Appendix D:
Phase 1 System Improvement Approaches

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D1: Rouge Valley Antecedent Moisture Model Report

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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.

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- 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.

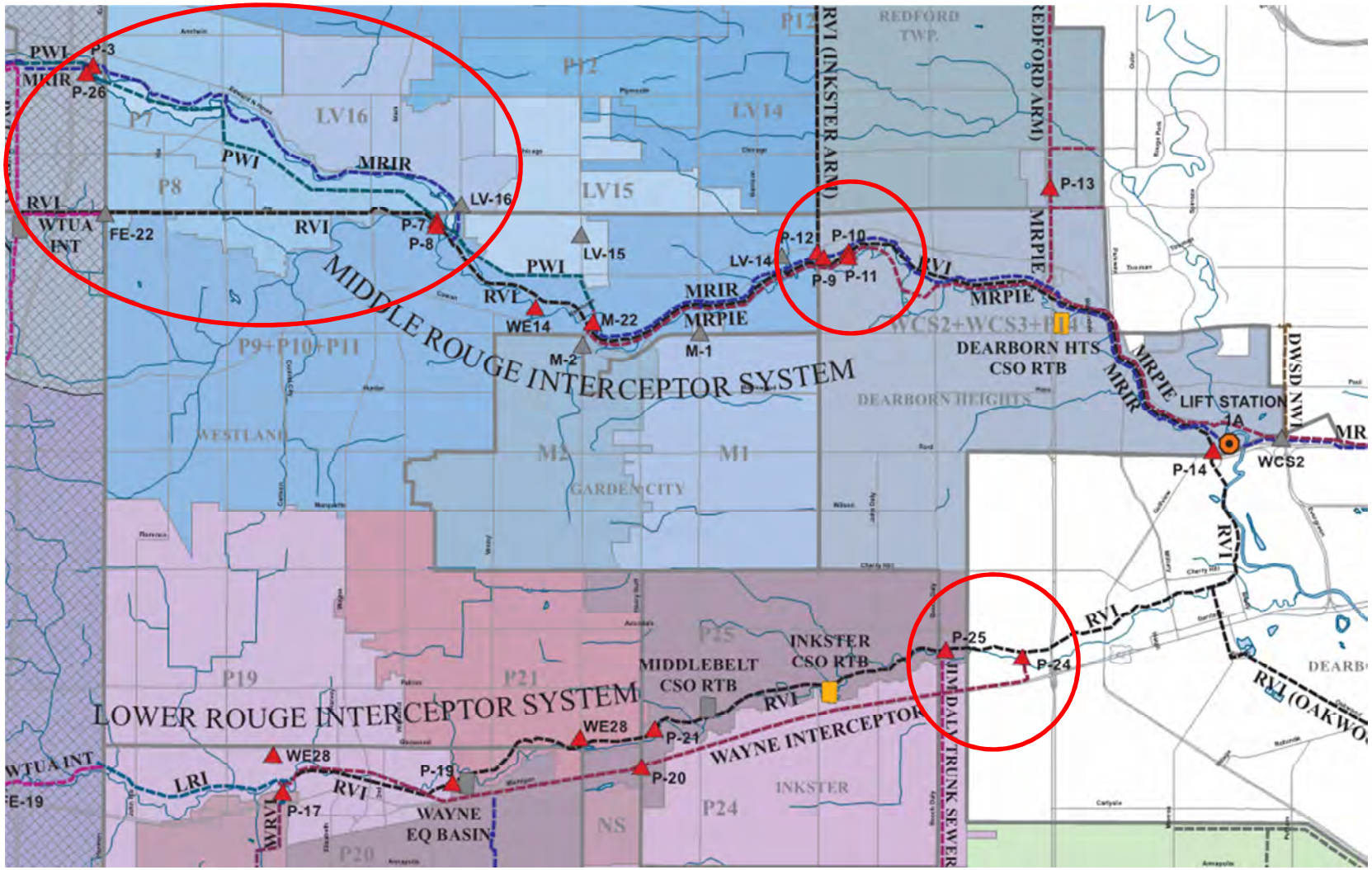

Figure 1 – Locations of AMM Flow Rate Estimates

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.

