Upper Malletts Stormwater Conveyance Study

Washtenaw County Water Resources Commissioner
Washtenaw County, Michigan

Prepared for:

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I. EXECUTIVE SUMMARY

Over the past several decades, neighborhoods within the Upper Malletts Creek watershed have experienced several flooding episodes. Flooding is most pronounced along Churchill, Wiltshire Court, Wiltshire, Delaware, Morehead, Mershon and Scio Church Roads, as well as Village Oaks/Chaucer Court. The drainage area includes developed and undeveloped land in the City, and in the surrounding townships west of I-94 - Pittsfield, Lodi, and Scio. Problems range from localized street flooding due to clogged catch basins to basement flooding due to overwhelmed storm sewers. The stormwater conveyance system is mostly piped with a few reaches of open channel. There have been recent storm events, including the March 15, 2012 storm, where flooding has damaged residential property.

The Washtenaw County Water Resources Commissioner (WCWRC) commissioned a stormwater conveyance study of the Upper Malletts Creek watershed. The study was requested by the City of Ann Arbor by resolution of the City Council and the City funded the study. The purpose stated in the resolution is to evaluate and identify opportunities for conveyance and storm water improvements in the Churchill Downs and Lansdowne sub-watershed areas that may be necessary or appropriate to provide, improve and restore storm water management and water quality protection functions within the drainage district. The study goals, discussed and confirmed during public process, include:

- Reduce probability of flooding by improving stormwater management
- Identify cost of implementation per level of service
- Avoid adversely impacting downstream interests
- Maintain and/or enhance water quality
- Create long-term sustainability

After gathering background information and public input, a comprehensive list of stormwater management techniques was created based on preliminary site observations. The key concepts for addressing surface flooding included reducing stormwater runoff volume, detaining stormwater runoff, and adequately conveying stormwater to detention or green areas. Examples of techniques that have been successfully implemented in other communities, generally listed from lowest to highest cost and from least to most impact, include:

- Curb and drainage inlet structure enhancements
- Street maintenance procedures
- Cleaning and/or repair of existing drainage infrastructure
- Enhancement or modification of existing detention facilities
- Overland stormwater flow management
- Bio retention or natural approaches
- New open/surface stormwater detention
- New underground storm water detention
- Upsizing and enhancement of storm sewer capacity

Experience has shown that long standing flooding problems in large developed watersheds often require a combination of management techniques to solve the issues. Over the course of the study, a list of these techniques was developed, refined and compiled into design alternatives. The alternatives were evaluated through engineering analysis and public engagement. Figure I-1 below indicates the sites that were considered for new detention or improvements to existing detention facilities.

Figure I-1: Screened Detention Locations

Based on the cost benefit analysis performed during the screening phase of the study, three detention projects in combination with storm sewer improvements were chosen for further analysis - Eisenhower Park, Lawton Park, and Pioneer High School (East of 7th Street) combined with Scio Church storm sewer improvement project. Each project manages stormwater for a portion of the watershed and reduces a percentage of the overall flooding previously experienced. In order to control the entirety of the flooding experienced in March of 2012, all three detention projects and the Scio Church storm sewer improvements must be implemented. In addition, there are several storm sewer retrofit projects associated with each basin that must be completed for the system to work properly.

Project A – Eisenhower Park Basins and Storm Sewer Improvements

This alternative would add two detention basins in Eisenhower Park. The two basins together are 2.5 acres in size, would have a combined storage volume of 10.8 acre-ft., and are connected by a 42" pipe (Figure I-2). For comparison purposes, an acre is approximately the size of one football field. Flow from the Covington Road storm sewer would be diverted to these new basins.

Figure I-2: Project A - Eisenhower Park Basins and Sewer Improvements

Project B – Pioneer Basin and Scio Church Storm Sewer Improvements
A detention basin would be created along the north side of Scio Church Road just east of 7th Street (Figure I-3). This basin is 2.8 acres in area and has a storage volume of 9.2 acre-ft. Since Scio Church Road will soon be completely reconstructed, the storm sewer in Scio Church could be upsized to accommodate a portion of the detention volume thereby reducing the detention area on land owned by Ann Arbor Public Schools. The amount of storage that could be achieved in the Scio Church storm sewer will be determined during detailed design.

Figure I-3: Project B – Pioneer Basin and Sewer Improvements

Project C – Lawton Park Basin and Storm Sewer Improvements

An underground detention basin would be constructed along the eastern edge of Lawton Park. This underground detention basin uses box culverts connected to create a storage capacity of 6.4 acre-ft. (Figure I-4). The basin encompasses an area of 1.1 acres. The basin will be connected to an overflow structure that will prevent the flooding of the storage chamber and allow flow downstream through the storm sewer under Mershon Drive.

Figure I-4: Project C – Lawton Park Underground Storage and Sewer Improvements

Cost estimates were prepared for the recommended alternatives. The costs were based on conceptual designs and the best available information. A contingency factor, costs for professional services, and permitting are included in the cost estimates to give a true picture of the total investment necessary. The costs were developed using 2013 dollars and an appropriate inflation factor must be used for future budgeting.

Table I-1: Alternative Costs

Street / Project Site Name	Storage Volume (cf)	Project Costs	Cost/Volume Storage
Eisenhower Park Basin	470,000	$2,100,000	$4.50
Pioneer Basin	400,000	$1,170,000	$2.90
Lawton Park Basin	280,000	$5,155,000	$18.40
Total		**$8,425,000**	

Green infrastructure solutions and street stormwater storage were also considered as part of the study. Green infrastructure includes Low Impact Design (LID) methods, which are an effective and responsible stormwater management technique, especially when combined with other upgrades to improve water quality and reduce time of concentration for runoff. The analysis included LID methods and the utilization of oversize storm sewers for detention within the street right-of-way (ROW). In many areas of the City, open land simply isn't available for construction of basins to store street runoff. ROW storage becomes the only viable option for reducing stormwater impact and has proven very effective when combined with LID methods. The types of ROW treatment solutions considered included:

- Porous pavement and stone reservoirs for runoff storage under the pavement
- Road diets (reducing the road cross section width) to reduce impervious area
- Rain gardens
- Oversize pipe storage

Utilizing information from previously completed projects, a cost benefit analysis for the ROW treatment improvements was completed. The sample projects were averaged for the volume provided per foot of street reconstruction and the cost per cubic foot of storage achieved. The ROW solutions cost per cubic feet of storage ranges from $43 to $353 with an average of $119.08. Comparatively, open detention ranges between $2.92 to $4.46 per cubic foot (an average of $3.69) and underground detention is estimated at $19.15 per cubic foot. After the initial public meetings and reviewing the soils information, small individual rain gardens were not further quantified or analyzed. Soil saturation is an issue and there have been a number of basement seepage complaints in the watershed. However, where opportunities exist, ROW treatment and private rain gardens should be combined with other improvements.

A critical component of the Upper Malletts Stormwater Conveyance Study was public engagement. Gathering input first on the problems and issues, then on the stormwater management alternatives was essential to accurately model the hydrologic response to rain and to select functional, acceptable alternatives. Public meetings, websites, social media, and personal contacts were all utilized to gather and distribute information appropriately. In addition, a Citizens Advisory Group made up of 12 residents was established to help guide the project.

Strong and consistent messaging was an essential part of the project. Key messages were developed and communicated to stakeholders throughout the study to ensure continuity and help maximize understanding and engagement.

During the study, the WCWRC and the City completed cleaning and storm sewer inspection within the watershed. This included more than 65,000 feet of storm sewer ranging in size from 12" to 72". The inspection found the sewer system to be in good condition and functioning properly. Deterioration, sediment and debris deposits were found, but these were very minor compared with expectations for a system of this size and age. Corrective measures were completed or are being planned for minor defects found. The findings of the inspections were that pipe deterioration or obstructions in the main lines of the storm sewer system were not a significant factor in the March 15, 2012 flooding event. However, inlet blockages caused by debris were an issue in many areas. These are being proactively managed by the WRC and City to reduce the occurrences of blockage.

The probability of future flooding will be reduced as the recommendations of the Upper Malletts Stormwater Conveyance Study are implemented. Each project manages stormwater for a portion of the watershed and reduces a percentage of the overall flooding previously experienced. To control the entirety of the flooding experienced in March of 2012, all three detention projects and the Scio Church storm sewer improvements must be implemented.

II. GATHER INFORMATION

A. Project Background

The Upper Malletts watershed is located upstream (west) of the Ann Arbor-Saline Road crossing of the Malletts Creek. A map of the watershed is shown in Figure II-1. The drainage area includes developed and undeveloped land in the City of Ann Arbor and in the surrounding townships west of I-94 - Pittsfield, Lodi, and Scio.

Over the past several decades, neighborhoods within the Upper Malletts Creek watershed have experienced several surface related flooding episodes. Flooding is most pronounced along Churchill, Wiltshire Ct, Wiltshire, Mershon, Morehead, Delaware, and Scio Church Roads, as well as Village Oaks/Chaucer Court. Problems have ranged from localized street flooding due to clogged catch basins to basement and overland flooding due to overwhelmed storm sewers. There have been recent storm events, including the March 15, 2012 storm, where flooding damaged residential property.

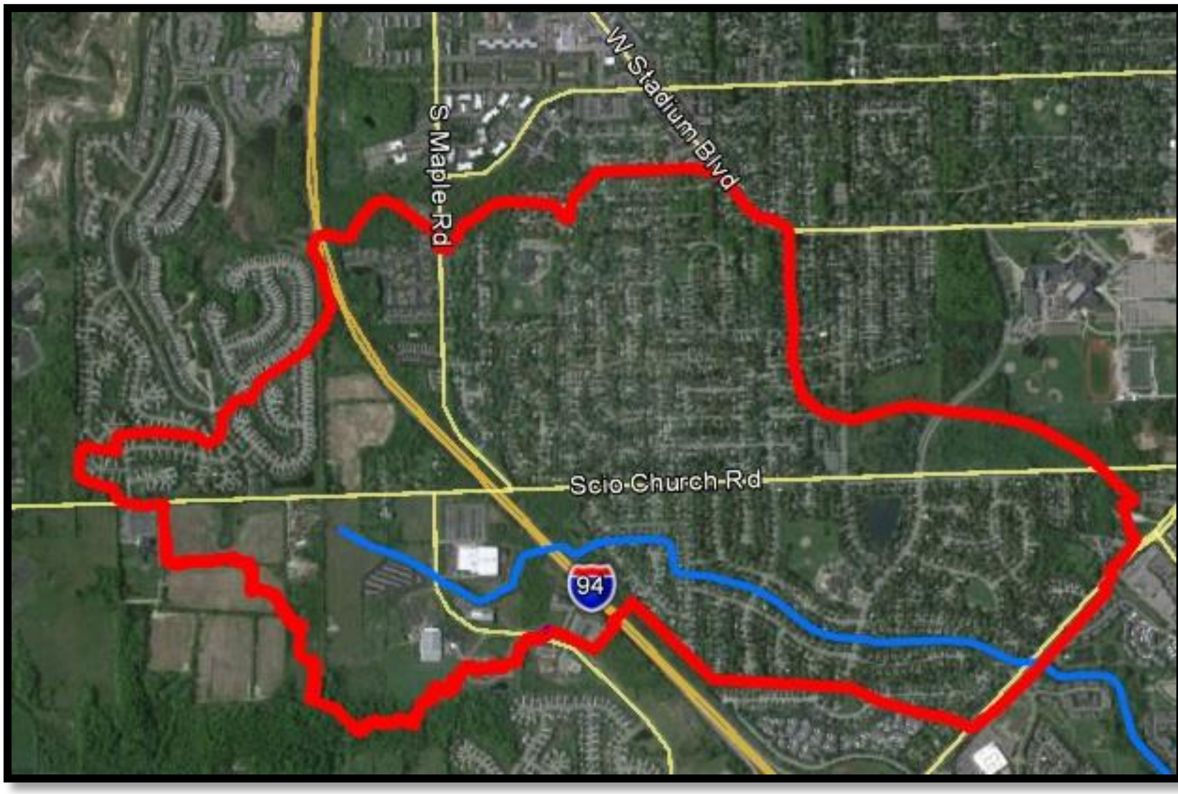


Figure II-1: Upper Malletts Creek Watershed (shown in red) and Drain (shown in blue)

Historically, portions of Upper Mallets Creek were converted from natural open creek drainage to enclosed drainage at the time of residential development. Enclosing and relocating a drain does not necessarily prevent runoff from following the original, overland natural drain course. Furthermore, land development causes a large runoff volume increase when compared to predevelopment conditions and the increased runoff is likely to follow the natural course of the drain. Figure II-2 shows an aerial image of the Upper Malletts Creek Watershed in 1947 with surface drainage patterns present at the time. It also shows wetland data from the Michigan Department of Environmental Quality indicating existing wetlands and areas with soils suitable to wetland establishment. Figure II-3 shows the same map overlain by existing building footprints.

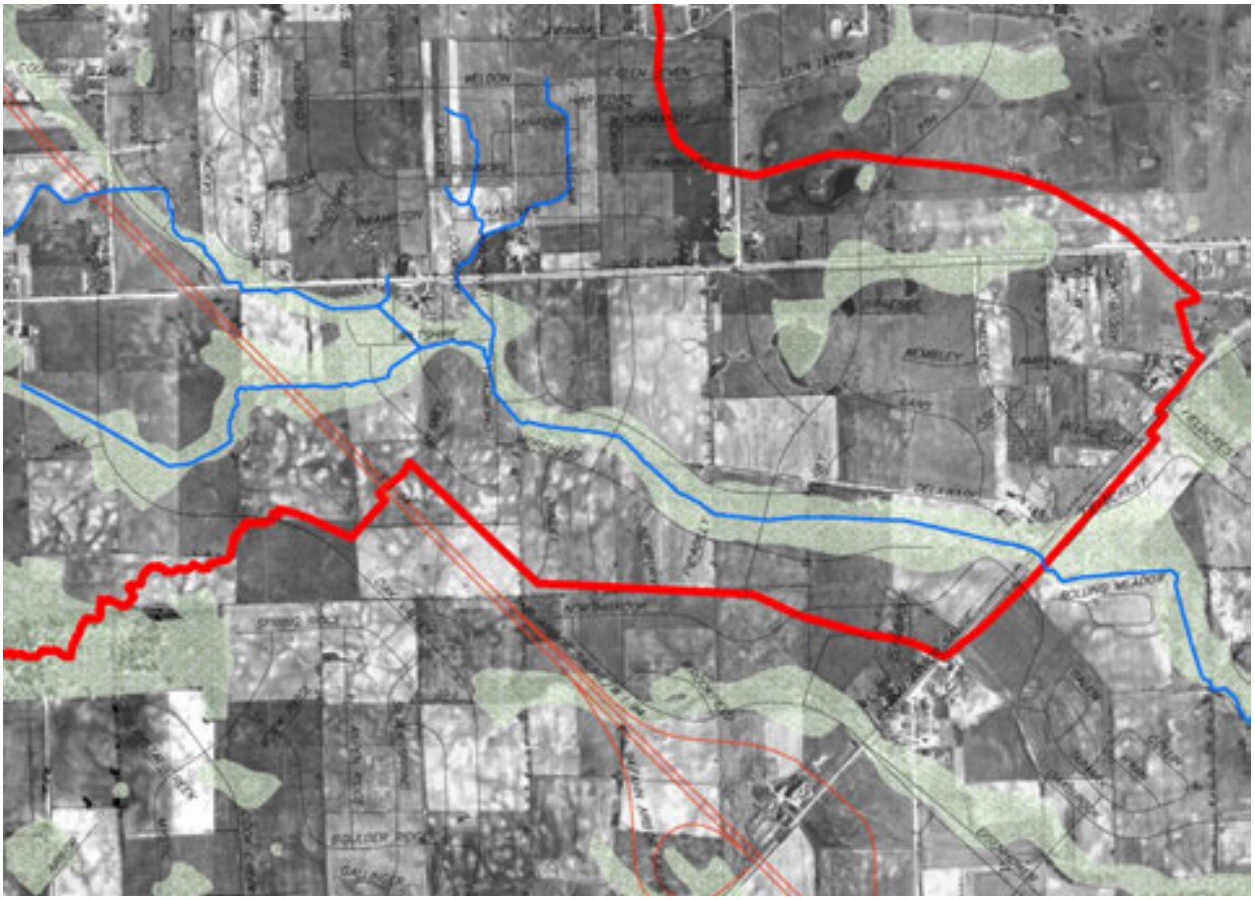


Figure II-2: Upper Malletts Creek Watershed near I-94 and Scio Church with 1947 Aerial Image

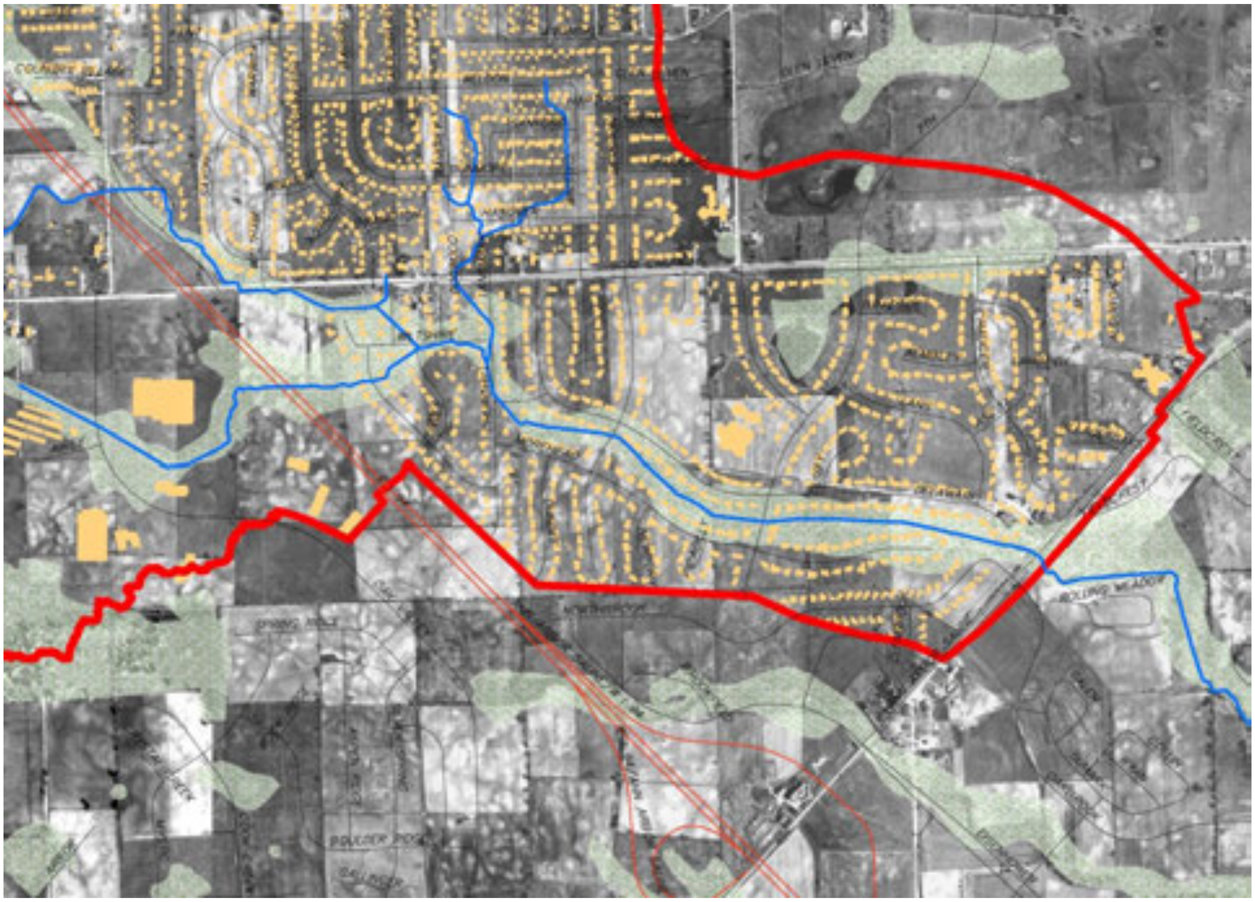


Figure II-3: 1947 Aerial Image Overlain with Existing Building Footprints

Comprehensive stormwater detention facilities for development within the City have not been constructed, as much of the development occurred prior to 1980 and detention requirements were not in place. More recent developments, especially those in the watershed area upstream of I-94, have detention facilities in place that met the standards at the time. The stormwater conveyance system within the City is mostly piped, with a few reaches of open channel.

Theories on the causes of the flooding vary by localized area, and large-scale flooding as experienced during the March 15, 2012 storm were initially believed to be caused by a combination of factors:

- Storm events that exceed the design capacity of the storm sewer. The March 2012 event exceeded the design capacity for numerous pipe segments within the system, causing surcharging and street backups.
- The lack of any detention, temporary storage, or other infiltration possibilities for the majority of the watershed certainly impacts the flooding potential. Combined with largely impervious soils, dense urban development and the associated increased impervious surface, large volumes of storm runoff are conveyed directly to the storm sewers with no ability to mitigate the peak intensity of the larger storm events.
- Insufficient inlet capacity, whether caused by a temporary blockage or too few or too small inlets, can have a significant effect on localized flooding. This was a factor in the flooding of Wiltshire and Wiltshire Court (temporary blockage of a major inlet) and along Hanover (insufficient inlet

capacity). It also contributed to flooding along Covington and Scio Church near 7th Street. Inlet capacity was also a minor factor in other areas, as noted in the analysis later in this report.
- Pipe blockages were ultimately ruled out as possible flooding causes, as detailed in Section IV-A.4 in this report.

The Upper Malletts Creek Stormwater Conveyance Study was completed in conjunction with two other studies/projects currently being administered by the City of Ann Arbor - the Stormwater Model Calibration and Analysis and the Sanitary Sewer System Flow Monitoring and Wet Weather Evaluation project. These three projects were coordinated in order to keep each team informed, but each project has been managed separately. A Technical Oversight and Advisory Group has been established for streamlining, coordination and a peer review opportunity (Figure II-4).

Figure II-4: Ann Arbor Stormwater Projects Organization

B. Study Goals

Initial project efforts included setting goals and criteria for the study results. Recommended improvements would be compared against the overall project goals to ensure the WCWRC's and City's needs were met. The study goals, discussed and confirmed during public process, include:

- Reduce probability of flooding by improving stormwater management. The main project goal was to eliminate or reduce flooding for storm events similar to the March 15, 2012 rainfall.
- Identify cost of implementation per level of service. All of the projects would be evaluated on a cost/benefit basis. Lower cost projects with significant impact would be given greater consideration than higher cost projects or those with less impact on the overall watershed.
- Avoid adversely impacting downstream interests. Since the downstream reaches of Malletts Creek have their own flooding concerns, runoff from the Upper Malletts watershed could not be conveyed downstream beyond Ann Arbor/Saline Road in a greater volume or rate than currently exists. Therefore, simply increasing the size of the conveyance system was not an acceptable option.

- Maintain and/or enhance water quality. Based on input from the City and WCWRC, emphasis would be placed on alternatives that would improve the stormwater quality.
- Create long-term sustainability. Projects that required only minor annual maintenance would be preferred over projects that required more maintenance. In addition, any short- and long-term operational costs would be taken into account.

The project goals were reiterated at all public informational meetings to reinforce their importance.

C. Information Gathered

1. March 15 NOAA Rainfall Data

A storm event on March 15, 2012 caused significant flooding and was the impetus for this study. Due to the extent of flooding and availability of visual evidence of flood levels, this storm event was used to establish a base line for evaluation of storm sewer system capacity. Radar rainfall data were obtained from the National Oceanic and Atmospheric Administration's (NOAA) Nation Climate Data Center (NCDC) in five minute intervals from March 9, 2012 at 3:55 to March 15, 2012 at 23:55 (Figure II-5).

2. Other Rainfall Data

Aggregate rainfall data were obtained from the City of Ann Arbor Rain Gauge website. Rainfall data were obtained at three different locations; Barton Pond, Jackson Road, and S. Industrial Road (Figure II-5). These data were used to corroborate the March 15 storm volumes shown by the radar rainfall data. The following is a link to the online database where the data were obtained: http://www.a2gov.org/government/publicservices/systems_planning/waterresources/dataandinformation/Pages/Rain.aspx

The side bar in Figure II-5 compares these rainfall data to Bulletin 71 rainfall depths for Washtenaw County. The March 15 storm event had similar volume a 10-year, 3-hour storm.

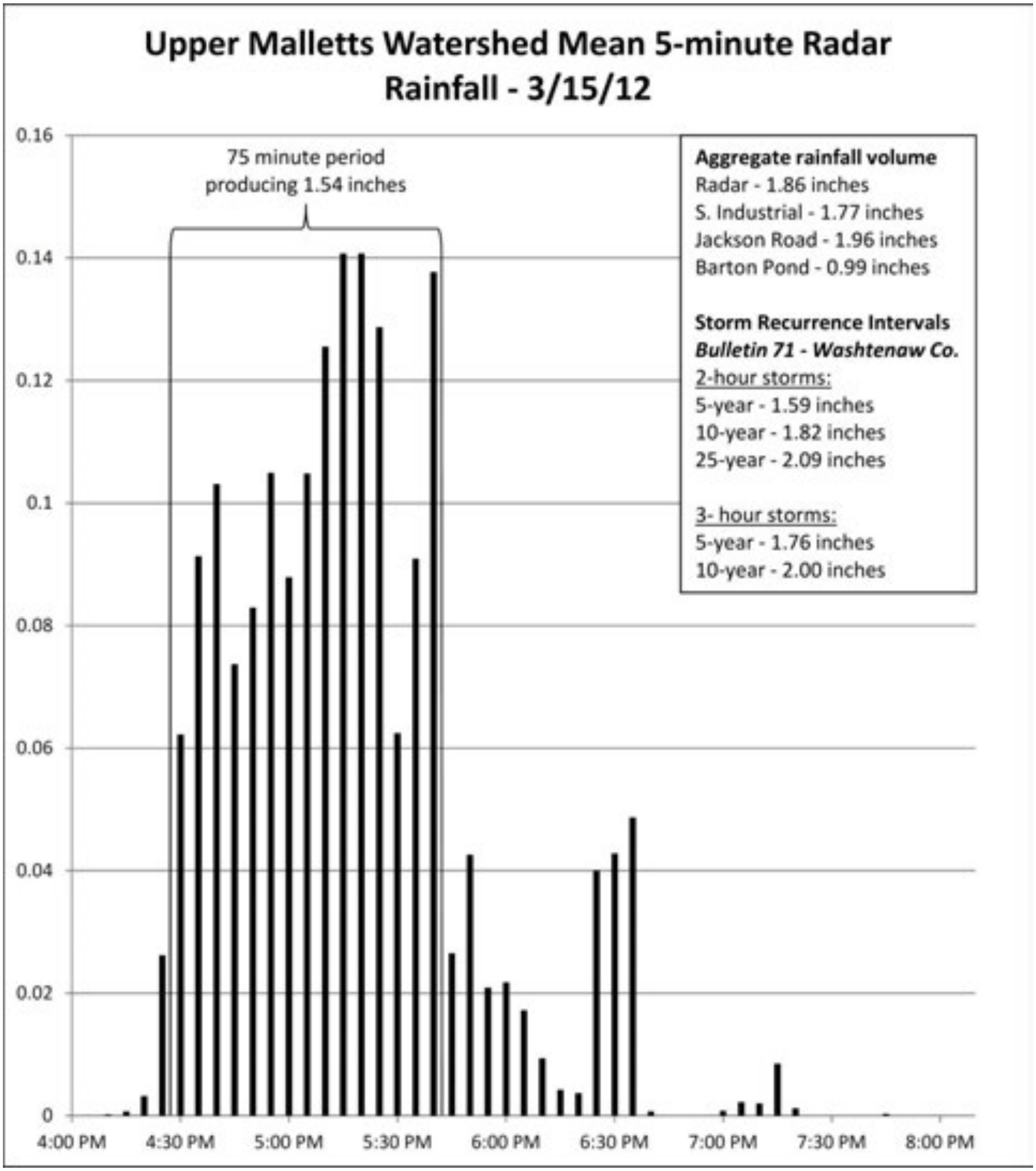


Figure II-5: Rainfall Data

3. GIS Information

Geographic Information System (GIS) information was obtained from the City of Ann Arbor, Michigan Geographic Data Library (MiGDL), United States Geological Survey (USGS), and Washtenaw County. The storm sewer and drainage structures under the City's jurisdiction, the county drain (both open and enclosed) information under the jurisdiction of the WCWRC, right-of-way (ROW), historical complaint data and parcel information was obtained from the City of Ann Arbor and WCWRC. The most recent aerial imagery and surface elevation information based on LIDAR data were obtained from the USGS. Two (2) foot contours were obtained from Washtenaw County. Road and rail centerlines, hydrography, political boundaries, water table data and soil data were obtained from MiGDL.

This information was used to develop the different project concepts and produce modeling results for the selected alternatives.

4. Storm Sewer Model

An EPA SWMM 5 storm water model of the entire City of Ann Arbor was provided by the City. The City has ongoing efforts to calibrate the model, which had been done on a limited basis for the Upper Malletts Creek watershed. The City's hydrologic calibration efforts for the Upper Mallets were based largely on field data collected including pictures and high water marks of the flooding that occurred on March 15 2012. The model version 2.1 provided on May 31, 2013 was used largely as provided with a few exceptions as noted in Section II-C.5.

5. Model Modifications

To better reflect field conditions and flooding observed on March 15, 2012, several modifications were made to the City of Ann Arbor's hydraulic model. To simplify the modeling process, the model was initially pared down to focus only on the Upper Malletts Creek watershed. Junction 97-50313 was converted from a node to an outfall and served as the outfall from the Upper Malletts Creek study area. This point was selected as the outfall since it was located about 4,200 feet downstream of Ann Arbor-Saline Road and any impact from backwater downstream was minimal. No modification to the hydraulic model was done downstream of Ann Arbor-Saline Road. The model was simply extended a sufficient distance to allow tailwater effects to propagate out of the model before they impacted the Malletts Creek upstream of Ann Arbor-Saline Road. Other modifications included adjusting pipe entrance and exit losses, adding obstructions, creating new design rainfall curves, adjusting pipe sizes, and adjusting elevations. A detailed list of changes made to the baseline existing conditions model is outlined in Table II-1 and the location of each change is shown in Figure II-6.

Table II-1: Model Modifications and Adjustments

Location	Description	Feature	Change	Purpose
1	Oak Valley Drive	Junction 91-51213_E1	Change name to 91-51213_X	Circumvent name length restrictions for GIS flood mapping.
2	West of I-94 north crossing	Storage 91-51212	Adjust storage curve up 1.5' and set invert at 950.00	Adjust elevations to match LIDAR topographic surface.
3	I-94 north crossing	Link 95-66014	Set entrance loss coefficient to 0.5	Increase entrance loss to culvert under expressway to reflect observed water ponding west of I-94.
4	I-94 south crossing	Link 95-66018	Set entrance loss coefficient to 0.9, exit loss coefficient to 1.0, changed diameter to 54", and added 1' sediment to pipe	Back water up west of I-94 to reflect observed field conditions.
5	Ice Cube	Storage 91-51213_C	Adjusted invert to 935.00	Raised invert 5' to match design drawings and field conditions.
6	Ice Cube	Link 91-51213_C1	Set entrance loss coefficient to 0.5, exit loss coefficient to 1.0, and changed diameter to 12"	Add restricted flow outlet from Ice Cube to be consistent with basin's actual outlet design.
7	West of Wilshire Ct.	Link 95-66070	Set entrance loss coefficient to 0.9, added 2' sediment to pipe	Restricted flow into enclosed storm sewer to reflect March 15 flooding.

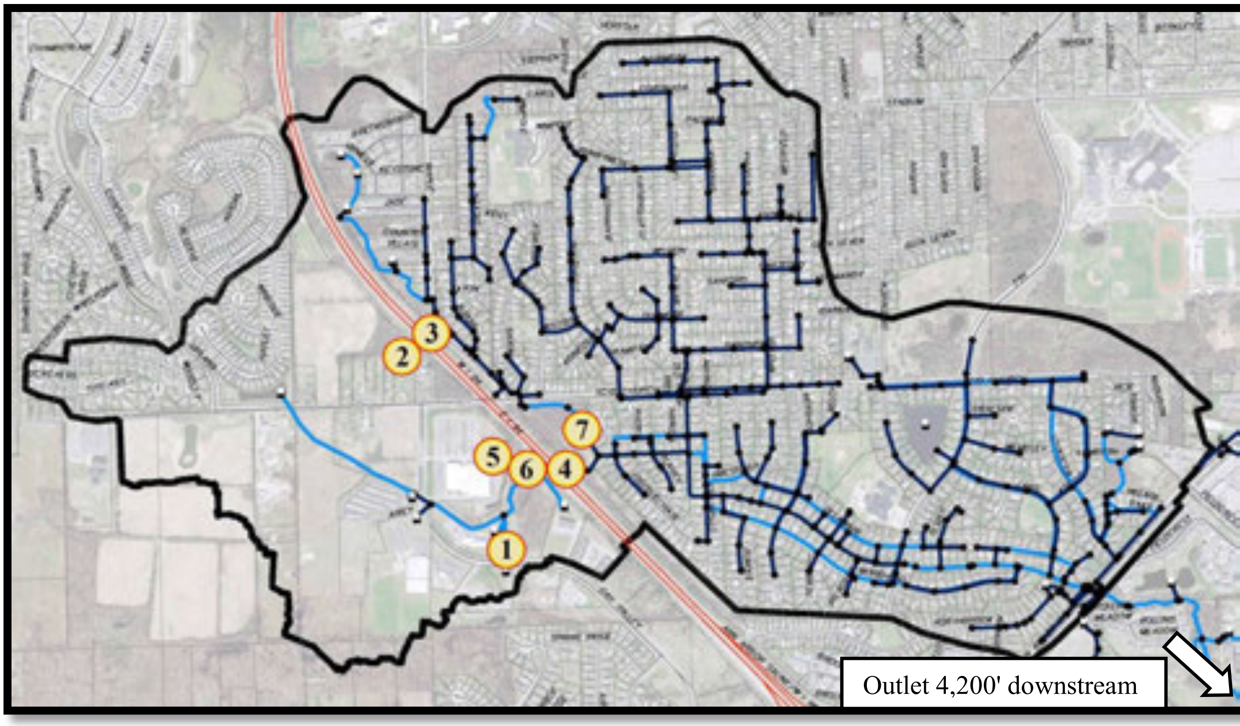


Figure II-6 : Map of March 15 Model Modifications and Adjustments

In addition to modifying the baseline model, numerous changes were made to the model to show conditions for various improvement alternatives recommended in this study. These changes are described in detail in Section VI. For all models showing proposed conditions, obstructions added to the existing conditions model were removed. Model results are shown in Appendix A: Flood Maps and described later in the report.

6. Soil Analysis

As part of the Upper Malletts Creek Stormwater Conveyance Study, soil borings were taken at various locations throughout the project area. The investigation identified soil and ground water conditions and permeability or infiltration rates for the soils to design stormwater management systems. Twelve separate borings were taken at distinct locations. A map of the locations is included in **Error! Reference source ot found.**. **Error! Reference source not found.**In addition to the sampling and soil classification completed at the boring site, laboratory permeability testing was conducted on select samples. The full soils analysis is included in Appendix B: Soil Boring Location Map and Soil Boring Report.

Most of the boring locations were selected to determine if the original streambed that ran through the neighborhood was still functional as an aquifer and to understand the presence of permeable soils. After reviewing historical aerials, locations were selected that were reasonably close to the original stream course. Several borings were also taken near potential detention areas to determine if soils were suitable for infiltration techniques.

The predominant soil type was found to be clay, with some traces of silt and gravel at various depths. Groundwater was generally encountered between 5’ and 15’ in depth, although no groundwater was encountered at three of the locations either during or immediately after drilling. Standard penetration resistance (N-values) ranged from 1 (soft) to 57 (very hard). The results for each boring are shown on the boring logs included in Appendix B: Soil Boring Location Map and Soil Boring Report.

The permeability analysis showed relatively poor permeability in the areas tested. Infiltration rates were quite low; meaning any management concepts that were infiltration dependent would be problematic in back-to-back storms. In addition, the borings didn't demonstrate any evidence of the original streambed that traversed the neighborhood.

7. *Storm Video Inspection and Map*

During the study, the WCWRC and the City inspected more than 65,000 feet of storm sewer ranging in size from 12" to 72". The inspection found the sewer system to be in good condition and functioning as designed. Deterioration, sediment and debris deposits were found, but these were very minor compared with expectations for a system of this size and age. All debris was removed. The initial findings were that pipe deterioration or obstructions in the main lines of the storm sewer system were not a significant factor in the March 15, 2012 flooding event. However, inlet blockages caused by debris were an issue in many areas. An analysis on the blockage effects is included in Section IV-4.

The larger portions of the storm sewer were inspected by physical entry into the system. A Remote Operated Vehicle (ROV) was used for smaller diameter pipes. Typical examples of the results are shown below. Cleaning of debris and minor repairs to the system were completed as part of the Upper Malletts Stormwater Conveyance Study.

Sewer in Good Condition:
The following is an example of a pipe in good condition and represents the pipe condition of a majority of the sewer system (Figure II-7).

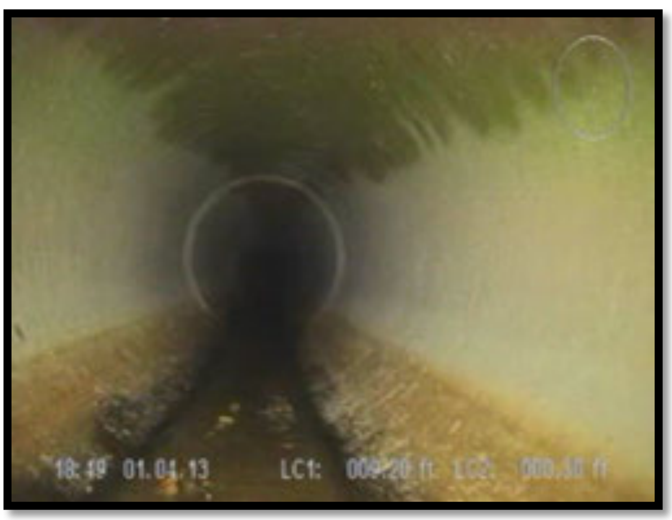


Figure II-7: Pipe in Good Condition

Blockages:
Isolated areas where blockages could impede the flow of water were located. The following example shows a buildup of sediment and organic debris (Figure II-8).

