

CITY OF ANN ARBOR

SANITARY SEWER IMPROVEMENTS PRELIMINARY ENGINEERING
VOLUME 3: MODELING AND PRELIMINARY ENGINEERING REPORT



JANUARY 2018



Introduction

In 2013 and 2014, the City of Ann Arbor conducted a Sanitary Sewer Wet Weather Evaluation (SSWWE) to evaluate the effectiveness of the City's footing drain disconnection program. The SSWWE included evaluation of the entire City and found five areas with potential capacity issues during wet weather events. These areas were evaluated as part of the 2016-2017 Sanitary Sewer Improvements and Preliminary Engineering (SSIPE) project. An additional area, Area F, was added to this project as an operation and maintenance evaluation by the City.

The scope and details of the SSIPE project are described in Volumes 1 and 2 of the project report. The following report discusses the hydrologic and hydraulic analyses completed as part of the SSIPE project. The following recommendations include a preliminary engineering analysis where applicable. This following background information is based on the five original project sheets, which are located in Appendix A of the SSES Report.

Area A Objective

As part of the 2013 Sanitary Sewer Wet Weather Evaluation Project (SSWWEPE), which evaluated the effectiveness of the Footing Drain Disconnect (FDD) Program, Project Area A, Huron/West Park was identified as an over loaded area with the 2013 hydraulic model. The model indicated that the sanitary pipe was over loaded in this region. The 2013 sanitary sewer model was calibrated to a downstream sanitary meter. The flow distribution upstream of this meter was estimated in the 2013 study. The model resulted in excessive surcharging in this area. The City had previously recognized this as a problem area and constructed a relief sewer downstream of the original metered location. There is no history of reported sewer backups in this area. The modeling team did not have high confidence in the surcharging identified in the hydraulic model based on the lack of citizen complaints.

For the current Sanitary Sewer Improvements and Preliminary Engineering (SSIPE) Project, Area A was subdivided with new meter locations upstream, and the flow distribution was updated in the hydraulic model based on the meter data. The Volume 1: Flow Monitoring Report discusses the details of the flow monitoring for Area A and the other identified Project Areas.

Area A Modeling Results

Existing Conditions

As discussed above, Area A was metered further for the current SSIPE study. The results of the metering were used to adjust the flow distribution in the upstream portion of Area A in the hydraulic model. The hydraulic model was run under Scenario B, which is the selected design. This event consists of a 25-year frequency event plus additional flow to account for growth planned by the City and growth expected in the Township. Scenario B also includes a 10% increase in peak flows within the City to account for climate change, an increase in the level of service from a 25- to a 50-year design event, or additional growth beyond that contained in the City's planned development list.

The existing conditions (2013 modeled physical pipe characteristics) were evaluated for modeling the Area A system. Similar to the results of the 2013 study, many pipes in Area A were overloaded during the design event model analysis. A profile of the overloaded pipes is shown in Figure 1.

For the section upstream of the ravine, it was determined through discussion with the City that an improvement was not necessary. Though the pipes surcharge, the HGL does not reach the measured basement elevations, as shown in Figures 1 and 2.

Alternative Solutions

The model was used to size and identify the extent of improvements needed. In an attempt to relieve the surcharging, several alternatives were explored, and two were chosen as viable options.

Alternative One – Doty to Arbana

Alternative Two – Dexter Ave to Arbana

Alternatives One and Two both resolve the issue of surcharging in Area A. Details of these alternatives are covered in the following preliminary engineering discussion. Figures 3-5 show the

profile of the sewer through the ravine and further downstream in Area A for existing and proposed conditions.

In addition to Alternatives One and Two, another alternative was considered. Preliminary engineering analysis concluded that the third was not feasible. Details of these options are discussed in the following section.

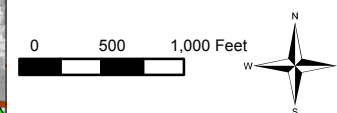


Project Area A Huron/West Park Trunkline

Figure 1

Legend

- Project Area
- Basement Survey Areas
- Proposed Meters
- Optional Meters
- 2013 Meter
- City Raingage
- 2013 PSR
- CAC Member



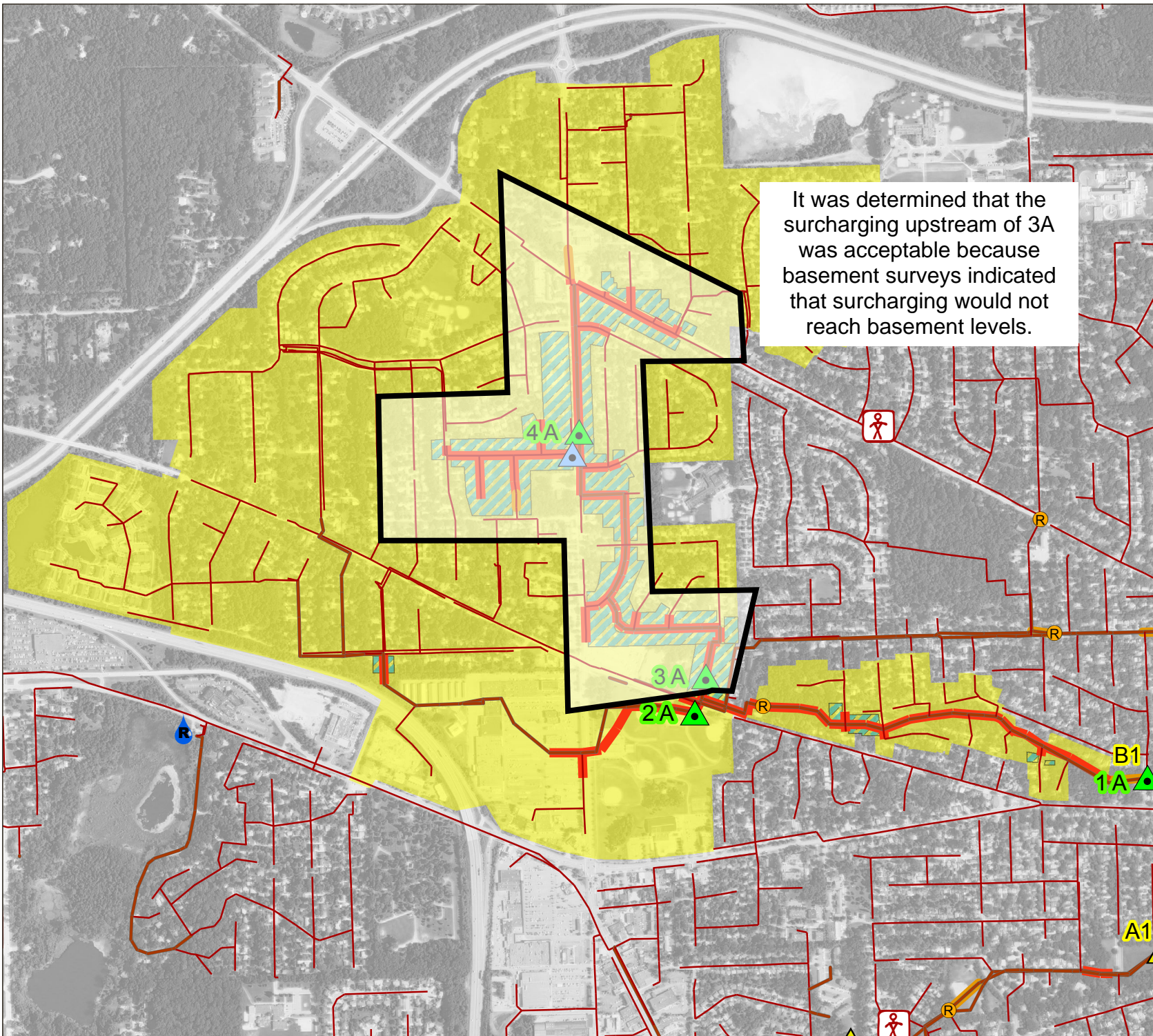
Source: Data provided by the City of Ann Arbor. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

