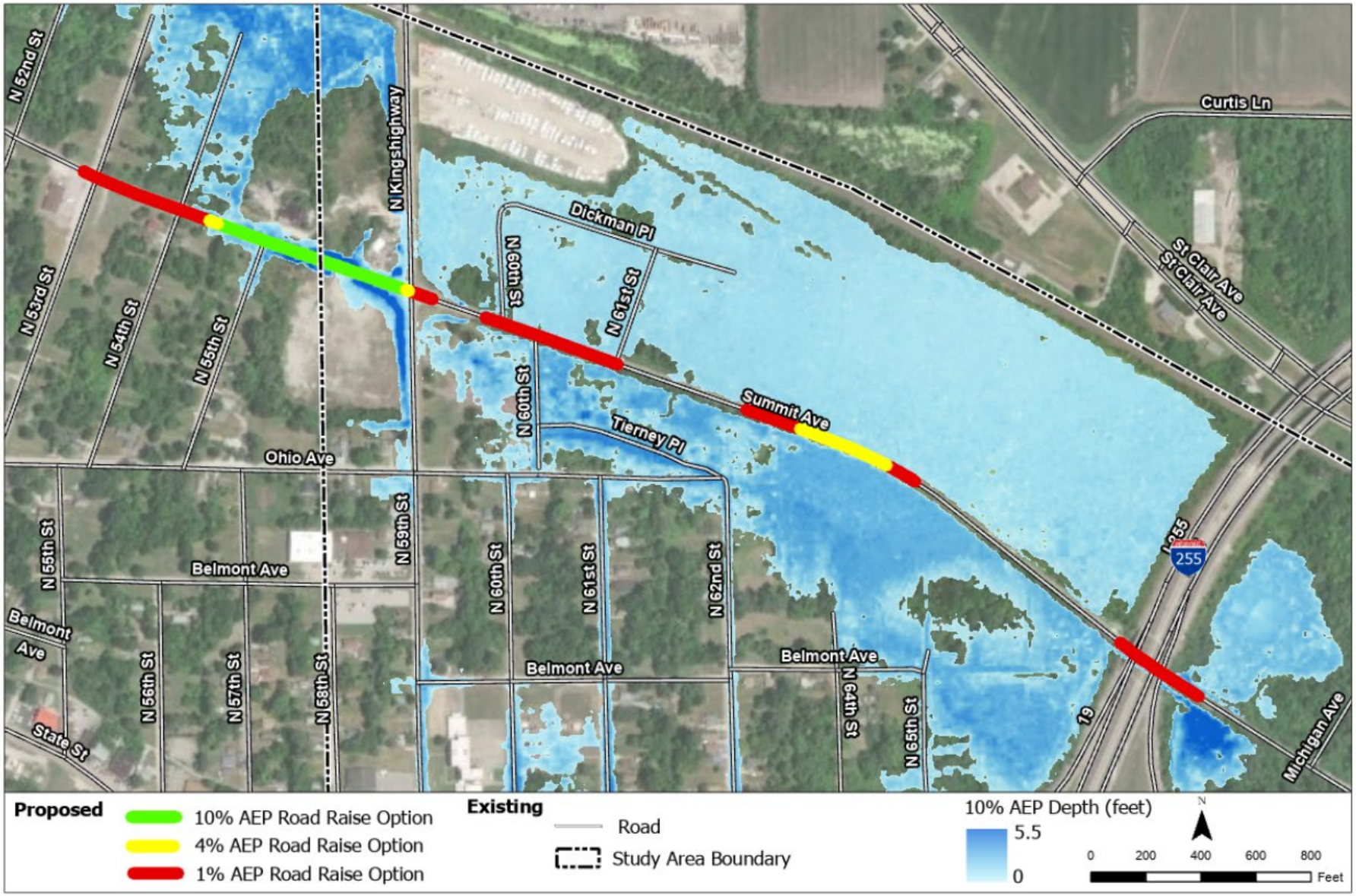

Figure 25. Alternative 1: Summit A (Limited Flood Risk Reduction) – Road Raise, 10% AEP event

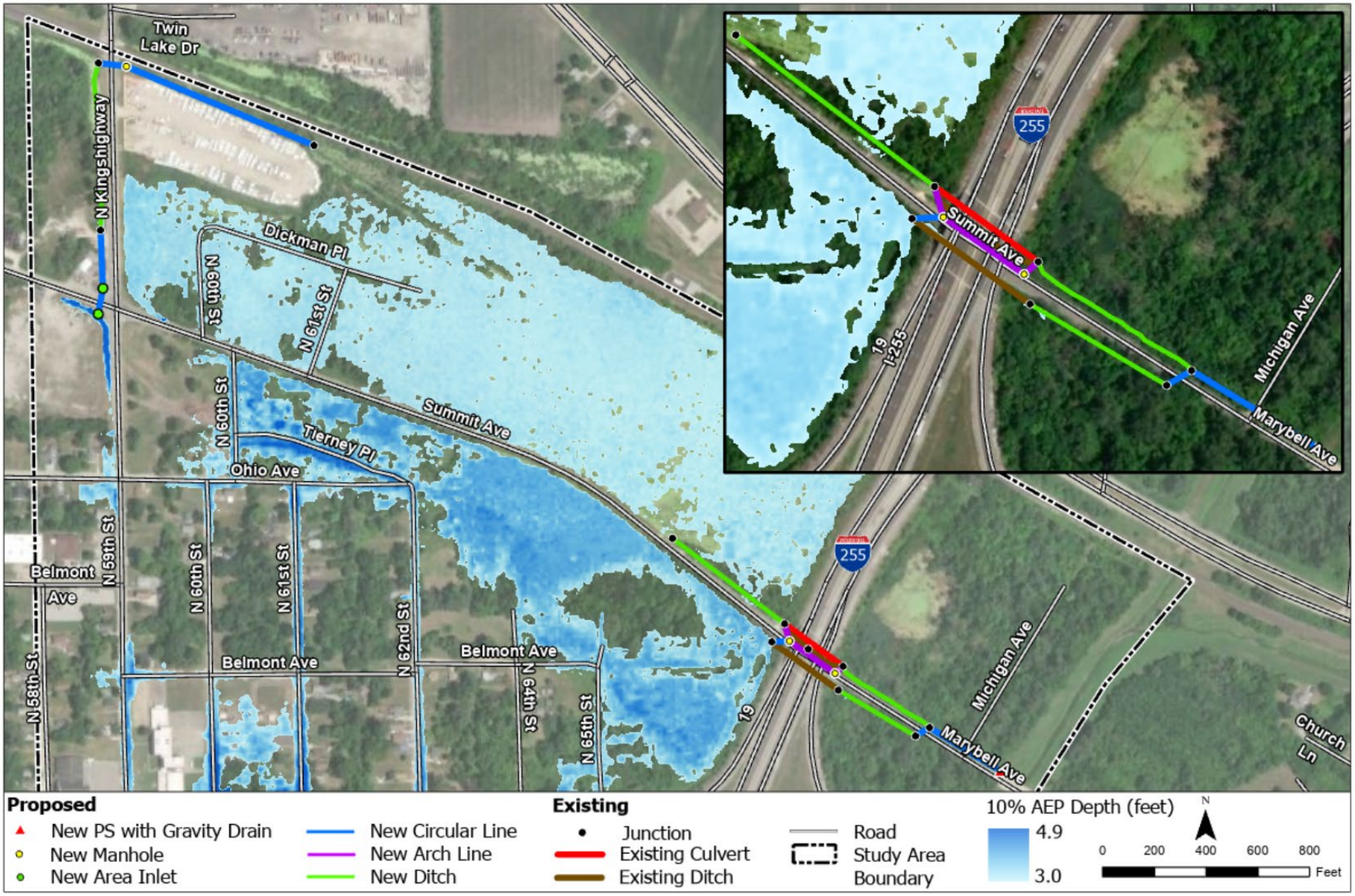

Figure 26. Alternative 2: Summit B (Maximum Flood Risk Reduction) – Wetland Drainage Improvements, 10% AEP event

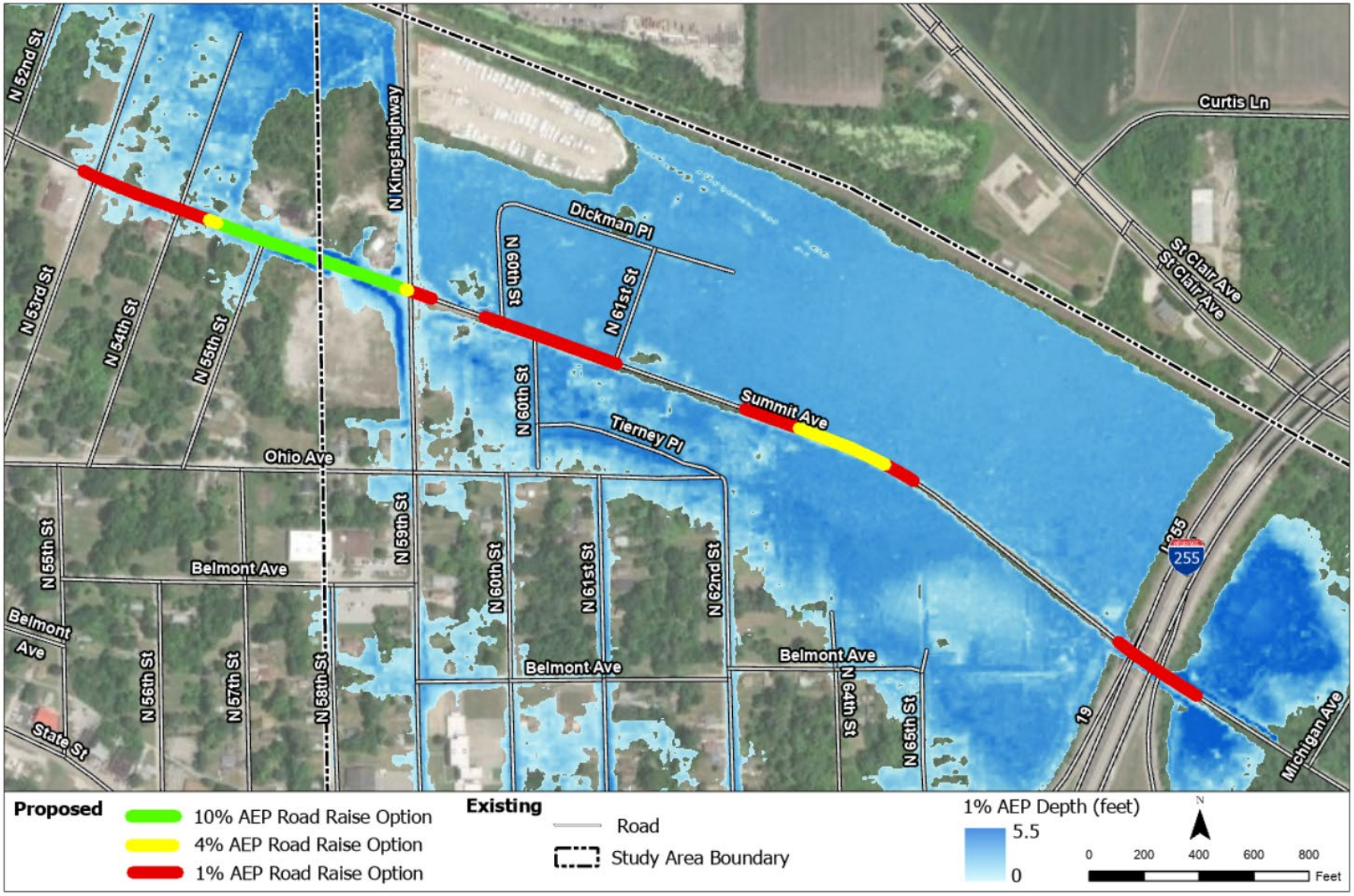

Figure 27. Alternative 1: Summit A (Limited Flood Risk Reduction) – Road Raise, 1% AEP event

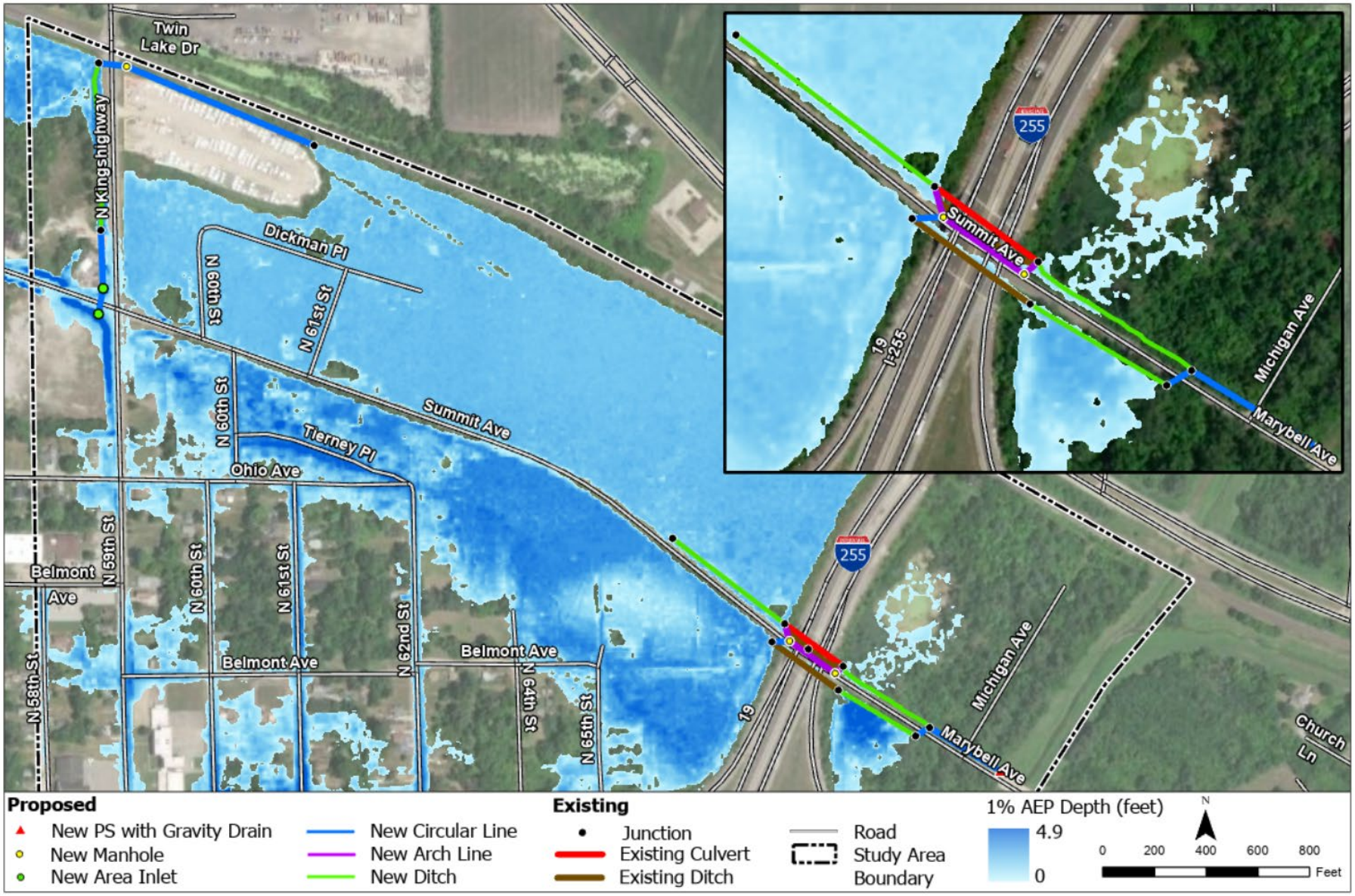

Figure 28. Alternative 2: Summit B (Maximum Flood Risk Reduction) – Wetland Drainage Improvements, 1% AEP event

4.1.3 State Street Alternatives Analysis

The 10% AEP storm event inundation for Alternatives 3 and 4 are shown in Figure 29 and Figure 30, respectively.

The 1% AEP storm event inundation for Alternatives 3 and 4 are shown in Figure 31 and Figure 32, respectively.

Alternative 3 focuses on improving drainage through the Interstate 255 and State Street interchange only. Items addressed are repairing broken and blocked inlets, replacing undersized lines, adding an additional main line down State Street, and adding a 100 cubic feet per second pump station that transfers water into Harding Ditch. For Alternative 3, the PCSWMM model shows that stormwater can be mostly contained underground during the 10% AEP storm event. During the 1% AEP storm event, water remains outside of residential structures and there will be a reduction in water surface on the Interstate 255 southbound on and off-ramps of 1.3 feet.

Alternative 4 focuses on improving drainage through the Interstate 255 and State Street interchange and collecting additional drainage from lines running along Kingshighway, 60th, and 61st Streets. Some of that drainage currently goes to the sanitary sewer system or to a non-functional storm sewer line. Items addressed are repairing broken and blocked inlets, replacing undersized lines, adding an additional main line down State Street, adding drainage from the non-functional sewer line on Kingshighway, adding in sewer lines that drain 60th and 61st Street, and adding a 175 cubic feet per second pump station that transfers water into Harding Ditch. For Alternative 4, the PCSWMM model shows that stormwater can be mostly contained underground during the 10% AEP storm event. During the 1% AEP storm event, water remains outside of residential structures and there will be a reduction in water surface on the Interstate 255 southbound on and off-ramps of 1.2 feet.

For both Alternative 3 and Alternative 4, there is some residual flooding in the area south of State Street between 63rd and Interstate 255 during the 10% AEP event. It is a low-lying area that is regularly inundated and to further alleviate flooding would require replacing a conduit that goes under Interstate 255. Since the area that is impacted is mostly vacant, the alternatives allow this area to continue to flood at the 10% AEP level. However, with the proposed modifications a water level reduction 0.4 feet for Alternative 3 and 0.5 feet for Alternative 4 is expected over this area during the 10% AEP storm event.

