Village of Cross Plains

Flood Control System Improvements

April 2020

JEWELL associates engineers, inc.

Engineers - Architects - Surveyors

MARS-EOR water-ecology-community

Table of Contents

Executive Summary ..... Tab 1

Brewery Creek and Black Earth Creek Flood Mitigation Preliminary Engineering Report ..... Tab 2

West Side Drainage Improvements Engineering Report ..... Tab 3

JEWELL
associates engineers, inc.
Engineers - Architects - Surveyors

Executive Summary

The Village of Cross Plains contracted with Jewell Associates Inc. to study the flood event of August 20, 2018 and to determine potential mitigation measures that could reduce the effects of future large rainfall events on the Village. Jewell consultant MARS-EOR looked at the Brewery Creek watershed to determine potential flood mitigation methods that could be implemented upstream of the Village, and a Black Earth Creek bypass that could reduce flood impacts on the west end of the Village. Jewell looked at potential infrastructure improvements within the Village. The following report summarizes the findings of the study and describes projects that could be implemented to mitigate future flooding. The report is composed of two parts. The first part includes MARS-EOR's study and recommendations for the Brewery Creek watershed, and the second part includes Jewell's study and recommendations for the drainage improvements on the Village's west side.

The Brewery Creek flood control project would significantly increase the flood storage capacity along the creek upstream of the Village. Multiple methods of flood mitigation were considered. Each method provides varying flood reduction and other benefits which are discussed in this report. A flood control dam would provide the most flood storage of the projects that were evaluated. The estimated cost for this project is $1,335,000.

The infrastructure improvements focused on the west side of the Village along Park Street. It was determined that improved conveyance of stormwater from the intersection of Park Street and Market street would have the largest impact on the surrounding area. The proposed project is to install a 42-inch diameter storm sewer and modify the profile of Park Street to increase the available capacity to move large amounts of surface water runoff to the creek. Three storm sewer discharge options at the creek were evaluated: direct discharge to the creek, a detention pond with a pump station, and a detention pond with a lowered wall. The recommendation is to install the storm sewer with a direct connection to the creek based on comparative cost and low maintenance requirements. The estimated cost for this project is $867,000.

Both areas of the study were evaluated for impacts to wetlands and cultural resources. Commonwealth Heritage Group performed a preliminary cultural resources review and Heartland Ecological Group prepared a desktop wetland determination. Both reports are included in the appendix. The wetland determination indicates that there will be some impacts to wetlands that will need to be considered during final design and construction. The cultural resources review indicates that there are no previously recorded archaeological sites or cemetery burial sites in either location, but archaeological surveys would need to be completed prior to construction. If Federal funds are used for the project, two properties with possible historic potential, located in the Brewery Creek study area, may need to be surveyed and evaluated if they will be directly or indirectly affected by the project.

Prepared by: EOR

For the Village of Cross Plains

Brewery Creek and Black Earth Creek Flood Mitigation Preliminary Engineering Report

04.01.2020

MARS-EOR
water-ecology-community

Cover Images [Calibri 10 point]

Photo of Brewery Creek crossing at St. Francis St taken on August 21, 2018. Photo provided by Town & Country Engineering.

TABLE OF CONTENTS

1. BACKGROUND 1
1.1. Purpose and Scope 1
1.2. August 2018 Flood 1
1.2.1. Precipitation 1
1.2.2. Flood Discharges 4
1.2.3. Flood Recurrence Estimates 6
2. DATA AND METHODS 9
2.1. Data 9
2.2. Hydrology 9
2.3. Hydraulic Modeling 11
2.4. Flood Insurance Study Model Deficiencies 14
3. FLOOD MITIGATION ALTERNATIVES 15
3.1. Watershed Hydrologic Restoration 15
3.2. Flood Conveyance Improvements 15
3.2.1. Black Earth Creek Flood Diversion West of Village 15
3.2.2. Brewery Creek Road Crossing Modifications 20
3.3. Brewery Creek Floodplain Storage 22
3.3.1. Floodplain and Channel Restoration 22
3.3.2. Reconstruction of County Highway P 23
3.3.3. Flood Control Dam 24
3.4. Brewery Creek Flood Mitigation Project Benefits 26
4. IMPLEMENTATION 29
4.1. Construction Procurement 29
4.2. Property Acquisition 29
4.3. Permitting 30
4.4. Project Schedule 32
4.5. Project Budget 33
4.6. Feasibility Analysis 33
4.6.1. Flood Easement Acquisition 33
4.6.2. Constructability 34

4.6.3. Dam Failure Considerations 34
4.6.4. Maintenance 34
5. ADDITIONAL FLOOD MITIGATION PLANNING CONSIDERATIONS 35
5.1. Flood Insurance Study 35
5.2. Potential Additional Benefits 35
APPENDIX A. MAPS
Figure A1 - Brewery Creek Floodplain Scrape
Figure A2 - Brewery Creek Flood Control Dam
Figure A3 - Estimated Floodplain Extents
APPENDIX B. PRELIMINARY CONSTRUCTION DRAWINGS
Existing Conditions – Brewery Creek Flood Storage Area
Preliminary Flood Control Dam Grading Plan and Details
Preliminary Floodplain Restoration Grading Plan
APPENDIX C. PRELIMINARY PROJECT BUDGET
Black Earth Creek Bypass Project Budget
Floodplain and Channel Restoration Project Budget
Reconstruction of County Hwy P Project Budget
Flood Control Dam Project Budget

LIST OF FIGURES

Figure 1. Rainfall Depth Frequency Estimates for Cross Plains from NOAA Atlas 14 1

Figure 2. Radar Estimated Rainfall Depths in the Black Earth Creek Watershed on August 20, 2018 2

Figure 3. Weather Underground Rain Gage Locations and Measured Rainfall Rate and Total for August 20, 2018. Map and data from Weather Underground 3

Figure 4. Cross Plains USGS Stream Gage Locations 4

Figure 5. August 20-21, 2018 USGS Cross Plains Gage Locations Measured Flood Discharges 5

Figure 6. August 20-21, 2018 Calculated Flood Discharges for Flow Contributions Upstream and within the Village 6

Figure 7. USGS Measured Peak Flood Flows Aug 20, 2018 and Flood Insurance Study (FIS) Estimated Flood Discharges 7

Figure 8. Photos of the Upstream (right) and Downstream (left) Portions of the Saint Francis St Brewery Creek Crossing. 8

Figure 9. Brewery Creek Subwatersheds 10

Figure 10. Synthetic Design Inflow Hydrographs for Brewery Creek Storage Area 11

Figure 11. Brewery Creek Storage Area Hydraulic Model Domain 12

Figure 12. Existing Conditions Flood Inundation Areas and August 2018 Peak flooding 13

Figure 13. Proposed Black Earth Creek Flood Bypass Location 16

Figure 14. Typical Cross Section of Black Earth Creek Flood Bypass Channel 16

Figure 15. Flood Profile on Black Earth Creek for 100-yr, 500-yr, and Aug 2018 events with, and without Flood Bypass. 18

Figure 16. 100-yr Flood Profile on Black Earth Creek with Flood Bypass Channel (solid blue) and with Bypass Channel and KP and RR Bridges Removed (dashed blue). 19

Figure 17. 500-yr Flood Profile on Black Earth Creek with Flood Bypass Channel (solid) and with Bypass and KP and RR Bridges Removed (dashed). 19

Figure 18. August 2018 Flood Profile on Black Earth Creek with Flood Bypass Channel (solid) and with Bypass and KP and RR Bridges Removed (dashed). 20

Figure 19. Brewery Creek Flood Profile near Thinness St 21

Figure 20. Floodplain Scrape and Reconnection on the Pecatonica River (from UW-Madison Hydroecology Lab) 22

Figure 21. Existing and Proposed CTH P Road Profile 23

Figure 22. Area of farmstead below flood control dam top elevation (918). 25
Figure 23. Flood Inundation Areas in Future Development Area 27
Figure 24. Brewery Creek Flood Mitigation 500-yr Inundation Mapping 28

LIST OF TABLES

Table 1. Cross Plains USGS Stream Gage Information 4
Table 2. Peak Flood Discharges (CFS) near on Black Earth and Brewery Creeks Compared to FIS Estimates 7
Table 3. Estimated Peak Flood Discharges on Brewery Creek 11
Table 4. Potential Flow Diversion from Bypass Channel on Black Earth Creek 17
Table 5. Black Earth Flood Elevations with Flood Bypass and Creek Crossing Modifications 17
Table 6. Effective Flood Storage Along Brewery Creek Between CTH P and Enchanted Valley Rd 26
Table 7. Peak Discharge (CFS) for 100-yr Flood Event on Brewery Creek at the Village Limits 26
Table 8. Anticipated Mitigation Projects Land and Easement Acquisition Needs 30
Table 9. Flood Control Dam Anticipated Permits 31
Table 10. Anticipated Applicable Permits by Project 31
Table 11. Proposed Project Schedule 32
Table 12. Preliminary Project Budget Estimate 33

1. BACKGROUND

1.1. Purpose and Scope

The Village of Cross Plains, located in Western Dane County, Wisconsin has historically experienced flooding from two tributaries flowing through the Village, Brewery Creek and Black Earth Creek. Flood damages have included flooding of residential, commercial, and industrial structures, streambank erosion, road closures, and damage to infrastructure. Most recently, in August 2018 an extreme flood event caused damage throughout the Village. To reduce risks from future extreme rainfall and flooding events the Village has contracted MARS-EOR (as a subcontractor to Jewell Associates Engineers) to develop flood mitigation plans for the Village. This report describes flood risks, critical areas of interest, and conceptual plans for potential projects to mitigate flooding risks within the Village. At the direction of Village staff, a significant focus of this report is flood mitigation on Brewery Creek, particularly, development of a flood storage area on the creek. Additionally, the report has been formatted to assist the Village in future grant applications.

1.2. August 2018 Flood

1.2.1. Precipitation

On August 20, 2018 western Dane County experienced an extreme rainfall event and significant flooding along Brewery Creek and Black Earth Creek resulting in extensive damage within the Village. Several rain gages within the county reported rainfall depths of 12-15" within a 12-hour period. Radar estimated rainfall depths[1] for the storm range between 7.0-11.5" in the Brewery Creek Watershed, with larger depths in the south and western portions of the watershed. The watershed wide average precipitation depth for the storm was 9.9". Using the NOAA rainfall Atlas 14 this average rainfall depth over a 12-hour period is nearly a 1000-yr rain event (Figure 1). Within the Black Earth Watershed (including the Brewery Creek Watershed) the average rainfall depth was very similar, an average depth of 10.0". The greatest rainfall depths occurred within the headwaters of the creek, east of the Village. A map of the radar estimated rainfall depths for the storm event is shown in Figure 2.

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
12-hr	2.20 (1.86-2.59)	2.52 (2.13-2.96)	3.10 (2.61-3.65)	3.65 (3.06-4.31)	4.50 (3.72-5.54)	5.23 (4.22-6.47)	6.03 (4.72-7.58)	6.90 (5.21-8.84)	8.17 (5.95-10.6)	9.20 (6.52-12.0)
24-hr	2.51 (2.15-2.92)	2.87 (2.45-3.34)	3.53 (3.01-4.12)	4.15 (3.52-4.86)	5.11 (4.27-6.24)	5.94 (4.84-7.28)	6.84 (5.40-8.52)	7.83 (5.96-9.93)	9.24 (6.80-11.9)	10.4 (7.43-13.5)

Figure 1. Rainfall Depth Frequency Estimates for Cross Plains from NOAA Atlas 14

[1] August 2018 gridded, radar-based rainfall totals developed by Dr. Daniel Wright at the University of Wisconsin Madison Department of Civil and Environmental Engineering.

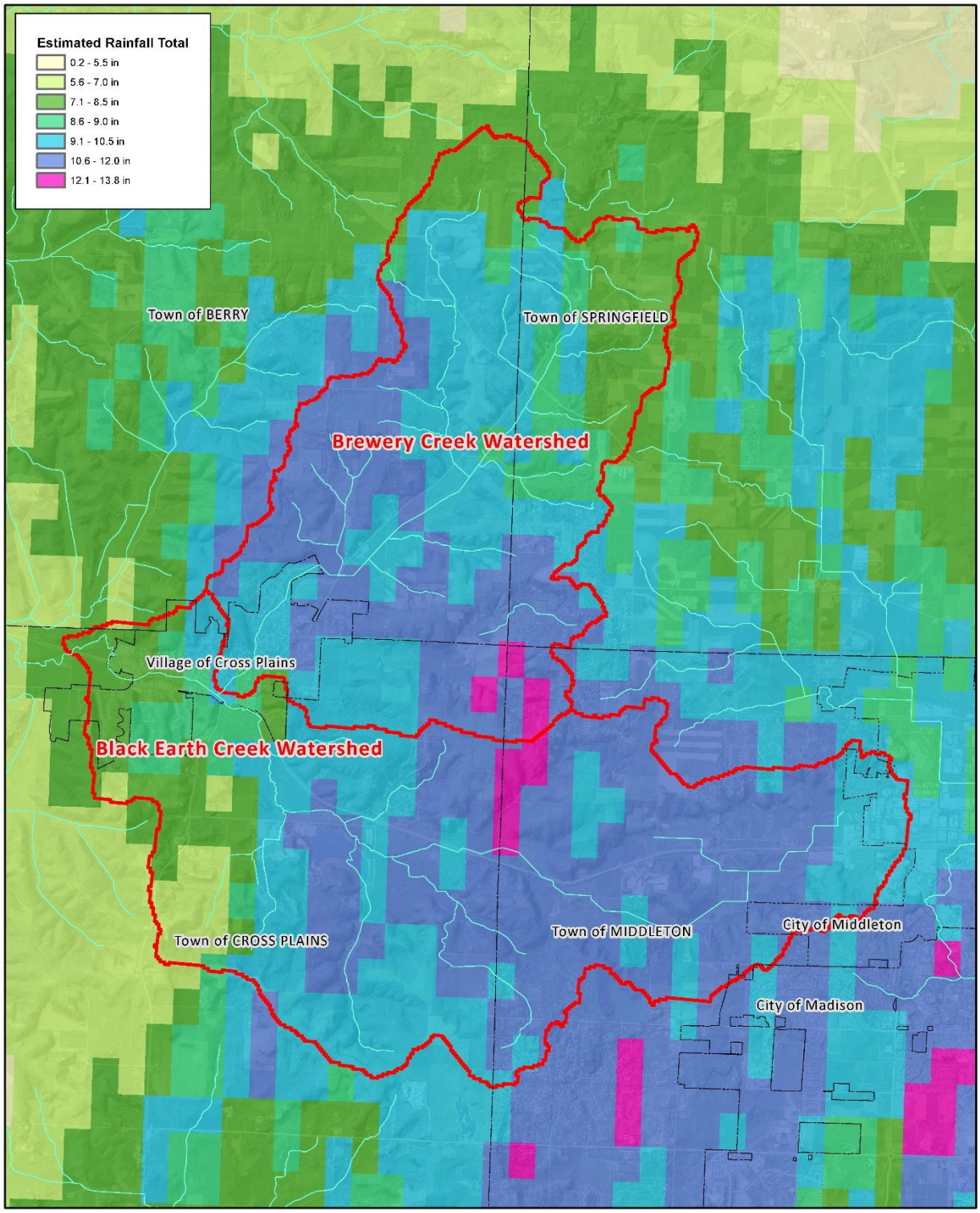


Figure 2. Radar Estimated Rainfall Depths in the Black Earth Creek Watershed on August 20, 2018

Rainfall timing and intensity was obtained by evaluating available Weather Underground stations, since there were no nearby NOAA rain gages near Cross Plains. For this report, data from August 20, 2018 were downloaded for two Weather Underground gages (KWMIDDL11 and KWICROSS12, Figure 3) near the Village with complete data for that date. The data obtained by these stations vary due to the variable spatial nature of intense thunderstorm events and the inconsistencies in citizen operated weather stations. However, these data do generally agree with the radar estimated rainfall depths. The data also demonstrate the extreme intensity of the storm, with the measured precipitation rates exceeding 4 in/hr and at times reach 6 in/hr (Figure 3).

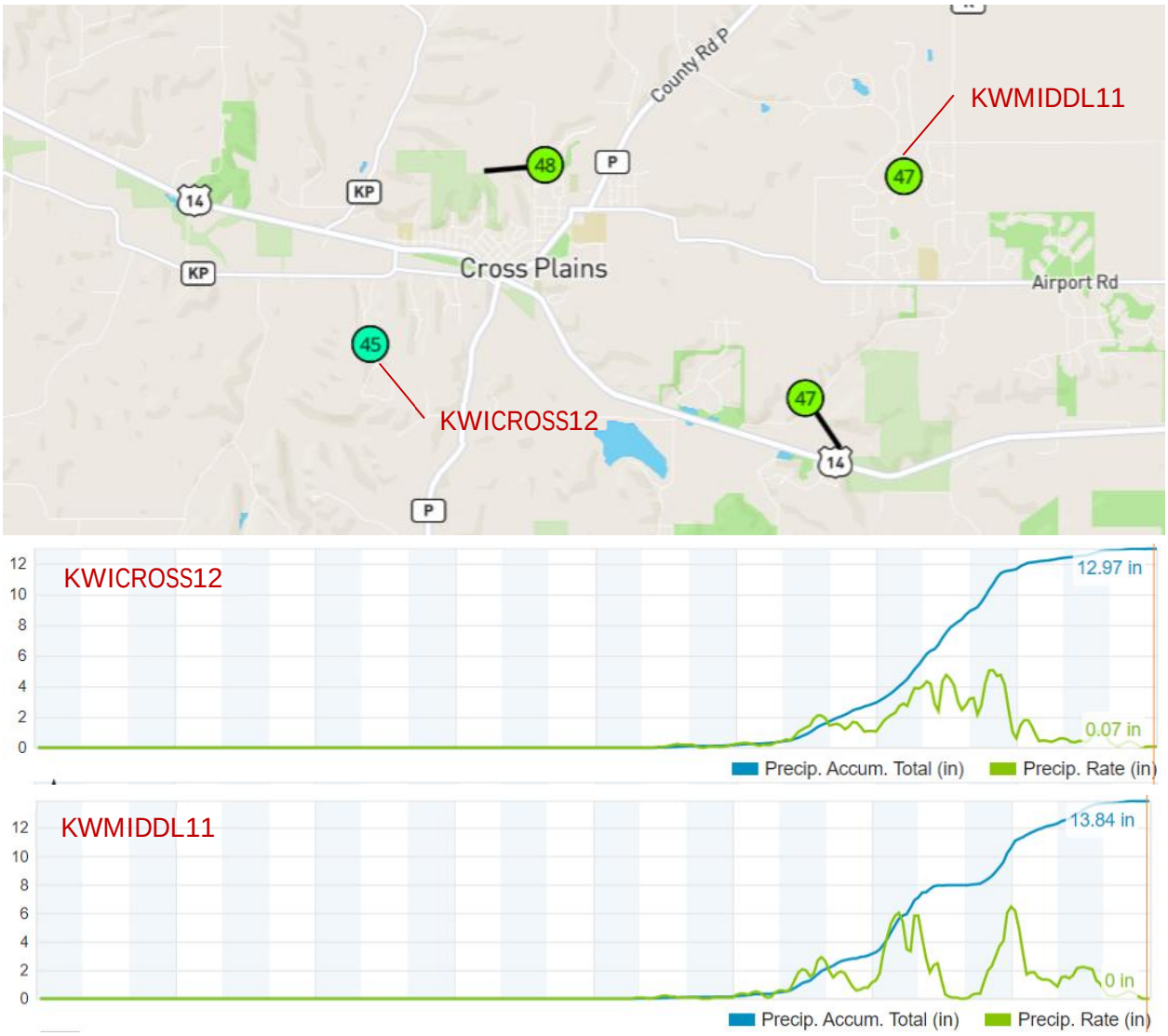


Figure 3. Weather Underground Rain Gage Locations and Measured Rainfall Rate and Total for August 20, 2018. Map and data from Weather Underground.

1.2.2. Flood Discharges

The intense rainfall event resulted in significant increase in flow in Black Earth Creek and Brewery Creek resulting in flooding along the waterways. Estimated flood discharges from this event were obtained from active stream gages within the watershed. Data from the active gages were also compared to limited observations made by residents and Village staff, damage photographs, and an inundation map produced by the Village's municipal engineer.

There are three active stream gages in the Village operated by the United States Geological Survey (USGS). Two gages are located upstream of the Village (one on each Brewery Creek and Black Earth Creek) and one gage located on downstream side of the Village near the wastewater treatment plant. A map of the gage locations is provided in Figure 4. USGS Descriptions and ID numbers are provide for reference in Table 1. Data from each of these gages was downloaded from the USGS National Water Information System: Web Interface and reviewed for the period of August 20-22, 2018.

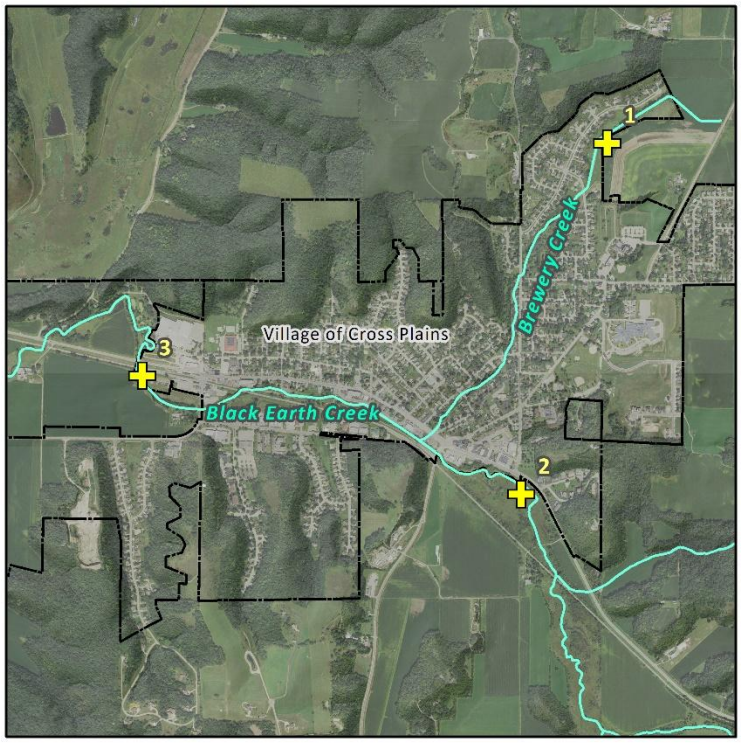


Figure 4. Cross Plains USGS Stream Gage Locations

Table 1. Cross Plains USGS Stream Gage Information

Location ID (see Figure 4)	USGS Description	USGS Station Number
1	BREWERY CREEK-UPSTREAM SITE-AT CROSS PLAINS, WI	05406469
2	BLACK EARTH CREEK NR BREWERY RD AT CROSS PLAINS,WI	05406457
3	BLACK EARTH CK NR TREATMENT PLNT @ CROSS PLAINS,WI	05406479

The accuracy of the USGS gage data was discussed with Nicolas Buer, a Hydrologist with the USGS. The stream gages on Brewery Creek and on Black Earth Creek downstream of the Village remained in operation during the entire flood event with no clear errors observed in the data, and the flow measurements are assumed to be reasonably accurate. The stream gage on Black Earth Creek at Brewery Rd. was fully inundated and unable to send data for a period of time during the flood. Using the data that was collected by the recorder and comparing the stage-discharge relationship with high-water marks at that location, estimated flows were calculated by the USGS. The stream gage was inundated and partially functioning (and therefore estimated flows were calculated) from 7:30 PM on August 20, 2018 to 11:30 AM on August 21.

Flow hydrographs for each of the USGS gages are provided in Figure 5. The peak discharges were 779 CFS on Brewery Creek, 1,050 CFS on Black Earth Creek at Brewery Rd, and 2,780 CFS on Black Earth Creek on the downstream side of the Village. All three hydrographs plotted from the gage data had steep rising limbs early in the flood event due the extreme intensity of the rainfall event. The steepest rise in flow, particularly on Black Earth Creek, occurred roughly 5-hours into the rain event, following a 1-hour period where the measured rainfall rates were consistently 4-6 in/hr. The Brewery Creek gage location had a relatively "flatter" hydrograph, a likely indication of upstream flow attenuation occurring along the creek in the low areas adjacent to the creek east of CTH P.

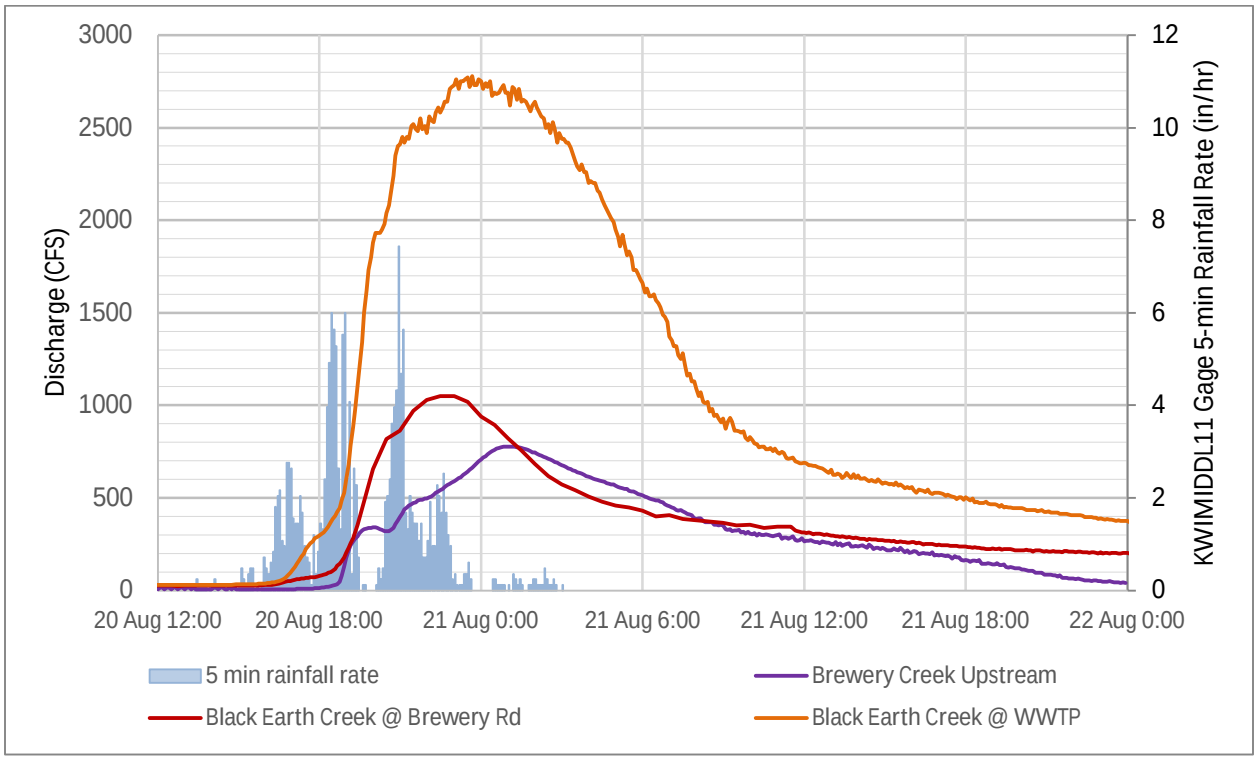


Figure 5. August 20-21, 2018 USGS Cross Plains Gage Locations Measured Flood Discharges

By adding and subtracting the streamflow hydrographs, the flow contribution to the flooding from other sources can be inferred. The hydrographs for the August 20 flood event from the USGS gages upstream of the Village were added to estimate flow contributions outside of the village limits. The

resulting hydrograph was subtracted from the measured flow on the downstream side of the village. These results are shown in Figure 6. During the peak of the flood the estimated flow contribution within the Village limits was 1,000-1,200 CFS. This alone is comparable to the 100-yr flood for Black Earth Creek, from just 5% of the contributing watershed.

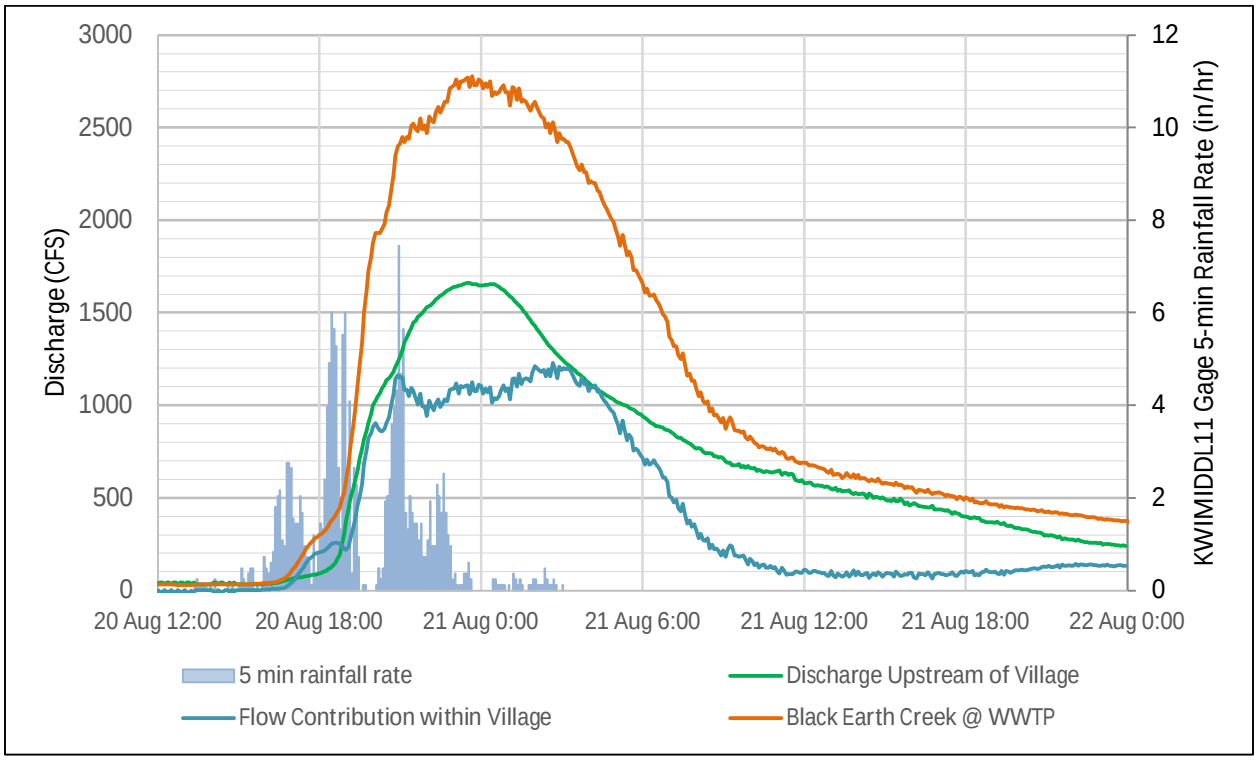


Figure 6. August 20-21, 2018 Calculated Flood Discharges for Flow Contributions Upstream and within the Village

1.2.3. Flood Recurrence Estimates

Assessing the actual expected flood event recurrence is difficult; however, the available data does provide some insights. With several caveats, the best that can be concluded is that along Brewery Creek the flooding likely exceeded that of the estimated 100-yr flood event, and flooding along Black Earth Creek likely exceeded that of the estimated 500-yr flood event.

The Flood Insurance Study (FIS) of Dane County provides calculated flows at three locations in, and near, Cross Plains for the 100- and 500-yr flood events[2]. These locations and the FIS flood flows are provided in Figure 7 and Table 2. These flow estimates are the best information available from study of the watershed, however, they do have limitations. One limitation is that the locations are not precisely the same so comparisons of the flood flows are only qualitative. Furthermore, the FIS report

[2] Using the terminology of a 100-yr flood is a shorthand way of saying there is a 1% chance in any given year. Similarly, a 500-yr flood is a flood event with an estimated 0.2% chance of happening any given year.

does not provide detail or backup documentation on how the flows were estimated, only the methodology used is provided. The FIS estimated flood discharges do not directly account for flow routing (attenuation) occurring upstream. It should also be noted that flood flow calculations are based on many factors beyond precipitation, so a 100- or 500-yr rainfall event would not necessarily be expected to result in a corresponding 100- or 500-yr flood. Finally, all flood estimates provided in the FIS are based on an analysis of past flooding events and do not account for climate change.

Table 2. Peak Flood Discharges (CFS) near on Black Earth and Brewery Creeks Compared to FIS Estimates

Location	Aug 2018 USGS Gage Peak	Flood Insurance Study	
		100-yr	500-yr
USGS Brewery Creek Upstream of Village	779	-	-
Brewery Creek at Confluence with Black Earth Creek	-	1,070	1,600
USGS Black Earth Creek at Brewery Rd	1,050	-	-
Black Earth Creek at Confluence w/ Brewery Creek	*1,652**	1,350	1,570
USGS Black Earth Creek at Treatment Plant	2,750	-	-
Black Earth Creek at Confluence with Garfoot Creek	-	1,800	2,146

*- Peak flow estimate from adding hydrographs from USGS gages at Brewery Creek Upstream of Village and Black Earth Creek at Brewery Rd.

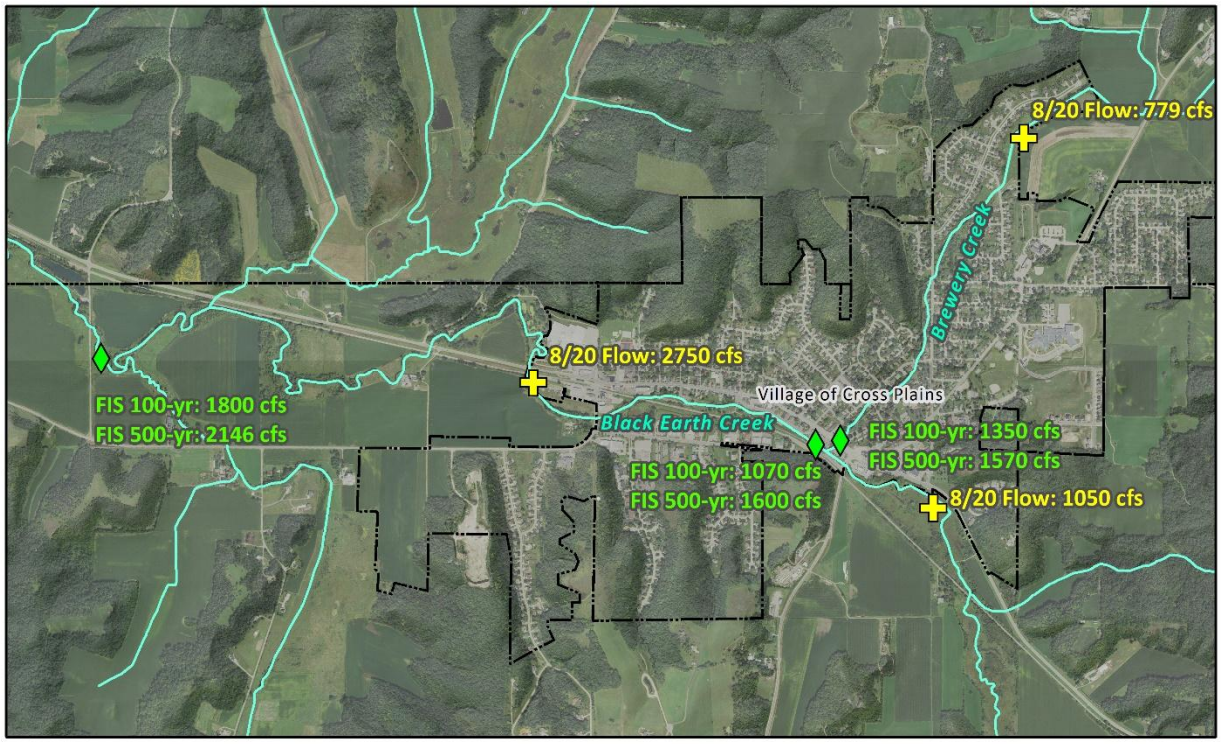


Figure 7. USGS Measured Peak Flood Flows Aug 20, 2018 and Flood Insurance Study (FIS) Estimated Flood Discharges

The measured flows along Brewery Creek upstream of CTH P were lower than expected (roughly 100-yr flood event) given that the watershed experienced a 500- to 1000-yr precipitation event. However, in reviewing damage photos taken the day after the flood there are some indications that the flow may have been higher than estimated by the gage. Town & Country Engineering provided photos of the Saint Francis St. crossing on Brewery Creek (approximately 1,100 ft downstream of the USGS gage) taken the morning after the flood. Debris collection on the upstream guardrail and erosion on the downstream embankment show that significant flow went over the roadway (Figure 8). The FIS hydraulic modeling in this area indicates that, if the culverts were clear, flows would need to be in excess of 1,200 CFS (compared to the measured 770 CFS). However, it is not known if the culverts were free of debris and sediment prior to, and during the flood. A cursory analysis indicated that the 1-2 feet of sediment accumulation in the culvert could result in overtopping of the roadway for a flow of less than 1,000 CFS.

Observations from Village staff and residents also supports the argument that the flood flows along Brewery Creek were much higher than what was estimated by the USGS gage. Jerry Gray indicated that during the peak flood a firefighter was standing on CTH P waist deep in water. For flow over the roadway at this location to be 2.5-3 ft deep, the estimated flood flow would likely have needed to be 3,000 CFS or more - more than three times that estimated by the gage. This depth of flow over the roadway could not be achieved by blocking of culverts or bridge openings in the area alone. Based on the FIS estimates 3,000 CFS would likely be well over a 1,000-yr flood event. The flood inundation map provided by Town & Country does not support the conclusion that flows were nearly that high. Therefore, it is difficult to conclude which method is most accurate for estimating flows on Brewery Creek. For the purpose of this report we have assumed that the USGS gage was accurate, with the understanding that there is evidence that the flows were much higher.

Figure 8. Photos of the Upstream (right) and Downstream (left) Portions of the Saint Francis St Brewery Creek Crossing.

2. DATA AND METHODS

2.1. Data

Primarily publicly available data was used for the analysis and design of the flood mitigation projects on Brewery Creek. Some information gathered by MARS-EOR in production of a yet to be approved Conditional Letter of Map Revision (CLOMR) for the was used (which is not currently publicly available information). The following information was used in this project.

- Effective Flood Insurance Study (FIS) model of Brewery Creek. 1D model built using US Army Corps of Engineers Hydrologic Engineering Center – River Analysis System (HEC-RAS) model. The FIS model terminates on Brewery Creek at the Village limits.
- CLOMR model submitted to FEMA and the DNR (and currently under review) on Brewery Creek for the proposed creek crossing at the St. Francis development. This model includes some survey cross sections of Brewery Creek and the Hwy P Crossing. The CLOMR model extended upstream to the field access road crossing Brewery Creek approximately 1,400 ft upstream of Hwy P.
- Effective FIS model of Black Earth Creek in HEC-RAS
- Steady-state peak flood flows developed in the FIS and CLOMR analysis for the Brewery Creek watershed and the watershed upstream of Hwy P for the 10-, 25-, 100-, and 500-yr flood events.
- United States Geological Survey (USGS) stream gage for Brewery Creek data available online.
- 2017 Dane County NAIP Aerial Imagery.
- 2018 National Land Cover Dataset (NLCD).
- 2017 Dane County LiDAR DEM.

2.2. Hydrology

For the purpose of analysis, the Brewery Creek Watershed was subdivided into three sub watersheds, referred to as Hwy P, North Tributary, and South Brewery (Figure 9). The flood mitigation hydrologic analysis focused on evaluating flows for the sub watershed upstream of Hwy P. Hydrographs for multiple design events were developed to design and analyze flood mitigation projects. A detailed hydrologic analysis of Black Earth Creek was not completed as there were no proposed flood mitigation projects to increase flood storage along the creek. The Village has expressed interest in evaluating flood control projects based on the August 2018 flood event.

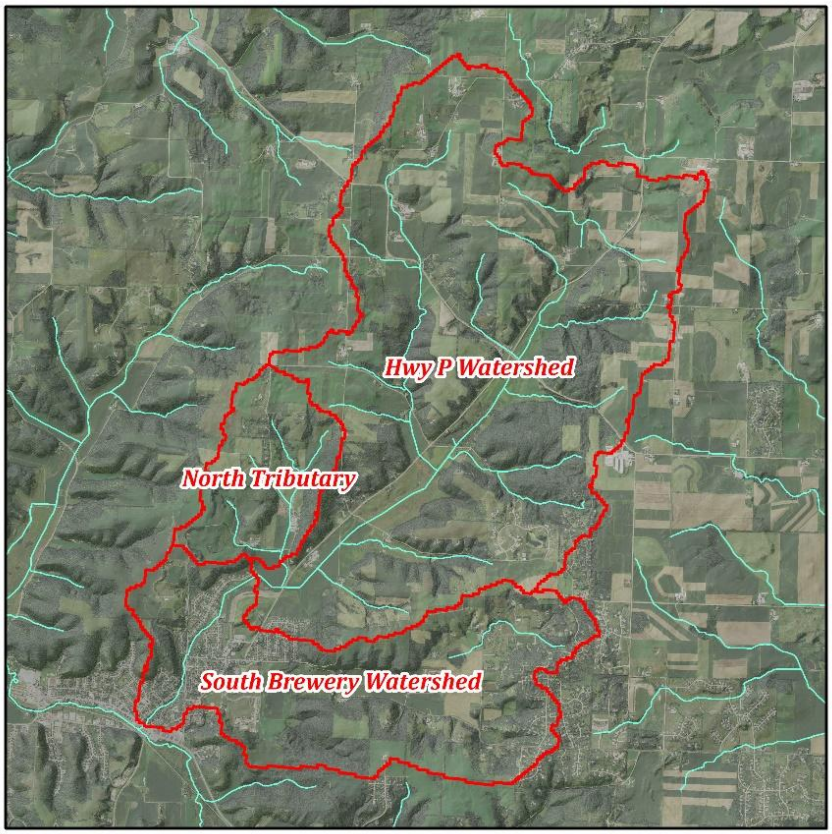


Figure 9. Brewery Creek Subwatersheds

A synthetic hydrograph shape was developed using Soil Conservation Service (SCS) Curve Number (CN) and TR-55 methodology for the Hwy P and North Tributary Watersheds. The sub-watershed areas were delineated using the Dane County LiDAR DEM. The watershed area upstream of Hwy P was calculated to be 7.1 square miles, while the North Tributary area is 0.96 square miles. The full Brewery Creek Watershed is 11.1 square miles. Land use areas were estimated from the NLCD and visual inspection of aerial photography. CN's were selected for each land use based on TR-55 guidance. The time of concentration for the watershed was determined using the LiDAR DEM. The NOAA Atlas 14, 12-hour rainfall depths for Dane County and the MSE 4 rainfall distribution were then simulated within HydroCAD. The hydrographs for the North Tributary were shifted so that when the two hydrographs for each subwatershed were added for a given storm event the peak flow matched the FIS flow at the Village limits.

After routing of the 100-yr hydrograph for the area upstream of Hwy P (with a peak flow of 957 CFS) through the hydraulic model, the calculated discharge at the Village Limits was 700 CFS, 10% lower than the peak flow of 770 CFS measured by the USGS gage on Brewery Creek during the August 2018 flood. Calculated peak discharge estimates the design floods are provided in Table **3** for reference, while the design hydrographs are shown in Figure 10.

Table 3. Estimated Peak Flood Discharges on Brewery Creek

Description		Location (Sub watershed)	Peak Flood Discharge (CFS)
FIS Estimated Flood Flows	25-yr	Brewery Creek at Village Limits (North Tributary and Upstream of Hwy P)	663
	100-yr		1,070
	500-yr		1,600
USGS Regression Equations area ratio	25-yr	Hwy P Crossing (Upstream of Hwy P)	594
	100-yr		957
	500-yr		1,440
USGS Regression Equations area ratio	25-yr	North Tributary	195
	100-yr		300
	500-yr		517

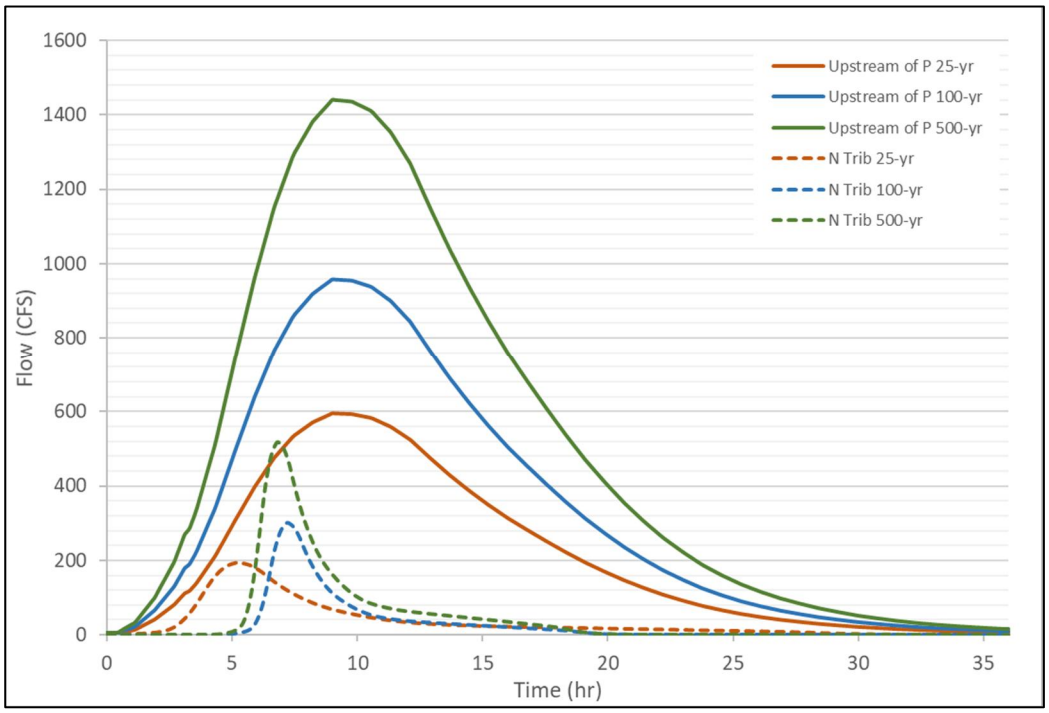


Figure 10. Synthetic Design Inflow Hydrographs for Brewery Creek Storage Area

2.3. Hydraulic Modeling

Existing 1D hydraulic models were used as the starting point for modeling flood flows on Black Earth and Brewery Creeks. Changes were made to the model geometries and flow files to evaluate existing flood events, as well as, changes from proposed projects.

An unsteady model (variable flow over time) of Brewery Creek was built in HEC-RAS to evaluate the current flood flow attenuation caused by the Hwy P crossing, as well as to design additional flood storage to further attenuate flood flows. The currently effective flood insurance study was used as the starting point for the analysis. Revisions were made to update the model to include the CLOMR

analysis completed by MARS-EOR for the proposed Creek Crossing at St Francis development adjacent to Brewery Creek. The Brewery Creek model was then extended upstream to Able Rd. The model domain is shown in Figure 11.

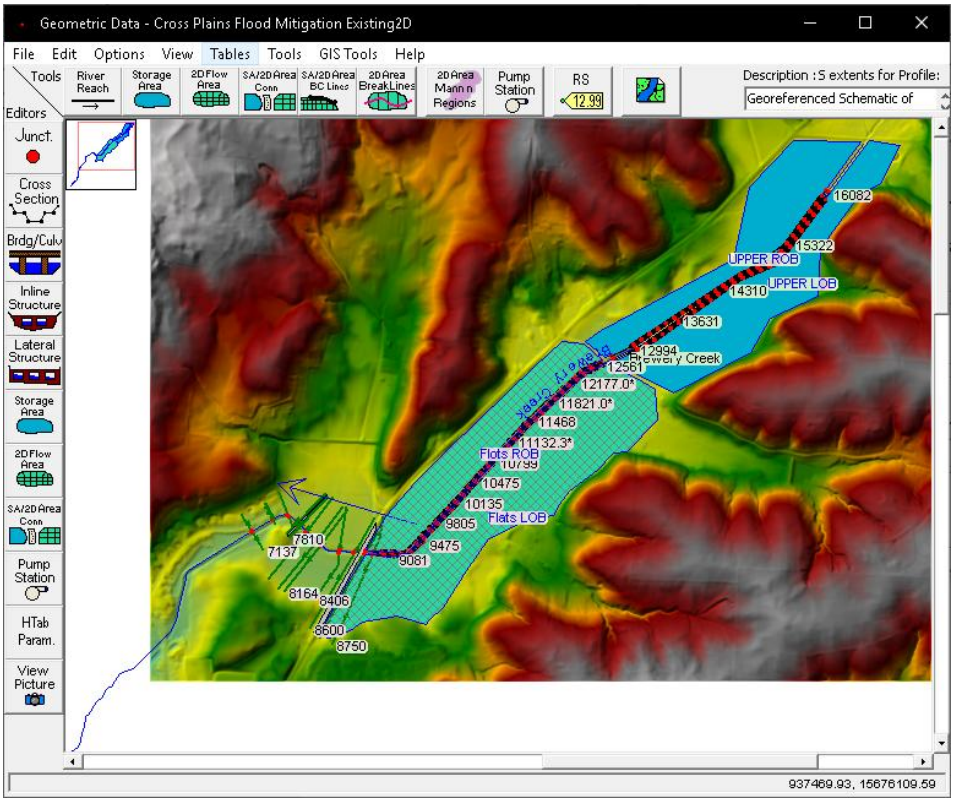


Figure 11. Brewery Creek Storage Area Hydraulic Model Domain

The low lying, areas upstream of Hwy P along Brewery Creek up to Albe Rd. were modeled as a series of storage areas connected to Brewery Creek. The banks of the river were modeled as lateral structures, allowing water to flow in and out of the storage areas as the topography allows. 2-dimension model areas with a 25-ft grid were built to simulate flow out onto the floodplain in the area between CTH P and Enchanted Valley Rd. This better represented flow attenuation on the floodplain, but greatly increase the model run time so the 2D areas were limited. The existing conditions model was developed from the LiDAR DEM. While proposed DEM's were developed for the potential projects that were evaluated. The existing driveway, field access road, and Enchanted Valley Rd. crossings were not modeled because detailed survey data or field measurements could not be obtained and it was assumed that the amount of flood storage in this area would be much more critical than the hydraulics at crossings for large flood events.

Flow hydrographs for the design storms were routed through the unsteady model to determine the amount of attenuation that would occur for each scenario. The north tributary hydrographs were added to the model downstream of CTH P. The resulting peak flow out of the model was then added to the steady state FIS model for Brewery Creek to assess the extent of flooding that would occur. The resulting existing conditions inundation areas were compared to the flood inundation map prepared

by Town & Country after the August 2018 event (Figure 12). The results were consistent with the findings of the hydrologic analysis in the upstream areas of Brewery Creek the flooding was likely on the order of magnitude of a 100- to 500-yr flood event. However, further down Brewery Creek along Brewery Rd., the inundation mapping from Town & Country diverged from the modeling analysis. This is likely a result of deficiencies in the way the FIS modeled flow through the Village and misrepresentation of the Brewery Rd. Bridge. This is discussed in more detail in Section 2.4.

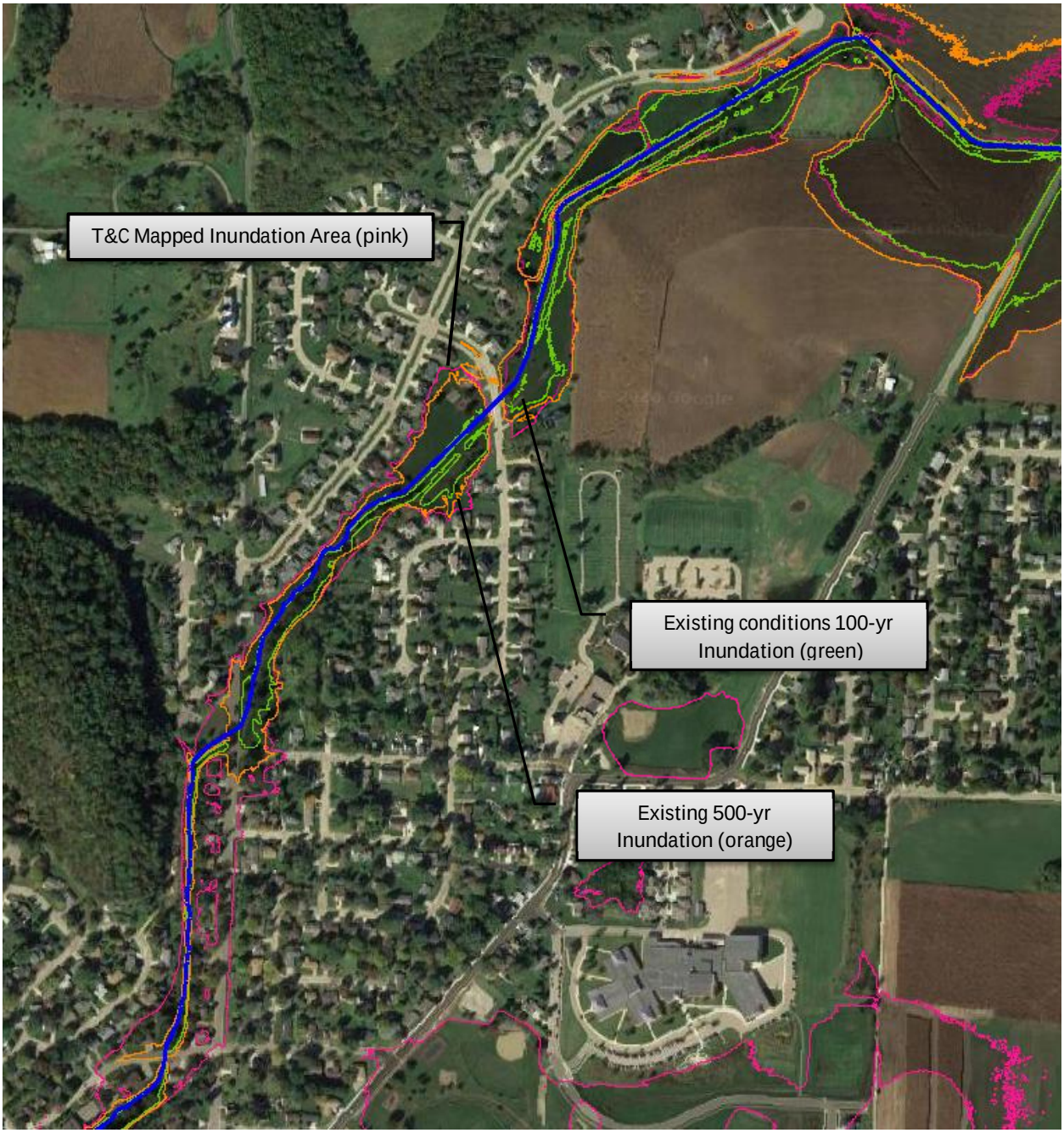


Figure 12. Existing Conditions Flood Inundation Areas and August 2018 Peak flooding

Evaluation of potential flood mitigation projects on Brewery Creek was made by adjusting the model geometry files. This including adjusting the DEM to account for floodplain excavation, raising the CTHP road profile, and adding a flood control structure. In addition, the channel and floodplain roughness were adjusted to simulate channel and wetland restoration for projects with extensive restoration components. The existing conditions model assumed a channel Manning's roughness coefficient of 0.03 and overbank roughness coefficient of 0.04. For projects with proposed channel meandering and restoration the channel roughness was increased to 0.035. While the floodplain roughness was increased from 0.04 to 0.05 to simulate conversion from cropland to densely vegetated wetlands.

The existing FIS HEC-RAS 1D model was used for hydraulic modeling of Black Earth Creek flood mitigation projects. Extensive modifications were not made to the existing conditions model geometry. However, the model was truncated to reduce run time increase the ease of data review. The modeling approach for proposed projects on Black Earth Creek is discussed in more detail in Section 3.2.1.

2.4. Flood Insurance Study Model Deficiencies

In comparing the findings of the updated hydrologic and hydraulic models to the FIS model and report a few deficiencies were identified with the effective FIS of Brewery Creek. The FIS likely significantly underrepresents flow in the channel for the assumed recurrence flood events. The FIS describes the Brewery Creek watershed as 8.0 square miles and the discharge at the confluence with Black Earth Creek is 1,070 CFS for a 100-yr event. However, for this report the total watershed contributing to Brewery Creek was calculated to be 11.1 square miles, while the watershed area of Brewery Creek upstream of the Village (where the current FIS terminates) is calculated to be 8.1 square miles. This suggests that the FIS only calculated the flow contributing to the upstream end of the model domain and did not consider flow accumulation going down the creek through the Village. Due to the relative steepness, high imperviousness, and proximity of the portions of the Village draining to Brewery Creek the FIS flows may be much lower than the actual flows of interest. Therefore, the mapped regulatory floodplain would be less extensive than it should be.

It was also noted that the area of Brewery Creek near Brewery Rd. and Thinness St. is not appropriately represented in the model. The FIS model assumes that all flow going over the Bridge on Brewery Rd will flow back into the channel on the west side of the roadway. In fact, a low point on Thinness St exists and any flow that flows over the roadway will be conveyed down Brewery Rd. This flow split was not represented in the hydraulic model. A detailed (potentially 2-dimensional) analysis would likely be needed to appropriately revise the model in this area. Again, the FIS may not be accurately representing the flood risk to infrastructure and properties along Brewery Rd, south of Thinness St. Addition discussion of this area of the model is provided in Section 3.2.2.

3. FLOOD MITIGATION ALTERNATIVES

Multiple methods of flood mitigation were considered to reduce peak flood flows on Brewery Creek. These included implementing upland conservation practices to reduce runoff to Brewery Creek, increasing flood conveyance, increasing the flood water storage, and providing improved connection between the channel and the floodplain. Each method provides varying flood reduction and other benefits. The Village of Cross Plains has expressed interest in creating a flood storage area on Brewery Creek upstream of Hwy P as an initial focus for flood mitigation, with an emphasis on maximizing benefits for extreme flood events. A continuing, comprehensive flood mitigation program should continue to evaluate and implement a wide variety of solutions.

3.1. Watershed Hydrologic Restoration

The Village has expressed interest in pursuing partnerships to design and implement best practices throughout the watershed to reduce runoff and improve water quality. Continuing to seek these kinds of projects could be vital to the success of the flood storage area along Brewery Creek. A watershed scale approach is often more cost effective than a large practice installed further down in a watershed. The watershed approach could target practices such as promoting infiltration, restoring wetlands, breaking drain tiles, stabilization of eroded slope and gullies, and promoting native and perennial land cover practices.