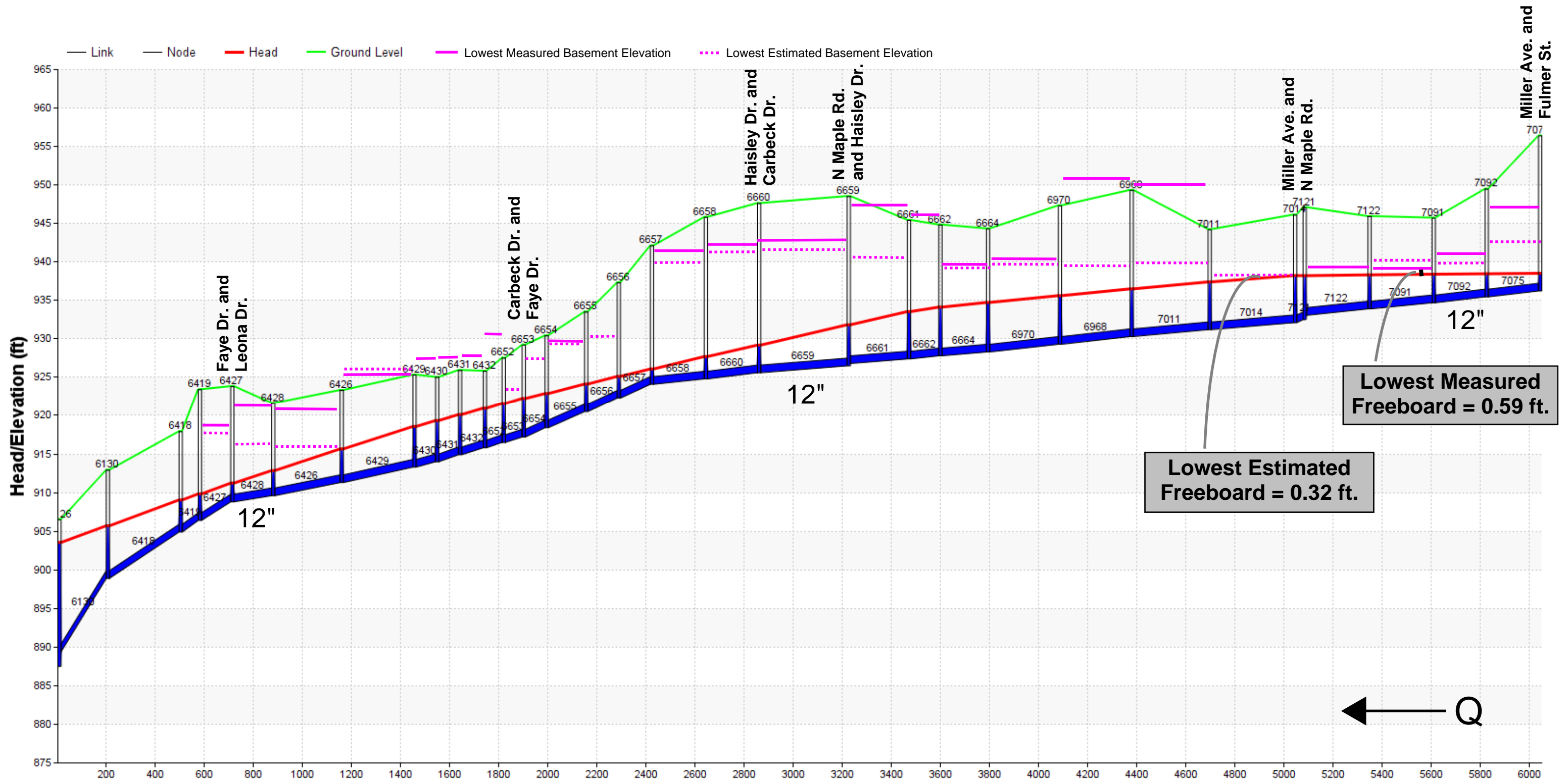
Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 IntlFeet