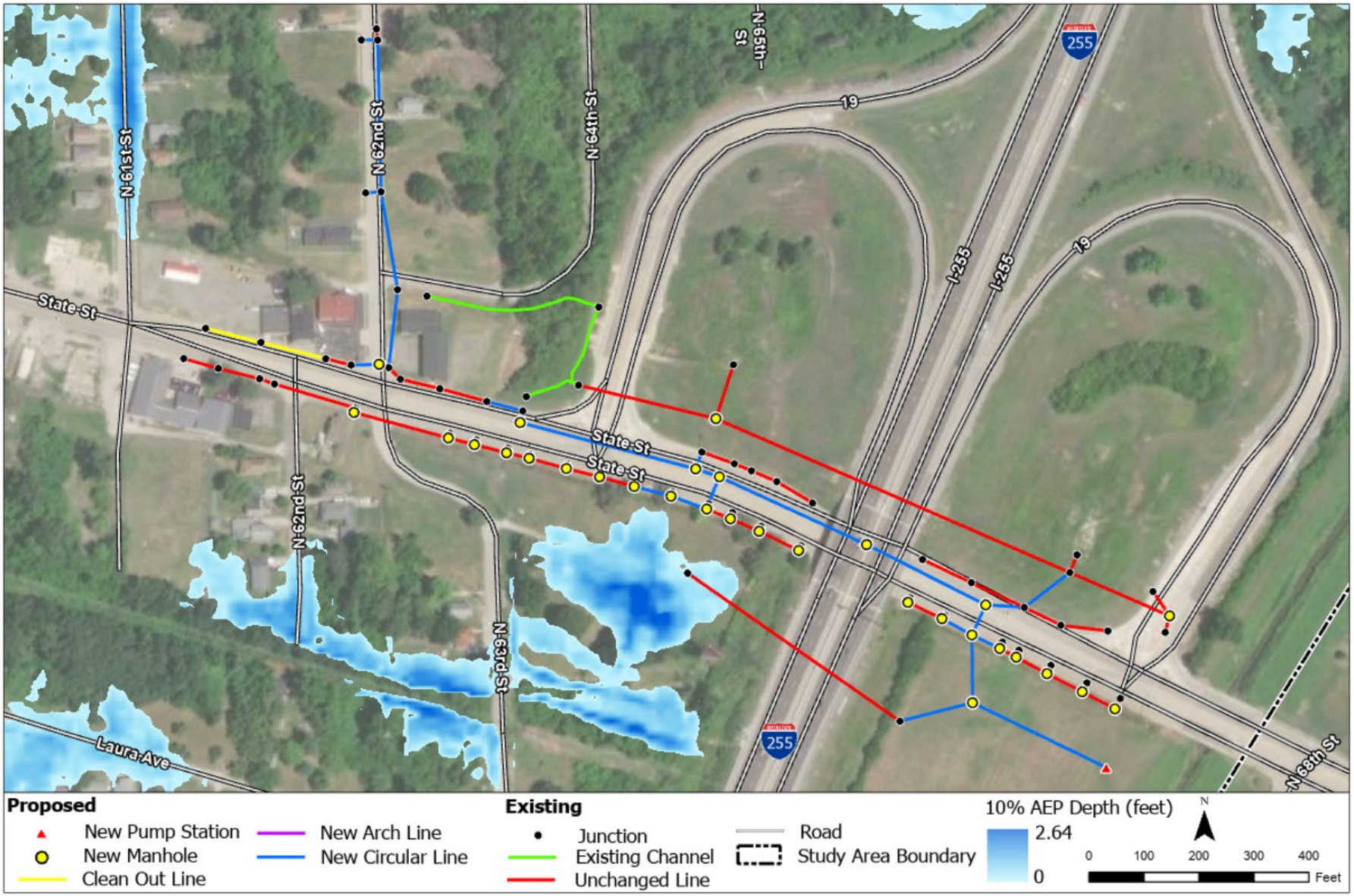

Figure 29. Alternative 3: State Street A (Limited Flood Risk Reduction) – 255 and State Street Drainage Improvements, 10% AEP event

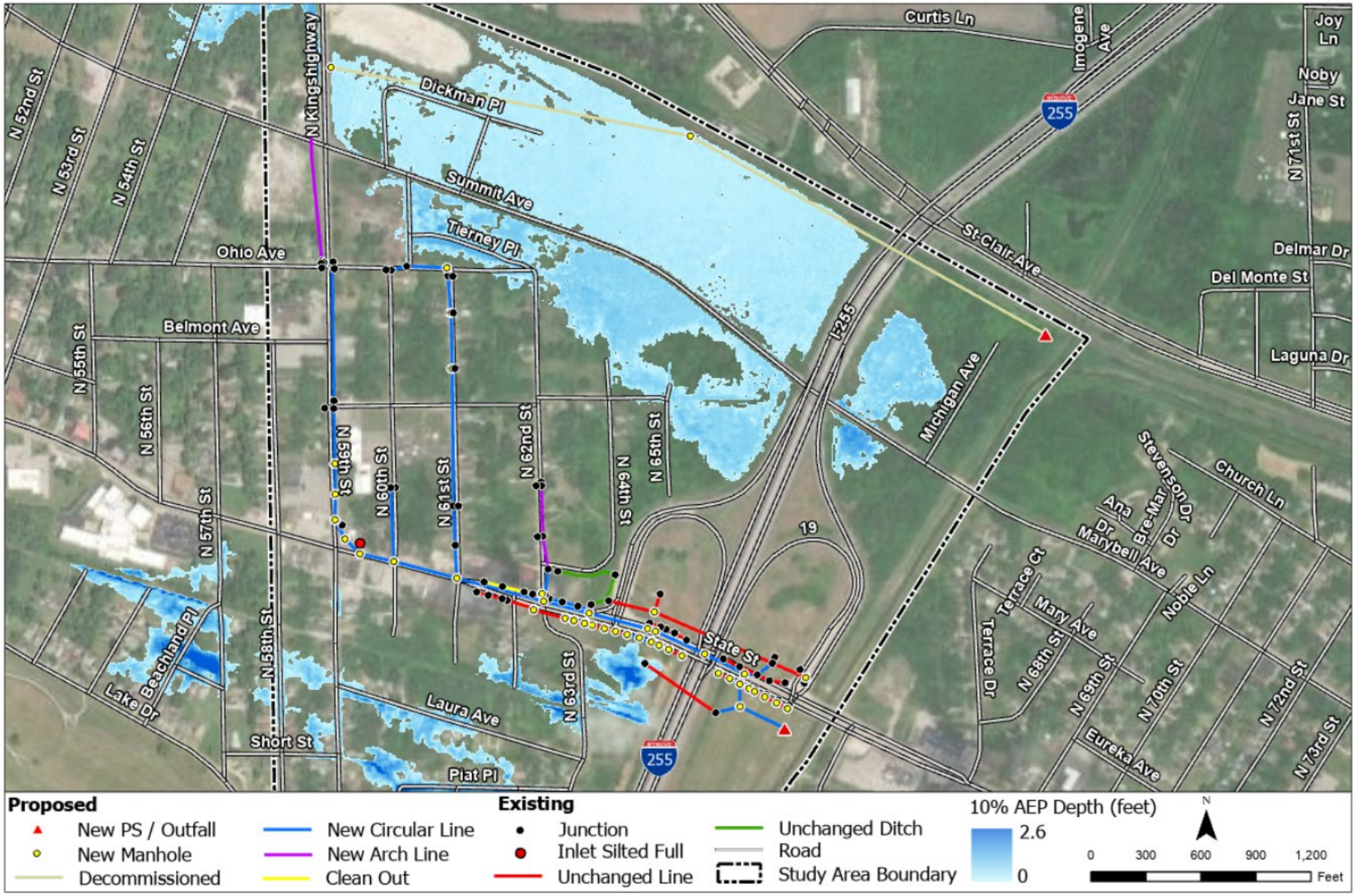

Figure 30. Alternative 4: State Street B (Maximum Flood Risk Reduction) – 255 and State Street Drainage Improvements with Additional Lines West, 10% AEP event

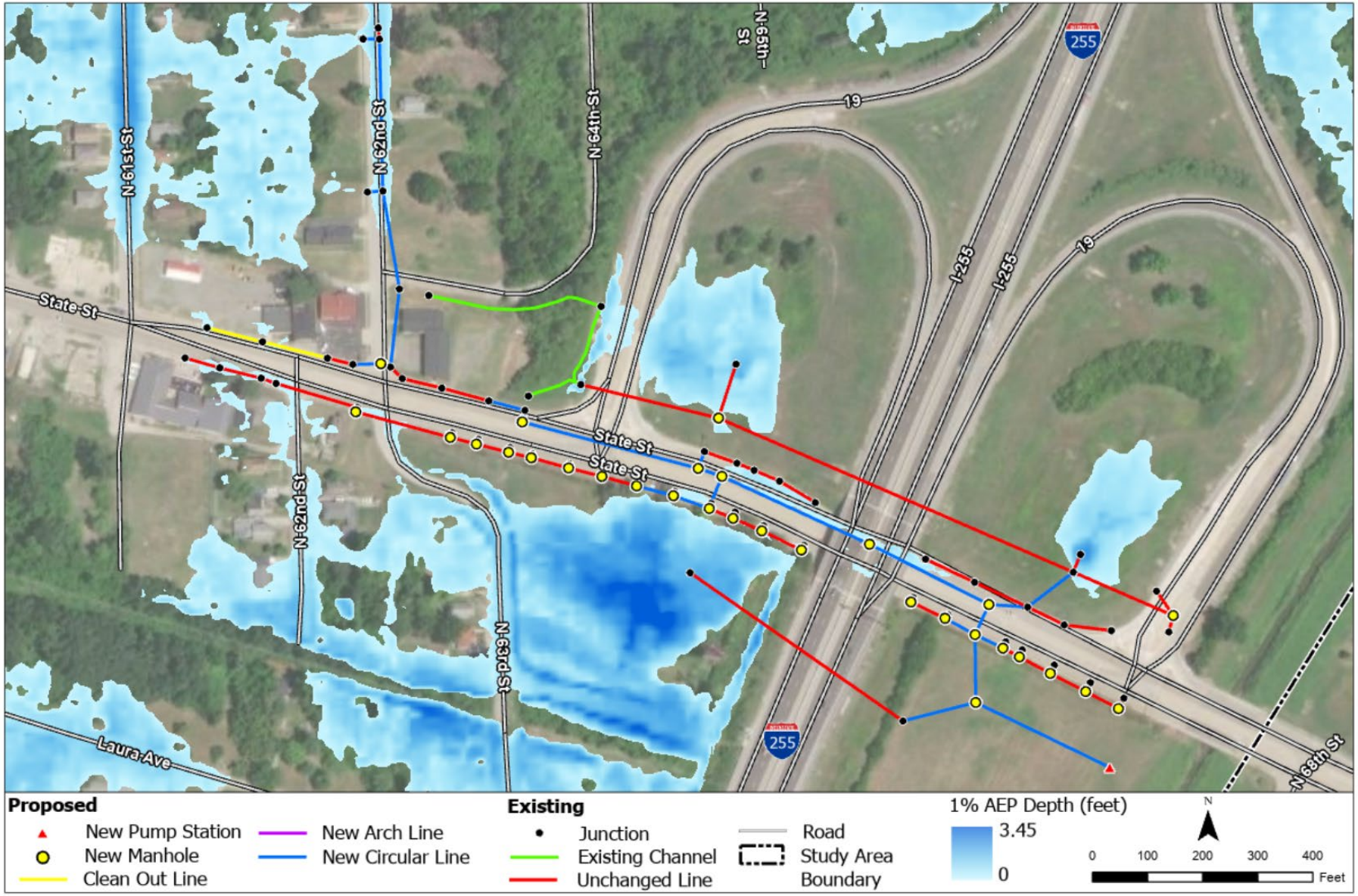

Figure 31. Alternative 3: State Street A (Limited Flood Risk Reduction) – 255 and State Street Drainage Improvements, 1% AEP event

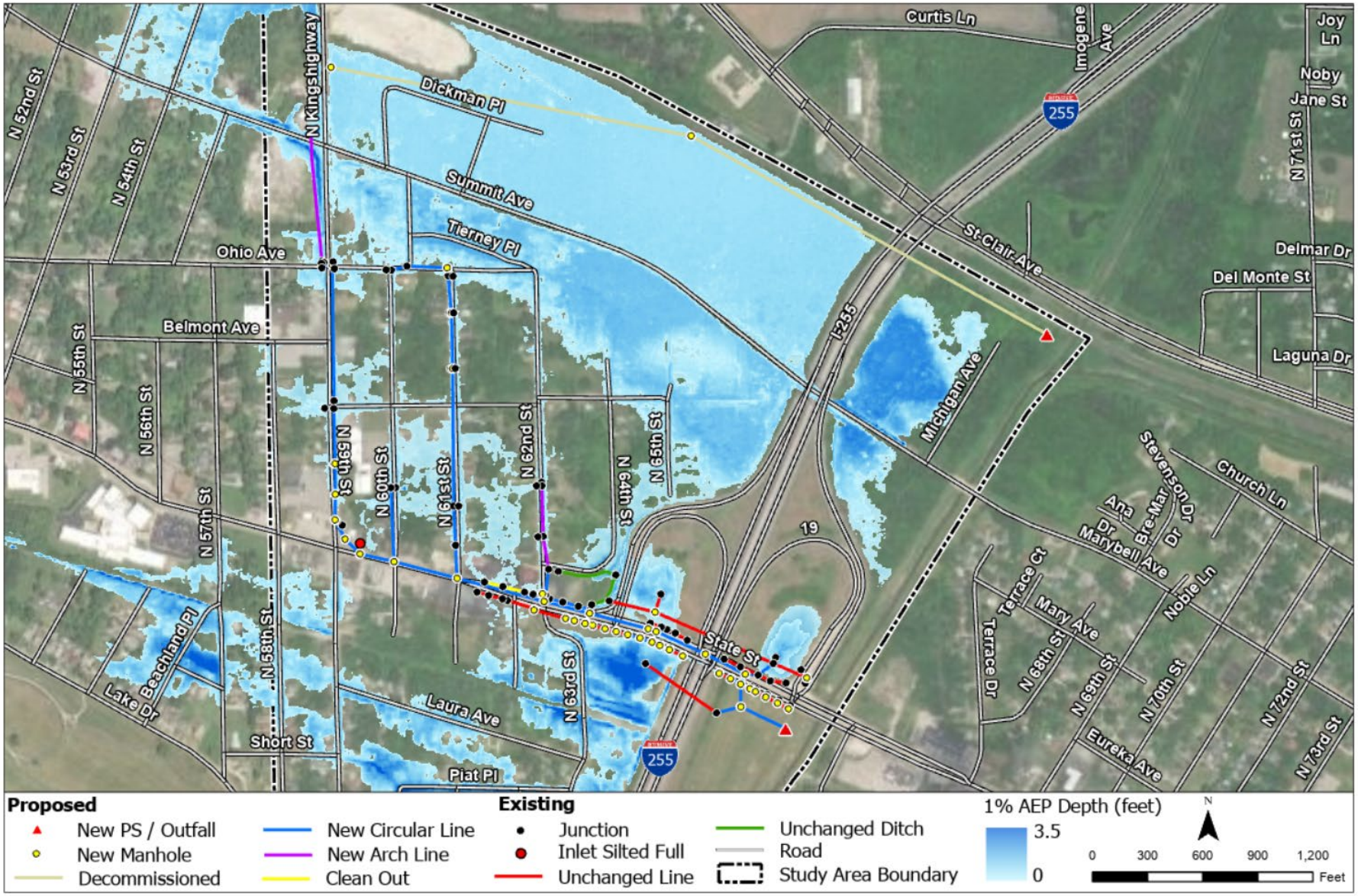

Figure 32. Alternative 4: State Street B (Maximum Flood Risk Reduction) – 255 and State Street Drainage Improvements with Additional Lines West, 1% AEP event

4.1.4 Piat Place Neighborhood Alternatives Analysis

The 10% AEP storm event inundation for Alternatives 5, 6, and 7 are shown in Figure 33, Figure 34, and Figure 355**Error! Reference source not found.**, respectively.

The 1% AEP storm event inundation for Alternatives 5, 6, and 7 are shown in Figure 36, Figure 37, and Figure 38, **Error! Reference source not found.**respectively.

Alternative 5 focuses on improving drainage by moving the water south down 62nd Street and into a new ditch in Frank Holton State Park (FHSP) that empties into Whispering Willow Lake. Items addressed are repairing broken and blocked inlets, putting ditch flow into the sewer system, replacing undersized lines, adding an additional main line down 62nd Street, and adding a ditch that channels water through FHSP into Whispering Willows Lake. For Alternative 5, the PCSWMM model shows that stormwater can be contained underground during the 10% AEP storm event. During the 1% AEP storm event, water remains outside of residential structures and in the streets. There is a general reduction in water surface of 1.3 feet on Piat Place during the 1% AEP event.

Alternative 6 focuses on improving drainage by moving the water to the east under Interstate 255 where water can be moved into Harding Ditch by pump station. Items addressed are repairing broken and blocked inlets, putting ditch flow into the sewer system, replacing undersized lines, boring a new main line under Interstate 255, and adding a 110 cubic feet per second pump station that moves the water into Harding Ditch. For Alternative 6, the PCSWMM model shows that stormwater can be contained underground during the 10% AEP storm event. During the 1% AEP storm event, water remains outside of residential structures and in the streets. There is a general reduction in water surface of 1.0 feet on Piat Place during the 1% AEP event.