Figure II-8: Sewer Blockage

Minor Cracks:
Some pipe sections exhibit minor cracks, as seen in Figure II-9. Although it depends on the location and severity, cracks like the one shown pose little short-term concern. The City of Ann Arbor will assess each location individually to determine if any corrective action is necessary.

Figure II-9: Minor Sewer Cracks

Broken Pipes:
Several broken pipes or separated joints were noted as pictured in the example in Figure II-10. Again, depending on the location and severity, broken joints may need to be addressed as part of city maintenance. These flaws did not contribute to the flooding on March 15, 2012 in any substantive way.

Figure II-10: Broken Pipes

The enclosed portion of the Malletts Creek Drain was inspected by WCWRC. Refer to Figure II-1 for a map showing the drain. A copy of the report is in Appendix C. The results of the inspection included:

- **Concrete Pipe:** Good condition with some minor spalling (flaking) in some locations; surface integrity is still intact.
- **Pipe Joints:** All joints are mechanically sound with no separations evident. Mortar is in good condition with slight infiltration in some locations.
- **Pipe Connection (taps):** The 4" PVC pipe connections for sump leads are in good condition and properly sealed. Lateral pipe connections are in good condition with minor infiltration. Some locations need to be sealed with mortar.
- **Manhole Structures:** Good condition with no issues at this time, although one beehive casting needs to be reset.
- **Online storm inlets (beehive/flat grates):** Good condition with minor maintenance issues. Some castings need to be reset and sealed.
- **Sedimentation:** No sediment was observed.

D. Historical Flooding Information and Map

During the early public involvement phase of the study, information was gathered on historical flooding within the project area. Residents were asked to provide anecdotal, photographic, and video records of flooding events on or near their property. The information was summarized on several maps which graphically depict the approximate boundaries of past flooding, specifically during the March 15, 2012 storm event (Figure II-11). Included in the project website, which is described in Section III of this report, was an interactive SMART Map (Figure II-12) designed to share the public input collected. The interactive map was updated monthly to reflect the addition information collected by the online reporting tool mentioned in Chapter III.

The public provided much data related to the March 15, 2012, which was critical to calibrating the model to the real world flooding event that occurred within the Ann Arbor city limits. Identification of the high water locations, supplemented with photographic evidence, testimony at public meetings, and information sent to the project team by other methods, helped refine the flooding map for the March 15 storm. More than 100 photos and several videos of the flooding were provided by stakeholders.

Figure II-11: Resident Reported Flooding with City

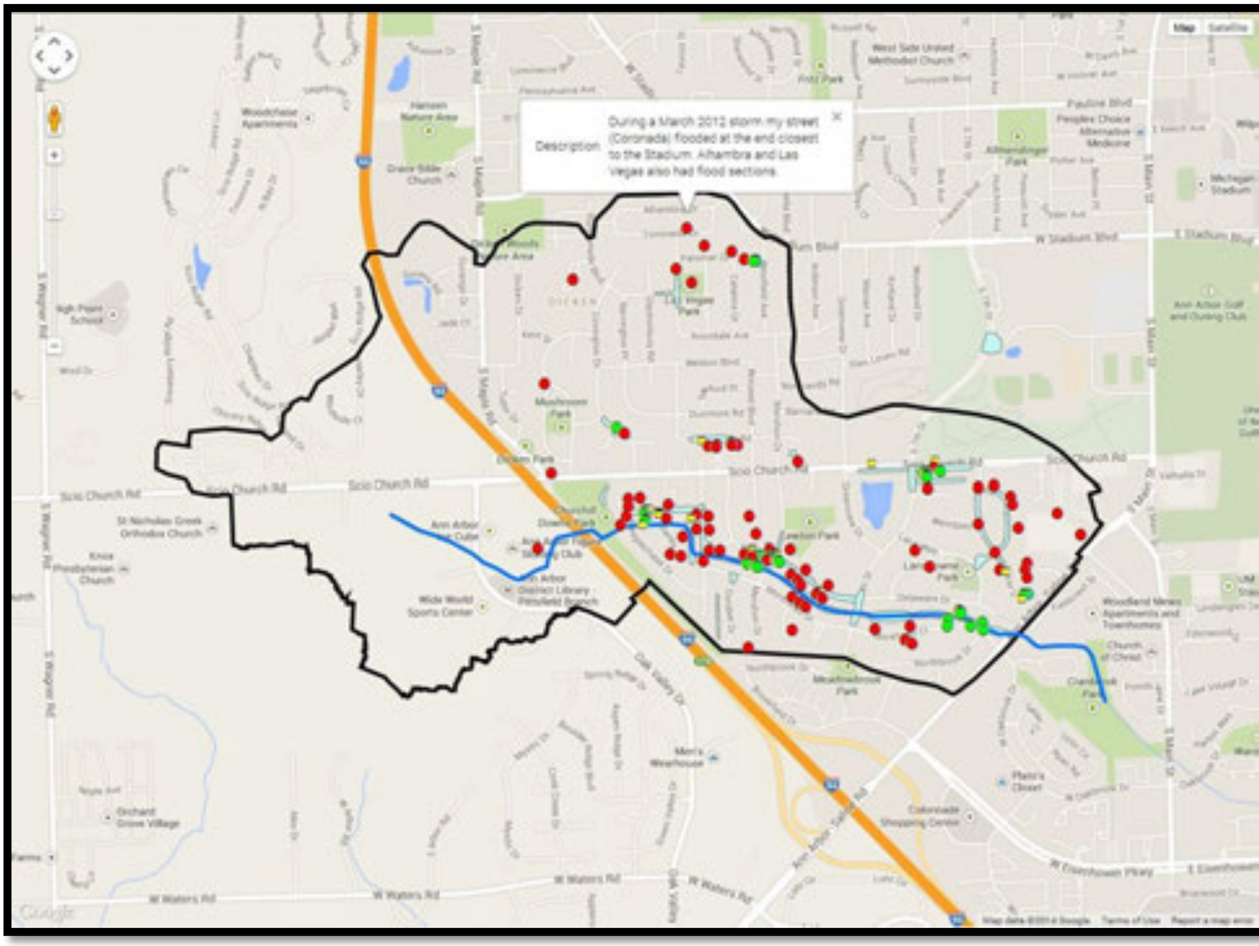


Figure II-12: SMART Map Website

III. PUBLIC ENGAGEMENT

Gathering input on the stormwater management alternatives was essential to selecting alternatives that were both functional and acceptable. Public meetings, websites, social media, and personal contacts were all utilized to gather and distribute information appropriately. A Citizens Advisory Group (CAG) was established to assist in guiding and overseeing the project. The CAG provided valuable insight into the history of the area, how the recommendations would impact local residents, and the general public's reaction to the material presented. CAG meetings were held at various milestones during the project, with the most important meetings held before public meetings. The CAG was able to review the proposed presentation material and suggest changes to improve communications.

A. Public Meetings

At various milestones throughout the course of the study, public meetings were held to gather information from past flooding and to update stakeholders on project progress. These proved to be extremely valuable, as residents provided substantial background information and a historical perspective that would otherwise have been unavailable. As noted, much of this information was included on various maps and graphics produced for the study.

Meeting summaries are provided in Appendix D. In general, the topics covered at each meeting were:

- **Public Meeting #1 (January 29, 2013)** – Introductory meeting reviewing the study goals and the project staff. Methods for sharing information with the project team were shared. Data were collected related to the March 15, 2012 flood event.
- **Public Meeting #2 (March 14, 2013)** – The project study area and project schedule were reviewed, potential stormwater management techniques were introduced, and the information gathered by the project team was shared. The public was given an opportunity to provide input on the stormwater management techniques.
- **Public Meeting #3 (May 21, 2013)** – The results of the storm sewer inspection and cleaning operation, the soil analysis, and the storm drain inlet capacity analysis were presented and discussed. The results of the first March 2012 storm event model were shown. The big focus at this meeting was the presentation of the potential detention areas, storm sewer improvements, and LID solutions. This information was reviewed and discussed in depth, with significant amounts of public response.
- **Public Meeting #4 (September 30, 2013)** – At this meeting, the preliminary recommendations of the watershed study were presented. The entire study process and engineering analysis were reviewed. The public was encouraged to offer feedback on the recommendations.
- **Public Meeting #5 (November 13, 2013)** – The draft report was presented for public review and comment.
- **Public Meeting #6 (January 29, 2014)** – The final draft report was presented, with the changes from the previous draft highlighted.

B. Individual Meetings

At the early public meetings, stakeholders were offered the option of having the project team visit their property to view historical flooding information and the impact of flooding on their property. Fifteen individual homeowners were interviewed and their input was invaluable to accurately calibrate the model to the actual flooding conditions. The interviews also offered an opportunity to gather ideas on flood management from the individual's perspective and get feedback on the study's progress.

C. Website & Other Digital Media

A project website was created to efficiently collect and disperse large amounts of information. The address of the site was provided at every public meeting: www.uppermallettsstudy.org (Figure III-1). The website had links to the flood reporting tool and contact information for the study leaders. Information and results gathered during the study were posted on the site and project updates were routinely provided. The website had more than 530 hits and proved to be a valuable tool for collecting and sharing information.

A Frequently Asked Questions (FAQ) document was developed for internal and external use and updated regularly on the website. This acted as a proactive messaging tool that addressed questions and concerns about the study early on and helped to minimize potential confusion.

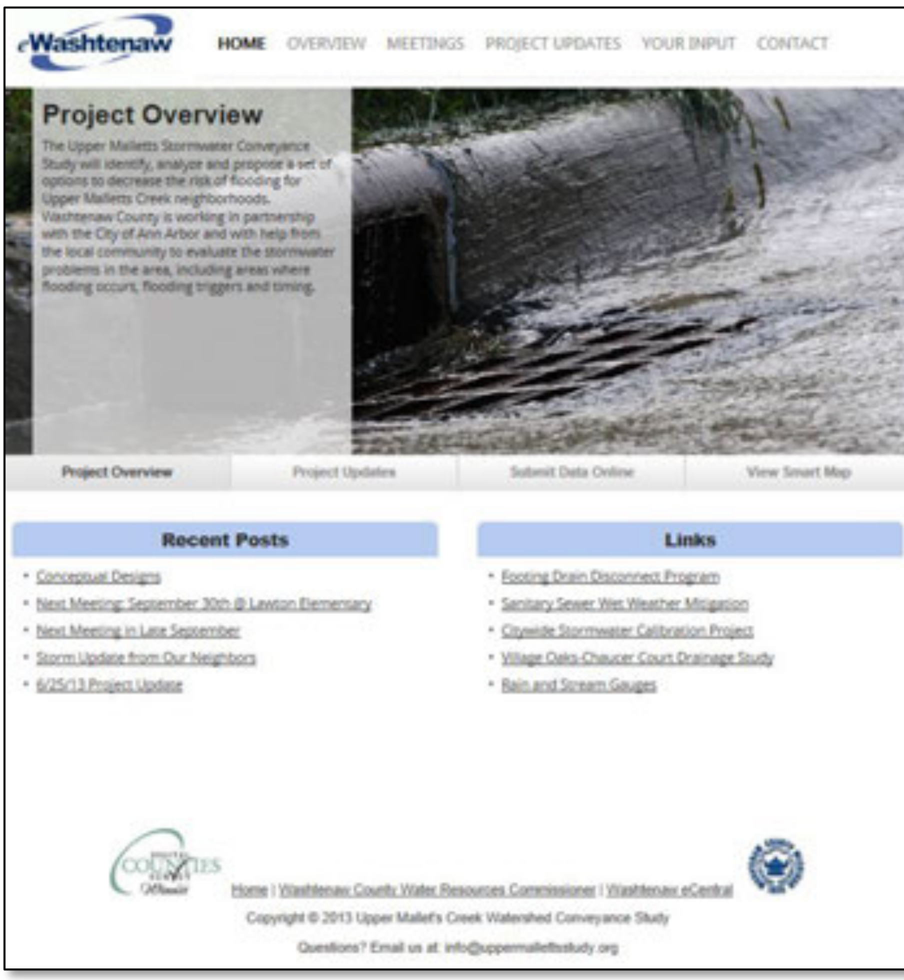


Figure III-1: Project Website

D. Flood Reporting Tool

A Flood Reporting Tool was developed to allow residents and City staff to promptly report surface flooding related problems with a date, time, location, contact information, and related photographs for each occurrence. This enhanced data for the GIS database was used to identify specific problem areas. A Mobile Web App accessible though mobile and tablet browsers was made available to the public to further encourage information sharing (Figure III-2).

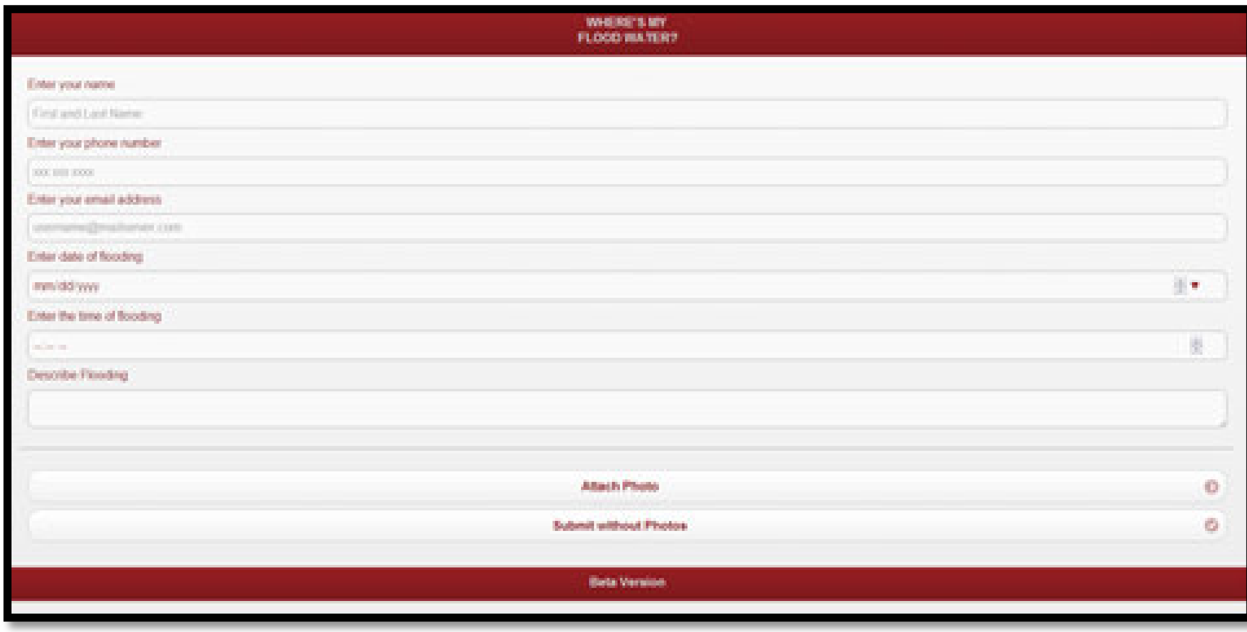


Figure III-2: Flood Reporting Web App

E. Media Outreach

The public meetings and study milestones required earned media support to raise awareness and encourage engagement from area residents. Techniques used included:

- Media advisories are brief summaries sent to media to alert them to upcoming newsworthy events. The team distributed media advisories about the Conveyance Study prior to public meetings or other events.
- News releases were distributed as a call-to-action for residents to attend future public meetings and to inform the public of any updates on the study.
- Talk Radio Interviews were completed by the WCWRC to increase study interest.
- Editorial Board Meetings with local editors, particularly AnnArbor.com, the Ann Arbor Chronicle and the Ann Arbor Observer, were held to thoroughly explain study objectives and gain positive editorial coverage.

IV. DATA COLLECTION, MONITORING & MODELING

A. Collection and Documentation of Data

Data were collected and documented to supplement the development of the stormwater model, including:

1. Field Observation of Overland Flow Patterns

Field observation of overland flow was conducted for a significant rain event on April 11, 2013. Based on data from the City of Ann Arbor's "South Industrial" rain gauge, this storm event produced 1.13 inches of rain over a period of 5 hours. Additionally, 0.47 inches of rain fell the day before, saturating the ground. Though street flooding was not observed to the extent of March 15, 2012, significant flow was observed in Malletts Creek and areas of ponding water accumulated in many of the same locations identified by landowners concerning the March 15, 2012 event. Figure IV-1 shows two areas of flow observed on April 11, 2013.

Figure IV-1 : Flooding during April 11, 2013 storm event 1) north of Scio Church Road on Pioneer High School Property (left) and 2) at Lans Basin middle weir (right)

2. High Water Mark Elevations/Landowner Interviews

High water mark locations were identified for the March 15, 2012 storm based on interviews with landowners in the Upper Malletts Creek watershed. These high water locations, supplemented with photographic evidence, testimony at public meetings, and information sent to the project team by various other methods, helped refine the map of flooding for the March 15 storm as shown in Figure II-11.

Flood limits were mapped using LIDAR topography referenced against observed high water locations. Based on this comparison, the baseline hydraulic model was calibrated so peak flooding during the simulated March 15, 2012 event closely mimicked observed flooding levels (See Section VI-B for details).

3. Preparation of a Map of Overland Flow Patterns

LIDAR topography was evaluated to identify likely overland flow patterns within the Upper Malletts Creek watershed. Though overland flow patterns do not precisely match sewer flow direction, this analysis provided insight into the flow of water once flooding begins. A map of overland flow pattern is provided in Figure IV-2. Note the watershed boundary shown on this map was later revised to better reflect flow conditions, partially due to this analysis.

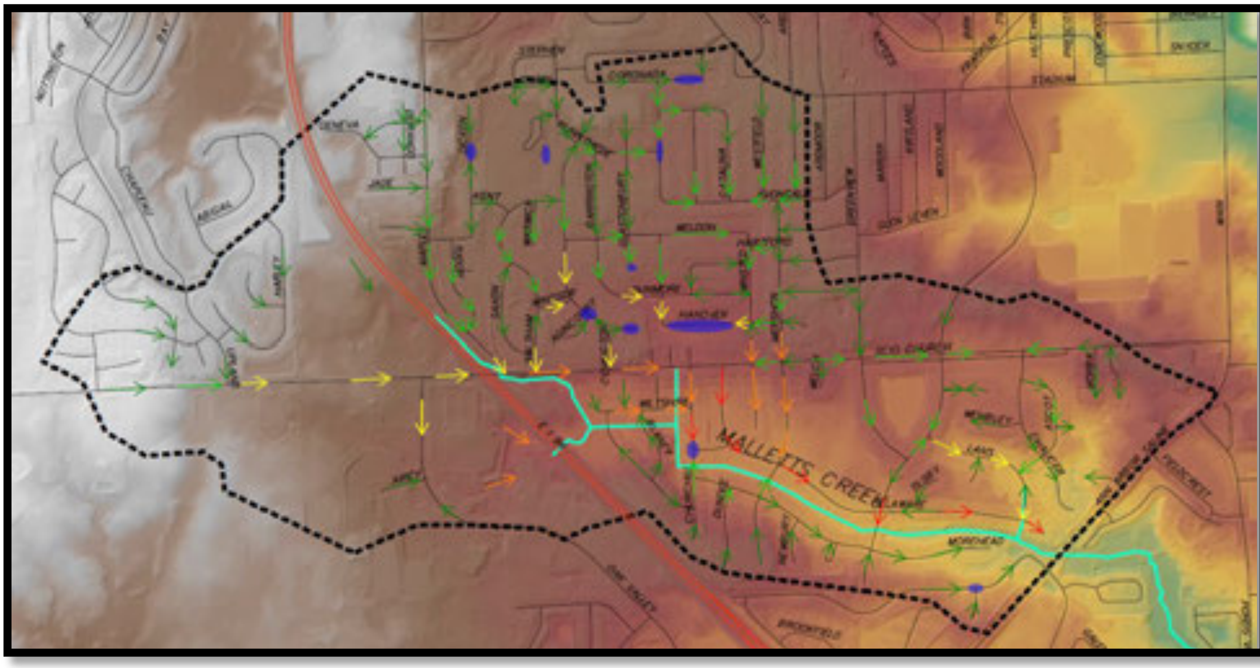


Figure IV-2 : Overland Flow Direction Map

4. Observing and Documenting Catch Basin Grates

A number of factors were taken into account to determine the root cause of flooding in the Upper Malletts Creek watershed. One possible source of localized flooding was inadequate inlet capacity on local street storm sewers. An analysis was performed to determine the capacity of the storm sewer inlets in specific areas of localized flooding. The analysis included locating inlets, determining inlet capacity, modeling stormwater runoff for rain events, and comparing the runoff values to the catch basin's inlet capacity. This provided specific information about inlet capacity versus the capacity needed to handle the modeled runoff for different areas.

Using the flooding and infrastructure information previously collected, specific flooding areas were field checked, and inlet grate dimension, curb inlet dimension, inlet grate make, model, description, and photographs were recorded. Detailed data for nearly 200 inlet grates were collected and information regarding the inlet's capacity was tabulated for analysis.

Drainage area sub-districts were delineated to determine the overland flow area contributing to flooding. An analysis was performed using the calculated inlet capacities and runoff rate for the sub-district. These two values were compared to determine if the inlets in each sub-district were capable of accepting the amount of runoff from a 10-year design event. This analysis was performed for several different field conditions including clogged inlets and varying ponding depths above the inlets. Three sub-districts were delineated north of Scio Church Road, one along Scio Church Road and three to the south of Scio Church Road.

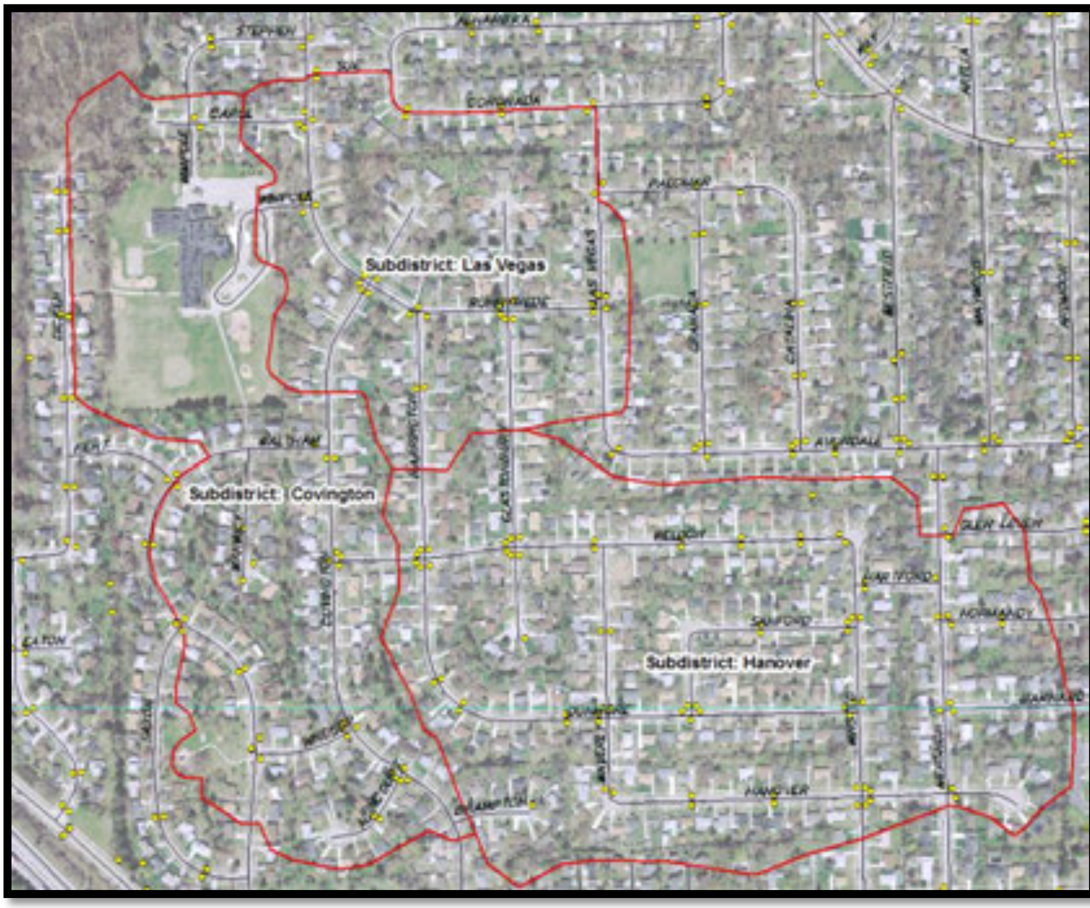


Figure IV-3: Upper Malletts Sub-district Map for Inlet Capacity Analysis

- The Hanover sub-district (Figure IV-3) is centered around a low point on Hanover Street between Winsted Street and Waverly Street. The Hanover sub-district is 67 acres and contains 85 inlets.
- To the west of the Hanover sub-district is the Covington sub-district (Figure IV-3). This area is centered around a low point on Covington Street at Agincourt and is 49 acres with 35 inlets.
- To the east of Covington sub-district and north of Hanover sub-district is the Las Vegas sub-district (Figure IV-3). The low point is at Las Vegas Drive and Runnymede Boulevard. This sub-district is 33 acres with 39 inlets. The Lambeth sub-district is south of the Scio Church sub-district with the low point at the end of Chaucer Drive. The area is 70 acres and has 61 inlets.

Figure IV-4: Upper Malletts Sub-district Map for Inlet Capacity Analysis

- To the west is the Delaware sub-district (Figure IV-4). The low points are between Delaware Drive and Morehead Drive from Churchill Drive to 7th Street. The area of this sub-district is 125 acres and has 146 inlets. This was the largest area analyzed and contained most of the flooding issues.
- Within the Delaware sub-district is the Lawton Elementary School sub-district (Figure IV-4). This was the smallest sub-district at 11 acres with 2 inlets.

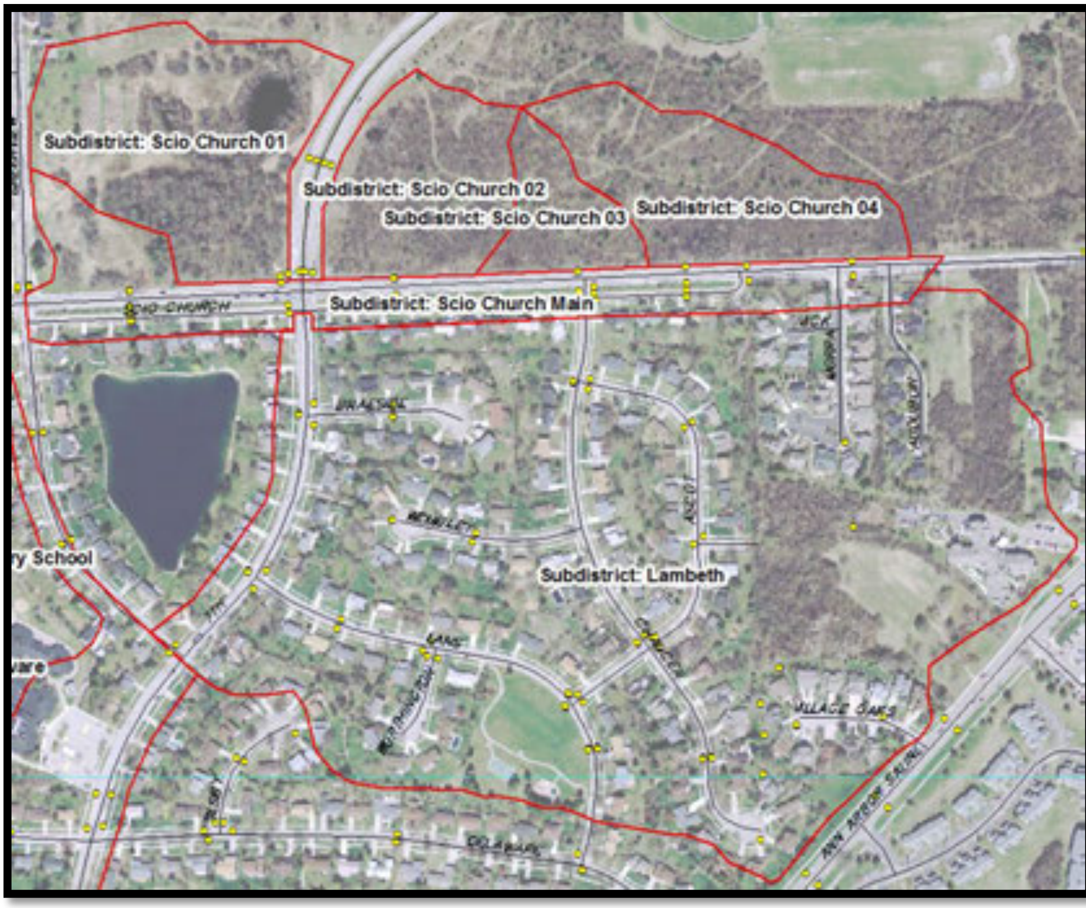


Figure IV-5: Upper Malletts Sub-district Map for Inlet Capacity Analysis

- The sub-districts along Scio Church Road had a specific focus on the undeveloped areas north of Scio Church Road adjacent to 7th Street, labeled as 1, 2, 3 and 4 (Figure IV-5), and how they drain into the storm sewer system adjacent to Scio Church Road. Those areas were combined with a section of Scio Church Road centered on the low point near 7th Street. This sub-district is 37 acres and has 33 inlets.

Table IV-1 is a summary of the number of inlets assessed and the size of each sub-district.

Table IV-1: Inlet Assessment

Sub-District Name	Total number of inlets	Area, acres
Hanover	85	67
Covington	35	49
Las Vegas	39	33
Scio Church	33	37
Lambeth	61	70
Delaware	146	125
Elem. School	2	11

5. *Catch Basin Capacity Calculation Methodology*

For each sub-district, inlet capacity was calculated and compared to peak runoff rates. Field data were used to calculate the total inlet capacity for each sub-district. A cumulative inlet capacity for each sub-district was calculated using an average inlet open area of the inlets surveyed. Four different capacities were calculated for each sub district:

- cumulative capacity under a 6" ponded depth, with clean inlets
- cumulative capacity under a 12" ponded depth, with clean inlets
- cumulative capacity under a 6" ponded depth, with inlets 50% clogged
- cumulative capacity under a 12" ponded depth, with inlets 50% clogged

The 50% clogged condition was chosen as a conservative estimate representative of the whole area, as some inlets will have little to no debris while others may be completely clogged during heavy rain events. The following equation is the general equation used to calculate the orifice capacity of the inlets.

$$i)\ Q = C_d \times A\sqrt{2 \times g \times h}$$

Where: Q = discharge in cubic feet per second
C_d = coefficient of discharge (0.60)
A = open area of the grate in square feet
g = the acceleration due to gravity
h = the height of water over grate.

The second calculation for the analysis was the stormwater runoff rate for each sub-district for the 10 percent annual probability storm. The rational method outlined in the Rules of the Washtenaw County Water Resource Commissioner was used to calculate these values. Runoff rates were calculated using the areas of the sub-districts, runoff coefficients determined based on land use, and rainfall intensities calculated using standard equations. The following equations were used:

$$ii)\ Q = C \times i \times A \qquad iii)\ i = \frac{136}{t_c + 20} \qquad iv)\ i = \frac{175}{t_c + 25}$$

Where: Q = discharge in cubic feet per second
C = coefficient of runoff
i = rainfall intensity in inches per hour
A = sub district area in acres
t_c = time of concentration in minutes

Eq. "*ii*" is the standard rational formula for calculating peak stormwater runoff. The C value is a ratio of surface runoff to rainfall and a weighted C value was calculated based on land use in each sub-district. Eq. "*iii*" and Eq. "*iv*" were used to calculate the rainfall intensity for a 10 percent annual probability storm. For a t_c less than 30 minutes, Eq. "*iii*" was used. Eq. "*iv*" was used for a t_c of 30 minutes or greater.

The output of the runoff rate calculation is shown in Table IV-2.

Table IV-2: Output of Runoff Rate Model

Sub-District Name	Total number of inlets	Area, acres	Cumulative capacity, cfs (6" ponding)	Cumulative capacity, cfs (50% blocked)	Total No. of Inlets in Flooded Area	Flooded area capacity, cfs (12" ponding)	Flooded area capacity, cfs (50% blocked)	**10-Year Storm Runoff Rate, cfs**	**10-Yr Storm (50% to Low Pt)**
Hanover	85	67	432	216	6	44	22	102	51
Covington	35	49	193	96	6	45	23	61	30
Las Vegas	39	33	181	90	9	61	30	53	27
Scio Church	33	37	175	87	10	76	38	65	33
Lambeth	61	70	343	172	20	164	82	106	53
Delaware	146	125	762	381	50	379	189	157	79
Lawton Elem.	2	11	17	9	2	23	11	12	6

Based on the analysis, three sub-districts had insufficient inlet capacity when comparing the capacity of the flooded area capacity with the 10-year storm runoff with 50% blockage: Hanover Street, Covington, and Lawton Elementary School. For two other districts, Las Vegas and Scio Church, the capacity and runoff are very close to equal. In these areas, flooding is very possible if the blockage assumptions made in the analysis are exceeded. The Scio Church sub-district is a special case resulting in more capacity needed in the Pioneer High School property but not along Scio Church Road. Each of the four sub-areas that make up the entire Scio Church sub-district have only one inlet to convey storm water in the storm sewer system. Increased capacity in those areas would prevent overtopping of storm water onto Scio Church Road flooding the sub-district.

Flooding relief for the areas with insufficient inlet capacity could involve adding additional catch basins or changing the type of casting on the existing catch basins. Detailed analysis on each of these areas should be conducted as part of a design project to determine the appropriate number and types of castings. The City has installed new inlets in the Hanover area since the study was started to provide flooding relief.

6. *Other Inlet Improvements*

As noted in Section II-C, an obstruction was added to the existing conditions model to accurately show flooding west of Wiltshire Ct. and South Scio Church. This obstruction was likely caused by vegetation and other debris blocking the inlet to the enclosed portion of the storm sewer system. As a short-term remedy, a bull nose grate is recommended on the inlet. This, coupled with proactive maintenance will reduce the likelihood of clogging on the inlet. The existing conditions model was run without this obstruction and the results have been included in Appendix A: Flood Maps. Flooding was shown to be eliminated west of Wiltshire Ct. and a moderate increase in flooding was predicted along Delaware because more water was released downstream.

V. PRELIMINARY ALTERNATIVES ANALYSIS

A. Development of List of Ideas and Concepts

A comprehensive list of stormwater management techniques was created based on preliminary site observations. Ideas were solicited from the project team, the Citizens Advisory Group and general public with all suggestions considered. The concepts were generic techniques that have been successfully implemented on other projects. The intent was to create a comprehensive and flexible toolbox to use in various areas throughout the watershed. The list of ideas was screened to identify methods that may not be feasible based on engineering fundamentals, ability to implement and public acceptance. The list of ideas included the following:

- Storm sewer system enhancements - Enhancements to the existing storm sewer systems can increase conveyance capacity if "choke" points restrict the flow.
- Street, curb and drainage inlet structure enhancements - Enhancements to streets such as improved storm drain inlet capacity and managed overland drainage patterns may reduce flooding in critical areas and convey water to desired areas.
- Street maintenance procedures - Comprehensive maintenance practices are key to optimal operation of a conveyance system.
- Bio retention or natural approaches to reduce stormwater volume - These Best Management Practices (BMPs) can reduce overall volume of surface runoff, improve water quality, attenuate peak flows, and promote attractive green areas in the community.
- Enhancement of existing detention facilities and ponds - Enhancement or operational modification to existing ponds and detention facilities may be a cost effective way to maximize stormwater detention capacity.
- New open/surface stormwater detention - Use of open spaces detain stormwater for flood control.
- Underground storm water detention by gravity and/or with pumping - Underground detention to detain water for flood control also has the potential to improve water quality, promote other infiltration-based green solutions and, with the addition of pumps, address high groundwater levels and basement seepage.

No one of these concepts alone will provide a viable solution, so potential solutions likely involve using an assortment of the concepts. The list of ideas was further refined and feasible concepts were compiled into design alternatives. The alternatives were evaluated through engineering analysis and public engagement.

B. Screening of Ideas and Concepts

After the initial list of management techniques was compiled, specific locations within the watershed were evaluated for the application of one or more of the management tools. Each location was categorized in relation to the type of improvements anticipated: potential areas for improvement to existing detention, potential areas for new surface detention, potential areas for new underground detention, potential storm sewer improvements, and Low Impact Design (LID) techniques for improving existing facilities.

1. *Detention Site Improvements*

Field inspections for individual sites were completed to thoroughly evaluate the potential impact on the watershed (Figure V-1). Each site was compared against criteria that included the following:

- Property type and ownership. This was a significant factor, as overall project cost would be a major consideration in final selection of alternatives and the need for property acquisition and easements can dramatically increase the cost of a project. Properties under WCWRC or City of Ann Arbor jurisdiction were given special consideration.
- Current land use. Unused or vacant sites were preferred over active-use parks or other uses.
- Relative elevation. The potential site was compared to the surrounding area to determine the natural drainage patterns and how the site could be useful. Sites at higher elevations are generally not as efficient or cost effective at managing stormwater as lower elevation sites.
- Outlet suitability. Each site was evaluated to determine if a suitable and effective outlet for the stormwater was readily available.
- General analysis. Other factors unique to each site were evaluated and noted.

The map below indicates the sites considered for detention improvements.

