Floodplain Analysis Report

Ebner Coulee - La Crosse County, Wisconsin

City of La Crosse, Wisconsin

FEMA Region V
SEH No. LACRS 151816

July 16, 2020

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March 1, 2020

RE: City of La Crosse, La Crosse County, WI
Ebner Coulee Letter of Map Revision
(LOMR) Application Submittal
SEH No. LACRS 151816 14.00

Attn: LOMC Manager
LOMC Clearinghouse
847 South Pickett Street
Alexandria, VA 22304-4605

Executive Summary – Ebner Coulee LOMR

Short Elliott Hendrickson, Inc. is submitting the enclosed information on behalf of the City of La Crosse, Wisconsin, as a submittal of the required materials for the Ebner Coulee Letter of Map Revision (LOMR). This application is for the revision of the Ebner Coulee FIRM based on a new hydrologic and hydraulic analysis using an alternate modeling methodology.

Project Overview

The purpose of this project is to reevaluate and update the hydrologic and hydraulic analysis of the Ebner Coulee watershed using an updated modeling methodology to more accurately depict the conditions of this complex urban floodplain system. The analysis was performed on behalf of the City of La Crosse, Wisconsin (WI) by Short Elliott Hendrickson Inc. (SEH). The goal of this reevaluation study is to update the floodplain boundaries for FEMA Map No. 55063C0262D in La Crosse, WI, to more accurately reflect hydrologic and hydraulic characteristics of the watershed.

Ebner Coulee consists, in part, of a manmade drainage channel running from Farnam Street up to a point where it begins to drain the channel out of a valley. The raised urban portion of the channel is approximately 3,700 feet long, and the effective model extends another 300 feet above that. At Farnam Street, it empties into an 8 x10 foot box culvert that is part of the cities storm sewer system. Located on the left bank of the channel is a low lying area drained only by City storm sewer. On the right bank of the channel is another low lying area drained by storm sewer and a railroad track. There is another area south of Farnam Street that is to be remapped as well, the effective modeling in this area is a level pool analysis as there is no raised channel to model with HEC-RAS.

The effective model cross-section data begins at Jackson Street with cross-section A, however subsequent remapping efforts extended the modeling all the way down to Farnam Street. This updated mapping added additional cross-sections to the model, but they do not appear to be present in the DFIRM XS data.

A 40-year flood event occurred in July of 2017, and high water marks were surveyed and residents in the floodplain were asked to complete a mail in survey allowing them to report any flooding they observed. An SRH-2D model was created to estimate the flow associated with the 2017 flood event based on the surveyed high water marks and citizen reports of flooding; this flow was then corrected to obtain a 100-

year calibrated flow. This 2D model was then used to calculate flow split out the channel, which informed and validated the final HEC-RAS model being submitted as part of this LOMR.

A 1D/2D integrated, dynamic hydrologic and hydraulic model of Ebner Coulee and the surrounding City storm sewer system was developed using XPSWMM (Version 2018.2) to model the flooding and flow rates in the low lying areas adjacent to the raised channel.

A 1D HEC-RAS (version 5.0.7) model was created to update and replace the effective model. This model consists of a channel down the main Ebner Coulee ditch, as well as a separate channel to model overtopped flows running down 28th Street. Several low lying areas that would not have effective flow were modeled using a level pool analysis with elevations from the 1D HEC-RAS model and 1D/2D XPSWMM model. The complexity is necessary to keep a similar layout as the effective model and to accurately model this complex urban system.

We are available to discuss any of the information provided and are hopeful that this LOMR will be approved.

Sincerely,

SHORT ELLIOTT HENDRICKSON INC.

Brad T Woznak

Brad Woznak, PE, C.F.M.

btw
Enclosure
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Ebner Coulee - La Crosse County, WisconsinWisconsin

Prepared for City of Watertown, South Dakota

1.0 Purpose of the Study

The purpose of this project is to reevaluate and update the hydrologic and hydraulic analysis of the Ebner Coulee watershed using an updated modeling methodology to more accurately depict the conditions of this complex urban floodplain system. The analysis was performed on behalf of the City of La Crosse, Wisconsin (WI) by Short Elliott Hendrickson Inc. (SEH). The goal of this reevaluation study is to update the floodplain boundaries for FEMA Map No. 55063C0262D in La Crosse, WI, to more accurately reflect hydrologic and hydraulic characteristics of the watershed. This study will update the floodplain boundaries and water surface profiles for the 100-year and 500-year flood events for Ebner Coulee. The project area is shown in **Figure 1**.

The previous FEMA approved flood insurance study (effective date of January 6, 2012) was performed by Mead & Hunt, Inc. using the USACE program HEC-RAS Version 4.1 for the hydraulic analysis of the system; this is an update of the original effective model completed with HEC-2 in the 1970s. The updated model used the original hydrology, which was developed with the Bureau of Public Roads Method, also called the Cook Method, with scaling of flood frequency from Gilmore Creek at Winona, MN. According to a letter from the USGS to the WDNR dated September 29, 1994 (USGS, 1994), "the Bureau of Public Roads and Cook methods are highly empirical and inappropriate for a watershed as steep as Ebner Coulee, and the [flood frequency] scaling procedures applied are inconsistent with current recommended procedures." The City believes the flow rates obtained are significantly too high, and more modern hydrologic modeling techniques support that claim.

Due to the fact that the main Ebner Coulee channel is at or above the surrounding floodplain, the effective model connected the overtopped flows to a separate channel through the use of lateral structures. The effective model did not incorporate City storm sewer into the flow calculations into the floodplain flow channel, which is problematic given that the storm sewer is the only outlet source of this low lying area and there is no natural outlet channel.

Since the completion of the 2012 effective study, fully integrated dynamic hydrologic and hydraulic modeling software has been developed and been approved by FEMA for floodplain studies. A fully dynamic model allows for a more robust mathematical solution that provides a better representation of the floodplain conditions and interaction with the storm sewer system and other complex urban drainage features that HEC-HMS and 1D HEC-RAS are unable to simulate.

FEMA allows individual States to manage their floodplain districts at stricter standards than the minimum requirements listed in 44 CFR. State of Wisconsin Natural Resources Chapter 116 promulgates the rule that only HEC-2 (now HEC-RAS) are acceptable in the

State of Wisconsin for flood studies. For this reason, submission of a 1D model is still easiest to obtain approval, however new SRH2D and 1D/2D XPSWMM models were developed and used heavily to inform flows and floodplain boundaries when creating a new 1D Unsteady HEC-RAS model for submittal to FEMA and LOMR remapping.

2.0 Background Data

2.1 Vertical Datum

All vertical geometry data, water surface profile elevations, and floodplain boundary elevations used in the updated modeling are referring to the NAVD88 vertical datum. The elevations in the FIS associated with Ebner Coulee are also in NAVD88.

2.2 Past Modeling and Geometric Data

Geometric data for the effective model was obtained from the Digital Flood Insurance Rate Map (DFIRM) data as shapefiles. **Figure 2.1** shows the FEMA geometry associated with the effective model and the effective DFIRM map. **Figure 2.2** shows a close up of the FEMA cross-sections with more detail and letter names. Note that cross-sections south of Jackson are not present in the DFIRM data, but are present in the effective model. The cross-sections are lettered separately between the main channel and the side channel.

The effective HEC-RAS model was obtained from the Wisconsin DNR.

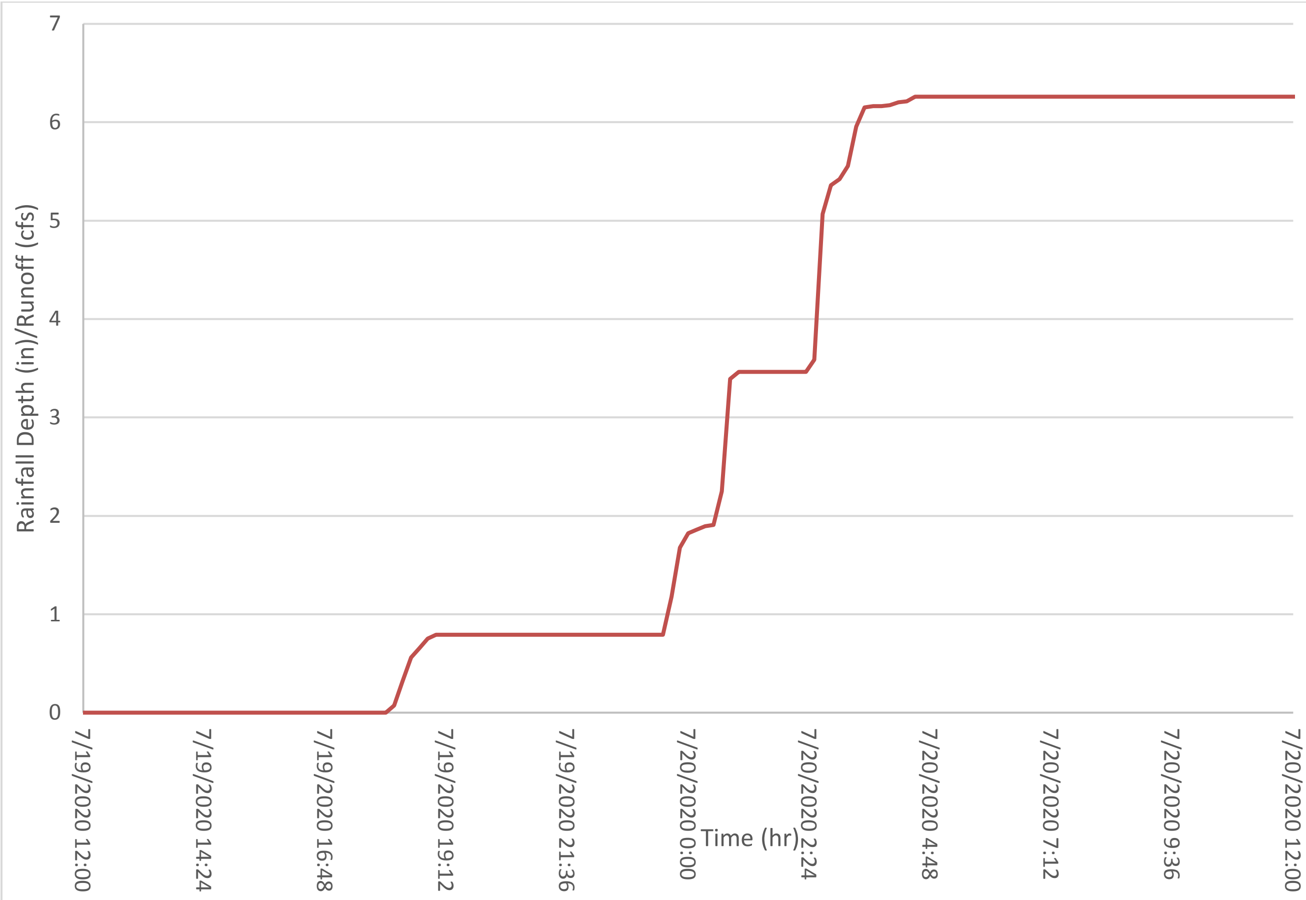
2.3 July 19-20th Storm Event

The nearest rainfall station is the National Weather Service (NWS) office at N2788 County Road FA. This station is not only monitored by the NWS directly, but is the closest station at only 1.2 miles from the center of the watershed draining to Ebner Coulee. The total at this station for the event was 6.26 inches, which occurred over a period of about 10 hours, with the majority occurring within 4 hours. This station only had rainfall depth data, it did not have distribution data. The nearest station that had rainfall distribution data is the La Crosse Municipal Airport, available on Wunderground.com in varying increments ranging from 2-10 minutes. The total at the Airport station is lower, 5.15 inches, so the rainfall distribution obtained adjusted to have the NWS station total of 6.26 inches.

Figure 3 shows the locations of the rainfall stations used.

Figure 4 shows the rainfall cumulative distribution from Wunderground.com with depth obtained from the NWS station.

Figure 4.1 – Cumulative Rainfall Depth at Ebner Coulee – July 19-20th 2017



In hydrologic models, it is typically assumed that rainfall depth does not vary across the watershed. In practice we understand that this is not always the case but that assumptions must be made to simply the model. Since the July 2017 event is so important to the calibration of this model update, additional efforts were undertake to establish the most likely average rainfall depth over the watershed. A review of local rain gages identified 6 other gages within several miles of the watershed that also captures the rain event. A Theisen polygon rainfall distribution analysis was completed using the 7 different rain gages in the surrounding area to determine if using the 6.26 inches was correct or if any other nearby stations should be weighted into the total.

Figure 4.2 shows the Theisen polygons and demonstrates that the watershed to Ebner Coulee is fully within the NWS station area. As such, it can be assumed that the 6.26" of rainfall should be assumed to have fallen uniformly across the entire watershed.

2.4 Hydrologic and Hydraulic Data

Past hydrologic data including SCS Curve Numbers (CN) and Time of Concentration (Tc) was not available. These values were calculated by SEH for the updated modeling. Tc was calculated using TR-55. CN was calculated using aerial photography for land use and USGS Web Soil Survey (WSS) for soil types. CN values were then further adjusted during calibration.

Manning's n value in the effective model were noted for reference, but were changed slightly for the 2D models and final LOMR model. The effective model uses a value of 0.04 for most of the raised channel, based on site visits and the knowledge that the city maintains the manmade raised section of the channel, a value of 0.04 was believed to be too high.

2.5 Topographic and Structure Data

SEH completed topographic surveying of the channel and it's berms in 2019. This survey was used to create a surface of the channel from Farnam Street to the location where the manmade channel transitions back to natural channel (shown in Figure 1), a significant number of breaklines were used to ensure the TIN of this surface is as accurate as possible.

Outside of this area, 2 foot LiDAR available from the County of La Crosse was used; this LiDAR was flown in 2017, the same year as the calibration event.

Storm sewer data was obtained from the City of La Crosse as a GIS shapefile. All main trunk storm sewer pipes had inverts, pipe sizes, and materials. The smaller feeder lines did not have inverts or pipe size. The sizes of these unlabeled pipes was assumed to be 12 inches, and inverts were estimated based on the invert of the main line pipe they tied into and the ground elevation.

The culvert at Farnam Street, the culvert at 29th Street, and the culverts and bridge for the 3320 and 3300 Floral Lane drive ways were all surveyed by SEH in 2019. **Appendix 1** shows the sketches of the structure survey.

Table 1 summarizes the primary data used for this study.

Table 1
Data Summary

Type	Description	Source	File Format	Notes
Pipe Attributes	Diameter, roughness, invert, top of casting, shape, length	City of La Crosse	.shp	SEH modified the shape for direct import to XPSWMM, including adding inverts and sizes to small feeder culverts.
Culvert Attributes	Invert, diameter, sediment fill, material	SEH	CAD Pts	
Drainage Areas	GIS Shapefile	SEH	.shp	Delineated using LiDAR
Hydrology Data	Curve Number, Time of Concentration	SEH		Developed by SEH using TR-55, aerial, WSS
DEM	2 Foot Raster	County of La Crosse	.tif	Used DEM to obtain surface data for all modeling, along with surveyed surface
Channel Topography	.h5, 1 foot raster	SEH	.tif	SEH surveyed, drew breaklines in SMS (.h5), exported as 1 foot raster (.tif)
Effective Channel Cross Sections	HECRAS Cross Sections	FEMA	.G01	Used as Reference

3.0 Hydrology – Ebner Coulee Channel

Due to the raised nature of the channel, hydrology for the channel flows should only be modeled to the top of the raised channel, as below that point no more overland flow would be able to contribute. **Figure 1** shows the location where this transition happens and **Figure 5.1** shows all the watersheds to the Ebner Coulee channel and the nearby storm sewer. **Figure 5.2** shows the soils data within this watershed to the Ebner Coulee channel obtained from WSS.

The contributing drainage area to the raised channel is 0.61 square miles. The area used in the FIS and effective modeling, 0.9 square miles, is incorrect; this is part of why the flows are too high. The area of 0.9 square miles seems to correlate to if the watershed were delineated to Jackson Street where the DFIRM effective model cross-sections end. Previous models either ignored the barrier between the channel and the residential area or the terrain data may not have been a high enough resolution to capture the separation. In this update, better available data allowed for the separation of this section from the contributing watershed.

3.1 Regression Equations

During an early phase of this remapping process, the Regional Regression Equations were run on the watershed to get a better understanding of if the effective flows might be higher than necessary. The equations for Wisconsin were obtained from Report 03–4250 (Walker, 2003). The Regression Equations indicated a peak 100-year flow of **428 cfs** when using the area of 0.9 square miles and a peak flow of **360 cfs** when using the correct area of 0.61 square miles.

According to language provided in FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C, the hydrologic analysis should base the test for significance on the confidence limits, plus or minus one standard error, of the more recent analysis:

"The Mapping Partner performing the hydrologic analysis should base the test for significance on the confidence limits of the more recent analysis. Plus or minus one standard error, which is equivalent to a 68-percent confidence interval, should be used to determine if the effective and new base flood discharges are significantly different. If the effective base flood discharges are within the 68-percent confidence interval (one standard error) of the new base flood discharges, the new estimates are not considered statistically different and there is no need for a new study based only on changes in the flood discharges. If the effective discharges fall outside the 68-percent confidence interval (one standard error) of the new discharges, the estimates are considered significantly different and a new study may be warranted based on changes in the flood discharges."

The effective 100 year peak flow of 1430 cfs is well above the flow calculated in the regression analysis, and also well outside of the 68-percent confidence interval (one standard error); indicating a new study is warranted based on the changes in the flood discharges. See **Appendix 2** for more information on the regression equation analysis.

The WDNR has requested additional hydrologic analysis beyond the regression equations to warrant a change in flow rates and LOMR.

3.2 HMS Model

An HMS model was created using SCS methodology (CN of 55 corresponding to B soils and forest, Tc of 68 minutes) and Atlas 14 rainfall depths. The flow rates produced from this model before any calibration were higher than the regression equations, 523 cfs for the 100-year event with a drainage area of 0.61 square miles, but still significantly lower than the 100-year FIS flows.

3.3 Calibration Based on July 2017 Event

A significant rainfall and flooding event occurred all across southwestern Wisconsin on July 19^{th} and 20^{th} 2017. This is a good calibration event due to the high rainfall depths and intensity. In response to this event, the City conducted two types of surveying.

The City surveyed high water lines in two locations of Ebner Coulee where flooding was most severe. The first was at Floral Lane, where water overtopped the channel due to two of the three culverts under the 3320 Floral Lane address driveway being completely plugged. Hydraulic models indicate that overtopping would have occurred here even if they had been open, but it was made worse by the flow restriction. The second main area of high water line surveying was just upstream of where the channel discharges into the Farnam Street culvert; this flooding occurred due to the grate of that culvert being partially plugged. Note that the HWL survey points were collected in June of 2018, 11 months after the event. Residents went out with City staff to assist with collecting points in the correct locations.

The second type of surveying was a written response survey. This was sent to all the residents in the area and asked a number of questions intended to determine if they had observed any flooding that would indicated whether or not they flooded or observed anything else useful for calibration. **Appendix 3** shows an example of the survey form sent out to residents.

Figure 6.1 shows the surveyed high water line (HWL) points. It also shows a visual representation of how residents responded to the written survey. Red homes indicate they did not have flood damages or observe flooding in their yard or a neighbors. Yellow indicates they did observe flooding in their yard or a neighbors, but did not have damages themselves. Green indicates that they did observe flooding and have damages, but the type of damage is not always specified and may not be damage to the home itself. Unmarked homes indicate no response. This is somewhat subjective and people may have interpreted the questions differently, but it demonstrates that the majority of residents did not experience flooding that reached their homes or caused damage. **Figure 6.2** shows the a zoomed in view of the surveyed HWL points and write in survey responses that were most critical for calibration of the July 2017 event channel flows.

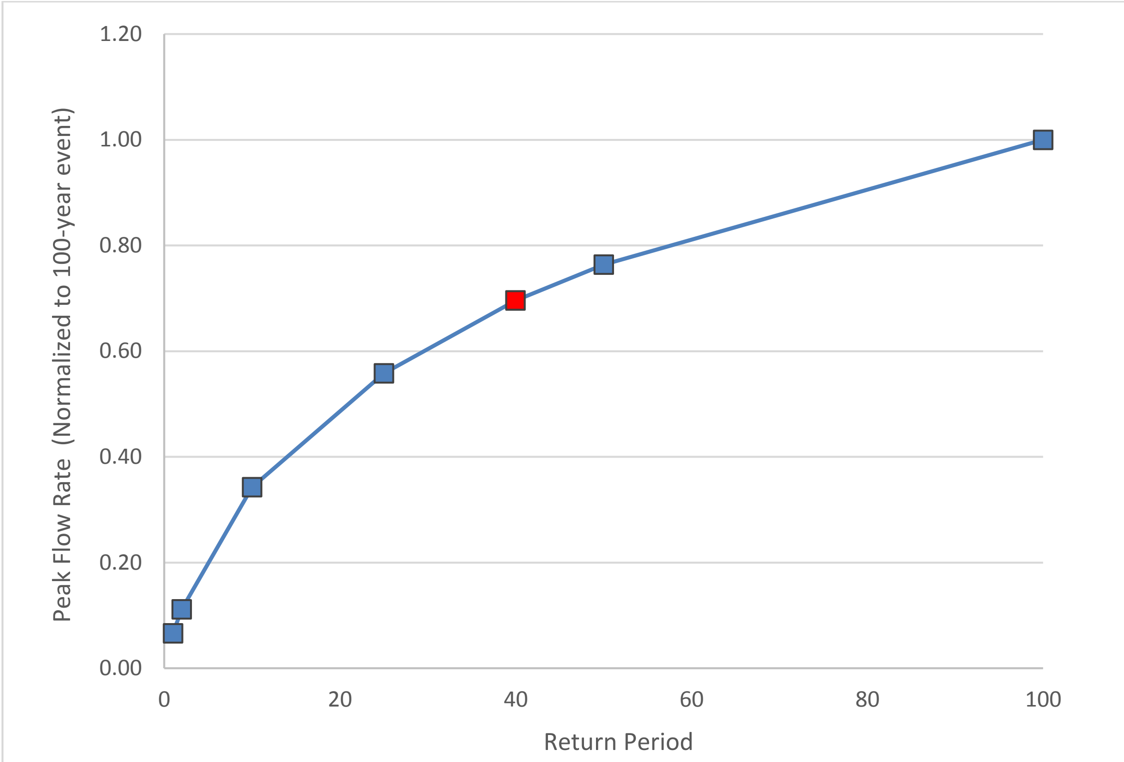
3.3.1 Return Period

A basin in the HMS model was calibrated to output 1431 cfs, matching the FIS 100-year flow when using the MSE3 distribution (no distribution from the old hydrologic modeling was available) and Atlas 14 rainfall depths.

The July 2017 rainfall distribution was put through this model to determine what the peak flow would have been for that event if the 1431 cfs 100-year flow rate was accurate. The peak flow for the 2017 event would have been around 1000 cfs with this method, this flow was modeled through some preliminary hydraulic models and showed a significant amount of homes flooded that did not flood during the event. This indicated the 100-year flows are too high. More details on this can be found in **Appendix 2**, which includes two memos with further details preliminary work done for this study.

Using this calibrated model, the July 2017 event was determined to be approximately a 40-year event. The 2017 event flow out of this model was plotted vs other return periods run with MSE3 distribution and Atlas 14 rainfall depths though the same model. **Figure 7** shows this plot, with the 100-year flow rate normalized to 1.0. The 2017 event peak flow is shown as the red marker.

Figure 7 – Return Period of the July 2017 Event



This plot demonstrates that the 2017 event flows were 70% of what the 100-year flows should be and makes it possible to calculate a calibrated 100-year flow rate if the true flow rate down the Ebner Coulee channel in July 2017 can be obtained.

3.3.2 SRH2D Hydraulic Model Calibration

Due to complex nature of channel and flow, a 2D model is needed to get the most accurate calibration results. The plugged culvert conditions in the Floral Lane area were well documented with photos and can easily be recreated in a hydraulic model, making this an ideal area to calibrate to.

The SRH 2D model extends all the way to Farnam Street from above the 3320 Floral Lane driveway culverts, the same section of channel as in the effective model. The culverts are included in detail. The boundary condition elevations at the Farnam Street culvert outlet were set such that the flood extents matched the surveyed high water marks along 27th Street S. The surface was made of the 2 foot La Crosse County 2017 LiDAR combined with topographic survey of the channel collected by SEH in 2019.

A series of flow rates were put through the model, and the inundation results and elevations were compared to the survey elevations to determine which flow(s) best match the survey. **Figure 8 to 11** show the inundation for flows 200, 300, 400, and 500 cfs in the Floral Lane area along with the surveyed HWL points. These results indicate that 200 cfs seems to be the lowest flow that could make sense with those calibration results. The points are close to the border, with a few barely inundated and a few further from being inundated. 400 cfs seems to be the highest flow that would make sense, all the points appear to be inundated. 500 cfs appears to be clearly too high, all the high water points are under water and there is overtopping and significant flooding at 739 Cliffwood Ln, these residents did not indicate their home flooded as shown in the 500 cfs results. All modeled flows inundated the points taken near the 3320 Floral Lane driveway culverts, as such those points were not used to calibrate the models further.

Figures 12.1 and 12.2 shows the elevations surveyed compared to water surface elevations of various flows at those points. This plot also makes it clear that several points may have been taken slightly within or outside the flood line. This figure demonstrates that the 300 to 400 cfs flows are at or above most points, and 500 and above is above all of them. 200 cfs is a better balance of above and below the survey elevations. **Table 2** shows the inundation results compared to the survey elevations.

Table 2 – SRH2D Water Surface Elevations (WSELs) (ft)

		SRH2D Peak WSELs at Various Flows			
Survey Point	HWL (Survey)	200 cfs	300 cfs	400 cfs	500 cfs
3	687.01	687.14	687.29	687.39	687.49
4	686.95	687.03	687.17	687.28	687.38
5	687.27	686.98	687.15	687.27	687.38
6	686.51	686.69	686.81	686.89	686.97
7	685.73	686.15	686.32	686.43	686.53
8	685.4	686.2	685.29	685.39	685.48
9	683.96	684.81	685.02	685.15	685.26
10	683.94	684.09	684.23	684.29	684.34

Based on the elevations and inundation results, the 2017 event must have been within the range of 200-400 cfs; this range is higher than would be ideal, so to narrow down the 2017 flow further, the 2D model results were looked at near the 29th Street Culvert. **Figure 6.2** shows a zoomed in version of the survey figure. 605 Cliffwood indicated that they did see evidence of water flowing in their yard or a neighbor's yard. However, 617 Cliffwood specifically replied that there was no water in their yard or street. There definitely was water in the street, so this comment can only be trusted so much, but it makes it clear they didn't have flood damage to their home. 608 Cliffwood and 621 28th St answered no to survey question 1 and 3, indicating they didn't have flood damage or evidence of flooding in their yard.

Additionally, the City commented that the channel did overtop just upstream of the 29th Street culvert on the south side. There was a low spot in the berm here due to pedestrian traffic, shown in **Figure 6.2**. That low spot is present in the 2017 LiDAR and was included in the calibration version of the SRH2D model. The City has repaired this low spot, the repair is included in the version of the model used to obtain the 100-year overtopping flows.

Figure 13 to 16 show the SRH2D results at this location for 275, 300, 325, and 375 cfs. The 375 cfs model results show a significant amount of flooding in the yards, but not quite reaching the homes, of 608 Cliffwood, 617 Cliffwood, and 621 28th Street, all of whom indicated they did not have flooding; this suggests that the true flow is not at the upper end of the 200-400 cfs range. The 325 cfs model results still show a fair amount of flow through the yard of 608 cliffwood and 621 28th, near the homes but not touching them. The 300 cfs model results show just a small amount of flow in their yard, which could have potentially been enough to be missed or not leave significant evidence in the form of debris or flattened grass. The 275 cfs model results do not show water in the yard of 608 Cliffwood and may be accurate, but could potentially be too low.