Alternative 7 focuses on improving drainage by moving the water south on 62nd Street and into a new wetland area in Frank Holton State Park that empties into Whispering Willow Lake. Items addressed are repairing broken and blocked inlets, putting ditch flow into the sewer system, replacing undersized lines, adding an additional main line down 62nd Street, and adding a wetland that impounds water in FHSP before emptying into Whispering Willows Lake. For Alternative 7, the PCSWMM model shows that stormwater can be contained underground during the 10% AEP storm event. During the 1% AEP storm event, water remains outside of residential structures and in the streets. There is a general reduction in water surface of 1.5 feet on Piat Place during the 1% AEP event.

These alternatives would require arch type pipes to be installed in the Piat Place neighborhood. This is primarily in the line that transects the neighborhood. It is because the area is at a low elevation and the lines can only have slight slope in order to be able to discharge into FHSP before the lake. Circular sewer pipes cannot be used if an acceptable cover is to be preserved in these low-lying areas.

Alternatives 5 and 7 have a similar sewer system configuration in the Piat Place neighborhood. The main difference is how the water traverses FHSP. The Alternative 5 ditch has a bottom width of five feet at a depth of 4.5 feet. The Alternative 7 wetland is a two feet deep retention pond with approximately 18 acre-feet of ponded volume. It was designed with a weir-controlled drop structure emptying into two three-foot diameter culverts. A swale to the wetland outlet is recommended across the pond to control erosion during dry conditions.

There are a lot of configuration options for the Alternative 7 wetland area. It could also be configured as a dry detention basin. IDNR is supportive of this detention/retention alternative. A primary goal of IDNR is to promote outdoor recreation. Any project alternative should not increase flood impacts on IDNR property that could adversely affect the existing purpose of the park. Any project designs should be done in coordination with IDNR to take into consideration future construction projects that IDNR is considering at FHSP. Currently, additional walking trails in the proposed area of the detention basin/retention pond are in IDNRs capital projects for the site. Final wetland and ditch design should incorporate these trails that potentially surround the project. Any project designs should also consider additional beneficial uses at FHSP. For example, a larger retention pond than currently proposed could be constructed that has normal water depths that could support additional fishing and provide the same or more detention storage. Long term maintenance of the project would also be a concern, and a final design that can help reduce maintenance and costs, including extra trash or debris concerns would be desirable.

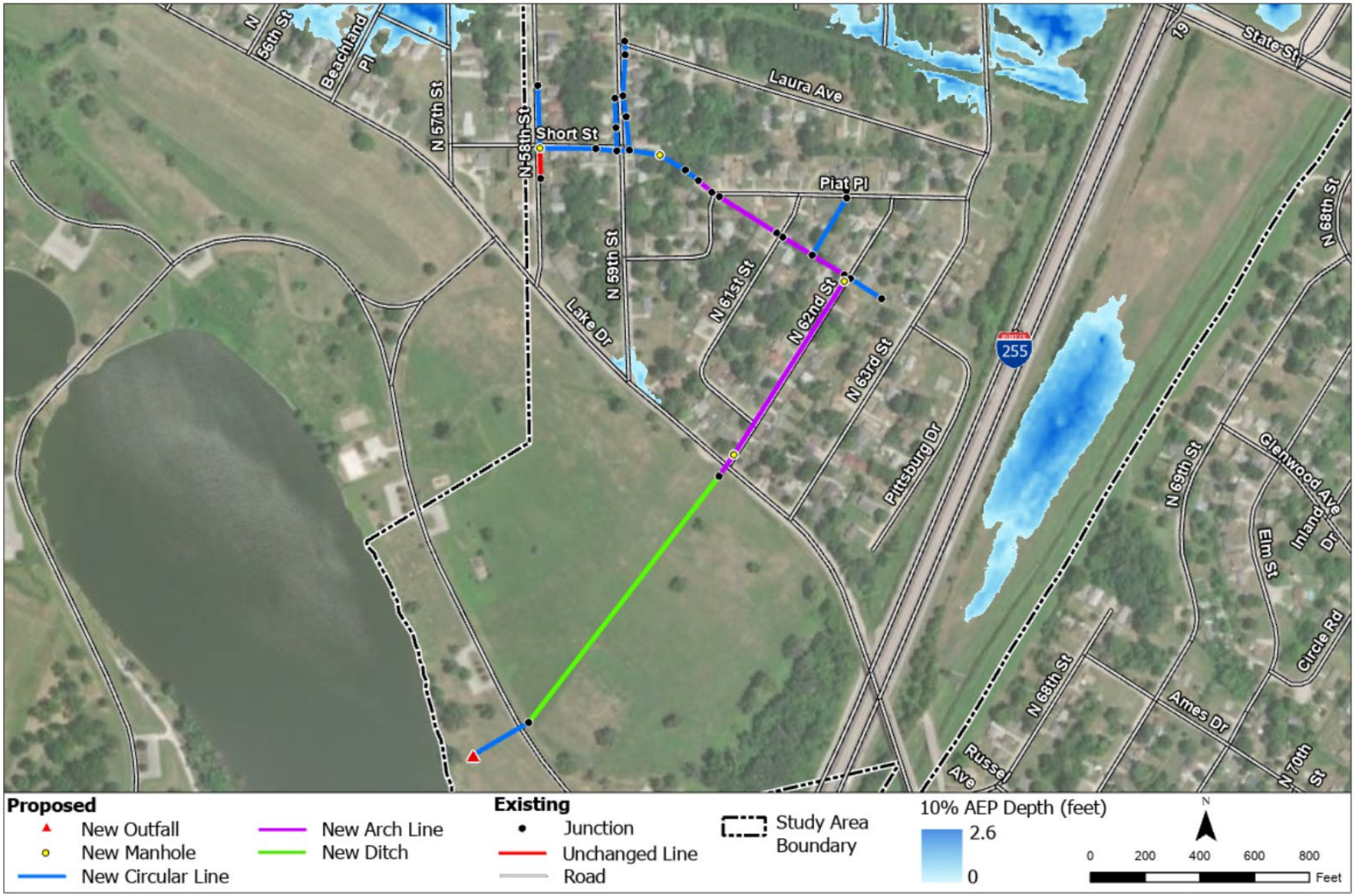

Figure 33. Alternative 5: Piat A (Intermediate Flood Risk Reduction A – South Ditch) – 10% AEP event

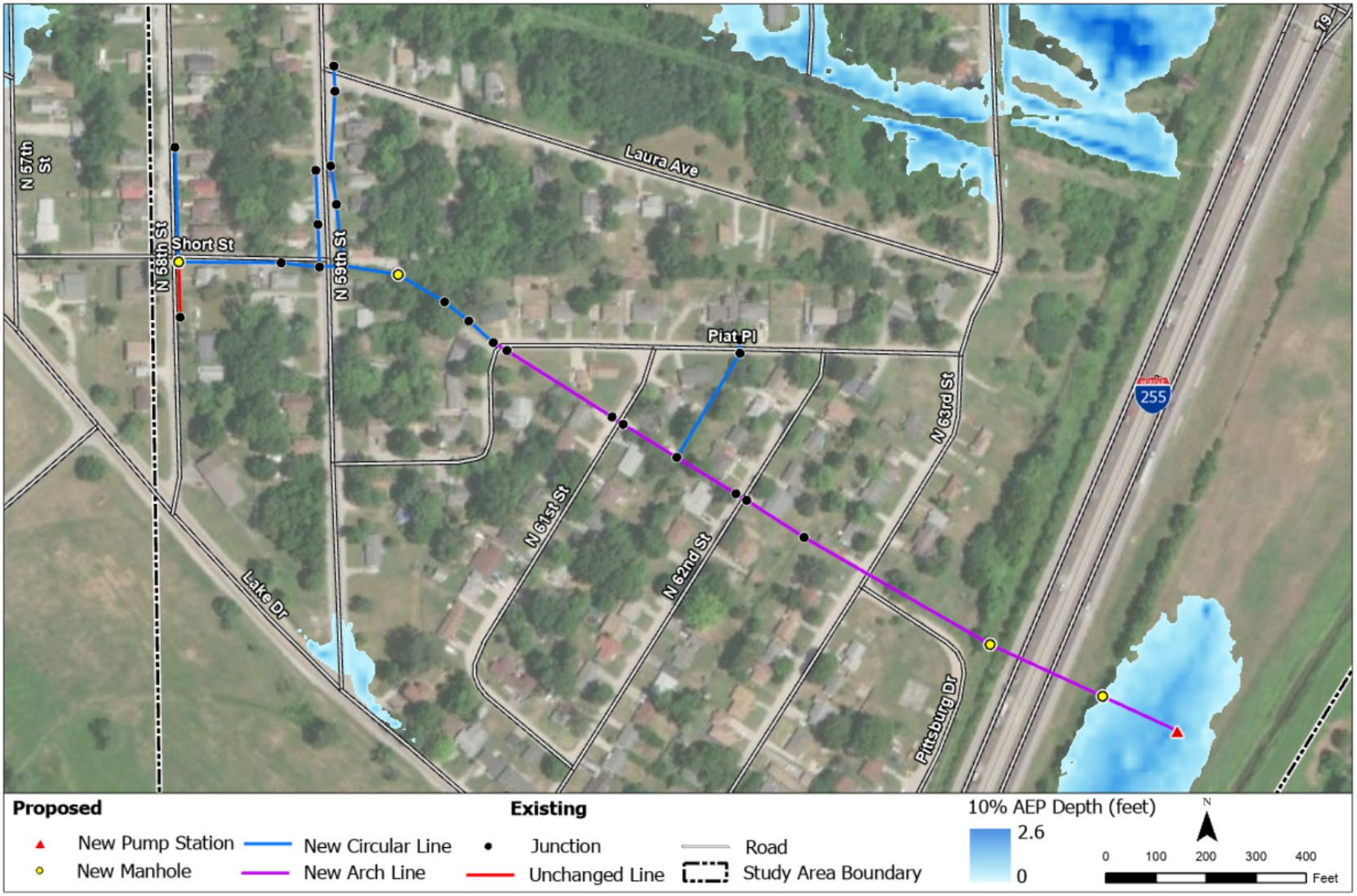

Figure 34. Alternative 6: Piat B (Intermediate Flood Risk Reduction B – East Under Highway) – 10% AEP event

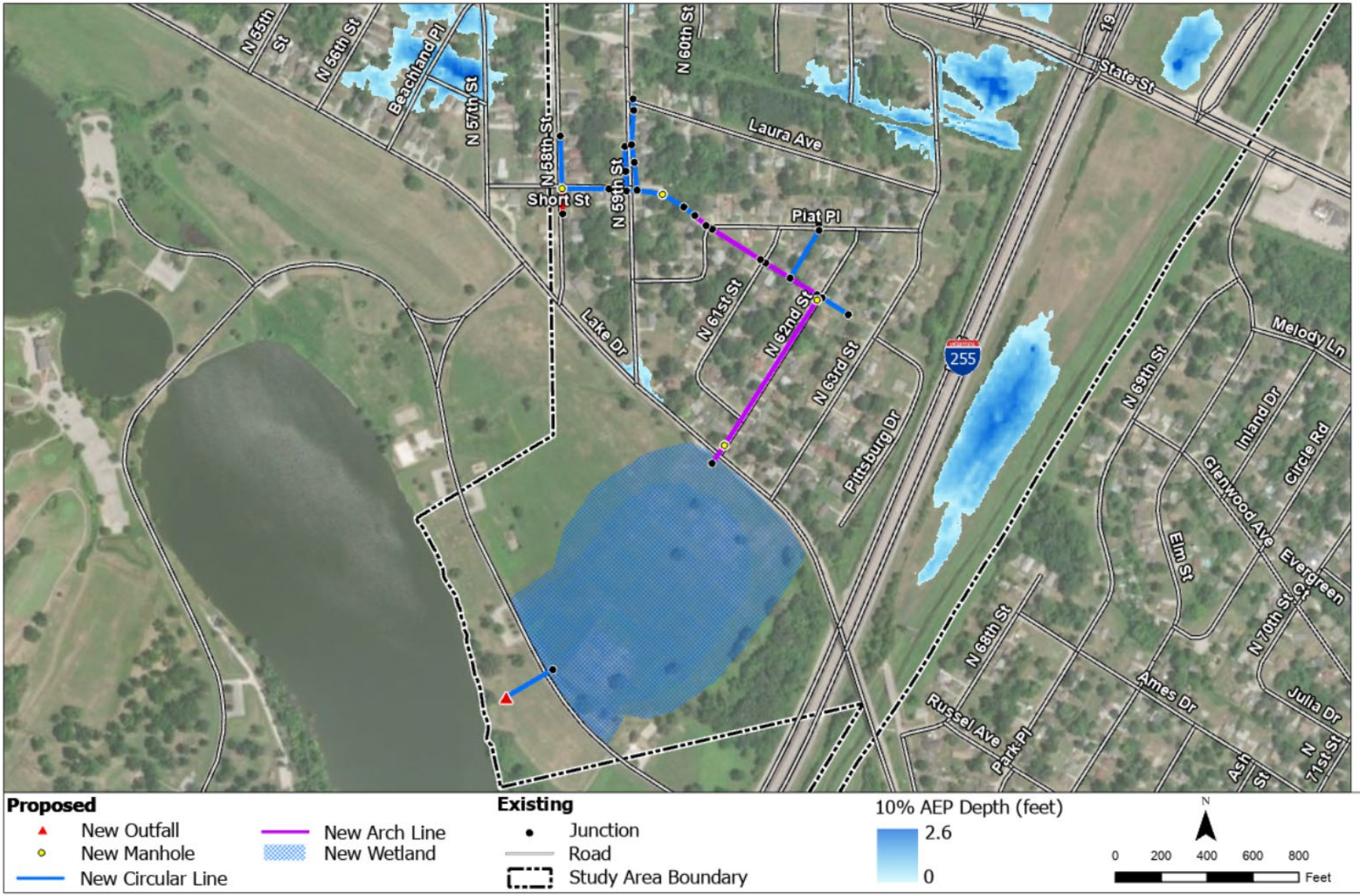

Figure 35. Alternative 7: Piat C (Maximum Flood Risk Reduction) – 10% AEP event

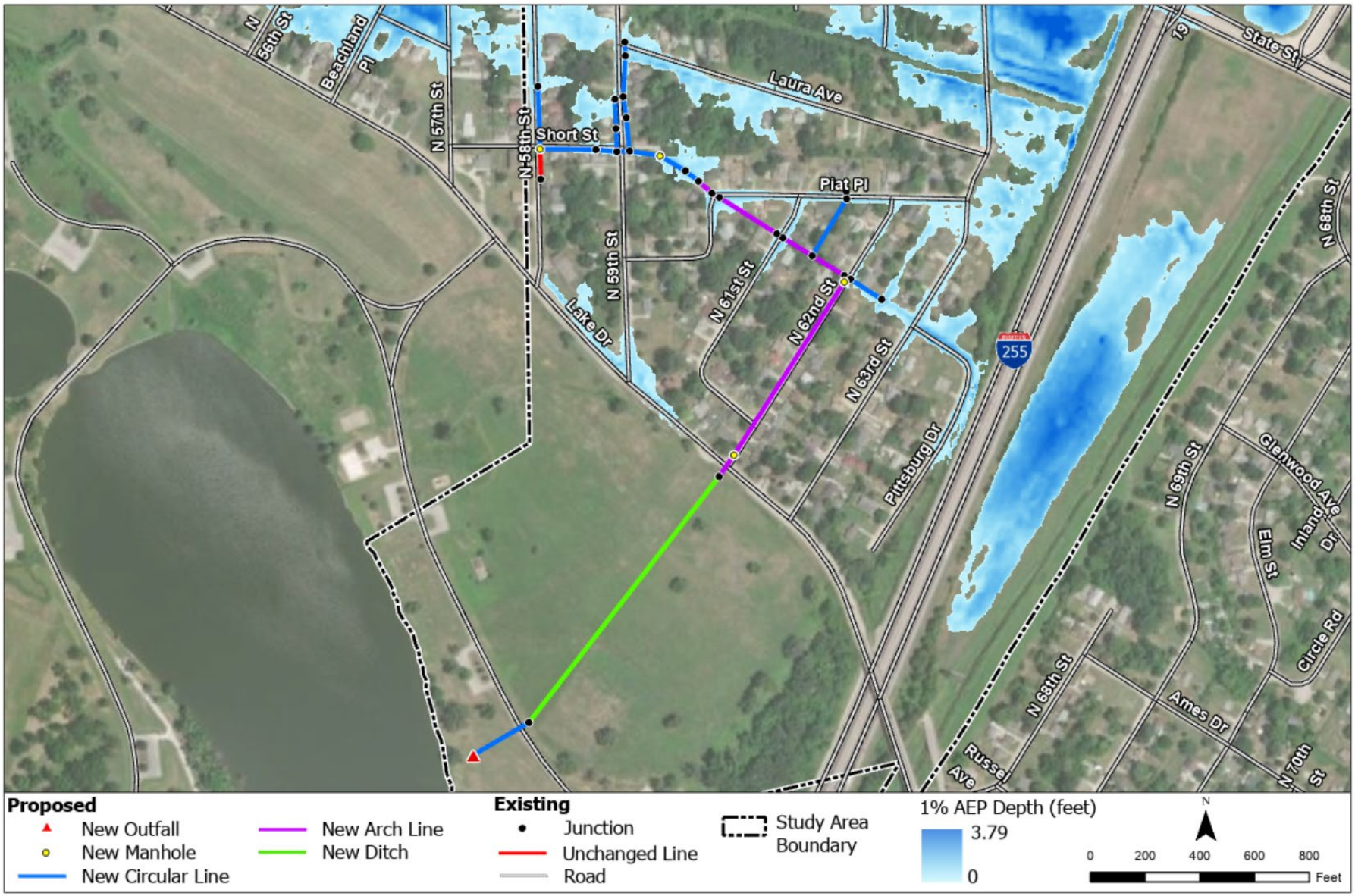

Figure 36. Alternative 5: Piat A (Intermediate Flood Risk Reduction A – South Ditch) – 1% AEP event

