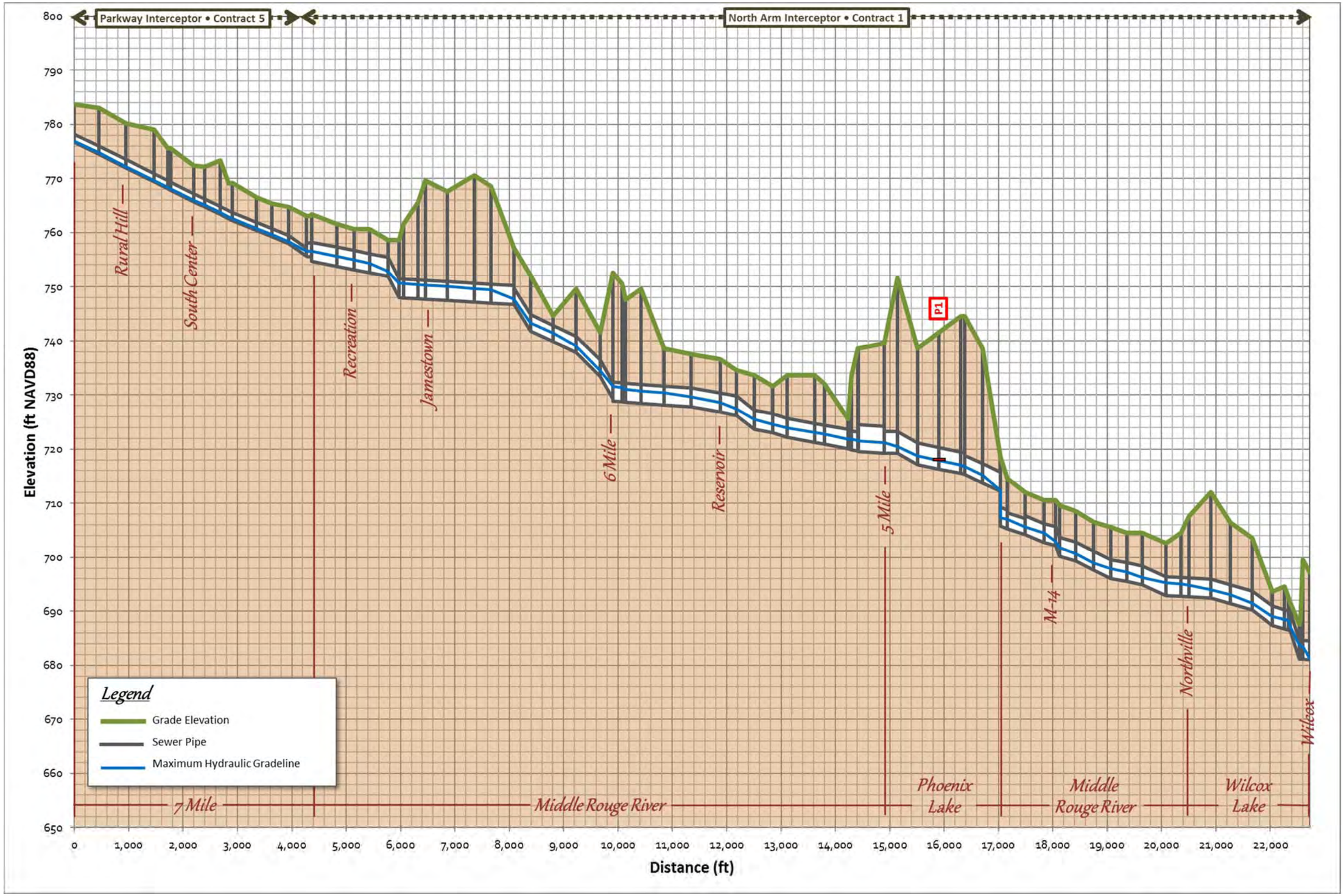
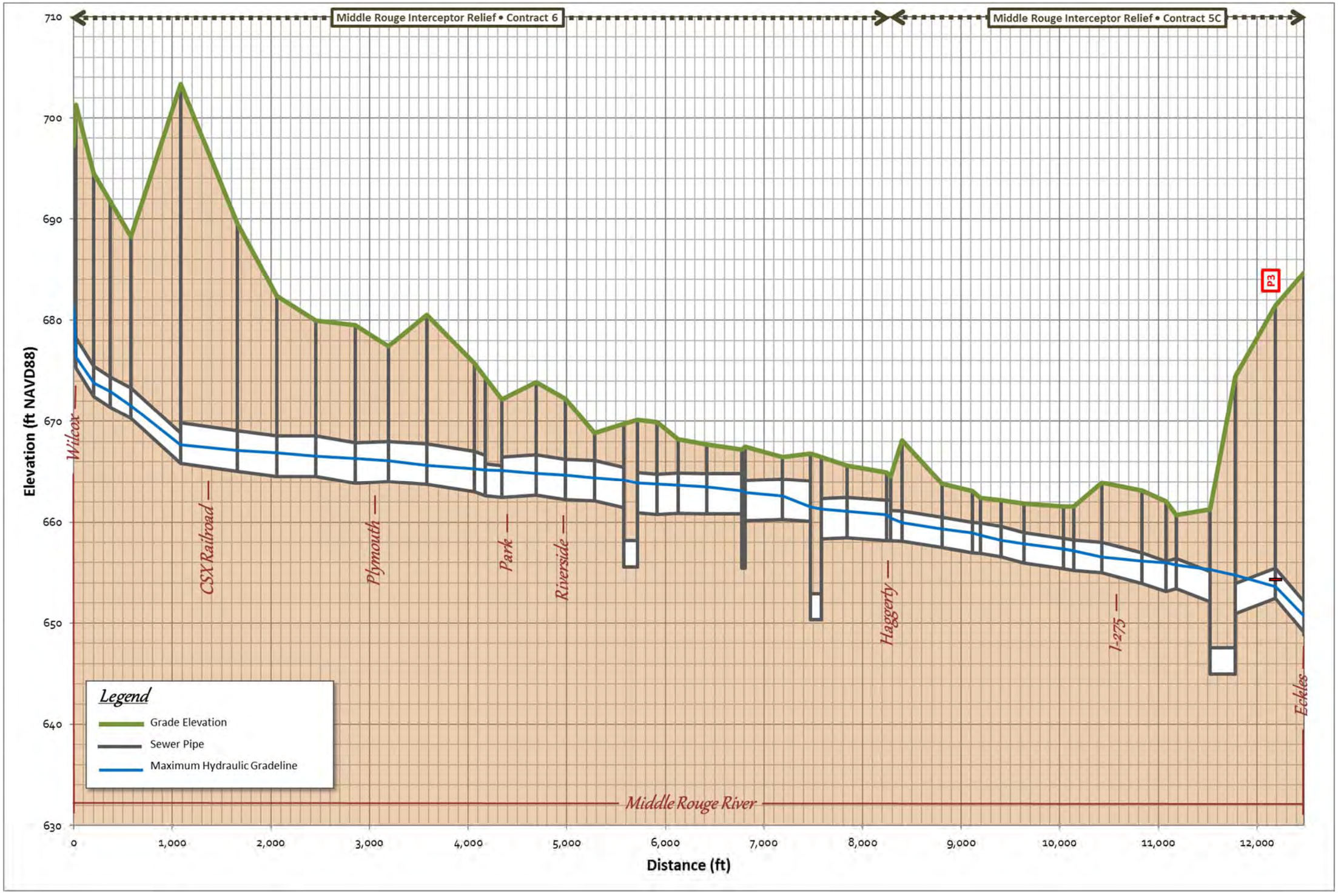
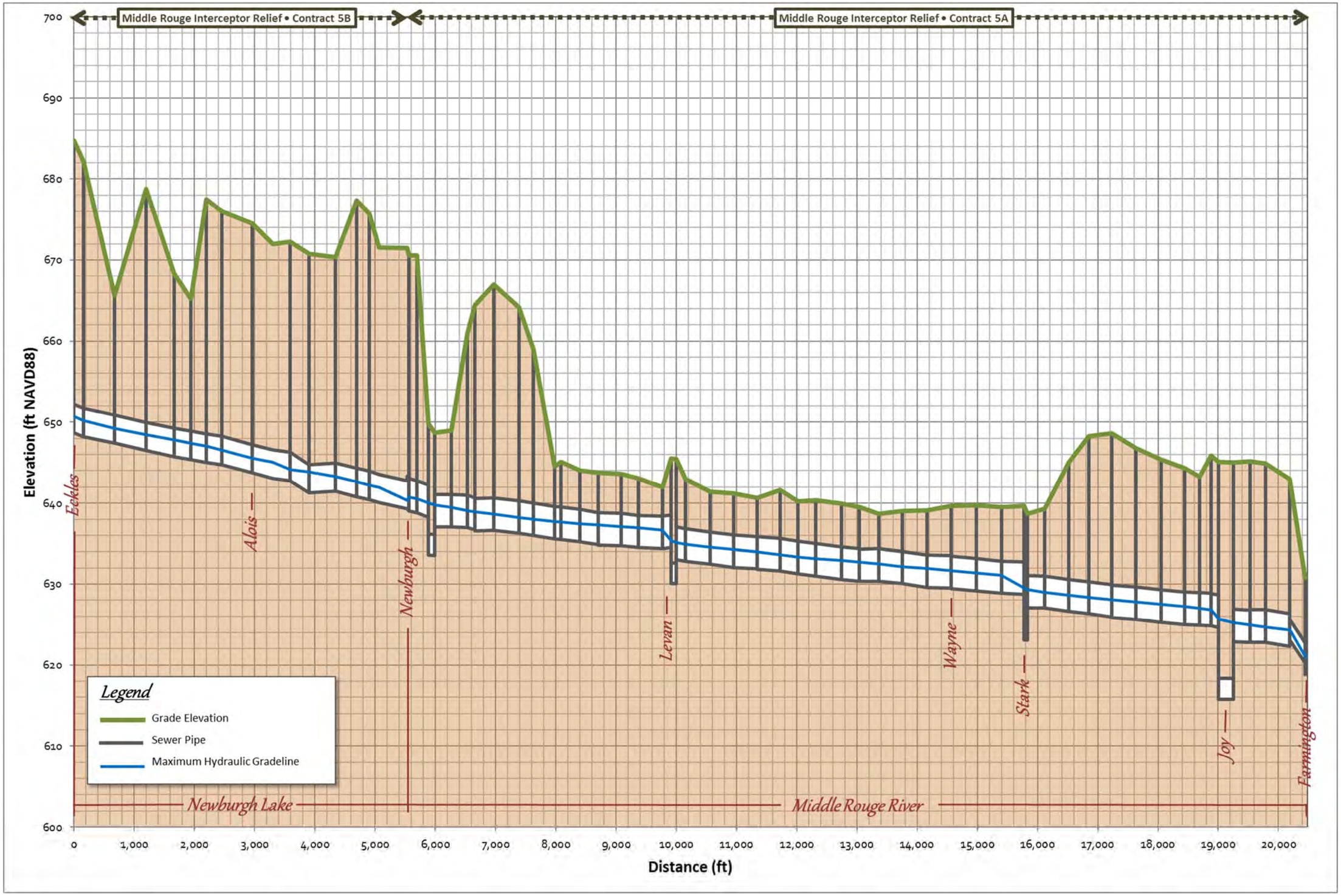
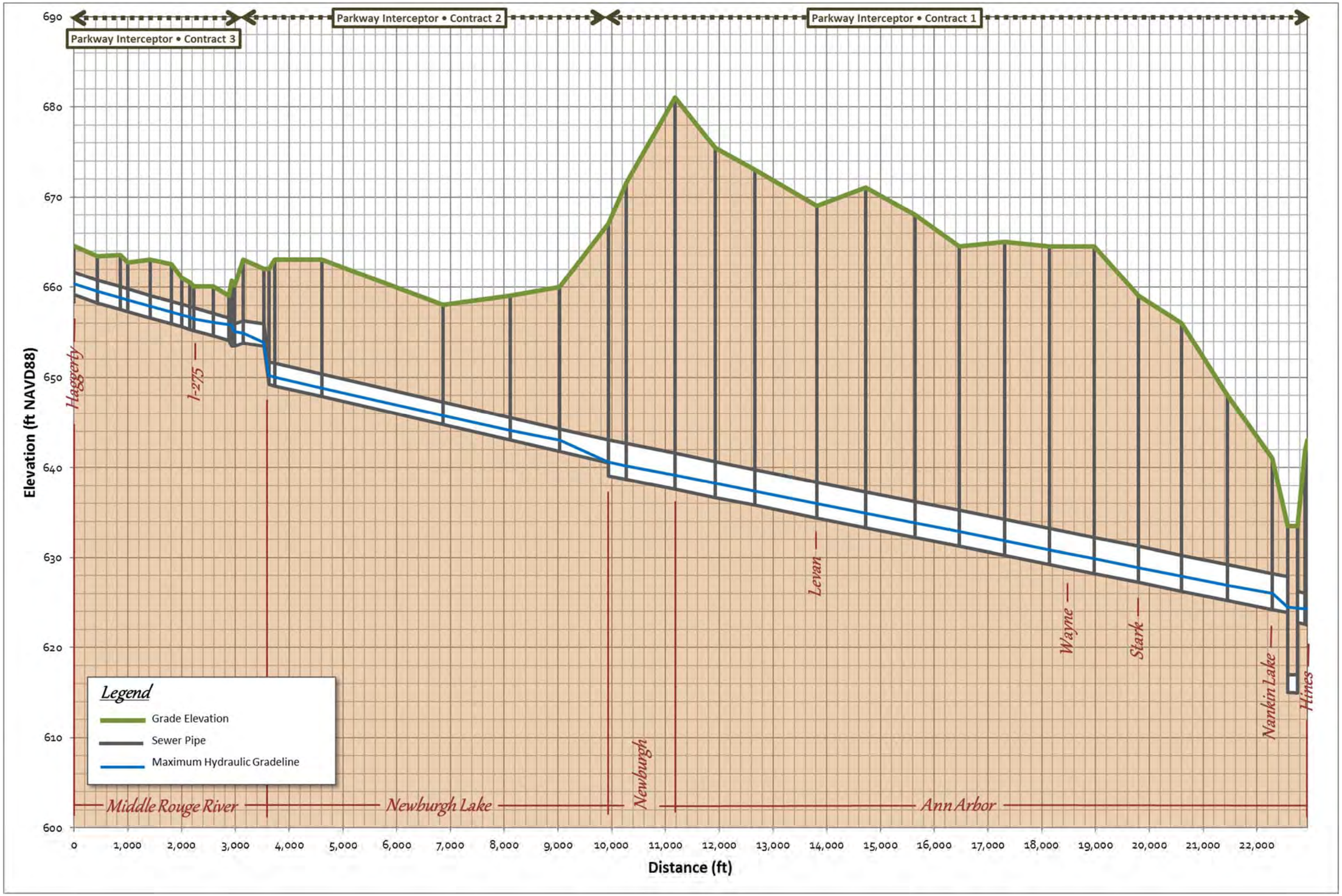
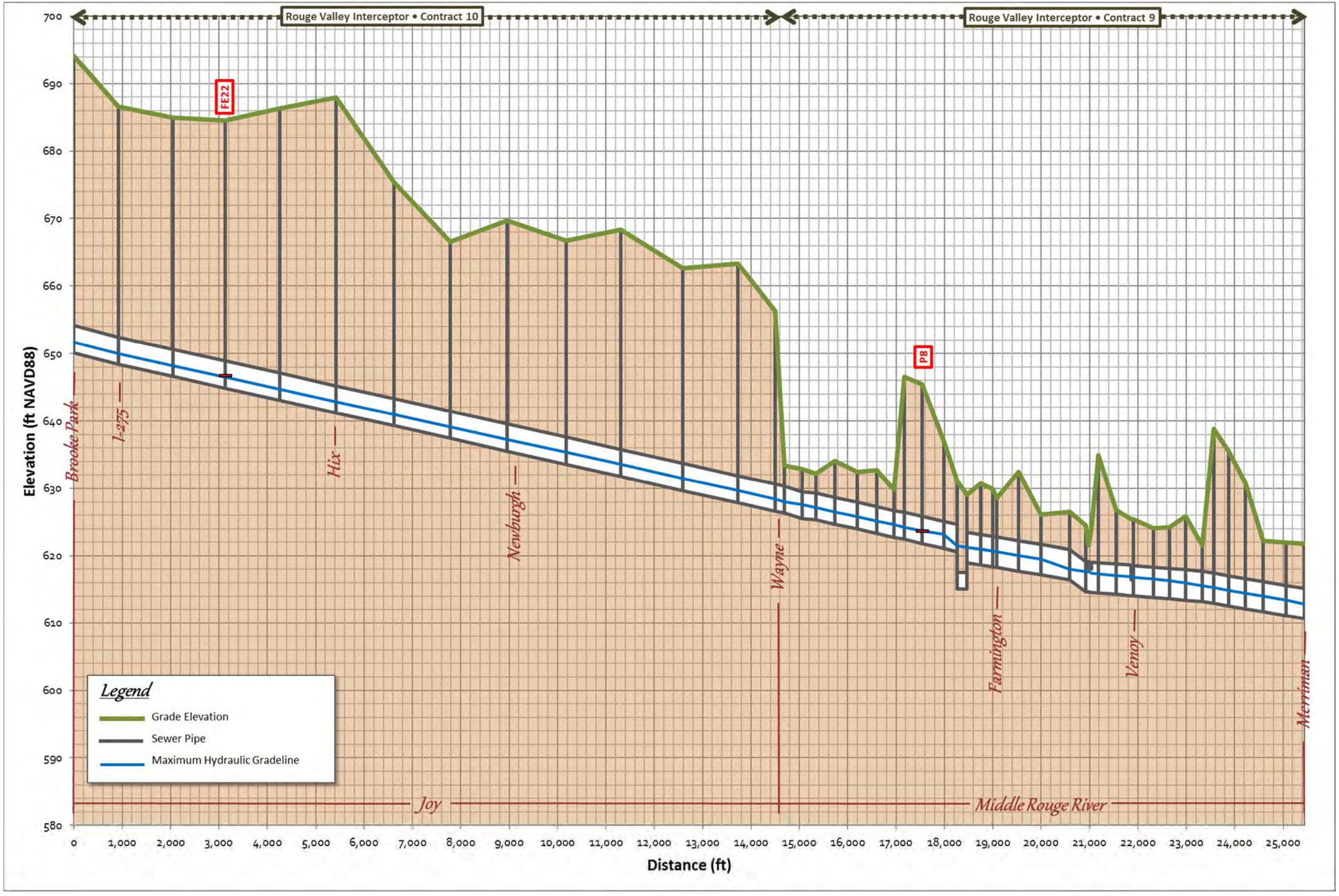
Appendix F
Maximum Hydraulic Gradeline Profiles for September 14, 2014 Calibration Event

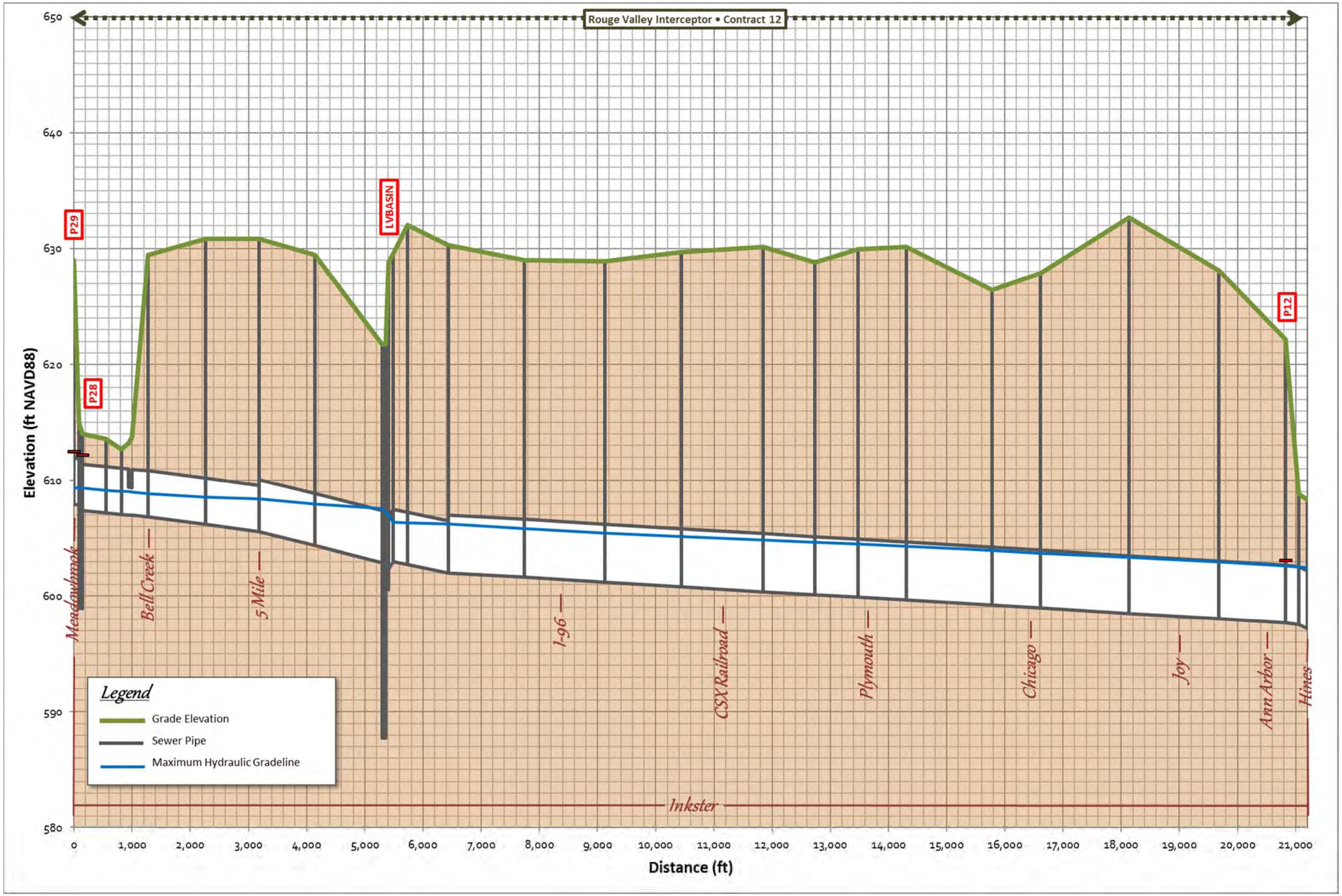

Parkway Interceptor • Contract 5
North Arm Interceptor • Contract 1
Elevation (ft NAVD88)
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
Rural Hill
South Center
Recreation
Jamestown
6 Mile
Reservoir
5 Mile
M-14
Northville
Wilcox
P1
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
7 Mile
Middle Rouge River
Phoenix Lake
Middle Rouge River
Wilcox Lake
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
21,000
22,000
Distance (ft)

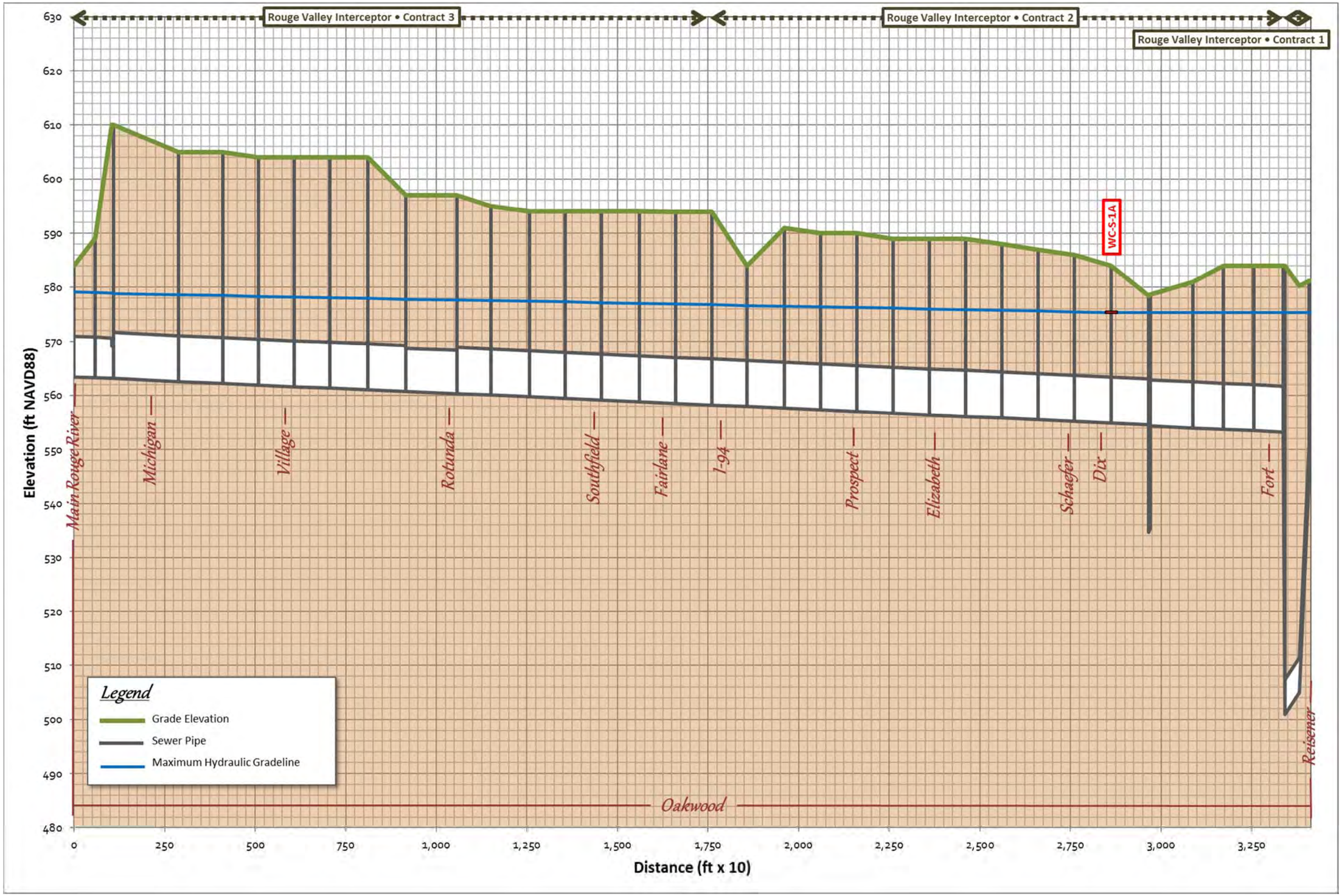

Middle Rouge Interceptor Relief • Contract 6
Middle Rouge Interceptor Relief • Contract 5C
P3
Elevation (ft NAVD88)
710
700
690
680
670
660
650
640
630
Wilcox
CSX Railroad
Plymouth
Park
Riverside
Haggerty
I-275
Eckles
Middle Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
Distance (ft)

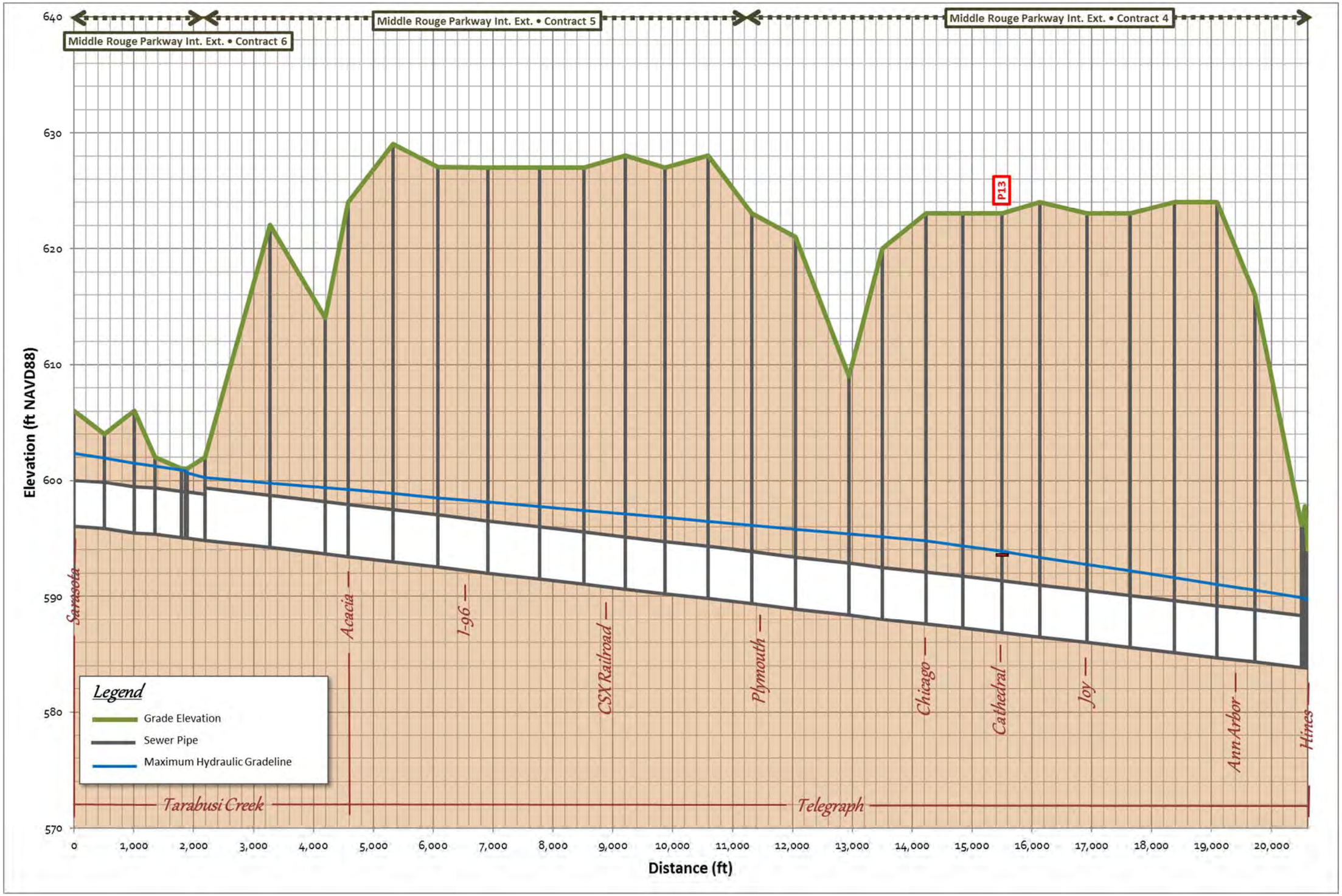

Middle Rouge Interceptor Relief • Contract 5B
Middle Rouge Interceptor Relief • Contract 5A
Elevation (ft NAVD88)
700
690
680
670
660
650
640
630
620
610
600
Eckles
Alois
Newburgh
Levan
Wayne
Stark
Joy
Farmington
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
Newburgh Lake
Middle Rouge River
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
Distance (ft)

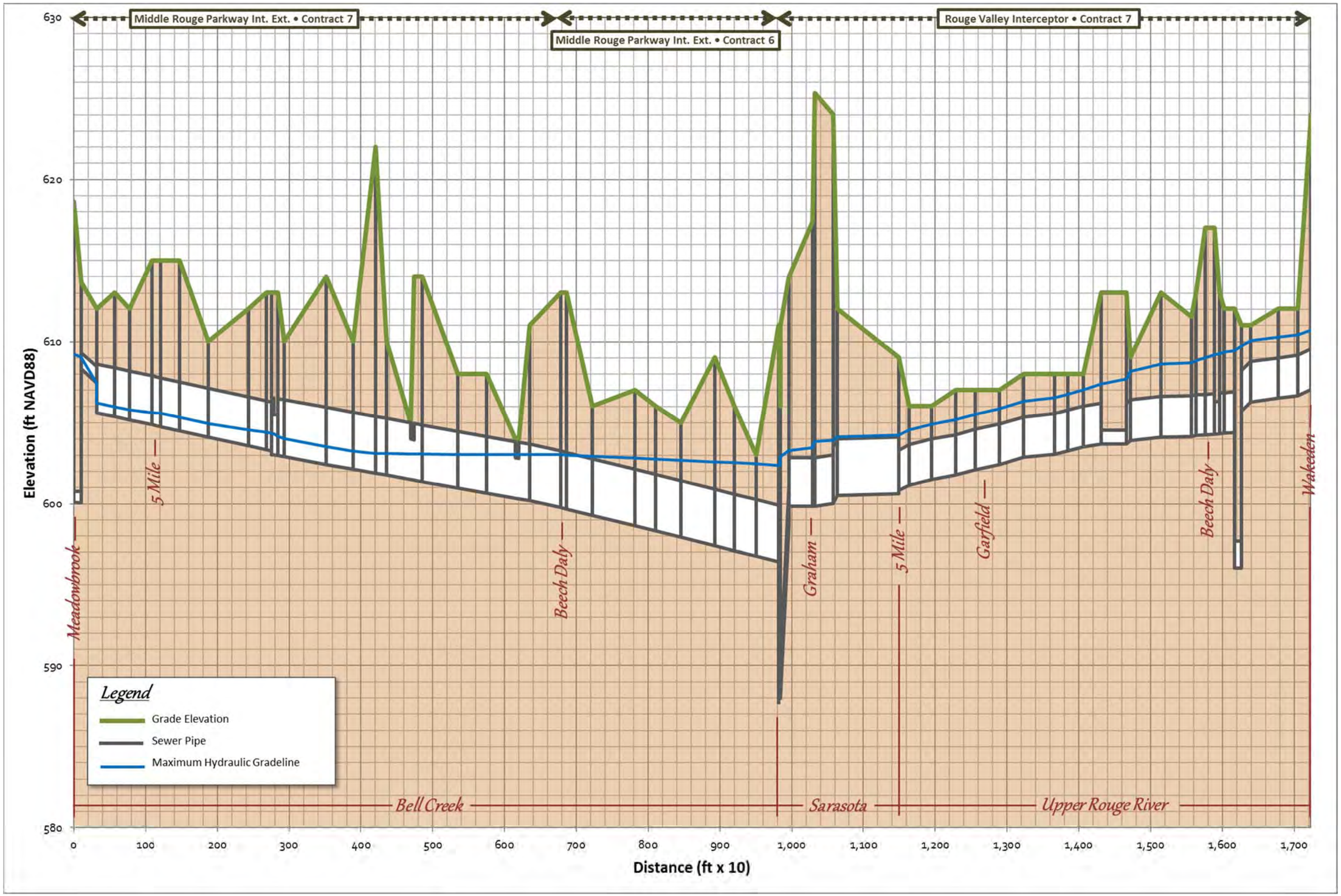

Parkway Interceptor • Contract 3
Parkway Interceptor • Contract 2
Parkway Interceptor • Contract 1
690
680
670
660
650
640
630
620
610
600
Elevation (ft NAVD88)
Haggerty
I-275
Levan
Wayne
Stark
Nankin Lake
Hines
Newburgh
Middle Rouge River
Newburgh Lake
Ann Arbor
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
21,000
22,000
Distance (ft)

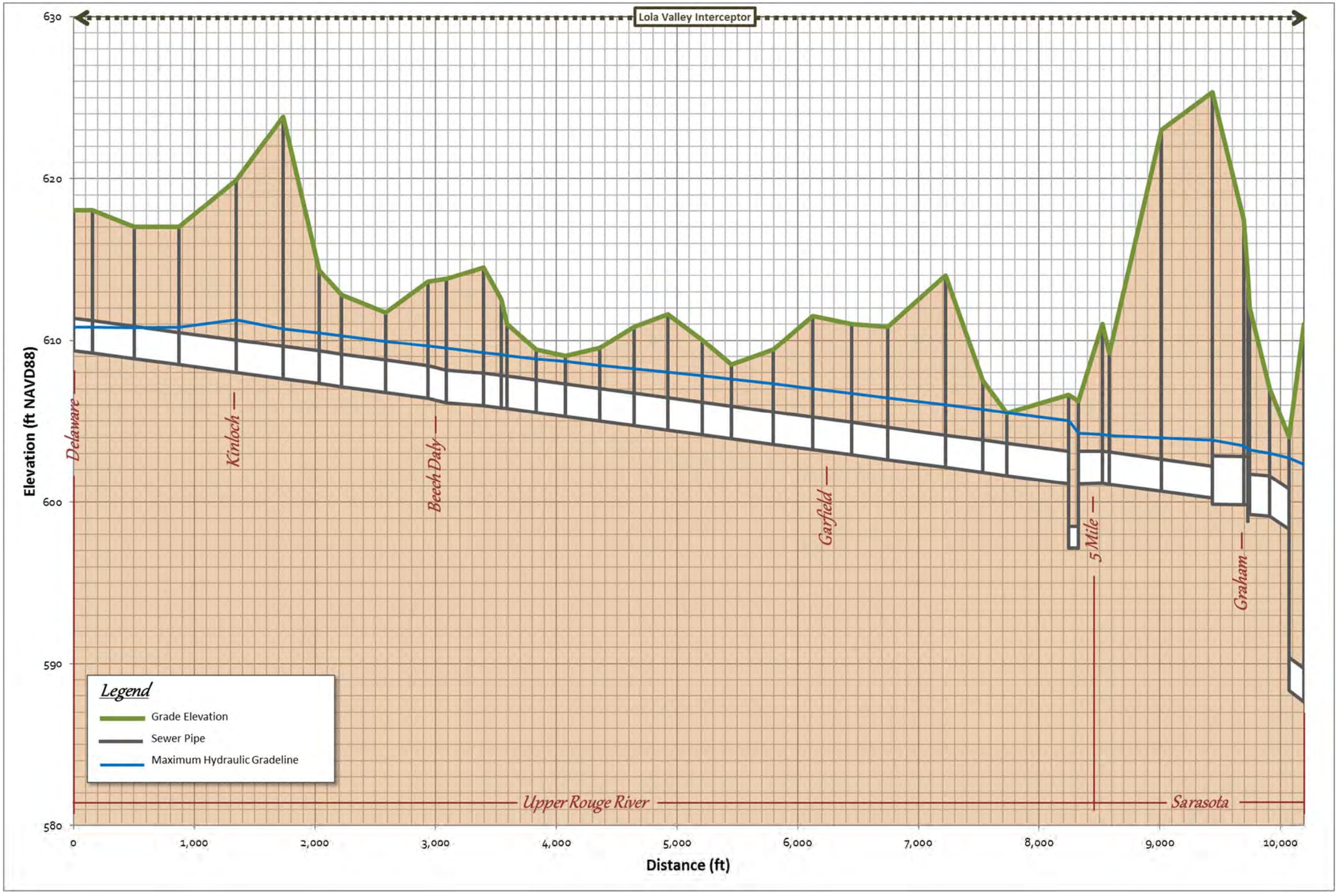

Rouge Valley Interceptor • Contract 10
Rouge Valley Interceptor • Contract 9
FE22
P8
Brooke Park
I-275
Hix
Newburgh
Wayne
Farmington
Venoy
Merriman
Joy
Middle Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
Elevation (ft NAVD88)
700
690
680
670
660
650
640
630
620
610
600
590
580
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
21,000
22,000
23,000
24,000
25,000
Distance (ft)

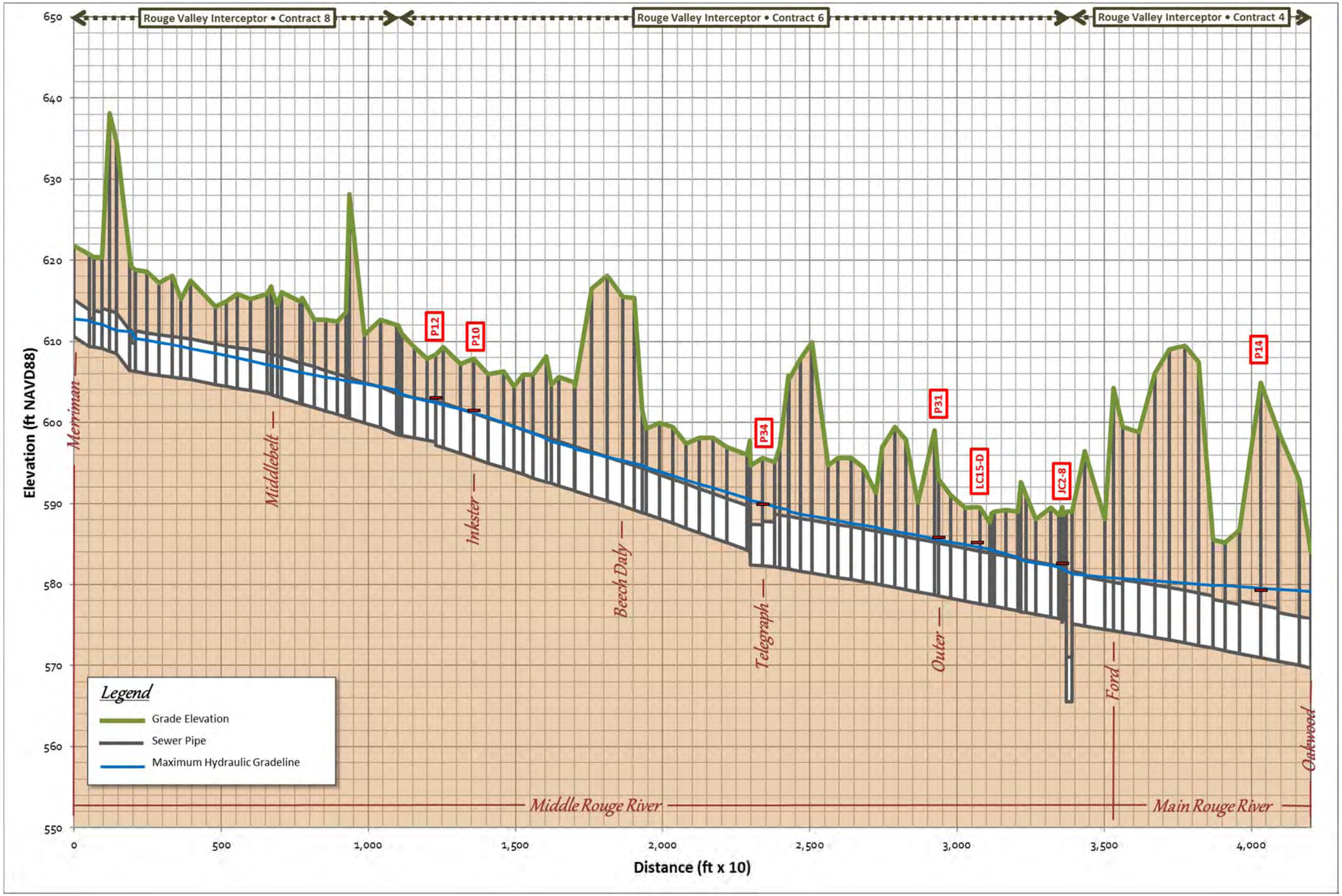

Rouge Valley Interceptor • Contract 12
P29
P28
LVBASIN
P12
Meadowbrook
Bell Creek
5 Mile
I-96
CSX Railroad
Plymouth
Chicago
Joy
Ann Arbor
Hines
Inkster
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
Elevation (ft NAVD88)
650
640
630
620
610
600
590
580
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
21,000
Distance (ft)

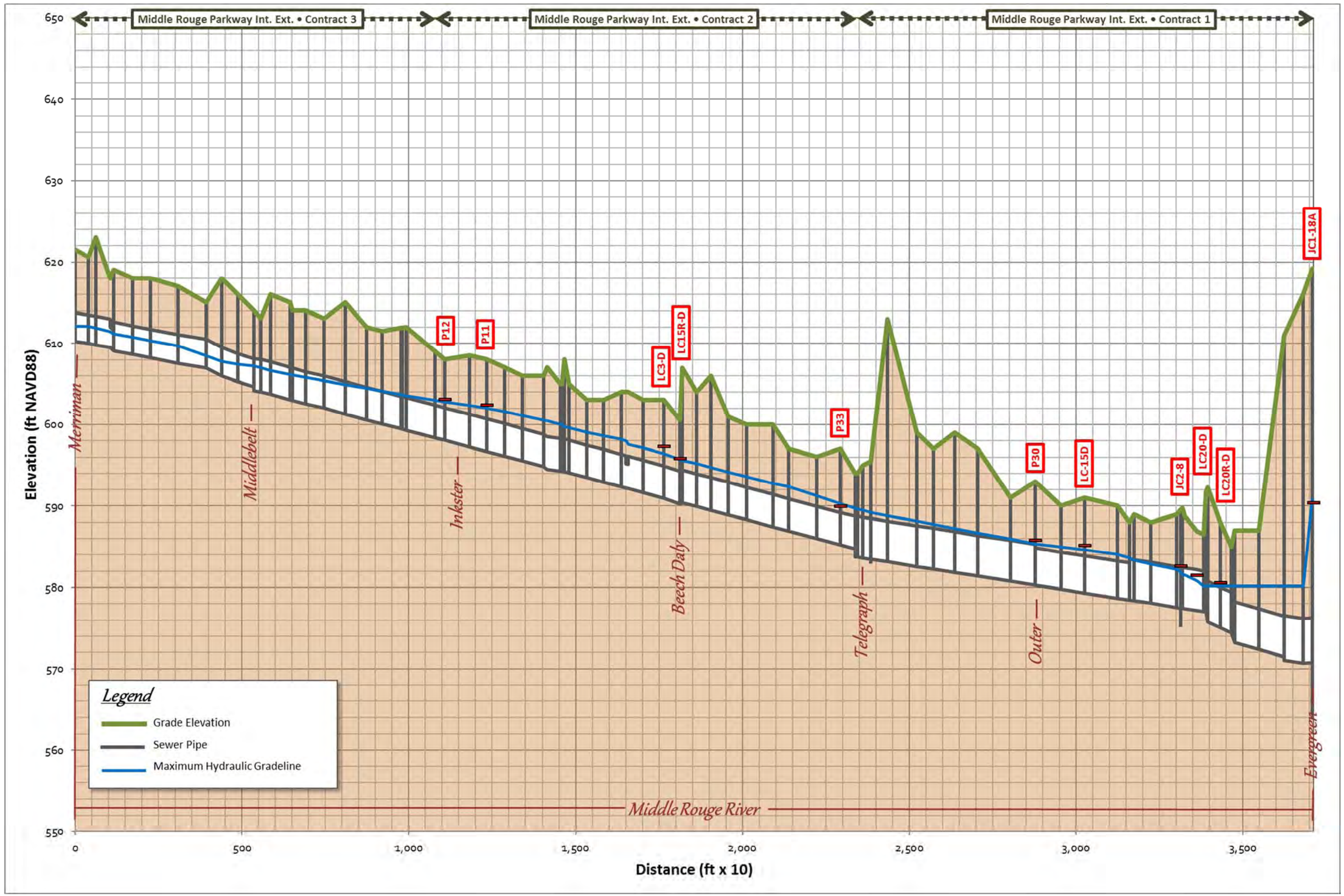

Rouge Valley Interceptor • Contract 3
Rouge Valley Interceptor • Contract 2
Rouge Valley Interceptor • Contract 1
WC-S-1A
Elevation (ft NAVD88)
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
Main Rouge River
Michigan
Village
Rotunda
Southfield
Fairlane
I-94
Prospect
Elizabeth
Schaefer
Dix
Fort
Reisener
Oakwood
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
250
500
750
1,000
1,250
1,500
1,750
2,000
2,250
2,500
2,750
3,000
3,250
Distance (ft x 10)