A sensitivity analysis on the outlet condition at Farnam Street was completed by also setting it to have free discharge or an unblocked grate; this had no impact on the overtopping flows in the 29th Street area, demonstrating that the blockage affected local water surface elevations near 27th Street, but did not impact overtopping of the channel further upstream.

Based on the above analysis, 300 cfs appears to be the most appropriate and realistic flow down the Ebner Coulee channel during the 2017 event.

3.3.3 HMS Model Calibration

The HMS model was adjusted to match this calibrated peak for the July 2017 rainfall distribution. The original CN value of 55 chosen for the forested watershed with B soils was reduced to 50 to achieve the peak of 300 cfs.

3.3.4 100-year Flow in Ebner Coulee Raised Channel

Based on the 2017 event calibration, the 40-year flow rate down the raised portion of the Ebner Coulee Channel is 300 cfs. As indicated in **Figure 7**, the 40-year flow for this watershed is 0.70 of the 100-year flow. Therefore, the calibrated 100-year flow is 300/0.70, or 429 cfs.

100-year Calibrated Flow: 429 cfs

An alternate way to obtain the 100-year peak flow from this calibration would have been to run the Atlas 14 100-year event through the HMS model that was calibrated to the 2017 event. This was done as a check, and the peak flow was around 400 cfs for the 100-year event, less than the 429 cfs peak obtained with the ratio adjustment method described above. The more conservative method was used, making the 100-year peak 429 cfs; therefore, the HMS model had to be calibrated again. Moving the CN values back up to 51.3 results in a 100-year peak flow of 429 cfs when using the MSE3 distribution and Atlas 14 rainfall depth. This is only a 7% reduction in CN from the originally estimated value of 55.

4.0 Hydrology – Floodplain Side Flows

Figure 1 demonstrates the section of Ebner Coulee that is raised where no additional flow area would contribute to it, and it shows the storm sewer system. The storm sewer drains these low areas and is the only outlet of a number of low spots. Modeling the storm sewer is the most accurate way to model what happens to flows that overtop the Ebner Coulee channel, and without accounting for it water will pond in an unrealistic way. Additionally, the area south of Farnam Street has no open channel and is fully urban area served by storm sewer.

Watersheds were delineated to main junctions of the storm sewer, **Figure 5.2** shows a closer view of the urban watersheds and sections of City Storm Sewer that were included in the model. Curve number (CN) for the watershed was estimated using the aerial photography and USGS Web Soil Survey (WSS) soils data. The majority of the area was classified as B soils, but further west, soils were just classified as "Urban Land, Valley Trains" and did not include a hydrologic soil group; these areas were also assumed to be B soils like the adjacent area that was classified. Flows were added directly to pipes, so flooding will only occur if they surcharge; this tests pipe capacity initially, with inlet capacity coming in to play for surcharged flows and flows that overtop the Ebner Coulee channel. Time of concentration (Tc) was calculated using TR-55 for each watershed north of Farnam. For the watersheds south of Farnam, the values were estimated by comparing area, slope, and flow path length to similar watersheds that had Tc calculated individually. The only pipe not fully included is the 60" pipe that enters from the west on Farnam; the hydrology for this pipe was approximate and was such that the pipe would flow full.

4.1.1.1 2D Hydraulics – Ebner Coulee Channel

The SRH2D model used for calibration was also used to determine the overtopping hydrographs out of the channel for the 100-year MSE3 Atlas 14 event. This model is the most accurate way to model overtopping and was used to inform and validate the final 1D model. 2D models can better represent the complex flow patterns that would occur in this area.

Several boundary conditions were checked at the Farnam Street culvert as a sensitivity analysis. The boundary condition was set such that free discharge was achieved, and it was set such that elevations at the culvert would be similar to the current FIS, which, given the much lower flow rate, would simulate a blocked culvert condition like what occurred in 2017. These differing boundary conditions had no impact on the amount of flow that overtops the channel upstream from the 90 degree bend.

5.0 2D Hydraulics – Floodplain and Areas Drained by Storm Sewer

A 1D/2D XPSWMM model was made to map the floodplain in the overbank/floodplain areas. This model will be used to inform the fully 1D HEC-RAS model submitted to FEMA, it will also be used to provide supplemental mapping for the City to use.

All storm pipe available in the city storm database was added to the model. Most small "feeder" pipes connecting catch basins to the main line did not have diameters or inverts. Inverts were estimated and diameters were assumed to be 12"; this should not have a significant impact on the results and is the most conservative way to estimate the properties of these pipes.

Flows (via SCS hydrology as described in **Section 4**) were added directly to the pipes at major junctions and at the beginning of new lines. This modeling technique assumes inlet capacity will not control and instead tests the capacity of the pipes themselves, any lack of capacity for a given event will result in flooding via surcharging.

The overtopping flow hydrographs obtained from the SRH2D model of the channel were added at their corresponding locations, rather than let XPSWMM model the channel flow. This was done for both the July 2017 event and the calibrated 100-year event.

All catch basins were included in the model, even if they did not have flow directly added to them; this allows for overland flows from the channel as well as any water that surcharges out of the pipes due to capacity to fully interact and be “drained” back into the storm sewer in a realistic manor.

5.1 Calibration

The XPSWMM model was calibrated to the 2017 event primarily by using the written survey responses received from the residents. Additionally, one of the comments and a high water mark survey point provided a good estimation of flood elevation at the intersection of 28th Street and Blackhawk Place.

Using the initial CN and Tc values, inundation was too high and inundated a number of homes that definitely did not flood during that event. Tc was adjusted by using the max length allowed for sheet flow, 300 feet, rather than the more conservative initial estimate of 150 feet. CN was reduced by 22%, this happened to move the values from being those associated with B soils, to be more in line with values typically associated with A soils.

Special Considerations:

- The rating curve at the Farnam St Culvert was set such that it approximates the blocked culvert for the 2017 event. For the 100-year and 500-year events, the culvert grate was modeled as being unblocked.
- There are several areas where flooding occurs higher up in the watershed due to small ravines discharging out of the bluffs and storm sewer surcharge. While these areas are not appropriate to map in the final FEMA LOMR because they are the result of “tributaries” rather than Ebner Coulee flooding, they can still inform the City about flood risk.

5.2 Results

After calibration, the 100-year Atlas 14 event was modeled in addition to the July 2017 event. **Figures 17.1/17.2, 18.1/18.2, 19.1/19.2** show the 2D model inundation results for the 2017 calibrated event, the 100-year event, and the 500-year event, respectively. The channel flow and overtopping portion of the inundation maps were developed from the SRH2D results, and the inundation outside of the Ebner Coulee channel was developed from the XPSWMM results. **Figures 18.3/18.4 and 19.3/19.4** show the depth results for the 100-year and 500-year flooding, developed from the XPSWMM model.

6.0 1D Hydraulics – Final Mapping

6.1 Critical Changes from Previous Study

There are a number of critical changes between the FEMA approved flood insurance study (effective date of January 6, 2012) and the updated study involving SRH2D, XPSWMM, and HEC-RAS.

The previous study input peak discharge rates developed from the Bureau of Public Roads method. These were added to a 1D HEC-RAS model updated in 2010 (effective in 2012) consisting of two channels, one for the main channel and one for overtopped flows running down 28th Street.

In contrast, the updated study uses hydrology information based on the currently accepted SCS hydrologic methodology, Atlas 14 rainfall depths, and MSE3 distribution, all calibrated to the July 2017 event. Final hydraulics to be submitted for the LOMR use a 1D unsteady HEC-RAS model that has been fully updated with new cross-sections and topographic data.

The SRH2D and XPSWMM model developed highly influence the calibration and flow inputs of the final 1D model as described in sections above. The dynamic methodology in the XPSWMM model allows the effect of storage and backwater in conduits and the timing of the hydrograph to yield a more accurate representation of the water surface profile. SRH2D is the most accurate method to model a narrow open channel containing culverts and bridges such as this and provides the most accurate information on overtopping flows. The significant changes are summarized below:

- Topology data updated based on current LiDAR and survey
- Storm sewer system modeled accurately in XPSWMM
- Accurate representation of storage included in XPSWMM model
- Pressure flow within storm sewer included in XPSWMM model
- SRH2D used to calibrate flow in Ebner Coulee channel based on July 2017 event
- SRH2D model used to estimate more accurate overtopping flow rates and volumes
- 1D cross-sections in main 1D Ebner Coulee channel updated, different intermediate cross-sections added
- Overflow 1D channel running down 28th Street updated with new and additional intermediate cross-sections. Outlet boundary of the low spot at the intersection of 28th Street and Blackhawk Place added based on XPSWMM model to result in the correct ponding elevations.
- Area south of Farnam Street (Pool 7) included in the model as a level pool
- Area at intersection of Floral Lane and 28th/29th Streets (Pool 1), a level pool storage area was created as this section is essentially hydraulically disconnected from the Ebner Coulee channel, aside from taking some overtopped flow.
- A rating curve was developed using HydroCAD for the grate at the channel outlet and incorporated into the 1D model.
- Unsteady HEC-RAS allows for a volumetric model that accounts for the storage of flood waters within the flood fringe areas.

6.2 Model Layout and Geometric Data

This analysis includes Ebner Coulee in the City of La Crosse, WI. The HEC-RAS model project extends approximately 4,500 feet upstream from Farnam Street. South of Farnam Street, between it and Highway 33, a level pool analysis was used as the final method for LOMR mapping since the area is drained solely by City stormsewer and has no open channel flow. Similarly, the area north of Ebner Coulee, along Floral Lane, and the railroad corridor east of Ebner Coulee were modeled as level pools since they have no outflow other than City storm sewer.

Figure 20 shows the layout of the updated HEC-RAS model cross-sections and geometry, as well as their names for referencing the tables. It also shows the areas modeled with level pool/storage.

6.3 Special Modeling Considerations

The culvert entrance to the 8x10 foot box culvert at Farnam Street is covered by a grate at roughly 45 degrees, see **Photo 1** included in **Appendix 4**. The outlet rating curve for the 1D model was developed using HydroCAD as a sharp crested rectangular weir, with the approximate open area between the slats estimated from photos and survey. There is approximately 7 feet of fall on the other side of this grate down to reach the invert of the box culvert, so the flow over the grate should function similarly to weir flow. In 2017 the culvert became plugged, resulting in more flooding towards 27th Street. The plugged condition was not represented in the final 100-year LOMR mapping.

The 1D HEC-RAS model used optimized lateral structures to estimate the overtopping that occurs near the 29th Street culvert. These overtopping flows were compared to the SRH2D model and are similar.

The culverts at the 3320 Floral Lane driveway crossing were assumed to be half full of sediment, based on the 2019 field visit. The culvert at 29th Street had it sediment depth set to approximately 5.2 feet based on the 2019 survey; this elevation is in line with the channel bottom, and there is no evidence that this culvert scours out significantly during large events. It is nearly the width of the channel, so flow contraction and expansion through the culvert would be minimal.

Photo 2 shows the channel upstream of the 29th Street culvert in August, demonstrating an un-mowed condition. **Photos 3** shows the channel downstream of the 29th Street culvert December, showing a recently mowed condition. The grass grows to around 2 feet tall when not mowed, but would flatten during a flood event.

Regarding the "Yes" response to Section D.1. of MT2 Form 2, the BFE raise only occurs within the drainage channel itself on the downstream end due to differing outlet boundary conditions and likely erroneously low flows in the channel in the effective model, pond and pool elevations are lowered compared to the effective mapping.

When Ebner Coulee overtops its banks and floods into the surrounding neighborhoods. The flow channelizes on 28th St. and flows south towards Farnam St. While the main channel of Ebner Coulee flows into the culvert entrance described above, this overflow route does not reconnect with the main channel and pools in the low lying areas surrounding 28th St. The only outlet for the water is to slowly drain through the City's storm sewer leaving the downstream reach of the overflow area a level pool during large flood events. To accurately model this, Farnam St. has been included in the model as a dam with an outlet rating curve that has been calibrated to match the modeled stormsewer capacities. It should be noted that there are cross-sections shown downstream of the dam, however those were included solely to provide continuity in the model and only carry the pilot channel flows. During floodplain mapping, the cross-section downstream of Farnam St. were disregarded and the floodplains located there were mapped as a storage area using level pool routing methodologies.

7.0 Study Results

7.1 Revised Flood Boundary Results

The revised water surface profile for Ebner Coulee were computed by the HEC-HMS and HEC-RAS models for the 100-year 24-hour storm. The 1% and 0.2% floodplains were mapped using CivilGEO's GeoHEC-RAS tools and the surface data. See the LOMR Application for the updated Annotated FIRM, Work Map, and tables for the 1% annual chance discharge comparison and the 100 –year floodplain and floodway water surface elevation comparisons.

Figure 21.1 and 21.2 show the new SEH 100-year Special Flood Hazard Area (SFHA) mapping and structures that would most likely be removed from the 100-year floodplain, but the bank or loan holder will be the ultimate decider of who is removed. SEH does not have a complete list of homes currently required to pay flood insurance, and a number of additional homes not shown in this figure may be able to be removed or may be able to receive reduced rates for flood insurance due to lower elevations.

7.1.1 Floodway Delineation

Per NR116.08(d) *Floodway Determinations: The hydraulic floodway lines shall be determined from the limits of effective flow based on the calculated regional flood water surface profile. Transitions shall take into account obstruction to flow such as road approach grades, bridges, or natural restrictions. General guidelines for transitions may be found in "HEC−2, Water Surface Profiles−User's Manual, appendix IV, Application of HEC−2 Bridge Routine" published by the Hydrologic Engineering Center, Davis, California. All areas of the floodplain including overbank areas that can be assumed to convey flood waters shall be included in the hydraulic floodway.*

In accordance with this rule, the floodway delineation presented here is limited to the main channels of the floodplain that is actively conveying water. In a conversation with Chris Olds, Wisconsin State Floodplain Engineer, on June 26th 2020, it was agreed that the floodway delineations for the unsteady 1D model will still use this methodology for the floodway delineation. A sensitivity analysis of the flood fringe areas was completed by SEH where an encroachment analysis was completed showing the flood fringe areas along 28th St being completely filled and not causing an increase to the BFE. This further proves that this area's flood storage is negligible and may be regulated at normal flood fringe without the need for compensatory storage. All other areas where a floodway has not been delineated and is modeled as a level pool will be required to monitor development for compensatory storage requirements so that future development does not increase the BFE.

7.1.2 Flood Storage Districts

As noted above, the level pool area at the downstream end of 28th St, starting at the south edge of Bluffview Park, will be regulated as a flood storage district with no floodway. Once flow reaches this location the velocities drop to near 0 fps and water is stored as it would be in a shallow lake. Maintaining the available flood storage volume to maintain the BFE is essential. All development within this area will be held to strict compensatory storage requirement to maintain the BFE.

Similarly, the areas north of Ebner Coulee, south of Farnam St, and west of the Ebner Coulee ditch were also modeled as level pools due to the lack defined channels and downstream outlets. For this reason, these areas will also continue to be regulated as flood storage districts.

References

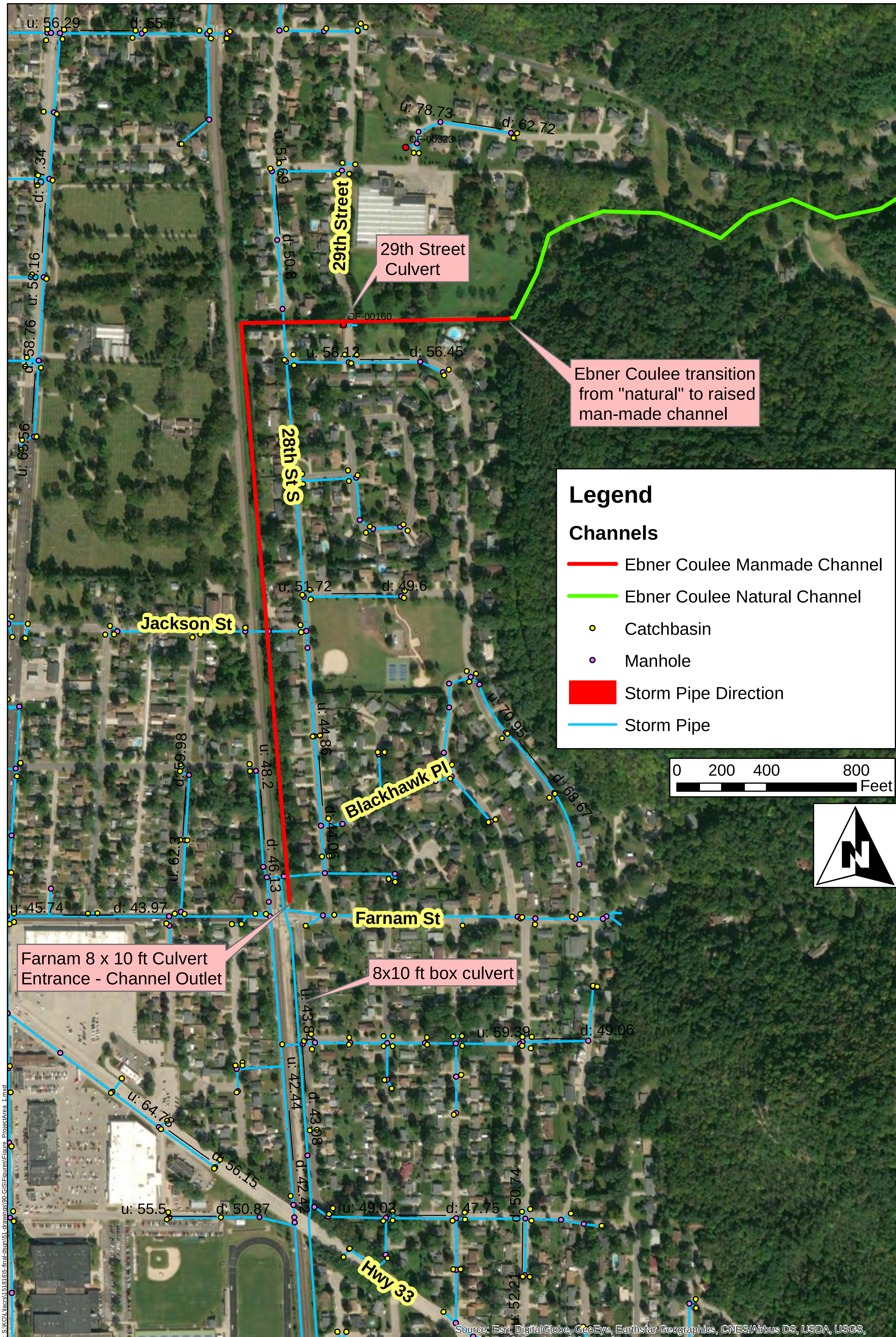
Federal Emergency Management Agency. (2012). *Flood Insurance Study, La Crosse County, Wisconsin and Incorporated Areas No. 55063CV001B.* La Crosse, WI.

U.S. Geological Survey. (1994). *Letter from the USGS to the Wisconsin DNR regarding the hydrologic analysis of Ebner Coulee at La Crosse, Wisconsin.*

J.F. Walker, W.R. Krug, U.S. Geological Survey, U.S. Department of the Interior. (2003). *Water-Resources Investigations Report 03–4250 "Flood-Frequency Characteristics of Wisconsin Streams"*

Federal Emergency Management Agency. (2009). *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C – Guidance for Riverine Flooding Analyses and Mapping.*

List of Figures



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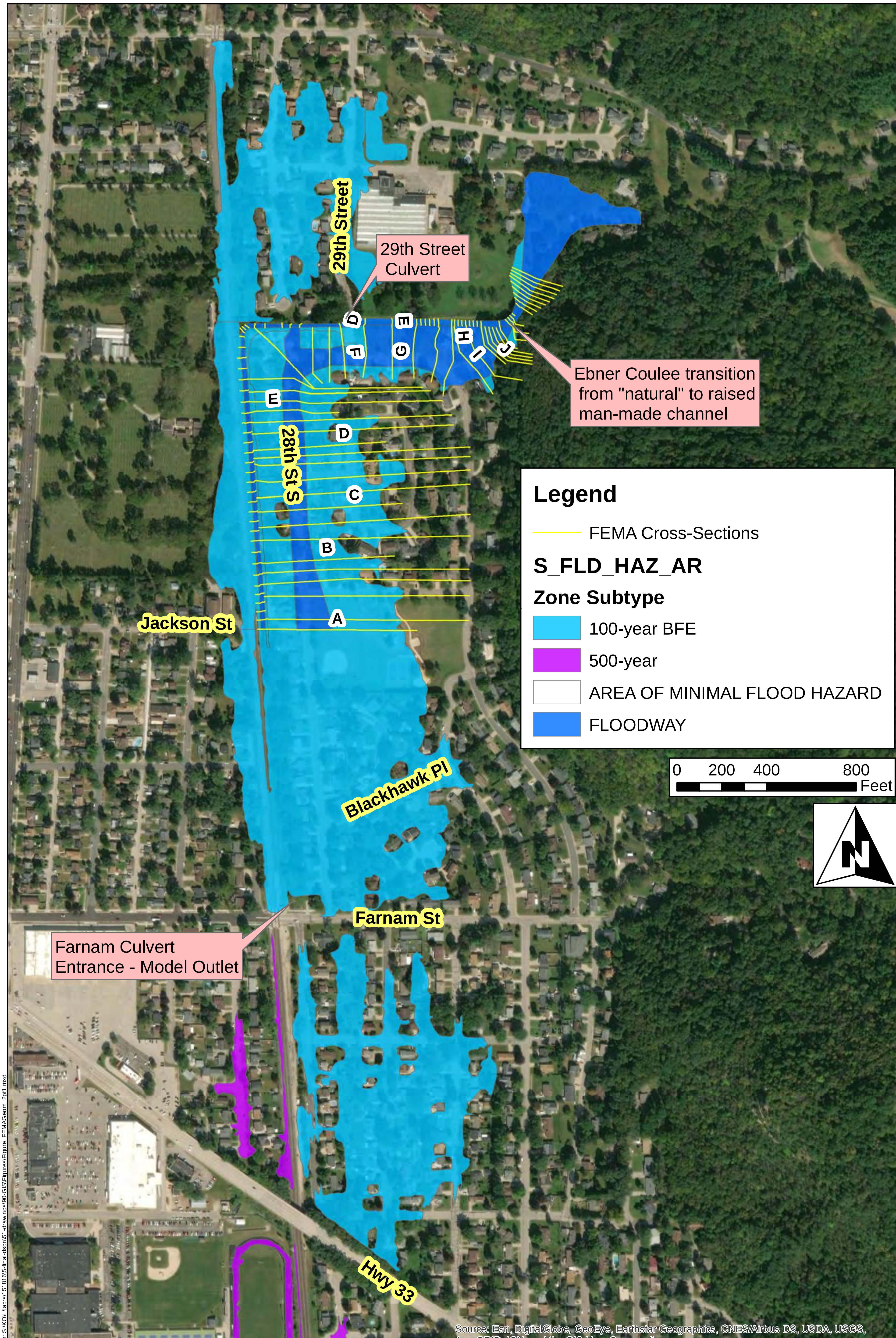
Project: LACRS 151816
Print Date: 2/17/2020

Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

Project Area & Critical Features

Ebner Coulee Flood Study
La Crosse, WI

Figure 1



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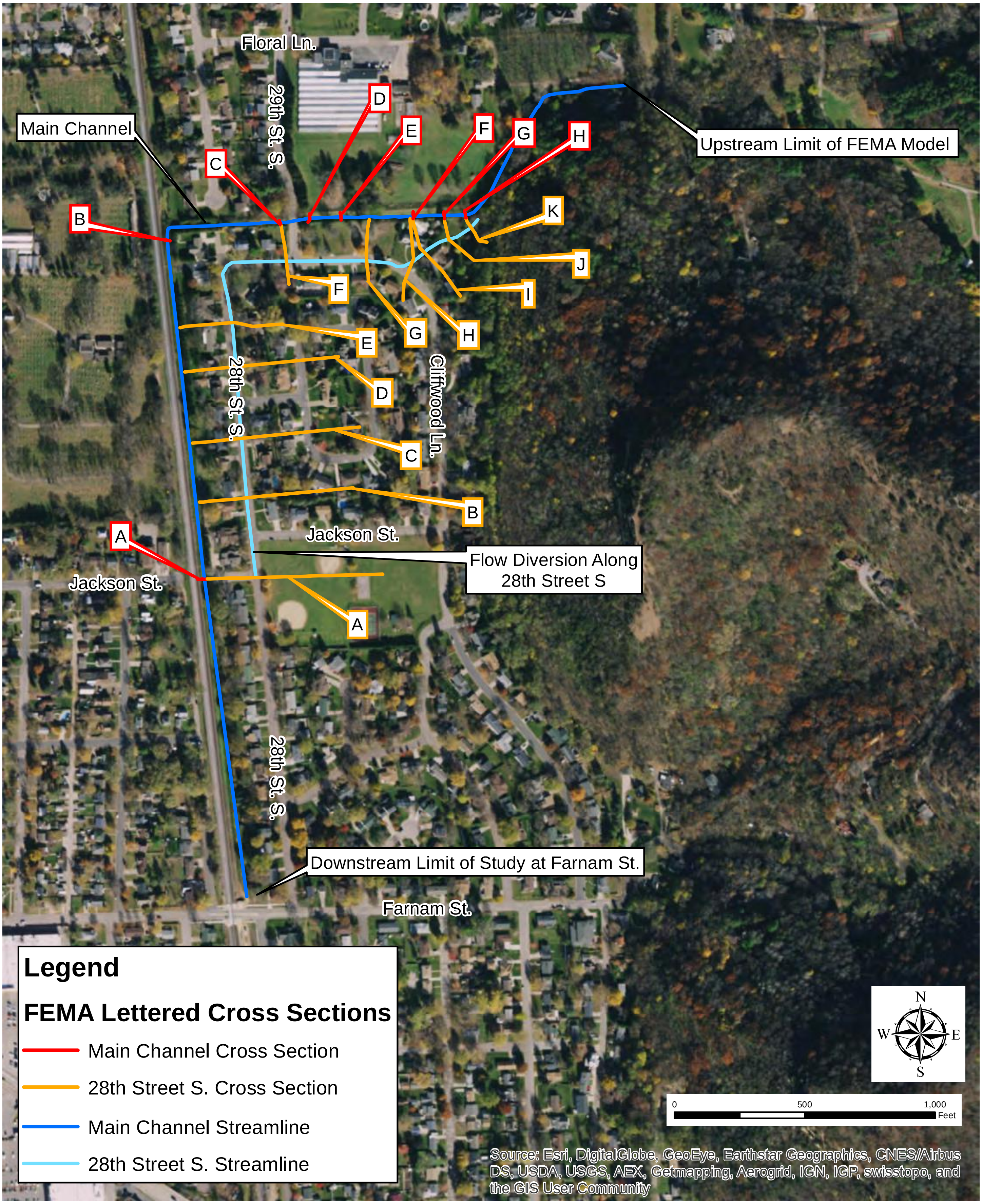
FEMA Effective XSs and Mapping