Map Published: January 5, 2017

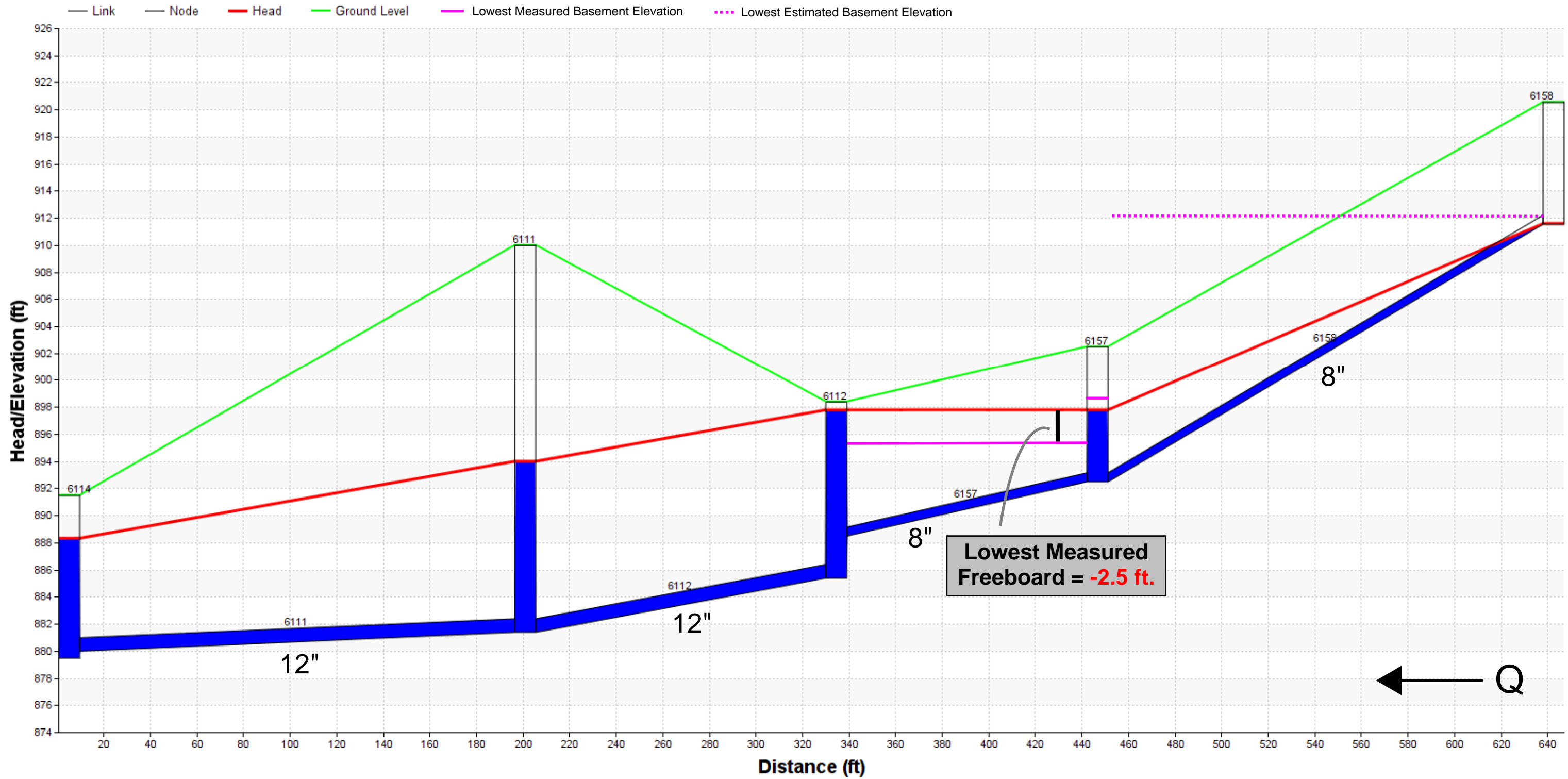


It was determined that the surcharging upstream of 3A was acceptable because basement surveys indicated that surcharging would not reach basement levels.