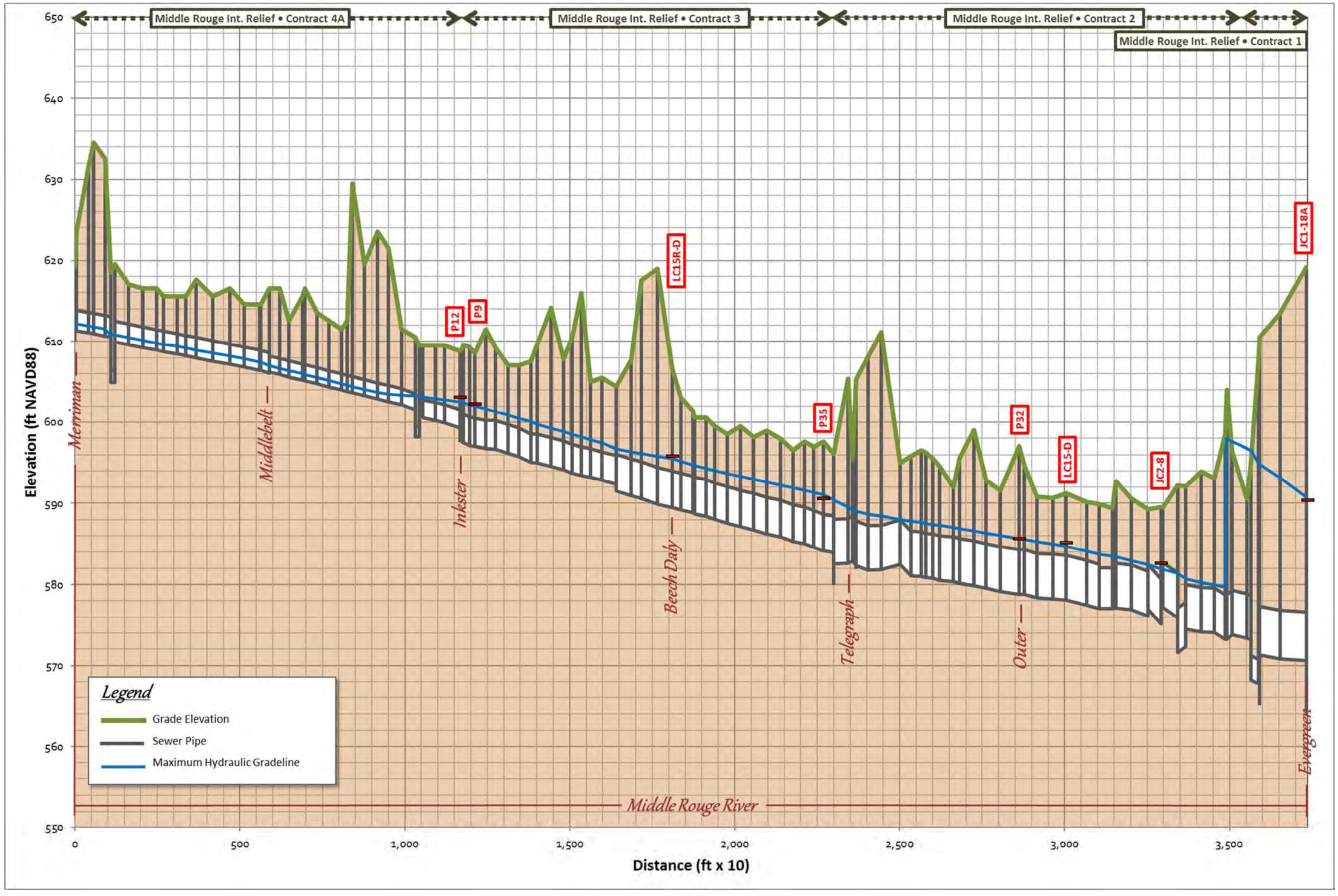

Middle Rouge Parkway Int. Ext. • Contract 6
Middle Rouge Parkway Int. Ext. • Contract 5
Middle Rouge Parkway Int. Ext. • Contract 4
P13
Elevation (ft NAVD88)
640
630
620
610
600
590
580
570
Sarasota
Acacia
I-96
CSX Railroad
Plymouth
Chicago
Cathedral
Joy
Ann Arbor
Hines
Tarabusi Creek
Telegraph
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
Distance (ft)

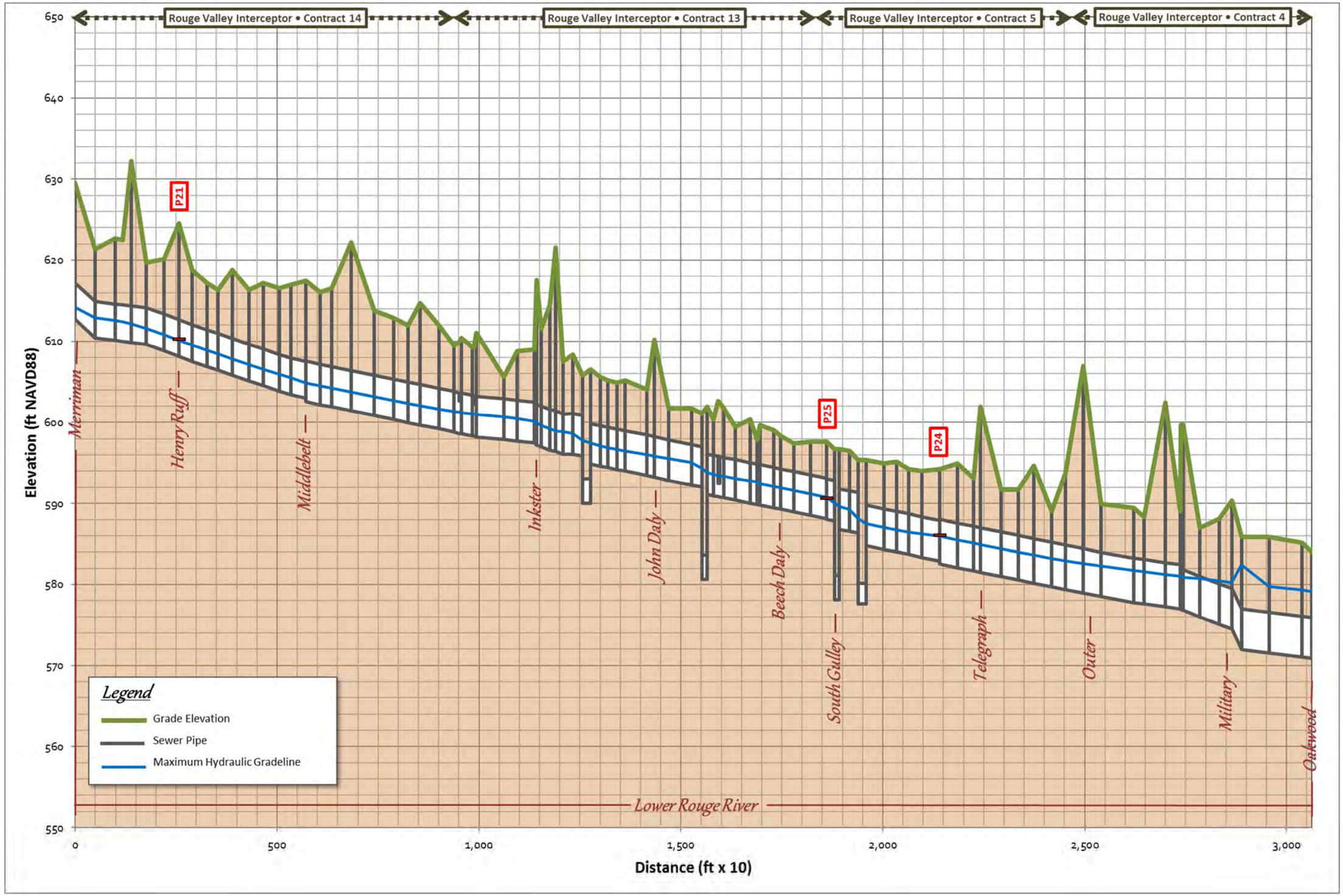

Middle Rouge Parkway Int. Ext. • Contract 7
Middle Rouge Parkway Int. Ext. • Contract 6
Rouge Valley Interceptor • Contract 7
Elevation (ft NAVD88)
630
620
610
600
590
580
Meadowbrook
5 Mile
Beech Daly
Graham
5 Mile
Garfield
Beech Daly
Wakeden
Bell Creek
Sarasota
Upper Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
Distance (ft x 10)

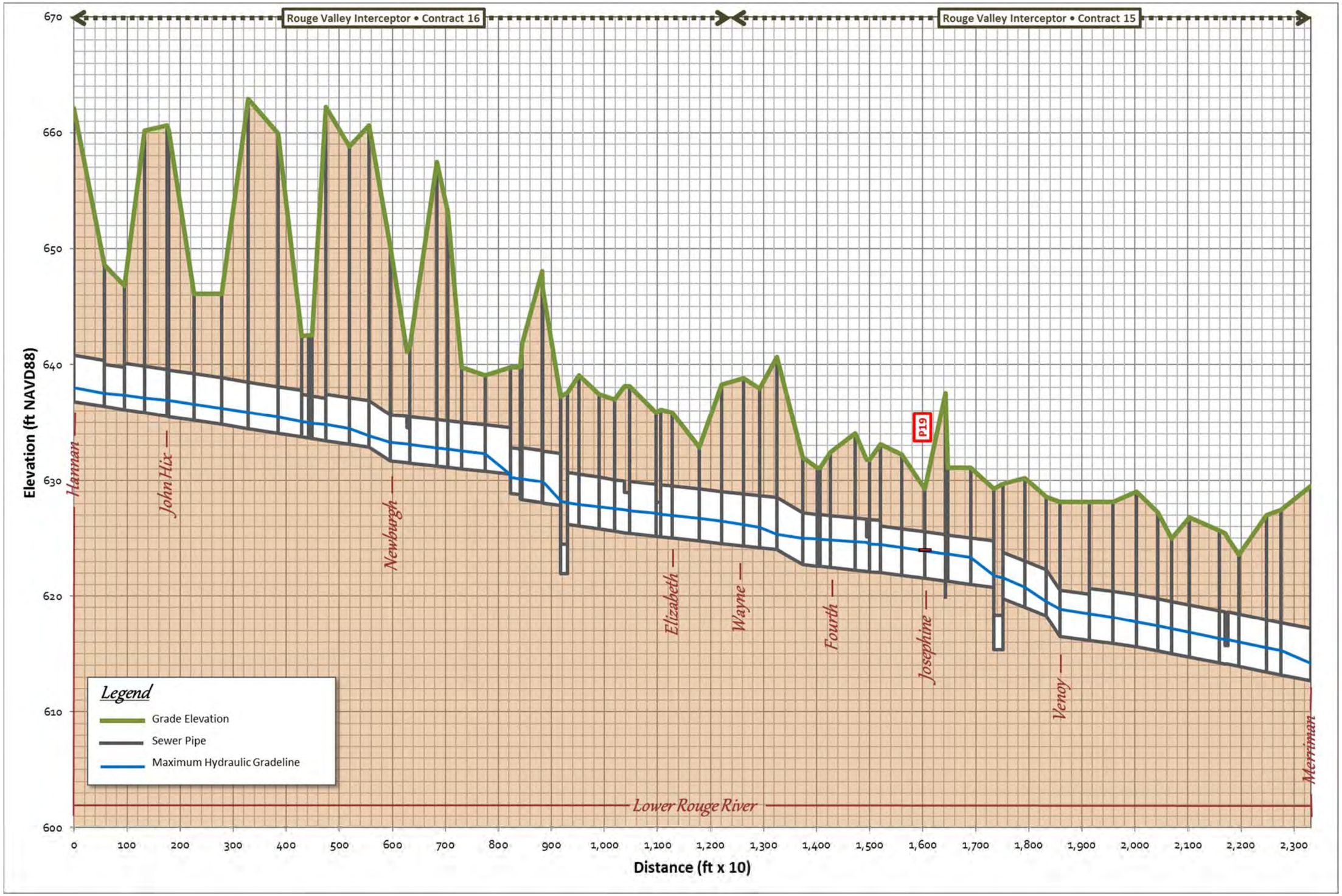

Lola Valley Interceptor
630
620
610
600
590
580
Elevation (ft NAVD88)
Delaware
Kinloch
Beech Daly
Garfield
5 Mile
Graham
Upper Rouge River
Sarasota
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Distance (ft)

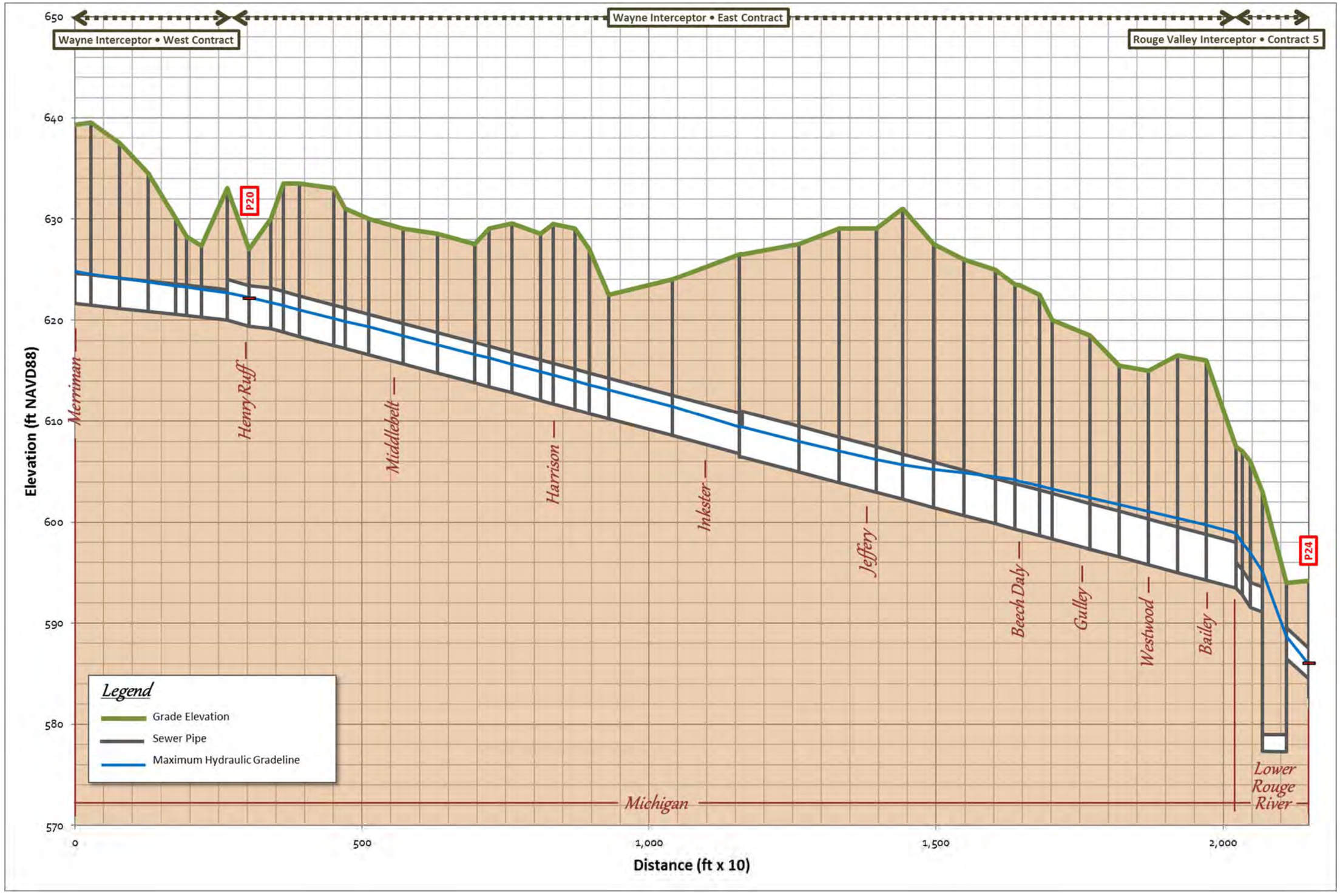

Rouge Valley Interceptor • Contract 8
Rouge Valley Interceptor • Contract 6
Rouge Valley Interceptor • Contract 4
Elevation (ft NAVD88)
650
640
630
620
610
600
590
580
570
560
550
Merriman
Middlebelt
Inkster
Beech Daly
Telegraph
Outer
Ford
Oakwood
P12
P10
P34
P31
LC15-D
JC2-8
P14
Middle Rouge River
Main Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Distance (ft x 10)

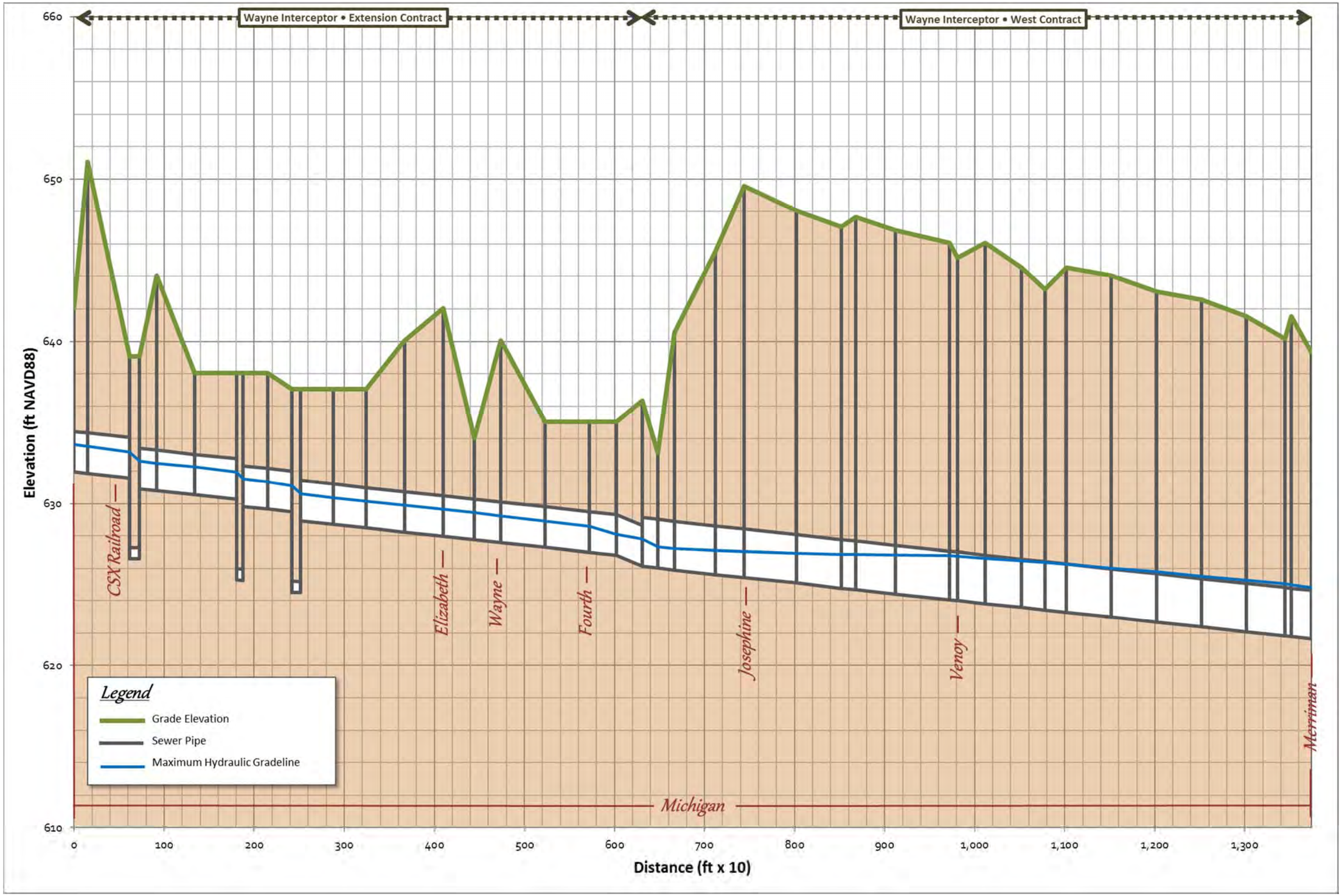

Middle Rouge Parkway Int. Ext. • Contract 3
Middle Rouge Parkway Int. Ext. • Contract 2
Middle Rouge Parkway Int. Ext. • Contract 1
Elevation (ft NAVD88)
650
640
630
620
610
600
590
580
570
560
550
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance (ft x 10)
P12
P11
LC3-D
LC15R-D
P33
P30
LC-15D
LC2-8
LC20-D
LC20R-D
JC1-18A
Merriman
Middlebelt
Inkster
Beech Daly
Telegraph
Outer
Evergreen
Middle Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline

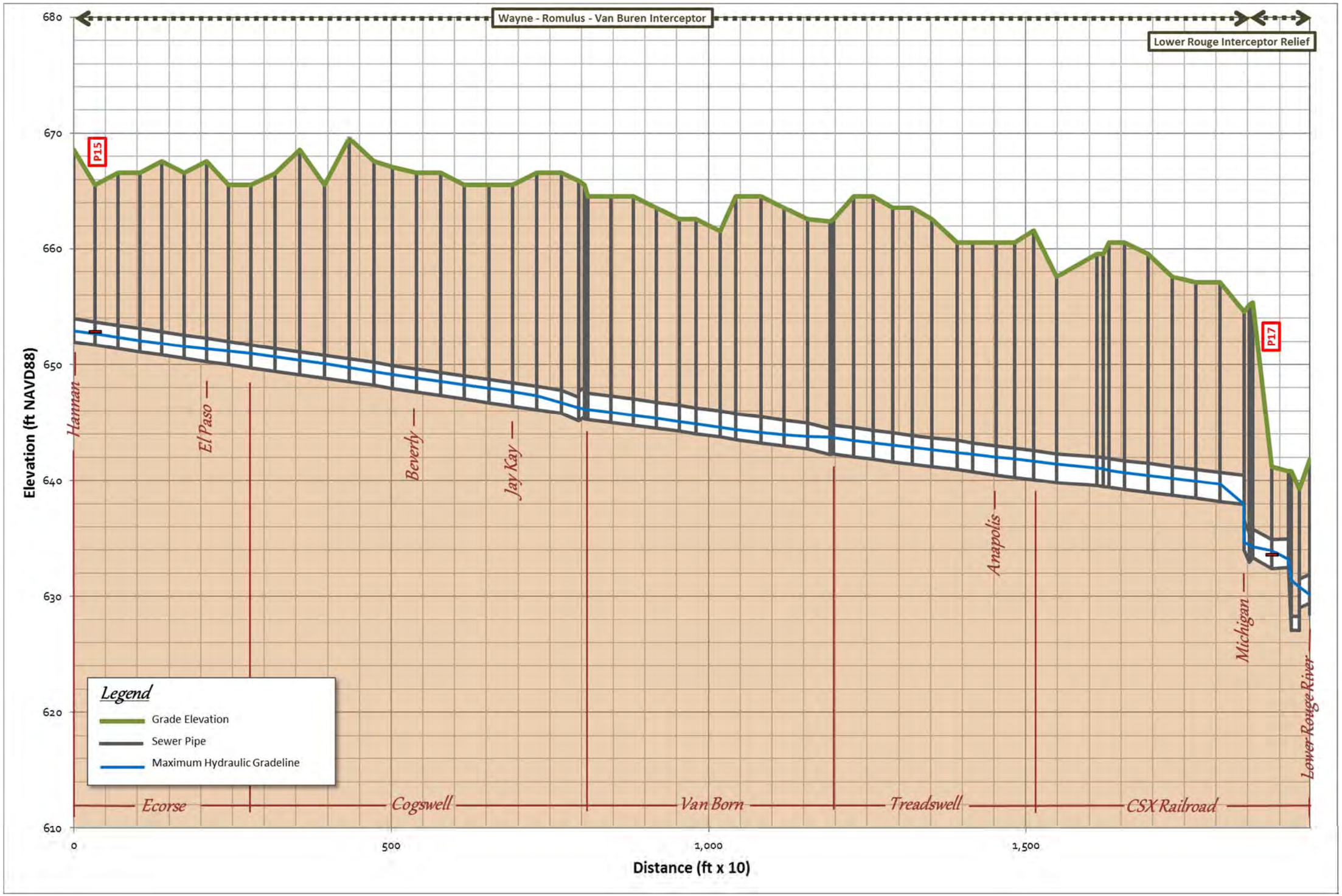

Middle Rouge Int. Relief • Contract 4A
Middle Rouge Int. Relief • Contract 3
Middle Rouge Int. Relief • Contract 2
Middle Rouge Int. Relief • Contract 1
Elevation (ft NAVD88)
650
640
630
620
610
600
590
580
570
560
550
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Distance (ft x 10)
Merriman
Middlebelt
Inkster
Beech Daly
Telegraph
Outer
Evergreen
Middle Rouge River
P12
P9
LC15R-D
P35
P32
LC15-D
JC2-8
JC1-18A
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline


Rouge Valley Interceptor • Contract 14
Rouge Valley Interceptor • Contract 13
Rouge Valley Interceptor • Contract 5
Rouge Valley Interceptor • Contract 4
Elevation (ft NAVD88)
650
640
630
620
610
600
590
580
570
560
550
P21
P25
P24
Merriman
Henry Ruff
Middlebelt
Inkster
John Daly
Beech Daly
South Gulley
Telegraph
Outer
Military
Oakwood
Lower Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
500
1,000
1,500
2,000
2,500
3,000
Distance (ft x 10)


Rouge Valley Interceptor • Contract 16
Rouge Valley Interceptor • Contract 15
Elevation (ft NAVD88)
670
660
650
640
630
620
610
600
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
Distance (ft x 10)
P19
Hamman
John Hix
Newburgh
Elizabeth
Wayne
Fourth
Josephine
Venoy
Merriman
Lower Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline


Wayne Interceptor • West Contract
Wayne Interceptor • East Contract
Rouge Valley Interceptor • Contract 5
650
640
630
620
610
600
590
580
570
Elevation (ft NAVD88)
P20
P24
Merriman
Henry Ruff
Middlebelt
Harrison
Inkster
Jeffery
Beech Daly
Gulley
Westwood
Bailey
Lower Rouge River
Michigan
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
0
500
1,000
1,500
2,000
Distance (ft x 10)


Wayne Interceptor • Extension Contract
Wayne Interceptor • West Contract
660
650
640
630
620
610
Elevation (ft NAVD88)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
Distance (ft x 10)
CSX Railroad
Elizabeth
Wayne
Fourth
Josephine
Venoy
Merriman
Michigan
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline


Wayne - Romulus - Van Buren Interceptor
Lower Rouge Interceptor Relief
P15
P17
Elevation (ft NAVD88)
680
670
660
650
640
630
620
610
Hannan
El Paso
Beverly
Jay Kay
Anapolis
Michigan
Lower Rouge River
Legend
Grade Elevation
Sewer Pipe
Maximum Hydraulic Gradeline
Ecorse
Cogswell
Van Born
Treadswell
CSX Railroad
0
500
1,000
1,500
Distance (ft x 10)

DRAFT – June 29, 2019

Appendix E: Rouge Valley Antecedent Moisture Model Report

ARCHITECTS. ENGINEERS. PLANNERS.

OHM Advancing Communities

Rouge Valley Antecedent Moisture Model Report
Wayne County
March 2015

Introduction

Wayne County is in the process of developing a Long Term Corrective Action Plan (LTCAP) to satisfy the terms of its ACO, which require the analysis and capital improvements along the RVSDS interceptor system. As part of the modeling effort, OHM Advisors is working with Applied Science, Inc. (ASI) to develop a hydrologic and hydraulic model of the RVSDS interceptor system.

As the design flow rates for the RVSDS will have a significant impact on the magnitude of capital investment, there is a need to enhance the County's confidence in the selection of design flow rates. This memorandum summarizes the results from the Antecedent Moisture Model (AMM) method to estimate peak flow rates for design events at key locations along the RVSDS interceptor.

The peak flow rates in this document can be compared to the RTK hydrologic calibration from ASI's EPA SWMM modeling effort. This comparison will help the project team determine the most appropriate flow rates to be used to the development of alternatives for the LTCAP.

The AMM model was applied at three locations (see Figure 1):

- Middle Rouge Upstream Flow Response (Meters P3 + P7+ P8)
  - This model was developed for the "drier" components of the RVSDS service area, primarily upstream of Joy Road. These areas generally have a smaller wet weather flow component than older communities further downstream.
  - Wet weather flows from WTUA (FE-22) were subtracted from this flow response in order to isolate the
- Middle Rouge Downstream (Meters P9 + P10 + P11)
  - This model was developed to measure the incremental flow between the upstream areas and the Inkster Arm.
  - The flow response in this incremental area is significantly higher than upstream areas, so the models were separated for ease of model calibration.

OHM Advisors
34000 PLYMOUTH ROAD
LIVONIA, MICHIGAN 48150
T 734.522.6711
F 734.522.6427
OHM-Advisors.com

- Lower Rouge (Meters P24 + P25)
    - This model was developed to measure the flow response from the Lower Rouge system.

For the Middle Rouge flow analysis, the calibrated models from the two analysis points were added to the WTUA wet weather flow hydrographs to calculate design-event peak flows for the interceptor immediately downstream of the Inkster Arm.

Key Findings

The 10-year recurrence interval flow rate was calculated for each of the analyzed points in the system, as this event magnitude has, in our experience, been representative of both the 10-year 1-hour (non-growing season) and 25-year 24-hour (growing season) flow responses. The 10-year peak flows, summarized below, are compared to the peak flows calculated by ASI using the RTK hydrologic model in EPA SWMM.

The peak flow rates between the AMM and the EPA SWMM hydrologic model are very similar. As such, we have increased confidence that the EPA SWMM model adequately represents the wet weather flow response within the RVSDS.

Location	**AMM 10-year peak flow (cfs)**	**EPA SWMM 10-yr/1-hr flow (cfs)**	**EPA SWMM 25-yr / 24-hr flow (cfs)**
Middle Rouge, Downstream of the Inkster Arm (P9 + P10 + P11)	210	216	210
Lower Rouge (P24 + P25)	111	101	96

The pre- vs. post-STCAP AMM analysis for the Middle Rouge system revealed a slight reduction in wet weather flow response for rainfall events of average magnitude (approximately 3%-4% peak flow reduction) in the post-STCAP regime. For the design event (i.e. 10-year recurrence interval), the AMM predicts a larger flow reduction of about 12%-13%. These findings suggest that the STCAP projects have had a positive impact on the RVSDS through a reduction in overall wet weather response.

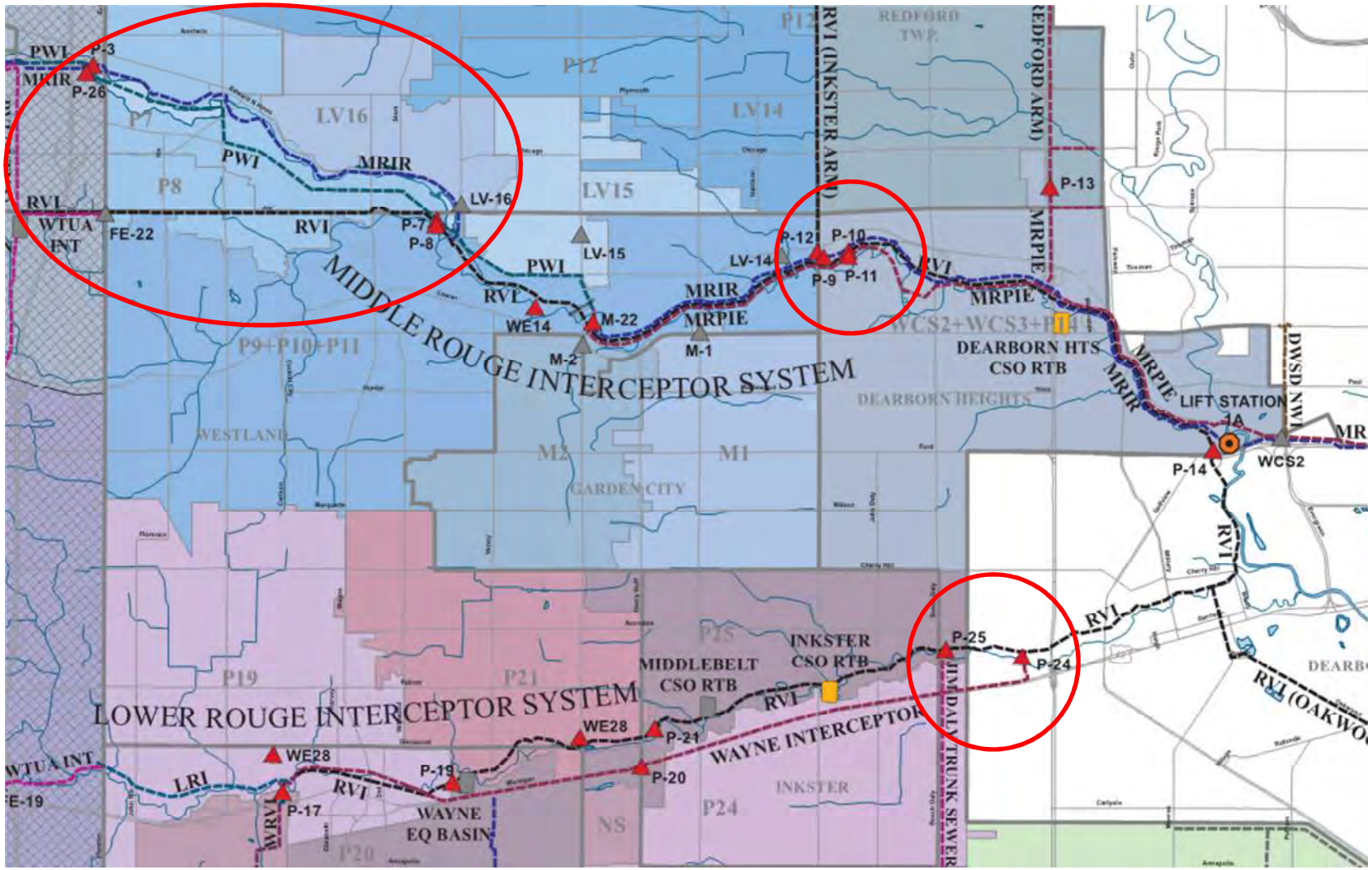


Figure 1 – Locations of AMM Flow Rate Estimates

Background

Purpose and Scope

1. *Collect background data and data processing*-The purpose of this task was to gather available rain and flow meter data at various locations in the Middle and Lower Rouge Interceptors in order to develop the Antecedent Moisture Model (AMM). Once the data were gathered, meter math was conducted for each model to obtain incremental flows.
2. *Antecedent Moisture Modeling*-The purpose of using the AMM was to create a continuous hydrologic model that predicts the effects of a wet weather response. The model is calibrated and validated to optimize the accuracy of fit of the predicted model to the observed conditions.
3. *Frequency Analyses*-The purpose of the frequency analyses was to identify the flow rates for a 10-year and 25-year recurrence interval for each model using 50 years of rain and air temperature data from the Detroit City Airport.

Antecedent Moisture Model

This study utilizes the AMM, which is a continuous hydrologic model that can accurately account for antecedent moisture and its effect on sanitary sewer wet weather response over continually varying climate conditions. Antecedent moisture is a term that describes the relative wetness or dryness of a sewershed. The AMM takes into consideration the ground's moisture and more accurately predicts the sewershed response over an extended period of time using rainfall and air temperature data.

Hydrology

Development of Antecedent Moisture Models for the RVSDS

A system schematic was developed to simplify the system and provide a visual explanation of the AMM hydrologic models that were developed. These schematics, originally developed as part of the 2006 study on the same system, are illustrated in Figures 2 and 3. AMMs were developed for the Middle and Lower Rouge Valley Interceptor System. Two models were created for the Middle Rouge to look at the branch incrementally. The third model was created for the entire Lower Rouge Interceptor. The areas for the model were chosen primarily based upon available metering data, but community boundaries and previous work were also taken into account.

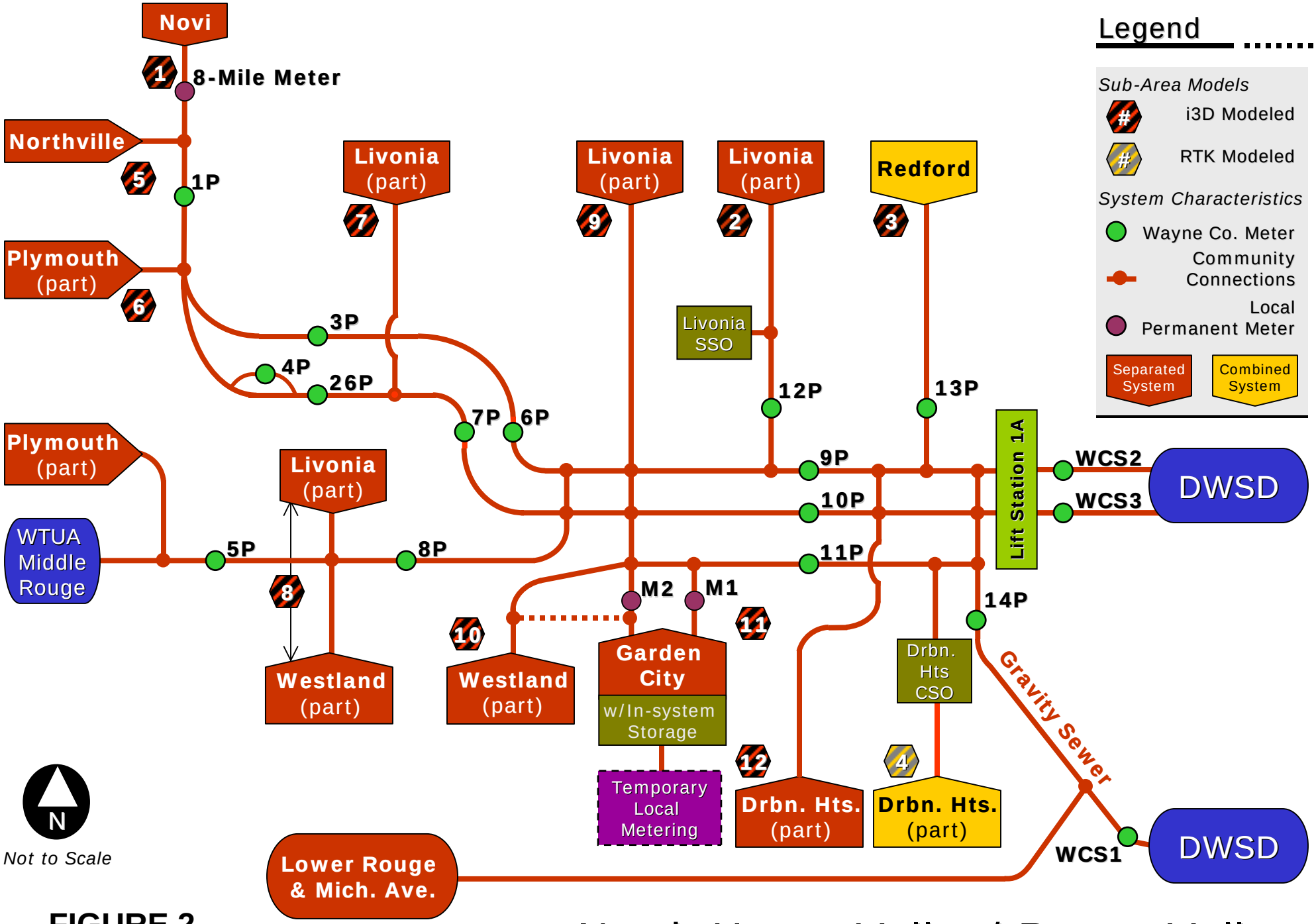


FIGURE 2

North Huron Valley/ Rouge Valley System Schematic

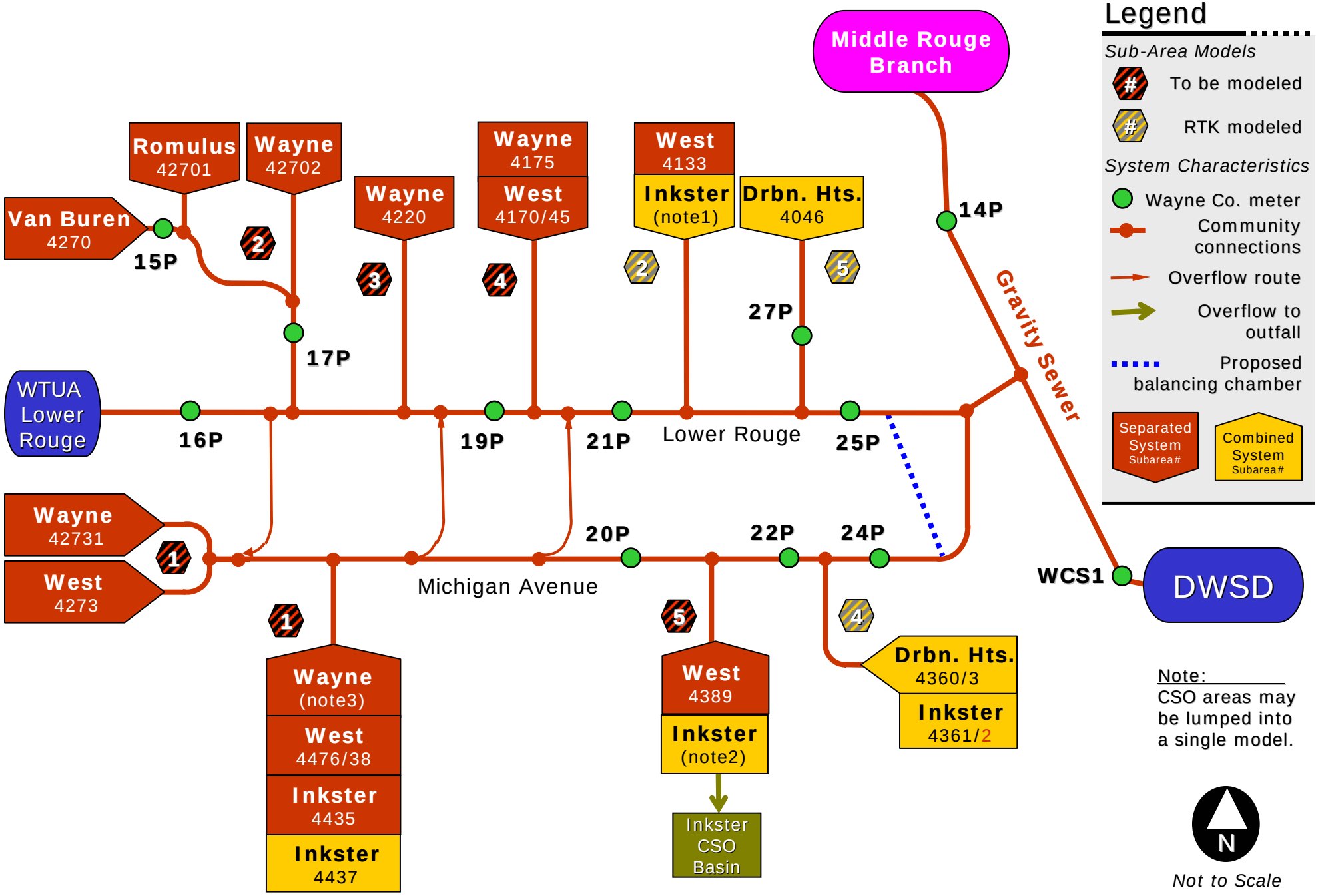


FIGURE 3

Lower Rouge and Michigan Avenue System Schematic

Once the meter and rain data were formatted and filtered, meter math was conducted for each model in order to combine flows from separate meters.

Model A (Dry) consisted of the upper Middle Rouge branch minus WTUA's flow meter (FE-22). Meter P3 was used as a substitute for Meter P6, as Meter P6 has not been active in the post-STCAP period. Meter P3 is the best substitute, as it is approximately equivalent to the flow that would have been measured at Meter P6. FE-22 data were subtracted so as to build a model specific to P3+P7+P8 (WTUA flows will be added back in when determining the downstream design-event flow rates).

Model B (Wet) is an incremental model of the Middle Rouge which focuses on flow contributions primarily downstream of Joy Road (i.e. Livonia, Westland, and Garden City). The upstream flow was subtracted (P3 + P7 + P8 – FE-22) from the downstream meters (P9 + P10 + P11) to create the incremental model. Since the wet weather flow responses downstream of Joy Road are typically considerably higher than those upstream of Joy Road, separate models were developed to reflect each area.

Model C (Lower Rouge), adds the two most downstream meters of the Lower Rouge Interceptor (P24 + P25). Table 1 provides the meter math used to develop each model.

Table 1 Summary of Meter Math

Location	Meter Math
Model A (Dry) – Middle Rouge	P3+P7+P8-FE-22
Model B (Wet) – Middle Rouge	P9+P10+P11-(P3+P7+P8)
Model C - Lower Rouge	P24+P25

The rain data for each model was provided by ASI. Table 2 lists the rain gauges used for the calibration of each model as well as the long term rainfall used for the frequency analysis. Temperature data from the Detroit City Airport (1949-2014) was used for the long-term AMM used for the flow frequency analysis.

Table 2 Summary of Rain Gauge Locations

Location	Rain Gauge for Calibration	Rain Gauge for Long Term Model
Model A	R11	Detroit City Airport (1949-2012)
Model B	R12	
Model C	R27	

Calibration and Validation

Three years (2012, 2013, and 2014) of meter data were used to build and calibrate the AMM. Only the data beyond June 2012 (post-STCAP) was used to calibrate the AMM. To calibrate the models, the diurnal flow pattern was filtered out and specific storms were defined. The daily diurnal flow pattern was filtered so that the resulting observed flow signal only contained inflow and infiltration (I/I). The storms that were chosen were based on ASI's analysis of the spatial variances of storms within Wayne County from 2012 to 2014. These storms each have a minimum of 0.5 inches of total rainfall and generally consist of uniform rainfall distribution. The storm events used in this analysis are listed in Table 3.