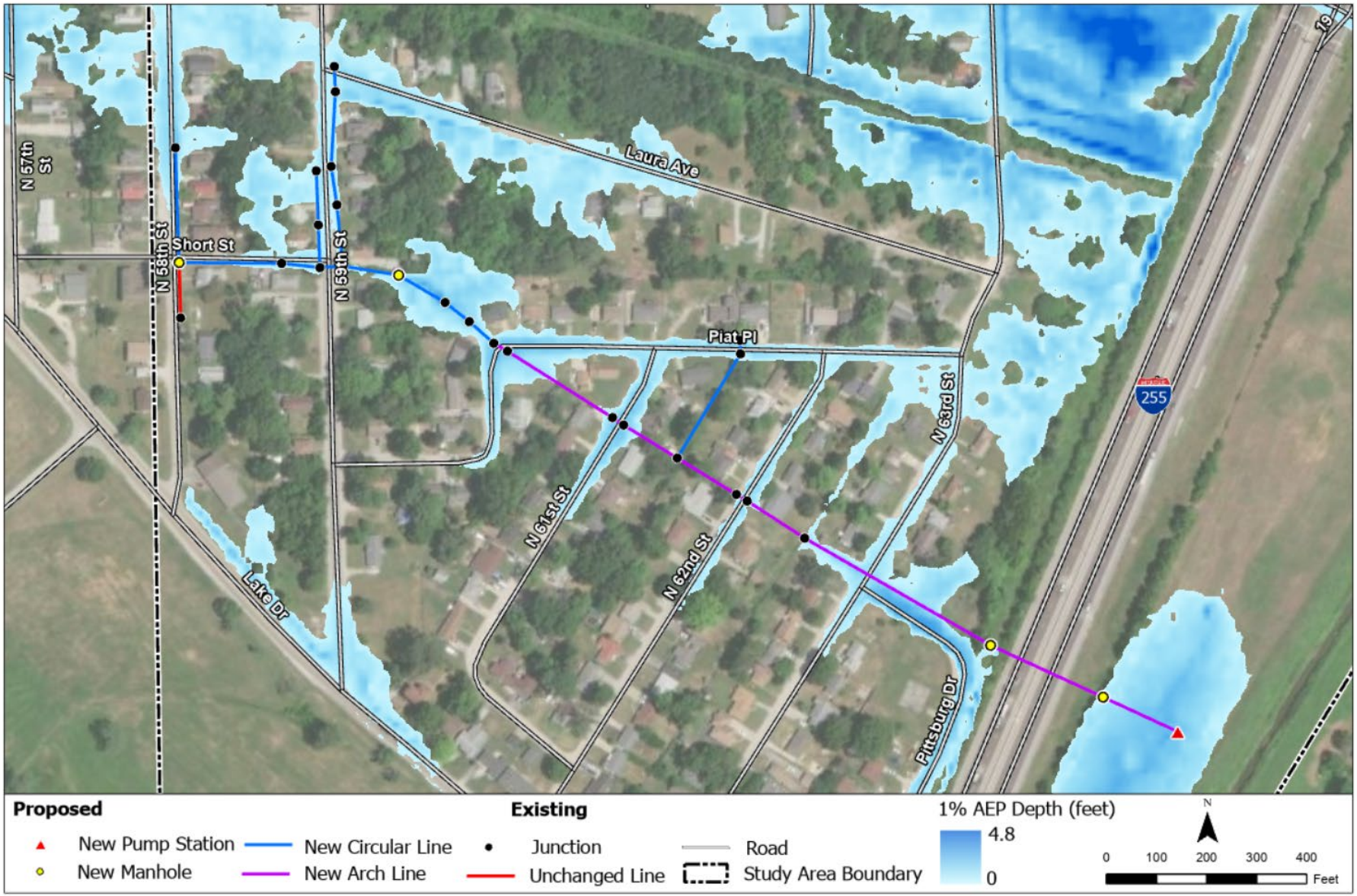

Figure 37. Alternative 6. Piat B (Intermediate Flood Risk Reduction B – East Under Highway) – 1% AEP event

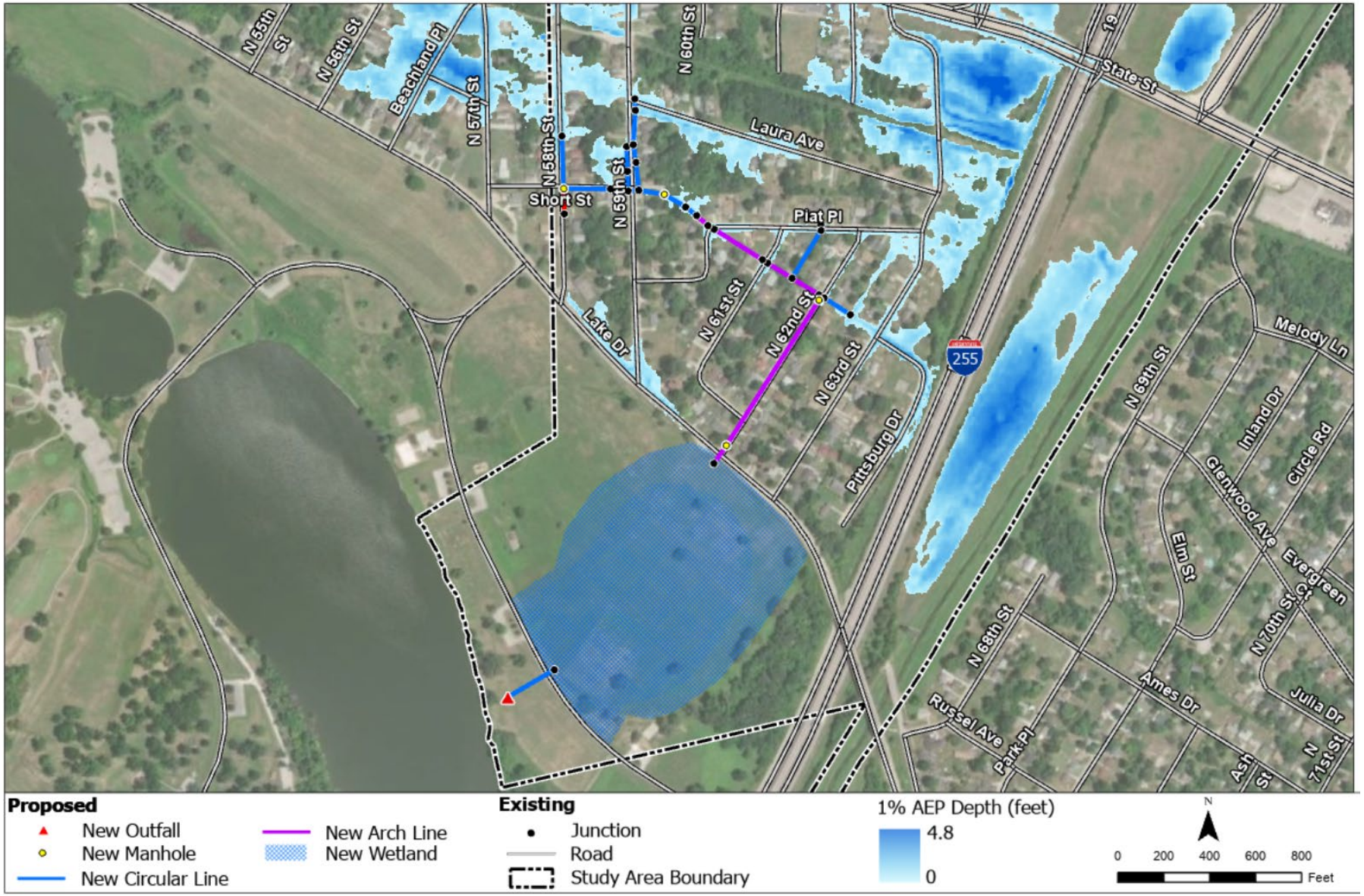

Figure 38. Alternative 7: Piat C (Maximum Flood Risk Reduction) – 1% AEP event

4.1.4.1 Piat South Impacts to Whispering Willow Lake

Impacts of bringing the drainage from the Piat Place neighborhood into Whispering Willow Lake was examined. This additional flow pertains to Alternatives 5 and 7, the Piat Place South alternatives. The magnitude and duration of flood exceedance was computed.

The proposed retention pond for Alternative 7 (wetland option) would attenuate inflow into the lake, resulting in a lower peak inflow when compared to Alternative 5. Accordingly, Alternative 7 would have less of an impact on water levels compared to Alternative 5. Therefore, Alternative 5 results are shown as a worst-case comparison, and the impacts of Alternative 7 were not analyzed.

The comparison of Whispering Willow Lake water surface levels for the existing condition and the with-additional drainage contribution for Alternative 5 are shown in Figure 39 (10% AEP) and Figure 40 (1% AEP).

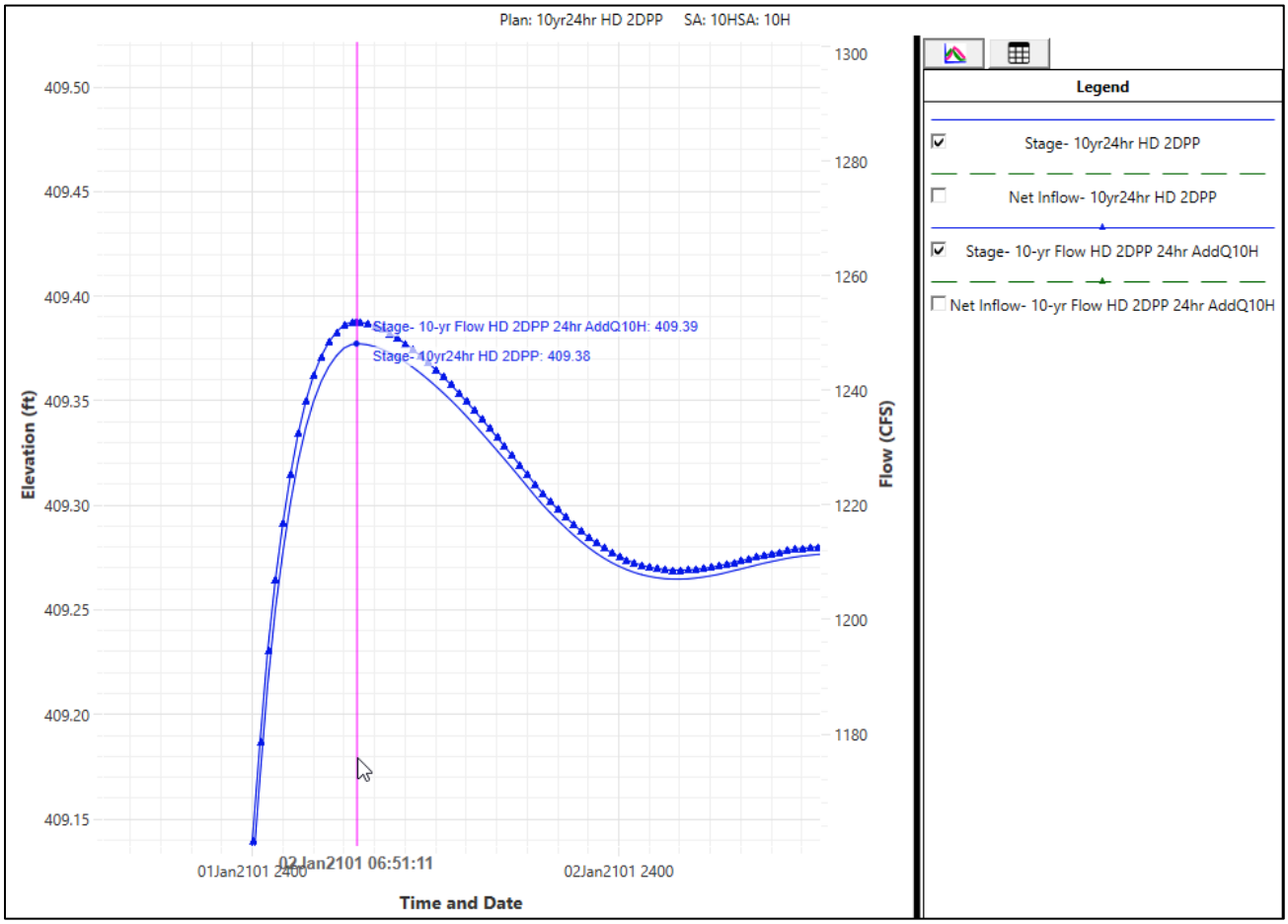

Figure 39. Whispering Willow Lake Water Surface Level Comparison of Alternative 5 and Existing Condition - 10% AEP Storm Event.

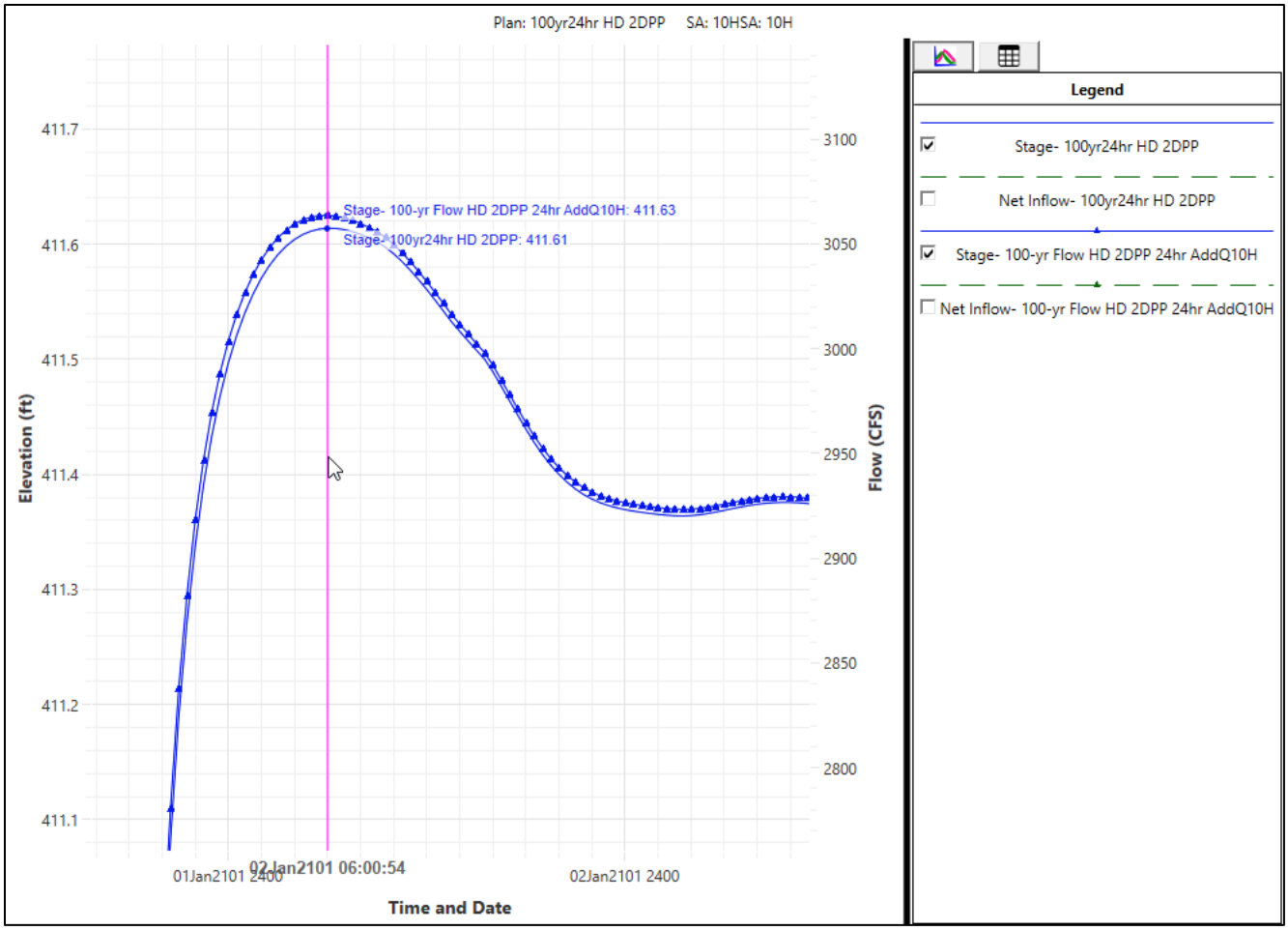

Figure 40. Whispering Willow Lake Water Surface Comparison of Alternative 5 and Existing Condition - 1% AEP Storm Event.

For a 24-hour duration storm, the Alternative 5 impact to the water surface is 0.01 feet for the 10% AEP event and 0.02 feet for the 1% AEP event. The duration of excess flooding is 18 to 20 hours for the 10% AEP event and 15 to 17 hours for the 1% AEP event. The results are tabulated in Table 5.

Table 5. 24-Hour Duration Storm Water Surface Changes at Whispering Willow Lake.

	10% AEP Storm Event		1% AEP Storm Event		10% AEP Storm Event	1% AEP Storm Event
Type	Existing	Piat South Ditch Alternative 5	Existing	Piat South Ditch Alternative 5	Difference	
Elev (ft NAVD 88)	409.38	409.39	411.61	411.63	0.01	0.02
Inflow (cfs)	1273	1290	2003	2040	17	37
Excess Duration (hours)	18-20		15-17			

The results show that there is negligible impact to Whispering Willow Lake stages from implementation of the Piat South alternatives. Therefore, the final Alternative 5 configuration includes this increased runoff volume into Whispering Willow Lake.