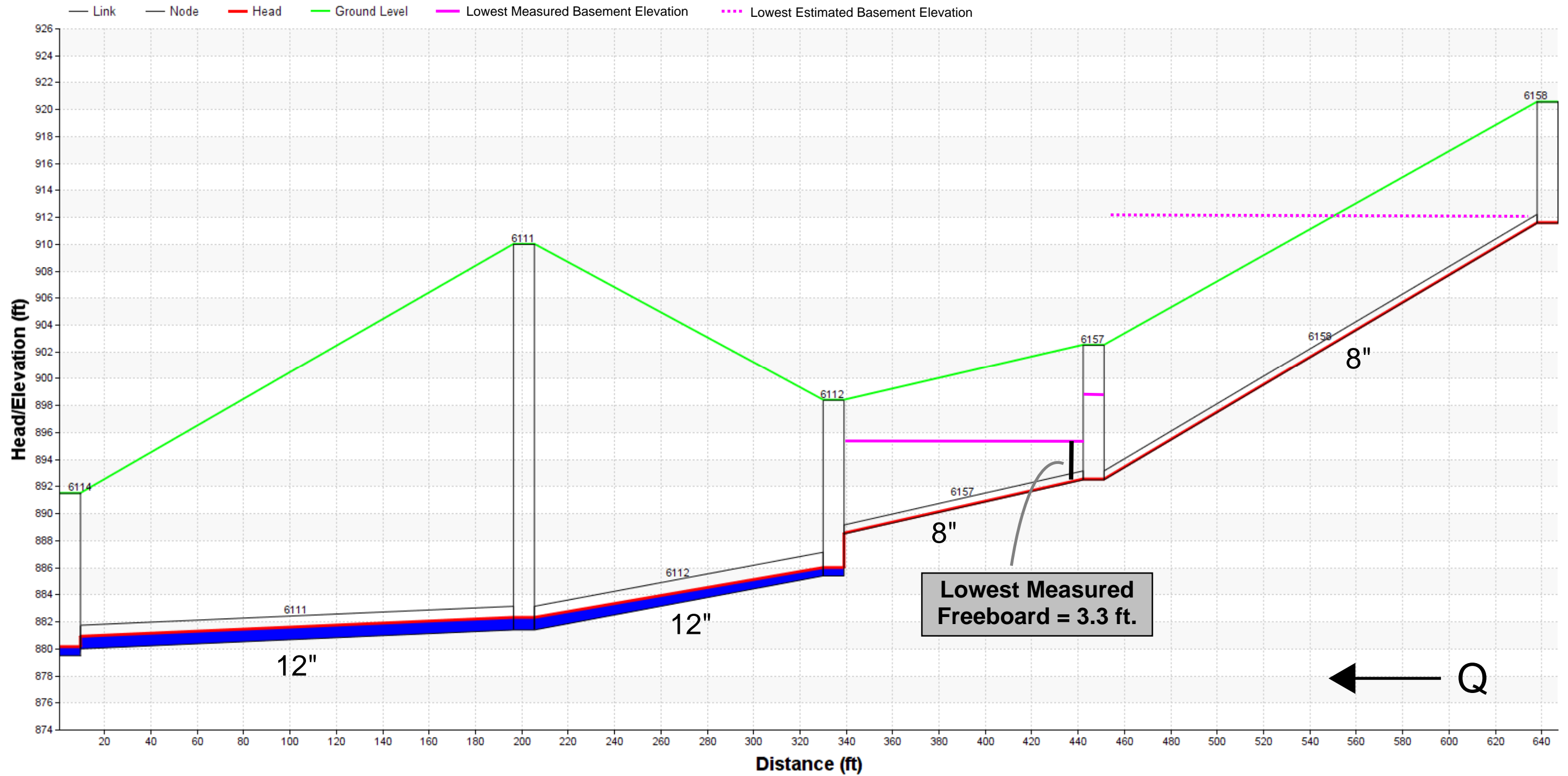




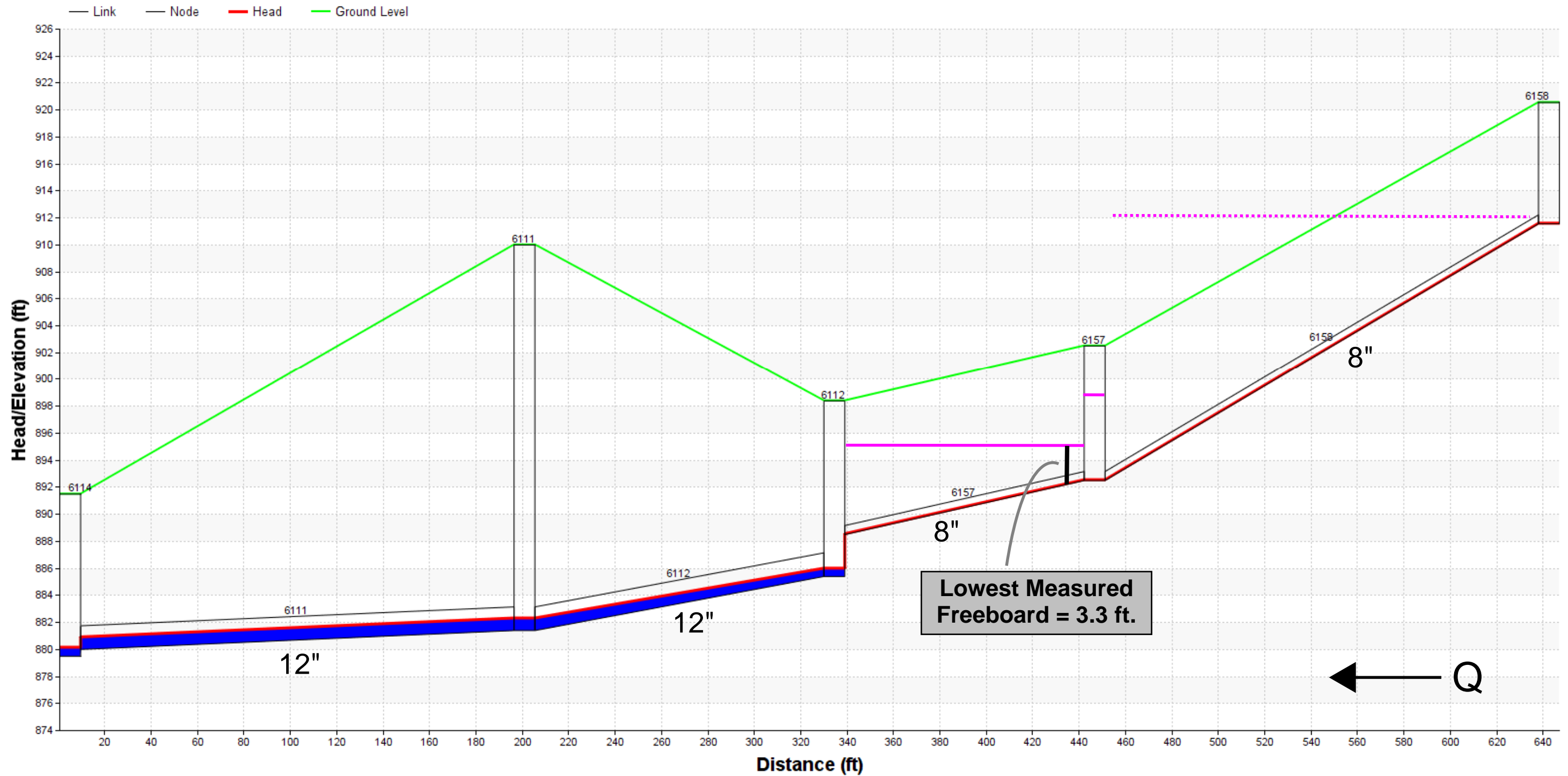
Area A - Upstream of Ravine - Existing Conditions



Area A - Doty Ave. - Existing Conditions



Area A - Doty Ave. - Entire Ravine Line Increased to 21"



Area A - Doty Ave. - Ravine Line Increased to 21" up to Doty

Preliminary Engineering

Sanitary sewers in the vicinity of Project Area A drain to the existing 12” and 18” diameter sewers in the ravine that runs between Linwood and Dexter Avenues. Existing sewage flows easterly in a 12” collector sewer from the vicinity of the Mapleridge apartments, through the ravine to Arbana Drive. This route is roughly parallel to Dexter Avenue. At Arbana Drive the flow continues into an existing 21” sewer just north of W. Huron St.

The objective of the project is to increase the size of the existing sewers to 21” in diameter to increase the sewer flow capacity for the project area. Another goal is to create a permanent path along the sewer that is navigable by sewer maintenance vehicles. Currently the existing sewer is not readily accessible. Photos of the areas are shown in Appendix A.

Alternative One – Doty to Arbana

Alternative One is to replace the existing 12” diameter sewers with a new 21” diameter sewer through the ravine from Doty Ave. to Arbana Drive. Figure 2 shows the profile along Doty Ave. with this improvement as compared to measured and estimated basement elevations.

Sewer Design

- i. The proposed sanitary sewer would be 21” reinforced concrete pipe in accordance with the Ann Arbor Design Standards. Concrete corrosion inhibitors, such as Xypex, can be added to the concrete mix at the time of pipe production. This will be considered at the time of design engineering. The City could also consider products which can be applied to the interior of the concrete pipes for protection.
- ii. The existing sewers have slopes of approximately 0.10% to 3.0%. The proposed sewer would have similar slopes.

Route Description

- i. The proposed route is along a wooded ravine through a residential neighborhood. The route would parallel the existing sanitary sewer.
- ii. Drains- The proposed sewer route follows the route of the “West Park – Fairgrounds” County Drain. (see attached map) There is also a local storm drainage system in the surface roads consisting of mostly 12” diameter sewers.
- iii. Roads – Several residential streets would have to be crossed by the proposed sewer. The existing pavement in those streets is asphalt in average condition. The roads have concrete curb and gutter.
- iv. The sewer passes through Maryfield Wildwood Park between Westwood and Revena.

Construction Methods

- i. The anticipated construction method would be open cut installation of the sewers. Installation of new sewers by the pipe bursting method was considered. This method would not be plausible for this project because of the desired inside diameter of the proposed sewer. The existing sewer has a 12” inside diameter and the desired inside diameter of the proposed sewer is 21”. A nominal size 24” plastic pipe (O.D. = 25.8”) would be required to achieve an inside diameter of at least 21”. This is because plastic pipe has thicker walls, and needs that thickness to withstand pull forces on the pipe during pipe bursting operations. It



is not feasible to pipe burst a 12” clay pipe to a condition whereby a new 24” plastic pipe could be pulled through the void.

- ii. Bypass pumping of the sewage flow would be required at times during the construction operations.

Potential Construction Challenges

- i. This is a wooded corridor with a number of large trees. Numerous trees will need to be cleared in order to create an access route along the length of the proposed sewer.
- ii. The ravine is up to 25 feet lower than adjacent roads. Access routes would have to be built for construction equipment to enter into the work zone.
- iii. Two roads may have to be crossed by a jack and bore operation. These are Westwood Ave. and Revena Blvd. There is already a segment of 21” pipe under Wildwood, so that road will not need to be disturbed.
- iv. Because the route of the sewer is along the “West Park – Fairgrounds” County Drain, weather and storm water will need to be considered and accommodated during construction operations. The proposed work will need to be coordinated with the Washtenaw County Water Resource Commissioner’s office.
- v. The operation of construction equipment and bypass pumping will produce heightened noise levels in a residential neighborhood that is not accustomed to it. Measures may need to be employed to mitigate noise from construction operations and bypass pumping.
- vi. The Maryfield Wildwood Park (see attached map) is central to the project area. Park land could be a desirable location for some construction staging. Coordination with the Parks and Recreation Dept. will be necessary to determine how and when the park land could be used for construction purposes.
- vii. Construction operations will have an impact on plants and wildlife along the ravine. Coordination will be required with any environmental agencies that have jurisdiction over this area. A sign near the sewer route on Revena indicates that the area is a “Certified Wildlife Habitat” by the National Wildlife Federation.