Table 3 Summary of Design Storms from ASI

ASI Storm Events
8/6/2012-8/11/2012
4/10/2013-4/12/2013
4/17/2013-4/19/2013
5/27/2013-5/29/2013
6/12/2013-6/13/2012
10/30/2013-11/1/2013
8/11/2014-8/13/2014*
9/10/14-9/11/2014

** The 8/11/14 storm event was not used for AMM model calibration, due to the presence of known SSOs and the higher variability of rainfall depths.*

These storm events (Table 3) created a starting block for defining design storms for each model. For each model, the selected storm events varied slightly because of the rain gauges used for the calibration. A storm cannot be defined in the AMM if there is no rainfall or if the storm did not provide a good flow response for modeling purposes. A non-ideal flow response could be the result of an SSO during an event, which resulted in the removal of the 8/11/2014 storm from two of the three AMM calibrations. The storms used for AMM calibration are listed in Table 4.

Table 4 Calibrated Storms for Each Model

Model A (Dry)	Total Rainfall	Model B (Wet)	Total Rainfall	Model C (Lower Rouge)	Total Rainfall
8/09/2012	1.43	8/14/2012	0.46	8/09/2012	1.11
4/17/2013	1.68	4/17/2013	1.69	4/17/2013	2.19
6/12/2013	1.3	09/20/2013	0.58	10/05/2013	0.78
10/30/2013	1.51	09/10/2014	1.63	9/10/2014	1.7
08/11/2014	3.09				

Calibration adjustments were made based on the model flow fitting the observed meter flow data as accurately as possible. Once each model was calibrated, the AMM was then validated using storm events excluded from the calibration. Validation tests the model performance for events not included in the calibration. The validation storms are listed in Table 5.

Table 5. Validation Design Storms for Each Model

Dry Design Storm	Total Rainfall	Wet Design Storm	Total Rainfall	Lower Rouge Design Storm	Total Rainfall
4/10/2013	2.2	4/11/2013	1.45	4/11/2013	1.96
5/27/2013	0.82	5/27/2013	1.12	5/27/2013	0.9
09/20/2013	2.02	10/30/2013	2.01	10/30/2013	1.95
09/10/2014	1.36				

Results

Accuracy of Fit

To quantify the percent error of peak flows and volumes for each design storm, accuracy of fit plots were created. These plots are illustrated in Appendix A. For each storm, the total errors for peak flow and volume were calculated as well as the net error of each. Storm events were not included in the analysis when observed data was flawed due to meter malfunction or an SSO. Net error is the average of all the errors and allows positive and negative values. Total error is the average of the absolute value of the errors. The goal of this study was to reach a net error close to 0 percent and a total error less than 20 percent. The summary of the calculated net and total errors is listed in Table 6. Negative values indicate that the AMM under-predicts and positive values indicate that the AMM over-predicts the observed flows.

Table 6 Summary of Net and Total Error for Each AM Model

	Net Peak Error	Total Peak Error	Net Volume Error	Total Volume Error
Model A (Dry)	0.68%	12.77%	-1.29%	10.71%
Model B (Wet)	-1.47%	8.51%	-0.55%	12.49%
Model C (Lower Rouge)	1.28%	7.20%	-1.93%	9.23%

The errors listed in Table 6 reveal that the model was successfully calibrated. The total errors indicate that the AMM predicted peak flows and peak volumes to within 10% of observed values. Net errors indicate that the AMM was not biased towards over- or under-prediction of flows or volumes.

Frequency Analyses

Frequency Analyses were performed for each model to determine the expected 10- and 25-year frequency peak flows. The expected peak flows are listed in Table 7 for each model. The Log Pearson Type III probability was used to describe the peak flow data. The parameters of the function are the mean, variance, and skewness of the data. The plots also include the 95% confidence interval and are illustrated in Appendix B.

Table 7 Summary of Peak Flows

Model	10-year (cfs)	25-year (cfs)
Model A (Dry)	28.3	32.2
Model B (Wet)	158.5	187.6
Model C (Lower Rouge)	**111.2**	**130.3**
Middle Rouge (downstream of Inkster Arm)	**Model A + Model B + WTUA = 28.3 + 158.5 + 23.2 = 210 cfs**	**Model A + Model B + WTUA = 32.2 + 187.6 + 23.2 = 243 cfs**

Pre vs Post-STCAP

One desired outcome of using the AMM analysis was to observe if the RVSDS has a different flow response after rehabilitation on the interceptor as a result of the STCAP project. Two model comparisons were conducted to review the potential differences in wet weather response.

In 2005, an AMM Study was conducted for the Rouge Valley Interceptor Systems. Similar frequency analyses were conducted; however, the models that were created were cumulative, not incremental. To analyze the impacts of the STCAP rehab (all of which occurred after 2005), Model A, Model B and the total WTUA design flow need to be added together to compare the Middle Rouge Interceptor 10-year peak flows between 2005 and 2014. Based on the draft report from Stantec, the design event peak flow from WTUA to the RVSDS will be 23.2 cfs (15 MGD). Table 8 summarizes the total 10-year peak flow for the Middle Rouge (immediately downstream of the Inkster Arm) for both the 2005 and 2014 AMM Studies. The frequency plots from the 2005 AMM Study are located in Appendix C.

Table 8 Comparison of 2005 and 2014 AM Model (10-year recurrence interval peak flows)

	2014 AMM Study		2005 AMM Study
3+7+8-WTUA	28.31 cfs	9+10+11	247 cfs
9+10+11-(3+7+8)	158.46 cfs		
WTUA (design flow)	23.2 cfs		
Total Middle Rouge	210 cfs	Total Middle Rouge	247 cfs

Comparing the 10-year peak flow of the 2005 AMM to the 2014 AMM suggests that the peak flow response is marginally lower (12%-13%) in the post-STCAP scenario. This statement applies only to the Middle Rouge interceptor, as the Lower Rouge interceptor (P24 + P25) did not have a stated design flow rate from the 2005 AMM Study (the Lower Rouge flow was calculated further upstream).

The other method to compare pre- vs. post-STCAP flows was to test the 2014 (post-STCAP) model (calibrated AMM from the P9+P10+P11 flow response) against pre-STCAP observed flows at the same location. There were two options available for the pre-rehabilitation meter data. Option 1 was data from 2000 to 2003, and the other option was to obtain meter data from 2008 to 2012. For the comparison, it was decided that the 2000-2003 meter data was the best choice. It had more reliable meter data and had already been calibrated in the 2005 AMM Study. The meter data from 2008 to 2012 was less reliable, as data gaps existed and 2012 was a historically-dry year.

The post-STCAP model was used against temperature and rainfall data from 2000-2003 and the flow/volume response were compared to observed data. An accuracy of fit analysis was performed to determine if there were any under- or over-prediction biases. Table 9 provides the net and total errors of this model comparison. The accuracy of fit indicates that the post-STCAP model is slightly biased towards under-predicting the peak flow and total flow volume.

The accuracy of fit figures for this analysis are illustrated in Appendix C.

Table 9 Accuracy of Fit for Post-STCAP Model Applied to 2000-2003 Observed Data

Net Peak Error	Total Peak Error	Net Volume Error	Total Volume Error
-3.17%	17.35%	-4.47%	15.85%

This suggests that the post-STCAP wet weather response is slightly lower (by 3%-4%) than the pre-STCAP response. Comparing the 10-year peak flow differences between the 2005 and 2014 models (247 cfs vs. 210 cfs), this suggests a higher (~13.8%) reduction in peak flow from STCAP.

Based on the above, we would conclude that the RVSDS has a lower wet weather flow response as compared to pre-STCAP conditions, ranging from 3%-4% for more frequent hydrologic events to over 10% for a design (i.e. 10-year) event.

DRAFT – June 29, 2019

Appendix F: SEMCOG Population Forecast Summary

SEMCOG Southeast Michigan Council of Governments

Developing Regional Solutions

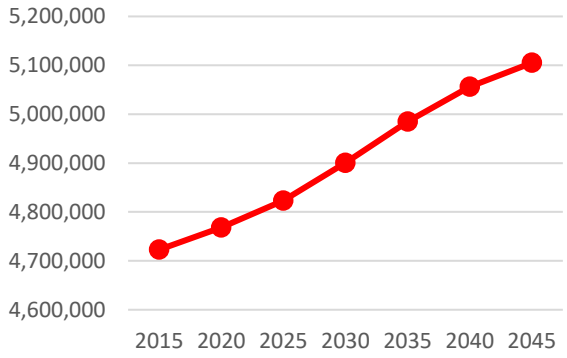
Southeast Michigan 2045 Forecast Summary

(Updated August 6, 2018)

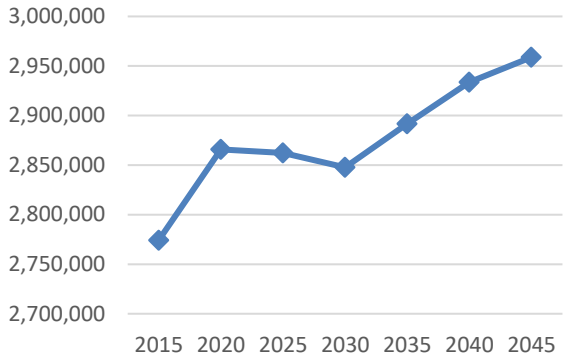
Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	4,722,764	4,823,101	4,985,096	5,104,922	382,158	8.1%
Households	1,862,504	1,952,708	2,041,199	2,080,015	217,511	11.7%
Household Size	2.49	2.43	2.40	2.41	-0.08	-3.2%

Population



Employment



Employment

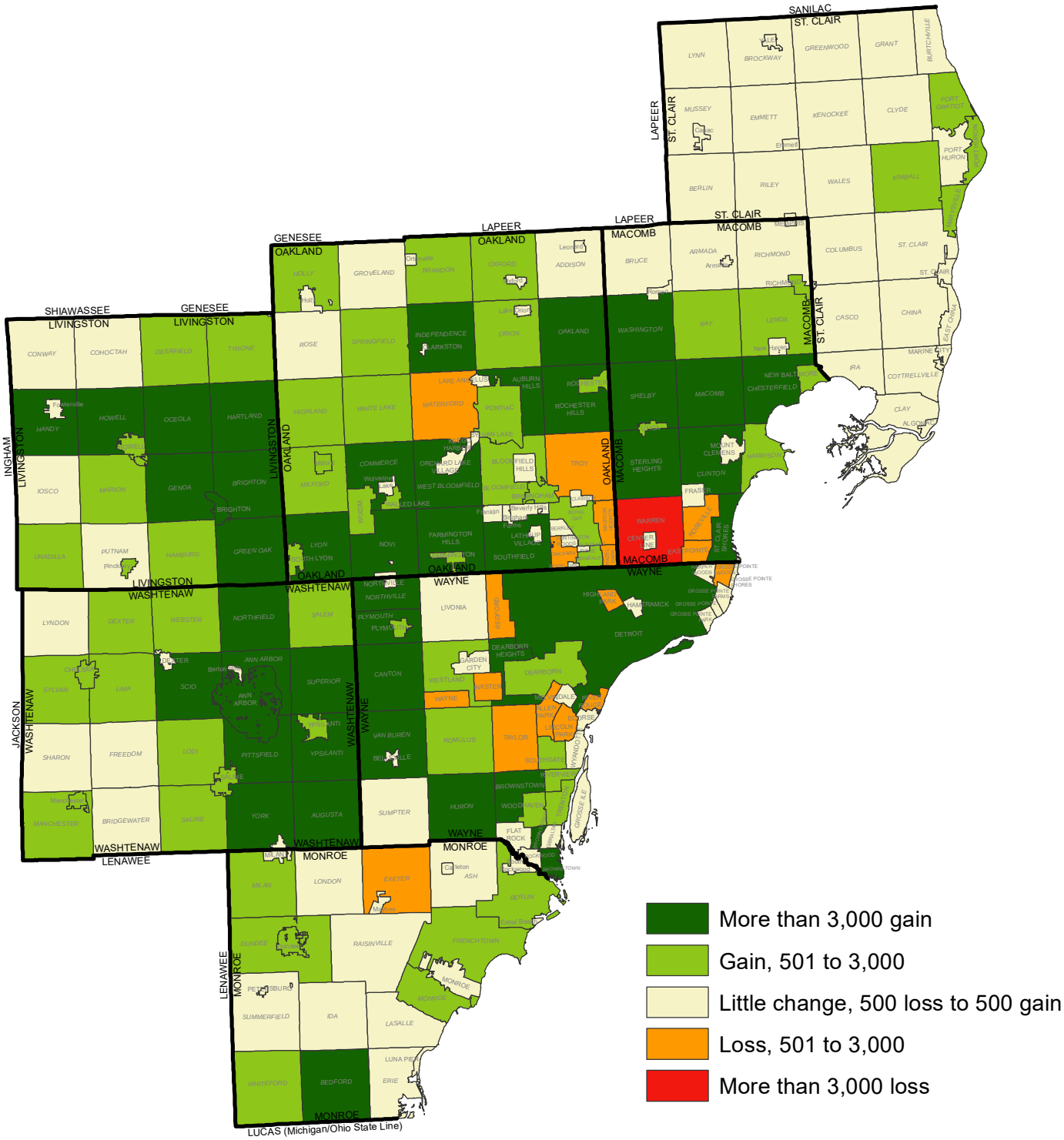
Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	128,238	134,679	135,405	135,937	7,699	6.0%
Manufacturing	264,051	241,442	212,884	193,079	-70,972	-26.9%
Wholesale Trade	100,371	103,146	102,436	101,832	1,461	1.5%
Retail Trade	270,318	264,583	247,291	234,864	-35,454	-13.1%
Transportation & Utilities	101,299	100,619	100,165	101,211	-88	-0.1%
Info & Finance Activities	294,740	298,939	297,387	299,188	4,448	1.5%
Prof/Tech Services & HQ	326,111	358,616	388,945	421,372	95,261	29.2%
Support & Waste Services	206,307	219,879	229,825	241,136	34,829	16.9%
Education Services	197,078	201,791	204,742	209,566	12,488	6.3%
Healthcare Services	382,516	419,173	449,085	491,295	108,779	28.4%
Leisure & Hospitality	248,362	263,039	268,963	277,003	28,641	11.5%
Other Services	162,934	164,955	163,690	161,592	-1,342	-0.8%
Public Administration	91,898	91,850	91,725	91,923	25	0.0%
Total Employment	**2,774,223**	**2,862,711**	**2,892,543**	**2,959,998**	**185,775**	**6.7%**

2045 Forecast by County for Southeast Michigan

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Southeast Michigan						
Population	4,722,764	4,823,101	4,985,096	5,104,922	382,158	8.1%
Households	1,862,504	1,952,708	2,041,199	2,080,015	217,511	11.7%
Employment	2,774,223	2,862,711	2,892,543	2,959,998	185,775	6.7%
Livingston County						
Population	187,287	210,770	230,740	241,566	54,279	29.0%
Households	70,617	82,400	91,884	95,489	24,872	35.2%
Employment	85,073	92,109	94,626	97,853	12,780	15.0%
Macomb County						
Population	865,307	900,421	922,028	924,956	59,649	6.9%
Households	339,681	362,803	377,412	377,720	38,039	11.2%
Employment	421,450	438,715	438,763	444,445	22,995	5.5%
Monroe County						
Population	148,998	150,525	154,850	156,274	7,276	4.9%
Households	58,493	61,366	64,369	64,838	6,345	10.8%
Employment	58,452	58,445	58,423	59,096	644	1.1%
Oakland County						
Population	1,242,788	1,274,576	1,301,621	1,319,089	76,301	6.1%
Households	500,460	528,296	546,404	550,757	50,297	10.1%
Employment	960,562	1,001,362	1,015,688	1,046,138	85,576	8.9%
St. Clair County						
Population	159,882	162,159	165,898	166,185	6,303	3.9%
Households	64,273	67,177	69,902	69,566	5,293	8.2%
Employment	64,234	65,581	65,992	66,711	2,477	3.9%
Washtenaw County						
Population	358,551	395,790	431,785	452,791	94,240	26.3%
Households	138,045	156,405	171,649	180,670	42,625	30.9%
Employment	256,651	274,110	283,994	296,410	39,759	15.5%
Wayne County						
Population	1,759,951	1,728,860	1,778,174	1,844,061	84,110	4.8%
Households	690,935	694,261	719,579	740,975	50,040	7.2%
Employment	927,801	932,389	935,057	949,345	21,544	2.3%

Population Change, 2015-2045

Southeast Michigan



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Southeast Michigan Council of Governments
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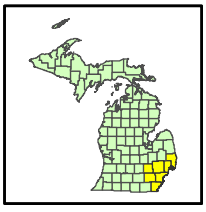
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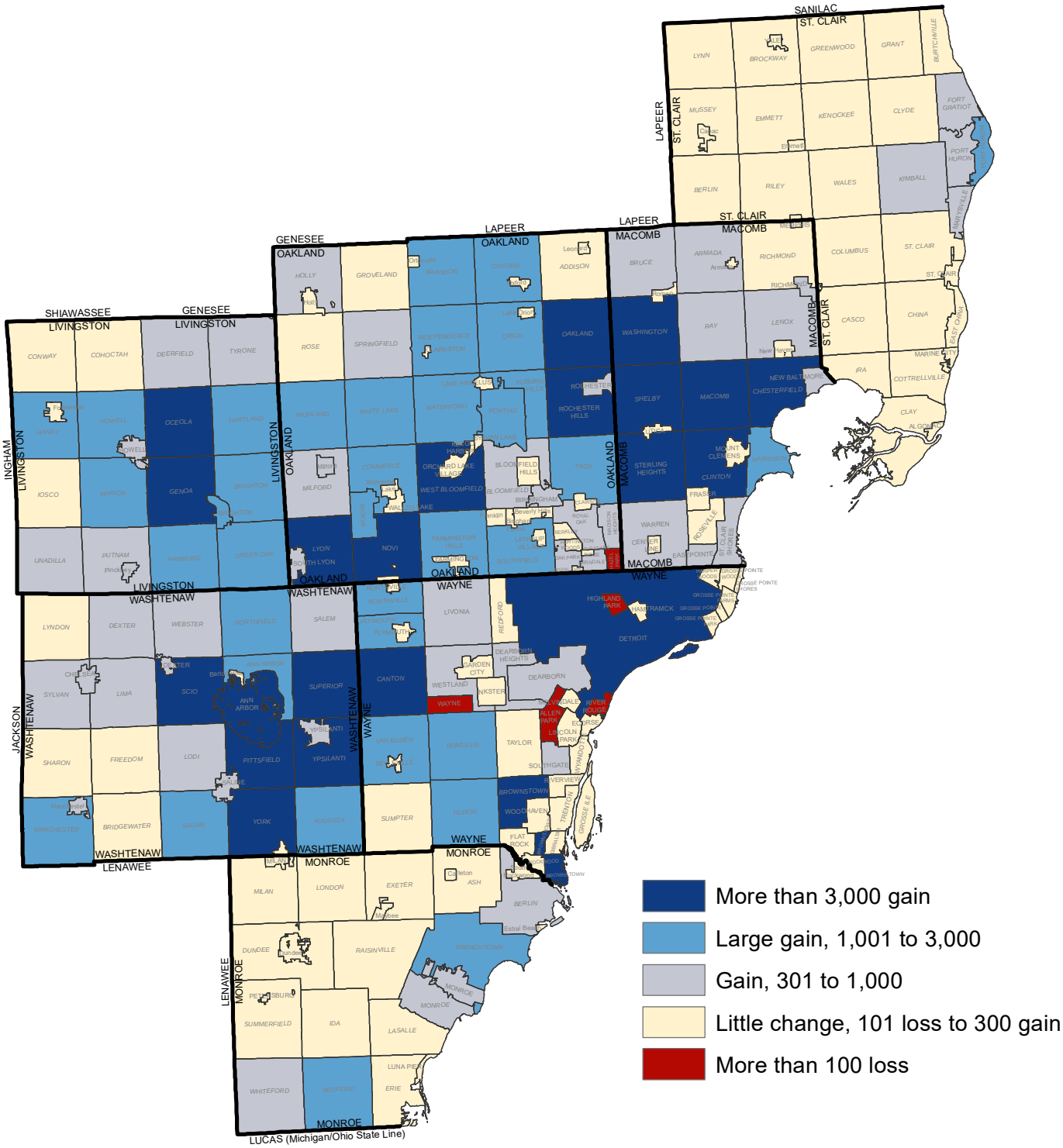
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State Plane NAD83 HARN
February 2018



Household Change, 2015-2045

Southeast Michigan



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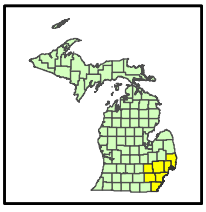
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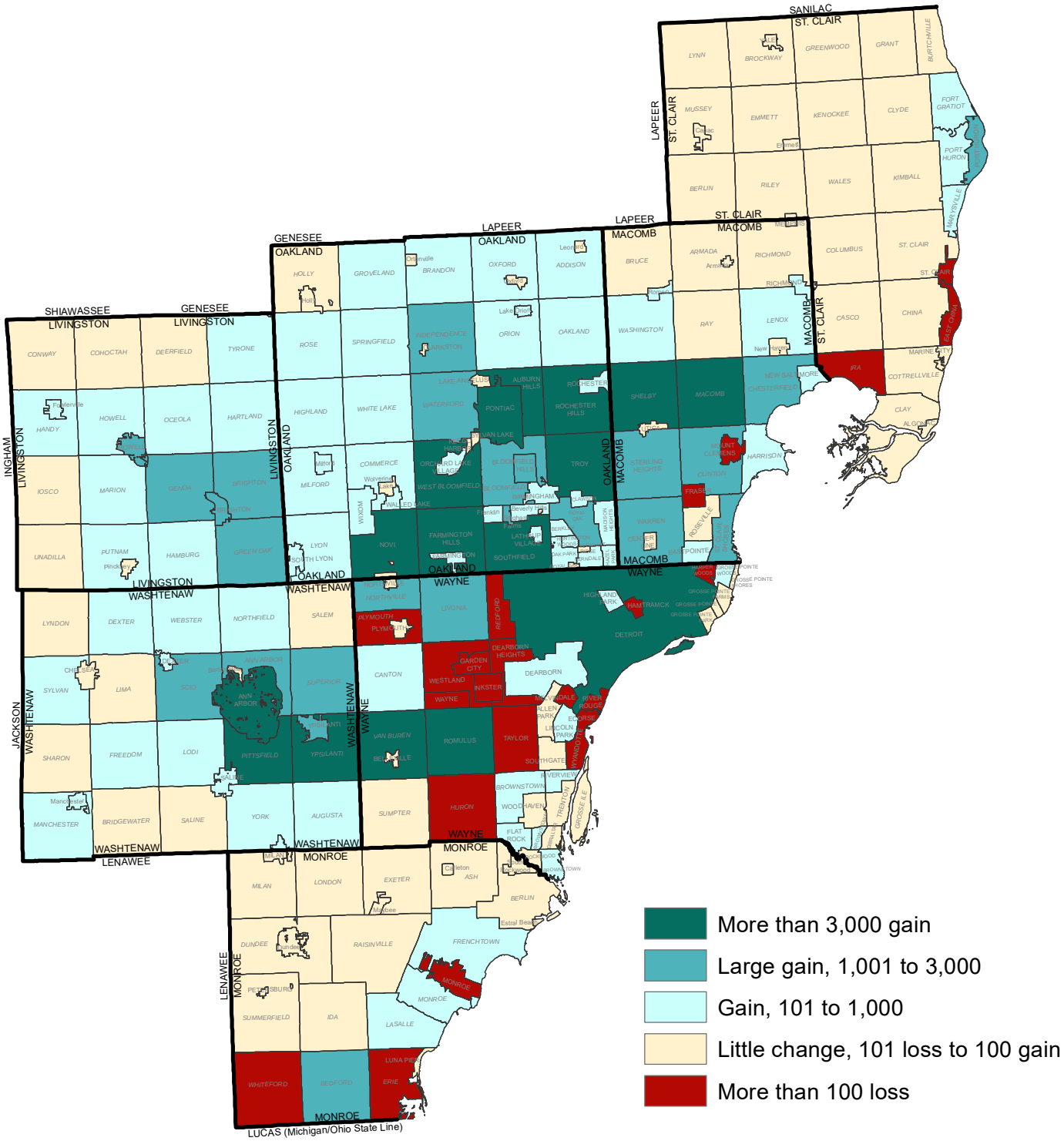
State Plane NAD83 HARN

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Employment Change, 2015-2045

Southeast Michigan



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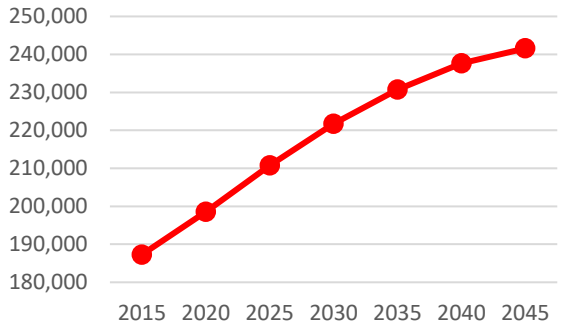
State Plane NAD83 HARN
February 2018

Livingston County 2045 Forecast Summary

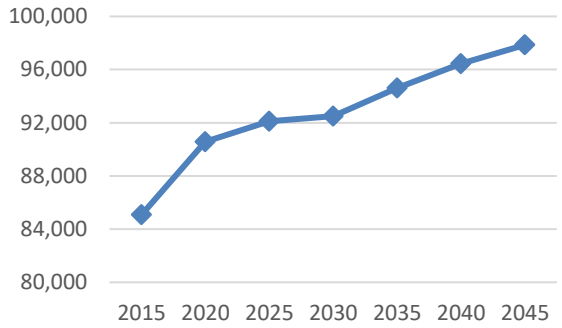
Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	187,287	210,770	230,740	241,566	54,279	29.0%
Households	70,617	82,400	91,884	95,489	24,872	35.2%
Household Size	2.63	2.54	2.49	2.50	-0.13	-4.9%

Population



Employment



Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	7,543	8,904	8,662	8,690	1,147	15.2%
Manufacturing	9,091	8,889	8,281	7,852	-1,239	-13.6%
Wholesale Trade	2,435	2,533	2,533	2,539	104	4.3%
Retail Trade	10,461	11,014	10,571	10,109	-352	-3.4%
Transportation & Utilities	2,255	2,304	2,360	2,484	229	10.2%
Info & Financial Activities	11,406	12,148	12,657	13,325	1,919	16.8%
Prof/Tech Services & HQ	7,423	8,263	9,085	9,917	2,494	33.6%
Support & Waste Services	5,639	6,278	6,758	7,287	1,648	29.2%
Education Services	4,202	4,524	4,694	4,837	635	15.1%
Healthcare Services	6,649	7,791	8,768	9,964	3,315	49.9%
Leisure & Hospitality	9,085	9,952	10,545	11,111	2,026	22.3%
Other Services	5,798	6,167	6,240	6,192	394	6.8%
Public Administration	3,086	3,342	3,472	3,546	460	14.9%
Total Employment	**85,073**	**92,109**	**94,626**	**97,853**	**12,780**	**15.0%**

SEMCOG Southeast Michigan Council of Governments

Developing Regional Solutions

2045 Forecast by Community for Livingston County

					Change 2015-45	
	2015	2025	2035	2045	Number	Percent
Brighton						
Population	7,478	11,147	11,595	12,127	4,649	62.2%
Households	3,683	4,673	4,735	4,753	1,070	29.1%
Employment	10,772	12,576	12,919	12,986	2,214	20.6%
Brighton Twp.						
Population	18,503	20,579	21,585	21,883	3,380	18.3%
Households	6,665	7,668	8,243	8,300	1,635	24.5%
Employment	10,791	11,674	12,025	12,425	1,634	15.1%
Cohoctah Twp.						
Population	3,430	3,116	3,077	3,142	-288	-8.4%
Households	1,215	1,192	1,223	1,234	19	1.6%
Employment	587	624	619	621	34	5.8%
Conway Twp.						
Population	3,473	3,166	3,614	3,788	315	9.1%
Households	1,201	1,202	1,443	1,489	288	24.0%
Employment	444	485	504	523	79	17.8%
Deerfield Twp.						
Population	4,292	4,337	4,594	5,019	727	16.9%
Households	1,572	1,600	1,727	1,905	333	21.2%
Employment	709	746	748	786	77	10.9%
Fenton (Livingston)						
Population	0	0	0	0	0	N/A
Households	0	0	0	0	0	N/A
Employment	0	0	0	0	0	N/A
Fowlerville						
Population	2,674	2,643	3,138	3,144	470	17.6%
Households	1,181	1,187	1,360	1,361	180	15.2%
Employment	2,865	3,010	3,132	3,292	427	14.9%
Genoa Twp.						
Population	20,416	25,972	30,999	32,907	12,491	61.2%
Households	8,287	11,020	13,383	14,124	5,837	70.4%
Employment	12,072	12,338	12,809	13,534	1,462	12.1%

2045 Forecast by Community for Livingston County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Green Oak Twp.						
Population	18,851	20,724	22,082	22,750	3,899	20.7%
Households	7,015	7,948	8,695	8,864	1,849	26.4%
Employment	9,609	10,785	11,055	11,349	1,740	18.1%
Hamburg Twp.						
Population	21,053	22,098	22,645	23,325	2,272	10.8%
Households	8,264	8,960	9,295	9,491	1,227	14.8%
Employment	5,527	5,691	5,912	6,113	586	10.6%
Handy Twp.						
Population	5,268	6,533	8,075	8,780	3,512	66.7%
Households	1,830	2,500	3,182	3,456	1,626	88.9%
Employment	994	1,006	1,043	1,126	132	13.3%
Hartland Twp.						
Population	15,558	17,184	19,201	19,871	4,313	27.7%
Households	5,244	6,285	7,302	7,604	2,360	45.0%
Employment	5,727	6,224	6,457	6,659	932	16.3%
Howell						
Population	9,439	10,221	10,491	11,256	1,817	19.2%
Households	4,036	4,243	4,335	4,620	584	14.5%
Employment	10,365	11,335	11,214	11,527	1,162	11.2%
Howell Twp.						
Population	7,217	8,714	10,245	11,024	3,807	52.8%
Households	2,666	3,339	4,043	4,301	1,635	61.3%
Employment	5,216	5,644	5,923	6,159	943	18.1%
Iosco Twp.						
Population	3,608	3,303	3,280	3,242	-366	-10.1%
Households	1,267	1,266	1,297	1,329	62	4.9%
Employment	520	555	555	565	45	8.7%
Marion Twp.						
Population	10,418	12,248	12,507	13,071	2,653	25.5%
Households	3,717	4,566	4,769	4,923	1,206	32.4%
Employment	2,017	2,181	2,260	2,376	359	17.8%

2045 Forecast by Community for Livingston County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Oceola Twp.						
Population	13,204	16,615	19,646	20,327	7,123	53.9%
Households	4,556	6,193	7,432	7,636	3,080	67.6%
Employment	2,202	2,374	2,533	2,683	481	21.8%
Pinckney						
Population	2,226	2,046	2,058	2,845	619	27.8%
Households	812	856	895	1,156	344	42.4%
Employment	1,021	1,035	1,020	1,044	23	2.3%
Putnam Twp.						
Population	6,003	5,781	6,106	6,333	330	5.5%
Households	2,220	2,293	2,460	2,580	360	16.2%
Employment	1,290	1,354	1,398	1,441	151	11.7%
Tyrone Twp.						
Population	10,793	11,064	11,906	12,486	1,693	15.7%
Households	3,858	4,084	4,463	4,708	850	22.0%
Employment	1,653	1,798	1,815	1,927	274	16.6%
Unadilla Twp.						
Population	3,383	3,279	3,896	4,246	863	25.5%
Households	1,328	1,325	1,602	1,655	327	24.6%
Employment	692	674	685	717	25	3.6%

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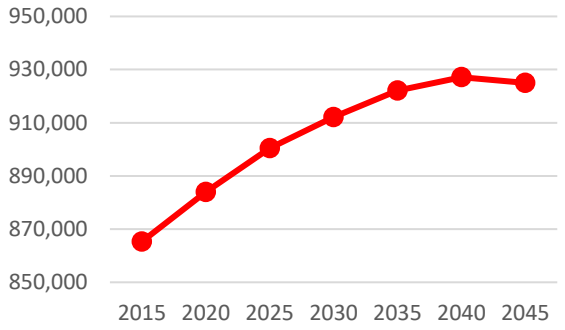
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Macomb County 2045 Forecast Summary

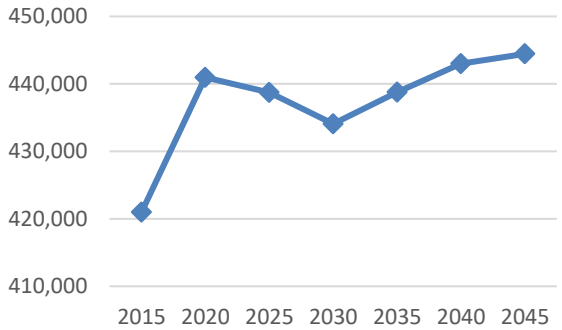
Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	865,307	900,421	922,028	924,956	59,649	6.9%
Households	339,681	362,803	377,412	377,720	38,039	11.2%
Household Size	2.52	2.45	2.41	2.41	-0.11	-4.4%

Population



Employment



Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	25,520	27,610	27,583	27,338	1,818	7.1%
Manufacturing	65,306	61,574	54,200	49,345	-15,961	-24.4%
Wholesale Trade	12,831	13,528	13,531	13,502	671	5.2%
Retail Trade	49,520	49,407	46,174	43,619	-5,901	-11.9%
Transportation & Utilities	12,365	12,746	13,021	13,508	1,143	9.2%
Info & Financial Activities	35,538	35,882	35,619	35,652	114	0.3%
Prof/Tech Services & HQ	38,665	43,458	46,438	49,616	10,951	28.3%
Support & Waste Services	31,034	34,174	36,431	38,970	7,936	25.6%
Education Services	22,505	23,241	23,284	23,459	954	4.2%
Healthcare Services	46,187	52,000	56,820	63,350	17,163	37.2%
Leisure & Hospitality	37,386	39,453	40,194	41,008	3,622	9.7%
Other Services	25,184	25,954	25,880	25,588	404	1.6%
Public Administration	19,409	19,688	19,588	19,490	81	0.4%
Total Employment	**421,450**	**438,715**	**438,763**	**444,445**	**22,995**	**5.5%**

2045 Forecast by Community for Macomb County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Armada						
Population	1,518	1,420	1,505	1,473	-45	-3.0%
Households	527	560	607	607	80	15.2%
Employment	591	569	560	584	-7	-1.2%
Armada Twp.						
Population	3,479	3,582	3,781	3,680	201	5.8%
Households	1,249	1,385	1,567	1,655	406	32.5%
Employment	1,488	1,466	1,492	1,490	2	0.1%
Bruce Twp.						
Population	6,346	6,296	6,692	6,542	196	3.1%
Households	2,159	2,390	2,617	2,657	498	23.1%
Employment	2,544	2,486	2,522	2,600	56	2.2%
Center Line						
Population	9,046	9,000	9,066	9,114	68	0.8%
Households	3,654	3,753	3,764	3,743	89	2.4%
Employment	4,742	4,710	4,752	4,774	32	0.7%
Chesterfield Twp.						
Population	44,986	49,587	51,877	51,464	6,478	14.4%
Households	16,838	19,018	20,400	20,518	3,680	21.9%
Employment	18,062	20,052	20,509	21,025	2,963	16.4%
Clinton Twp.						
Population	100,692	110,938	112,836	114,413	13,721	13.6%
Households	43,399	46,140	47,106	47,025	3,626	8.4%
Employment	48,922	49,593	49,829	50,766	1,844	3.8%
Eastpointe						
Population	32,706	31,378	30,499	30,843	-1,863	-5.7%
Households	12,409	13,029	13,034	13,005	596	4.8%
Employment	9,140	9,003	9,051	9,487	347	3.8%
Fraser						
Population	14,165	14,428	14,520	14,529	364	2.6%
Households	6,168	6,228	6,281	6,270	102	1.7%
Employment	9,671	9,552	9,327	9,444	-227	-2.3%

2045 Forecast by Community for Macomb County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Grosse Pointe Shores (Macomb)						
Population	78	88	87	82	4	5.1%
Households	33	33	33	33	0	0.0%
Employment	114	104	96	96	-18	-15.8%
Harrison Twp.						
Population	25,656	27,369	28,149	28,554	2,898	11.3%
Households	11,406	12,080	12,471	12,484	1,078	9.5%
Employment	8,808	9,160	9,320	9,373	565	6.4%
Lenox Twp.						
Population	5,463	5,913	7,258	7,322	1,859	34.0%
Households	1,610	1,848	2,435	2,456	846	52.5%
Employment	1,996	1,969	2,043	2,109	113	5.7%
Macomb Twp.						
Population	86,322	93,733	98,779	97,427	11,105	12.9%
Households	28,778	34,772	37,553	37,724	8,946	31.1%
Employment	19,065	20,429	22,474	24,101	5,036	26.4%
Memphis (Macomb)						
Population	828	684	691	667	-161	-19.4%
Households	303	317	337	333	30	9.9%
Employment	348	319	329	314	-34	-9.8%
Mount Clemens						
Population	15,909	15,911	16,063	16,245	336	2.1%
Households	6,561	6,562	6,559	6,547	-14	-0.2%
Employment	16,798	16,426	16,471	16,572	-226	-1.3%
New Baltimore						
Population	11,764	12,480	12,620	12,454	690	5.9%
Households	4,413	4,773	4,985	4,976	563	12.8%
Employment	3,524	3,734	3,751	3,847	323	9.2%
New Haven						
Population	4,966	4,895	4,884	4,692	-274	-5.5%
Households	1,673	1,743	1,800	1,810	137	8.2%
Employment	1,293	1,242	1,277	1,377	84	6.5%

2045 Forecast by Community for Macomb County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Ray Twp.						
Population	3,600	3,909	4,340	4,421	821	22.8%
Households	1,419	1,587	1,811	1,850	431	30.4%
Employment	1,337	1,406	1,385	1,415	78	5.8%
Richmond (Macomb)						
Population	5,891	6,286	6,332	6,540	649	11.0%
Households	2,296	2,604	2,712	2,779	483	21.0%
Employment	2,788	2,840	2,897	2,976	188	6.7%
Richmond Twp.						
Population	3,551	3,571	3,849	3,897	346	9.7%
Households	1,160	1,202	1,336	1,324	164	14.1%
Employment	1,094	1,081	1,089	1,113	19	1.7%
Romeo						
Population	3,602	3,651	3,591	3,647	45	1.2%
Households	1,496	1,533	1,537	1,542	46	3.1%
Employment	3,828	4,094	4,093	4,046	218	5.7%
Roseville						
Population	47,892	47,304	46,697	46,995	-897	-1.9%
Households	19,686	19,842	19,969	19,873	187	0.9%
Employment	22,839	22,566	22,311	22,850	11	0.0%
Shelby Twp.						
Population	79,081	84,819	85,730	85,844	6,763	8.6%
Households	30,207	33,077	34,158	34,277	4,070	13.5%
Employment	33,055	37,372	37,598	38,408	5,353	16.2%
Sterling Heights						
Population	132,550	134,623	137,539	137,756	5,206	3.9%
Households	50,598	53,454	55,559	55,517	4,919	9.7%
Employment	70,245	74,856	73,257	72,587	2,342	3.3%
St. Clair Shores						
Population	60,208	61,936	62,595	63,276	3,068	5.1%
Households	26,836	27,149	27,758	27,476	640	2.4%
Employment	23,482	24,272	24,024	24,727	1,245	5.3%

2045 Forecast by Community for Macomb County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Utica						
Population	4,565	5,133	5,278	5,290	725	15.9%
Households	2,252	2,335	2,389	2,325	73	3.2%
Employment	5,613	5,478	5,375	5,524	-89	-1.6%
Warren						
Population	135,070	129,210	128,632	129,364	-5,706	-4.2%
Households	53,368	53,609	54,031	54,043	675	1.3%
Employment	102,583	106,314	105,257	104,820	2,237	2.2%
Washington Twp.						
Population	25,373	32,277	38,138	38,425	13,052	51.4%
Households	9,183	11,780	14,603	14,871	5,688	61.9%
Employment	7,480	7,622	7,674	8,020	540	7.2%

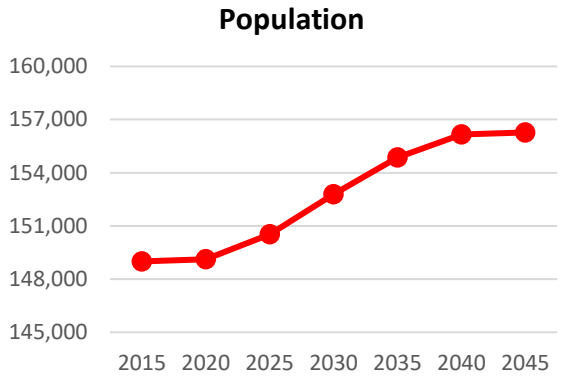
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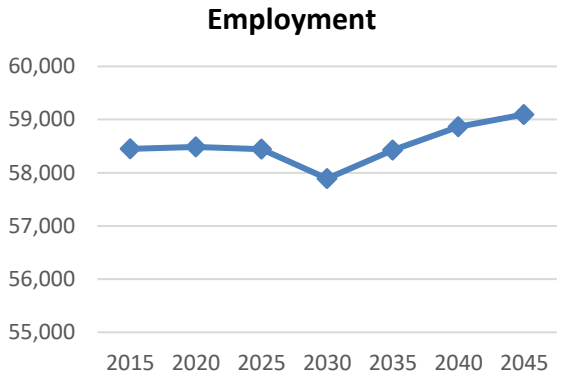
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Monroe County 2045 Forecast Summary

Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	148,998	150,525	154,850	156,274	7,276	4.9%
Households	58,493	61,366	64,369	64,838	6,345	10.8%
Household Size	2.52	2.42	2.37	2.37	-0.15	-6.0%





Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	5,814	5,547	5,295	5,063	-751	-12.9%
Manufacturing	5,799	5,187	4,582	4,208	-1,591	-27.4%
Wholesale Trade	2,077	2,104	2,076	2,069	-8	-0.4%
Retail Trade	7,432	6,851	6,345	5,962	-1,470	-19.8%
Transportation & Utilities	3,326	3,122	2,966	2,809	-517	-15.5%
Info & Financial Activities	4,768	4,759	4,725	4,751	-17	-0.4%
Prof/Tech Services & HQ	4,025	4,239	4,489	4,740	715	17.8%
Support & Waste Services	3,222	3,648	3,976	4,303	1,081	33.6%
Education Services	4,162	4,180	4,227	4,289	127	3.1%
Healthcare Services	6,195	6,840	7,557	8,540	2,345	37.9%
Leisure & Hospitality	5,822	5,973	6,126	6,341	519	8.9%
Other Services	3,561	3,739	3,782	3,734	173	4.9%
Public Administration	2,249	2,256	2,277	2,287	38	1.7%
Total Employment	**58,452**	**58,445**	**58,423**	**59,096**	**644**	**1.1%**

2045 Forecast by Community for Monroe County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Ash Twp.						
Population	5,569	5,378	5,281	5,239	-330	-5.9%
Households	2,027	2,136	2,160	2,152	125	6.2%
Employment	2,466	2,494	2,386	2,393	-73	-3.0%
Bedford Twp.						
Population	30,469	32,561	33,735	34,237	3,768	12.4%
Households	11,979	13,127	13,905	14,101	2,122	17.7%
Employment	9,653	10,475	10,564	10,683	1,030	10.7%
Berlin Twp. (Monroe)						
Population	7,065	7,585	7,804	7,729	664	9.4%
Households	2,714	2,969	3,132	3,152	438	16.1%
Employment	1,562	1,485	1,448	1,472	-90	-5.8%
Carleton						
Population	2,118	2,077	2,118	2,148	30	1.4%
Households	935	939	950	948	13	1.4%
Employment	508	482	452	445	-63	-12.4%
Dundee						
Population	3,798	3,969	4,162	4,423	625	16.5%
Households	1,705	1,791	1,870	1,922	217	12.7%
Employment	3,597	3,634	3,521	3,498	-99	-2.8%
Dundee Twp.						
Population	2,471	2,507	2,971	2,991	520	21.0%
Households	994	1,037	1,253	1,267	273	27.5%
Employment	703	694	657	659	-44	-6.3%
Erie Twp.						
Population	4,624	4,437	4,311	4,285	-339	-7.3%
Households	1,800	1,822	1,851	1,855	55	3.1%
Employment	1,659	1,582	1,549	1,516	-143	-8.6%
Estral Beach						
Population	459	433	446	444	-15	-3.3%
Households	189	195	203	203	14	7.4%
Employment	39	44	47	48	9	23.1%

2045 Forecast by Community for Monroe County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Exeter Twp.						
Population	3,807	3,526	3,320	3,240	-567	-14.9%
Households	1,234	1,241	1,237	1,245	11	0.9%
Employment	775	796	816	811	36	4.6%
Frenchtown Twp.						
Population	21,032	20,096	22,091	22,156	1,124	5.3%
Households	8,053	8,388	9,318	9,323	1,270	15.8%
Employment	9,909	10,721	10,737	10,743	834	8.4%
Ida Twp.						
Population	4,152	4,152	4,050	3,970	-182	-4.4%
Households	1,734	1,702	1,692	1,689	-45	-2.6%
Employment	1,084	1,068	1,042	1,056	-28	-2.6%
LaSalle Twp.						
Population	4,850	4,558	4,445	4,438	-412	-8.5%
Households	1,880	1,827	1,844	1,863	-17	-0.9%
Employment	697	755	772	801	104	14.9%
London Twp.						
Population	2,941	2,711	2,656	2,653	-288	-9.8%
Households	1,132	1,098	1,111	1,115	-17	-1.5%
Employment	376	382	389	409	33	8.8%
Luna Pier						
Population	1,379	1,490	1,501	1,505	126	9.1%
Households	615	670	679	665	50	8.1%
Employment	288	288	322	369	81	28.1%
Maybee						
Population	494	408	415	390	-104	-21.1%
Households	188	187	195	187	-1	-0.5%
Employment	180	158	156	157	-23	-12.8%
Milan (Monroe)						
Population	2,115	2,096	2,055	2,077	-38	-1.8%
Households	834	860	862	876	42	5.0%
Employment	865	902	869	871	6	0.7%