4.2 Analysis of Harding Ditch Portion of Study Area

To assess the degree of flooding in the region from Harding Ditch, a HEC-RAS model was created from a 2012 existing MESD system model. The Harding Ditch portion extends from Interstate 64 downstream to the south pump station. It includes the Harding Ditch overbank areas as well as interconnected lakes. These areas are mostly represented as 1D storage areas. More complex flow regions were modeled as 2D areas. These include the Canal 1 reach and the north overbank near the south pump station. More information regarding the HEC-RAS model built for this study is discussed in Section 3.3 in more detail.

To assess changes in Harding Ditch over time, new channel cross section data was gathered by USACE in 2024. These cross-sections were compared against what was in the original 2012 HEC-RAS model. The 2012 model was built with both cross sections surveyed in 2012 and from plans of the original design channel. Differences in Harding Ditch frequency water surface profiles are discussed. Also, potential measures that would reduce Harding Ditch stages are presented.

4.2.1 Existing Condition Profiles

The illustrations showing the 10% AEP and 1% AEP storm event profiles for Harding Ditch existing conditions are shown in Figure 41 and Figure 42. In the figures, both the pump-on and off profiles are shown. The effects of pump operation yield higher water surface levels at the downstream end of Harding Ditch. High Mississippi River stages do have a significant impact on Harding Ditch levels downstream of Canal 1.

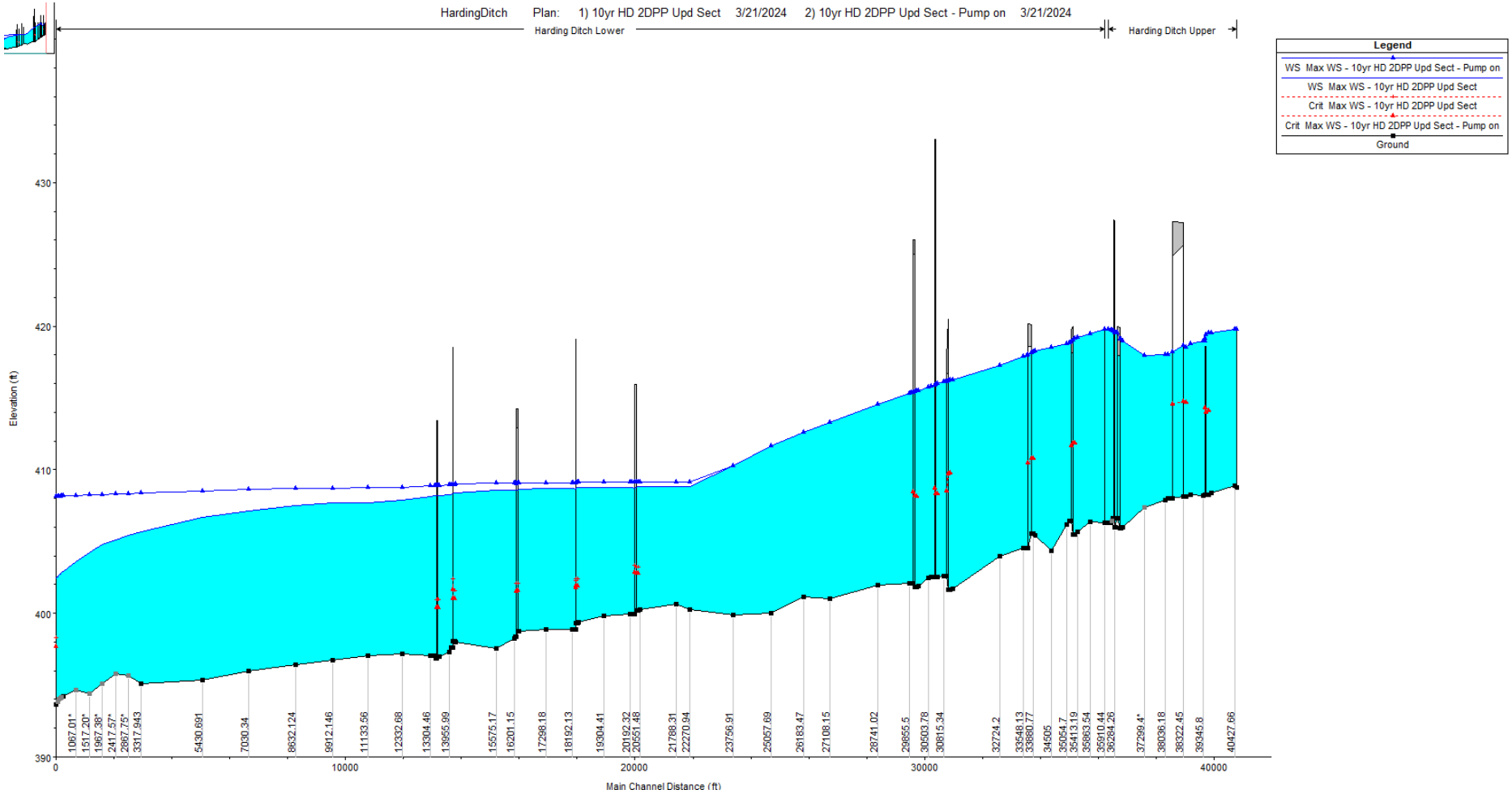

Figure 41. Harding Ditch Existing Condition Profile – 10% AEP Storm Event

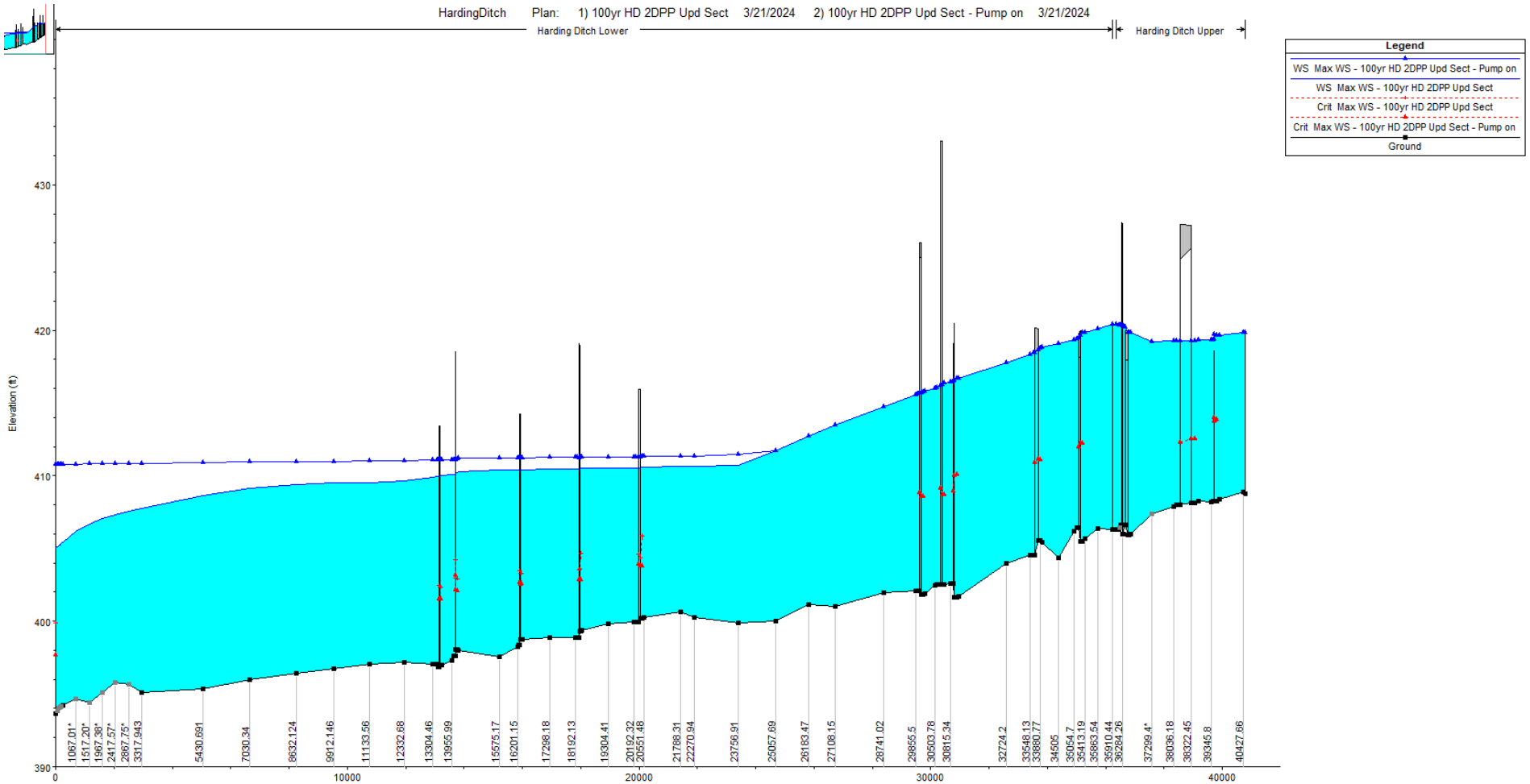

Figure 42. Harding Ditch Existing Condition Profile – 1% AEP Storm Event

4.2.2 Harding Ditch Pump Station Backwater

High Mississippi River stages require operation of the MESD south pump station for the drainage from Harding Ditch. When stages exceed 21.5 feet at the St. Louis gage on the Mississippi River, the gravity drains at the south pump station are closed and pump operation moves water from Harding Ditch into Prairie Du Pont Creek. While under these higher backwater conditions, operation of the pump station is not as efficient for conveyance of stormwater as during gravity flow conditions (low Mississippi River stages). Though the probability of a high Mississippi River stage coincident with a 10% AEP or 1% AEP interior flood event is low, extensive Harding Ditch backwater flooding is still possible.

Results from the HEC-RAS modeling of the Harding Ditch project area demonstrate that the influence of backwater flooding from Harding Ditch extends approximately five miles upstream of the south pump station during a 1% AEP storm event. This places the backwater effect to just upstream of the Canal 1 confluence. This signifies that the backwater effects propagate upstream on Canal 1 as well as influence the FHSP lake levels.

Harding Ditch backwater reaches Lake Drive on Canal 1 during the 1% AEP storm event with low Mississippi River stages as well. The extent of the Canal 1 watershed flooding is shown in Figure 43 for the 1% AEP flood event for both low and high Mississippi River stages. Blue is the inundation with high Mississippi River stages and purple is with low stages. The flooding extents below Lake Drive on Canal 1 and in the FHSP lakes are the areas with the highest deviation in coverage.

Figure 43 inundation also captures the effect of Harding Ditch overtopping the notch in the levee at the Parkside pump station. From the HEC-RAS model, it was estimated that the Parkside pump station levee notch is overtopped during a 10% AEP flood event on Harding Ditch with low Mississippi River stages.

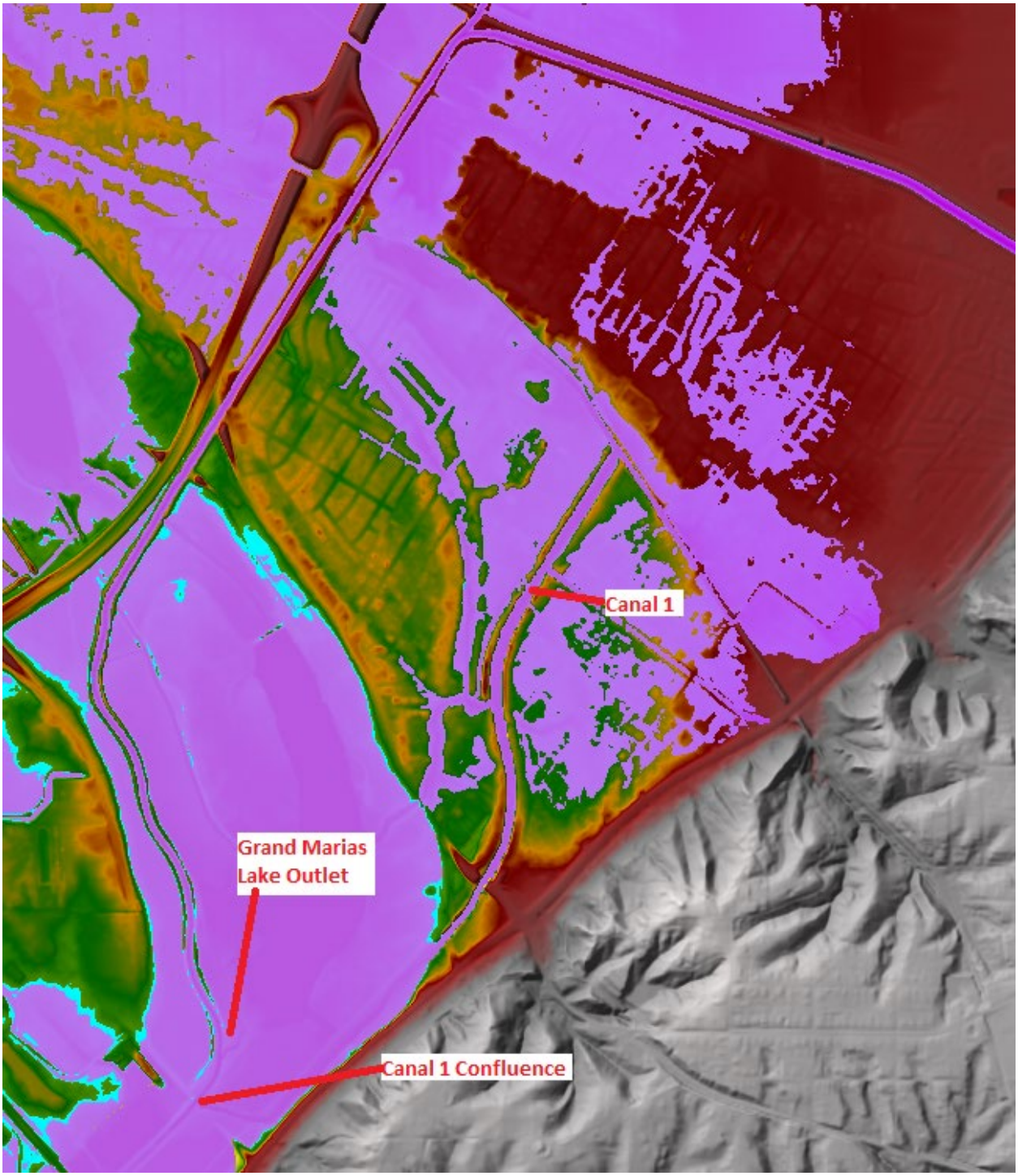

Figure 43. HEC-RAS Simulated 1% AEP Event Inundation During High and Low Mississippi River Stages

During a 72-hour duration storm event, drainage from the Canal 1 watershed peaks and then recedes before elevated backwater flooding in Harding Ditch develops. When that elevated backwater flooding develops, the water level in Canal 1 near Lake Drive is approximately 0.7 feet deeper with the pumps operating than during gravity flow conditions during a 1% AEP event and 0.3 feet deeper during a 10% AEP event.

4.2.3 Channel Condition Changes

New Harding Ditch channel cross sections were gathered by USACE for the Harding Ditch reach between Schoenberger Creek and the south pump station. The model geometry was updated, by merging the new channel surveys with the 2012 model cross sections. Comparing channel conditions in the 2012 Harding Ditch model to the new cross-sections, the effects of change in the channel conditions were ascertained.

Results of the channel survey showed differing channel changes over the stretch of Harding Ditch from Schoenberger Creek to the south pump station. Figure 44 shows that in the lower sections of Harding Ditch, nearest to the south pump station, the channel has narrowed and undergone deposition. Figure 45 shows that in the upper sections of Harding Ditch, the channel has narrowed and eroded.