Traffic Control Considerations

- i. It is anticipated that there would be temporary road blockages during construction. The local traffic in the neighborhood could be managed with traffic control devices. The existing road network in the neighborhood allows for alternate routes to enable residents to access their homes.
- ii. There is an existing park in the middle of the neighborhood. Coordination would be required with the Parks and Recreation Dept. to manage pedestrian and other traffic coming and going from the park.
- iii. Dexter Road is a heavily travelled road. Construction traffic would be travelling on the road and slowing down to turn into the subdivision. Although traffic control devices may not need to be set up in Dexter Ave., the typical flow of traffic could be slowed due to the movements of construction vehicles.
- iv. Easement Needs: Both temporary and permanent easements will be needed along the route in order to build the proposed sewer. Research will be required by the City to determine locations of any existing easements. Also, coordination with the Washtenaw County Water Resources Commissioner’s office will be needed to determine what easements they have in the project area.



- v. Existing soil conditions: No investigations were performed under the scope of this study.
- vi. Existing buried utilities: No investigations were performed under the scope of this study.

A summary of pipe lengths in the project under Alternative One are shown in the following table.

Table 1: Alternative One Sewer Lengths

Alternative One - Sewer Segments	Existing Sewer Diameter	Proposed Sewer Diameter	Distance, feet
Doty Ave. to Arbana Dr.	12"	21"	2,800
TOTAL			2,800

Alternative Two – Dexter Ave. to Arbana

Alternative Two is to replace the existing 12” and 18” diameter sewers with 21” diameter sewer through the ravine from a point in Dexter Ave. near the Mapleridge Apartments to Arbana Drive.

Sewer Design

- i. The proposed sanitary sewer would be 21” reinforced concrete pipe in accordance with the Ann Arbor Design Standards. Concrete corrosion inhibitors, such as Xypex, can be added to the concrete mix at the time of pipe production. This will be considered at time of design engineering. The City could also consider products such as Sika Shield which can be applied to the interior of the concrete pipes for protection
- ii. The existing sewers have slopes of approximately 0.10% to 3.0%. The proposed sewer would have similar slopes.

Route Description

- i. The beginning of the route is in Dexter Ave. near the Mapleridge Apts. The remainder of the proposed route is along a wooded ravine through a residential neighborhood. The route would parallel the existing sanitary sewer.
- ii. Drains-The proposed sewer route follows the route of the “West Park – Fairgrounds” County Drain. (see attached map) The drain is enclosed in a 72” storm sewer pipe that runs parallel to the sanitary sewer from Dexter Ave. to Doty Ave. There is also a local storm drainage system in the surface roads consisting of mostly 12” diameter sewers.
- iii. Roads – Several residential streets would need to be crossed. The existing pavement in those streets is asphalt in average condition. The roads have concrete curb and gutter. Dexter is a 66 feet wide arterial road with 2 lanes of pavement. The pavement is 34 feet wide from back to back of curbs. Curb and gutter is 2 ft wide.
- iv. The sewer passes through Maryfield Wildwood Park between Westwood and Revena.



Construction Methods

- i. The anticipated construction method through the ravine would be open cut installation of the sewers. Installation of new sewers by the pipe bursting method was considered. This method would not be plausible for this project because of the desired inside diameter of the proposed sewer. The existing sewer has a 12” inside diameter and the desired inside diameter of the proposed sewer is 21”. A nominal size 24” plastic pipe (O.D. = 25.8”) would be required to achieve an inside diameter of at least 21”. This is because plastic pipe has thicker walls, and needs that thickness to withstand pull forces on the pipe during pipe bursting operations. It is not feasible to pipe burst a 12” clay pipe to a condition whereby a new 24” plastic pipe could be pulled through the void.
- ii. Open cut installation of the sewer in Dexter Ave. would not be possible without closing the road during construction. This is due to the sewer depth and presence of other utilities. In this case the entire paved surface in the sewer construction area would be removed and replaced. Alternately, the road could be partially closed and pits constructed to allow for jacking and boring sewer segments into place. The pros and cons of these options would need to be further evaluated at the time of engineering design. For the purposes of this preliminary study, installation by jack and bore has been assumed for the opinion of probable construction costs.
- iii. Bypass pumping of the sewage flow would be required at times during the construction operations.

Potential Construction Challenges

- i. This is a wooded corridor with a number of large trees. Numerous trees will need to be cleared in order to create an access route along the length of the proposed sewer.
- ii. The ravine is up to 25 feet lower than adjacent roads. Access routes would have to be built for construction equipment to enter into the work zone.
- iii. Work in Dexter Ave: Because of the sewer depth and existing utilities in Dexter Ave., it is anticipated that the segments of sewer in Dexter Ave. would be constructed by jacking and boring the pipe into place.
- iv. Dexter Ave. is a heavily travelled road. Construction traffic would be travelling on the road and slowing down to turn into the subdivision. The typical flow of traffic could be slowed due to the movements of construction vehicles. The road will have to be partially or fully closed during the construction of the sewer segments in Dexter Ave.
- v. Two roads within the neighborhood may have to be crossed by a jack and bore operation. These are Westwood Ave. and Revena Blvd. There is already a segment of 21” pipe under Wildwood, so that road will not need to be disturbed.
- vi. Because the route of the sewer is along a ravine, weather and storm water will need to be considered and accommodated during construction operations. Coordination will be required with the Washtenaw County Water Resources Commissioner’s office.
- vii. The operation of construction equipment and bypass pumping will produce heightened noise levels in a residential neighborhood that is not accustomed to it. Measures may need to be employed to mitigate noise from construction operations and bypass pumping.
- viii. The Maryfield Wildwood Park is central to the project area. Park land could be a desirable location for some construction staging. Coordination with the Parks and Recreation Dept. will be necessary to determine how and when the park land could be used for construction purposes.

- ix. Construction operations will have an impact on plants and wildlife along the ravine. Coordination will be required with any environmental agencies that have jurisdiction over this area. A sign near the sewer route on Revena indicates that the area is a “Certified Wildlife Habitat” by the National Wildlife Federation.