2045 Forecast by Community for Monroe County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Milan Twp.						
Population	1,565	1,484	1,818	2,137	572	36.5%
Households	622	618	756	872	250	40.2%
Employment	348	342	361	363	15	4.3%
Monroe						
Population	20,519	20,771	20,700	20,834	315	1.5%
Households	7,997	8,351	8,439	8,429	432	5.4%
Employment	12,050	10,666	10,808	11,075	-975	-8.1%
Monroe Twp.						
Population	13,979	14,002	14,615	14,816	837	6.0%
Households	5,656	5,816	6,103	6,099	443	7.8%
Employment	7,465	7,403	7,518	7,690	225	3.0%
Petersburg						
Population	1,120	1,066	991	1,017	-103	-9.2%
Households	442	437	432	429	-13	-2.9%
Employment	279	276	277	266	-13	-4.7%
Raisinville Twp.						
Population	5,862	6,124	6,207	6,254	392	6.7%
Households	2,154	2,288	2,407	2,448	294	13.6%
Employment	765	767	781	803	38	5.0%
South Rockwood						
Population	1,532	1,656	1,613	1,639	107	7.0%
Households	682	714	714	715	33	4.8%
Employment	275	249	250	253	-22	-8.0%
Summerfield Twp.						
Population	2,960	2,885	2,865	2,851	-109	-3.7%
Households	1,181	1,166	1,205	1,196	15	1.3%
Employment	1,064	988	967	979	-85	-8.0%
Whiteford Twp.						
Population	4,118	4,553	4,680	4,801	683	16.6%
Households	1,746	1,987	2,051	2,087	341	19.5%
Employment	1,845	1,794	1,734	1,736	-109	-5.9%

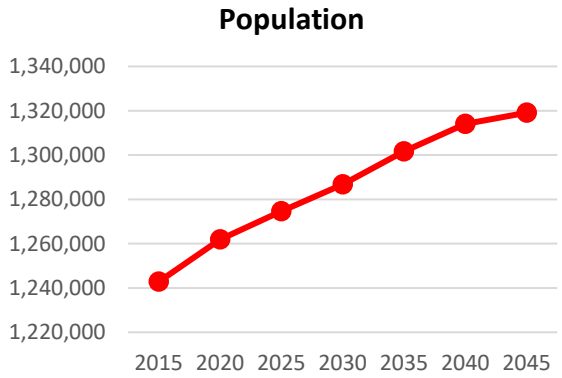
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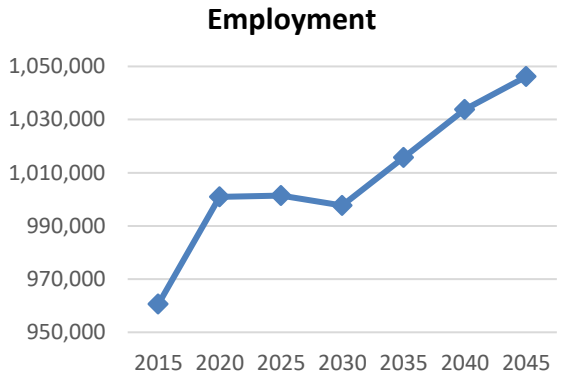
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Oakland County 2045 Forecast Summary

Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	1,242,788	1,274,576	1,301,621	1,319,089	76,301	6.1%
Households	500,460	528,296	546,404	550,757	50,297	10.1%
Household Size	2.45	2.38	2.35	2.36	-0.09	-3.7%





Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	42,687	46,472	46,436	47,678	4,991	11.7%
Manufacturing	67,487	60,964	53,649	48,523	-18,964	-28.1%
Wholesale Trade	43,594	44,836	44,340	43,992	398	0.9%
Retail Trade	94,434	92,486	85,348	80,166	-14,268	-15.1%
Transportation & Utilities	19,417	19,762	19,920	20,485	1,068	5.5%
Info & Financial Activities	136,091	138,932	138,412	139,586	3,495	2.6%
Prof/Tech Services & HQ	154,755	171,344	187,645	205,911	51,156	33.1%
Support & Waste Services	86,471	90,368	92,852	96,158	9,687	11.2%
Education Services	50,323	51,364	51,687	52,881	2,558	5.1%
Healthcare Services	117,136	130,827	141,161	155,307	38,171	32.6%
Leisure & Hospitality	79,482	85,109	86,575	88,862	9,380	11.8%
Other Services	49,852	49,847	48,763	47,764	-2,088	-4.2%
Public Administration	18,833	19,051	18,900	18,825	-8	0.0%
Total Employment	**960,562**	**1,001,362**	**1,015,688**	**1,046,138**	**85,576**	**8.9%**

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Addison Twp.						
Population	6,119	5,944	6,064	6,008	-111	-1.8%
Households	2,243	2,340	2,409	2,416	173	7.7%
Employment	1,464	1,516	1,536	1,576	112	7.7%
Auburn Hills						
Population	24,732	27,123	27,524	28,084	3,352	13.6%
Households	9,476	10,647	10,911	10,909	1,433	15.1%
Employment	66,539	70,534	71,501	76,053	9,514	14.3%
Berkley						
Population	15,166	14,807	14,997	14,964	-202	-1.3%
Households	6,507	6,551	6,677	6,696	189	2.9%
Employment	6,620	6,874	6,907	7,138	518	7.8%
Beverly Hills						
Population	10,320	9,960	9,949	10,029	-291	-2.8%
Households	4,043	4,025	4,060	4,066	23	0.6%
Employment	4,646	4,800	4,876	5,057	411	8.8%
Bingham Farms						
Population	1,049	1,028	1,041	1,080	31	3.0%
Households	470	464	459	454	-16	-3.4%
Employment	7,923	8,672	8,986	9,330	1,407	17.8%
Birmingham						
Population	20,516	21,525	22,000	22,251	1,735	8.5%
Households	9,464	9,893	10,190	10,220	756	8.0%
Employment	20,325	20,793	20,931	21,297	972	4.8%
Bloomfield Hills						
Population	4,091	4,015	4,082	4,266	175	4.3%
Households	1,542	1,587	1,602	1,599	57	3.7%
Employment	9,709	10,123	10,539	10,905	1,196	12.3%
Bloomfield Twp.						
Population	41,364	41,340	41,446	42,188	824	2.0%
Households	16,684	16,960	17,087	17,168	484	2.9%
Employment	26,691	27,596	28,358	29,614	2,923	11.0%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Brandon Twp.						
Population	13,609	14,148	14,786	14,811	1,202	8.8%
Households	4,820	5,199	5,688	5,822	1,002	20.8%
Employment	3,045	3,172	3,187	3,283	238	7.8%
Clarkston						
Population	876	871	909	919	43	4.9%
Households	397	396	408	400	3	0.8%
Employment	826	850	855	852	26	3.1%
Clawson						
Population	11,661	11,674	11,736	11,935	274	2.3%
Households	5,528	5,472	5,537	5,550	22	0.4%
Employment	5,622	5,726	5,788	5,967	345	6.1%
Commerce Twp.						
Population	37,607	40,555	41,157	42,023	4,416	11.7%
Households	13,869	15,257	15,740	15,918	2,049	14.8%
Employment	20,923	21,020	21,089	21,444	521	2.5%
Farmington						
Population	10,220	10,420	10,589	10,795	575	5.6%
Households	4,740	4,825	4,860	4,875	135	2.8%
Employment	6,535	6,683	6,751	7,047	512	7.8%
Farmington Hills						
Population	80,033	81,290	83,452	85,200	5,167	6.5%
Households	34,158	34,878	36,054	36,308	2,150	6.3%
Employment	82,185	86,042	87,856	90,250	8,065	9.8%
Fenton (Oakland)						
Population	2	2	2	2	0	0.0%
Households	1	1	1	1	0	0.0%
Employment	0	1	1	1	1	N/A
Ferndale						
Population	20,428	20,635	20,942	21,069	641	3.1%
Households	9,211	9,469	9,659	9,705	494	5.4%
Employment	12,858	12,924	12,858	13,130	272	2.1%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Franklin						
Population	3,009	2,889	2,849	2,972	-37	-1.2%
Households	1,137	1,131	1,132	1,141	4	0.4%
Employment	1,328	1,371	1,391	1,435	107	8.1%
Groveland Twp.						
Population	5,156	5,023	5,056	5,024	-132	-2.6%
Households	1,896	2,026	2,055	2,056	160	8.4%
Employment	1,694	1,797	1,830	1,862	168	9.9%
Hazel Park						
Population	16,016	14,817	14,532	14,448	-1,568	-9.8%
Households	6,847	6,733	6,743	6,714	-133	-1.9%
Employment	6,011	6,341	6,425	6,503	492	8.2%
Highland Twp.						
Population	18,198	18,146	19,451	19,782	1,584	8.7%
Households	7,063	7,380	8,172	8,314	1,251	17.7%
Employment	7,492	7,862	7,821	8,103	611	8.2%
Holly						
Population	5,988	5,783	5,743	5,749	-239	-4.0%
Households	2,431	2,430	2,473	2,466	35	1.4%
Employment	2,637	2,713	2,706	2,728	91	3.5%
Holly Twp.						
Population	5,199	5,257	5,770	5,861	662	12.7%
Households	1,955	2,075	2,346	2,398	443	22.7%
Employment	1,097	1,167	1,166	1,185	88	8.0%
Huntington Woods						
Population	6,230	6,246	6,267	6,247	17	0.3%
Households	2,319	2,370	2,406	2,413	94	4.1%
Employment	2,556	2,621	2,713	2,846	290	11.3%
Independence Twp.						
Population	35,074	37,471	39,174	39,922	4,848	13.8%
Households	13,346	14,708	15,781	16,177	2,831	21.2%
Employment	17,024	17,633	17,909	18,493	1,469	8.6%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Keego Harbor						
Population	3,039	3,069	3,116	3,148	109	3.6%
Households	1,274	1,342	1,371	1,376	102	8.0%
Employment	1,759	1,784	1,770	1,829	70	4.0%
Lake Angelus						
Population	300	304	295	290	-10	-3.3%
Households	142	148	149	149	7	4.9%
Employment	104	105	106	111	7	6.7%
Lake Orion						
Population	2,830	3,086	3,203	3,295	465	16.4%
Households	1,266	1,346	1,381	1,370	104	8.2%
Employment	1,945	2,062	2,130	2,179	234	12.0%
Lathrup Village						
Population	3,982	3,881	3,852	3,803	-179	-4.5%
Households	1,585	1,607	1,617	1,611	26	1.6%
Employment	3,815	3,903	3,980	4,116	301	7.9%
Leonard						
Population	384	351	344	348	-36	-9.4%
Households	147	150	159	161	14	9.5%
Employment	196	195	193	192	-4	-2.0%
Lyon Twp.						
Population	17,211	23,468	26,208	26,408	9,197	53.4%
Households	6,472	9,126	10,318	10,448	3,976	61.4%
Employment	9,693	10,400	10,674	10,693	1,000	10.3%
Madison Heights						
Population	30,749	29,614	29,456	29,757	-992	-3.2%
Households	13,016	13,280	13,478	13,508	492	3.8%
Employment	28,723	29,131	28,948	29,567	844	2.9%
Milford						
Population	6,237	6,769	6,945	7,004	767	12.3%
Households	2,670	2,902	2,961	2,993	323	12.1%
Employment	3,656	3,734	3,778	3,861	205	5.6%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Milford Twp.						
Population	9,701	11,070	11,141	11,034	1,333	13.7%
Households	3,715	4,375	4,475	4,480	765	20.6%
Employment	8,396	8,821	8,947	9,100	704	8.4%
Northville (Oakland)						
Population	3,138	3,122	3,102	3,119	-19	-0.6%
Households	1,322	1,322	1,338	1,331	9	0.7%
Employment	895	937	935	963	68	7.6%
Novi						
Population	60,458	64,801	66,609	67,417	6,959	11.5%
Households	24,334	26,193	27,215	27,345	3,011	12.4%
Employment	53,859	56,040	56,335	57,880	4,021	7.5%
Novi Twp.						
Population	141	140	137	140	-1	-0.7%
Households	54	53	53	53	-1	-1.9%
Employment	25	28	28	30	5	20.0%
Oakland Twp.						
Population	18,176	21,822	24,858	25,924	7,748	42.6%
Households	6,301	8,199	9,735	10,352	4,051	64.3%
Employment	5,151	5,291	5,364	5,525	374	7.3%
Oak Park						
Population	30,837	29,919	29,380	29,129	-1,708	-5.5%
Households	11,928	12,469	12,480	12,491	563	4.7%
Employment	16,735	16,954	17,169	17,629	894	5.3%
Orchard Lake Village						
Population	2,353	2,235	2,300	2,263	-90	-3.8%
Households	849	843	866	871	22	2.6%
Employment	1,617	1,678	1,714	1,741	124	7.7%
Orion Twp.						
Population	35,287	34,925	36,570	37,032	1,745	4.9%
Households	12,372	13,209	14,225	14,652	2,280	18.4%
Employment	17,033	17,269	17,373	17,431	398	2.3%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Ortonville						
Population	1,364	1,135	1,096	1,064	-300	-22.0%
Households	508	460	461	457	-51	-10.0%
Employment	1,011	1,027	1,010	1,023	12	1.2%
Oxford						
Population	3,077	2,885	2,953	2,890	-187	-6.1%
Households	1,259	1,258	1,286	1,275	16	1.3%
Employment	2,236	2,279	2,240	2,248	12	0.5%
Oxford Twp.						
Population	16,772	17,640	18,976	19,449	2,677	16.0%
Households	6,001	6,867	7,686	7,857	1,856	30.9%
Employment	5,818	5,949	6,011	6,171	353	6.1%
Pleasant Ridge						
Population	2,489	2,447	2,468	2,518	29	1.2%
Households	1,097	1,088	1,091	1,089	-8	-0.7%
Employment	969	978	1,001	1,015	46	4.7%
Pontiac						
Population	60,283	61,196	60,651	61,667	1,384	2.3%
Households	23,819	25,301	25,409	25,540	1,721	7.2%
Employment	38,036	40,077	40,303	41,582	3,546	9.3%
Rochester						
Population	13,181	14,424	14,454	14,657	1,476	11.2%
Households	5,649	6,183	6,237	6,264	615	10.9%
Employment	9,036	9,119	9,163	9,363	327	3.6%
Rochester Hills						
Population	73,706	76,940	78,711	79,709	6,003	8.1%
Households	28,410	30,946	32,239	32,471	4,061	14.3%
Employment	41,559	43,018	43,813	45,431	3,872	9.3%
Rose Twp.						
Population	5,848	5,628	5,632	5,858	10	0.2%
Households	2,338	2,312	2,366	2,434	96	4.1%
Employment	1,132	1,217	1,241	1,278	146	12.9%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Royal Oak						
Population	59,510	60,556	60,665	61,612	2,102	3.5%
Households	28,457	29,110	29,346	29,386	929	3.3%
Employment	38,807	40,155	40,382	41,411	2,604	6.7%
Royal Oak Twp.						
Population	2,378	2,407	2,333	2,313	-65	-2.7%
Households	979	1,006	963	959	-20	-2.0%
Employment	1,370	1,403	1,411	1,469	99	7.2%
Southfield						
Population	77,859	81,895	82,606	83,816	5,957	7.7%
Households	34,060	35,473	35,559	35,499	1,439	4.2%
Employment	114,969	122,736	125,792	131,001	16,032	13.9%
Southfield Twp.						
Population	19	13	15	15	-4	-21.1%
Households	8	6	6	6	-2	-25.0%
Employment	0	0	1	0	0	N/A
South Lyon						
Population	11,263	11,655	11,750	12,074	811	7.2%
Households	4,802	5,046	5,126	5,117	315	6.6%
Employment	4,291	4,366	4,314	4,412	121	2.8%
Springfield Twp.						
Population	13,617	13,975	14,430	14,467	850	6.2%
Households	4,989	5,365	5,709	5,751	762	15.3%
Employment	5,655	5,732	5,679	5,763	108	1.9%
Sylvan Lake						
Population	1,701	1,785	1,816	1,865	164	9.6%
Households	826	832	847	843	17	2.1%
Employment	950	976	952	957	7	0.7%
Troy						
Population	85,299	83,561	83,586	83,911	-1,388	-1.6%
Households	31,394	32,565	33,188	33,400	2,006	6.4%
Employment	129,642	136,614	139,592	141,790	12,148	9.4%

2045 Forecast by Community for Oakland County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Walled Lake						
Population	7,142	7,467	7,493	7,860	718	10.1%
Households	3,393	3,504	3,538	3,559	166	4.9%
Employment	4,092	4,212	4,177	4,232	140	3.4%
Waterford Twp.						
Population	74,656	72,389	73,020	74,059	-597	-0.8%
Households	30,198	30,358	31,022	31,249	1,051	3.5%
Employment	33,441	34,271	34,566	35,394	1,953	5.8%
West Bloomfield Twp.						
Population	65,847	65,992	68,631	69,854	4,007	6.1%
Households	24,793	25,919	27,386	27,844	3,051	12.3%
Employment	31,007	32,271	32,912	34,433	3,426	11.0%
White Lake Twp.						
Population	30,786	30,124	31,920	32,194	1,408	4.6%
Households	11,811	12,234	13,432	13,570	1,759	14.9%
Employment	9,785	9,863	9,814	10,009	224	2.3%
Wixom						
Population	14,369	16,609	17,032	17,066	2,697	18.8%
Households	6,308	7,241	7,352	7,341	1,033	16.4%
Employment	16,526	17,022	16,966	17,262	736	4.5%

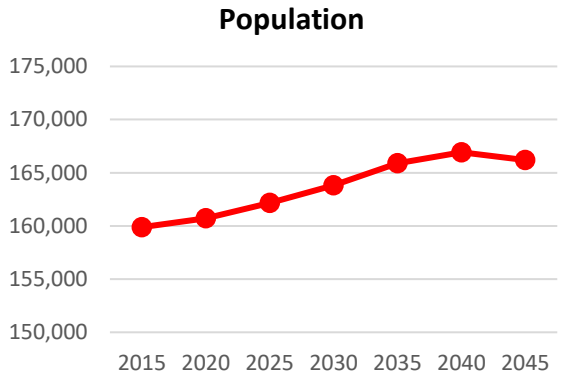
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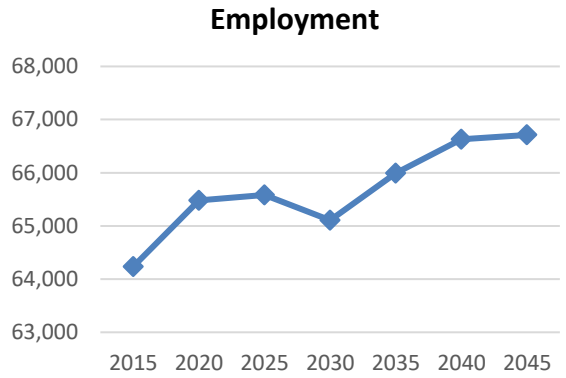
Developing Regional Solutions

St. Clair County 2045 Forecast Summary

Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	159,882	162,159	165,898	166,185	6,303	3.9%
Households	64,273	67,177	69,902	69,566	5,293	8.2%
Household Size	2.46	2.38	2.34	2.35	-0.11	-4.5%





Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	4,785	4,830	4,787	4,634	-151	-3.2%
Manufacturing	7,715	6,916	6,067	5,456	-2,259	-29.3%
Wholesale Trade	1,661	1,690	1,687	1,672	11	0.7%
Retail Trade	7,980	7,750	7,198	6,675	-1,305	-16.4%
Transportation & Utilities	3,372	3,220	3,104	2,996	-376	-11.2%
Info & Financial Activities	6,431	6,456	6,441	6,470	39	0.6%
Prof/Tech Services & HQ	3,198	3,487	3,822	4,158	960	30.0%
Support & Waste Services	2,697	3,147	3,543	3,887	1,190	44.1%
Education Services	4,381	4,462	4,535	4,607	226	5.2%
Healthcare Services	8,950	10,068	11,028	12,294	3,344	37.4%
Leisure & Hospitality	5,792	6,038	6,192	6,344	552	9.5%
Other Services	4,104	4,329	4,386	4,323	219	5.3%
Public Administration	3,168	3,188	3,202	3,195	27	0.9%
Total Employment	**64,234**	**65,581**	**65,992**	**66,711**	**2,477**	**3.9%**

2045 Forecast by Community for St. Clair County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Algonac						
Population	4,289	4,274	4,275	4,285	-4	-0.1%
Households	1,918	1,947	1,980	1,956	38	2.0%
Employment	753	734	768	788	35	4.6%
Berlin Twp. (St. Clair)						
Population	2,822	2,904	2,866	2,853	31	1.1%
Households	1,162	1,171	1,170	1,150	-12	-1.0%
Employment	415	444	439	441	26	6.3%
Brockway Twp.						
Population	2,063	1,979	1,976	1,933	-130	-6.3%
Households	741	745	775	766	25	3.4%
Employment	432	401	386	377	-55	-12.7%
Burtchville Twp.						
Population	4,397	4,075	4,672	4,655	258	5.9%
Households	1,780	1,767	2,018	2,008	228	12.8%
Employment	609	601	612	610	1	0.2%
Capac						
Population	1,943	1,744	1,700	1,582	-361	-18.6%
Households	731	731	736	730	-1	-0.1%
Employment	570	505	474	480	-90	-15.8%
Casco Twp.						
Population	4,204	4,156	4,092	3,949	-255	-6.1%
Households	1,527	1,615	1,631	1,596	69	4.5%
Employment	1,097	1,092	1,087	1,112	15	1.4%
China Twp.						
Population	3,574	3,884	3,852	3,835	261	7.3%
Households	1,301	1,411	1,439	1,425	124	9.5%
Employment	1,009	919	953	978	-31	-3.1%
Clay Twp.						
Population	8,728	8,958	8,759	8,979	251	2.9%
Households	4,058	4,057	4,012	3,974	-84	-2.1%
Employment	2,129	2,022	2,072	2,089	-40	-1.9%

2045 Forecast by Community for St. Clair County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Clyde Twp.						
Population	5,111	5,393	5,504	5,563	452	8.8%
Households	2,088	2,189	2,253	2,264	176	8.4%
Employment	760	758	767	794	34	4.5%
Columbus Twp.						
Population	3,555	3,636	3,708	3,734	179	5.0%
Households	1,425	1,433	1,455	1,446	21	1.5%
Employment	684	677	692	702	18	2.6%
Cottrellville Twp.						
Population	3,120	3,367	3,401	3,384	264	8.5%
Households	1,277	1,389	1,417	1,408	131	10.3%
Employment	492	468	504	510	18	3.7%
East China Twp.						
Population	4,047	4,139	4,286	4,399	352	8.7%
Households	1,683	1,682	1,686	1,668	-15	-0.9%
Employment	2,352	2,253	2,282	2,246	-106	-4.5%
Emmett						
Population	257	217	216	220	-37	-14.4%
Households	87	89	91	87	0	0.0%
Employment	192	190	181	178	-14	-7.3%
Emmett Twp.						
Population	2,295	2,335	2,291	2,320	25	1.1%
Households	822	845	843	836	14	1.7%
Employment	253	265	268	256	3	1.2%
Fort Gratiot Twp.						
Population	11,669	12,175	12,525	12,493	824	7.1%
Households	4,631	4,953	5,082	5,029	398	8.6%
Employment	6,866	7,271	7,397	7,484	618	9.0%
Grant Twp.						
Population	1,791	1,878	1,833	1,804	13	0.7%
Households	692	705	703	699	7	1.0%
Employment	269	286	290	289	20	7.4%

2045 Forecast by Community for St. Clair County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Greenwood Twp.						
Population	1,404	1,378	1,373	1,373	-31	-2.2%
Households	533	535	526	522	-11	-2.1%
Employment	248	254	250	247	-1	-0.4%
Ira Twp.						
Population	4,501	4,457	4,543	4,631	130	2.9%
Households	1,832	1,869	1,970	2,002	170	9.3%
Employment	1,594	1,417	1,395	1,429	-165	-10.4%
Kenockee Twp.						
Population	2,294	2,328	2,328	2,279	-15	-0.7%
Households	929	940	964	959	30	3.2%
Employment	312	335	332	333	21	6.7%
Kimball Twp.						
Population	8,503	9,238	10,462	10,521	2,018	23.7%
Households	3,648	3,895	4,512	4,507	859	23.5%
Employment	2,465	2,386	2,413	2,443	-22	-0.9%
Lynn Twp.						
Population	1,266	1,187	1,138	1,159	-107	-8.5%
Households	465	460	460	463	-2	-0.4%
Employment	187	179	178	185	-2	-1.1%
Marine City						
Population	3,969	3,928	3,763	3,783	-186	-4.7%
Households	1,787	1,777	1,755	1,743	-44	-2.5%
Employment	2,486	2,403	2,306	2,392	-94	-3.8%
Marysville						
Population	10,199	10,516	11,001	11,156	957	9.4%
Households	4,281	4,500	4,705	4,709	428	10.0%
Employment	5,992	6,716	6,758	6,863	871	14.5%
Memphis (St. Clair)						
Population	341	317	320	314	-27	-7.9%
Households	147	137	145	140	-7	-4.8%
Employment	148	134	130	138	-10	-6.8%

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2045 Forecast by Community for St. Clair County

					Change 2015-45	
	2015	2025	2035	2045	Number	Percent
Mussey Twp.						
Population	2,365	2,339	2,316	2,240	-125	-5.3%
Households	838	858	879	870	32	3.8%
Employment	364	340	331	348	-16	-4.4%
Port Huron						
Population	28,294	28,246	28,762	29,131	837	3.0%
Households	11,547	12,313	12,991	13,083	1,536	13.3%
Employment	18,892	19,925	20,127	20,259	1,367	7.2%
Port Huron Twp.						
Population	11,800	11,591	12,414	12,266	466	3.9%
Households	4,143	4,492	4,918	4,867	724	17.5%
Employment	5,366	5,540	5,496	5,658	292	5.4%
Richmond (St. Clair)						
Population	1	2	2	3	2	200.0%
Households	1	1	1	1	0	0.0%
Employment	11	10	8	6	-5	-45.5%
Riley Twp.						
Population	3,340	3,397	3,313	3,281	-59	-1.8%
Households	1,215	1,271	1,278	1,268	53	4.4%
Employment	543	544	566	530	-13	-2.4%
St. Clair						
Population	5,481	5,770	5,765	5,651	170	3.1%
Households	2,348	2,523	2,515	2,454	106	4.5%
Employment	3,376	3,195	3,155	3,105	-271	-8.0%
St. Clair Twp.						
Population	6,979	7,173	7,326	7,277	298	4.3%
Households	2,662	2,856	2,944	2,905	243	9.1%
Employment	1,829	1,799	1,836	1,877	48	2.6%
Wales Twp.						
Population	3,359	3,268	3,189	3,205	-154	-4.6%
Households	1,222	1,263	1,295	1,294	72	5.9%
Employment	505	514	507	520	15	3.0%

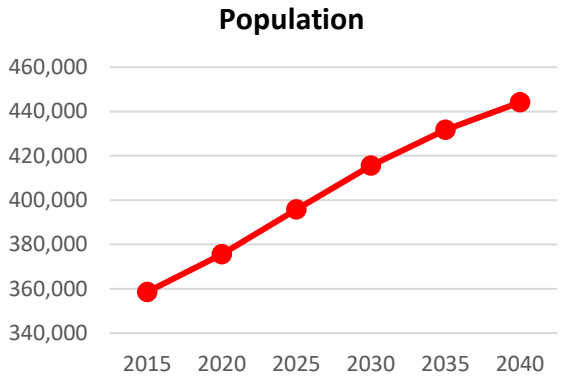
2045 Forecast by Community for St. Clair County

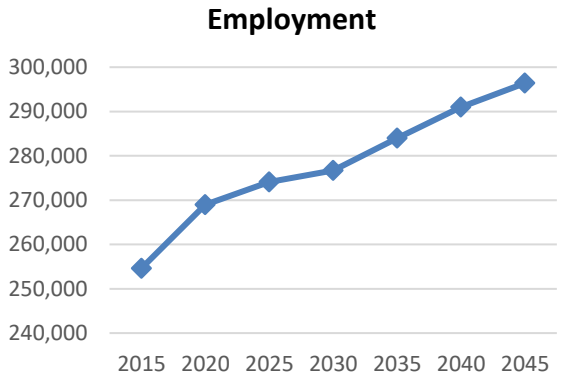
	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Yale						
Population	1,921	1,910	1,927	1,927	6	0.3%
Households	752	758	753	737	-15	-2.0%
Employment	1,034	1,004	1,032	1,044	10	1.0%

Washtenaw County 2045 Forecast Summary

Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	358,551	395,790	431,785	452,791	94,240	26.3%
Households	138,045	156,405	171,649	180,670	42,625	30.9%
Household Size	2.42	2.37	2.36	2.35	-0.07	-2.9%





Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	8,159	8,915	9,107	9,380	1,221	15.0%
Manufacturing	15,668	14,714	13,279	12,136	-3,532	-22.5%
Wholesale Trade	5,586	5,752	5,708	5,675	89	1.6%
Retail Trade	19,236	20,546	19,811	19,260	24	0.1%
Transportation & Utilities	5,400	5,418	5,429	5,503	103	1.9%
Info & Financial Activities	22,367	22,363	22,277	22,456	89	0.4%
Prof/Tech Services & HQ	25,489	28,514	31,550	34,861	9,372	36.8%
Support & Waste Services	13,936	15,371	16,589	17,840	3,904	28.0%
Education Services	51,494	55,226	57,471	59,494	8,000	15.5%
Healthcare Services	50,991	56,125	60,100	65,630	14,639	28.7%
Leisure & Hospitality	21,469	23,363	24,476	25,630	4,161	19.4%
Other Services	10,994	11,649	11,872	12,082	1,088	9.9%
Public Administration	5,862	6,154	6,325	6,463	601	10.3%
Total Employment	**256,651**	**274,110**	**283,994**	**296,410**	**39,759**	**15.5%**

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2045 Forecast by Community for Washtenaw County

					Change 2015-45	
	2015	2025	2035	2045	Number	Percent
Ann Arbor						
Population	117,303	126,027	130,493	132,325	15,022	12.8%
Households	46,640	49,842	50,184	50,208	3,568	7.7%
Employment	128,089	136,056	141,062	146,132	18,043	14.1%
Ann Arbor Twp.						
Population	4,771	8,056	8,636	8,625	3,854	80.8%
Households	1,790	3,083	3,311	3,367	1,577	88.1%
Employment	8,878	10,848	11,058	11,583	2,705	30.5%
Augusta Twp.						
Population	6,596	8,405	11,375	12,207	5,611	85.1%
Households	2,376	3,331	4,716	5,082	2,706	113.9%
Employment	1,569	1,679	1,746	1,908	339	21.6%
Barton Hills						
Population	350	368	380	385	35	10.0%
Households	132	166	172	172	40	30.3%
Employment	276	284	272	280	4	1.4%
Bridgewater Twp.						
Population	1,663	1,591	1,606	1,652	-11	-0.7%
Households	601	651	687	709	108	18.0%
Employment	444	453	416	428	-16	-3.6%
Chelsea						
Population	4,823	6,506	6,779	6,913	2,090	43.3%
Households	2,127	2,809	2,943	2,975	848	39.9%
Employment	6,533	6,289	6,446	6,545	12	0.2%
Dexter						
Population	4,351	4,530	4,613	4,641	290	6.7%
Households	1,611	1,870	1,976	1,999	388	24.1%
Employment	3,813	3,890	4,040	4,314	501	13.1%
Dexter Twp.						
Population	6,530	6,662	6,983	7,326	796	12.2%
Households	2,445	2,577	2,797	2,997	552	22.6%
Employment	1,325	1,375	1,488	1,593	268	20.2%

2045 Forecast by Community for Washtenaw County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Freedom Twp.						
Population	1,420	1,321	1,314	1,220	-200	-14.1%
Households	604	573	569	554	-50	-8.3%
Employment	441	488	531	575	134	30.4%
Lima Twp.						
Population	3,503	3,498	4,257	4,869	1,366	39.0%
Households	1,264	1,337	1,689	1,970	706	55.9%
Employment	1,095	1,064	1,065	1,072	-23	-2.1%
Lodi Twp.						
Population	5,775	6,076	6,864	7,138	1,363	23.6%
Households	2,109	2,324	2,694	2,848	739	35.0%
Employment	1,985	2,121	2,099	2,226	241	12.1%
Lyndon Twp.						
Population	2,656	2,776	2,890	3,067	411	15.5%
Households	966	1,092	1,168	1,207	241	24.9%
Employment	601	659	698	719	118	19.6%
Manchester						
Population	1,877	2,434	3,096	3,253	1,376	73.3%
Households	834	1,078	1,396	1,474	640	76.7%
Employment	901	1,008	1,226	1,464	563	62.5%
Manchester Twp.						
Population	2,526	2,725	4,335	4,721	2,195	86.9%
Households	957	1,113	1,968	2,072	1,115	116.5%
Employment	515	552	595	646	131	25.4%
Milan (Washtenaw)						
Population	3,484	3,545	3,430	3,397	-87	-2.5%
Households	1,371	1,462	1,457	1,456	85	6.2%
Employment	1,499	1,636	1,684	1,809	310	20.7%
Northfield Twp.						
Population	8,167	9,709	10,469	12,388	4,221	51.7%
Households	3,267	4,104	4,458	5,283	2,016	61.7%
Employment	2,849	2,764	2,835	3,106	257	9.0%

2045 Forecast by Community for Washtenaw County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Pittsfield Twp.						
Population	38,917	44,134	49,732	55,486	16,569	42.6%
Households	14,229	16,439	18,977	21,419	7,190	50.5%
Employment	25,359	27,241	28,716	30,531	5,172	20.4%
Salem Twp.						
Population	6,395	7,451	7,877	8,034	1,639	25.6%
Households	2,437	2,969	3,181	3,263	826	33.9%
Employment	1,829	1,846	1,871	1,908	79	4.3%
Saline						
Population	8,190	8,633	8,710	8,711	521	6.4%
Households	3,486	3,765	3,822	3,799	313	9.0%
Employment	9,016	9,195	9,252	9,928	912	10.1%
Saline Twp.						
Population	1,890	2,048	3,237	4,377	2,487	131.6%
Households	803	905	1,487	1,999	1,196	148.9%
Employment	481	478	474	525	44	9.1%
Scio Twp.						
Population	17,893	21,816	24,653	26,281	8,388	46.9%
Households	6,412	8,688	10,088	11,110	4,698	73.3%
Employment	15,092	15,764	16,828	17,275	2,183	14.5%
Sharon Twp.						
Population	1,695	1,683	1,755	1,713	18	1.1%
Households	668	698	760	770	102	15.3%
Employment	325	380	418	420	95	29.2%
Superior Twp.						
Population	13,148	14,456	17,831	19,330	6,182	47.0%
Households	4,674	5,613	7,254	8,070	3,396	72.7%
Employment	9,970	10,693	10,919	11,155	1,185	11.9%
Sylvan Twp.						
Population	2,815	3,739	4,630	4,693	1,878	66.7%
Households	1,176	1,542	1,941	1,978	802	68.2%
Employment	1,406	1,597	1,808	1,881	475	33.8%

2045 Forecast by Community for Washtenaw County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Webster Twp.						
Population	5,925	6,161	6,849	7,104	1,179	19.9%
Households	2,195	2,387	2,732	2,843	648	29.5%
Employment	1,555	1,596	1,682	1,765	210	13.5%
York Twp.						
Population	8,444	12,509	16,881	17,334	8,890	105.3%
Households	2,368	4,255	6,074	6,263	3,895	164.5%
Employment	2,874	3,632	3,534	3,677	803	27.9%
Ypsilanti						
Population	22,086	23,062	23,743	24,480	2,394	10.8%
Households	8,653	8,825	8,898	9,176	523	6.0%
Employment	11,260	12,090	12,441	13,191	1,931	17.1%
Ypsilanti Twp.						
Population	55,358	55,869	58,367	61,121	5,763	10.4%
Households	21,850	22,907	24,250	25,607	3,757	17.2%
Employment	16,671	18,432	18,790	19,754	3,083	18.5%

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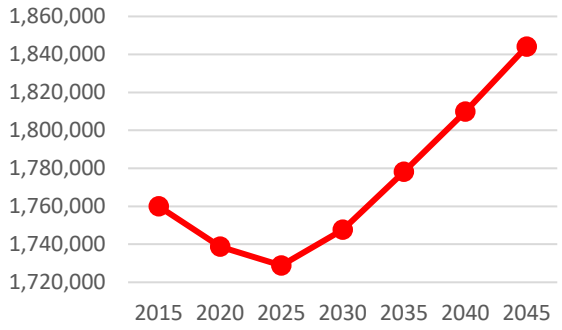
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Wayne County 2045 Forecast Summary

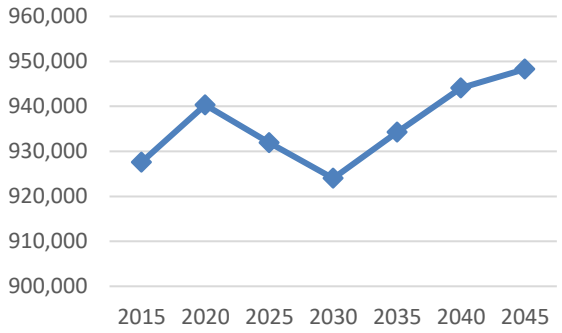
Population and Households

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Population	1,759,951	1,728,860	1,778,174	1,844,061	84,110	4.8%
Households	690,935	694,261	719,579	740,975	50,040	7.2%
Household Size	2.51	2.45	2.43	2.45	-0.06	-2.4%

Population



Employment



Employment

Sector	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Nat Res & Construction	33,730	32,401	33,535	33,154	-576	-1.7%
Manufacturing	92,985	83,198	72,826	65,559	-27,426	-29.5%
Wholesale Trade	32,187	32,703	32,561	32,383	196	0.6%
Retail Trade	81,255	76,529	71,844	69,073	-12,182	-15.0%
Transportation & Utilities	55,164	54,047	53,365	53,426	-1,738	-3.2%
Info & Financial Activities	78,139	78,399	77,256	76,948	-1,191	-1.5%
Prof/Tech Services & HQ	92,556	99,311	105,916	112,169	19,613	21.2%
Support & Waste Services	63,308	66,893	69,676	72,691	9,383	14.8%
Education Services	60,011	58,794	58,844	59,999	-12	0.0%
Healthcare Services	146,408	155,522	163,651	176,210	29,802	20.4%
Leisure & Hospitality	89,326	93,151	94,855	97,707	8,381	9.4%
Other Services	63,441	63,270	62,767	61,909	-1,532	-2.4%
Public Administration	39,291	38,171	37,961	38,117	-1,174	-3.0%
Total Employment	**927,801**	**932,389**	**935,057**	**949,345**	**21,544**	**2.3%**

2045 Forecast by Community for Wayne County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Allen Park						
Population	28,804	26,493	26,517	27,045	-1,759	-6.1%
Households	11,519	11,056	11,259	11,398	-121	-1.1%
Employment	14,423	14,253	14,101	14,398	-25	-0.2%
Belleville						
Population	4,002	3,585	3,638	3,787	-215	-5.4%
Households	1,733	1,595	1,626	1,651	-82	-4.7%
Employment	2,539	2,480	2,476	2,522	-17	-0.7%
Brownstown Twp.						
Population	31,216	31,104	33,539	35,690	4,474	14.3%
Households	11,730	12,547	13,828	14,792	3,062	26.1%
Employment	11,264	11,435	11,359	11,668	404	3.6%
Canton Twp.						
Population	92,521	101,086	110,226	114,119	21,598	23.3%
Households	33,659	37,976	42,235	43,737	10,078	29.9%
Employment	33,807	33,167	33,299	34,364	557	1.6%
Detroit						
Population	657,119	631,668	657,136	694,812	37,693	5.7%
Households	257,357	252,393	264,135	277,932	20,575	8.0%
Employment	336,795	345,026	346,182	351,179	14,384	4.3%
Dearborn						
Population	101,785	100,886	101,938	103,684	1,899	1.9%
Households	33,965	34,697	34,919	34,836	871	2.6%
Employment	89,861	88,807	89,059	90,515	654	0.7%
Dearborn Heights						
Population	59,371	60,865	62,132	62,542	3,171	5.3%
Households	22,506	22,976	23,087	23,051	545	2.4%
Employment	14,836	14,375	14,253	14,600	-236	-1.6%
Ecorse						
Population	8,877	8,824	8,649	8,690	-187	-2.1%
Households	3,498	3,705	3,755	3,766	268	7.7%
Employment	2,394	2,259	2,331	2,290	-104	-4.3%

2045 Forecast by Community for Wayne County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Flat Rock						
Population	9,695	9,133	9,357	9,902	207	2.1%
Households	3,741	3,643	3,796	3,985	244	6.5%
Employment	6,584	7,237	7,120	6,905	321	4.9%
Garden City						
Population	26,994	26,049	26,555	26,764	-230	-0.9%
Households	10,856	10,799	10,995	11,109	253	2.3%
Employment	10,322	10,094	10,065	10,151	-171	-1.7%
Gibraltar						
Population	4,837	4,925	4,917	5,276	439	9.1%
Households	2,049	2,053	2,100	2,180	131	6.4%
Employment	1,529	1,528	1,526	1,499	-30	-2.0%
Grosse Ile Twp.						
Population	10,304	9,834	10,305	10,666	362	3.5%
Households	4,172	4,079	4,264	4,380	208	5.0%
Employment	3,332	3,273	3,317	3,396	64	1.9%
Grosse Pointe						
Population	5,326	5,249	5,192	5,194	-132	-2.5%
Households	2,226	2,252	2,288	2,281	55	2.5%
Employment	4,622	4,596	4,654	4,688	66	1.4%
Grosse Pointe Farms						
Population	9,476	9,058	9,112	9,111	-365	-3.9%
Households	3,706	3,705	3,727	3,716	10	0.3%
Employment	5,685	5,567	5,568	5,709	24	0.4%
Grosse Pointe Park						
Population	12,529	12,095	12,017	12,201	-328	-2.6%
Households	4,922	4,949	4,966	4,977	55	1.1%
Employment	2,769	2,762	2,803	2,865	96	3.5%
Grosse Pointe Shores (Wayne)						
Population	2,532	2,409	2,499	2,555	23	0.9%
Households	1,021	1,016	1,053	1,064	43	4.2%
Employment	971	983	1,006	1,037	66	6.8%

2045 Forecast by Community for Wayne County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Grosse Pointe Woods						
Population	15,721	15,132	14,948	15,077	-644	-4.1%
Households	6,311	6,191	6,234	6,220	-91	-1.4%
Employment	6,231	6,201	6,242	6,449	218	3.5%
Hamtramck						
Population	22,902	22,879	23,135	23,349	447	2.0%
Households	7,133	7,253	7,308	7,331	198	2.8%
Employment	3,892	3,771	3,686	3,763	-129	-3.3%
Harper Woods						
Population	15,108	14,387	14,400	14,682	-426	-2.8%
Households	6,016	6,103	6,222	6,293	277	4.6%
Employment	5,271	4,644	4,593	4,679	-592	-11.2%
Highland Park						
Population	11,398	11,722	10,687	10,670	-728	-6.4%
Households	4,850	5,046	4,721	4,608	-242	-5.0%
Employment	6,181	6,140	6,282	6,329	148	2.4%
Huron Twp.						
Population	15,389	15,520	17,675	19,901	4,512	29.3%
Households	5,755	6,277	7,289	7,761	2,006	34.9%
Employment	4,266	4,122	4,013	4,103	-163	-3.8%
Inkster						
Population	25,760	24,808	24,259	24,420	-1,340	-5.2%
Households	10,147	10,367	10,375	10,431	284	2.8%
Employment	5,275	5,026	5,025	5,131	-144	-2.7%
Lincoln Park						
Population	37,323	35,025	34,908	35,618	-1,705	-4.6%
Households	14,570	14,318	14,600	14,716	146	1.0%
Employment	8,844	8,894	9,103	9,201	357	4.0%
Livonia						
Population	94,159	91,997	92,923	94,228	69	0.1%
Households	37,957	37,692	38,379	38,677	720	1.9%
Employment	85,999	87,714	87,576	88,876	2,877	3.3%

2045 Forecast by Community for Wayne County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Melvindale						
Population	10,160	9,543	9,710	9,830	-330	-3.2%
Households	4,344	4,275	4,385	4,415	71	1.6%
Employment	4,339	4,065	3,988	3,931	-408	-9.4%
Northville (Wayne)						
Population	2,690	2,676	2,903	3,064	374	13.9%
Households	1,182	1,184	1,267	1,271	89	7.5%
Employment	3,565	3,446	3,452	3,589	24	0.7%
Northville Twp.						
Population	30,306	34,771	36,157	36,886	6,580	21.7%
Households	11,847	13,401	14,019	14,305	2,458	20.7%
Employment	10,380	10,810	10,958	11,402	1,022	9.8%
Plymouth						
Population	8,872	9,341	9,534	9,786	914	10.3%
Households	4,141	4,080	4,147	4,250	109	2.6%
Employment	8,611	8,461	8,508	8,625	14	0.2%
Plymouth Twp.						
Population	27,440	29,130	30,121	30,649	3,209	11.7%
Households	11,260	12,336	13,018	13,325	2,065	18.3%
Employment	27,972	26,810	26,733	26,929	-1,043	-3.7%
Redford Twp.						
Population	47,880	44,719	44,772	45,277	-2,603	-5.4%
Households	19,201	18,798	19,146	19,398	197	1.0%
Employment	19,357	18,443	17,788	17,734	-1,623	-8.4%
River Rouge						
Population	6,776	5,743	5,536	5,462	-1,314	-19.4%
Households	2,552	2,348	2,314	2,307	-245	-9.6%
Employment	2,722	2,579	2,486	2,517	-205	-7.5%
Riverview						
Population	11,912	11,921	12,242	12,662	750	6.3%
Households	5,209	5,122	5,187	5,269	60	1.2%
Employment	4,960	4,907	5,008	5,255	295	5.9%

2045 Forecast by Community for Wayne County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Rockwood						
Population	2,880	2,704	2,780	2,952	72	2.5%
Households	1,194	1,167	1,180	1,271	77	6.4%
Employment	933	877	879	849	-84	-9.0%
Romulus						
Population	24,010	24,425	24,836	26,330	2,320	9.7%
Households	9,197	9,719	10,131	10,678	1,481	16.1%
Employment	37,490	40,030	40,663	41,333	3,843	10.3%
Southgate						
Population	29,963	29,193	29,834	30,615	652	2.2%
Households	12,954	12,822	13,190	13,326	372	2.9%
Employment	14,680	14,485	14,488	14,646	-34	-0.2%
Sumpter Twp.						
Population	8,323	8,178	8,191	8,641	318	3.8%
Households	3,294	3,238	3,351	3,446	152	4.6%
Employment	2,043	2,017	2,035	2,069	26	1.3%
Taylor						
Population	61,731	57,911	57,844	58,820	-2,911	-4.7%
Households	24,565	24,213	24,532	24,788	223	0.9%
Employment	33,731	33,105	33,037	33,417	-314	-0.9%
Trenton						
Population	17,807	17,324	17,511	18,507	700	3.9%
Households	7,884	7,686	7,752	8,010	126	1.6%
Employment	10,143	10,101	10,082	10,198	55	0.5%
Van Buren Twp.						
Population	29,274	31,898	34,064	35,966	6,692	22.9%
Households	12,276	13,225	14,207	14,950	2,674	21.8%
Employment	14,661	15,942	18,119	19,062	4,401	30.0%
Wayne						
Population	17,010	15,867	15,737	15,910	-1,100	-6.5%
Households	6,915	6,698	6,697	6,685	-230	-3.3%
Employment	15,920	14,910	14,363	14,167	-1,753	-11.0%

2045 Forecast by Community for Wayne County

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Westland						
Population	83,452	83,475	83,841	85,427	1,975	2.4%
Households	36,003	36,139	36,424	36,617	614	1.7%
Employment	27,207	25,696	25,726	26,268	-939	-3.5%
Woodhaven						
Population	12,385	12,184	12,592	13,216	831	6.7%
Households	5,278	5,124	5,264	5,359	81	1.5%
Employment	7,350	7,467	7,391	7,324	-26	-0.4%
Wyandotte						
Population	23,932	23,124	23,305	24,078	146	0.6%
Households	10,240	9,998	10,207	10,413	173	1.7%
Employment	14,045	13,884	13,714	13,713	-332	-2.4%

2045 Forecast for Multi-County Communities

	2015	2025	2035	2045	Change 2015-45 Number	Change 2015-45 Percent
Fenton *						
Population	2	2	2	2	0	0.0%
Households	1	1	1	1	0	0.0%
Employment	0	1	1	1	1	N/A
Grosse Pointe Shores						
Population	2,610	2,497	2,586	2,637	27	1.0%
Households	1,054	1,049	1,086	1,097	43	4.1%
Employment	1,085	1,087	1,102	1,133	48	4.4%
Memphis						
Population	1,169	1,001	1,011	981	-188	-16.1%
Households	450	454	482	473	23	5.1%
Employment	496	453	459	452	-44	-8.9%
Milan						
Population	5,599	5,641	5,485	5,474	-125	-2.2%
Households	2,205	2,322	2,319	2,332	127	5.8%
Employment	2,364	2,538	2,553	2,680	316	13.4%
Northville						
Population	5,828	5,798	6,005	6,183	355	6.1%
Households	2,504	2,506	2,605	2,602	98	3.9%
Employment	4,460	4,383	4,387	4,552	92	2.1%
Richmond						
Population	5,892	6,288	6,334	6,543	651	11.0%
Households	2,297	2,605	2,713	2,780	483	21.0%
Employment	2,799	2,850	2,905	2,982	183	6.5%

* Fenton includes only those portions within the SEMCOG region.