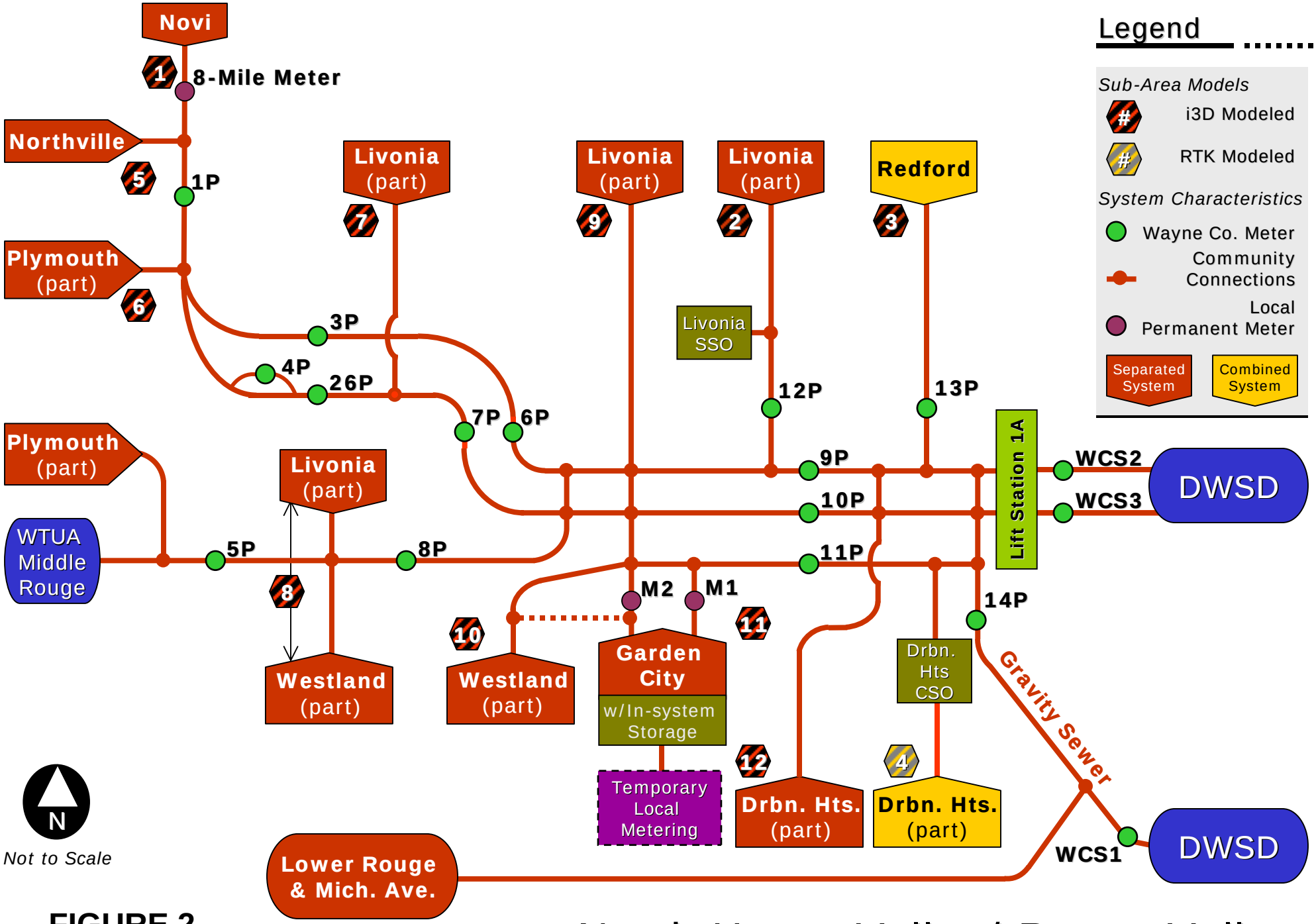

FIGURE 2

North Huron Valley/ Rouge Valley System Schematic

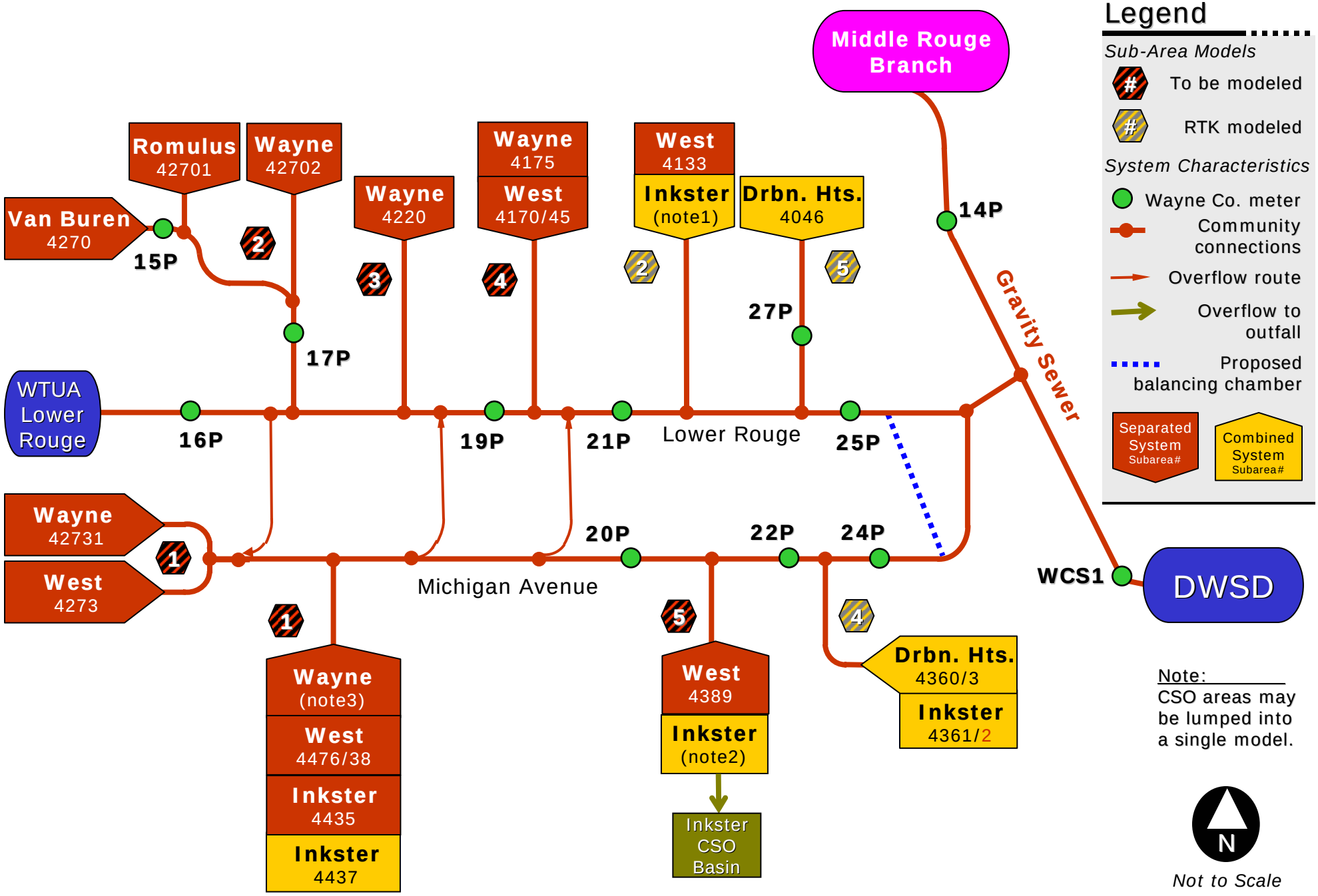

FIGURE 3

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.

D2: Floodplain Manhole Inspection Results (Task G)

Wayne County Rouge Valley Sewage Disposal System

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

April 26, 2016

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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

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.

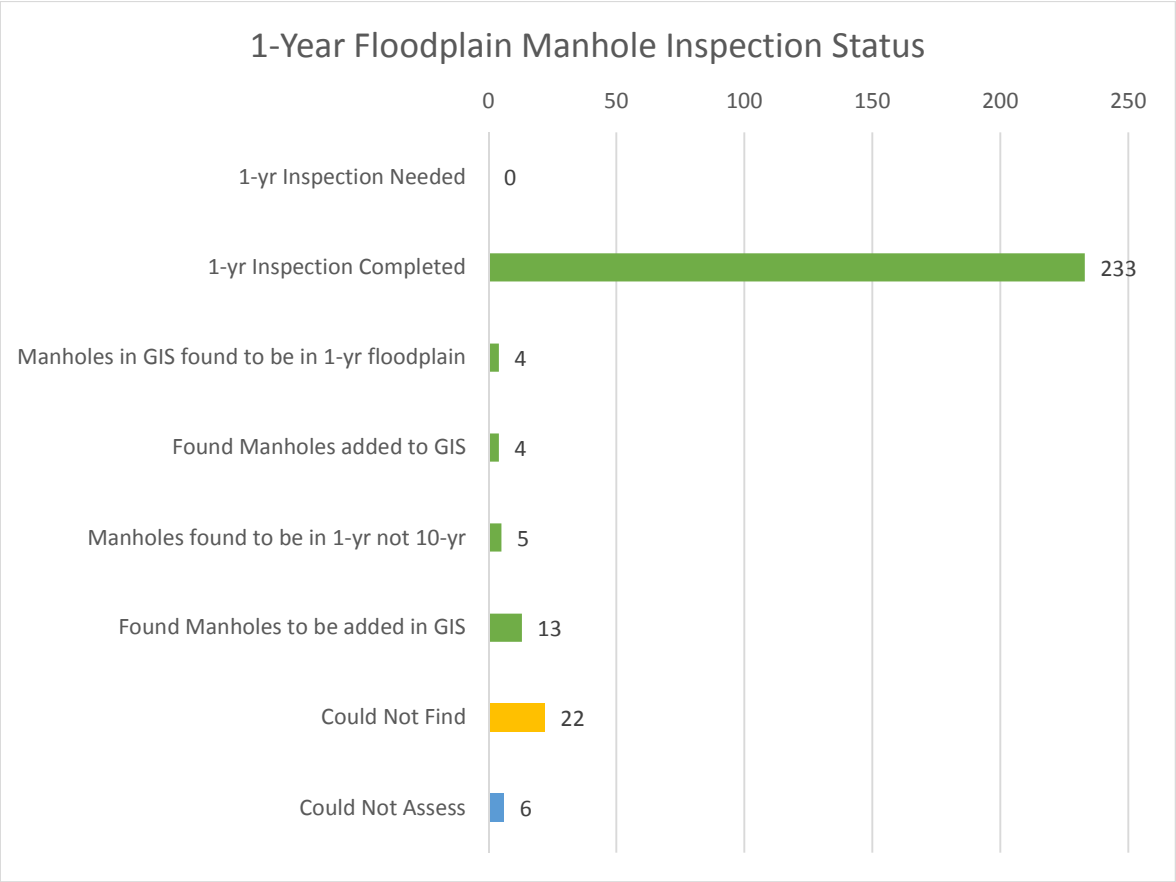

Figure 1 Manholes in 1-year floodplain found and inspected.

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

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	

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.

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

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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

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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

D3: Recommendations for System Venting (Task I)

Wayne County Rouge Valley Sewage Disposal System

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

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.