Stormwater runoff within the village could be controlled to reduce flood discharges. As was demonstrated in evaluation of the USGS gage data for the August 2018 flood, for very intense rainfall events a significant portion of the runoff entering Brewery and Black Earth Creek is coming from impervious surfaces and tributary valleys within the village limits. Given the topography and the existing development within the village there may be some practical limitations to what can be done. However, promoting runoff detention or infiltration beyond state or county requirements, installation of pervious pavements, and limiting the construction of new impervious surfaces are all potential methods to reduce stormwater surface runoff contributions to flooding.

Quantifying the extent of potential projects and the associated benefits of these watershed approaches is beyond the scope of this study. Additional detailed future study is highly recommended.

3.2. Flood Conveyance Improvements

3.2.1. Black Earth Creek Flood Diversion West of Village

There is potential to create a flood diversion on Black Earth Creek that could benefit several property owners on the west side of Cross Plains. Immediately west of the Village, near the wastewater treatment plant, Black Earth Creek goes under a railroad bridge and Hwy 14 and then shortly downstream the creek turns back under the highway and railroad. The railroad bridge at both

locations is a significant restriction to flow for the 100- and 500-yr floods. The topography on the south side of Hwy 14 would allow for a bypass channel to be cut parallel to the roadway (Figure 13).

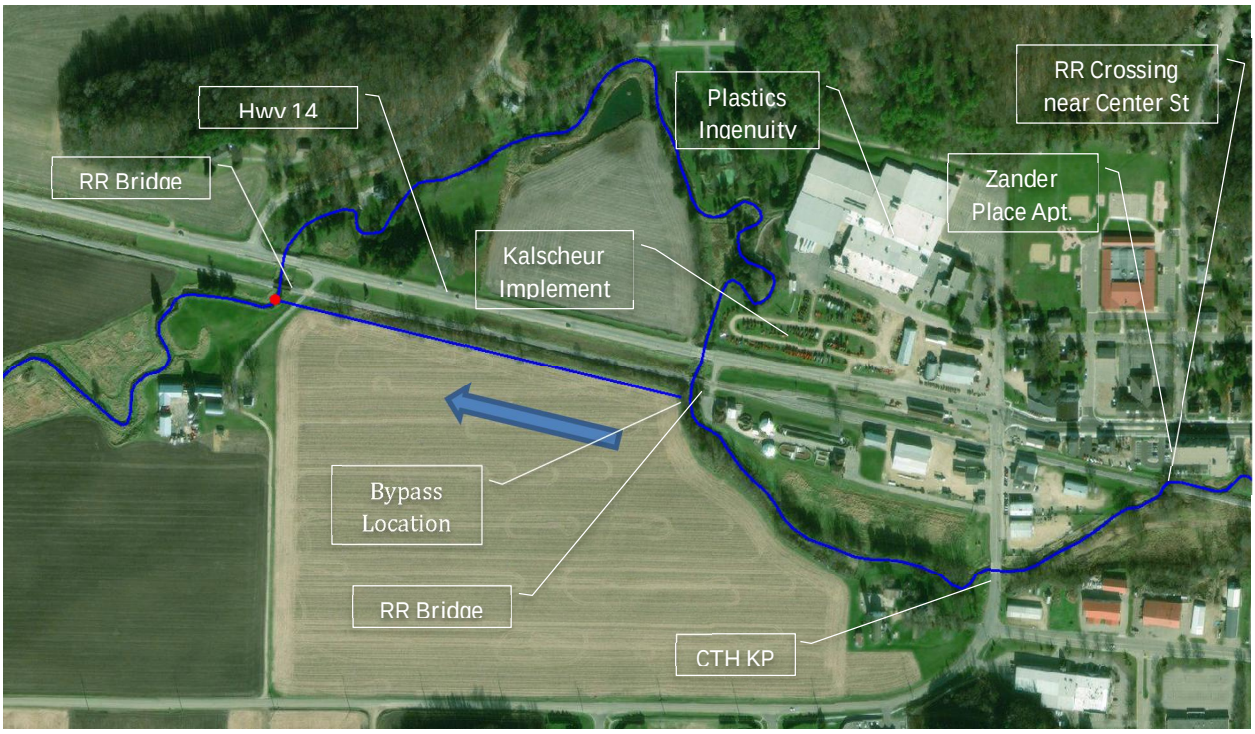


Figure 13. Proposed Black Earth Creek Flood Bypass Location

The proposed diversion would cut into the existing terrain approximately 3-4 ft deep and extend roughly 1,550 ft to cut off the channel meander. In order to provide enough capacity for large flood events the bypass channel would likely need to be set around the 25-yr flood elevation in Black Earth Creek at that location. The proposed channel would have a 5 ft bottom width and a maximum top width of 50 ft. A typical cross section of the channel is provided in Figure 14. Details such as designing a driveway crossing at the farmstead south of Hwy 14 have not been evaluated.

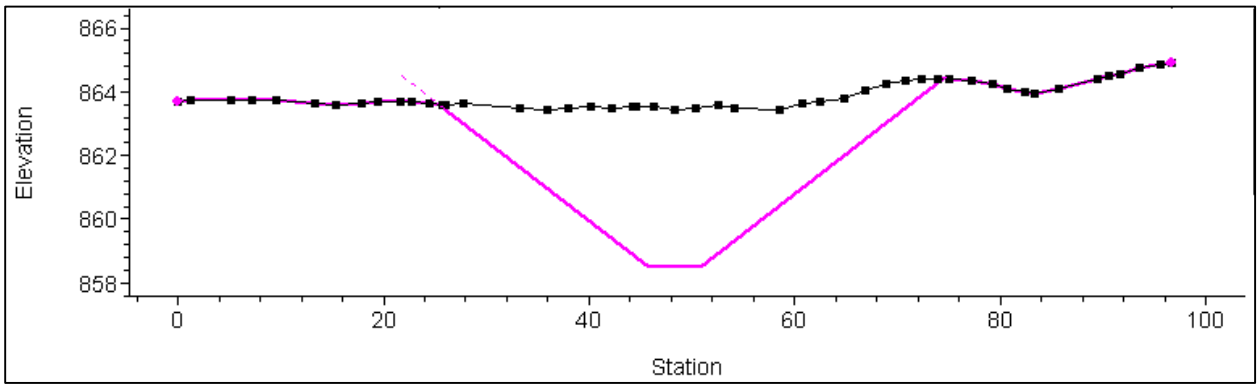


Figure 14. Typical Cross Section of Black Earth Creek Flood Bypass Channel

An iterative approach was used in the steady state FIS model for Black Earth Creek to determine how much flow would bypass the existing creek channel north of Hwy 14 for the 100- and 500-yr flood events, as well as, the August 2018 flood. This was completed by adjusting the flow file within HEC-RAS and splitting the flow at the bypass location until the flow elevation over the bypass weir matched the flow elevation in the main channel. The modeling indicated that the bypass channel could divert 18% of the flow during the 100- and 500-yr flood events and 22% during an event of the magnitude of August 2018. A summary of the flow diversion for each event is provided in Table 4.

Table 4. Potential Flow Diversion from Bypass Channel on Black Earth Creek

	Peak Discharge (CFS)		
	100-yr	500-yr	August 18 Flood
Total flow upstream of bypass	1,137	1,570	2,750
Flow diverted by bypass channel	213	287	603

Construction of this channel could reduce flooding for properties on the north side of Hwy 14 adjacent to Black Earth Creek and lower the flood profile for nearly 2,000 ft upstream. However, the existing bridge at Hwy KP and the railroad bridge upstream of KP near Center St. become restrictive and limit the upstream benefits. Improvements to these crossings could further extend the benefits of construction of a flood bypass channel. A cursory analysis removed the bridges (but did not modify the channel) to assess the likely maximum benefit that could be achieved by construction of the flood bypass and major redesign of these two crossings. The flood elevation at several locations along Black Earth Creek under these different scenarios is provided in Table 5.

Table 5. Black Earth Flood Elevations with Flood Bypass and Creek Crossing Modifications

Location	Existing	With Bypass	With Bypass and Removing CTH KP & RR Bridge from Model
100-yr Flood (1,800 cfs)			
Plastics Ingenuity	856.8	856.5	856.5
Kalscheur Implement	858.2	858.1	858.1
Wastewater Treatment Plant	861.1	860.5	860.5
West of Market Street	862.0	861.8	861.5
Zander Place Apartments/Coach's Club	863.3	863.3	862.4
500-yr Flood (2,146 cfs)			
Plastics Ingenuity	857.1	856.7	856.7
Kalscheur Implement	858.4	858.2	858.2
Wastewater Treatment Plant	861.6	860.9	860.9
West of Market Street	862.4	862.1	861.9
Zander Place Apartments/Coach's Club	863.5	863.5	862.8
August 2018 Flood (2,750 cfs)			
Plastics Ingenuity	858.8	858.0	858.0
Kalscheur Implement	859.5	858.9	858.9
Wastewater Treatment Plant	862.9	861.8	861.8
West of Market Street	863.9	863.4	863.4
Zander Place Apartments/Coach's Club	864.4	864.2	864.0

Generally, implementation of the bypass alone results in a reduction in the flood elevation of up to 0.5 ft for the 100-yr flood event, 0.75 ft for the 500-yr flood event, and 1.0 ft for the August 2018 flood. A flood profile plot for these three flood events is provided in Figure 15. The improvements are greatest near the bypass and decrease moving upstream and downstream. Flood profiles for the 100-yr, 500-yr, and the August 2018 floods are shown in Figure 16 through Figure 18. Interestingly, significantly improving the bridges to increase conveyance could extend flood reductions roughly another 1,000 ft upstream. However, this would likely come at a significant cost. Additionally, for the most extreme flood event considered (August 2018) improvements at the bridges would not result in any added benefit beyond construction of the bypass channel.

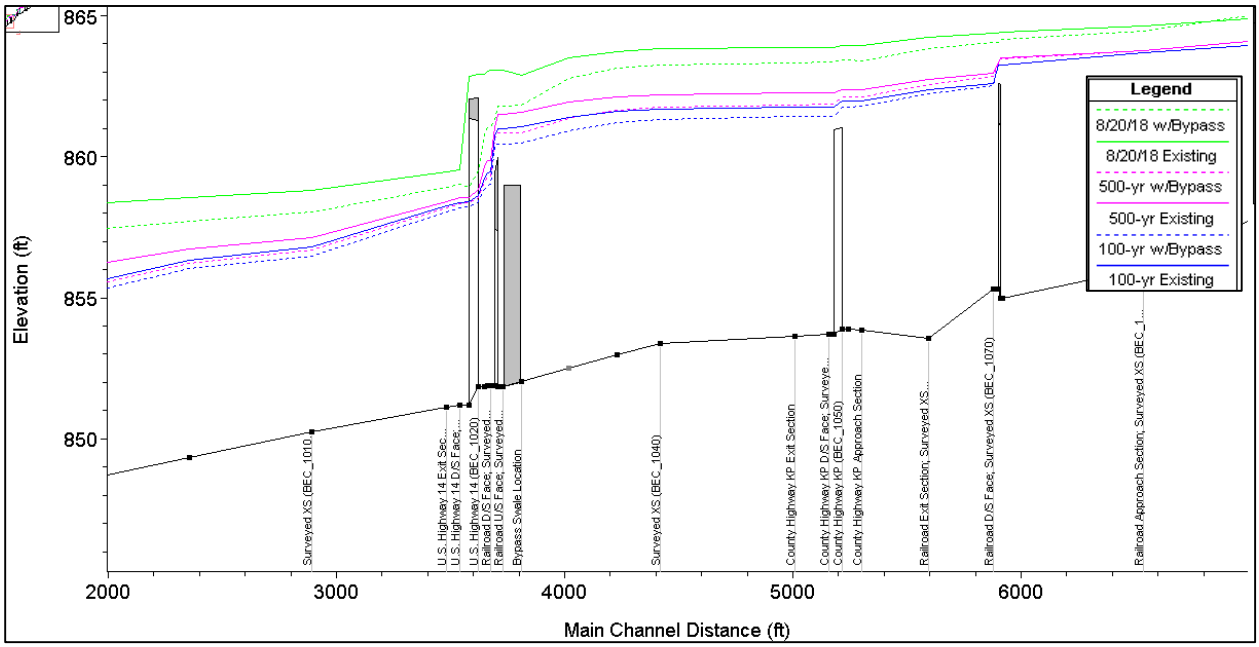


Figure 15. Flood Profile on Black Earth Creek for 100-yr, 500-yr, and Aug 2018 events with, and without Flood Bypass.

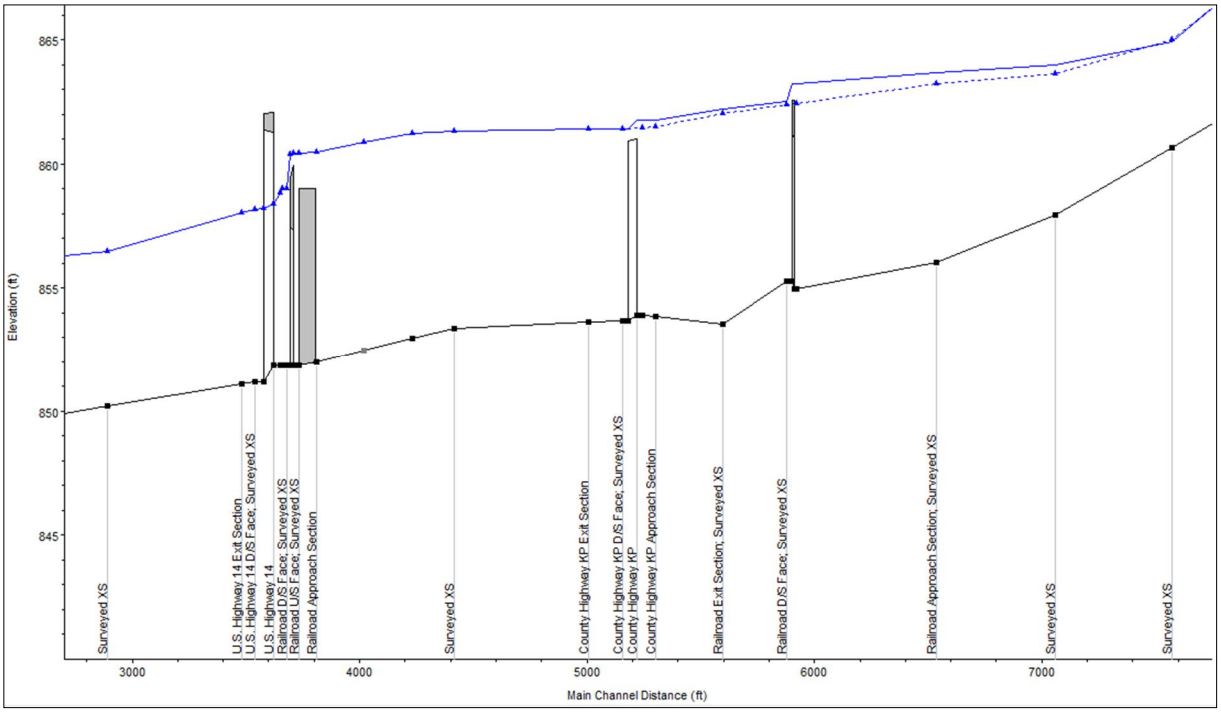


Figure 16. 100-yr Flood Profile on Black Earth Creek with Flood Bypass Channel (solid blue) and with Bypass Channel and KP and RR Bridges Removed (dashed blue).

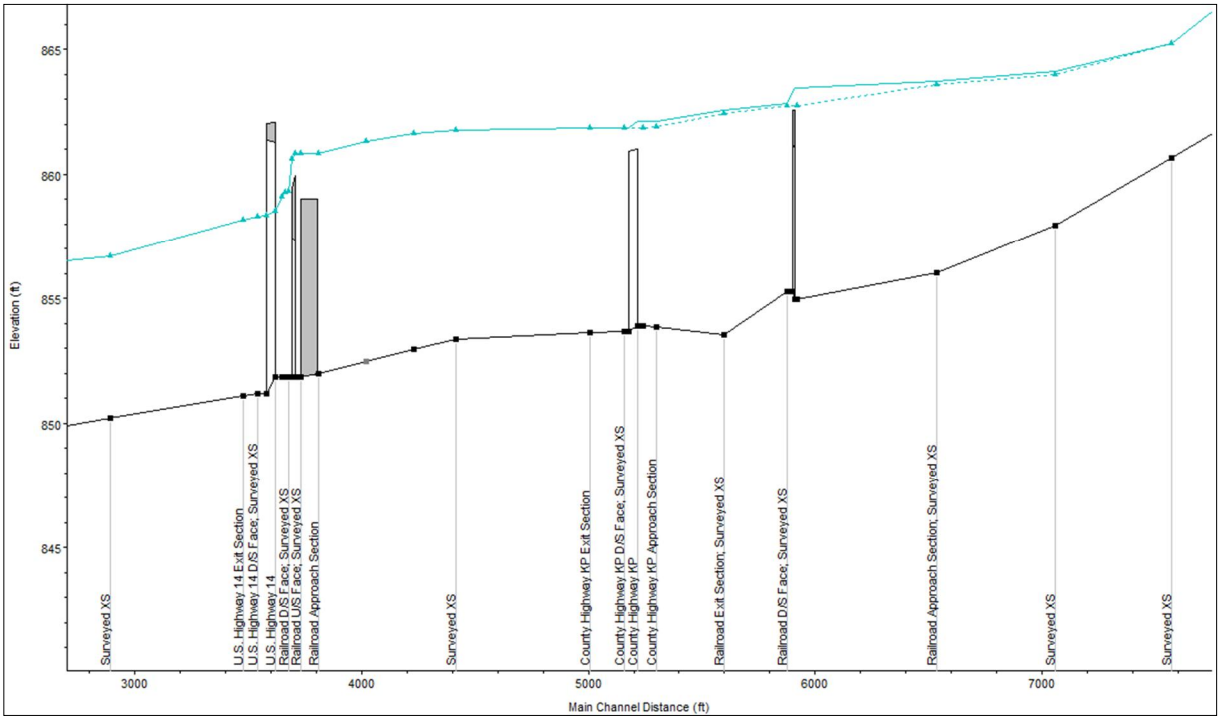


Figure 17. 500-yr Flood Profile on Black Earth Creek with Flood Bypass Channel (solid) and with Bypass and KP and RR Bridges Removed (dashed).

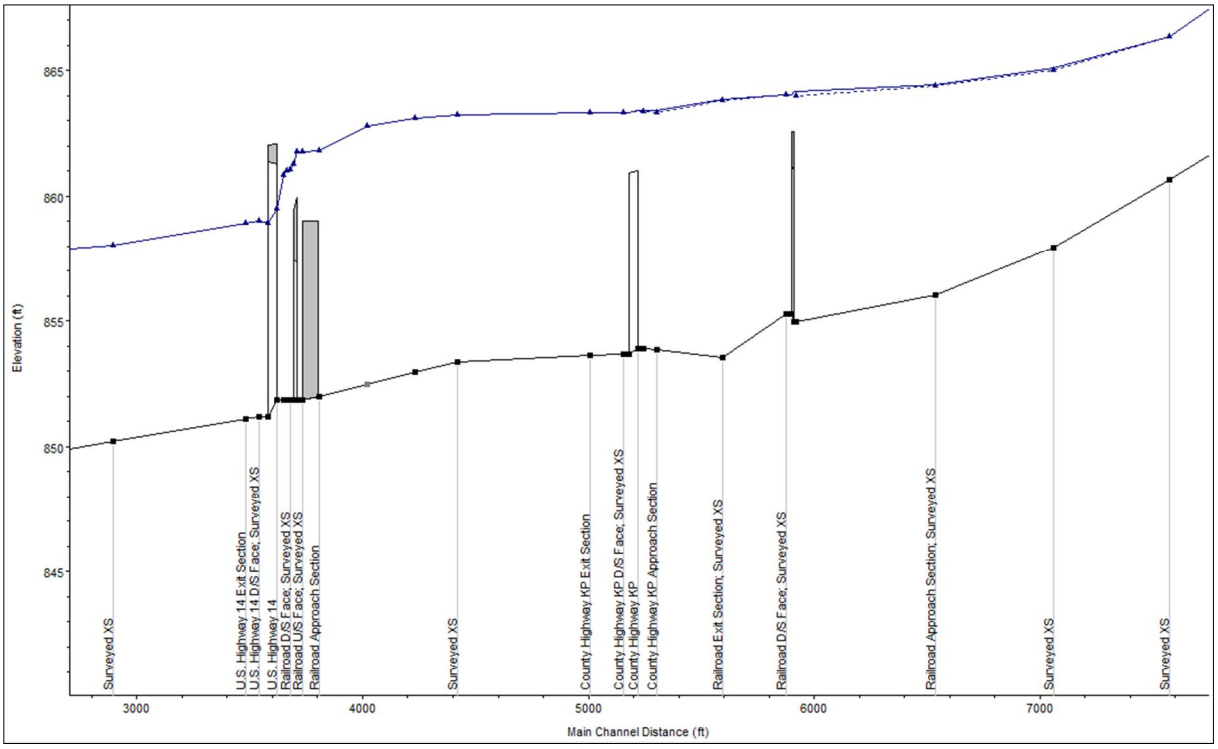


Figure 18. August 2018 Flood Profile on Black Earth Creek with Flood Bypass Channel (solid) and with Bypass and KP and RR Bridges Removed (dashed).

3.2.2. Brewery Creek Road Crossing Modifications

A review of the damage photos and flood inundation map provided by Town and Country clearly indicated that water flowed over several road crossings along Brewery Creek during the August 2018 Flood. The most significant damage observed in the photos occurred along Brewery Rd between Thinness St and Valley St. In reviewing the existing FIS model, it was apparent that the culvert crossing on Brewery Rd was not appropriately being represented.

The hydraulic modeling indicates that this crossing is a significant restriction to flood flows on Brewery Creek (Figure 19). Damage from the August 2018 flood clearly demonstrates that a significant amount of water went over the bridge and down Brewery Rd. The hydraulic model suggests that to prevent the over topping of the bridge flood flows would need to be reduced to well below 500 CFS. This target is likely not achievable for a significant flood event on the order of a 100-yr flood, much less the August 2018 event. Even complete removal of the bridge and increasing conveyance capacity in the channel (as shown in Figure 19) may not be sufficient to prevent water from flowing down Brewery Rd during 100-yr or larger flood events. Raising Brewery Rd and Thinness St at this location along with improved conveyance through the crossing may significantly reduce flood flows down Brewery Rd, however, there are practical limitations to accomplishing this due to the proximity to homes. Consideration should be given to redesign of this crossing in conjunction as part of the flood mitigation plan. However, only redesigning the crossing will not provide significant additional protection of infrastructure downstream on Brewery Rd. Additional

detailed 2-Dimensional modeling could be warranted to fully understand the hydraulics around the channel crossing and what kind of improvements could be made.

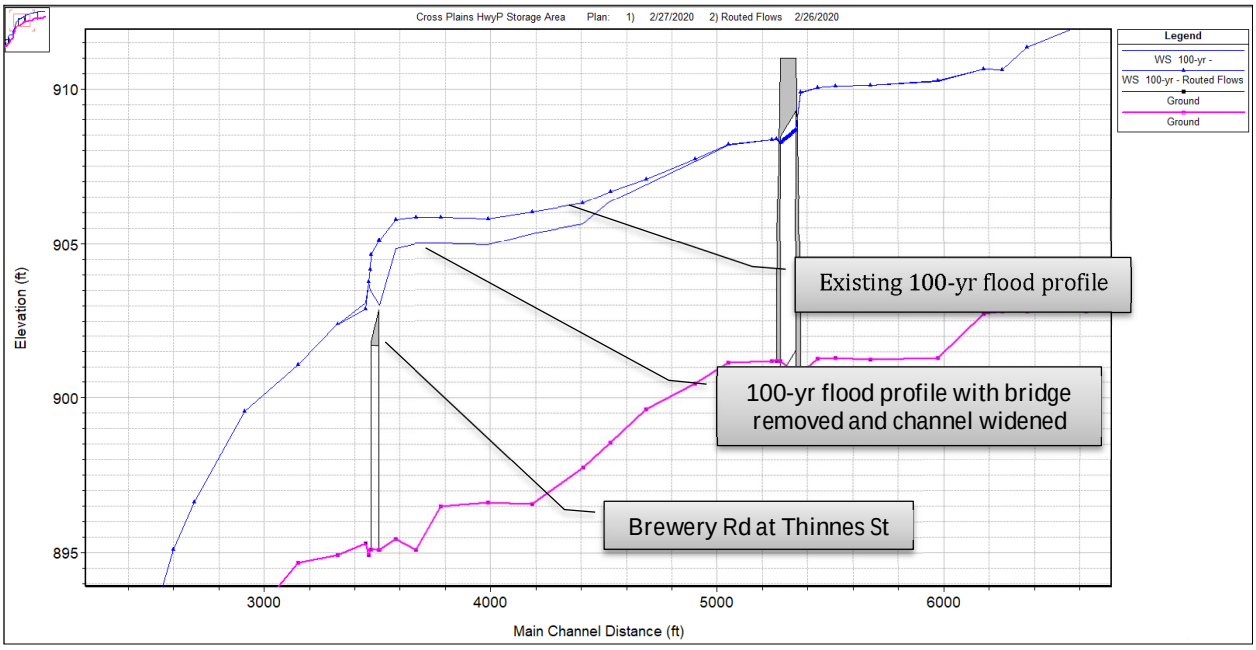


Figure 19. Brewery Creek Flood Profile near Thinness St

Redesign of crossing further downstream at Valley St, Lewis St, or Hwy 14 to improve conveyance could reduce flooding along Brewery Creek during periods of low water on Black Earth Creek. However, during the August 2018 flood event the key contributor of the flooding of the area of Brewery Creek between Hwy 14 and Lewis St was likely backwater from Black Earth Creek. The hydraulic model of Brewery Creek suggests that there are no improvements on Brewery Creek in conveyance or flood storage that would reduce flooding between Hwy 14 and Valley St for an event like the August 2018 flood.

Village staff have indicated there is no current interest in pursuing redesign of road crossings on Brewery Creek. They acknowledged that the restricted bridges may in fact be providing some flow attenuation along the creek during extreme flood events. Increase the conveyance through these crossing could, in fact, result in more flooding at downstream locations. The area of concern around the Thinness St crossing at Brewery Rd was noted. Given the likelihood of overtopping under current conditions Brewery Rd should be avoided for evacuation or emergency routes.

3.3. Brewery Creek Floodplain Storage

3.3.1. Floodplain and Channel Restoration

Flood storage upstream of Hwy P could be increased by significant floodplain excavation along the Brewery Creek channel upstream of the highway crossing (Figure A1). This would also provide more connection between the channel and the overbank floodplain. A similar floodplain restoration project was completed approximately 10 years ago in the Pecatonica River watershed (Figure 20). Ecological benefits would come from stream remeandering, native vegetation restoration, and reconnection of floodplain wetlands with the stream. Flood attenuation would likely be most significant for small floods, some attenuation would still be provided for larger events. Such a restoration project requires much less effort to implement than a significant flood control dam. The floodplain restoration would be easier to permit and likely face less opposition than a dam, and alternative funding for restoration projects could be available.

Figure 20. Floodplain Scrape and Reconnection on the Pecatonica River (from UW-Madison Hydroecology Lab)

Preliminary grading plans for the floodplain scrape and channel meander project have been prepared and are included in Appendix B. The proposed project would excavate approximately 2 ft down over large areas adjacent to the channel and increase connection with the floodplain. The Village has expressed interest in setting aside an open space or park area in the northern portion of the project area and build a bike path to provide access. Therefore, preliminary grading plans and a bike path alignment have been provided (though these areas were not included in the cost estimates, discussed later). This project also includes significant areas of wetland and prairie restoration which would provide benefits to native habitats, water quality, and recreational opportunities. The preliminary design includes approximately 36 ac of wetland restoration and 34 acres of native prairie restoration.

A cursory exploration of the site soils and groundwater conditions found that in the Spring of 2020 ground water elevations were generally 1.5-2.0 ft below the existing ground near the existing channel. The existing fields are extensively tiled which is likely artificially lowering the groundwater elevation. High groundwater may practically limit the extent of excavation, however, it does not preclude the project from being completed. Areas of lower wetland or open water scrapes could provide a variety of water quality and habitat benefits. Additionally, the excavation would provide a

means for groundwater to drain, and after a period it will likely reach a new lower equilibrium in the areas that were excavated.

The excavation of the floodplain scrapes will generate a significant amount of material. This material may be sold as clean fill, or even potentially, as nutrient rich sediment significant value may be generated from the sale of the material to help offset project costs.

3.3.2. Reconstruction of County Highway P

Re-construction and raising CTH P was considered as a potential method for increasing flood storage along Brewery Creek. The road was most recently improved in 2019 and it may be especially difficult to persuade village and county residents that another major improvement project on the highway is warranted. However, raising the road could significantly increase the flood storage on Brewery Creek upstream of the village. There, also may be reduced construction cost and permitting effort as compared to some other structural flood mitigation alternatives. However, it is possible that the raised road would be regulated as a dam by the DNR, which could increase the design and permitting effort required. Additionally, raising the roadway would increase the areas inundated during large flood events and necessitate the need to obtain flood easements from impacted landowners.

The proposed project would raise the profile of CTH P by 1.5 ft from the current lowest point of the roadway. It is estimated that approximately 700 ft of the roadway would need to be rebuilt to raise the road profile by at least 1.5 ft from the current lowest point (approximately 914). A screen shot from the HEC-RAS hydraulic model is shown in Figure 21. Detailed plan and profile drawings for the highway rebuild project were not prepared.

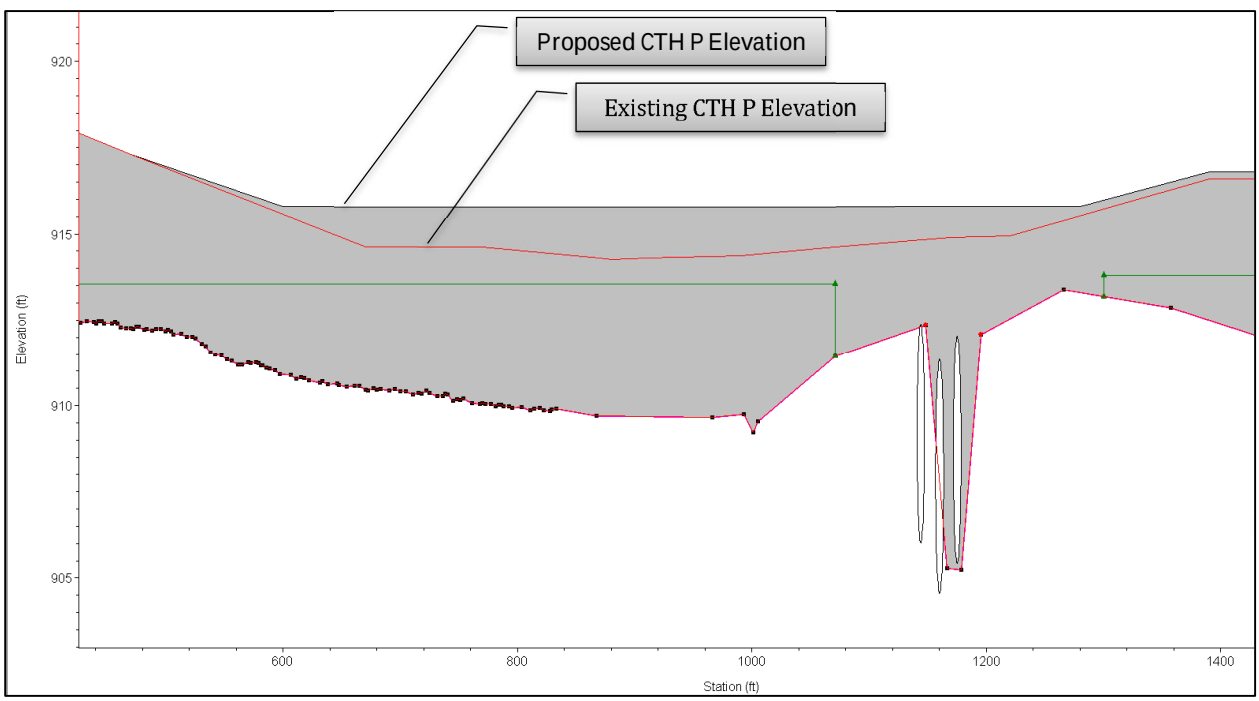


Figure 21. Existing and Proposed CTH P Road Profile

3.3.3. Flood Control Dam

A dam could significantly increase the flood storage volume within the Brewery Creek valley, with more storage per unit land area than other alternatives. Dams require substantial permit approvals and ongoing maintenance and safety procedures. While it could maximize flood storage, it may also encounter significant opposition due to environmental concerns. Some of these concerns could be alleviated if elements of the floodplain restoration alternative described above are included with a dam. This is possible if no permanent impoundment is created (e.g. if low flows are passed through the dam unobstructed and only flood flows are detained).

Along with the construction of the dam there is an opportunity to improve water quality, habitat, and provide recreational opportunities. These benefits could be achieved by meandering the existing stream channel to provide a more natural stream alignment. Scraping out accumulated sediment adjacent to the channel to increase flood storage and to provide increase connection between the stream channel and the floodplain. Restoring the areas to native wetland vegetation would increase habitat and provide opportunities for improved water quality. These scrape areas would also generate material that could be used in construction of the flood control dam. Finally, restoration of the existing agricultural land to native prairie vegetation would reduce runoff volume and nutrient export from the areas, as well as, providing habitat and recreational opportunities (such as hiking or biking trails). The preliminary design of the flood control dam has been completed to balance the design constraints of maximizing flood storage and flood flow attenuation, while minimizing construction costs and impacts to upstream properties.

The proposed project includes construction of a 1,350 ft-long and 6-8 ft-tall embankment on the east side of Hwy P. The dam has been sized to detain the 100-year flood discharge on Brewery Creek with an overflow elevation set to 917.0 ft and top of berm elevation of 918.0 ft. The existing overflow elevation of Hwy P is approximately 913.8 ft. The effective flood storage upstream of Hwy P would increase by approximately 105 ac-ft by raising this overflow elevation a little over 2 ft.

A low flow outlet through the dam would allow baseflow through the structure, including allowing fish passage, without significant attenuation of flow. This low flow structure also plays a role in how high water can pond during large flood events. This preliminary design includes a 110-ft-long 6 ft x 7 ft box culvert as the low flow outlet. Different outlet structures may be evaluated during detailed design of the project. Preliminary construction drawings for the flood control dam are provided in Appendix B.

The existing channel would be realigned to have a more natural stream meander. The precise alignment will be determined during final project design. The detailed analysis may include an assessment of stream sediment loading and transport to reduce the risk of stream meandering and downcutting from compromising the design. Alternative methods, such as grade control structures, could be used to allow the creek to create its own alignment. However, this would likely necessitate multiple locations of armoring and/or a downstream drop structure, these options have not been evaluated.

Wetland/floodplain scrapes adjacent to the creek would be constructed to provide additional storage for attenuating flood events. The excavation of these areas would contribute material for constructing the flood control dam. The total area of wetland scrape is 12.5 acres.

To prevent flooding impacts to the existing farmstead north and west of Brewery Creek on Hwy P, a proposed berm would be extended from the flood control dam to the north side of the farmstead. The farm buildings are not at a higher risk of flooding for events less than the 100-yr flood event, so the berm is not necessarily needed. If constructed in conjunction with the bike path this would serve as a levee; however, it is not anticipated that this would be permitted as a levee according to FEMA standards. The elevation of the ground adjacent to the home is estimated to be 923 ft, more than 5 ft above the top of the dam. However, several non-habitable structures are located below 918 ft, which would be at somewhat higher risk of flooding due to construction of the flood control dam. The approximate area of the farmstead below the top of berm elevation is shown in Figure 22.

Figure 22. Area of farmstead below flood control dam top elevation (918).

The village has expressed interest in reserving portions of the parcels for future park use, including construction of a recreational trail. A proposed alignment for the trail is shown in Appendix A, this also includes proposed preliminary grading of the park to raise it above the maximum ponding of the flood storage area. This grading plan would be potentially subject to significant revision in detailed site design.

Finally, all areas that are purchased that are not committed to other uses will be restored to native prairie. This may be either wet mesic or upland prairie. The total area of potential prairie restoration associated with the project is 53 acres. The proposed restoration is shown in Figure A1.

3.4. Brewery Creek Flood Mitigation Project Benefits

All the proposed projects could provide flood control benefits along Brewery Creek during large flooding events. It is our opinion that it will be a more cost effective approach to design flood control projects to a smaller flood event, however, the results are presented for projects for floods ranging between a 50-yr flood and the August 2018 flood (which exceeded a 500-yr flood event).

The primary means of reducing flood flows is by increasing the amount of effective flood storage between CTH P and Enchanted Valley Rd. The floodplain restoration project increases storage through excavation below the flood elevation while the other methods increase the overflow elevation for the area. A summary of the change in flood storage for each proposed project is proved in Table 6. All projects were evaluated as "stand-alone" projects; however, the combination of projects could potentially provide even further benefits than described here.

Table 6. Effective Flood Storage Along Brewery Creek Between CTH P and Enchanted Valley Rd

	Control Elevation	Estimated Flood Storage (ac-ft)	Increase from Existing (ac-ft)
Existing Conditions	914.0 (CTH P existing elevation)	134	-
Floodplain Restoration	914.0 (CTH P existing elevation)	190	56 (+42%)
Reconstruction of CTH P	915.6 (raised CTH P elevation)	261	127 (+95%)
Flood Control Dam	917.0 (dam spillway elevation)	329	195 (146%)

The flood control dam has the greatest impact in reducing flood flows upstream of the Village. With the flood control dam in place the calculated discharge decreases 27% from the baseline conditions. Calculated peak discharges and the percent reduction in flow from the existing conditions model are summarized in Table 7. The reconstruction of CTH would have very little to no effect for 100-yr and smaller flood events. Very little water goes over the roadway during the 100-yr event and so raising the road would only have a small impact. This analysis assumed that the culverts would be replaced in-kind. Full redesign of this creek crossing could have impacts for smaller design events as well.

Table 7. Peak Discharge (CFS) for 100-yr Flood Event on Brewery Creek at the Village Limits

Scenario	Peak Discharge (% reduction from Existing Conditions)		
	50-yr	100-yr	500-yr
Flood Insurance Study	663	1,070	1,600
Existing Conditions Routed	525	700	1,256
Floodplain Restoration	515 (2%)	670 (4%)	1,235 (2%)
Reconstruction of CTH P	525 (0%)	689 (2%)	912 (27%)
Flood Control Dam	352 (33%)	430 (36%)	790 (37%)

The decrease in discharges with the flood control dam results in a roughly 1.0 ft decrease in the 100-year flood elevation along Brewery Creek. These benefits decrease further downstream as the watershed contributing area increases. However, due to limitations in the way the FIS analysis was completed (discussed in Sections 2.4 and 5.1) the benefits cannot be precisely described in terms of

flood inundation area or reduced street flooding without a significant modeling effort to account for stormwater contributions from areas within the Village.

The construction of the flood control dam or raising CTH P does result in an increase in the regulatory flood elevation (100-yr) upstream of CTH P by more than 1.0'. This could impact the ability to develop the areas south of the flood storage area. The extent of flooding in the area flooded during a 100-yr flood event for existing conditions and with CTHP raised is shown in Figure 23. Note that the inundation area shown is not the regulatory flood elevation presented in the CLOMR. This is because different modeling methodologies are generally used in the FIS. Flood insurance studies require a more conservative steady state modeling approach to define the regulatory floodplain. The areas to be developed could likely be filled to elevate them out of the floodplain. However, this area must be studied in detail and plans coordinated with the developer during any final flood mitigation project design. The flood control dam flood elevation is not mapped below as modeling a dam using a steady state approach results in a very conservatively high flood elevation.

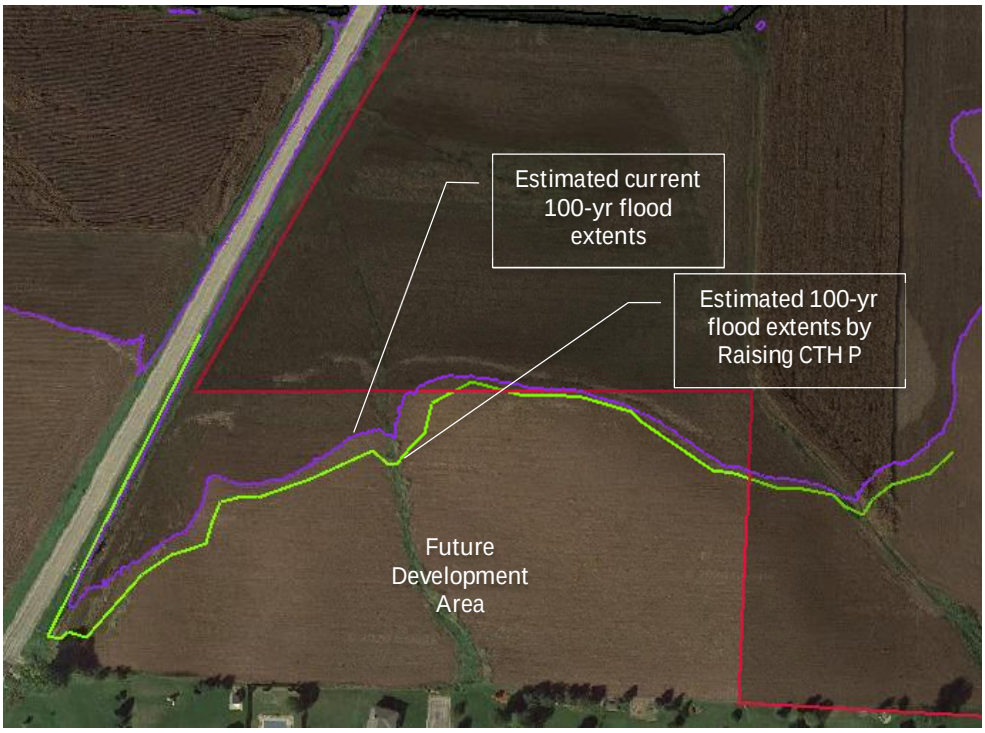


Figure 23. Flood Inundation Areas in Future Development Area

The attenuated flows were then put into the steady state FIS model of Brewery Creek to evaluate flooding benefits. Figure 24 shows the 500-yr flood inundation areas for the different proposed scenarios mapped on the Dane County DEM. Despite large differences in the flows for the 500-yr event there are not drastic differences in the areas that are flooded during a 500-yr flood.

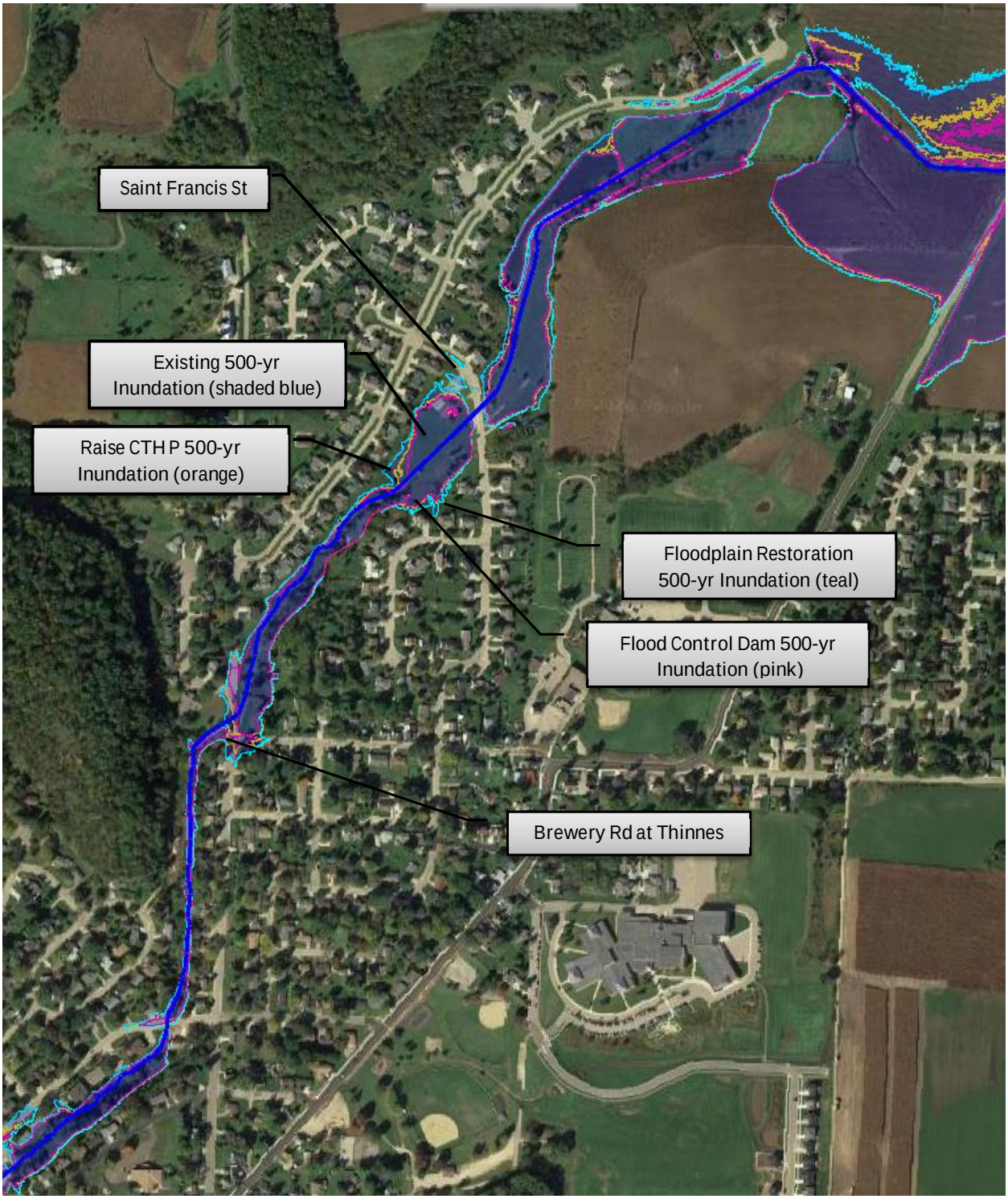


Figure 24. Brewery Creek Flood Mitigation 500-yr Inundation Mapping

4. IMPLEMENTATION

To assist the Village in understanding the scope of the potential projects that were evaluated for flood mitigation, detailed assessments were completed including the development of preliminary grading plans, project designs and construction schedule and costs, as well as permit considerations. The following section has also been prepared to assist in the development of future grant applications by the Village.

Given the number and variety of potential projects being considered, a varying conceptual level of design was developed in order to assist the Village evaluate the efficacy and constructability of future projects. Based the Village's preference, extra effort was put into developing the details for project implementation for storage improvements along Brewery Creek.

4.1. Construction Procurement

It is assumed that for all potential projects, the construction procurement will be administered by the Village through competitive bidding process. There are no clear indications that alternative method would be preferable.

4.2. Property Acquisition

Several of the proposed construction projects will require the acquisition of multiple parcels outside of the Village limits, as well as, potentially the procurement of flood easements. Final land and flood easement acquisition should not be completed until final design of any proposed project is completed.

The construction of the proposed flood control dam, wetland scrapes, and native vegetation restoration can be completed within five parcels immediately upstream (east) of Hwy P. The total project area is estimated to be 70.5 acres. Please note that the construction of the flood control dam does not actually preclude farming the parcels of interest. The design only results in increased risk of flooding for events larger than a 25-yr flood. Therefore, it is possible that the full area may not need to be purchased.

It is estimated that 4.0 acres of land would need to be purchased to construct and maintain a flood diversion on Brewery Creek west of the Village.

Estimates for land value vary widely depending on the data source and the landowner willingness to sell, productivity of the land, and the availability for future development. Based on a review of the available Access Dane parcel data the average assessed value for the parcels of interest is approximately $1,840/acre. A recent report (2017) on farmland values in Wisconsin published by UW Extension[3] estimated average agricultural land values in 2017 at $5,900/ac in south-central Wisconsin and $3,600 for southwest Wisconsin. For the purpose of this report a land value of

[3] https://fyi.extension.wisc.edu/farmteam/files/2018/04/Wisconsin-Ag-Land-Prices-2012-2017-final.pdf

$4,000/ac was used. Please note that the purchase price could vary significantly from this estimate. A summary of the estimated land acquisition needs for each project is provided in Table 8.

Construction of any impediment to flow to increase flood storage will result in increased flood risk of upstream areas. This includes the raising of Hwy P or the construction of a flood control dam along Brewery Creek. To conform with state and federal flood insurance program requirements the Village will need to obtain flood easements from property owners experienced increased risk from a 100-yr flood event. The number of impacted property owners and the total area of easements needed cannot be fully described until full detailed design and analysis of the project has been completed. A preliminary analysis estimated that the increased area of flooding during the 100-year flood is 7.5 acres and 1.0 outside of the proposed project area for construction of a flood control dam and the raising of CTH P, respectively. Figure A3 shows the estimated flooding extents for existing and proposed conditions. A planning level estimate of a one-time payment of $500 per acre was assumed for this analysis. Final easement costs will likely vary significantly depending on the landowners' willingness to negotiate with the Village. A summary of the anticipated easement acquisition needs for each project is provided in Table 8. If the Village cannot obtain flood easements it could potentially put the projects at risk as the project would not be in conformance with FEMA and State floodplain regulations, additional discussion is provided in Section 4.6.1.

Table 8. Anticipated Mitigation Projects Land and Easement Acquisition Needs

Project	Land Acquisition (ac)	Land Acquisition Cost	Flood Easements (ac)	Flood Easement Costs
Black Earth Creek Diversion	4.0	$16,000	-	-
Floodplain and Channel Restoration	70.5	$282,000	-	-
Reconstruction of CTH P*	-	-	1.0	$500
Flood Control Dam	70.5	$282,000	7.5	$3,750

* It may be necessary to obtain grading or access easements to raise CTH P. It is estimated that the total easement area needed would be less than 0.5 ac.

4.3. Permitting

Federal, State, and Local authorities will have review authority for the proposed projects. A list of the potentially applicable permits is provided in Table 9. The actual level of permitting required will be dependent on the final design. All reasonable efforts will be made to limit the permitting to the extent possible. It is assumed that all permits required by the DNR will be individual permits, which include a 90-day public comment period. Additional time for permit approval was added to allow for a response to regulator comments on the proposed design. The need for right-of-way permits was not assessed. Projects including work in the right-of-way would likely involve collaboration with the appropriate entity and potentially State, County, or Railroad right-of way permits.

At this point in time, the extent of wetlands in the project areas is not precisely known. Heartland Ecological Group, Inc. is providing review of the proposed projects and available information on the extent of wetlands. However, for the evaluation of permitting needs, we assumed construction will very likely be occurring within regulatory wetlands. Additional discussion will be provided in the narrative provided to Jewell Engineers, Assoc. by Heartland.

Table 9. Flood Control Dam Anticipated Permits

Permit Authority	Permit	Minimum Review Period
FEMA	Letter of Map Revision*	180 days*
WDNR	NR 216 – Stormwater Runoff	30 days
WDNR	Chapter 30 – Waterway Protection	120 days
WDNR	Chapter 30 –New Culvert Permit	120 days
WDNR	Chapter 30 – Stream Realignment	120 days
WDNR	Chapter 31 – New Dam Construction (large dam)	120 days
WDNR	Wetland Impacts	120 days
USACE	(concurrent with DNR Chapter 30 submittals)	120 days
Dane County	Shoreland Erosion Control	60 days

*The project location will result in changes to the regulatory floodplain. Therefore, it is anticipated that a Letter of Map Revision (LOMR) will be needed. However, we anticipate that the LOMR could be submitted at the completion of the project and it will not impact the construction timeline.

Each potential project will have a variable level of permitting required. The anticipated permit applicability for each project is provided in Table 10.

Table 10. Anticipated Applicable Permits by Project

Permit	Black Earth Creek Diversion	Floodplain and Channel Restoration	Reconstruction of CTH P	Flood Control Dam
Letter of Map Revision (FEMA)	X	X	X	X
NR 216 – Stormwater Runoff (WDNR)	X	X		X
Chapter 30 – Waterway Protection (WDNR)	X	X	X	X
Chapter 30 –New Culvert Permit (WDNR)			X	X
Chapter 30 – Stream Realignment (WDNR)		X		X
Chapter 31 – New Dam Construction (large dam) (WDNR)				X
Wetland Impacts (WDNR)	X	X		X
USACE Permits	X	X	X	X
Shoreland Erosion Control (Dane County)	X	X	X	X

As part of the submittals to the DNR, the project would need to evaluate the presence of protected or endangered species and cultural/historic resources. A preliminary review of the WDNR endangered species database was completed using the Natural Heritage Inventory (NHI) Public Portal. This review identified several protected species. Specific species and required courses of action were not identified in the review. However, it is anticipated that any impacts to endangered species from the project will be permittable due to the increase in habitat from the proposed native restoration. If there are any cultural/historic resources present at any of the potential project sites, the project could potentially be delayed if additional study is needed.

4.4. Project Schedule

A proposed project schedule was developed based on the preliminary design and anticipated permit needs. It was assumed that all permit submittals could be made concurrently. This excludes the LOMR to officially revise flood maps, which would be completed after construction has concluded. Additionally, it is assumed that the land and easement acquisition could be completed concurrently with the permit review period and finalized contingent upon permit approval. Additional detailed design may be needed, depending on the feedback from regulators. The bid solicitation, and contract negotiation with the selected contractor, would not be completed until all permits were in hand. Construction timelines are likely to vary depending on weather, site conditions, and contractor availability. Additional vegetation restoration work may continue well beyond the initial construction period for the large-scale restoration projects, depending on the time of year the site grading work is completed. A simplified Gantt chart for each project is provided in Table 11.

Table 11. Proposed Project Schedule

Phase	Duration	Month																	
Black Earth Creek Diversion																			
Detailed Design	2-3 months																		
Permit Review	3 months																		
Property and Easement Acquisition	3 months																		
Bid Solicitation and Contract Award	2 months																		
Construction	3 months																		
Brewery Creek Floodplain and Channel Restoration																			
Detailed Design	3-4 months																		
Permit Review	6 months																		
Property and Easement Acquisition	2 months																		
Bid Solicitation and Contract Award	2 months																		
Construction	4-6 months																		
CTH P Reconstruction																			
Detailed Design	2-3 months																		
Permit Review	2-3 months																		
Property and Easement Acquisition	2-3 months																		
Bid Solicitation and Contract Award	2 months																		
Construction	3 months																		
Brewery Creek Flood Control Dam																			
Detailed Design	3-4 months																		
Permit Review	6 months																		
Property and Easement Acquisition	4 months																		
Bid Solicitation and Contract Award	2 months																		
Construction	4-6 months																		

4.5. Project Budget

A project budget was developed from each of the conceptual project designs. The project budgets include cost estimates for land acquisition, engineering fees, inspection fees, as well as, construction and restoration.

Construction estimates were prepared based on earthwork, material, and restoration quantities estimated using AutoCAD Civil 3D design software. Unit prices were based on local experience in project bidding, RS Means Site Work and Landscaping Costs, and discussion with local contractors. Engineering data collection and design fees were calculated as a percentage of the anticipated construction costs. A planning level contingency of 20% was used for each project. Estimated project budgets are provided in Table 12. Itemized budgets along with the SF 424C classification and assumptions used in development of unit prices for each line item are provided in Appendix C. The grading costs associated with construction of the open space park area and the bike path berm are not included in the base project budgets, as the Village has expressed that funds for those projects may come from other sources. However, high level planning level cost estimates have been provided for reference as additional items in the cost estimates in Appendix C.

Table 12. Preliminary Project Budget Estimate

Project	Planning Level Costs
Black Earth Creek Bypass	$207,000
Brewery Creek Floodplain and Channel Restoration	$1,217,000
Brewery Creek Flood Control Dam	$1,335,000
County Hwy P Reconstruction	$297,000

4.6. Feasibility Analysis

The construction of any proposed flood mitigation projects would require a significant design, permitting, construction, and ongoing maintenance effort. However, given the available data and analysis all projects presented are feasible. There are several items that are especially critical to the successful implementation of these projects. Additional discussion of the most critical factors is provided below.

4.6.1. Flood Easement Acquisition

The potential flood mitigation projects could be put at risk if the Village is unable to negotiate flood easements with impacted landowners upstream of the project. Easements are required to obtain a LOMR from FEMA for all parcels impacted by increased flooding during the 100-yr flood event. If one or more landowners are not inclined to designate their land as a permanent flood easement, it could prevent the construction of the project altogether. Given recent large flood events, and the intent to mitigate flooding events from events larger than the regulatory flood, it may be appropriate to consider easements for upstream parcels for flood events larger than the 100-yr flood.

4.6.2. Constructability

The preliminary assessment of available data indicates that all potentially proposed projects are constructible. However, detailed site-specific data collection was not within the scope of this report.

For projects involving significant earthwork a detailed geotechnical and soil investigation should be completed. If material is required to be imported for the construction, costs could be substantially higher than provided in the above cost estimates. Furthermore, site conditions during construction may significantly impact the construction timeline and costs. Extremely wet soils or higher than anticipated groundwater during construction may significantly increase construction effort and therefore costs. Some of these risks will be mitigated during detailed design with additional data collection.

4.6.3. Dam Failure Considerations

In detailed design a dam failure analysis should be performed during design of a flood control dam. This is a requirement of the DNR's dam management program; however, it should be completed regardless of whether the structure is regulated as a dam or not. A significant head differential will exist during large flood events when the flood storage area is full. Failure of the dam would likely result in a greater discharge of flow all at one time, resulting in more damage downstream than from the flood without the dam in place. Development downstream of the dam would need to be regulated carefully to ensure that life and property are not put at undue risk.

4.6.4. Maintenance

All proposed projects will require routine maintenance to ensure that the flood storage areas function as designed.

For the proposed flood control dam, it is likely that inspections and maintenance activities are documented in compliance with NR 333. This includes routine inspection of the dam embankment, spillway, and outlet structure. Regular mowing should be provided to ensure that woody vegetation cannot become established on the embankment. Assuming the structure is regulated as a large dam it will also require regular reporting to the DNR to demonstrate that these practices are being followed.

Areas excavated within the floodplain should be inspected regularly and dredged routinely to prevent the accumulation of sediment. The upstream areas are the most likely to accumulate significant volumes of sediment and would likely be designed as de-facto sediment traps in detailed project design. Without frequent dredging of sediment there will be a reduction in the flood storage volume, and it could adversely impact the native restoration.