DRAFT – June 29, 2019

Appendix G: Floodplain Manhole Inspection Results

Wayne County Rouge Valley Sewage Disposal System

Floodplain Manhole Inspection Results
Long Term Corrective Action Plan – Phase 1 (Task G)
Floodplain Manhole Inspection

DRAFT

April 26, 2016

Prepared by:
OHM Advisors
34000 Plymouth Road
Livonia, MI 48150

Rouge Valley Sewage Disposal System
Phase 1: Floodplain Manhole Inspection
March 8, 2016

Introduction

Wayne County is in the process of developing a Long Term Corrective Action Plan (LTCAP) to satisfy the terms of its ACO, which require the analysis and capital improvements along the Rouge Valley Sewage Disposal System (RVSDS) interceptor system. Wayne County has been diligently working since the Short Term Corrective Action Plan (STCAP) in 2012 to develop the LTCAP. A two phase strategy is in place to meet the requirements of the FOA 2117. Phase 1 is to address existing sanitary sewer overflow (SSO) problems in the Middle and Lower Rouge. As part of that effort, OHM Advisors has inspected all accessible manholes within the 1-year floodplain of the Middle and Lower Rouge rivers. This effort will result in a manhole improvements plan (to be developed in 2016) that will address potential inflow sources into the RVSDS interceptor system.

Data Collection

Under the STCAP, Wayne County has already rehabilitated 968 manholes, including modifications intended to prevent river inflow along the Middle and Lower Rouge floodplains. To continue work from the STCAP, it was deemed necessary to re-inspect manholes within the 1-year floodplain (first priority) to verify whether the rehabilitation (which often included sealed/bolted manhole covers) was still effective (it has been about 4-5 years since the STCAP was implemented). An additional round of manhole inspections (those below the 2-year floodplain and above the 1-year floodplain) will occur in March/April 2016.

259 manholes were identified as being below the 1-year floodplain and were inspected in late 2015 along the Middle and Lower Rouge interceptors. The survey crew used GIS Collector (mobile application) to keep inventory of the manholes assessed. In addition to the original identified manholes, 26 more manholes with rim elevations below the 1-year floodplain were found, identified, and inspected as 1-year floodplain structures. Of these, four were not identified as 1-year floodplain manholes from ASI's list, but were in Wayne County's GIS database. An additional four were found by the field crew that where not in the current GIS database. Five structures, which were identified by ASI to be in the 10-year floodplain, were actually found to be in the 1-year floodplain. These thirteen manholes have already been updated in the RVSDS GIS database by OHM Advisors. Thirteen more manholes in the 1-year floodplain were found by the field crew that were also not in GIS; however, these still need to be added to the database.

A map of all locations inspected is provided in Appendix A. Additionally, imagery (including hyperlinks to images) for each manhole found and inspected can be found in Appendix A. No more

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manholes need to be assessed in the 1-year floodplain. A bar chart referencing the map is also provided in Table 1. Green designates completed inspections.

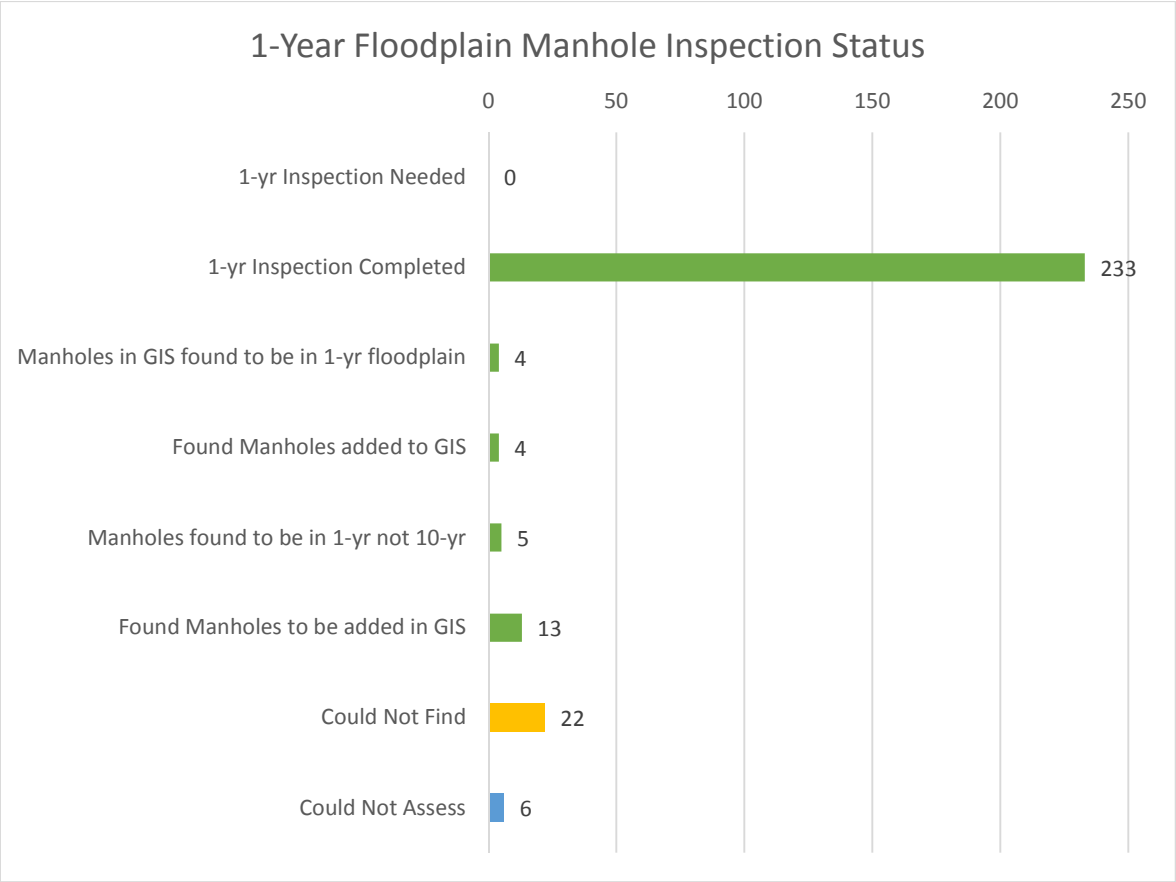


Figure 1 Manholes in 1-year floodplain found and inspected.

For each manhole found, the field crew inspected the cover, adjustment ring and frame, and chimney. The field crew inspected a total of 259 manholes. Of the manholes inspected, thirteen of the manholes were not identified in GIS Collector. This could be due to the following reason(s):

- Wayne County's GIS database is missing data.
- Field crew inspected manholes on local systems and adjacent to the RVSDS. In these cases, the inspection still provides valuable information, as the structures would still be susceptible to inflow if the covers are not secure.

After further analysis of the thirteen unknown manholes, it appears the structures are likely part of the RVSDS interceptors and will need to be added to the GIS database for future tracking.

Figure 2 (Appendix A) illustrates the locations of the 26 manholes described in the previous paragraphs. Table 1 lists the details for those manholes which status changed as part of this effort, including newly-found manholes.

Table 1 Summary of Manholes found in the 1-year floodplain

Structure ID	Manhole Status	X-Coordinate	Y-Coordinate
RVI 16-19	Found Manhole added to GIS	-83.411282	42.282387
RVI-19A	Found Manhole added to GIS	-83.412426	42.282172
RVI-19B	Found Manhole added to GIS	-83.412278	42.282174
RVI-19C	Found Manhole added to GIS	-83.411282	42.282387
WI X-23	Manhole found to be in 1-yr not 10-yr	-83.395771	42.284472
WI X-22	Manhole found to be in 1-yr not 10-yr	-83.395436	42.28472
WI X-14	Manhole found to be in 1-yr not 10-yr	-83.388798	42.285149
WI X-16	Manhole found to be in 1-yr not 10-yr	-83.389002	42.285175
WI X-18	Manhole found to be in 1-yr not 10-yr	-83.391302	42.285258
RVI 8-10	Manhole in GIS found to be in 1-yr floodplain	-83.330167	42.343697
NHV 2-29	Manhole in GIS found to be in 1-yr floodplain	-83.265593	42.344098
NHV 6-57	Manhole in GIS found to be in 1-yr floodplain	-83.317103	42.348234
RVI 8-04	Manhole in GIS found to be in 1-yr floodplain	-83.322945	42.345644
RVI 8-09	Found Manhole to be added to GIS	-83.327902	42.343962
NHV 3-09	Found Manhole to be added to GIS	-83.286517	42.347428
RVI 6-45	Found Manhole to be added to GIS	-83.300559	42.351791
Abandoned Regulator	Found Manhole to be added to GIS	-83.276146	42.347099
Missing point Before MR I-10	Found Manhole to be added to GIS	-83.259083	42.337048
DH local connection siphon?	Found Manhole to be added to GIS	-83.249565	42.330609
Post 15 J	Found Manhole to be added to GIS	-83.245928	42.331429
Post 15 K	Found Manhole to be added to GIS	-83.246428	42.331124
RVI 4-16B	Found Manhole to be added to GIS	-83.249432	42.330231
5L-04	Found Manhole to be added to GIS	-83.331958	42.343267
RVI 16-19A?	Found Manhole to be added to GIS	-83.412169	42.282142
Unknown local 1	Found Manhole to be added to GIS	-83.291937	42.302578
RVI 16-27	Found Manhole to be added to GIS	-83.424071	42.284115

Key Findings

In general, the RVSDS interceptor manholes within the 1-year floodplain were found to have significant maintenance deficiencies that would increase the likelihood of wet weather inflow. The most common deficiency, missing gasket/bolts, was observed in 26% of the inspected manholes. In these cases, the missing bolts were observed in close proximity to the manhole, which suggests that the manhole was previously removed and the bolts were not replaced. Several manholes in the

vicinity of the Warren Valley Golf Course clubhouse were noted to have missing bolts, which suggests that golf course staff may have removed these manholes in an attempt to dewater the area around the clubhouse during previous wet weather events. In total, 51% of the inspected manholes had deficiencies.

All 1-year floodplain manhole inspection data were analyzed based on manhole components that are missing, are in poor condition, or pose a potential threat to public safety. These components include the cover, gasket/bolts, and adjustment ring and frame. Manholes with missing lids or observed overflow potential (based on the presence of debris in the vicinity of the manhole) are of concern to the safety of the public. Table 2 lists the manholes with deficient characteristics that could negatively impact the RVSDS interceptor during wet weather events. Appendix B includes a more comprehensive table listing each component with the structure ID and observed characteristics of each manhole.

Table 2 Summary of Manholes with Missing or Poor Condition Components

Component	Number of Manholes	Percent of Manholes Inspected
Missing Gasket/Bolts	66	26%
Poor Condition Rim	4	2%
Missing/Loose Frame and Seal	43	17%
Evidence of SSO	10	4%
Missing Lid	1	0%

Additionally, the data collected were compared to improvements made during 2010 and 2011 as part of the RVSDS STCAP. It is of interest to Wayne County to determine whether the improvements made to the structures have held since 2010 and 2011. Only one manhole, RV1 13-03, was found to have had new gasket/bolts replaced in 2011 and is now missing bolts and in poor condition; otherwise, the rehabilitated manholes from the STCAP have stayed intact.

Many manholes were identified to have multiple component repair needs. Table 3 lists the multiple combinations of rehabilitation needed per manhole.

Table 3 Summary of Multiple Components per Manhole

Component	Number of Manholes
Missing Gasket/Bolts ***and*** Frame Missing or Poor	16
Missing Gasket/Bolts ***and*** Evidence of SSO	4
Missing Gasket/Bolts, Frame, ***and*** Evidence of SSO	1
Missing Gasket/Bolts ***and*** Poor Condition Rim	1
Missing Frame ***and*** Poor Condition Rim	1

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April Floodplain Manhole Inspection

Additional floodplain manholes were inspected in April. The manholes that were inspected are within the 2-year floodplain of the Middle and Lower Rouge rivers. A total of 20 manholes were identified in the 2-year floodplain. The survey crew used GIS Collector to keep inventory of the manholes assessed.

A map of all locations inspected is provided in Appendix C. Additionally, image (including hyperlinks to images) for each manhole found and inspected can be found in Appendix C. No more manholes need to be assessed in the 2-year floodplain.

All 2-year floodplain manholes inspection data were analyzed similarly to the 1-year floodplain manholes. The analysis was based on manhole components that are missing, are in poor condition, or pose a potential threat to public safety. These components include the cover, gasket/bolts, and adjustment ring and frame. Table 4 lists the manholes with deficient characteristics that could negatively impact the RVSDS interceptor during wet weather events, and Table 5 list the multiple combinations of rehabilitation needed per manhole. Appendix C includes a more comprehensive table listing each component with the structure ID and observed characteristics of each manhole.

Additionally, the data collected were compared to improvements made during 2010 and 2011 as part of the RVSDS STCAP. Only one manhole in the 2-year floodplain, RVI 14-05, was found to have had new gasket/bolts replaced in 2011 and is now in poor condition.

Table 4 Summary of Manholes with Missing or Poor Condition Components

Component	Number of Manholes	Percent of Manholes Inspected
Missing Gasket/Bolts	7	35%
Poor Condition Rim	3	15%
Missing/Loose Frame and Seal	19	95%

Table 5 Summary of Multiple Components per Manhole

Component	Number of Manholes
Missing Gasket/Bolts ***and*** Frame Missing or Poor	5
Missing Gasket/Bolts, Frame ***and*** Poor Condition Rim	2
Missing Frame ***and*** Poor Condition Rim	1

Recommendations

It is recommended that Wayne County addresses the following manholes for improvements in Phase 1 of the LTCAP, in the order presented below.

- Replace the missing manhole lid for RVI 13-23.
- Address manholes with multiple components in poor condition or missing below in the 1-year and 2-year floodplain.
- Address manholes with only one component in poor condition or missing. First, focus on the manholes in the 1-year and 2-year floodplain with missing gaskets and bolts and then move onto manholes with poor seals and frame.
- Use tamper-proof bolts for future manhole improvements. Focus the use of tamper-proof bolts in high-risk areas, including the Warren Valley Golf Course and other manholes in easily-accessible areas. In the long term, all 1-year floodplain manholes should have tamper-proof bolts.

Facility ID	Floodplain	Component	Improvements Made by Wayne County
RVI 13-23	1-year	Missing Manhole Lid	Yes
5L-04	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
5L-17	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
Abandoned Regulator	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
Unknown Facility ID-Before MR I-10	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
MR II-10F	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
MR II-10G	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
MR III-12A	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
NHV 2-11	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
NHV 2-17	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
NHV 2-21	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
NHV 3-38	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
NHV 4A-03	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
RVI 6-09	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
RVI 6-28	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
SA06SE032	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
RVI 16-04A	1-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	

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INK-23	1-year	Missing Gasket/Bolts ***and*** Evidence of SSO	
NHV 3-13	1-year	Missing Gasket/Bolts ***and*** Evidence of SSO	
NHV 4A-02	1-year	Missing Gasket/Bolts ***and*** Evidence of SSO	
RVI 6-37	1-year	Missing Gasket/Bolts ***and*** Evidence of SSO	
SA06SE014	1-year	Missing Gasket/Bolts, Frame, ***and*** Evidence of SSO	
RVI 4-16C	1-year	Missing Gasket/Bolts ***and*** Poor Condition Rim	
NHV 4A-05	1-year	Missing Frame ***and*** Poor Condition Rim	
INK-09	2-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
NHV 5A-01	2-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
RVI 14-05	2-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
RVI 5-12A	2-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
WI X-26	2-year	Missing Gasket/Bolts ***and*** Frame Missing or Poor	
SA09NW043	2-year	Missing Gasket/Bolts, Frame ***and*** Poor Condition Rim	
SA09NW048	2-year	Missing Gasket/Bolts, Frame ***and*** Poor Condition Rim	
SA09NW042	2-year	Missing Frame ***and*** Poor Condition Rim	

Additionally, it will likely be necessary for Wayne County to conduct a regular inspection and training program for the manholes within the 1-year and 2-year floodplain, including:

- Bi-annual inspection of 1-year and 2-year floodplain manholes (similar in scope to this inspection).
    - Track condition of floodplain manholes in GIS.
- Regular training for Wayne County Operations staff to ensure manholes are property seated and bolted after every access.
- Training for Warren Valley Golf Course staff on importance of maintaining sealed manhole rims. This may require inspection of these manholes during wet weather events to ensure the staff is not removing the manhole covers.

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Appendix A: Data Collection

RVSDS
One Year Floodplain Manhole Inspections

Figure 1

N
W E
S

0 2,000 4,000 6,000
Feet

1" = 2,000'

Manholes
- 1-yr Inspection Completed
- Manholes in GIS found to be in 1-yr floodplain
- Found Manholes added to GIS
- Manholes found to be in 1-yr not 10-yr
- Could Not Find
- Could Not Assess
- Found Manholes to be added to GIS

Sanitary Gravity Main

Source: Data provided by Wayne County and ESRI. 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 HARN StatePlane Michigan North FIPS 2111 Feet Intl

Map Published: November 30, 2015

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

OHM Advancing Communities
888.522.6711 | ohm-advisors.com

Table 1 Imagery for all Manholes Inspected

Structure ID	Latitude	Longitude	Interceptor	Image 1 Hyperlink	Image 2 Hyperlink	Image 3 Hyperlink	Image 4 Hyperlink	Image 5 Hyperlink	Image 6 Hyperlink	Image 7 Hyperlink	Image 8 Hyperlink
5L-01	42.3440737	-83.3322644	Middle Rouge	5L-01	5L-01	5L-01	5L-01	5L-01	5L-01	5L-01	5L-01
5L-04	42.34326717	-83.3319585	Middle Rouge	5L-04	5L-04	5L-04	5L-04	5L-04	5L-04	5L-04	5L-04
5L-08	42.3401562	-83.3398175	Middle Rouge	5L-08	5L-08	5L-08	5L-08	5L-08	5L-08	5L-08	5L-08
5L-15	42.3383044	-83.35053378	Middle Rouge	5L-15	5L-15	5L-15	5L-15	5L-15	5L-15	5L-15	5L-15
5L-16	42.3414012	-83.3510882	Middle Rouge	5L-16	5L-16	5L-16	5L-16	5L-16	5L-16	5L-16	5L-16
5L-17	42.34140848	-83.35255393	Middle Rouge	5L-17	5L-17	5L-17	5L-17	5L-17	5L-17	5L-17	5L-17
6L-01	42.3496897	-83.314755	Middle Rouge	6L-01	6L-01	6L-01	6L-01	6L-01	6L-01	6L-01	6L-01
6L-02	42.3501965	-83.31517783	Middle Rouge	6L-02	6L-02	6L-02	6L-02	6L-02	6L-02	6L-02	6L-02
6L-04	42.3476658	-83.3166513	Middle Rouge	6L-04	6L-04	6L-04	6L-04	6L-04	6L-04	6L-04	6L-04
Abandoned Regulator	42.3470985	-83.2761465	Middle Rouge	Abandoned Regulator	Abandoned Regulator	Abandoned Regulator	Abandoned Regulator	Abandoned Regulator	Abandoned Regulator	Abandoned Regulator	Abandoned Regulator
DH local connection siphon?	42.33060883	-83.249565	Middle Rouge	DH local connection siphon?	DH local connection siphon?	DH local connection siphon?	DH local connection siphon?	DH local connection siphon?	DH local connection siphon?	DH local connection siphon?	DH local connection siphon?
INK-03	42.3519455	-83.3063006	Middle Rouge	INK-03	INK-03	INK-03	INK-03	INK-03	INK-03	INK-03	INK-03
INK-16	42.3478452	-83.2880348	Middle Rouge	INK-16	INK-16	INK-16	INK-16	INK-16	INK-16	INK-16	INK-16
INK-18	42.34687867	-83.27847933	Middle Rouge	INK-18	INK-18	INK-18	INK-18	INK-18	INK-18	INK-18	INK-18
INK-20	42.34732167	-83.27710833	Middle Rouge	INK-20	INK-20	INK-20	INK-20	INK-20	INK-20	INK-20	INK-20
INK-21	42.34731933	-83.27707533	Middle Rouge	INK-21	INK-21	INK-21	INK-21	INK-21	INK-21	INK-21	INK-21
INK-23	42.34413183	-83.26732433	Middle Rouge	INK-23	INK-23	INK-23	INK-23	INK-23	INK-23	INK-23	INK-23
INK-24	42.34335867	-83.26770567	Middle Rouge	INK-24	INK-24	INK-24	INK-24	INK-24	INK-24	INK-24	INK-24
JC 2-8?	42.3310872	-83.2500346	Middle Rouge	JC 2-8?	JC 2-8?	JC 2-8?	JC 2-8?	JC 2-8?	JC 2-8?	JC 2-8?	JC 2-8?
Merrimanhollow	42.3418159	-83.35277035	Middle Rouge	Merrimanhollow	Merrimanhollow	Merrimanhollow	Merrimanhollow	Merrimanhollow	Merrimanhollow	Merrimanhollow	Merrimanhollow
Missing point on BeforeMR I-10	42.33704783	-83.25908317	Middle Rouge	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10	Missing point on BeforeMR I-10
MR 3-15	42.3429873	-83.3354509	Middle Rouge	MR 3-15	MR 3-15	MR 3-15	MR 3-15	MR 3-15	MR 3-15	MR 3-15	MR 3-15
MR I-04	42.33103933	-83.24414567	Middle Rouge	MR I-04	MR I-04	MR I-04	MR I-04	MR I-04	MR I-04	MR I-04	MR I-04
MR I-05	42.33110883	-83.24453917	Middle Rouge	MR I-05	MR I-05	MR I-05	MR I-05	MR I-05	MR I-05	MR I-05	MR I-05
MR I-05A	42.3313055	-83.24581983	Middle Rouge	MR I-05A	MR I-05A	MR I-05A	MR I-05A	MR I-05A	MR I-05A	MR I-05A	MR I-05A
MR I-06	42.331052	-83.250443	Middle Rouge	MR I-06	MR I-06	MR I-06	MR I-06	MR I-06	MR I-06	MR I-06	MR I-06
MR I-06A	42.331116	-83.2498012	Middle Rouge	MR I-06A	MR I-06A	MR I-06A	MR I-06A	MR I-06A	MR I-06A	MR I-06A	MR I-06A
MR I-07	42.33148767	-83.25318267	Middle Rouge	MR I-07	MR I-07	MR I-07	MR I-07	MR I-07	MR I-07	MR I-07	MR I-07
MR I-07B	42.3321785	-83.255069	Middle Rouge	MR I-07B	MR I-07B	MR I-07B	MR I-07B	MR I-07B	MR I-07B	MR I-07B	MR I-07B
MR I-08	42.33265333	-83.25637367	Middle Rouge	MR I-08	MR I-08	MR I-08	MR I-08	MR I-08	MR I-08	MR I-08	MR I-08
MR I-10	42.336497	-83.25888167	Middle Rouge	MR I-10	MR I-10	MR I-10	MR I-10	MR I-10	MR I-10	MR I-10	MR I-10
MR I-13	42.341927	-83.2632615	Middle Rouge	MR I-13	MR I-13	MR I-13	MR I-13	MR I-13	MR I-13	MR I-13	MR I-13
MR II -18	42.3507215	-83.3073749	Middle Rouge	MR II -18	MR II -18	MR II -18	MR II -18	MR II -18	MR II -18	MR II -18	MR II -18

MR II-02	42.3475894	-83.2785988	Middle Rouge	MR II-02	MR II-02	MR II-02	MR II-02	MR II-02	MR II-02	MR II-02	MR II-02
MR II-03	42.3473317	-83.2816941	Middle Rouge	MR II-03	MR II-03	MR II-03	MR II-03	MR II-03	MR II-03	MR II-03	MR II-03
MR II-04	42.3472386	-83.2835206	Middle Rouge	MR II-04	MR II-04	MR II-04	MR II-04	MR II-04	MR II-04	MR II-04	MR II-04
MR II-05	42.3469957	-83.2864858	Middle Rouge	MR II-05	MR II-05	MR II-05	MR II-05	MR II-05	MR II-05	MR II-05	MR II-05
MR II-06	42.3472802	-83.2884881	Middle Rouge	MR II-06	MR II-06	MR II-06	MR II-06	MR II-06	MR II-06	MR II-06	MR II-06
MR II-07	42.3475429	-83.2902919	Middle Rouge	MR II-07	MR II-07	MR II-07	MR II-07	MR II-07	MR II-07	MR II-07	MR II-07
MR II-10	42.34554367	-83.29464883	Middle Rouge	MR II-10	MR II-10	MR II-10	MR II-10	MR II-10	MR II-10	MR II-10	MR II-10
MR II-10B	42.3437446	-83.2955597	Middle Rouge	MR II-10B	MR II-10B	MR II-10B	MR II-10B	MR II-10B	MR II-10B	MR II-10B	MR II-10B
MR II-10C	42.3432995	-83.296013	Middle Rouge	MR II-10C	MR II-10C	MR II-10C	MR II-10C	MR II-10C	MR II-10C	MR II-10C	MR II-10C
MR II-10F	42.3446922	-83.2957287	Middle Rouge	MR II-10F	MR II-10F	MR II-10F	MR II-10F	MR II-10F	MR II-10F	MR II-10F	MR II-10F
MR II-10G	42.34395067	-83.29666133	Middle Rouge	MR II-10G	MR II-10G	MR II-10G	MR II-10G	MR II-10G	MR II-10G	MR II-10G	MR II-10G
MR II-10H	42.3436	-83.29703483	Middle Rouge	MR II-10H	MR II-10H	MR II-10H	MR II-10H	MR II-10H	MR II-10H	MR II-10H	MR II-10H
MR II-10I	42.34342433	-83.297332	Middle Rouge	MR II-10I	MR II-10I	MR II-10I	MR II-10I	MR II-10I	MR II-10I	MR II-10I	MR II-10I
MR II-11	42.3459629	-83.2968405	Middle Rouge	MR II-11	MR II-11	MR II-11	MR II-11	MR II-11	MR II-11	MR II-11	MR II-11
MR II-12	42.3465685	-83.29906	Middle Rouge	MR II-12	MR II-12	MR II-12	MR II-12	MR II-12	MR II-12	MR II-12	MR II-12
MR II-13	42.3479631	-83.2996568	Middle Rouge	MR II-13	MR II-13	MR II-13	MR II-13	MR II-13	MR II-13	MR II-13	MR II-13
MR II-14	42.3493012	-83.3001088	Middle Rouge	MR II-14	MR II-14	MR II-14	MR II-14	MR II-14	MR II-14	MR II-14	MR II-14
MR II-15	42.3505787	-83.3010757	Middle Rouge	MR II-15	MR II-15	MR II-15	MR II-15	MR II-15	MR II-15	MR II-15	MR II-15
MR II-15A	42.350899	-83.30188917	Middle Rouge	MR II-15A	MR II-15A	MR II-15A	MR II-15A	MR II-15A	MR II-15A	MR II-15A	MR II-15A
MR II-17	42.3516462	-83.3058822	Middle Rouge	MR II-17	MR II-17	MR II-17	MR II-17	MR II-17	MR II-17	MR II-17	MR II-17
MR II-19	42.349807	-83.30884117	Middle Rouge	MR II-19	MR II-19	MR II-19	MR II-19	MR II-19	MR II-19	MR II-19	MR II-19
MR II-20	42.3488905	-83.31061583	Middle Rouge	MR II-20	MR II-20	MR II-20	MR II-20	MR II-20	MR II-20	MR II-20	MR II-20
MR II-21	42.34920717	-83.313151	Middle Rouge	MR II-21	MR II-21	MR II-21	MR II-21	MR II-21	MR II-21	MR II-21	MR II-21
MR III-01	42.3492377	-83.3142735	Middle Rouge	MR III-01	MR III-01	MR III-01	MR III-01	MR III-01	MR III-01	MR III-01	MR III-01
MR III-02	42.3482248	-83.3170952	Middle Rouge	MR III-02	MR III-02	MR III-02	MR III-02	MR III-02	MR III-02	MR III-02	MR III-02
MR III-05	42.34575767	-83.32291917	Middle Rouge	MR III-05	MR III-05	MR III-05	MR III-05	MR III-05	MR III-05	MR III-05	MR III-05
MR III-06	42.34439167	-83.32437183	Middle Rouge	MR III-06	MR III-06	MR III-06	MR III-06	MR III-06	MR III-06	MR III-06	MR III-06
MR III-10	42.34406483	-83.32639617	Middle Rouge	MR III-10	MR III-10	MR III-10	MR III-10	MR III-10	MR III-10	MR III-10	MR III-10
MR III-10A	42.3438149	-83.3277905	Middle Rouge	MR III-10A	MR III-10A	MR III-10A	MR III-10A	MR III-10A	MR III-10A	MR III-10A	MR III-10A
MR III-11	42.3438635	-83.3282076	Middle Rouge	MR III-11	MR III-11	MR III-11	MR III-11	MR III-11	MR III-11	MR III-11	MR III-11
MR III-12	42.3436772	-83.3301884	Middle Rouge	MR III-12	MR III-12	MR III-12	MR III-12	MR III-12	MR III-12	MR III-12	MR III-12
MR III-12A	42.3436534	-83.3321169	Middle Rouge	MR III-12A	MR III-12A	MR III-12A	MR III-12A	MR III-12A	MR III-12A	MR III-12A	MR III-12A
MR III-13	42.3436653	-83.332192	Middle Rouge	MR III-13	MR III-13	MR III-13	MR III-13	MR III-13	MR III-13	MR III-13	MR III-13
MR III-14	42.3436613	-83.3337611	Middle Rouge	MR III-14	MR III-14	MR III-14	MR III-14	MR III-14	MR III-14	MR III-14	MR III-14
MR III-16	42.3417343	-83.3378541	Middle Rouge	MR III-16	MR III-16	MR III-16	MR III-16	MR III-16	MR III-16	MR III-16	MR III-16
MR III-17	42.3403683	-83.3399409	Middle Rouge	MR III-17	MR III-17	MR III-17	MR III-17	MR III-17	MR III-17	MR III-17	MR III-17
MR III-18	42.339387	-83.3426929	Middle Rouge	MR III-18	MR III-18	MR III-18	MR III-18	MR III-18	MR III-18	MR III-18	MR III-18
MR III-19	42.3387961	-83.3445597	Middle Rouge	MR III-19	MR III-19	MR III-19	MR III-19	MR III-19	MR III-19	MR III-19	MR III-19

MR III-20	42.3388298	-83.3466974	Middle Rouge	MR III-20	MR III-20	MR III-20	MR III-20	MR III-20	MR III-20	MR III-20	MR III-20
MR III-22	42.3394663	-83.3487439	Middle Rouge	MR III-22	MR III-22	MR III-22	MR III-22	MR III-22	MR III-22	MR III-22	MR III-22
MR III-23A	42.34016867	-83.35254716	Middle Rouge	MR III-23A	MR III-23A	MR III-23A	MR III-23A	MR III-23A	MR III-23A	MR III-23A	MR III-23A
MR III-23B	42.34051113	-83.35244882	Middle Rouge	MR III-23B	MR III-23B	MR III-23B	MR III-23B	MR III-23B	MR III-23B	MR III-23B	MR III-23B
MR III-23C	42.3408362	-83.3500823	Middle Rouge	MR III-23C	MR III-23C	MR III-23C	MR III-23C	MR III-23C	MR III-23C	MR III-23C	MR III-23C
NHV 2-08A	42.3310426	-83.2498629	Middle Rouge	NHV 2-08A	NHV 2-08A	NHV 2-08A	NHV 2-08A	NHV 2-08A	NHV 2-08A	NHV 2-08A	NHV 2-08A
NHV 2-11	42.33095733	-83.25143433	Middle Rouge	NHV 2-11	NHV 2-11	NHV 2-11	NHV 2-11	NHV 2-11	NHV 2-11	NHV 2-11	NHV 2-11
NHV 2-12	42.33142483	-83.25324917	Middle Rouge	NHV 2-12	NHV 2-12	NHV 2-12	NHV 2-12	NHV 2-12	NHV 2-12	NHV 2-12	NHV 2-12
NHV 2-14	42.332137	-83.2551155	Middle Rouge	NHV 2-14	NHV 2-14	NHV 2-14	NHV 2-14	NHV 2-14	NHV 2-14	NHV 2-14	NHV 2-14
NHV 2-16	42.333116	-83.2576745	Middle Rouge	NHV 2-16	NHV 2-16	NHV 2-16	NHV 2-16	NHV 2-16	NHV 2-16	NHV 2-16	NHV 2-16
NHV 2-17	42.33463617	-83.25829533	Middle Rouge	NHV 2-17	NHV 2-17	NHV 2-17	NHV 2-17	NHV 2-17	NHV 2-17	NHV 2-17	NHV 2-17
NHV 2-18	42.33573483	-83.2586845	Middle Rouge	NHV 2-18	NHV 2-18	NHV 2-18	NHV 2-18	NHV 2-18	NHV 2-18	NHV 2-18	NHV 2-18
NHV 2-21	42.3440846	-83.2655968	Middle Rouge	NHV 2-21	NHV 2-21	NHV 2-21	NHV 2-21	NHV 2-21	NHV 2-21	NHV 2-21	NHV 2-21
NHV 2-22	42.3387942	-83.262358	Middle Rouge	NHV 2-22	NHV 2-22	NHV 2-22	NHV 2-22	NHV 2-22	NHV 2-22	NHV 2-22	NHV 2-22
NHV 2-23	42.3397295	-83.26322133	Middle Rouge	NHV 2-23	NHV 2-23	NHV 2-23	NHV 2-23	NHV 2-23	NHV 2-23	NHV 2-23	NHV 2-23
NHV 2-26	42.34242767	-83.263631	Middle Rouge	NHV 2-26	NHV 2-26	NHV 2-26	NHV 2-26	NHV 2-26	NHV 2-26	NHV 2-26	NHV 2-26
NHV 2-27	42.3434204	-83.264371	Middle Rouge	NHV 2-27	NHV 2-27	NHV 2-27	NHV 2-27	NHV 2-27	NHV 2-27	NHV 2-27	NHV 2-27
NHV 2-28	42.34380183	-83.26496117	Middle Rouge	NHV 2-28	NHV 2-28	NHV 2-28	NHV 2-28	NHV 2-28	NHV 2-28	NHV 2-28	NHV 2-28
NHV 2-30	42.34424733	-83.26610867	Middle Rouge	NHV 2-30	NHV 2-30	NHV 2-30	NHV 2-30	NHV 2-30	NHV 2-30	NHV 2-30	NHV 2-30
NHV 2-31	42.344459	-83.26720933	Middle Rouge	NHV 2-31	NHV 2-31	NHV 2-31	NHV 2-31	NHV 2-31	NHV 2-31	NHV 2-31	NHV 2-31
NHV 3-01	42.34737467	-83.27586067	Middle Rouge	NHV 3-01	NHV 3-01	NHV 3-01	NHV 3-01	NHV 3-01	NHV 3-01	NHV 3-01	NHV 3-01
NHV 3-02	42.34774767	-83.27682483	Middle Rouge	NHV 3-02	NHV 3-02	NHV 3-02	NHV 3-02	NHV 3-02	NHV 3-02	NHV 3-02	NHV 3-02
NHV 3-03	42.3479015	-83.27787667	Middle Rouge	NHV 3-03	NHV 3-03	NHV 3-03	NHV 3-03	NHV 3-03	NHV 3-03	NHV 3-03	NHV 3-03
NHV 3-04	42.348055	-83.2791125	Middle Rouge	NHV 3-04	NHV 3-04	NHV 3-04	NHV 3-04	NHV 3-04	NHV 3-04	NHV 3-04	NHV 3-04
NHV 3-05	42.3480067	-83.2806064	Middle Rouge	NHV 3-05	NHV 3-05	NHV 3-05	NHV 3-05	NHV 3-05	NHV 3-05	NHV 3-05	NHV 3-05
NHV 3-06	42.3478769	-83.2820816	Middle Rouge	NHV 3-06	NHV 3-06	NHV 3-06	NHV 3-06	NHV 3-06	NHV 3-06	NHV 3-06	NHV 3-06
NHV 3-07	42.34777167	-83.283483	Middle Rouge	NHV 3-07	NHV 3-07	NHV 3-07	NHV 3-07	NHV 3-07	NHV 3-07	NHV 3-07	NHV 3-07
NHV 3-08	42.3476205	-83.2849625	Middle Rouge	NHV 3-08	NHV 3-08	NHV 3-08	NHV 3-08	NHV 3-08	NHV 3-08	NHV 3-08	NHV 3-08
NHV 3-09	42.3474279	-83.2865167	Middle Rouge	NHV 3-09	NHV 3-09	NHV 3-09	NHV 3-09	NHV 3-09	NHV 3-09	NHV 3-09	NHV 3-09
NHV 3-10	42.3475131	-83.287894	Middle Rouge	NHV 3-10	NHV 3-10	NHV 3-10	NHV 3-10	NHV 3-10	NHV 3-10	NHV 3-10	NHV 3-10
NHV 3-11	42.3478471	-83.2887617	Middle Rouge	NHV 3-11	NHV 3-11	NHV 3-11	NHV 3-11	NHV 3-11	NHV 3-11	NHV 3-11	NHV 3-11
NHV 3-12	42.34790933	-83.29008683	Middle Rouge	NHV 3-12	NHV 3-12	NHV 3-12	NHV 3-12	NHV 3-12	NHV 3-12	NHV 3-12	NHV 3-12
NHV 3-13	42.3476826	-83.2903871	Middle Rouge	NHV 3-13	NHV 3-13	NHV 3-13	NHV 3-13	NHV 3-13	NHV 3-13	NHV 3-13	NHV 3-13
NHV 3-22	42.3505925	-83.29918667	Middle Rouge	NHV 3-22	NHV 3-22	NHV 3-22	NHV 3-22	NHV 3-22	NHV 3-22	NHV 3-22	NHV 3-22
NHV 3-29	42.3518593	-83.3061907	Middle Rouge	NHV 3-29	NHV 3-29	NHV 3-29	NHV 3-29	NHV 3-29	NHV 3-29	NHV 3-29	NHV 3-29
NHV 3-30	42.3513409	-83.3072904	Middle Rouge	NHV 3-30	NHV 3-30	NHV 3-30	NHV 3-30	NHV 3-30	NHV 3-30	NHV 3-30	NHV 3-30
NHV 3-37W	42.34969267	-83.31309217	Middle Rouge	NHV 3-37W	NHV 3-37W	NHV 3-37W	NHV 3-37W	NHV 3-37W	NHV 3-37W	NHV 3-37W	NHV 3-37W
NHV 3-38	42.3465635	-83.29346867	Middle Rouge	NHV 3-38	NHV 3-38	NHV 3-38	NHV 3-38	NHV 3-38	NHV 3-38	NHV 3-38	NHV 3-38
NHV 4A-01	42.3493285	-83.31496783	Middle Rouge	NHV 4A-01	NHV 4A-01	NHV 4A-01	NHV 4A-01	NHV 4A-01	NHV 4A-01	NHV 4A-01	NHV 4A-01
NHV 4A-02	42.3489929	-83.3159553	Middle Rouge	NHV 4A-02	NHV 4A-02	NHV 4A-02	NHV 4A-02	NHV 4A-02	NHV 4A-02	NHV 4A-02	NHV 4A-02

NHV 4A-03	42.3483318	-83.317515	Middle Rouge	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03
NHV 4A-03	42.3484884	-83.3171636	Middle Rouge	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03	NHV 4A-03
NHV 4A-04	42.34824367	-83.317901	Middle Rouge	NHV 4A-04	NHV 4A-04	NHV 4A-04	NHV 4A-04	NHV 4A-04	NHV 4A-04	NHV 4A-04	NHV 4A-04
NHV 4A-05	42.3479056	-83.319367	Middle Rouge	NHV 4A-05	NHV 4A-05	NHV 4A-05	NHV 4A-05	NHV 4A-05	NHV 4A-05	NHV 4A-05	NHV 4A-05
NHV 4A-13	42.34416117	-83.32613783	Middle Rouge	NHV 4A-13	NHV 4A-13	NHV 4A-13	NHV 4A-13	NHV 4A-13	NHV 4A-13	NHV 4A-13	NHV 4A-13
NHV 4A-13A	42.3439537	-83.3274284	Middle Rouge	NHV 4A-13A	NHV 4A-13A	NHV 4A-13A	NHV 4A-13A	NHV 4A-13A	NHV 4A-13A	NHV 4A-13A	NHV 4A-13A
NHV 4A-14	42.3440895	-83.3275276	Middle Rouge	NHV 4A-14	NHV 4A-14	NHV 4A-14	NHV 4A-14	NHV 4A-14	NHV 4A-14	NHV 4A-14	NHV 4A-14
NHV 4A-15	42.3438605	-83.3291638	Middle Rouge	NHV 4A-15	NHV 4A-15	NHV 4A-15	NHV 4A-15	NHV 4A-15	NHV 4A-15	NHV 4A-15	NHV 4A-15
NHV 4A-16	42.3437426	-83.3301951	Middle Rouge	NHV 4A-16	NHV 4A-16	NHV 4A-16	NHV 4A-16	NHV 4A-16	NHV 4A-16	NHV 4A-16	NHV 4A-16
NHV 4A-16A	42.3439289	-83.3312935	Middle Rouge	NHV 4A-16A	NHV 4A-16A	NHV 4A-16A	NHV 4A-16A	NHV 4A-16A	NHV 4A-16A	NHV 4A-16A	NHV 4A-16A
NHV 4A-16B	42.3438338	-83.3313136	Middle Rouge	NHV 4A-16B	NHV 4A-16B	NHV 4A-16B	NHV 4A-16B	NHV 4A-16B	NHV 4A-16B	NHV 4A-16B	NHV 4A-16B
NHV 4A-16C	42.343693	-83.3310413	Middle Rouge	NHV 4A-16C	NHV 4A-16C	NHV 4A-16C	NHV 4A-16C	NHV 4A-16C	NHV 4A-16C	NHV 4A-16C	NHV 4A-16C
NHV 4A-17	42.343927	-83.3323932	Middle Rouge	NHV 4A-17	NHV 4A-17	NHV 4A-17	NHV 4A-17	NHV 4A-17	NHV 4A-17	NHV 4A-17	NHV 4A-17
NHV 4A-17A	42.3438992	-83.3322161	Middle Rouge	NHV 4A-17A	NHV 4A-17A	NHV 4A-17A	NHV 4A-17A	NHV 4A-17A	NHV 4A-17A	NHV 4A-17A	NHV 4A-17A
NHV 4A-18	42.3437446	-83.3340991	Middle Rouge	NHV 4A-18	NHV 4A-18	NHV 4A-18	NHV 4A-18	NHV 4A-18	NHV 4A-18	NHV 4A-18	NHV 4A-18
NHV 4A-19	42.3430348	-83.3354723	Middle Rouge	NHV 4A-19	NHV 4A-19	NHV 4A-19	NHV 4A-19	NHV 4A-19	NHV 4A-19	NHV 4A-19	NHV 4A-19
NHV 4A-19A	42.3430745	-83.3355206	Middle Rouge	NHV 4A-19A	NHV 4A-19A	NHV 4A-19A	NHV 4A-19A	NHV 4A-19A	NHV 4A-19A	NHV 4A-19A	NHV 4A-19A
NHV 4A-20	42.342218	-83.3369315	Middle Rouge	NHV 4A-20	NHV 4A-20	NHV 4A-20	NHV 4A-20	NHV 4A-20	NHV 4A-20	NHV 4A-20	NHV 4A-20
NHV 4A-21	42.3413973	-83.338412	Middle Rouge	NHV 4A-21	NHV 4A-21	NHV 4A-21	NHV 4A-21	NHV 4A-21	NHV 4A-21	NHV 4A-21	NHV 4A-21
NHV 4A-23	42.3404754	-83.3399731	Middle Rouge	NHV 4A-23	NHV 4A-23	NHV 4A-23	NHV 4A-23	NHV 4A-23	NHV 4A-23	NHV 4A-23	NHV 4A-23
NHV 4A-24	42.33991083	-83.3414565	Middle Rouge	NHV 4A-24	NHV 4A-24	NHV 4A-24	NHV 4A-24	NHV 4A-24	NHV 4A-24	NHV 4A-24	NHV 4A-24
NHV 4A-25	42.3396546	-83.3421497	Middle Rouge	NHV 4A-25	NHV 4A-25	NHV 4A-25	NHV 4A-25	NHV 4A-25	NHV 4A-25	NHV 4A-25	NHV 4A-25
NHV 4A-27	42.339264	-83.3452678	Middle Rouge	NHV 4A-27	NHV 4A-27	NHV 4A-27	NHV 4A-27	NHV 4A-27	NHV 4A-27	NHV 4A-27	NHV 4A-27
NHV 4A-29	42.3390103	-83.3472741	Middle Rouge	NHV 4A-29	NHV 4A-29	NHV 4A-29	NHV 4A-29	NHV 4A-29	NHV 4A-29	NHV 4A-29	NHV 4A-29
NHV 4A-34	42.3410127	-83.349967	Middle Rouge	NHV 4A-34	NHV 4A-34	NHV 4A-34	NHV 4A-34	NHV 4A-34	NHV 4A-34	NHV 4A-34	NHV 4A-34
NHV 6-54	42.3492387	-83.3131537	Middle Rouge	NHV 6-54	NHV 6-54	NHV 6-54	NHV 6-54	NHV 6-54	NHV 6-54	NHV 6-54	NHV 6-54
NHV 6-55	42.3492724	-83.3142453	Middle Rouge	NHV 6-55	NHV 6-55	NHV 6-55	NHV 6-55	NHV 6-55	NHV 6-55	NHV 6-55	NHV 6-55
NHV 6-57	42.34824733	-83.31710083	Middle Rouge	NHV 6-57	NHV 6-57	NHV 6-57	NHV 6-57	NHV 6-57	NHV 6-57	NHV 6-57	NHV 6-57
NHV 9-16	42.28306517	-83.39822017	Lower Rouge	NHV 9-16	NHV 9-16	NHV 9-16	NHV 9-16	NHV 9-16	NHV 9-16	NHV 9-16	NHV 9-16
NHV 9-17	42.2823345	-83.39815583	Lower Rouge	NHV 9-17	NHV 9-17	NHV 9-17	NHV 9-17	NHV 9-17	NHV 9-17	NHV 9-17	NHV 9-17
NHV A4-26	42.3394742	-83.343401	Middle Rouge	NHV A4-26	NHV A4-26	NHV A4-26	NHV A4-26	NHV A4-26	NHV A4-26	NHV A4-26	NHV A4-26
NVH 3-37	42.34967633	-83.31298433	Middle Rouge	NVH 3-37	NVH 3-37	NVH 3-37	NVH 3-37	NVH 3-37	NVH 3-37	NVH 3-37	NVH 3-37
Post 15 J	42.3314285	-83.24592817	Middle Rouge	Post 15 J	Post 15 J	Post 15 J	Post 15 J	Post 15 J	Post 15 J	Post 15 J	Post 15 J
Post 15 K	42.3311235	-83.24642833	Middle Rouge	Post 15 K	Post 15 K	Post 15 K	Post 15 K	Post 15 K	Post 15 K	Post 15 K	Post 15 K
RVI 13-02	42.30264417	-83.28918933	Lower Rouge	RVI 13-02	RVI 13-02	RVI 13-02	RVI 13-02	RVI 13-02	RVI 13-02	RVI 13-02	RVI 13-02