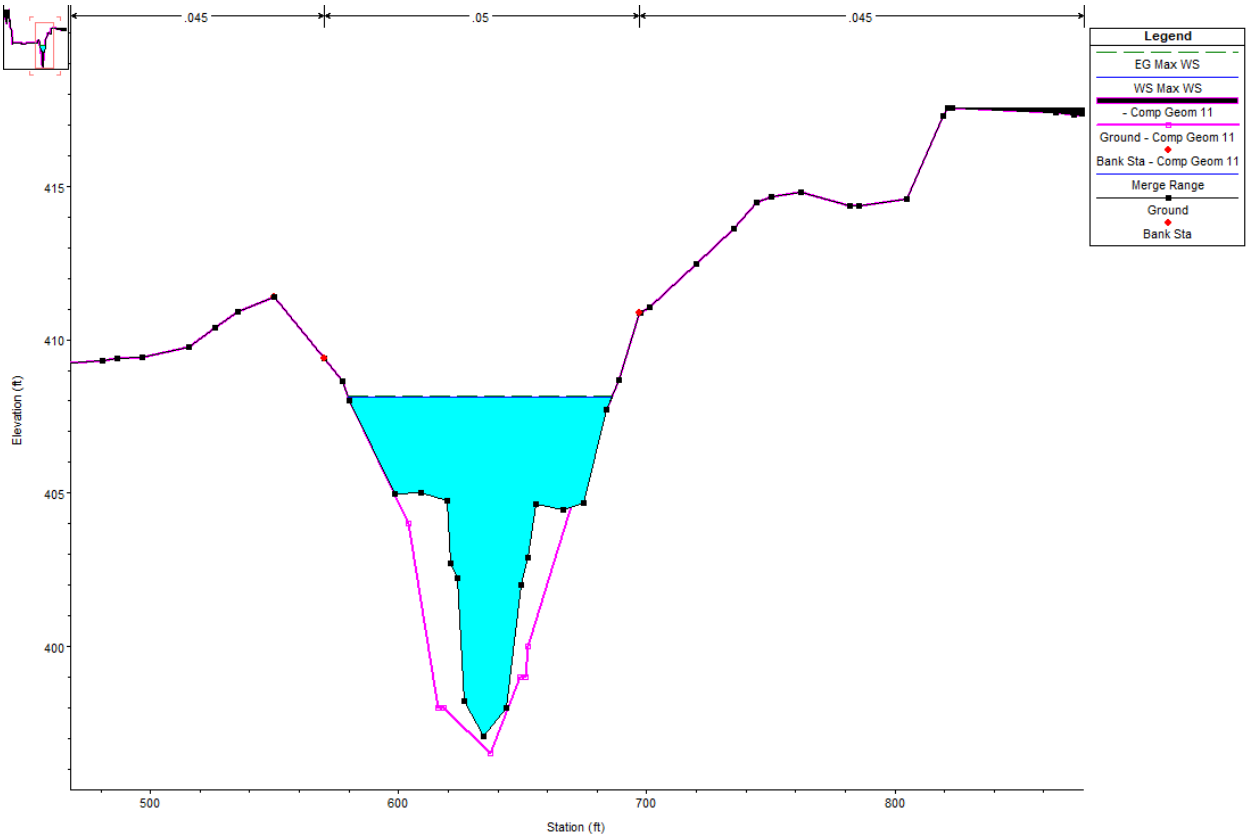

Figure 44. Harding Ditch Channel Cross Section Changes - Lower Cross Section. (Purple 2012 section and Black 2024 survey)

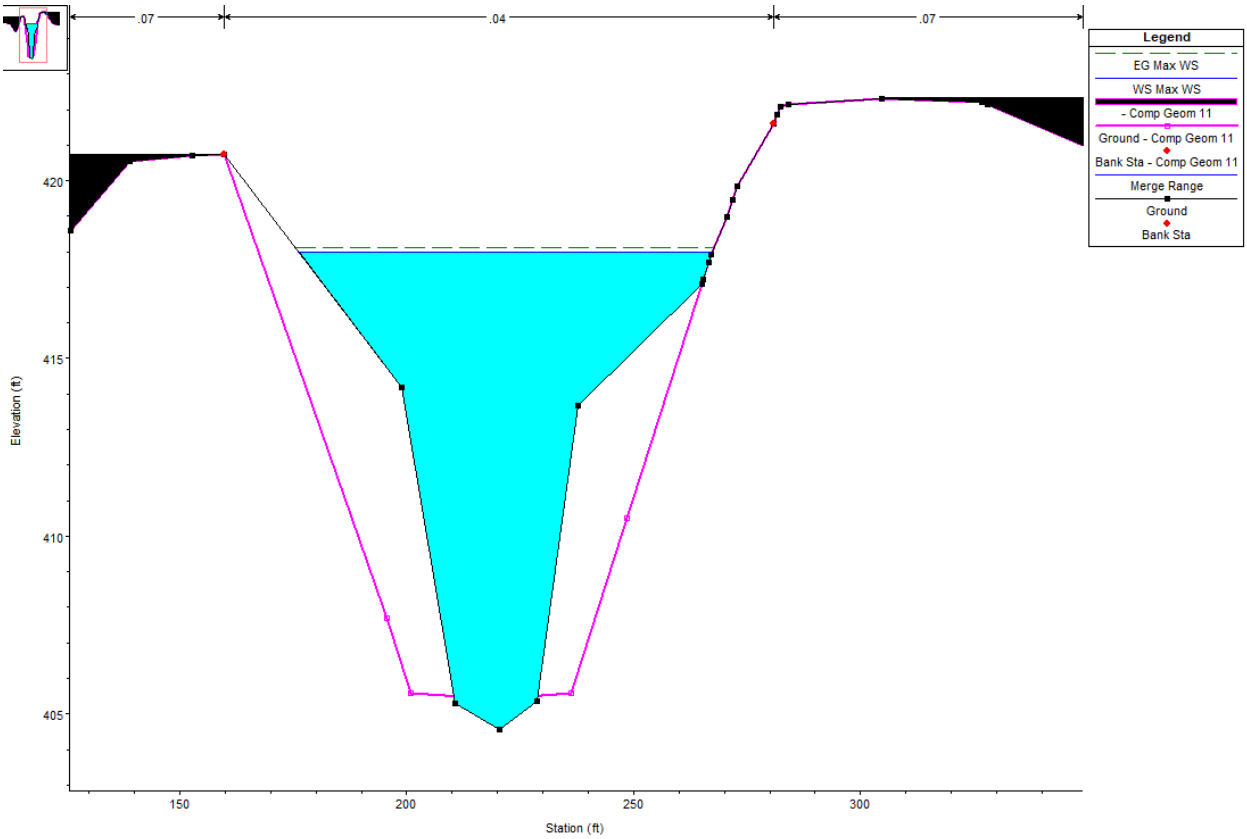

Figure 45. Harding Ditch Channel Cross Section Changes - Upper Cross Section. (Purple 2012 section and Black 2024 survey)

As the channel narrows, deposition of the sediment would be expected in areas closest to the south pump station. Especially during the reoccurring backwater conditions. The extents of the backwater zone is approximately the break point of the channel erosion/deposition. As a result of this deposition downstream, the channel needs to be in an erosive state upstream to maintain channel equilibrium. Channel equilibrium is reached when there is a balance between the amount of sediment load being supplied to the system and the capacity of the system to carry the sediment load.

4.2.4 Channel Change Effects on Water Surface Profile

Using HEC-RAS, profiles comparing the water surface changes between the 2012 channel geometry and the 2024 current condition were examined. Figure 46 and Figure 47 show the profile comparisons of the 2012 model with the current conditions for the 10% AEP and the 1% AEP storm events when the pumps are off and gravity outflow dominates. Also captured in the figures is the channel minimum elevation changes. The blue band (solid lines bound) is the 2012 geometry water surface and channel bottom. The triangle marked solid blue line is the current conditions water surface profile and the dotted solid black line is the current condition channel bottom. The zones of downstream deposition and upstream erosion can be identified.

As shown in the Figure 46 and Figure 47, the effects of channel change over the last 12 years have increased the water surface levels.

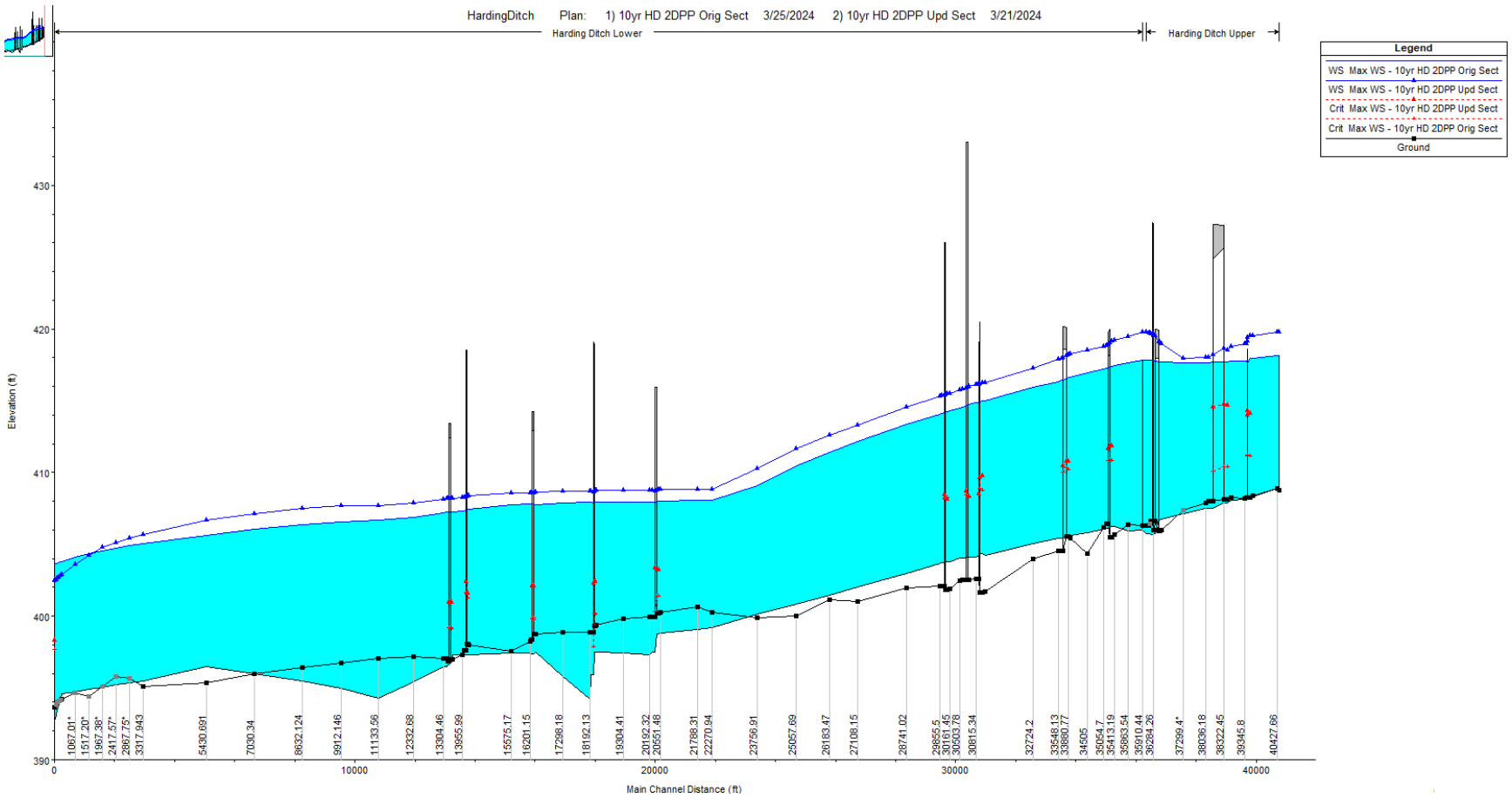

Figure 46. Harding Ditch 10% AEP Storm Event - Current vs. 2012 Model Geometry

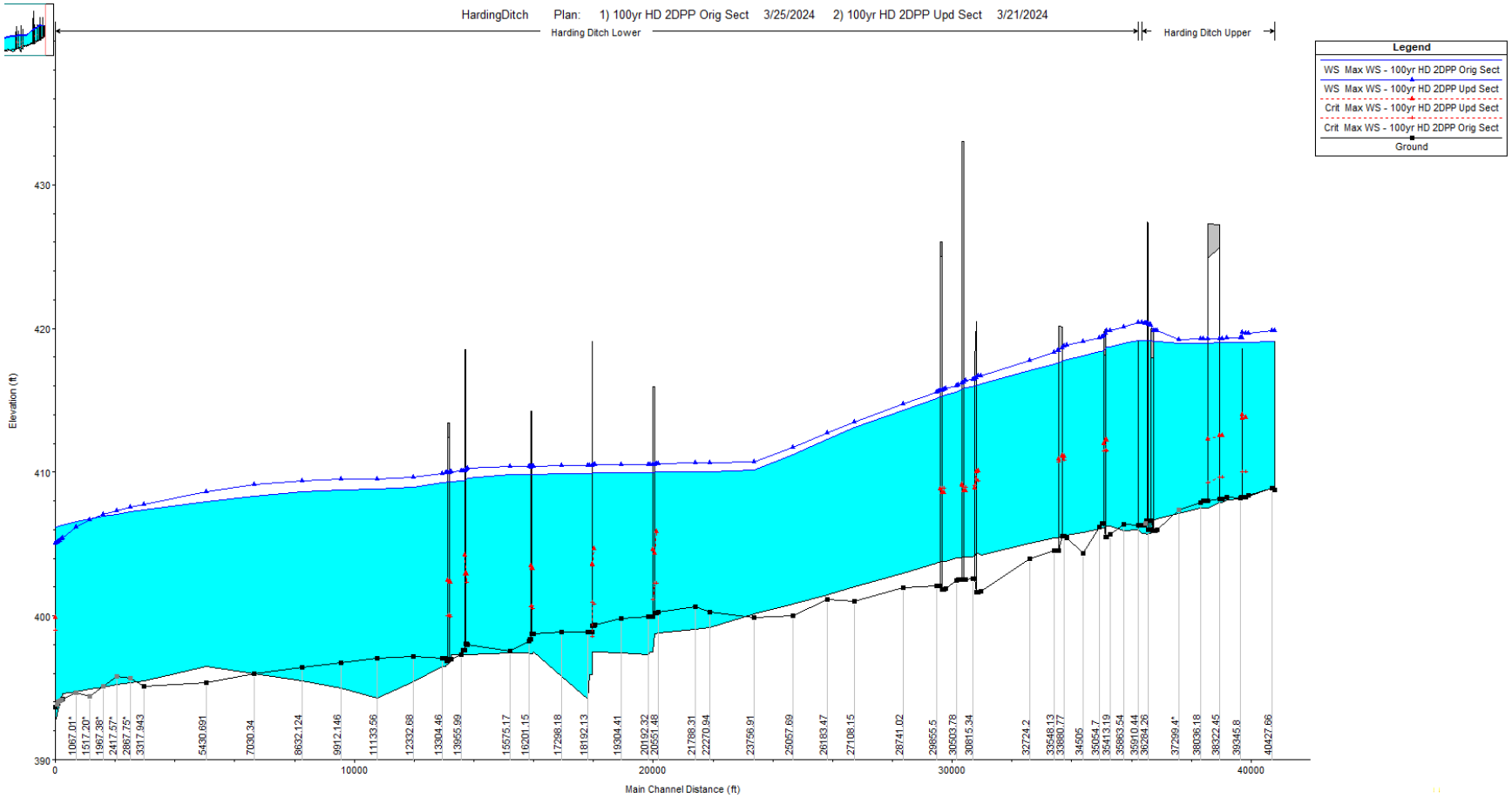

Figure 47. Harding Ditch 1% AEP Storm Event - Current vs. 2012 Model Geometry

4.2.5 Coincident Frequency Analysis

To establish a relationship between stage versus frequency, a coincident frequency analysis was performed at locations along Harding Ditch. This was done through examination of the Harding Ditch computed water surface with high and low Mississippi stages. Coincident frequency takes into account the duration and frequency of stages on the Mississippi River when determining frequency water levels on Harding Ditch. This can be used to identify both the extent of backwater influence and a weighted frequency water surface elevation relationship between pump-on and off conditions.

HEC-SSP version 2.3 was used to perform the coincident frequency on Harding Ditch and duration analysis on the Mississippi River at St. Louis. Annex 2 shows the coincident frequency plots at various locations on Harding Ditch. Figure 48 shows the coincident frequency profiles on Harding Ditch. As was shown in Figure 46, the extents of backwater influence go from the south pump station to just upstream of Canal 1. Upstream of the backwater zone, the water levels for a given frequency remain the same whether the pumps are on or off.

Because of the constant discharge approach on the Mississippi River to produce pump-on and off conditions on Harding Ditch, only two response curves are used in HEC-SSP over the range of Mississippi stage durations. Also, since there was a lack of south pump station pump curve information, constant pump outflows were assumed for the full range of head. These factors are a potential source of error in the coincident frequency analysis. However, this simplistic approach to the pump operation should still produce reasonable results since discharge variance for a given head is usually small in the pump full capacity operating range.

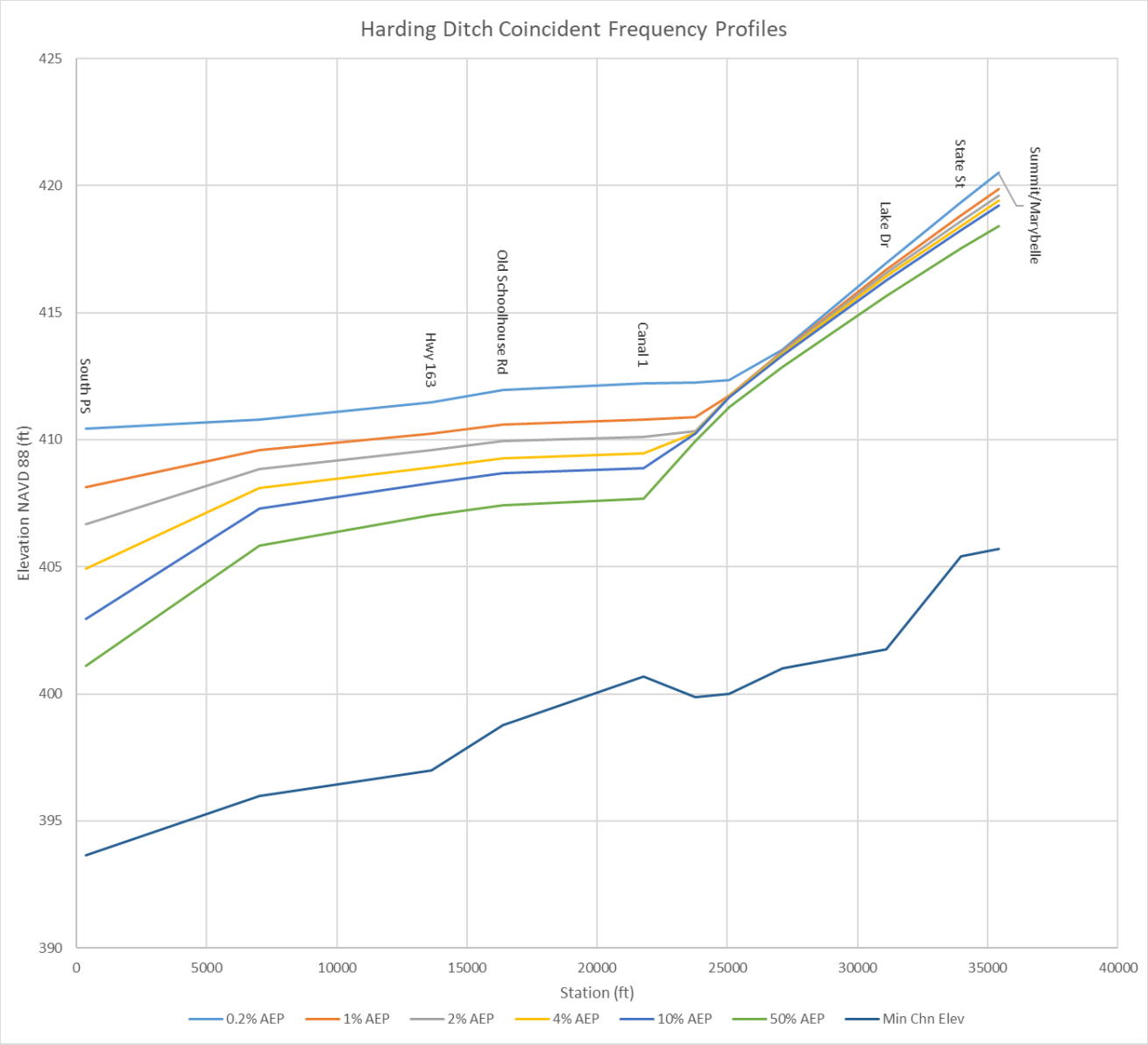

Figure 48. Harding Ditch Coincident Frequency Profiles

4.2.6 Harding Ditch Dredging and Widening

As was discussed in Sections 4.2.2 and 4.2.3, the channel has narrowed over time. It degraded in the upstream sections and aggregated in the downstream segments. This has led to increased water levels in Harding Ditch. With that in mind, returning the channel to original design conditions is warranted.