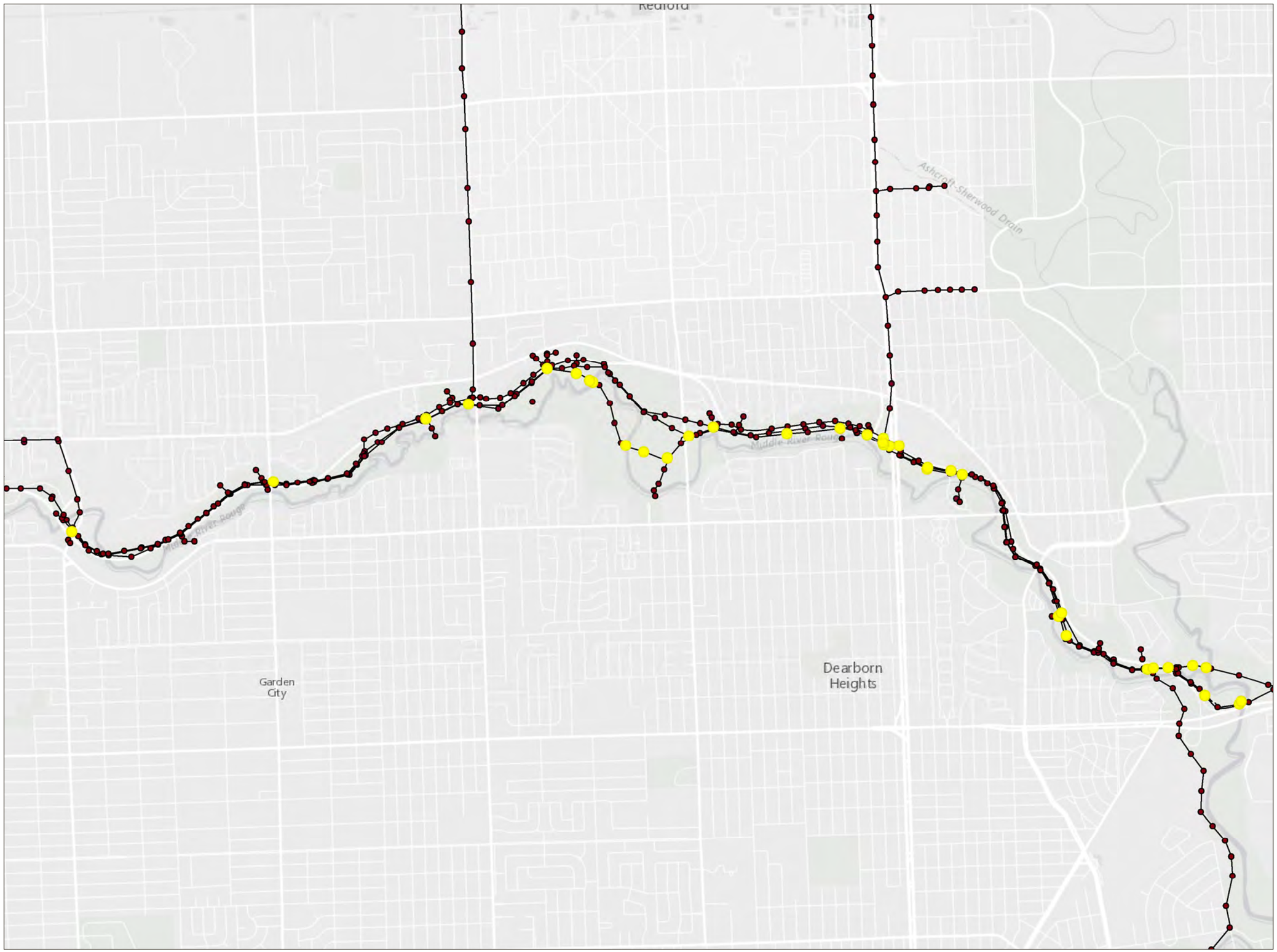
System Venting Locations

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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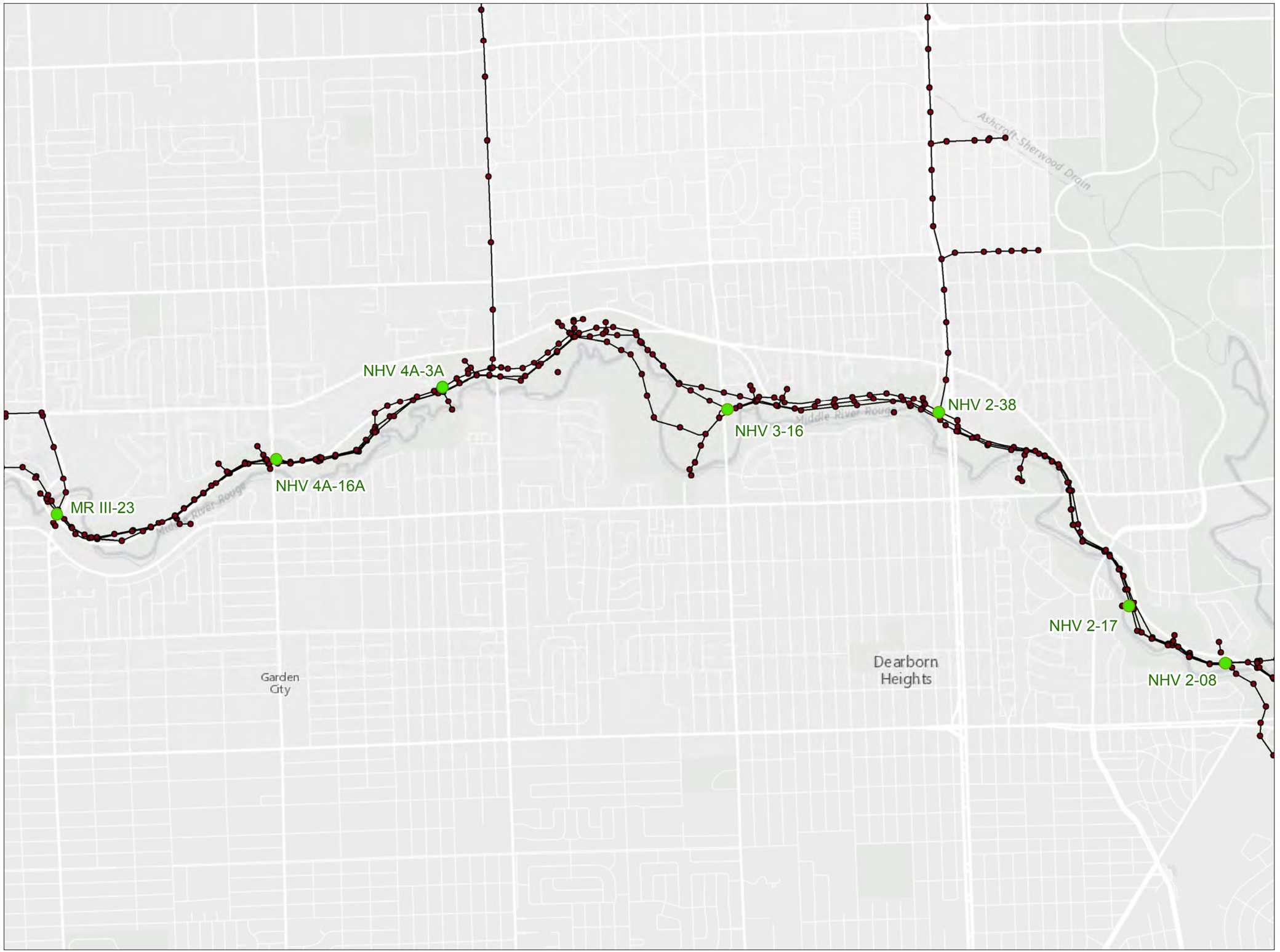
The first pass at eliminating structures for consideration was the proximity to roadway and recreational areas. The Middle Rouge Interceptor runs along Edward N Hines Drive where there are recreational areas along the entire reach. The venting systems need to be, ideally, in isolated areas away from 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.

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



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.

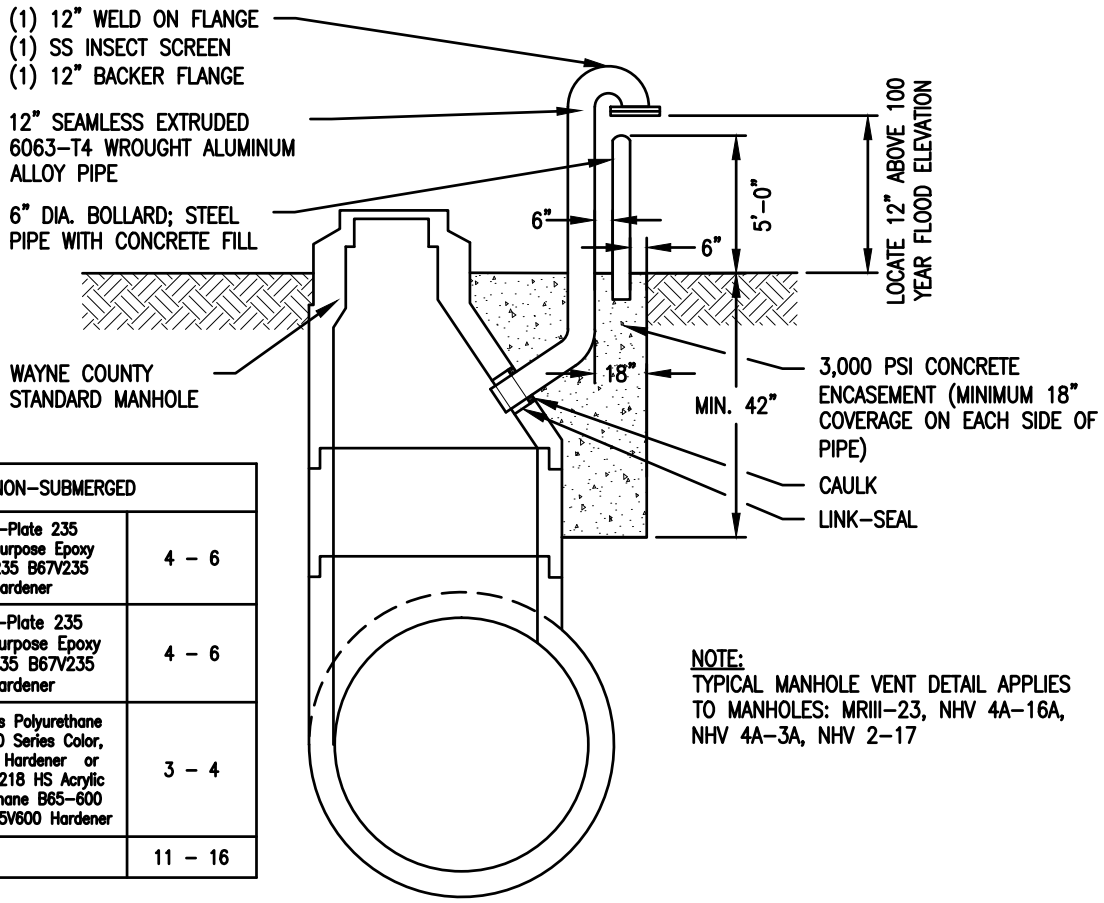
The appropriate accommodations for each manhole and junction are referenced in the standard detail sheets and provided in Table 2. The 100-year floodplain elevation for each structure was determined in GIS using FEMA data. A freeboard of 12 inches above the 100-year floodplain elevation was assumed to 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.

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.

Appendix A: System Venting Details

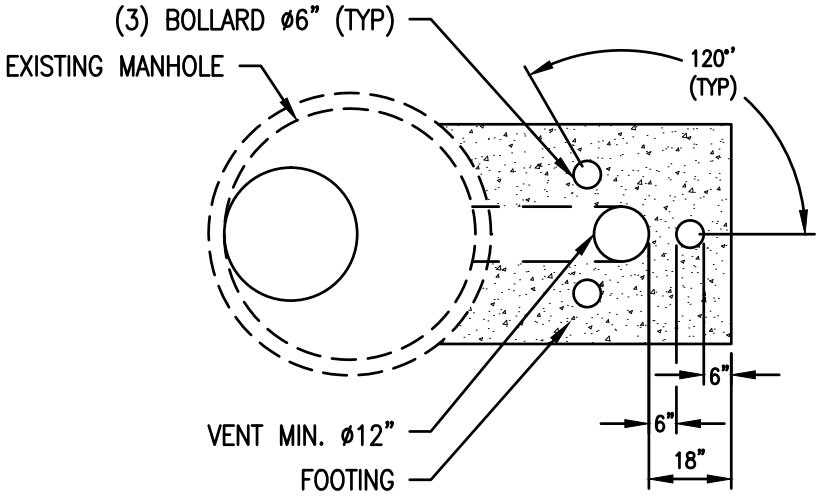


EXTERIOR NON-SUBMERGED		
PRIME COAT	Dura-Plate 235 Multi-Purpose Epoxy B67-235 B67V235 Hardener	4 - 6
FIRST COAT	Dura-Plate 235 Multi-Purpose Epoxy B67-235 B67V235 Hardener	4 - 6
SECOND COAT	Hi-Solids Polyurethane B65-300 Series Color, B60V30 Hardener or Acrolon 218 HS Acrylic Polyurethane B65-600 Series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