RVI 13-03	42.30235583	-83.2904065	Lower Rouge	RVI 13-03	RVI 13-03	RVI 13-03	RVI 13-03	RVI 13-03	RVI 13-03	RVI 13-03	RVI 13-03	RVI 13-03
RVI 13-04	42.30227217	-83.29092767	Lower Rouge	RVI 13-04	RVI 13-04	RVI 13-04	RVI 13-04	RVI 13-04	RVI 13-04	RVI 13-04	RVI 13-04	RVI 13-04
RVI 13-04A	42.30225983	-83.29225683	Lower Rouge	RVI 13-04A	RVI 13-04A	RVI 13-04A	RVI 13-04A	RVI 13-04A	RVI 13-04A	RVI 13-04A	RVI 13-04A	RVI 13-04A
RVI 13-10	42.3007275	-83.297514	Lower Rouge	RVI 13-10	RVI 13-10	RVI 13-10	RVI 13-10	RVI 13-10	RVI 13-10	RVI 13-10	RVI 13-10	RVI 13-10
RVI 13-11	42.29969367	-83.29904067	Lower Rouge	RVI 13-11	RVI 13-11	RVI 13-11	RVI 13-11	RVI 13-11	RVI 13-11	RVI 13-11	RVI 13-11	RVI 13-11
RVI 13-17A	42.298853	-83.3062825	Lower Rouge	RVI 13-17A	RVI 13-17A	RVI 13-17A	RVI 13-17A	RVI 13-17A	RVI 13-17A	RVI 13-17A	RVI 13-17A	RVI 13-17A
RVI 13-23	42.29785367	-83.31283583	Lower Rouge	RVI 13-23	RVI 13-23	RVI 13-23	RVI 13-23	RVI 13-23	RVI 13-23	RVI 13-23	RVI 13-23	RVI 13-23
RVI 14-01	42.29721383	-83.31736267	Lower Rouge	RVI 14-01	RVI 14-01	RVI 14-01	RVI 14-01	RVI 14-01	RVI 14-01	RVI 14-01	RVI 14-01	RVI 14-01
RVI 14-04	42.2966176	-83.3215168	Lower Rouge	RVI 14-04	RVI 14-04	RVI 14-04	RVI 14-04	RVI 14-04	RVI 14-04	RVI 14-04	RVI 14-04	RVI 14-04
RVI 15-17	42.2840575	-83.37180833	Lower Rouge	RVI 15-17	RVI 15-17	RVI 15-17	RVI 15-17	RVI 15-17	RVI 15-17	RVI 15-17	RVI 15-17	RVI 15-17
RVI 15-19	42.28318733	-83.376062	Lower Rouge	RVI 15-19	RVI 15-19	RVI 15-19	RVI 15-19	RVI 15-19	RVI 15-19	RVI 15-19	RVI 15-19	RVI 15-19
RVI 15-WC	42.28553233	-83.36746467	Lower Rouge	RVI 15-WC	RVI 15-WC	RVI 15-WC	RVI 15-WC	RVI 15-WC	RVI 15-WC	RVI 15-WC	RVI 15-WC	RVI 15-WC
RVI 16-03	42.28446783	-83.38657183	Lower Rouge	RVI 16-03	RVI 16-03	RVI 16-03	RVI 16-03	RVI 16-03	RVI 16-03	RVI 16-03	RVI 16-03	RVI 16-03
RVI 16-04A	42.28512217	-83.38902417	Lower Rouge	RVI 16-04A	RVI 16-04A	RVI 16-04A	RVI 16-04A	RVI 16-04A	RVI 16-04A	RVI 16-04A	RVI 16-04A	RVI 16-04A
RVI 16-05	42.2852115	-83.389488	Lower Rouge	RVI 16-05	RVI 16-05	RVI 16-05	RVI 16-05	RVI 16-05	RVI 16-05	RVI 16-05	RVI 16-05	RVI 16-05
RVI 16-06	42.28521433	-83.39126433	Lower Rouge	RVI 16-06	RVI 16-06	RVI 16-06	RVI 16-06	RVI 16-06	RVI 16-06	RVI 16-06	RVI 16-06	RVI 16-06
RVI 16-08	42.28529083	-83.39339133	Lower Rouge	RVI 16-08	RVI 16-08	RVI 16-08	RVI 16-08	RVI 16-08	RVI 16-08	RVI 16-08	RVI 16-08	RVI 16-08
RVI 16-09A	42.2846835	-83.3953675	Lower Rouge	RVI 16-09A	RVI 16-09A	RVI 16-09A	RVI 16-09A	RVI 16-09A	RVI 16-09A	RVI 16-09A	RVI 16-09A	RVI 16-09A
RVI 16-09B	42.284503	-83.3957785	Lower Rouge	RVI 16-09B	RVI 16-09B	RVI 16-09B	RVI 16-09B	RVI 16-09B	RVI 16-09B	RVI 16-09B	RVI 16-09B	RVI 16-09B
RVI 16-12	42.28325633	-83.4005055	Lower Rouge	RVI 16-12	RVI 16-12	RVI 16-12	RVI 16-12	RVI 16-12	RVI 16-12	RVI 16-12	RVI 16-12	RVI 16-12
RVI 16-13	42.28268683	-83.40190467	Lower Rouge	RVI 16-13	RVI 16-13	RVI 16-13	RVI 16-13	RVI 16-13	RVI 16-13	RVI 16-13	RVI 16-13	RVI 16-13
RVI 16-16	42.28302717	-83.40682383	Lower Rouge	RVI 16-16	RVI 16-16	RVI 16-16	RVI 16-16	RVI 16-16	RVI 16-16	RVI 16-16	RVI 16-16	RVI 16-16
RVI 16-19A	42.28213483	-83.4124355	Lower Rouge	RVI 16-19A	RVI 16-19A	RVI 16-19A	RVI 16-19A	RVI 16-19A	RVI 16-19A	RVI 16-19A	RVI 16-19A	RVI 16-19A
RVI 16-19A?	42.282142	-83.41216917	Lower Rouge	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?	RVI 16-19A?
RVI 16-19B	42.28222717	-83.412317	Lower Rouge	RVI 16-19B	RVI 16-19B	RVI 16-19B	RVI 16-19B	RVI 16-19B	RVI 16-19B	RVI 16-19B	RVI 16-19B	RVI 16-19B
RVI 16-19C	42.28247117	-83.41125717	Lower Rouge	RVI 16-19C	RVI 16-19C	RVI 16-19C	RVI 16-19C	RVI 16-19C	RVI 16-19C	RVI 16-19C	RVI 16-19C	RVI 16-19C
RVI 16-23	42.28194183	-83.41824033	Lower Rouge	RVI 16-23	RVI 16-23	RVI 16-23	RVI 16-23	RVI 16-23	RVI 16-23	RVI 16-23	RVI 16-23	RVI 16-23
RVI 16-24	42.2823235	-83.4200615	Lower Rouge	RVI 16-24	RVI 16-24	RVI 16-24	RVI 16-24	RVI 16-24	RVI 16-24	RVI 16-24	RVI 16-24	RVI 16-24
RVI 16-27	42.28411517	-83.4240715	Lower Rouge	RVI 16-27	RVI 16-27	RVI 16-27	RVI 16-27	RVI 16-27	RVI 16-27	RVI 16-27	RVI 16-27	RVI 16-27
RVI 4-16B	42.3302306	-83.2494324	Middle Rouge	RVI 4-16B	RVI 4-16B	RVI 4-16B	RVI 4-16B	RVI 4-16B	RVI 4-16B	RVI 4-16B	RVI 4-16B	RVI 4-16B
RVI 4-16C	42.33076183	-83.249557	Middle Rouge	RVI 4-16C	RVI 4-16C	RVI 4-16C	RVI 4-16C	RVI 4-16C	RVI 4-16C	RVI 4-16C	RVI 4-16C	RVI 4-16C
RVI 4-17	42.31098917	-83.246605	Middle Rouge	RVI 4-17	RVI 4-17	RVI 4-17	RVI 4-17	RVI 4-17	RVI 4-17	RVI 4-17	RVI 4-17	RVI 4-17
RVI 4-17A	42.31131933	-83.24581417	Lower Rouge	RVI 4-17A	RVI 4-17A	RVI 4-17A	RVI 4-17A	RVI 4-17A	RVI 4-17A	RVI 4-17A	RVI 4-17A	RVI 4-17A
RVI 4-18	42.31029917	-83.24945533	Lower Rouge	RVI 4-18	RVI 4-18	RVI 4-18	RVI 4-18	RVI 4-18	RVI 4-18	RVI 4-18	RVI 4-18	RVI 4-18
RVI 4-19	42.31013467	-83.25199767	Lower Rouge	RVI 4-19	RVI 4-19	RVI 4-19	RVI 4-19	RVI 4-19	RVI 4-19	RVI 4-19	RVI 4-19	RVI 4-19
RVI 4-25	42.30736	-83.25958167	Lower Rouge	RVI 4-25	RVI 4-25	RVI 4-25	RVI 4-25	RVI 4-25	RVI 4-25	RVI 4-25	RVI 4-25	RVI 4-25
RVI 4-26	42.30715767	-83.260448	Lower Rouge	RVI 4-26	RVI 4-26	RVI 4-26	RVI 4-26	RVI 4-26	RVI 4-26	RVI 4-26	RVI 4-26	RVI 4-26
RVI 4-28	42.3053735	-83.26233267	Lower Rouge	RVI 4-28	RVI 4-28	RVI 4-28	RVI 4-28	RVI 4-28	RVI 4-28	RVI 4-28	RVI 4-28	RVI 4-28

RVI 5-01	42.30484617	-83.26687783	Lower Rouge	RVI 5-01	RVI 5-01	RVI 5-01	RVI 5-01	RVI 5-01	RVI 5-01	RVI 5-01	RVI 5-01
RVI 5-03	42.30416067	-83.26971783	Lower Rouge	RVI 5-03	RVI 5-03	RVI 5-03	RVI 5-03	RVI 5-03	RVI 5-03	RVI 5-03	RVI 5-03
RVI 5-04	42.303483	-83.27101867	Lower Rouge	RVI 5-04	RVI 5-04	RVI 5-04	RVI 5-04	RVI 5-04	RVI 5-04	RVI 5-04	RVI 5-04
RVI 5-09	42.30251417	-83.27780417	Lower Rouge	RVI 5-09	RVI 5-09	RVI 5-09	RVI 5-09	RVI 5-09	RVI 5-09	RVI 5-09	RVI 5-09
RVI 6-01	42.33099783	-83.25042567	Middle Rouge	RVI 6-01	RVI 6-01	RVI 6-01	RVI 6-01	RVI 6-01	RVI 6-01	RVI 6-01	RVI 6-01
RVI 6-02	42.33097867	-83.25149567	Middle Rouge	RVI 6-02	RVI 6-02	RVI 6-02	RVI 6-02	RVI 6-02	RVI 6-02	RVI 6-02	RVI 6-02
RVI 6-03	42.33146517	-83.25322933	Middle Rouge	RVI 6-03	RVI 6-03	RVI 6-03	RVI 6-03	RVI 6-03	RVI 6-03	RVI 6-03	RVI 6-03
RVI 6-06	42.3321505	-83.25505267	Middle Rouge	RVI 6-06	RVI 6-06	RVI 6-06	RVI 6-06	RVI 6-06	RVI 6-06	RVI 6-06	RVI 6-06
RVI 6-07	42.3325845	-83.25636733	Middle Rouge	RVI 6-07	RVI 6-07	RVI 6-07	RVI 6-07	RVI 6-07	RVI 6-07	RVI 6-07	RVI 6-07
RVI 6-09?	42.33436467	-83.258152	Middle Rouge	RVI 6-09?	RVI 6-09?	RVI 6-09?	RVI 6-09?	RVI 6-09?	RVI 6-09?	RVI 6-09?	RVI 6-09?
RVI 6-10A	42.330998	-83.2498308	Middle Rouge	RVI 6-10A	RVI 6-10A	RVI 6-10A	RVI 6-10A	RVI 6-10A	RVI 6-10A	RVI 6-10A	RVI 6-10A
RVI 6-11	42.336984	-83.2591501	Middle Rouge	RVI 6-11	RVI 6-11	RVI 6-11	RVI 6-11	RVI 6-11	RVI 6-11	RVI 6-11	RVI 6-11
RVI 6-14	42.33883867	-83.262321	Middle Rouge	RVI 6-14	RVI 6-14	RVI 6-14	RVI 6-14	RVI 6-14	RVI 6-14	RVI 6-14	RVI 6-14
RVI 6-18	42.34248917	-83.2635335	Middle Rouge	RVI 6-18	RVI 6-18	RVI 6-18	RVI 6-18	RVI 6-18	RVI 6-18	RVI 6-18	RVI 6-18
RVI 6-19	42.3434819	-83.2643589	Middle Rouge	RVI 6-19	RVI 6-19	RVI 6-19	RVI 6-19	RVI 6-19	RVI 6-19	RVI 6-19	RVI 6-19
RVI 6-20	42.344151	-83.26560883	Middle Rouge	RVI 6-20	RVI 6-20	RVI 6-20	RVI 6-20	RVI 6-20	RVI 6-20	RVI 6-20	RVI 6-20
RVI 6-21	42.3444895	-83.2671905	Middle Rouge	RVI 6-21	RVI 6-21	RVI 6-21	RVI 6-21	RVI 6-21	RVI 6-21	RVI 6-21	RVI 6-21
RVI 6-27	42.34641383	-83.27455367	Middle Rouge	RVI 6-27	RVI 6-27	RVI 6-27	RVI 6-27	RVI 6-27	RVI 6-27	RVI 6-27	RVI 6-27
RVI 6-28	42.34704283	-83.27619533	Middle Rouge	RVI 6-28	RVI 6-28	RVI 6-28	RVI 6-28	RVI 6-28	RVI 6-28	RVI 6-28	RVI 6-28
RVI 6-29	42.3474645	-83.2772535	Middle Rouge	RVI 6-29	RVI 6-29	RVI 6-29	RVI 6-29	RVI 6-29	RVI 6-29	RVI 6-29	RVI 6-29
RVI 6-30	42.3476479	-83.2777217	Middle Rouge	RVI 6-30	RVI 6-30	RVI 6-30	RVI 6-30	RVI 6-30	RVI 6-30	RVI 6-30	RVI 6-30
RVI 6-31	42.3477589	-83.2802698	Middle Rouge	RVI 6-31	RVI 6-31	RVI 6-31	RVI 6-31	RVI 6-31	RVI 6-31	RVI 6-31	RVI 6-31
RVI 6-32	42.3476043	-83.2819234	Middle Rouge	RVI 6-32	RVI 6-32	RVI 6-32	RVI 6-32	RVI 6-32	RVI 6-32	RVI 6-32	RVI 6-32
RVI 6-33	42.3475141	-83.2836105	Middle Rouge	RVI 6-33	RVI 6-33	RVI 6-33	RVI 6-33	RVI 6-33	RVI 6-33	RVI 6-33	RVI 6-33
RVI 6-34	42.3472762	-83.2853056	Middle Rouge	RVI 6-34	RVI 6-34	RVI 6-34	RVI 6-34	RVI 6-34	RVI 6-34	RVI 6-34	RVI 6-34
RVI 6-35	42.3471186	-83.2870075	Middle Rouge	RVI 6-35	RVI 6-35	RVI 6-35	RVI 6-35	RVI 6-35	RVI 6-35	RVI 6-35	RVI 6-35
RVI 6-36	42.3473397	-83.288594	Middle Rouge	RVI 6-36	RVI 6-36	RVI 6-36	RVI 6-36	RVI 6-36	RVI 6-36	RVI 6-36	RVI 6-36
RVI 6-37	42.3476539	-83.290194	Middle Rouge	RVI 6-37	RVI 6-37	RVI 6-37	RVI 6-37	RVI 6-37	RVI 6-37	RVI 6-37	RVI 6-37
RVI 6-43	42.3508582	-83.2995911	Middle Rouge	RVI 6-43	RVI 6-43	RVI 6-43	RVI 6-43	RVI 6-43	RVI 6-43	RVI 6-43	RVI 6-43
RVI 6-44	42.35138167	-83.30026017	Middle Rouge	RVI 6-44	RVI 6-44	RVI 6-44	RVI 6-44	RVI 6-44	RVI 6-44	RVI 6-44	RVI 6-44
RVI 6-45	42.3517909	-83.3005594	Middle Rouge	RVI 6-45	RVI 6-45	RVI 6-45	RVI 6-45	RVI 6-45	RVI 6-45	RVI 6-45	RVI 6-45
RVI 6-46	42.3517919	-83.3022103	Middle Rouge	RVI 6-46	RVI 6-46	RVI 6-46	RVI 6-46	RVI 6-46	RVI 6-46	RVI 6-46	RVI 6-46
RVI 6-47	42.3518791	-83.3033878	Middle Rouge	RVI 6-47	RVI 6-47	RVI 6-47	RVI 6-47	RVI 6-47	RVI 6-47	RVI 6-47	RVI 6-47
RVI 6-49	42.351664	-83.3059613	Middle Rouge	RVI 6-49	RVI 6-49	RVI 6-49	RVI 6-49	RVI 6-49	RVI 6-49	RVI 6-49	RVI 6-49
RVI 6-50	42.3507958	-83.307344	Middle Rouge	RVI 6-50	RVI 6-50	RVI 6-50	RVI 6-50	RVI 6-50	RVI 6-50	RVI 6-50	RVI 6-50
RVI 6-51	42.3499771	-83.3087495	Middle Rouge	RVI 6-51	RVI 6-51	RVI 6-51	RVI 6-51	RVI 6-51	RVI 6-51	RVI 6-51	RVI 6-51
RVI 6-52	42.3491723	-83.310096	Middle Rouge	RVI 6-52	RVI 6-52	RVI 6-52	RVI 6-52	RVI 6-52	RVI 6-52	RVI 6-52	RVI 6-52

RVI 8-04	42.3457012	-83.3229786	Middle Rouge	RVI 8-04	RVI 8-04	RVI 8-04	RVI 8-04	RVI 8-04	RVI 8-04	RVI 8-04	RVI 8-04
RVI 8-05	42.3450916	-83.323617	Middle Rouge	RVI 8-05	RVI 8-05	RVI 8-05	RVI 8-05	RVI 8-05	RVI 8-05	RVI 8-05	RVI 8-05
RVI 8-07	42.34413533	-83.326169	Middle Rouge	RVI 8-07	RVI 8-07	RVI 8-07	RVI 8-07	RVI 8-07	RVI 8-07	RVI 8-07	RVI 8-07
RVI 8-08	42.3438685	-83.3276309	Middle Rouge	RVI 8-08	RVI 8-08	RVI 8-08	RVI 8-08	RVI 8-08	RVI 8-08	RVI 8-08	RVI 8-08
RVI 8-09	42.3439616	-83.3279018	Middle Rouge	RVI 8-09	RVI 8-09	RVI 8-09	RVI 8-09	RVI 8-09	RVI 8-09	RVI 8-09	RVI 8-09
RVI 8-10	42.3437	-83.330171	Middle Rouge	RVI 8-10	RVI 8-10	RVI 8-10	RVI 8-10	RVI 8-10	RVI 8-10	RVI 8-10	RVI 8-10
RVI 8-12	42.3438814	-83.3314571	Middle Rouge	RVI 8-12	RVI 8-12	RVI 8-12	RVI 8-12	RVI 8-12	RVI 8-12	RVI 8-12	RVI 8-12
RVI 8-14	42.3436514	-83.3340964	Middle Rouge	RVI 8-14	RVI 8-14	RVI 8-14	RVI 8-14	RVI 8-14	RVI 8-14	RVI 8-14	RVI 8-14
RVI 8-15	42.3429793	-83.3355582	Middle Rouge	RVI 8-15	RVI 8-15	RVI 8-15	RVI 8-15	RVI 8-15	RVI 8-15	RVI 8-15	RVI 8-15
RVI 8-16	42.3423925	-83.3364969	Middle Rouge	RVI 8-16	RVI 8-16	RVI 8-16	RVI 8-16	RVI 8-16	RVI 8-16	RVI 8-16	RVI 8-16
RVI 8-17	42.3417541	-83.3378702	Middle Rouge	RVI 8-17	RVI 8-17	RVI 8-17	RVI 8-17	RVI 8-17	RVI 8-17	RVI 8-17	RVI 8-17
RVI 8-19	42.3404159	-83.3399999	Middle Rouge	RVI 8-19	RVI 8-19	RVI 8-19	RVI 8-19	RVI 8-19	RVI 8-19	RVI 8-19	RVI 8-19
RVI 8-19A	42.3403664	-83.3400187	Middle Rouge	RVI 8-19A	RVI 8-19A	RVI 8-19A	RVI 8-19A	RVI 8-19A	RVI 8-19A	RVI 8-19A	RVI 8-19A
RVI 8-20	42.339962	-83.34120333	Middle Rouge	RVI 8-20	RVI 8-20	RVI 8-20	RVI 8-20	RVI 8-20	RVI 8-20	RVI 8-20	RVI 8-20
RVI 8-21	42.3395931	-83.3421054	Middle Rouge	RVI 8-21	RVI 8-21	RVI 8-21	RVI 8-21	RVI 8-21	RVI 8-21	RVI 8-21	RVI 8-21
RVI 8-22	42.3394306	-83.3434895	Middle Rouge	RVI 8-22	RVI 8-22	RVI 8-22	RVI 8-22	RVI 8-22	RVI 8-22	RVI 8-22	RVI 8-22
RVI 8-23A	42.3388754	-83.3466505	Middle Rouge	RVI 8-23A	RVI 8-23A	RVI 8-23A	RVI 8-23A	RVI 8-23A	RVI 8-23A	RVI 8-23A	RVI 8-23A
RVI 8-24	42.3390222	-83.3475208	Middle Rouge	RVI 8-24	RVI 8-24	RVI 8-24	RVI 8-24	RVI 8-24	RVI 8-24	RVI 8-24	RVI 8-24
RVI 8-27	42.3412506	-83.3505571	Middle Rouge	RVI 8-27	RVI 8-27	RVI 8-27	RVI 8-27	RVI 8-27	RVI 8-27	RVI 8-27	RVI 8-27
SA06SE014	42.34447433	-83.2932205	Middle Rouge	SA06SE014	SA06SE014	SA06SE014	SA06SE014	SA06SE014	SA06SE014	SA06SE014	SA06SE014
SA06SE016	42.34552067	-83.29329167	Middle Rouge	SA06SE016	SA06SE016	SA06SE016	SA06SE016	SA06SE016	SA06SE016	SA06SE016	SA06SE016
SA06SE032	42.3464825	-83.293387	Middle Rouge	SA06SE032	SA06SE032	SA06SE032	SA06SE032	SA06SE032	SA06SE032	SA06SE032	SA06SE032
Unknown local 1	42.30257783	-83.29193733	Lower Rouge	Unknown local 1	Unknown local 1	Unknown local 1	Unknown local 1	Unknown local 1	Unknown local 1	Unknown local 1	Unknown local 1
WAY-15	42.283809	-83.37758233	Lower Rouge	WAY-15	WAY-15	WAY-15	WAY-15	WAY-15	WAY-15	WAY-15	WAY-15
WI X-02	42.28341433	-83.37750517	Lower Rouge	WI X-02	WI X-02	WI X-02	WI X-02	WI X-02	WI X-02	WI X-02	WI X-02
WI X-03	42.28339767	-83.37750567	Lower Rouge	WI X-03	WI X-03	WI X-03	WI X-03	WI X-03	WI X-03	WI X-03	WI X-03
WI X-12	42.284986	-83.388322	Lower Rouge	WI X-12	WI X-12	WI X-12	WI X-12	WI X-12	WI X-12	WI X-12	WI X-12
WI X-13	42.28508167	-83.38866383	Lower Rouge	WI X-13	WI X-13	WI X-13	WI X-13	WI X-13	WI X-13	WI X-13	WI X-13
WI X-14	42.285126	-83.38883367	Lower Rouge	WI X-14	WI X-14	WI X-14	WI X-14	WI X-14	WI X-14	WI X-14	WI X-14
WI X-15	42.28508333	-83.38883683	Lower Rouge	WI X-15	WI X-15	WI X-15	WI X-15	WI X-15	WI X-15	WI X-15	WI X-15
WI X-16	42.28515883	-83.38904267	Lower Rouge	WI X-16	WI X-16	WI X-16	WI X-16	WI X-16	WI X-16	WI X-16	WI X-16
WI X-18	42.2852485	-83.391295	Lower Rouge	WI X-18	WI X-18	WI X-18	WI X-18	WI X-18	WI X-18	WI X-18	WI X-18
WI X-20	42.2853395	-83.39342367	Lower Rouge	WI X-20	WI X-20	WI X-20	WI X-20	WI X-20	WI X-20	WI X-20	WI X-20
WI X-22	42.2846845	-83.395406	Lower Rouge	WI X-22	WI X-22	WI X-22	WI X-22	WI X-22	WI X-22	WI X-22	WI X-22
WI X-23	42.284513	-83.395788	Lower Rouge	WI X-23	WI X-23	WI X-23	WI X-23	WI X-23	WI X-23	WI X-23	WI X-23

WI X-27	42.28305383	-83.39830017	Lower Rouge	WI X-27	WI X-27	WI X-27	WI X-27	WI X-27	WI X-27	WI X-27	WI X-27	WI X-27

Appendix B: Key Findings

Table 1 Component Summary of Poor or Missing Gaskets/Bolts

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
INK-23	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
MR II -18	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
MR III-02	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
NHV 2-17	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Corroded (Pitted)	Sound
NHV 2-21	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Cracked
NHV 2-31	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
NHV 6-55	Middle Rouge	Road Shoulder	Poor condition	Sound	0		Sound	Sound
NHV 6-57	Middle Rouge	Sidewalk	Poor condition	Bolts Missing	0		Sound	Sound
NVH 3-37	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
RVI 13-03	Lower Rouge	Field or Woods	Poor condition	Bolts Missing	1	Sound	Sound	Sound
RVI 16-09A	Lower Rouge	Field or Woods	Poor condition	Bolts Missing	1	Sound	Sound	Sound
RVI 8-16	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
Unknown local 1	Lower Rouge	Field or Woods	Poor condition	Bolts Missing	3	Sound	Sound	Sound
5L-04	Middle Rouge	Field or Woods	Missing	Missing	0		Missing	Missing
6L-02	Middle Rouge	Field or Woods	Missing	Sound	1	Sound	Sound	Sound
Abandoned Regulator	Middle Rouge	ROW/Easement	Missing	Broken	0		Sound	Missing
DH local connection siphon?	Middle Rouge	Field or Woods	Missing	Sound	0		Sound	Sound
Missing point on Before MR I-10	Middle Rouge	Field or Woods	Missing	Sound	-1		Sound	Loose (Not Attached)
MR II-10	Middle Rouge	Field or Woods	Missing	Sound	0		Sound	Sound
MR II-10I	Middle Rouge	Field or Woods	Missing	Bolts Missing	0		Sound	Sound
NHV 2-11	Middle Rouge	Field or Woods	Missing	Corroded (Pitted)	0		Broken	Sound
NHV 9-17	Lower Rouge	Field or Woods	Missing	Bolts Missing	2	Sound	Sound	Sound
RVI 16-13	Lower Rouge	Field or Woods	Missing	Sound	12	Sound	Sound	Sound

RVI 16-16	Lower Rouge	Field or Woods	Missing	Sound	2	Sound	Sound	Sound
RVI 6-09	Middle Rouge	Field or Woods	Missing	Sound	5	Sound	Corroded (Pitted)	Loose (Not Attached)
RVI 6-28	Middle Rouge	Field or Woods	Missing	Bolts Missing	9	Sound	Sound	Loose (Not Attached)
RVI 6-47	Middle Rouge	Field or Woods	Missing	Sound	5.5	Sound	Sound	Sound
SA06SE032	Middle Rouge	Field or Woods	Missing	Sound	0		Sound	Loose (Not Attached)
WI X-27	Lower Rouge	Field or Woods	Missing	Sound	0		Sound	Sound
5L-17	Middle Rouge	Roadway	Good condition	Sound	0		Corroded (Pitted)	Sound
INK-24	Middle Rouge	Field or Woods	Good condition	Bolts Missing	-3		Sound	Sound
MR I-08	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
MR II-07	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
MR II-10F	Middle Rouge	Field or Woods	Good condition	Bolts Missing	1	Sound	Sound	Loose (Not Attached)
MR II-10G	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
MR II-10H	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
MR II-19	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
MR III-12A	Middle Rouge	Greenbelt	Good condition	Sound	0		Corroded (Pitted)	Sound
MR III-13	Middle Rouge	Greenbelt	Good condition	Bolts Missing	0		Sound	Sound
MR III-19	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
MR III-23A	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
MR III-23C	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
NHV 2-12	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
NHV 3-12	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound

NHV 3-13	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
NHV 4A-02	Middle Rouge	Field or Woods	Good condition	Bolts Missing	2	Sound	Sound	Sound
NHV 4A-03	Middle Rouge	ROW/Easement	Good condition	Bolts Missing	0		Sound	Sound
NHV 4A-15	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
NHV 4A-34	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
NHV 9-16	Lower Rouge	Field or Woods	Good condition	Bolts Missing	8	Sound	Sound	Sound
RVI 13-17A	Lower Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
RVI 15-WC	Lower Rouge	Field or Woods	Good condition	Bolts Missing	7		Sound	Sound
RVI 16-04A	Lower Rouge	Field or Woods	Good condition	Bolts Missing	4	Sound	Sound	Loose (Not Attached)
RVI 4-16C	Middle Rouge	Field or Woods	Good condition	Bolts Missing	3	Leaking	Sound	Sound
RVI 5-04	Lower Rouge	Sidewalk	Good condition	Sound	0		Sound	Sound
RVI 6-03	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
RVI 6-11	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
RVI 6-37	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
RVI 6-50	Middle Rouge	Sidewalk	Good condition	Sound	0		Sound	Sound
RVI 6-51	Middle Rouge	Sidewalk	Good condition	Bolts Missing	0		Sound	Sound
RVI 8-27	Middle Rouge	Field or Woods	Good condition	Sound	5	Sound	Sound	Sound
SA06SE014	Middle Rouge	Field or Woods	Good condition	Bolts Missing	1	Sound	Sound	Loose (Not Attached)
WI X-13	Lower Rouge	Field or Woods	Good condition	Sound	12	Sound	Sound	Sound
WI X-22	Lower Rouge	Field or Woods	Good condition	Sound	9		Sound	Sound

NHV 3-38	Middle Rouge	Field or Woods		Bolts Missing	0		Corroded (Pitted)	Sound
WI X-14	Lower Rouge	Field or Woods		Sound	7	Sound	Sound	Sound

Table 2 Component Summary of Poor Conditioned Rim

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
RVI 13-10	Lower Rouge	Field or Woods	Good condition	Sound	4	Corroded	Sound	Sound
INK-18	Middle Rouge	Field or Woods	Good condition	Sound	2	Cracked	Sound	Sound
NHV 4A-05	Middle Rouge	ROW/Easement	Good condition	Sound	10	Leaking	Sound	Loose (Not Attached)
RVI 4-16C	Middle Rouge	Field or Woods	Good condition	Bolts Missing	3	Leaking	Sound	Sound

Table 3 Component Summary of Poor Conditioned Frame and Seal

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
5L-04	Middle Rouge	Field or Woods	Missing	Missing	0		Missing	Missing
5L-17	Middle Rouge	Roadway	Good condition	Sound	0		Corroded (Pitted)	Sound
Abandoned Regulator	Middle Rouge	ROW/Easement	Missing	Broken	0		Sound	Missing
Merrimanhollow	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
Missing point on BeforeMR I-10	Middle Rouge	Field or Woods	Missing	Sound	-1		Sound	Loose (Not Attached)
MR I-07	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
MR II-10B	Middle Rouge	Field or Woods	Good condition	Sound	1	Sound	Sound	Loose (Not Attached)
MR II-10F	Middle Rouge	Field or Woods	Good condition	Bolts Missing	1	Sound	Sound	Loose (Not Attached)
MR II-10G	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
MR II-12	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
MR III-12A	Middle Rouge	Greenbelt	Good condition	Sound	0		Corroded (Pitted)	Sound
NHV 2-11	Middle Rouge	Field or Woods	Missing	Corroded (Pitted)	0		Broken	Sound
NHV 2-17	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Corroded (Pitted)	Sound
NHV 2-21	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Cracked
NHV 3-38	Middle Rouge	Field or Woods		Bolts Missing	0		Corroded (Pitted)	Sound
NHV 4A-01	Middle Rouge	Field or Woods	Poor condition	Sound	0		Sound	Loose (Not Attached)
NHV 4A-03	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
NHV 4A-05	Middle Rouge	ROW/Easement	Good condition	Sound	10	Leaking	Sound	Loose (Not Attached)

NHV 4A-17	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
NHV 4A-18	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
NHV 4A-19	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
NHV 4A-21	Middle Rouge	Field or Woods	Good condition	Sound	2		Sound	Loose (Not Attached)
NHV 4A-24	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 13-02	Lower Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 13-04A	Lower Rouge	Field or Woods	Poor condition	Sound	2	Sound	Corroded (Pitted)	Sound
RVI 16-04A	Lower Rouge	Field or Woods	Good condition	Bolts Missing	4	Sound	Sound	Loose (Not Attached)
RVI 4-25	Lower Rouge	Field or Woods	Good condition	Sound	12	Sound	Sound	Loose (Not Attached)
RVI 4-26	Lower Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 4-28	Lower Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 6-02	Middle Rouge	Field or Woods	Poor condition	Corroded (Pitted)	-3		Sound	Loose (Not Attached)
RVI 6-09?	Middle Rouge	Field or Woods	Missing	Sound	5	Sound	Corroded (Pitted)	Loose (Not Attached)
RVI 6-18	Middle Rouge	ROW/Easement	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 6-28	Middle Rouge	Field or Woods	Missing	Bolts Missing	9	Sound	Sound	Loose (Not Attached)
RVI 6-34	Middle Rouge	ROW/Easement	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 6-46	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 8-05	Middle Rouge	Sidewalk	Poor condition	Sound	0		Sound	Loose (Not Attached)
RVI 8-19	Middle Rouge	Field or Woods	Poor condition	Sound	0		Sound	Loose (Not Attached)
RVI 8-19A	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)
RVI 8-20	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)

SA06SE014	Middle Rouge	Field or Woods	Good condition	Bolts Missing	1	Sound	Sound	Loose (Not Attached)
SA06SE016	Middle Rouge	Field or Woods	Good condition	Sound	1	Sound	Sound	Loose (Not Attached)
SA06SE032	Middle Rouge	Field or Woods	Missing	Sound	0		Sound	Loose (Not Attached)
WI X-15	Lower Rouge	Field or Woods	Good condition	Sound	0		Sound	Loose (Not Attached)

Table 4 Component Summary of Evidence of SSOs

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
INK-23	Middle Rouge	Field or Woods	Poor condition	Bolts Missing	0		Sound	Sound
MR I-05	Middle Rouge	Field or Woods	Good condition	Sound	7	Sound	Sound	Sound
MR I-06	Middle Rouge	Field or Woods	Good condition	Sound	2	Sound	Sound	Sound
NHV 3-09	Middle Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
NHV 3-13	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
NHV 4A-02	Middle Rouge	Field or Woods	Good condition	Bolts Missing	2	Sound	Sound	Sound
RVI 5-03	Lower Rouge	Field or Woods	Good condition	Sound	0		Sound	Sound
RVI 6-37	Middle Rouge	Field or Woods	Good condition	Bolts Missing	0		Sound	Sound
SA06SE014	Middle Rouge	Field or Woods	Good condition	Bolts Missing	1	Sound	Sound	Loose (Not Attached)
MR I-05A	Middle Rouge	Field or Woods	Good condition	Sound	2.5		Sound	Sound

Table 5 Manhole with Missing Lid

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
RVI 13-23	Lower Rouge	Field or Woods	Good condition	Missing	2	Sound	Sound	Sound

Appendix C: 2-year Floodplain Manhole Data

RVSDS
Two Year Floodplain Manhole Inspections

Figure 1
2 Year Manhole Status

N
W E
S

0 2,000 4,000 6,000
Feet

1" = 2,000'

2 Year Floodplain Manhole Status

- Yes
- No
- Could Not Find
- Could Not Assess
- Could Not Open
- Non 2 Year Floodplain Manholes
- Non-Floodplain Manholes
- Sanitary Gravity Main

Source: Data provided by Wayne County and ESRI. 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 HARN StatePlane Michigan North FIPS 2111 Feet Intl

Map Published: April 27, 2016

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

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888.522.6711 | ohm-advisors.com

Table 1 Imagery for all Manholes Inspected

Structure ID	Latitude	Longitude	Interceptor	Image 1 Hyperlink	Image 2 Hyperlink	Image 3 Hyperlink	Image 4 Hyperlink	Image 5 Hyperlink	Image 6 Hyperlink	Image 7 Hyperlink
NVH 5A-01	-83.372	42.351	Middle Rouge	NHV 5A-01	NHV 5A-01	NHV 5A-01	NHV 5A-01	NHV 5A-01		
INK-09	-83.3032	42.35262	Middle Rouge	INK-09	INK-09	INK-09	INK-09	INK-09		
SA09NW048	-83.2648	42.33439	Middle Rouge	SA09NW048	SA09NW048	SA09NW048				
SA09NW043	-83.2662	42.3338	Middle Rouge	SA09NW043	SA09NW043	SA09NW043	SA09NW043	SA09NW043	SA09NW043	SA09NW043
SA09NW042	-83.2667	42.33358	Middle Rouge	SA09NW042	SA09NW042	SA09NW042	SA09NW042	SA09NW042	SA09NW042	SA09NW042
SA09NE104	-83.259	42.33459	Middle Rouge	SA09NE104	SA09NE104	SA09NE104	SA09NE104	SA09NE104		
SA09NE103	-83.2589	42.3346	Middle Rouge	SA09NE103	SA09NE103	SA09NE103	SA09NE103	SA09NE103		
SA10SW004	-83.2467	42.33434	Middle Rouge	SA10SW004	SA10SW004	SA10SW004	SA10SW004	SA10SW004	SA10SW004	
SA10SW006	-83.2464	42.33427	Middle Rouge	SA10SW006	SA10SW006	SA10SW006	SA10SW006	SA10SW006		
SA10SW005	-83.2464	42.33433	Middle Rouge	SA10SW005	SA10SW005	SA10SW005	SA10SW005	SA10SW005		
SA10SW007	-83.2463	42.33417	Middle Rouge	SA10SW007	SA10SW007	SA10SW007	SA10SW007	SA10SW007	SA10SW007	
SA10SW010	-83.2459	42.33333	Middle Rouge	SA10SW010	SA10SW010	SA10SW010	SA10SW010	SA10SW010	SA10SW010	
SA10SW009	-83.2458	42.3333	Middle Rouge	SA10SW009	SA10SW009	SA10SW009	SA10SW009	SA10SW009		
SA10SW008	-83.2459	42.33324	Middle Rouge	SA10SW008	SA10SW008	SA10SW008	SA10SW008	SA10SW008		
RVI 4-21	-83.2538	42.30936	Lower Rouge	RVI 4-21	RVI 4-21	RVI 4-21	RVI 4-21			

RVI 5-10	-83.279	42.30266	Lower Rouge	RVI 5-10	RVI 5-10	RVI 5-10	RVI 5-10			
RVI 5-12A	-83.2827	42.30251	Lower Rouge	RVI 5-12A	RVI 5-12A	RVI 5-12A	RVI 5-12A	RVI 5-12A	RVI 5-12A	
RVI 5-13B	-83.2854	42.30254	Lower Rouge	RVI 5-13B	RVI 5-13B	RVI 5-13B	RVI 5-13B	RVI 5-13B		
RVI 14-05	-83.3228	42.29633	Lower Rouge	RVI 14-05	RVI 14-05	RVI 14-05	RVI 14-05	RVI 14-05		
WI X-26	-83.3983	42.28339	Lower Rouge	WI X-26	WI X-26	WI X-26	WI X-26			

Table 2 Component Summary of Poor or Missing Gaskets/Bolts

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
NVH 5A-01	Middle Rouge	Greenbelt	Missing	Bolts Missing	0		Corroded (Pitted)	Sound
INK-09	Middle Rouge	Field or Woods	Missing	Sound	4	Sound	Corroded (Pitted)	Sound
SA09NW048	Middle Rouge	Field or Woods	Missing	Sound	63	Cracked	Corroded (Pitted)	Sound
WI X-26	Lower Rouge	Field or Woods	Missing	Sound	9	Sound	Corroded (Pitted)	Sound
SA09NW043	Middle Rouge	Yard	Poor condition	Sound	61	Cracked	Corroded (Pitted)	Loose (Not Attached)

RVI 5-12A	Lower Rouge	Field or Woods	Poor condition	Sound	0		Corroded (Pitted)	Sound
RVI 14-05	Lower Rouge	Field or Woods	Poor condition	Sound	0		Corroded (Pitted)	Loose (Not Attached)

Table 3 Component Summary of Poor Conditioned Rim

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
SA09NW048	Middle Rouge	Field or Woods	Missing	Sound	63	Cracked	Corroded (Pitted)	Sound
SA09NW043	Middle Rouge	Yard	Poor condition	Sound	61	Cracked	Corroded (Pitted)	Loose (Not Attached)
SA09NW042	Middle Rouge	Yard		Sound	58	Cracked	Corroded (Pitted)	Loose (Not Attached)

Table 4 Component Summary of Poor Conditioned Frame and Seal

Structure ID	Interceptor	Structure Location	Gasket	Cover Condition	Rim to Grade Elevation	If Rim to Grade >0, Exterior Condition	Frame Condition	Frame Seal Condition
SA09NW043	Middle Rouge	Yard	Poor condition	Sound	61	Cracked	Corroded (Pitted)	Loose (Not Attached)
SA09NW042	Middle Rouge	Yard		Sound	58	Cracked	Corroded (Pitted)	Loose (Not Attached)
SA10SW010	Middle Rouge	Field or Woods	Good condition	Sound	21	Sound	Corroded (Pitted)	Loose (Not Attached)
RVI 14-05	Lower Rouge	Field or Woods	Poor condition	Sound	0		Corroded (Pitted)	Loose (Not Attached)
NVH 5A-01	Middle Rouge	Greenbelt	Missing	Bolts Missing	0		Corroded (Pitted)	Sound
INK-09	Middle Rouge	Field or Woods	Missing	Sound	4	Sound	Corroded (Pitted)	Sound
SA09NW048	Middle Rouge	Field or Woods	Missing	Sound	63	Cracked	Corroded (Pitted)	Sound
SA09NE104	Middle Rouge	Field or Woods	Good condition	Sound	29	Sound	Corroded (Pitted)	Sound
SA09NE103	Middle Rouge	Field or Woods	Good condition	Sound	11	Sound	Corroded (Pitted)	Sound
SA10SW004	Middle Rouge	Field or Woods	Good condition	Sound	16	Sound	Corroded (Pitted)	Sound
SA10SW006	Middle Rouge	Field or Woods	Good condition	Sound	17	Sound	Corroded (Pitted)	Sound

SA10SW005	Middle Rouge	Field or Woods	Good condition	Sound	17	Sound	Corroded (Pitted)	Sound
SA10SW007	Middle Rouge	Field or Woods	Good condition	Sound	17	Sound	Corroded (Pitted)	Sound
SA10SW009	Middle Rouge	Field or Woods	Good condition	Sound	11	Sound	Corroded (Pitted)	Sound
SA10SW008	Middle Rouge	Field or Woods	Good condition	Sound	12	Sound	Corroded (Pitted)	Sound
RVI 5-10	Lower Rouge	Field or Woods	Good condition	Sound	0		Corroded (Pitted)	Sound
RVI 5-12A	Lower Rouge	Field or Woods	Poor condition	Sound	0		Corroded (Pitted)	Sound
RVI 5-13B	Lower Rouge	Field or Woods	Good condition	Bolts Missing	1	Sound	Corroded (Pitted)	Sound

DRAFT – June 29, 2019

Appendix H: LS1A Operational Modifications

WADE TRIM

DRAFT MEMORANDUM

TO: Razik Alsaigh, Wayne County
Greg Kacvinsky, OHM
Karen Ridgway, Applied Science, Inc.