Traffic Control Considerations

- i. It is anticipated that there would be temporary road blockages during construction. The local traffic in the neighborhood could be managed with traffic control devices.
- ii. There is an existing park in the middle of the neighborhood. Coordination would be required with the Parks and Recreation Dept. to manage pedestrian and other traffic coming and going from the park.
- iii. Dexter Road is a heavily travelled road. Construction traffic would be travelling on the road and slowing down to turn into the subdivision. The typical flow of traffic could be slowed due to the movements of construction vehicles. The road would need to be partially or fully shut closed during construction of sewer in Dexter Ave.
- iv. Easement Needs: Both temporary and permanent easements will be needed in order to build the project. Research will be required by the City to determine locations of any existing easements. Also, coordination with the Washtenaw County Water Resources Commissioner’s office will be needed to determine what easements they have in the project area.
- v. Existing soil conditions: No investigations were performed under the scope of this study.
- vi. Existing buried utilities: No investigations were performed under the scope of this study.

A summary of pipe lengths in the project area under Alternative Two are shown in the following table.

Table 2: Alternative Two Sewer Lengths

Alternative Two - Street Segments	Existing Sewer Diameter	Proposed Sewer Diameter	Distance, feet
Mapleridge Apts to Doty Ave.	18”	21”	1,450
Doty Ave. to Arbana Dr.	12”	21”	2,800
TOTAL			4,250

Other Option Considered

Constructing a new 21” diameter sewer in Dexter Avenue from the vicinity of Mapleridge Apartments to Doty Ave. was considered. In this option, sewage would flow easterly on Dexter, then turn north on Doty, and be directed into new 21” sewer flowing east from Doty. This would avoid approximately 900 feet of sewer construction through the ravine.

With this option, sewer depths would reach up to 37 feet. Open cut construction would require the complete closure and reconstruction of Dexter Ave. in the project area. Sewers can be installed by horizontal directional drilling under certain circumstances, but it is not a viable option for this route.

The accuracy of the pilot hole drilling at these depths is typically within 1% of the pipe length installed. This accuracy level cannot be tolerated for the pipe slopes needed for this project, which are as low as 0.11%.

This route was not considered further because of the reasons stated above.

Opinions of Probable Construction Costs

The detailed opinions of probable construction costs are attached. The totals are:

- i. Alternative One - \$2,943,000
- ii. Alternative Two - \$4,988,000

Conceptual Plans

Preliminary conceptual plans for each option are attached.

Photos

Representative photos of the project area are attached in Appendix A.

Appendix A

Photos of Area with Recommended Improvements

**PHOTOS ARE VERY LARGE
AND NOT INCLUDED IN THIS PDF**

Appendix B

Preliminary Cost Estimates

Project Summary Engineer's Opinion of Probable Project Costs

Owner: City of Ann Arbor
 Project: Sanitary Sewer Improvement Project
 Work: AREA A - OPTION 1
Upsize existing sewer from 12 inch to 21 inch
Route through ravine from Doty Ave. to Arbana Drive

Date: 3/8/2017
 Project No. 0028-15-0051
 Prepared By: E.Gumpper
 Reviewed By: _____

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization (5%)	1	LS	\$78,000	\$78,000
2	Soil Erosion and Sediment Control (5%)	1	LS	\$71,000	\$71,000
3	Traffic Maintenance and Control (5%)	1	LS	\$71,000	\$71,000
4	Digital Video Route Survey	1	LS	\$5,000	\$5,000
5	Exploratory Excavations	10	EA	\$2,000	\$20,000
6	Earthwork for access ramps to ravine	1	LS	\$50,000	\$50,000
7	Sewer, 21 inch, Tr Det A (10'-20' Deep)	2500	FT	\$210	\$525,000
8	Sewer, 21 inch, Tr Det A (over 20' deep)	200	FT	\$230	\$46,000
9	Sewer, 21 inch, Bore & Jack in 36" Steel Casing (Revena)	100	FT	\$600	\$60,000
10	Sewer Reconnections	10	EA	\$5,000	\$50,000
11	Trench Under Cut and Back Fill (6A)	500	CYD	\$50	\$25,000
12	Dewatering Trench	500	FT	\$50	\$25,000
13	Bypass Pumping	1	LS	\$50,000	\$50,000
14	Sanitary Sewer Manhole, 4 ft diameter	8	EA	\$12,000	\$96,000
15	Sanitary Sewer Manhole, 5 ft diameter	8	EA	\$16,000	\$128,000
16	Storm Sewer, 12 inch	100	FT	\$100	\$10,000
17	Storm Drain Manhole, 4 ft diameter	4	EA	\$10,000	\$40,000
18	Abandon Existing sewer with Flowable Fill	100	CYD	\$200	\$20,000
19	Pavement Remove and Replacement	400	SYD	\$50	\$20,000
20	Curb and Gutter, Remove and Replace	200	FT	\$25	\$5,000
21	Sidewalk , Remove and Replace	2000	SFT	\$5	\$10,000
22	Subgrade Undercut and Refill	50	CYD	\$100	\$5,000
23	Permanent aggregate maintenance path	5200	SYD	\$20	\$104,000
24	Clearing & Tree Removal	1	LS	\$50,000	\$50,000
25	Green Belt Restoration	13700	SYD	\$5	\$68,500
26	Utility Relocation Allowance	1	LS	\$25,000	\$25,000
27	Easement Acquisition Allowance	1	LS	\$80,000	\$80,000
28	Permit Application Allowance	1	LS	\$10,000	\$10,000
29	General Conditions & Requirements	10	%		\$175,000.00
	CONSTRUCTION SUBTOTAL				\$1,923,000.00
	Engineering, Contract Admin, Constr Eng, Observation	25	%		\$481,000.00
	Geotechnical Services	3	%		\$58,000.00
	Contingencies	25	%		\$481,000.00
	ENGINEER'S OPINION OF PROJECT COST				\$2,943,000.00
	PROJECT ASSUMPTIONS				
	Residential Pavement thickness	3" asphalt	and	8" agg base	
	Easements needed in ravine area				
	Construction method open cut				
	Design flow is XX CFS. Proposed pipe is 21" diameter at 0.0 to 0.0% slope.				
	Pipe is 21" RCP with corrosion inhibitor added				
	Geotechnical investigations and existing utility research was out of the scope of this study.				
	Pavement work includes costs for removal and replacement of HMA, aggregate base, underdrain, and pavement markings.				