Ebner Coulee Flood Study
La Crosse, WI

Figure 2.1



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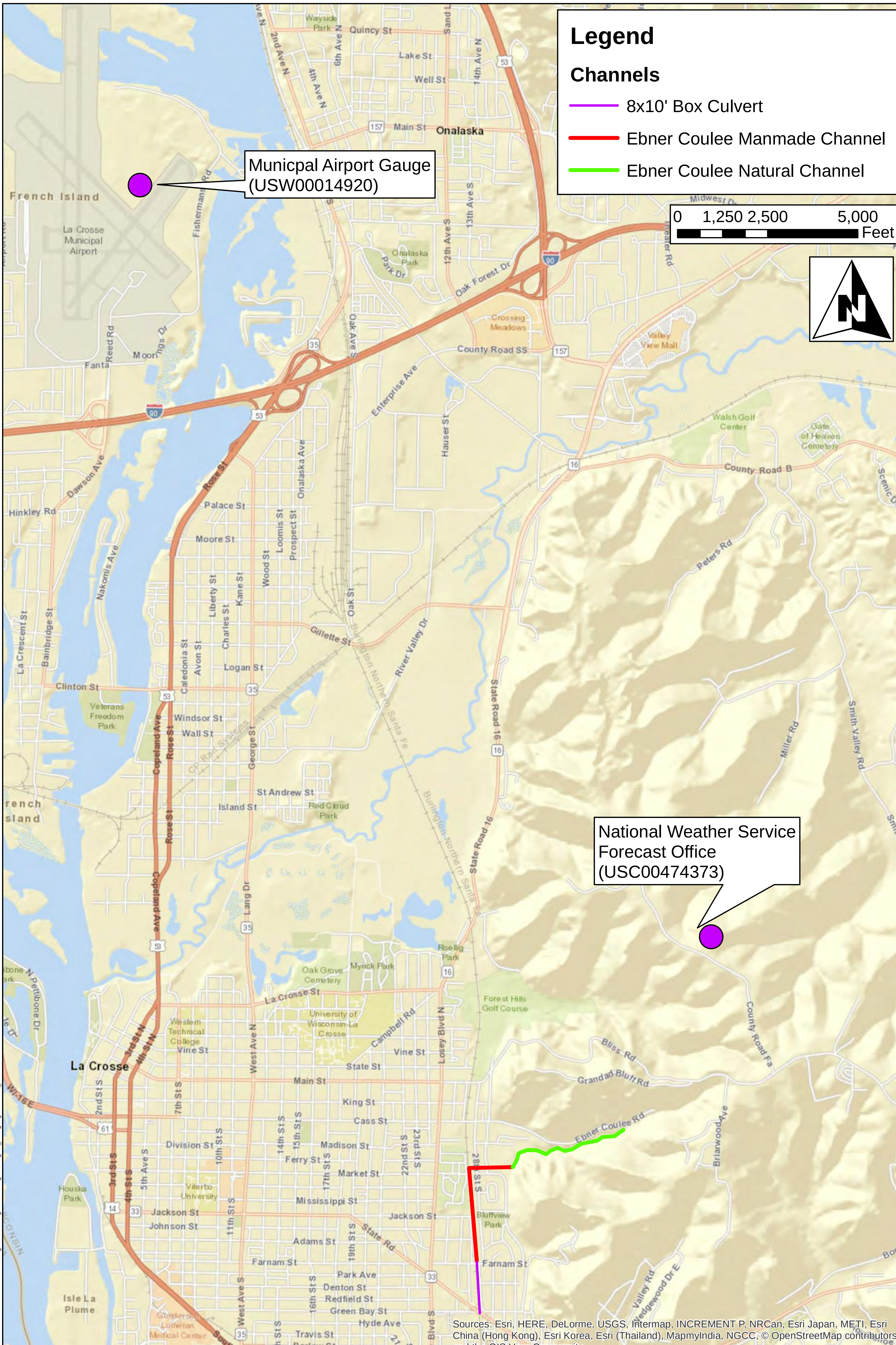
Project Number: 142540
Print Date: 8/22/2017

Map by: rpichelmann
Projection: NAD1983 StatePlane WI South
Source: ESRI, FEMA & SEH

EBNER COULEE FLOODWAY FIRM REMAPPING
La Crosse, WI

FIGURE 2.2
System Overview



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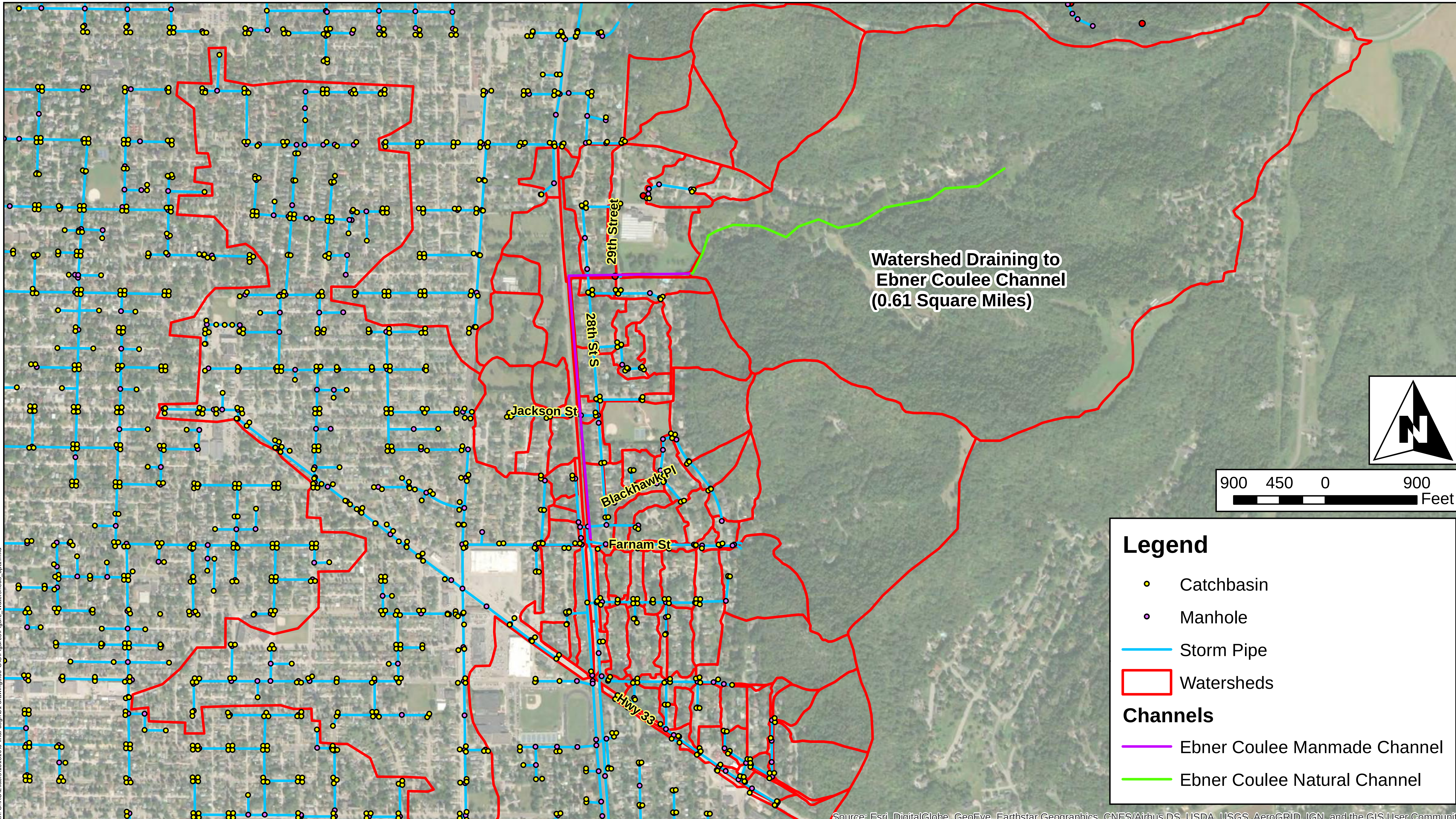
Weather Station Locations

Ebner Coulee Flood Study

La Crosse, WI

Figure 3



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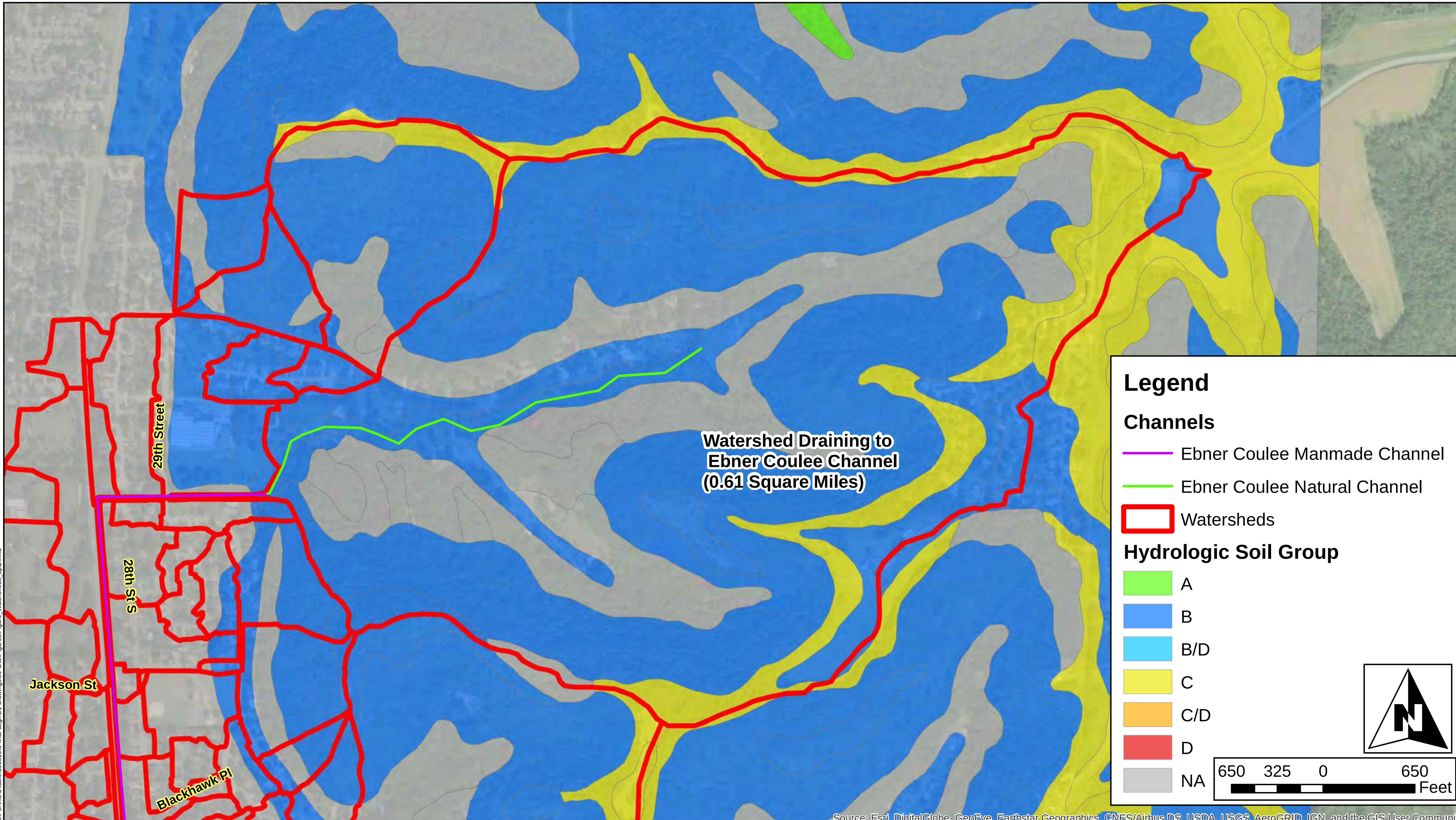
Watersheds - Entire Project Area

Ebner Coulee Flood Study
La Crosse, WI

Figure 5.1



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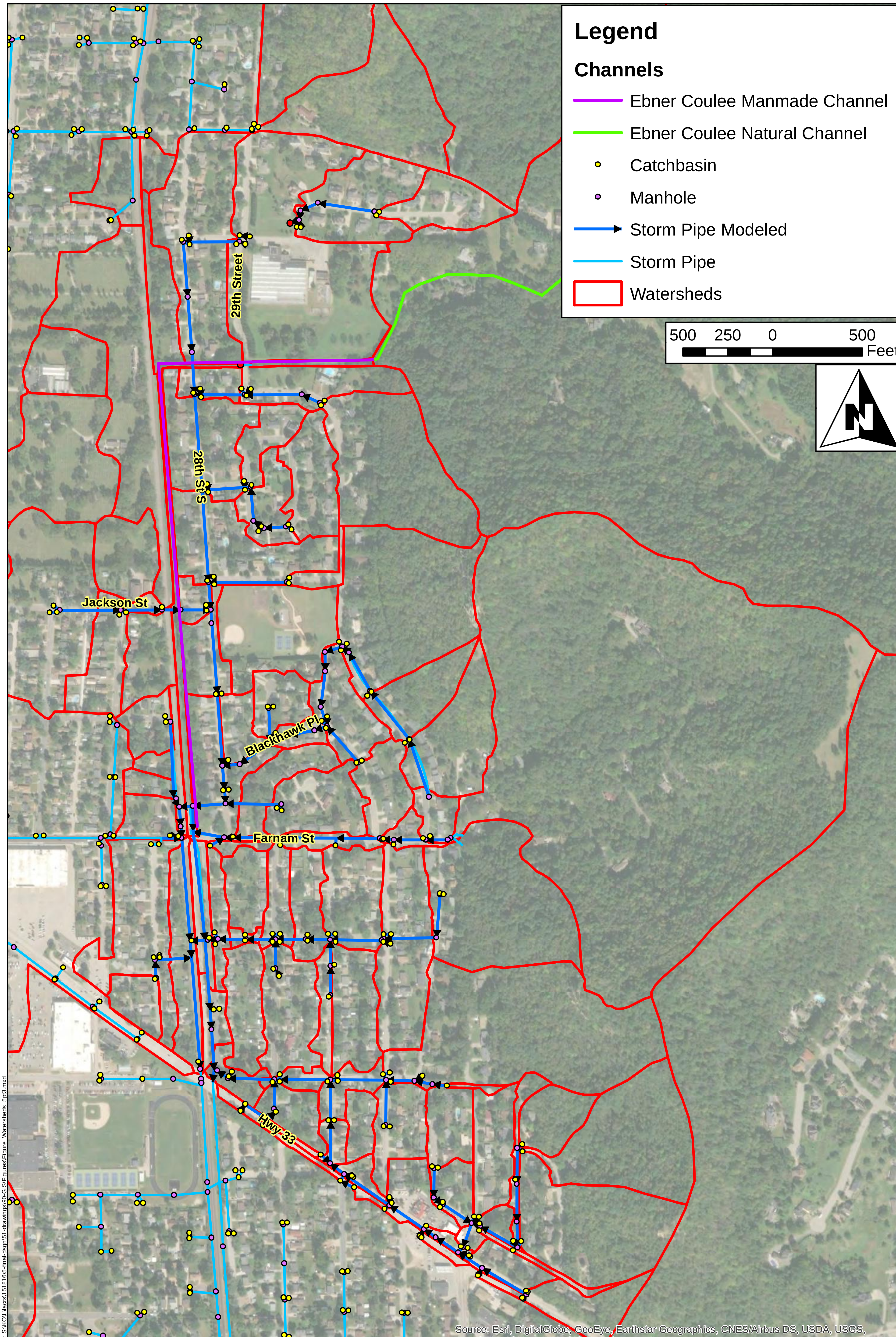
Watershed to Ebner Coulee Raised Channel - Web Soil Survey Data

Ebner Coulee Flood Study
La Crosse, WI

Figure 5.2



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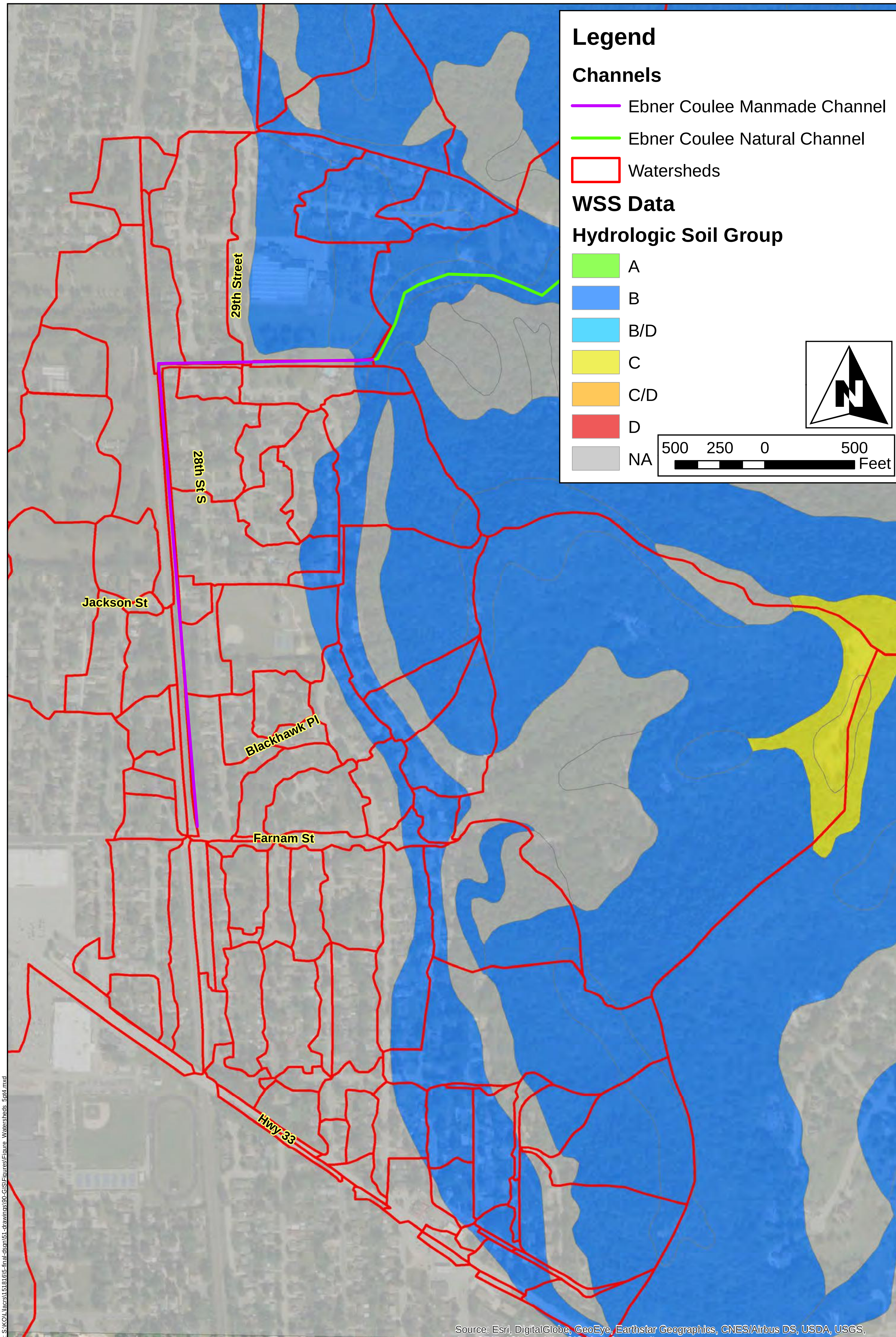
Watersheds - Urban Areas
Ebner Coulee Flood Study
La Crosse, WI

Figure 5.3



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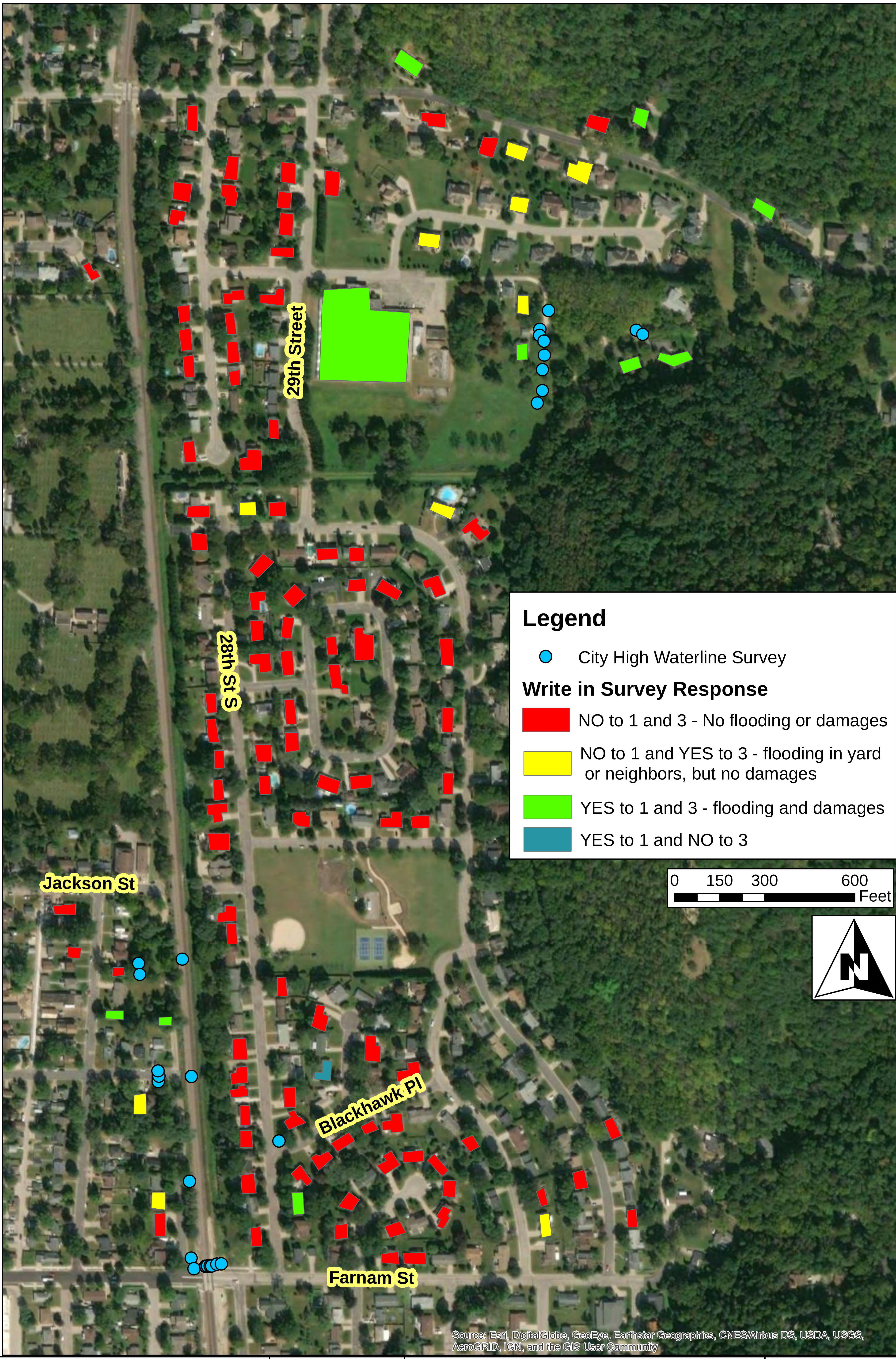
Urban Area Watersheds
Web Soil Survey Data
Ebner Coulee Flood Study
La Crosse, WI

Figure 5.4



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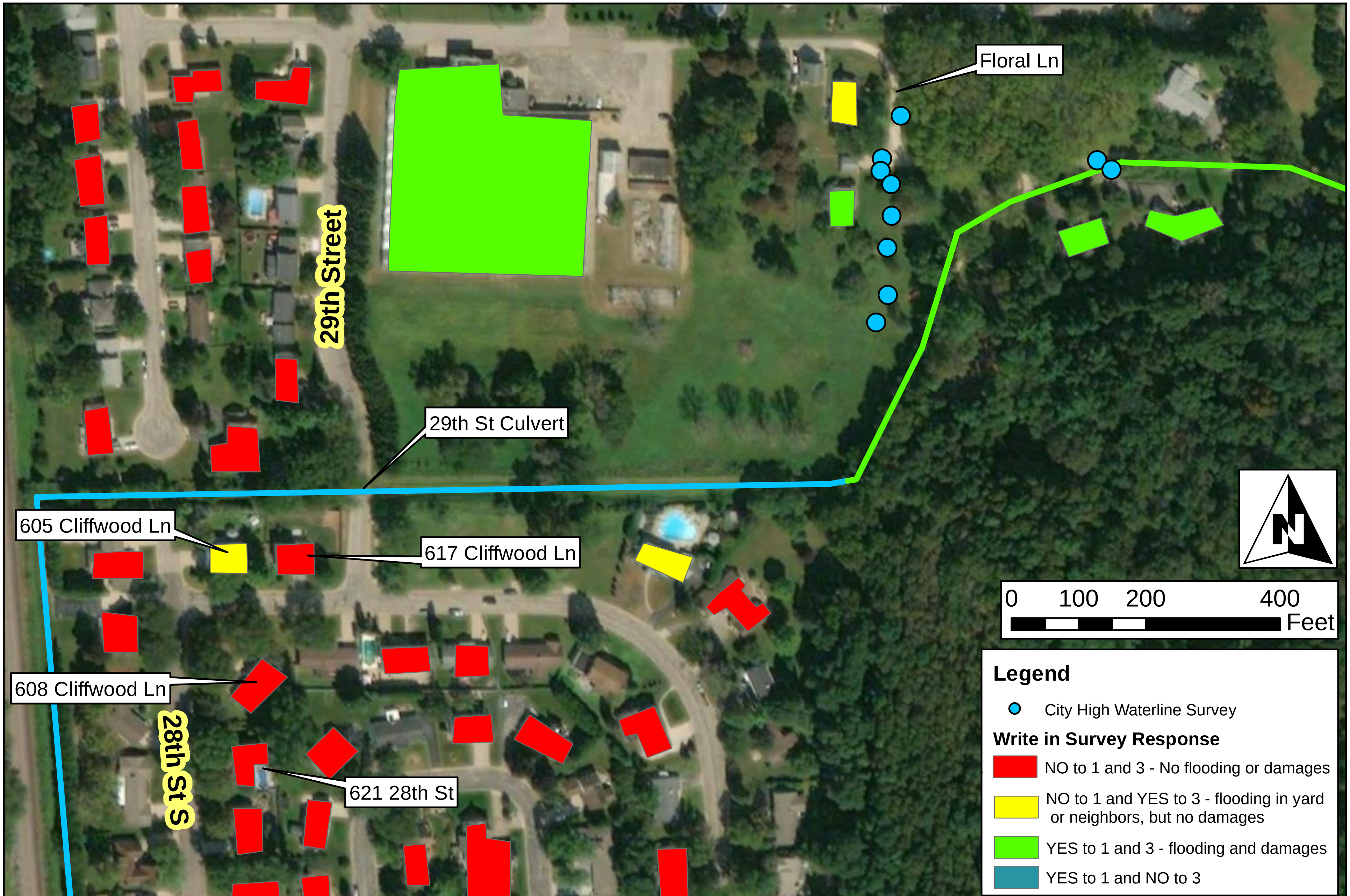
Survey of 2017 Flood Event
Ebner Coulee Flood Study
La Crosse, WI