FROM: Steve Kalinowski, Wade Trim

DATE: January 15, 2016

SUBJECT: LTCAP Phase 1
Task H: LSIA Operational Modifications
Draft Technical Memorandum

1. Purpose

The purpose of Task H: LS1A Operational Modifications is to field investigate and identify potential sources of headloss through LS1A that may be contributing to unexplained surcharging that does not match hydraulic modeling results for the Middle Rouge Interceptor upstream of LS1A. The results of the investigation are to be used to formulate and recommend potential Phase 1 operational modifications that can improve the facility operations and performance, thus allowing the facility to better operate at its intended flow capacity while minimizing the hydraulic impact in the upstream interceptor system. This document also introduces concept designs for future improvements to be considered for Phase 2 alternative evaluation.

An updated and more detailed hydrologic/hydraulic model of the RVSDS was recently created under the LTCAP project. This model uses the SWMM5 program and includes a representation of LS1A at the downstream end of the Middle Rouge interceptor system. LS1A was represented in the model using as-built information that assumes the conduits, siphons, screens, bar racks, gates and pumps upstream, downstream and at LS1A operate as designed and are in a well-maintained and fully-operational condition. A schematic view of LS1A and its relation to the Rouge Valley Interceptors is presented in Figure 1.

Attempts were made to calibrate and validate the SWMM5 model using flow meter, level sensor and pumping data for storm events in April 2013 and September 2014. The SWMM5 model did not calibrate/validate well in the vicinity and upstream of LS1A. Questions were raised about the operability/status and condition of the

Wade Trim Associates, Inc.
25251 Northline Road
P.O. Box 10
Taylor, MI 48180

734.947.9700
800.482.2864
734.947.9726 fax
www.wadetrim.com

siphons, bar racks, screens, gate and pumps at LS1A. Field investigations were conducted to verify the condition and status of the equipment at LS1A.

The primary concern for LS1A performance is that surcharging has been observed at Junction Chamber 2-8 (located upstream of LS1A), during historical rain events that did not utilize the full 250 cfs pumping capacity of the lift station. This indicates potential impacts of operational issues or unexplained head loss for transport of flow to the lift station.

Specific items investigated under Task H include:

- Potential for pump recirculation
- Additional data needs for monitoring and SCADA control
- Review of bar rack performance for flow into the wet well and potential options for screening upgrades to improve the efficiency of wet well inflow
- Review of potential impacts for siphons and junction chambers

The Task H investigations are part of the LTCAP Phase I work tasks in conjunction with other related tasks to investigate potential sources of unexplained head loss, including Task I: System Venting and Task E: SCADA System Improvements. Technical memoranda for Tasks I and E have already been submitted to the County for review.

2. Background

A. LS1A Description of Operation

Lift Station 1A (LS1A) is located at the downstream end of the Middle Rouge Valley interceptors and is a major component of the Rouge Valley Sewage Disposal System (refer to Figure 1 Schematic). The Middle Rouge Valley interceptors flow by gravity into the Middle Rouge Junction Chamber (MRJC) at Junction Chamber 2-8. From the MRJC, the flow continues along on one of three routes. The first route is towards the south in a 78-inch diameter pipe that discharges into the Oakwood Interceptor. This flow is metered by the WCS1 meter. The second and third routes are toward the east in 60-inch (MRPI) and 66-inch (MRIR) diameter pipes. These pipes are tributary to LS1A and flow towards the WCS2 and WCS3 meters and discharge into the Northwest Interceptor (NWI). Under dry weather and low flow conditions, the flow in the 60-inch and 66-inch pipes continue by gravity to JC-18A and meters WCS2 and WCS3.

During wet weather, flow continues to be routed in the 78-inch diameter pipe to the Oakwood Interceptor and the WCS1 meter by gravity. However, when the hydraulic grade line in the NWI becomes high enough, LS1A must operate to

keep the hydraulic grade line at JC 2-8 below levels that would surcharge the Middle Rouge Interceptors. A flap gate on the upstream MRPI connection at JC-18A prevents backflow through the MRPI. Overflow into the LS1A wet well occurs at a diversion chamber at JC-1 on the MRPI when the level is high. Based on the metered flow levels in JC-18A,which is an indicator of downstream levels in the DWSD system, three slide gates (SLs) within the LS1A station operate: SL-3 will close, preventing gravity flow through the MRIR, and SL-1 and SL-2 will open, allowing the MRIR flow to enter the LS1A wet well.

Based on the LS1A wet well level, the six pumps at LS1A will operate, lifting the flow into the downstream 66-inch pipe. The contract design throughput of LS1A is 250 cfs. The firm capacity of the lift station with four large pumps operating is 267 cfs.

B. Previous LS1A improvements

LS1A was constructed and initially placed into operation in 1998. Two previous upgrades have been implemented. The first was in 2009 when the bar rack on the 54-inch overflow connection from JC-1 was removed, and a new screening building and automated screen was installed. The second major upgrade occurred in 2011 as part of the Short-Term Corrective Action Program (STCAP). During the STCAP implementation, improvements were made to the discharge chamber outlet and downstream siphon crossing of the Rouge River. These improvements have improved station performance, but have not fully addressed operational issues that have been experienced at the lift station.

3. Evaluation of Operational Issues

A. Pump recirculation

There are two potential sources for pump recirculation. The major source can occur if control gate SL-3 is not fully closed when the lift station pumps are operating. This condition was documented to have occurred during recent historical rain events. Based on this finding, Wayne County made additional SCADA programming changes in September 2015 to ensure that gate SL-1 is closed whenever a pump is in operation. The modification made is expected to address the primary pump recirculation issue. This will be verified as part of the final LTCAP data analysis and model calibration scheduled after the recommended SCADA improvements are completed in 2016.

A secondary pump recirculation issue can occur through a 16-inch vent pipe located in the pump discharge chamber. This can occur if the flow level in the LS1A discharge chamber exceeds the vent pipe top elevation, or if the vent pipe is damaged. There is a bubbler level recorder in the discharge chamber that can be used to monitor the discharge chamber levels for comparison with the top of

vent opening. This bubbler was recommended to be calibrated and historized as part of the SCADA project improvements to assess downstream conditions and the performance of the newly installed downstream siphon improvements. The level data can also be used to assess if the discharge chamber levels under improvement conditions exceed the vent elevation. If so, the vent should be removed and plugged.

B. Monitoring and SCADA control upgrades

Potential upgrades to the system monitoring and SCADA controls were reviewed with Wayne County staff in a meeting held on November 10, 2015. As a result of the meeting, the following items were recommended to be added to the monitoring and SCADA System:

1. Re –program SL-3 at LS1A to remain closed if any pumps are running at LS1A. Also, SL-1 and SL-2 should be programmed to be open whenever SL-3 is closed.

2. The bubbler in the discharge box appears to be working but the discharge box is empty in dry weather. Check the calibration of the bubbler reading in wet weather by measuring the depth to the water surface in the access/vent structure and comparing it to the bubbler reading. Also, historize the discharge box level.

3. The bubbler that measures the wet well level has an existing range of 20 feet. The range needs to be extended to about 30 feet.

4. Obtain from DWSD/GLWA the flow rate data for Meters WCS2 and WCS3 and display near real-time readings in LS1A and on the Wayne County ftp site. This will allow the County to assess the real impacts of DWSD/GLWA hydraulic boundary conditions, which should allow the County to optimize future operations to accommodate DWSD/GLWA hydraulic conditions. DWSD/GLWA hydraulic conditions can significantly impact LS1A and the performance of the Middle Rouge Interceptor system.

5. Add a redundant level sensor at JC-18A for reliability purposes. The additional level sensor could be a pressure transducer mounted above the sludge depth in the chamber.

6. Review the Adjustment Factor (AF) versus time for Meter WCS2. Sludge accumulation occurs with time and may be affecting the accuracy of this flow meter.

7. Historize the dewatering flow meters at the Redford, Inkster and Dearborn Heights RTBs.

8. Obtain and store the dewatering/regulator flow rates for the Inkster RTB on Middlebelt Road and the Wayne EQ basin.

There are several ongoing projects that can be used to implement these recommendations. These recommendations should be completed prior to the LTCAP re-calibration monitoring period that begins upon completion of the Phase 1 improvements.

C. Screening Improvements

The automated Duperon mechanical screen, installed in 2008, was designed to replace the manually-cleaned bar rack on the 54-inch influent sewer from JC-1. The other 66-inch influent sewer to the lift station flows through the wet well transitioning to an 84" x 72" open channel. Two 8' x 6' slide gates, SL-1 and SL-2, are installed in each side of the channel. These gates are normally closed and only opened concurrent with closing SL-3 when the DWSD/GLWA system is surcharged to a level requiring lift station operation.

Slide gates SL-1 and SL-2 are equipped with manually-cleaned bar racks located on the upstream channel side of the gate. The bar racks are very difficult to access for cleaning and have been prone to clogging during wet weather events. When this occurs, flow levels can increase beyond the intended design conditions and potentially increase upstream head loss up to two feet to allow flow to enter the wet wells by overtopping the channel wall. The following options were reviewed to address this screening issue:

a. Remove bar racks – The bar racks were installed to protect the pumps from large debris and ragging. Some of this debris is already entering the wet well through the bar rack openings, and overtopping the channel walls, when the bar racks become blinded. While removing the bar racks would reduce head loss at this location, it may worsen conditions in the wet well and increase the risk for pump failures. Ragging issues have been reported by Wayne County staff in the past on one of the small pumps. The potential risk for additional pump failures, which could result in reduced pumping capacity and potentially greater impacts to upstream hydraulic levels, makes this option very risky. Consideration was given for installing screens around the pump inlets. However, if the pump screens become blinded, they would significantly reduce pump capacity and be in a much more difficult submerged location to access and clean if clogged. For these reasons, removal of the bar racks is not recommended.

b. Install automated screens at existing bar rack location – The dual side opening configuration of the bar racks within the wet well channel in relation to the control gates and open channel do not allow consideration

for a single mechanical screen to be installed at this location without major improvements within the existing wet well and building structure. While it may be possible to install a single screen on the east side gate opening and extend the screen from the wet well through the courtyard, it would require structural modifications within the wet well to support the screen, and would restrict equipment access and other uses of the courtyard. Options for installing a new mechanical screen on the 66-inch influent sewer should therefore consider an alternative location that would not have a major impact on the existing facility.

c. Route flow to existing screen – The existing Duperon screen was designed for a design flow of 90 cfs and conservatively sized as a continuous use screen to function with blinding of up to 50% of the screening area. Wayne County staff has reported that the new screen has performed well without blinding. Since it is an intermittent use application, it may be possible to utilize the existing automated screen for influent flow from both the 54-inch and 66-inch influent sewers. This would require a new connection from the existing 66-inch sewer to the 20' x 6' box culvert upstream of the existing screening building at the abandoned Bar Rack structure BR-1. The connection would also require a new control gate to be installed on the connection to the box culvert. The gate would normally be closed to allow dry weather flow to continue through the lift station. When downstream DWSD levels are restricting gravity flow, SL-3 would be closed and the new gate opened to direct flow from the 66-inch sewer to the box culvert and existing mechanical screen.

   We have prepared preliminary hydraulic calculations for increasing the design flow through the existing mechanical screen to the firm pumping capacity of 267 cfs and it appears feasible. This needs to be confirmed with the screen manufacturer and verified with the updated Rouge Valley System hydraulic model to confirm no adverse upstream impacts. The planning level cost estimate for this conceptual alternative will be calculated during the development of the LTCAP Report (to be prepared in March-April 2016).

d. Install new screen – Should it be determined that the existing screen is not sufficiently sized to handle the total influent flow for both connections, a new wider screen could be installed within the 20' x 6' culvert. This would require removing the existing screen and 10-foot concrete channel at the existing location. If removing the concrete channel is too difficult and costly, the wider screen may be more cost effective to construct at a new location upstream in the box culvert, if necessary. The planning level cost estimate for this alternative will be calculated during the development of the LTCAP Report (to be prepared in March-April 2016).

D. Junction and Siphon Chamber

a. Junction Chamber 1 – A field investigation was conducted on Junction Chamber JC-1 to determine the status of overflow weir. The structure was confirmed to have no weir plates installed. This is consistent with the note on the final measure plans that identifies that weir plates were to be stored at LS-1A for future use if needed. It was also confirmed that there are a number of weir plates stacked in the courtyard at the lift station. The elevation of the overflow weir is therefore the final measure elevation of the concrete weir as shown on the plans. Since there are no weir plates, the 60-inch MRPIE interceptor will overflow at the lowest potential design elevation as modeled and is therefore not contributing added head loss upstream.

b. Siphon Chambers – The LS-1A discharge chamber improvements and new siphon crossing downstream of LS-1A was installed to reduce hydraulic gradients downstream of the lift station to acceptable levels and eliminate potential for control room flooding. Performance of this siphon can be monitored in the future using the discharge chamber bubbler data that is recommended to be calibrated and historized as part of the SCADA control upgrades. Siphon S-4 located upstream of the LS-1A was inspected with sonar equipment as part of the 2008 SSES and recommended for cleaning as part of the recently completed STCAP improvements. This siphon can contribute additional headloss if impacted by debris buildup and should be periodically inspected.

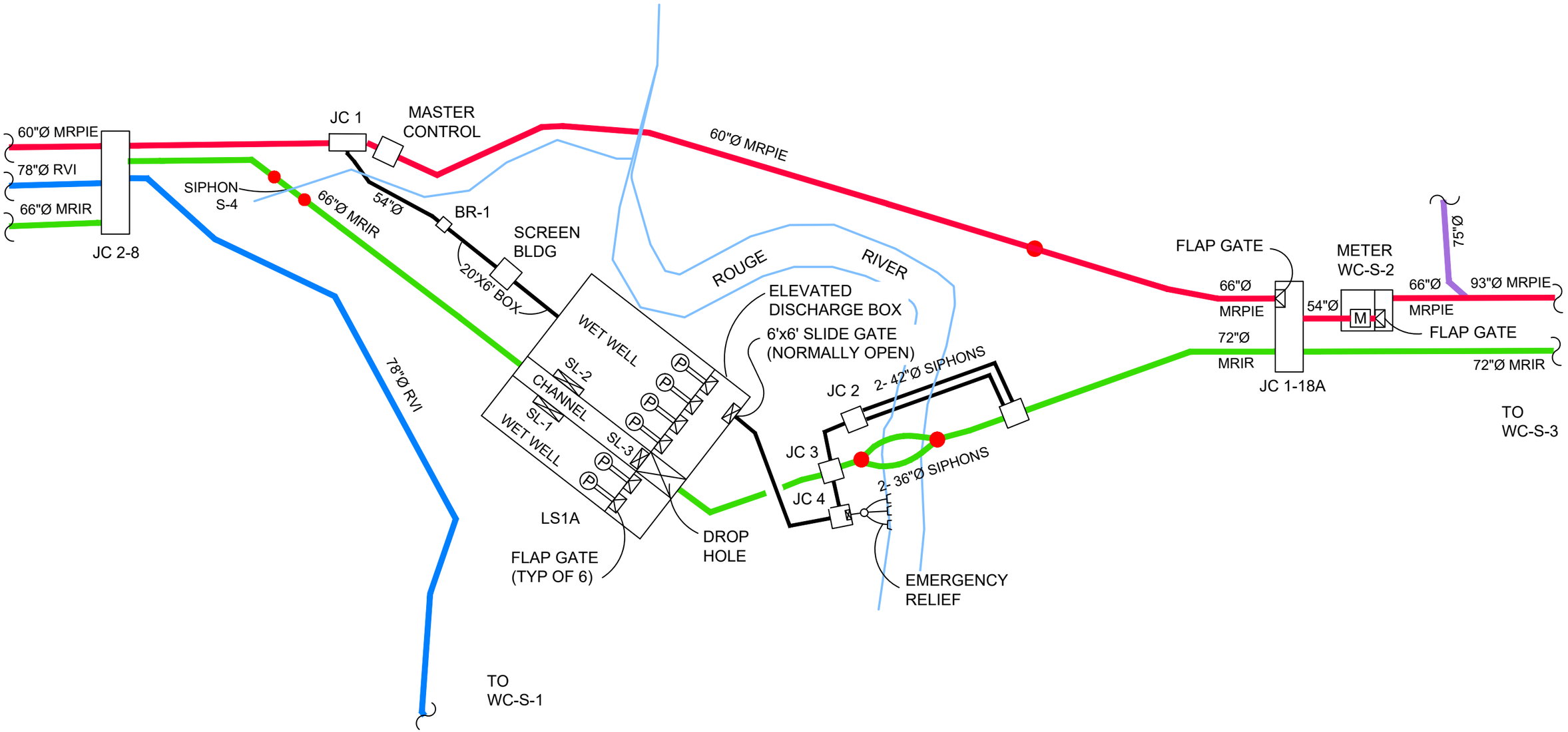
4. Recommendations

It is recommended that the SCADA upgrades listed in Section 3B be implemented as a Phase 1 improvement, and that LS1A performance be evaluated in conjunction with completion of the other Phase 1 improvements as part of the LTCAP recalibration and monitoring period, to confirm the potential impact that LS1A operations has on upstream hydraulic levels. It is also recommended that the concept design to utilize the existing automated screen for both influent sewers be further evaluated to confirm hydraulic feasibility and costs. This will allow Wayne County to consider implementation of the mechanical screen upgrades as part of the strategy for the Phase 2 LTCAP improvements, or otherwise be scheduled as an O&M capital improvement as funding is available.

The appropriate strategy to retrofit the LS1A screening will be determined after the modeling effort confirms the source(s) of surcharging along the Middle Rouge Interceptor upstream of LS1A. At that time, we will have a higher level of confidence about the sensitivity of the hydraulic grade line in the interceptor to the various hydraulic scenarios at LS1A. The modeling efforts will be performed during Phase 1

of the LTCAP. We anticipate that recommendations for the LS1A screening will be identified during Phase 2 of the LTCAP.

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LTCAP Phase I LS-1A MEMO.docx



PROJECT MANAGER:_
C:\KALINOWSKI\LS1A SCHEMATIC.DWG - LAYOUT1 - ---- - PLOTTED 1/15/2016 11:26 AM BY FLANAGAN, MARTIN
FIELD BOOK INFORMATION:_

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Detroit, MI 48226
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FIGURE 1

LS1A SCHEMATIC

JOB NO.

SHEET
1

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DRAFT – June 29, 2019

Appendix I: RVSDS System Venting

Wayne County Rouge Valley Sewage Disposal System

Recommendations for System Venting
Long Term Corrective Action Plan – Phase 1 (Task I)
System Venting

Draft

March 8, 2016

Prepared by:
OHM Advisors
34000 Plymouth Road
Livonia, MI 48150

Rouge Valley Sewage Disposal System
Phase 1: System Venting
March 8, 2016

Introduction

Wayne County is in the process of implementing a Long Term Corrective Action Plan (LTCAP) to satisfy the terms of its ACO, which require the analysis and capital improvements along the Rouge Valley Sewage Disposal System (RVSDS) interceptor system. Wayne County has been diligently working since 2012 to develop the LTCAP. A two phase strategy is in place to meet the requirements of the FOA 2117. Phase 1 is to address existing sanitary sewer overflow (SSO) problems in the Middle Lower Rouge. As part of that effort, OHM Advisors is working to identify a list of structure locations that should be system vented.

During the process of calibrating the hydraulic model of the RVSDS, it was difficult to calibrate the hydraulic model for the lower reaches of the Middle Rouge between Inkster Road and Lift Station 1A (LS1A). Hydraulic parameters, such as junction losses and pipe fiction losses, were adjusted in order to duplicate observed conditions; however, these adjustments did not reconcile the hydraulic discrepancies between the observed and modeled flow depth. These discrepancies hinder the ability for the project team to confidently plan large-scale capital improvements based on this model; therefore, additional work has been identified to determine the sources of the hydraulic discrepancies and to retrofit the system so as to achieve the expected hydraulic capacity.

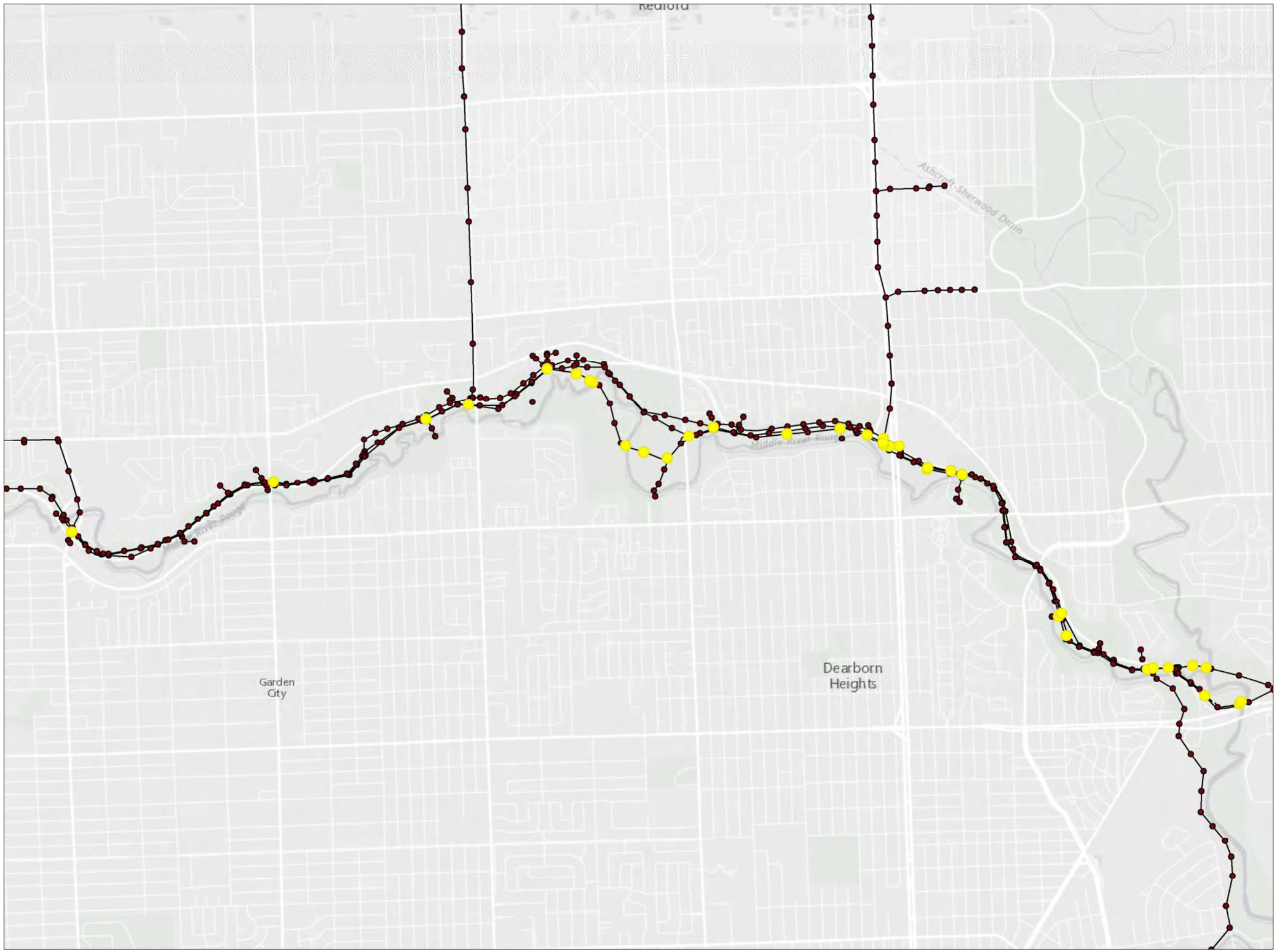
System Venting Locations

One of the additional tasks to address hydraulic deficiencies in the RVSDS is adding venting to the RVSDS interceptor system along the Middle Rouge reach through which hydraulic discrepancies have been observed. A gravity sewer requires adequate venting to operate efficiently, especially in cases where there are multiple junctions and local community flow inputs, as these transitions typically require adequate venting to avoid scenarios with compressed air and/or vacuums, both of which can significantly reduce the hydraulic capacity of the interceptor system. Given the County's recent efforts to seal manholes along the Middle Rouge floodplain to avoid river inflows, the need for venting has become clearer.

Effective locations for system venting are at structures with the following characteristics:

i. Local community flow inputs into interceptor
ii. Upstream of siphons or sewer size transitions, such as a river crossing
iii. At structures with hydraulic restrictions, such as a crossing (conflict) sewer
iv. Interceptor junctions

Using these characteristics, over thirty potential locations for venting systems were found. Figure 1 illustrations all local inputs, siphons and interceptor junctions between Merriman Road and LS1A.



Potential Venting Locations

- Potential Venting Locations
- Sanitary Manhole
- Sanitary Gravity Main

0 3,167 6,334
Feet

1" = 3167'

Source: Data provided by Wayne County. 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: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: February 18, 2016

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P:\0126_0165\0144130031_RVSDS LTCAP Project Plan_GIS_Working\Doezema\Venting Needs\Venting Needs_11x17.mxd

The first pass at eliminating structures for consideration was the proximity to roadway and recreational areas. The Middle Rouge Interceptor runs along Edward N Hines Drive where there are recreational areas along the entire reach. The venting systems need to be, ideally, in isolated areas away from the road and pathways. To ensure the safety of the public and to reduce the likelihood of vandalism, field visits were necessary to review each potential location. A total of five locations were eliminated due to the safety of the location.

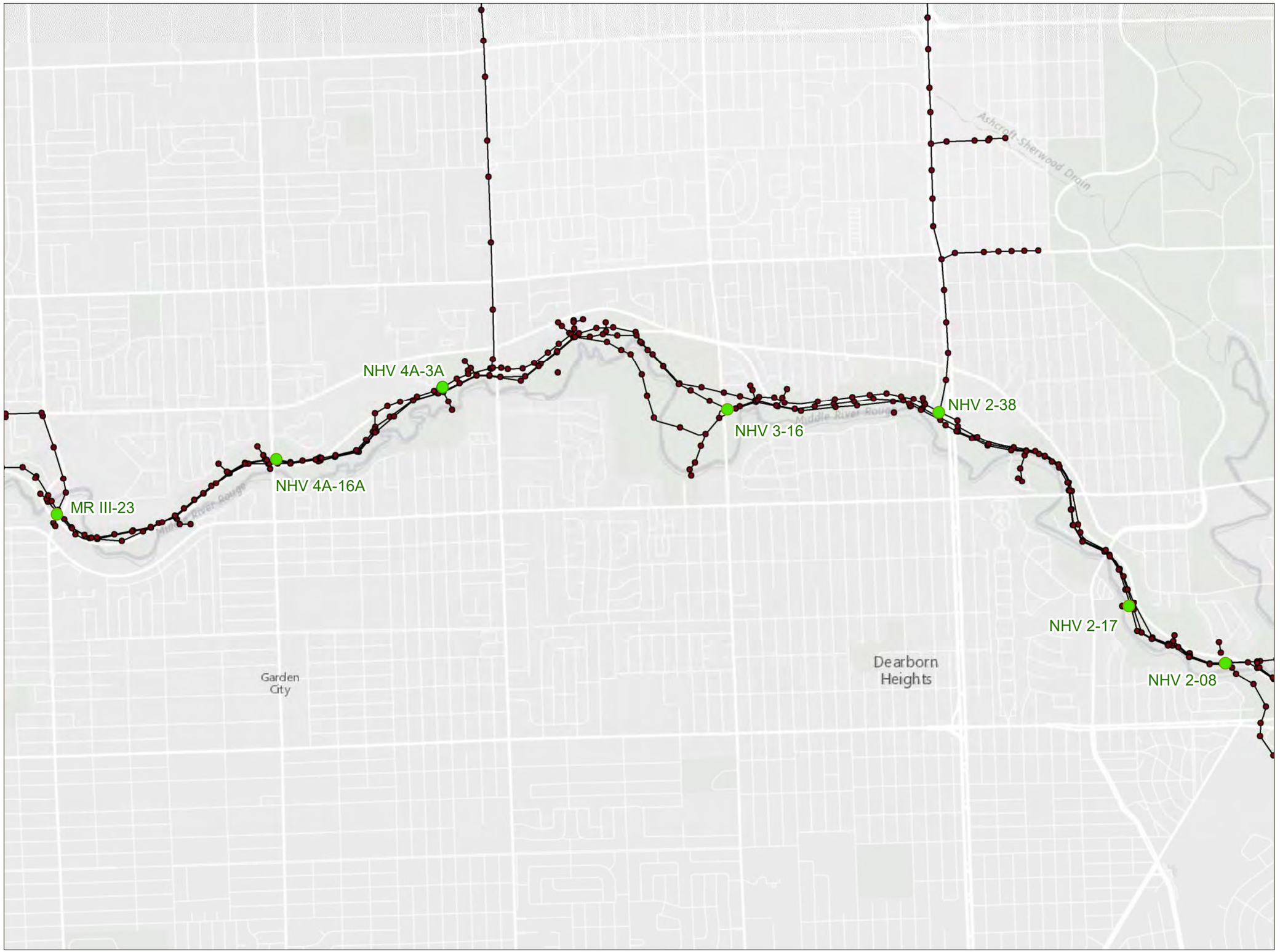
Additionally, the maximum total inflow through each manhole as well as the inlet (community inflow) pipe size was analyzed at each junction using the RVSDS EPA SWMM model. Structures with significant inflow potential (via community flow inputs) were given priority for consideration as a vent structure. After consulting with ASI on potential locations and conducting multiple field visits, four manholes and three junctions were determined as the most effective locations to vent the system and enhance hydraulic capacity. With ASI's knowledge of the system, they recommended Wayne County vent three manholes upstream of Inkster Road. These manholes are potential problems since they connect all three interceptors and will likely enhance system performance. The majority of the locations have multiple inlet pipes greater than 12 inches and a maximum total inflow greater than 30 MGD. Table 1 provides the final list of manholes proposed to be vented. Figure 2 illustrates the final location of each system vent between Inkster Road and LS1A.

Draft

Table 1 Summary of Final Venting Systems

Facility ID	Type of Structure	Need for Venting	Rim Elevation	Invert Elevation	Depth (ft)	Max Total Inflow (MGD)	Non-Interceptor Inlet Pipe (ft)	Location Reference to pathway	Distance to Pathway (ft)
NHV 2-08	Junction Chamber	Lower Rouge Inflow Point	589.17	576.16; 577.97	13.6	169.7	-	South	34
NHV 4A-3A	Standard Manhole	Interceptor Connection	610.04	600.52	9.5	5.7	-	Across the street	38
NHV 4A-16A	Standard Manhole	Interceptor Connection	616.02	606.54; 606.67	8.1	5.9	-	Across the street	>50
MR III-23	Standard Manhole	Interceptor Connection	623.10	611.23	11.9	11.8	-	Across the street	>50
NHV 2-17	Standard Manhole	Community Inflow Point	591.7	578.62	13.1	56.2	1.5	West	42
NHV 3-16	Junction Chamber	Community Inflow Point	606.57	589.96; 591.28	18.3	48.2	3.5	South	>50
NHV 2-38	Junction Chamber	Redford Arm Inflow Point	595.66	581.41	17.0	36.5	4.5	Across the street	34

Draft



Final Venting Locations

- Venting Locations
- Sanitary Manhole
- Sanitary Gravity Main

0 2,917 5,834
Feet

1" = 2917'

Source: Data provided by Wayne County. 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: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: March 9, 2016

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System Venting Details

Two standard details were created for the installation of the system vent. One standard is for a typical Wayne County manhole structure with a 42-inch or larger sewer and the other standard is for all junction chambers. For each junction chamber there is a plan view provided with details from As-Built drawings provided by Wayne County. All structure standards and plan view details are provided in Appendix A. The configuration of vent locations for each structure was determined based on photo/video data available from structure inspections and considers adjacent surface features so as to avoid conflicts with nearby facilities and to facilitate maintenance. The proposed configurations are shown in section and plan view.

The vents are proposed to enter the manholes as high as is practical to avoid being choked off during surcharge events. In general, the vents are proposed to be installed in the top manhole section (offset cone section) so as to accomplish this goal. For junction chambers, we propose to install vents in the circular manhole structure above the main box so as to avoid coring into a much thicker and heavily reinforced top slab or side wall.

The diameter of the vent stacks is designed to be a minimum of 12 inches. This pipe is larger than typical pump station vent stacks due to the magnitude of flow. Our initial review of the flow rates suggests that a 12-inch diameter vent will be sufficient to manage the airflow needs into and out of any of the structures identified in this memorandum.

The appropriate accommodations for each manhole and junction are referenced in the standard detail sheets and provided in Table 2. The 100-year floodplain elevation for each structure was determined in GIS using FEMA data. A freeboard of 12 inches above the 100-year floodplain elevation was assumed to avoid inundation during a flood event. The height of the venting stack was calculated based on the difference between the 100-year freeboard and the ground surface elevation immediately adjacent to the structure. The majority of the structures are in the 1-year floodplain, which, in some cases, is up to 10 feet below the 100-year floodplain. This will result in vent stack heights between 5 and 11 feet. Structure NHV 3-16 is not in the 100-year floodplain; however, a minimum height of 5 feet was deemed necessary for safety reasons. To protect the vent stacks from the public and to clearly mark the vents for Wayne County's Public Works Department, three five feet high bollards are recommended approximately 120 degrees apart surrounding the stack (for those structures in closer proximity to the roadway). The detail sheet for the bollards is provided in Appendix A.

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Table 2 Summary of Structure Accommodations

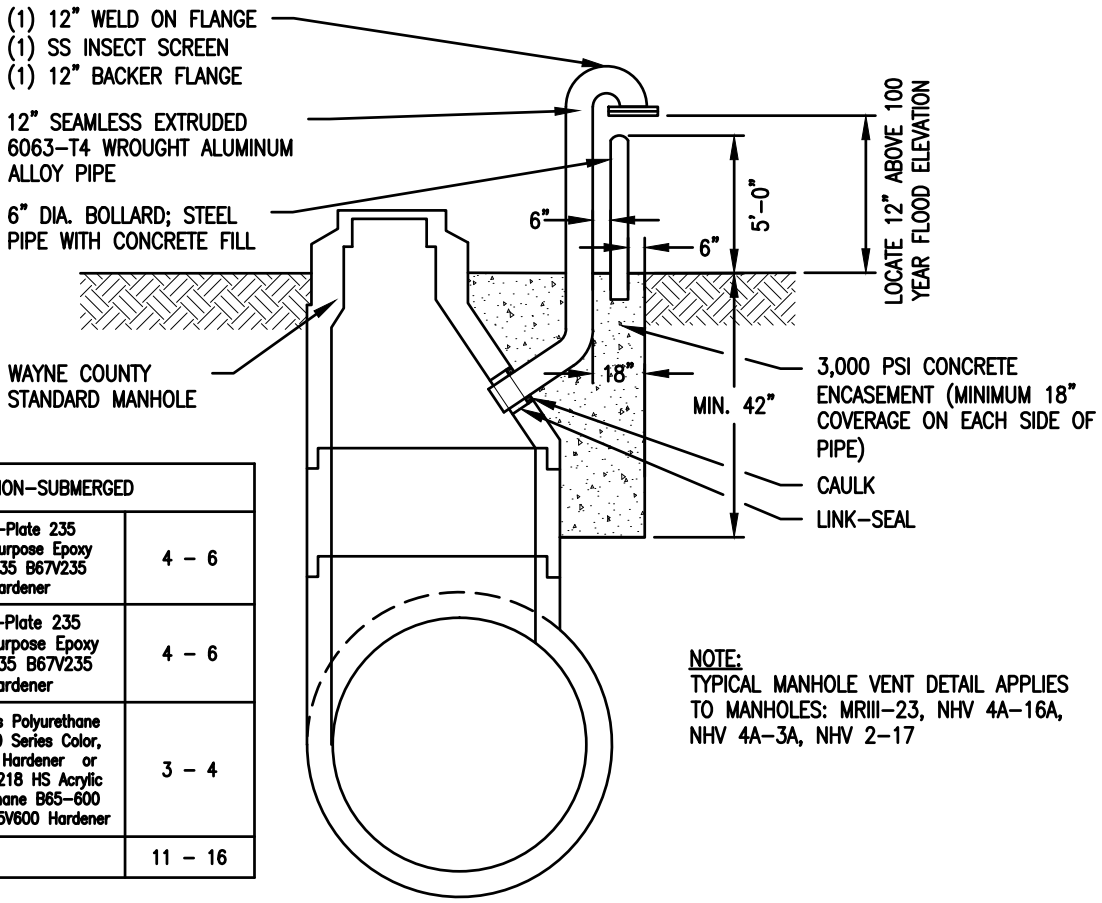
Facility ID	Rim Elevation	Invert Elevation	100 year floodplain	1-foot Freeboard	Height of Stack (ft)	Bollards Required?	Position of Venting
NHV 2-08	589.17	576.16; 577.97	599.1	600.1	10.9	Yes	Refer to Details
NHV 2-17	591	578.62	600.3	601.3	10.3	Yes	Opposite of ladder
NHV 3-16	606.57	589.96; 591.28	606.4	607.4	5	No	Refer to Details
NHV 2-38	595.66	581.41	602.5	603.5	7.8	Yes	Refer to Details
NHV 4A-3A*	610.04	600.52	614.9	615.9	5.9	Yes	Opposite of ladder
NHV 4A-16A	614.60	606.54; 606.67	620.7	621.7	5.7	Yes	Opposite of ladder
MR III-23	623.10	611.23	625.5	626.5	5	Yes	Opposite of ladder

*The vent stack at NHV 4A-3A is located roughly six feet away from parking.

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Appendix A: System Venting Details

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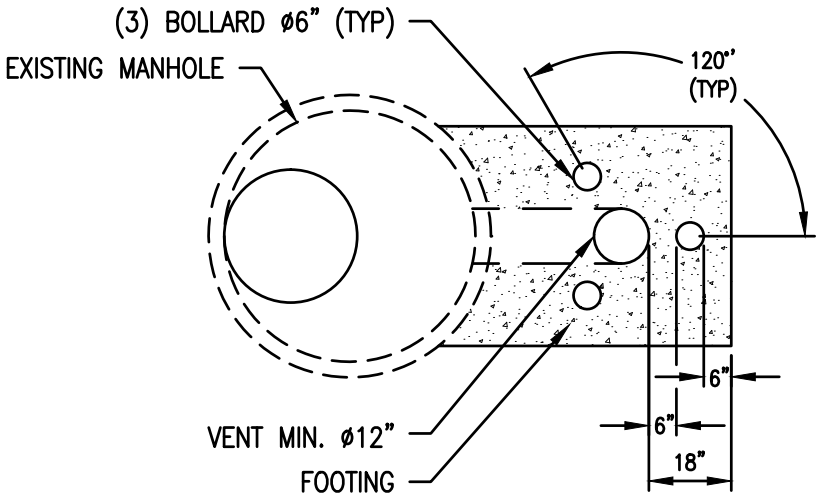


EXTERIOR NON-SUBMERGED		
PRIME COAT	Dura-Plate 235 Multi-Purpose Epoxy B67-235 B67V235 Hardener	4 - 6
FIRST COAT	Dura-Plate 235 Multi-Purpose Epoxy B67-235 B67V235 Hardener	4 - 6
SECOND COAT	Hi-Solids Polyurethane B65-300 Series Color, B60V30 Hardener or Acrolon 218 HS Acrylic Polyurethane B65-600 Series B65V600 Hardener	3 - 4
FINAL DFT		11 - 16

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NOTE:
TYPICAL MANHOLE VENT DETAIL APPLIES TO MANHOLES: MRIII-23, NHV 4A-16A, NHV 4A-3A, NHV 2-17

TYPICAL MANHOLE VENT DETAIL
NOT TO SCALE



TYPICAL VENT & BOLLARD PLAN FOR STANDARD MANHOLE
NOT TO SCALE

RVSDS LTCAP PHASE 1: SYSTEM VENTING
TYPICAL MANHOLE VENT DETAIL

SCALE H: N.T.S. V: N.T.S.
SHEET 1 OF 16

CLIENT: WAYNE COUNTY
JOB #: 0144-13-0030

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STANDARD DETAIL VENT HEIGHT								
FACILITY ID	RIM ELEVATION	INVERT ELEVATION	100 YEAR FLOODPLAIN	1-FT FREEBOARD	HEIGHT OF STACK (FT)	BOLLARDS REQUIRED?	POSITION OF VENTING	MAP
NHV 2-08	589.17	576.16; 577.97	599.1	600.1	10.9	YES	REFER TO DETAILS	SHEET 10
NHV 2-38	595.66	581.41	602.5	603.5	7.8	YES	REFER TO DETAILS	SHEET 11
NHV 3-16	606.57	589.96; 591.28	606.4	607.4	5	NO	REFER TO DETAILS	SHEET 12
MR III-23	623.10	611.23	625.5	626.5	5	YES	OPPOSITE OF LADDER	SHEET 13
NHV 4A-16A	614.60	606.54; 606.67	620.7	621.7	5.7	YES	OPPOSITE OF LADDER	SHEET 14
NHV 4A-3A	610.04	600.52	614.9	615.9	5.9	YES	OPPOSITE OF LADDER	SHEET 15
NHV 2-17	591	578.62	600.3	601.3	10.3	YES	OPPOSITE OF LADDER	SHEET 16

RVSDS LTCAP PHASE 1: SYSTEM VENTING
STANDARD MANHOLE VENT HEIGHT TABLE

SCALE
H: N.T.S. V: N.T.S.

SHEET
2
OF 16

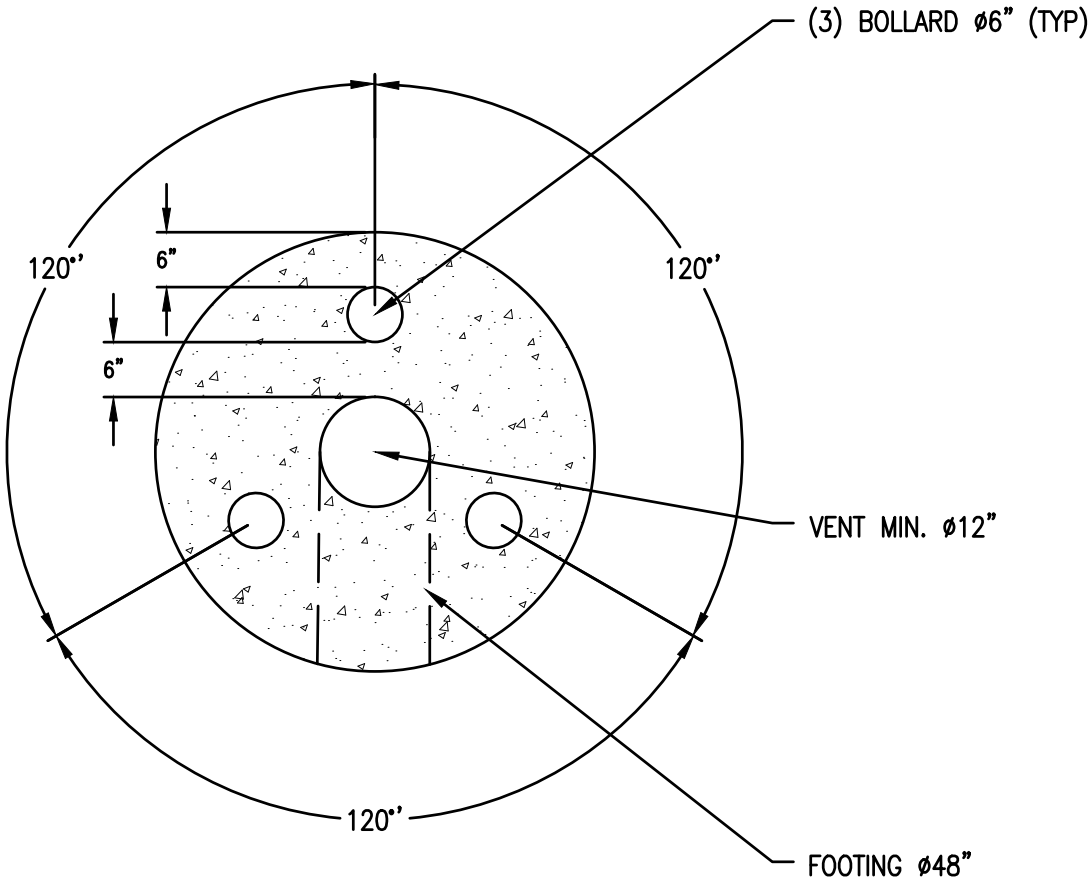
CLIENT:
WAYNE COUNTY

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0144-13-0030

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TYPICAL VENT & BOLLARD PLAN FOR JUNCTION CHAMBER

NOT TO SCALE

RVSDS LTCAP PHASE 1: SYSTEM VENTING
TYPICAL VENT & BOLLARD PLAN

SCALE H: N.T.S. V: N.T.S.