Project Summary Engineer's Opinion of Probable Project Costs

Owner: City of Ann Arbor
 Project: Sanitary Sewer Improvement Project
 Work: AREA A - OPTION 2
Upsize existing sewer from 12 inch and 18 inch to 21 inch diameter
Route from Dexter Ave. through ravine to Arbana Drive

Date: 3/8/2017
 Project No. 0028-15-0051
 Prepared By: E.Gumpper
 Reviewed By: _____

Item No.	Item Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization (5%)	1	LS	\$134,000	\$134,000
2	Soil Erosion and Sediment Control (5%)	1	LS	\$116,000	\$116,000
3	Traffic Maintenance and Control (10%)	1	LS	\$232,000	\$232,000
4	Digital Video Route Survey	1	LS	\$7,000	\$7,000
5	Exploratory Excavations	20	EA	\$2,000	\$40,000
6	Earthwork for access ramps to ravine	1	LS	\$100,000	\$100,000
7	Sewer, 21 inch, Tr Det A (10'-20' Deep)	3400	FT	\$210	\$714,000
8	Sewer, 21 inch, Tr Det A (over 20' deep)	200	FT	\$230	\$46,000
9	Sewer, 21 inch, Bore & Jack in 36" Steel Casing	650	FT	\$600	\$390,000
10	Sewer Reconnections	10	EA	\$5,000	\$50,000
11	Trench Under Cut and Back Fill (6A)	700	CYD	\$50	\$35,000
12	Dewatering Trench	700	FT	\$50	\$35,000
13	Bypass Pumping	1	LS	\$75,000	\$75,000
14	Sanitary Sewer Manhole, 4 ft diameter	12	EA	\$12,000	\$144,000
15	Sanitary Sewer Manhole, 5 ft diameter	12	EA	\$16,000	\$192,000
16	Storm Sewer, 12 inch	150	FT	\$100	\$15,000
17	Storm Drain Manhole, 4 ft diameter	6	EA	\$10,000	\$60,000
18	Abandon Existing Sewer with Flowable Fill	200	CYD	\$200	\$40,000
19	Pavement Remove and Replacement, Residential	400	SYD	\$50	\$20,000
20	Pavement Remove and Replacement, Dexter Ave	400	SYD	\$70	\$28,000
21	Curb and Gutter, Remove and Replace	200	FT	\$25	\$5,000
22	Sidewalk, Remove and Replace	2000	SFT	\$5	\$10,000
23	Subgrade Undercut and Refill	50	CYD	\$100	\$5,000
24	Permanent aggregate maintenance path	6800	SYD	\$20	\$136,000
25	Clearing & Tree Removal	1	LS	\$75,000	\$75,000
26	Green Belt Restoration	20000	SYD	\$5	\$100,000
27	Utility Relocation Allowance	1	LS	\$50,000	\$50,000
28	Easement Acquisition Allowance	1	LS	\$100,000	\$100,000
29	Permit Application Allowance	1	LS	\$10,000	\$10,000
30	General Conditions & Requirements	10	%		\$296,000.00
CONSTRUCTION SUBTOTAL					\$3,260,000.00
	Engineering, Contract Admin, Constr Eng, Observation	25	%		\$815,000.00
	Geotechnical Services	3	%		\$98,000.00
	Contingencies	25	%		\$815,000.00
ENGINEER'S OPINION OF PROJECT COST					\$4,988,000.00
PROJECT ASSUMPTIONS					
	Residential Pavement thickness	3" asphalt	and	8" agg base	
	Easements needed in ravine area				
	Construction method: open cut through ravine and pipe jacked in place in Dexter Ave.				
	Dexter Ave. will be limited to one lane of traffic or shut completely				
	Design flow is XX CFS. Proposed pipe is 21" diameter at 0.1 to 3.0% slope.				
	Pipe is 21" RCP with corrosion inhibitor added.				
	Geotechnical investigations and existing utility research was out of the scope of this study.				
	Pavement work includes costs for removal and replacement of HMA, aggregate base, underdrain, and pavement markings.				

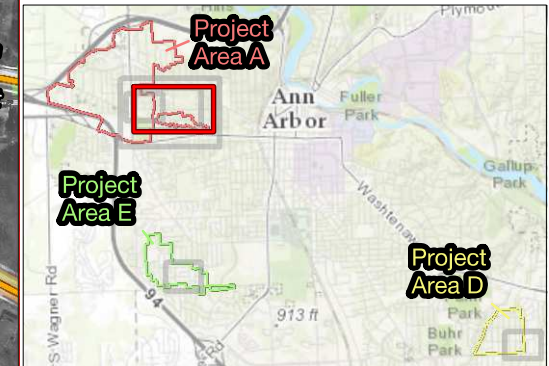
Appendix C

Preliminary Conceptual Plans

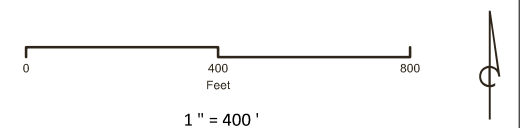


Ann Arbor Sanitary Sewer Improvements

Area A - Option 1



- Improvement Areas**
 - Area A
 - Area D
 - Area E
- Proposed Sanitary Mains - Size**
 - 12"
 - 18"
 - 21"
- Sanitary Main - Type**
 - Collector
 - Force Main
 - Storm Manhole
 - Storm Discharge Point
 - Storm Catchbasin
 - Storm Main
- Project Areas**
 - Project Area A
 - Project Area D
 - Project Area E
- Sanitary Manhole**



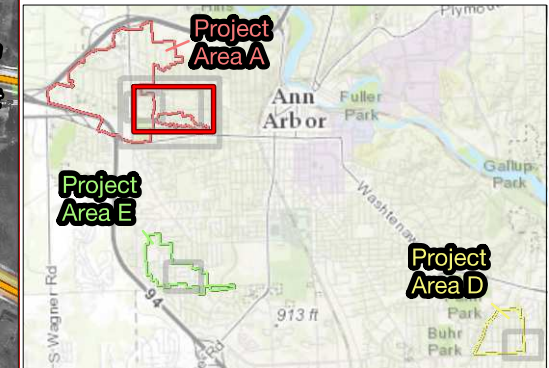
Source: Data provided by Washtenaw County and the City of Ann Arbor. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
Map Published: February 16, 2017

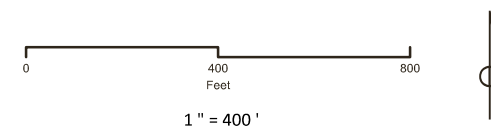


Ann Arbor Sanitary Sewer Improvements

Area A - Option 2



- Improvement Areas**
- Area A
 - Area D
 - Area E
- Proposed Sanitary Mains - Size**
- 12"
 - 18"
 - 21"
- Sanitary Main - Type**
- Collector
 - Force Main
 - Storm Manhole
 - Storm Discharge Point
 - Storm Catchbasin
 - Storm Main
- Project Areas**
- Project Area A
 - Project Area D
 - Project Area E
- Sanitary Manhole**
- Sanitary Manhole



Source: Data provided by Washtenaw County and the City of Ann Arbor. OHM Advisors does not warrant the accuracy of the data and/or the map. This document is intended to depict the approximate spatial location of the mapped features within the Community and all use is strictly at the user's own risk.