Figure 6.1



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Source: ESRI, SEH

Survey of 2017 Flood Event - Floral Ln and 29th St Area

Ebner Coulee Flood Study
La Crosse, WI

Figure 6.2

Figure 8 – SRH2D Inundation at Floral Lane – 200 cfs

Figure 9 – SRH2D Inundation at Floral Lane – 300 cfs

Figure 10 – SRH2D Inundation at Floral Lane – 400 cfs

Figure 11 – SRH2D Inundation at Floral Lane – 500 cfs

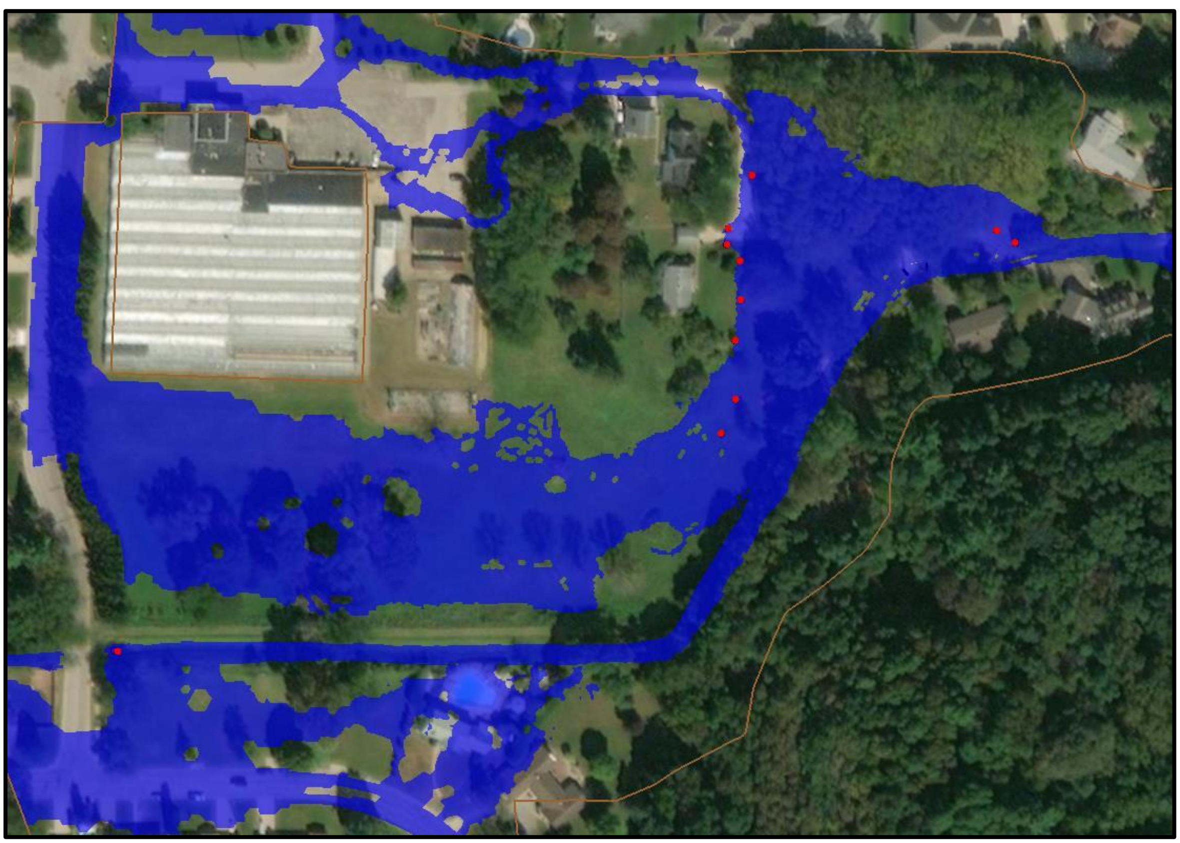


Figure 12.1 – Water Surface Elevations (WSELs) Compared to Survey Elevations

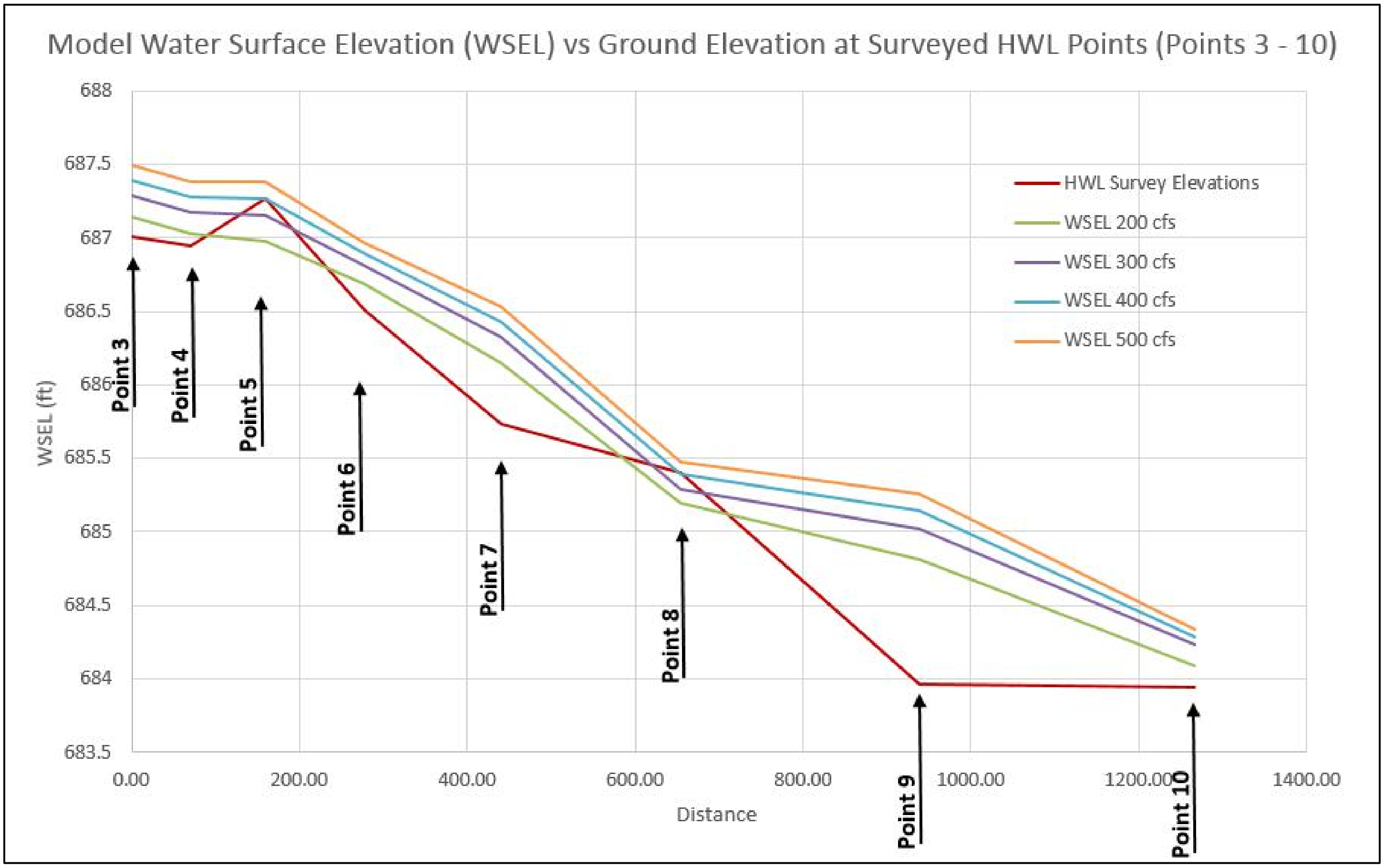


Figure 12.2 – HWL Point Locations with Numbers for Reference

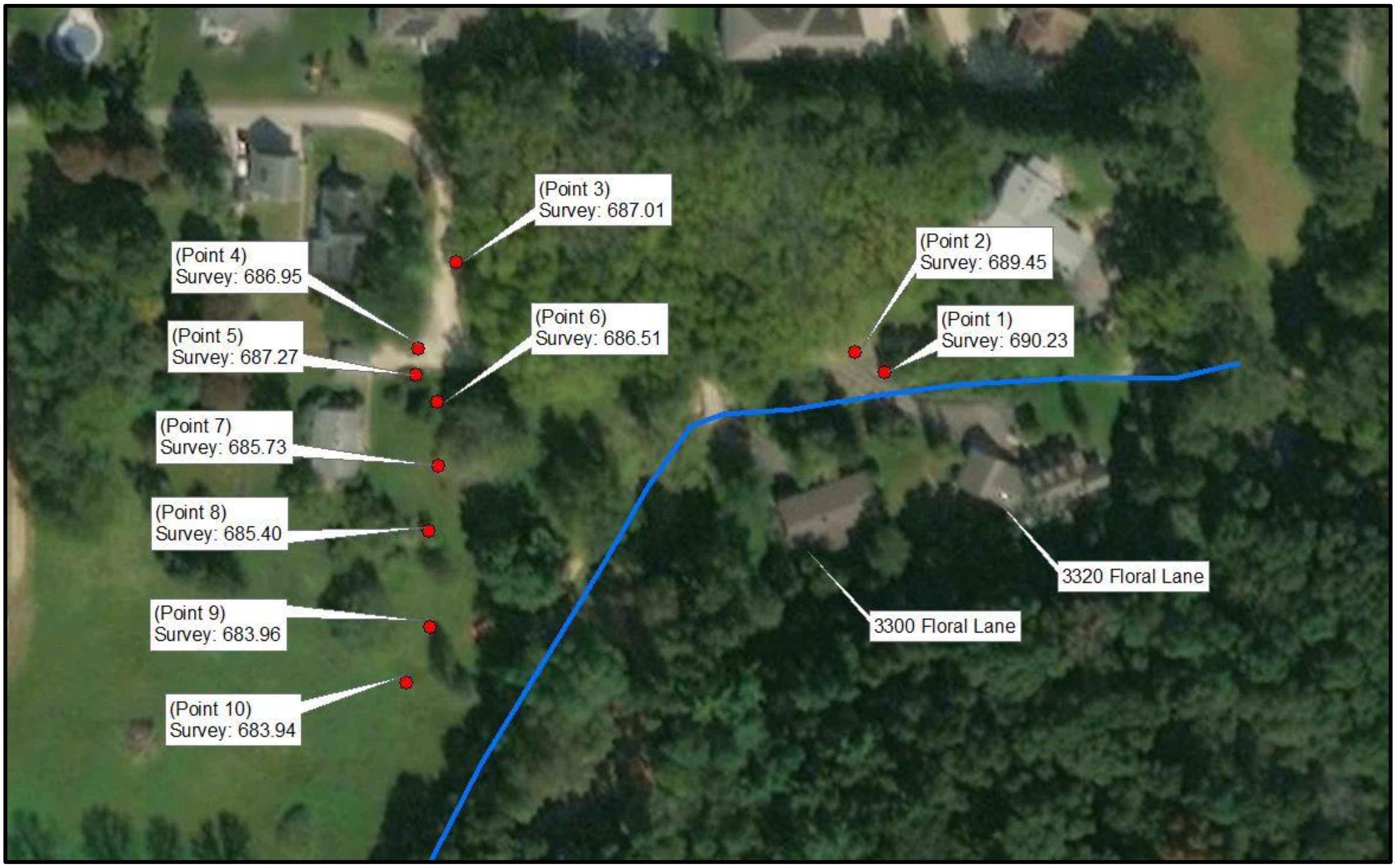


Figure 13 – SRH2D Inundation at 29th Street Culvert Area – 275 cfs

Figure 14 – SRH2D Inundation at 29th Street Culvert Area – 300 cfs

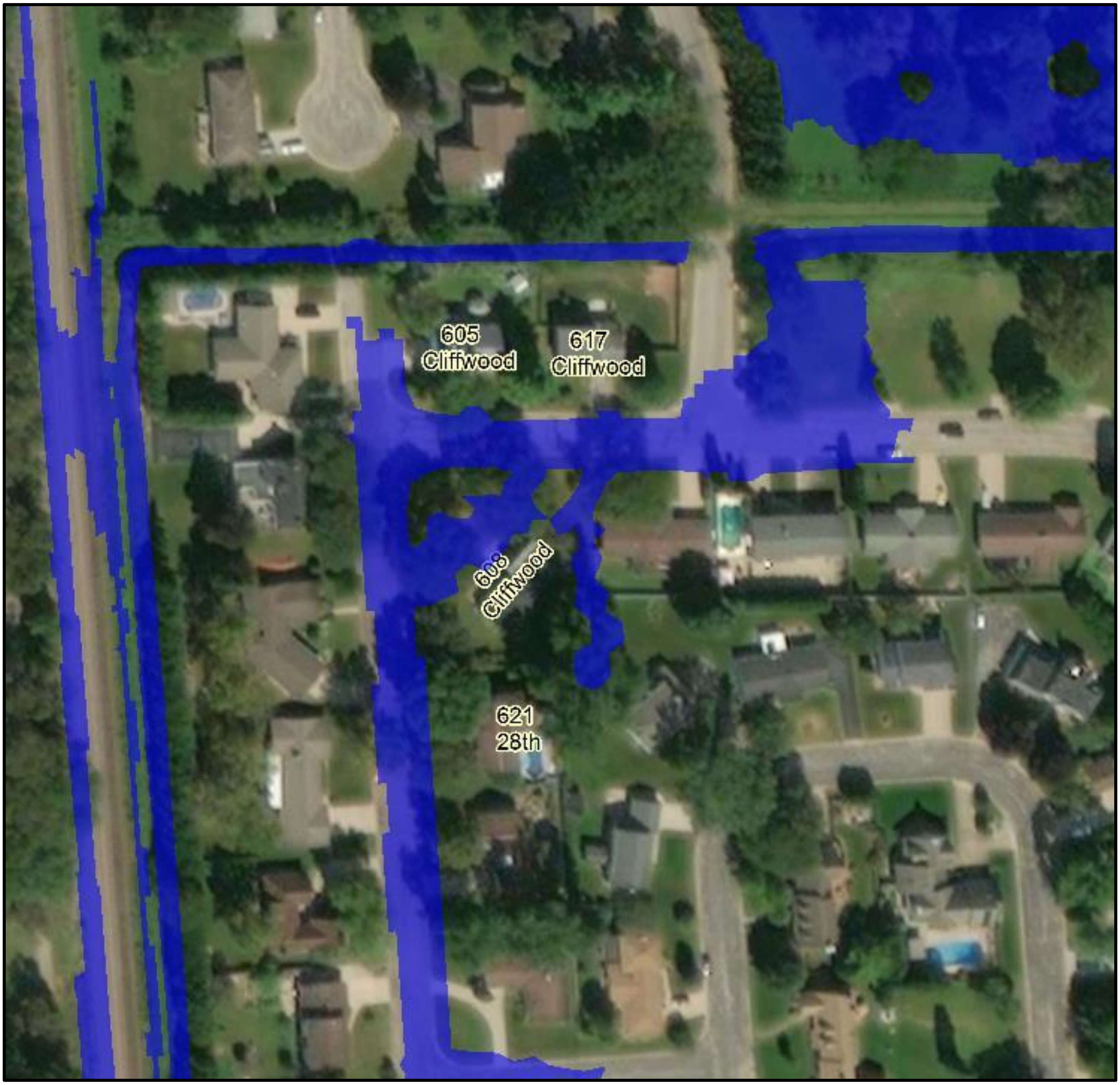
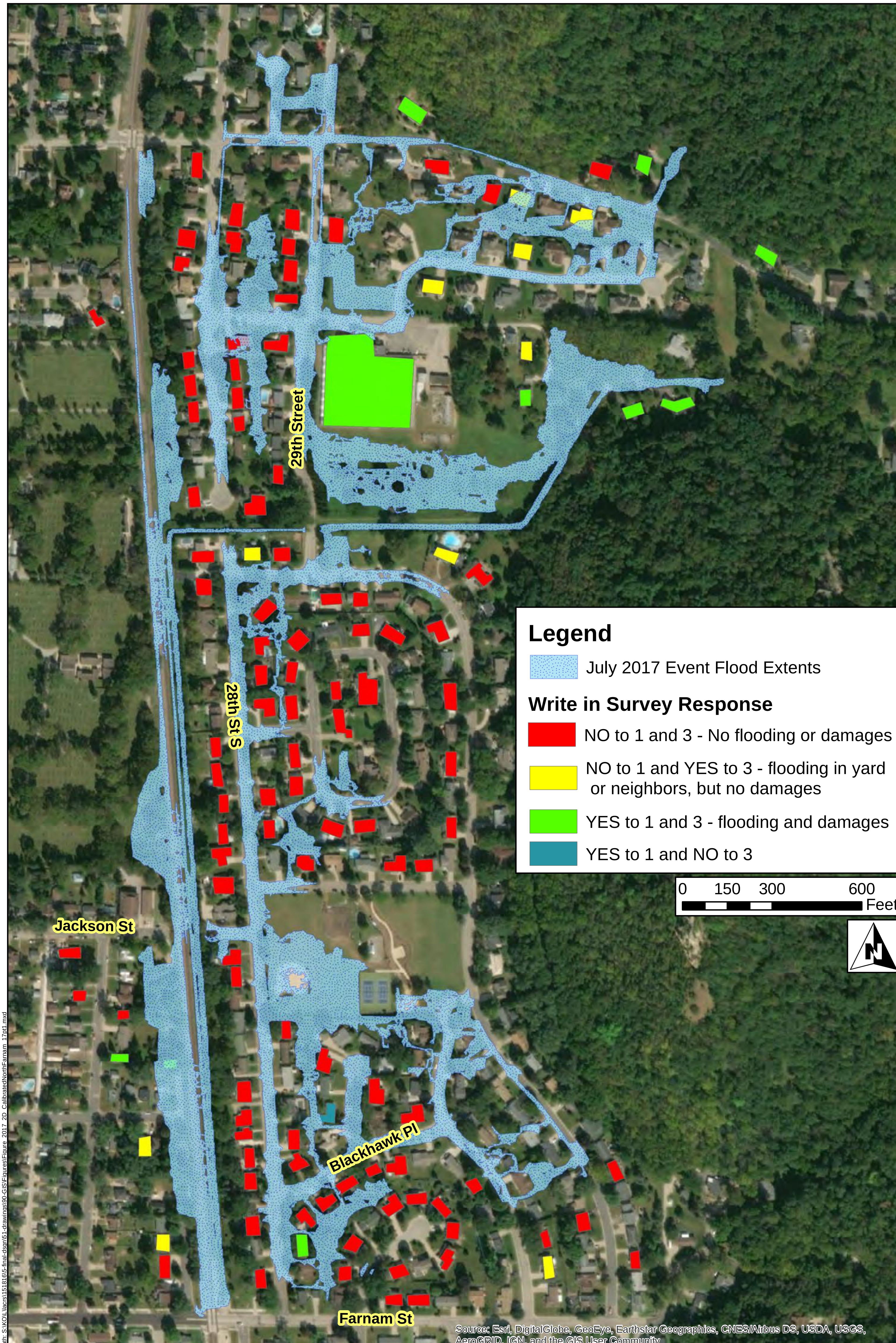


Figure 15 – SRH2D Inundation at 29th Street Culvert Area – 325 cfs

Figure 16 – SRH2D Inundation at 29th Street Culvert Area – 375 cfs



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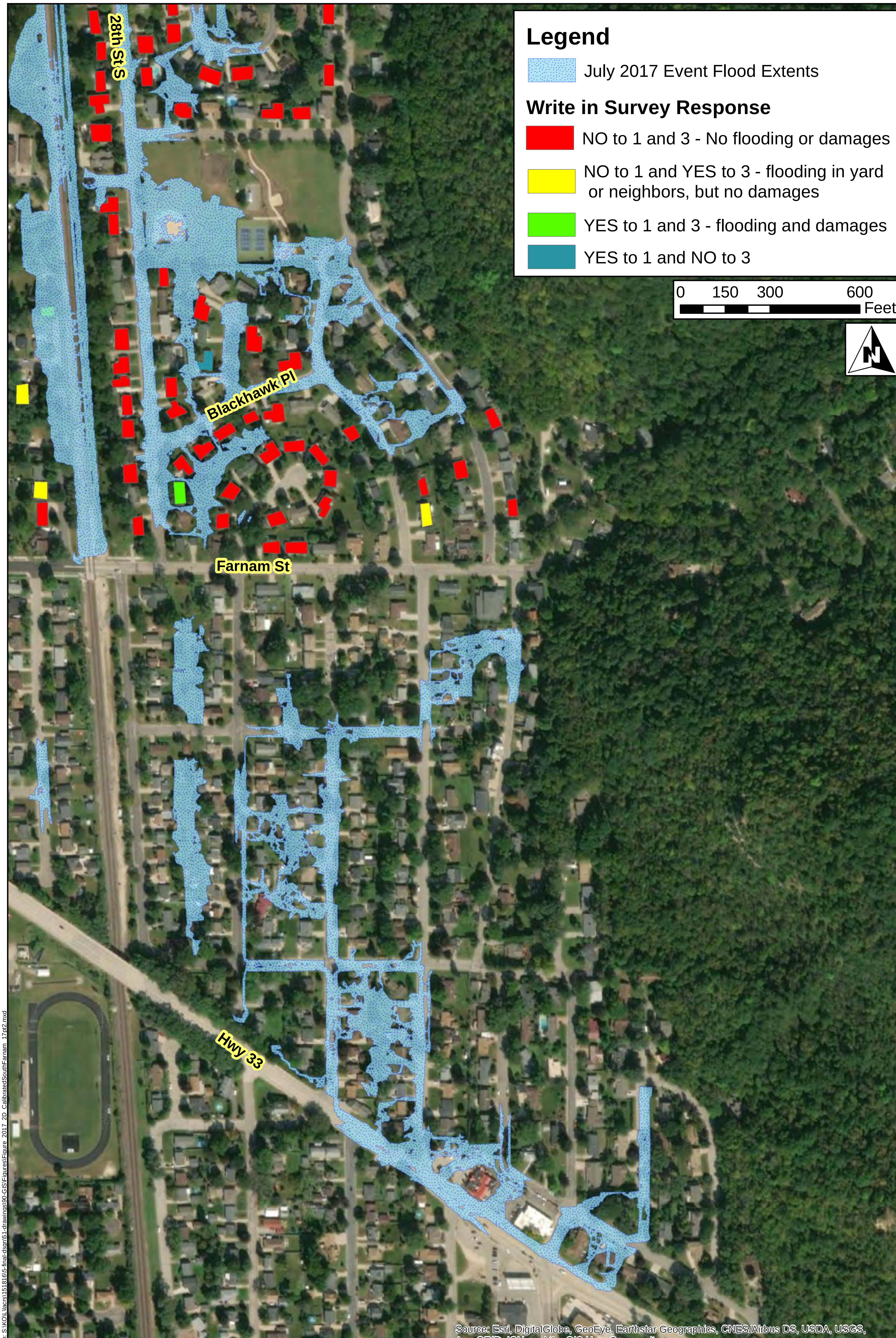
Projection: Wisconsin State Plane South
Source: ESRI, SEH

July 2017 XPSWMM 2D Results

Ebner Coulee Flood Study
La Crosse, WI

Figure 17.1



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July 2017 XPSWMM 2D Results
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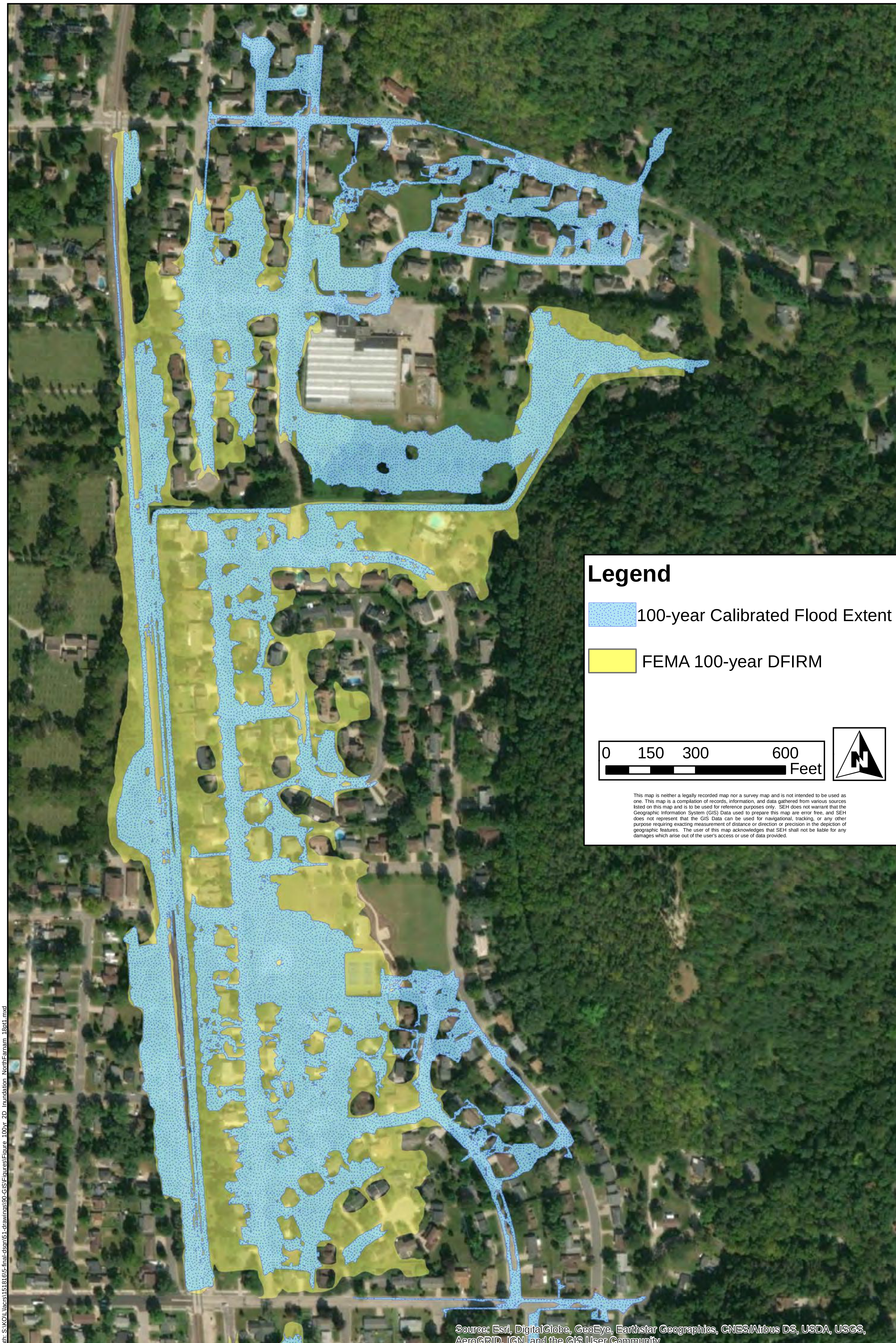
La Crosse, WI

Figure 17.2



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100-year XPSWMM 2D Inundation

Ebner Coulee Flood Study

La Crosse, WI

Figure 18.1

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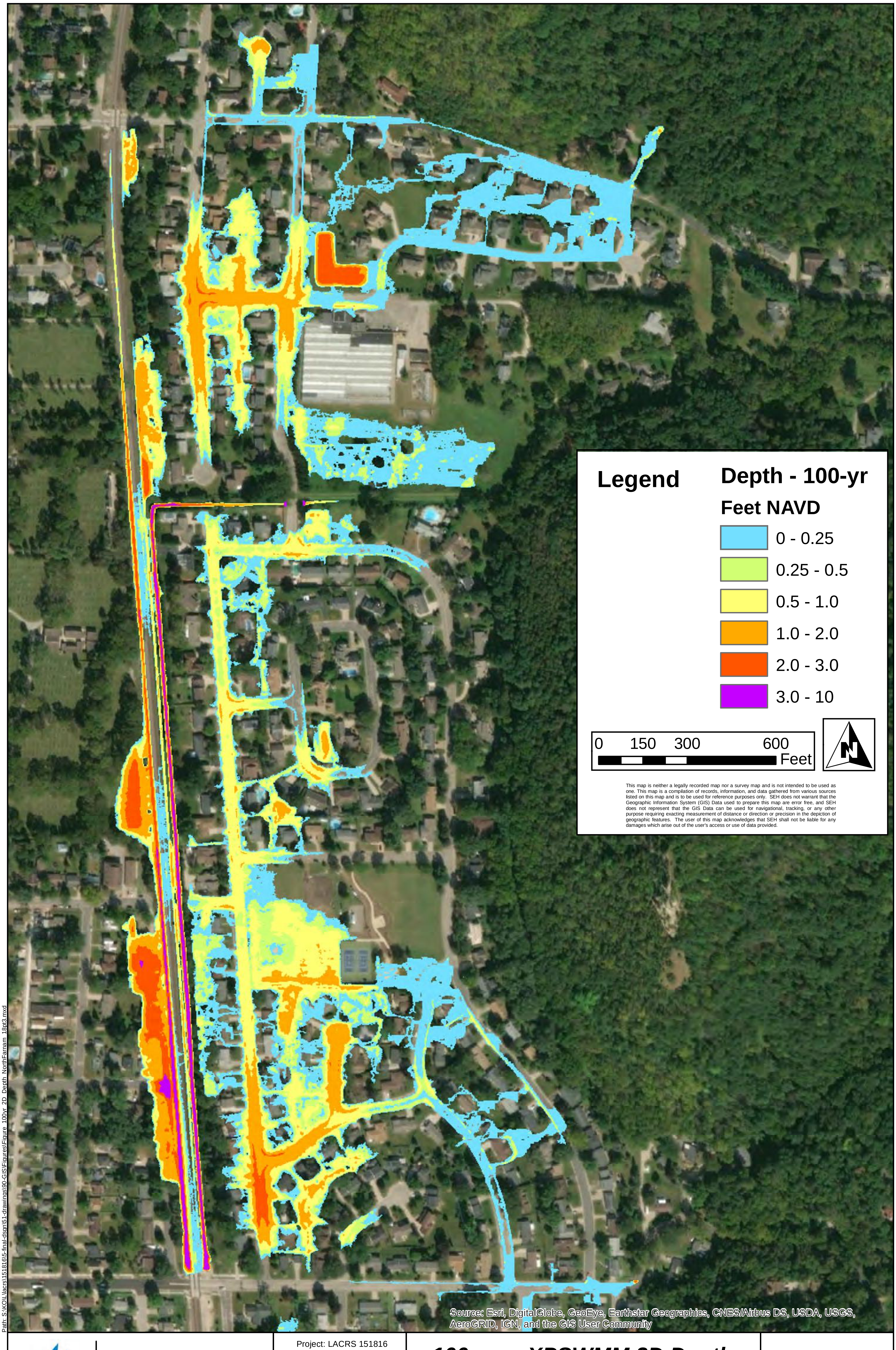
Source: ESRI, SEH