5. ADDITIONAL FLOOD MITIGATION PLANNING CONSIDERATIONS

5.1. Flood Insurance Study

Due to the potential deficiencies identified in the FIS (discussed in Section 2.4 on page 14) the Village, and residents along Brewery Creek may not have an accurate representation of flood risks. It is suggested that an additional studying and modeling of the Brewery Creek corridor within the Village be completed to better understand how water is moving thorough the Village in large flood events. This could also help to illuminate some of the benefits provided by construction of a flood storage area upstream on Brewery Creek. Additional study may also warrant submittal of LOMR to FEMA to revise the regulatory flood maps.

5.2. Potential Additional Benefits

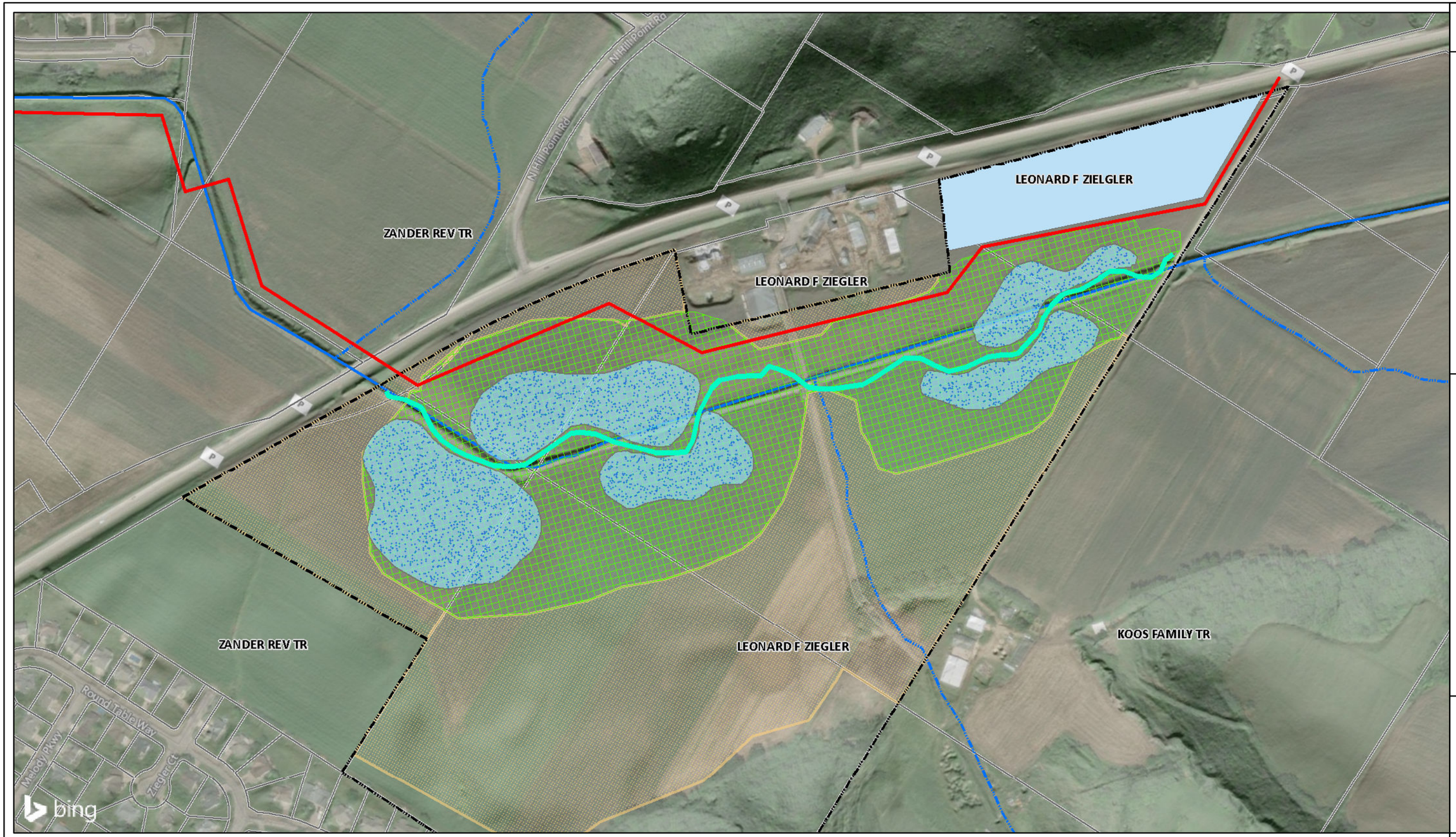
Construction of a flood storage area along Brewery Creek has the potential for significant ancillary benefits beyond the flood mitigation. It is understood that the Village has interest in developing park space, recreational trails, and native restoration in conjunction with flood storage project on Brewery Creek. Beyond the recreation and habitat benefits additional economic value could be generated by the Village from projects such as water quality trading or installation of solar arrays.

Land conversion from agricultural use to perennial native vegetation significantly reduces nutrient losses to receiving waters. This land use change could be used to generate water quality trading credits which could be used by the Village wastewater treatment plant or potentially sold to other wastewater dischargers within the Black Earth Creek, or potentially, Wisconsin River Watersheds.

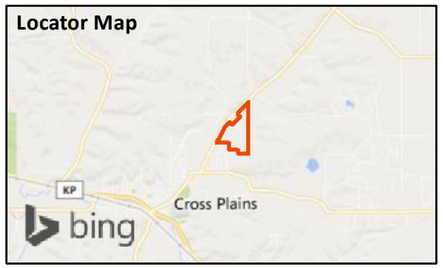
The flood storage area ground cover could also be compatible with the installation of solar arrays. Standard practice for the installation of solar arrays is to plant native perennial vegetation surrounding the solar panels. Furthermore, MARS-EOR has done a significant amount of work for local utility companies in evaluating marginal lands (wetlands and floodplains) for the siting of solar facilities. If a reasonable connection to the electrical grid can be established from this location the Village could potentially partner with a local utility or developer to install solar and provide a renewable source of energy for the community.

APPENDIX A. MAPS

Appendix A.1. Figure A1 - Brewery Creek Floodplain Scrape
Appendix A.2. Figure A2 - Brewery Creek Flood Control Dam
Appendix A.3. Figure A3 - Estimated Floodplain Extents



Locator Map



Legend

- Project Boundary
- 30' Wide Trail Corridor
- Open Space for Park
- Stream Remeander Alignment
- Open Water
- Upland Prairie Restoration
- Floodplain Scrape (Wetland/Wet Mesic Prairie)
- Dane County Parcels

Restored Areas:

Floodplain Scrape Area = 36 Acres
Upland Prairie = 34 acres
Park/Open Space = 5 Acres

Existing Storage Upstream HWY P: 134 ac-ft
Additional Storage Created: 56 ac-ft

Service Layer Credits: © 2020 Microsoft Corporation © 2020 HERE
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the

Parcel data from WI State Cartographer's Office.

Main Map Projection: WI State Plane South (ft) - NAD 1983 (HARN).

Locator map not to scale.

DRAWN BY	CHECKED BY
GDL	RSS

MARS-EOR water-ecology-community
EMMONS & OLIVIER RESOURCES, INC.
119 South Main Street | Cottage Grove, WI 53527
(608) 839-4422 | www.eorinc.com

NORTH BREWERY CREEK FLOODPLAIN SCRAPE CONCEPT DESIGN

Cross Plains Flood Mitigation
Village of Cross Plains
Dane County, WI

Village of Cross Plains

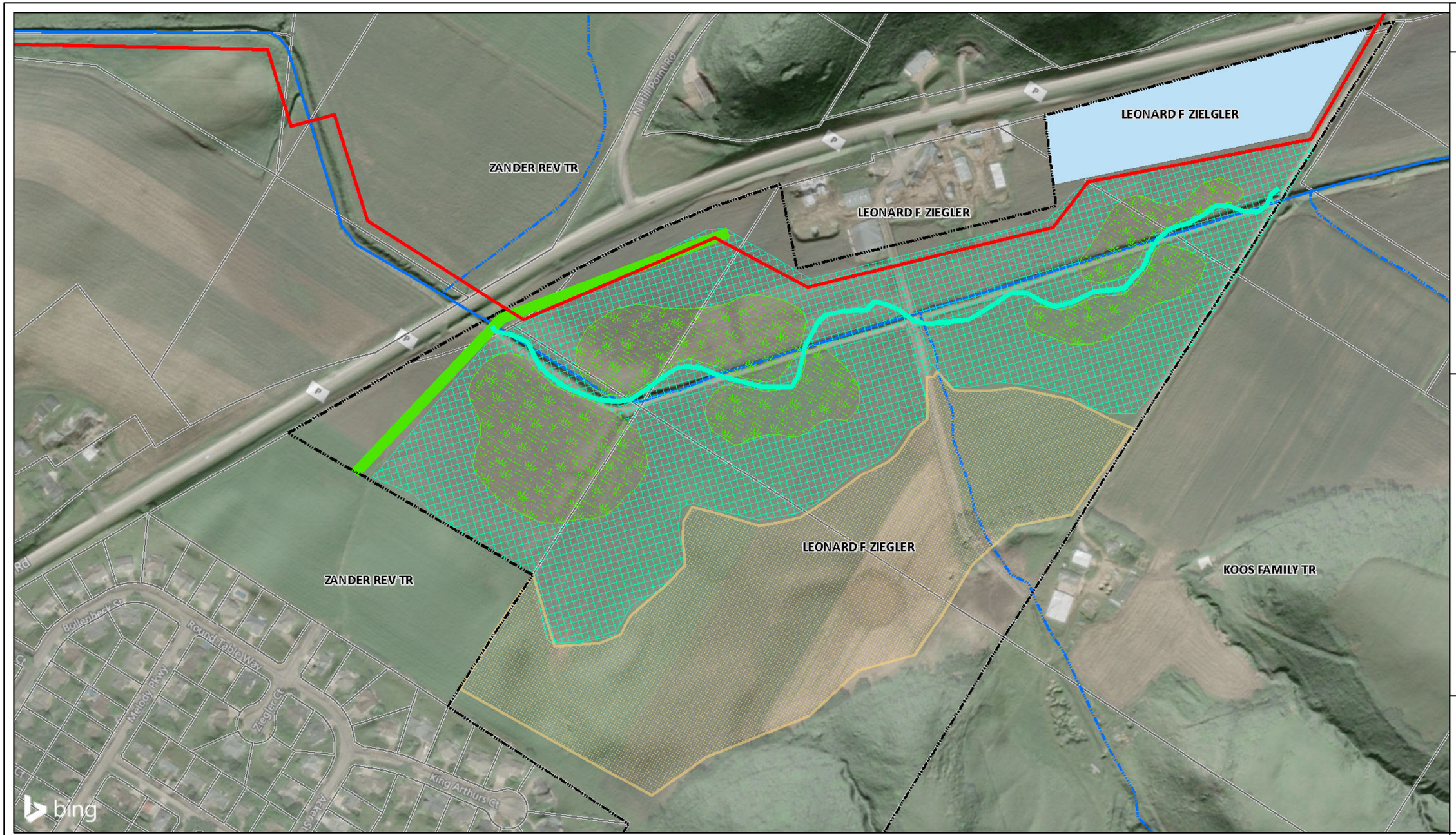
N W E S

0 150 300 Feet

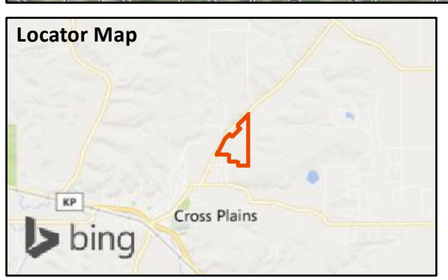
SCALE
1 inch = 300 feet

PROJECT NO.	DATE
01564-0001	3/31/2020

FIGURE NO.
Figure A1



Locator Map



Legend

- Project Boundary
- 30' Wide Trail Corridor
- Open Space for Park
- Stream Remeander Alignment
- Flood Control Berm
- Wetland/Flood Bench Scrape
- Wet Mesic Prairie Area
- Upland Prairie Restoration
- Dane County Parcels

Restored Areas:

Wetland = 12.4 Acres
Wet Mesic Prairie = 30 Acres
Upland Prairie = 23 Acres
Park/Open Space = 5 Acres

Appox. Existing Storage Upstream HWY P: 134 ac-ft
Estimated Additional Storage Created: 195 ac-ft

Service Layer Credits: © 2020 Microsoft Corporation © 2020 HERE
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the

Parcel data from WI State Cartographer's Office.

Main Map Projection: WI State Plane South (ft) - NAD 1983 (HARN).

Locator map not to scale.

DRAWN BY	CHECKED BY
GDL	RSS

MARS-EOR water-ecology-community
EMMONS & OLIVIER RESOURCES, INC.
119 South Main Street | Cottage Grove, WI 53527
(608) 839-4422 | www.eorinc.com

NORTH BREWERY CREEK FLOOD CONTROL DAM CONCEPT DESIGN

Cross Plains Flood Mitigation
Village of Cross Plains
Dane County, WI

Village of Cross Plains

N W E S

0 150 300 Feet

SCALE
1 inch = 300 feet

PROJECT NO.	DATE
01564-0001	3/31/2020

FIGURE NO.
Figure A2

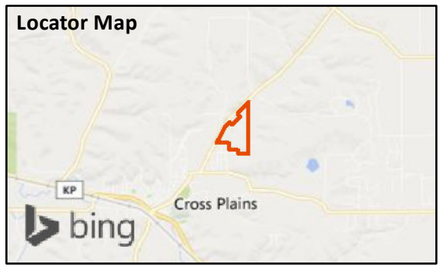
Flood areas upstream of Enchanted Valley are approximate. The area has not been modeled in a high level of detail.

Preliminary hydraulic model truncated at Village limits.

Increased area of innndation ouside of project boundary

Estimated current 100-yr flood innundation area (shaded blue).

Locator Map



Legend

- Project Boundary
- Existing 100 year Flood Innundation
- Floodplain Restoration 100 year Innundation
- Flood Control Dam 100 year Innundation
- Dane County Parcels

Service Layer Credits: © 2020 Microsoft Corporation © 2020 HERE
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the

Parcel data from WI State Cartographer's Office.

Main Map Projection: WI State Plane South (ft) - NAD 1983 (HARN).

Locator map not to scale.

DRAWN BY	CHECKED BY
GDL	RSS

MARS-EOR water-ecology-community
EMMONS & OLIVIER RESOURCES, INC.
119 South Main Street | Cottage Grove, WI 53527
(608) 839-4422 | www.eorinc.com

NORTH BREWERY CREEK ESTIMATED FLOODPLAIN EXTENTS

Cross Plains Flood Mitigation
Village of Cross Plains
Dane County, WI

Village of Cross Plains

N W E S

0 200 400 Feet

SCALE
1 inch = 400 feet

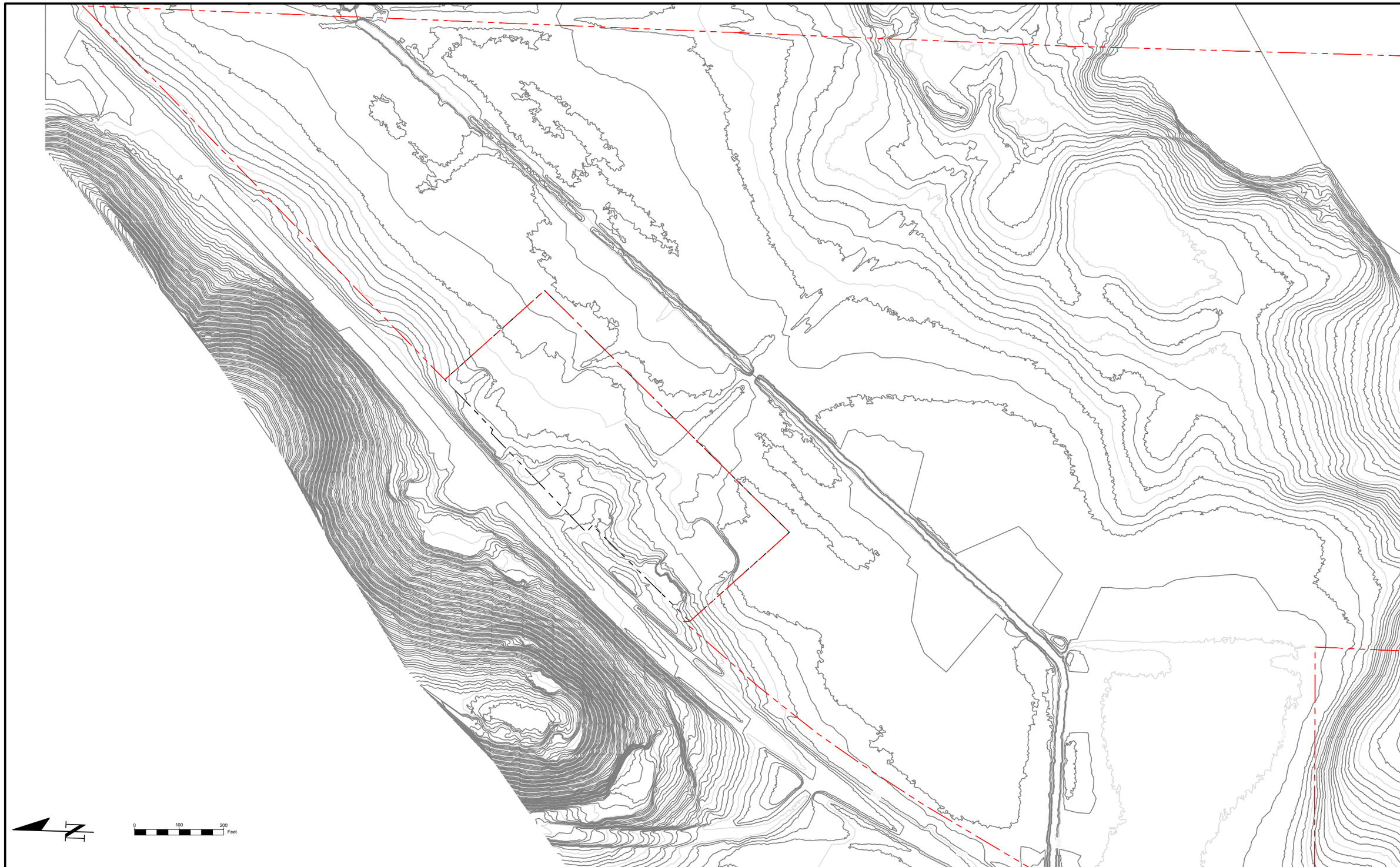
PROJECT NO.	DATE
01564-0001	3/31/2020

FIGURE NO.

Figure A3

APPENDIX B. PRELIMINARY CONSTRUCTION DRAWINGS

Appendix B.1. Existing Conditions – Brewery Creek Flood Storage Area
Appendix B.2. Preliminary Flood Control Dam Grading Plan and Details
Appendix B.3. Preliminary Floodplain Restoration Grading Plan

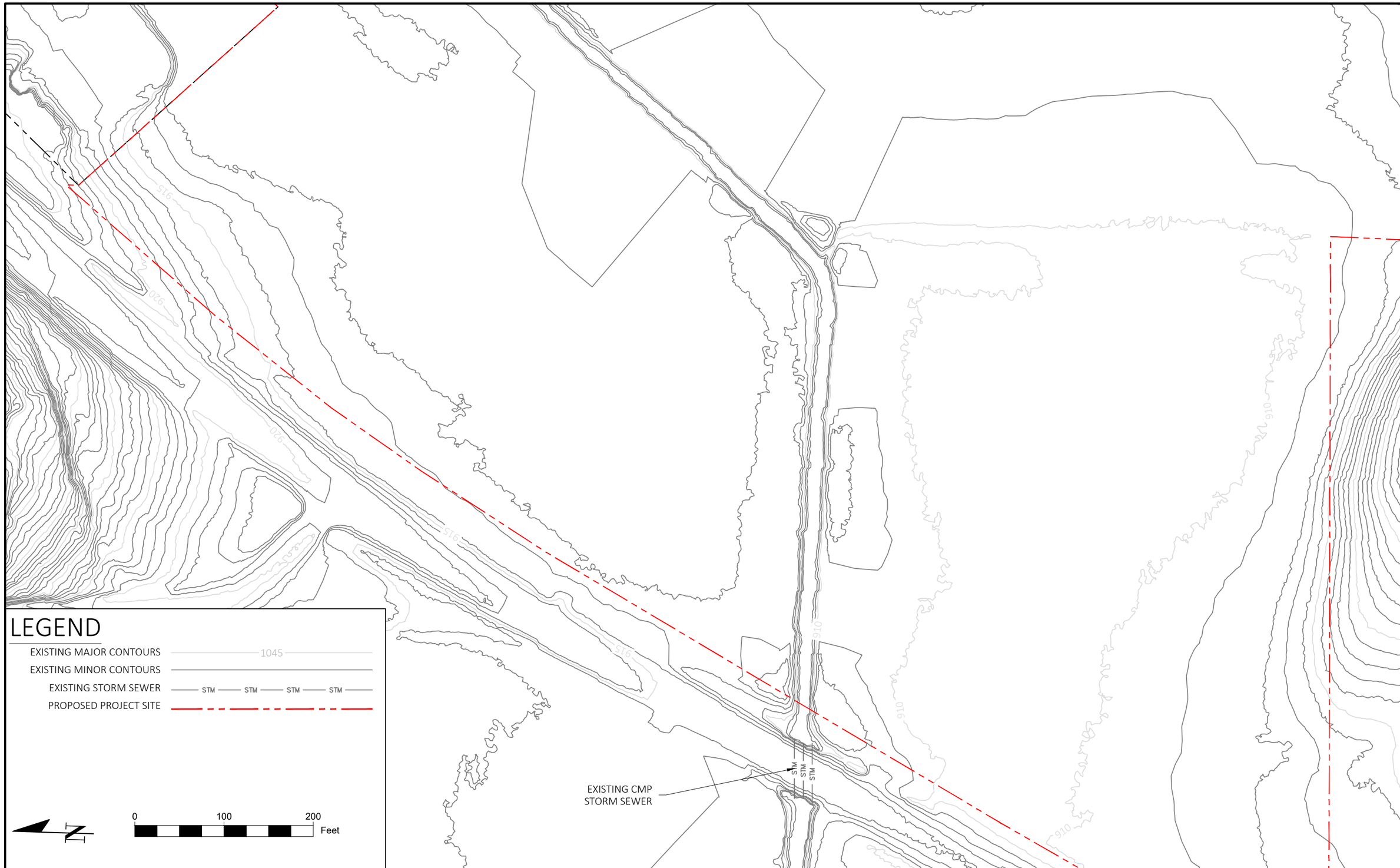


MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK EXISTING CONDITIONS	SHEET 1

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\EXISTING CONDITIONS.DWG
LAYOUT NAME - Overview

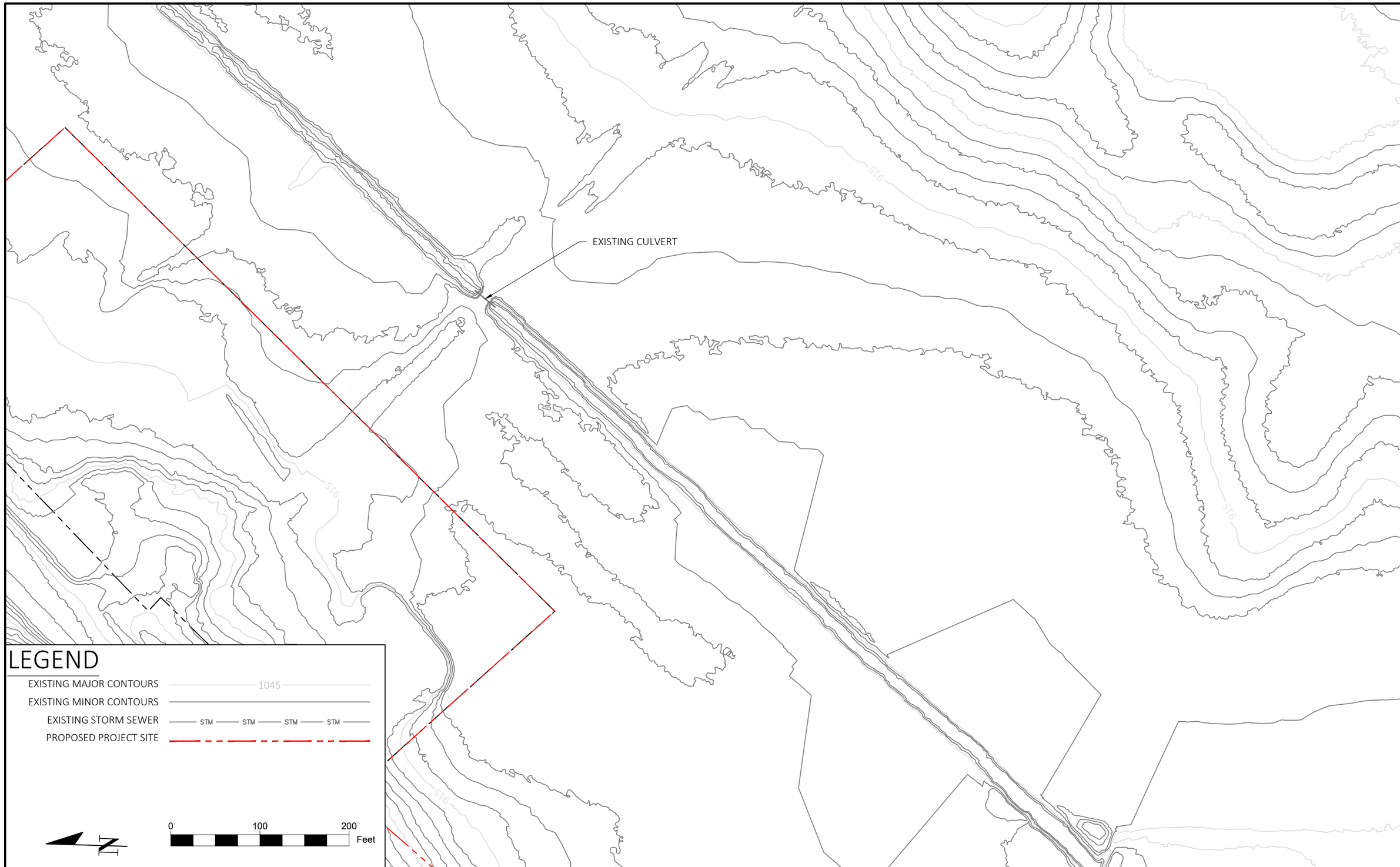
PLOT DATE : 3/26/2020 11:49 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 200 FT



MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK EXISTING CONDITIONS	SHEET 2

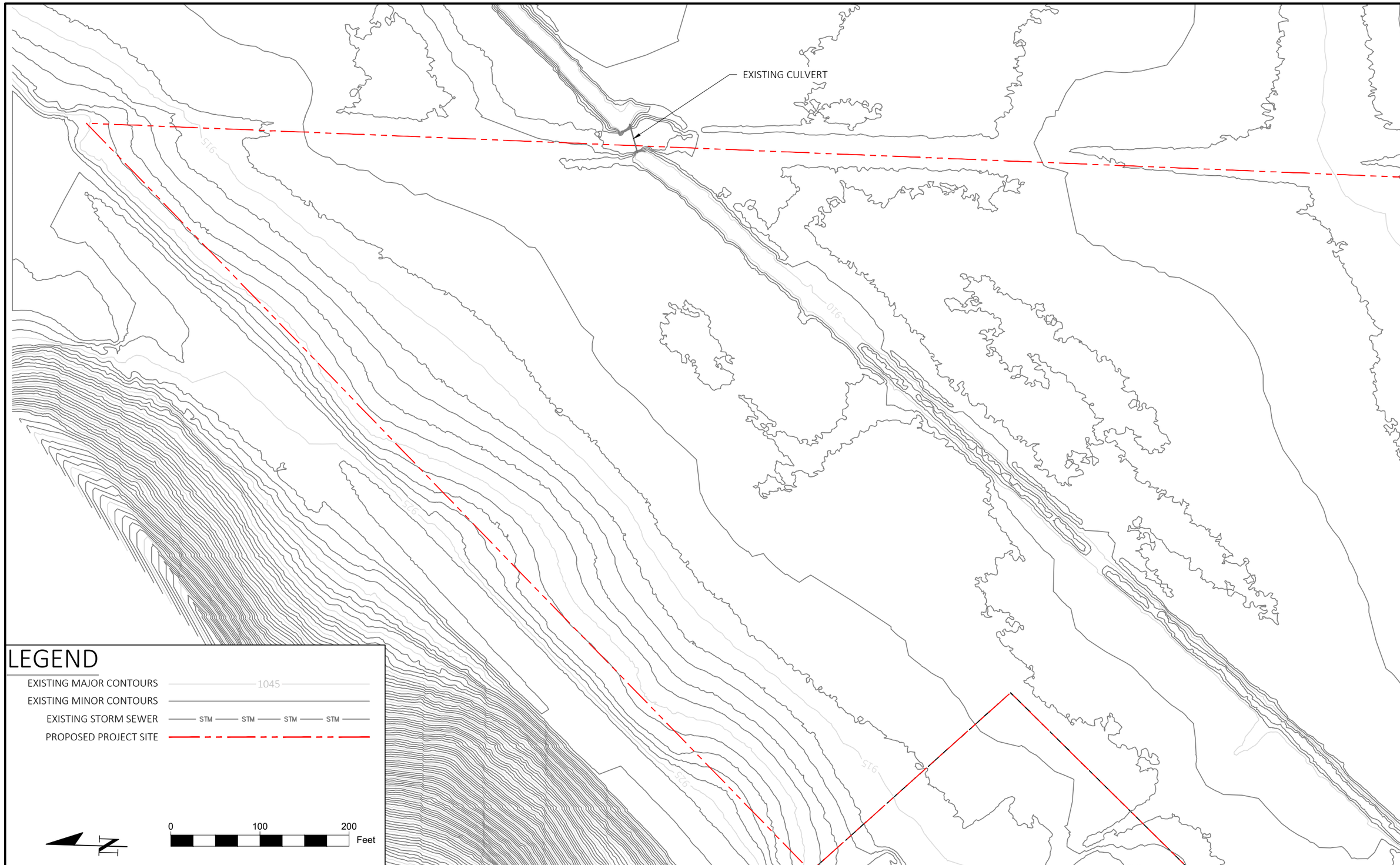
FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\EXISTING CONDITIONS.DWG
LAYOUT NAME - Existing Conditions 1
PLOT DATE : 3/26/2020 11:49 AM
PLOT BY : RYAN STENJEM
PLOT NAME :
PLOT SCALE : 1 IN : 100 FT



MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK EXISTING CONDITIONS	SHEET 3

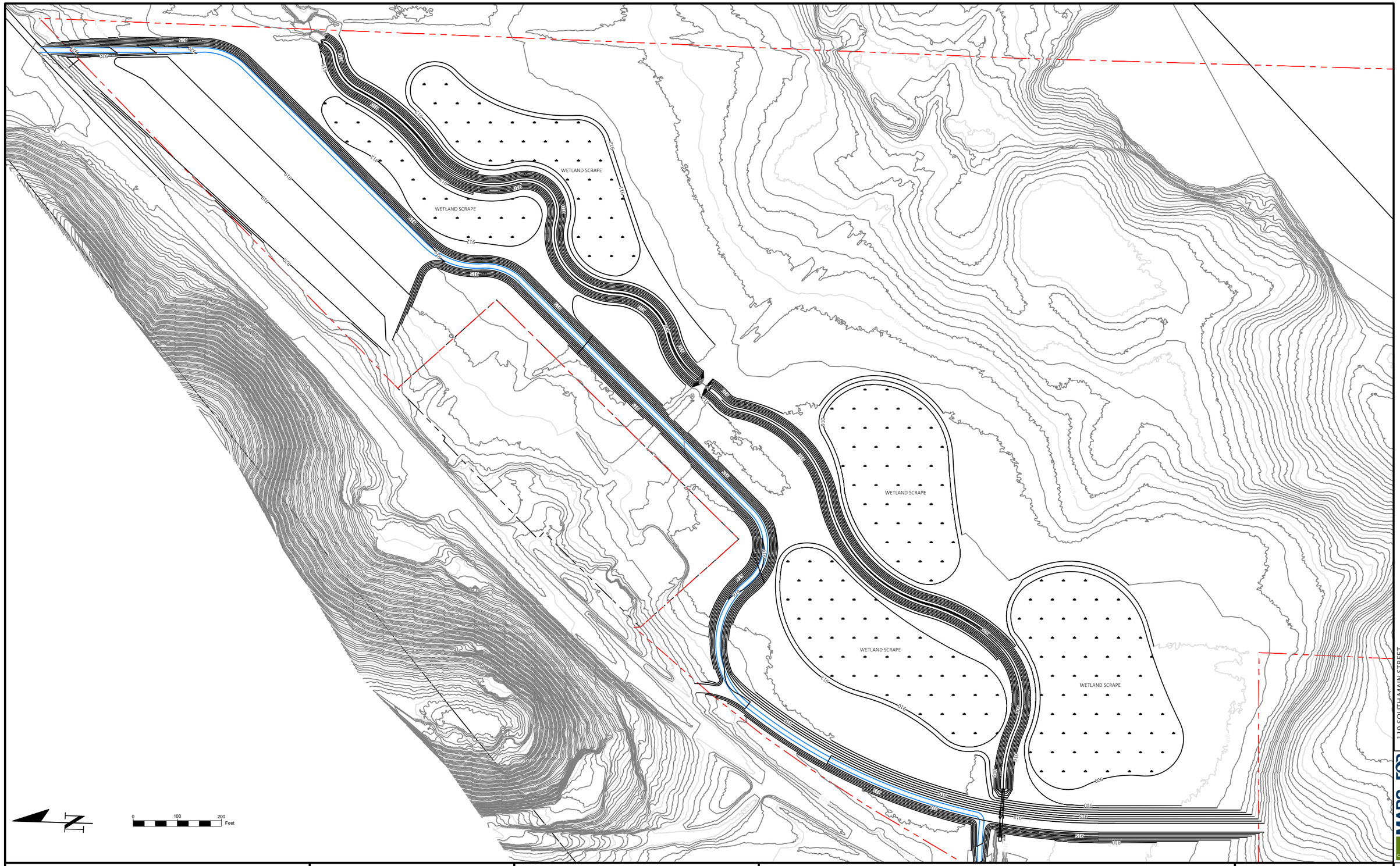
FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\EXISTING CONDITIONS.DWG
LAYOUT NAME - Existing Conditions 2
PLOT DATE : 3/26/2020 11:49 AM
PLOT BY : RYAN STENJEM
PLOT NAME :
PLOT SCALE : 1 IN : 100 FT



MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK EXISTING CONDITIONS	SHEET 4

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\EXISTING CONDITIONS.DWG
LAYOUT NAME - Existing Conditions 3
PLOT DATE : 3/26/2020 11:50 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 100 FT



MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION DAM	SHEET 1

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\OPEN SPACE GRADING PLAN.DWG
LAYOUT NAME - Overview

PLOT DATE : 3/26/2020 11:44 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 200 FT

WETLAND SCRAPE

WETLAND SCRAPE

OVERFLOW WEIR
ELEV: 917'

PROPOSED STORM SEWER
7' X 6' BOX CULVERT

TOP OF BERM
ELEV: 918'

LEGEND

EXISTING MAJOR CONTOURS	1045
EXISTING MINOR CONTOURS	
PROPOSED MAJOR CONTOURS	1050
PROPOSED MINOR CONTOURS	1049
EXISTING STORM SEWER	STM STM STM STM
PROPOSED STORM SEWER	STM STM STM STM
PROPOSED PROJECT SITE	
PROPOSED BIKE PATH	

0 100 200 Feet

MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION DAM	SHEET 2

PROPOSED CULVERT

EXISTING CULVERT

PROPOSED CULVERT

WETLAND SCRAPE

WETLAND SCRAPE

LEGEND

EXISTING MAJOR CONTOURS	1045
EXISTING MINOR CONTOURS	
PROPOSED MAJOR CONTOURS	1050
PROPOSED MINOR CONTOURS	1049
EXISTING STORM SEWER	STM STM STM STM
PROPOSED STORM SEWER	STM STM STM STM
PROPOSED PROJECT SITE	
PROPOSED BIKE PATH	

0 100 200 Feet

MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION DAM	SHEET 3

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\OPEN SPACE GRADING PLAN.DWG
LAYOUT NAME - Grading Plan 2

PLOT DATE : 3/26/2020 11:42 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 100 FT

EXISTING CULVERT

WETLAND SCRAPE

WETLAND SCRAPE

PROPOSED CULVERT

LEGEND

EXISTING MAJOR CONTOURS	1045
EXISTING MINOR CONTOURS	
PROPOSED MAJOR CONTOURS	1050
PROPOSED MINOR CONTOURS	1049
EXISTING STORM SEWER	STM STM STM STM
PROPOSED STORM SEWER	STM STM STM STM
PROPOSED PROJECT SITE	
PROPOSED BIKE PATH	

0 100 200 Feet

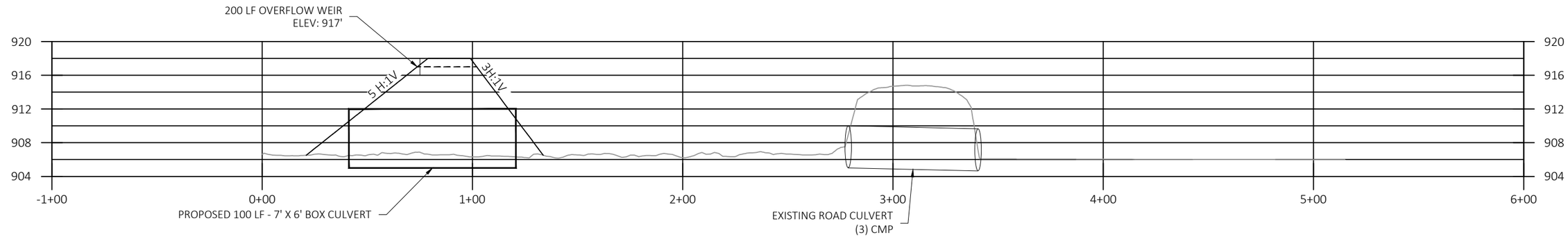
N

MARS-EOR
WATER · ECOLOGY · COMMUNITY
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION DAM	SHEET 4

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\OPEN SPACE GRADING PLAN.DWG
LAYOUT NAME - Grading Plan 3

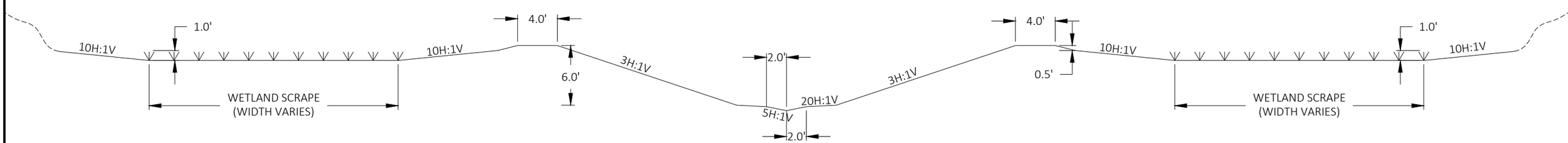
PLOT DATE : 3/26/2020 11:42 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 100 FT



PROPOSED FLOOD STORAGE BERM

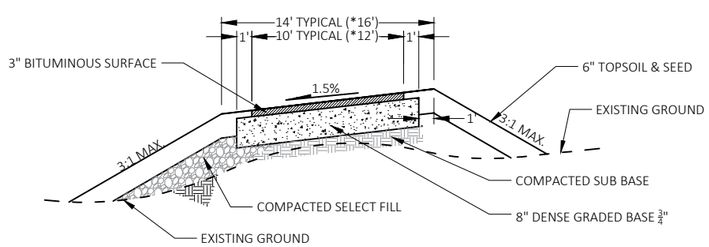
PROFILE VIEW

Note: Existing channel contour data from Dane County LiDAR. May not represent channel bottom.



TYPICAL STREAM MEANDER AND WETLAND SCRAPE

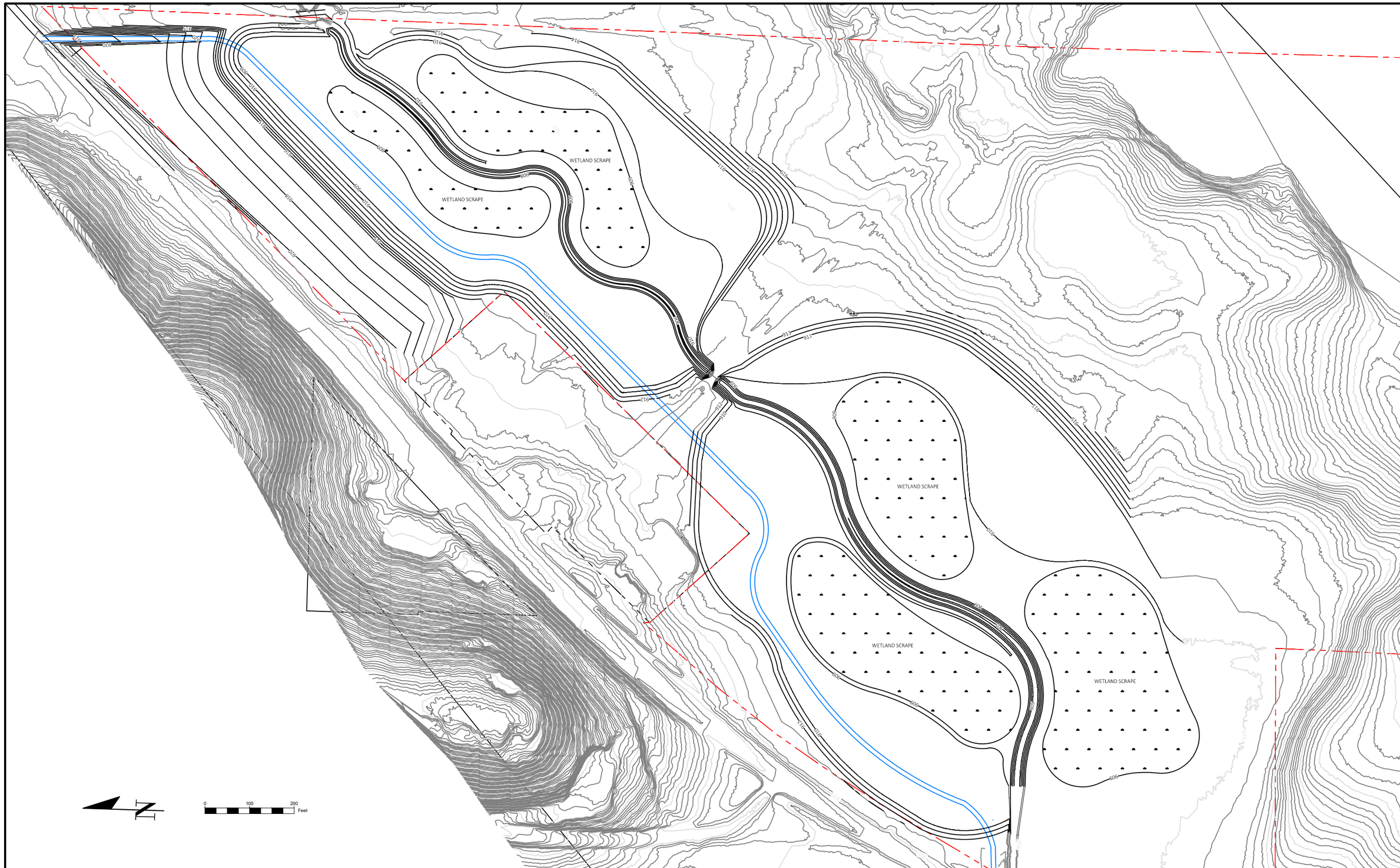
CROSS SECTION



MULTI-USE IMPERVIOUS PATH SECTION

119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422
MARS-EOR
water - ecology - community

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: DETAILS	SHEET 5



MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION FLOODPLAIN SCRAPE	SHEET 1

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\SCRAPE GRADING PLAN.DWG
LAYOUT NAME - Overview

PLOT DATE : 3/26/2020 11:25 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 200 FT

WETLAND SCRAPE

WETLAND SCRAPE

PROPOSED CHANNEL ALIGNMENT TIED INTO EXISTING BED. EXISTING CHANNEL CONTOURS NOT AVAILABLE BELOW ORDINARY WATER LEVEL.

LEGEND

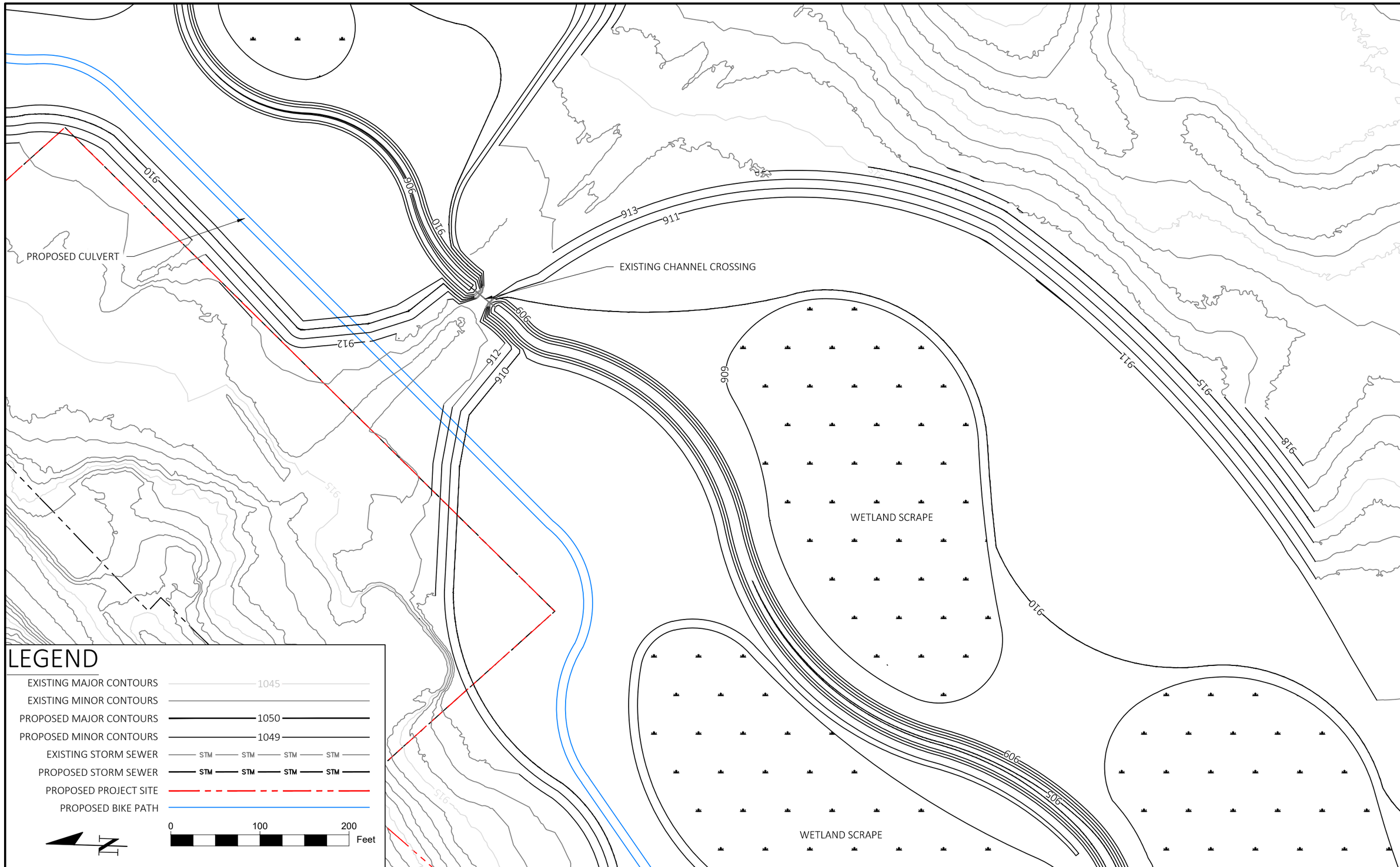
EXISTING MAJOR CONTOURS	1045
EXISTING MINOR CONTOURS	
PROPOSED MAJOR CONTOURS	1050
PROPOSED MINOR CONTOURS	1049
EXISTING STORM SEWER	STM STM STM STM
PROPOSED STORM SEWER	STM STM STM STM
PROPOSED PROJECT SITE	
PROPOSED BIKE PATH	

0 100 200 Feet

MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION FLOODPLAIN SCRAPE	SHEET 2

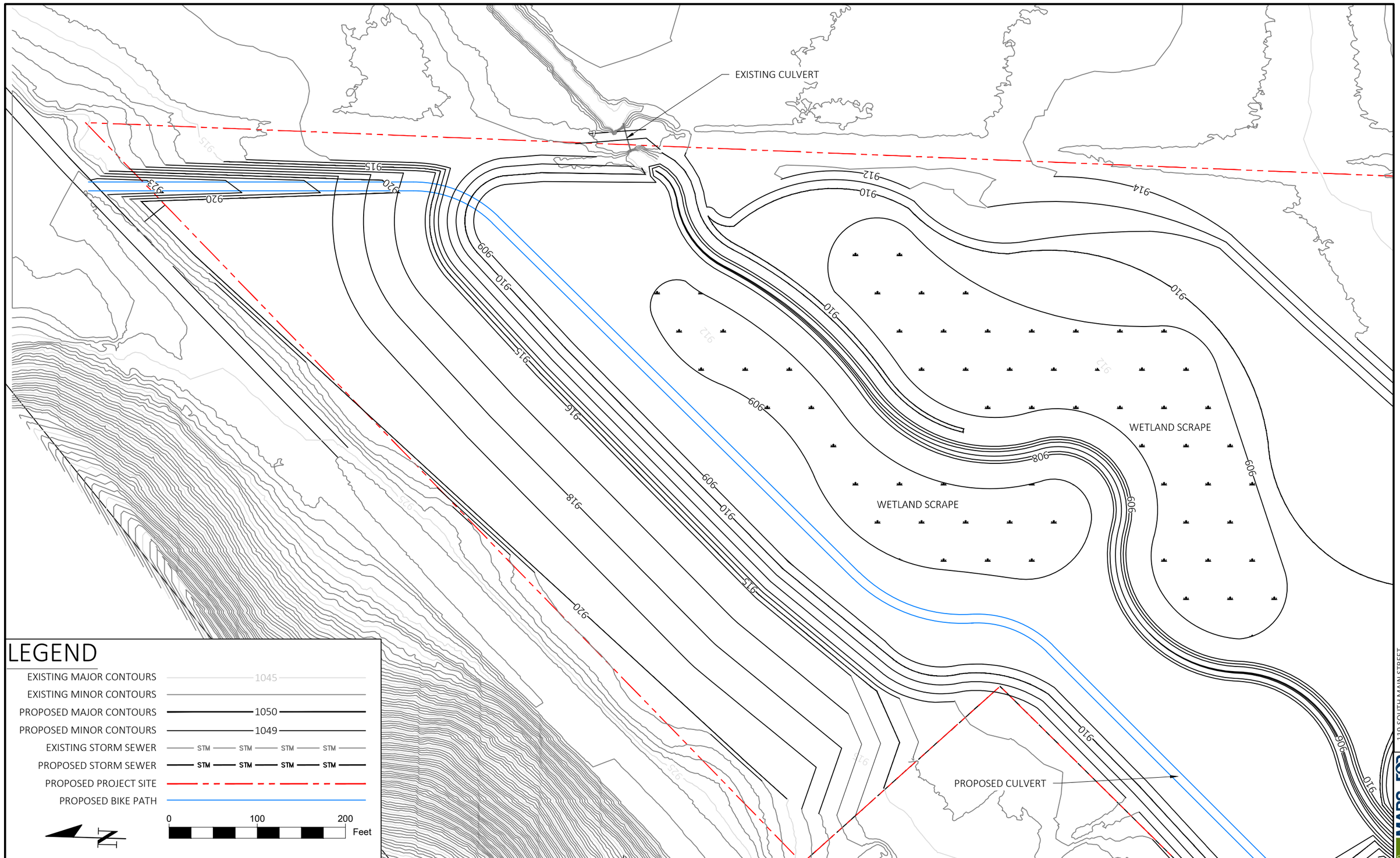
FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\SCRAPE GRADING PLAN.DWG
LAYOUT NAME - Grading Plan 1
PLOT DATE : 3/26/2020 11:24 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 100 FT



PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION FLOODPLAIN SCRAPE	SHEET 3

MARS-EOR
water · ecology · community
119 SOUTH MAIN STREET
COTTAGE GROVE, WI 53527 (608) 839.4422

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\SCRAPE GRADING PLAN.DWG
LAYOUT NAME - Grading Plan 2
PLOT DATE : 3/26/2020 11:30 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 100 FT



PROJECT: VILLAGE OF CROSS PLAINS FLOOD MITIGATION	OWNER: VILLAGE OF CROSS PLAINS	STREET: CO HWY P	TITLE: BREWERY CREEK FLOOD MITIGATION FLOODPLAIN SCRAPE	SHEET 4

FILE NAME : P:\01564-0001 VILLAGE OF CROSS PLAINS FLOOD MITIGATION\DRAWINGS\SURFACES\SCRAPE GRADING PLAN.DWG
LAYOUT NAME - Grading Plan 3
PLOT DATE : 3/26/2020 11:31 AM PLOT BY : RYAN STENJEM PLOT NAME : PLOT SCALE : 1 IN : 100 FT

APPENDIX C. PRELIMINARY PROJECT BUDGET

Appendix C.1. Black Earth Creek Bypass Project Budget
Appendix C.2. Floodplain and Channel Restoration Project Budget
Appendix C.3. Reconstruction of County Hwy P Project Budget
Appendix C.4. Flood Control Dam Project Budget

Village of Cross Plains
Black Earth Creek Flood Bypass

Conceptual Construction Costs
MARS-EOR

SF 424C Classfication	Item No.	Material	QTY	Units	Unit Rate	Cost
2	1	Land Acquisition	4	AC	$4,000	$16,000.00
4	2	Engineering Design Fees	1	LS	$23,000	$23,000.00
5	3	Engineering Data Collection	1	LS	$7,000	$7,000.00
6	4	Construction Support and Inspection	1	LS	$4,000	$4,000.00
7	5	Permit Application Fees	1	LS	$8,000	$8,000.00
	6	Mobilization	1	EA	$5,000.00	$5,000.00
	7	Excavation	10,000	CY	$3.50	$35,000.00
	8	Remove and respread topsoil	4,900	CY	$3.50	$17,000.00
9	9	Rip Rap	200	CY	$50.00	$10,000.00
	10	Dispose Excess Material Nearby	10,000	CY	$3.50	$35,000.00
	11	Upland Restoration	4.0	AC	$1,200.00	$4,800.00
	12	Erosion Control	1	EA	$7,500.00	$7,500.00
					Total	$172,300.00
					Contingency	20%
13					Contingency $	$35,000.00
					Total Preliminary Estimate	$207,300.00

Potential Additionals

Notes	
Item 1	Average assesed land value is $1,875, 2017 UW Extension Report Estimated Farmland in Driftless area at $3,600/ac and $5,900 in south central WI
Item 2	Assumed design fees of 20% of project construction costs
Item 3	Assumes data collection (survey and soils data) 6% of construction costs
Item 4	Assumes project inspection fees of 3% of construction costs
Item 5	Assumes $150 for each DNR Permit and $6,500 LOMR Fee and $870 for County Erosion Control
Items 6-12	Based on recent bids and adjusted reviewing RS Means Values for similar sized projects
Other Notes:	All cost values rounded to the nearest $1,000
	No guarantee is provided as to the completeness or accuracy of this estimate

Village of Cross Plains
Brewery Creek Floodplain Restoration

Conceptual Construction Costs
MARS-EOR

SF 424C Classfication	Item No.	Material	QTY	Units	Unit Rate	Cost
2	1	Land Acquisition	70.5	AC	$4,000	$282,000.00
	2	Flood Easement Acquisition	0	AC	$500	$0.00
4	3	Engineering Design Fees	1	LS	$34,000	$34,000.00
5	4	Engineering Data Collection	1	LS	$7,000	$7,000.00
6	5	Construction Support and Inspection	1	LS	$7,000	$7,000.00
7	6	Permit Application Fees	1	LS	$11,000	$11,000.00
9	7	Mobilization	1	EA	$5,000.00	$5,000.00
	8	Scrape Excavation	130,000	CY	$2.25	$293,000.00
	9	Remove and respread topsoil	90,000	CY	$3.25	$293,000.00
	10	Ditch Plug	8,100.0	CY	$2.00	$16,000.00
	11	Strem Re-meander Excavation	9,400	CY	$5.05	$47,000.00
	12	Rip Rap	200	CY	$50.00	$10,000.00
	13	Excess Fill Dispose Nearby	131,300	CY	-$2.50	-$328,000.00
	14	Wetland Restoration	12.4	AC	$5,000.00	$62,000.00
	15	Wet Mesic Prairie	30.0	AC	$5,000.00	$150,000.00
	16	Upland Restoration	23.0	AC	$5,000.00	$115,000.00
	17	Erosion Control	1	EA	$10,000.00	$10,000.00
					Total	$1,014,000.00
					Contingency	20%
13					Contingency $	$203,000.00
					Total Preliminary Estimate	$1,217,000.00
		Potential Additionals				
9	18	Borrow and Place Fill for Park Grading	20,000	CY	$20.00	$400,000.00

Notes

Item 1	Average assesed land value is $1,875, 2017 UW Extension Report Estimated Farmland in Driftless
Item 2	Assumed all areas of increased flooding will require purchase of flood easement
Item 3	Assumed design fees of 05% of project construction costs
Item 4	Assumes data collection (survey and soils data) 1% of construction costs
Item 5	Assumes project inspection fees of 1% of construction costs
Item 6	Assumes $150 for each DNR Permit and $6,500 LOMR Fee
Items 7-10	Based on recent bids and adjusted reviewing RS Means Values
Item 11	Based on RS Means estimate for excavation
Item 12	Assumes 10% of remeandered streambank would require Rip-Rap
Item 13	Assumes Excess material could be sold to adjacent project for net profit of $2.50/CY
Item 14-16	Planning level costs provided by Heartland through vegetation establishment
Item 17	Allowance to cover costs of erosion control practice installation
Other Notes:	All cost values rounded to the nearest $1,000
	No guarantee is provided as to the completeness or accuracy of this estimate