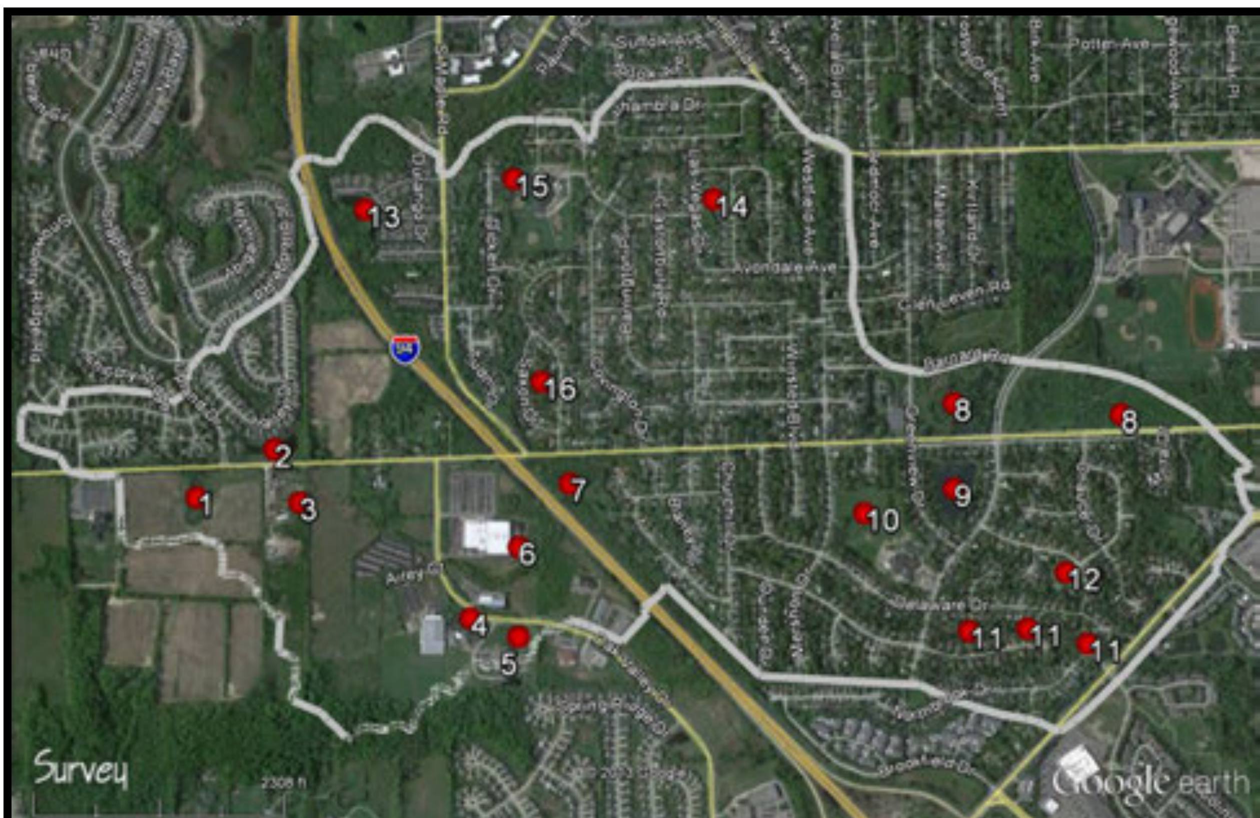


Figure V-1: Screened Detention Locations

<u>Site 1 – Scio Church Farm Field West of I-94</u>

- **Property Type:** Private property. Permanent easements or ROW would be necessary.
- **Land Use:** The area under consideration is a medium sized pond, located within a farm field.

- **Elevation:** The pond is located at the upper end of the drainage area. Storage at the high end of the system is generally less efficient than storage at the low end.
- **Outlet:** The pond outlet is not readily evident or available. It appears to be a natural low area within the associated parcel, possibly created by the property owner.
- **General Comments:** A controlled outlet for this pond was not evident. Creating storage is possible, but the benefit to the overall district would be minimal as the surrounding area is all farmland with low agricultural runoff. Creating an outlet would be expensive.

<u>Site 2 – Meadowinds Detention Basin</u>

- **Property Type:** Private property. Permanent easements or ROW would be necessary.
- **Land Use:** The area under consideration is an existing detention basin / pond.
- **Elevation:** The pond is located at the upper end of the drainage area. Storage at the high end of the system is generally less efficient than storage at the low end.
- **Outlet:** The basin outlets to Scio Church Road. The outlet appears to be working properly.
- **General Comments:** Creating additional storage within this basin would be relatively easy and inexpensive. The existing water level could be lowered 1’ with the addition of a few small holes in the outlet structure. The holes could be very small, which would dewater the pond slowly. The only drawback would be the condition of the banks and maintaining the manicured look.

<u>Site 3 – Landscape Supply Pond</u>

- **Property Type:** Private property. Permanent easements or ROW would be necessary.
- **Land Use:** The area under consideration is a small pond, located within a landscape supply / nursery.
- **Elevation:** The pond is located at the upper end of the drainage area. Storage at the high end of the system is generally less efficient than storage at the low end.
- **Outlet:** The pond outlet is not readily evident or available.
- **General Comments:** There is a large low area east of this site that may also be potential storage area. However, it would be difficult to create additional storage due to the lack of a proper outlet, and the contributing area is already generally agricultural in nature with low runoff.

<u>Sites 4 & 5 – Wide World of Sports / Ann Arbor Hospice Detention Basins</u>

- **Property Type:** Private property. Permanent easements or ROW would be necessary.
- **Land Use:** The areas under consideration are existing detention basins or low areas. The existing basins in these areas appear to be functioning properly.
- **Elevation:** The basins are located at the upper end of the drainage area. Storage at the high end of the system is generally less efficient than storage at the low end.
- **Outlet:** The outlet of the basin is a large wetland area and swale west of I-94.
- **General Comments:** These basins are working properly. Creating any additional storage in these areas would be difficult and not cost effective. The storage volume would be very low for the cost associated with creating it.

<u>Site 6 –Ann Arbor Ice Cube Detention Basin</u>

- **Property Type:** Private property. Permanent easements or ROW would be necessary.
- **Land Use:** The area under consideration is an existing detention basin.
- **Elevation:** The pond is at the high end of the watershed, but the site was designed to drain toward it.
- **Outlet:** The outlet of the basin is a large wetland area and swale west of I-94.
- **General Comments:** At the time of initial inspection, the basin was not operating properly and was not providing storage for the site. The outlet was severely plugged and the pond dewatered

by evaporation and seepage thru the bank wall. The area east of the pond has potential for a large volume of storage. The area is low, and has a substantial outlet with the 60" pipe under I-94. Maintenance work to restore the basin to working condition was completed during the study.

Site 7 – Eisenhower / Churchill Park

- **Property Type:** Public property owned by the City of Ann Arbor. Permanent easements or ROW are not necessary.
- **Land Use:** The area has an active-use park with some open space, a play structure and a small basketball court, and an undeveloped wooded area.
- **Elevation:** The site has both high and low points; significant earthwork may be necessary to create any storage. The site is located at the mid-point of overall system.
- **Outlet:** The outlet is very good, with two large (60") pipes within the park boundary.
- **General Comments:** There are some small wetland areas on the southern end of the parcel. The site has several areas that could be stormwater storage areas but would require large amounts of earthwork. Since the City already owns the parcel, this has strong potential for becoming part of the long term system management areas.

Site 8 – Pioneer High School East and West of 7th Street

- **Property Type:** Public property owned by Ann Arbor Public Schools. Permanent easements or ROW would be necessary for any work.
- **Land Use:** The area is two large undeveloped parcels. The area west of 7th Street is wooded, but many of the trees are dead. The area east of 7th Street is mostly scrub brush and small trees. There are a number of trails running through the area, and the area east of 7th has a disc golf course.
- **Elevation:** The area is at the high end of the watershed in the area.
- **Outlet:** There are several outlet points for runoff from these parcels. These are all overland flow points that discharge either into catch basins and/or over the curb into Scio Church Road. This is a large area that discharges into several small pipes, which may be contributing to street flooding. The outlet state is prone to debris accumulation.
- **General Comments:** The area appears to be comprised of heavy soils with little ability to absorb runoff. There is a pond on the parcel west of 7th that outlets via a small swale to the corner of 7th and Scio Church. The pond has no capacity for storage. The outlets are very poor. The perched pond would have some storage potential if the outlet was reconstructed. The area east of 7th could be graded to provide storage without much difficulty. The City should ensure the drainage is properly accommodated during the reconstruction of Scio Church.

Site 9 – Lans Lake

- **Property Type:** Private property that appears to be owned by an HOA. Easements would be necessary to do any work.
- **Land Use:** The parcel is a large pond.
- **Elevation:** The area is at the higher end of the system and appears to be a naturally perched pond.
- **Outlet:** The pond elevation is controlled by a small PVC pipe overflow located on the east side of the pond. The pipe is connected to the Lans Way storm sewer system and eventually outlets to the creek.
- **General Comments:** This area has the potential for a very large volume of storage with very little capital investment. A flooding easement would be required around the entire perimeter of the pond, which may be difficult due to the numbers of property owners involved. The overflow control structure would need to be revised. The pond could be tied to the Scio Church reconstruction project and the pond could be an overflow mechanism for the entire area. Permitting for improvements would be problematic.

Site 10 –Lawton Park

- **Property Type:** Public property owned by the City of Ann Arbor. Permanent easements or ROW are not necessary. School property is adjacent to the City parcel.
- **Land Use:** The area is being used as a park. The park is mostly open space and grass field.
- **Elevation:** The elevation is poor, since it is generally higher than much of the drainage area. However, it is immediately upstream of Delaware Street and the Upper Malletts Drain.
- **Outlet:** The outlet ultimately would be the Upper Malletts Drain, which is deep enough to provide positive drainage for any potential underground detention.
- **General Comments:** This site has the potential for a very large amount of underground storage. There are no site constraints other than the significant amount of earthwork that would be necessary to construct the storage. This would be a high cost option but may be part of the long term solution for run-off control in the region.

Site 11 – Lans Basin

- **Property Type:** The area is an established county drain and is considered a common area by the residents. An HOA exists for the homes that surround the pond. Permanent easements or ROW, and temporary construction easements for access and some of the bank stabilization work are necessary.
- **Land Use:** The area is being used as a pond.
- **Elevation:** The area is a natural low point.
- **Outlet:** The ponds/drain outlets to Malletts Creek.
- **General Comments:** The three existing dams have structural deficiencies and require rehabilitation. The two homes at the lowest point of the drain have lower floor openings that are relatively close to the normal water elevation in the drain, so any additional storage volume on this section is unlikely. The entire length of drain exhibits poor water quality and there is evidence of large sediment deposits on the upper section. It has been suggested by residents that the upper pond was 10-15 feet deep at one point, but is now about 2-5 feet deep. The initial concept for improvement to this area includes:
    - Remove the lowest dam and restore that section of the drain to a natural channel. This will provide several feet of storage in this lower section while mitigating potential downstream impacts. Due to the low elevation of the homes on this section, the only way to achieve significant storage is to lower the normal water elevation.
    - Move the second dam downstream several hundred feet, to the area where the large storm sewer from Lans Way empties into the drain. This will create additional storage volume within this section of drain. All of the homes in this section are quite a bit higher than the drain, so creation of new flooding problems is not anticipated. This dam is in the best condition of all three, but still needs significant repairs or replacement.
    - Reconstruct the third dam in place, but at an elevation 2-3' lower. This would be done in conjunction with dredging this section of the drain to minimize any surface area reduction of the pond, and restoring/stabilizing the drain banks, which are currently eroded. The depth of the dredging necessary is unknown. The pond surface area would decrease, but it appears the surface area has expanded over the last 10 years as the drain has filled with sediment. While dredging and stabilizing the banks, the slopes could be increased to minimize the reduction. It may be possible to incorporate a stoplog in this dam to lower the water elevation in the winter to further minimize bank erosion. Lowering the pond elevation would provide additional storage volume similar to numbers 1 and 2 above.
    - For each of the dam reconstructions noted above, a green approach would be used including installation of a series of rock-riffle grade controls to spread out the grade

change over a greater distance. This would introduce oxygen into the drain and improve the water quality, which is very poor over the entire length of the open channel section. The dam for the upper reach would probably require sheet piling to control the water elevation, but rock-riffles would still be used downstream. Other green techniques would be used on the entire section of drain to improve the water quality and help control drainage.

Site 12 – Lansdowne Park

- **Property Type:** Public property owned by the City of Ann Arbor. Permanent easements or ROW are not necessary.
- **Land Use:** The area is being used as a park, with mostly open space and grass field. There is a play structure, basketball court, and asphalt pathway.
- **Elevation:** The area is basically at grade and is not an apparent low point within the system. To be functional, the water storage depth would have to be at least 6 feet below the surface.
- **Outlet:** The outlet would be the storm sewer in Lans Way, outletting to the open drain. The outlet would probably have to be lowered to accomplish any significant detention on the site.
- **General Comments:** There are no apparent wetlands on the site, and the natural resource value from a water resource perspective is negligible. Open detention on site is not feasible without changing the land use. The lot is small to medium size, with large trees on the south boundary. Making the site usable would likely require underground detention and significant re-working of the storm sewer to make the outlet function properly. The work would be very expensive on a per-cubic-foot-of-volume-provided basis.

Site 13 – Cardinal Homes Detention Basin

- **Property Type:** Private property. Permanent easements or ROW would be necessary.
- **Land Use:** The area under consideration is a detention basin / pond.
- **Elevation:** The pond is located at the high end of the system.
- **Outlet:** The basin outlets to a large wetland to the south and eventually to the I-94 ROW. The outlet is weir flow over the basin banks and exhibits erosion.
- **General Comments:** Creating additional storage within this basin would require significant embankment. The existing water level could be lowered slightly with the addition of a new outlet structure but would negatively impact the appearance of the area. Since this is at the upper end of the system, impact on the overall watershed would be minimal.

Site 14 –Las Vegas Park

- **Property Type:** Public property owned by the City of Ann Arbor. Permanent easements or ROW are not necessary.
- **Land Use:** The area is used as a park, with mostly open space and grass field. There is a play structure and a small basketball court.
- **Elevation:** The area is basically at grade and is not an apparent low point within the system. To be functional, the water storage depth would have to be at least 6 feet below the surface.
- **Outlet:** The outlet would be the storm sewer under Granada. The outlet would probably have to be lowered to accomplish any significant detention on the site, which is not really due to the distance from the downstream outlet.
- **General Comments:** The natural resource value from a water resource perspective is negligible. Open detention on site would have to be very shallow to avoid changing the land use. The lot is small to medium size, with large trees on the south boundary. Creating substantial storage at the site would likely require underground detention and significant re-working of the storm sewer to make the outlet function properly. The work would be very expensive on a per-cubic-foot-of-volume provided basis.

Site 15 –Dicken Elementary / Dicken Woods Nature Area

- **Property Type:** Public property owned by the City of Ann Arbor and Ann Arbor Public Schools. Permanent easements or ROW would be necessary. School property is adjacent to the park parcel.
- **Land Use:** The area being used as an elementary school and a park that is mostly wooded.
- **Elevation:** The area is located at the high end of the watershed.
- **Outlet:** There is an existing swale and outlet along the western edge of the school property. The eventual outlet is the storm sewer in Dicken Drive.
- **General Comments:** There is limited potential for detention at this site. The elevations are low and the outlet would be a concern. Since it is at the high point of the system, overall watershed impact would be minimal.

Site 16 –Mushroom Park

- **Property Type:** Public property owned by the City of Ann Arbor. Permanent easements or ROW are not necessary.
- **Land Use:** The area is used as a park, with mostly open space and a play structure.
- **Elevation:** The elevation is poor and is higher than much of the area that surrounds it.
- **Outlet:** The outlet would be the storm system on Waltham Drive.
- **General Comments:** This site has very limited potential for storage. The space is small and compact, and detention would have to be underground to avoid changing the land use. Available depth for underground storage would be minimal without changes to the receiving storm sewer system.

Note that Village Oaks and the area immediately to the north of the homes are within the area of the Upper Malletts study but not included as part of the project findings. The area is within the watershed and historical flooding was reported using the Upper Malletts flood reporting tool. However, this area has been previously studied and implementation of that study's recommendations is ongoing. The previous study can be located at the following link:

> http://www.a2gov.org/government/publicservices/systems_planning/waterresources/Stormwater/stormwaterprojects/Pages/VillageOaksStudy.aspx

The data from the previous study were included in the modeling efforts for the Upper Malletts study, with the assumption that the recommended improvements were in place.

After an initial screening, potential volumes for each detention alternative improvement were estimated based on site constraints. Several locations (Sites 1, 3, 4, 5, 12, 15, and 16) were eliminated early due to the readily apparent difficulties in utilizing the sites and the limited benefit they would bring. The volumes at this time were very conceptual based on visual observation, elevation data from the LIDAR, and storm sewer information from the GIS. Note that these were initial volume estimates and the volumes were revised further as the study progressed and more detailed concepts were created. For example, the volume in the Pioneer basin east of 7th Street was dramatically increased as more information became available. The remaining alternatives are summarized in Table V-1.

Table V-1: Preliminary Detention Alternatives

Name	Area (ac)	Depth (ft)	Potential Volume (ft^3)	Volume (ac-ft)	Potential Area (sq. ft.)
Areas Within City Boundary					
Lawton Park	2.62	7.25	825,000	18.9	114,000
Eisenhower Park	2.23	6.5	630,000	14.5	97,000
Lans Lake	4.36	2.5	475,000	10.9	190,000
Lans Basin	1.86	2.5	200,000	4.6	81,000
Pioneer HS (W of 7th)	0.6	3	80,000	1.8	26,000
Pioneer HS (E of 7th)	0.87	1	40,000	0.9	38,000
Cardinal Homes	0.83	2	70,000	1.6	36,000
Las Vegas	0.18	0.5	4,000	0.1	8,000
	Subtotal		**2,324,000**	**53.4**	
Areas Outside of City Boundary					
Ice Cube	0.37	5.5	90,000	2.1	16,000
Meadowinds Basin	1.17	1	50,000	1.1	51,000
	Subtotal		**140,000**	**3.2**	
Total Potential Volume in Watershed			**2,464,000**	**56.6**	

Excess runoff was compared to outlet capacity at Ann Arbor-Saline Road, the most downstream point in the study, to determine an approximate volume of storage that would be needed to fully address flooding on March 15, 2012. Excess runoff was calculated by summing all sub-basin hydrographs in the stormwater model and comparing the peak flow rate generated to the hydraulic capacity of the culvert under Ann Arbor-Saline Road. Based on this analysis, approximately 26 ac-ft of storage would be needed throughout the system to fully address flooding on March 15, 2012. Though this calculation did not include a flow routing analysis which would account for variations in the timing of peak flows, it did indicate an order of magnitude for storage that would be necessary. Ultimately, this estimation of storage volume was very close to the total storage included in the final solution. The large volume requirement indicated that potential storage improvements of only one (1) or two (2) ac-ft would have minimal impact on flooding such as that observed in 2012. To contain study costs, the impact of constructing or improving all of the potential stormwater basins was not included in the detailed modeling. Rather, the initial concepts were expanded and evaluated during the study using a weighted alternative system.

Public feedback played a significant role in the decision-making process. A comprehensive public education and feedback process, as described in Section III, was used to solicit public input during multiple stages of alternative development. For example, although Lans Lake had the potential of storing upwards of 10 ac-ft, all possible site access and use of the existing detention facility was privately owned. Permits and easements would be very difficult to obtain, and the lake's water quality degradation would be severe. Based on these challenges, the decision was made to eliminate the option from further analysis.

2. *Alternative Scoring*

After developing conceptual volumes for the basins and sizes for the storm sewer improvements, each management alternative was evaluated against a list of criteria (Table V-2). Scoring was on a scale of 1 to 10 and was based on a combination of engineering calculations and judgment. The scores for each category were then tabulated to get a composite score for the alternative. This allowed an empirical evaluation of each alternative.

<u>Alternative Scoring</u>

- **Property Ownership:** High scores were given for projects on property already owned by the City or WCWRC. Low scores were given to solutions on private property that would require a large number of easements.
- **Capital Cost:** Low-cost projects received high scores; high-cost projects were assigned low scores.
- **Operation and Maintenance Costs:** Projects requiring little to no long-term maintenance were scored high, while projects requiring maintenance for normal operation were scored low.
- **Flood Mitigation Impact:** Alternatives with the greatest impact on the overall watershed were given high scores, while projects with no or minimal impact were scored low. Projects that had significant impact on a local area within the watershed were also scored higher.
- **Water Quality Improvements:** Alternatives with the greatest impact on water quality were given high scores. Projects that typically result in high Total Suspended Solids (TSS) removal and Total Phosphorous (TP) were judged as significantly improving water quality.
- **Social and Cultural Impact:** High scores were assigned to projects that did not significantly alter land use or that would result in improved facilities or property usage. Low scores were given if a project would negatively change the use of the property.
- **Public Acceptance:** Projects that would be generally supported by the public were given high scores. Projects that may be negatively received were given low scores.
- **Ability to Implement:** Projects that could be easily constructed were scored high while difficult, complex and time-consuming projects were rated low.
- **Funding Potential:** If funding beyond normal City/WRC budget categories was available for a project it was scored high. If projects could not be funded from grants or loans, they were given low scores.

Table V-2: Alternative Scoring

Name	Prop. Owner	Capital Cost	O&M Costs	Flood Mitigation Impact	Water Quality Improv.	Social & Cultural Impact	Public Accept	Ability to Implement	Funding Potential	Total Score
Detention Alternatives										
Eisenhower Park	10	4	8	9	8	6	7	5	8	**65**
Ice Cube	3	10	10	2	8	8	9	9	1	**60**
Lawton Park	10	1	5	9	8	8	8	2	8	**59**
Pioneer HS (E of 7th)	7	5	7	9	8	5	6	5	5	**57**
Pioneer HS (W of 7th)	7	5	6	4	8	7	6	5	5	**53**
Lans Basin	5	2	7	6	8	6	6	2	8	**50**
Las Vegas	10	5	8	2	8	4	6	5	2	**50**
Lans Lake	3	8	9	7	8	2	1	9	1	**48**
Meadowinds Basin	3	9	8	2	8	2	3	10	1	**46**
Cardinal Homes	3	6	9	2	8	7	5	4	1	**45**
Storm Sewer Improvement Alternatives										
Scio Church Road	10	6	8	5	2	8	8	6	3	**56**
Hanover/Dogwood	10	3	8	3	2	8	8	3	1	**46**
Wiltshire/Churchill	10	2	8	4	2	8	8	3	1	**46**
Chaucer/Ascot/Lans	10	2	8	3	2	8	8	3	1	**45**
Low Impact Design Solutions										
Road Diets	10	6	8	3	10	4	3	4	2	**50**
Porous Pavements	7	3	3	4	10	5	6	3	2	**43**
Rain Gardens	3	7	5	1	10	7	7	2	1	**43**

3. Storm Sewer System Improvements

In addition to detention, areas where storm sewer improvements could potentially mitigate or manage flooding were considered. Potential improvements include replacing the existing sewer with new, larger diameter sewer to increase flow capacity, new sewer to provide relief for an existing sewer, or new oversize sewer to provide additional detention. Specific areas reviewed include:

- Scio Church Road – New oversize sewer to provide local detention. This option was evaluated and is easily implemented as part of the planned road reconstruction project. The additional underground pipe storage will offset the volume needed in the nearby detention basin. The final size of the storm sewer and the exact amount of storage will need to be determined during detailed design.
- Chaucer/Ascot/Lans – New, larger diameter sewer. Preliminary analysis determined enlarging this sewer was found to have a detrimental impact downstream of Ann Arbor-Saline Road. While it eliminated the local flooding, a larger volume was sent downstream at a rate that exceeded the storage available downstream.
- Hanover/Dogwood - New, larger diameter sewer. This option could be completed with future road reconstruction; however the impact on residents and high cost exceeded the benefit.
- Wiltshire/Churchill/Delaware – A new relief sewer to provide additional capacity. The existing sewer would remain in place with new overflow controls to manage the flow in the new sewer. Like Hanover/Dogwood, this is a potential future option but the cost is high for the benefit provided.
- Mershon– New, larger diameter sewer. Similar to those noted directly above, this is a future option.

4. *Green Infrastructure and Under Street Storage Solutions*

Green infrastructure solutions and street stormwater storage were also considered. Green infrastructure includes Low Impact Design (LID) methods, which are an effective and responsible stormwater management technique, especially when combined with other upgrades to improve water quality and reduce time of concentration for runoff. While not a LID method, the utilization of oversize storm sewers for detention within the street right-of-way (ROW) was included in this potential solution set. ROW storage is very effective when combined with LID methods and is easily completed as part of a road reconstruction project. The types of ROW treatment solutions considered included:

- Porous pavement for select road reconstructions and private parking lots. Stone reservoirs for runoff storage under the pavement are also very possible.
- Road diets (reducing the road cross section width) to reduce impervious area
- Rain gardens at surface detention areas and rear yards – private
- Oversize pipe storage

A cost benefit analysis for the ROW treatment improvements was completed utilizing information from completed projects. Several sample ROW treatment projects were chosen that would be similar to stormwater management projects that could be completed within the watershed. Note that the chosen projects were generally street reconstruction projects on City controlled rights-of-way, although there are some small basin improvements included. For study purposes, LID solutions for large parcels within the Upper Malletts watershed were evaluated as part of the detention screening alternatives.

- Stone School Road Stormwater Facilities (I-94 to Eisenhower) – The project includes constructing oversize pipe for storage and 20 small rain gardens to manage the "first flush" storm and a large portion of the bankfull event. The first flush system is designed to control the first 0.5 inches of rain and the bankfull storm event is approximately equal to a 2-year storm.
- Miller Road Green Corridor (Maple to Newport) - The project includes constructing oversize pipe for storage and small rain gardens. Bioretention facilities are also included in the project outside of the road right-of-way. The improvements manage the first flush storm and a portion of the bankfull event.
- W. Madison Ave – The project has one block of infiltration via stone trench along with small rain gardens at intersections. It also includes oversized pipe for additional storage. Overall, the project will manage the first flush and bankfull events.

Table V-3 summarizes the potential storage volume and costs for each of the sample projects. The volume of storage per foot of street and the cost per cubic feet of storage were also averaged for use in the LID analysis. The recommended projects are also shown for comparison purposes.

Table V-3: LID Volume/Cost Analysis

Street / Project Site Name	Storage Volume (cf)	Project Costs	Cost/Volume Storage	Length (ft)	Volume per Length (cf/ft)
Project Recommendations					
Eisenhower Churchill Park Basin	470000	$2,095,000	$4.46		
Pioneer Basin (Scio Church)	400000	$1,169,000	$2.92		
Lawton Park Basin	280000	$5,362,000	$19.15		
Comparative Projects (as constructed)					
Pioneer Basin (Stadium)	255000	$4,203,543	$16.48		
Doyle Park*	1910000	$3,646,668	$1.91		
Right-of-Way Storage Projects (as constructed)					
Stone School	15300	$5,404,000	$353	1615	9.5
Miller Road	41200	$1,792,000	$43	4600	9
W. Madison Ave.	17700	$3,196,200	$181	2500	7.1
Equivalent Needed to Treat Upper Malletts Stormwater in Road ROW					
Eisenhower	470000	$65,677,900	$139.74	55078	8.5
Pioneer	400000	$55,896,100	$139.74	46875	8.5
Lawton	280000	$39,127,300	$139.74	32812	8.5

* Doyle Park involved a retrofit of a basin that was originally constructed in 1977. Excavation costs were low as a result.

To compare the ROW solutions with other types of management techniques, the sample projects were averaged for the volume provided per foot of street reconstruction and the cost per cubic foot of storage achieved. As a general rule, the ROW solutions are not as cost effective as the open detention or underground detention systems. The ROW solutions cost per cubic feet of storage ranges from $43 to $353 with an average of $119.08. Comparatively, proposed open detention ranges between $2.92 to $4.46 per cubic foot (an average of $3.69) and underground detention is estimated at $19.15 per cubic foot.

In addition to cost, the length of street required to provide an equivalent volume of storage was compared, and the total cost for providing that detention was calculated. The average value for volume per foot of street storage of 8.5 cubic foot/foot was used for this calculation. Also, the average cost per mile for the sample ROW treatment projects was calculated at $6.63 million, which was used to determine the total project costs for an equivalent road length needed to treat the Upper Malletts stormwater using ROW treatment.

City street mileage within the defined Upper Malletts watershed is approximately 15.8 miles. That is not enough mileage, even after reconstructing all the streets, to provide total the required detention volume necessary to manage the March 2012 flooding. If detailed engineering studies of each street were conducted, it is likely the volume of storage available per foot of street could be increased. The stone reservoir under the street could be increased in depth or some type of open bottom chamber could be utilized. Other utilities located in the right-of-way, such as water main and sanitary sewer, may also limit the amount of storage that could be achieved. Ultimately a cost versus benefit analysis for each street should be conducted to determine the amount of storage that can be achieved.

Underground storage was also evaluated for a simpler alternative. During future road construction, storm sewer trench backfill or two feet of road base material could be replaced with stone backfill instead of the typical granular material. Using some typical cross sections – sewer trenches 5 feet deep, 36" sewer, 1:1 side slopes and road base 24 feet wide and two feet deep – additional storage could be obtained with a nominal cost increase. Assuming 35% void space, the stone storm trench and stone road base would generate approximately 8 and 17 cubic feet of storage per foot of length, respectively. Incremental cost for stone versus sand backfill is approximately $17 per foot of length for both options. The net result is the cost for volume of storage for pipe trench backfill is $2.13 and for road base backfill is $0.94. This compares very favorably to the per cubic foot costs for open and underground detention systems. Note that the storage amount per foot would likely end up less than the amount calculated due to underground conflicts, but this may be a reasonable alternative to other types of street detention.

After the initial public meetings and reviewing the soils information, small individual rain gardens were not further quantified or analyzed. Soil saturation is an issue and there have been a number of basement seepage complaints in the watershed. Comments were also made about how frequently sump pumps in various areas are running. WCWRC has assisted in private property rain garden construction, on an individual basis, in Upper Malletts and will continue to do so.

This analysis was completed to provide a comparison of ROW storage methods versus open land storage possibilities. Because they are large impervious surfaces, roads and streets are significant contributors to the stormwater volume in any particular area. In many areas of the City, open land simply isn't available for construction of basins to store street runoff. ROW storage becomes the only viable option for reducing stormwater impact. Fortunately, in the Upper Malletts area there are several large open spaces where detention can be implemented and is very cost effective when compared to other alternatives, hence the recommendations. These methods are not mutually exclusive. ROW rain gardens and swales, stormwater retrofit storage under road surfaces, tree boxes and other Low Impact practices should be considered as opportunities arise. The upcoming road work at S. Seventh and Scio Church represent such an opportunity.

Where opportunities exist, ROW treatment and private rain gardens should be combined with other improvements to improve water quality and provide some additional storage, but the significant amount of volume required to mitigate events like the March 2012 storm simply cannot be cost effectively managed by LID solutions. Depending on order of implementation, the final basin sizes recommended by the study may be reduced by the volume achieved using LID storm detention in the streets.

It should also be noted that both the Eisenhower basin and the Pioneer basin can be developed as LID solutions. The design should include grading to minimize impact on the surrounding area and the proper plantings to allow future infiltration.

C. Recommendation of Alternatives for Detailed Analysis

Based on public feedback and an evaluation of the feasibility of each alternative, the project team, in conjunction with the Citizens Advisory Group, identified seven potential alternative combinations of detention options. The Eisenhower Park, Lawton Park, and Pioneer High School (East of 7th Street) were selected based on having the highest scores, particularly in their storage potential and ability to meet project goals. The Scio Church storm sewer improvement project was also chosen due to its connection to the Pioneer detention project and the fact that it is on the City's Capital Improvements Plan for 2015. This made it very likely that a stormwater management project would be completed soon.

One project that scored very high but was not chosen for analysis was the Ice Cube detention basin. During the study, WRC was able to contact the property owner and coordinate the proper maintenance work to restore the basin to working condition. This provided management of runoff immediately upstream of the I-94 crossing for a parcel with a large amount of impervious surface.

VI. FINAL ALTERNATIVES ANALYSIS

A. *Completion of SWMM Modeling*

The Upper Malletts Creek Drainage District was evaluated using Version 5.0 of the Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) in conjunction with Autodesk Storm and Sanitary 2012. This model was run for existing and proposed alternatives and incorporated three different flow analyses. Flow rates for the 50 percent, 10 percent, 1 percent annual probability storm and the rainfall event on March 15, 2012 were analyzed to evaluate the function of the proposed alternative detention designs. Model errors were all in an acceptable range with only one with an absolute value above 1.0% as shown below in Table VI-1. Appendix F: Model Node Diagram, shows the node diagram for each of the four models evaluated.

Table VI-1: Alternative Scoring

Model	Storm Event	Continuity Errors	
		Runoff	Flow Routing
Original	3/15/12	-0.017%	-0.030%
	50%	-0.004%	0.025%
	10%	-0.005%	0.007%
	1%	-0.005%	-0.012%
Project A	3/15/12	-0.017%	0.000%
	50%	-0.004%	0.024%
	10%	-0.005%	0.007%
	1%	-0.005%	-0.020%
Project B	3/15/12	-0.017%	0.011%
	50%	-0.004%	0.028%
	10%	-0.005%	0.002%
	1%	-0.005%	-0.026%
Project C	3/15/12	-0.017%	-0.421%
	50%	-0.004%	-0.462%
	10%	-0.005%	-0.448%
	1%	-0.005%	-0.416%

B. *Calibration*

The City of Ann Arbor's stormwater model was provided for use on the study. This model was developed as part of the City's Stormwater Model Calibration and Analysis previously mentioned. Radar rainfall data from the March 15, 2012 event were evaluated with the model and results were compared to anecdotal flooding information compiled from photographs, landowner interviews, and feedback at public meetings. This comparison was provided to the City of Ann Arbor and their consultant. The City made some revisions to the model and a revised version was provided as a "calibrated" model. It was not within the scope of the Upper Malletts study to evaluate the efficacy of the model or validate its calibration for any event other than March 15, 2012 and, therefore, the model was calibrated to match actual flooding conditions for the specified event. The flood elevations for the following nodes were increased to calibrate the model to flooding that was observed on Covington and Hanover Road (Table VI-2 and Figure VI-1) as a result of inadequate inlet capacity.

Table VI-2: Flooding Calibration Nodes

Node	Location	Rise in Elevation
92-52444	Covington	8ft
92-52484	Covington	10ft
92-52486	Hanover	6ft
92-52487	Hanover	6ft

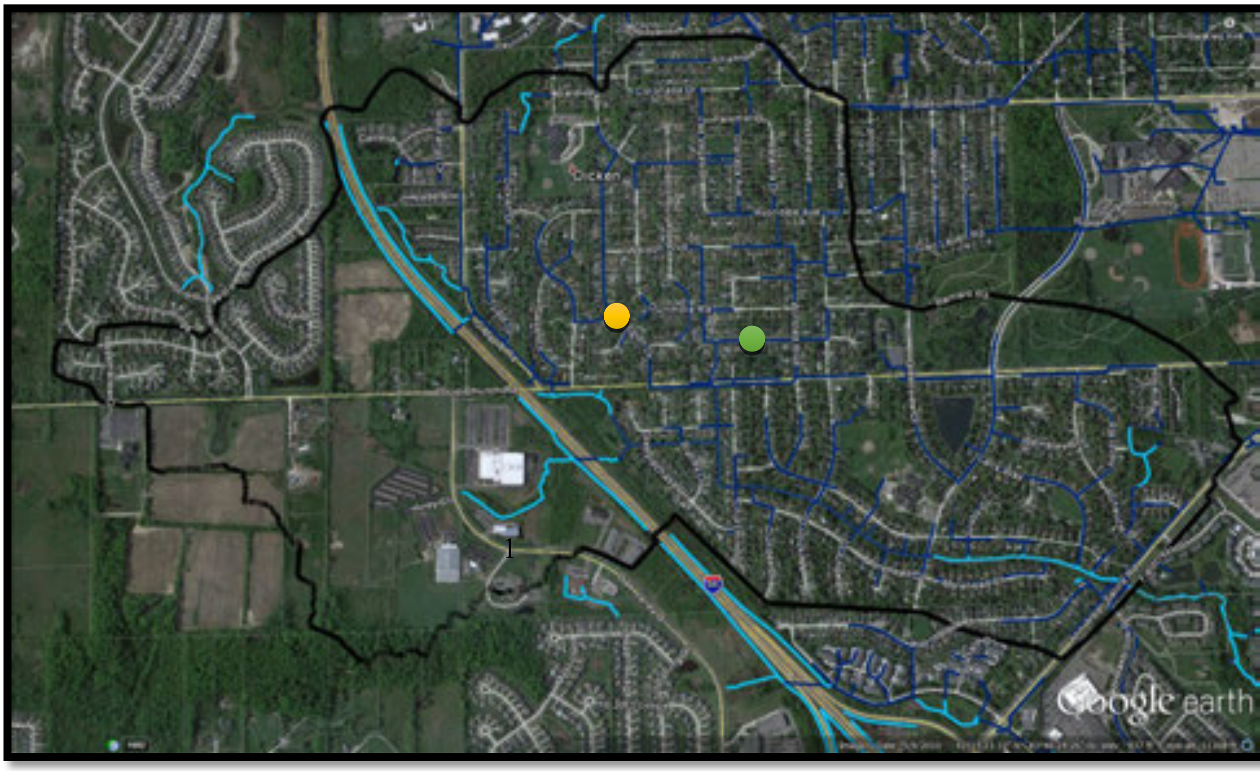


Figure VI-1: Storm Sewer Map (No Improvements) – Flooding Calibration Nodes

Nodes 92-63025 and 92-93024 were removed from the model due to iteration inconsistencies. The nodes were located at the west end of the storm sewer along Scio Church Road. These two nodes were causing unnecessary flooding and instability in the model (Figure VI-2).

Figure VI-2: Storm Sewer Map (No Improvements) – Location of Removed Nodes

C. Comparison to March 15 Observations

Upon completion of the model calibration process, model results for the original conditions model during the March 15, 2012 rainfall event were compared to flooding limits based on anecdotal information including: landowner testimony, photographs, and video evidence. The model results, shown in Figure VI-3, closely correlated to observations from landowners during the March 15 event. This comparison was verified during a review with the Citizens' Advisory Group and at public informational meetings.