100-year XPSWMM 2D Inundation

Ebner Coulee Flood Study

La Crosse, WI

Figure 18.2



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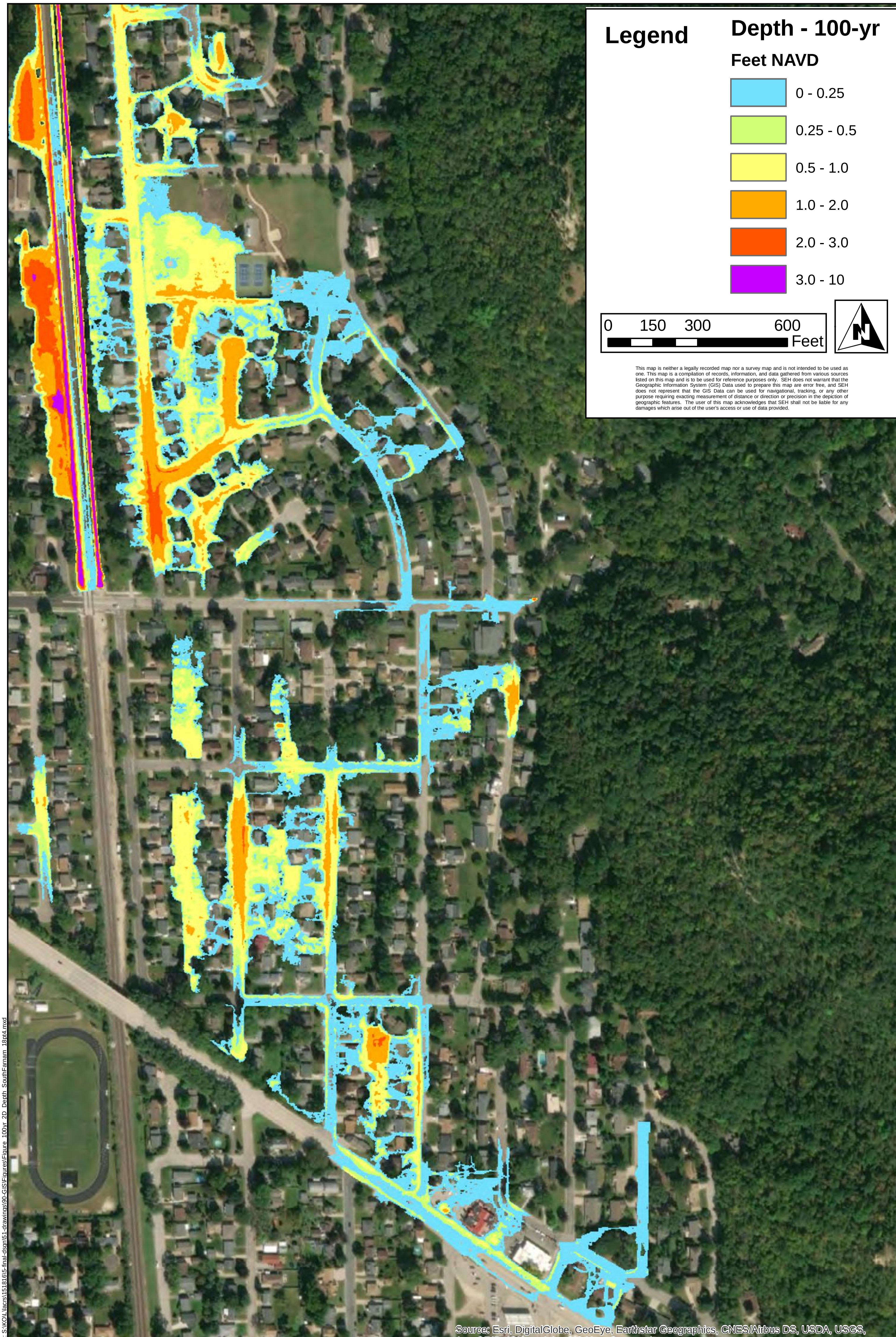
Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

100-year XPSWMM 2D Depth

Ebner Coulee Flood Study

La Crosse, WI

Figure 18.3



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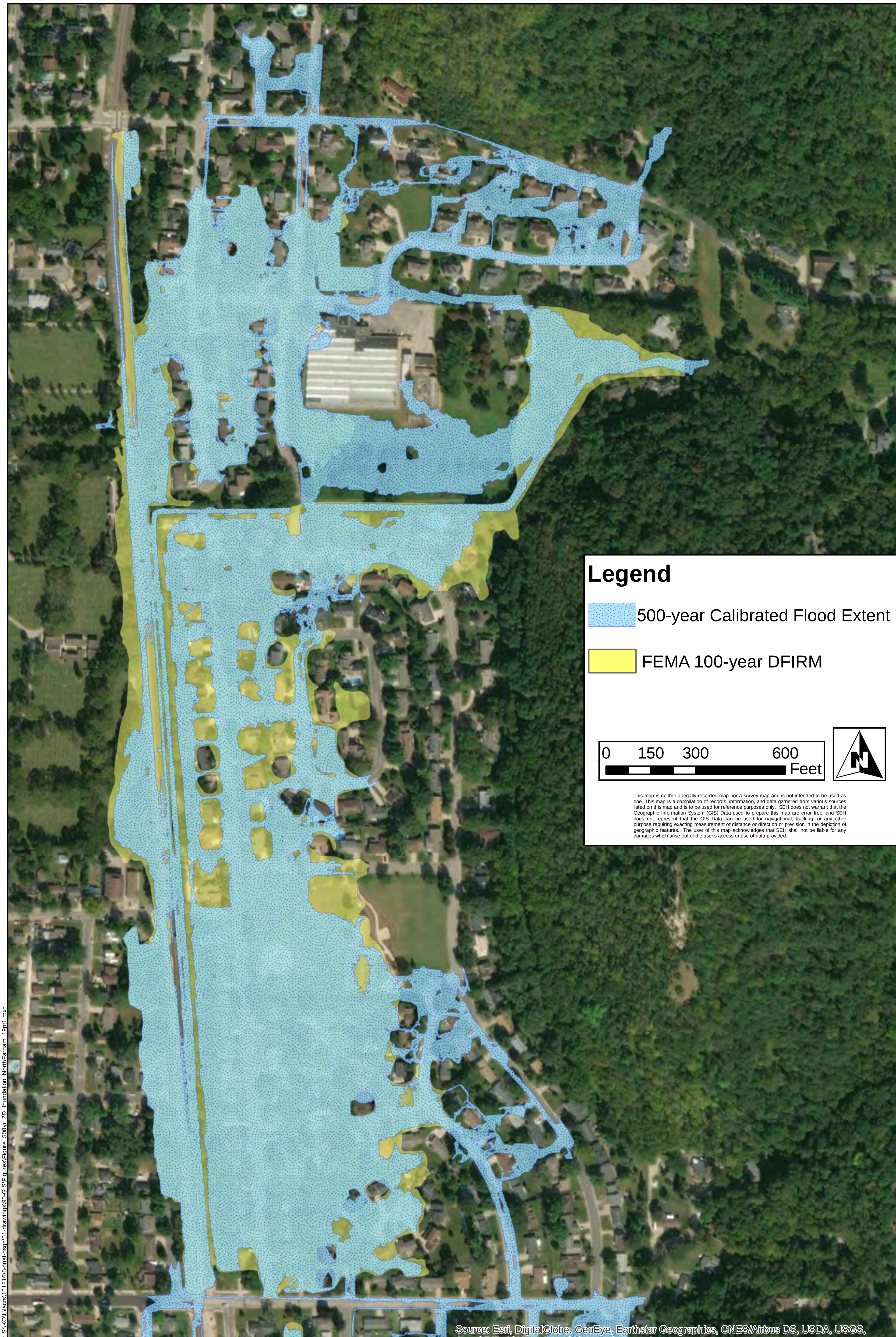
Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

100-year XPSWMM 2D Depth
Ebner Coulee Flood Study
La Crosse, WI

Figure 18.4



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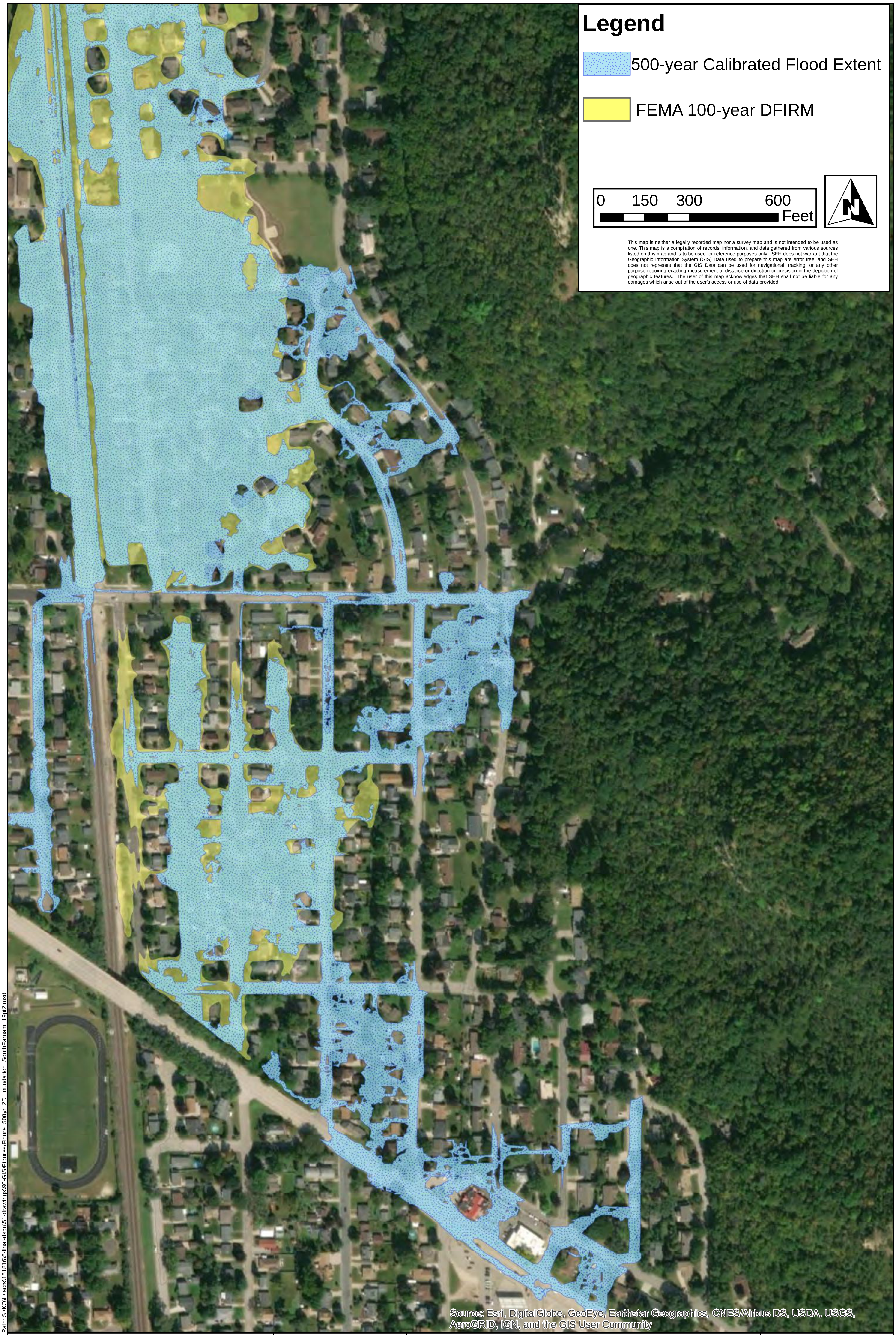
Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

500-year XPSWMM 2D Inundation

Ebner Coulee Flood Study

La Crosse, WI

Figure 19.1



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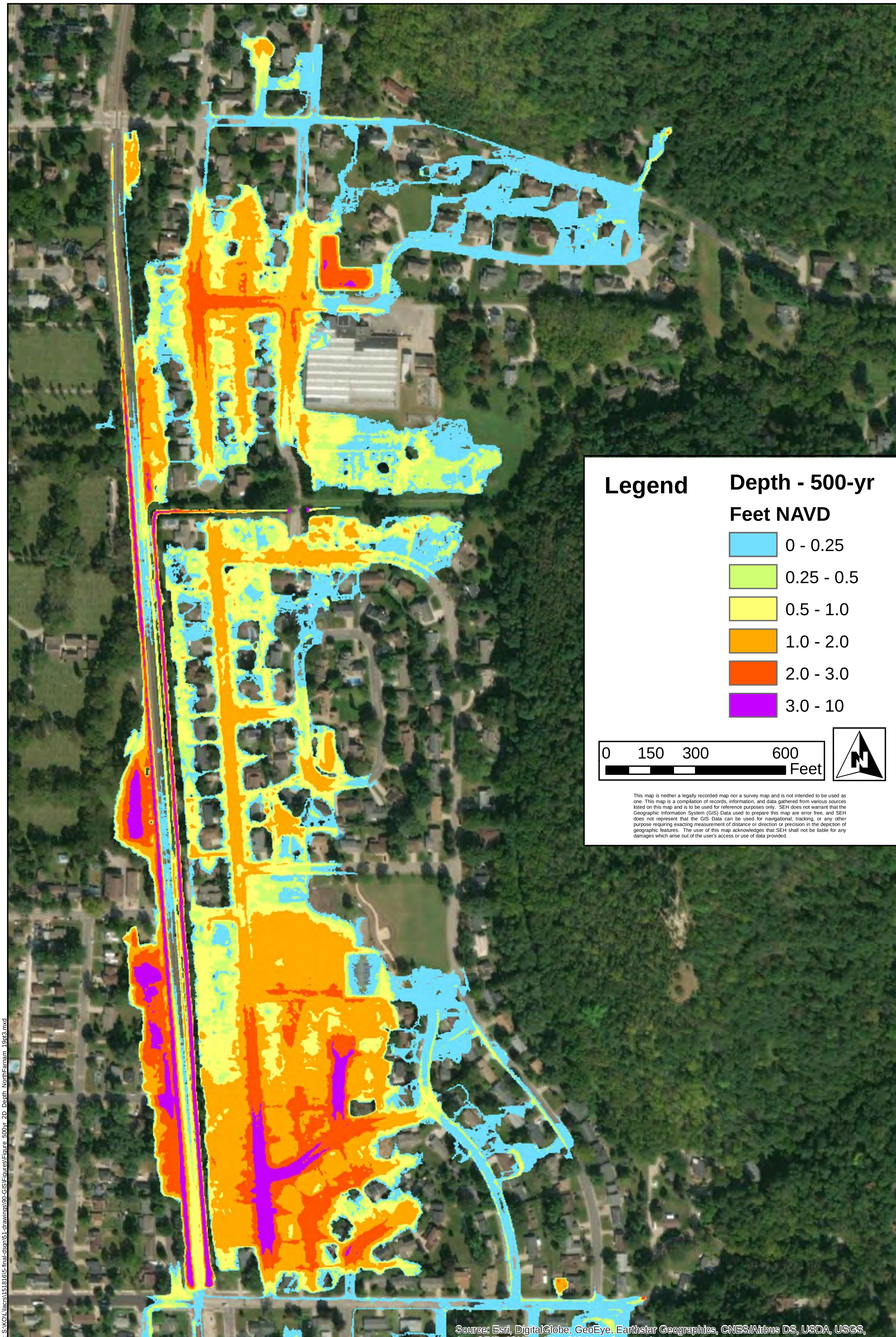
Project: LACRS 151816
Print Date: 7/9/2020

Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

500-year XPSWMM 2D Inundation

Ebner Coulee Flood Study
La Crosse, WI

Figure 19.2



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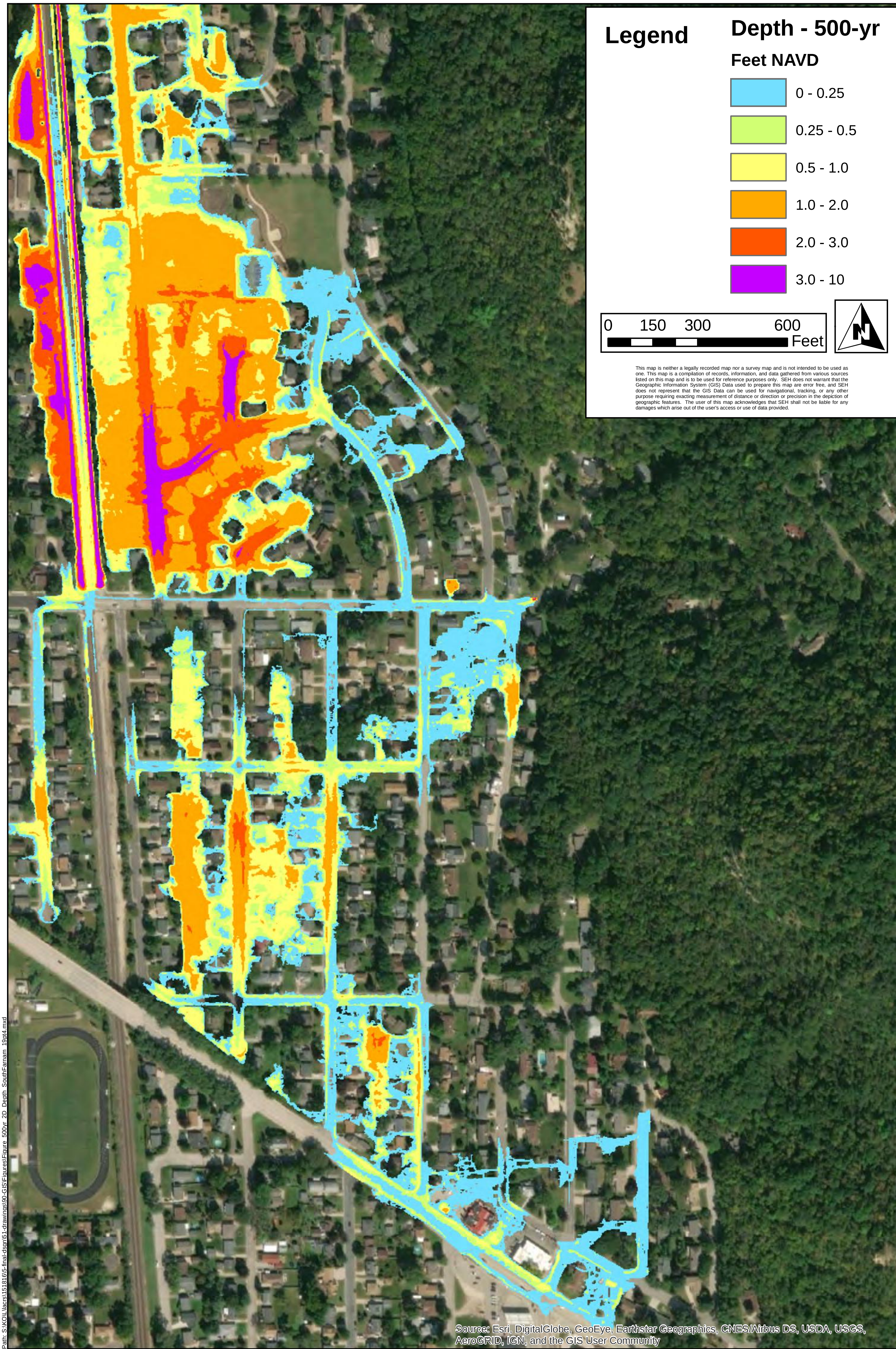
SEH	3535 VADNAIS CENTER DR. ST. PAUL, MN 55110 PHONE: (651) 490-2000 FAX: (888) 908-8166 TF: (800) 325-2055 www.sehinc.com	Project: LACRS 151816 Print Date: 7/9/2020 Map by: rmondloch Projection: Wisconsin State Plane South Source: ESRI, SEH	***500-year XPSWMM 2D Depth*** Ebner Coulee Flood Study La Crosse, WI	Figure 19.3



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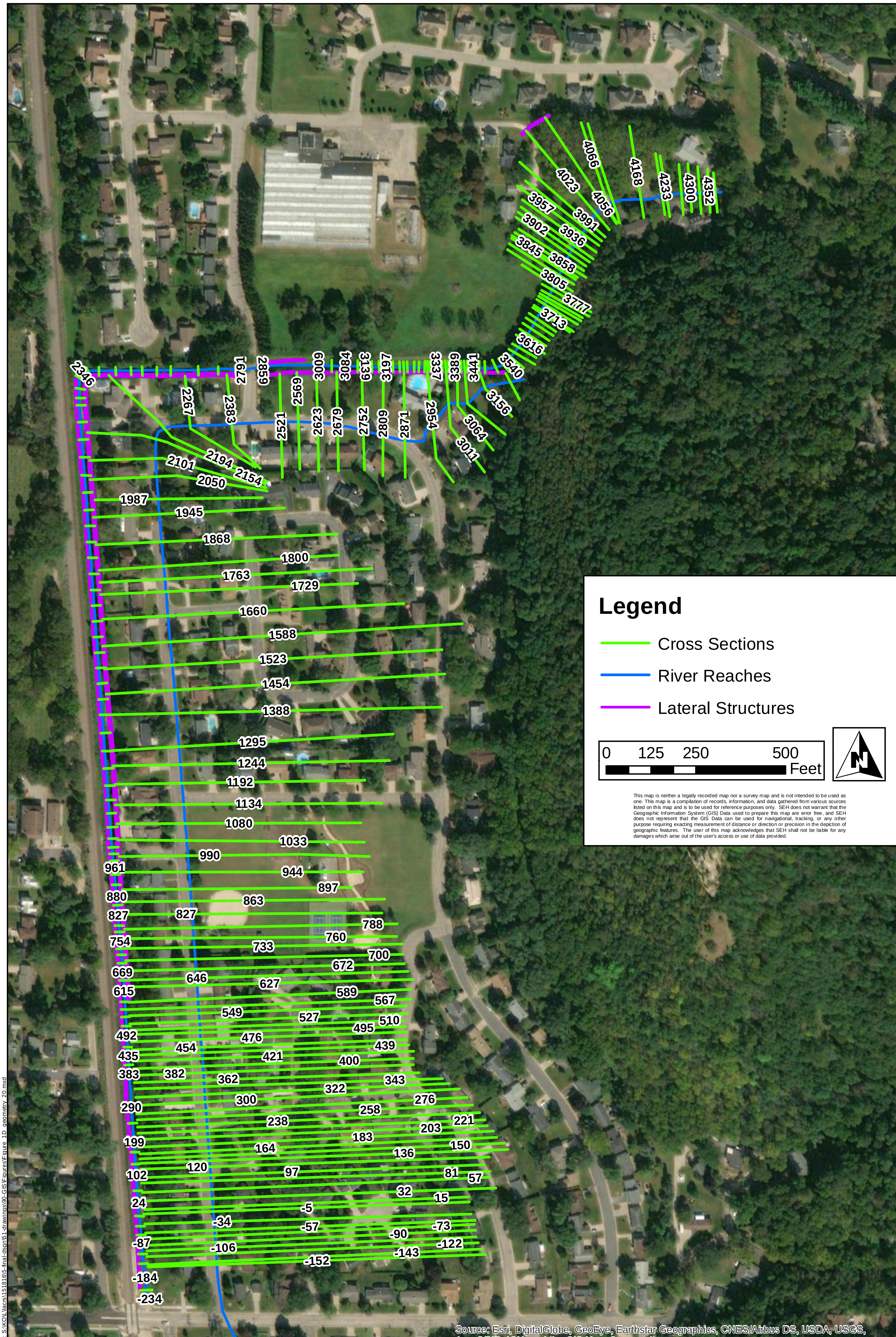
500-year XPSWMM 2D Depth

Ebner Coulee Flood Study

La Crosse, WI

Figure 19.4



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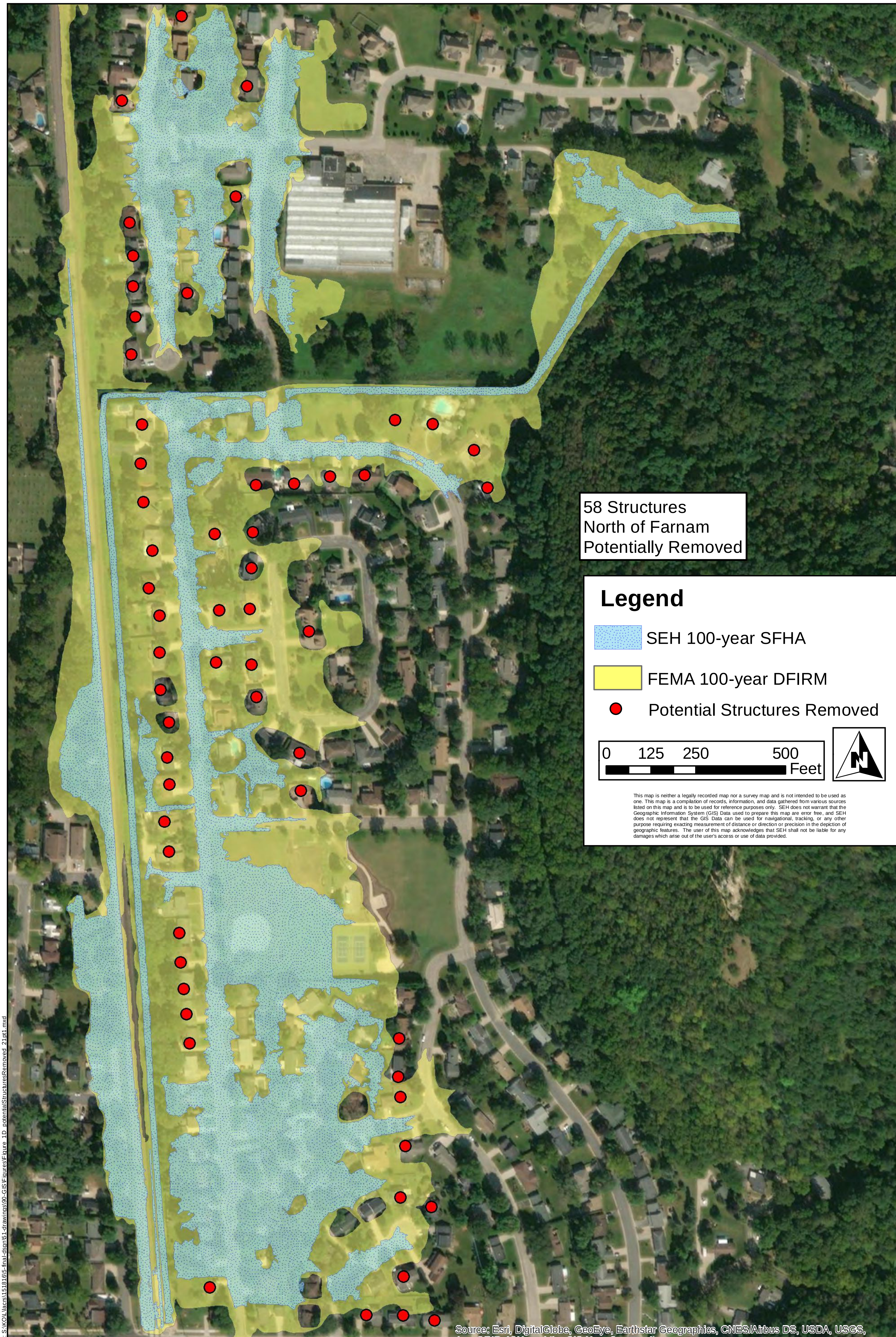
Print Date: 7/15/2020

Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

1D HEC-RAS Geometry - SEH LOMR

Ebner Coulee Flood Study
La Crosse, WI

Figure
20



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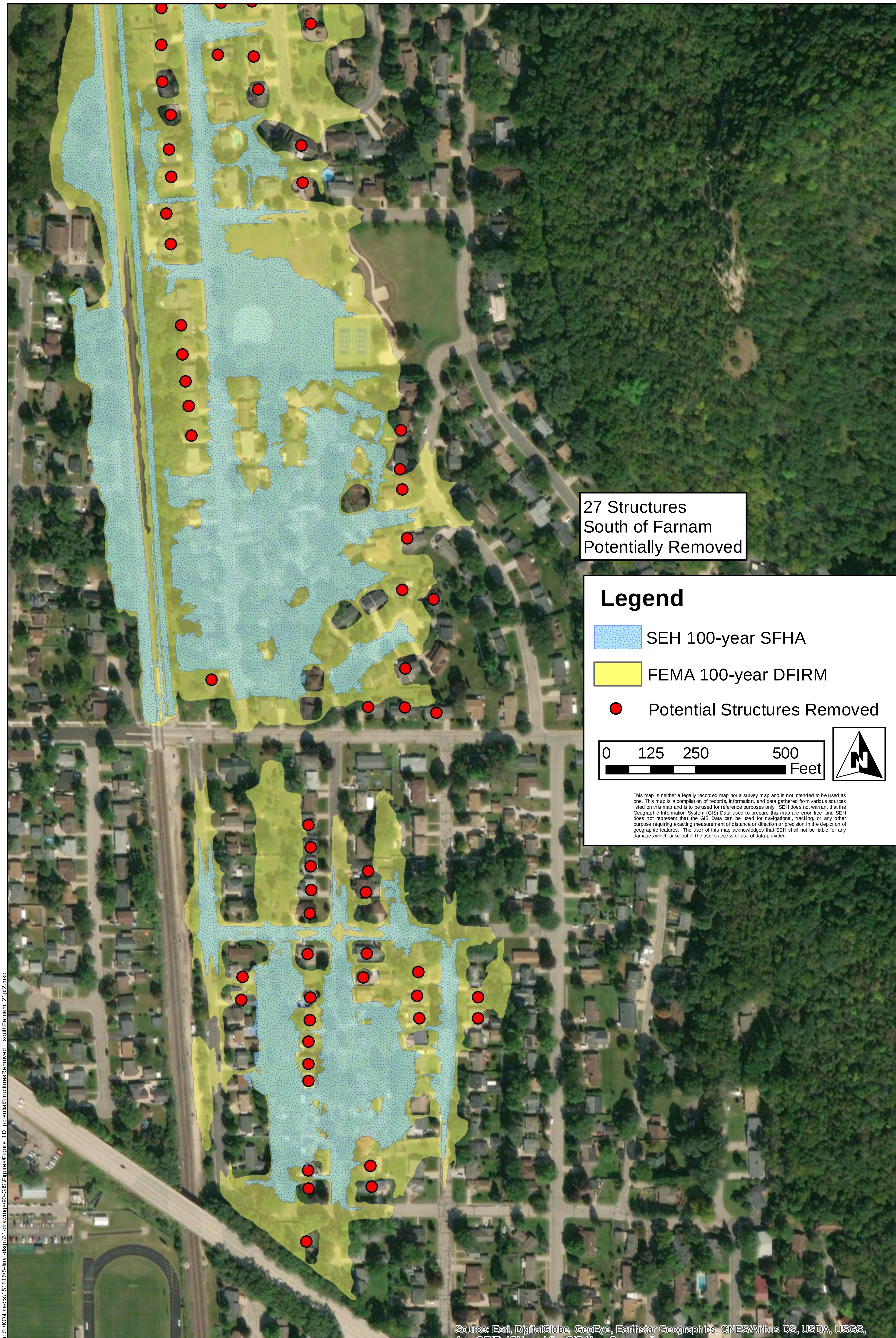
Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

Potential Structures Removed
Ebner Coulee Flood Study
La Crosse, WI

Figure 21.1



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Map by: rmondloch
Projection: Wisconsin State Plane South
Source: ESRI, SEH

Potential Structures Removed

Ebner Coulee Flood Study

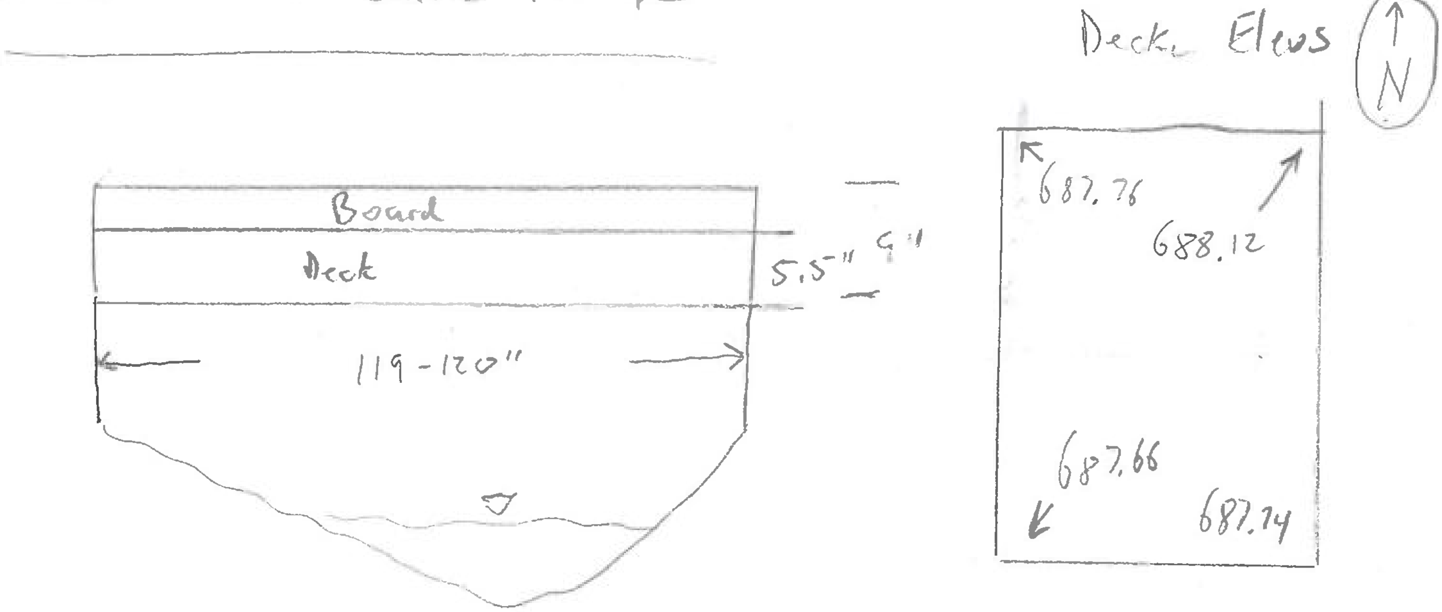
La Crosse, WI

Figure 21.2

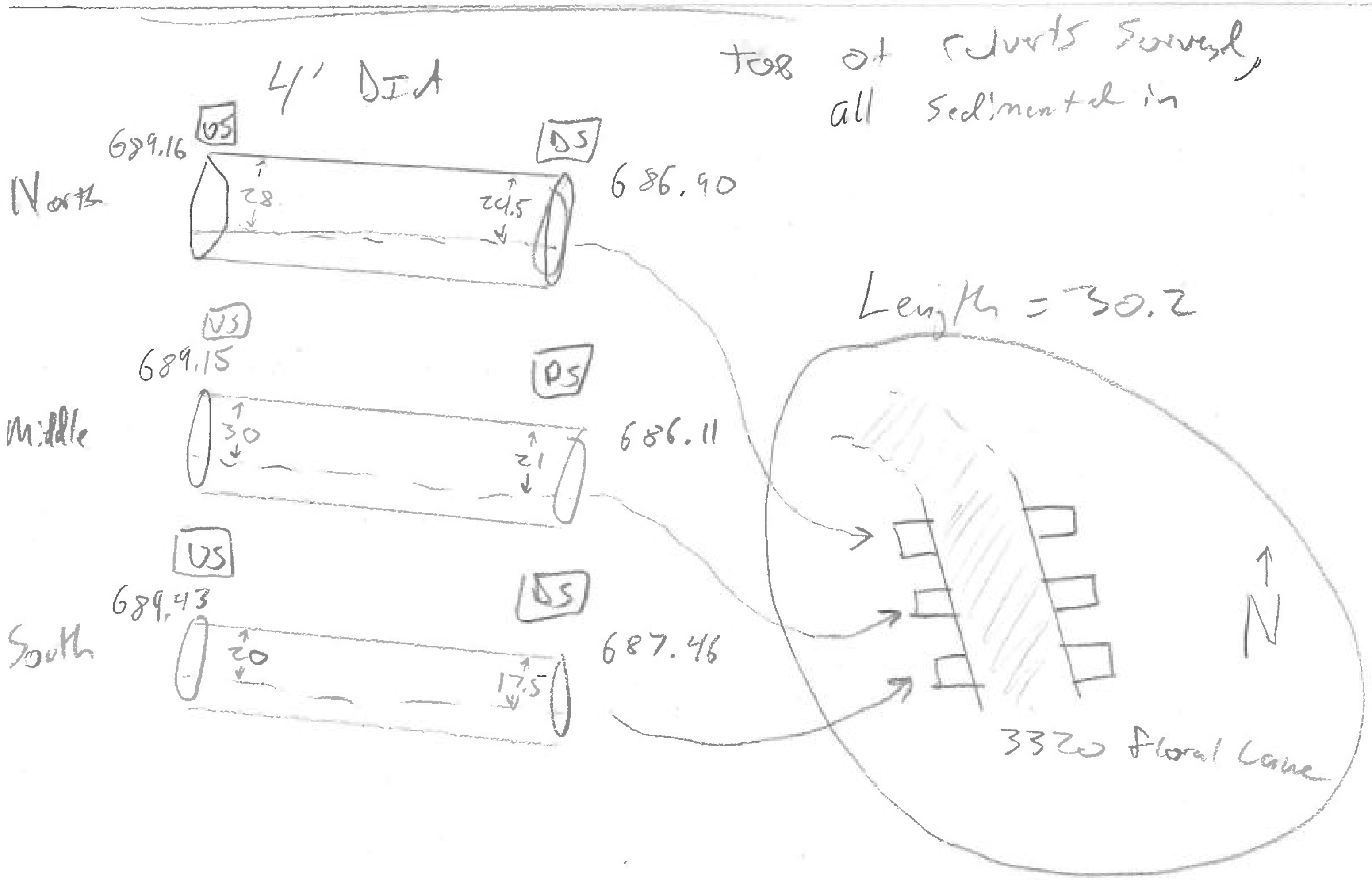
APPENDIX 1

HYDRAULIC STRUCUTRE SURVEY SKETCHES

3300 Floral Lane Bridge



3320 Floral Lane Culverts



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Date: By: SEH #:
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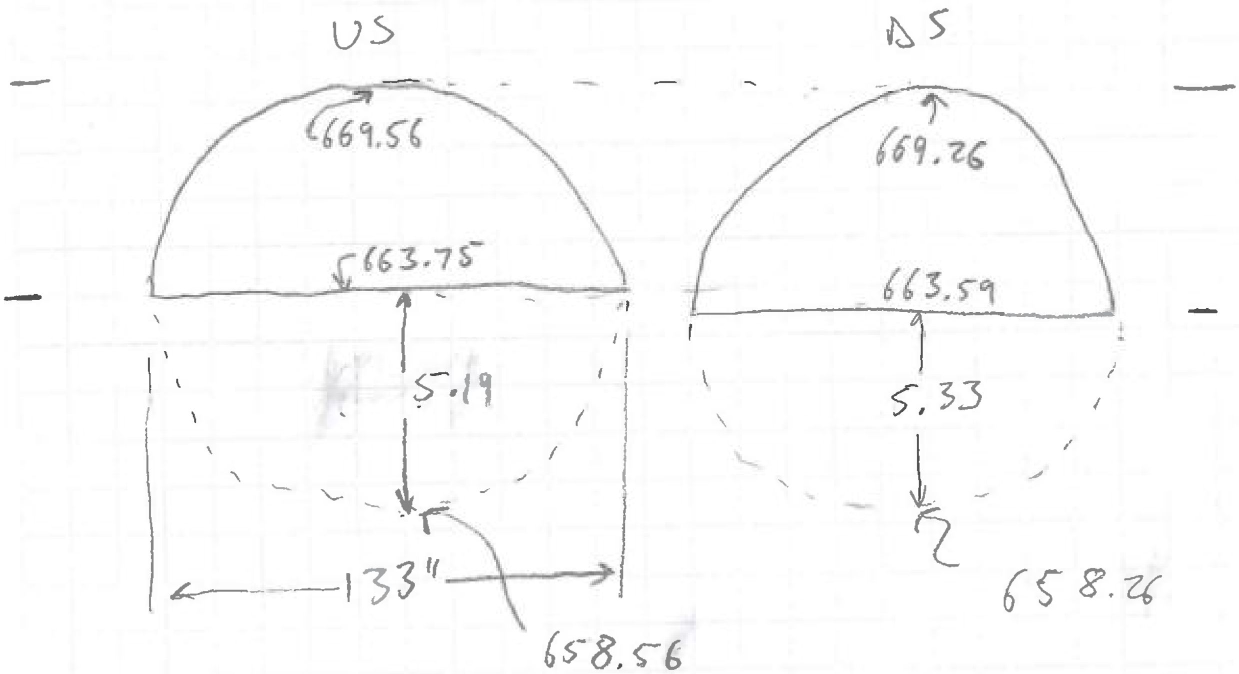
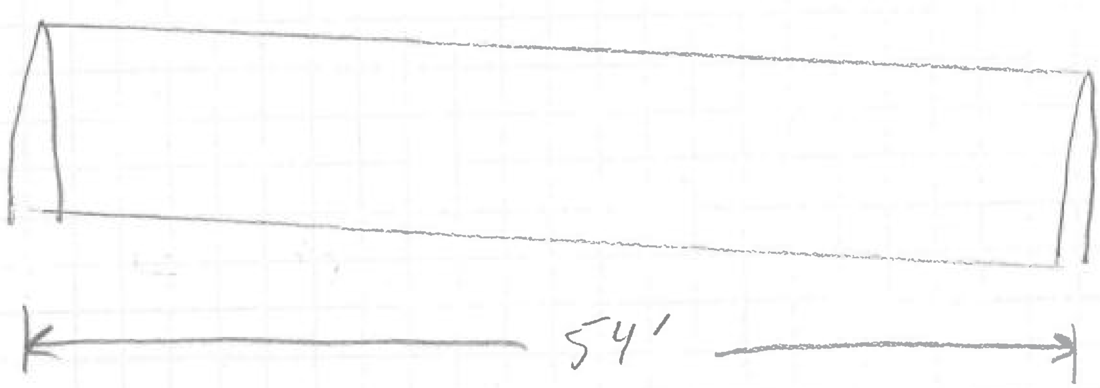
Sheet No: Of:

29th St Culvert ~11' DIA CMP



Assuming height is 11'



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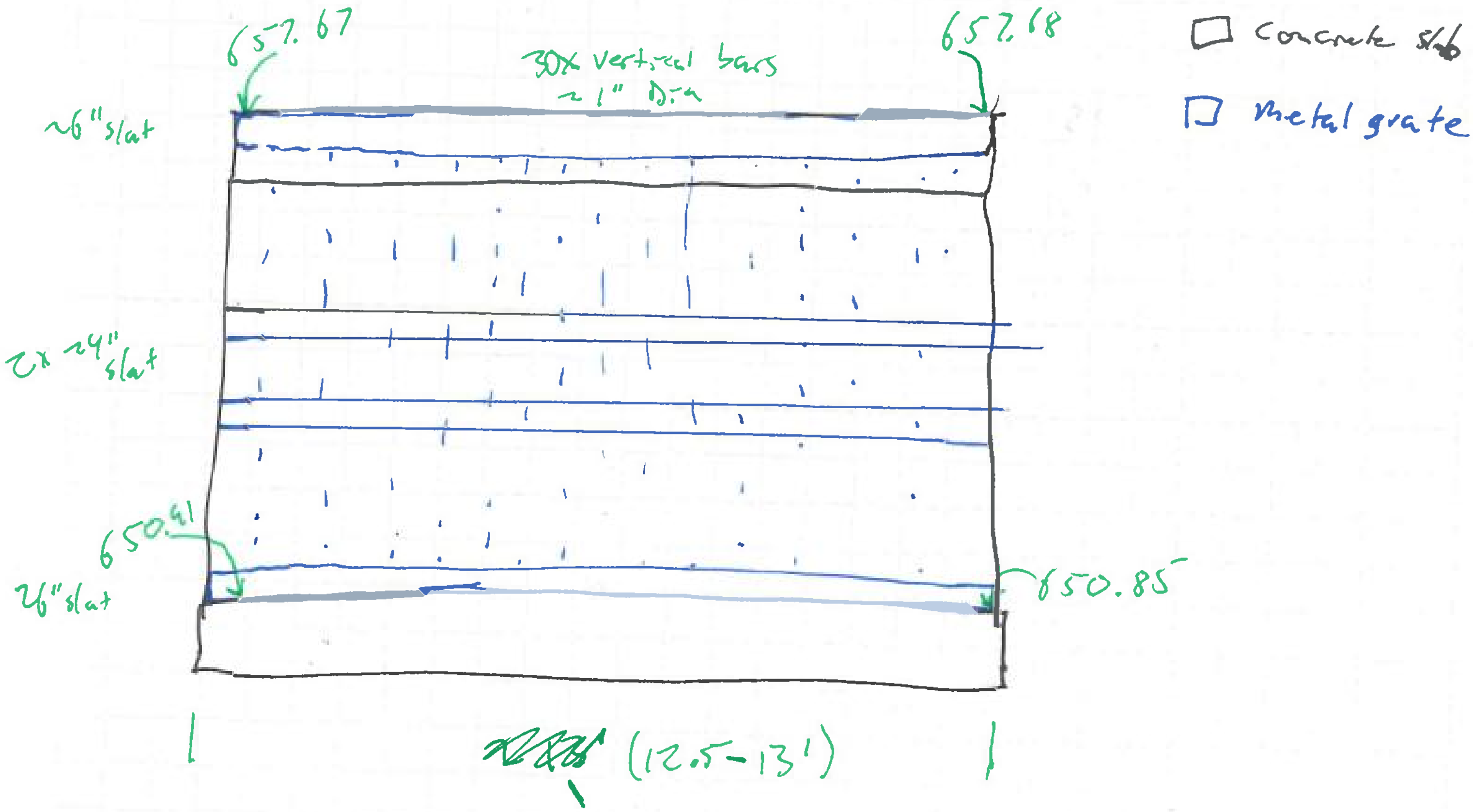

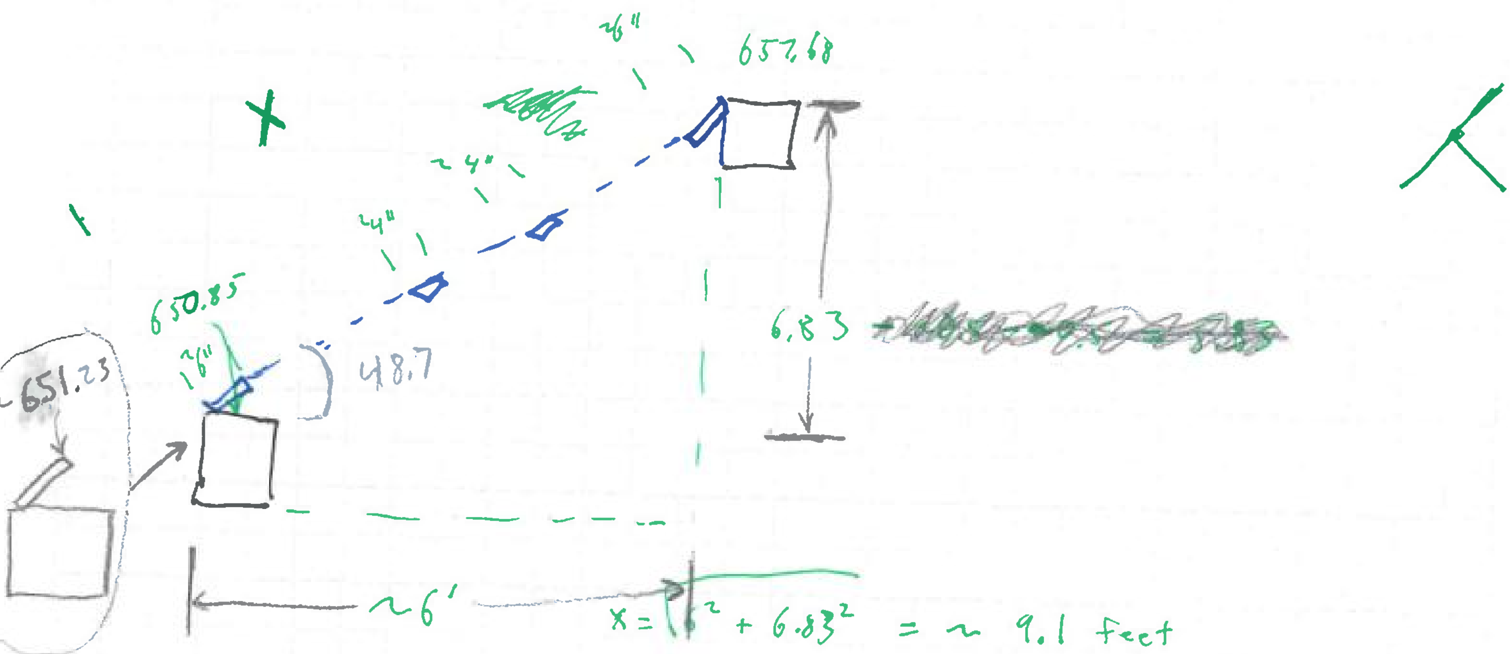

$x = \sqrt{6^2 + 6.83^2} = \sim 9.1$ feet

Gross area = 9.1 x 12.5 = 113.75

Removing slats Net area = 113.75 − 0.5(12.5)(2) − 0.33(12.5)(2) − $(\frac{1}{12})(30)$

= 90.5 (higher than 8x10 Box Area)

APPENDIX 2

REPORTS CONTAINING BACKGROUND INFORMATION AND PRELIMINARY WORK

SEH

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MEMORANDUM

TO: Mr. Bernard Lenz

FROM: Brad Woznak, PE, PH, CFM

DATE: August 3, 2017

RE: Ebner Coulee Floodway FIRM Remapping: Hydrologic Analysis

Background

The City of La Crosse has engaged SEH to determine the feasibility of submitting a Letter of Map Revision (LOMR) to FEMA for the Ebner Coulee Floodway and Floodplain. The City has requested that this work be completed in phases, with the first task focusing on the hydrology of the Ebner Coulee system. The peak discharge rates for Ebner Coulee reported in the effective FEMA Flood Insurance Study (FIS) were developed using the Bureau of Public Roads Method, also called the Cook Method, with scaling of flood frequency from Gilmore Creek at Winona, MN. According to a letter from the USGS to the WiDNR dated September 29, 1994, “the Bureau of Public Roads and Cook methods are highly empirical and inappropriate for a watershed as steep as Ebner Coulee, and the [flood frequency] scaling procedures applied are inconsistent with current recommended procedures.”

In order to determine the feasibility of submitting a LOMR to FEMA based primarily on revised hydrology, SEH has reviewed the existing FEMA Flood Insurance Study (FIS) and model information, and estimated new peak flow values entering the modeled area using the methods described in Water Resources Investigation Report 03-4250 “Flood-Frequency Characteristics of Wisconsin Streams”. A new flood hydrograph was then developed using HEC-HMS, and FEMA’s guidelines were used to determine if the results are statistically significant enough to warrant modification of the FIS/FIRM. This memorandum provides a summary of the work completed by SEH to date.

Hydrology Analysis

Data Collection

The effective FIS was obtained from the FEMA web portal and the effective HEC-RAS model was obtained from the Wisconsin DNR through the Surface Water Data Viewer tool. FEMA GIS data including the Special Flood Hazard Area map, cross-sections, and streamline were also obtained and will be used as a starting point for any future modifications to the hydraulic model. The City of La Crosse GIS staff provided a one meter resolution LiDAR-derived DEM for the county and the city. The city’s storm sewer GIS database was also provided.

Review of Existing FIS and Available Models

The FEMA effective HEC-RAS model extends from Farnam Street (downstream limit) to 950 feet east of 29th Street S (upstream limit); this is where Ebner Coulee leaves the bluff area and enters the flatter residential area. **Error! Reference source not found.** (attached) shows the FEMA lettered cross-sections and streamlines. There are two streamlines; the north and west streamline is for the main channel, and the south and east streamline is for flow that diverts out of the main channel and flows through the residential area. Some flow also diverts to the north and is included in the FEMA mapping, but the cross-sections do not extend to the north.

The drainage area listed in Table 8 (included below) of the La Crosse County FIS is 0.9 square miles for all flows in the Ebner Coulee main channel and Ebner Coulee Southeast bank models. Based on modern LiDAR data, the drainage area to the upstream limit of the model is 0.61 square miles, and the drainage area to the downstream limit of the model at Farnam Street is 1.13 square miles, as shown in Figure 1 (attached). The drainage area to FEMA's most downstream lettered cross-section, A, was calculated using LiDAR to be 0.88 square miles. Based on this LiDAR calculation and USGS quad maps, it appears that the drainage area of 0.9 square miles indicated in the FIS was originally calculated to the point at the end of the lettered cross-sections near Jackson Street, and then reported in the FIS as the drainage area for all parts of the model.

Table 8 of the Effective FEMA FIS – Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
EBNER COULEE MAIN CHANNEL					
Upstream of Overflow to Ebner Coulee Southeast Bank	0.9	N/A	N/A	1,430	N/A
Upstream of South 29th Street	0.9	N/A	N/A	301	N/A
Approximately 1240 feet Upstream of Farnam Street	0.9	N/A	N/A	247	N/A
EBNER COULEE SOUTHEAST BANK					
Upstream of South 29th Street	0.9	N/A	N/A	820	N/A
Approximately 1260 feet Upstream of Farnam Street	0.9	N/A	N/A	836	N/A

Table 8 of the La Crosse County FIS shows that for the 1% Annual Chance Flood, a peak discharge rate of 1430 cfs was used for the main channel of Ebner Coulee upstream of the overflow location. Table 8 also shows that less than 300 cfs of the 1430 cfs starting flow remains in the channel by the time it reaches Jackson Street. The remainder overflows out of the main channel and is modeled separately. The focus of Task 1 is only to estimate the peak flow at the upstream end of the modeled reach, the new flow diversion will be analyzed at a later time.

USGS Regression Analysis & Flood-Frequency Equations using W-RIR 03-4250

Regression equations are relations between flood-frequency and drainage-basin characteristics that have been developed by a multiple-regression analysis. The peak flow in Ebner Coulee was estimated using the regression equations and methodology provided in USGS Water-Resources Investigations Report 03-4250. This process involved delineating a new watershed to the upstream limit of the effective HEC-RAS model based on the LiDAR-derived DEM, and estimating the percentage of forested area and the approximate slope through the watershed using GIS. The watershed draining to the upstream limit of the model is 0.61 square miles as shown in Figure 1 (attached). The flood-frequency equations provided in the USGS document were then used to estimate the peak discharge rates. Table 1 shows the resulting peak flow for the 100-year event. Plus and minus one standard error were also calculated using the ESE (equivalent standard error) provided in the USGS document; this is also shown in Table 1.