Modeling to support designs for alternatives 8, 9, and 10 for Harding Ditch was conducted. Using the HEC-RAS model with its current cross section geometry, a trapezoidal channel was driven through the cross sections using the Channel Modification editor. Figure 49 shows a sample of the channel modification sections for a trapezoidal channel with a base width of 30 feet. The extents of the channel modifications are shown in Figure 18 and detailed in Section 4.1. The first trapezoidal cut section examined has a modified base width of 30 feet and extends from the south pump station upstream 2.6 miles. The second trapezoidal cut section examined has a modified base width of 25 feet and extends from 2.6 miles upstream of the south pump station to Schoenberger Creek.

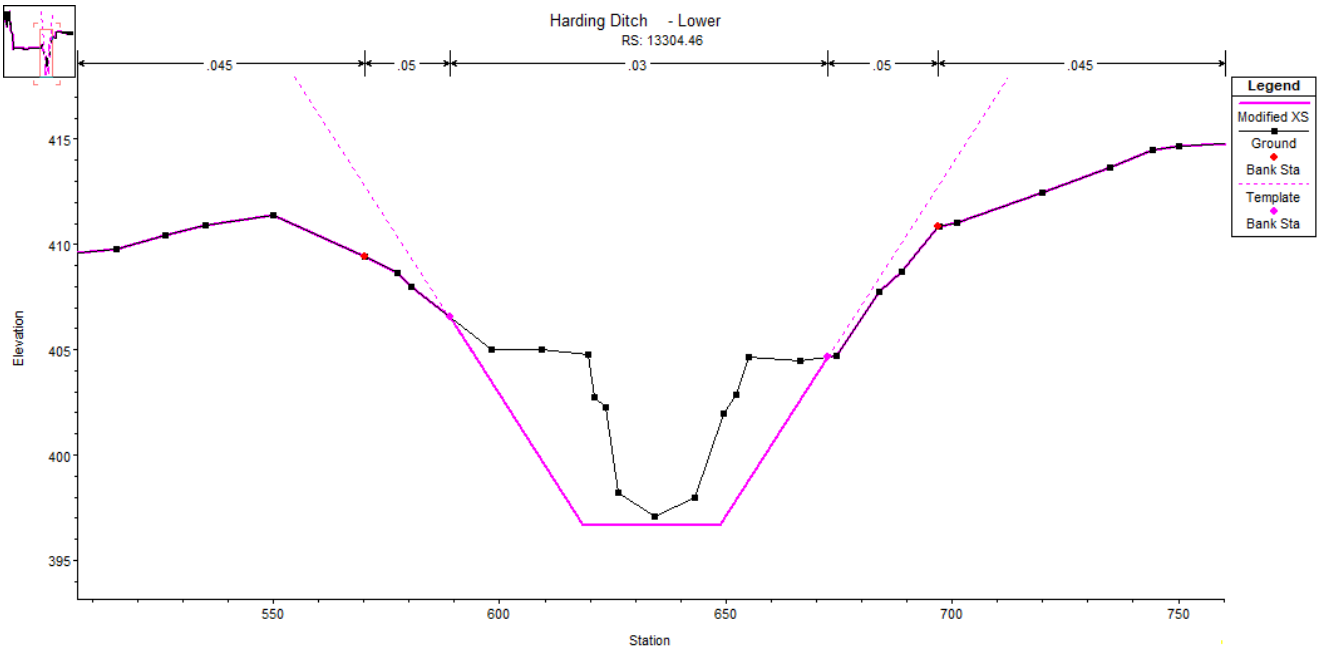

Figure 49. Channel Modification Cross Section 13304.46

The results of the proposed dredging and widening alternatives are shown in Figures 50 through 53 for the 10% AEP and 1% AEP storm events. Figure 50 and Figure 51 show the proposed widening versus the current (2024) channel condition. Figure 52 and Figure 53 show the proposed widening measure versus the 2012 channel condition. The blue band (solid lines bound) is the current or 2012 condition water surface with the channel bottom. The triangle marked solid blue line is the modified channel conditions water surface profile and the dotted solid black line is the modified condition channel bottom.

For the widening measure as compared to the current conditions, the magnitude of stage reduction downstream of Canal 1 for the 10% AEP storm event is an average of 2.0 feet. Upstream of Canal 1 the average reduction is 1.5 feet. For the 1% AEP storm event, the average reduction downstream of Canal 1 is 1.6 feet. Upstream of Canal 1 the average is reduction is 1.0 feet. From the figures it can be seen

that channel widening does bring the current condition water surface below the 2012 model computed water surface profile.

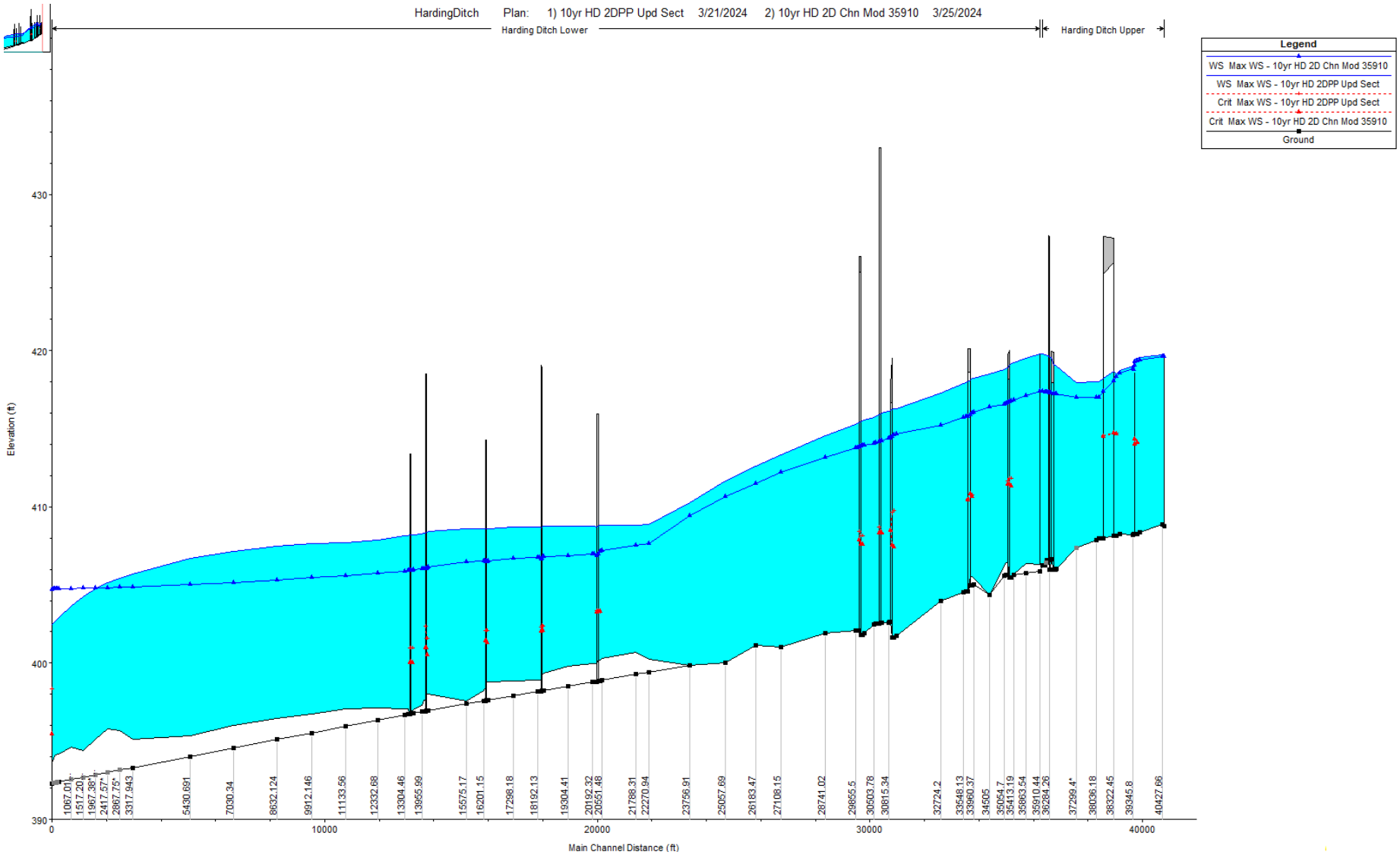

Figure 50. Existing Condition versus Proposed Dredging and Widening Condition - 10% AEP Storm Event

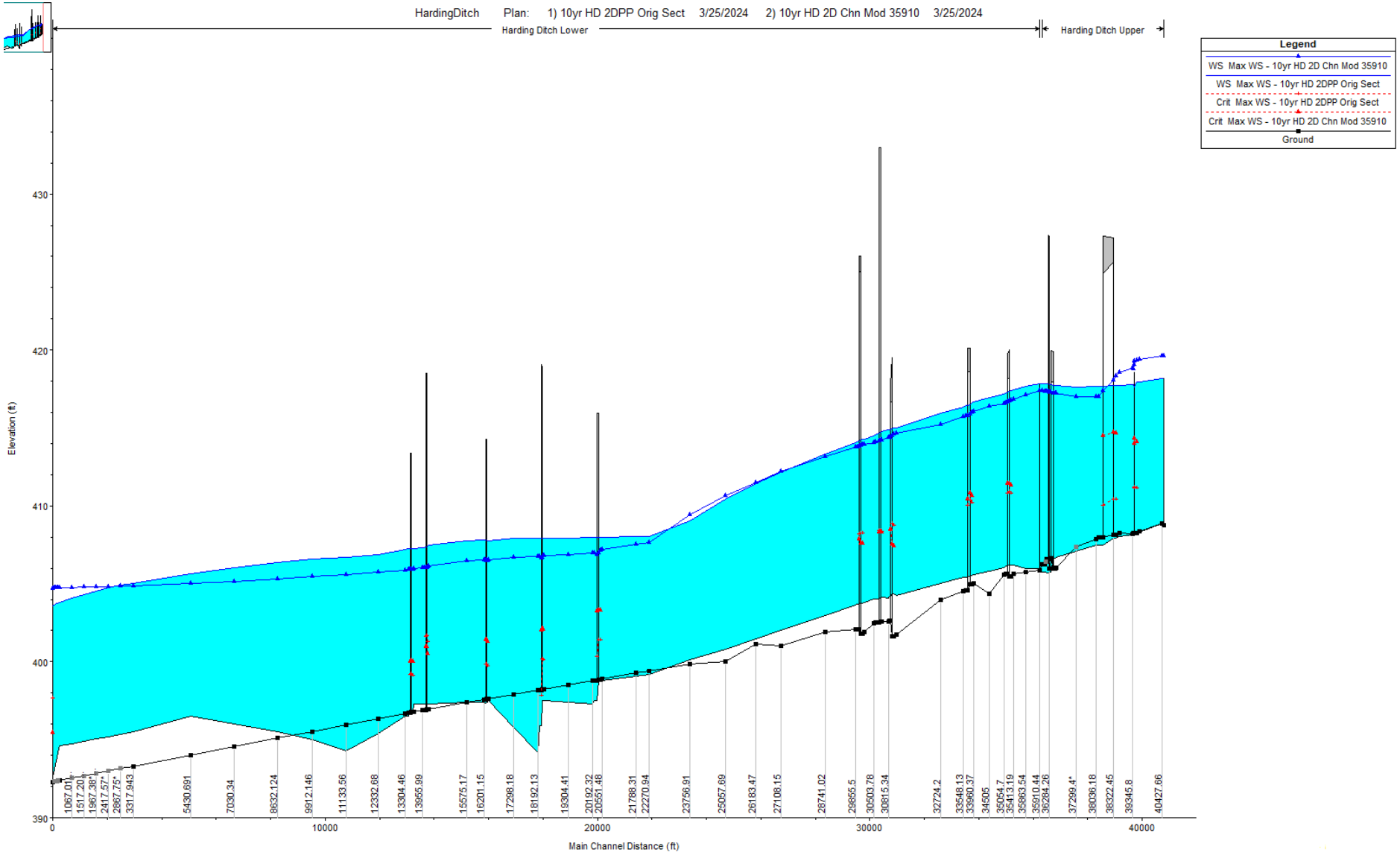

Figure 51. 2012 Condition versus Proposed Dredging and Widening Condition - 10% AEP Storm Event

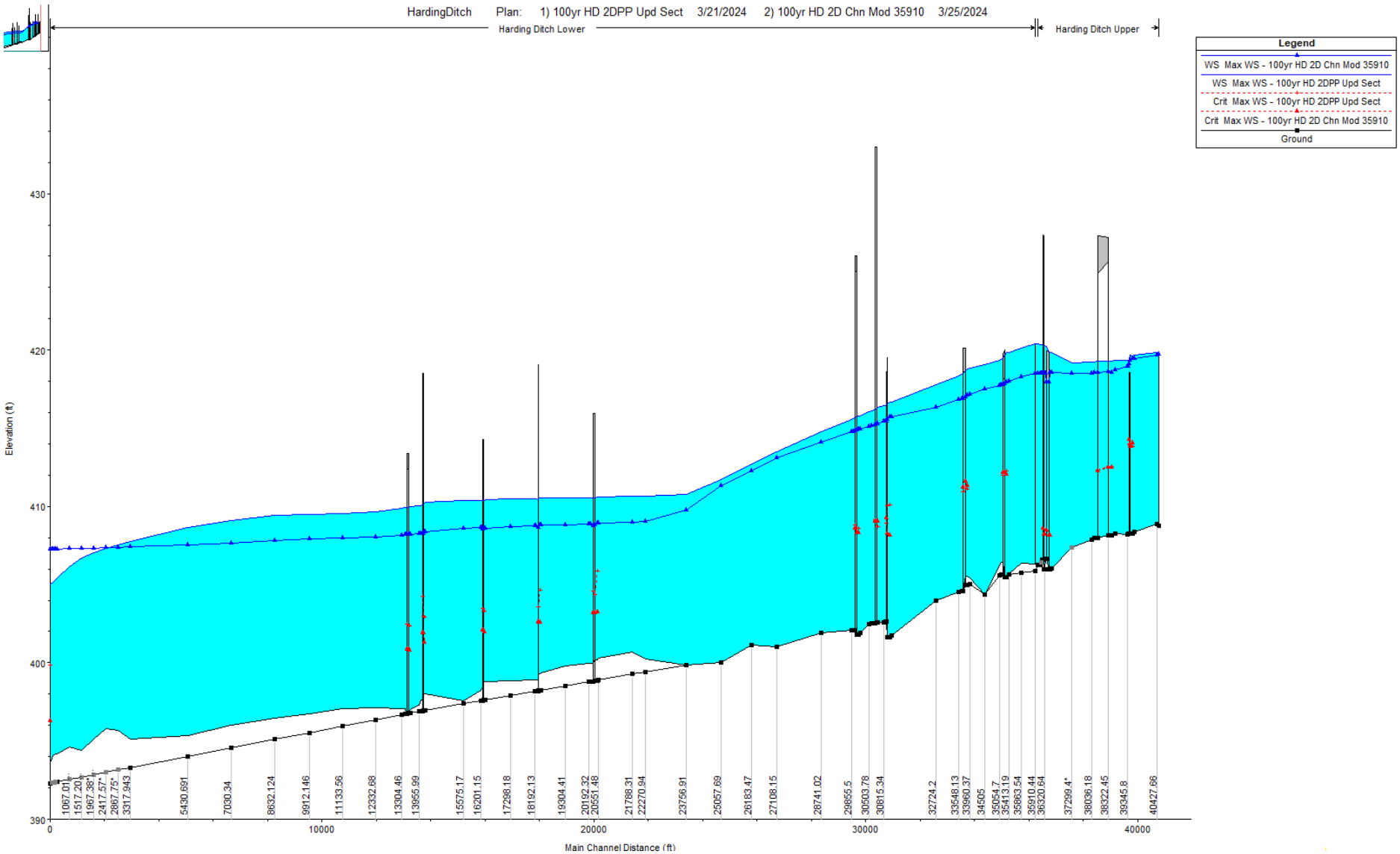

Figure 52. Existing Condition versus Proposed Dredging and Widening Condition - 1% AEP Storm Event