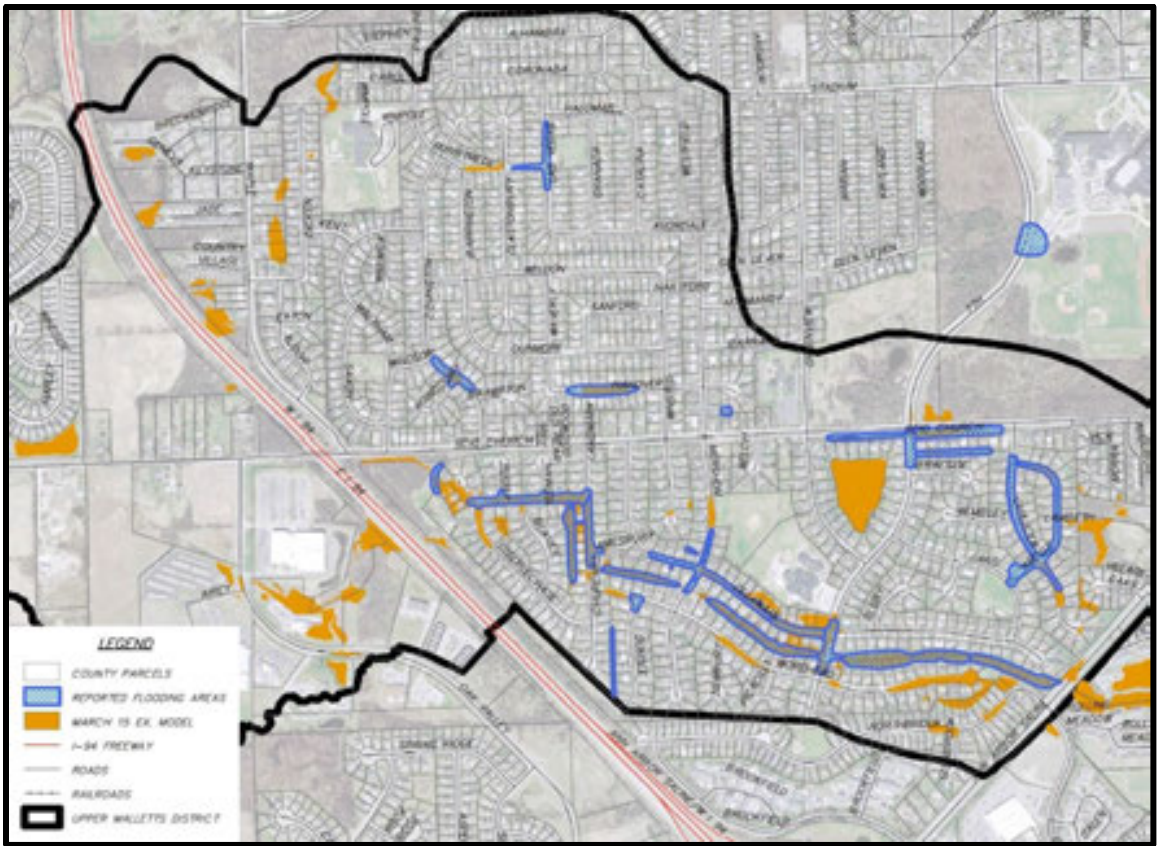


Figure VI-3: March 15, 2012 Flooding Comparison

D. Footing Drain Disconnect

Additional influent flow from footing drain disconnects was added by assuming 10 GPM per household running 50 percent of the time. The additional flow from the footing drain disconnects was added at five nodes in the model (Table VI-3 and Figure VI-4). The influent flow was assumed to be constant throughout the rainfall simulation. Incorporating footing drain disconnects from 1762 parcels within the drainage district added a total of 19.62cfs of flow.

Table VI-3: Footing Drain Disconnect Influent Modeling Flows

Influent Point	*# of Parcels*	*Avg. GPM/Parcel*	*Total CFS*	*@ Node*
Point 1	371	5	4.13	97-50009
Point 2	158	5	1.76	92-52498
Point 3	439	5	4.89	92-52128
Point 4	363	5	4.04	97-50020
Point 5	431	5	4.80	97-50320

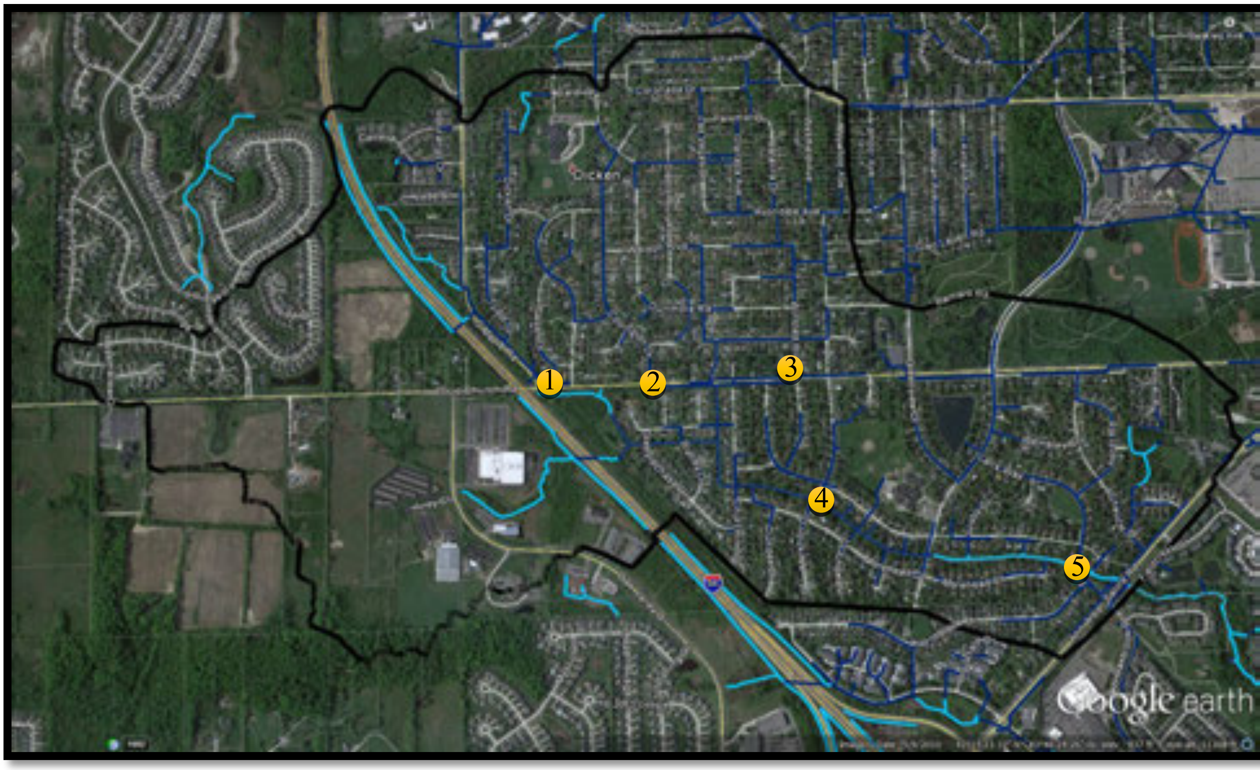


Figure VI-4: Storm Sewer Map (No Improvements) - Footing Drain Disconnect Inflow Points

E. Design Storms

The model was initially run with a standard SCS Type II rainfall distribution. This distribution was determined to have an extremely large peak rainfall intensity for the current model, which was calibrated to the March 15, 2012 rainfall event. The March 15 event was a short, constant low intensity storm. Running the model with a SCS Type II rainfall event produced unrealistic results compared to real-time visual information received from property owners. Though the SCS Type II rainfall distribution may produce reasonable results for some hydrology models, its high-intensity, short duration peak tends to over-predict runoff in portions of the Midwest. This issue is only exacerbated by the steep slopes in the Upper Malletts Creek watershed. Additionally, the Upper Malletts Creek model was calibrated to actual rainfall data. A highly idealized storm event, such as an SCS Type II, is significantly different than an actual rainfall hyetograph; therefore, the results varied substantially from observed rainfall events. Based on this, a more realistic rainfall distribution was selected to more closely mirror actual rainfall events for Midwestern climate. According to Bulletin 71 from the Midwestern Climate Center (MCC), SCS rainfall distribution models were considered unsatisfactory for use in the Midwest. Thus, quartile distribution curves were analyzed to determine their applicability to this model. The second-quartile distribution was determined to best fit the actual rainfall patterns of the Upper Malletts district during the March 15 storm (Figure VI-5 and Figure VI-6).

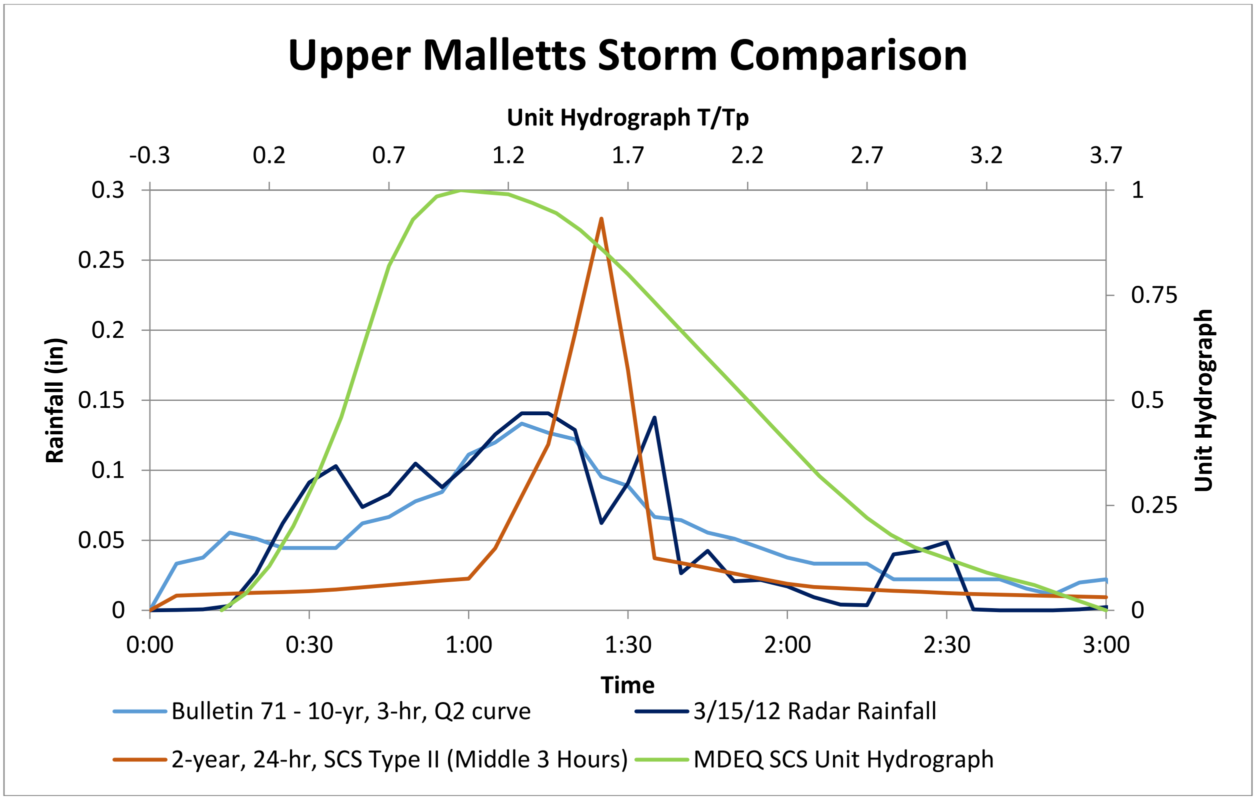


Figure VI-5: Comparison of Rainfall Distributions

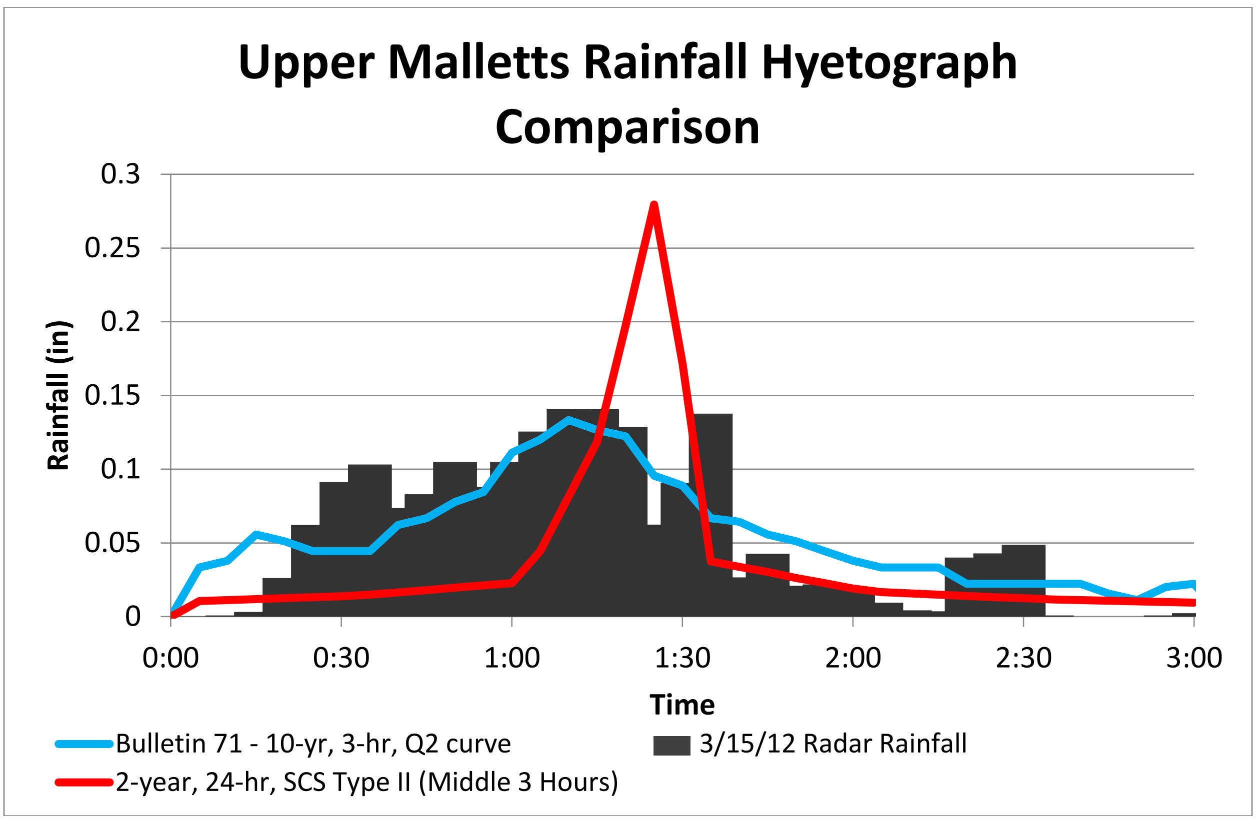


Figure VI-6: Hyetograph Comparison

F. Alternatives

Three different alternatives were analyzed using the model. The alternatives were derived from the preliminary analysis of detention/storage locations. The alternatives incorporate sewer improvements plus engineered detention basins. The alternatives are cumulative or a progression based upon the previous alternative.

1. Project A – Eisenhower Park

This alternative would add two detention basins in Eisenhower Park. The two basins together are 2.5 acres in size, would have a combined storage volume of 10.8 acre-ft. and are connected by a 42" pipe (Figure VI-7). Flow from the Covington Road storm sewer would be diverted to these new basins by installing 42" storm sewer along Scio Church Road. It is expected that LID techniques would be incorporated into the project.

Figure VI-7: Project A - Eisenhower Park Basins and Sewer Improvements

2. Project B – Pioneer High School

Building upon Project A, a detention basin would be created along the north side of Scio Church Road just east of 7th Street as shown in Figure VI-8. This basin is 2.8 acres in area and has a storage volume of 9.2 acre-ft. Since Scio Church Road will be completely reconstructed soon, the storm sewer in Scio Church would also be sized to accommodate a portion of the detention volume for the area. The amount of storage that could be achieved in the Scio Church storm sewer will be determined during detailed design and deducted from the open detention basin volume.

Figure VI-8: Project B – Pioneer Basin and Sewer Improvements

3. *Project C – Lawton Park*

An underground detention basin would be constructed along the eastern edge of Lawton Park along with a new storm sewer under Scio Church Road and Mershon Drive as shown in Figure VI-9. The project also includes the replacement of a small section of the Upper Malletts Drain storm sewer between the Lans Basin and 7th Street and the removal of a sediment bar in the west portion of Lans Basin. The storm sewer replacement may help mitigate upstream flooding with Projects A and B as well, however; since excess runoff is not fully detained in these two (2) projects, increasing the pipe size at 7th Street could result in adverse downstream effects. Adding a basin at Lawton Park maximizes upstream detention before improving downstream hydraulics. Improved hydraulic components near 7th Street were not included in the hydraulic modeling process for Projects A or B.

The underground detention basin uses connected box culverts to create a storage capacity of 6.4 acre-ft. The basin encompasses an area of approximately 1.1 acres. The basin will be connected to an overflow structure that will prevent the flooding of the storage chamber and allow flow downstream through the storm sewer under Mershon Drive. The location shown on Figure VI-9 is a schematic and conceptual only to determine if sufficient area exists within the park to construct a basin. During the final design process, the location and shape of the basin should be refined based on a thorough public input process. Concerns about construction disturbance were voiced during the study public process that will need to be addressed. The intent would be to locate the basin as far as possible from the homes.

Note that the property at 2036 Mershon has a gravity feed drain for the house's footing drain that was installed in lieu of a sump pump. The gravity line from the footing drain is connected to the storm sewer in Mershon. This connection should be maintained when the storm sewer in Mershon is replaced to accommodate the Lawton Park basin.

The proposed culvert replacement at Seventh Street should be installed after all three detention facilities have been constructed. With Project A or Project B, the design storm will likely still produce overland flow at Seventh Street. Therefore, all of the stormwater is not reaching the main Malletts Creek storm sewer in these projects. Only in Project C is the stormwater completely contained within the pipe system during the design storm. Under this scenario, the increased pipe size at Seventh Street is necessary to compensate for the elimination of overland flow.

Figure VI-9: Project C – Lawton Park Underground Storage and Sewer Improvements

4. *Sewer and Detention Improvement Summary*

The following are the proposed improvements to the storm sewer necessary for the improvements to function properly (Figure VI-10):

1 Covington Disconnect (Project A, B, C) - Covington Road storm sewer disconnected from flowing east on Scio Church and rerouted into the north Eisenhower basin via new storm sewer.

2 Covington / Eisenhower Improvement (Project A, B, C) – New sewer conveying Covington Road flow in north Eisenhower basin and a new sewer connecting the north Eisenhower Basin to south Eisenhower Basin.

- 42” diameter sewer connecting Covington Road. to the north basin in Eisenhower Park
- 42” diameter culvert connecting the north basin to the south basin

3 Scio Church at S 7th Street (Project B, C) - Storm sewer improvements along Scio Church south of Pioneer High School

- Storm sewer improvements along Scio Church from road replacement

- 36” Pipe crossing S 7th Street to collect overland flow to convey into proposed basin

4 7th Street Disconnect (Project B, C) – Sewer on 7th Street at Scio Church Road was disconnected

5 7th Street Crossing Improvement (Project C) – Replacing filled open channel with a 6’x8’ Box Culvert and sediment bar removal.

6 Winsted Blvd. and Waverly Road Disconnect (Project C) – Disconnect flow from Winsted Blvd. to Waverly Road, forcing all flow from northern Winsted Blvd to flow down to Scio Church.

7 Scio Church Disconnect (Project C) – Splitting Scio Church storm sewer at Winsted Blvd. creating two different networks

8 Mershon Dr. and Scio Church Storm Sewer (Project C) – Improving sewer along Scio Church starting at Winsted Blvd heading east till Mershon Dr. Adding storm sewer along Mershon Dr. from Scio Church to proposed underground detention at Lawton Park.

- Sewer along Scio Church between Mershon and Winsted was increased to 60” diameter pipe
- 48” Sewer was added to connect the improved 60” pipe on Scio Church Road to the inlet of the Lawton Park Basin

Figure VI-10: Storm Sewer and Detention Improvements and Disconnects

G. Flood Maps

Flood maps (Appendix A: Flood Maps) were created for all four models (existing conditions, Eisenhower Park, Pioneer HS, Lawton Park) for four (4) rainfall events (March 15, 2013, 2, 10, and 100 year design storms). The maps show locations where there is a possibility of flooding the roadway or adjacent land. As a benchmark for quantifying improvement for each project, the March 15 storm event will be used as reference in the following section. As noted previously, this storm event was roughly equivalent to a 10-year, 3-hour storm event.

1. *Project A – Eisenhower Park Basin*

Analysis of Project A showed a substantial decrease in flooding due to the addition of the Eisenhower Basin, specifically along Wiltshire Court and Churchill Drive. There was also some decrease in flood levels shown along Delaware Drive and Mershon Drive. The decrease in flooding shown along Covington Drive and Hanover Road was attributed to inlet improvements above and beyond the improvements created by adding the Eisenhower Basin. Overall, model results indicate approximately 11 acres less flooding in Project A in comparison to existing conditions for the March 15 storm.

2. *Project B – Pioneer High School Basin*

With the addition of the Pioneer Basin and Scio Church storm sewer as part of Project B, modeled flooding areas were shown to decrease by an additional two (2) acres beyond what was predicted for Project A. Improvements under this alternative would be focused primarily along Scio Church Road, Ascot Road, and Chaucer Drive.

3. *Project C – Lawton Park Basin*

By implementing Project C, model results indicate approximately two (2) fewer acres of flooding for the March 15 storm when compared to Project B. This would bring the total reduction in flooding during the March 15 storm to around 15 acres when compared to existing conditions. The focus of flooding reduction generated by Project C would be near the proposed Lawton Basin, along Delaware Drive and in back yards between Delaware Drive and Morehead Drive.

H. Cost Analysis

Detailed line item cost estimates were prepared for the recommended alternatives. The costs were based on conceptual designs and the best available information. The costs were developed using 2013 dollars and can be used for future budgeting or funding applications with the appropriate inflation factored in. A contingency factor of approximately 20%, costs for professional services and permitting are included in the cost estimates to give a true picture of the scope of the investment necessary to implement the projects. Copies of the detailed estimates are included in Appendix E.

In order to provide comparison against other types of projects, including the LID projects previously analyzed and projects recently constructed, the total costs for each of these projects was also converted to cost per cubic feet of storage.

Table VI-4: Alternative Costs

Street / Project Site Name	Storage Volume (cf)	Project Costs	Cost/Volume Storage
Eisenhower Park Basin	470,000	$2,100,000	$4.50
Pioneer Basin	400,000	$1,170,000	$2.90
Lawton Park Basin	280,000	$5,155,000	$18.40
Total		**$8,425,000**	

For comparison purposes, the Doyle Park project noted in Table V-3 was recently completed at a cost of $3.65 million, including all construction and professional costs. The project involved 1.91 million cubic feet of storage, resulting in a per cubic foot cost for storage of $1.91.

These projects are significant in size and scope. Project funding may be available for projects of this type through the State of Michigan State Revolving Fund, SAW Program, and other programs may be available in the future. However, most programs would be loans rather than grants, requiring long term payback of the principal with interest. If these projects will be implemented, they will be included in the City's long-term capital improvement planning to determine priority and the feasibility of future funding.

VII. RECOMMENDATIONS & CONCLUSION

Five public meetings were held with an average attendance of more than 50 citizens. Field meetings were held at more than 20 reported flooding locations. To reach the conclusions in this study, specific problems identified by neighborhood residents were compiled and analyzed, overall goals were agreed upon during public process, and a cost-benefit analysis including modeling and simulation of dozens of situations was performed. Storage within the project area was found to best meet project goals.

Of 17 potential storage sites, three detention solutions and one storm sewer improvement must be completed to effectively manage the flooding within the Upper Malletts Creek watershed to meet the stated objective of a dramatic reduction in surface flooding during an event like March 15, 2012. Storage at Eisenhower Park, Lawton Park, and Pioneer High School (east of 7th Street) were selected. The Scio Church storm sewer improvement project was also chosen due to its connection to the Pioneer detention project. Each solution manages stormwater for a portion of the watershed and reduces a percentage of the overall flooding previously experienced. In addition, there are other minor storm sewer improvements included with each basin that must be completed for the system to work properly.

This report provides a suite of three solutions because none of the 17 storage sites or other alternatives considered were found to have a substantial positive impact on all of the reported flooding problems, mainly due to three factors. The 886 acre watershed, topography, and resulting flow paths of the water did not allow for development of other feasible alternatives (to this suite of three projects) that would provide a benefit to all or even a majority of the neighborhood. Thus, each phase provides relief to specific geographic sub-areas with Project A having the most immediate positive impact for the most residents, both on quantity of flow managed and reduction in severity and number of problems in future rain events. Project B is listed second primarily due to the programming of Scio Church Road in the near future. In summary, the City could choose any sequencing desired, but based on the analysis described in this report, if phasing is required, we would recommend Project A as the first to move forward.

Details on the recommended improvements include:

Project A – Eisenhower Park Basins and Storm Sewer Improvements
This alternative adds two detention basins in Eisenhower Park. The two basins have a combined storage volume of 10.7 acre-ft. and are connected by storm sewer. In addition to the two detention basins, flow from the Covington Road sewer was diverted directly into the proposed North basin, to provide the most cost-effective relief for downstream residents.

Project B – Pioneer Basin and Scio Church Storm Sewer Improvements
A detention basin would be created along the north side of Scio Church Road just east of 7th Street. This basin has a storage volume of 9 acre-ft. The storm sewer in Scio Church would also be sized to accommodate a portion of the detention volume for the area.

Project C – Lawton Park Basin and Storm Sewer Improvements
An underground detention basin would be constructed along the eastern edge of Lawton Park. This underground detention basin would use connected box culverts to create a storage capacity of 6.4 acre-ft. The basin would be connected to an overflow structure that would prevent the flooding of the storage chamber and allow flow downstream through the Mershon storm sewer. New storm sewer would be installed along Mershon Drive and Scio Church Road to convey water into the new basin. Also, a small section of the Malletts Creek storm sewer would be replaced at 7th Street and sediment would be cleaned out of the western end of Lans Basin.

The total project cost for all projects is approximately $8.425 million.

Also as part of the study, cleaning and storm sewer inspection of over 35,000 feet of City and County owned pipes and structures within the watershed was completed. The inspection found the sewer system to be in generally good condition and functioning at design capacity. Minor deterioration or sediment and debris deposits, consistent with expectations for a system of this size and age, were found and the initial findings were that pipe deterioration or obstructions in the main line of the storm sewer system were not a significant factor in previous flooding events, with the exception of a likely external blockage on 3/15/12 of the 42" diameter pipe west of Wiltshire Boulevard. Corrective measures were completed or are being planned for this suspected issue along with the few routine maintenance issues that were found. In addition, the County worked with Pittsfield Township to resolve long-standing deficiencies with a large detention basin at the Ice Cube, and that construction is nearly complete.

After gathering public input and feedback on the stormwater management alternatives, selections were made that were both functional and acceptable to stakeholders who shared a common goal of improved stormwater management in the area. Implementation of the recommended solutions will effectively achieve the project goals, including reducing the severity and probability of future surface flooding in the Upper Malletts Creek watershed, using the 3/15/12 storm event as the basis of conceptual design.

Should the City wish for the WCWRC to proceed with one or more of the recommended solutions, a petition would be required. As with other joint projects to implement study concepts, a project-specific public engagement and design process would allow further input from neighbors on both implementation and restoration.