MARS-EOR
water-ecology-community

Village of Cross Plains
County Highway P Reconstruction

Conceptual Construction Costs
MARS-EOR

SF 424C Classfication	Item No.	Material	QTY	Units	Unit Rate	Cost
2	1	Grading Easement Acquisition	0.5	AC	$500	$250.00
	2	Flood Easement Acquisition	1	AC	$500	$500.00
4	3	Engineering Design Fees	1	LS	$35,000	$35,000.00
5	4	Engineering Data Collection	1	LS	$9,000	$9,000.00
6	5	Construction Support and Inspection	1	LS	$7,000	$7,000.00
7	6	Permit Application Fees	1	LS	$7,000	$7,000.00
9	7	Mobilization	1	EA	$5,000.00	$5,000.00
	8	Saw Cut	50	LF	$2.75	$137.50
	9	Pavement Removal	2,400	SY	$5.00	$12,000.00
	10	Import and Place Fill	1,100	CY	$20.00	$22,000.00
	11	New Pavement	1,000	TON	$70.00	$70,000.00
	12	New 3' Shoulder	1,400	LF	$11.50	$16,100.00
	13	Pavement Markings	700	LF	$2.50	$1,750.00
	14	CMP Culverts - Remove and Replace	3	EA	$15,000.00	$45,000.00
	15	Upland Restoration	0.5	AC	$1,200.00	$600.00
	16	Erosion Control	1	EA	$15,000.00	$15,000.00
					Total	$246,337.50
					Contingency	20%
13					Contingency $	$50,000.00
					Total Preliminary Estimate	$297,000.00

Potential Additionals

9	

Notes	
Item 1	Assumed a 15' impact on either side or roadway
Item 2	Assumed all areas of increased flooding will require purchase of flood easement
Item 3	Assumed design and permitting fees of 20% of project construction costs
Item 4	Assumes data collection (survey and soils data) 5% of construction costs
Item 5	Assumes project inspection fees of 4% of construction costs
Item 6	Assumes $6,500 LOMR application fee, and $150 for each DNR Permit
Items 7-15	Based on recent bids on wetland mitigation site in Wisconsin and adjusted reviewing RS Means and WIDOT Unit Rate Values
Item 16	Allowance for the installation of erosion control practices
Other Notes:	All cost values rounded to the nearest $1,000
	No guarantee is provided as to the completeness or accuracy of this estimate

MARS-EOR
water-ecology-community

Village of Cross Plains
Brewery Creek Flood Control Dam

Conceptual Construction Costs
MARS-EOR

SF 424C Classfication	Item No.	Material	QTY	Units	Unit Rate	Cost
2	1	Land Acquisition	70.5	AC	$4,000	$282,000.00
	2	Flood Easement Acquisition	7.5	AC	$500	$3,800.00
4	3	Engineering Design Fees	1	LS	$57,000	$57,000.00
5	4	Engineering Data Collection	1	LS	$19,000	$19,000.00
6	5	Construction Support and Inspection	1	LS	$19,000	$19,000.00
7	6	Permit Application Fees	1	LS	$17,000	$17,000.00
9	7	Mobilization	1	EA	$5,000.00	$5,000.00
	8	Scrape Excavation	24,000	CY	$2.50	$60,000.00
	9	Remove and Respread Topsoil	20,000	CY	$3.50	$70,000.00
	10	Ditch Plug	8,100.0	CY	$2.00	$16,000.00
	11	Strem Re-meander Excavation	9,400	CY	$5.05	$47,000.00
	12	Rip Rap	200	CY	$50.00	$10,000.00
	13	100'- 6X7 Box Culvert w/end Sections	1	EA	$35,000.00	$35,000.00
	14	Embankment Construction	16,500	CY	$7.00	$116,000.00
	15	Excess Dispose onsite in uplands	8,800	CY	$2.00	$18,000.00
	16	Wetland Restoration	12.4	AC	$5,000.00	$62,000.00
	17	Wet Mesic Prairie	30.0	AC	$5,000.00	$150,000.00
	18	Upland Restoration	23.0	AC	$5,000.00	$115,000.00
	19	Erosion Control	1	EA	$10,000.00	$10,000.00
					Total	$1,111,800.00
					Contingency	20%
13					Contingency $	$223,000.00
					Total Preliminary Estimate	$1,334,800.00

		Potential Additionals				
9	20	Borrow and Place Fill for Park Grading	28,000	CY	$20.00	$560,000.00
	21	Borrow and Place Fill for Bike Path	18,000	CY	$20.00	$360,000.00

Notes

Item 1	Average assesed land value is $1,875, 2017 UW Extension Report Estimated Farmland in Driftless area at $3,600/ac
Item 2	Assumed all areas of increased flooding will require purchase of flood easement
Item 3	Assumed design fees of 10% of project construction costs
Item 4	Assumes data collection (survey and soils data) 4% of construction costs
Item 5	Assumes project inspection fees of 3% of construction costs
Item 6	Assumes $6,500 LOMR application fee, and $150 for each DNR Permit
Items 7-10	Based on recent bids on wetland mitigation site in Wisconsin and adjusted reviewing RS Means
Item 11	Based on RS Means estimate for excavation
Item 12	Assumes 10% of remeandered streambank would require Rip-Rap
Item 13	Based on RS Means estimate for material and installation, checked against bid values for similar size structures
Item 14	Based on RS Means estimate for material placement and compaction
Item 16-19	Planning level costs provided by Heartland through vegetation establishment
Items 20-21	Based on RS Means estimate for material borrow and placement
Other Notes:	All cost values rounded to the nearest $1,000
	No guarantee is provided as to the completeness or accuracy of this estimate

Village of Cross Plains

West Side Drainage Improvements Engineering Report

April 2020

JEWELL
associates engineers, inc.
Engineers - Architects - Surveyors

Table of Contents

Page

1. **Background** 1
2. **Stormwater Modeling** 2
3. **West Side Storm Sewer Project** 3
   - 3.1. Project Overview 3
   - 3.2. Storm Sewer Improvements 4
     - 3.2.1. Option 1 – Direct Discharge to Creek 4
     - 3.2.2. Option 2 – Detention Pond with Pump Station 5
     - 3.2.3. Option 3 – Detention Pond with Lowered Wall 5
   - 3.3. Backflow Prevention 6
   - 3.4. Street Reconstruction 7
   - 3.5. Coordination with Plastic Ingenuity 7
   - 3.6. Preliminary Cost Estimates 8
4. **Discussion** 8
   - 4.1. Option 1 – Direct Discharge to Creek 8
   - 4.2. Option 2 – Detention Pond with Pump Station 9
   - 4.3. Option 3 – Detention Pond with Lowered Wall 9
   - 4.4. Project Challenges 10
   - 4.5. Recommendations 10
5. I**mplementation** 10
   - 5.1. Construction Procurement 10
   - 5.2. Permits and Agency Coordination 10
     - 5.2.1. Construction Permits 10
     - 5.2.2. Cultural Resources Review 10
     - 5.2.3. Wetland Impact Review 11
   - 5.3. Underground Utility Coordination 11
   - 5.4. Project Schedule 11

Appendix

Appendix A. Drawings

1. West Side Storm Sewer – Option 1
2. West Side Storm Sewer – Option 2
3. West Side Storm Sewer – Option 3
4. Plan & Profile Market Street
5. Plan & Profile Park Street (Sheet 1 of 2)
6. Plan & Profile Park Street (Sheet 2 of 2)
7. Berm Grading Plan
8. Berm Sections
9. Road Sections
10. Finished Typical Sections
11. Existing Storm Sewer Backflow Preventers

JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

Appendix B. Cost Estimates

Appendix C. Stormwater Modeling Images
1. Existing Conditions – Without Parking Lot Berm (During Surge from Northeast)
2. Proposed Conditions – With Parking Lot Berm (During Surge from Northeast)
3. Existing Conditions – Without Parking Lot Berm (During Surge Along Park Street)
4. Proposed Conditions – With Parking Lot Berm (During Surge Along Park Street)

Appendix D. HydroCad Modeling Results

Appendix E. Commonwealth Heritage Group – Preliminary Cultural Resources Review

Appendix F. Heartland Ecological Group – Desktop Wetland Determination

List of Figures	Page
Figure 1. Aerial Map of Inundated Areas as a Result of the August 2018 Flooding in Cross Plains	1
Figure 2. Project Location Map	2
Figure 3. Proposed 42-Inch Storm Sewer and Curb Inlets	4
Figure 4. 42-Inch Storm Sewer Discharging Directly to the Creek	4
Figure 5. Detention Pond with a Pump Station	5
Figure 6. Detention Pond with a Lowered Wall Section	6
Figure 7. Proposed Park Street Cross Section at Plastic Ingenuity Parking Lot Entrance	7
Figure 8. Plastic Ingenuity Located on the Northwest Corner of Park Street and Market Street	8

List of Tables	Page
Table 1. Water Elevation of Creek Compared to Water Elevation in Pond	6
Table 2. Park Street Flood Water Elevation Comparison	7
Table 3. Estimated Project Costs	8
Table 4. Summary of Potential Wetland Areas	11
Table 5. Proposed Project Schedule	11

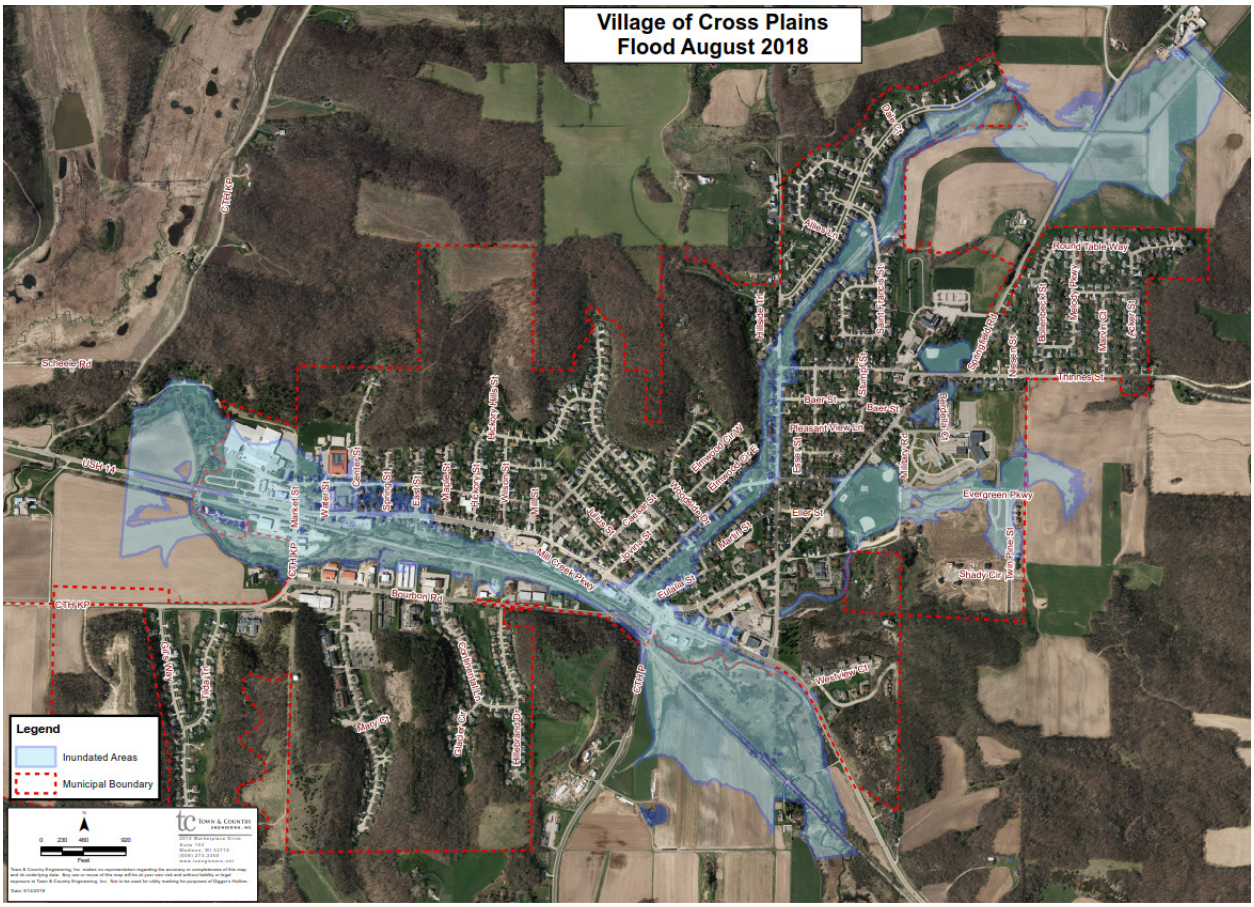


Figure 1. Aerial Map of Inundated Areas as a Result of the August 2018 Flooding in Cross Plains. **(Town and Country)**

1. Background

On August 20, 2018 the Cross Plains area received what was estimated to be 15 to 19 inches of rain in a 24-hour period. This caused major flooding throughout the Village. The flood water entered the Village from three main sources: Black Earth Creek, Brewery Creek, and runoff from the hills on the north side of the Village. As part of an initiative to reduce the impacts of major storm events on Cross Plains, the Village has chosen to pursue projects along the Brewery Creek and on the west side of the Village as shown on the attached map.

The west side of the Village was affected by all three of the main sources of flood water during the 2018 storm event. The Black Earth Creek runs along the west side of the Village, downstream of the confluence with the Brewery Creek. Runoff from the hills entered the north side of the Village and a large portion of this runoff flowed west down Park Street. The storm sewers along Park Street were overloaded, surcharged and unable to convey the heavy flow of water flowing down the street. As a result, the businesses and residents in this area experienced a large amount water damage from the storm. The Village determined that a project to reduce flooding in this area would have a positive impact on businesses and homeowners. In addition, most of the property needed for the project is Village owned or the property owners that would be affected by the project are willing to cooperate with a mitigation project.

The Village hired Jewell Associates Engineers to develop a cost-effective solution that would reduce the impacts of flood events in this area of the Village. Jewell has developed preliminary designs that would improve drainage and help move flood water through this area of the Village, so it is less likely to flood the residences and businesses nearby.

Figure 2. Project Location Map

2. Stormwater Modeling

Since the actual amount of surface water runoff in the Park Street and Market Street area during the storm is unknown, we attempted to recreate the flows based on the information known, such as the approximate rainfall amount and reported high water levels. As a basis for the proposed improvements along Park Street and Market Street, computer modeling was used to estimate flows and water levels during a large storm event. The effective flood model for Black Earth Creek as it passes through the Village of Cross Plains was downloaded from the WDNR website. This 1-dimensional model was analyzed for the 500-year flood event to determine what effects the creek-based flood flow has on the property at the west end of the Village. After studying the results, it was determined that a portion of the flooding occurring in the western parking lot at the Plastic Ingenuity property could be directly attributed to the flow of Black Earth Creek; however, the more severe flooding that took place at the west end of the Village was due to surface runoff. In order to appropriately model the surface runoff, a more robust 2-dimensional model was created for the drainage area. Instead of using cross section data to analyze flooding, a 2-dimensional model creates a digital surface of the drainage basin allowing significantly more detail in the calculations. The newly created 2-dimensional model begins just downstream of the confluence of Black Earth Creek and Brewery Creek and then continues westward through the Village to a point approximately 900 feet beyond the Village limits. County LiDAR data was used to create the digital surface model and then a 15-inch storm event was applied to the model to determine the flooding impacts.

After studying the results from the new model, it was determined that a large portion of the runoff from the drainage area just northeast of the Plastic Ingenuity property (Center Street vicinity) drains into the northeast parking lot on the Plastic Ingenuity property. In addition, a portion of the runoff from the drainage area north of the Village (Hickory Hill Street vicinity and Cross Street vicinity) makes its way down to Park Street and then drains westward towards the west end of the Village. While a part of this flow does manage to discharge south towards Main Street and then into Black Earth Creek, a large portion of the runoff continues westward down Park Street towards Black Earth Creek. Based on the model results, it is estimated that the flow at the intersection of Park Street and Market Street may have been approximately 430 cfs.

Because of the large amount of runoff that makes its way from the drainage area north of the Village and onto properties at the west end of the Village, it was determined that an earthen berm along Market Street running north from Park Street would be an important part of the solution to help reduce the amount of surface water runoff that impacts the Plastic Ingenuity property. It was also determined that a large storm sewer pipe would be beneficial to move more potential surface runoff below ground from the Market Street and Park Street intersection to the outfall by the Black Earth Creek.

The proposed project site was also modeled using HydroCAD software. HydroCAD is used to model stormwater detention ponds and other stormwater treatment devices. This software calculates the peak stormwater flowrate generated from the areas upstream of the project site during specified rainfall events. The modeling results and a figure showing the areas contributing stormwater runoff to the intersection of Market Street and Park Street are presented in Appendix D. We estimated that 75% of the overland flow from these areas would flow to the intersection.

The HydroCAD model indicates that a 15-inch storm would generate approximately 86 ac-ft (3.75 million cubic feet) of runoff and the peak flow rate during the August 2018 storm may have been 760 cfs (341,000 gpm) in the area of the intersection of Park Street and Market Street.

3. West Side Storm Sewer Project

3.1. Project Overview

The goal of the project is to move the flood water from the intersection of Market Street and Park Street to the Black Earth Creek in a manner than reduces the impact to the surrounding businesses and residences. This project will improve stormwater drainage along Park Street and Market Street and provide better conveyance of flood water to the creek by upsizing the existing storm sewer in Park Street and lowering the Park Street profile to the creek. The proposed storm sewer and road modifications will also lower the flood water levels in the vicinity of the intersection and between Plastic Ingenuity and Kalscheur Implement. An earthen berm will be constructed north from the Park Street and Market Street intersection to direct storm water runoff away from Plastic Ingenuity and towards the new storm sewer. Backflow preventers will be installed at existing and proposed storm sewer outlets and at storm drain connections. The design and effectiveness of this proposed project are based on data from the two stormwater models as presented above. Preliminary design drawings of the proposed improvements are included in Appendix A.

3.2. Storm Sewer Improvements

A 42-inch diameter storm sewer would be installed along Park Street from the intersection of Market Street west towards the creek, replacing the existing 18-inch storm sewer. At the proposed slope, the 42-inch pipe has a capacity of approximately 64 cfs when full. Additional storm sewer inlets will be added in the intersection and the intersection will be lowered to improve the capture of surface water. A 36-inch storm sewer would be stubbed to the north at the Plastic Ingenuity parking lot for a future connection for Plastic Ingenuity. The new storm sewer would either discharge directly to the Black Earth Creek, or to a small detention pond. Three discharge options were evaluated in this study and are described below.

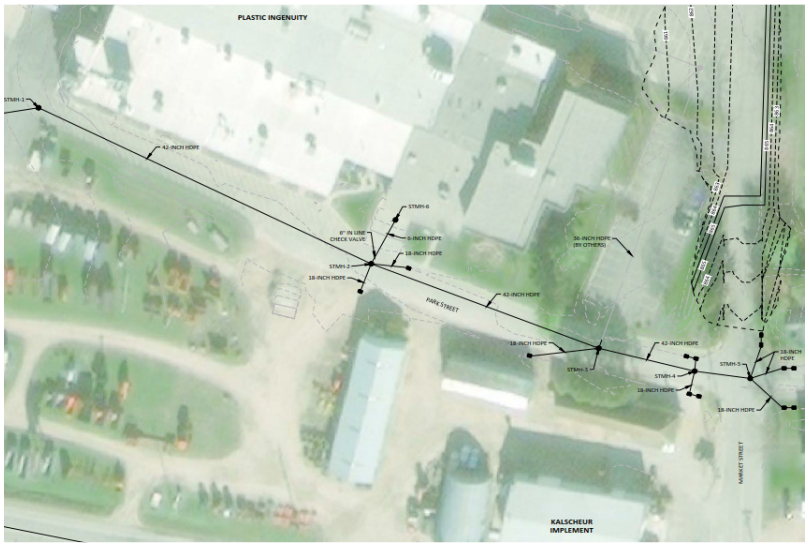


Figure 3. Proposed 42-Inch Storm Sewer and Curb Inlets.

3.2.1. Option 1 – Direct Discharge to Creek

Option 1 is to run a 42-inch storm sewer from the intersection of Park Street and Market Street to the Black Earth Creek and discharge directly to the creek. Since the existing storm sewer discharges directly to the creek, the proposed 42-inch storm sewer could also discharge directly to the creek, according to DNR regulations. A backflow prevention device would be installed on the end of the storm sewer and the outlet area would be reconstructed with heavy riprap to provide additional stabilization.

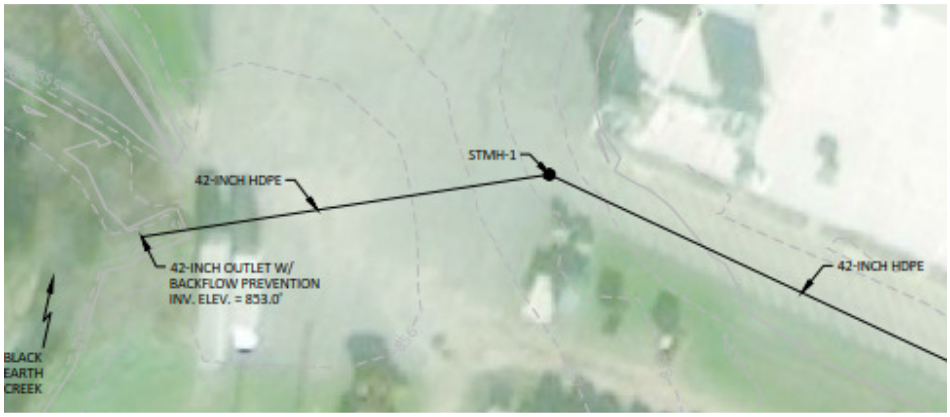


Figure 4. 42-Inch Storm Sewer Discharging Directly to the Creek.

3.2.2. Option 2 – Detention Pond with Pump Station

Option 2 would be to construct a detention pond along the east bank of the Black Earth Creek on what is currently Kalscheur Implement property. The pond would provide detention and suspended solids removal for smaller storm events. A combination of a steel sheet pile wall with a concrete cap and a short concrete wall would be constructed to form the west side of the detention pond. The wall would be constructed to an elevation of 860, which is high enough to keep the Black Earth Creek water from flowing into the detention area during storm events. Pipes through the base of the wall would provide drainage for low flow events and a low-level drain. The pipes through the wall would be equipped with backflow devices to prevent the creek from backing into the detention pond when the creek rises.

This option would require a pump station on the upstream side of the wall with a capacity large enough to pump water over or through the wall during large storm events to keep the water level from rising too high behind the wall and causing flooding.

One additional benefit to digging a detention pond would be that the excavated material could be used to fill an area of the Kalscheur Implement site to raise it above the flood plain, making it suitable to build on.

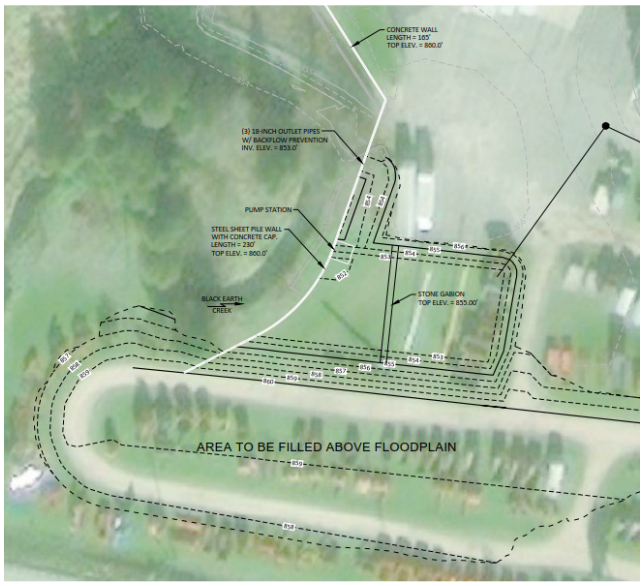


Figure 5. Detention Pond with a Pump Station.

3.2.3. Option 3 – Detention Pond with Lowered Wall

In this option, the detention pond would be constructed as in Option 2. The top of the wall would be built to elevation 860 for the southern portion of the wall, but 165 feet of the wall on the north end would be built to an elevation of approximately 857. This elevation is above the 100-yr flood elevation of the creek and would keep out all but the largest flooding events. The lower portion of the wall would provide an emergency overflow from the detention pond to discharge higher flows during large storm events, starting around the 10-year storm. No pump station would be needed with this alternative.

Table 1 below shows the relationship between the creek elevation and the water level in the pond for various storms.

Table 1. Water Elevation of Creek compared to Water Elevation in Pond

Storm Event	Black Earth Creek Elevation	Water Elevation in Pond	Notes
2-year	854.2	856.1	Water in pond drains through pipes in walls.
10-year	855.6	857.2	Water at peak of storm would spill over lowered wall section.
100-year	856.8	857.5	Creek flood elevation below wall. Water from pond spilling over into creek.
August 2018	858.8	858.2	Creek flood elevation exceeds peak elevation of water in pond. Water would flow into pond from creek.
August 2018	858.0*	858.2	Elevation of creek is higher than lowered wall section, but elevation of flow from detention pond is slightly higher during peak runoff.

*This assumes the creation of a bypass ditch along the south edge of HWY 14 west of the Village.

The lowered wall alternative would protect the pond from creek water flooding for smaller storms. According to modeling results, during a 100-year storm event the water in the pond would raise to a level of about 857.5 as it overtopped the lower section of wall into the creek. During a storm event such as the August 2018 event, the maximum water elevation in the pond would rise to 858.2. However, modeling shows that the elevation of the creek reached 858.8 in this location during the August 2018 event, so the flood waters would essentially be equalizing over the wall.

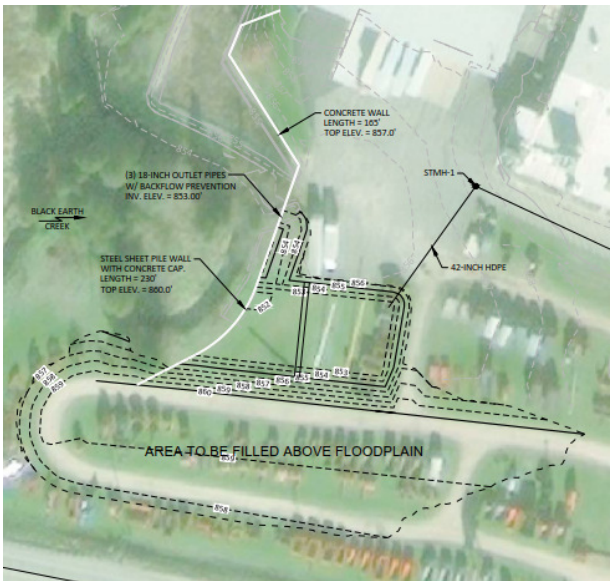


Figure 6. Detention Pond with a Lowered Wall Section.

3.3. Backflow Prevention

Backflow prevention devices would be installed on existing storm sewer building connections and several other storm sewer outlet pipes to prevent system backups during flood events. Storm sewer backups increased flood damage during the August 2018 event. The check valves are designed to allow flow through the pipe if there is positive flow. Once the creek rises and starts backflowing into the storm sewer, the check valve would close. If the head pressure on the upstream end of the pipe becomes greater than the downstream head at the creek, the check valve would open to allow drainage.

3.4. Street Reconstruction

Park Street to the west of the intersection will be reconstructed and the finished elevation would be lowered to convey more flood water to the west. The model results shown in the table below indicate the storm water runoff generated by various storm events. Calculations were performed to approximate what the flood water elevation would be in Park Street during existing conditions and proposed conditions just west of the intersection at the Plastic Ingenuity parking lot entrance. It is estimated that the revision to Park street could reduce the flood water elevation in the immediate area by up to two feet, although a more detailed design of the road would have to be performed to confirm this.

Table 2. Park Street Flood Water Elevation Comparison

Storm Event	Peak Runoff Flow Rate (cfs)	Peak Flow in 42-inch Pipe (cfs)	Peak Flow in Park Street (cfs)	Flood Water Elevation in Park Street at Plastic Ingenuity Parking Lot Entrance (Section E-E)		Change in Flood Water Elevation in Park Street (feet)
				Existing	Proposed	
2-yr (2.84”)	41	41	0	N/A	N/A	N/A
10-yr (4.09”)	88	64	24	862.21	859.95	2.26
100-yr (6.66”)	219	64	155	862.65	860.50	2.15
15” in 24 hours	760	64	696	863.51*	861.47	2.04

*Stormwater from road exceeds the elevation of the Plastic Ingenuity parking lot driveway and can flood parking lot.

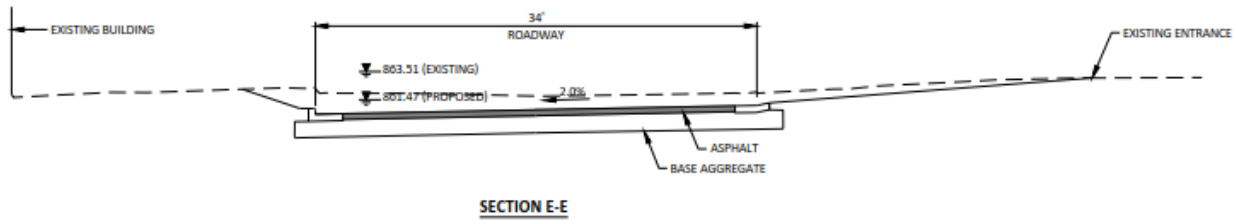


Figure 7. Proposed Park Street Cross Section at Plastic Ingenuity’s Parking Lot Entrance.

3.5. Coordination with Plastic Ingenuity

The Village is coordinating this project with Plastic Ingenuity. The Plastic Ingenuity facility was flooded during the event of 2018. The plant had to be shut down and the inside of the building needed to be cleaned up and restored. The owner of Plastic Ingenuity is planning to do some work around the building to improve drainage and reduce the chances of future flooding. The Village would work with Plastic Ingenuity to construct an earthen berm from the northwest corner of Market Street and Park Street, north into the northeast parking lot. This would keep surface runoff from the hills out of the Plastic Ingenuity parking lot and direct it to the intersection. The ground would be raised to an elevation of 865 along the driveway at the eastern limits of Plastic Ingenuity’s property as shown on drawing Sheets 7 and 8 in Appendix A. The berm construction would be part of the project no matter which alternative is selected.

Figure 8. Plastic Ingenuity Located on the Northwest Corner of Park Street and Market Street.

The effects of the berm can be seen on the Stormwater Modeling Images in Appendix C. It is estimated that the revision to Park street could reduce the flood water elevation in the immediate area by up to two feet, although a more detailed design of the road would have to be performed to confirm this.

3.6. Preliminary Cost Estimates

Cost estimates for the 3 options considered are presented in Table 3 below. A 20% contingency was included in the estimates and engineering fees were estimated at 15% of the overall project cost. Preliminary detailed construction cost estimates for the proposed improvements are in Appendix B.

Table 3. Estimated Project Costs

Project	Estimated Project Cost
Option 1 – Direct Discharge to Creek	$867,000
Option 2 – Detention Pond with Pump Station	$3.9 to $6.5 million
Option 3 – Detention Pond with Lowered Wall	$1.25 million

4. Discussion

Pros and cons of the three storm sewer outfall options are discussed below. Project challenges and our recommendation are also presented.

4.1. Option 1 - Direct Discharge to Creek

Option 1 is to run a 42-inch storm sewer from the intersection of Park Street and Market Street to the Black Earth Creek and discharge directly to the creek. Some pros and cons of this option are listed below.

Direct Discharge Pros:

- Minimal wetland impacts
- Minimal maintenance
- Least expensive alternative

Direct Discharge Cons:

- Less fill available for Kalscheur Equipment property
- No stormwater treatment for smaller storms

4.2. Option 2 - Detention Pond with Pump Station

Standard stormwater designs are typically based on moderating peak flows by storing runoff and slowly discharging the stored water over a longer period of time. In this case, the area available for storage is minimal compared to the volume of water produced by a storm of the magnitude that occurred in August of 2018. The estimated peak runoff flow in this area of Park Street during the August 2018 storm may have been as high as 430 to 760 cubic feet per second. The anticipated storage available in the outfall location is approximately 119,000 cubic feet, which would fill up in less than 5 minutes during the peak of an extremely large storm event. Because the storage capacity is so minimal, a pump station would have to be designed to keep up with the peak flow or the water behind the wall would back up even higher than the creek level. This would require the pump station to have an extremely large pumping capacity. A budgetary cost for one 36" vertical propeller pump that can pump 32,000 gpm (71 cfs) is $300,000. An estimated additional $550,000 would be needed for controls and a pump station structure and an emergency generator. The pump station would have to be equipped with approximately 6 to 10 of these large pumps to have the pumping capacity equal to the estimated peak runoff during the August 2018 storm event.

Pump Station Pros:

- Wall will protect Plastic Ingenuity and Kalscheur Implement properties from creek flooding
- It's an active method to remove water from the pond
- No matter what the creek elevation is, water can still be discharged from the pond
- Fill material available to raise some of Kalscheur Implement property

Pump Station Cons:

- High cost (budgetary estimate of $2 to $4 million for high capacity pump station)
- Pumps would operate infrequently
- Ongoing maintenance required
- Backup generator(s) with enough capacity would be required
- Can only pump water as fast as it is conveyed to the pump station
- Reliant on mechanical system operation during unfavorable conditions

4.3. Option 3 – Detention Pond with Lowered Wall

Option 3 is the same as Option 2 with a lowered wall in lieu of the pump station. Some pros and cons of this alternative are listed below.

Lowered Wall Pros:

- Less expensive than pump station alternative
- Lower maintenance
- Stormwater treatment provided for smaller storms
- Fill material available to raise some of Kalscheur Implement property

Lowered Wall Cons:

- Flood water elevations in the area by the creek would remain about the same during large storm events
- Water must drain by gravity from pond area

4.4. Project Challenges

The challenges facing the construction of this project are typical of many underground utility projects. There are several existing utilities within the street where the new 42-inch storm sewer is proposed to go. Based on the preliminary design, the existing water main in Park Street will have to be relocated and other utilities, including the sanitary sewer service from Plastic Ingenuity and a buried cable TV on the west side of the intersection may need adjustment or relocation. Construction will have to abide by DNR wetland and erosion control standards and permit requirements.

4.5. Recommendations

Option 1 is the recommended option due to the low cost and low maintenance required. And although this option will not protect the area near the creek from high creek water, water from the creek did not flood Plastic Ingenuity or Kalscheur Implement during the August 2018 storm event.

5. Implementation

5.1. Construction Procurement

Construction procurement will be through the traditional means of design/bid/build using the sealed competitive bid process. It is anticipated that the sanitary sewer project would be bid with the Brewery Creek flood control project.

5.2. Permits and Agency Coordination

5.2.1. Construction Permits

Permits and coordination will be required with regulatory agencies for the general construction of this project and since the west end of the project is adjacent to the Black Earth Creek. The proposed project would be subject to modifications to meet the permit requirements set by these agencies. It is anticipated that coordination and permits will be required with the following agencies:

- Army Corps of Engineers
- Fish and Wildlife
- DNR
- Dane County
- FEMA

It is anticipated that these permits could be obtained within 2-3 months. Permit applications would be made as soon as the design was finalized. In some cases, permitting may overlap with bidding depending on turnaround time.

5.2.2. Cultural Resources Review

Commonwealth Heritage Group performed a preliminary cultural resources review of the Brewery Creek study area and the location of the west side storm sewer project. The preliminary review determined that there are no previously recorded archaeological sites or cemetery/burial sites in either location, but archaeological surveys will need to be completed prior to construction. The report identifies two

properties in the vicinity of the Brewery Creek study area that may need to be surveyed and evaluated if they will be directly or indirectly affected by any projects. This report is attached in Appendix E.

5.2.3. Wetland Impact Review

A desktop wetland delineation was performed by Heartland Ecological Group for the Brewery Creek study area. Although a formal wetland delineation would have to be completed prior to any construction work, the report gives an idea of what wetland impacts can be expected. This report is attached in Appendix F. A summary of what was found is presented in Table 4 below.

Table 4. Summary of Potential Wetland Areas

Wetland ID	Wetland Description	*Surface Water Connections	Regulatory Jurisdiction	Acreage (on-site)
W-1	Farmed Wet Meadow	Contiguous to Brewery Creek	WDNR and USACE	2.09
W-2	Farmed Wet Meadow	Contiguous to Brewery Creek	WDNR and USACE	3.89
W-3	Farmed Wet Meadow	Potentially Isolated	WDNR Only	1.52
W-4	Brewery Creek and Wetland Fringe		WDNR and USACE	1.16
*Classification based on Heartland's professional opinion. Jurisdictional authority of wetland and waterway protective areas under NR 151 lies with the WDNR. Local zoning authorities may have additional restrictions. USACE has authority for determining federal jurisdiction of wetlands and waterways.				**8.66**

5.3. Underground Utility Coordination

During final design of the project, utility companies with underground facilities in the area would be notified of the proposed project so the locations of the utilities can be determined and moved if necessary. Since most of the work is planned to be within Village right of way, no fees for utility relocations are anticipated. Known utilities include natural gas, electric, television, sanitary sewer, potable water, and communications.

5.4. Project Schedule

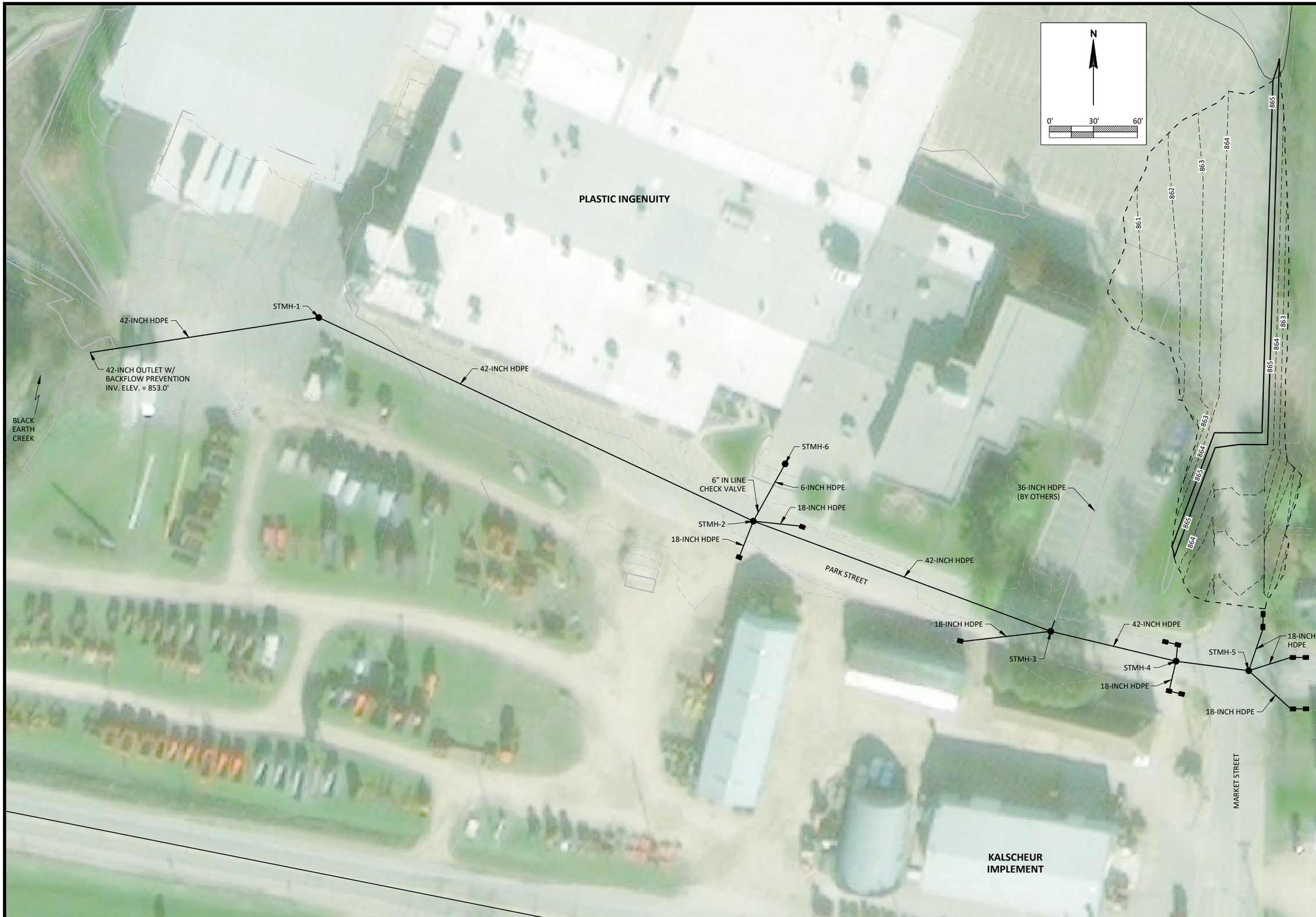
Below is an anticipated project schedule.

Table 5. Proposed Project Schedule

Phase	Duration	Month												
Detailed Design	2 months													
Permit Review	2-3 months													
Property and Easement Acquisition	6 months													
Bid Solicitation and Contract Award	2 months													
Construction	2 months													

Appendix A. Drawings

1. West Side Storm Sewer – Option 1
2. West Side Storm Sewer – Option 2
3. West Side Storm Sewer – Option 3
4. Plan & Profile Market Street
5. Plan & Profile Park Street (Sheet 1 of 2)
6. Plan & Profile Park Street (Sheet 2 of 2)
7. Berm Grading Plan
8. Berm Sections
9. Road Sections
10. Finished Typical Sections
11. Existing Storm Sewer Backflow Preventers



JEWELL
associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

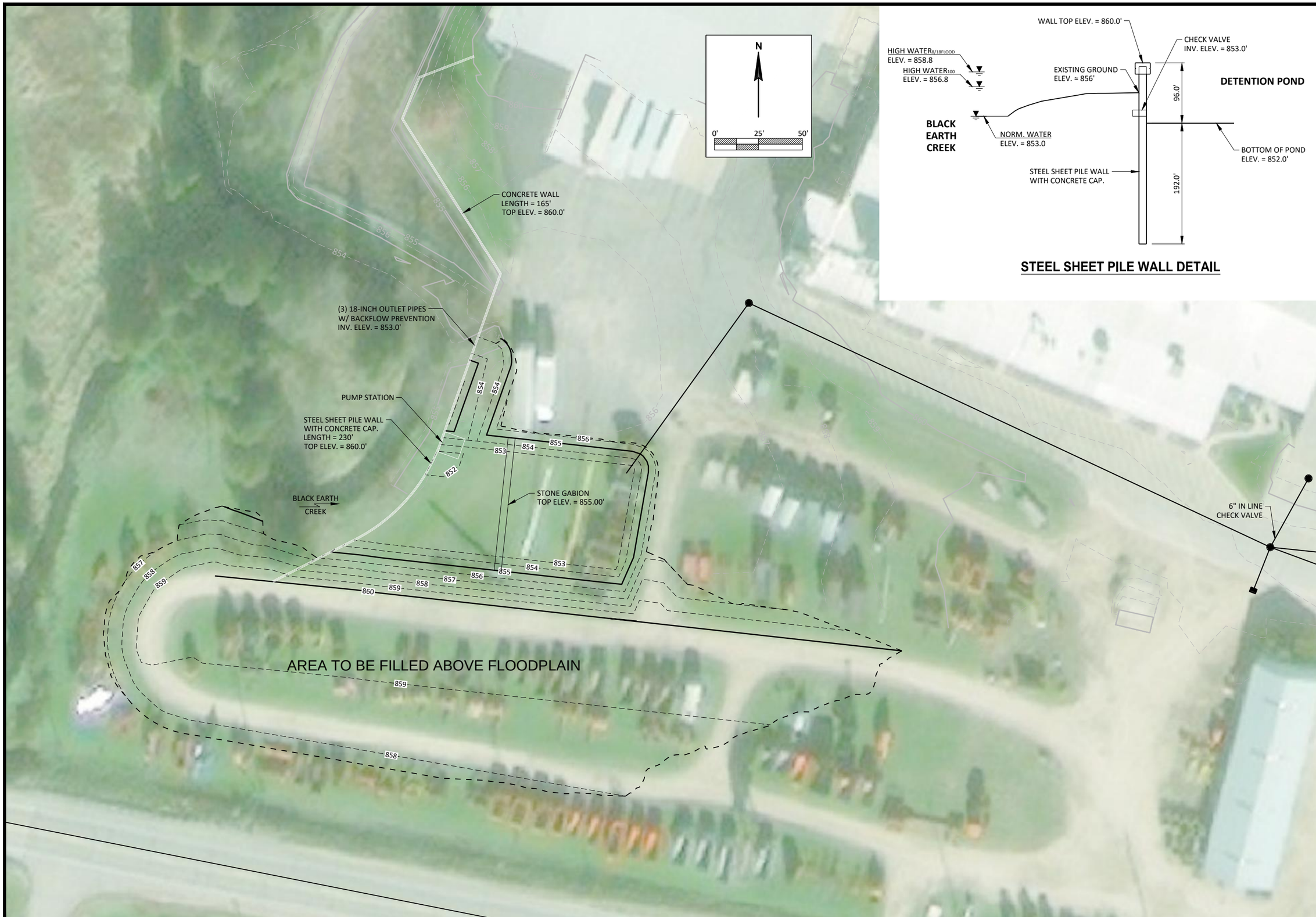
Date
4/9/20

Date	Revision

Drawing Name
West Side Storm Sewer - Option 1

Sheet No.
1

Project Number
CA2010



JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

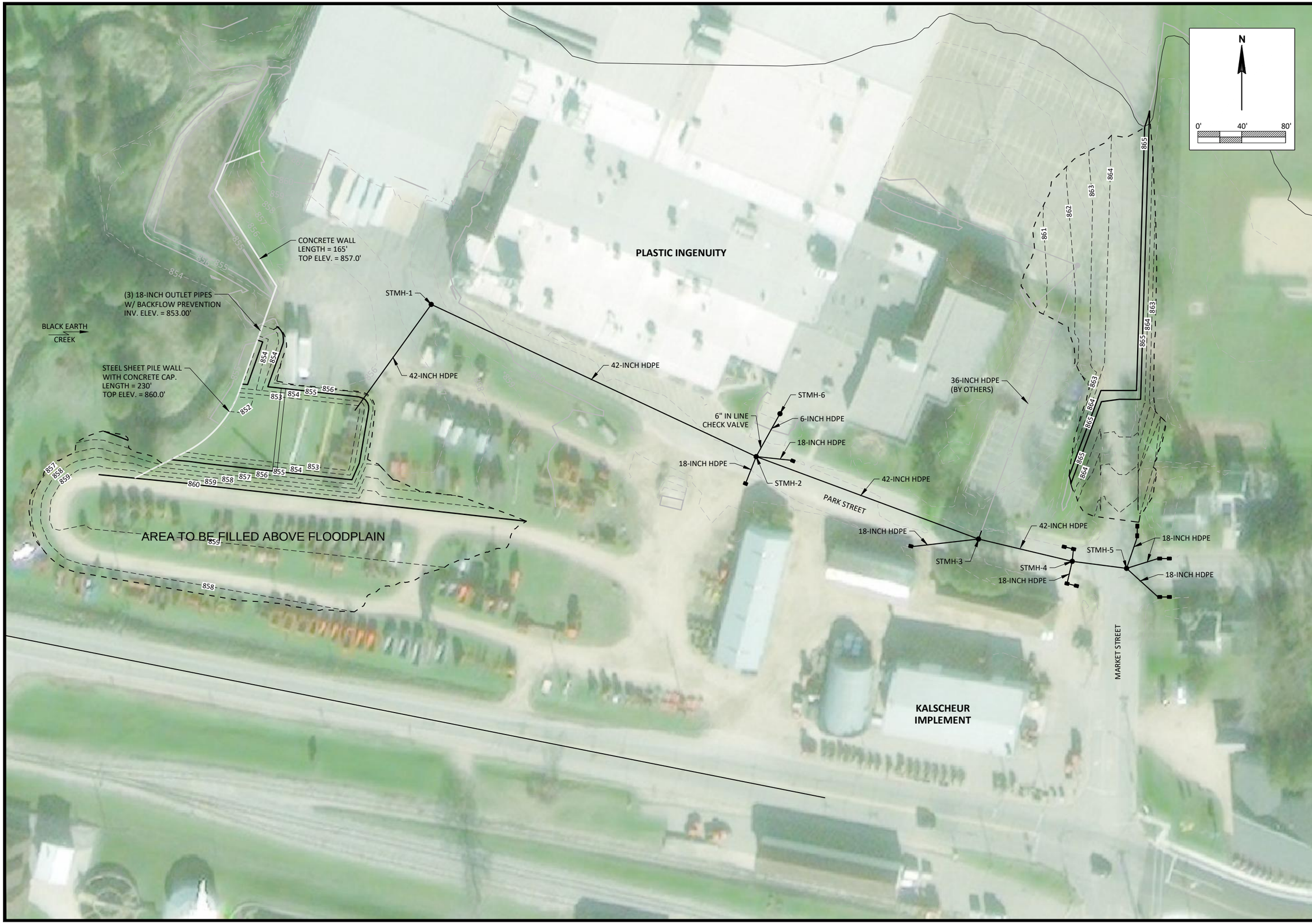
Date
4/9/20

Date	Revision

Drawing Name
West Side Storm Sewer - Option 2

Sheet No.
2

Project Number
CA2010



JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

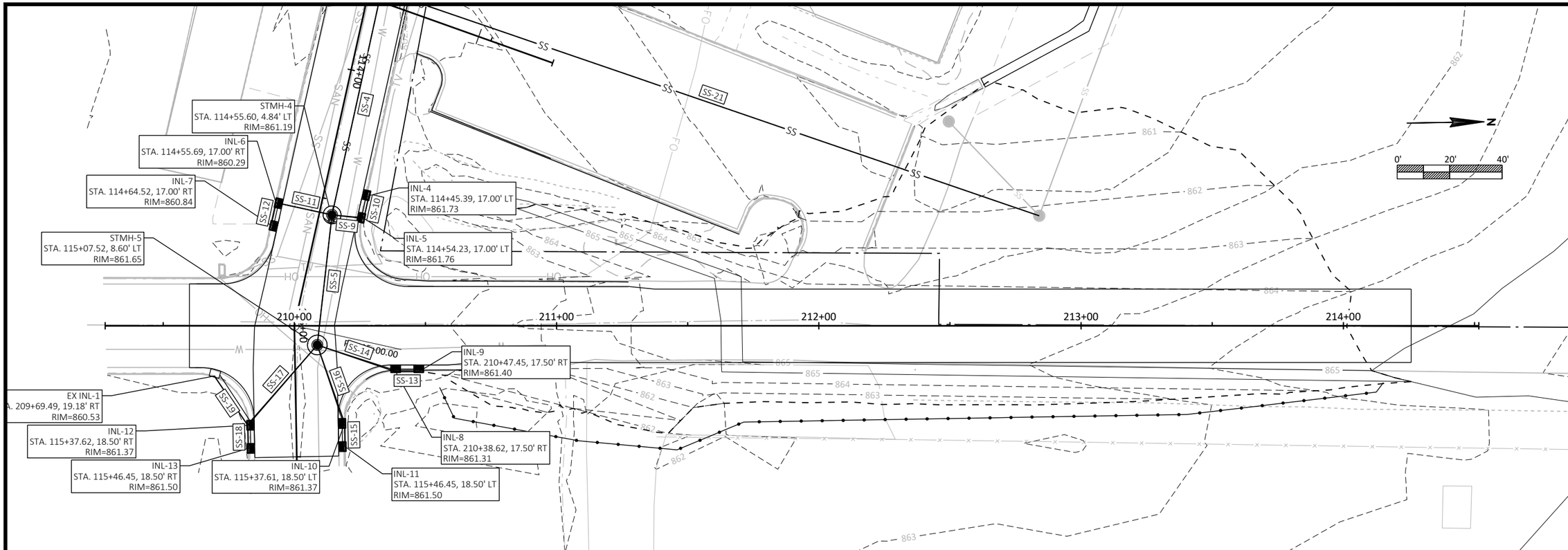
Date
4/9/20

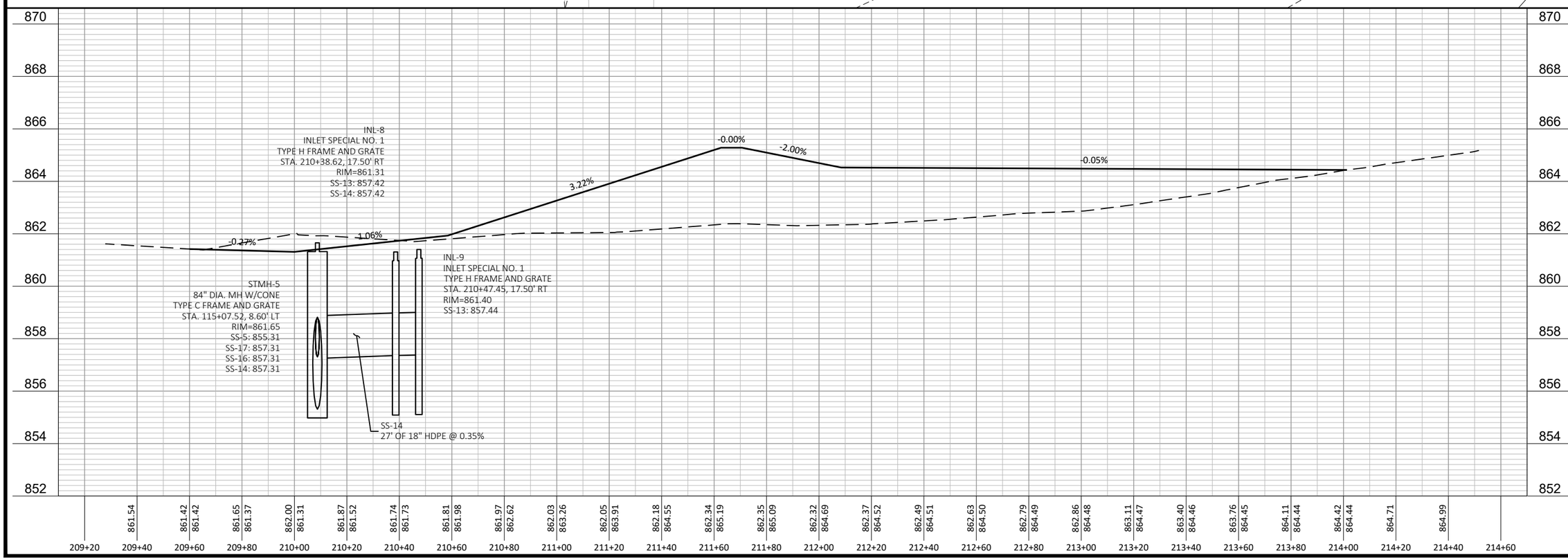
Date	Revision

Drawing Name
West Side Storm Sewer - Option 3

Sheet No.
3

Project Number
CA2010





JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

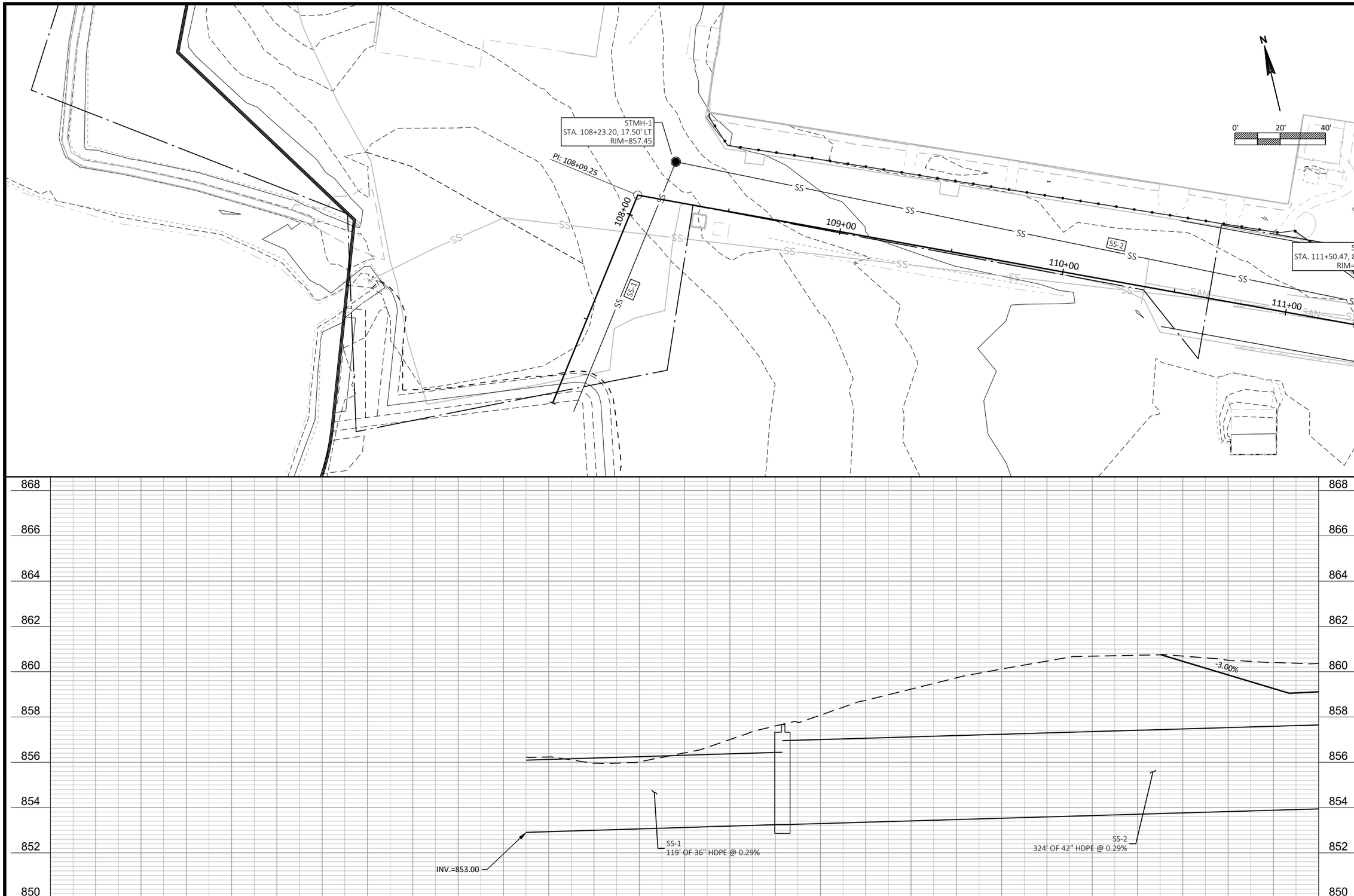
Date
4/9/20

Date	Revision

Drawing Name
Plan & Profile Market Street

Sheet No.
4

Project Number
CA2010



JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

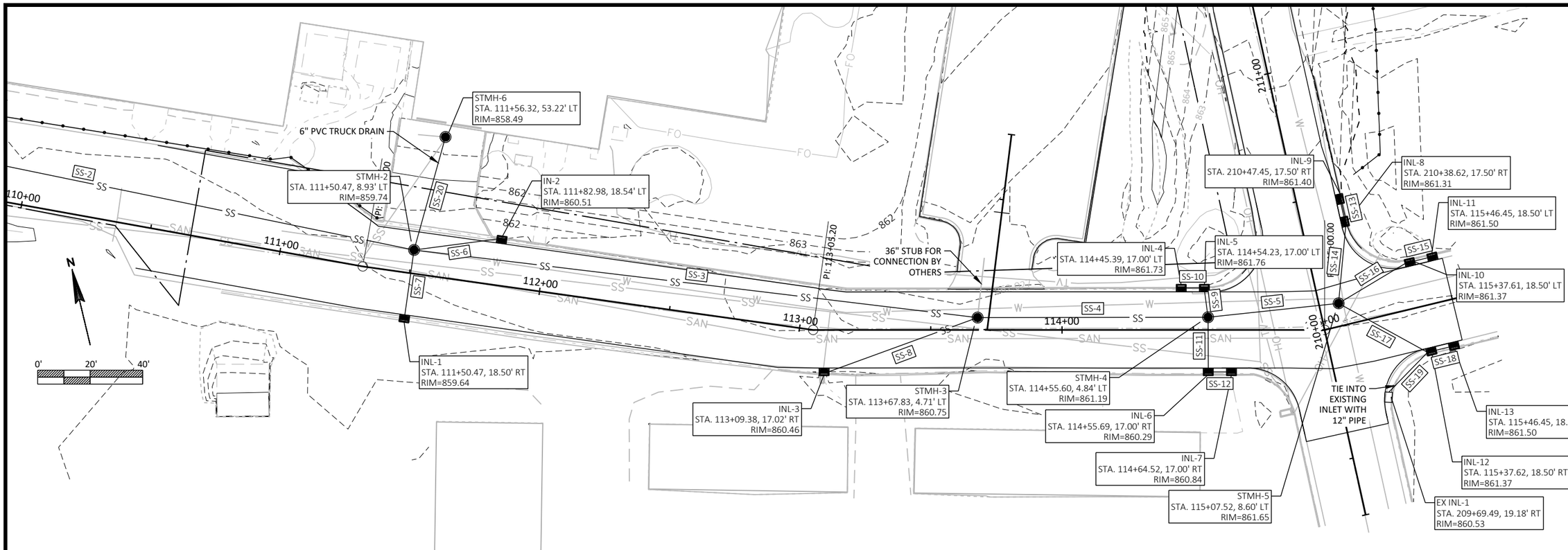
Date
4/9/20

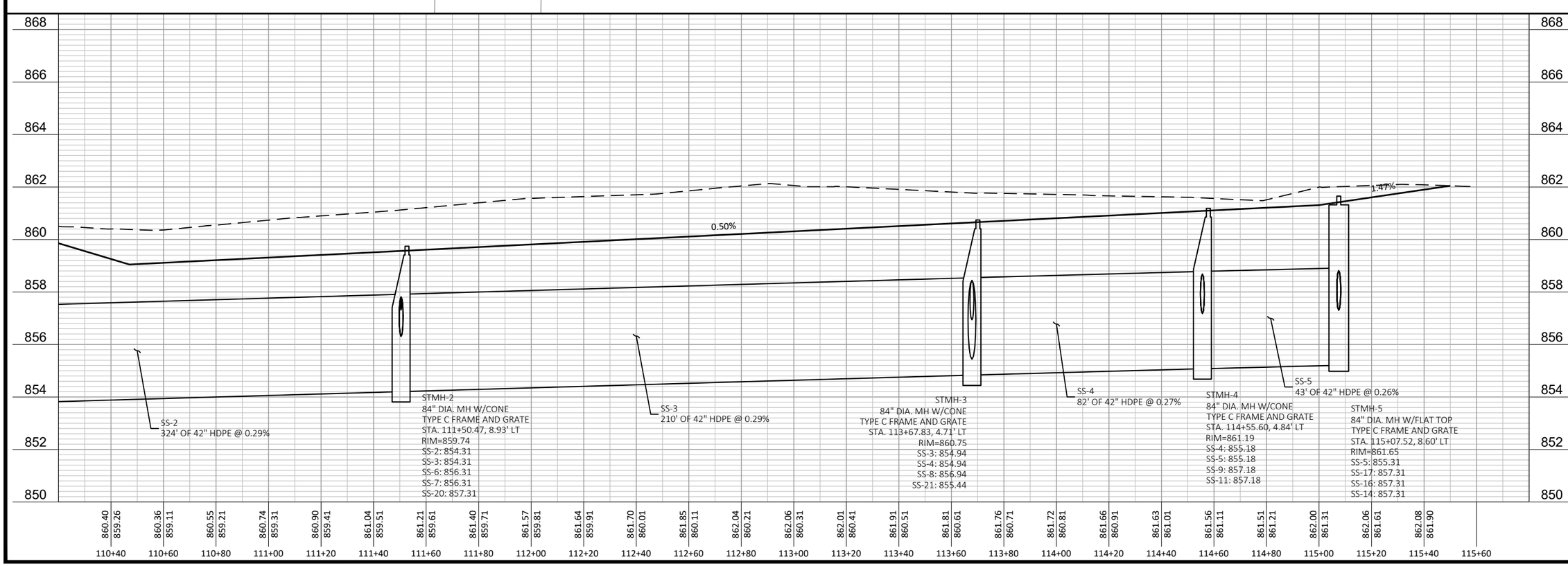
Date	Revision

Drawing Name
Plan & Profile Park Street (Sheet 1 of 2)