Table 1: Regression Analysis & Flood-Frequency Equation Results

Source	Location	Drainage Area (SqMi)	Peak Flow (cfs)	ESE (%)	Minus 1 Standard Error (cfs)	Plus 1 Standard Error(cfs)
FEMA Effective	All Locations	0.9	1430.0			
Regression Eq.	Upstream Limit of Fema Model	0.61	360.8	44	202.0	519.5
Regression Eq.	Jackson Street	0.88	399.6	44	223.8	575.4
Regression Eq.	Farnman Street	1.13	440.9	44	246.9	634.9

Check for Statistical Significance per FEMA Guidelines
According to language provided in FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C, the hydrologic analysis should base the test for significance on the confidence limits, plus or minus one standard error, of the more recent analysis:

> *"The Mapping Partner performing the hydrologic analysis should base the test for significance on the confidence limits of the more recent analysis. Plus or minus one standard error, which is equivalent to a 68-percent confidence interval, should be used to determine if the effective and new base flood discharges are significantly different. If the effective base flood discharges are within the 68-percent confidence interval (one standard error) of the new base flood discharges, the new estimates are not considered statistically different and there is no need for a new study based only on changes in the flood discharges. If the effective discharges fall outside the 68-percent confidence interval (one standard error) of the new discharges, the estimates are considered significantly different and a new study may be warranted based on changes in the flood discharges."*

Figure 2 (below) shows that the effective 100 year peak flow of 1430 cfs is well above the flow calculated in the regression analysis, and also well outside of the 68-percent confidence interval (one standard error); indicating a new study is warranted based on the changes in the flood discharges.

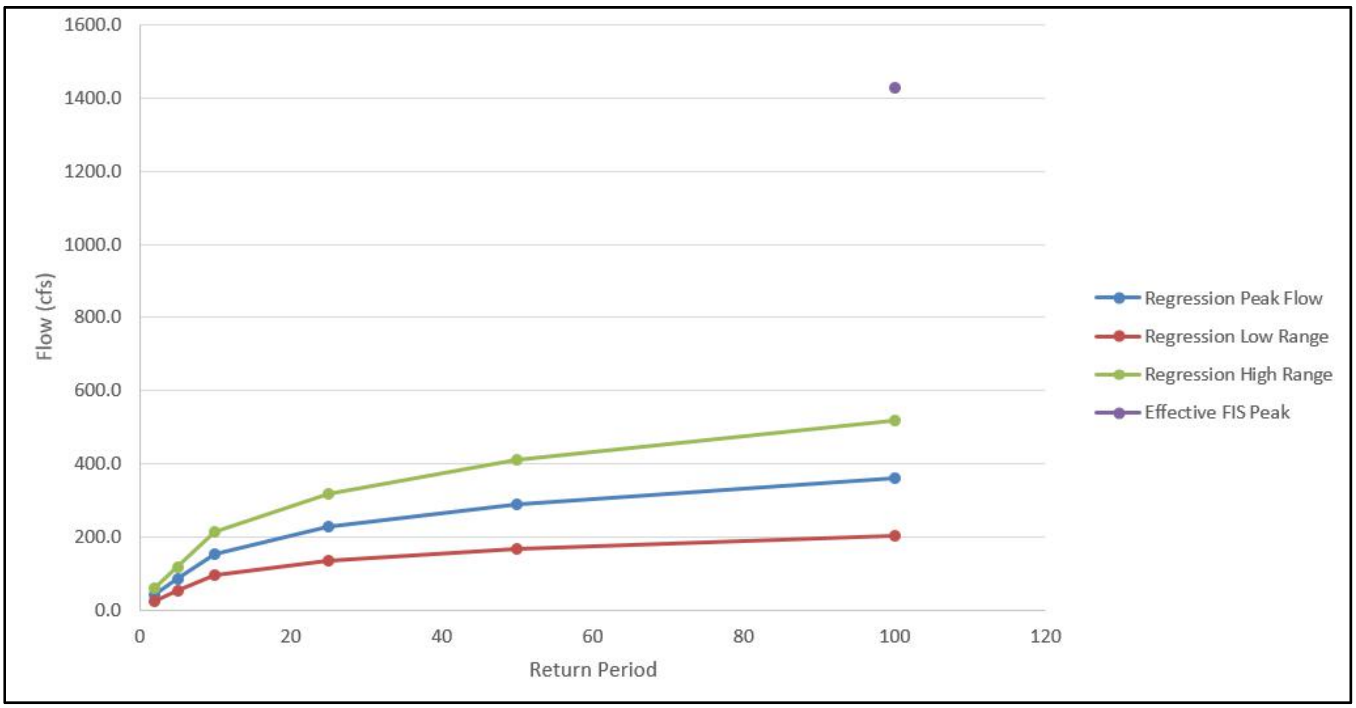

Figure 2: Statistical Summary

HEC-HMS Model
A HEC-HMS model was created to develop a hydrograph that could be associated with the regression equation peak flow and used in an unsteady HEC-RAS analysis. Figure 3 (included on the following page) shows the hydrograph developed using HEC-HMS, matching the regression equation peak flow estimate for the upstream limit of the Ebner Coulee hydraulic model. This hydrograph will be used in future hydraulic analyses.

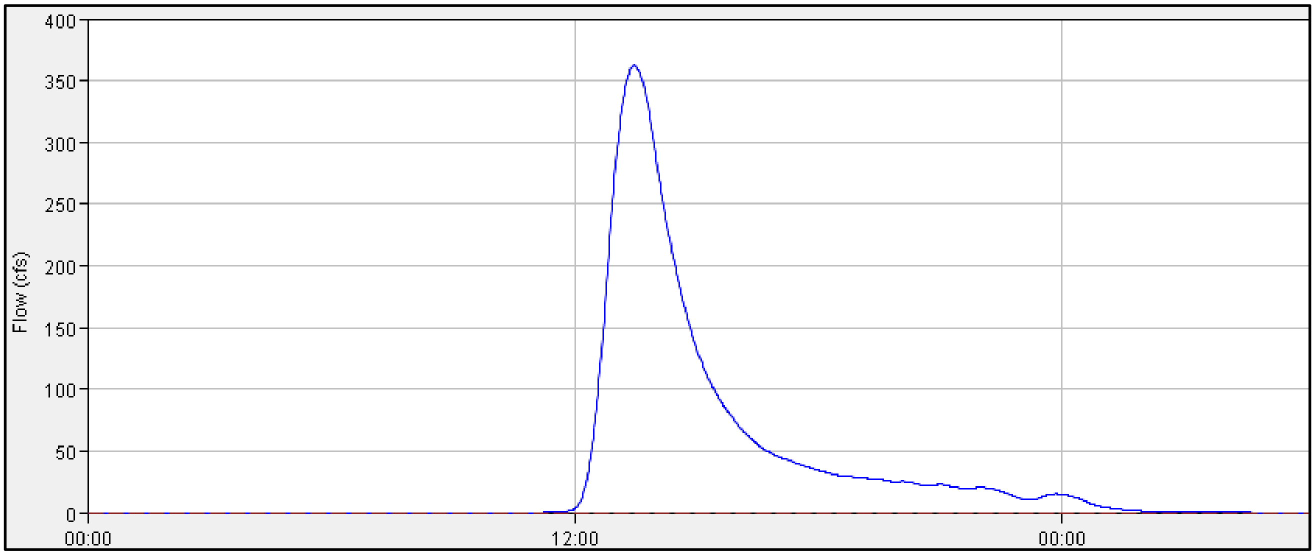

Figure 3: Calibrated Regression Hydrograph

R.M.
Attachment

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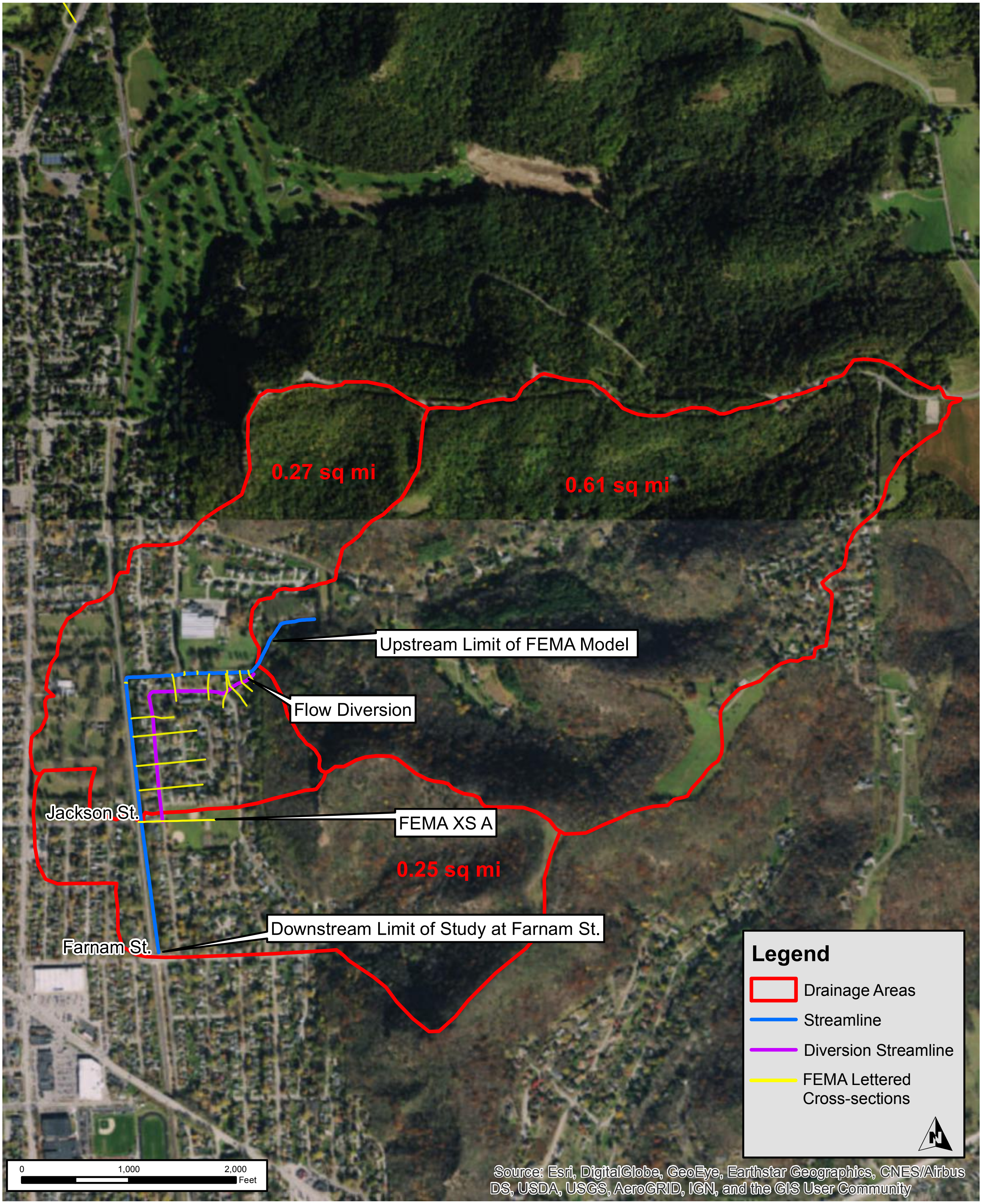

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Project Number: 142540
Print Date: 8/3/2017

Map by: rmondloch
Projection: NAD_1983_StatePlane_Wisconsin_South_FIPS_4803_Feet
Source: ESRI, FEMA & SEH

Ebner Coulee
La Crosse, WI

FIGURE 1
Drainage Areas

Building a Better World for All of Us®

MEMORANDUM

TO: Mr. Bernard Lenz, PE

FROM: Brad Woznak, PE, PH, CFM
Riley Mondloch, EIT

DATE: December 4, 2017

RE: Ebner Coulee Modeling Phase 2 - Historic Rainfall Analysis

Background

During the first phase of this analysis, SEH estimated flow rates into Ebner Coulee using the USGS Regional Regression equations for Wisconsin and performed modeling to demonstrate that the FEMA effective flood maps may be overestimating floodplain extents due to an overestimation of peak flow rates. See Attachment 1 for the report from the first phase of this project. The results from the first phase of the report were presented to the City of La Crosse Floodplain Task Force Committee. The initial study indicated the potential for significantly lower discharge rates than those published in the effective FIS, which were based on a hydrologic analysis from the late 1970s. Because an overestimation of the flood risks can place an undue burden on the City's residents, the results of the first phase warranted additional analysis of the flow rates. The Wisconsin DNR and ultimately FEMA will require greater scientific justification and proof beyond a just utilization of the regional regression equations over that of the previous hydrologic methodology in order to concur with a letter of map revision based on revised flow rates.

This second phase of the project, discussed in this memo, involves utilizing a hydrologic model to develop peak flow rates, a methodology similar to that originally utilized for the effective FIS. SEH contacted the Wisconsin DNR for the effective hydrologic model and obtained a hardcopy output of the HEC-1 model dated September 1979. SEH performed an in-depth review of the effective HEC-1 model and it was determined that this model was only utilized to route hydrographs developed by other methods and does not perform any rainfall-runoff computations. Similar to the argument made by the USGS in September 1994, it does not appear that sufficient information is available in the FIS documentation to reproduce the design hydrographs from the original FIS. Given this reason, SEH developed a HEC-HMS model, with TR-55 methodology, to perform rainfall runoff-modeling for estimating peak discharge rates for Ebner Coulee. Once the HEC-HMS model was developed, calibration and verification was performed by analyzing historic rainfall events over the past 20 years to a hydrologic model that has been calibrated to first the 1430 cfs FIS discharge and then to peak flow rates developed utilizing the USGS regional regression equations.

The peak flow rates from the three most intense historic rainfalls were calculated with each of the models and results input into the 1D/2D HEC-RAS model developed during the first phase of the project. Floodplain mapping was generated for each of the models and overlaid on the same mapping in an effort to validate the model results to the inundation experienced in the field for each of the three events. Since major flooding has not been observed in this area with any storms over the last 20 years, if the model results indicate significant flooding for the three most intense historic events, it is likely that calculated peak runoff rates are being overestimated.

The ultimate goal of this study is to either verify that the FIS discharge rates are appropriate for the associated flood risk or if not, to develop a scientific methodology that can be moved forward for discussion with the Wisconsin DNR to obtain overview and concurrence in support of a Letter of Map Revision submittal to FEMA.

Daily and Hourly Historic Rainfall Analysis
There are two rainfall gauging stations of interest for this study with available data for daily rainfall totals. The first station is the La Crosse Municipal Airport, station number USW00014920. The second station is the La Crosse Weather Forecast Office, station number USC00474373. The Weather Forecast Office is a newer station and does not appear to have data before 2000. The Municipal Airport station is approximately 5 miles away from Ebner Coulee, and the Weather Forecast Office station is about 1 mile away from Ebner Coulee. Given the closer distance, it would be ideal to use the Weather Forecast Office data only, however this station does not record hourly rainfall data, so it was necessary to include hourly data from the Municipal Airport station. See attached Figure 1 for a map showing the weather station locations.

Daily rainfall totals between 2001 and November 2017 were obtained for both stations and used to select the peak rainfall event for each year. Rainfall depths of the peak storm for each year at both stations are shown in Table 2. The values at the Weather Forecast Office were slightly higher for most years. The duration of the rainfall events typically varied between 12 and 36 hours.

Hourly rainfall depths were only available at the Municipal Airport station and were obtained from two sources. The NOAA NCDC has hourly rainfall reports from 2003 to 2012 that contain data for this station. WeatherUnderground.com was used to obtain hourly data for 2001, 2002, and 2013-2017. Neither of these sources had hourly rainfall data for 1997 to 2000. The project scope indicated performing the analysis on rainfall data back to 1997, but no data was available at the Weather Forecast Office before 2001 and no hourly data was available at the Municipal Airport station before 2001. We reviewed the yearly peak daily rainfall totals from 1997 to 2000 and it does not appear that any major storms occurred in this time period, so removing these four years from the analysis, will not impact the results.

The historic rainfall data was used to create hourly increment unit hyetographs for the peak storm of each year. These are plots of time versus cumulative rainfall depth for each storm normalized to 1 inch of depth. They are then multiplied by the total depth for each storm; this methodology allowed use of the closer Weather Forecast Office depths with the rainfall distributions from the Municipal Airport Location.

Available rainfall data from WeatherUnderground.com is reported in increments less than an hour, this more detailed data was used to create hyetographs with 10 minute increments for the three largest events. The hyetographs with a shorter time increment better capture short, intense periods of rainfall and may result in higher, more realistic runoff hydrographs. Since the data obtained from Weather Underground has inconsistent recording times at this location, ranging from 3 minutes to 1 hour, it was necessary to interpolate between some records to create the consistent 10 minute increment distribution for input into the HEC-HMS model.

HMS Model Calibration
HEC-HMS version 4.2.1 was used for the hydrologic analysis for this phase of the project.

From a review of available documentation, it appears that the effective FIS hydrologic analysis developed the flood hydrograph by scaling of the flood frequency information from Gilmore Creek in Winona, MN based on calculations utilizing the Bureau of Public Roads Method, also called the Cook Method. The USACE HEC-1 model was utilized to route the hydrograph through the Ebner Coulee System with UNET modeling utilized to develop water surface elevations.

During the first phase of this project, SEH estimated flow rates using the USGS Regional Regression Equations for Wisconsin; that analysis resulted in flow rates much lower than the 1430 cfs depicted in the effective FIS as the 1-percent discharge. See Table 1 for the Regression Equation results.

Table 1: Phase 1 Regression Equation Results

Source	Location	Drainage Area (SqMi)	Peak Flow (cfs)	ESE (%)	Minus 1 Standard Error (cfs)	Plus 1 Standard Error(cfs)
FEMA Effective	All Locations	0.9	1430.0			
Regression Eq.	Upstream Limit of Fema Model	0.61	360.8	44	202.0	519.5
Regression Eq.	Jackson Street	0.88	428.5	44	240.0	617.0
Regression Eq.	Farnman Street	1.13	494.7	44	277.0	712.3

During the first phase of the project, a HEC-HMS model using the SCS hydrologic method was also developed as another means to estimate peak flow rates; this methodology resulted in flow rates higher than the Regression Equations (100-year discharge of 601 cfs for the 0.61 square mile drainage area to the upstream end of the model), but still significantly lower than the 1430 cfs effective flow rate. SCS hydrology with HEC-HMS is being used again for this second phase of the project to create a hydrologic model calibrated to the 1430 cfs for the 100 year event.

An area of 0.9 square miles was used for the calibrated watershed model, this area corresponds to the larger watershed to the top of Jackson Street, not the top of the Ebner Coulee drainage ditch. It was determined that this was the only drainage area utilized in the original FIS to obtain the 1-percent flow rate of 1430 cfs. Based on the hydrologic characteristics, the Curve number (CN) and time of concentration of 58 and 67 minutes, respectively, were estimated.

Executing the hydrologic model with these original parameters results in a flow rate of 892 cfs, well below the 1430 cfs desired for calibration, so the CN was increased to 65 and time of concentration was lowered to 49. These values result in a 100 year peak flow rate of 1431 cfs, making this the HEC-HMS model calibrated to the FIS flow rate. Changing the CN and time of concentration to these values is reasonable for the following reasons: The original CN corresponded to B classified soils, because that is the majority soil classification in this area according the NRCS soils data. The new value of 65 corresponds to the same land cover distribution, but with half C classified soils and half B classified soils. The NRCS soils data is very approximate, and there are some C soils in the drainage area, so using a balanced value is very reasonable. Estimating the time of concentration is relatively approximate, so lowering it by 18 minutes is not unrealistic given the steep slopes of the watershed.

HEC-HMS Hydrologic Modeling with FIS Calibrated Model

A HEC-HMS model run was developed for each year utilizing the FIS calibrated hydrologic model and the historic unit hyetograph distributions from the Municipal Airport station with La Crosse Weather Forecast Office station total depths. These depths should be more appropriate for the Ebner Coulee watershed given the closer distance, the rainfall distribution was assumed to be similar to that of the Municipal Airport. Table 2 shows the peak flow rate results for each storm from the FIS calibrated HMS model. The approximate duration over which the majority of the rainfall total fell is also shown in Table 2, note that the rainfall distributions varied greatly, so for some storms the rainfall total may have fallen continuously while for others may have been made up of several separate periods of rainfall. The Atlas 14 rainfall depths for the 1-, 2-, 10-, 50-, and 100-year, 24-hour storm events with MSE3 distributions were also modeled in the FIS calibrated model for comparison and are shown in Table 3.

Table 2: Highest Total Storm Depth per Year and FIS calibrated HEC-HMS Peak Flow Results

	Total Storm Depth (in)			
	Municipal Airport	Weather Forecast Office		
Year	USW00014920	USC00474373	Peak Flow(cfs)	Duration (hours)
2001	3.12	4.19	318	32
2002	2.7	2.9	77	45
2003	1.05	1.39	3	28
2004	3.53	2.76	53	41
2005	3.15	2.96	171	28
2006	1.82	2.89	110	25
2007	6.76	7.59	**326**	40
2008	4.4	5.31	**527**	36
2009	3.33	3.36	317	23
2010	3.87	3.99	148	29
2011	0.98	2.58	153	36
2012	1.61	1.63	11	15
2013	2.77	2.42	74	29
2014	1.16	2.77	117	22
2015	1.49	2.32	40	14
2016	4.7	4.28	111	32
2017	5.15	6.26	**996**	12

Table 3: Atlas 14 Depths with MSE3 Distribution Peak Flow Results

Storm	Atlas 14 Depth	Q Peak (cfs)
MSE3 - 1 yr, 24 hr	2.61	95
MSE3 - 2 yr, 24 hr	3.01	159
MSE3 - 10 yr, 24 hr	4.47	490
MSE3 - 50 yr, 24 hr	6.53	1093
MSE3 - 100 yr, 24 hr	7.57	1431

HEC-RAS Hydraulic Modeling

The unsteady 1D-2D coupled HEC-RAS model from the first phase of the project was used for this analysis. HEC-RAS version 5.0.3 was used. This model uses 1D techniques to represent flow within the ditched portion of Ebner Coulee, and 2D techniques for the floodplain areas, when flow spills out of the channel. This model was chosen because it the best mix of preserving the original FIS modeling methodology while incorporating 2D modeling techniques for the complex overbank flows that cannot be properly represented with 1D flow methods. The three highest peak flow historic events were modeled, the years of these events are 2007, 2008, and 2017.

The HEC-HMS model was calibrated with a drainage area of 0.9 square miles to match the drainage area in the original FIS study; from a review of the watershed, this corresponds to the area draining to the top of Jackson

Street. The historic flow hydrographs obtained from this FIS calibrated HEC-HMS model were input at Jackson Street in the HEC-RAS model, which differs from the effective FIS HEC-RAS model which included the hydrograph from this drainage area at the top of the model/start of the Ebner Coulee. To estimate the discharge at the upstream end of the Coulee, the FIS calibrated HEC-HMS model was duplicated and the drainage area was modified to 0.61 square miles, the area draining to the top of the coulee system. This was used to obtain the flow hydrograph at the top of the coulee system for the historic storms. Table 4 shows the historic peak flows to Jackson Street and the historic peak flows to the top of the Ebner Coulee ditch for the three storms modeled. Note that the hydrograph applied to the HEC-RAS model at Jackson Street is actually the result of the total hydrograph with the top of model hydrograph subtracted from it, so the flows below Jackson Street will be summed correctly. Travel time between the two points is minimal and was neglected with this methodology.

Table 4: Peak Flows of Hydrographs used in HEC-RAS (FIS calibrated HEC-HMS model)

	Peak Flow(cfs)	
Year	0.9 Sq-mi	0.61 Sq-mi
2007	326	221
2008	527	357
2017	996	675

Figures 2, 3, and 4 depict the inundation of these three historic events as modeled with the unsteady 1D-2D HEC-RAS model using hydrographs developed with the FIS calibrated HEC-HMS model. The FEMA effective 1-percent floodplain is also shown for comparison.

Historic Storms Compared to Regional Regression Equations

For phase 1 of the project, a HEC-HMS model was developed using the MSE3 distribution with a 7.1 inch 100 year, 24 hour rainfall depth and calibrated to output flows matching the results from the USGS Regional Regression Equations (RRE). Similar to the modeling performed with phase 2, there was a version of this model with a drainage area of 0.61 square miles (to the top of the coulee/start of model) and a model with a drainage area of 0.9 square miles (to Jackson Street) matching the original FIS drainage area.

The three peak historic rainfall events were modeled with these RRE calibrated HEC-HMS models to obtain peak flows and hydrographs for the historic events calibrated to the Regional Regression Equation results. The 10, 50, and 100 year events with MSE3 distributions and Atlas 14 rainfall depths were also modeled with this calibrated model for comparison. The RRE calibrated HEC-HMS model peak flow rates for the historic events are shown in Table 5; this is a revised version of Table 4 showing the RRE calibrated HEC-HMS model peak flow rates compared to the FIS calibrated HEC-HMS model peak flow rates. Table 6 shows the MSE3 distribution peak flow rates from the RRE calibrated HEC-HMS model; the 100 year MSE3 peak flow is higher than the Regression Equation peak flow rates because Atlas 14 rainfall depths are slightly higher than the regression equation publication rainfall depths. The RRE calibrated peak flows are lower in 2008 than they are in 2007, opposite as seen with the FIS calibrated model; this is because the RRE calibrated HMS models have a different curve number and required much higher time of concentration/lag time and the lower rainfall depth and resulting runoff volume results in lower peak runoff rates.

Table 5: FIS Calibrated Peak Flow Rates versus RRE Calibrated Peak Flow Rates

	FIS Calibrated Historic Peak Flow (cfs)		RRE Calibrated Historic Peak Flow (cfs)	
Year	0.9 Sq-mi	0.61 Sq-mi	0.9 Sq-mi	0.61 Sq-mi
2007	326	221	241	172
2008	527	357	169	151
2017	996	675	441	317

Table 6: MSE3 Peak Flows from RRE Calibrated HEC-HMS Model

		RRE Calibrated Model MSE3 Peak Flow (cfs)	
Storm	Atlas 14 Depth	0.9 Sq-mi	0.61 Sq-mi
MSE3 - 10 yr, 24 hr	4.47	42	29
MSE3 - 50 yr, 24 hr	6.53	360	302
MSE3 - 100 yr, 24 hr	7.57	486	414

The runoff hydrographs developed from the RRE calibrated models were modeled in HEC-RAS and the resulting flood inundation areas are also depicted in Figures 2, 3, and 4.The purpose of this is to compare the observed historic flooding in the area to that of the inundation areas calculated from the various hydrologic methodologies. The method which most closely matches that of historic observations would be the most appropriate to utilize to represent the flood risk for the area.

Results Discussion

From a review of the available rainfall data from the past 20 years of record, it is apparent that none of the historic rainfall events reproduced the 100 year published flow rate, despite the August 2007 (40-hour duration) storm having rainfall totals near the 100 year Atlas 14 totals. The reason for this is that the real-world rainfall events do not always follow the MSE3 distribution which was used to calibrate the model. It's important to note that the original design hydrograph used in the effective modeling is unknown and not available for calibration against. The MSE3 distribution is conservative because it is developed utilizing the critical duration events and is typically used for design purposes. This means that the "true" 100 year rainfall distribution may be less intense than the MSE3 distribution, but the MSE3 is currently the most widely accepted rainfall distribution for this area.