Appendix A: Flood Maps

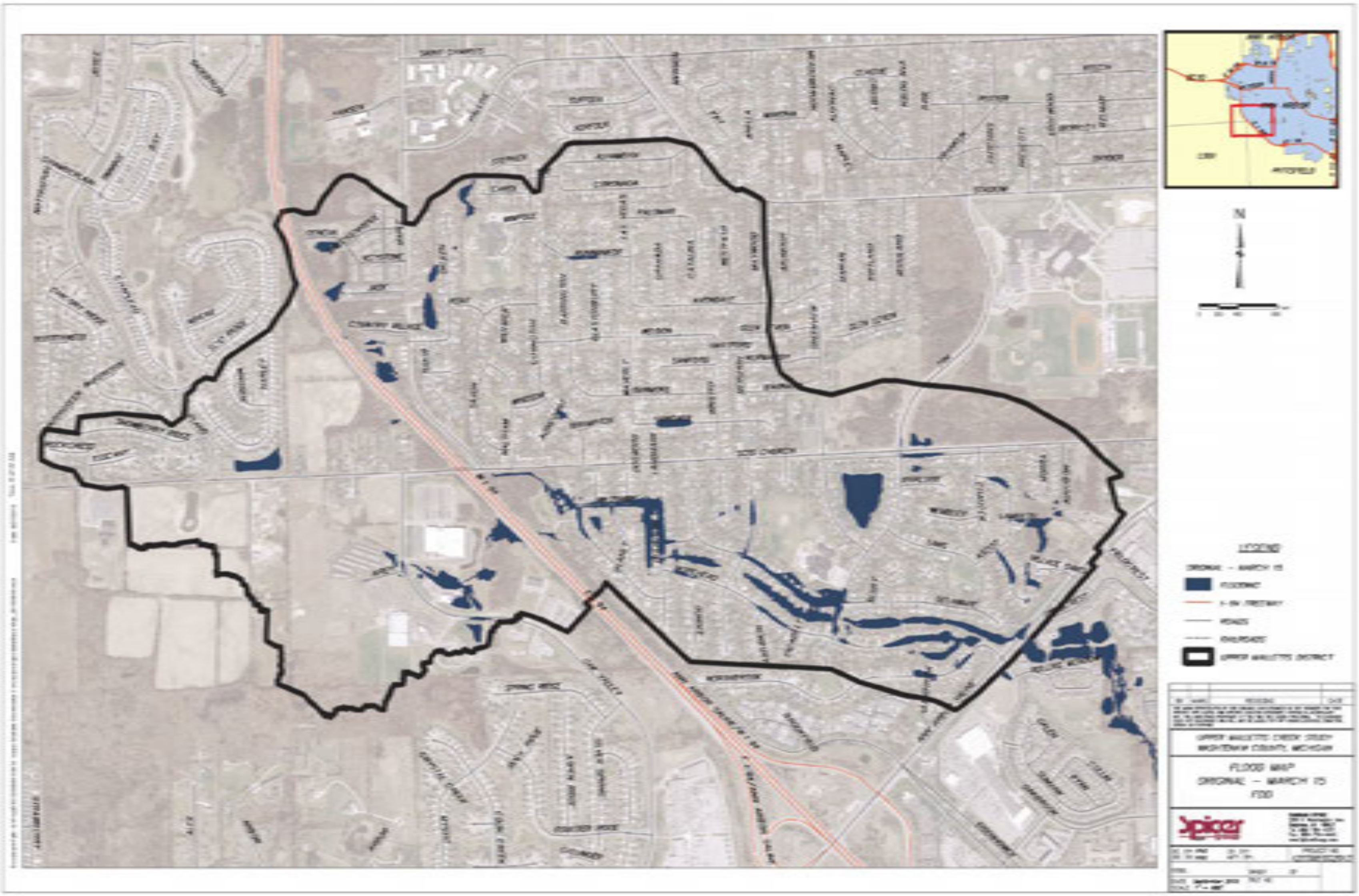


Figure A-1: No Improvements – March 15 Rainfall Event

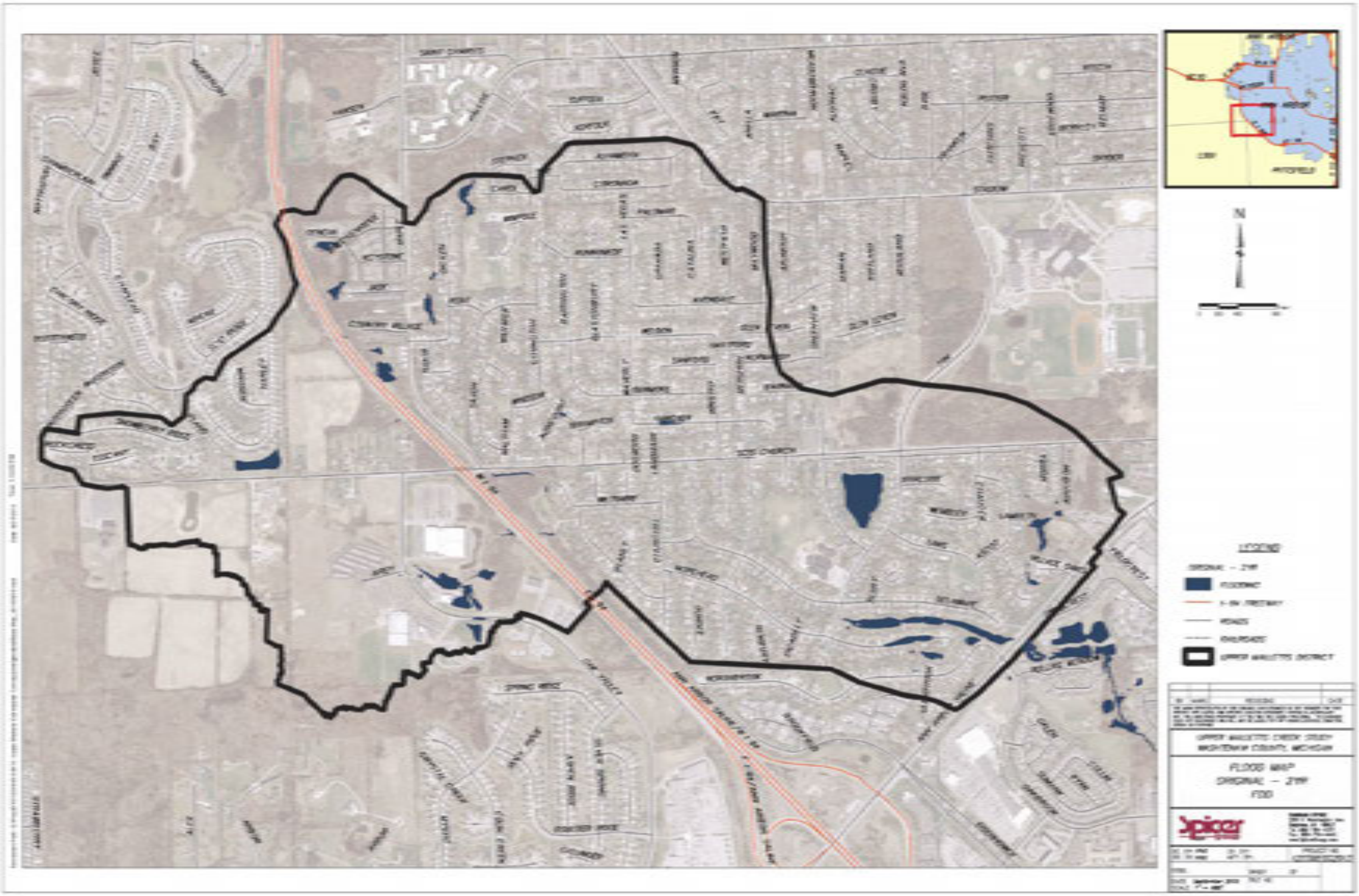


Figure A-2: No Improvements – 2 Year Design Storm

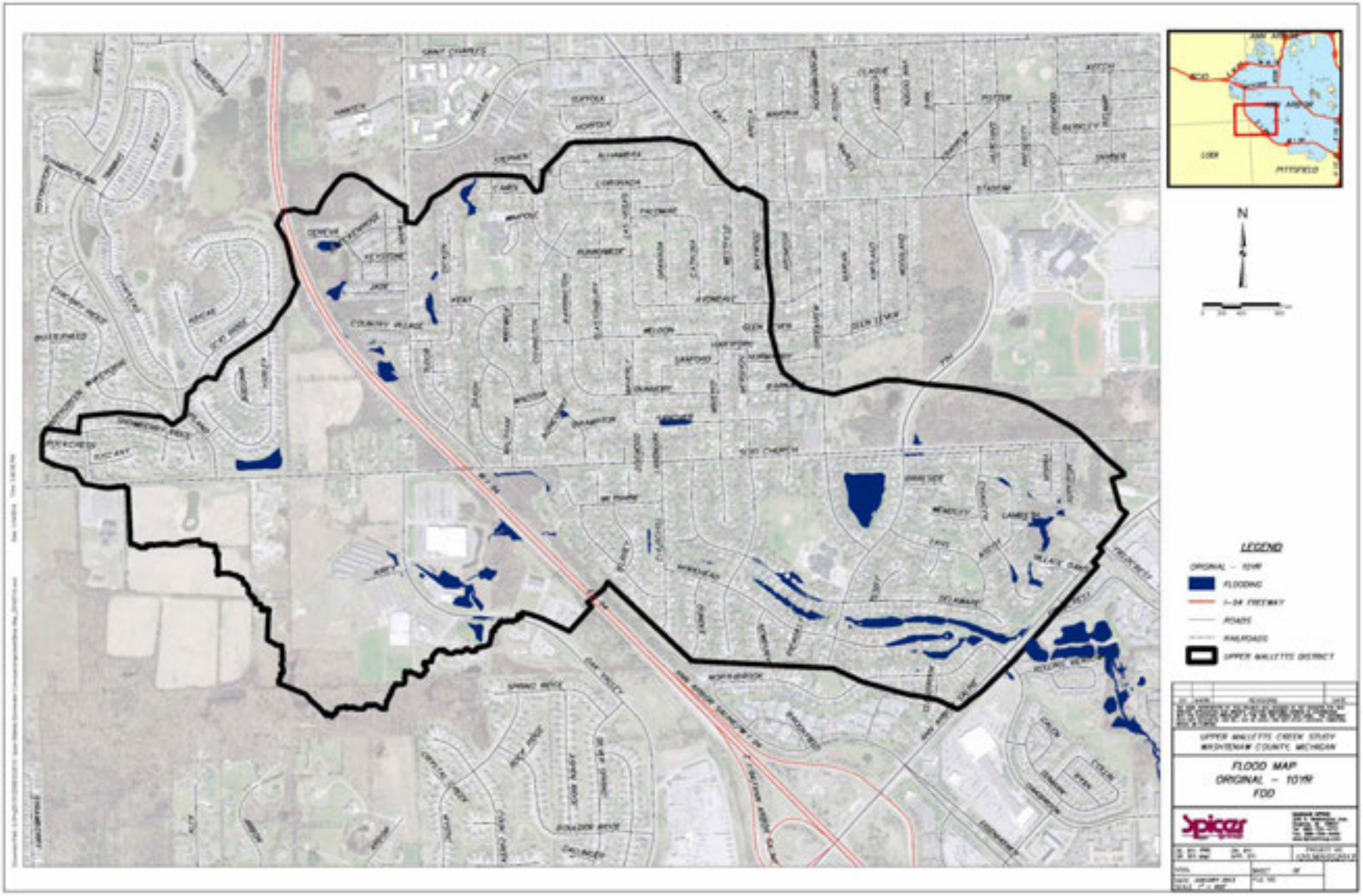


Figure A-3: No Improvements – 10 Year Design Storm

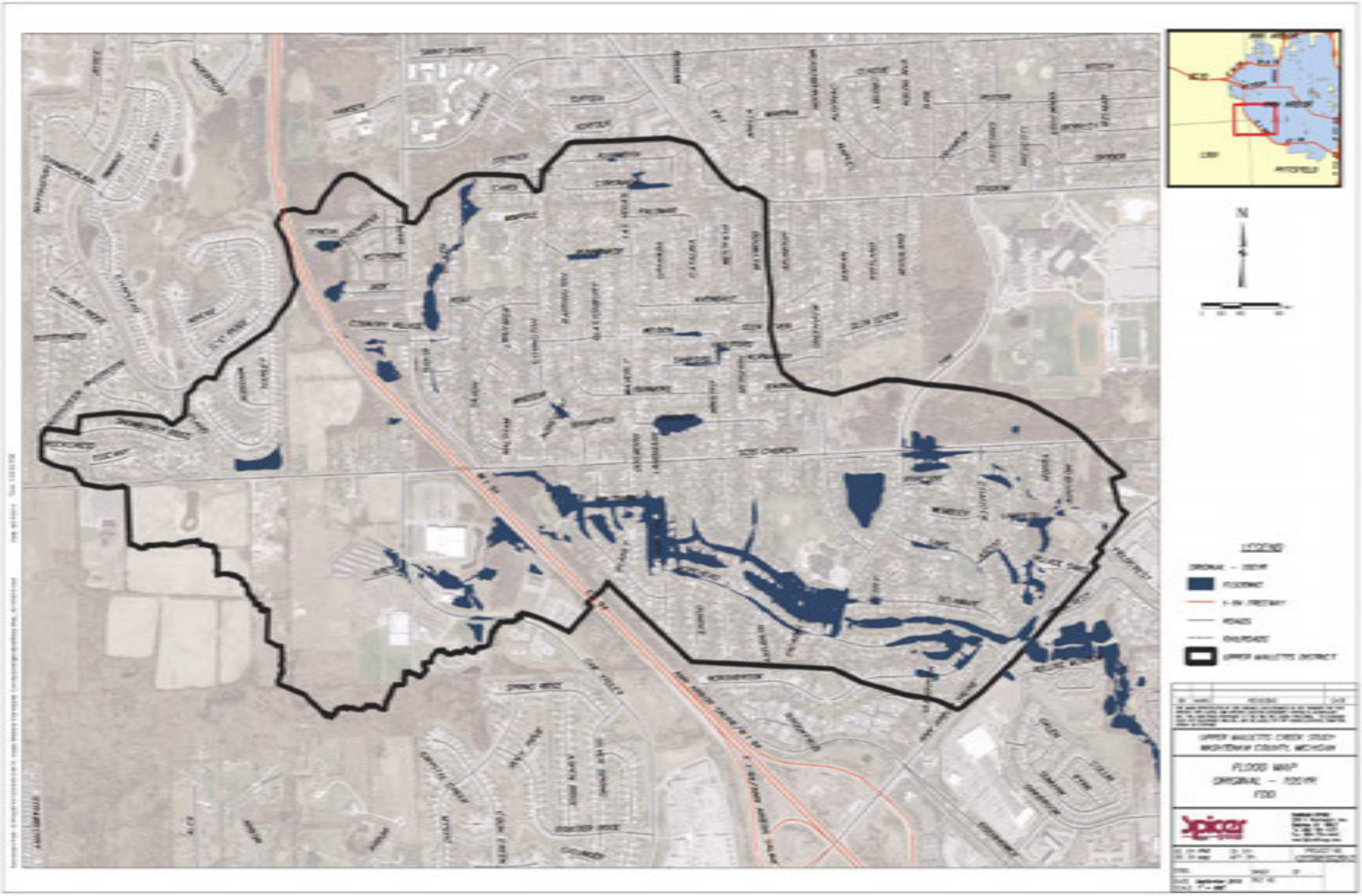


Figure A-4: No Improvements – 100 Year Design Storm

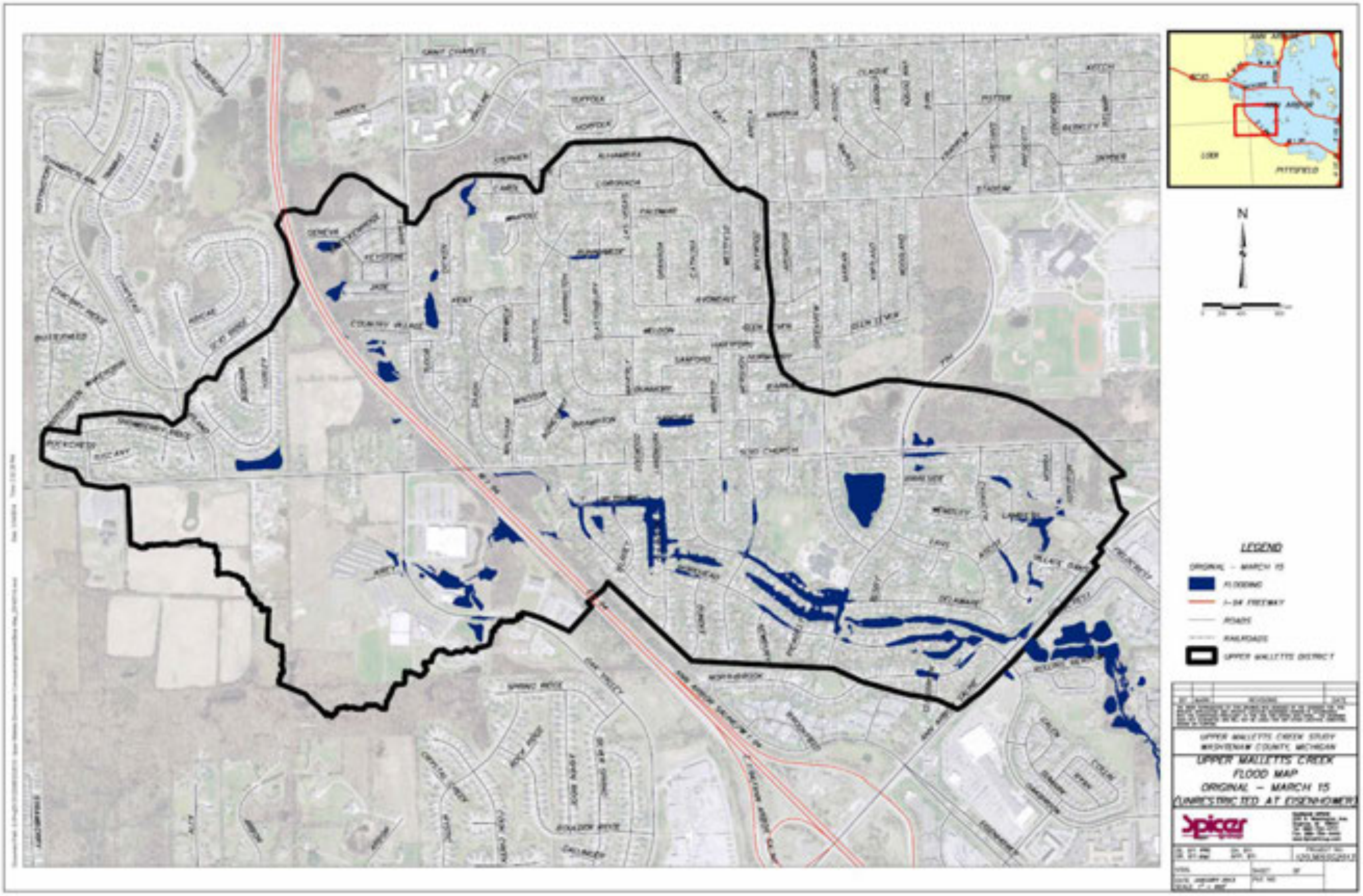


Figure A-5: Improved Inlet at Eisenhower – March 15 Rainfall Event

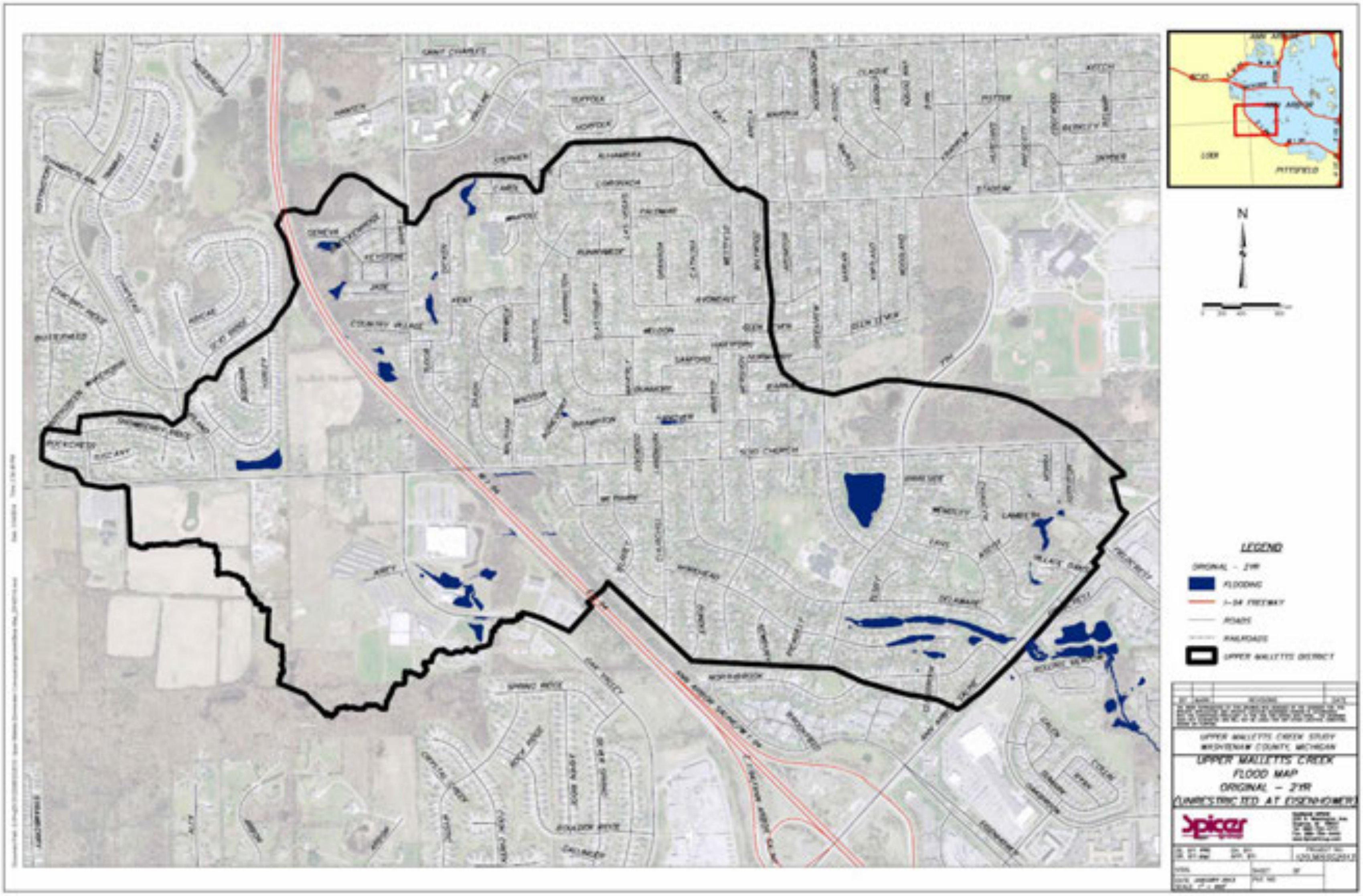


Figure A-6: Improved Inlet at Eisenhower – 2 Year Design Storm

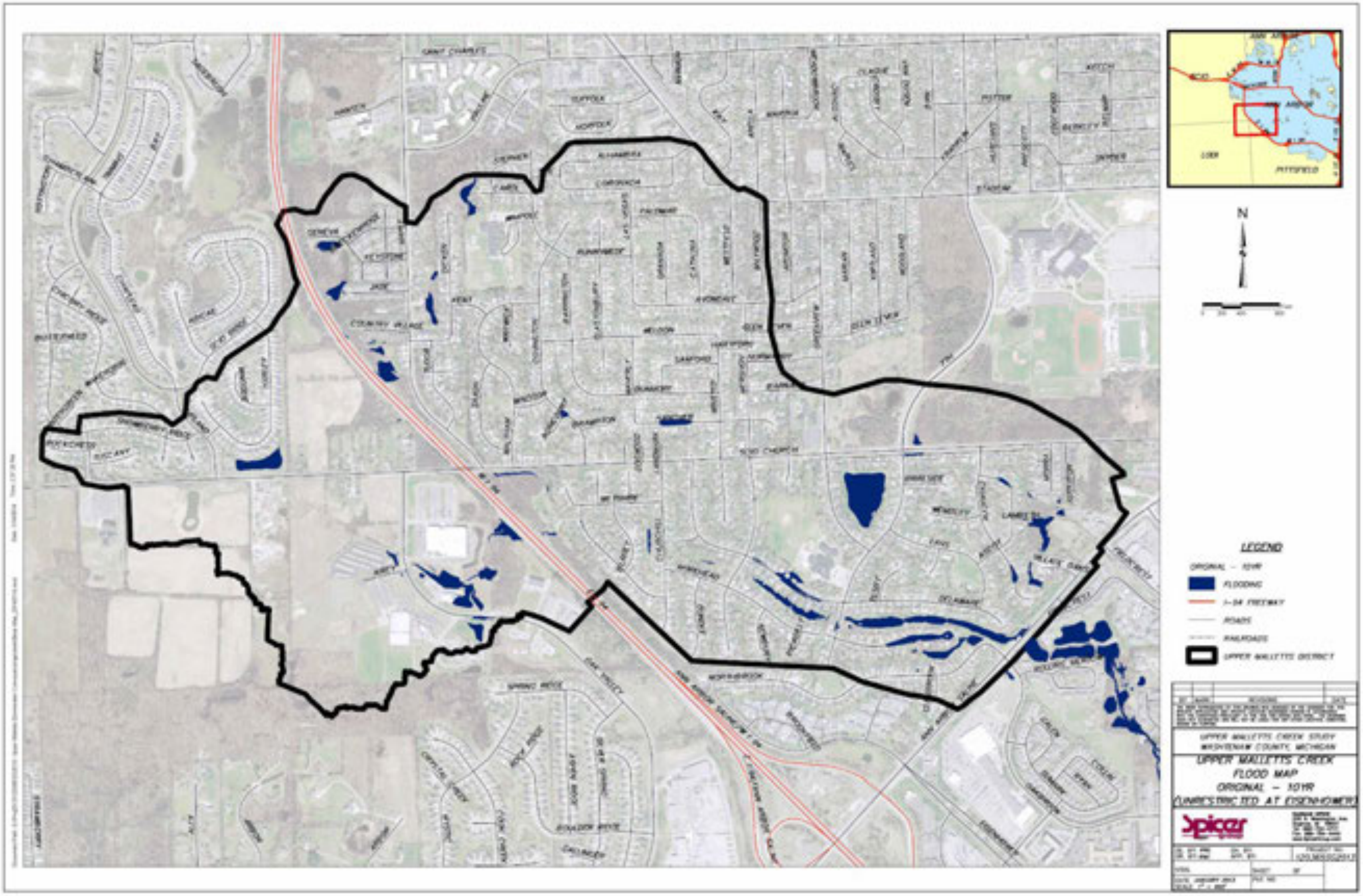


Figure A-7: Improved Inlet at Eisenhower – 10 Year Design Storm

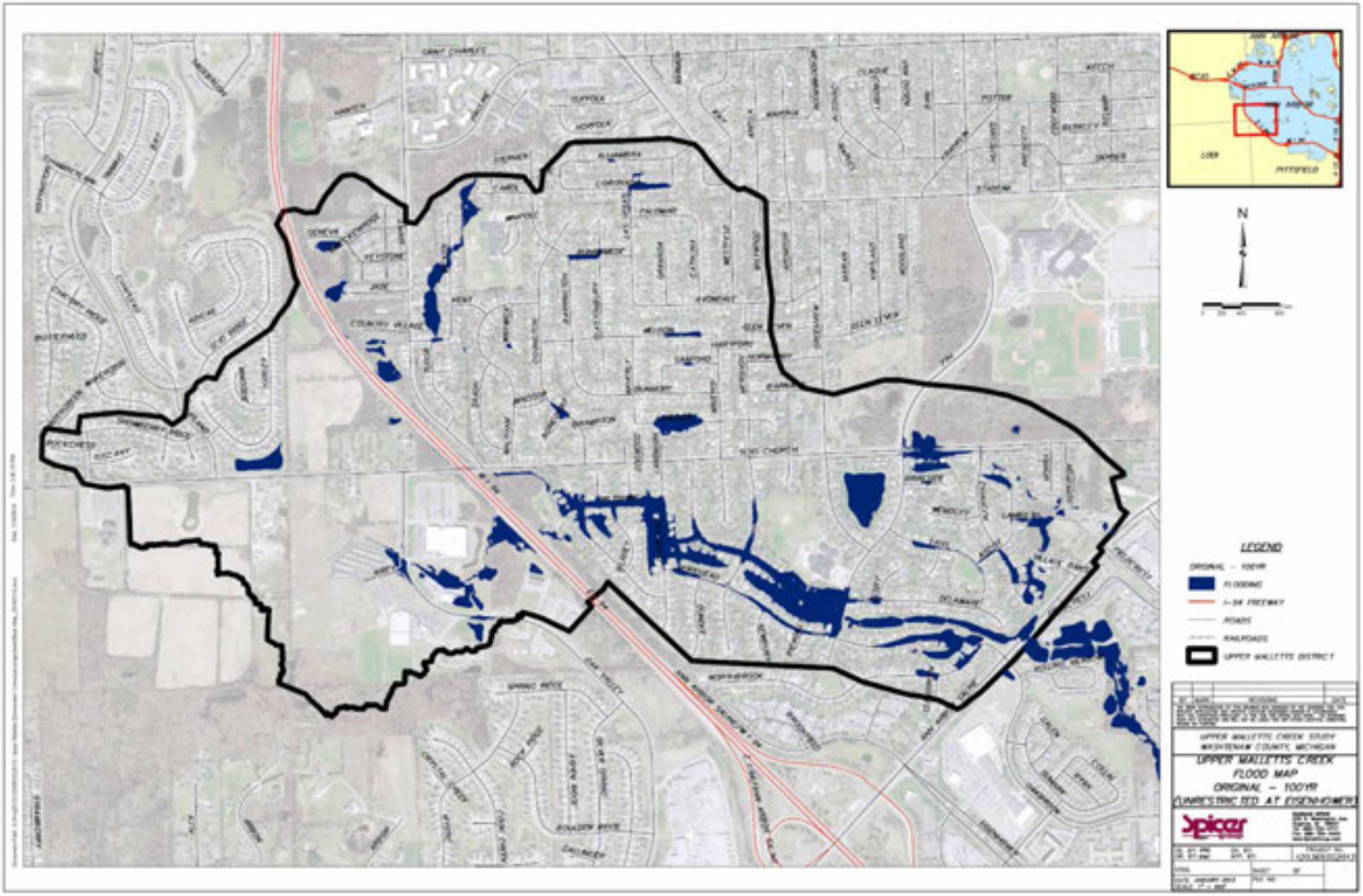


Figure A-8: Improved Inlet at Eisenhower – 100 Year Design Storm

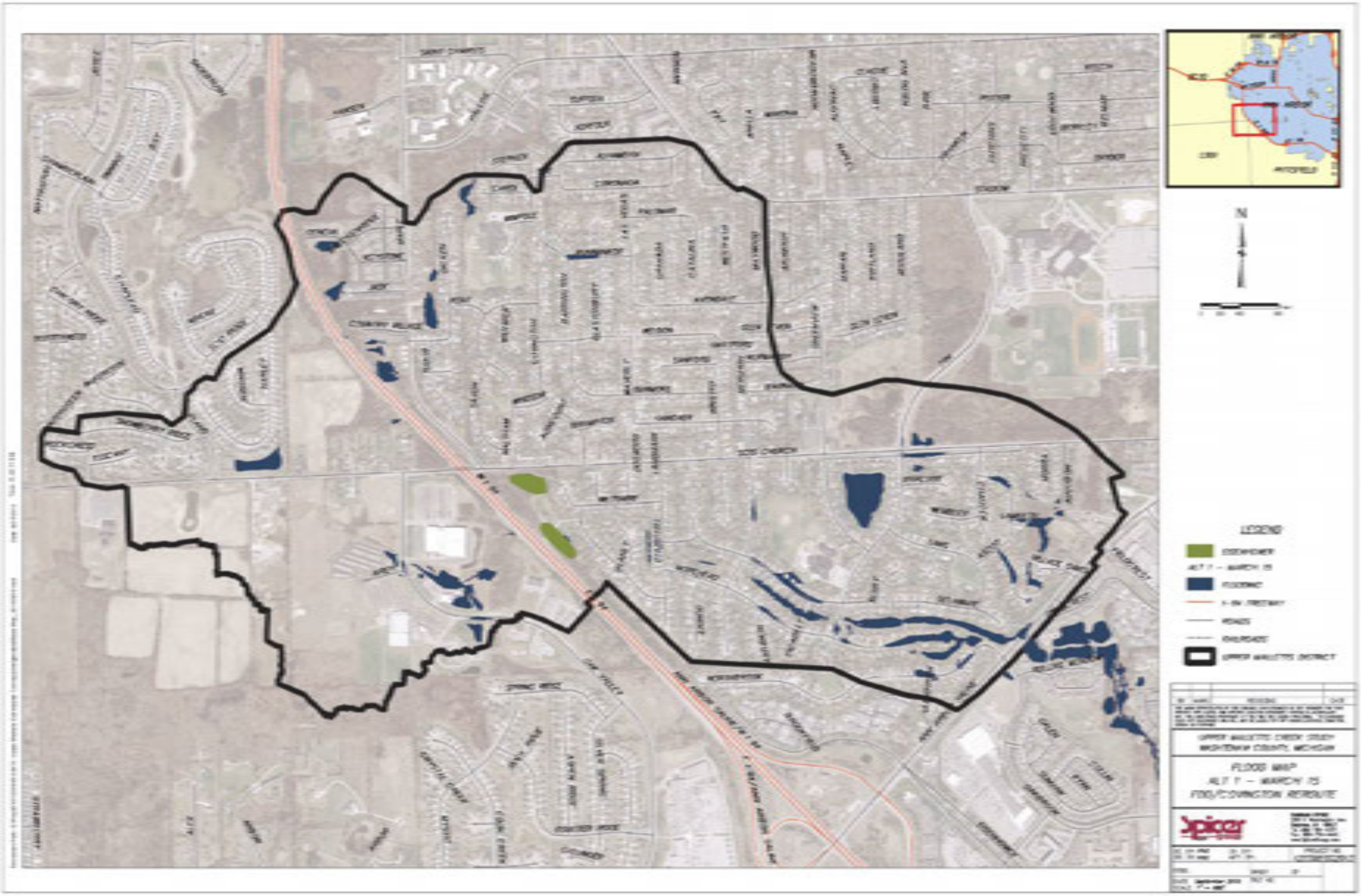


Figure A-9: Project A – March 15 Rainfall Event

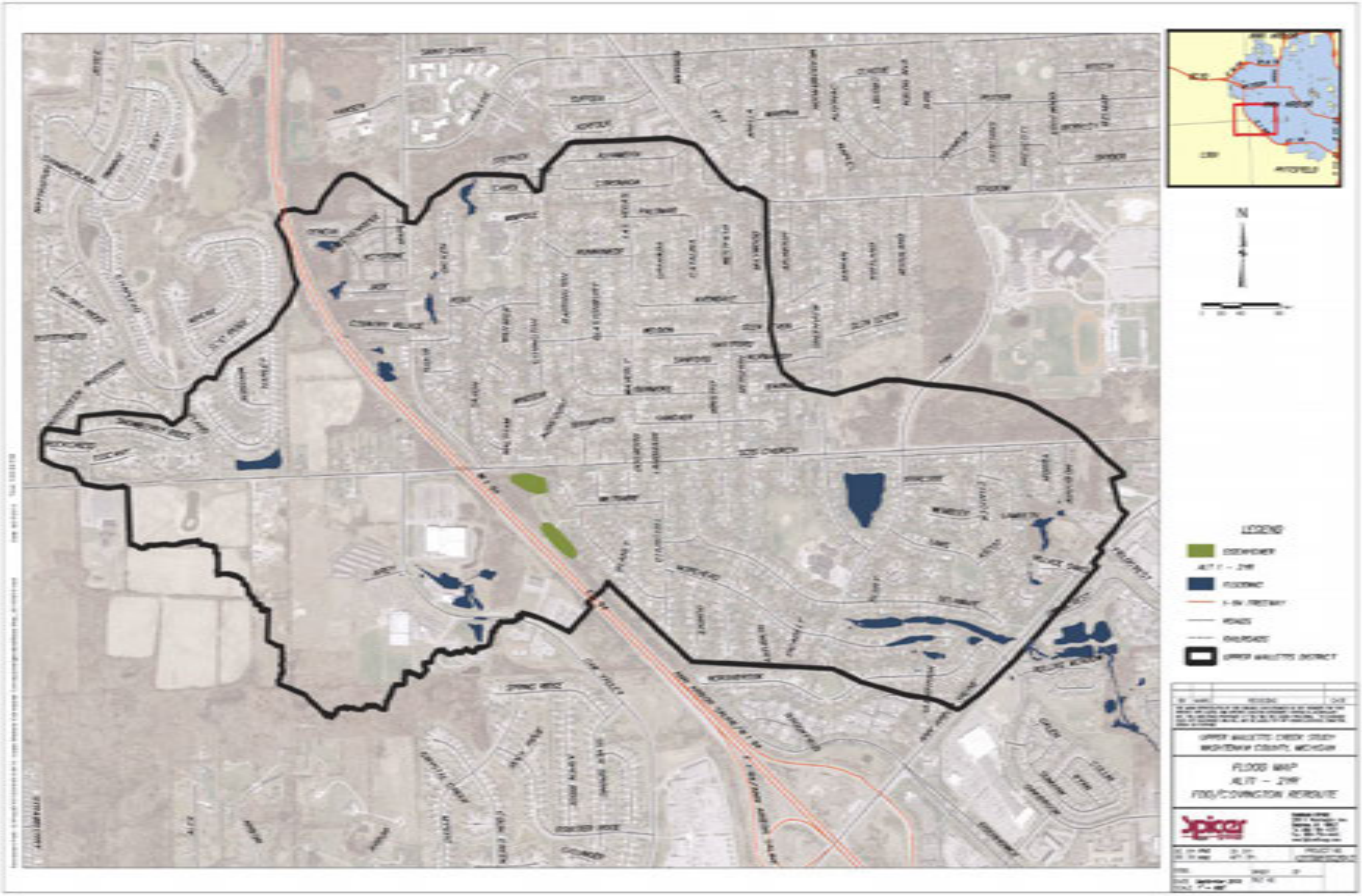


Figure A-10: Project A – 2 Year Design Storm

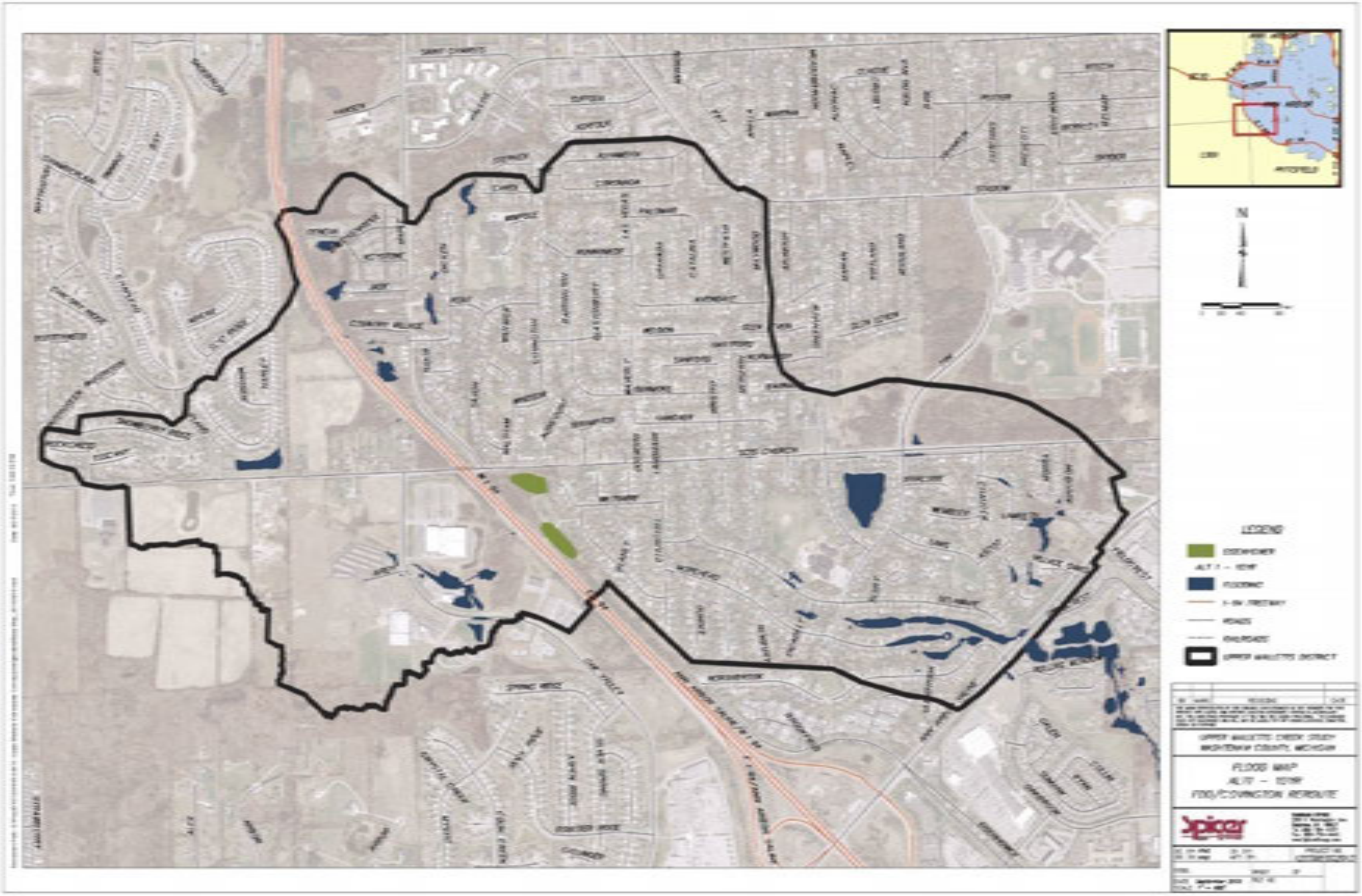


Figure A-11: Project A – 10 Year Design Storm

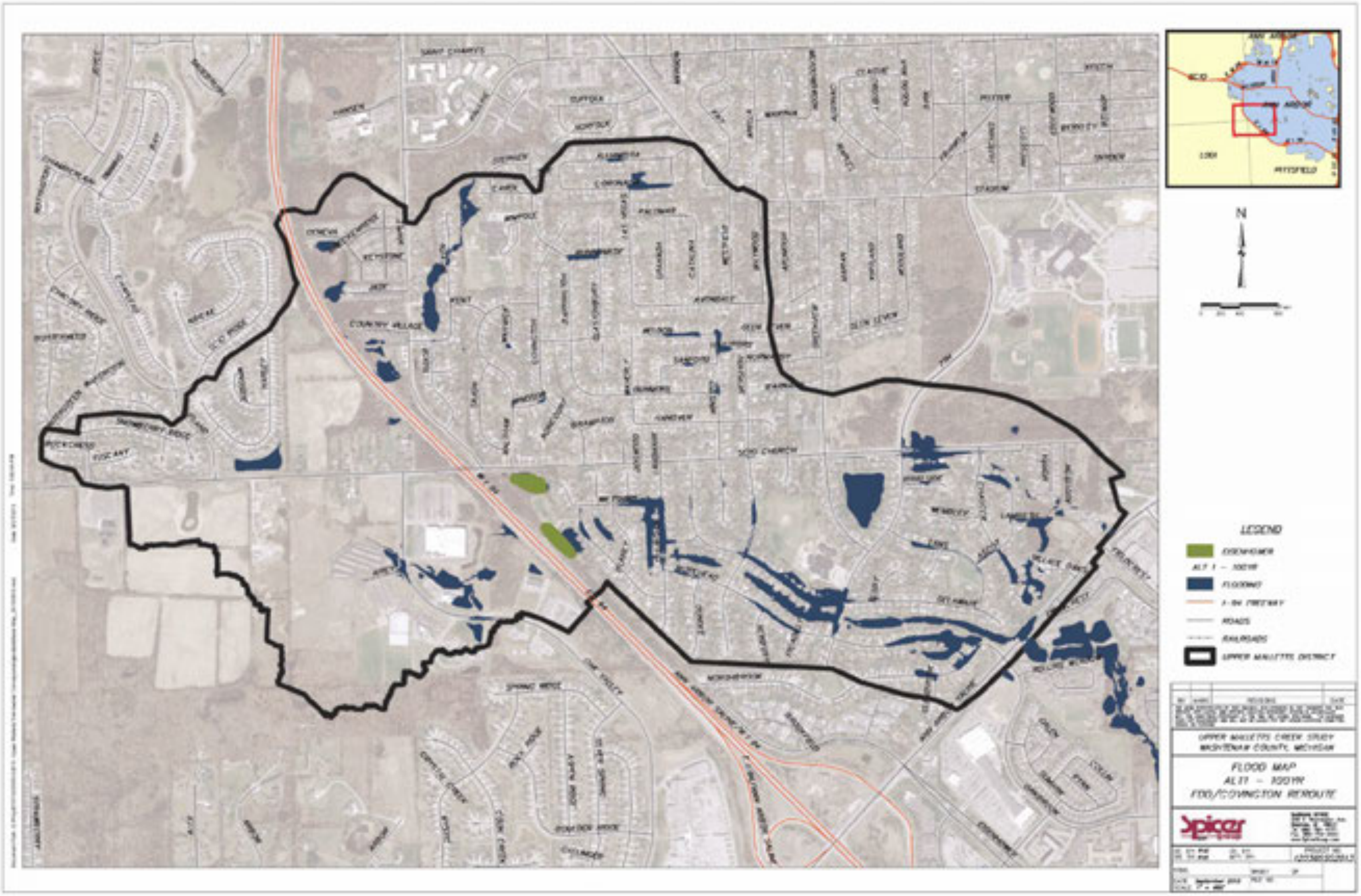


Figure A-12: Project A – 100 Year Design Storm

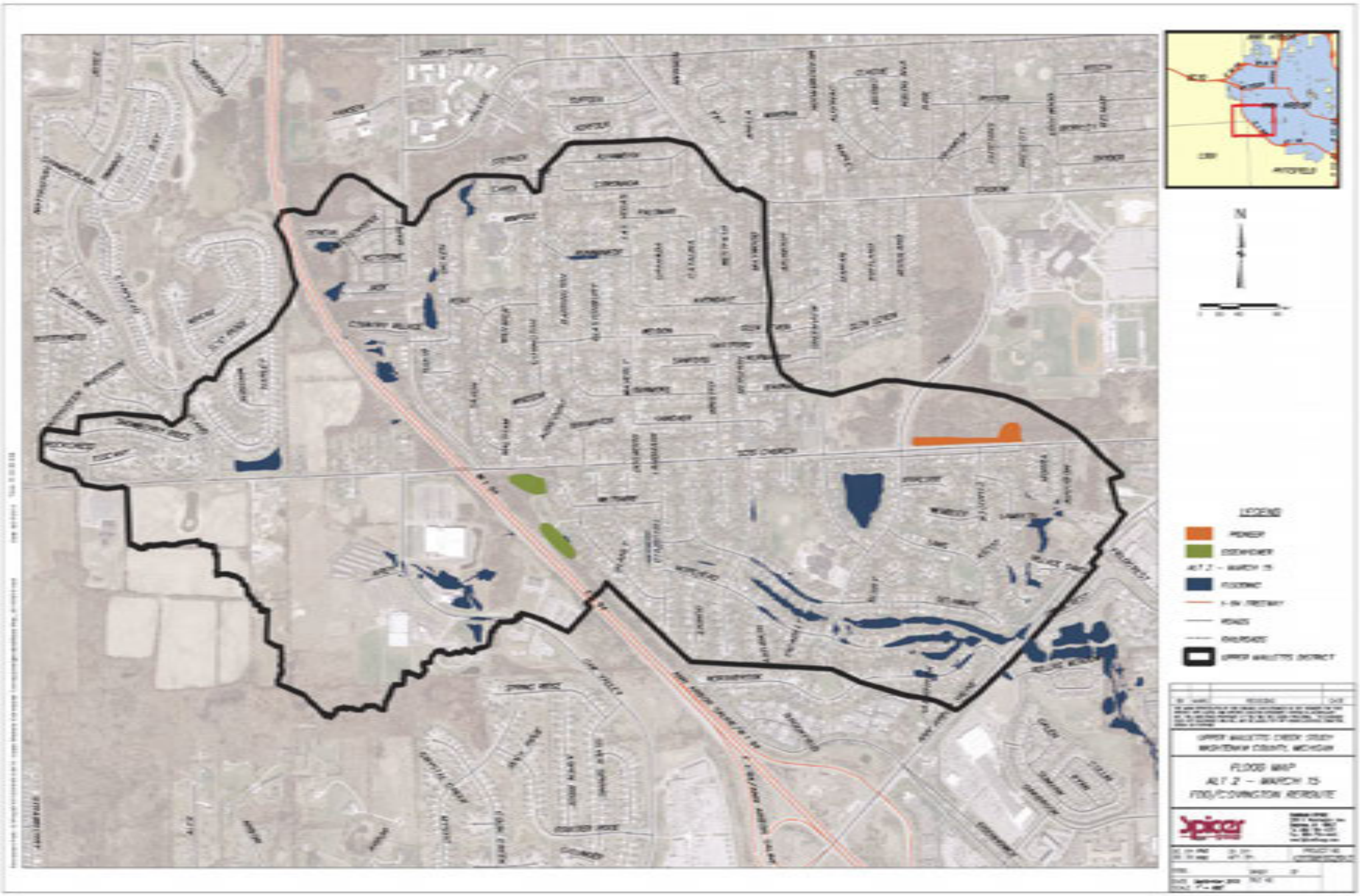


Figure A-13: Project B – March 15 Rainfall Event

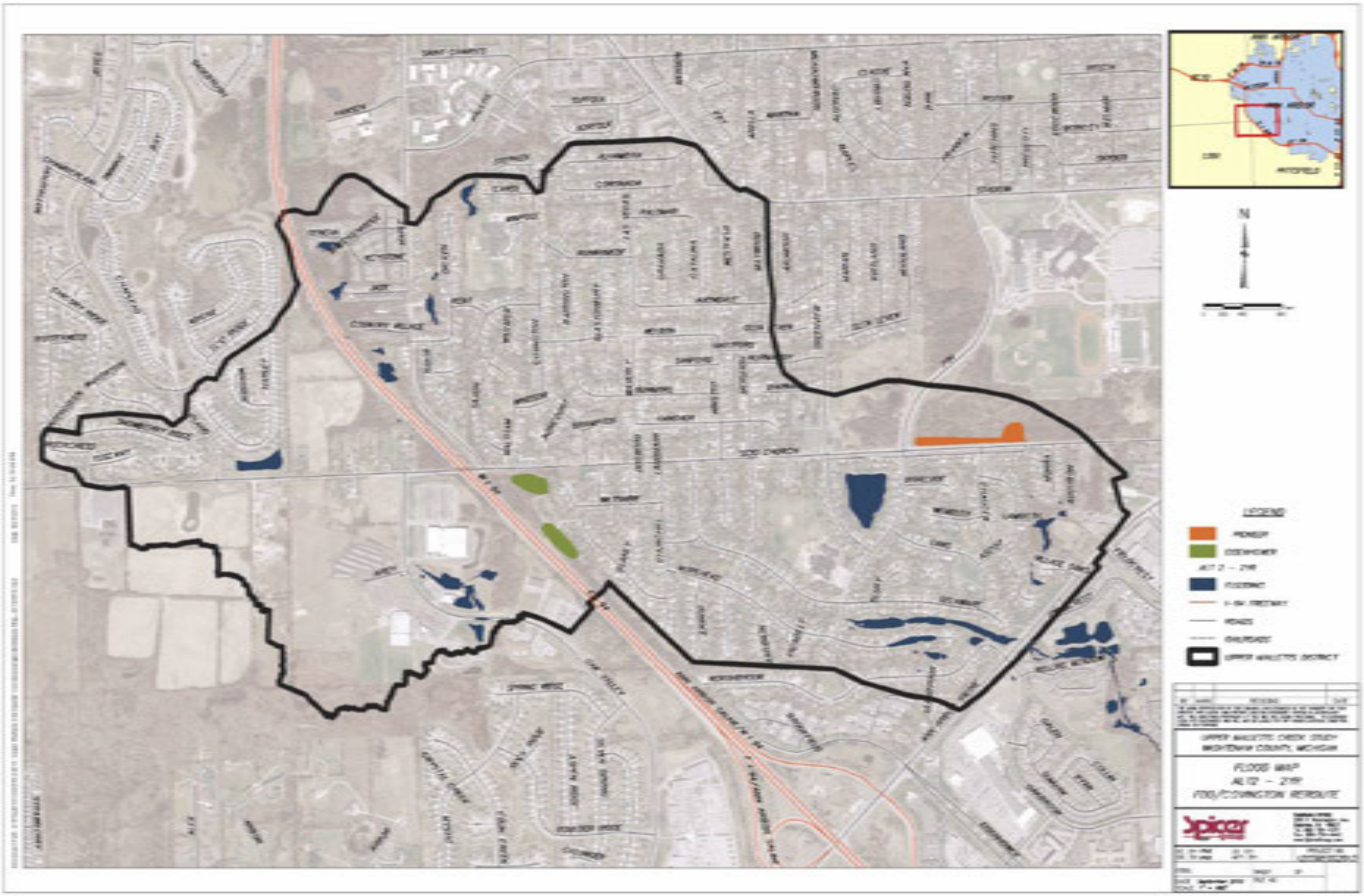


Figure A-14: Project B – 2 Year Design Storm

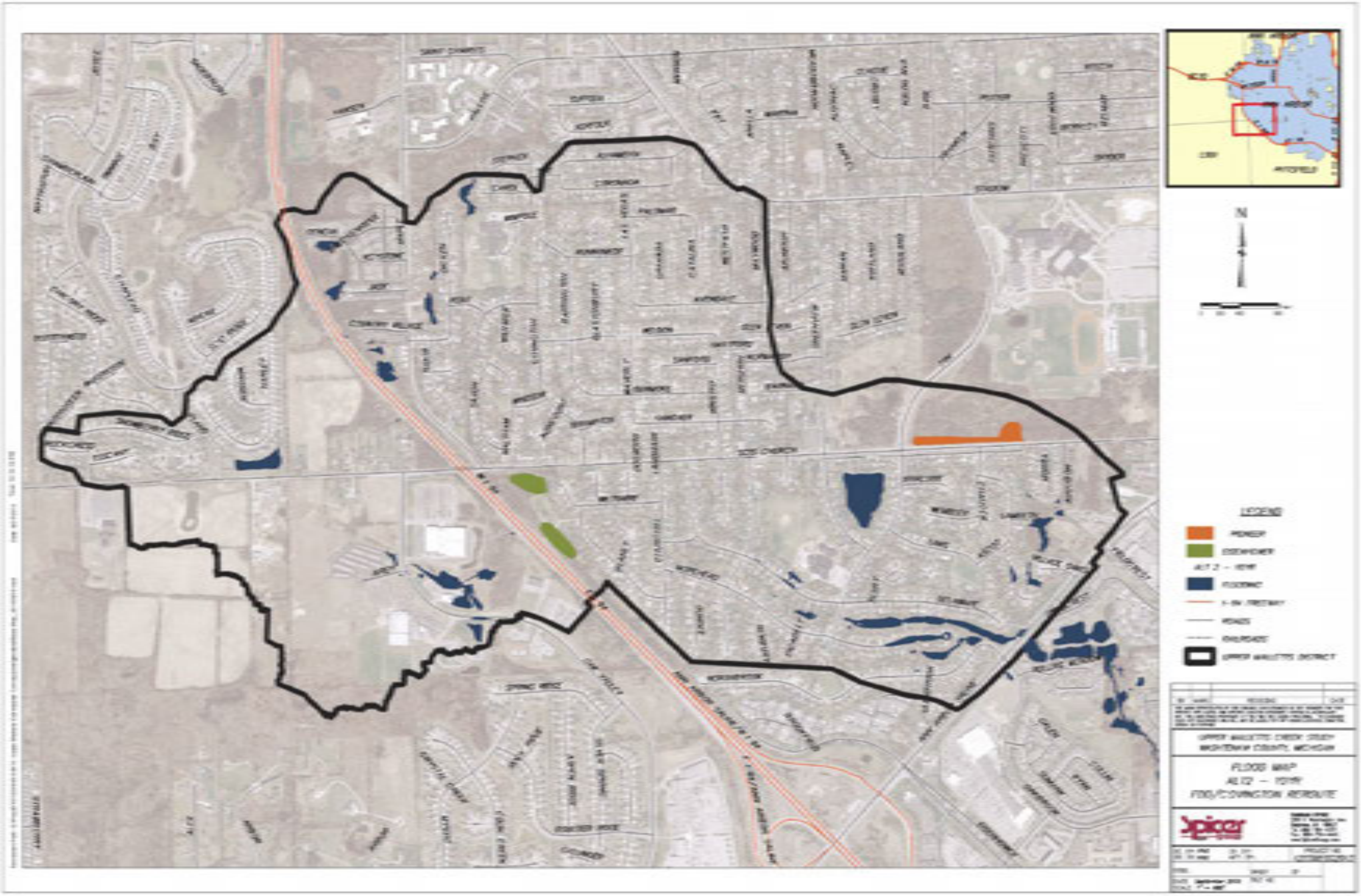


Figure A-15: Project B – 10 Year Design Storm

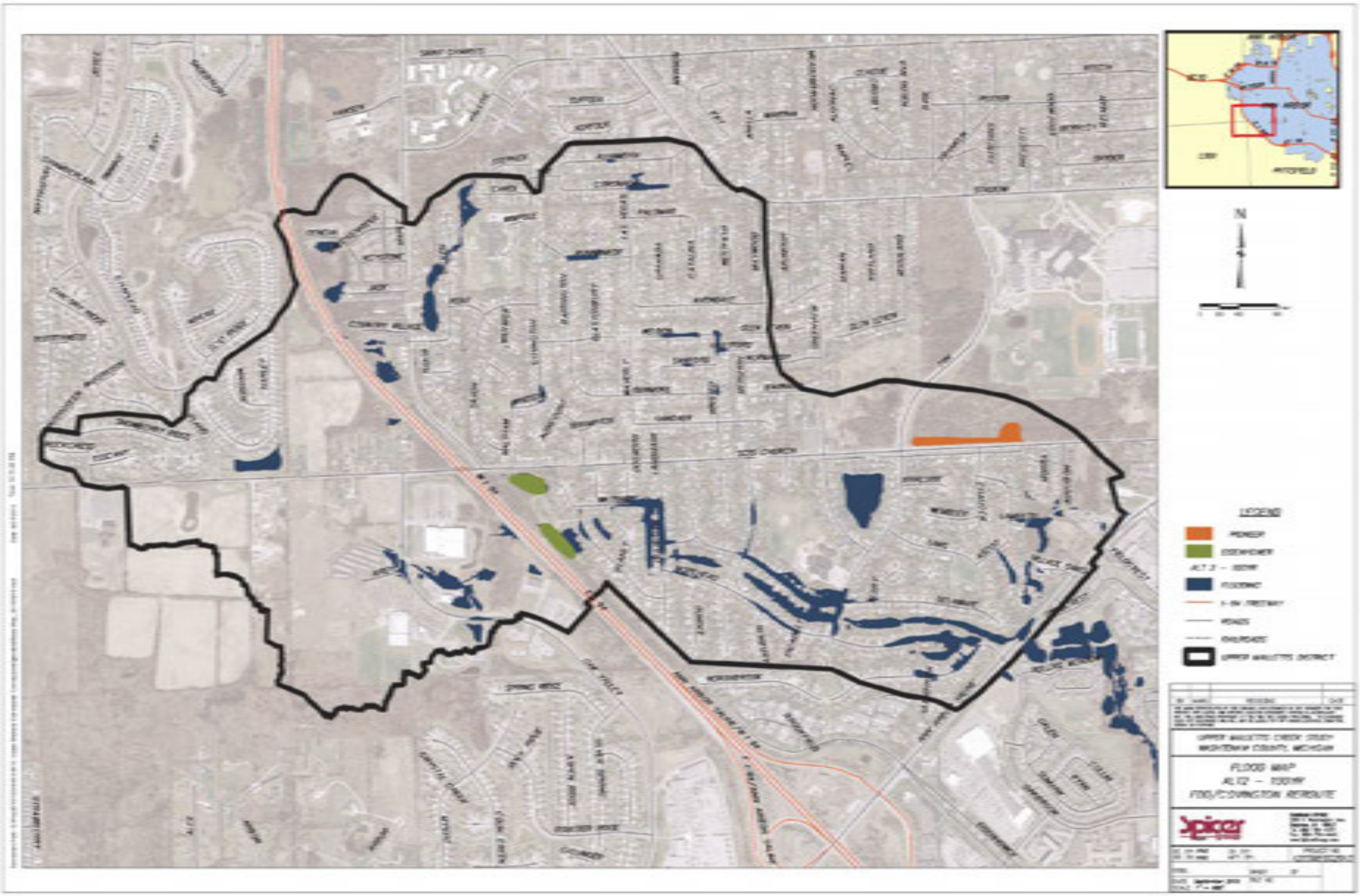


Figure A-16: Project B – 100 Year Design Storm

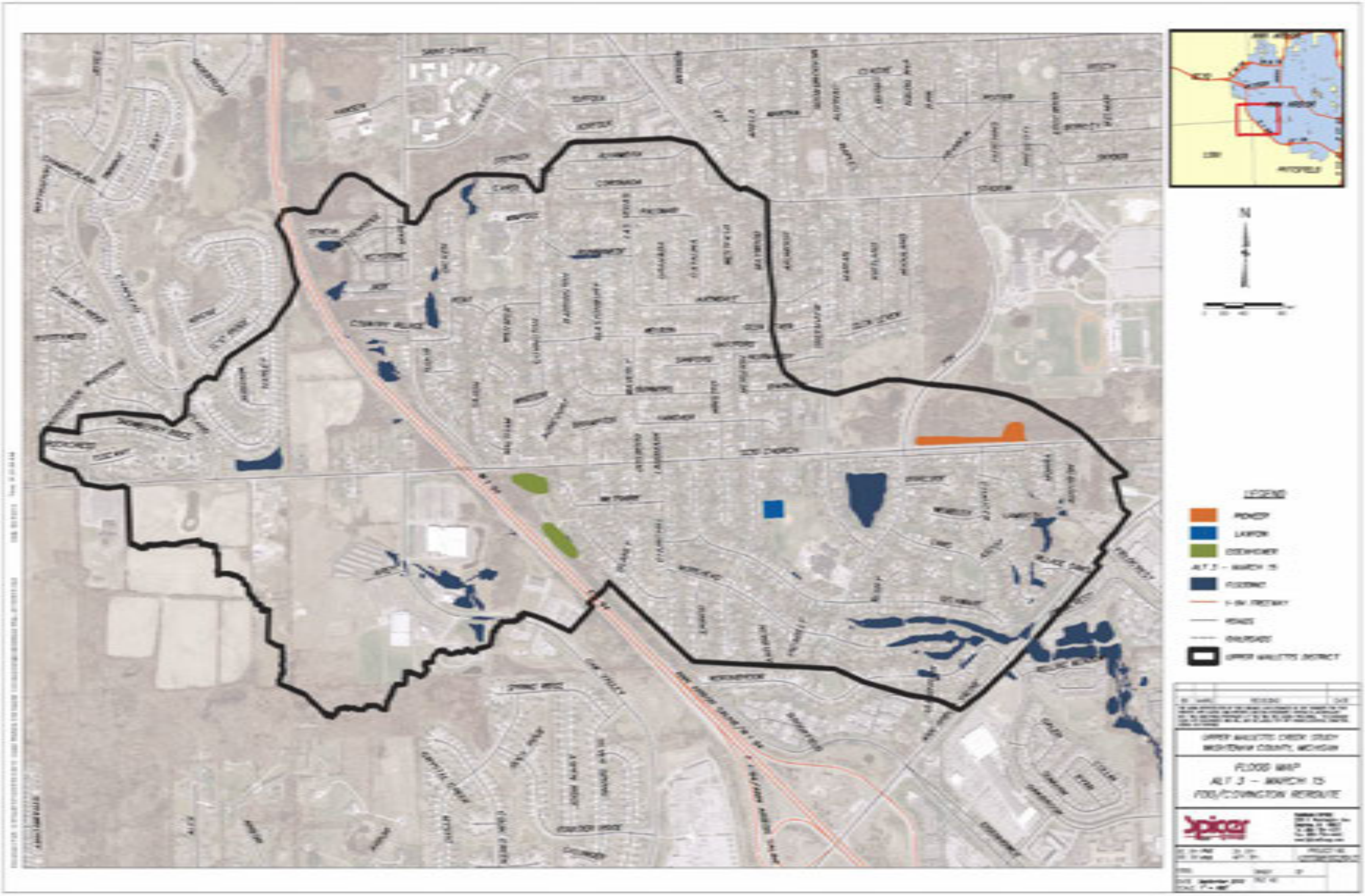


Figure A-17: Project C – March 15 Rainfall Event

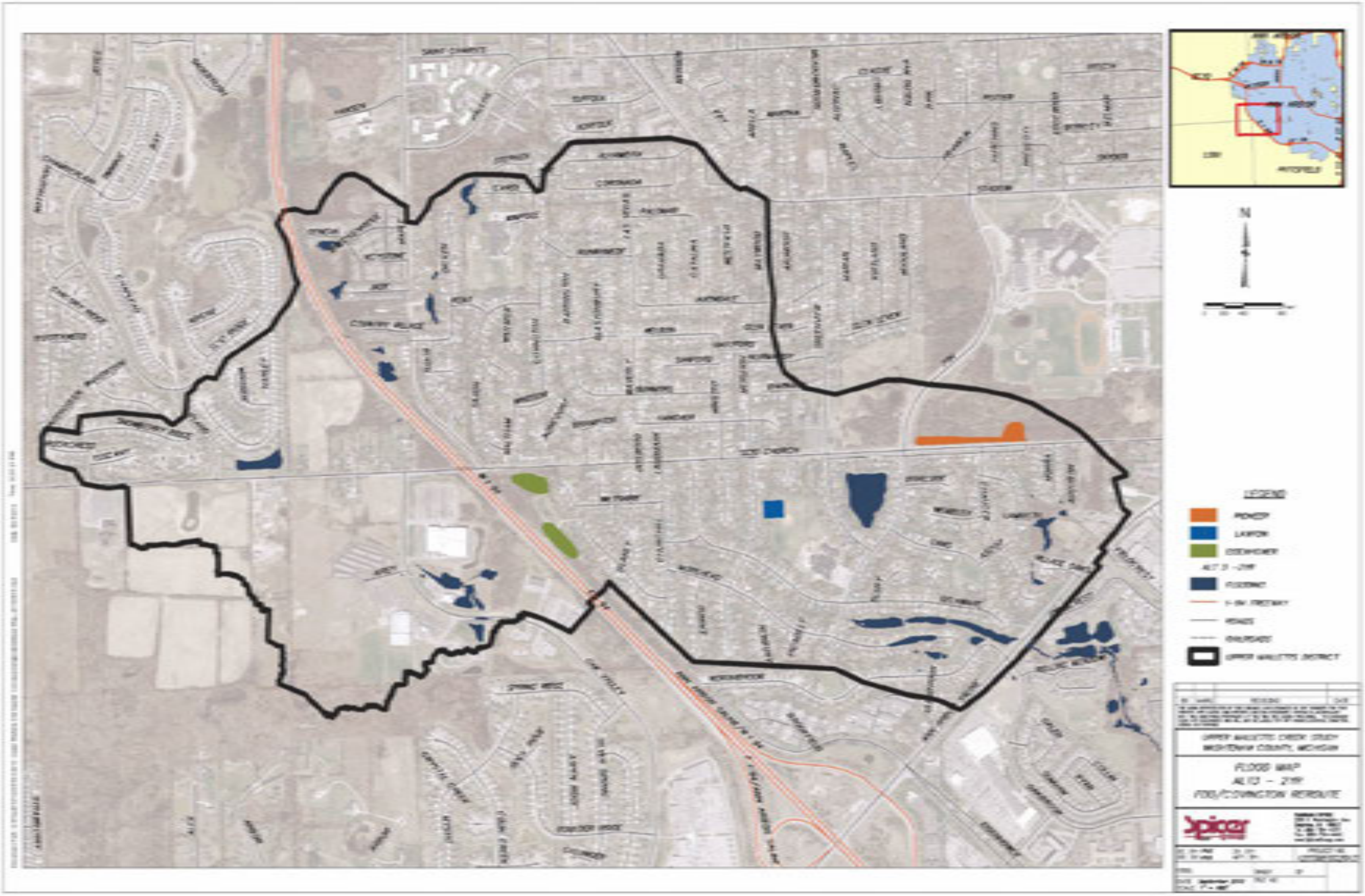


Figure A-18: Project C – 2 Year Design Storm

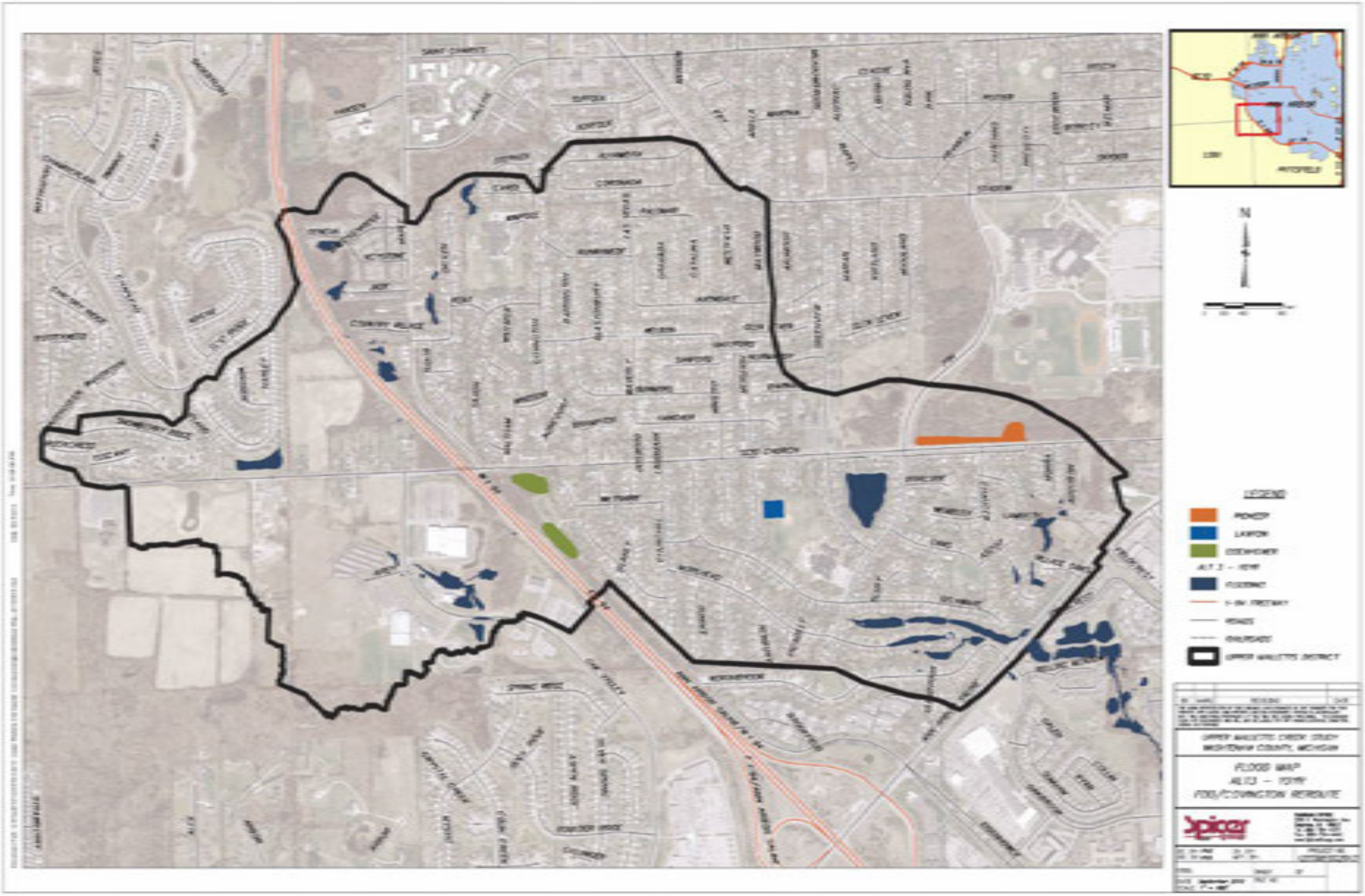


Figure A-19: Project C – 10 Year Design Storm

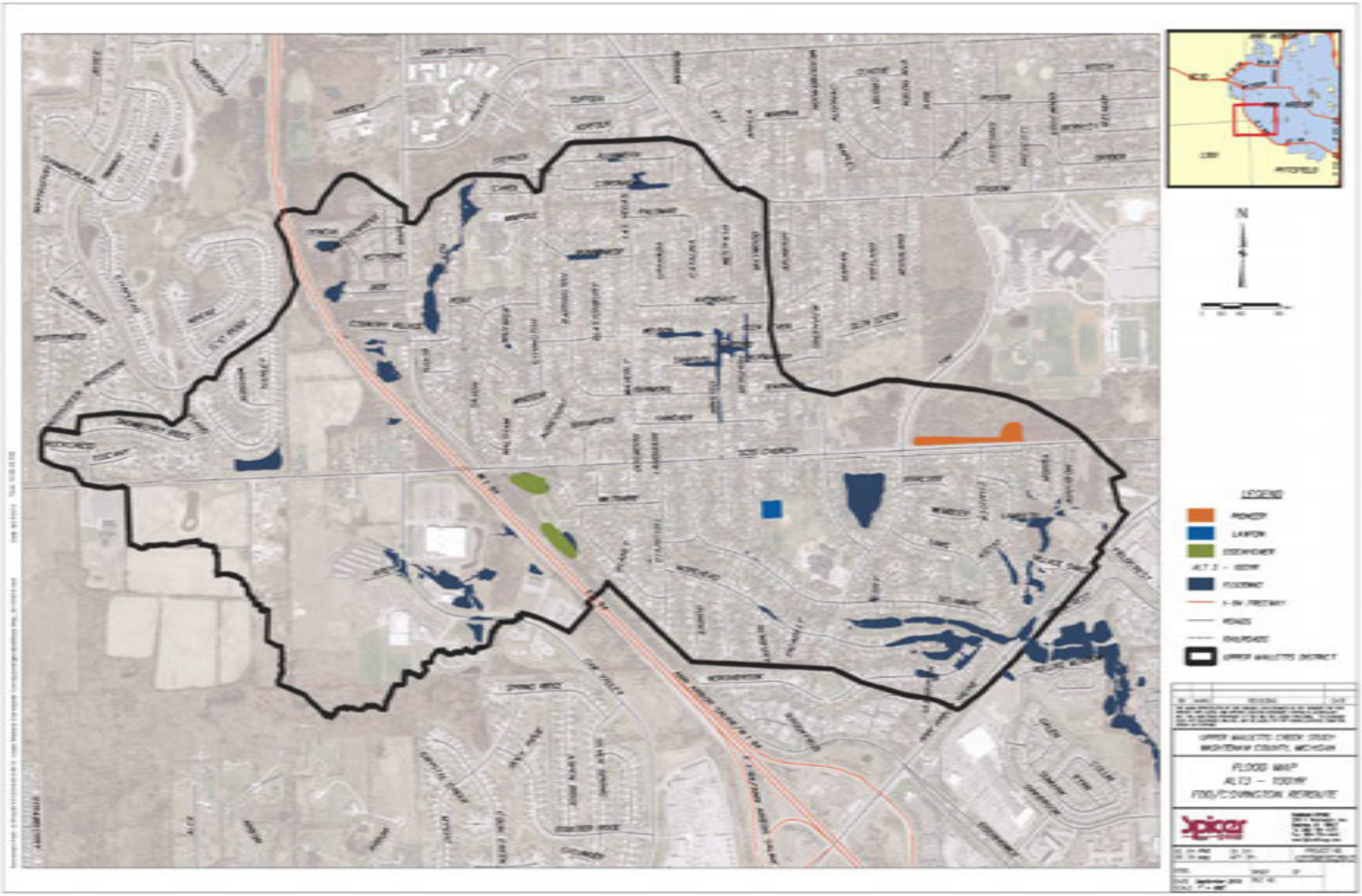
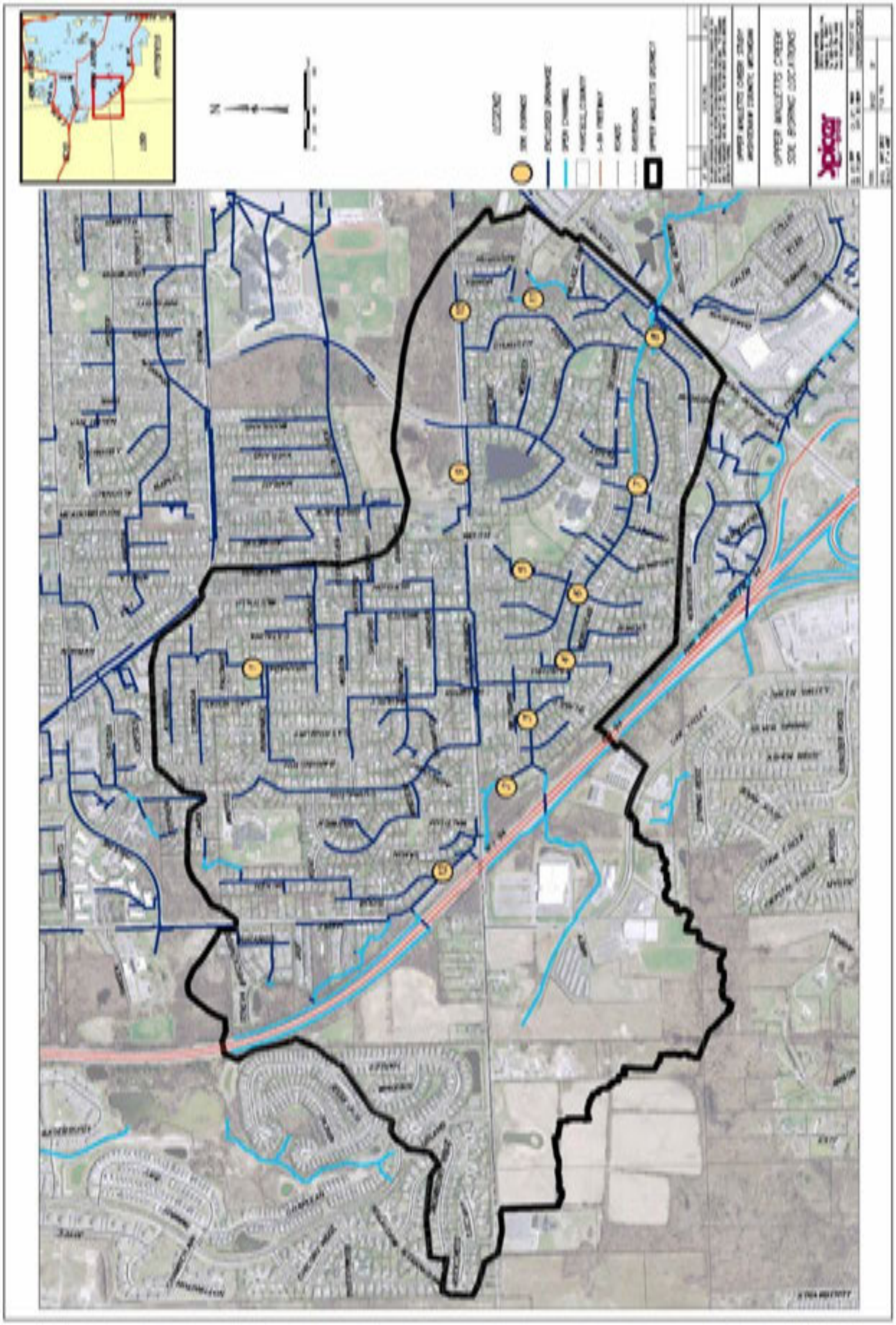


Figure A-20: Project C – 100 Year Design Storm

Appendix B: Soil Boring Location Map and Soil Boring Report



Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 1 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 4/30/2013

Completed: 4/30/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.17	Moist Dark Brown Clayey TOPSOIL (2")			
2.5	LS	2 3 5		Plastic Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
5.0	LS	2 3 4	5.5				
7.5	LS	3 4 6	8	Firm Moist Brown CLAY With Some Silt, Trace Of Gravel & Wet Sand Seam At 8'			
10.0	LS	4 7 12	11	Stiff Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
12.5			14	Medium Compact Wet Brown Fine To Medium SAND With Trace Of Gravel			
15.0	LS	4 7 10		Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel With Sand Seam At 24.8'			
17.5							
20.0	LS	4 9 12		PRELIMINARY			
22.5	LS	4 7 14	25				

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 8' & 11'

At Completion: 12'

Boring No. 1

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 2 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 4/30/2013

Completed: 4/30/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.17	Moist Dark Brown Clayey TOPSOIL (2")			
	LS	2 3 3		Plastic Moist Brown CLAY With Some Silt & Trace Of Gravel			
2.5							
	LS	2 2 3					
5.0							
	LS	2 2 3					
7.5							
	LS	2 2 3	9.5				
10.0				Loose Wet Brown Fine To Medium SAND With Trace Of Gravel			
12.5							
	LS	6 5 5	14.5				
15.0				Firm Moist Gray CLAY With Some Silt & Trace Of Gravel			
17.5							
	LS	3 5 8					
20.0							
22.5							
	LS	3 4 6	25	Bottom of Borehole at 25'			

PRELIMINARY

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 9'6"

At Completion: 17'0"

Boring No. 2

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 3
Job No.: 53410
Project: Upper Mallets Creek Watershed, Scio Church Road & I-94
Client: Spicer Group, Inc.
Type of Rig: Truck
Location: Ann Arbor & Pittsfield Township, Michigan
Drilling Method: Solid Stem Augers
Drilled By: L. Mickle
Ground Surface Elevation:
Started: 4/30/2013
Completed: 4/30/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.25	Moist Dark Brown Clayey TOPSOIL (3")			
2.5	LS	3 4 6	3	Firm Moist Brown CLAY With Some Silt & Trace Of Gravel			
5.0	LS	3 7 11		Stiff Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
7.5	LS	7 12 16					
10.0	LS	6 9 12					
12.5			12	Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
15.0	LS	5 9 13					
17.5			18	Plastic Moist Gray CLAY With Some Silt & Trace Of Gravel			
20.0	LS	3 3 4	21	Firm Moist Gray CLAY With Some Silt & Trace Of Gravel			
22.5	LS	4 6 8	25				

PRELIMINARY

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None
At Completion: None
Boring No. 3

Testing Engineers & Consultants, Inc.

1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 4 **Job No.:** 53410

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Client: Spicer Group, Inc.

Type of Rig: Truck

Location: Ann Arbor & Pittsfield Township, Michigan