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl

Map Published: February 16, 2017

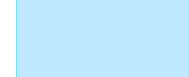


Ann Arbor Township County Drain Map

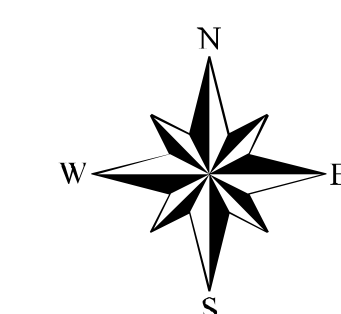
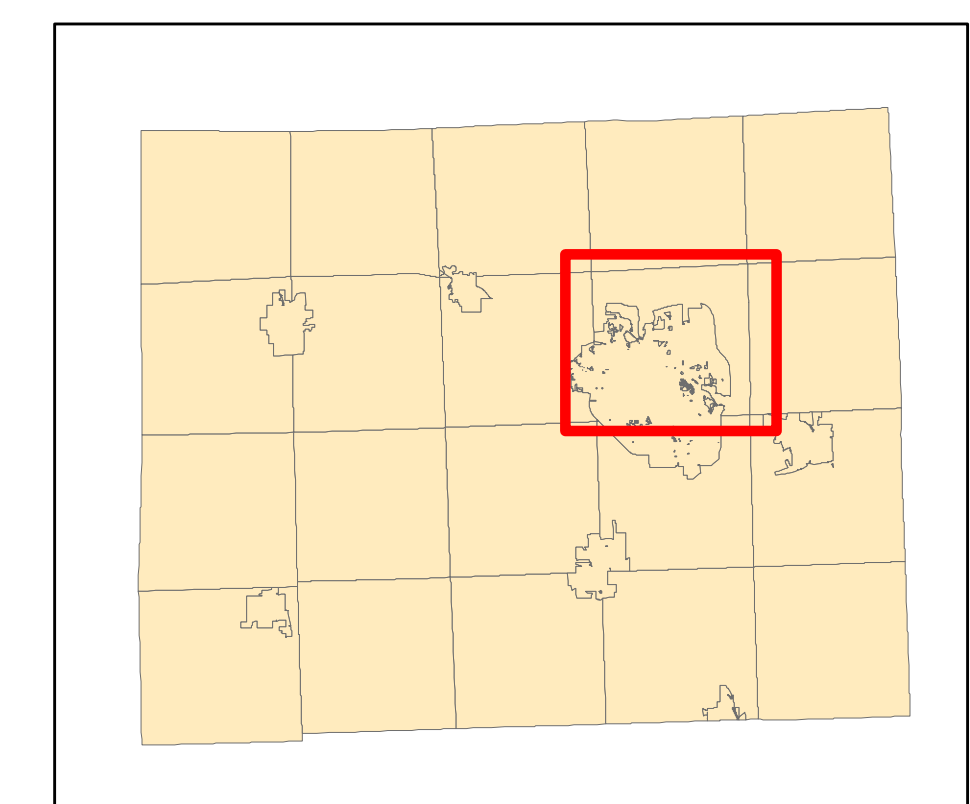


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Legend

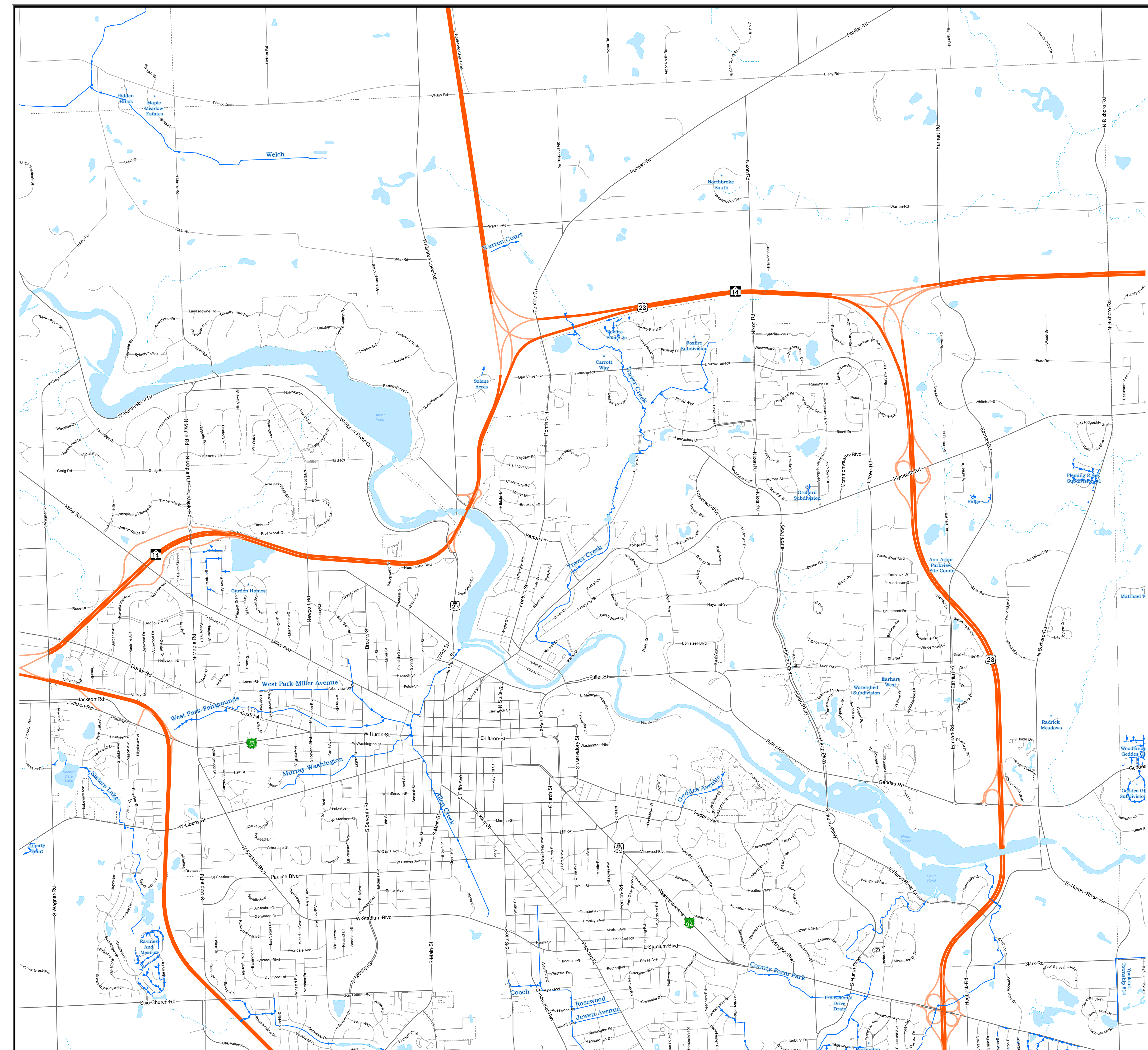
-  Lakes
-  County Drain Systems
-  Waters of the State



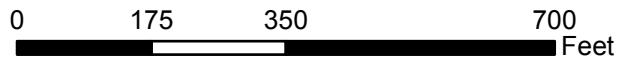
0 1,600 3,200
 Feet

1:19,200

Map Published On : Date: 1/12/2016



Maryfield Wildwood Park



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