PAINT:
PAINT THE ALUMINUM ALLOY WITH SHERWIN- WILLIAMS COMPANY PAINT AS LISTED OR APPROVED EQUAL

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:
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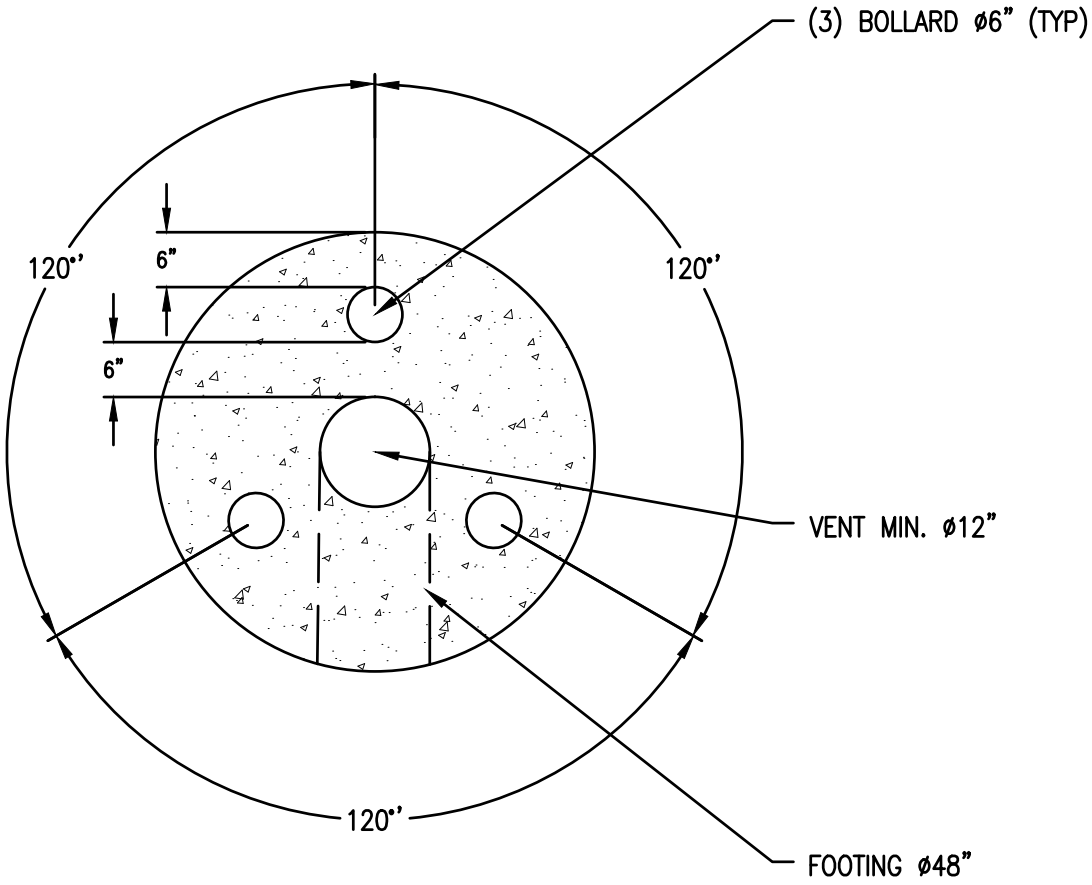

TYPICAL VENT & BOLLARD PLAN FOR JUNCTION CHAMBER

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

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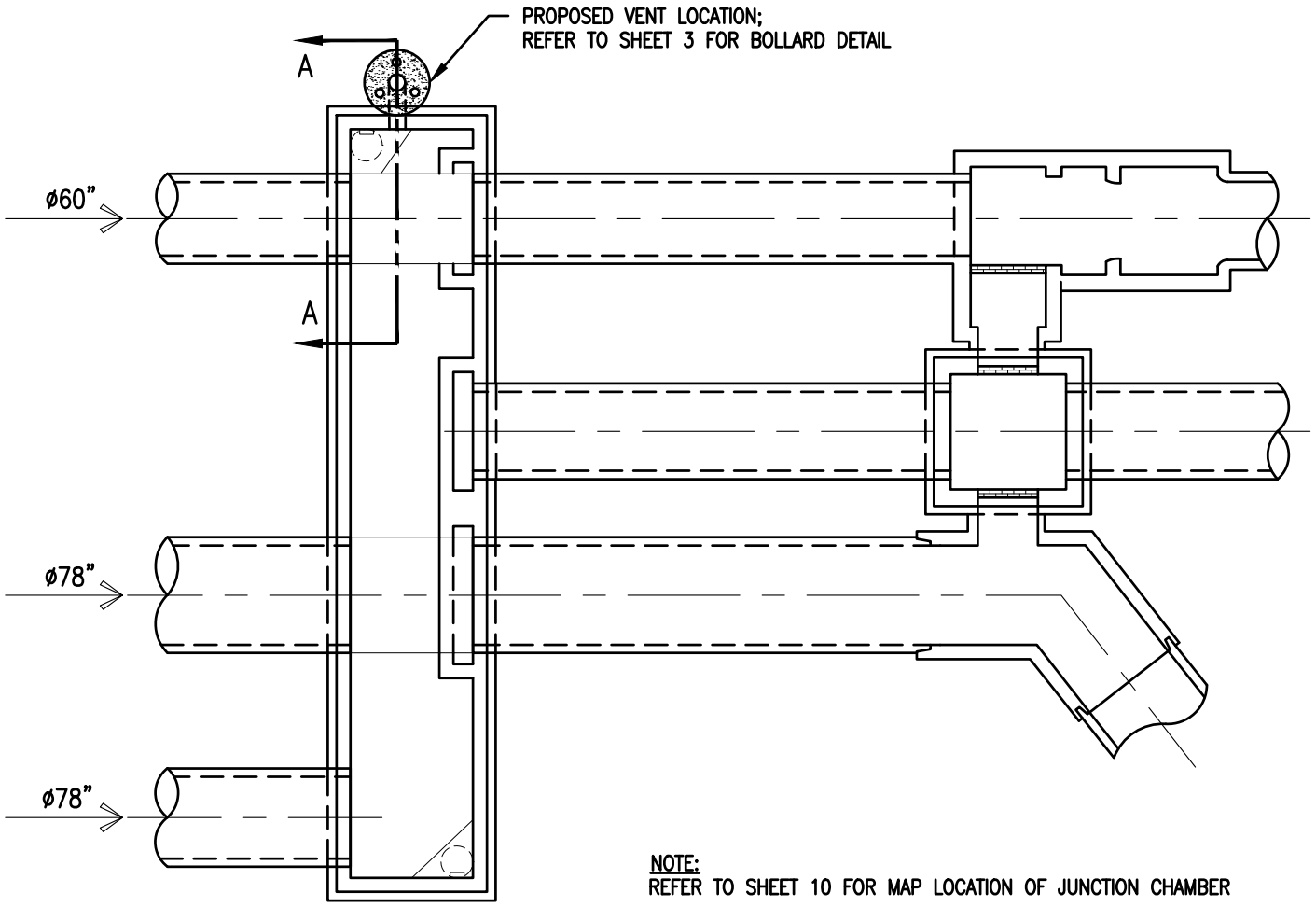

NOTE:
REFER TO SHEET 10 FOR MAP LOCATION OF JUNCTION CHAMBER

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

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OF 16

CLIENT:
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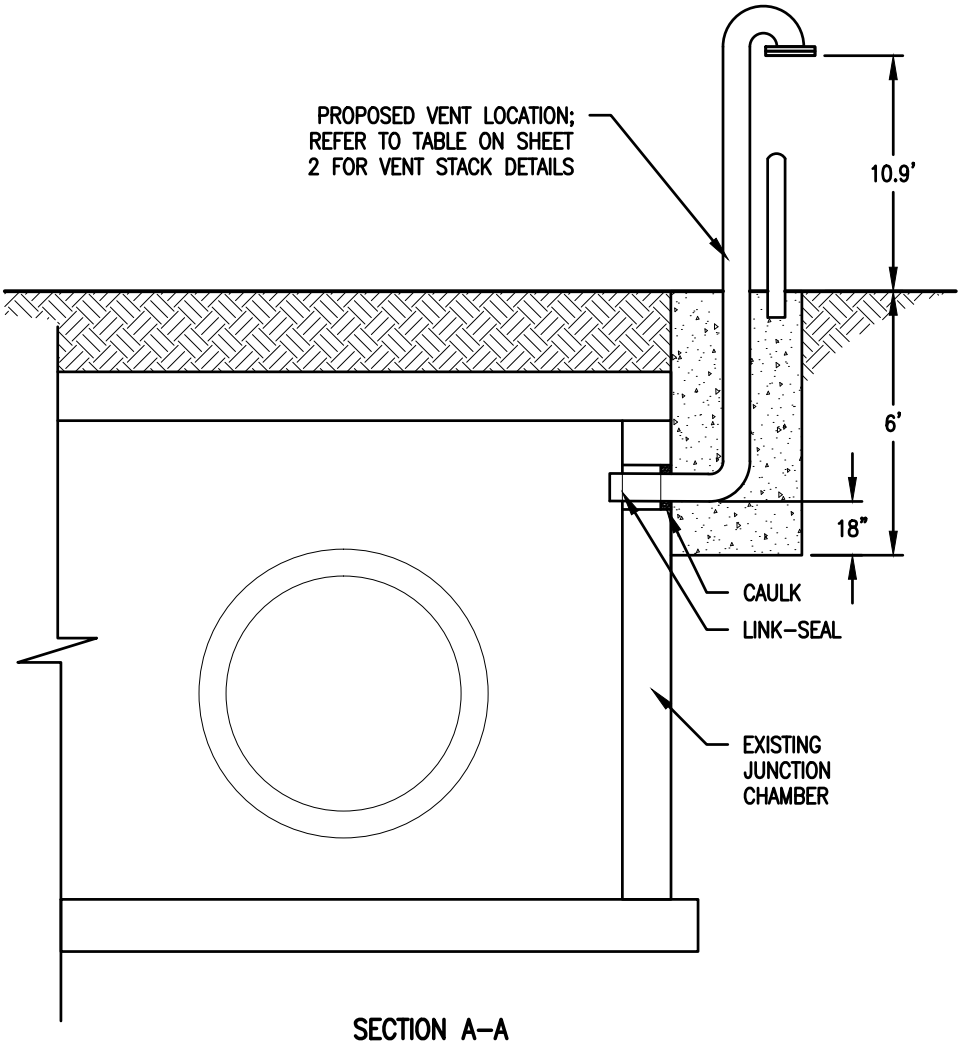