Drilling Method: Solid Stem Augers

Drilled By: I. Mickle

Ground Surface Elevation:

Started: 4/30/2013

Completed: 4/30/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.17	Moist Dark Brown Clayey TOPSOIL (2")			
2.5	LS	2 4 6		Firm Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
5.0	LS	2 4 7	5.5				
7.5	LS	7 11 18	9	Stiff Moist Brown CLAY With Some Silt & Trace Of Gravel			
10.0	LS	7 16 31	11.5	Extremely Stiff Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
12.5				Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
15.0	LS	4 6 10	17				
17.5				Firm Moist Gray CLAY With Some Silt, Trace Of Gravel & Wet Sand Seams			
20.0	LS	3 4 6					
22.5	LS	3 5 7	25				

PRELIMINARY

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 19'0"

At Completion: 19'3"

Boring No. 4

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 5 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/1/2013

Completed: 5/1/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.67	Moist Dark Brown Clayey TOPSOIL (8")			
	LS	2 3 5					
2.5			3	Plastic Moist Brown CLAY With Some Silt			
	LS	4 8 13		Stiff Moist Brown Oxidized CLAY With Some Silt			
5.0							
			6				
	LS	7 13 19		Extremely Stiff Moist Brown Oxidized CLAY With Some Silt			
7.5							
	LS	6 14 21					
10.0							
			12				
12.5				Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
	LS	4 8 12					
15.0				PRELIMINARY			
17.5			18				
	LS	4 7 8		Firm Moist Gray CLAY With Some Silt & Trace Of Gravel			
20.0							
22.5							
	LS	3 4 6					
			25	Bottom of Borehole at 25'			

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None

At Completion: None

Boring No. 5

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 6 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 4/30/2013

Completed: 4/30/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.33	Moist Dark Brown Clayey TOPSOIL (4")			
2.5	LS	2 4 5		Firm Moist Brown Clay With Some Silt & Trace Of Gravel-FILL			
5.0	LS	5 5 6	5.5				
7.5	LS	1 1 2	8	Soft Moist Variegated Clay With Some Silt, Trace Of Gravel & Wet Sand Seam-FILL			
10.0	LS	1 1 1	11	Very Soft Moist Variegated Clay With Some Silt, Trace Of Gravel & Sand Seams-FILL			
12.5				Firm Moist Gray CLAY WithSome Silt & Trace Of Gravel			
15.0	LS	4 6 9					
17.5							
20.0	LS	3 5 8					
22.5	LS	3 4 7	25				

PRELIMINARY

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 6'0"

At Completion: None

Boring No. 6

Testing Engineers & Consultants, Inc.
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(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 7 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/1/2013

Completed: 5/1/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.17	Moist Dark Brown Clayey TOPSOIL (2")			
2.5	LS	3 4 5		Firm Moist Brown Clay With Some Silt-FILL			
5.0	LS	4 6 6	4	Medium Compact Moist Brown Medium To Fine SAND With Some Clay & Trace Of Gravel			
7.5	LS	3 4 6	5.5	Firm Moist Variegated Clay With Some Silt-FILL			
10.0	LS	2 4 7	9	Firm Moist Brown CLAY With Some Silt			
12.5, 15.0	LS	4 8 13	12	Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
17.5, 20.0	LS	3 5 7	17	Firm Moist Gray CLAY With Some Silt, Trace Of Gravel & Wet Sand Seam			
22.5	LS	8 13 16	22	Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
			24.5				
			25				

PRELIMINARY

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 18'0"

At Completion: 15'7"

Boring No. 7

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1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 7 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/1/2013

Completed: 5/1/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
				Medium Compact Moist Brown Medium SAND With Trace Of Gravel			
				Bottom of Borehole at 25'			
27.5							
30.0							
32.5				PRELIMINARY			
35.0							
37.5							
40.0							
42.5							
45.0							
47.5							

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 18'0"

At Completion: 15'7"

Boring No. 7

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 8 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/1/2013

Completed: 5/1/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.33	Moist Dark Brown Sandy TOPSOIL (4")			
2.5	LS	3 4 4	2	Plastic Moist Brown CLAY With Some Silt			
5.0	LS	3 4 4	5.5	Loose Moist Brown Sand With Trace Of Gravel-FILL			
7.5	LS	4 7 10	8	Stiff Moist Brown CLAY With Some Silt			
10.0	LS	4 6 9	12	Firm Moist Gray CLAY With Some Silt & Trace Of Gravel			
12.5 / 15.0	LS	6 9 13	17.5	Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
17.5	LS	19 42/6"	19	Compact Wet Gray Fine SAND			
20.0 / 22.5	LS	9 32 57	25	Hard Moist Gray CLAY With Some Silt & Trace Of Gravel			

PRELIMINARY

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of Dry Weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 17'0"

At Completion: 14'0"

Boring No. 8

Testing Engineers & Consultants, Inc.