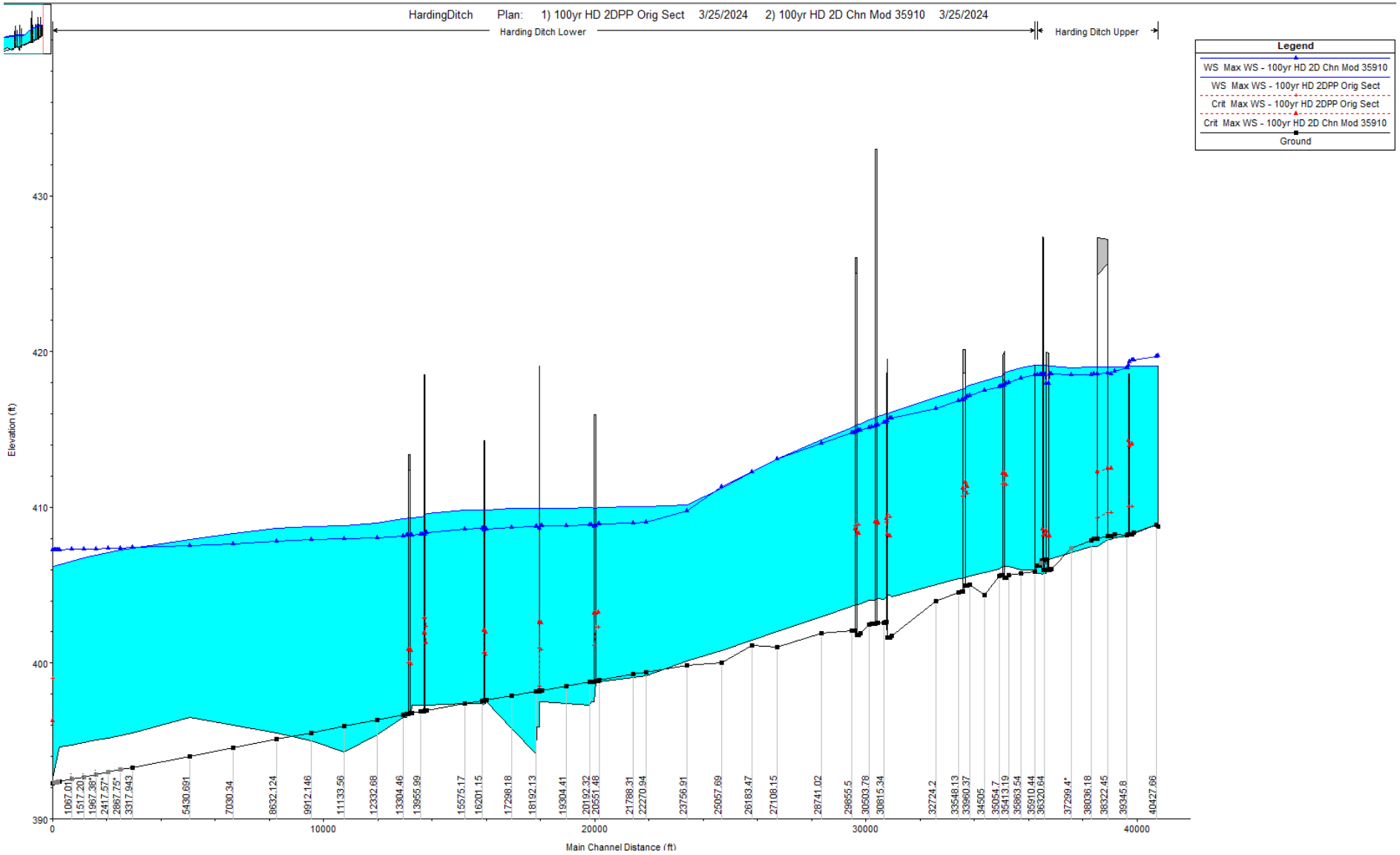

Figure 53. 2012 Condition versus Proposed Dredging and Widening Condition - 1% AEP Storm Event

4.2.7 South Pump Station Capacity Increase

Along with channel widening and deepening, Harding Ditch Alternatives 9 and 10 call for an increase in pump capacity at the south pump station. Alternative 9 increases the number of pumps by one and Alternative 10 increases the number of pumps by two. In the 2012 model, the south pump station has four pumps, each with a capacity of 131.5 cubic feet per second.

For the alternatives, the channel widening and deepening HEC-RAS geometry was modified to increase the number of pumps in the pump group definition by one and two pumps at the south pump station. The computed water surface profiles for the pump addition alternatives for the 10% AEP and 1% AEP storm event are shown in Figure 54 and Figure 55. The blue band (solid lines bound) is the current condition water surface with its channel bottom. The triangle marked solid blue lines are the modified additional one and two pump alternative water surface profiles and the dotted solid black line is the modified condition channel bottom.

For the one and two additional pump alternatives, the magnitude of stage reduction downstream of Canal 1 for the 10% AEP storm event is an average of 0.6 feet and 1.2 feet, respectively. Upstream of Canal 1 the average reduction is 1.5 feet for both pump alternatives. For the 1% AEP storm event, the average reduction with the addition of one and two pumps downstream of Canal 1 is 0.3 feet and 0.5 feet, respectively. Upstream of Canal 1 the average reduction is 1.0 feet. The main reason for the same difference between one and two pump additions upstream of Canal 1, is that the effects of backwater from the south pump station only propagate up to Canal 1. The water surface reduction in that upstream reach is due to the channel widening. The reductions due to the pump station changes are only in the backwater zone.

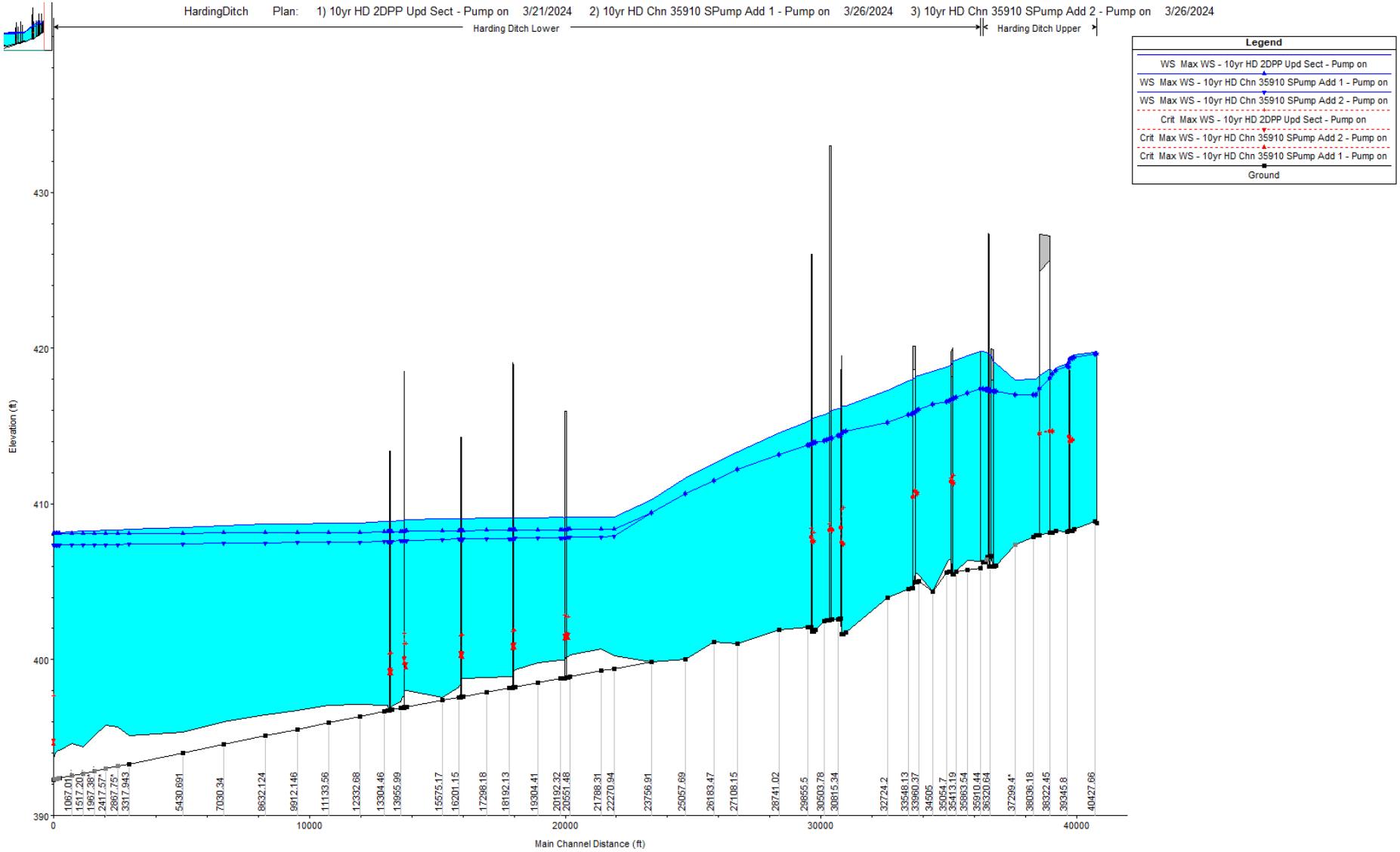

Figure 54. Widening and Dredging with the Addition of 1 and 2 Pumps at the South Pump Station - 10% AEP Storm Event

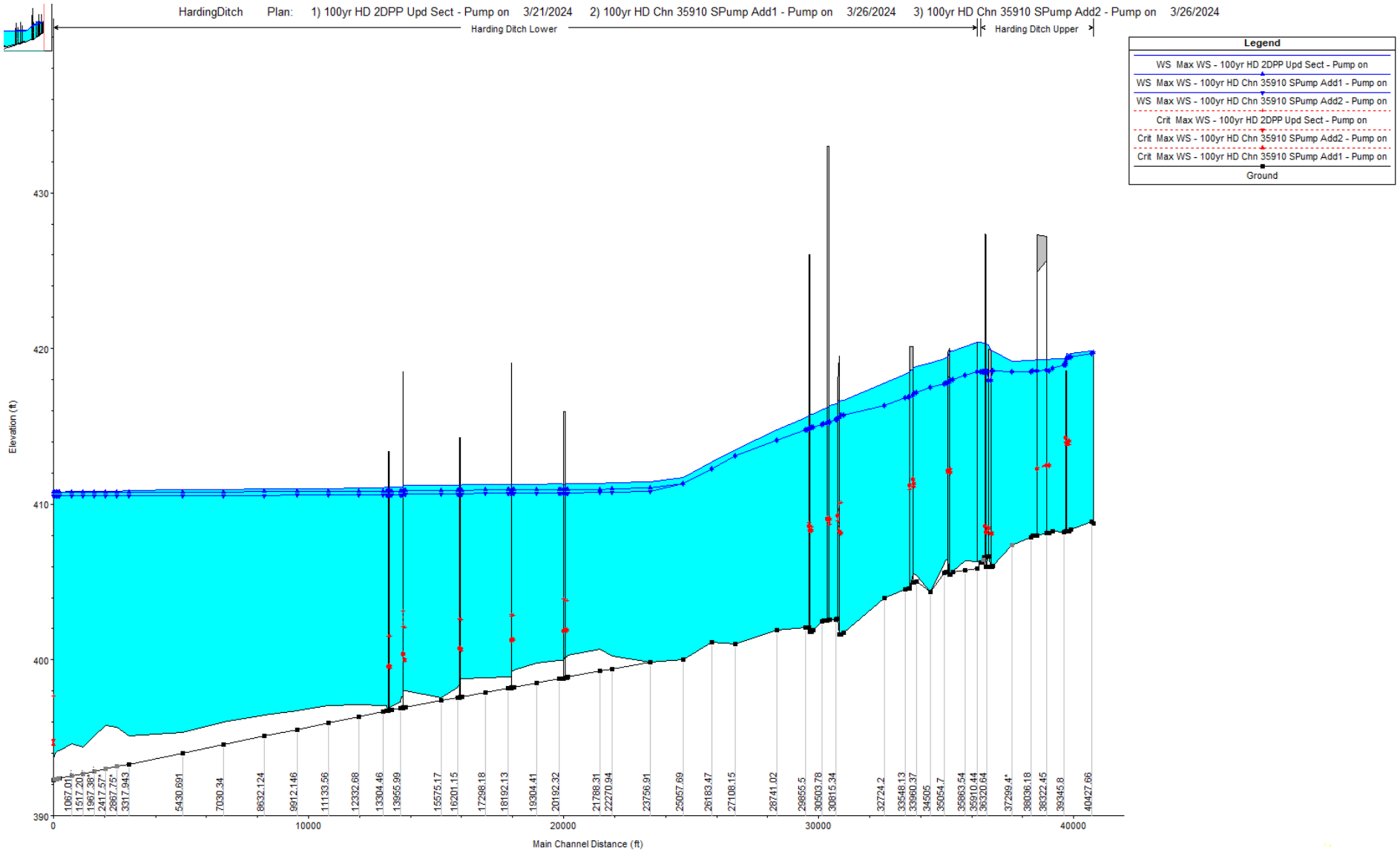

Figure 55. Widening and Dredging with the Addition of 1 and 2 Pumps at the South Pump Station - 1% AEP Storm Event

5.0 Conclusion

Focusing on flooding in the Piat Place portion of the study area, the alternatives examined in this study show a reduction in water surface elevation throughout the watersheds examined. The hydraulic modeling relied on the 10% AEP 24-hour duration storm event for the basis of the designs, and it was showed that conveyance of stormwater can be contained underground. It has also been shown that through implementation of the flood risk reduction measures there is a significant reduction in damages during the 1% AEP storm event.

One major change that should be considered is to add pump stations when moving water from the proposed storm sewer systems into Harding Ditch. Higher Harding Ditch stages do have an adverse impact on backup into the storm sewer systems. Drainage is limited with flap gates closed. Also, to provide adequate drainage by having lower conduit invert elevations, the pumps will need to be operated on a full-time basis. The exception being with the north wetland drainage improvement plan that employs a gravity drain.

The greatest improvement to interior drainage of the Piat Place portion of the study area would be achieved if all the measures from all the alternatives are implemented. Although the modeling shows that some surface drainage issues may still exist during the less frequent events, the corrective measures presented will reduce flood risk for long term benefit.

For the north wetland alternatives (Alternatives 1 and 2), the simplest solution to the water encroachment on Summit Avenue would be to raise the road. Drainage improvements could also improve the environmental value of the wetland itself. Both alternatives provide positive benefit.

For the alternatives at Interstate 255 and State Street without and with additional sewer systems added from the west (Alternatives 3 and 4), the best option for flood risk reduction would be to implement Alternative 4. Both alternatives alleviate flooding at the Interstate 255 interchange, but picking up drainage from the defstorm sewer line along and east of Kingshighway is a necessary flood reduction measure. A lot of this section of the storm sewer system is blocked and not functioning at all. Also, separating out stormwater from the sanitary system west of Interstate 255 is a best practice. Reducing volume to the sanitary system will alleviate sanitary system backup which is a significant problem in the project area.

For the Piat Place alternatives (alternatives 5, 6, and 7), bringing the water south into a wetland prior to discharging into Whispering Willow Lake will have the most benefit. Also, the idea of a potential lake/retention pond within the FHSP field south of 62nd Street and Lake Drive is of particular interest to IDNR. They would like to see park improvements that provide an environmental and recreational benefit. Also, the Piat drainage south alternatives (alternatives 5 and 6), reduce flood risk without requiring a costly pump station or impact to Interstate 255.

Shown by the existing conditions HEC-RAS model, most of the interior flooding occurs from being unable to drain these areas during high Harding Ditch stages. This cannot directly be attributed to Harding Ditch because of the existence of functional flap gates on the culvert or storm sewer system outfalls. From the USACE survey, almost all the flap gates along Harding Ditch appear functional. They were recently repaired by MESD. Flooding up Canal 1 is an issue due to the extent of backwater from Harding

Ditch and the fact that a low spot in the levee at the Parkside pump station overtops during a 10% AEP storm event.

The channel condition changes seen by the comparison of the 2012 HEC-RAS model geometry with USACE survey cross sections, has had a significant impact on Harding Ditch stages. The most significant factor in the stage increase is the channel narrowing. Restoring the ditch to its original design state would lower the water surface during flood events.

The potential for flooding in the Canal 1 area from Harding Ditch still exists even after implementation of the flood risk reduction measures (alternatives 8, 9, and 10). All these alternatives significantly reduce stages on Harding Ditch and Canal 1. However, the greatest impact on stage reduction is from the dredging and widening of Harding Ditch (Alternative 8). Additional south pump station pumps do lead to a reduction in Harding Ditch stages, but the reduction is only seen downstream of Canal 1. And the magnitude and extent of the reduction may not be justifiable based on the cost-benefit ratio with modifying the pump station.

This analysis shows that the corrective measures proposed will have a positive effect on flood risk. Though they may not be benefit-cost justifiable, other social effects such as social vulnerability of the project area residents has significance. These aspects should be further examined with a more comprehensive study of the Harding Ditch watershed extending upstream of Schoenberger Creek. Capturing more of Harding Ditch would yield additional measures that should be considered to reduce flood risk in the watershed.

6.0 References

St. Clair County, IL Storm Water Control Code, May 2017 (accessed April, 2023); https://www.co.st-clair.il.us/webdocuments/CountyCode/Stormwater%20Control%20Code.txt

HeartLands Conservancy, Prairie Du Pont Watershed (accessed August 2024); https://heartlandsconservancy.org/pdp/

HEC-RAS Hydraulic Reference Manual; December 2020 (accessed April, 2023); https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest

NOAA Atlas 14 Point Precipitation Frequency Estimates, April 2023 (accessed April 2023); https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

6.1 Software

PCSWMM 2022, Computation Hydraulics Institute (CHI) version 7.5.3406

HEC-RAS version 6.5

HEC-SSP version 2.3

EPA-SWMM version 5.1.015

ArcGIS Pro, ESRI, version 3.0

Google Earth Pro, Google version 7.3.4.8248

Annex 1 - Proposed and Existing Storm Sewer Pipe Tables

Annex 2 - Harding Ditch Coincident Frequency Curves