2007 Peak Event

The 2007 event had the highest rainfall total depth. The rainfall depth over 40 hours is almost equal to the 100 year Atlas 14 depth at the Weather Forecast Office. Approximately 6.7 inches of this total fell in approximately 25 hours, which makes this portion of the storm initially appear to approximate a 50 year, 24 hour event. However, the calculated peak flow rate is nowhere near the 1093 cfs associated with the 2-percent event. Figure 5 shows the cumulative rainfall of the 2007 storm and the resulting runoff hydrograph from the FIS calibrated model. There are three periods of higher intensity rainfall that produce separate runoff peaks, this is part of the reason the peak flow rate is much lower than 1093 cfs. Figure 6 shows the 2007 storm cumulative rainfall and the MSE distribution cumulative rainfall for a 100 year, 24 hour storm. The MSE3 distribution has a very short intense period of rainfall where the majority of the rain falls within a 20 to 30 minute time period. The historic 2007 storm had slower steady rainfall spread over a longer time, which does not result in the same peak runoff even though the total reported storm totals are near the 100 year Atlas 14 depths.

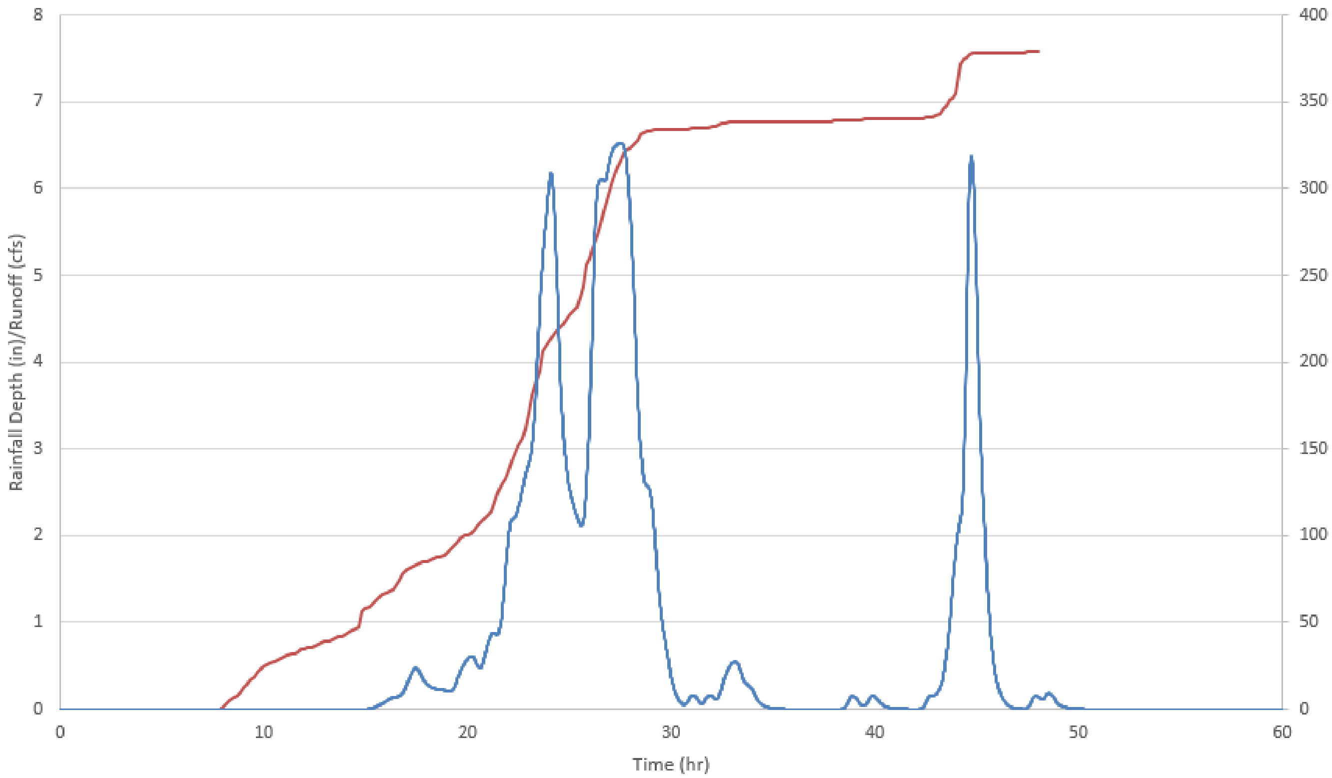

Figure 5: 2007 Historic Cumulative Rainfall and Resulting Runoff from FIS Calibrated HMS Model

See Figure 2 for the flooding inundation area results of the 2007 event from HEC-RAS. The inundation results from both the FIS calibration and RRE calibration are shown. The structures that would be at least partially inundated with the FIS calibration are also shown. For both calibrations, there is only very minimal flooding and only 2 structures that would appear to be inundated. For the FIS calibration, a small amount of flow would still break out from the Ebner Coulee ditch upstream from the 29th Street culvert, and flow would break out over the west bank between Jackson and Farnam Street. The RRE calibrated model is showing inundation to the west of the train tracks north of Farnam Street; flooding in this area is likely overestimated by the model because as previously discussed, not all of the runoff from the drainage area delineated to Jackson Street would actually get into the channel. Much of it would be picked up by storm sewer or stored in other depressions.

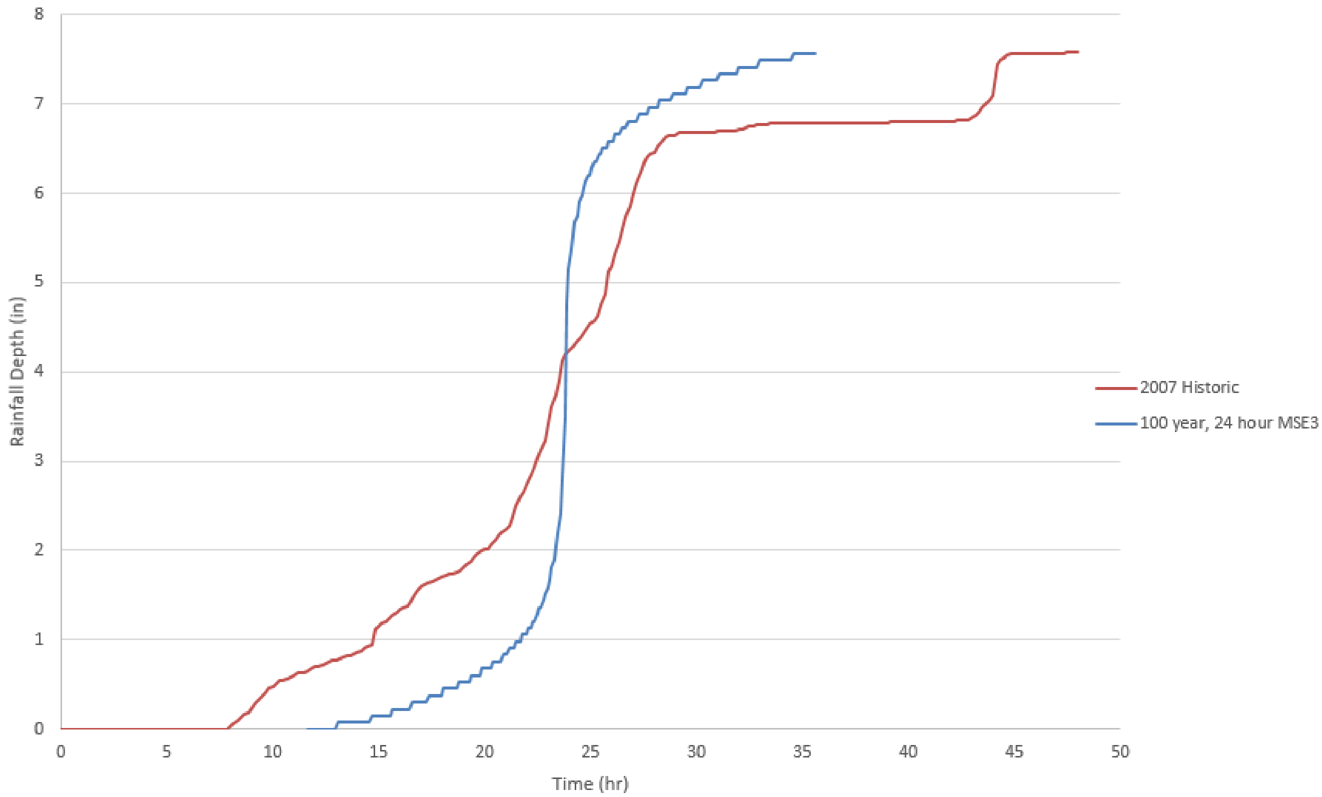

Figure 6: 2007 Historic Cumulative Depth and 100 year, 24 hour MSE3 Cumulative Depth

2008 Peak Event
As shown in Figure 7, the 2008 event has a similar cumulative rainfall distribution as the 2007 event, with slow, steady rain over a long time. However, the 2008 event had one period of high intensity where over an inch of rain fell in under an hour. This intense period resulted in a short but relatively high flow period of runoff.

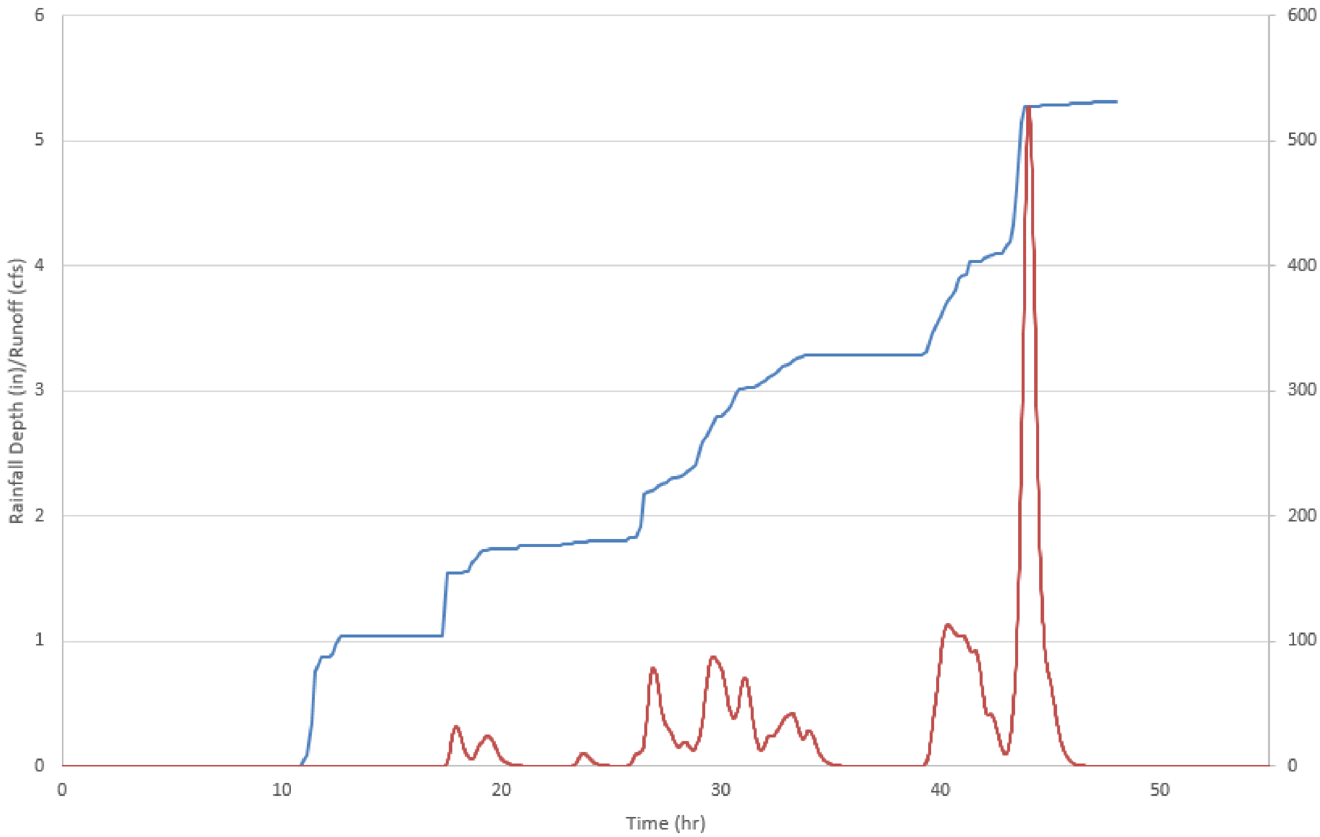

Figure 7: 2008 Historic Cumulative Rainfall and Resulting Runoff from FIS Calibrated HMS Model

For the 2008 event, more flow breaks out of the Ebner Coulee ditch upstream from the 29th Street culvert in the FIS calibrated model. This water then runs down the street and ponds up north of Farnam Street. Like with the first phase of modeling, the city storm sewer in this area was not modeled; this is consistent with the original FIS modeling technique. Approximately 24 homes appear to be at least partially inundated with this calibrated modeling. Based on feedback obtained during the City of La Crosse Floodplain Task Force Committee meeting, no homes were inundated during this event. The 2008 event results from the RRE calibrated model, shows only extremely minimal flooding to the west of the train tracks north of Farnam Street, which appears to be more in line with historic observations in the field.

2017 Peak Event

The 2017 event had the second highest total rainfall depths and produced the highest calculated runoff in the last 20 years. There are several periods of very high rainfall intensity, with the highest producing over an inch of rain in approximately 10 minutes. Aside from the period around hour 25 where the rainfall stopped temporarily, the rainfall distribution of this storm is much closer in shape and intensity to the MSE3 distribution than the storms of 2007 and 2008. The total rainfall depth at the Weather Forecast Office station is approximately a quarter of an inch less than the Atlas 14 50-year, 24 hour rainfall depth of 6.53 inches. The total storm length was approximately 12 hours, with most of the rain falling in just 5 to 6 hours. The Atlas 14 100 year, 12 hour rainfall total is 6.72 inches; this indicates that the July 2017 storm had a recurrence interval nearly that of a 50 year event.

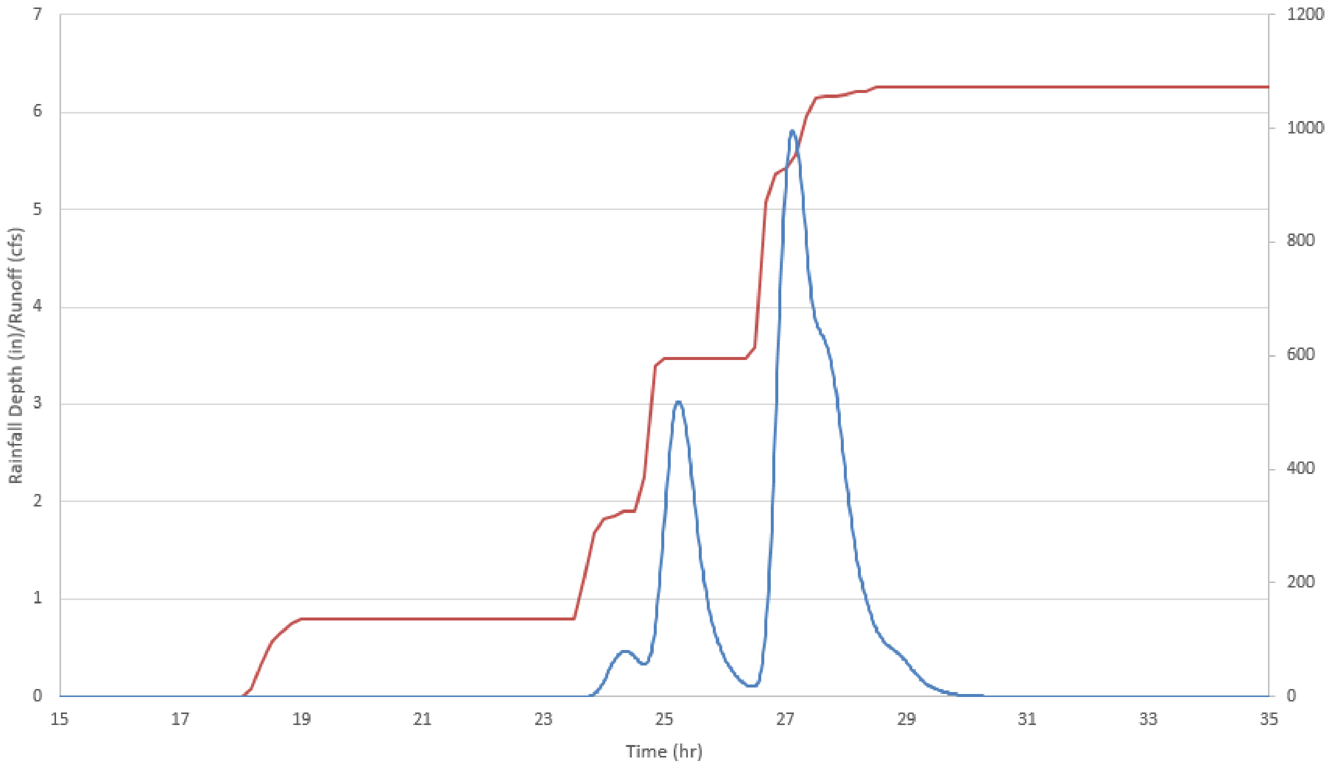

Figure 8: 2017 Historic Cumulative Rainfall and Resulting Runoff from Calibrated HMS Model

For the 2017 event FIS calibrated model, there is significant flow break out from the Ebner Coulee ditch upstream from the 29th Street culvert and flow break out from the right bank near the upstream end of the Ebner Coulee model. This results in additional inundation north of the drainage ditch, like what is seen in the effective FEMA inundation map. The flooding and ponding north of Farnam Street is major. Up to 88 homes appear to be at least partially inundated with this FIS calibrated modeling of the 2017 event, when no homes were reported to be inundated during this event.

For the 2017 event RRE calibrated model, there is still a significant amount of break out flow predicted from the left bank of the Ebner Coulee ditch upstream from the 29th Street culvert. This is similar to the amount of flooding seen with the model results associated with Regional Regression Equation developed 100 year event, from Phase 1 of the study. Based on input during the City's Flood Task Force Committee, even this inundation area is greater than that experienced in the field. This could suggest that even the Regional Regression Equation flow estimates over predict that experienced, but what may be more likely is that the 29th Street culvert or Ebner Coulee drainage ditch 1D geometry in the model is more restrictive than it is in reality, forcing more water out of the channel at this location. The 1D channel portion of the model has not been changed from the FIS effective model.

Summary

A 100-year (1-percent) event does not appear to have occurred in the Ebner Coulee watershed over the last 20 years; however, the 2017 storm was very close to that of a 50-year event. A 50-year flow rate is not reported in the Flood Insurance Study (FIS), but would be expected to be around 1100 cfs based on the FIS calibrated HMS model. The HEC-RAS modeling indicates that a 50-year event and the 2017 event would cause major flooding when using a model calibrated to the FIS 100-year flow. The fact that a nearly 50-year flood event and several other major events occurred in the last 20 years, and no major flooding was reported as the modeling would indicate strongly that the published 1-percent effective flow rate of 1430 cfs is too high and a Letter of Map Revision (LOMR) based on a hydrologic analysis with lower discharge rates predicated on a hydrologic model calibrated to the USGS Regional Regression equations would be warranted.

R.M.

Attachment 1: Technical Feasibility Report – Ebner Coulee Floodway FIRM Remapping
Attachment 2: Figure 1 – Weather Station Locations
Attachment 3: Figure 2 – 2007 Peak Event Calibrated Inundation
Attachment 4: Figure 3 – 2008 Peak Event Calibrated Inundation
Attachment 5: Figure 4 – 2017 Peak Event Calibrated Inundation

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Project Number: LACRS 142540
Print Date: 11/29/2017

Map by: rmondloch
Projection: NAD_1983_StatePlane_Wisconsin_South_FIPS_4803_Feet
Source: ESRI, FEMA & SEH

Ebner Coulee Floodway FIRM Remapping
La Crosse, WI

FIGURE 1
Weather Station Locations

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Project Number: LACRS 142540
Print Date: 12/1/2017

Map by: rmondloch
Projection: NAD_1983_StatePlane_Wisconsin_South_FIPS_4803_Feet
Source: ESRI, FEMA & SEH

Ebner Coulee Floodway FIRM Remapping
La Crosse, WI

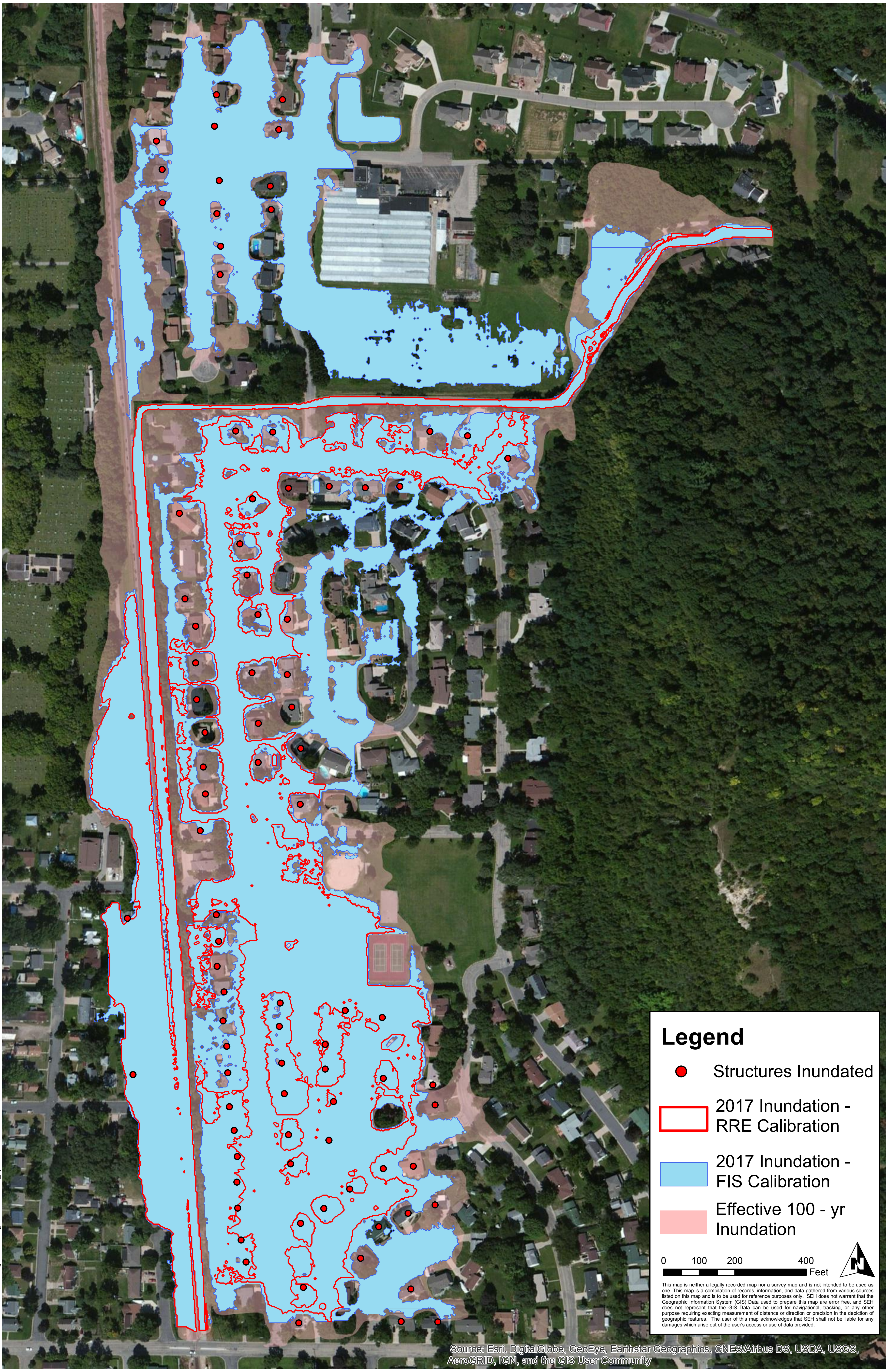
FIGURE 2
2007 Peak Event
Calibrated Inundation

Project Number: LACRS 142540
Print Date: 12/4/2017

Map by: rmondloch
Projection: NAD_1983_StatePlane_Wisconsin_South_FIPS_4803_Feet
Source: ESRI, FEMA & SEH

Ebner Coulee Floodway FIRM Remapping
La Crosse, WI

FIGURE 3
2008 Peak Event
Calibrated Inundation



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Print Date: 12/4/2017

Map by: rmondloch
Projection: NAD_1983_StatePlane_Wisconsin_South_FIPS_4803_Feet
Source: ESRI, FEMA & SEH

SEH

Ebner Coulee Floodway FIRM Remapping
La Crosse, WI

FIGURE 4
2017 Peak Event
Calibrated Inundation

APPENDIX 3

WIRTTEN SURVEY SENT TO RESIDENTS REGARDING THE JULY 2017 FLOOD – EXAMPLE

EBNER COULEE FLOOD SURVEY **February 2, 2018**

Greetings:

You are being contacted in an effort to gather historical flooding information from property owners located in the Ebner Coulee watershed of La Crosse and Shelby. The City has done preliminary studies that indicate the run-off model used to create current floodplain maps over predicts the extent of flooding in your neighborhood. The reason for this survey is to gather observations of flooding during the July 19-21 of 2017 rain event for the purpose of comparing observed flooding depth and extents to model predicted flooding depth and extents. The goal is to convince WDNR and FEMA to allow the City to revise the modeling approach to get results that more accurately match what is being observed. We need your help with those observations!

Pictures of water or debris lines would be the best documentation of flooding that we could get. But to document that you were not flooded is also very critical as the model used to make the current flood map indicated 88 houses would have been inundated with flood water during the July 2017 event. We don't believe that happened, so returning a survey indicating you were not flooded is very, very important data to have to help prove our case for a remapping. We hope that by improving these maps there is potential for reduced flood insurance rates for the properties impacted.

If you have historical pictures of flooding or debris lines those would also be useful, but we are particularly interested in the July 19-21, 2017 storm event. It is critical that we gather as much and as accurate of information as possible about this event to complete this project. Please complete this survey at your earliest convenience. We will be compiling results starting March 1st. Thank You.

Mail survey and pictures to:

Bernard Lenz – P. E.
City of La Crosse Engineering Department
400 La Crosse St.
La Crosse, WI 54601
608-789-7364

Or scan and email surveys and pictures to:

EbnerCouleeFlooding@cityoflacrosse.org

++

Question 1: Did you receive any flooding related impacts or damages to your property or residence from the July 19-21 of 2017 event?

YES ☐ NO ☒

Question 2: Did you see any significant standing water near or from the Ebner Coulee drainage ditch during the dates specified above?

YES ☐ NO ☒

Question 3: Did you observe any flowing water through your yard or a neighbor's yard?

YES ☐ NO ☒

Question 4: Did you see any evidence of flooding that had already disappeared? This would include things such as debris, flattened grass, exposed soil, or another indication there was standing or flowing water.

YES ☐ NO ☒

EBNER COULEE FLOOD SURVEY **February 2, 2018**

Question 5: Did you make any observations of water level within the Ebner Coulee drainage ditch itself?

YES ☐ NO ☒

Question 6: Did you make any other observations during this storm event that you feel would be helpful in assessing the flood levels? If so, please state them below.

____

____

____

Question 7: Do you have any pictures or documentation of historical flooding in Ebner Coulee?

YES ☐ NO ☒

Question 8: Describe You.

Name: Dave Christensen Year's in current residence: 12 yrs, since 2006

Address: 817 28th St S. Phone #: 796-0092

Email: wheeljen@charter.net

Best Way and Time to Contact email, or phone during daytime

If your answer was YES to any of the questions please attach a description of your observations and/or provide any documentation or photos that you have of the damage or water levels. If you prefer we call you to discuss your observation check here.

CALL ME ☐

Depending on your survey responses, a representative from the City may be following up with you to gather additional information or survey data. We hope you are willing to meet with City staff at your residence and discuss/point out any observations you may have made so staff can survey the location and elevation of those observations. Again, Thank You.

Please email or mail the survey and pictures to the address listed on page 1.

APPENDIX 4

PHOTOS

Photo 1 – Grate at entrance to 8x10 foot box culvert under Farnam Street

Photo 2 – Channel upstream of August, un-mowed (Just upstream of 29th Street Culvert)

Photo 3 – Channel in December, after being mowed (near railroad, upstream of Farnam Street culvert)