SHEET 3 OF 16

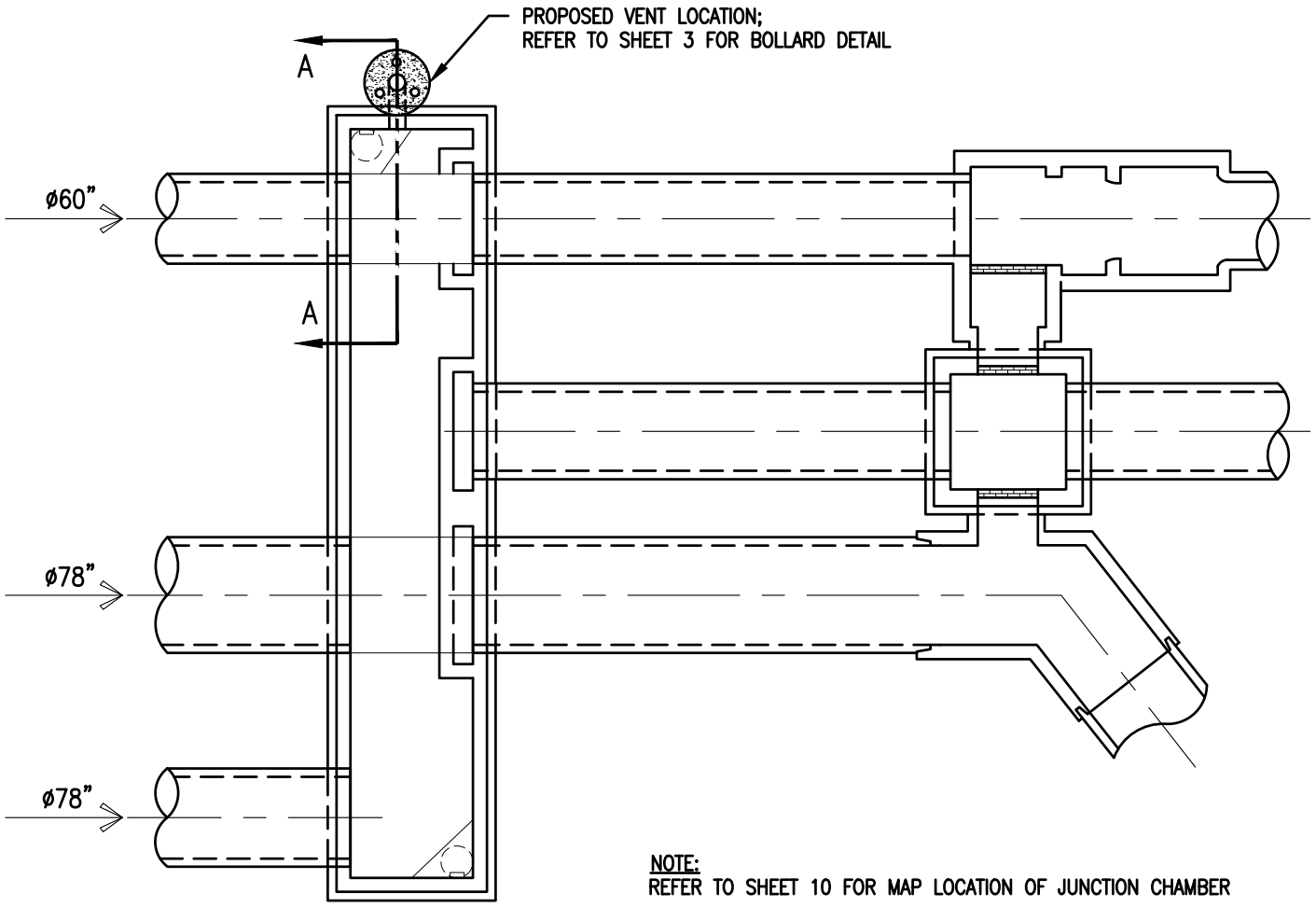
CLIENT: WAYNE COUNTY

JOB # 0144-13-0030

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NOTE:
REFER TO SHEET 10 FOR MAP LOCATION OF JUNCTION CHAMBER

JUNCTION CHAMBER #2-08 PLAN VIEW

NOT TO SCALE

N

RVSDS LTCAP PHASE 1: SYSTEM VENTING
JUNCTION CHAMBER #2-08 PLAN VIEW

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OF 16

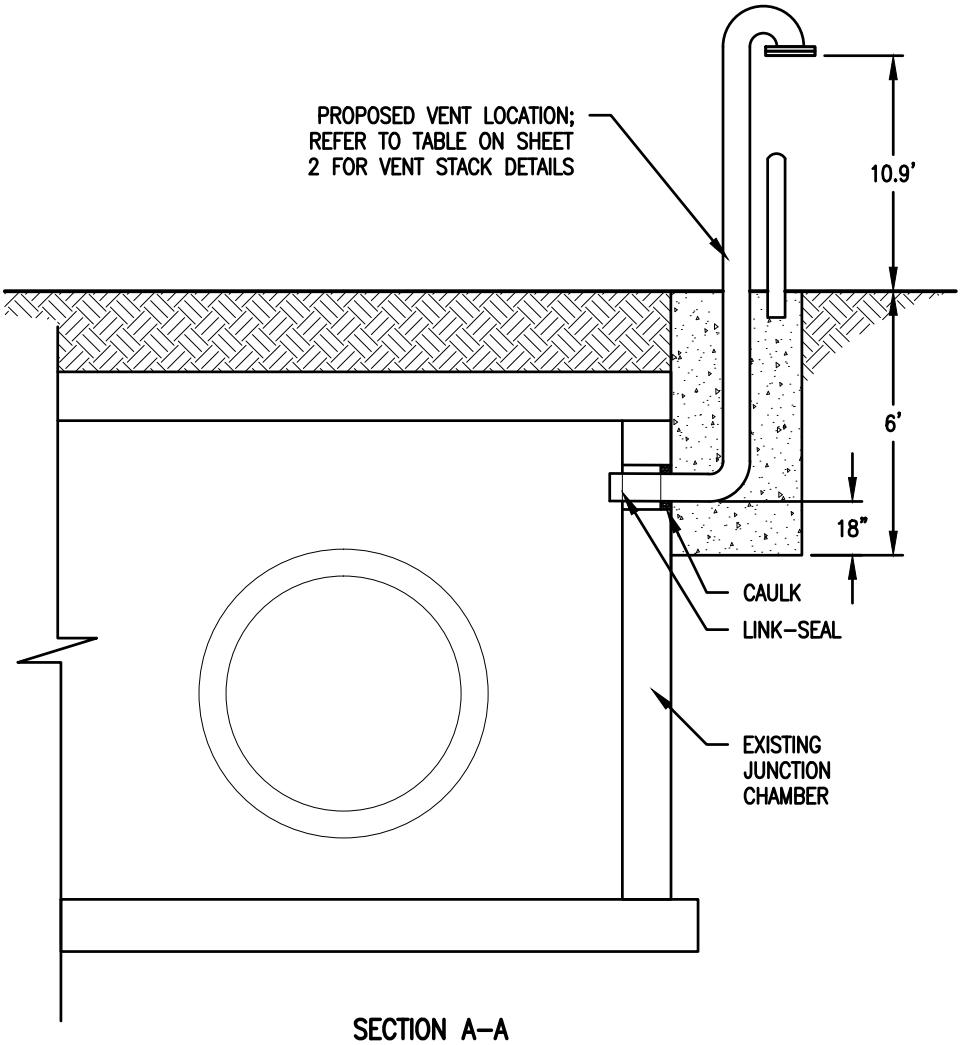
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SECTION A-A

JUNCTION CHAMBER #2-08 SECTION VIEW

NOT TO SCALE

RVSDS LTCAP PHASE 1: SYSTEM VENTING
JUNCTION CHAMBER #2-08 SECTION VIEW

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OF 16

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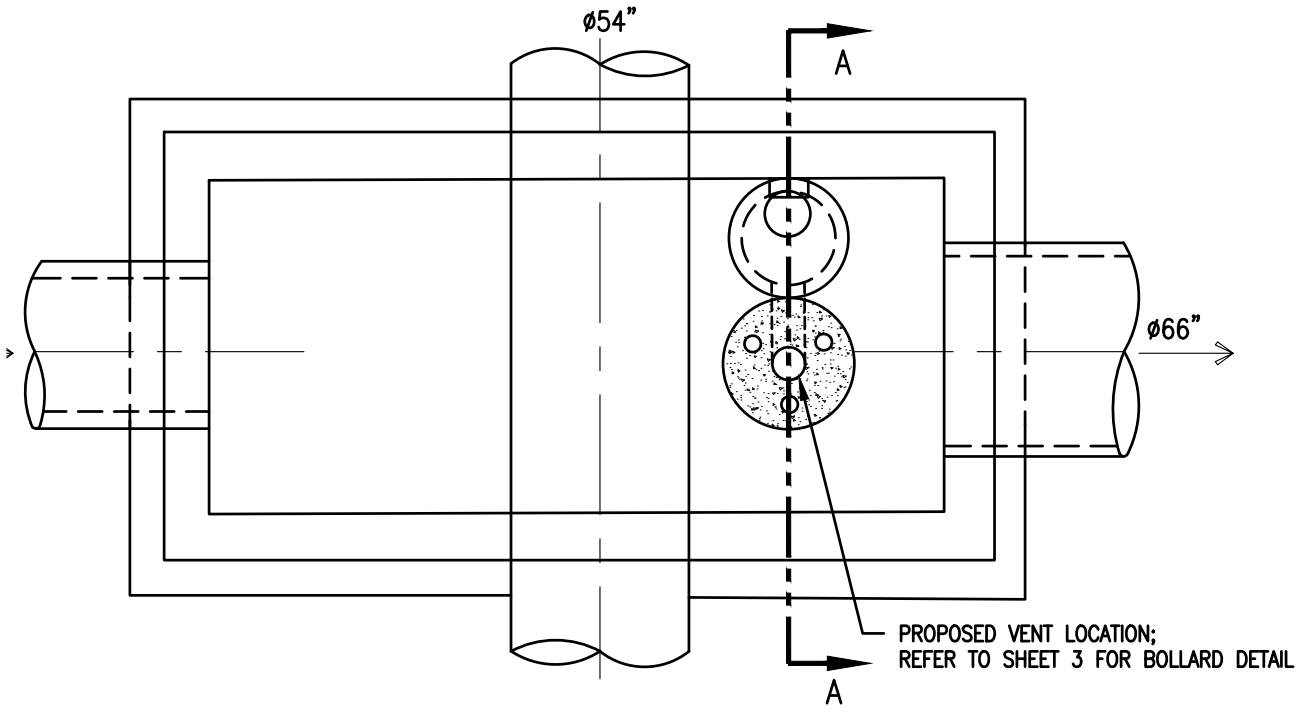
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NOTES:
CORE VENTING SYSTEM INTO THE CONE OF THE MANHOLE, OPPOSITE OF THE LADDER/SOUTH.

REFER TO SHEET 11 FOR MAP LOCATION OF JUNCTION CHAMBER.



JUNCTION CHAMBER #2-38 PLAN VIEW

NOT TO SCALE

N

RVSDS LTCAP PHASE 1: SYSTEM VENTING
JUNCTION CHAMBER #2-38 PLAN VIEW

SCALE H: N.T.S. V: N.T.S.

SHEET 6 OF 16

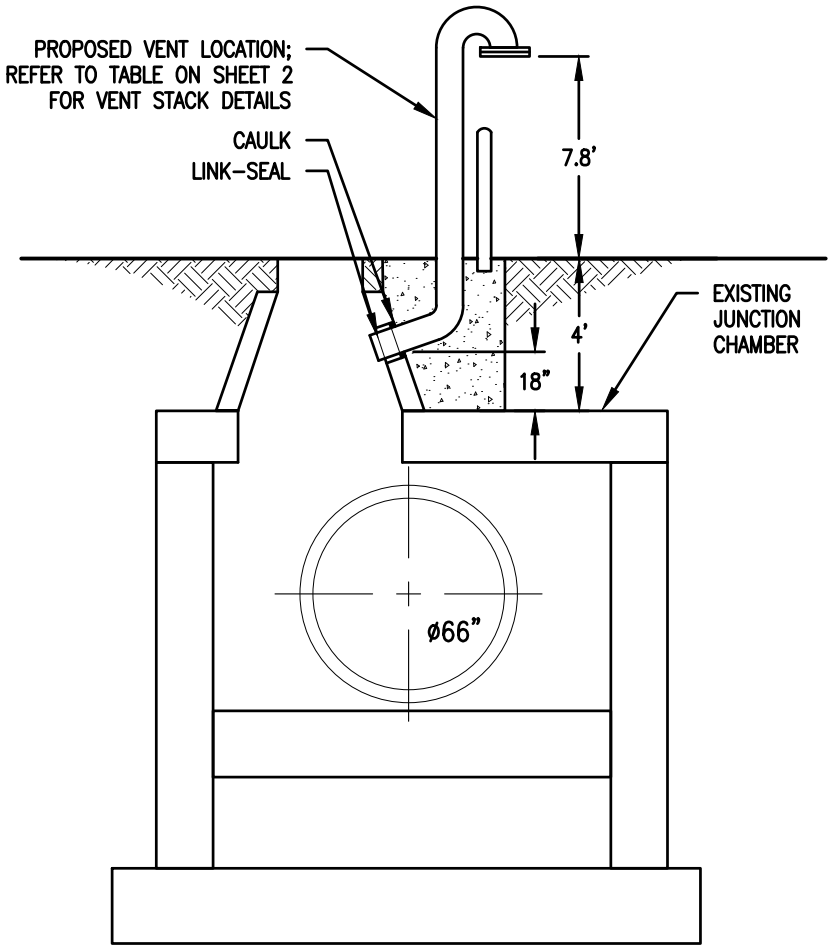
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SECTION A-A

JUNCTION CHAMBER #2-38 SECTION VIEW

NOT TO SCALE

RVSDS LTCAP PHASE 1: SYSTEM VENTING
JUNCTION CHAMBER #2-38 SECTION VIEW

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OF 16

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JOB #
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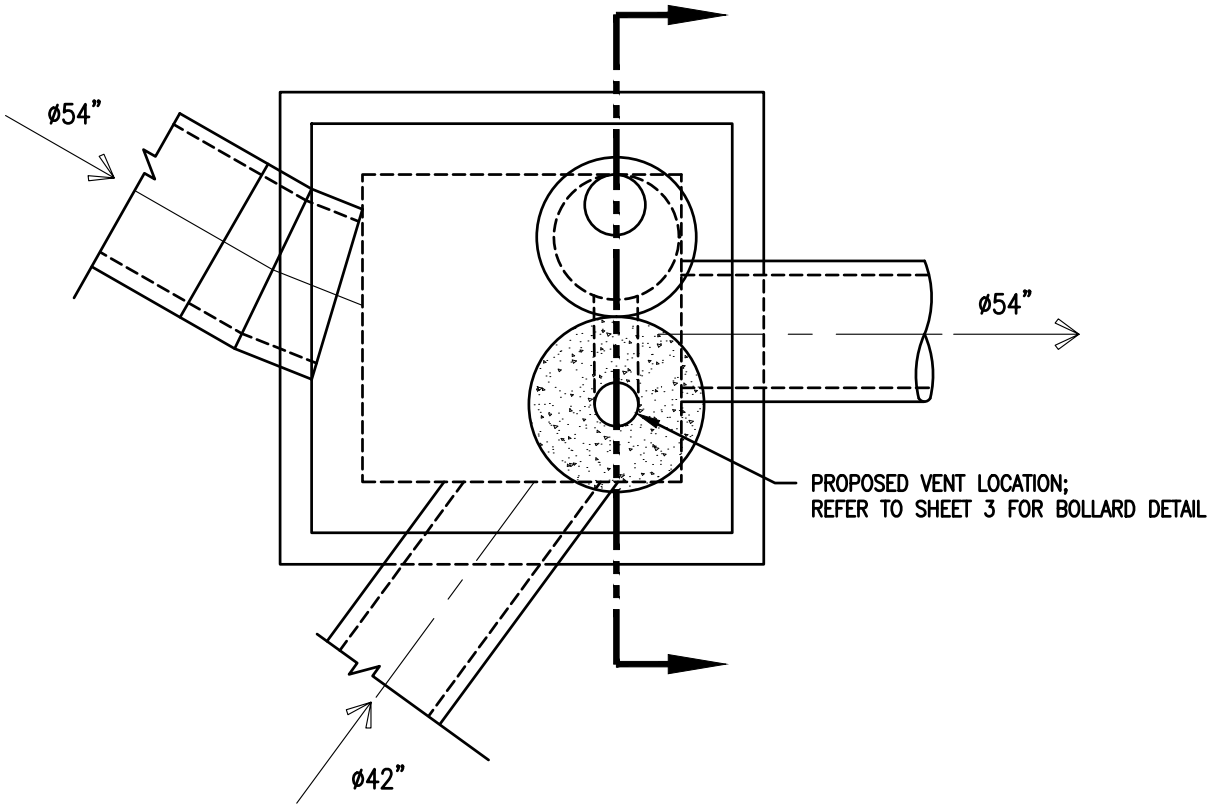
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NOTES:
CORE VENTING SYSTEM INTO THE CONE OF THE MANHOLE, OPPOSITE OF THE LADDER.

REFER TO SHEET 12 FOR MAP LOCATION OF JUNCTION CHAMBER.



JUNCTION CHAMBER #3-16 PLAN VIEW

NOT TO SCALE

N

RVSDS LTCAP PHASE 1: SYSTEM VENTING
JUNCTION CHAMBER #3-16 PLAN VIEW

SCALE
H: N.T.S. V: N.T.S.

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8
OF 16

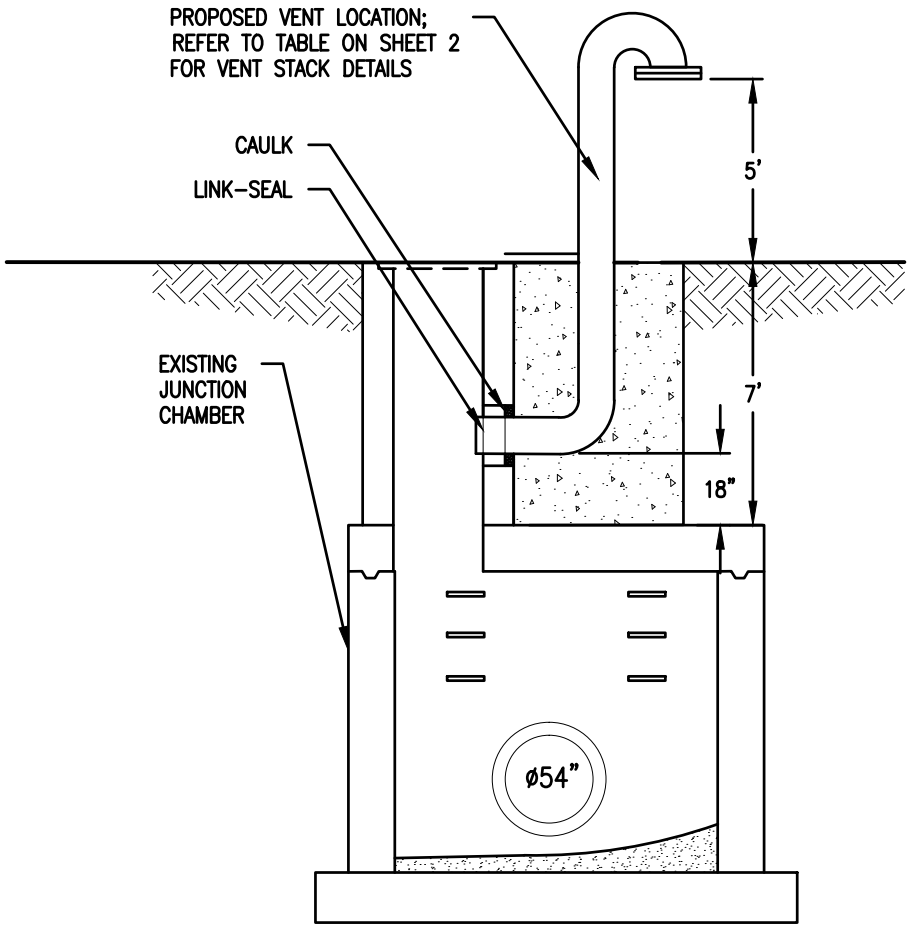
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SECTION A-A

JUNCTION CHAMBER #3-16 SECTION VIEW

NOT TO SCALE

RVSDS LTCAP PHASE 1: SYSTEM VENTING
JUNCTION CHAMBER #3-16 SECTION VIEW

SCALE
H: N.T.S. V: N.T.S.

SHEET
9
OF 16

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NHV 2-08 Location Sheet 10

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13425265
Y: 304847

Refer to Sheets 1, 2, 3, 4 and 5.

0 100 200
Feet

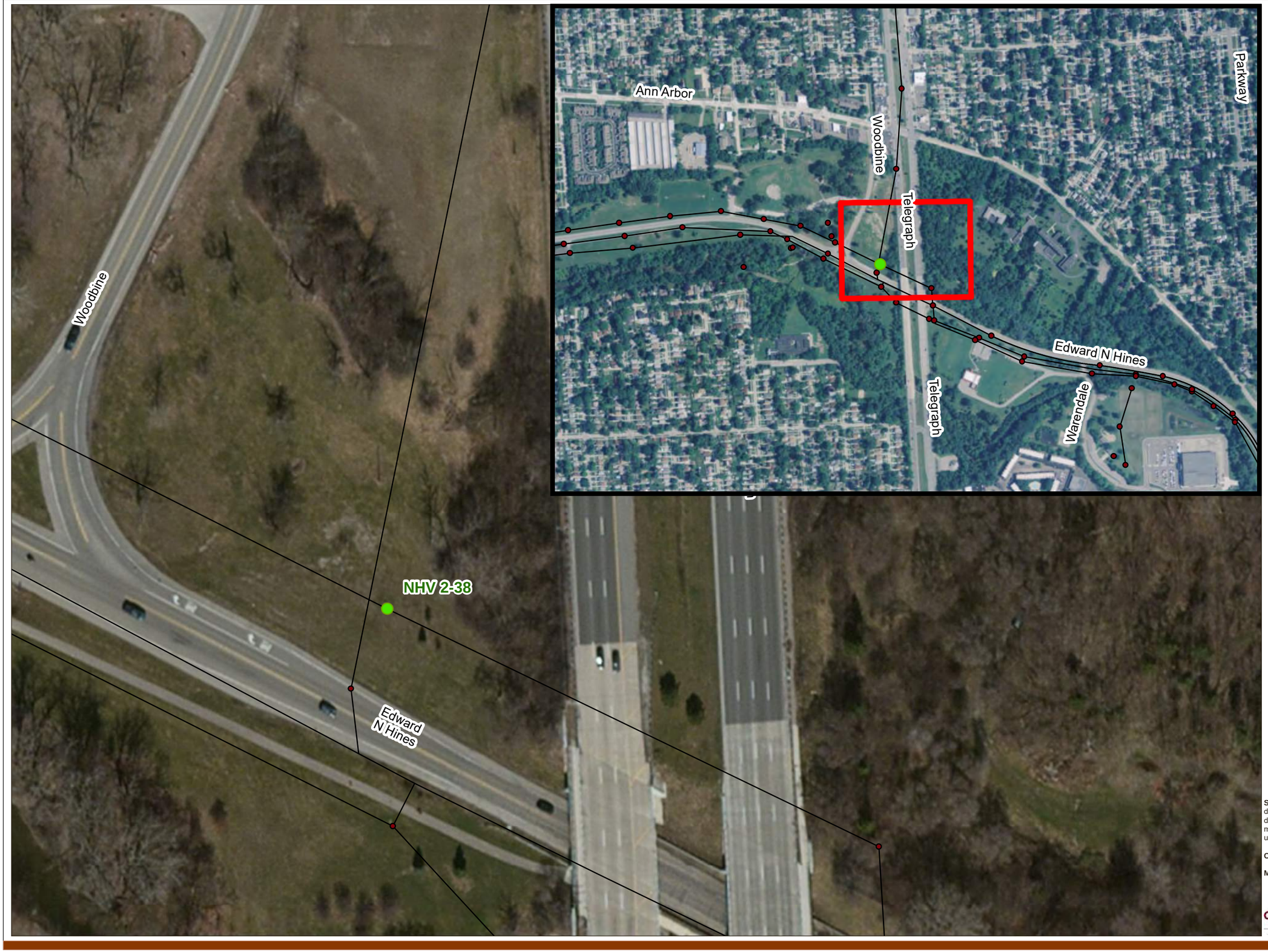
1" = 100'

Source: Data provided by Wayne County and ESRI. 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: WGS 1984 Web Mercator Auxiliary Sphere

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NHV 2-38 Location Sheet 11

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13418551
Y: 310551

Refer to Sheets 1, 2, 3, 6 and 7.

0 100 200
Feet

1" = 100'

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NHV 3-16 Location Sheet 12

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13413655
Y: 310546

Refer to Sheets 1, 2, 3, 8 and 9.

0 200 400
Feet

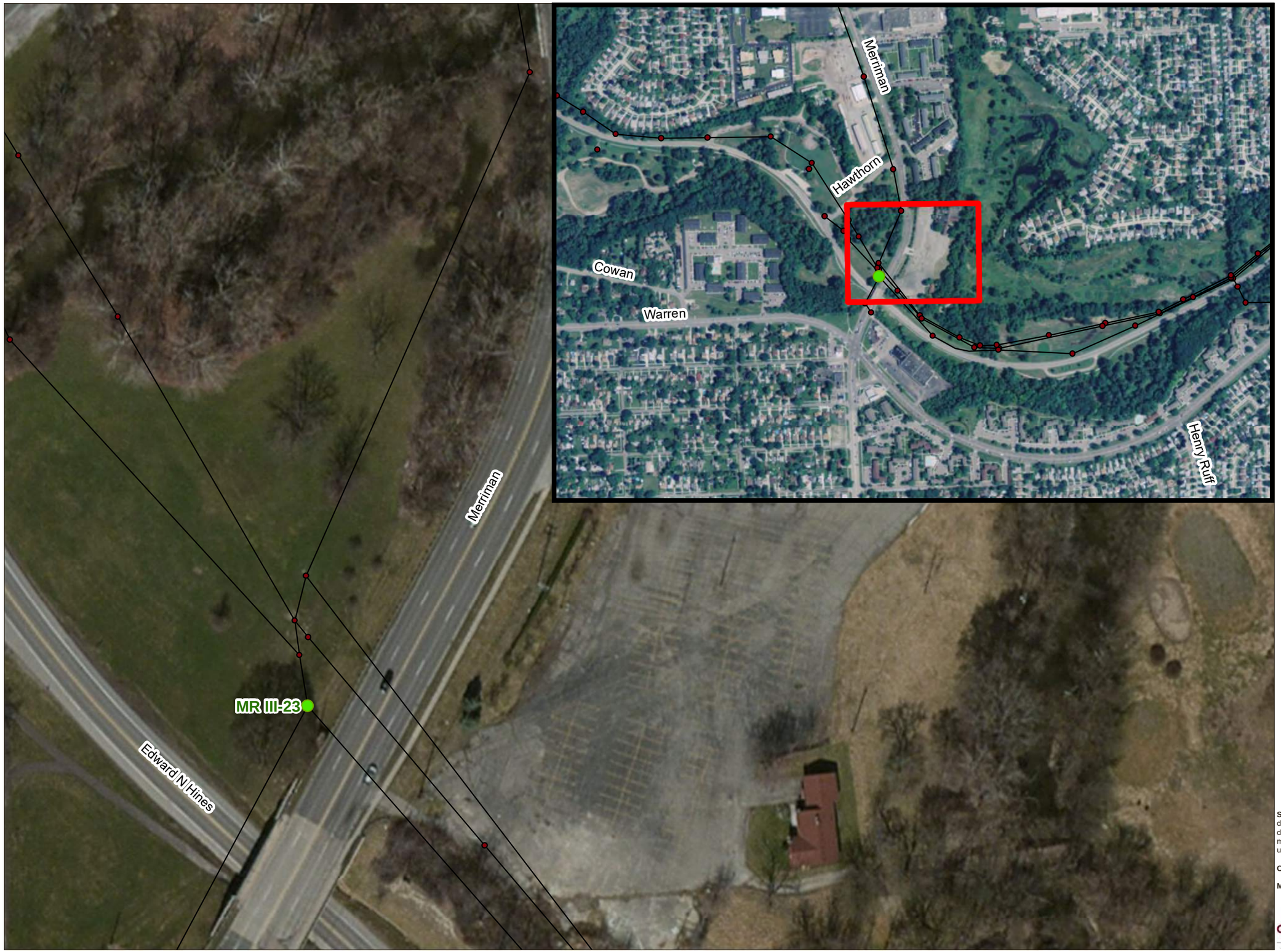
1" = 200'

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MR III-23 Location Sheet 13

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13398165
Y: 3079414

Refer to Sheets 1, 2, and 3.

0 100 200
Feet

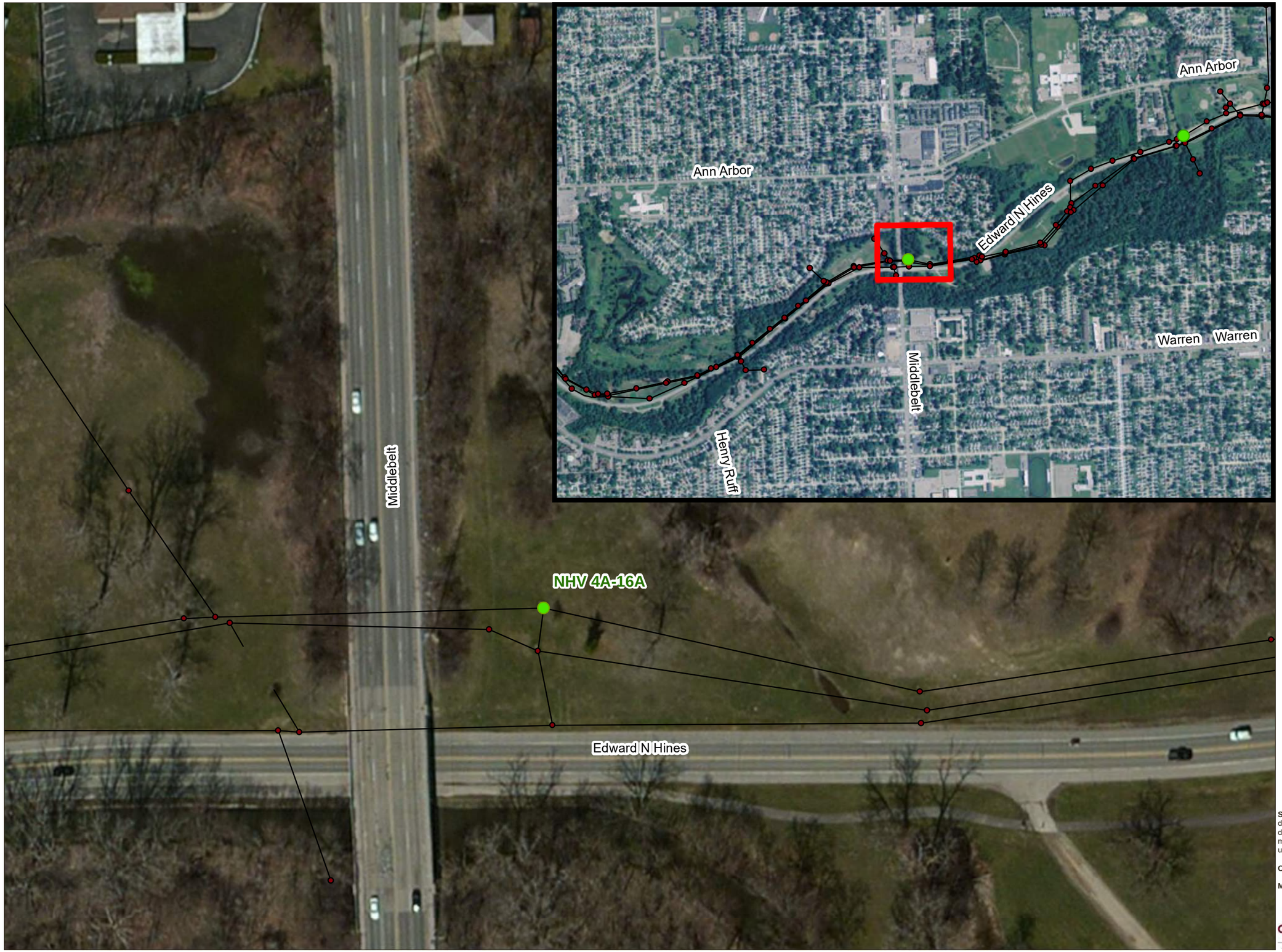
1" = 100'

Source: Data provided by Wayne County and ESRI. 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.

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NHV 4A-16A Location Sheet 14

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13403227
Y: 309269

Refer to Sheets 1, 2, and 3.

0 100 200
Feet

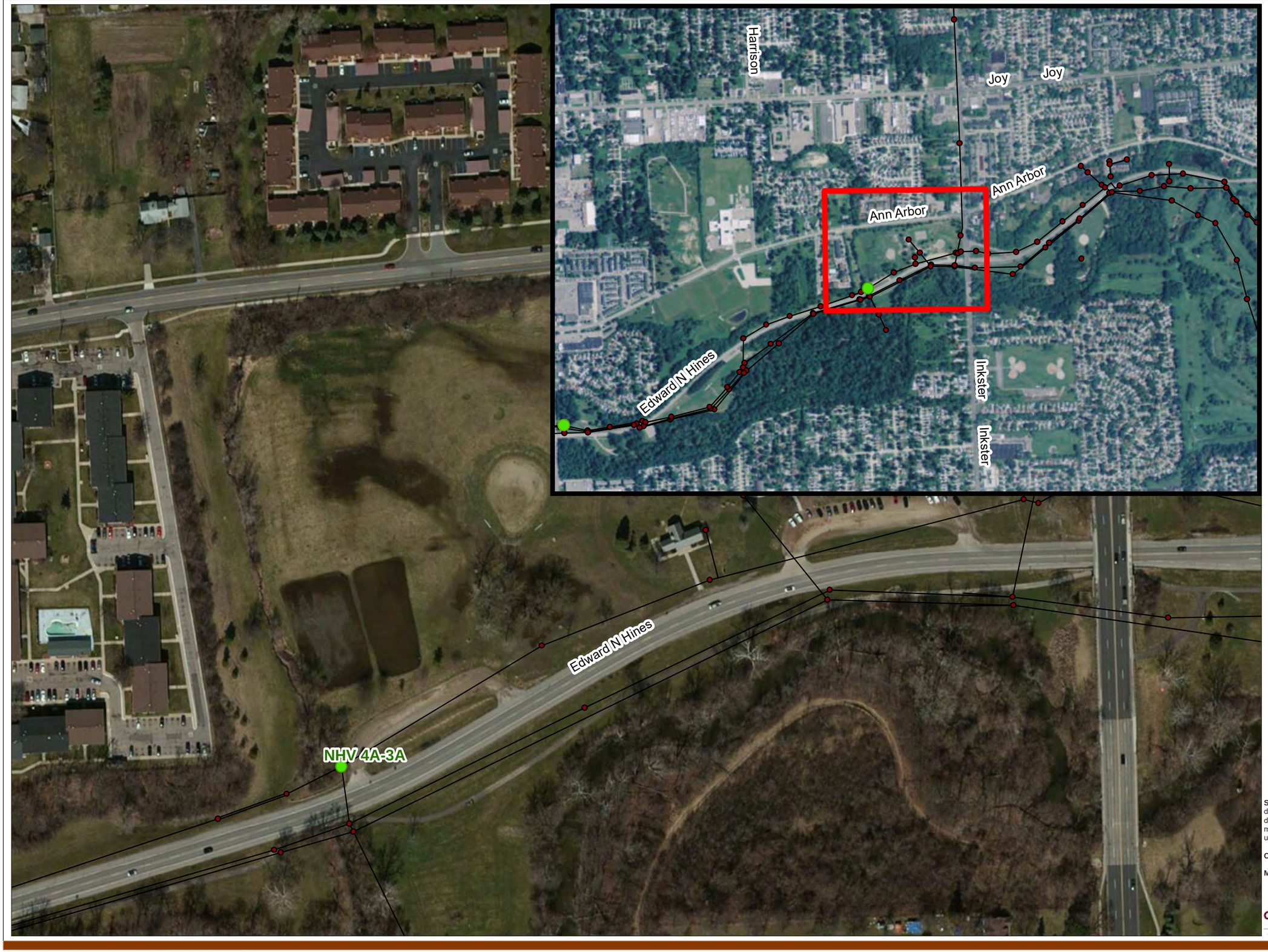
1" = 100'

Source: Data provided by Wayne County and ESRI. 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.

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NHV 4A-3A Location Sheet 15

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13407029
Y: 310981

Refer to Sheets 1, 2, and 3.

0 200 400
Feet

1" = 200'

Source: Data provided by Wayne County and ESRI. 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: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: June 23, 2016

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NHV 2-17 Location Sheet 16

Venting Locations
Sanitary Manhole
Sanitary Gravity Main

State Plane Coordinates
X: 13423017
Y: 306141

Refer to Sheets 1, 2, and 3.

0 200 400
Feet

1" = 200'

Source: Data provided by Wayne County and ESRI. 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: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: June 23, 2016

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DRAFT – June 29, 2019

Appendix J: Wet Weather Mobilization

Wayne County Rouge Valley Sewage Disposal System

August 16, 2016 Wet Weather Mobilization
Long Term Corrective Action Plan – Phase 1 (Task M)

DRAFT

October 12, 2016

Prepared by:
OHM Advisors
34000 Plymouth Road
Livonia, MI 48150

Rouge Valley Sewage Disposal System
Phase 1: Wet Weather Mobilization
October 12, 2016

Introduction

Wayne County is in the process of implementing a Long Term Corrective Action Plan (LTCAP) to satisfy the terms of its ACO, which require the analysis and capital improvements along the Rouge Valley Sewage Disposal System (RVSDS) interceptor system. Wayne County has been diligently working since 2012 to develop the LTCAP. A two phase strategy is in place to meet the requirements of the FOA 2117. Phase 1 is to address existing sanitary sewer overflow (SSO) problems in the Middle Lower Rouge. As part of that effort, OHM Advisors is working to improve management and knowledge of the RVSDS service area by observing manholes and junctions after storm events.

Visual inspection of the RVSDS during wet weather events will help to confirm what is happening at key locations where system-critical hydrologic and hydraulic dynamics are anticipated This will also help increase confidence in the hydrologic/hydraulic model.

The Wet Weather Monitoring Team has been in effect since May 1, 2016 and consist of six people, two from each of the three consultants under contract for this program (OHM, ASI, and Wade Trim). OHM maintains the team list and is responsible for emailing and texting the mobilization orders.

Response Protocol

Mobilizations are only anticipated during an event that will exceed the threshold of an annual (i.e. 1-year) event. Mobilizations will only occur when the rainfall appears to be falling in a relatively uniform and widespread pattern over the RVSDS service area. The response from convective thunderstorms over small portions of the service area will not be observed.

OHM Advisors monitors rainfall precipitation forecasts from the National Weather Service's Weather Prediction Center. The weather is daily monitored for precipitation prediction for the next two (2) to three (3) days. If more than one inch of rainfall is predicted for any single 24-hour period, a WET WEATHER WATCH is issued to the team. This alerts the primary and backup team members that a wet weather mobilization may be necessary within the next day or two and to be ready for additional instructions.

When wet weather is imminent, OHM monitors radar based rainfall depth estimates produced by the approaching storm. The total storm rainfall depth estimates from the National Weather Service Enhanced Radar Image is used for this task. If the radar estimates indicate at least one inch of rainfall is imminent and is tracking towards the RVSDS service area, a WET WEATHER ALERT will be issued to the team. At this point, the team members will be on standby and will be available to mobilize if given a follow up order.

As rainfall occurs over the RVSDS service area, the RVSDS Interceptors take several hours for the precipitation to have a full impact on flows and flow depths. As such, there will be adequate time to review the hydrologic response in the Middle and Lower Branches of the Rouge River and use that information to determine if a mobilization is necessary. OHM Advisors will review the USGS Streamflow data for the following gages:

- USGS 04167000 (Middle Rouge at Garden City)
- USGS 04168000 (Lower Rouge at Inkster)
- USGS 04167150 (Middle Rouge at Dearborn Heights)

The gage height and flow data will be closely tracked during a wet weather alert. If the gage heights are trending towards depths exceeding 9 to 10 feet for the three referenced USGS gages, OHM Advisors will issue a MOBILIZATION ORDER.

Mobilization Locations

The mobilization assignments for the project team currently under contract with Wayne County are as following:

- Wade Trim: Lift Station 1A (including the Master Control, JC 2-08 and JC 1-18A), RVI 13-23 and RVI 13-22
- ASI: GLWA hydraulic conditions at key locations/facilities, such as the Hubbell-Southfield CSO regulator and RTB and other accessible junctions (i.e. junction with stop logs at NWI/RVI crossing) that would impact the RVSDS including the Area 13 local sewer reaches in Dearborn Heights
- OHM: Middle Rouge Interceptor, including Inkster Arm and key structures primarily downstream of Middlebelt Road, including the Lefler-Ready Relief, Lefler Ready, and Red Run, downstream to, but not including JC 2-08. Specific structures include:
    - M-22, M-21, M-20, JC 3-16, MH 3-24 (MRPIE)
    - SA09NW048 (Dearborn Heights Sewer)

The team will measure rim to invert and water depth at each structure and note of any SSOs. Additionally, photographs and videos will be collected at each facility inspection, including, if appropriate, hand sketches to illustrate the operation of the inspected component.

Mobilization Order

A Wet Weather mobilization order was issued on August 16, 2016 at 6 AM. The maximum gage height for the three USGS Gages between midnight and 6 am on August 16th were:

- USGS 04167000 (Middle Rouge at Garden City)-8.3 feet
- USGS 04168000 (Lower Rouge at Inkster)-9.7 feet
- USGS 04167150 (Middle Rouge at Dearborn Heights)-8.5 feet

According to the NOAA National Weather Service Forecast, the total amount of rainfall at the Detroit Metropolitan Airport on August 16th was 1.96 inches.

DRAFT

The team visited their respected structures where they took pictures and measurements. Table 1 lists all measurements and observations at each structure. Appendix A provides all pictures of the August 16th mobilization order.

On average, the structures fared well through the storm. Only four structures were observed to have SSOs and one structure, MR III-16, that was still submerged under water during the mobilization. Even though many of the structures handled the storm well, M-20 was problematic. M-20 is located on the south side of the Rouge River and west of Middlebelt Road. In June, the manhole cover wasn't bulleted down and had popped off into the river. Field crew fixed the problem and bulleted the lid down. During the August 16th storm, there was so much hydraulic pressure through the junction chamber, the concrete slab holding the cover in place blew off, exposing the manhole structure. The concrete structure for the junction chamber is also in poor condition. There are cracks in the concrete slab that is causing significant inflow into the system. The figure below illustrates the scenario at M-20.



Figure 1: The structure condition at M-20

Table 1: Measurements and Observations For August 16th

Time	Consultant	Structure Id	Rim to Invert (ft)	Top of Water to Rim (ft)	Water Depth (ft)	Evidence of SSO	Submerged	Note
10:15 AM	Wade Trim	L-34	-	8	-	No	No	
10:30 AM		RVI 13-23	9.2	7	2.2	No	No	
10:50 AM		RVI 13-22	11.8	9	2.8	No	No	
N/A		JC 2-8	13.4	7.8	5.6	No	No	West of Structure, North MH
N/A		JC 1	14.3	8	6.3	No	No	
7:17 AM; 8:45 AM	ASI	RVI 2-S1C		5.3; 7.0		Yes	No	
6:23 AM; 7:45 AM		WC S-2		33.4; 34.0		Yes	No	Surcharging in manhole has collected a layer of floating debris
6:35 AM; 7:56 AM		WC S-3		17.0; 18.1				
6:44 AM; 8:06 AM		Gate VR-8		16.5; 17.1		Yes	No	
7:15 AM	OHM	M-22B	15.9	12.8	3.1	No	No	
		M-22C	-	-	-	No	No	Metered
		M-22D	16.1	8.8	7.3	No	No	
7:57 AM		MR III-16	-		-	No	Yes	4 inches of water above structure
8:00 AM		M-20A	6	5	1	Yes	No	Structure blown off metal frame
		M-20B	8.9	1.6	7.3	Yes	No	
		M-20C	8.9	1.5	7.4	Yes	No	
		M-20D	-	-	-	Yes	No	Couldn't open
9:12 AM		M-21	9.7	8.7	1	No	No	
9:34 AM		SA09NW048	-	-	-	No	No	Resident has known manhole lid to have blown off frame

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Recommendations

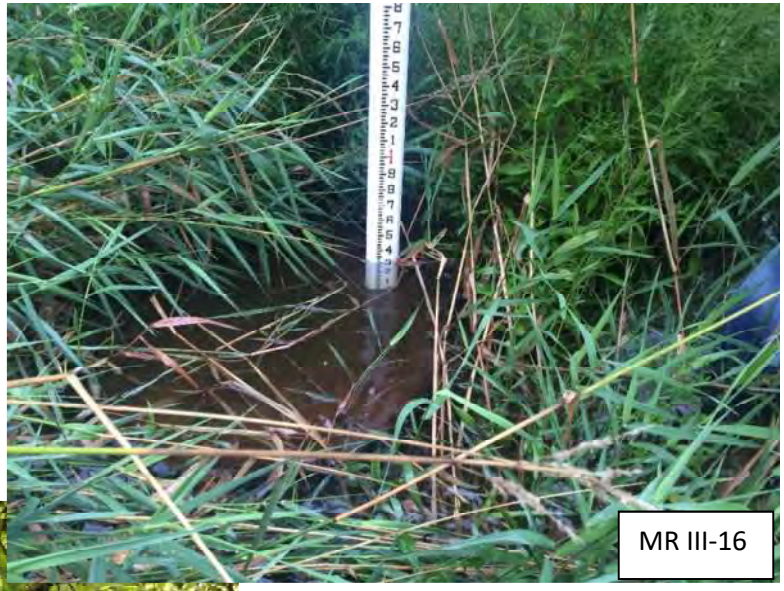
It is recommended that Wayne County address the structure condition at M-20 during Phase 1 of the LTCAP. The suggested approach for M-20 would be to rebuild the entire structure and approve M-20 as a planned overflow location. The chamber is currently in the 1 –year floodplain and in poor condition. It would be ideal to raise the structure approximately 2 feet. However, it will need to be determined whether the structure can be raised without negatively impacting upstream properties, i.e. basement backups due to additional wet weather surcharging. Additionally, instead of using a standard manhole cover, use a cast-in place access hatch with spring-loaded hinges to allow for overflows while closing and sealing after surcharge to prevent river inflow.

DRAFT

Appendix A: Mobilization Photographs



M-20



MR III-16



SA09NW048


M-22


M-22


M-22



RVI Upstream of Siphon – HGL Just Below Crown (844)



RVI Upstream of Siphon – HGL Surcharged (717)



L-34 Outfall

MH 13-23









APPROACH TO MH 13-23










WAYNE COUNTY
INTERCEPTOR SEWER







Junction Chamber 2-8



Junction Chamber 2-8



Junction Chamber 2-8



Junction Chamber 2-8



Junction Chamber 2-8





Junction Chamber 2-8



Junction Chamber 2-8






master control




junction chamber 1


JC 1


JC 1


JC 1


JC 1


vent stack


Wayne Interceptor siphon


vent stack


vent stack

CSO 53 L34

ayne Interceptor siphon

CSO 53 L34


MH 13-23


MH 13-23


RVI 13-22