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(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 9 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/2/2013

Completed: 5/2/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.25	Moist Dark Brown Clayey TOPSOIL (3")			
2.5	LS	1 2 3	2	Soft Moist Dark Brown Clayey TOPSOIL With Some Silt & Wet Seam			
5.0	LS	5 6 11	4	Firm Moist Brown Oxidized CLAY With Some Silt			
			6	Stiff Moist Brown Oxidized CLAY With Some Silt			
7.5	LS	6 16 28	8	Extremely Stiff Moist Brown CLAY With Some Silt & Trace Of Gravel			
10.0	LS	9 19 30		Extremely Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
12.5							
15.0	LS	9 15 18	17				
17.5				Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
20.0	LS	8 10 15					
22.5	LS	7 8 10	25				

PRELIMINARY

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 1'6"

At Completion: None

Boring No. 9

Testing Engineers & Consultants, Inc.

1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 10 **Job No.:** 53410	**Project:** Upper Mallets Creek Watershed, Scio Church Road & I-94
Client: Spicer Group, Inc.	
Type of Rig: All-Terrain Vehicle	**Location:** Ann Arbor & Pittsfield Township, Michigan
Drilling Method: Solid Stem Augers	**Drilled By:** I. Mickle
Ground Surface Elevation:	**Started:** 5/2/2013
	Completed: 5/2/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.33	Moist Dark Brown Clayey TOPSOIL (4")			
	LS	2 3 5					
2.5			3	Plastic Moist Brown CLAY With Some Silt, Trace Of Sand & Gravel			
	LS	4 5 8		Firm Moist Brown CLAY With Some Silt & Trace Of Gravel			
5.0			5.5				
	LS	4 8 12		Stiff Moist Brown Oxidized CLAY With Some Silt			
7.5			8				
	LS	12 25 37		Hard Moist Brown CLAY With Some Silt & Trace Of Gravel			
10.0							
			12				
12.5				Extremely Stiff Moist Gray Oxidized CLAY With Some Silt & Clayey Brown Sand Seams			
	LS	8 14 26					
15.0							
			17				
17.5				Stiff Moist Gray CLAY With Some Silt, Trace Of Gravel & Wet Sand Seams			
	LS	6 8 10					
20.0				PRELIMINARY			
22.5							
	LS	3 6 9	25				

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 18'0"

At Completion: 19'4"

Boring No. 10

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 11 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: All-Terrain Vehicle

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/2/2013

Completed: 5/2/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
	LS	2 2 3	.67	Moist Dark Brown Sandy TOPSOIL With Trace Of Crushed Stone (8")			
2.5	LS	3 4 6	3	Plastic Moist Brown Clay With Some Silt, Trace Of Gravel & Sand Seams-FILL			
5.0			5.5	Firm Moist Brown CLAY WithSome Silt, Trace Of Sand, Gravel & Wet Seam			
7.5	LS	6 10 14	9	Stiff Moist Brown CLAY With Some Silt & Trace Of Gravel			
10.0	LS	8 14 28	12	Extremely Stiff Moist Brown CLAY With Some Silt & Trace Of Gravel			
12.5 / 15.0 / 17.5 / 20.0	LS / LS	10 13 17 / 9 13 15	22	Stiff Moist Gray CLAY With Some Silt & Trace Of Gravel			
22.5	LS	14 32 54	25	Hard Moist Gray CLAY With Some Silt, Trace Of Gravel & Wet Sand Seams			

PRELIMINARY

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of Dry Weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 5'6" & 22'

At Completion: 9'0"

Boring No. 11

Testing Engineers & Consultants, Inc.

1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: 12 **Job No.:** 53410

Client: Spicer Group, Inc.

Type of Rig: Truck

Drilling Method: Solid Stem Augers

Ground Surface Elevation:

Project: Upper Mallets Creek Watershed, Scio Church Road & I-94

Location: Ann Arbor & Pittsfield Township, Michigan

Drilled By: I. Mickle

Started: 5/1/2013

Completed: 5/1/2013

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.5	Moist Dark Brown Sandy TOPSOIL (6")			
2.5	LS	3 5 5	3	Firm Moist Brown CLAY With Some Silt			
5.0	LS	2 3 3		Plastic Moist Brown CLAY With Some Silt & Trace Of Gravel			
7.5	LS	3 3 5	8				
10.0	LS	3 4 5		Firm Moist Variegated CLAY With Some Silt			
12.5			12	Firm Moist Gray CLAY With Some Silt & Trace Of Gravel			
15.0	LS	6 7 7		**PRELIMINARY**			
17.5							
20.0	LS	3 5 6					
22.5	LS	3 5 6	25				

Bottom of Borehole at 25'

"N" - Standard Penetration Resistance
SS - 2" I.D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None

At Completion: None

Boring No. 12

Appendix C: Sewer Inspection Report

Malletts Creek Drain

Pipe Inspection

Report:

Branch "A" (R1 to R13) pipe size 66" & 72" in diameter and is reinforced concrete pipe. Due to the water level inside the pipe an internal inspection from R1 to R3 was not completed.

- *Station 1+00:* 72" Pipe outfall with headwall (photos 1-3)
  - The exterior bell of the pipe is showing signs of deterioration
  - Headwall (gabion baskets) are in good condition

- *Station 1+71 (R2):* Manhole structure
  - No inspection of structure was completed due to water level

- *Station 3+85 (clock position 9:00):* 15" Concrete pipe (photo 4)
  - Good condition, low flow

- *Station 4+40 (clock position 2:00):* 4" PVC pipe
  - Good condition, no flow

- *Station 4+60 (clock position 9:00):* 4" PVC pipe
  - Good condition, no flow

- *Station 4+80 (R3) (clock position 12:00):* Beehive inlet (photo 5)
  - Good condition

- *Station 5+38 (clock position 2:00):* 4" PVC pipe
  - Good condition, no flow

- *Station 5+58 (clock position 3:00):* 15" Concrete pipe (photo 6)
  - Pipe is in good condition, low flow
  - Poor seal with minor infiltration

- *Station 5+62 (clock position 10:00):* 4" PVC pipe
  - Good condition, no flow

Malletts Creek Drain

Pipe Inspection

- *Station 6+70 (clock position 10:00):* 4" PVC pipe
    - Good condition, no flow
- *Station 7+00 (clock position 1:00):* 4" PVC pipe (photo 7)
    - Good condition, no flow
- *Station 7+24 (clock position 10:00):* 4" PVC pipe (photo 8)
    - Good condition, no flow
    - Extending into pipe approximately 2"
- *Station 7+34 (clock position 12:00)*: 12" Clay pipe, yard drain (photo 9)
    - Poor connection, exposed rebar
- *Station 7+88 (clock position 9:00):* 12" Concrete pipe (photo 10)
    - Good condition, low flow
    - Poor seal around bottom of pipe, minor infiltration
- *Station 8+04 (clock position 2:00):* Pipe joint (photo 11)
    - Minor spalling, exposed rebar
- *Station 8+22 (clock position 9:00):* 4" PVC pipe (photo 12)
    - Good condition, no flow
- *Station 8+44 (clock position 2:00):* Pipe joint (photo 13)
    - Minor spalling at joint
- *Station 8+90 (clock position 9:00):* 15" Concrete pipe (photo 14)
    - Pipe is in good condition, low flow
    - Poor seal around pipe, minor infiltration
- Station 8+95 (clock position 3:00) 15" Concrete pipe (photo 15)
    - Pipe is in good condition, low flow
    - Poor seal around connection, minor infiltration

- Exposed rebar

- *Station 9+00 (R4)(clock position 12:00):* Beehive inlet
  - Good condition

- *Station 9+05 (clock position 1:00*): 4" PVC pipe
  - Good condition

- *Station 9+50 (clock position 9:00):* 4" Cast iron pipe (photo 16)
  - Pipe is in good condition, low flow
  - Poor seal around pipe, minor infiltration

- *Station 9+81 (clock position 9:00):* 4" PVC pipe
  - Good condition

- *Station 10+08 (clock position 12:00-9:00):* Pipe joint (photo 17)
  - Minor spalling around joint

- *Station 10+20 (clock position 1:00):* 4" PVC pipe
  - Good condition

- *Station 10+57 (clock position 10:00):* 4" PVC pipe
  - Good condition

- *Station 10+75 (clock position9:00):* 12" Concrete pipe (photo 18)
  - Pipe is in good condition, low flow
  - Minor infiltration

- *Station 10+85 (clock position 2:00):* 4" PVC pipe
  - Good condition

- *Station 11+66 (R5)(clock position 12:00):* Beehive inlet (photo 19)
  - Good condition

Malletts Creek Drain

Pipe Inspection

- *Station 11+88 (clock position 1:00):* 4" PVC pipe
  - Good condition
- *Station 12+25 (clock position 9:00):* 4" PVC pipe
  - Good condition
- *Station 13+42 (clock position 1:00):* 4" PVC pipe
  - Good condition
- *Station 13+83 (clock position 8:00):* 42" Concrete pipe (photo 20)
  - Good condition, low flow
- *Station 13+95 (clock position 3:00):* 18" concrete pipe (photo 21)
  - Good condition, low flow
  - Minor infiltration at bottom of pipe
- *Station 14+32 (clock position 12:00):* 12" Concrete pipe (photos 22,23)
  - Pipe is bulk headed, no flow
  - Exposed rebar
  - Evidence of infiltration around pipe connection
- *Station 14+48 (clock position 1:00):* 4"PVC pipe
  - Good condition
- *Station 16+42 (R6)(clock position 12:00):* Beehive inlet (photo 24)
  - Good condition
- *Station 16+60 (clock position 1:00):* 4" PVC pipe
  - Good condition
- *Station 17+34 (clock position 12:00):* Beehive inlet (photo 25)
  - Poor seal
  - Exposed rebar

Malletts Creek Drain

Pipe Inspection

- *Station 17+93 (clock position 2:00):* 4" PVC pipe
  - Good condition
- *Station 18+27 (clock position 9:00):* 4" PVC pipe
  - Good condition
- *Station 18+53 (R7) (clock position 12:00):* Beehive inlet (photo 26)
  - Poor seal around casting
  - Vegetation over grate
- *Station 18+80 (clock position 2:00):* 4" PVC pipe
  - Good condition
- *Station 20+08 (clock position 3:00):* 18" Concrete pipe (photo 27)
  - Good condition, low flow
- *Station 20+15 (clock position 9:00):* 12" Clay pipe (photo 28)
  - Good condition, no flow
- *Station 21+70 (clock position 3:00):* 12" Concrete pipe (photos 29,30)
  - Good condition, slight flow
  - Mineral deposits at discharge point
- *Station 21+71 (clock position 9:00):* 15" Concrete pipe (photo 31)
  - Good condition, low flow
- *Station 23+94 (clock position 12:00):* 18" inlet (photos 32,33)
  - Good condition
  - Bulk headed
- *Station 24+03 (clock position 9:00):* 12" Concrete pipe (photo 34)
  - Pipe is in good condition
  - Poor connection, pipe is partially blocked due to an insufficient cut into the main

- Exposed rebar

- *Station 25+34 (clock position 9:00):* 12" Clay pipe (photo 35)
  - Poor condition, offset joint, no flow
  - Poor connection with exposed rebar

- *Station 27+26 (R8):* Junction chamber with beehive grate (photos 36,37)
  - Good condition, concrete block
  - Casting needs to be reset and sealed
  - Erosion around casting

- *Station 28+91 (clock position 3:00):* 15" Concrete pipe (photos 38,39)
  - Good condition, low flow
  - Mineral deposits at discharge point

- *Station 28+91 (clock position 9:00):* 12" Concrete pipe (photo 40)
  - Good condition, slight flow

- *Station 32+54 (R13):* Junction chamber (photos 41,42)
  - Good condition, concrete block

End of branch "A" inspection

Branch "B" (R8-R10) pipe size is 66" in diameter and is reinforced concrete pipe.

- *Station 0+00 (R8):* Junction chamber (See Sta. 27+26 of Branch A)

- *Station 3+40 (R9):* Manhole structure (photo 43)
  - Good condition, pre-cast concrete

- *Station 3+40 (clock position9:00):* 12" Concrete pipe (photo 44)
  - Good condition, low flow

Malletts Creek Drain

Pipe Inspection

- *Station 3+40 (clock position 3:00):* 12' Concrete pipe (photo 45)
    - Good condition, slight flow
- *Station 3+50 (clock position 2:00):* 6" PVC pipe (photo 46)
    - Good condition, no flow
    - Minor infiltration
- *Station 5+25 (clock position 12:00):* Flat grate inlet (photo 47)
    - Poor condition, double casting
    - Exposed rebar, poor seal
- *Station 6+72 (clock position 1:00):* 8" PVC pipe
    - Good condition
- *Station 6+95 (clock position 9:00):* 15" Concrete pipe (photo 48)
    - Good condition, slight flow
- *Station 6+96 (clock position 3:00):* 15" Concrete pipe (photo 49)
    - Good condition, slight flow
    - Exposed rebar around connection
- *Station 7+10 (clock position 3:00):* 8" PVC pipe (photo 50)
    - Good condition, slight flow
    - Minor infiltration at bottom of connection
- *Station 7+10 (clock position 9:00):* 4" PVC pipe (photo 51)
    - Good condition, no flow
- *Station 8+60 (R10):* Junction chamber (photos 52,53)
    - Good condition, concrete block

End of branch "B" inspection.

Branch "C" (R10-R11) pipe size is 60" in diameter and is reinforced concrete pipe.

All pipe joints are in good condition, no spalling of the main, and no connections to the pipe were observed though this section.

- *Station 0+00 (R10):* Junction chamber (See Sta. 8+60 Branch B)

- *Station 1+83 (R11):* Inlet (photos 54,55)
    - Good condition, low flow
    - Minor sediment at inlet and debris on grate

End of branch "C" inspection.

Branch "D" (R10-R12) pipe size is 60" in diameter and is reinforced concrete pipe.

All pipe joints are in good condition, no spalling of the main, and no connections to the pipe were observed though this section.

- *Station 0+00 (R10):* Junction chamber (See Sta. 8+60 Branch B)

- *Station 3+30 (R12):* Manhole Structure (photos 56,57,58,59)
    - Good condition, concrete block drop structure
    - Low flow
    - Pipe connections need to be sealed

End of branch "D" inspection.

The following photos show the condition of the interior walls of the main in various locations.

Branch "A" photos 60, 61, 62, 63

Branch "B" photos 64, 65

Branch "C" photo 66

Branch "D" photo 67

Malletts Creek Drain

Pipe Inspection

Photo 1 branch "A" station 1+00(R1): 72" pipe outlet

Photo 2 branch "A" station 1+00(R1): outlet pipe

Photo 3 branch "A" station 1+00(R1): outlet pipe

Photo 4 branch "A" station 3+85: 15"concrete pipe

Photo 5 branch "A" station 4+80 (R3): beehive inlet

Photo 6 branch "A" station 5+58: 15" concrete pipe

Photo 7 branch "A" station 7+00: 4" PVC pipe

Photo 8 branch "A" station 7+24: 4" PVC pipe

Photo 9 branch "A" station 7+34: 12" clay pipe

Photo 10 branch "A" station 7+88: 12" concrete pipe

Photo 11 branch "A" station 8+04 pipe joint, minor spalling

Photo 12 branch "A" station 8+22: 4" PVC pipe

Photo 13 branch "A" station 8+44: pipe joint, minor spalling

Photo 14 branch "A" station 8+90: 15" concrete pipe

Photo 15 branch "A" station 8+95: 15" concrete pipe

Photo 16 branch "A" station 9+50: 4" cast iron pipe

Photo 17 branch "A" station 10+08: pipe joint, minor spalling

Photo 18 branch "A" station 10+75: 12" concrete pipe

Photo 19 branch "A" station 11+66 (R5): beehive inlet

Photo 20 branch "A" station 13+83: 42" concrete pipe

Photo 21 branch "A" station 13+95: 18" concrete pipe

Photo 22 branch "A" station 14+32: 12" concrete pipe (bulk headed)

Photo 23 branch "A" station 14+32: 12" concrete pipe (bulk headed)

Photo 24 branch "A" station 16+42 (R6): beehive inlet

Photo 25 branch "A" station 17+34: beehive inlet

Photo 26 branch "A" station 18+53 (R7): beehive inlet

Photo 27 branch "A" station 20+08: 18" concrete pipe

Photo 28 branch "A" station 20+15: 12" clay pipe

Photo 29 branch "A" station 21+70: 12" concrete pipe

Photo 30 branch "A" station 21+70: 12" concrete pipe

Photo 31 branch "A" station 21+71: 15" concrete pipe

Photo 32 branch "A" station 23+94: 18" concrete pipe

Photo 33 branch "A" station 23+94: 18" concrete pipe

Photo 34 branch "A" station 24+03: 12" concrete pipe

Photo 35 branch "A" station 25+34: 12" clay pipe

Photo 36 branch "A" station 27+26 (R8): junction chamber

Photo 37 branch "A" station 27+26 (R8): junction chamber

Photo 38 branch "A" station 28+91: 15" concrete pipe

Photo 39 branch "A" station 28+91: 15" concrete pipe

Photo 40 branch "A" station 28+91 12" concrete pipe

Photo 41 branch "A" station 32+54 (R13): junction chamber

Photo 42 branch "A" station 32+54 (R13): junction chamber

Photo 43 branch "B" station 3+40 (R9): precast manhole structure

Photo 44 branch "B" station 3+40: 12" concrete pipe

Photo 45 branch "B" station 3+40: 12" concrete pipe

Photo 46 branch "B" station 3+50: 6" PVC pipe

Photo 47 branch "B" station 5+25: flat grate inlet

Photo 48 branch "B" station 6+95: 15" concrete pipe

Photo 49 branch "B" station 6+96: 15" concrete pipe

Photo 50 branch "B" station 7+10: 8" PVC pipe

Photo 51 branch "B" station 7+10: 4" PVC pipe

Photo 52 branch "B" station 8+60 (R10): junction chamber

Photo 53 branch "B" station 8+60 (R10): junction chamber

Photo 54 branch "C" station 1+83 (R11): inlet

Photo 55 branch "C" station 1+83 (R11): inlet

Photo 56 branch "D" station 3+30 (R12): manhole structure

Photo 57 branch "D" station 3+30 (R12): manhole structure

Photo 58 branch "D" station 3+30 (R12): manhole structure

Photo 59 branch "D" station 3+30 (R12): manhole structure

Photo 60 branch "A" interior wall of pipe

Photo 61 branch "A" interior wall of pipe

Photo 62 branch "A" interior wall of pipe

Photo 63 branch "A" interior wall of pipe

Photo 64 branch "B" interior wall of pipe

Photo 65 branch "B" interior wall of pipe

Photo 66 branch "C" interior wall of pipe

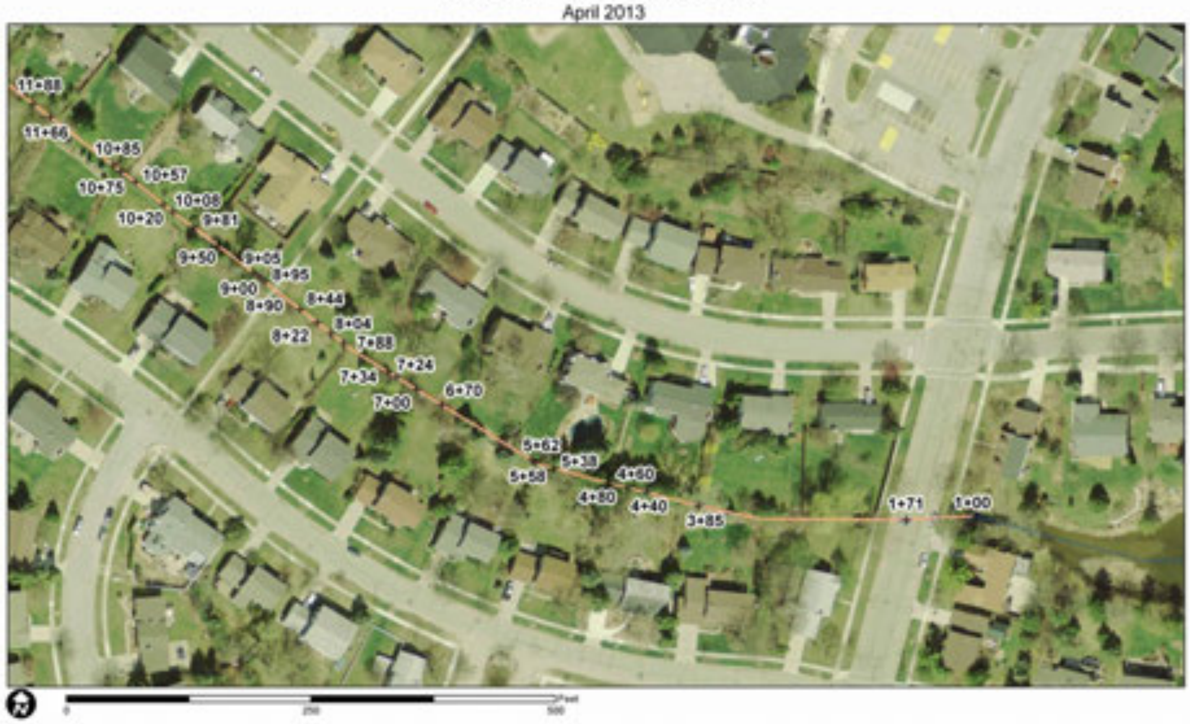
Photo 67 branch "D" interior wall of pipe

Mallett's Creek Pipe Inspection

April 2013

Mallett's Creek Pipe Inspection
Branch A - Sta. 11+88 to 32+54
April 2013

Mallett's Creek Pipe Inspection
Branch A - Sta. 1+00 to 11+88
April 2013



Mallett's Creek Pipe Inspection
Branch B
April 2013

Mallett's Creek Pipe Inspection
Branch C

April 2013

Mallett's Creek Pipe Inspection
Branch D

April 2013

Appendix D: Public Meeting Summaries

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Overview: Upper Malletts Stormwater Study

What is the goal of the Upper Malletts Stormwater Conveyance Study?
The goal of the study is to determine ways to better manage stormwater and reduce flooding in the Upper Malletts Creek neighborhoods. By using data collected by the City of Ann Arbor, from area residents and exploratory research, the study will identify, analyze and propose a set of options to decrease the risk of flooding in the neighborhood.

Where is the Upper Malletts Creek Study Area?
The study area includes the neighborhoods located Southwest of Downtown Ann Arbor along I-94, along Scio Church Road between Main Street and Wagner Road and the areas surrounding the Dicken and Lawton elementary schools. For a larger version of the map, visit UpperMallettsStudy.org.

How long will the study take?
The study will take approximately one year to complete and will include the following phases:
- *February – March 2013*: Gather data and reach out to stakeholders for input
- *March – September 2013*: Analyze stormwater management alternatives and continue public involvement with informational meetings and individual site visits
- *September – December 2013*: Develop recommendations for improved stormwater management
- *January – February 2014*: Draft and finalize a report that recommends improved stormwater management options

Where can I find more information?
Visit www.UpperMallettsStudy.org for regular project updates, news and background information. You can also report flooding problems in your neighborhood through the website and request a home visit with an engineer working on the study if you've had flooding problems.

How can I provide input to the study?
The best ways to participate in the study are by (1) attending the public meetings, and (2) using the online flood reporting tool at www.UpperMallettsStudy.org

How is the study funded?
The study is funded by the City of Ann Arbor.

When will the projects recommended in the study be implemented?
Some projects are already planned to reduce runoff – (i.e. street reconstruction at Scio Church and Seventh). Additional projects will be identified by February [2014?]. Implementation of some

projects may occur immediately after the completion of the study, other projects may be programmed into the City of Ann Arbor's Capital Improvement Plan

What will residents be required to pay to reduce flooding?

Currently there are no plans to increase funding (aka - the stormwater fee on your water bill) to pay for stormwater management implementation. Decisions on whether additional funding is necessary to implement the study recommendations will be made via a public process. Grants and loans may also be used to offset the amount needed for implementation.

Who is managing the study?

The Office of Evan M. Pratt, P.E., Washtenaw County Water Resources Commissioner(WCWRC), is leading the study. The Project Manager for the study is WCWRC Environmental Manager Harry Sheehan.

Questions about the study can be emailed to info@UpperMallettsStudy.org, or by calling (734) 222-6851.

Notes on Upper Malletts Conveyance Study Public Meeting (5/21/13)

Approximately 50 people attended (45 signed in, plus a few who didn't)

Written Comments

- How much "relief" volume do we need to add?
- How to determine this?
- How many inches of rain equal a "10 year", "20 year" storm?
- Is MDOT really fixing I-94?
- Can we increase drain size under I-94?
- What would happen if we added more water (from footing drains) to the storm drains? Sounds like the drains are already over capacity.
- My neighbor, Kathleen Griffiths, 1235 Morehead Court, requested home visit from engineering team at last public meeting. Has not been contacted.
- Potential Detention Volumes Chart – add columns for:
    - Water quality improvement
    - Long term maintenance frequency, cost, difficulty, etc.
    - Disruption factor (how difficult to construct)
    - Volumes for Scio Church reconstruction
    - What is included in "benefit" and "cost"?
- For underground facility at Lawton, how would water get to it? (New storm sewer?)
- How much water do we need to detain?
- Great presentation by Ron! Thanks
- Need more info generally about water coming from upstream, Pittsfield Twp – is this part of the model?
- Why flooding now? What has changed? Climate, runoff, speed?
- What rain data history has been accessed? Are rains today bigger?
- Are upstream landowners meeting agreements made when they made surface changes?
- Reliability of mechanical solutions?
- Improving storm catchments in Lawton will flow to Delaware.

Location-specific Comments

- **Churchill Downs Park**
    - Could become a very nice usable park area. Currently is nearly inaccessible.
    - There is a playground area there that is used, but a lot of unused space. Where would this be? *(Not in the playground.)*
    - Is underground detention possible at this location? *(No. There is not enough vertical drop on this site to make the outlet gravity flow. Open detention is less costly, and there is an opportunity here to build open detention.)*
    - Right now there is existing detention at Scio & Maple, and the water flows over an 8' berm to 2035 Wiltshire Ct. Manholes pop off now on

Delaware. In the 41 years I have lived here, there have been 4 events like this. How will you ensure that even more water doesn't come over that berm? *(A detention pond above Wiltshire will release water at a slower rate than currently.)*

- **Ann Arbor Ice Cube**
    - Opportunities: pond should drain completely between rains. Usually half full now.
- **Lans Basin**
    - Opportunities: ponds should have more variable volume. Ponds are silted in.
- **Las Vegas Park**
    - Isn't the park higher than the road? *(This would include lowering the sidewalk to the elevation of the curb, and providing a shallow swale to direct flood water into the park. It would involve re-grading most of the park, and planting grass.)*
- **Pioneer High School (W of 7th)**
    - This pond has silted in since we came. It could be dredged to provide more volume without harming woodlands.
- **Pioneer High School (E of 7th)**
    - Would improve drainage of woodlands making park more walkable.
    - Low benefit, but seems easy & cheap. Why not do it? *(The project would have to work with the school. So it may or may not be possible.)*
- **Lawton Park**
    - Put water under 7th Street instead!
    - Opportunities: Would dry out playground earlier in spring for soccer fields.
    - Challenges: Would this drain by gravity? Fields are heavily used for play. Manholes would be unpleasant.
    - What about siltation – cleaning it out? Are we just making another problem for 30 years from now? *(Vac trucks access it through manholes, and can vacuum that silt out. We want to capture that silt so it doesn't end up in the river.)*
    - Pioneer underground detention – how is it going? *(At Pioneer, the detention was able to be connected to a sand seam. So the first ½" of rain is infiltrated now, and some larger storms detained. Eventually that sand seam will plug up, and the underground basin will just provide detention.)*

General Comments

- Put website on handout
- What does "high" cost mean? (*Lawton Park underground detention would be somewhere in the vicinity of $12-15M*)
- Who pays? *(The County can apply for State Revolving Loan Funding. For Pioneer, the County had a 2 ½%, 20-year loan, with 40% forgiveness as part of*

the stimulus funding. All of these projects would be part of the already-existing Stormwater Utility Fee, which residents pay city-wide. There would be no additional special assessments.)

- When would this happen? *(The Pioneer underground detention constructed started in November, and lasted until that spring, when grass was planted.)*
- The volumes chart – can you publish it on the website?
- How will this be paid for? *(Budgeted into the existing stormwater fee monies, and financed over time.)*
- Will there be new tax assessments? *(No.)*
- What are the different timelines? What ends in February? *(This study ends in February, and will include recommendations at that time.)*
- When would solutions/construction begin? (Scio Church road will be reconstructed in 2015. The other solutions would be after that.)
- Cause of flooding: Why is it worse now? It didn't used to flood like this before. Make sure you are fixing the cause of the problem, not just the symptom.
- Isn't there a big storage basin proposed North of Village Oaks? Why isn't it included here? *(That project is in the docket to be built. This study assumes that basin will be built.)*
- Doesn't the south side of I-94 go into this watershed?
- Someone noted 4.5" of rain on the March 15th event, not just 4.25". *(location?)*
- MDOT plans include work on I-94. Why don't we have them pave it with porous pavement, for stormwater, sound attenuation, reduction of hydroplaning? Talk to MDOT to encourage them to install porous pavement at this sharp curve.
- Some detention basins seem to be full most of the time. *(The Ice Cube detention basin was the only one we looked at that wasn't functioning properly.)*
- How to handle a wet backyard? *(Our office provides assistance on how to plant a rain garden. This is a good opportunity to do so. www.ewashtenaw.org/raingardens)*
- Explore Road Diet opportunities to reduce impervious surface & add storm detention below the road. *(These will be explored.)*
- Please put this presentation on the website.

Upper Malletts Creek
Stormwater Conveyance Study
Project Update

September 30, 2013
6:30-8:30 p.m.

MEETING SUMMARY

Washtenaw County Water Resources Commissioner (WCWRC) representative briefly reviewed the activities that have previously occurred as part of the study:

- Collected rain data, flooding data, additional information from residents
- Video documentation, photos of previous flooding events
- Reviewed many different areas where storm water storage was possible
- Modeled the storm water flow for various storm events
- Initial review Started thinking that there would be several alternatives, but it turns out there are few alternatives
- Study phase will be completed in February according to original schedule. No funding for design and construction of any improvements is in the current City Capital Improvement Plan (CIP) or is budgeted, except for Scio Church Road (Seventh to Main) which is in the CIP for 2016 and may be looked at in conjunction with the Pioneer High project
- A separate public process is involved with design and construction funding. City council ultimately will control any potential project funding with help from WCWRC
- Spicer Group representative provided an overview of the recommendations.

The project goals were reviewed and have stayed consistent throughout the project:

- Reduce probability of flooding
- Identify costs
- Don't adversely impact downstream neighbors
- Maintain or enhance water quality.
- Long term sustainability

The study area was reviewed along with all areas considered for storm water detention.

- The map of the flooding reported by residents after the March 2012 storm was discussed along with a comparison of storm water model predictions for the same storm event.

The Eisenhower Basin Alternative was presented

- 470,000 cu/ft of storage, 2.0 acres area, $2.1 million total cost including engineering and contingencies
- Showed significant reduction of on-street flooding downstream, especially in the Wiltshire/Churchill area

The Pioneer Basin/Scio Church Improvements were presented

- Basin primarily serves Pioneer HS property.
- 400,000 cu/ft storage, 2.8 acres, $1.2 million including engineering and contingencies
- Reduces flooding along the Scio Church service drive and Chaucer Court

The Lawton Park Basin was presented

- New storm sewer and underground storage tank
- Reduces flooding along Delaware
- 280,000 cu/ft, 1.1 acres, $5.15 million including engineering and contingencies

Questions:

Is the Eisenhower basin big enough, especially with future development potential to the west?

- Because the area west of I-94 is largely undeveloped, run-off is at the agricultural rate which is low. Future development will have detention requirements that are more stringent than the design of the Eisenhower basin.

Capacity of the ice cube? People might want to drive by there to get a sense of the size of the detention ponds near Eisenhower

- Ice Cube pond is being fixed so that it will function properly. The ice cube basin is approximately 90,000 cubic feet

What will the detention ponds look like? How about Lawton Park?

- Lawton could look as it does today, or the public could say that they want to see some improvements and that could be part of the process
- The detention ponds will have water like a pond when it rains, but will be dry otherwise
- Discussions with Ann Arbor Public Schools regarding the Pioneer basin still need to occur

Where will the money come from?

- Projects will be added to the Capital Improvement Plan
- Projects will be then need to be added to the budget, will look for grants, loans, or public financing (revolving loans from the state)
- How effective are the improvements without the Lawton basin?
- The interactive mapping associated with each alternative shows the impact on the flooding with and without specific options.

This is shown as three alternatives, are they being prioritized?

- That decision will be a public process -- city council, public input, grant funding availability, etc

How does the FDD impact the model?

- Used a very conservative model that assumes all people are hooked to the footing drains, half of FD are discharging at the storm's peak, and capacity has been built into each basin to accommodate the FD flow.

Scio Church constriction project -- how far west will road improvement go?

- Approximately from 7th to Main, and could include storage and therefore the detention basin at Pioneer might not need to be as large.

Why not measure/use a gauge for the flow west of I-94?

- A gauge was placed near the I-94 crossing as part of this study.

What about maintenance at Eisenhower and those costs?

- County would be responsible in partnership with the city.
- Projects include scheduled maintenance plans that would be incorporated

Why is nothing proposed at Village Oaks?

- The City has previously studied this area, has budgeted for a basin and is doing planning and land acquisition to build the basin
- Potential developer for the property may build the basin

How satisfied is the county with the previous Pioneer detention project?

- Pioneer demotion basin was similar to what Lawton would be but there are differences in the soil composition that make the functionality different.
- That project was about $3.5 million and was more of a water quality project, but WCWRC has felt the project to be worthwhile.

Why re-route storm water from Covington to Eisenhower instead of Lawton?

- Storage at the Eisenhower basin is more cost effective per cubic foot than the Lawton basin. The challenge is that there is always going to be concerns about moving water from one place to another, and the information is being looked at very carefully to ensure no additional flooding will occur.

Why go under the street in the Pioneer / Scio Church area so that you can always see the levels and monitor it?

- The city owns the street and not the school property at Pioneer, so access is more readily available
- It is more a cost effective option

Has the city considered dredging the Lans Basin ponds?

- Yes, it was considered during a prior study phase. Constructability and long term maintenance have eliminated this alternative. There is little storage available at this site without changing the dams and water storage elevation.

How do we gauge the relative cost/benefit of the recommended improvements?

- City was asked to evaluate the issue and provide a technical solution. Ultimately it will be up to the city, through public input to decide if they are worth doing.

Will the city continue with the FDD if this project continues?

- There are three concurrent studies that are separate. The Upper Malletts watershed recommendation is going to be done by February, and it's not clear yet if the FDD study will be done before that or how long the FDD study will take.

With all the concern about West Nile, etc., what's the impact of detention ponds and mosquitoes?

- The biggest public health concern is permanent pools of water. These basins are designed to be drained in 72 hours -- faster than the life cycle of mosquito. http://en.wikipedia.org/wiki/Culex_tarsalis

Why was Las Vegas Park taken off the list?

- Detaining water in that area has minimal impact on the downstream system, but the project could still be done if the local need is there. The option will be included in the final report.

How much benefit would there be if everyone built a rain garden?

- It makes a difference, but for the very large rain events it wouldn't provide nearly enough storage volume to control flooding.

- The street flooding is the most critical.

Is there groundwater table up or down from previous levels?

- The city collected soil borings but there isn't sufficient data from previous years to make a determination on changes to the groundwater elevation.

Is the city saying they will do one, a combination or all three? If you only had to do two or one them what would you do?

- All three are recommended to address the March 15, 2012 event. That was the directive of the study. If fewer options had to happen then it would be a public process to determine the best decision.

What is the time period that maintenance needs to be done for the detention areas?