Sheet No.
5

Project Number
CA2010





JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

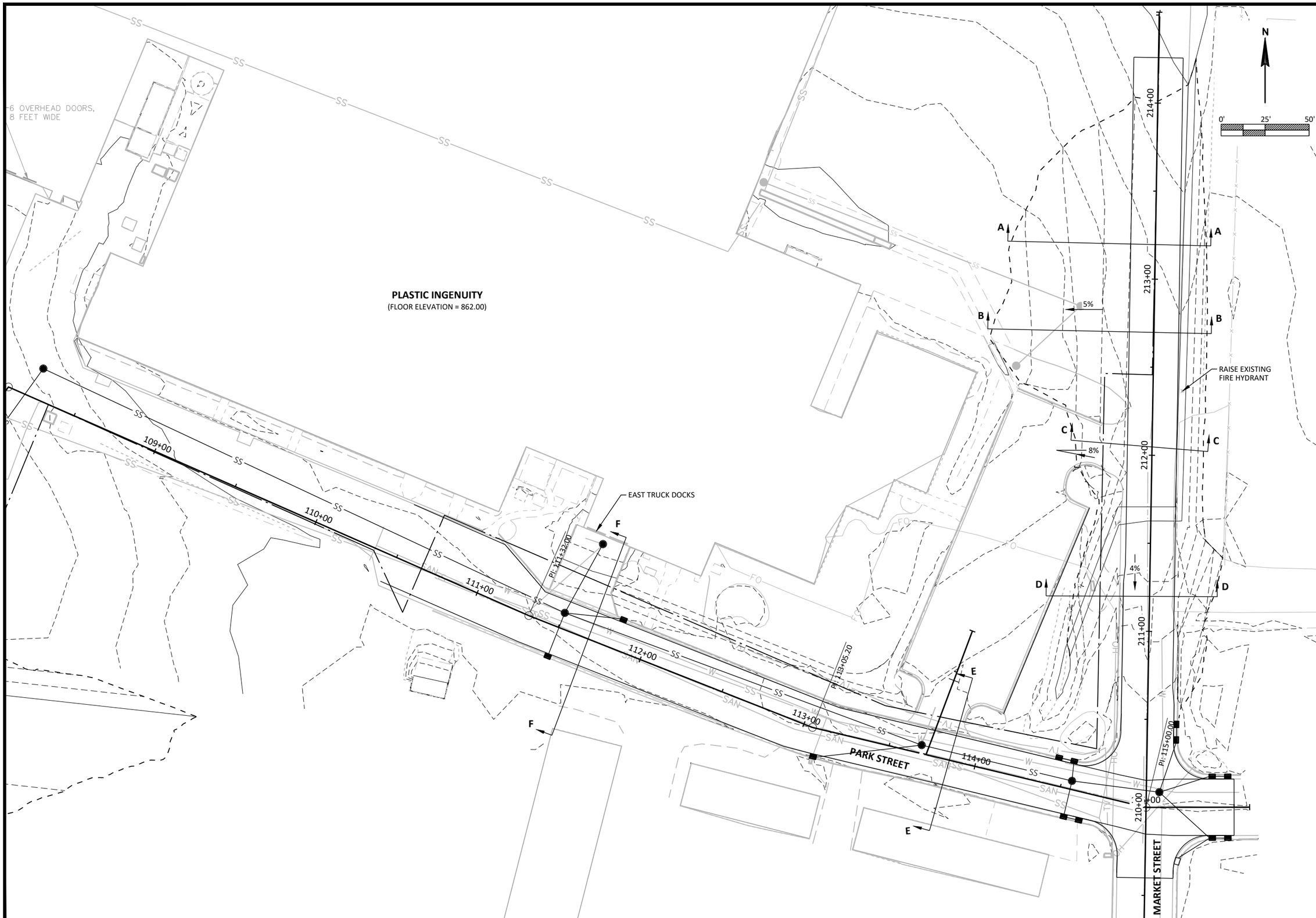
Date
4/9/20

Date	Revision

Drawing Name
Plan & Profile
Park Street
(Sheet 2 of 2)

Sheet No.
6

Project Number
CA2010



JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

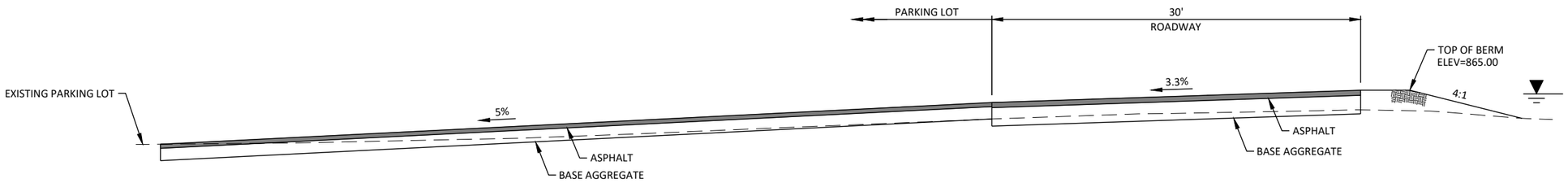
Date
4/9/20

Date	Revision

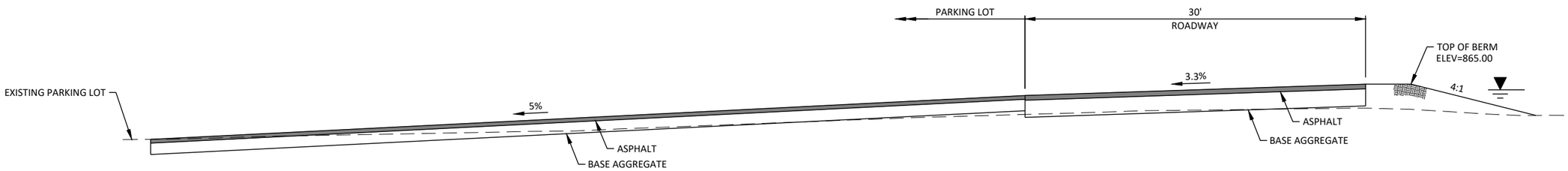
Drawing Name
Berm Grading Plan

Sheet No.
7

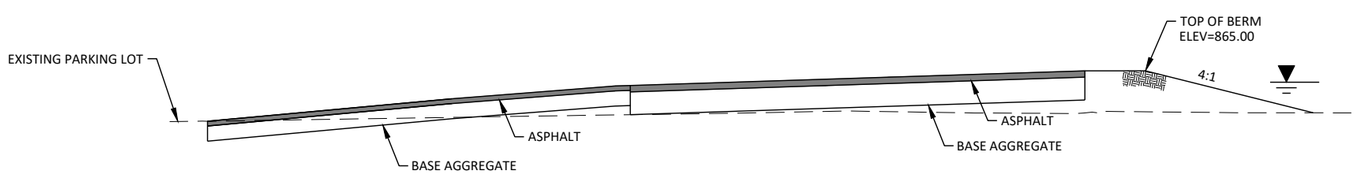
Project Number
CA2010



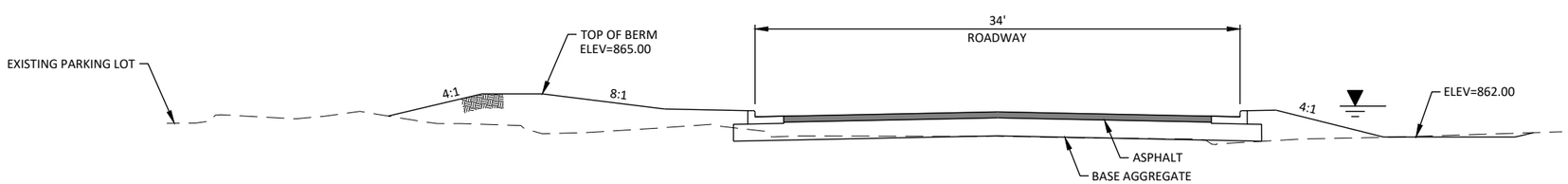
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D

JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

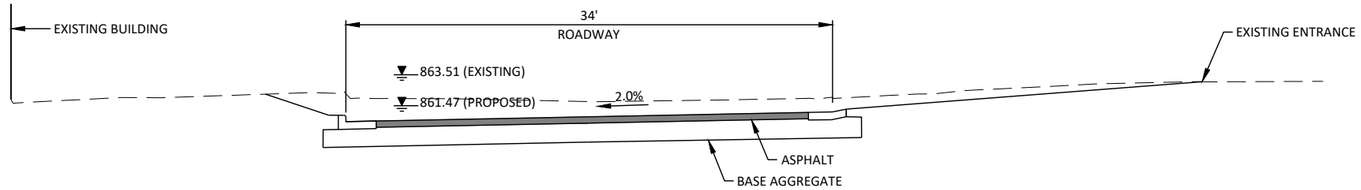
Date
4/9/20

Date	Revision

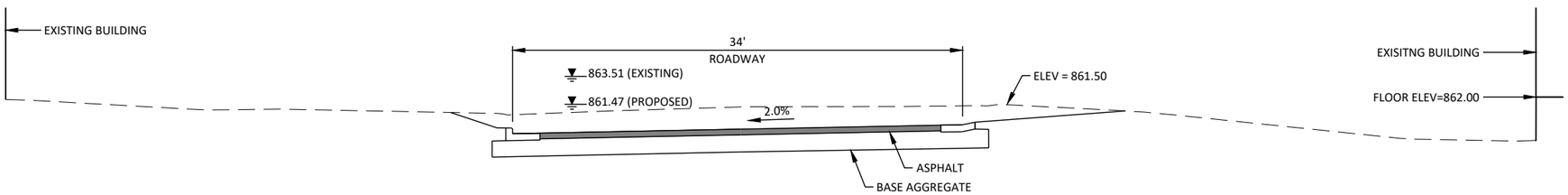
Drawing Name
Berm Sections

Sheet No.
8

Project Number
CA2010



SECTION E-E



SECTION F-F

JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

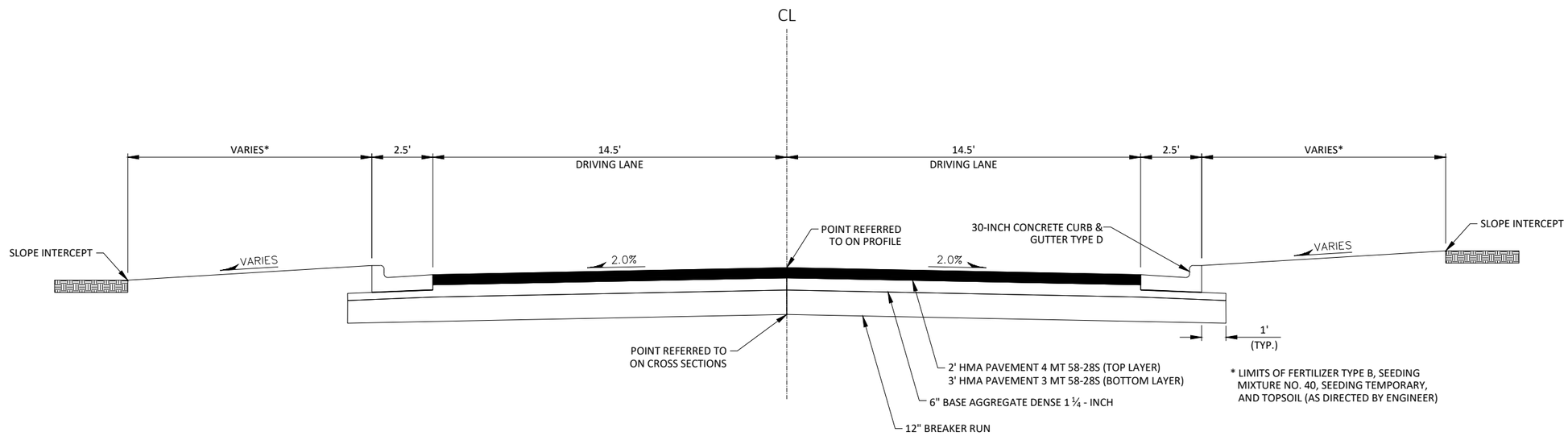
Date
4/9/20

Date	Revision

Drawing Name
Road Sections

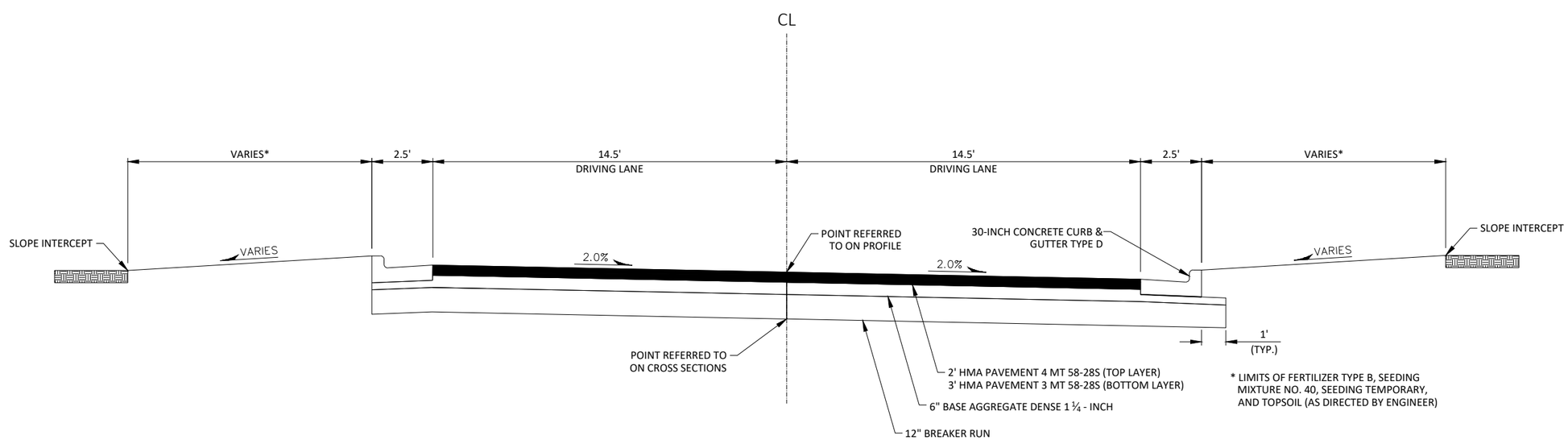
Sheet No.
9

Project Number
CA2010



TYPICAL FINISHED SECTION

(2.0% CROWNED)



TYPICAL FINISHED SECTION

(2.0% CROSS SLOPE)

JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

Date
4/9/20

Date	Revision

Drawing Name
Finished Typical Sections

Sheet No.
10

Project Number
CA2010

JEWELL associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

Date
4/9/20

Date	Revision

Drawing Name
Existing Storm Sewer Backflow Preventers

Sheet No.
11

Project Number
CA2010

Appendix B. Cost Estimates

Cross Plains Flood Control Estimate - West Side Storm Sewer - Option 1 - Direct Discharge to Creek

ITEM NO.	APPROX. QUANTITY	ITEM UNIT	ITEM DESCRIPTION	UNIT PRICE	TOTAL COST
1	1	EA	Mobilization	$15,000	$15,000
2	2,000	CY	Excavation Common	$15	$30,000
3	2,500	CY	Fill	$15	$37,500
4	700	LF	Silt Fence	$2	$1,400
5	1,720	SY	E-Mat - Class 1 Type B	$3	$5,160
6	5,570	SY	Seeding	$1.25	$6,963
7	5,570	SY	Salvaged Topsoil	$2	$11,140
8	1	EA	Hydrant Extension	$1,000	$1,000
9	681	LF	42-inch HDPE Storm Sewer	$110	$74,910
10	20	LF	36-inch HDPE Storm Sewer	$85	$1,700
11	722	LF	18-inch HDPE Storm Sewer	$55	$39,710
12	30	LF	12-inch HDPE Storm Sewer	$40	$1,200
13	45	LF	6-inch PVC Storm Sewer	$35	$1,575
14	13	EA	2'x3' Storm Sewer Inlet	$1,800	$23,400
15	1	LS	Remove/Abandon Existing Storm Sewer	$10,000	$10,000
16	500	LF	Relocate water or sanitary sewer	$70	$35,000
17	5	EA	84-inch Diam. Storm Sewer Manhole	$8,500	$42,500
18	1	EA	48-inch Diam. Storm Sewer Manhole	$5,000	$5,000
20	365	Ton	Base Aggregate Dense - Driveway	$10	$3,650
21	2,800	Ton	Base Aggregate Dense	$10	$28,000
22	5,000	Ton	3" Breaker Run	$8	$40,000
25	1	LS	Backflow Prevention	$50,000	$50,000
27	640	LF	Remove Curb and Gutter	$5	$3,200
28	1,300	LF	Concrete Curb and Gutter 30"	$20	$26,000
29	1,800	Ton	Asphalt Pavement	$90	$162,000
30	380	Gal	Tack Coat	$2	$760
				SubTotal	$656,768
				Contingency (20%) =	$131,354
				Engineering (15%) =	$78,812
				Total Estimated Cost =	$866,933

Cross Plains Flood Control Estimate - West Side Storm Sewer - Option 2 - Detention Pond with Pump Station (760 cfs)

ITEM NO.	APPROX. QUANTITY	ITEM UNIT	ITEM DESCRIPTION	UNIT PRICE	TOTAL COST
1	1	EA	Mobilization	$15,000	$15,000
2	3,525	CY	Excavation Common	$15	$52,875
3	5,030	CY	Fill	$15	$75,450
4	700	LF	Silt Fence	$2	$1,400
5	2,600	SY	E-Mat - Class 1 Type B	$3	$7,800
6	7,280	SY	Seeding	$1.25	$9,100
7	7,280	SY	Salvaged Topsoil	$2	$14,560
8	1	EA	Hydrant Extension	$1,000	$1,000
9	769	LF	42-inch HDPE Storm Sewer	$110	$84,590
10	20	LF	36-inch HDPE Storm Sewer	$85	$1,700
11	247	LF	18-inch HDPE Storm Sewer	$55	$13,585
12	20	LF	12-inch HDPE Storm Sewer	$40	$800
13	40	LF	6-inch PVC Storm Sewer	$35	$1,400
14	13	EA	2'x3' Storm Sewer Inlet	$1,800	$23,400
15	1	LS	Remove/Abandon Existing Storm Sewer	$10,000	$10,000
16	500	LF	Relocate water or sanitary sewer	$70	$35,000
17	5	EA	84-inch Diam. Storm Sewer Manhole	$8,500	$42,500
18	1	EA	48-inch Diam. Storm Sewer Manhole	$5,000	$5,000
19	7	EA	Stone Gabions	$900	$6,300
20	365	Ton	Base Aggregate Dense - Driveway	$10	$3,650
21	2,475	Ton	Base Aggregate Dense	$10	$24,750
22	4,720	Ton	3" Breaker Run	$8	$37,760
23	4,500	SF	Steel Sheet Piling	$50	$225,000
24	45	CY	Concrete Cap on Sheet Pile Wall	$700	$31,500
25	33	CY	Concrete Wall	$700	$23,100
26	1	LS	Backflow Prevention	$50,000	$50,000
27	1	LS	Stormwater Pump Station with Generator	$4,000,000	$4,000,000
28	640	LF	Remove Curb and Gutter	$5	$3,200
29	1,300	LF	Concrete Curb and Gutter 30"	$20	$26,000
30	1,500	Ton	Asphalt Pavement	$90	$135,000
31	345	Gal	Tack Coat	$2	$690
				SubTotal	$4,962,110

Contingency (20%) =	$992,422
Engineering (15%) =	$595,453
Total Estimated Cost =	$6,549,985

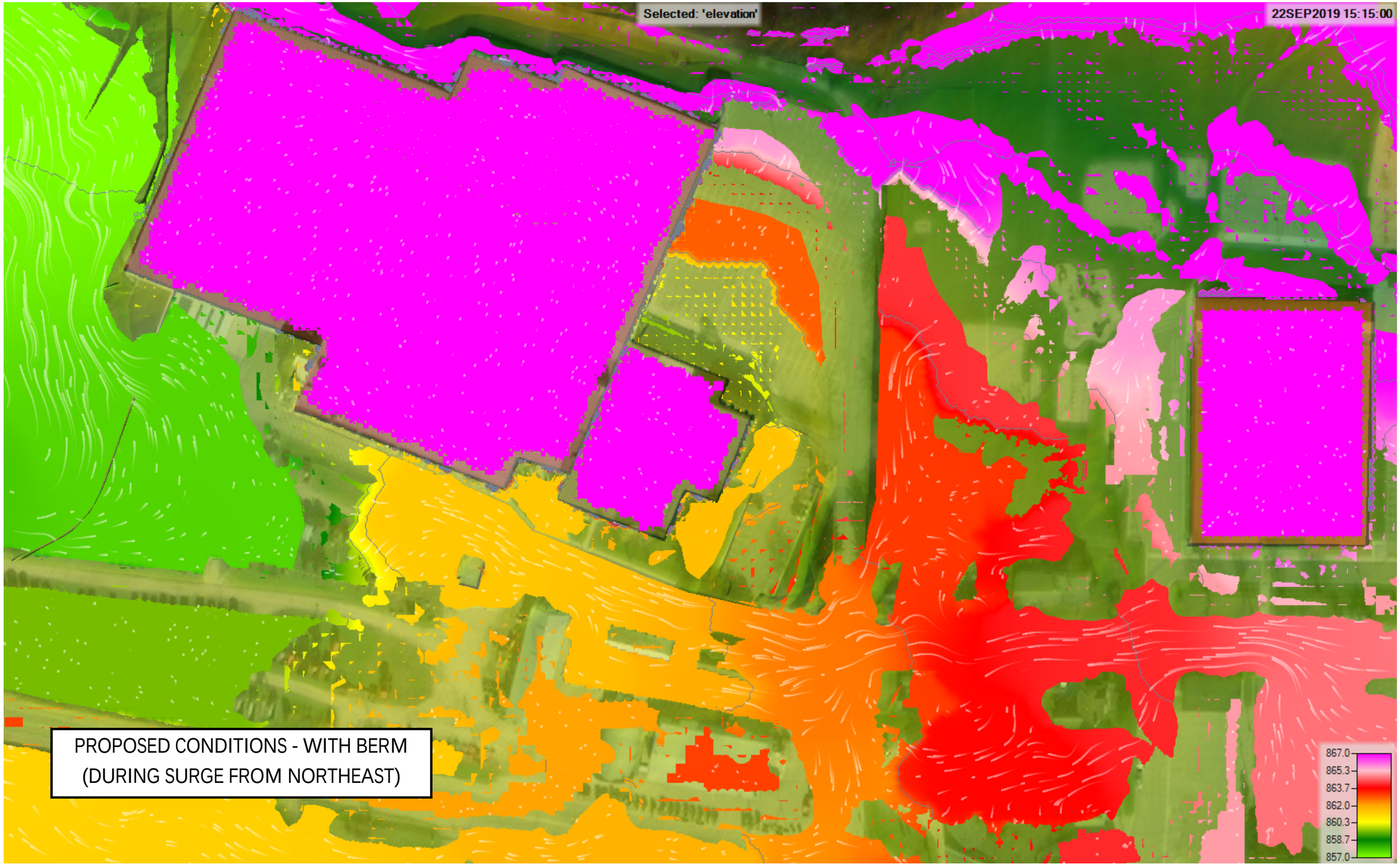
Cross Plains Flood Control Estimate - West Side Storm Sewer - Option 3 - Detention Pond with Lowered Wall

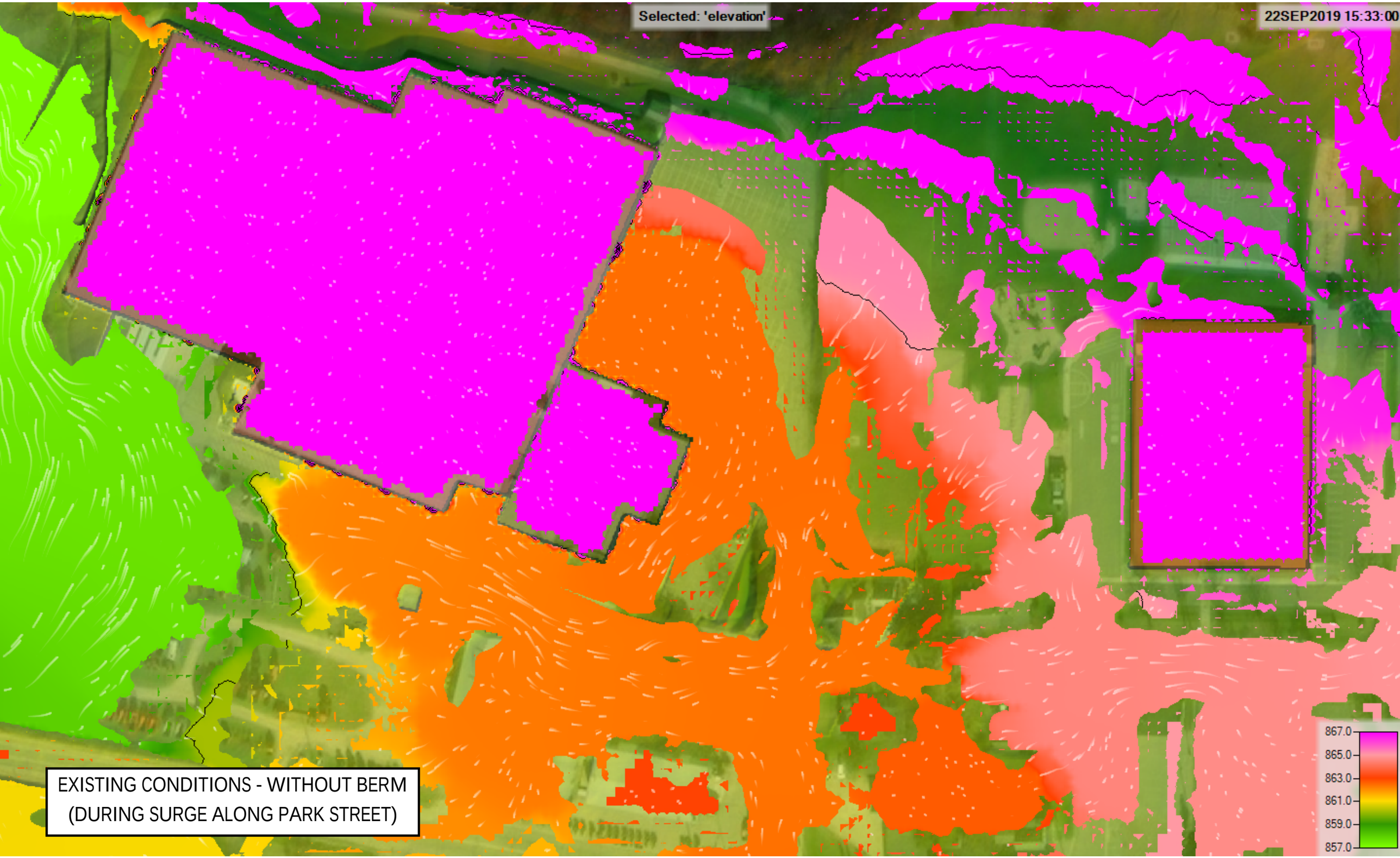
ITEM NO.	APPROX. QUANTITY	ITEM UNIT	ITEM DESCRIPTION	UNIT PRICE	TOTAL COST
1	1	EA	Mobilization	$15,000	$15,000
2	3,525	CY	Excavation Common	$15	$52,875
3	5,030	CY	Fill	$15	$75,450
4	700	LF	Silt Fence	$2	$1,400
5	2,600	SY	E-Mat - Class 1 Type B	$3	$7,800
6	7,280	SY	Seeding	$1.25	$9,100
7	7,280	SY	Salvaged Topsoil	$2	$14,560
8	1	EA	Hydrant Extension	$1,000	$1,000
9	769	LF	42-inch HDPE Storm Sewer	$110	$84,590
10	20	LF	36-inch HDPE Storm Sewer	$85	$1,700
11	247	LF	18-inch HDPE Storm Sewer	$55	$13,585
12	20	LF	12-inch HDPE Storm Sewer	$40	$800
13	40	LF	6-inch PVC Storm Sewer	$35	$1,400
14	13	EA	2'x3' Storm Sewer Inlet	$1,800	$23,400
15	1	LS	Remove/Abandon Existing Storm Sewer	$10,000	$10,000
16	500	LF	Relocate water or sanitary sewer	$70	$35,000
17	5	EA	84-inch Diam. Storm Sewer Manhole	$8,500	$42,500
18	1	EA	48-inch Diam. Storm Sewer Manhole	$5,000	$5,000
19	7	EA	Stone Gabions	$900	$6,300
20	365	Ton	Base Aggregate Dense - Driveway	$10	$3,650
21	2,475	Ton	Base Aggregate Dense	$10	$24,750
22	4,720	Ton	3" Breaker Run	$8	$37,760
23	4,500	SF	Steel Sheet Piling	$50	$225,000
24	45	CY	Concrete Cap on Sheet Pile Wall	$700	$31,500
25	13	CY	Concrete Wall	$700	$9,100
26	1	LS	Backflow Prevention	$50,000	$50,000
27	640	LF	Remove Curb and Gutter	$5	$3,200
28	1,300	LF	Concrete Curb and Gutter 30"	$20	$26,000
29	1,500	Ton	Asphalt Pavement	$90	$135,000
30	345	Gal	Tack Coat	$2	$690
				SubTotal	$948,110
				Contingency (20%) =	$189,622
				Engineering (15%) =	$113,773
				Total Estimated Cost =	$1,251,505

Appendix C. Stormwater Modeling Images

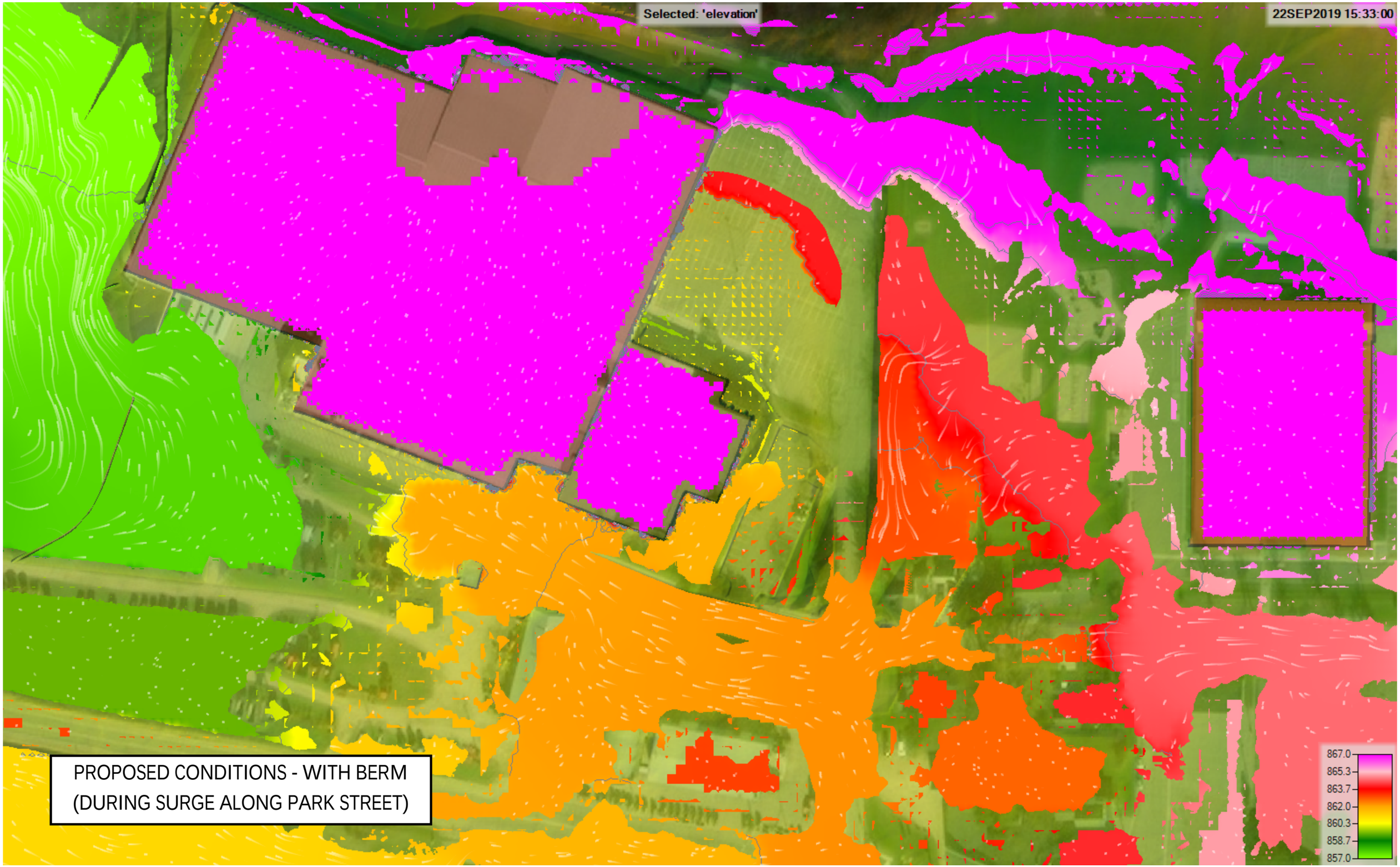
1. Existing Conditions – Without Berm (During Surge from Northeast)
2. Proposed Conditions – With Berm (During Surge from Northeast)
3. Existing Conditions – Without Berm (During Surge Along Park Street)
4. Proposed Conditions – With Berm (During Surge Along Park Street)

EXISTING CONDITIONS - WITHOUT BERM
(DURING SURGE FROM NORHEAST)

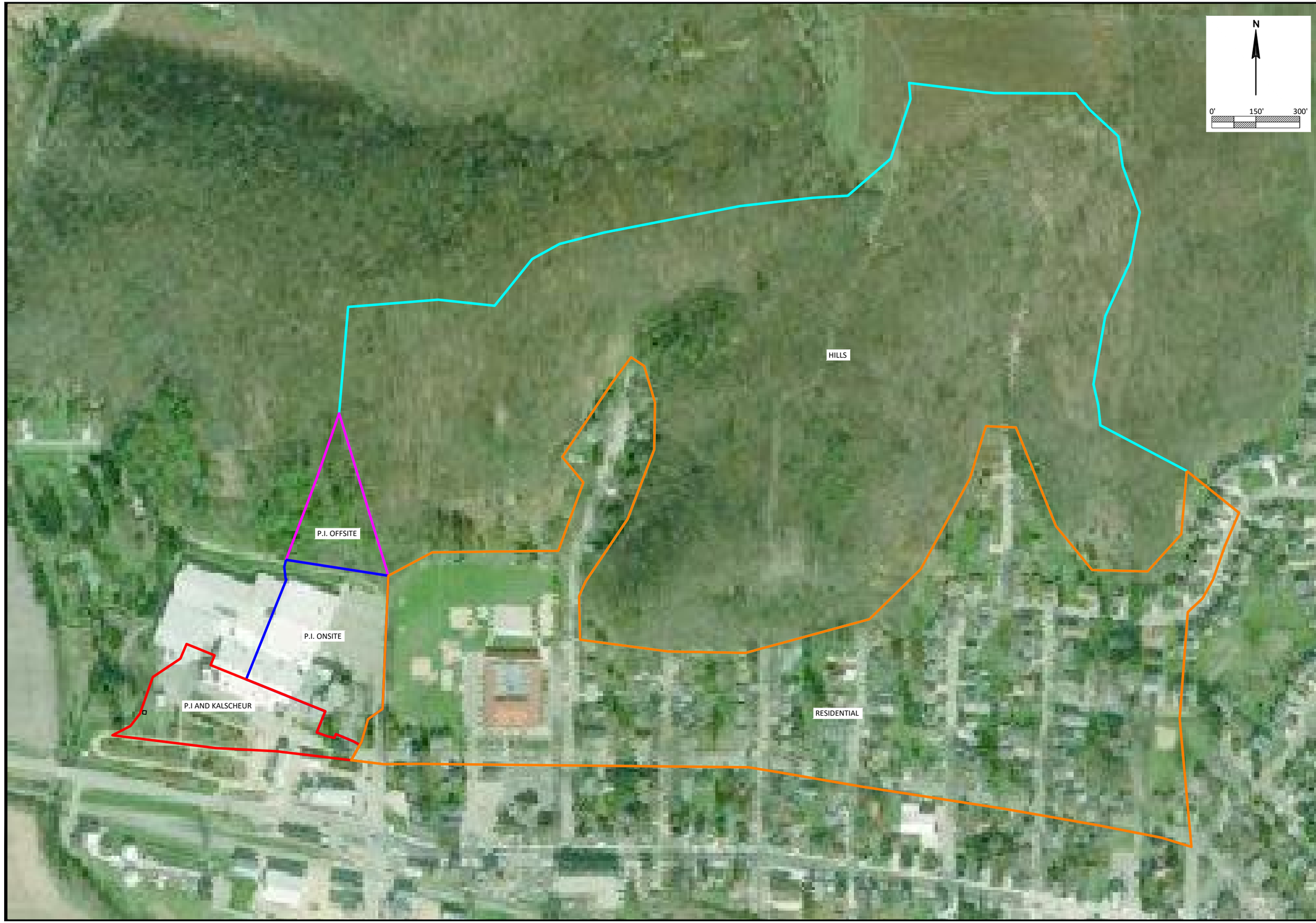

Selected: 'elevation'
22SEP2019 15:15:00
PROPOSED CONDITIONS - WITH BERM
(DURING SURGE FROM NORTHEAST)
867.0
865.3
863.7
862.0
860.3
858.7
857.0



EXISTING CONDITIONS - WITHOUT BERM
(DURING SURGE ALONG PARK STREET)


Selected: 'elevation'
22SEP2019 15:33:00
PROPOSED CONDITIONS - WITH BERM
(DURING SURGE ALONG PARK STREET)
867.0
865.3
863.7
862.0
860.3
858.7
857.0

Appendix D. HydroCAD Modeling Results



JEWELL
associates engineers, inc.
Engineers - Architects - Surveyors

560 Sunrise Drive
Spring Green, WI 53588
phone: 608-588-7484

THIS DOCUMENT, THE IDEAS AND DESIGNS INCORPORATED HEREIN AS AN INSTRUMENT OF SERVICE, IS THE PROPERTY OF JEWELL ASSOCIATES ENGINEERS, INC. AND IS NOT TO BE USED IN WHOLE OR IN PART WITHOUT PRIOR WRITTEN AUTHORIZATION OF JEWELL ASSOCIATES ENGINEERS, INC.

Cross Plains Flood Control
Cross Plains, Wisconsin

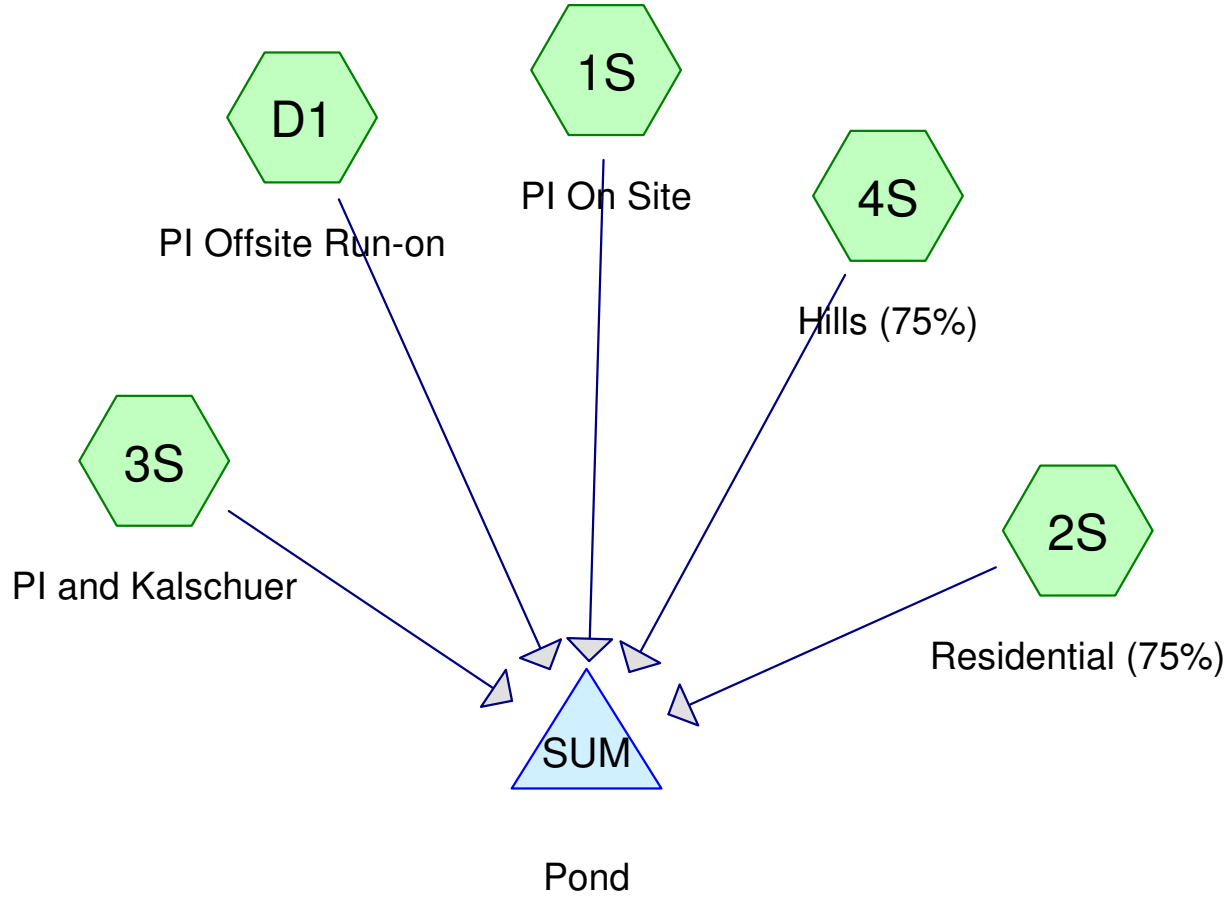
Date
2/28/20

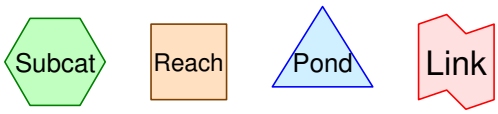
Date	Revision

Drawing Name
HydroCAD Drainage Areas

Sheet No.
Fig-1

Project Number
CA2010





Routing Diagram for HydroCAD - Cross Plains Flood Control (3-30-20 Revision)
Prepared by Hewlett-Packard Company, Printed 4/9/2020
HydroCAD® 10.00-14 s/n 05862 © 2015 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: PI On Site

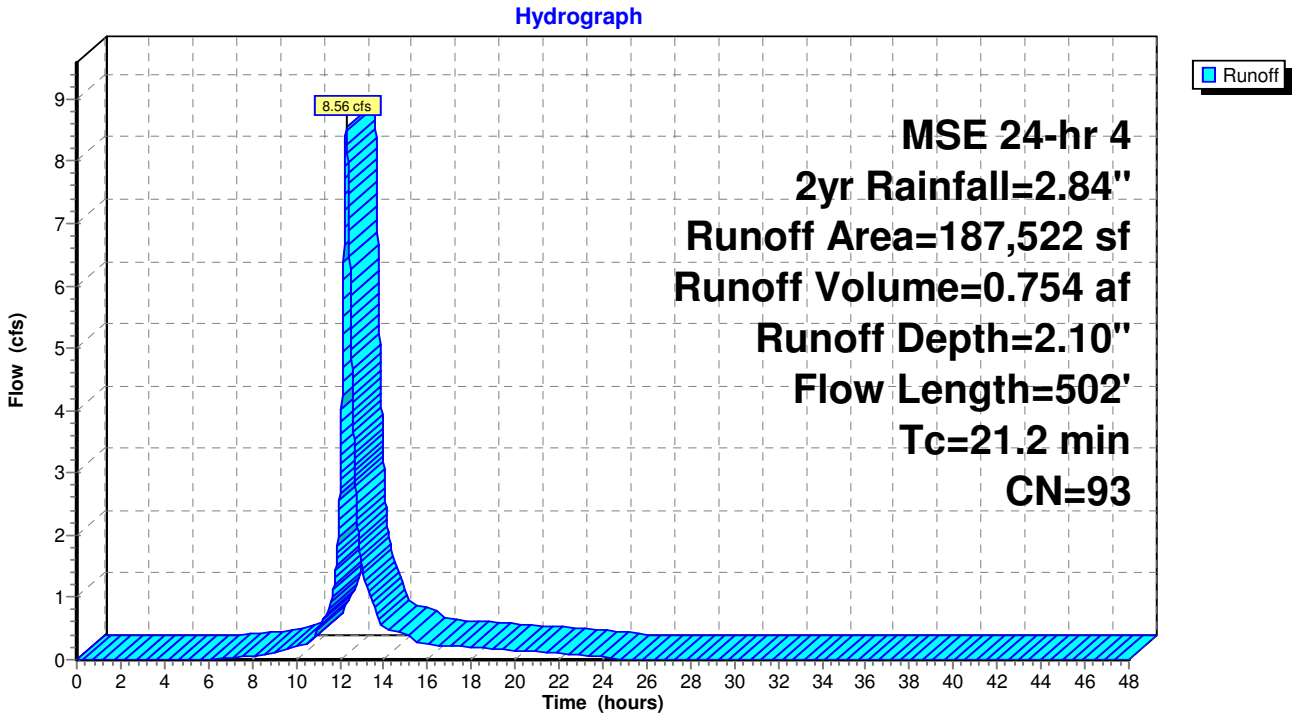
Runoff = 8.56 cfs @ 12.30 hrs, Volume= 0.754 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 2yr Rainfall=2.84"

Area (sf)	CN	Description
3,861	96	Gravel surface, HSG C
80,243	98	Roofs, HSG B
75,531	98	Paved parking, HSG B
26,618	61	>75% Grass cover, Good, HSG B
1,269	98	Paved parking, HSG B
187,522	93	Weighted Average
30,479		16.25% Pervious Area
157,043		83.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	209	0.0300	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
1.5	24	0.2000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
0.9	67	0.0300	1.25		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.25"
0.9	202	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
21.2	502	Total			

Subcatchment 1S: PI On Site



Summary for Subcatchment 2S: Residential (75%)

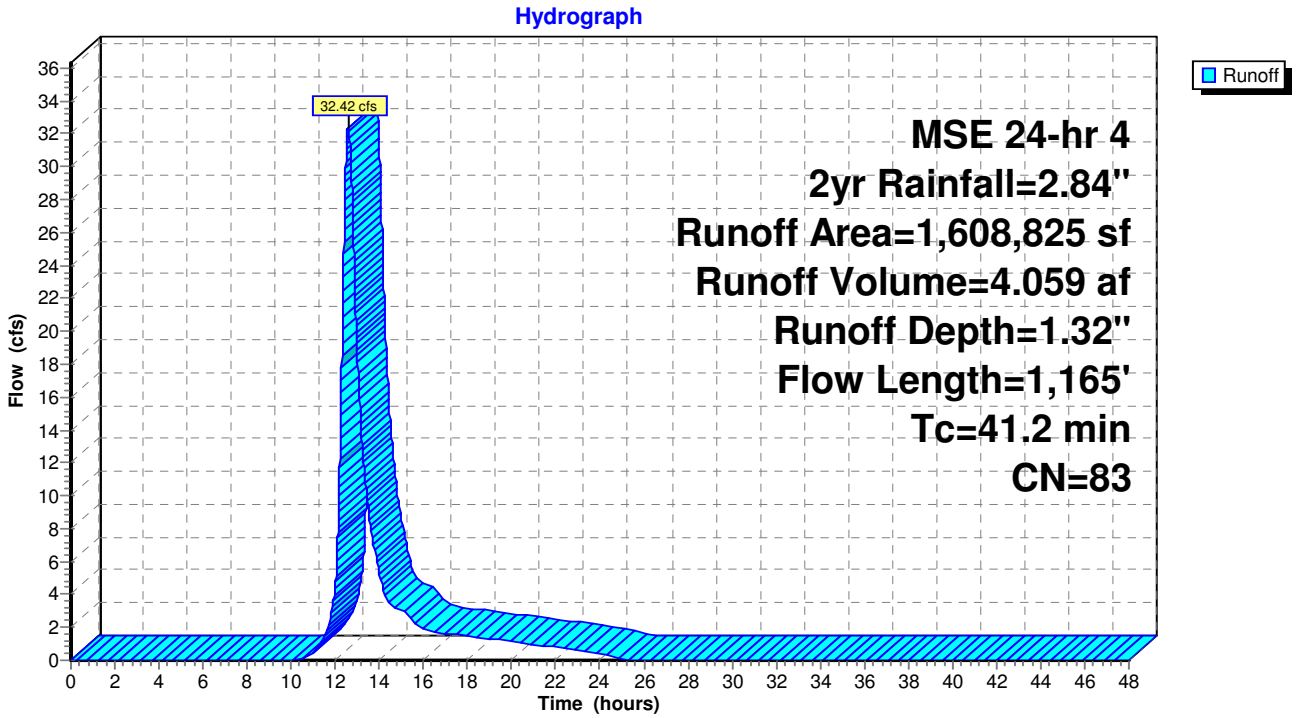
Runoff = 32.42 cfs @ 12.59 hrs, Volume= 4.059 af, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 2yr Rainfall=2.84"

Area (sf)	CN	Description
1,608,825	83	1/4 acre lots, 38% imp, HSG C
997,472		62.00% Pervious Area
611,354		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
32.1	300	0.0367	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.25"
5.1	576	0.0135	1.87		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0	289	0.0035	1.20		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
41.2	1,165	Total			

Subcatchment 2S: Residential (75%)



Summary for Subcatchment 3S: PI and Kalschuer

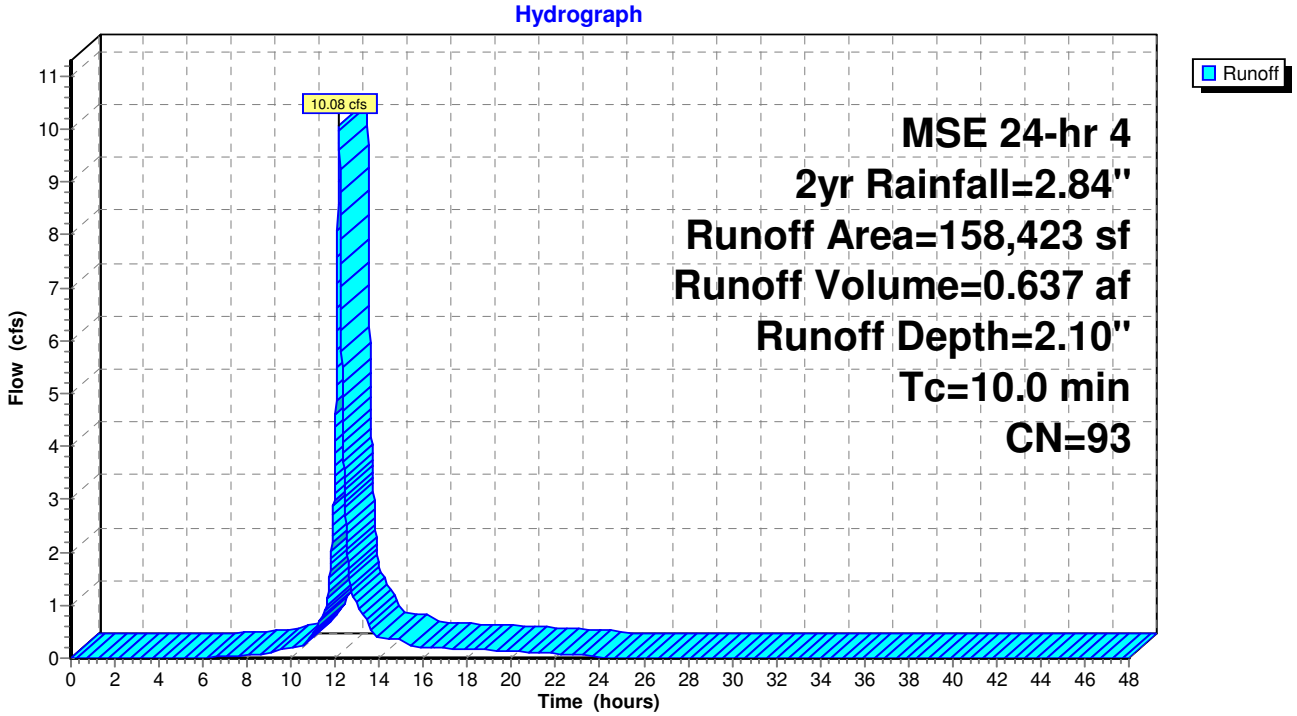
Runoff = 10.08 cfs @ 12.17 hrs, Volume= 0.637 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 2yr Rainfall=2.84"

Area (sf)	CN	Description
158,423	93	Urban industrial, 72% imp, HSG D
44,358		28.00% Pervious Area
114,065		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 3S: PI and Kalschuer



Summary for Subcatchment 4S: Hills (75%)