SECTION A-A

JUNCTION CHAMBER #2-08 SECTION VIEW

NOT TO SCALE

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

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

SHEET
5
OF 16

CLIENT:
WAYNE COUNTY

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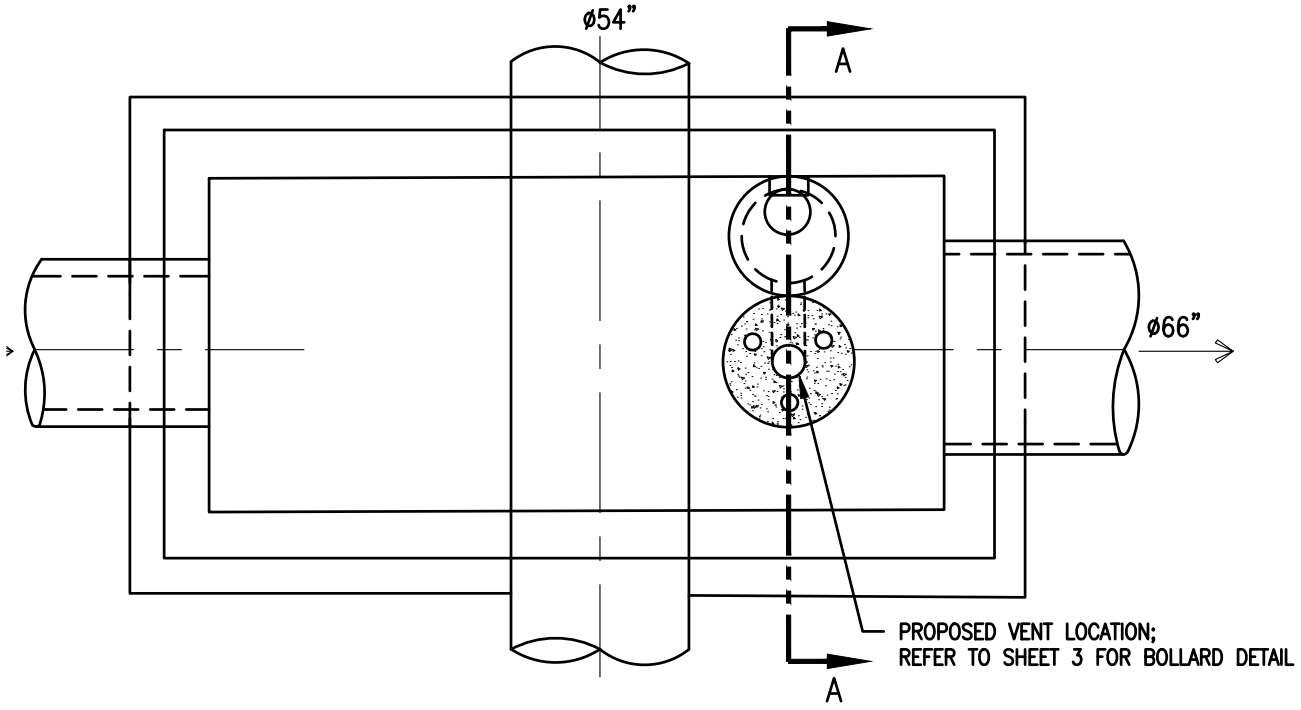
NOTES:
CORE VENTING SYSTEM INTO THE CONE OF THE MANHOLE, OPPOSITE OF THE LADDER/SOUTH.

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

CLIENT: WAYNE COUNTY

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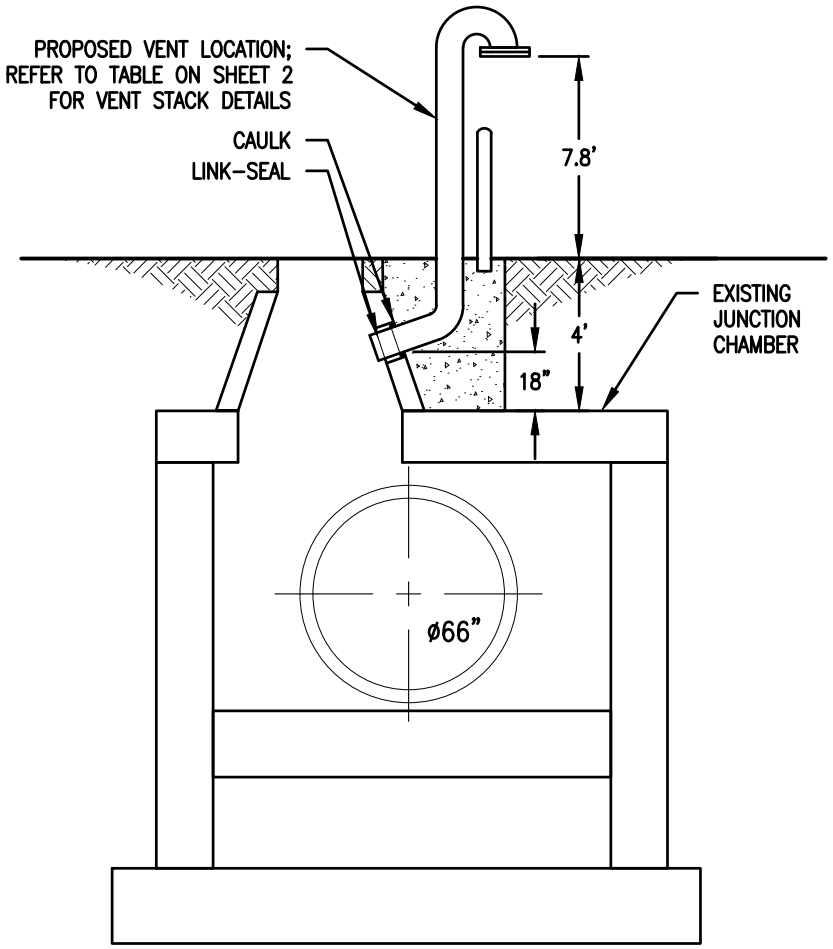

SECTION A-A

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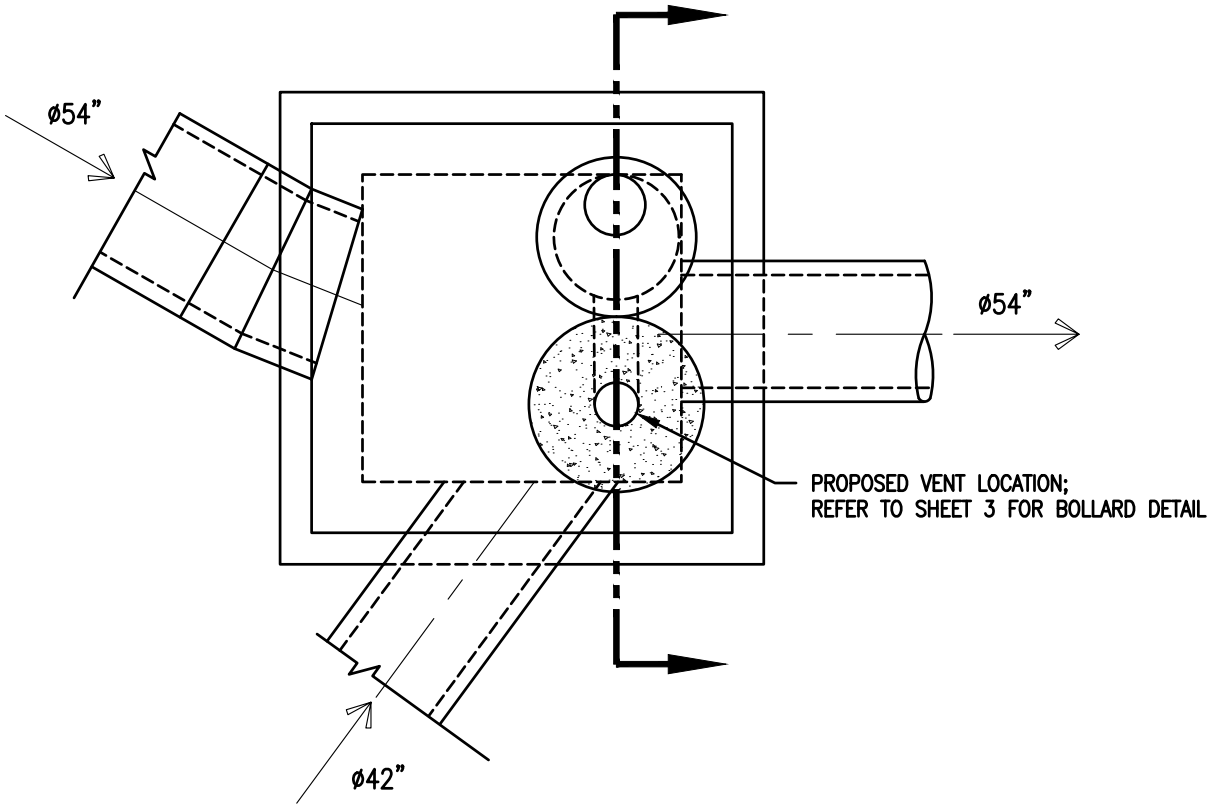
NOTES:
CORE VENTING SYSTEM INTO THE CONE OF THE MANHOLE, OPPOSITE OF THE LADDER.