- Debris and settlement will eventually become an issue. Regular maintenance would be done to clean out sediment and make sure there are no structural problems.

What can community members do to impact funding/ranking these projects?

- Participate in the CIP process the City goes through every two years.

How can people find out about the CIP process?

- Go to the City website, systems planning page, CIP and sign up for GovDelivery emails for CIP (click link and go to right of page, "sign up to receive CIP email updates")

Next Steps

- Report will go to city council
- They can choose to accept, do nothing or some combination
- Projects will go to CIP. Soonest for these projects will go into CIP is 2015.
- Evaluation of projects
  - Do we have the money, can we get the money?
- Reminder that this project came from resolution from city council.
  - Come up with opportunities
  - Not to implement
- What can be done as a community to ensure projects get approved?
  - Talk to city council members
  - CIP has its own public meetings. Attend those and provide comments.

Upper Malletts Creek
Stormwater Conveyance Study
Project Update

November 13, 2013
6:30-8:00 p.m.

MEETING SUMMARY

Washtenaw County Water Resources Commissioner (WCWRC) representative briefly reviewed the activities that have previously occurred as part of the study:

- Procedures for data collection during study process.
- Information that was collected for previous flooding events was reviewed.
- Reviewed areas where storm water storage was possible.
- An overview of the recommendations was presented, including the Eisenhower Park basin, the Pioneer/Scio Church improvements, and the Lawton Park basin. This included the flooding reductions associated with the various improvements.
- Study phase will be completed in February according to original schedule. No funding for design and construction of any improvements is in the current City Capital Improvement Plan (CIP) or is budgeted, except for Scio Church Road (Seventh to Main) which is in the CIP for 2016 and may be looked at in conjunction with the Pioneer High project.

Questions:

Will the flooding previously experienced on Wiltshire and Wiltshire Ct. be eliminated after the improvements are complete?

- Yes, the flooding will be managed for storms equal to the level of the March 15, 2012 event.

Are the soils clay where the ponds are proposed?

- Yes, preliminary analysis shows predominately clay soils. The ponds will drain via gravity.

Are open ponds with standing water a safety hazard for people?

- Design standards, construction methods, and maintenance procedures currently exist to minimize the potential hazards. The purpose for these is to keep people safe.

There are many young families in the area that will be concerned over safety.

- Public safety is reviewed as each project is implemented through the City's standard project protocols.

What were the factors in selecting the Lawton Park location? Were the negative effects on resident's personal space considered?

- The study looked for large open spaces within the watershed that were capable of storing large water volumes. Priority was given to sites already under City jurisdiction and sites that could be drained by gravity. The Lawton basin will have an overflow route to the south. Other factors were also part of the decision process.

Please explain how overflow of the basins will work?

- Using the Pioneer basin as an example, a control structure will be installed with a small orifice on the bottom of the basin to restrict the flow. The control structure will have a large opening near the top to convey the overflow to a suitable location. Often this involves additional storm sewer.

The recommended solutions have been estimated at $8.5 million. What was the cost of the study?

- The study cost was approximately $215,000.

Will the study recommendations work long term, such as 30 years from now?

- Yes, with proper maintenance they will work long term. Design and construction will favor low maintenance solutions. Any new developments will have to meet current stormwater management requirements and will have their own basins.

If scoring in the evaluation matrix were changed, resulting in lower scores for the recommended improvements, would other improvements have more impact?

- It is unlikely the scores would change enough to change the recommendations. Other projects will not have as much impact on the stormwater management as those that have been recommended. Other potential improvements haven't been modeled as extensively.

What have the final results been for the Pioneer storage basin previously constructed as part of the Allen's Creek project? Are non-working basins monitored?

- The results for the Allen's Creek/Pioneer basin have been good. The basin was constructed over a sand seam to allow infiltration. 40% of the flow is managed via infiltration, the rest is sent to Allen's Creek.
- WCWRC works with many different agencies to continually monitor detention basins.

What was the cause and impact of the Ice Cube detention basin failure?

- The outlet became clogged with sediment and debris and was not functioning. The basin could not dewater properly, causing stormwater to outlet into the watershed with being detained. The outlet has been reconstructed and the basin is operating properly.

What needs to be done to the two stormwater inlets on the Lawton Elementary parcel? The Scio Church improvements have been mentioned several times, what is this? Since the soil borings show deep clay, does that mean there is no groundwater movement?

- The study recommends additional catch basins be added to manage the runoff.
- Scio Church Road will be reconstructed from 7th Street to Main Street. This project has already been included in the City's Capital Improvement Plan.
- There may still be groundwater movement in clay soils, but it would be very slow.

What is the spoils (excess excavation material) leveling area noted on the concept drawings?

- The areas shown for excess excavation material leveling were to quantify the amount of excess excavation material that is to be removed versus the land areas available for balancing. While some excess excavation material may be left on site, the volume is significant and a majority may have to be removed from the site.

How do excess excavation material factor into the project costs?

- Excess excavation material is very costly to remove. It is more cost effective to level within the site. To be conservative, the estimates assume almost all of the excess excavation material will be removed.

Can the Lawton Park basin be moved within the site?

- The design shown at this point is purely conceptual. The location and layout will likely change based on public input during the design process.

What is the variation in elevation at Lawton Park?

- There is a 10-12' elevation difference between the park and the low point at Mershon/Delaware. The goal is to move the storage from the streets to the underground basin in the park.

Will removing the Eisenhower Park vegetation to construct the basins increase the noise from I-94?

- Yes, the noise can be expected to increase as the vegetated buffer is lost. Constructing noise control berms as part of the project may be possible. Vegetation will also be replaced as part of the project.

Is the intention to submit all three projects as a package plan?

- Yes, all three projects are necessary to manage the March 15, 2012 storm. The request from the City was to provide service for this level of storm event.

Is it possible to move the Lawton Park basin to the east on the concept drawings?

- In the Lawton section of the report, a note will be added that public input requested the basin be as far as possible from the homes. The information will then be noted and available when future design is considered.

If the Lawton basin overflows, will the homes on Mershon south of the basin see increased flow?

- The basins will decrease flooding on Mershon and Delaware for storm events less than the March 15 storm. During larger events the basin may overflow to the storm sewer as it is today.

Will the Lawton basin increase the flow to the catch basins directly behind Lawton Elementary?

- The systems will be separate, but this will need to be looked at closely during the design process to make sure all the problems in the area are being addressed. It may be possible to create additional berms along the south side of the park to better manage the flooding in that area.
- The report will note the concerns raised about surface drainage in this area.
- Earthwork in Lawton should include addressing surface runoff problems to a reasonable extent, particularly for property adjacent to and downhill from Lawton park and school.

Explain how the Pioneer basin works locally and regionally?

- The basin directly reduces flooding on Scio Church, Chaucer, Chaucer Ct., and Lambeth. It has lesser effects on flooding in other areas.

Will the Pioneer basin be disruptive to the use of the property as it exists today?

- Yes, but the impacts will be taken into account during the design process and efforts will be made to reduce the impact. It may be possible to improve the use of the area.

Will an email be sent out to the distribution list when the report is being sent to the City Council?

- Yes, an email will be sent.

Next Steps

- Consensus of the group was to have another meeting once the final report was available for review.
- A request was made to have modeling/mapping of other alternatives available at the next meeting, but that is unlikely without expanding the scope of the study.

January 29, 2014

Upper Mallets Creek Townhall Meeting Minutes
Taken by: Catie Wytychak

1. Is it possible to show wetlands from 1940s without the overlay of homes so that we can see a before and after visual of the area?
    a. Yes, that can be included.
2. What happened to the creek that runs along Maples, it is no longer shown in the graphic.
    a. The creek isn't included in the layer because our source didn't include it – USGS
3. Is there no longer a crossing of the drain on the eastern side of the site area?
    a. That is correct
4. Does 'soil suitable for wetlands' mean that there was historically a wetlands?
    a. The area has wetlands suitable soil which means that historically there was a wetlands. In the 1947 areal the land was dedicated to farming but the farmers used tiles to drain the area. The soils can be identified by the species that exist on them.
5. What is the gray are in the bottom right quadrant of the graphic, to the left of the lake and almost touching scio-church road? Was it a gravel pit?
    a. No, it was likely wheat or corn or whatever crop that was grown.
6. When 'flooding' is referred to, do you mean surface flooding or basement flooding?
    a. Flooding refers to when water can't infiltrate into the stormwater system so there is excess water.
7. Where is the drain that filled with debris located?
    a. Behind the houses on the left side of Wilshire Court, where the creek comes into the drain.
8. If the ice cube situation would have been different, could it have exasperated the situation?
    a. Yes, but we don't know if it would have increased the peak flow because it is upstream. The area is now cleared up/restored.
9. What about the water from the Delaware *(unsure if this was the question)*
    a. This may have increased the time length of the flooding but not the quantity of the peak event.
10. I would like to make the suggestion that the drains be marked by their diameter on the map. Some are marked and others aren't, for example one going into the pond, the other going to Eisenhower and another going to Lawton. What would the underground reconstruction of scio-church do?
    a. The underground reconstruction of scio-church would slow and store water
11. Will the length from Winsted to Schian hold 6,000 ft^3 for storage or what? The pipes seem to go from 48'' to 60'' to 48''.
    a. Water typically travels into larger pipes but in this case, the elevation gains/losses alter the needed diameter of pipes.
12. In Lawton Basin, will you have to rebuild Schian Road and will you consider porous pavement?

    a. The high water table makes it inappropriate to put pervious pavement in that area because the water table is above the basement level in most areas. The soil and elevation changes also make pervious pavement inappropriate for this area.
13. After the March 15th stormwater event, how many reports were made to homes/basements?
    a. About 4 or so, mostly water entered homes through window wells.
14. I ask because maybe it would be more cost effective to weather proof specific homes to solve individual problems and not spend so much on this project.
    a. We were asked to do this project but now that we know the cost that it would require to manage another 10 year flood, we may look at alternative strategies.
15. Do we not meet the 10 year flood requirements?
    a. You meet the requirements established at the time your neighborhood was built, which isn't as strict as a 10 year flood requirement.
16. Is the March 15th event the worse we could expect to see?
    a. Its impossible to know but evidence shows that increasingly intense storm events will occur more often.
17. So if this project is approvied, we don't know if this will work for future storm events.
    a. Correct, a 10 year event means there is a 10% chance that an event of this dimension will occur each year. It doesn't necessarily mean the storm occurs once every ten years.
18. 16. With the substantial development occurring on the other side of 94, could we divert water from Mallets neighborhood into Mallets creek through the parking lot to avoid basement flooding?
    a. Politically and topologically it may not be possible and it would be pushing the problem into someone else's backyard. We do not want to set that precedent.
19. 17. Any new development will be required to have retention facilities for a 100 year storm event.
    a. Yes, those are the new stormwater rules.
20. 18. Would the box culvert proposal help reduce stormwater flow and improve water quality by reducing turbidity even without the three proposed re/detention basins of this project?
    a. No, the box culvert portion of the project is only effective if the re/detention basins are in place because they are key in channeling the water from surface flooding into the stormwater system. If the water isn't channeled into the stormwater system, the box culvert won't be able to perform.
21. 19. What is the future timeline for this project?
    a. The document will be finalized in March and the city council (neighborhood ward) will either ask for a submittal or a public presentation. The City Improvement Project process will commence in the fall. Throughout the future of this project, public input will be important and welcome.
22. 20. Can you speak to the article in the Observe that quotes Jen saying that this project won't be completed for five years?
    a. Jen- The stormwater fund comes from utility fees that average about $100/household/year and are based on the home's impervious surfaces. This accrues

about $6/year of which $2 for administration, a portion to stormwater components of new road projects and another portion to existing debts. That leaves about $1/year, so in a best case scenario, we could accrue $5 in five years.

23. 21. What are the other projects being funded by the stormwater fund.
    a. There is flooding in other parts of Ann Arbor, sewage overflows, mold etc.
24. 22. What is the sump pump estimate based on?
    a. The estimate assumes that the sump pump is running at 10 gallons/minute and that everyone is using them at the same time. It is an overestimate, it is more likely to estimate 5 gal/minute. *(not sure I understood this correctly)*
25. 23. Note that John Nichol's property: 2036 Mershan Rd has a gravity feed drain which should be added to the final document.
26. 24. Note that the graphic on page 50 of the pdf doesn't match the new location of Lawton Basin.

Appendix E: Detailed Cost Opinions

PRELIMINARY ESTIMATE OF COST

UPPER MALLETTS STORMWATER CONVEYANCE STUDY
EISENHOWER PARK DETENTION BASIN
CITY OF ANN ARBOR
WASHTENAW COUNTY

Item No.	Estimated Quantity	Unit	Description	Unit Price	Amount
DETENTION POND CONSTRUCTION					
1.	1	Lump Sum	Mobilization	$7 000.00	$7 000.00
2.	10	Acre	Site Clearing and Tree Removal	$8 000.00	$80 000.00
3.	260	Lin. Ft	Haul Road, 12 ft wide	$35.00	$9 100.00
4.	1 250	Lin. Ft.	42" Storm Sewer	$150.00	$187 500.00
5.	3	Each	42" Flared End Sections	$250.00	$750.00
6.	33 000	Cu. Yd.	Earth Excavation	$8.00	$264 000.00
7.	30 000	Cu. Yd.	Spoil Hauling	$13.00	$390 000.00
8.	3 000	Cu. Yd.	Spoil Leveling	$8.00	$24 000.00
9.	2	Each	48" Outlet Control Structure	$4 000.00	$8 000.00
10.	2 500	Sq. Yd.	Remove Existing Pavement	$25.00	$62 500.00
11.	300	Ton	HMA Wearing Course	$70.00	$21 000.00
12.	350	Ton	HMA Leveling Course	$70.00	$24 500.00
13.	2 500	Sq. Yd.	8" Aggregate Base Course	$10.00	$25 000.00
14.	1 200	Cu. Yd.	Subgrade Undercutting	$25.00	$30 000.00
15.	1 000	Lin. Ft.	4" Perforated Underdrain	$2.00	$2 000.00
16.	4 000	Lin. Ft.	Concrete Sidewalk, Remove and Replace	$25.00	$100 000.00
17.	1	Lump Sum	Allowance for Remove and Replace Park Amenities	$50 000.00	$50 000.00
18.	100	Each	Evergreen Tree Plantings	$400.00	$40 000.00
19.	50	Each	Deciduous Tree Plantings	$400.00	$20 000.00
20.	1	Lump Sum	Final Grading, Seeding and Mulching	$16 000.00	$16 000.00
21.	1	Lump Sum	Soil Erosion and Sedimentation Control	$6 000.00	$6 000.00
22.	1	Lump Sum	Traffic Control	$3 000.00	$3 000.00
Subtotal - Eisenhower Park Detention Basin					**$1 395 250.00**
Contingency					$280 000.00
Professional Services and Permitting					$420 000.00
TOTAL PROJECT COSTS					**$2 095 250.00**

PRELIMINARY ESTIMATE OF COST

UPPER MALLETTS STORMWATER CONVEYANCE STUDY
PIONEER DETENTION BASIN
CITY OF ANN ARBOR
WASHTENAW COUNTY

Item No.	Estimated Quantity	Unit	Description	Unit Price	Amount
DETENTION POND CONSTRUCTION					
1.	1	Lump Sum	Mobilization	$7 000.00	$7 000.00
2.	4	Acres	Site Clearing and Tree Removal	$8 000.00	$32 000.00
3.	25 000	Cu. Yd.	Earth Excavation	$8.00	$200 000.00
4.	25 000	Cu. Yd.	Spoil Hauling	$13.00	$325 000.00
5.	1	Lump Sum	Allowance for Relocate Disc Golf Course	$5 000.00	$5 000.00
6.	1	Lump Sum	Landscaping, Final Grading, Seeding and Mulching	$25 000.00	$25 000.00
Subtotal Detention Pond Construction					$594 000.00
STORM SEWER IMPROVEMENTS					
7.	230	Lin. Ft.	36" Storm Sewer	$120.00	$27 600.00
8.	130	Lin. Ft.	10" Storm Sewer	$40.00	$5 200.00
9.	2	Each	36" Flared End Section	$200.00	$400.00
10.	1	Each	48" Outlet Control Structure	$4 000.00	$4 000.00
11.	1	Each	5' Diameter Manhole	$6 000.00	$6 000.00
12.	2	Each	Disconnect Existing Storm Sewer	$600.00	$1 200.00
13.	1	Lump Sum	Ditch Maintenance	$4 000.00	$4 000.00
14.	100	Lin. Ft.	Concrete Curb & Gutter, Remove and Replace	$30.00	$3 000.00
15.	100	Sq. Ft.	Concrete Sidewalk, Remove and Replace	$6.00	$600.00
16.	1	Lump Sum	Site Clean-Up	$2 000.00	$2 000.00
17.	1	Lump Sum	Soil Erosion and Sedimentation Control	$4 000.00	$4 000.00
18.	1	Lump Sum	Traffic Control	$15 000.00	$15 000.00
Subtotal Storm Sewer Improvements					$73 000.00
SCIO CHURCH ROAD 24" STORM SEWER PROJECT					
19.	1 600	Lin. Ft.	24" Storm Sewer	$60.00	$96 000.00
20.	4	Each	4' Diameter Manhole	$3 000.00	$12 000.00
21.	8	Each	Storm Inlet Connection	$500.00	$4 000.00
Subtotal Scio Church Road 24" Storm Sewer Project					$112 000.00
Subtotal - Pioneer Detention Basin					**$779 000.00**
Contingency					$160 000.00
Professional Services and Permitting					$230 000.00
TOTAL PROJECT COSTS					**$1 169 000.00**

NOTE: All costs associated with pavement removal, replacement, and restoration of Scio Church Road shall be performed by others as part of a separate project.

PRELIMINARY ESTIMATE OF COST

UPPER MALLETTS STORMWATER CONVEYANCE STUDY
7th STREET CULVERT
CITY OF ANN ARBOR
WASHTENAW COUNTY

Item No.	Estimated Quantity	Unit	Description	Unit Price	Amount
STORM SEWER IMPROVEMENTS					
1.	1	Lump Sum	Mobilization	$7 000.00	$7 000.00
2.	70	Lin. Ft.	6' Rise x 8' Span Precast Concrete Box Culvert	$1 000.00	$70 000.00
3.	1	Each	24" Diameter Access Manhole	$500.00	$500.00
4.	1	Lump Sum	By-Pass Pumping	$15 000.00	$15 000.00
5.	2	Each	Lateral Tile Connection to Storm Sewer	$500.00	$1 000.00
6.	1	Each	Existing Storm Sewer Tie In	$1 000.00	$1 000.00
7.	200	Sq. Ft.	Concrete Sidewalk, Remove and Replace	$6.00	$1 200.00
8.	50	Lin. Ft.	Concrete Curb & Gutter, Remove and Replace	$30.00	$1 500.00
9.	2 500	Sq. Ft.	Asphalt Road, Remove and Replace	$10.00	$25 000.00
10.	1	Lump Sum	Sediment Cleanout	$3 000.00	$3 000.00
11.	1	Lump Sum	Site Restoration and Cleanup	$2 000.00	$2 000.00
12.	1	Lump Sum	Soil Erosion and Sedimentation Control	$2 500.00	$2 500.00
13.	1	Lump Sum	Traffic Control	$7 000.00	$7 000.00
Subtotal - 7th Street Culvert					**$136 700.00**
Contingency					$30 000.00
Professional Services and Permitting					$40 000.00
TOTAL PROJECT COSTS					**$206 700.00**

PRELIMINARY ESTIMATE OF COST

UPPER MALLETTS STORMWATER CONVEYANCE STUDY
LAWTON PARK DETENTION BASIN
CITY OF ANN ARBOR
WASHTENAW COUNTY

Item No.	Estimated Quantity	Unit	Description	Unit Price	Amount
UNDERGROUND DETENTION BASIN CONSTRUCTION					
1.	1	Lump Sum	Mobilization	$7 000.00	$7 000.00
2.	15 500	Cu. Ft.	Earth Excavation	$8.00	$124 000.00
3.	15 500	Cu. Ft.	Spoil Hauling	$13.00	$201 500.00
4.	1	Lump Sum	Shoring and Excavation Stabilization	$50 000.00	$50 000.00
5.	1	Lump Sum	Underground Storage Basin, Pre-Cast Concrete	$2 125 000.00	$2 125 000.00
6.	40	Each	Cleanout/Access Hatch, Complete	$300.00	$12 000.00
7.	350	Lin. Ft.	60" Storm Sewer	$400.00	$140 000.00
8.	1 000	Lin. Ft.	48" Storm Sewer	$200.00	$200 000.00
9.	60	Lin. Ft.	18" Storm Sewer	$60.00	$3 600.00
10.	4	Each	8' Diameter Manhole	$10 000.00	$40 000.00
11.	1	Each	6' Diameter Manhole	$8 000.00	$8 000.00
12.	1	Each	4' Diameter Manhole	$3 000.00	$3 000.00
13.	1	Lump Sum	Outlet/Overflow Chamber	$9 000.00	$9 000.00
14.	2	Each	Disconnect Existing Storm Sewer	$600.00	$1 200.00
15.	200	Lin. Ft.	Remove Existing 12" Storm Sewer	$100.00	$20 000.00
16.	5 800	Sq. Yd.	Remove Existing Pavement	$25.00	$145 000.00
17.	700	Ton	HMA Wearing Course	$70.00	$49 000.00
18.	870	Ton	HMA Leveling Course	$70.00	$60 900.00
19.	5 800	Sq. Yd.	8" Aggregate Base Course	$10.00	$58 000.00
20.	750	Cu. Yd.	Subgrade Undercutting	$25.00	$18 750.00
21.	3 000	Lin. Ft.	4" Perforated Underdrain	$2.00	$6 000.00
22.	1 000	Sq. Ft.	Concrete Sidewalk, Remove and Replace	$6.00	$6 000.00
23.	2 400	Lin. Ft.	Concrete Curb & Gutter, Remove and Replace	$30.00	$72 000.00
24.	1	Lump Sum	Allowance for Remove and Replace Park Amenities	$10 000.00	$10 000.00
25.	1	Lump Sum	Allowance for Specialty Landscaping	$20 000.00	$20 000.00
26.	1	Lump Sum	Final Grading, Seeding and Mulching	$15 000.00	$15 000.00
27.	1	Lump Sum	Soil Erosion and Sedimentation Control	$10 000.00	$10 000.00
28.	1	Lump Sum	Traffic Control	$20 000.00	$20 000.00
Subtotal - Lawton Park Dention Basin					**$3 434 950.00**
Contingency					$690 000.00
Professional Services and Permitting					$1 030 000.00
TOTAL PROJECT COSTS					**$5 154 950.00**

Appendix F: Model Node Diagram

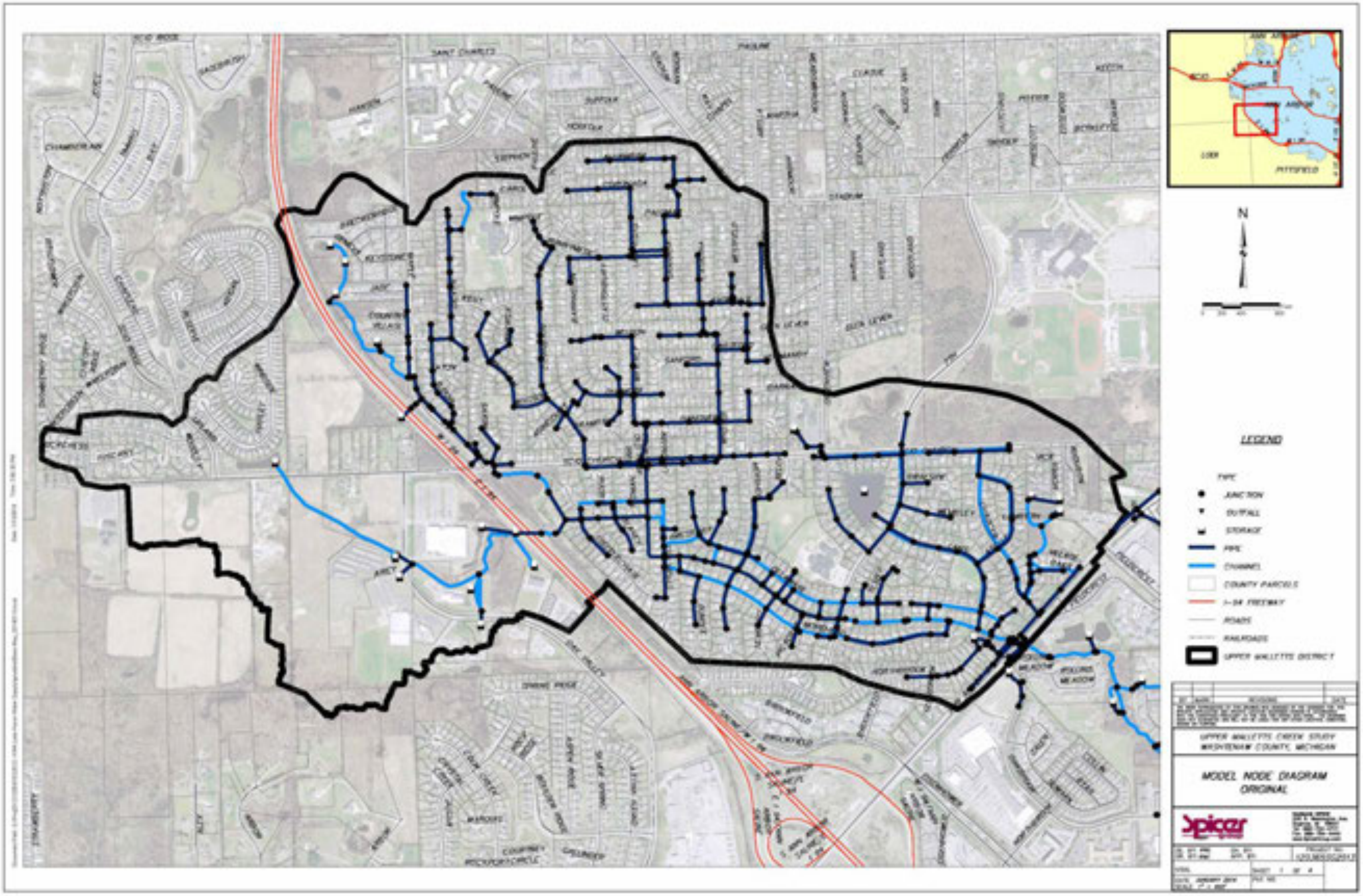

Figure VII-1: No Improvements – Model Node Diagram

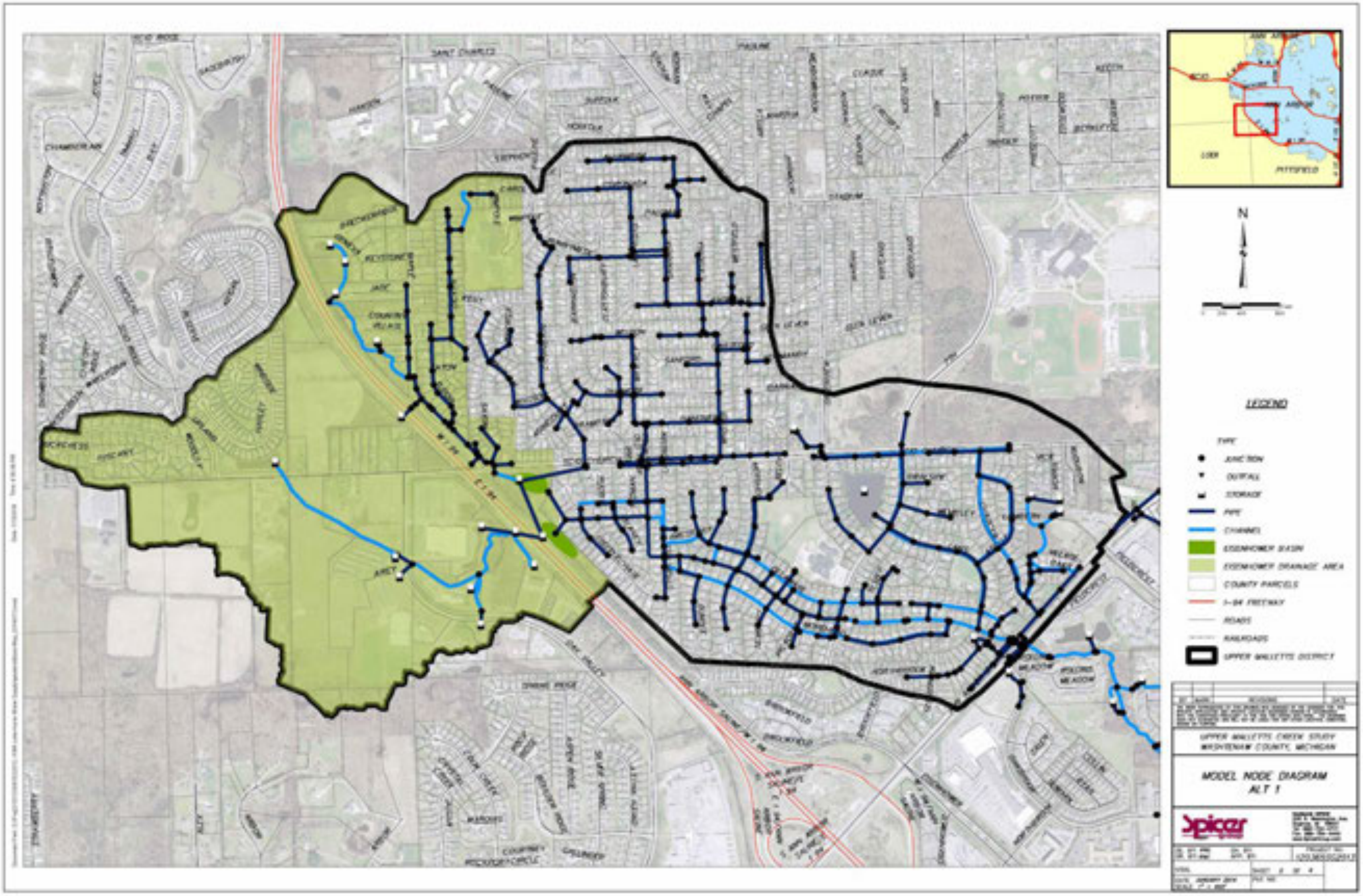

Figure VII-2: Project A – Model Node Diagram

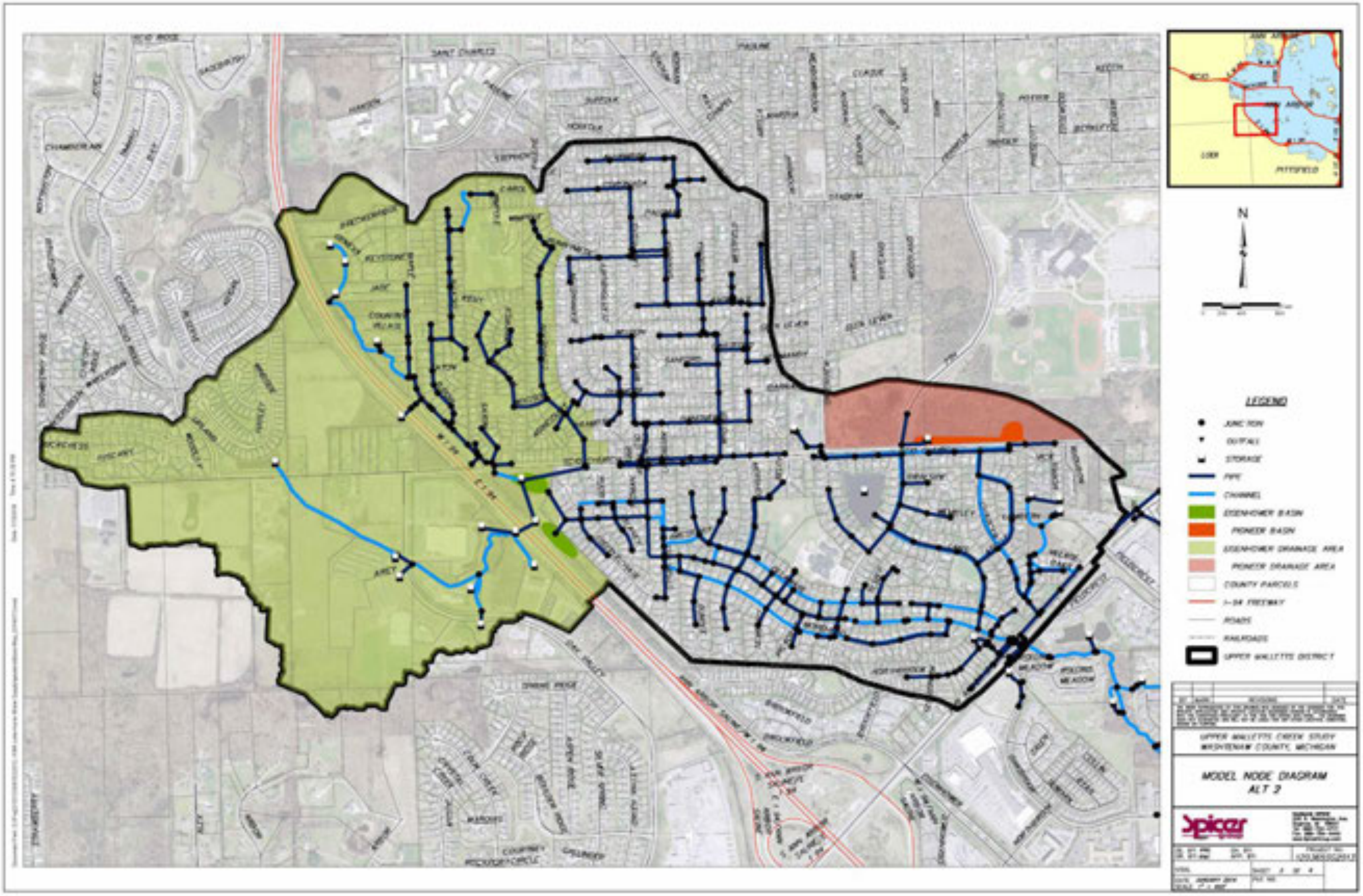

Figure VII-3: Project B – Model Node Diagram

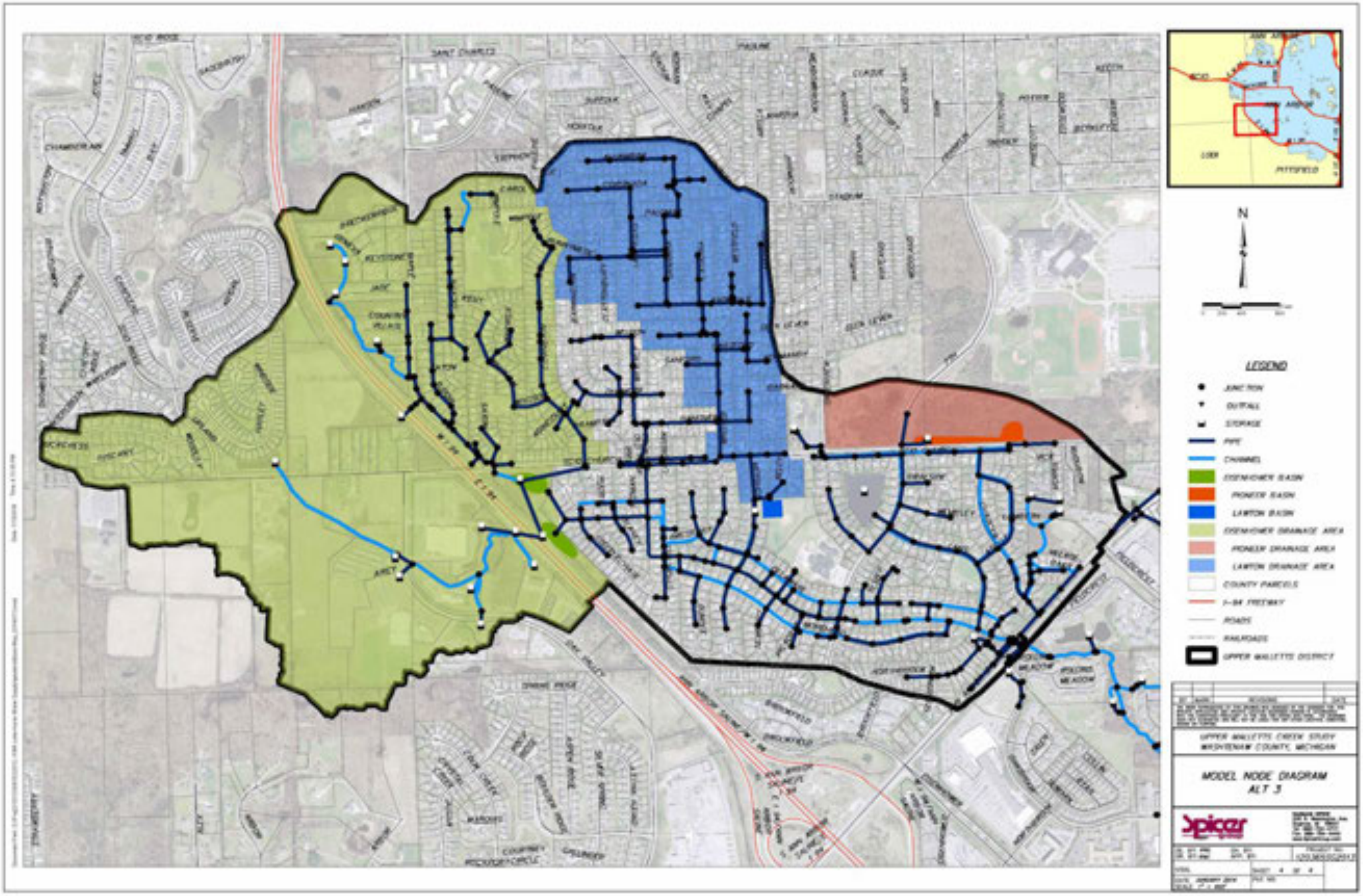

Figure VII-4: Project C – Model Node Diagram

Appendix G: Pipe Network Maps and Profiles