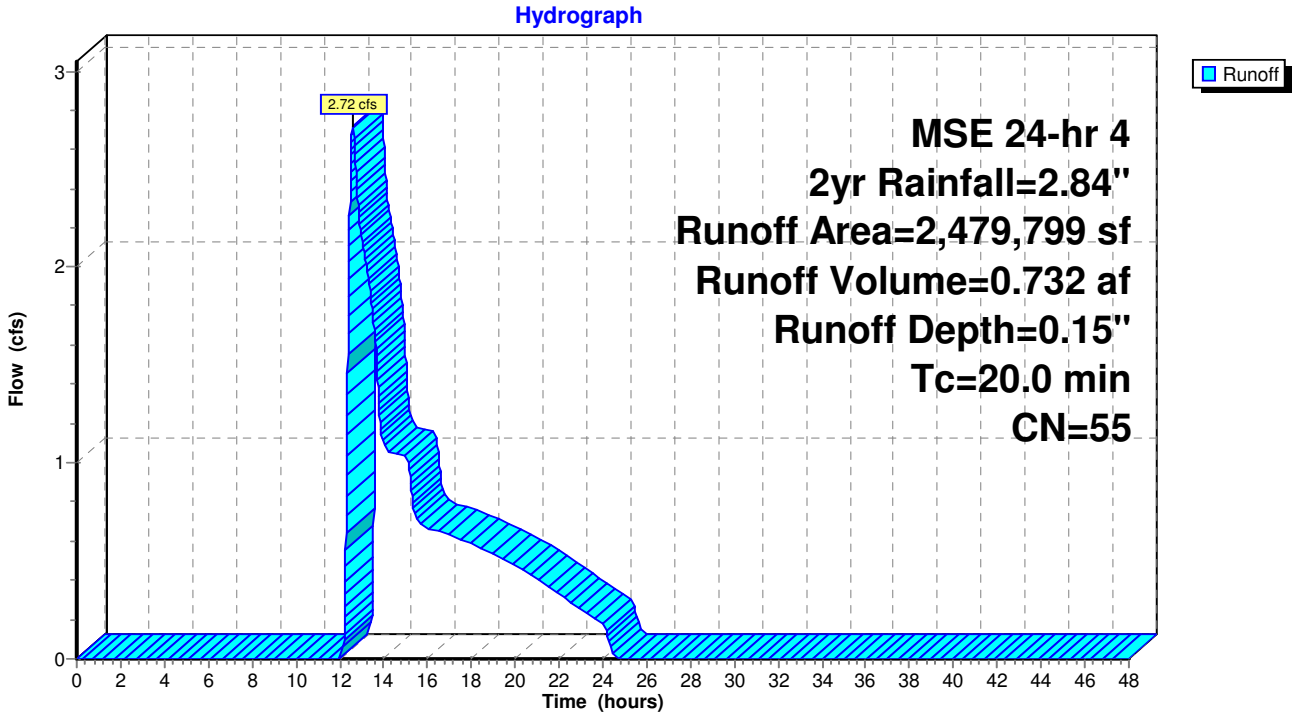
Runoff = 2.72 cfs @ 12.60 hrs, Volume= 0.732 af, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 2yr Rainfall=2.84"

Area (sf)	CN	Description
2,479,799	55	Woods, Good, HSG B
2,479,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry,**

Subcatchment 4S: Hills (75%)



Summary for Subcatchment D1: PI Offsite Run-on

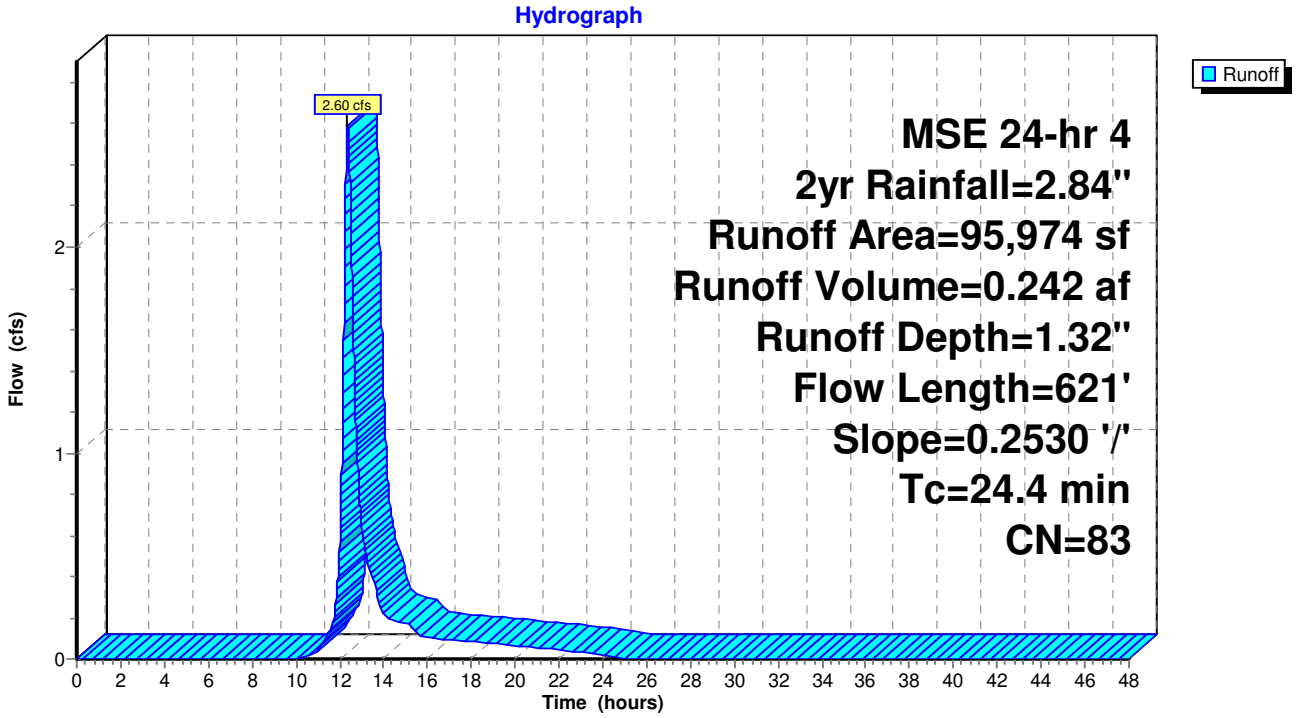
Runoff = 2.60 cfs @ 12.36 hrs, Volume= 0.242 af, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 2yr Rainfall=2.84"

Area (sf)	CN	Description
95,974	83	Woods, Poor, HSG D
95,974		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.3	300	0.2530	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.25"
2.1	321	0.2530	2.51		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.4	621	Total			

Subcatchment D1: PI Offsite Run-on



Summary for Pond SUM: Pond

Inflow Area = 104.007 ac, 19.48% Impervious, Inflow Depth = 0.74" for 2yr event
Inflow = 43.67 cfs @ 12.50 hrs, Volume= 6.424 af
Outflow = 34.66 cfs @ 12.77 hrs, Volume= 6.335 af, Atten= 21%, Lag= 16.4 min
Primary = 34.66 cfs @ 12.77 hrs, Volume= 6.335 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 856.09' @ 12.77 hrs Surf.Area= 23,182 sf Storage= 35,364 cf

Plug-Flow detention time= 28.4 min calculated for 6.334 af (99% of inflow)
Center-of-Mass det. time= 20.4 min (875.7 - 855.2)

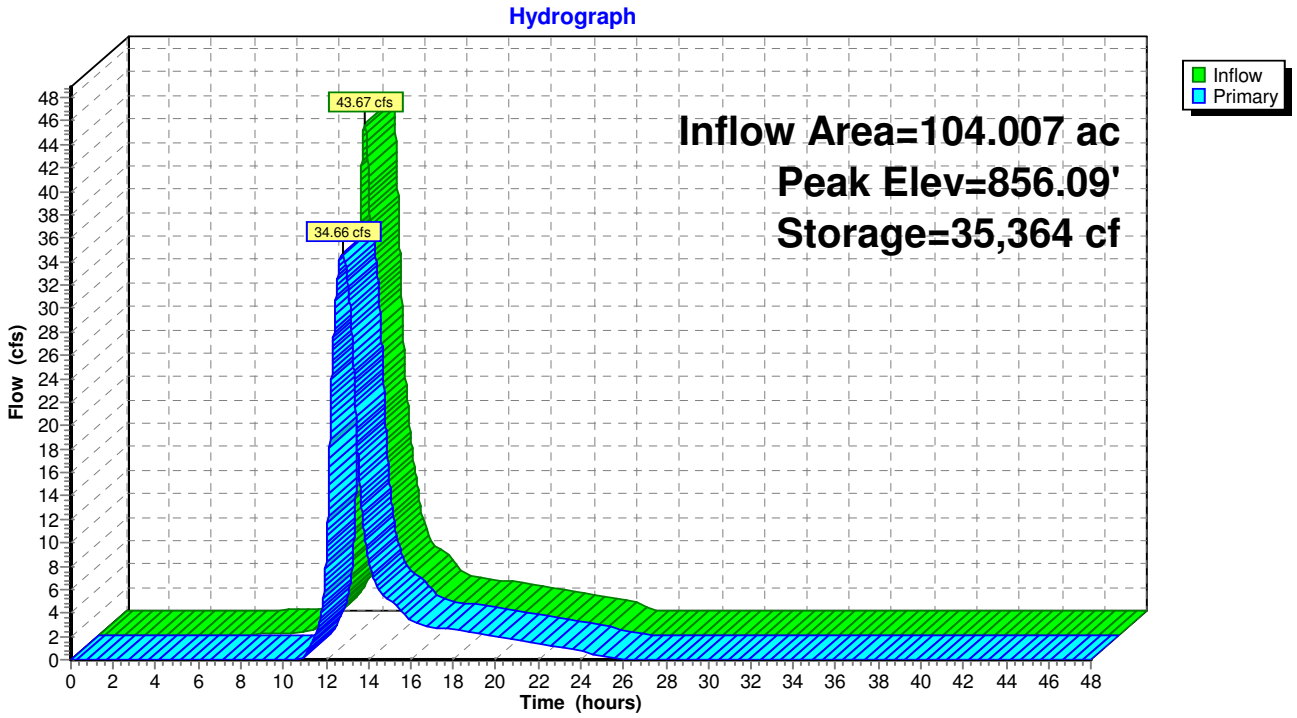
Volume	Invert	Avail.Storage	Storage Description
#1	853.00'	310,235 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
853.00	7,458	393.0	0	0	7,458
854.00	8,764	423.0	8,102	8,102	9,448
855.00	10,135	453.0	9,441	17,543	11,585
856.00	22,007	647.0	15,692	33,236	28,576
857.00	36,038	1,077.0	28,736	61,971	87,574
858.00	51,163	1,205.0	43,380	105,351	110,847
859.00	61,079	1,252.0	56,048	161,399	120,118
860.00	72,068	1,673.0	66,498	227,897	218,123
861.00	93,055	2,288.0	82,338	310,235	411,985

Device	Routing	Invert	Outlet Devices
#1	Primary	857.00'	**165.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#2	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=34.66 cfs @ 12.77 hrs HW=856.09' (Free Discharge)
- **1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
- **2=Orifice/Grate** (Orifice Controls 11.55 cfs @ 6.54 fps)
- **3=Orifice/Grate** (Orifice Controls 11.55 cfs @ 6.54 fps)
- **4=Orifice/Grate** (Orifice Controls 11.55 cfs @ 6.54 fps)

Pond SUM: Pond



Summary for Subcatchment 1S: PI On Site

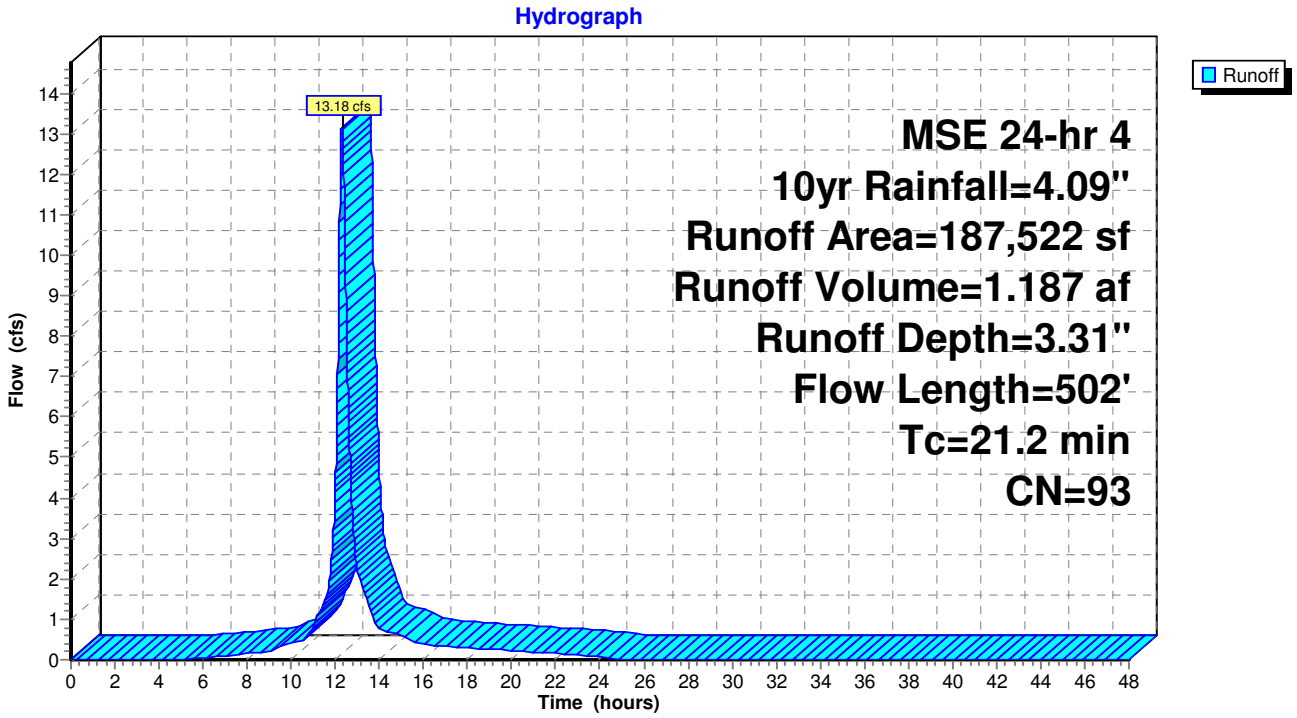
Runoff = 13.18 cfs @ 12.30 hrs, Volume= 1.187 af, Depth= 3.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 10yr Rainfall=4.09"

Area (sf)	CN	Description
3,861	96	Gravel surface, HSG C
80,243	98	Roofs, HSG B
75,531	98	Paved parking, HSG B
26,618	61	>75% Grass cover, Good, HSG B
1,269	98	Paved parking, HSG B
187,522	93	Weighted Average
30,479		16.25% Pervious Area
157,043		83.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	209	0.0300	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
1.5	24	0.2000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
0.9	67	0.0300	1.25		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.25"
0.9	202	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
21.2	502	Total			

Subcatchment 1S: PI On Site



Summary for Subcatchment 2S: Residential (75%)

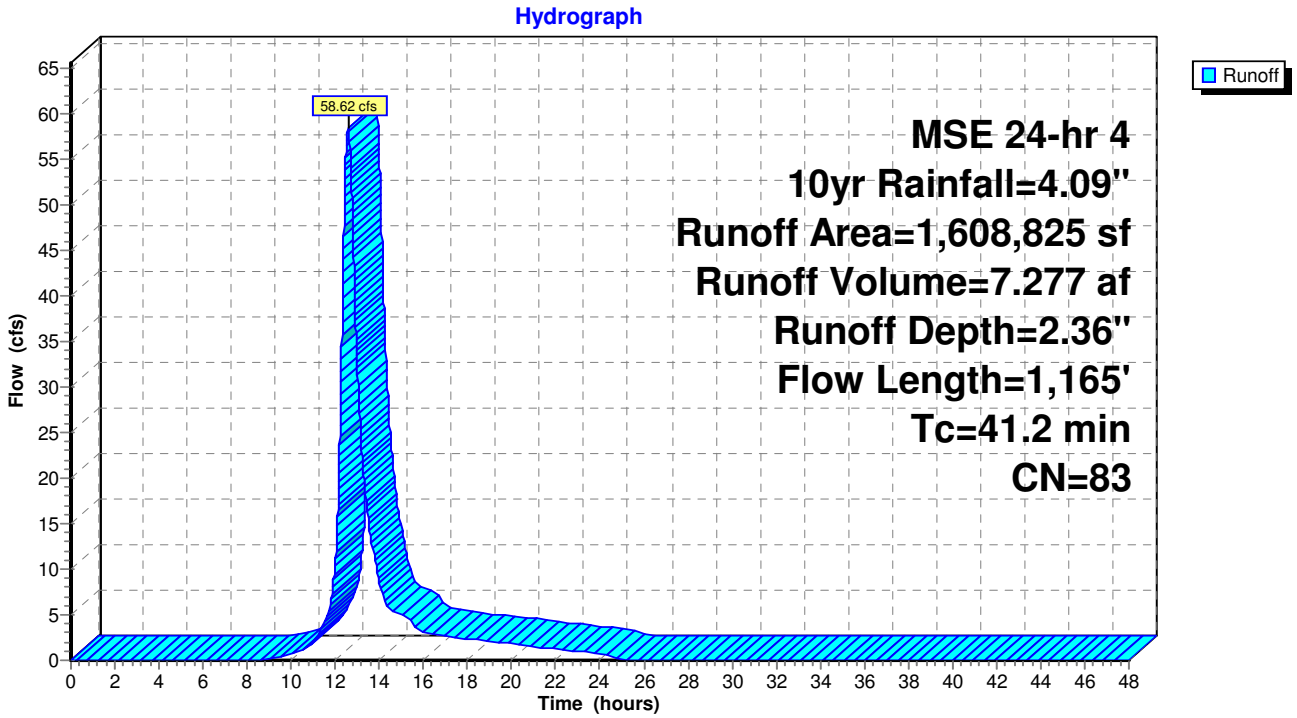
Runoff = 58.62 cfs @ 12.59 hrs, Volume= 7.277 af, Depth= 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 10yr Rainfall=4.09"

Area (sf)	CN	Description
1,608,825	83	1/4 acre lots, 38% imp, HSG C
997,472		62.00% Pervious Area
611,354		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
32.1	300	0.0367	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.25"
5.1	576	0.0135	1.87		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0	289	0.0035	1.20		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
41.2	1,165	Total			

Subcatchment 2S: Residential (75%)



Summary for Subcatchment 3S: PI and Kalschuer

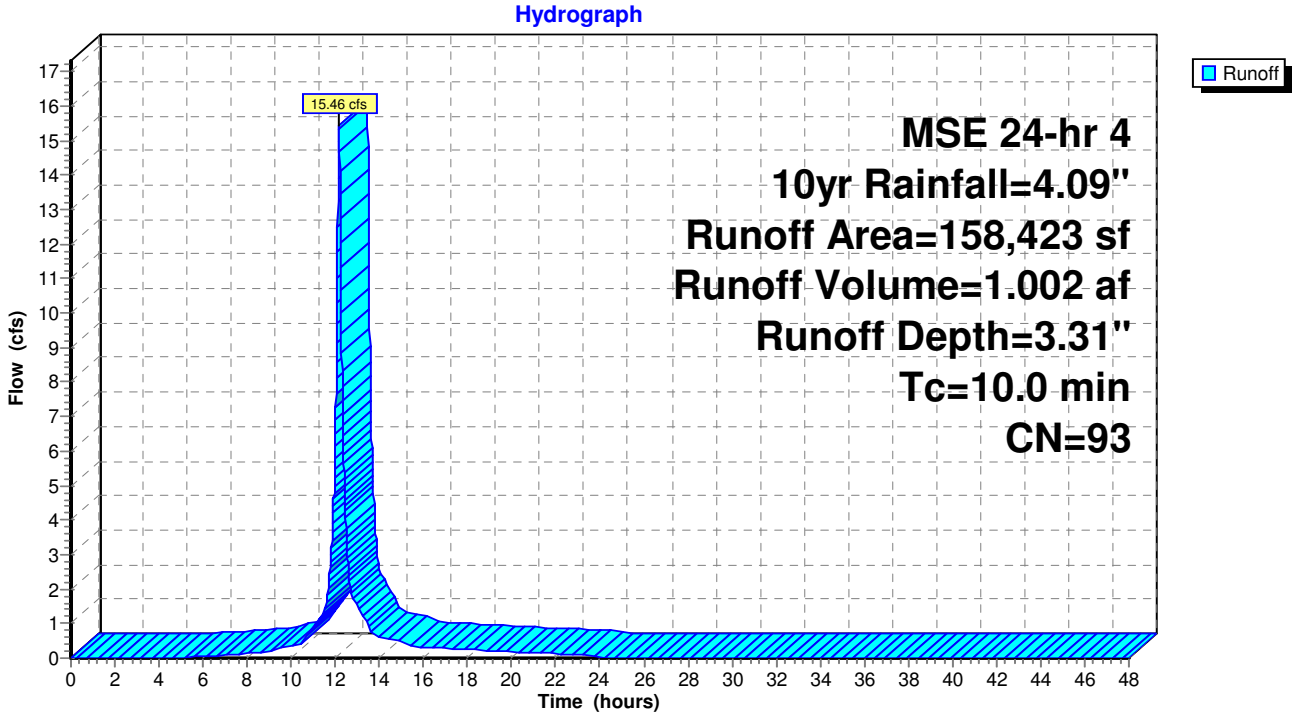
Runoff = 15.46 cfs @ 12.17 hrs, Volume= 1.002 af, Depth= 3.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 10yr Rainfall=4.09"

Area (sf)	CN	Description
158,423	93	Urban industrial, 72% imp, HSG D
44,358		28.00% Pervious Area
114,065		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 3S: PI and Kalschuer



Summary for Subcatchment 4S: Hills (75%)

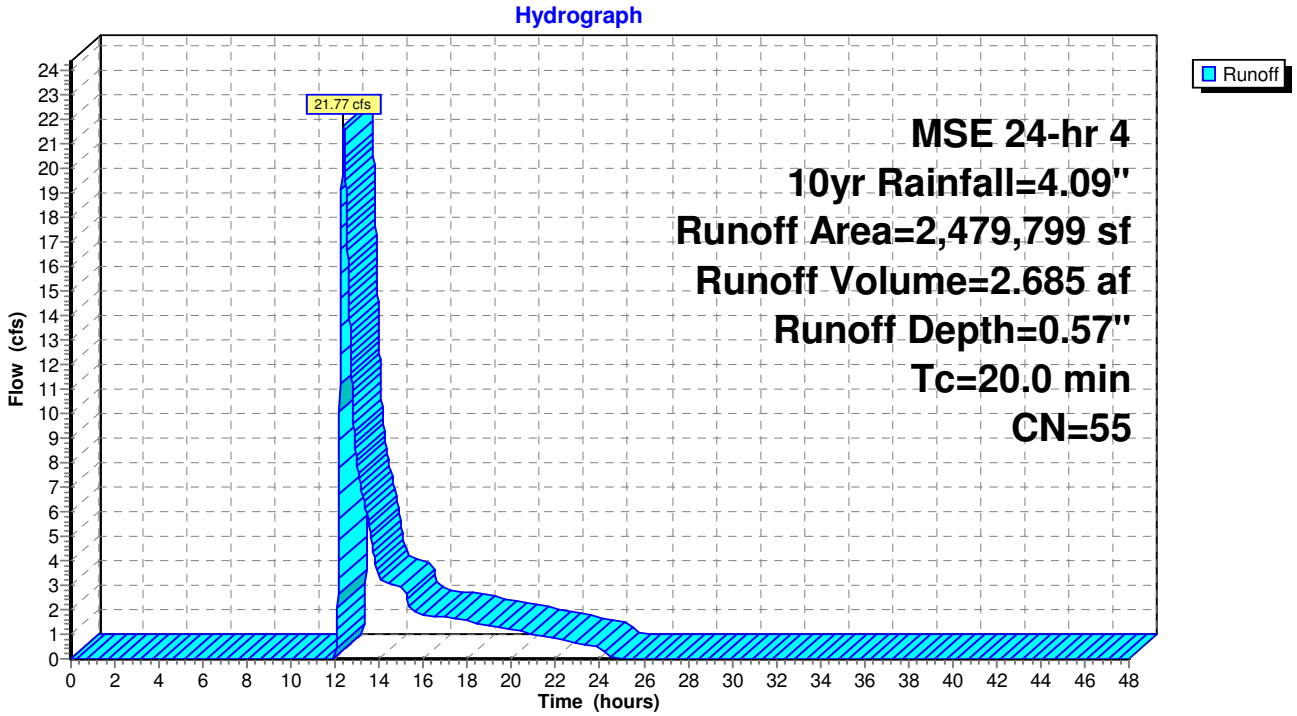
Runoff = 21.77 cfs @ 12.38 hrs, Volume= 2.685 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 10yr Rainfall=4.09"

Area (sf)	CN	Description
2,479,799	55	Woods, Good, HSG B
2,479,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry,**

Subcatchment 4S: Hills (75%)



Summary for Subcatchment D1: PI Offsite Run-on

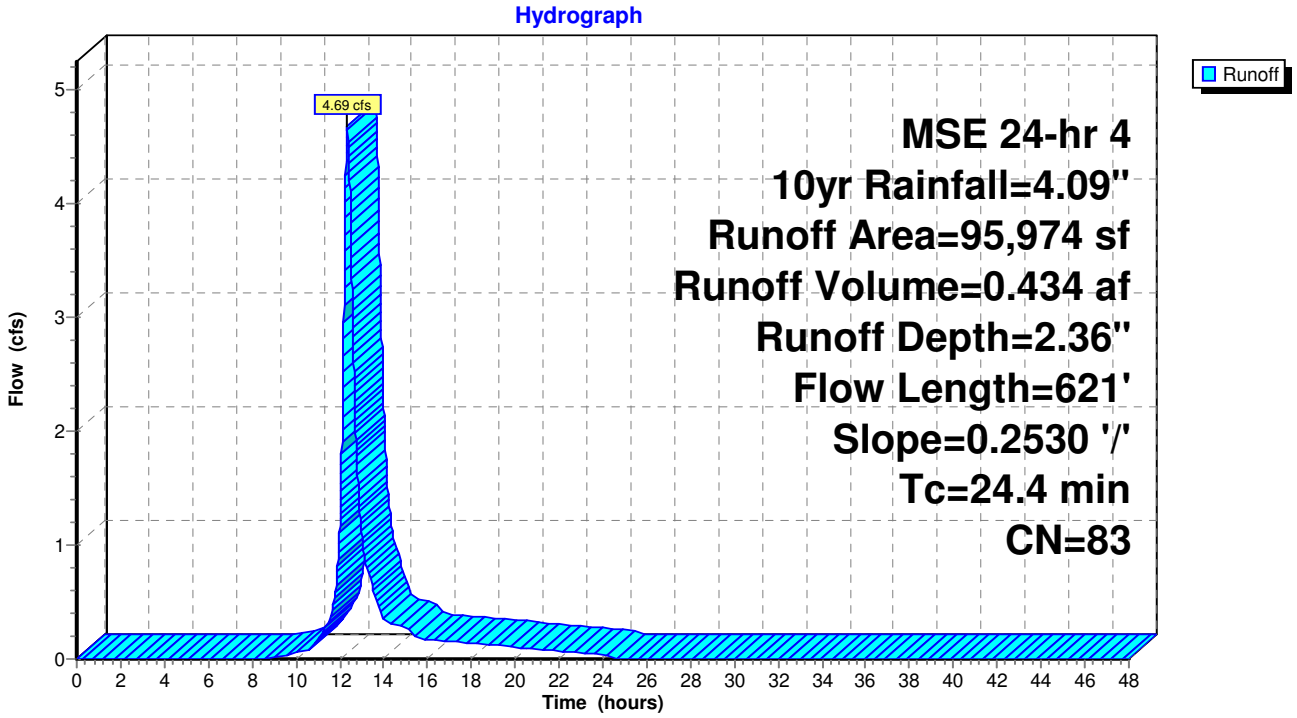
Runoff = 4.69 cfs @ 12.34 hrs, Volume= 0.434 af, Depth= 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 10yr Rainfall=4.09"

Area (sf)	CN	Description
95,974	83	Woods, Poor, HSG D
95,974		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.3	300	0.2530	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.25"
2.1	321	0.2530	2.51		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.4	621	Total			

Subcatchment D1: PI Offsite Run-on



Summary for Pond SUM: Pond

Inflow Area = 104.007 ac, 19.48% Impervious, Inflow Depth = 1.45" for 10yr event
Inflow = 92.31 cfs @ 12.45 hrs, Volume= 12.586 af
Outflow = 88.93 cfs @ 12.55 hrs, Volume= 12.497 af, Atten= 4%, Lag= 5.9 min
Primary = 88.93 cfs @ 12.55 hrs, Volume= 12.497 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 857.19' @ 12.55 hrs Surf.Area= 38,686 sf Storage= 69,011 cf

Plug-Flow detention time= 23.3 min calculated for 12.494 af (99% of inflow)
Center-of-Mass det. time= 19.2 min (864.1 - 844.9)

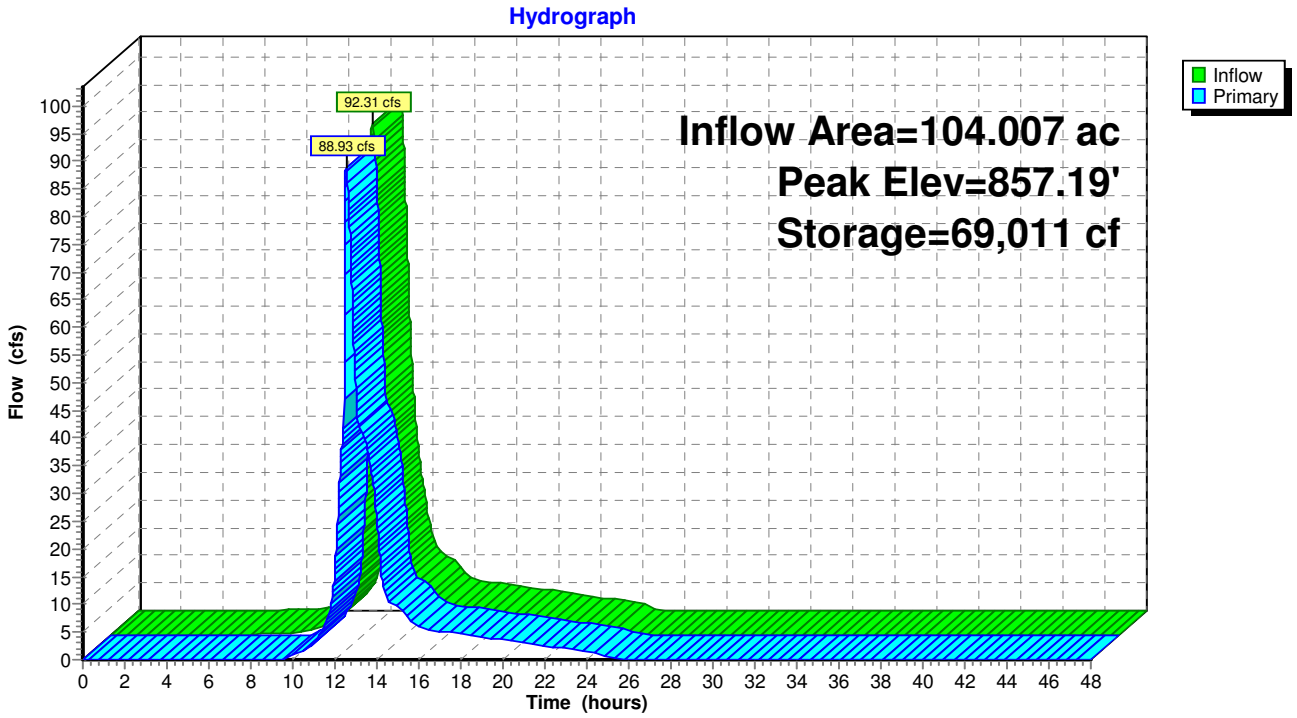
Volume	Invert	Avail.Storage	Storage Description
#1	853.00'	310,235 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
853.00	7,458	393.0	0	0	7,458
854.00	8,764	423.0	8,102	8,102	9,448
855.00	10,135	453.0	9,441	17,543	11,585
856.00	22,007	647.0	15,692	33,236	28,576
857.00	36,038	1,077.0	28,736	61,971	87,574
858.00	51,163	1,205.0	43,380	105,351	110,847
859.00	61,079	1,252.0	56,048	161,399	120,118
860.00	72,068	1,673.0	66,498	227,897	218,123
861.00	93,055	2,288.0	82,338	310,235	411,985

Device	Routing	Invert	Outlet Devices
#1	Primary	857.00'	**165.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#2	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=88.21 cfs @ 12.55 hrs HW=857.19' (Free Discharge)
- **1=Sharp-Crested Rectangular Weir** (Weir Controls 44.46 cfs @ 1.43 fps)
- **2=Orifice/Grate** (Orifice Controls 14.59 cfs @ 8.25 fps)
- **3=Orifice/Grate** (Orifice Controls 14.59 cfs @ 8.25 fps)
- **4=Orifice/Grate** (Orifice Controls 14.59 cfs @ 8.25 fps)

Pond SUM: Pond



Summary for Subcatchment 1S: PI On Site

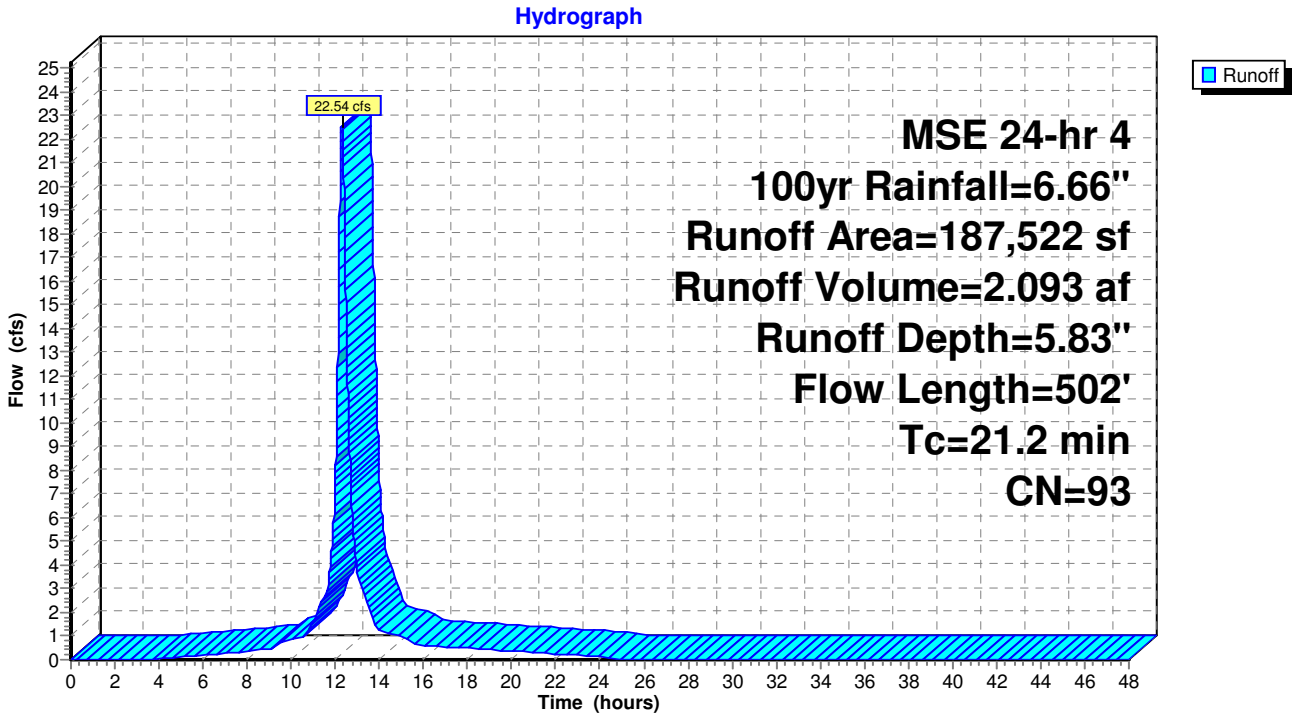
Runoff = 22.54 cfs @ 12.30 hrs, Volume= 2.093 af, Depth= 5.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100yr Rainfall=6.66"

Area (sf)	CN	Description
3,861	96	Gravel surface, HSG C
80,243	98	Roofs, HSG B
75,531	98	Paved parking, HSG B
26,618	61	>75% Grass cover, Good, HSG B
1,269	98	Paved parking, HSG B
187,522	93	Weighted Average
30,479		16.25% Pervious Area
157,043		83.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	209	0.0300	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
1.5	24	0.2000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
0.9	67	0.0300	1.25		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.25"
0.9	202	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
21.2	502	Total			

Subcatchment 1S: PI On Site



Summary for Subcatchment 2S: Residential (75%)

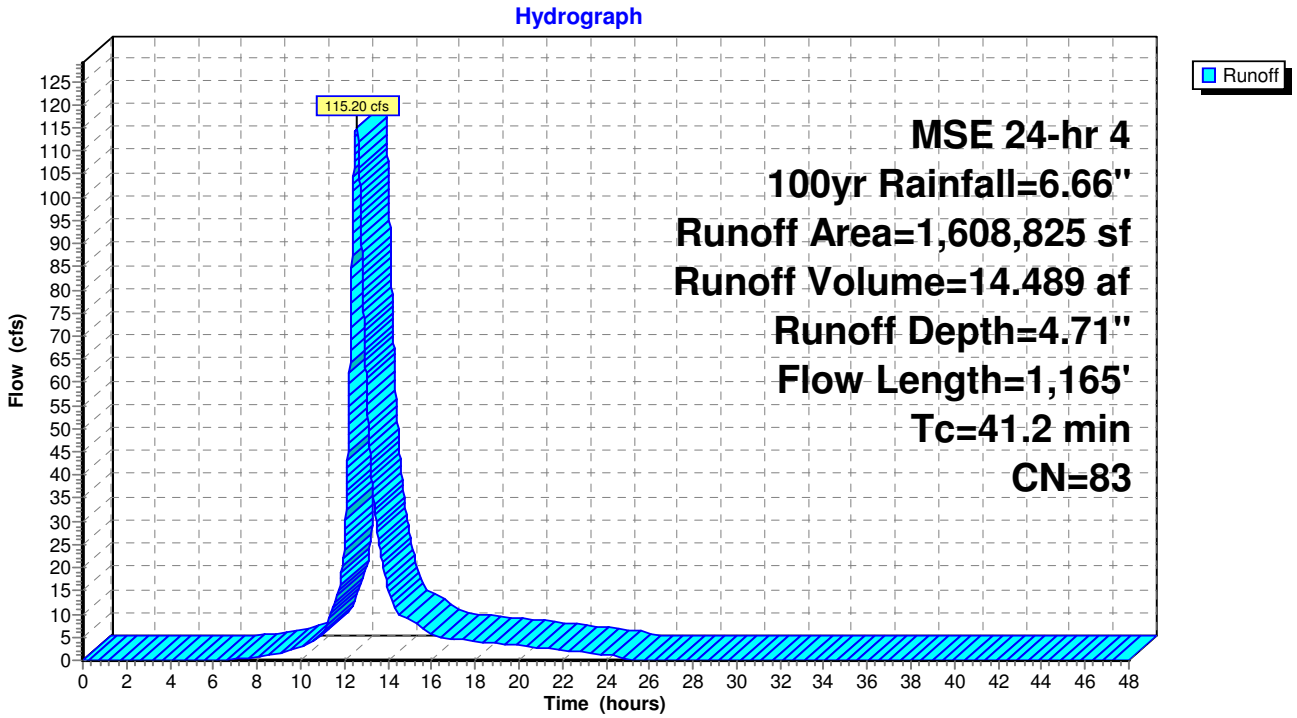
Runoff = 115.20 cfs @ 12.58 hrs, Volume= 14.489 af, Depth= 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100yr Rainfall=6.66"

Area (sf)	CN	Description
1,608,825	83	1/4 acre lots, 38% imp, HSG C
997,472		62.00% Pervious Area
611,354		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
32.1	300	0.0367	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.25"
5.1	576	0.0135	1.87		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0	289	0.0035	1.20		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
41.2	1,165	Total			

Subcatchment 2S: Residential (75%)



Summary for Subcatchment 3S: PI and Kalschuer

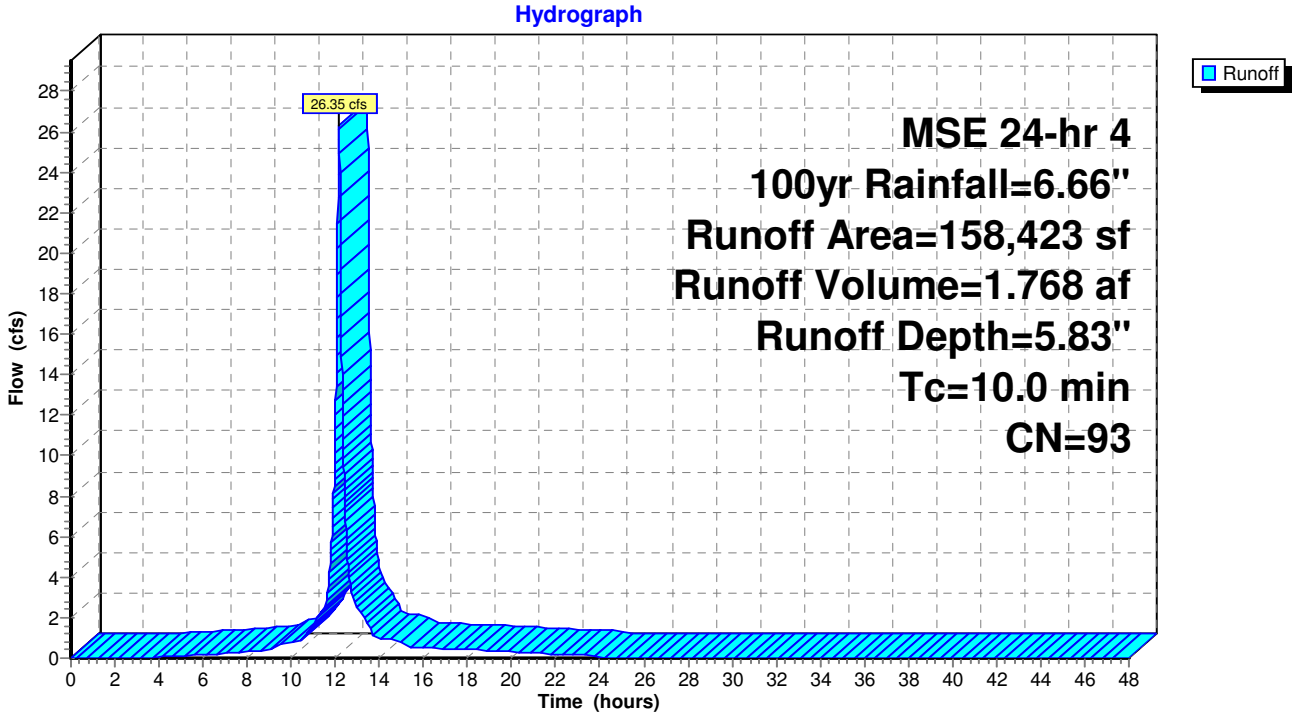
Runoff = 26.35 cfs @ 12.17 hrs, Volume= 1.768 af, Depth= 5.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100yr Rainfall=6.66"

Area (sf)	CN	Description
158,423	93	Urban industrial, 72% imp, HSG D
44,358		28.00% Pervious Area
114,065		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 3S: PI and Kalschuer



Summary for Subcatchment 4S: Hills (75%)

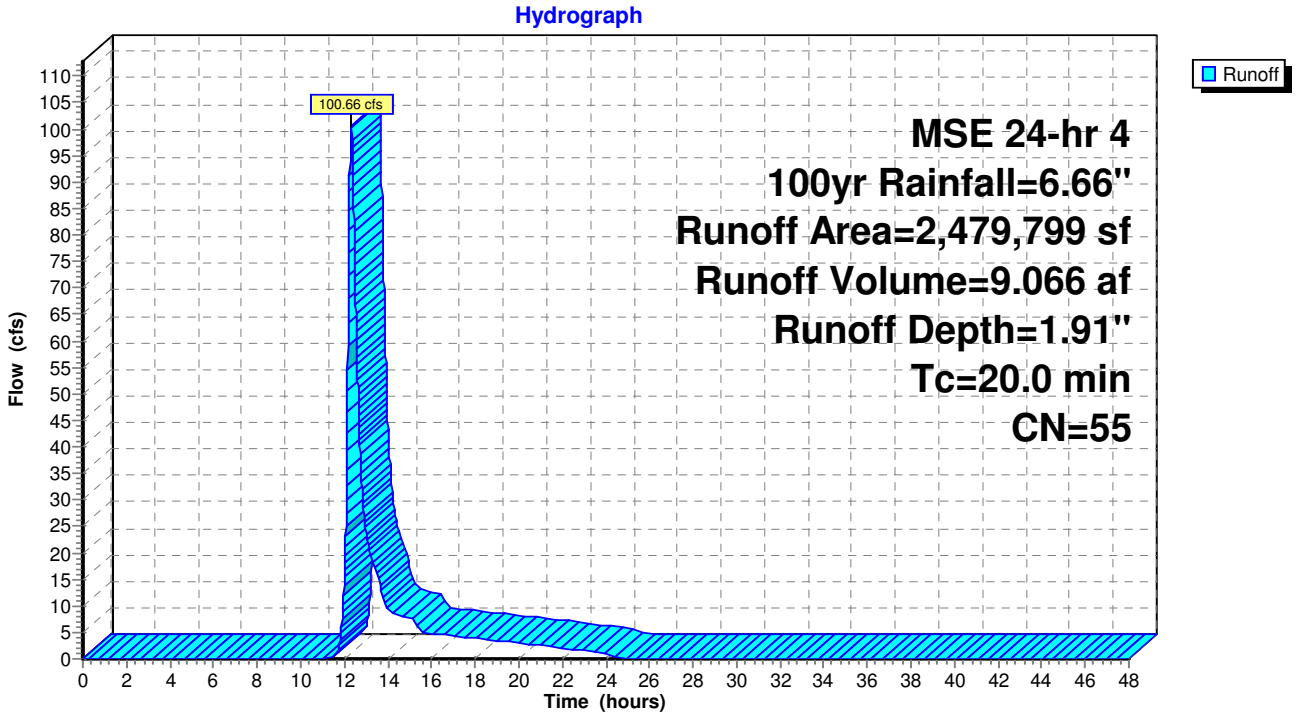
Runoff = 100.66 cfs @ 12.33 hrs, Volume= 9.066 af, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100yr Rainfall=6.66"

Area (sf)	CN	Description
2,479,799	55	Woods, Good, HSG B
2,479,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry,**

Subcatchment 4S: Hills (75%)



Summary for Subcatchment D1: PI Offsite Run-on

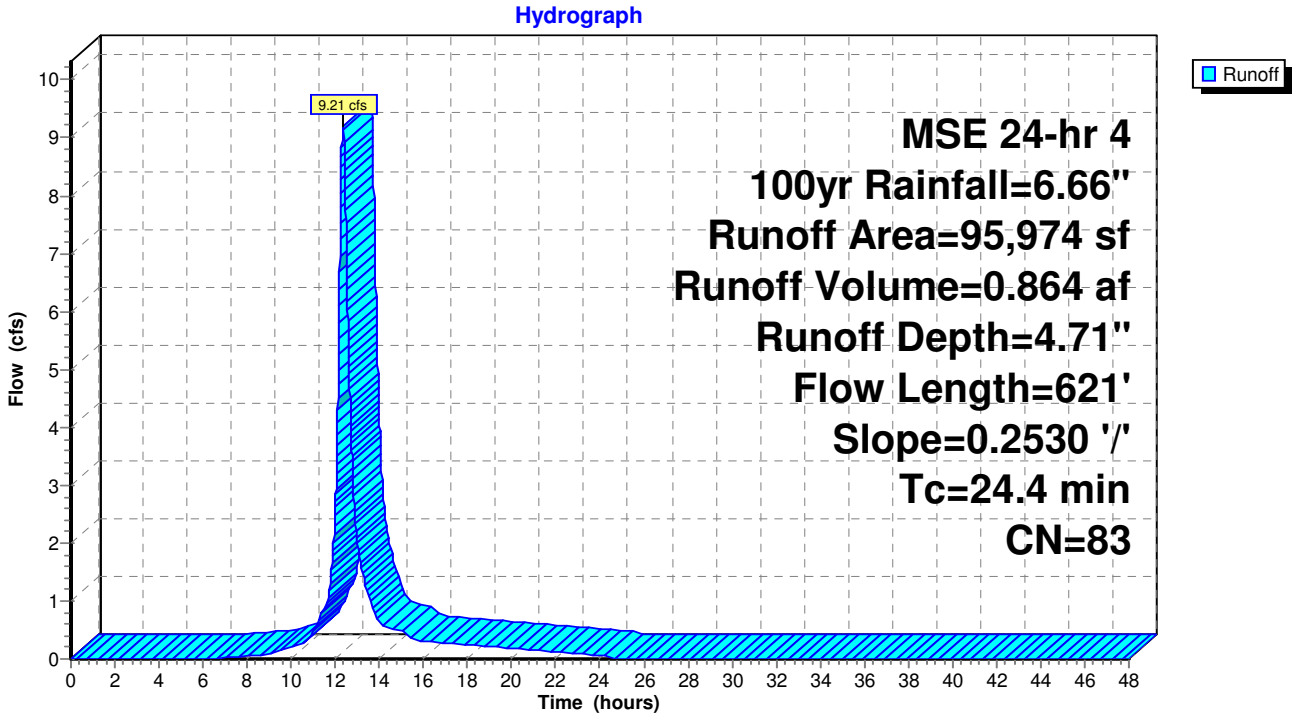
Runoff = 9.21 cfs @ 12.34 hrs, Volume= 0.864 af, Depth= 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 100yr Rainfall=6.66"

Area (sf)	CN	Description
95,974	83	Woods, Poor, HSG D
95,974		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.3	300	0.2530	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.25"
2.1	321	0.2530	2.51		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.4	621	Total			

Subcatchment D1: PI Offsite Run-on



Summary for Pond SUM: Pond

Inflow Area = 104.007 ac, 19.48% Impervious, Inflow Depth = 3.26" for 100yr event
Inflow = 228.88 cfs @ 12.37 hrs, Volume= 28.282 af
Outflow = 228.09 cfs @ 12.39 hrs, Volume= 28.192 af, Atten= 0%, Lag= 1.4 min
Primary = 228.09 cfs @ 12.39 hrs, Volume= 28.192 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 857.48' @ 12.39 hrs Surf.Area= 42,951 sf Storage= 80,861 cf

Plug-Flow detention time= 15.3 min calculated for 28.192 af (100% of inflow)
Center-of-Mass det. time= 13.3 min (843.5 - 830.2)

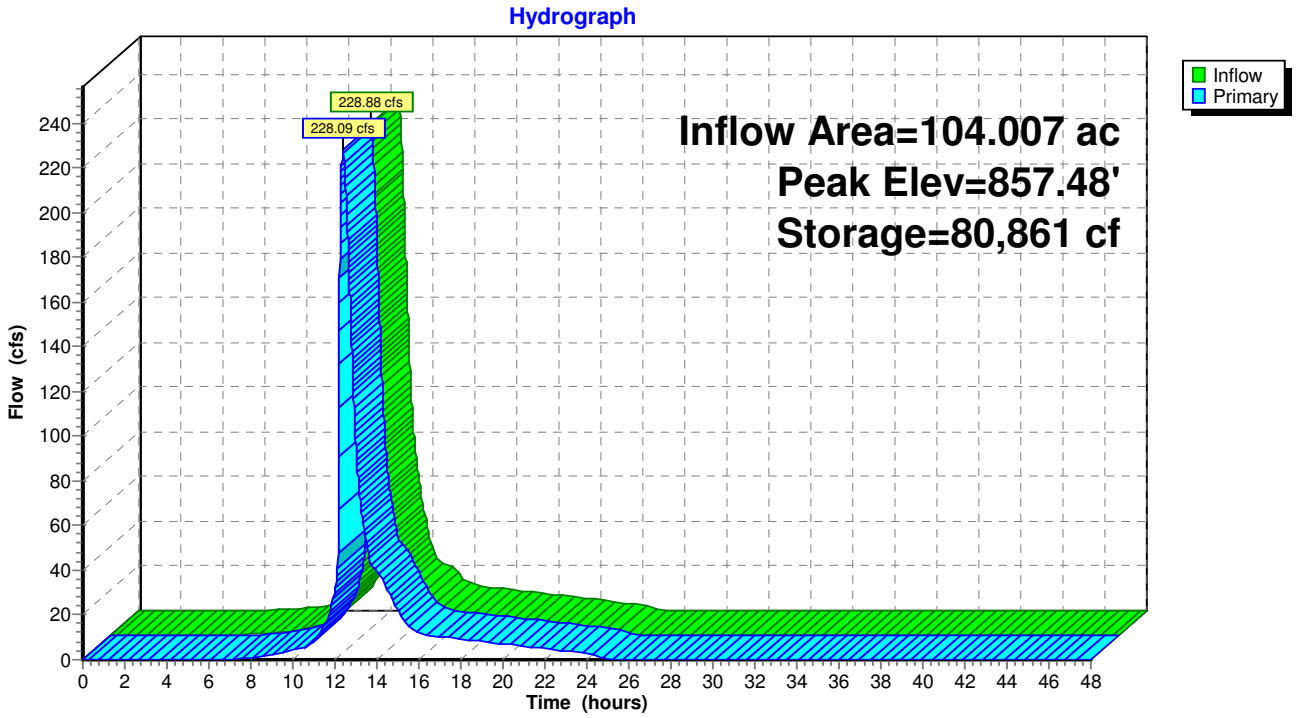
Volume	Invert	Avail.Storage	Storage Description
#1	853.00'	310,235 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
853.00	7,458	393.0	0	0	7,458
854.00	8,764	423.0	8,102	8,102	9,448
855.00	10,135	453.0	9,441	17,543	11,585
856.00	22,007	647.0	15,692	33,236	28,576
857.00	36,038	1,077.0	28,736	61,971	87,574
858.00	51,163	1,205.0	43,380	105,351	110,847
859.00	61,079	1,252.0	56,048	161,399	120,118
860.00	72,068	1,673.0	66,498	227,897	218,123
861.00	93,055	2,288.0	82,338	310,235	411,985

Device	Routing	Invert	Outlet Devices
#1	Primary	857.00'	**165.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#2	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=228.04 cfs @ 12.39 hrs HW=857.48' (Free Discharge)
- **1=Sharp-Crested Rectangular Weir** (Weir Controls 182.17 cfs @ 2.31 fps)
- **2=Orifice/Grate** (Orifice Controls 15.29 cfs @ 8.65 fps)
- **3=Orifice/Grate** (Orifice Controls 15.29 cfs @ 8.65 fps)
- **4=Orifice/Grate** (Orifice Controls 15.29 cfs @ 8.65 fps)

Pond SUM: Pond



Summary for Subcatchment 1S: PI On Site

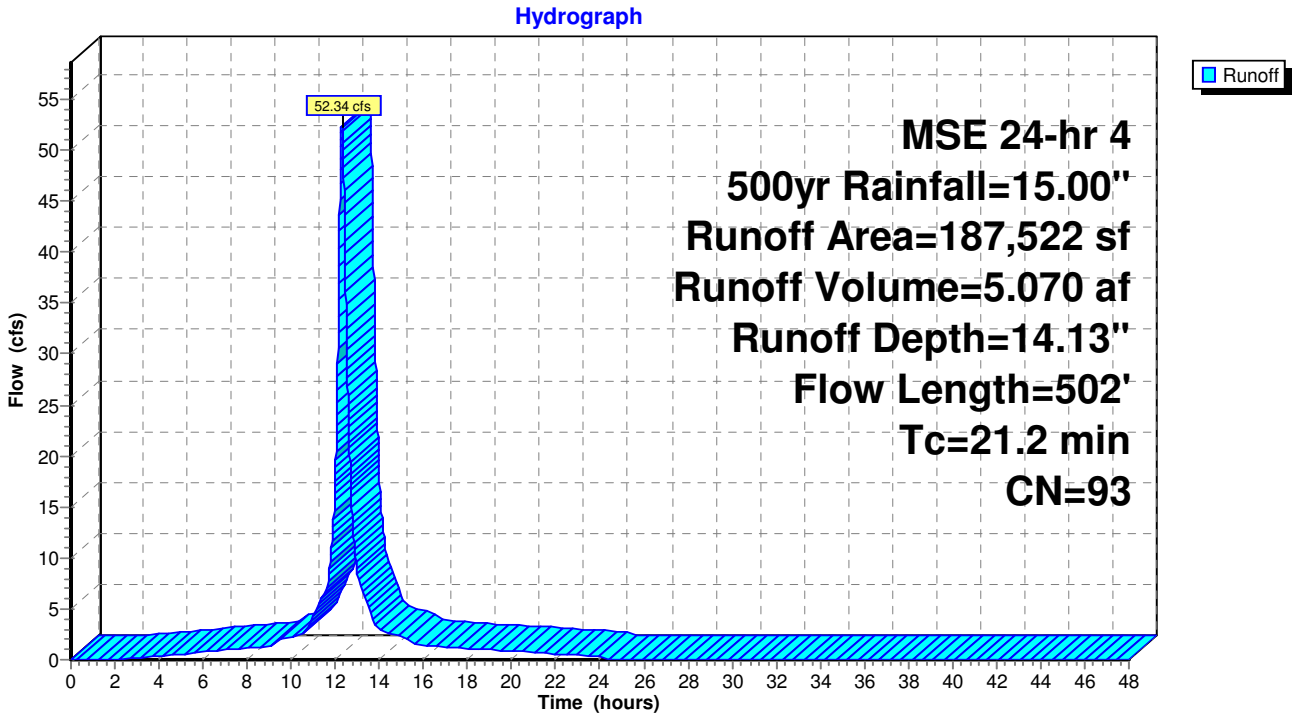
Runoff = 52.34 cfs @ 12.30 hrs, Volume= 5.070 af, Depth=14.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 500yr Rainfall=15.00"

Area (sf)	CN	Description
3,861	96	Gravel surface, HSG C
80,243	98	Roofs, HSG B
75,531	98	Paved parking, HSG B
26,618	61	>75% Grass cover, Good, HSG B
1,269	98	Paved parking, HSG B
187,522	93	Weighted Average
30,479		16.25% Pervious Area
157,043		83.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	209	0.0300	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
1.5	24	0.2000	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.25"
0.9	67	0.0300	1.25		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.25"
0.9	202	0.0320	3.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
21.2	502	Total			