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.

SHEET
8
OF 16

CLIENT:
WAYNE COUNTY

JOB #
0144-13-0030

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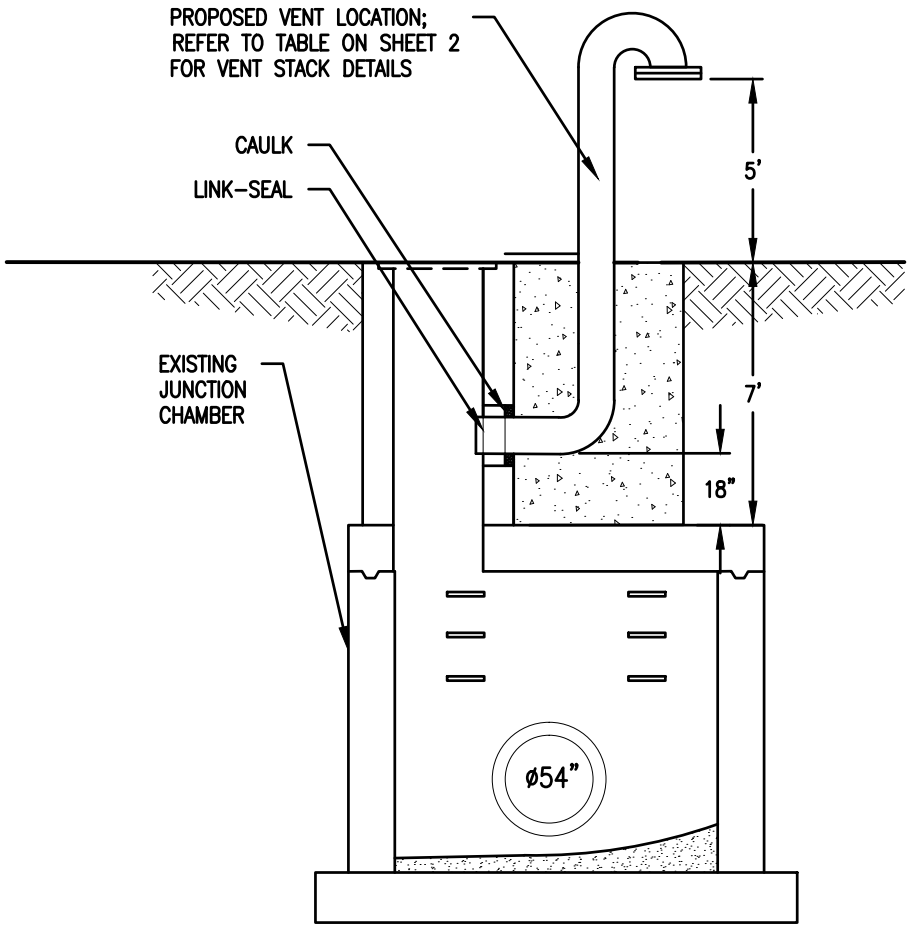

SECTION A-A

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
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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

Map Published: June 23, 2016

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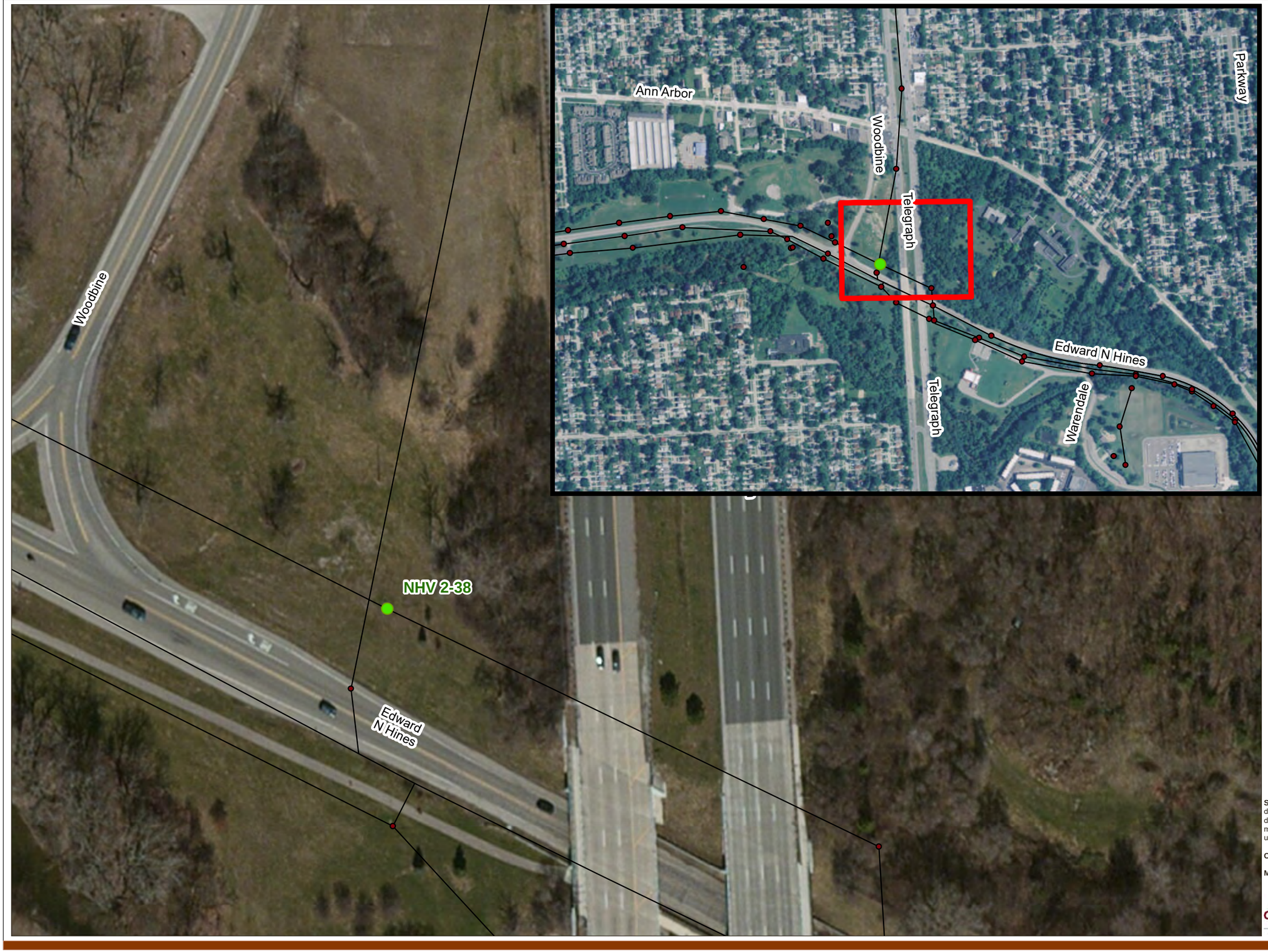

NHV 2-38 Location Sheet 11

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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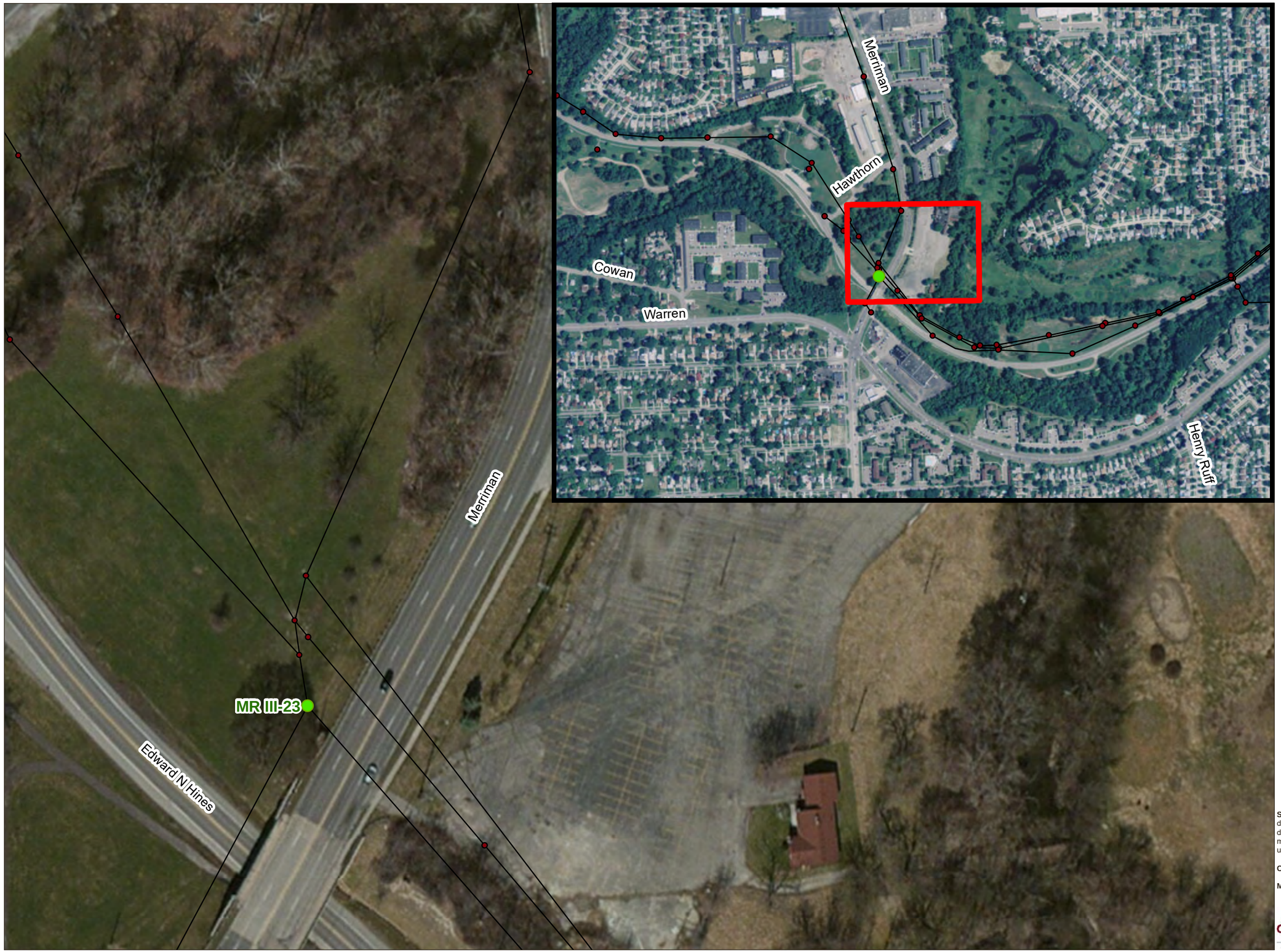

MR III-23 Location Sheet 13

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'

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Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: June 23, 2016

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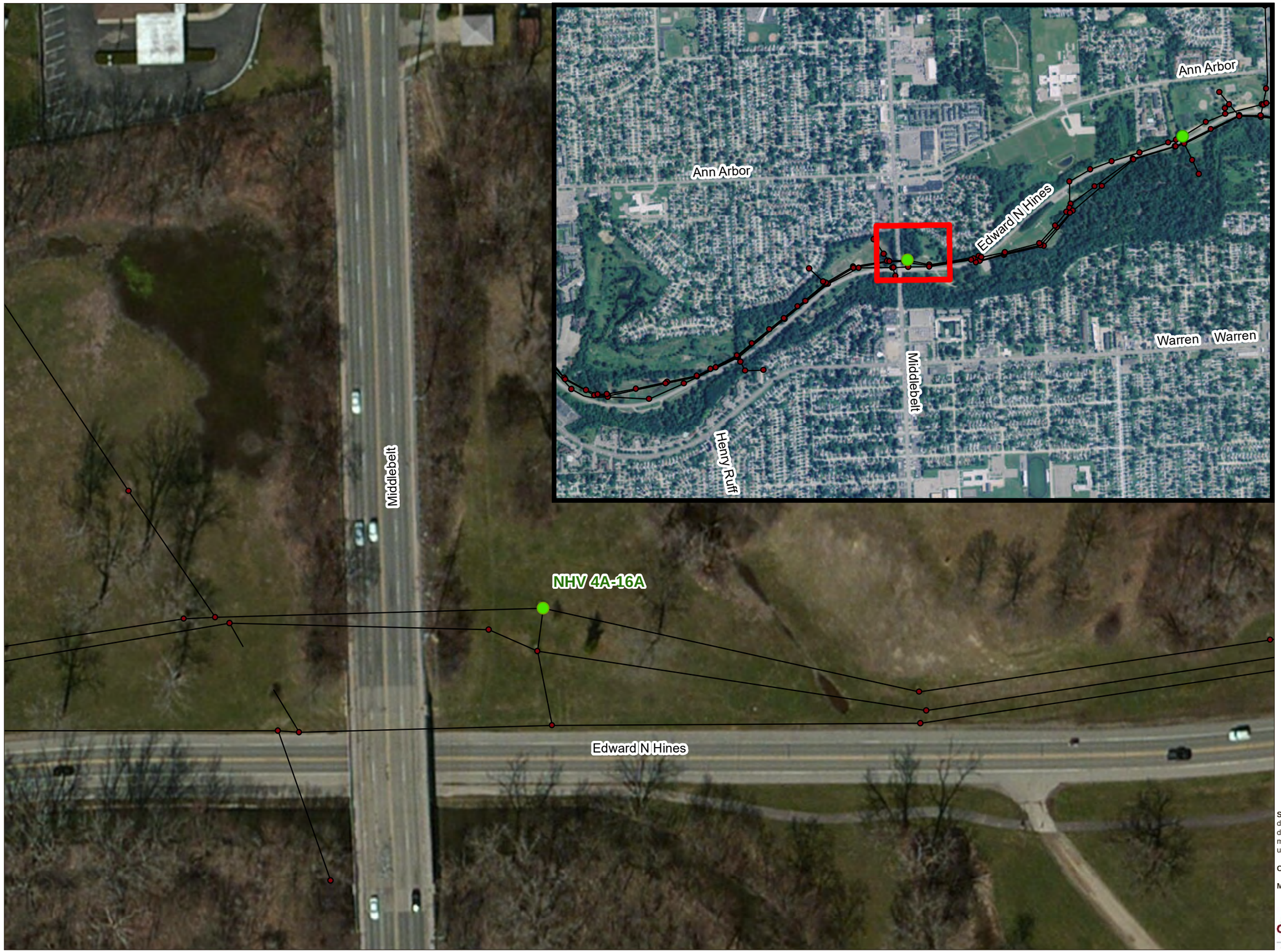

NHV 4A-16A Location Sheet 14

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'

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Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: June 23, 2016

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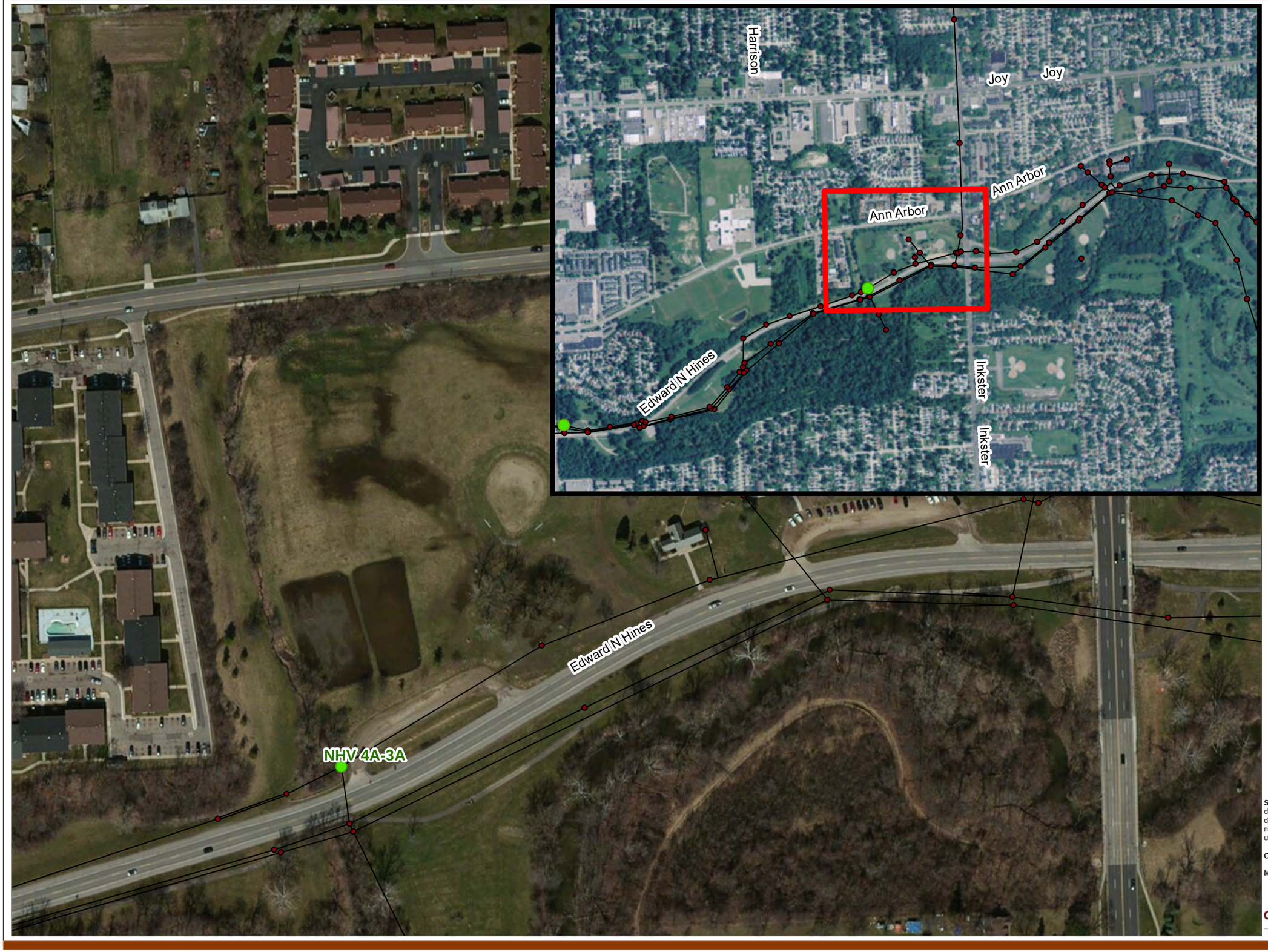

NHV 4A-3A Location Sheet 15

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'

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Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere

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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'

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Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere

Map Published: June 23, 2016

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D4: Lift Station 1A Operational Modifications (Task H)

Wayne County Rouge Valley Sewage Disposal System

Task H – Lift Station 1A Operational Modifications

Revised Draft: November 22, 2016

Prepared by:
Wade Trim Associates
25251 Northline Road
Taylor, MI 48180

and

Wayne County Department of Public Services
Environmental Services Group

Table of Contents

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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 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. This memorandum presents the evaluation conducted for the Task H evaluations. Refer to separate technical memoranda for Tasks I and E recommendations.