Subcatchment 1S: PI On Site



Summary for Subcatchment 2S: Residential (75%)

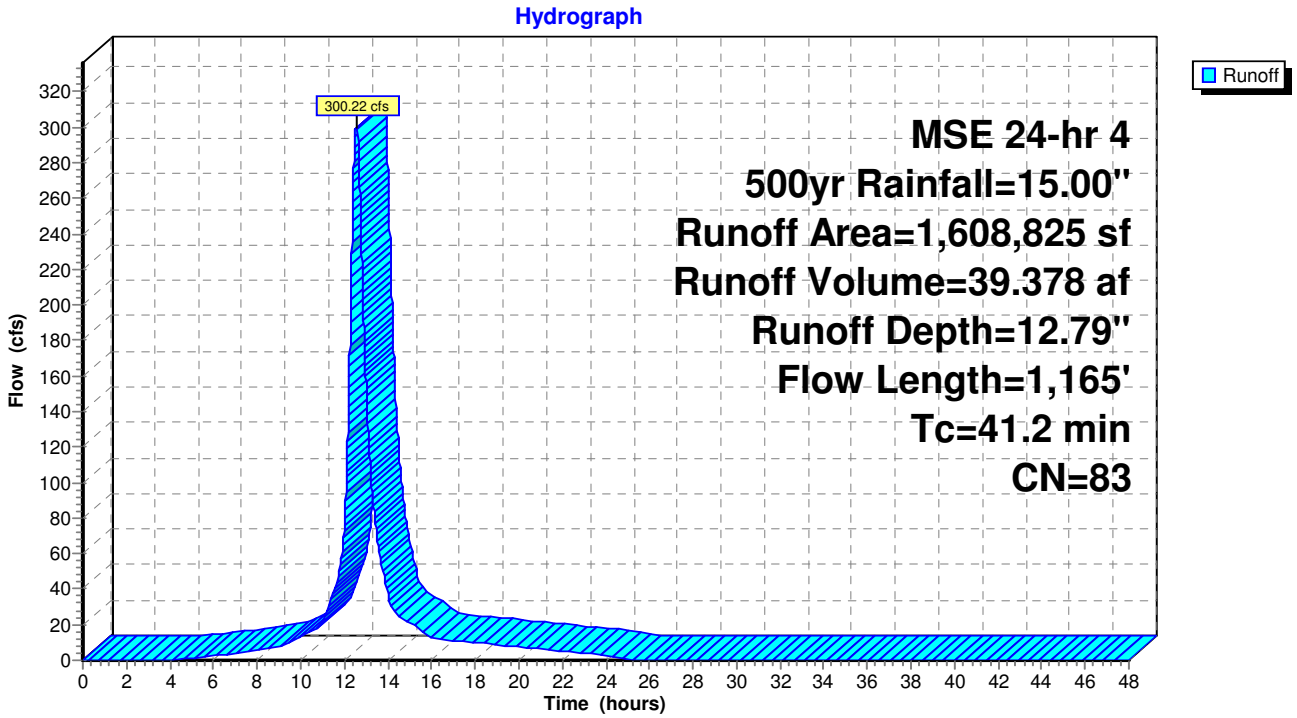
Runoff = 300.22 cfs @ 12.54 hrs, Volume= 39.378 af, Depth=12.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 500yr Rainfall=15.00"

Area (sf)	CN	Description
1,608,825	83	1/4 acre lots, 38% imp, HSG C
997,472		62.00% Pervious Area
611,354		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
32.1	300	0.0367	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.25"
5.1	576	0.0135	1.87		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.0	289	0.0035	1.20		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
41.2	1,165	Total			

Subcatchment 2S: Residential (75%)



Summary for Subcatchment 3S: PI and Kalschuer

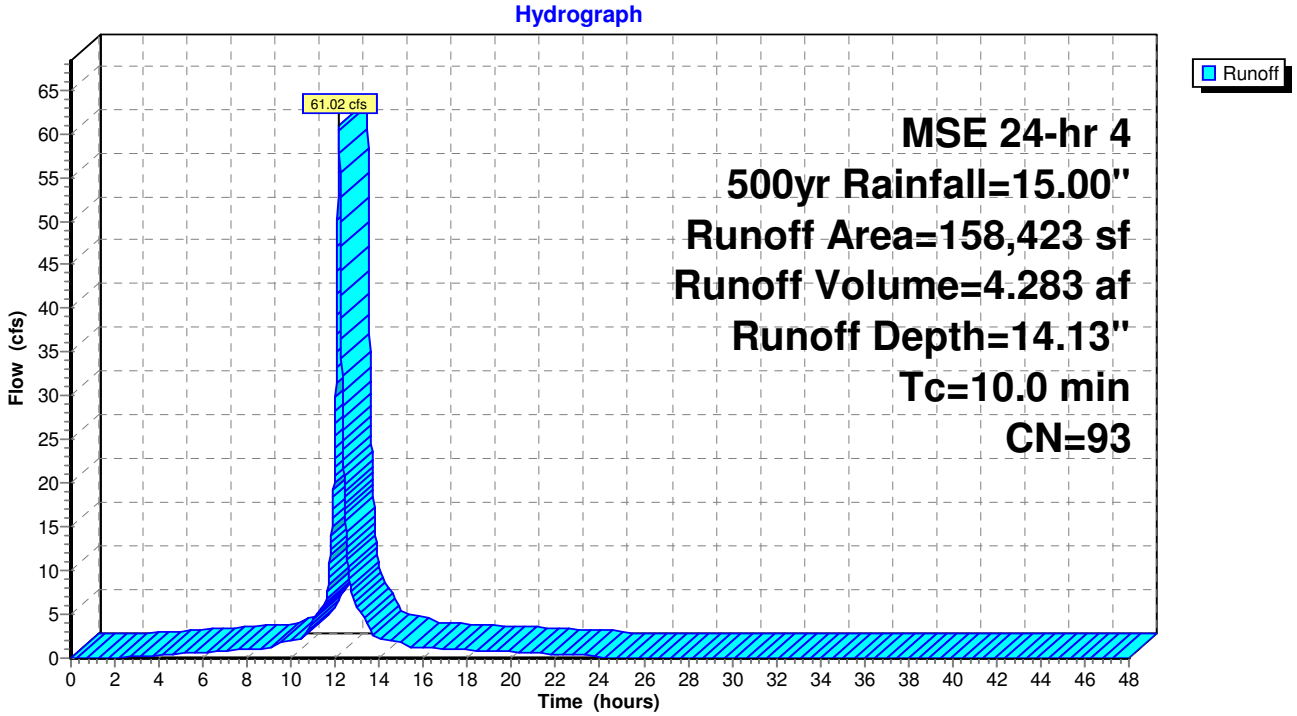
Runoff = 61.02 cfs @ 12.17 hrs, Volume= 4.283 af, Depth=14.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 500yr Rainfall=15.00"

Area (sf)	CN	Description
158,423	93	Urban industrial, 72% imp, HSG D
44,358		28.00% Pervious Area
114,065		72.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 3S: PI and Kalschuer



Summary for Subcatchment 4S: Hills (75%)

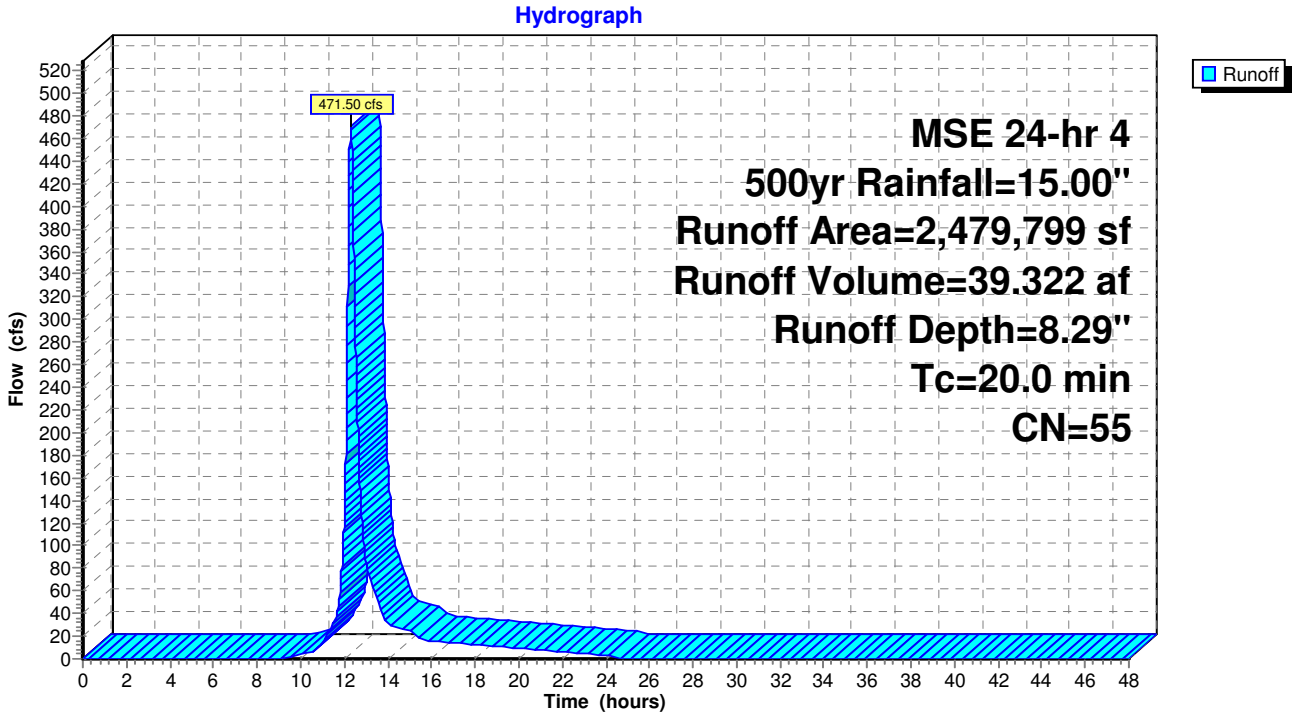
Runoff = 471.50 cfs @ 12.29 hrs, Volume= 39.322 af, Depth= 8.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 500yr Rainfall=15.00"

Area (sf)	CN	Description
2,479,799	55	Woods, Good, HSG B
2,479,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					**Direct Entry,**

Subcatchment 4S: Hills (75%)



Summary for Subcatchment D1: PI Offsite Run-on

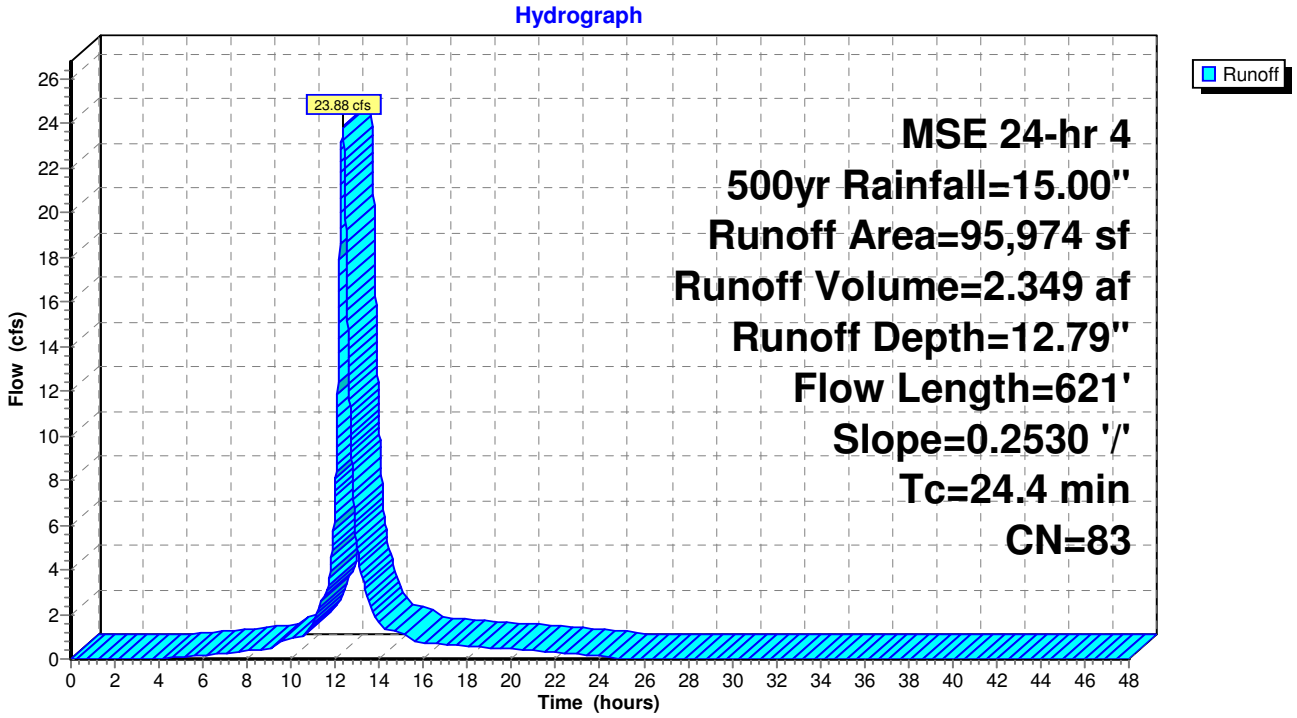
Runoff = 23.88 cfs @ 12.34 hrs, Volume= 2.349 af, Depth=12.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
MSE 24-hr 4 500yr Rainfall=15.00"

Area (sf)	CN	Description
95,974	83	Woods, Poor, HSG D
95,974		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.3	300	0.2530	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.25"
2.1	321	0.2530	2.51		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
24.4	621	Total			

Subcatchment D1: PI Offsite Run-on



Summary for Pond SUM: Pond

Inflow Area = 104.007 ac, 19.48% Impervious, Inflow Depth = 10.43" for 500yr event
Inflow = 787.25 cfs @ 12.33 hrs, Volume= 90.403 af
Outflow = 785.20 cfs @ 12.34 hrs, Volume= 90.314 af, Atten= 0%, Lag= 0.8 min
Primary = 785.20 cfs @ 12.34 hrs, Volume= 90.314 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 858.19' @ 12.34 hrs Surf.Area= 52,990 sf Storage= 115,302 cf

Plug-Flow detention time= 9.0 min calculated for 90.295 af (100% of inflow)
Center-of-Mass det. time= 8.4 min (816.4 - 807.9)

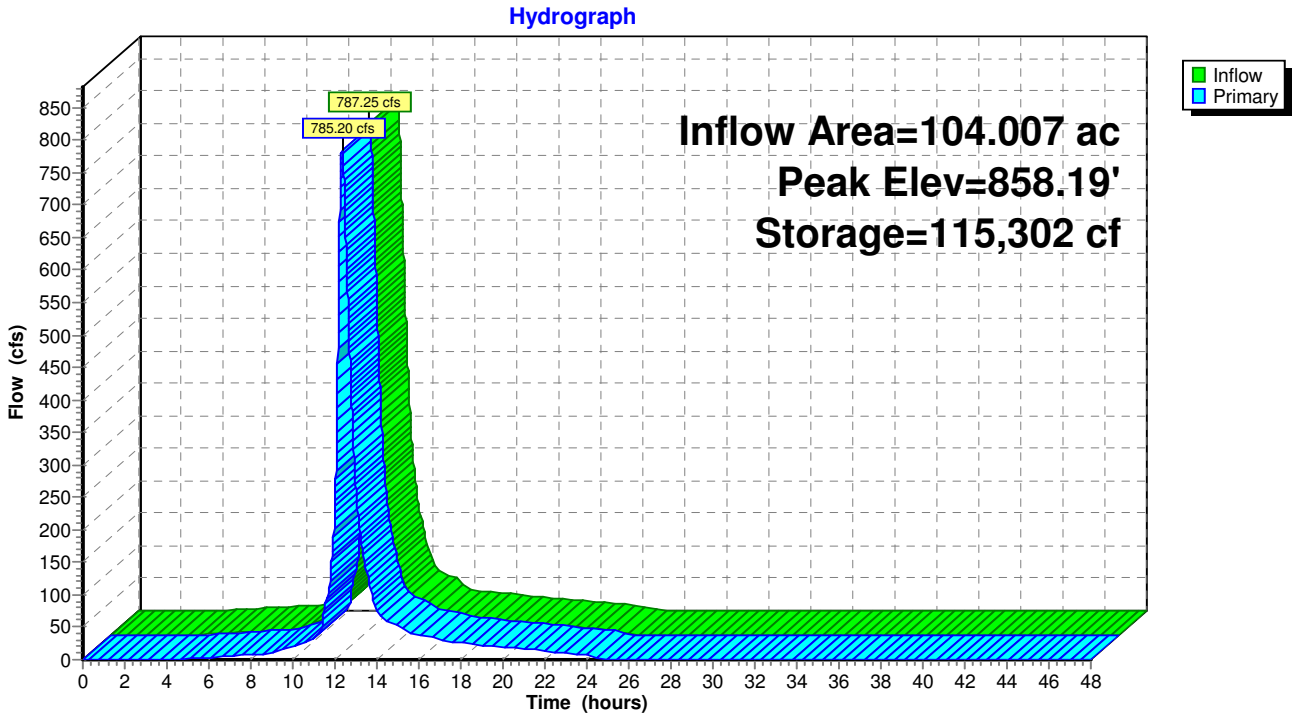
Volume	Invert	Avail.Storage	Storage Description
#1	853.00'	310,235 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
853.00	7,458	393.0	0	0	7,458
854.00	8,764	423.0	8,102	8,102	9,448
855.00	10,135	453.0	9,441	17,543	11,585
856.00	22,007	647.0	15,692	33,236	28,576
857.00	36,038	1,077.0	28,736	61,971	87,574
858.00	51,163	1,205.0	43,380	105,351	110,847
859.00	61,079	1,252.0	56,048	161,399	120,118
860.00	72,068	1,673.0	66,498	227,897	218,123
861.00	93,055	2,288.0	82,338	310,235	411,985

Device	Routing	Invert	Outlet Devices
#1	Primary	857.00'	**165.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 3.0' Crest Height
#2	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600
#4	Primary	853.50'	**18.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=784.90 cfs @ 12.34 hrs HW=858.19' (Free Discharge)
- **1=Sharp-Crested Rectangular Weir** (Weir Controls 734.22 cfs @ 3.74 fps)
- **2=Orifice/Grate** (Orifice Controls 16.89 cfs @ 9.56 fps)
- **3=Orifice/Grate** (Orifice Controls 16.89 cfs @ 9.56 fps)
- **4=Orifice/Grate** (Orifice Controls 16.89 cfs @ 9.56 fps)

Pond SUM: Pond



Appendix E. Commonwealth Heritage Group Preliminary Cultural Resources Review

COMMONWEALTH
HERITAGE GROUP

WISCONSIN OFFICE
8669 North Deerwood Drive
Milwaukee, WI 53209
(414) 446-4121

April 1, 2020
W-1791

Greg Jewell, PE, PLS
JEWELL Associates Engineers, Inc.
560 Sunrise Drive
Spring Green, WI 53588

RE: Cross Plains Flood Control System Improvements
Preliminary Cultural Resources Review

Dear Mr. Jewell:

Improvements are proposed for the existing flood control system in the village of Cross Plains, Dane County, Wisconsin. The project is expected to receive federal funding from the U.S. Economic Development Administration and, therefore, will need to comply with Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations (Section 106). Section 106 requires the consideration of effects to properties listed on, or eligible for listing on, the National Register of Historic Places (National Register). The project also will need to comply with Wisconsin's burial sites law, Wisconsin Statute 157.70, which provides legal protection for human burial sites from unauthorized disturbance.

Commonwealth Heritage Group, Inc. (Commonwealth) was contracted by JEWELL Associates Engineeers, Inc. to complete a preliminary cultural resources review of the project to identify documented historic and archaeological resources in the project area, as well as any other areas of cultural sensitivity that may be impacted. Specifically, Commonwealth reviewed two separate undertakings associated with the larger flood control project. Project 1 involves adding a flood control berm, realigning a stream, and scraping out a wetland at a one-foot depth (Figure 1). Project 2 involves adding a 255-foot steel sheet pile wall, development of a retention area, and filling a parking lot with the retention area spoils (Figure 2).

A review of the Wisconsin Historic Preservation Database (WHPD) indicated there are no previously recorded archaeological sites or cemetery/burial sites that may be impacted by Project 1 or Project 2. Under Section 106, archaeological surveys will need to be completed in any areas of potential ground disturbance (the project footprint) to determine if there will be any effects to significant archaeological sites.

According to the WHPD, there is one previously surveyed property in the vicinity of Project 1, a farmstead at 4996 County Highway P (AHI #4917; location identified on Figure 1). The property has not been evaluated for National Register eligibility. In accordance with the Wisconsin State Historic

Preservation Office (SHPO) *Survey Manual*, the property will need to resurveyed if it will be directly or indirectly affected by the project, but based on a desktop review it does not appear to have potential architectural and/or historical significance. Another farmstead is located in the vicinity of Project 1 at 5054 County Highway P that appears to have buildings and structures of historic age (50 years or older). The property may need to be surveyed and evaluated for National Register eligibility if it will be directly or indirectly affected by the project. Its location has also been identified on Figure 1. The residences immediately south of Project 1 appear to date from c.2000 and, therefore, are not of historic age.

There are no previously surveyed properties in the vicinity of Project 2. The only property with buildings and structures within the project area is an industrial facility (Plastic Ingenuity) with an address of 1017 Park Street (location identified on Figure 2). The main building was constructed in 1975 and appears to have been greatly expanded between 1980 and 2000.[1] Based on a desktop review it does not appear the property has potential architectural and/or historical significance or would even meet Wisconsin SHPO survey criteria.

Please let me know if you have any questions or concerns regarding the results of our preliminary cultural resources review. As always, additional review of the project may be necessary if plans change.

Sincerely,

Greg Rainka Architectural Historian

Enclosures

[1] Plastic Ingenuity, "History," accessed April 1, 2020, https://www.plasticingenuity.com/history; NETROnline.com. Historic Aerials. Nationwide Environmental Title Research, LLC, accessed April 1, 2020, https://www.historicaerials.com/viewer.

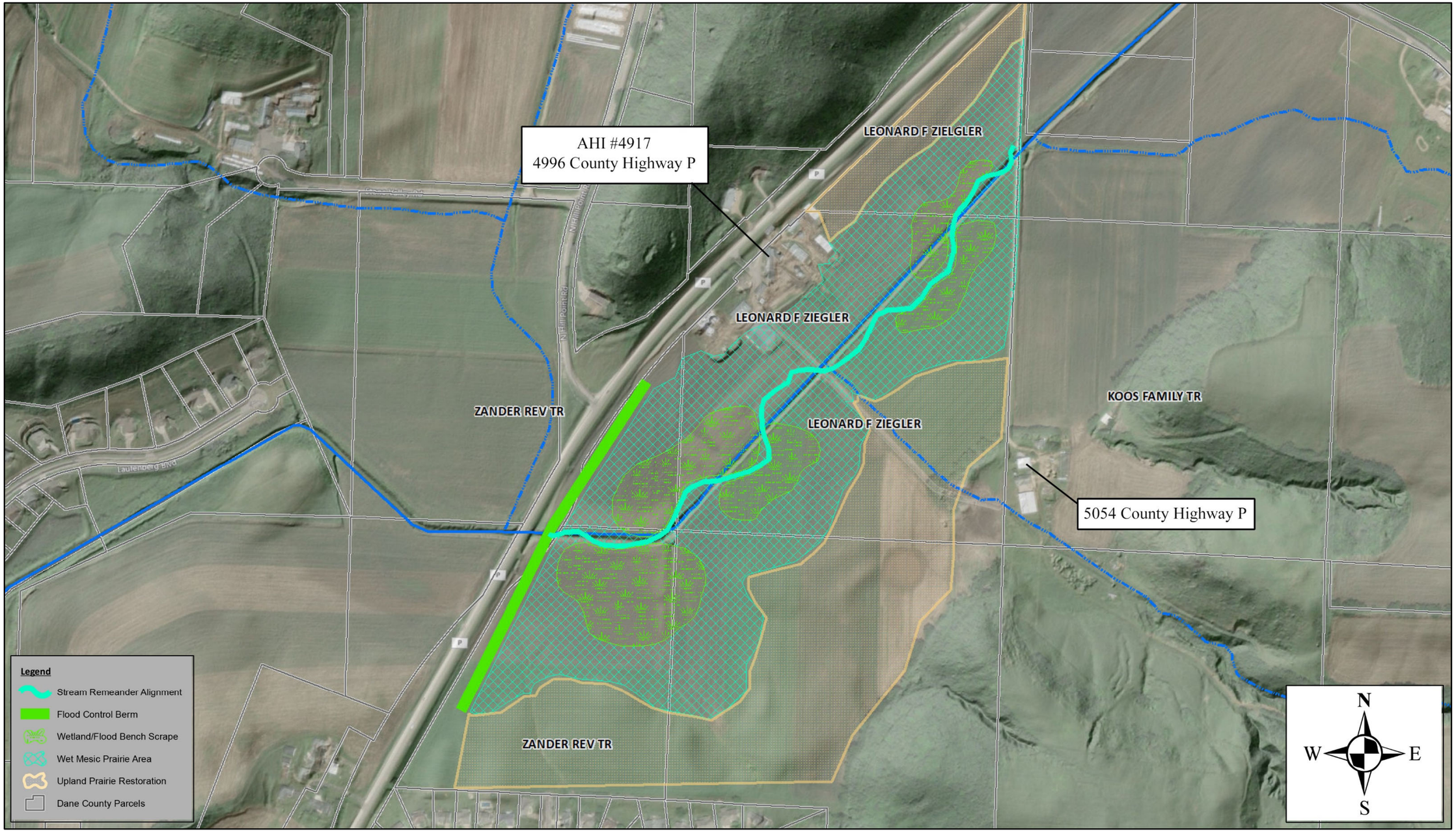


Figure 1. Overview of Project 1

Figure 2. Overview of Project 2

Appendix F. Heartland Ecological Group Desktop Wetland Determination

Heartland
ECOLOGICAL GROUP INC
506 Springdale Street, Mount Horeb, WI 53572

April 7, 2020

Greg Jewell PE, PLS
President
Jewell Associates Engineers Inc.
560 Sunrise Drive
Spring Green WI. 53533

RE: Desktop Wetland Determination – Cross Plains Flood Control, Town of Berry, Dane County, Wisconsin

Dear Mr.Jewell:

Heartland Ecological Group, Inc. ("Heartland") completed a desktop wetland determination of the Cross Plains Flood Control project area ("Project Area" or "Study Area) on behalf of the Village of Cross Plains. The Project Area is being evaluated as a location for a landscape-scale flood mitigation project. The desktop analysis and a site drive by were completed by Scott Fuchs, Environmental Technician. The 108.60-acre site (the "Study Area") lies south of County Highway P, in Section 35, T8N, R7E, Town of Berry, Dane County, Wisconsin (Attachment 1, Figure 1). The purpose of the wetland determination was to evaluate the extent and type of wetlands within the Study Area. Note that the methods utilized in this wetland determination are generally used prior to, or in conjunction with, field sampling methods described in the USACE Wetland Delineation Manual ("1987 Corps Manual"). The findings of this determination should not be used in place of a formal wetland delineation, nor would they be accepted as a wetland delineation by the Wisconsin Department of Natural Resources (WDNR) or United States Army Corps of Engineers (USACE) for the purposes of pursuing permits.

METHODS

Wetland determinations utilized available resources including the U.S. Geological Survey (USGS) WI 7.5 Minute Series (Topographic) Map (Attachment 1, Figure 2), the Soil Survey Geographic (SSURGO) Database, Web Soil Survey (Attachment 1, Figure 3), the National Wetland Inventory mapping (Attachment 1, Figure 4), and aerial imagery available through the U.S. Department of Agriculture (USDA) Farm Service Agency's (FSA) National Agriculture Imagery Program (NAIP), Google Earth™, and Dane County's interactive mapping application.

In actively farmed areas within the Study Area where hydric soils may be present, methods described in Chapter 5 (Difficult Wetland Situations) of the Regional Supplement were followed. Available aerial imagery was analyzed using procedures described in the *Guidance for Offsite Hydrology/Wetland Determinations* (USACE and Minnesota Board of Water and Soil Resources, July 2016 – "July 2016 Guidance"). An off-site aerial imagery analysis (Off-Site Analysis) was completed to document the presence or absence of wetland signatures and assist in the wetland determination. A wetland signature is evidence, recorded by aerial imagery, of ponding, flooding, or impacts of saturation for sufficient duration to meet wetland hydrology and possibly wetland vegetation criteria. Wetland signatures often vary

based on the type and seasonal date of the aerial imagery. For example, there are seven (7) standardized signature types in actively farmed settings described in the July 2016 Guidance. To assist in interpretations of wetland signatures, a WETS analysis was used to compare antecedent precipitation in the three (3) months leading up to each aerial image to the long-term (30-year) precipitation averages and standard deviation to determine if each year was normal, wet, or dry.

Areas within agricultural fields are typically determined to be wetland if hydric soils are present and 50 percent or more of the aerial images taken in the five (5) (or more) most recent normal precipitation years show at least one (1) of the wetland signatures per the July 2016 Guidance. Although the off-site analysis concentrates on wetland signatures in normal precipitation years, the years determined to be wet and dry were also analyzed and considered. Determinations of wetlands in agricultural areas are typically based on an outline of the largest wetland signature on an image taken in a "normal" precipitation year, and if signatures were visible in at least 50 percent of the years (USDA, NRCS 1998).

Offsite

Heartland completed a wetland delineation of the property directly west of the Study Area in early 2019. This property consists of similar topography and land uses as the Study Area. Therefore, similar wetland signatures appearing in areas that were field-verified to be wetlands are assumed to also be wetlands within the Study Area.

Available historic documents including field notes recorded during the original Wisconsin land survey and aerial imagery recorded in 1937 were reviewed to determine the historic presence of wetlands within the Study Area (see Attachment 3).

RESULTS

The topography within the Study Area was rolling, with various hills, depressions, and slopes. The topography is generally sloping towards a ditched portion of Brewery Creek which traverses the Study Area. A topographic high of approximately 1054 feet above mean sea level (msl) is present in the hills within the southeastern portion of the Study Area, and topographic lows of approximately 910 feet msl are present within the channel of Brewery Creek (Attachment 1, Figures 2 and 5). Land uses within the Study Area and surrounding areas are primarily agricultural row cropping with residential, pasture, and woodland areas also present.

Soils mapped by the NRCS Soil Survey within the Study Area and their hydric status are summarized in Table 1 and illustrated on Figure 3. Those areas of the Study Area with hydric or potentially hydric soils mapped on by the NRCS were the primary focus of the wetland determination. The predominantly hydric Wacousta silty clay loam and Orion silt loam soil types are present within the agricultural fields bordering Brewery Creek. These poorly drained soils support wetland hydrology and are generally found within wetlands. The Wisconsin Wetlands Inventory (WWI) mapping (Attachment 1, Figure 5) does not identify wetlands within the Study Area.

Table 1. Summary of NRCS Mapped Soils within the Study Area

Soil symbol: Soil Unit Name	Soil Unit Component	Soil Unit Component Percentage	Landform	Hydric status
1125F: Dorerton, very stony-Elbaville complex, 30 to 60 percent slopes	Dorerton-Very stony	55-65	Valley sides	No
	Elbaville	20-30	Valley sides	No
	Churchtown	3-10	Valley sides	No
	Dorerton-Nonstony	1-5	Valley sides	No
	Rockbluff	1-5	Valley sides	No
	Brodale	0-5	Valley sides	No
FeaB2: Festina silt loam, 1 to 6 percent slopes, moderately eroded	Festina-Moderately eroded	80-100	Terraces	No
	Ella-Moderately eroded	0-10	Terraces	No
	Plumcreek-Moderately eroded	0-10	Terraces	No
KdC2: Kidder loam, 6 to 12 percent slopes, eroded	Kidder-Eroded	90-100	Drumlins	No
	Fox	0-6	Drumlins	No
	McHenry-Eroded	0-5	Drumlins	No
KdD2: Kidder loam, 12 to 20 percent slopes, eroded	Kidder-Eroded	90-100	Moraines	No
	Casco-Eroded	0-5	Moraines	No
	McHenry	0-5	Moraines	No
KrE2: Kidder soils, 20 to 35 percent slopes, eroded	Kidder-Loam	60	Terminal moraines, recessionial moraines, drumlins	No

Soil symbol: Soil Unit Name	Soil Unit Component	Soil Unit Component Percentage	Landform	Hydric status
	Kidder-Sandy loam	30	Terminal moraines, recessionial moraines, drumlins	No
MdC2: McHenry silt loam, 6 to 12 percent slopes, eroded	McHenry-Eroded	85-95	Moraines	No
	Kidder-Eroded	3-8	Moraines	No
	Kendall	2-7	Drainageways	No
Or: Orion silt loam, 0 to 3 percent slopes, occasionally flooded	Orion-Occasionally flooded	80-95	Flood plains, drainageways	No
	Arenzville-Occassionally flooded	3-10	Drainageways, flood plains	No
	Ettrick-Frequently flooded	1-5	Depressions on flood plains	Yes
	Bearpen-Rarely flooded	1-5	Flood plains	No
Os: Orion silt loam, wet	Orion variant-Wet	90	Flood plains on stream terraces, depressions on stream terraces	Yes
	Otter	4	Flood plains	Yes
	Sable	3	Drainageways	Yes
	Wacousta	3	Drainageways	Yes
PrC: Port Byron silt loam, 6 to 12 percent slopes	Port Byron	100	Valley sides	No
RaA: Radford silt loam, 0 to 3 percent slopes	Radford	80-95	Flood plains, drainageways	No
	Otter	2-8	Flood plains, drainageways	Yes
	Sable	2-5	Depressions	Yes
	Sebewa	1-4	Depressions	Yes

Soil symbol: Soil Unit Name	Soil Unit Component	Soil Unit Component Percentage	Landform	Hydric status
	Drummer	0-3	Depressions	Yes
SvC2: Seaton silt loam, driftless valley, 6 to 12 percent slopes, moderately eroded	Seaton	90-100	Knolls	No
	Council	0-3	Knolls	No
	Greenridge	0-4	Knolls	No
	Lambeau	0-3	Knolls	No
SvD2: Seaton silt loam, driftless valley, 12 to 20 percent slopes, moderately eroded	Seaton	90-100	Knolls	No
	Council	0-3	Knolls	No
	Greenridge	0-4	Knolls	No
	Lambeau	0-3	Knolls	No
TrB: Troxel silt loam, 0 to 3 percent slopes	Troxel-Wet substratum	80-90	Moraines, depressions	No
	Elburn	5-11	Drainageways	No
	Plano	5-9	Till plains	No
VrB: Virgil silt loam, 1 to 4 percent slopes	Virgil	85-95	Interdrumlins	No
	St. Charles	2-7	Drumlins	No
	Sable	3-8	Interdrumlins	Yes
Wa: Wacousta silty clay loam, 0 to 2 percent slopes	Wacousta	80-90	Interdrumlins	Yes
	Sable	5-10	Interdrumlins	Yes
	Sebewa	5-10	Interdrumlins	Yes

WETLANDS IDENTIFIED

W-1

Potential wetland area W-1 is 2.09 acres in size and is contiguous with an off-site wetland that was field-delineated by Heartland in 2019. This wetland is present within areas mapped by the NRCS to contain the predominantly hydric Wacousta silty clay loam and Orion silt loam soil types. These poorly drained soils support wetland hydrology and are generally

found within wetlands. Senescent cattail (*Typha sp.)* vegetation remaining from the previous growing season was observed to present within W-1 during the site drive by. Cattails are an obligate (OBL) wetland species, meaning they occur nearly exclusively within wetlands. W-1 featured wetland signatures in 50% of the normal precipitation year imagery reviewed during the offsite imagery analysis.

W-2

Potential wetland area W-2 is 3.89 acres in size and is located in the northeastern corner of the Study Area. This wetland is present within the NRCS-mapped Wacousta silty clay loam soil type. This wetland was also observed to contain senescent cattail vegetation remaining from the previous growing season. W-2 featured wetland signatures in 50% of the normal precipitation year imagery reviewed during the offsite imagery analysis.

W-3

Potential wetland area W-3 is 1.52 acres in size and is located within a depression in the southeastern portion of the Study Area. This depression collects surface runoff originating in the hilly terrain in the southeastern corner of the Study Area, which becomes impounded within the depression as it travels downhill. The depression may also impound groundwater seepage. Although W-3 is located within the non-hydric NRCS-mapped Troxel silt loam, it featured wetland signatures in 70% of the normal precipitation year imagery reviewed during the offsite imagery analysis, occasionally containing standing water in normal and wet years. W-3 was located too far from the road to observe its vegetation during the site drive by; however, during the aerial imagery review, the depression was commonly not planted and/or was completely drowned out of agricultural crops.

Brewery Creek

Brewery Creek and its wetland fringe are 1.16 acres in size and traverse the Study Area from northeast to southwest. Off-site portions of Brewery Creek delineated in 2019 contained reed canary grass (*Phalaris arundinacea)* and cattails. Although vegetation within Brewery Creek and its wetland fringe could not be observed during the site drive by, it's likely that the vegetation within is similar to that identified during the 2019 wetland delineation. Off-site portions of Brewer Creek featured a channel approximately 10 feet wide at the ordinary high water mark and 30 feet wide at the top of the ditch embankment; the ditched creek is 10-15 feet from the top of the embankment to its bed. Throughout the aerial imagery review, Brewery Creek remained unchanged and water can be observed within its channel in about half of the aerial images reviewed.

Table 2. Summary of Potential Wetland Areas

Wetland ID	Wetland Description	*Surface Water Connections	Regulatory Jurisdiction	Acreage (on-site)
W-1	Farmed Wet Meadow	Contiguous to Brewery Creek	WDNR and USACE	2.09
W-2	Farmed Wet Meadow	Contiguous to Brewery Creek	WDNR and USACE	3.89
W-3	Farmed Wet Meadow	Potentially isolated	WDNR Only	1.52
W-4	Brewery Creek and Wetland Fringe		WDNR and USACE	1.16
**Classification based on Heartland's professional opinion. Jurisdictional authority of wetland and waterway protective areas under NR 151 lies with the WDNR. Local zoning authorities may have additional restrictions. USACE has authority for determining federal jurisdiction of wetlands and waterways.*				**8.66**

HISTORIC CONTEXT

The Original Wisconsin Land Survey conducted in 1833 recorded observations along the boundary between sections 35 and 36 of Berry Township, which also makes up the eastern boundary of the Study Area. The survey notes document the presence of marsh vegetation between 54 and 70 chains moving north along this boundary. A sketch map of the Berry Township was also conducted in conjunction with the observations made along section lines (see Attachment 3). This sketch map indicates that the marsh continued west and made up the majority of the northerneastern quarter of section 35. It is likely that prior to conversion to agriculture, approximately one-third to one-half of the Study Area would have supported wetland vegetation.

Brewery Creek had already been ditched at the time of the 1937 aerial photograph, and the adjacent agricultural fields were already being utilized for crop production at this time. Potential drain tile signatures are present in some of the aerial imagery reviewed over the period of 1984 - 2018. Along with the ditching of Brewery Creek, increased drainage via tile allows for upland crop cultivation in an area that was historically wetland.

SUMMARY AND REGULATORY CONSIDERATIONS

Wetlands present within the Study Area consist of farmed wetlands and the fringes of the ditched portion of Brewery Creek that traverses the Study Area. Farmed wetlands are agricultural areas that meet the USACE's definition of a wetland but are still utilized for agricultural row cropping. This type of wetland is able to support upland crops in dry or normal years but will not support cultivation of crops in wetter than normal years due to a high water table. Potential drain tile signatures were observed during the review of historic aerial imagery. These wetlands would likely support wet meadow or shallow marsh vegetation were they not utilized for agriculture.

Wetlands W-1, W-2, and the fringes of Brewery Creek would likely be under the regulatory jurisdiction of both the USACE and the WDNR as they are either contiguous with, or in close proximity to Brewery Creek, a navigable waterway. Wetland W-3 is isolated from Brewery Creek and may only fall under the WDNR's jurisdiction as nonfederal wetland. W-3 is supported by runoff from the steep hills to the southeast that is impounded within a depression. It does not have appear to have a surface connection to Brewery Creek.

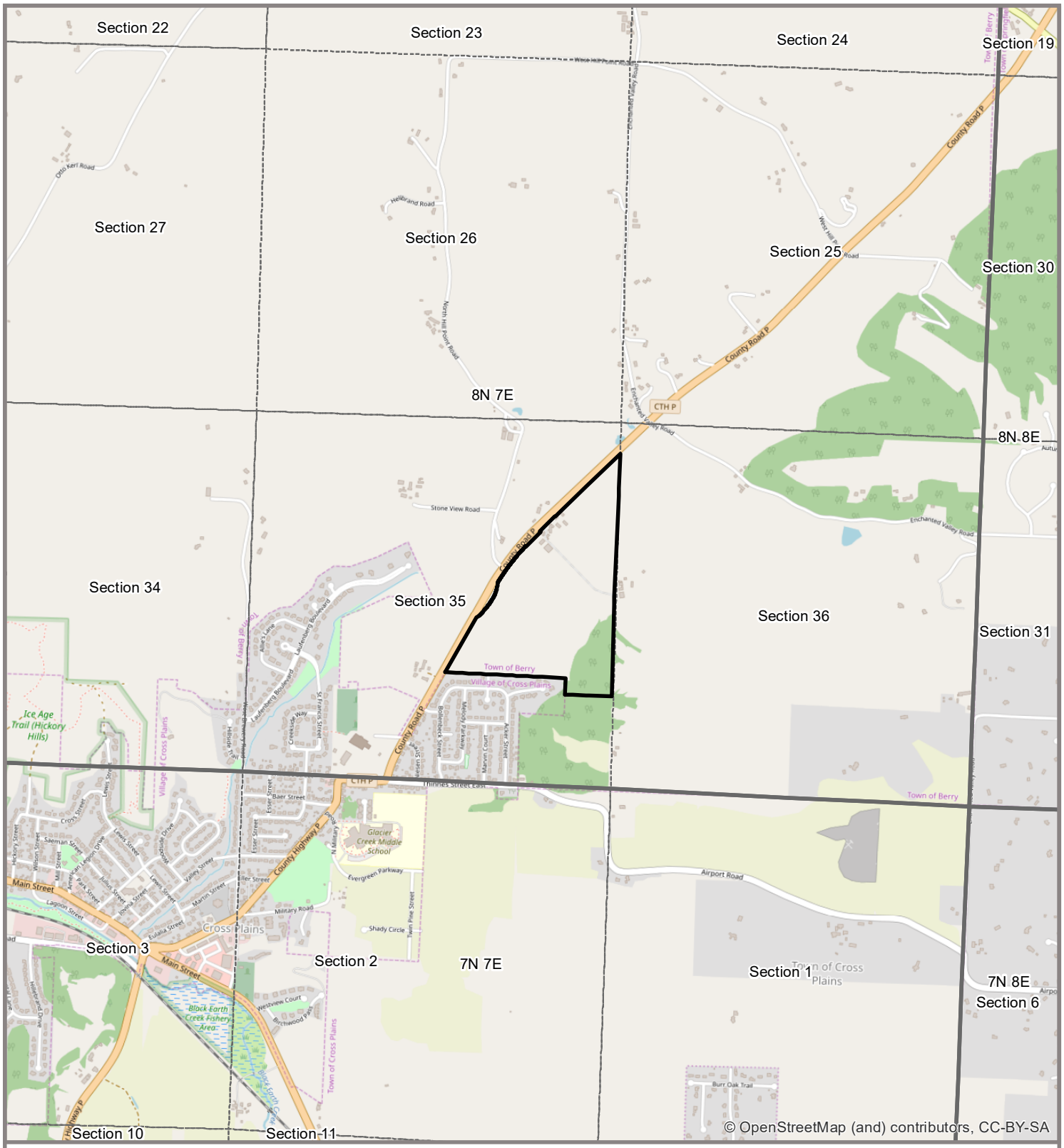
Please feel free to contact me if you have any questions regarding this wetland determination.

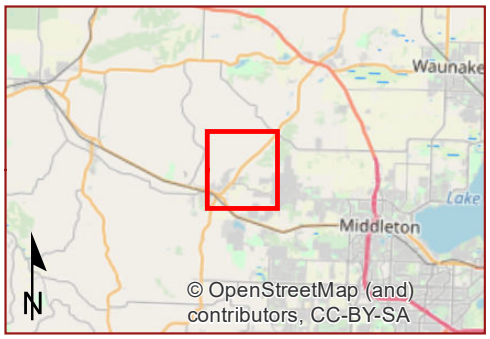
Regards,

Scott Fuchs, Environmental Technician
Heartland Ecological Group, Inc.
scott@heartlandecological.com
608.490.2450 Ext. 4

Attachments:
1 – Figures 1-6
2 – Aerial Imagery Review
3 – Historic Information

Attachment 1 | Figures





Study Area (108.60 ac)

Township

Section

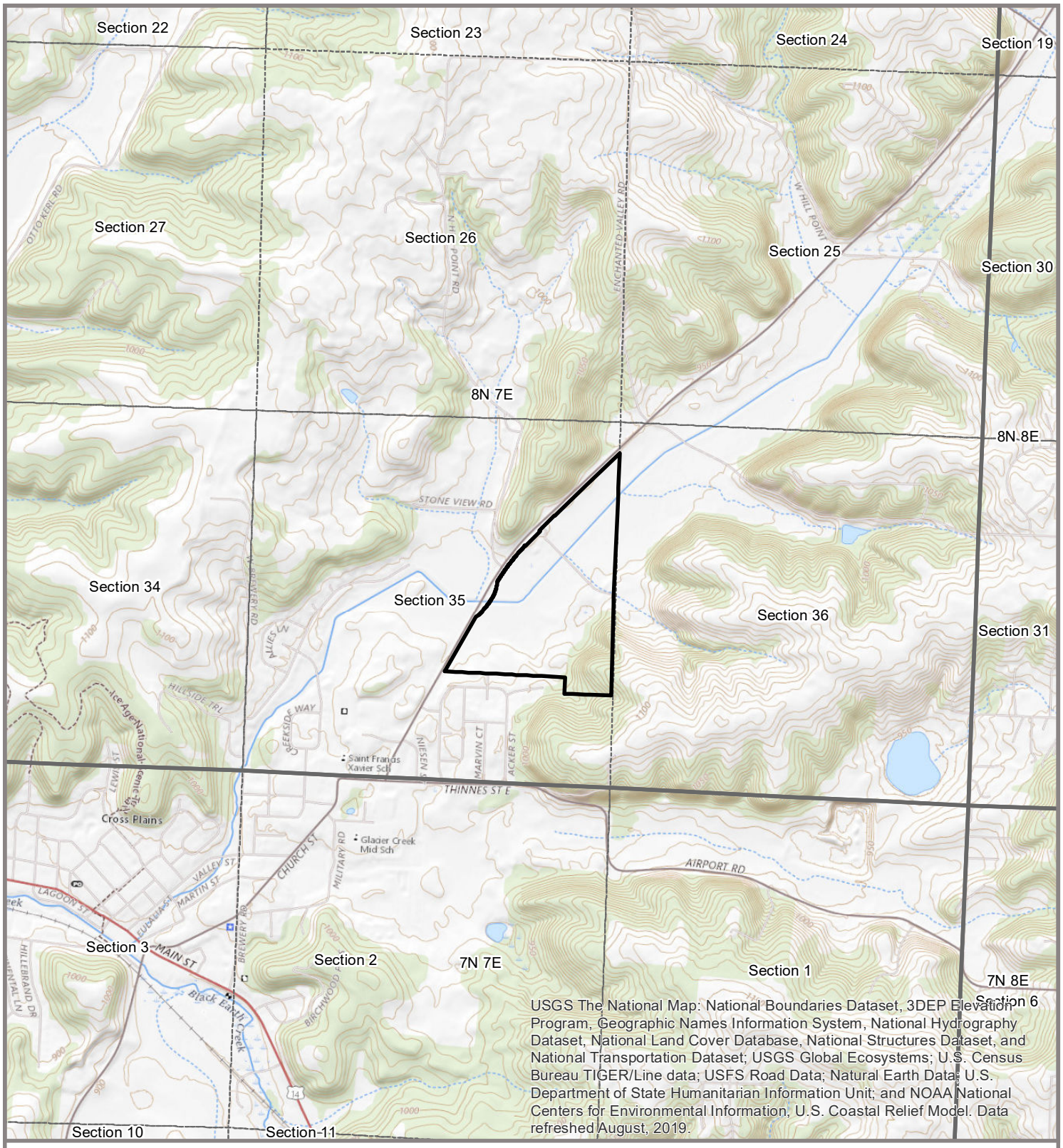
0 1,000 2,000 Ft

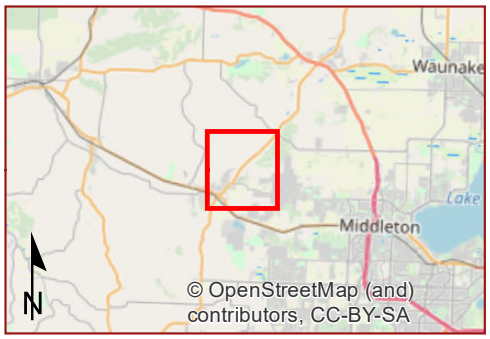
Heartland ECOLOGICAL GROUP INC

Figure 1. Project Location

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

OpenStreetMap
Data: ESRI *4/2/2020*





Study Area (108.60 ac)

Township

Section

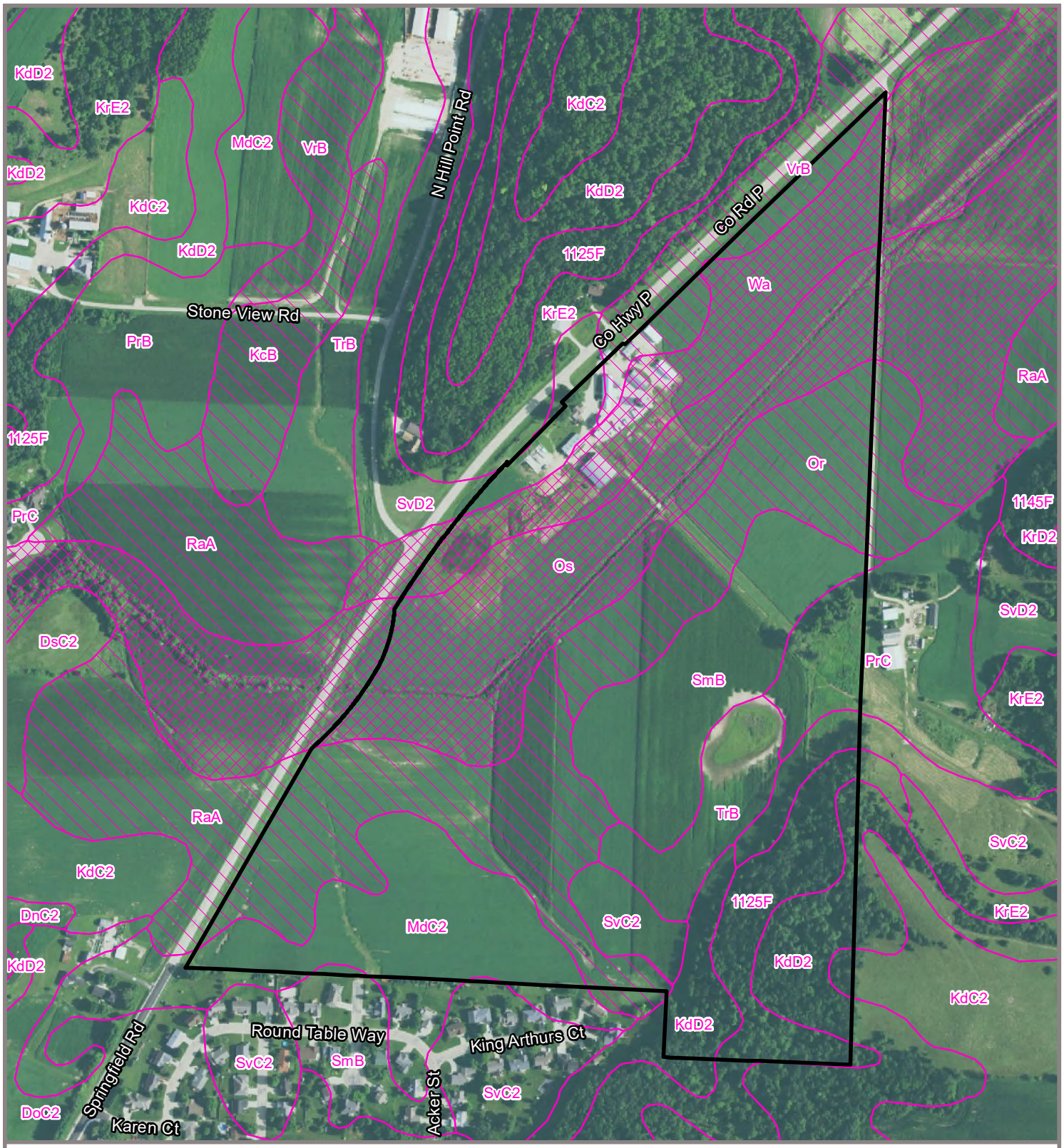
0 1,000 2,000 Ft

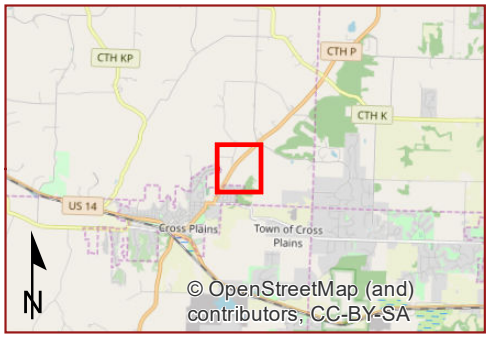
Heartland ECOLOGICAL GROUP INC

Figure 2. USGS Topography

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

USGS Topo
Data: USGS *4/2/2020*





Study Area (108.60 ac)

0 250 500 Ft

NRCS Soil Survey Data

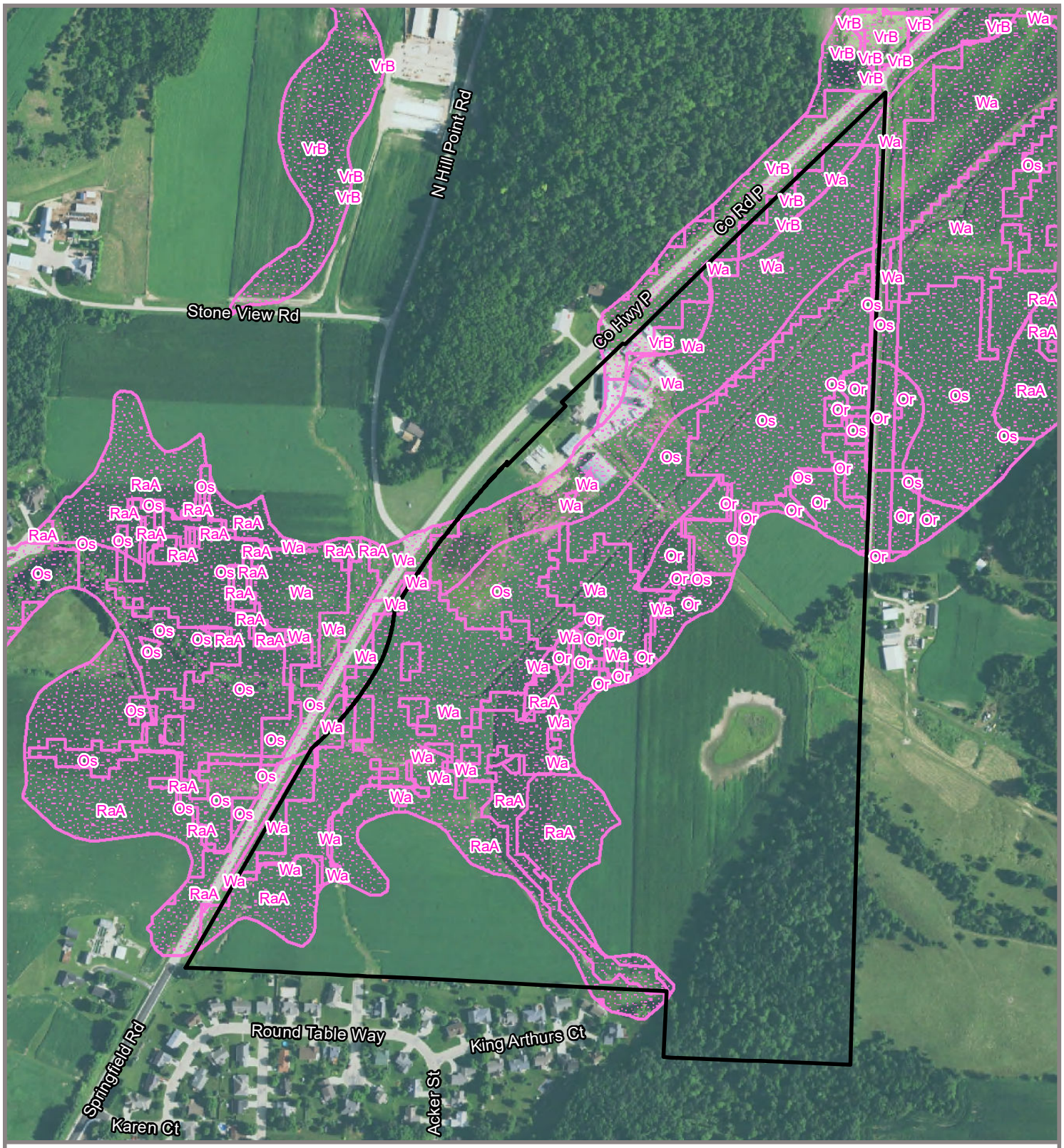
- Predominantly Hydric (85-100%)
- Partially Hydric (15-84%)
- Predominantly Non-Hydric (1-14%)
- Non-Hydric (0%)

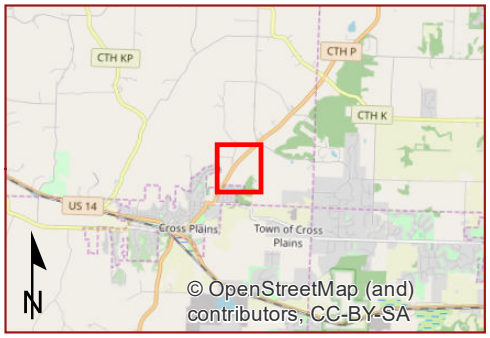
Heartland ECOLOGICAL GROUP INC

Figure 3. NRCS Hydric Soils

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2018 NAIP
Data: NRCS *4/2/2020*





Study Area (108.60 ac)

Maximum Extent Wetland Indicators

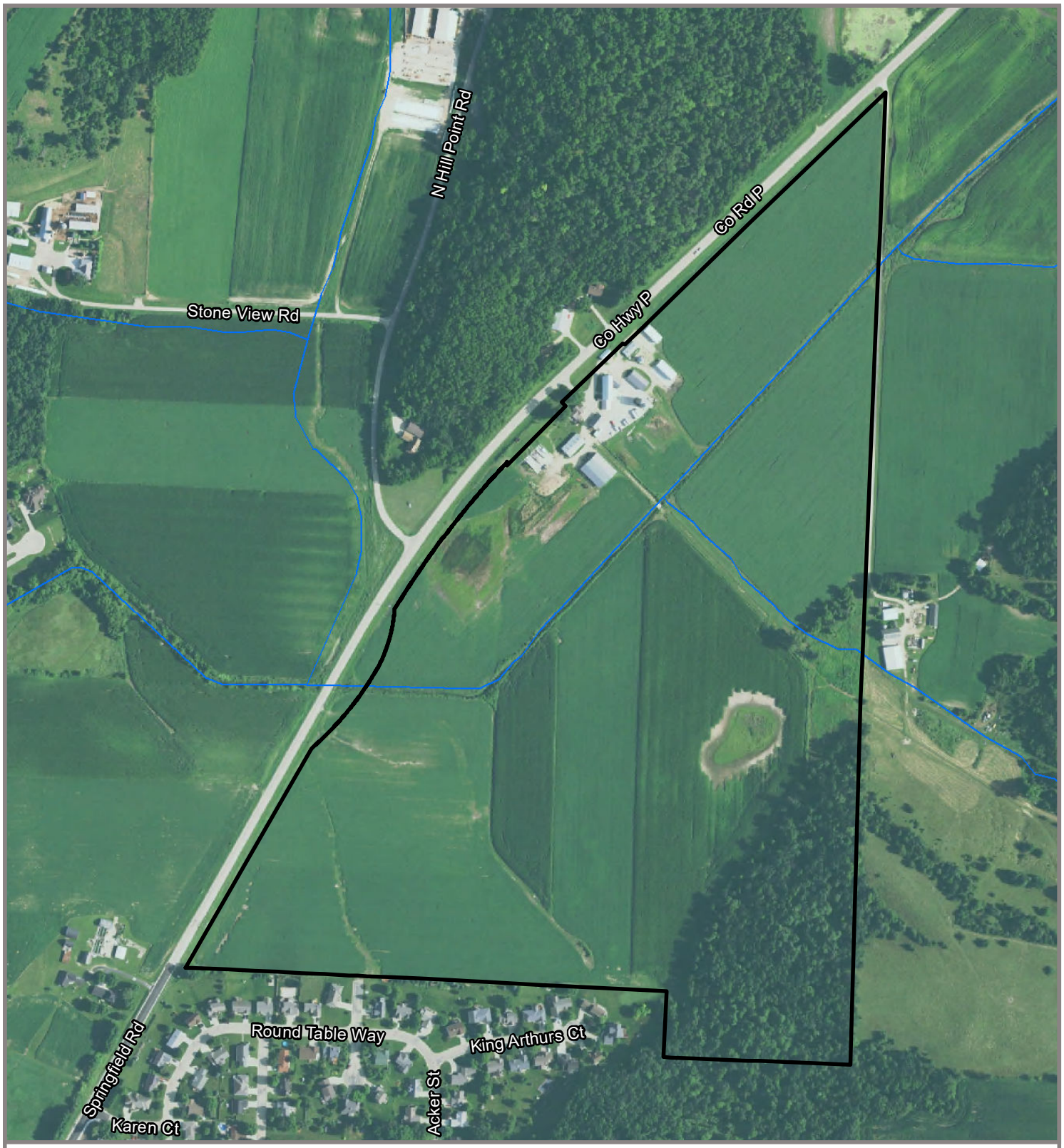
0 250 500 Ft

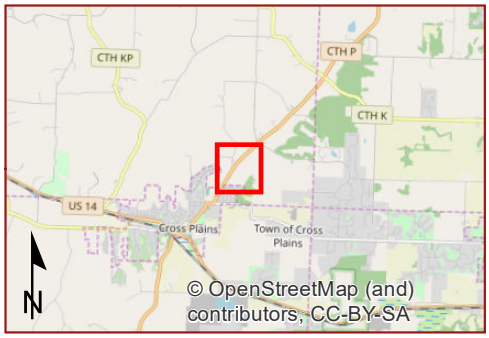
Heartland ECOLOGICAL GROUP INC

Figure 4. SWDV Wetland Indicators

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2018 NAIP
Data: WDNR *4/2/2020*





Study Area (108.60 ac)

WWI Wetlands (No Features in Map Extent)

NHD Waterway

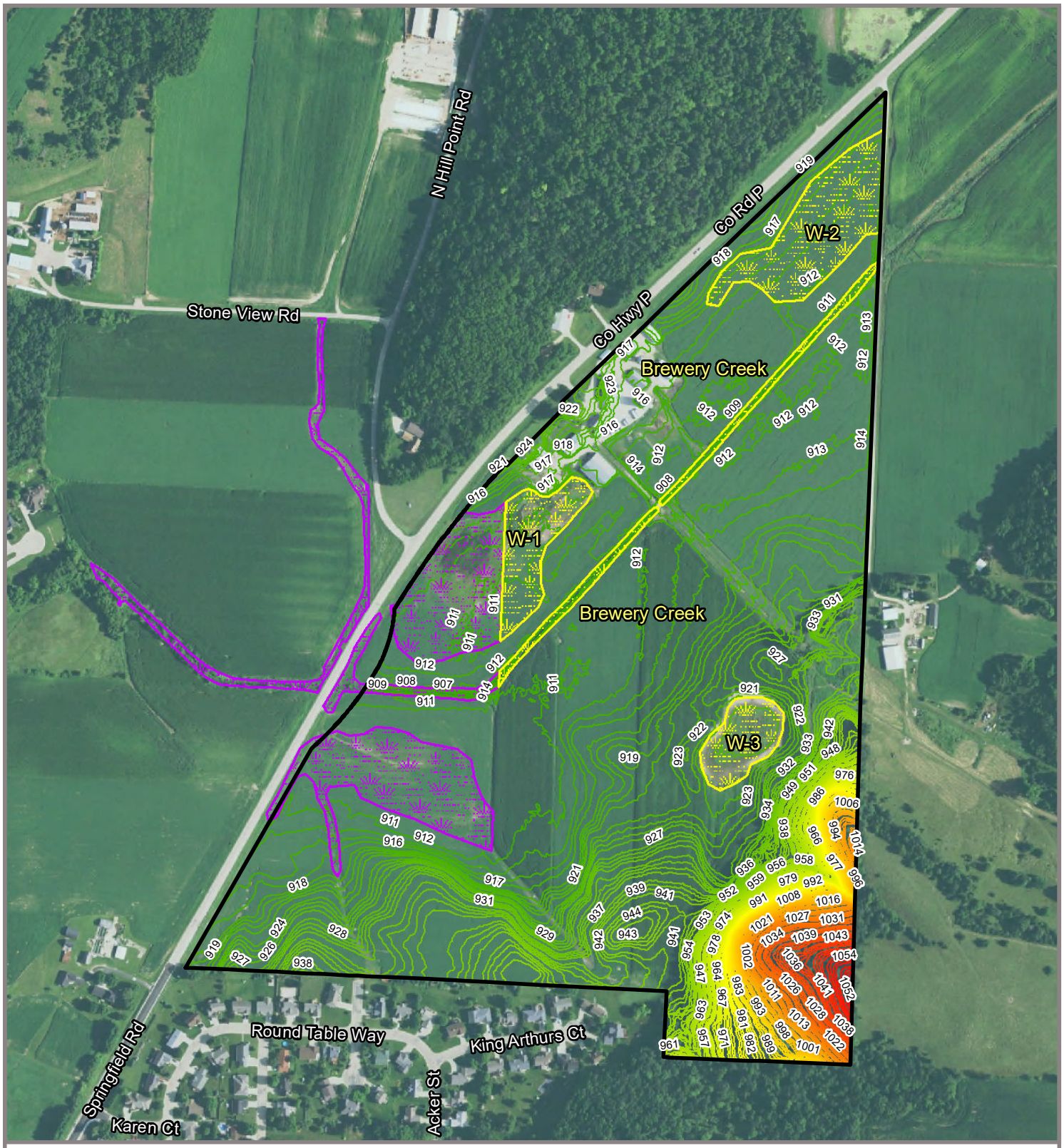
0 250 500 Ft

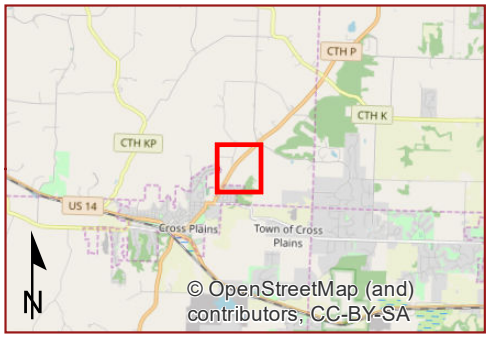
Heartland ECOLOGICAL GROUP INC

Figure 5. Wisconsin Wetland Inventory

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2018 NAIP
Data: WDNR, USGS *4/2/2020*





Study Area (108.60 ac)

2019 HEG Field Delineated Wetlands

2020 Desktop Wetland Determination

0 250 500 Ft

Heartland ECOLOGICAL GROUP INC

Figure 6. Desktop Wetland Delineation

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2018 NAIP
Data: HEG, Dane Co *4/7/2020*

Attachment 2 | Aerial Imagery Review

Heartland
ECOLOGICAL GROUP INC

Field data sheet reference (if applicable): _____

TABLE A1

Wetland Hydrology from Aerial Imagery - Recording Form*

Project Name: **Cross Plains Flood Control** *Date:* **4/7/2020** *County:* **Dane**

Investigator: **Scott Fuchs** *Legal Description (T, R, S):* **T8N** **R7E** **Sec. 35**

Summary Table

Date Image Taken (M-Y)	Image Source	Climate Condition (wet, dry, normal)	Image Interpretation(s)				
			See Appendix Reference image for general outlines of Areas 1-5				
			Area: 1	Area: 2	Area: 3	Area: 4	Area 5
Jul-84	FSA Slide	Wet	CS	CS/DO	CS/DO	CS/DO	CS/DO
Aug-85	FSA Slide	Dry	NV	CS	NV	NV	SS/DO
Jul-93	FSA Slide	Wet	SS/DO	SS/DO	SS/DO	DO	SW/DO
Jul-94	FSA Slide	Dry	NV	CS	NV	NV	NV
Sep-95	FSA Slide	Normal	NV	NV	NV	**DO**	NV
Oct-96	FSA Slide	Dry	SS	NSS	SS	SS	WS/DO
Jul-97	FSA Slide	Normal	NV	**CS**	**CS**	NV	NV
Jul-98	FSA Slide	Wet	NV	DO	SS	NV/NSS	WS
Jul-99	FSA Slide	Normal	NV	NV	NV	NV	**WS**
Aug-00	FSA Slide	Normal	**CS**	**CS**	NV	NV	**SW/DO**
Jul-01	FSA Slide	Normal	**CS**	NV	NV/NSS	NV	**DO**
Jul-03	FSA Slide	Normal	**SS**	NV	NV	NV	**SS**
Jun-04	NAIP	Normal	NV	**AP**	NV	NV	**SS/DO**
Aug-05	NAIP	Dry	SS	NV	NV	NV	NV
Jun-06	NAIP	Normal	NV	NV	NV	NV	NV
Jun-08	NAIP	Normal	**SW/CS**	**SW/CS**	NV	NV	**SW**
Jul-10	NAIP	Wet	CS	NV	NV/NSS	NV	CS
Jul-13	NAIP	Wet	SS	SS	NV/NSS	NV	SS/DO
Oct-15	NAIP	Wet	SS	SS	NV	NV	WS
Sep-17	NAIP	Normal	**CS**	**CS**	NV	NV	**CS/DO**
Jul-18	NAIP	Wet	CS	NV	NV	NV	WS
Normal Climate Condition			**Area: 1**	**Area: 2**	**Area: 3**	**Area: 4**	**Area 5**
		Number	10	10	10	10	10
		Number with wet signatures	5	5	1	1	7
		Percent with wet signatures	50%	50%	10%	10%	70%

Key		
WS - Wetland Signature	SS - Soil Wetness Signature	CS - Crop Stress
NC - Not Cropped	AP - Altered Pattern	NV - Normal Vegetative Cover
DO - Drowned Out	SW - Standing Water	NSS - No Soil Wetness Signature
Other labels or comments:		

- Use above key to label image interpretations. It is imperative that the reviewer read and understand the guidance associated with the use of these labels. If alternate If alternate labels are used, indicate in box above.
- If less than five (5) images taken during normal climate conditions are available, use an equal number of images taken during wet and dry climate conditions and use as many images as you have available. Describe the results using this methodology in your report.

* Source: http://www.bwsr.state.mn.us/wetlands/delineation/Guidance_for_Offsite_Hydrology_and_Wetland_Determinations.pdf

Heartland
ECOLOGICAL GROUP INC

Field data sheet reference (if applicable): _____

Wetland Determination from Aerial Imagery - Recording Form*

Project Name: **Cross Plains Flood Control** *Date:* **4/7/2020** *County:* **Dane**

Investigator: **Scott Fuchs** *Legal Description (T, R, S):* **T8N** **R7E** **Sec. 35**

Use the decision matrix below to create Table A2

Hydric Soils Present?[1]	Identified on NWI or WWI?[2]	Percent with Wet Signatures from TABLE A1	Field Verification Required?[3]	Wetland?
Yes	Yes	>50%	No	**Yes**
Yes	Yes	30-50%	No	**Yes**
Yes	Yes	<30%	Yes	**Yes, if other hydrology indicators are present**
Yes	No	>50%	No	**Yes**
Yes	No	30-50%	Yes	**Yes, if other hydrology indicators are present**
Yes	No	<30%	No	**No**
No	Yes	>50%	No	**Yes**
No	Yes	30-50%	No	**Yes**
No	Yes	<30%	No	**No**
No	No	>50%	Yes	**Yes, if other hydrology indicators are present**
No	No	30-50%	Yes	**Yes, if other hydrology indicators are present**
No	No	<30%	No	**No**

[1] The presence of hydric soils can be determined from the "Hydric Rating by Map Unit Feature" under "Land Classifications" from the Web Soil Survey. "Not Hydric" is the only category considered to not have hydric soils. Field sampling for the presence/absence of hydric soil indicators can be used in lieu of the hydric rating if appropriately documented by providing completed field data sheets.

[2] At minimum, the most updated NWI data available for the area must be reviewed for this step. Any and all other local or regional wetland maps that are publically available should be reviewed.

[3] Area should be reviewed in the field for the presence/absence of wetland hydrology indicators per the applicable 87 Manual Regional Supplement, including the D2 indicator (geomorphic position).

TABLE A2

Area	Hydric Soils Present?[1]	Identified on NWI or WWI?	Percent with Wet Signatures from TABLE A1	Other Hydrology Indicators Present?[1]	Wetland?
1	Yes	No	50%	N/A	
2	Yes	No	50%	N/A	
3	Yes	No	10%	N/A	
4	Yes	No	10%	N/A	
5	No	No	70%	N/A	
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

[1] Answer "N/A" if field verification is not required and was not conducted.

* Source: http://www.bwsr.state.mn.us/wetlands/delineation/Guidance_for_Offsite_Hydrology_and_Wetland_Determinations.pdf

June Aerial Imagery

Off-Site Aerial Imagery Analysis

Date	Monthly Rainfall in Inches [1]						Weighted Sum	Relative Wetness
	March	Weighted Precip	April	Weighted Precip	May	Weighted Precip		
June 2004 NAIP	3.77	3	1.91	2	11.13	9	14	**Normal**
June 2006 NAIP	2.49	2	6.34	6	5.04	6	14	**Normal**
June 2008 NAIP	1.91	2	7.64	6	2.54	3	11	**Normal**
30% chance less than**	1.27		3.05		2.99			
30 Year Average**	2.31		4.18		4.34			
30% chance more than**	2.82		4.92		5.17			

UW-Arboretum Weather Station

30-Year Average (1990-2020) from NOAA ACIS Website:

http://agacis.rcc-acis.org/

July Aerial Imagery

Off-Site Aerial Imagery Analysis

Date	Monthly Rainfall in Inches [1]						Weighted Sum	Relative Wetness
	April	Weighted Precip	May	Weighted Precip	June	Weighted Precip		
1984 FSA	4.28	2	4.02	4	7.12	9	15	Wet
1993 FSA	6.15	3	4.31	4	7.49	9	16	Wet
1994 FSA	1.72	1	2.97	2	5.80	6	9	Dry
1997 FSA	1.81	1	3.85	4	5.83	6	11	Normal
1998 FSA	5.25	3	4.78	4	8.12	9	16	Wet
1999 FSA	7.85	3	4.29	4	4.67	6	13	Normal
2001 FSA	3.35	2	4.63	4	5.86	6	12	Normal
2003 FSA	2.77	1	6.97	6	3.61	6	13	Normal
2010 NAIP	4.52	2	4.19	4	8.64	9	15	Wet
2013 NAIP	6.55	3	7.09	6	11.73	9	18	Wet
2018 NAIP	2.60	1	9.59	6	11.03	9	16	Wet
30% chance less than**	3.05		2.99		3.32			
30 Year Average**	4.18		4.34		5.61			
30% chance more than**	4.92		5.17		6.81			

UW-Arboretum Weather Station
30-Year Average (1990-2020) from NOAA ACIS Website:
http://agacis.rcc-acis.org/

August Aerial Imagery

Off-Site Aerial Imagery Analysis

Date	Monthly Rainfall in Inches [1]						Weighted Sum	Relative Wetness
	May	Weighted Precip	June	Weighted Precip	July	Weighted Precip		
1985 FSA	3.70	2	2.66	2	2.14	3	7	Dry
2000 FSA	7.16	3	9.61	6	2.83	3	12	Normal
2005 NAIP	3.71	2	1.76	2	2.62	3	7	Dry
30% chance less than**	2.99		3.32		3.18			
30 Year Average**	4.34		5.61		4.63			
30% chance more than**	5.17		6.81		5.51			

UW-Arboretum Weather Station
30-Year Average (1990-2020) from NOAA ACIS Website:
http://agacis.rcc-acis.org/

September Aerial Imagery

Off-Site Aerial Imagery Analysis

Date	Monthly Rainfall in Inches [1]						Weighted Sum	Relative Wetness
	June	Weighted Precip	July	Weighted Precip	August	Weighted Precip		
1995 FSA	1.43	1	4.41	4	3.40	6	11	**Normal**
2017 NAIP	7.92	3	10.49	6	2.70	3	12	**Normal**
30% chance less than**	3.32		3.18		2.79			
30 Year Average**	5.61		4.63		4.30			
30% chance more than**	6.81		5.51		5.17			

UW-Arboretum Weather Station

30-Year Average (1990-2020) from NOAA ACIS Website:

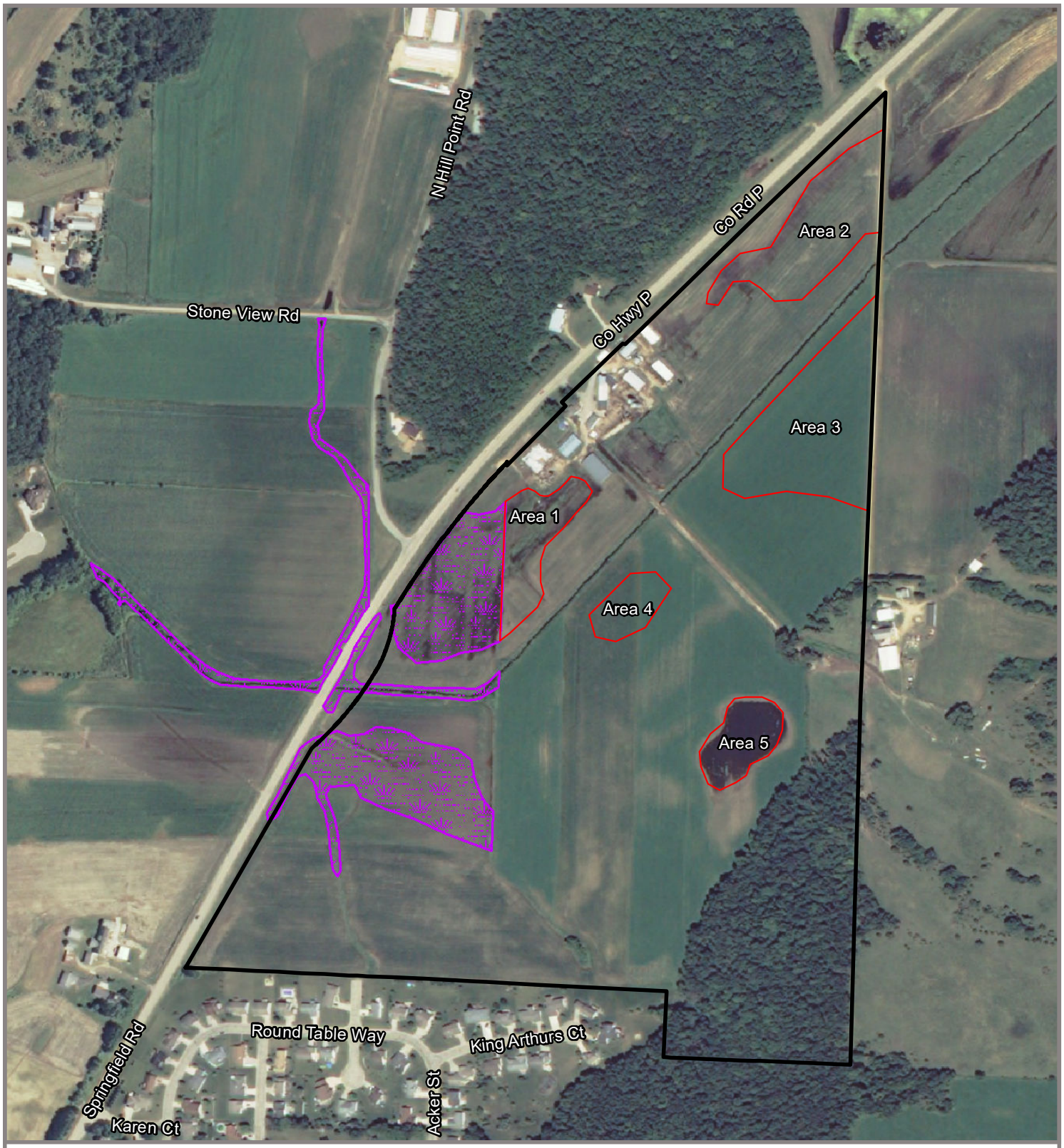
http://agacis.rcc-acis.org/

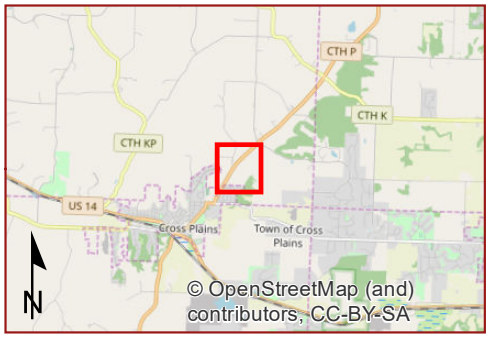
October Aerial Imagery

Off-Site Aerial Imagery Analysis

Date	Monthly Rainfall in Inches [1]						Weighted Sum	Relative Wetness
	July	Weighted Precip	August	Weighted Precip	September	Weighted Precip		
1996 FSA	4.38	2	1.49	2	1.43	3	7	Dry
2015 NAIP	4.68	2	4.30	4	6.11	9	15	Wet
30% chance less than**	3.18		2.79		2.28			
30 Year Average**	4.63		4.30		3.55			
30% chance more than**	5.51		5.17		4.28			

UW-Arboretum Weather Station
30-Year Average (1990-2020) from NOAA ACIS Website:
http://agacis.rcc-acis.org/





Study Area (108.60 ac)

Offsite Analysis

2019 Field Delineated Wetlands

0 250 500 Ft

Heartland ECOLOGICAL GROUP INC

Offsite Wetland Imagery Analysis

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2008 NAIP
Data: USDA *4/7/2020*

July 1984 – Wet

August 1985 – Dry

July 1993 – Wet

July 1994 – Dry

September 1995 – Normal

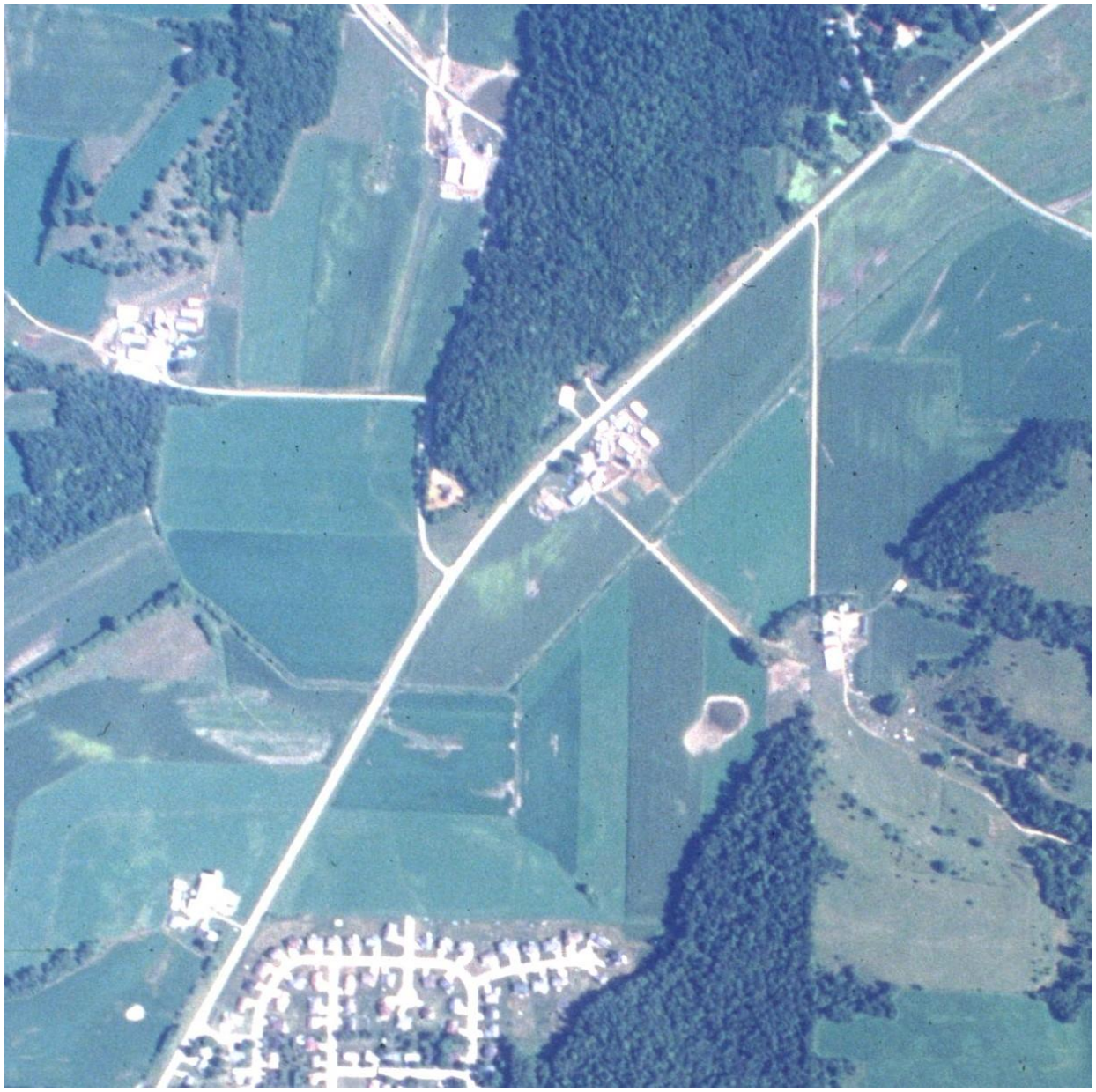
October 1996 – Dry

July 1997 – Normal

July 1998 – Wet

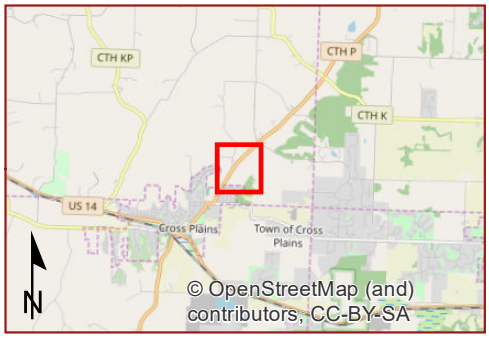
July 1999 – Normal

August 2000 – Normal



July 2001 – Normal

July 2003 – Normal



Study Area (108.60 ac)

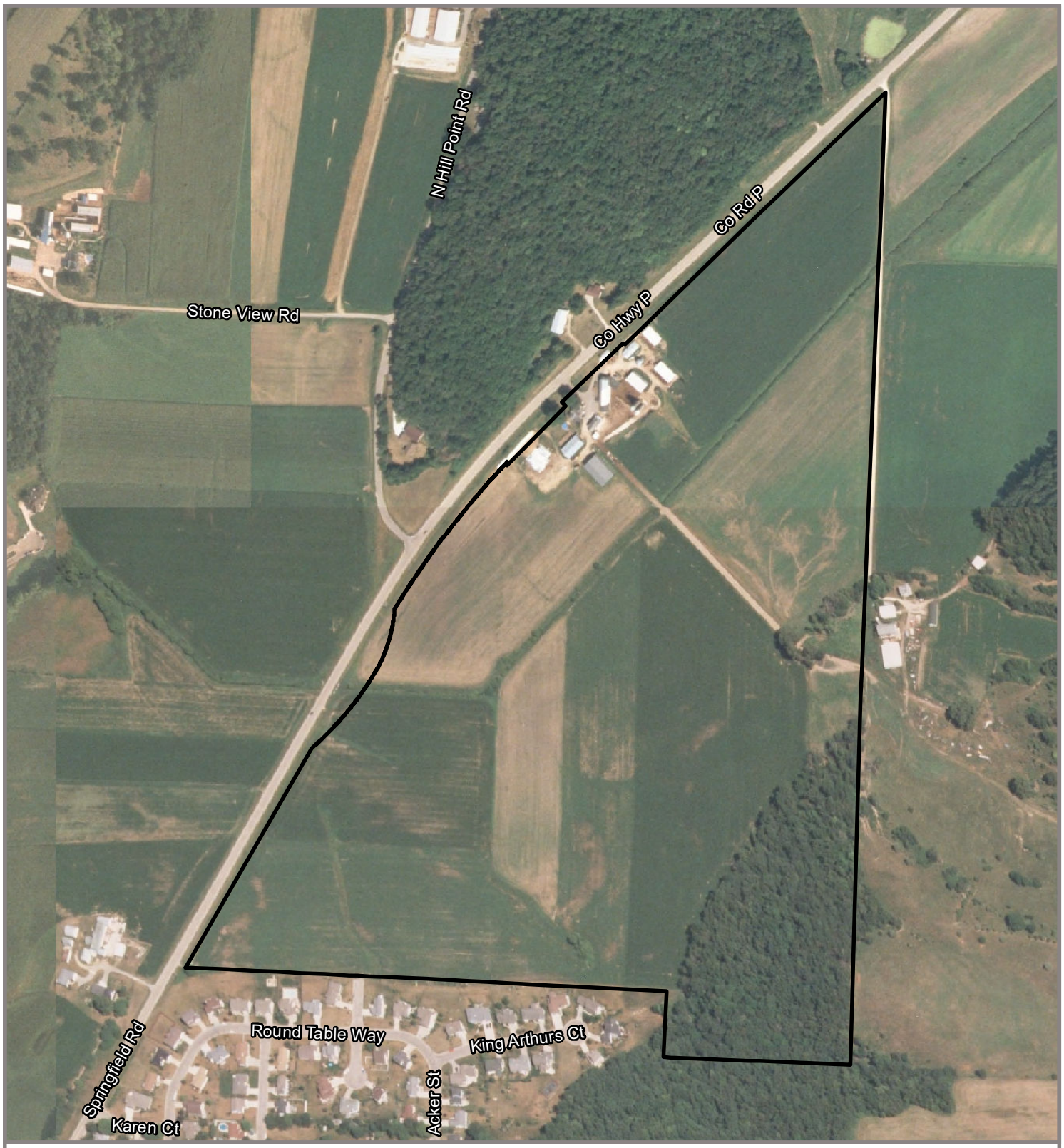
0 250 500 Ft

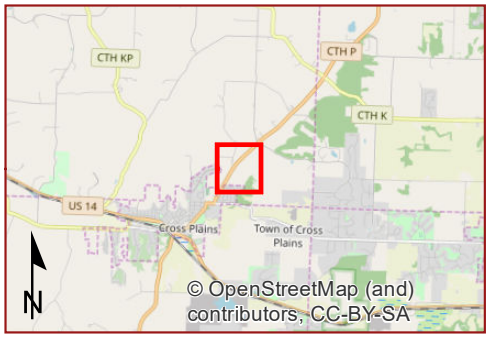
Heartland
ECOLOGICAL GROUP INC

Appendix: 2004-07-15
NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2004 NAIP
Data: USDA *4/2/2020*





Study Area (108.60 ac)

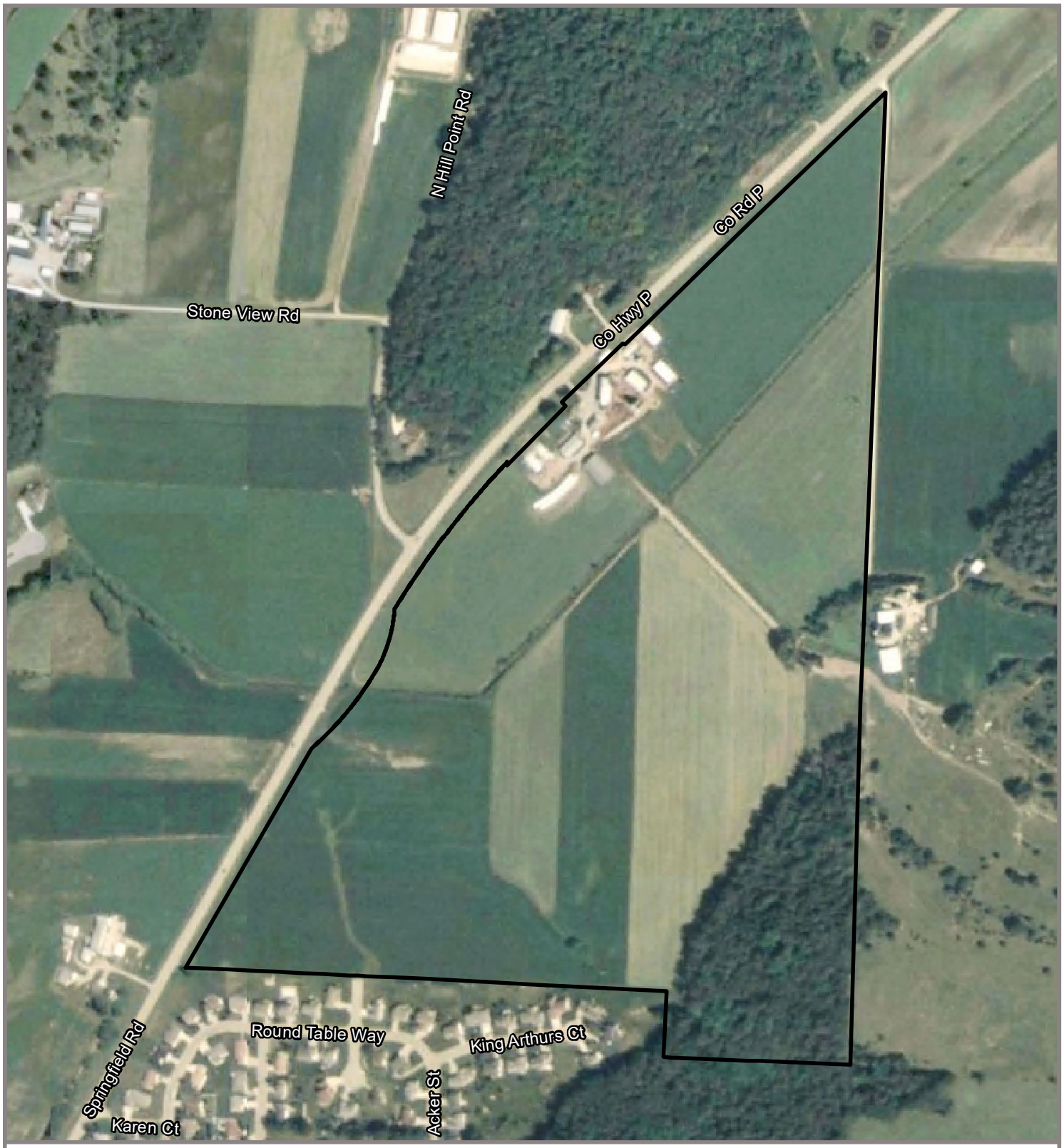
0 250 500 Ft

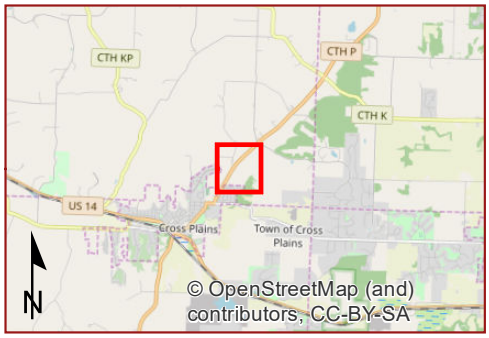
Heartland
ECOLOGICAL GROUP INC

Appendix: 2005-08-02 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2005 NAIP
Data: USDA *4/2/2020*





Study Area (108.60 ac)

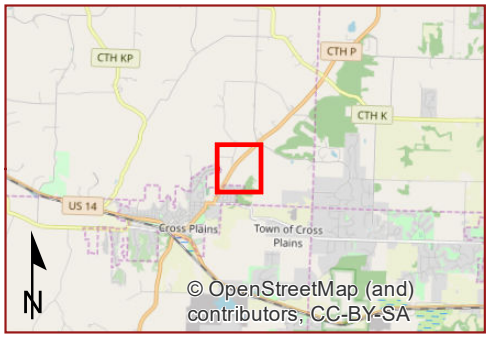
0 250 500 Ft

Heartland
ECOLOGICAL GROUP INC

Appendix: 2006-07-15 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2006 NAIP
Data: USDA *4/2/2020*



Study Area (108.60 ac)

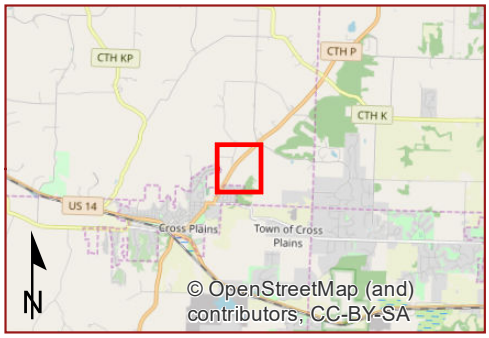
0 250 500 Ft

Heartland
ECOLOGICAL GROUP INC

Appendix: 2008-07-09 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2008 NAIP
Data: USDA *4/2/2020*



Study Area (108.60 ac)

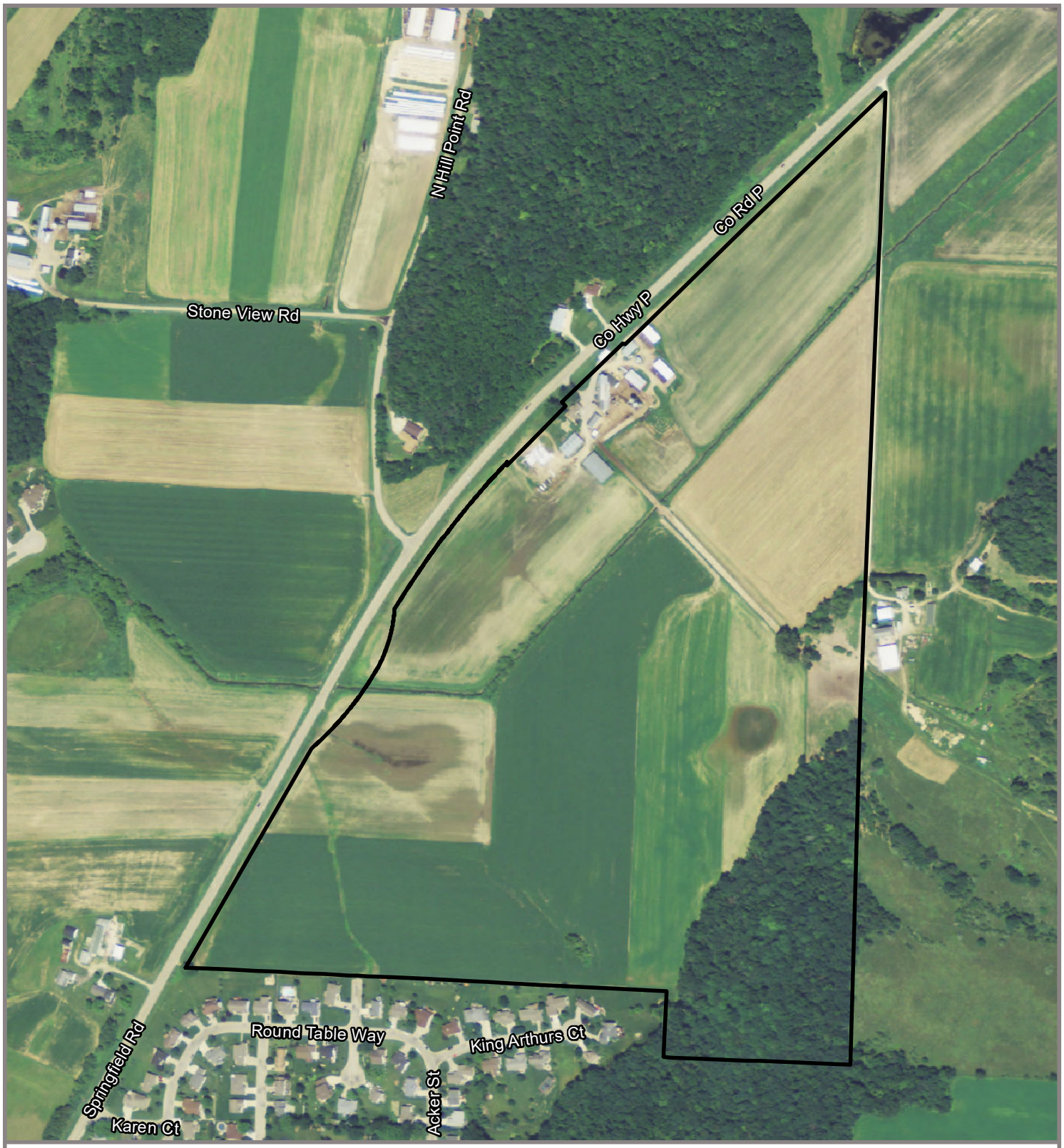
0 250 500 Ft

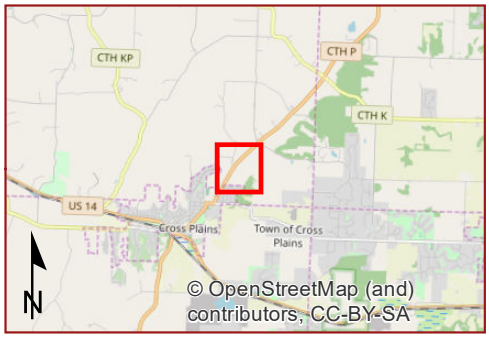
Heartland ECOLOGICAL GROUP INC

Appendix: 2010-07-02 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2010 NAIP
Data: USDA *4/2/2020*





Study Area (108.60 ac)

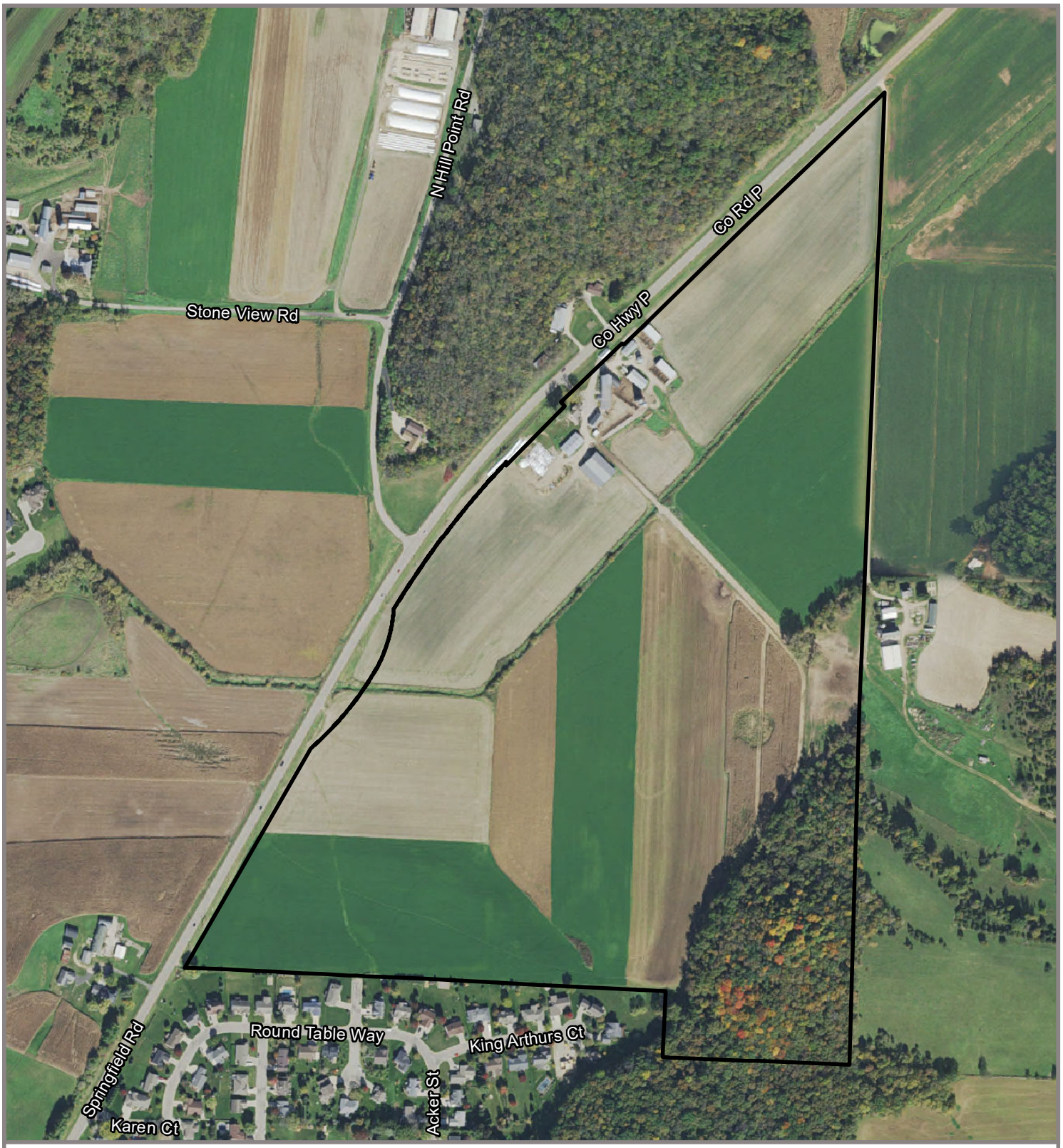
0 250 500 Ft

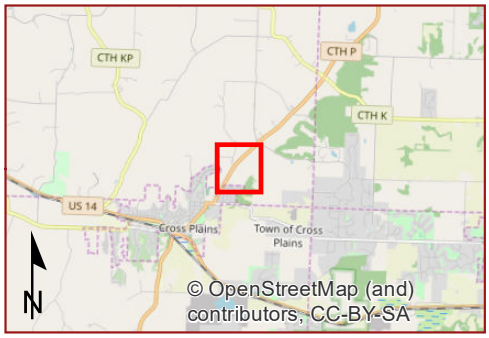
Heartland
ECOLOGICAL GROUP INC

Appendix: 2013-07-04 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2013 NAIP
Data: USDA *4/2/2020*





Study Area (108.60 ac)

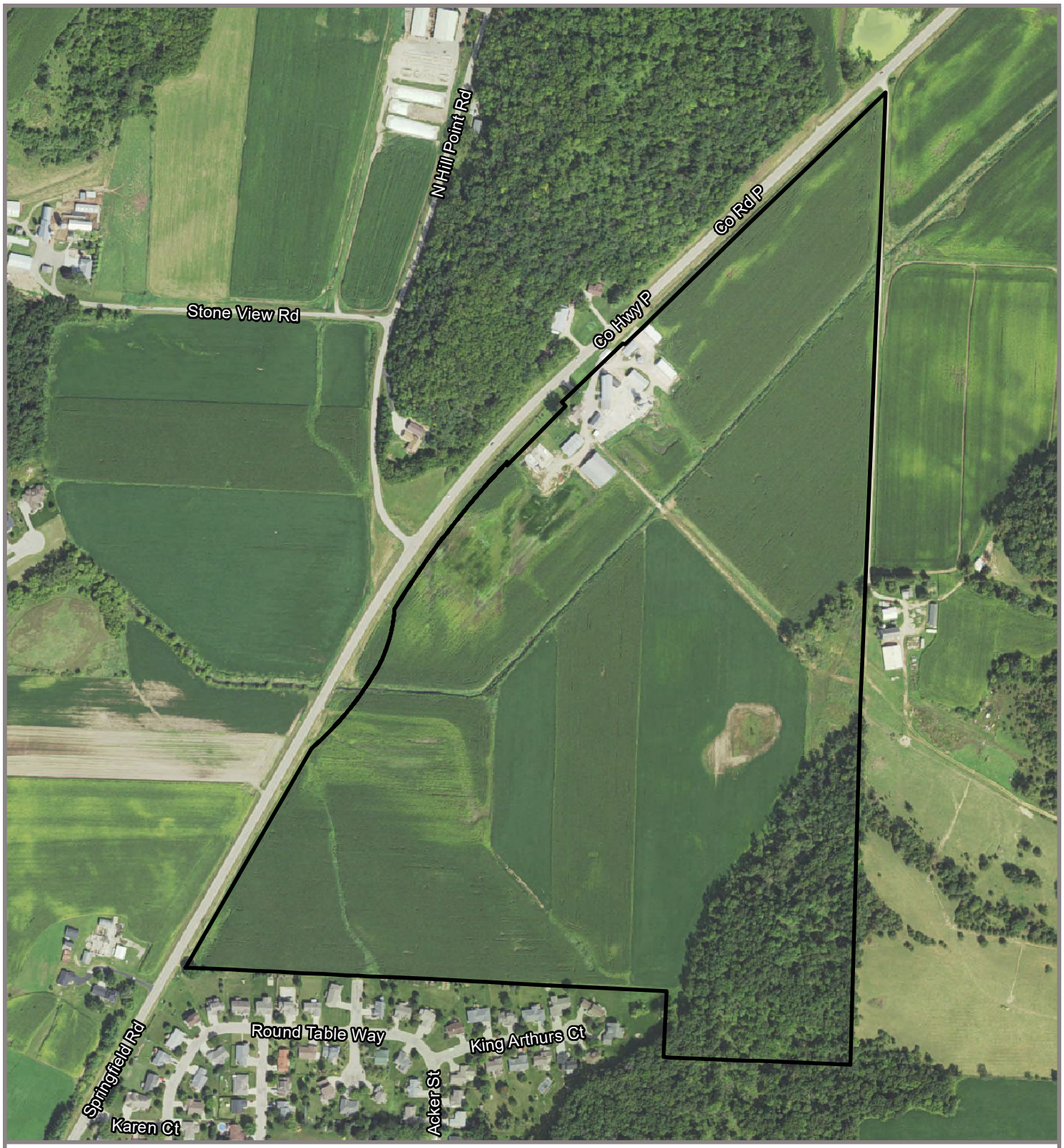
0 250 500 Ft

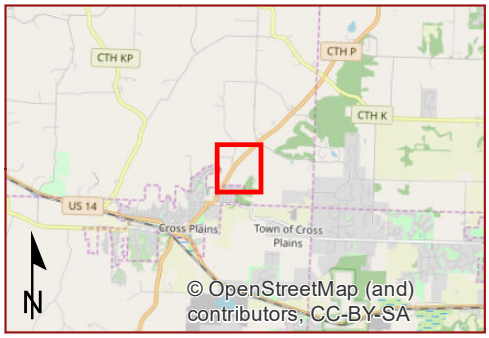
Heartland ECOLOGICAL GROUP INC

Appendix: 2015-10-11 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2015 NAIP
Data: USDA *4/2/2020*





Study Area (108.60 ac)

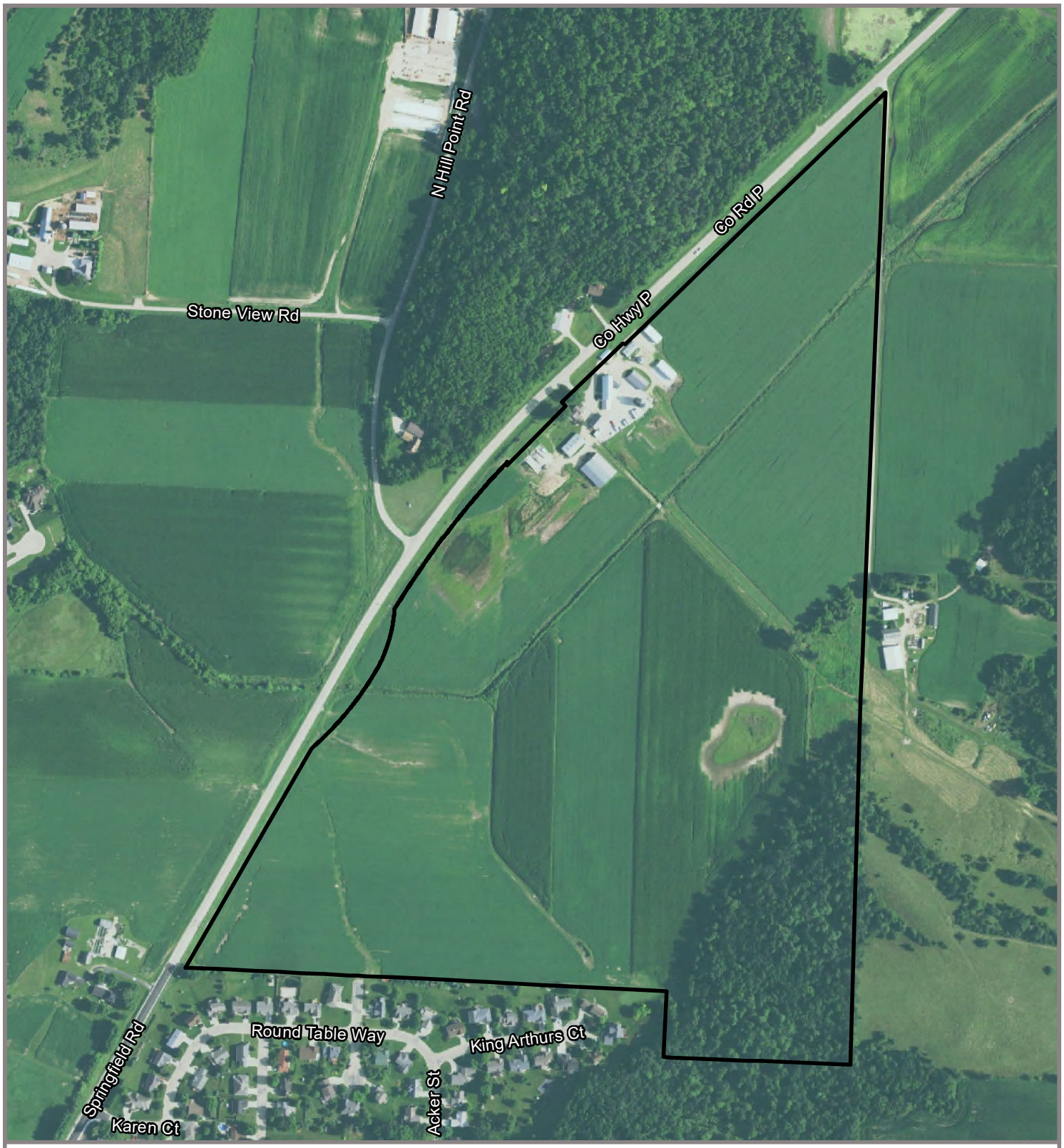
0 250 500 Ft

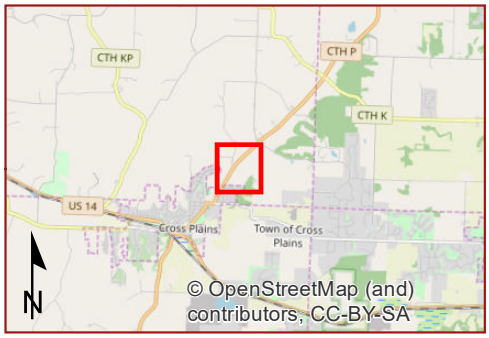
Heartland
ECOLOGICAL GROUP INC

Appendix: 2017-09-03
NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2017 NAIP
Data: USDA *4/2/2020*





Study Area (108.60 ac)

0 250 500 Ft

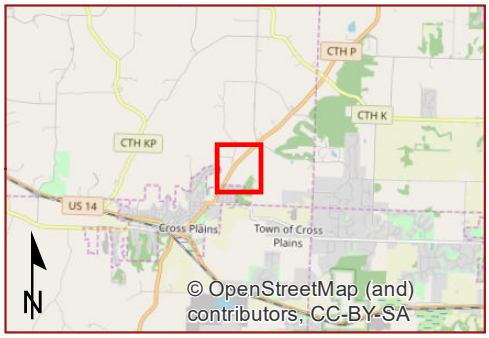
Heartland
ECOLOGICAL GROUP INC

Appendix: 2018-07-28 NAIP Aerial Imagery

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

2018 NAIP
Data: USDA *4/2/2020*

Attachment 3 | Historic Information



Study Area (108.60 ac)

0 250 500 Ft

Heartland
ECOLOGICAL GROUP INC

Appendix: 1937 Orthophoto

Cross Plains Flood Control
Project #20200293
T8N, R7E, S35
T Berry, Dane Co, WI

1937 Orthophoto
Data: WI St. Cart. Office 4/7/2020