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 1-18A 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 1-18A 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 1-18A, 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 in 2015. Based on this finding, Wayne County made additional SCADA programming changes in September 2015 to ensure that gate SL-3 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 for 2016 (and 2017 if needed).

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 not, the vent can be left in place. However, if the discharge levels exceed the vent pipe elevation, the vent to the wet well should be removed and plugged to prevent recirculation, and a new vent outlet provided, if needed.

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 as documented in Attachment A:

1. Re-program Gate Operations at Liftstation 1A - 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. Calibrate LS1A Wet Well Discharge Box Bubbler - 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. Expand the Range of the LS-1A Wet Well - 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 to record higher wet well levels that may be occurring during pump operation.

4. Display Real Time Flow Rates for Meters WC S-2 and WCS-3 - Obtain from DWSD/GLWA the flow rate data for Meters WCS2 and WCS3 and display readings at LS-1A ad on the Wayne County ftp site. This will allow the County to assess the impacts of DWSD/GLWA hydraulic boundary conditions, and 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. Historize Dewatering Flow Rates from County Owned/Operated CSO RTBs - Historize the dewatering flow meters at the Redford, Inkster and Dearborn Heights RTBs so data can be utilized for system operation and performance monitoring.

6. Obtain Dewatering Operating Data from Community Owned Facilities - Obtain and store the dewatering/regulator flow rates for the Inkster RTB on Middlebelt Road and the Wayne EQ basin to be utilized for system operation and performance monitoring.

   There are several ongoing projects that can be used to implement these recommendations. These recommendations should be completed prior to the LTCAP model re-calibration monitoring period in 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 serving the existing 54-inch influent sewer was designed for a design flow of 90 cfs, and conservatively sized to function as a continuous use screen 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 diversion chamber and connection from the existing 66-inch sewer to the 20’ x 8’ box culvert upstream of the existing screening building (refer to Figure 2).

   The proposed diversion chamber would be equipped with a new control gate SL-5 to be installed on the connection to the existing box culvert. The gate would normally be closed to allow dry weather flow to continue through the lift station to the downstream interceptoer. When downstream DWSD levels are restricting

gravity flow, SL-3 would be closed and the new gate SL-5 opened to direct flow from the 66-inch sewer to the box culvert and existing mechanical screen. The proposed modifications are shown on Figure 2.

Preliminary calculations were developed and evaluated for increasing the design flow through the existing mechanical screen to the LS-1A pumping capacity of 250 cfs, and it appears hydraulically feasible. A summary of the preliminary hydraulic modeling analysis conducted by Applied Science for this screen improvement concept is included in Attachment B. Based on the modeling analysis, ASI recommends a 6' x 8' control gate be installed to divert flow into the box culvert, with a 6.5' high baffle plate installed in the box culvert to reduce flow velocities through the existing screen to optimize performance. This analysis needs to be further confirmed with the screen manufacturer and verified with the updated Rouge Valley System hydraulic model after the final recalibration to confirm no adverse upstream impacts.

A conceptual cost estimate for this option based on the concept level analysis is provided in Attachment C. This concept alternative will be further evaluated to confirm optimal design configuration and requirements with refined costs as part of the Phase 2 LTCAP evaluations

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 8' 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, if needed, will be calculated during the development of the Phase 2 LTCAP Report.

In addition to the above options, Wayne County has secured a contract with an outside vendor to perform more frequent manually cleaning of the existing SL-1 and SL-2 bar racks for a pilot test period in 2016. The performance of this enhanced cleaning effort will be monitored to determine the frequency and extent of debris buildup, and determine if more frequent manual cleaning may be effective for long-term operations, or whether it further supports the need to implement the Phase 2 screening improvements as a capital improvement project.

D. Junction and Siphon Chambers

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.

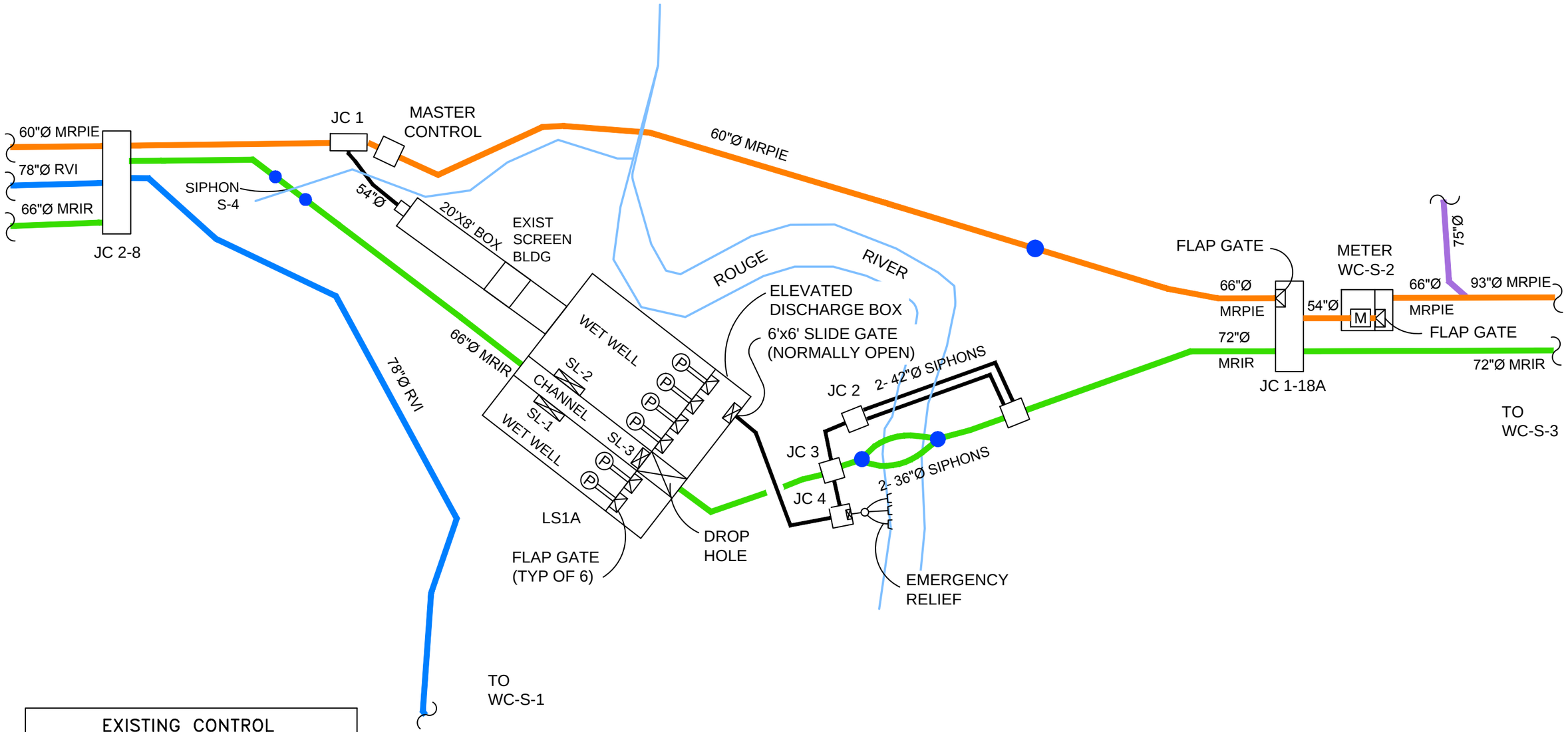
4. Recommendations

It is recommended that the Task 1F SCADA upgrades as documented in Attachment A be implemented as a Phase 1 improvement, and that LS1A performance be re-evaluated in conjunction with completion of the other Phase 1 improvements as part of the LTCAP recalibration and monitoring period to be conducted in 2016 and 2017. This will confirm the potential impact that LS1A operations have on upstream hydraulic levels preliminary, and assess the effectiveness of the pilot project for more frequent manual cleaning of the existing bar racks.

It is also recommended that the concept design to utilize the existing automated screen for both LS-1A influent sewers be further evaluated as part of the Phase 2 LTCAP analysis 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. We anticipate that refined cost estimates and recommendations for the LS1A screening will be identified during Phase 2 of the LTCAP.



EXISTING CONTROL GATE OPERATION		
CONDITION	SL 1 & 2	SL 3
DRY WEATHER	CLOSED	OPEN
WET WEATHER	OPEN	CLOSED

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ROUGE VALLEY
SEWAGE DISPOSAL SYSTEM

LS1A SCHEMATIC
EXISTING CONDITIONS

JOB NO.
WAW2035-01D

SHEET
1

PROJECT MANAGER: _
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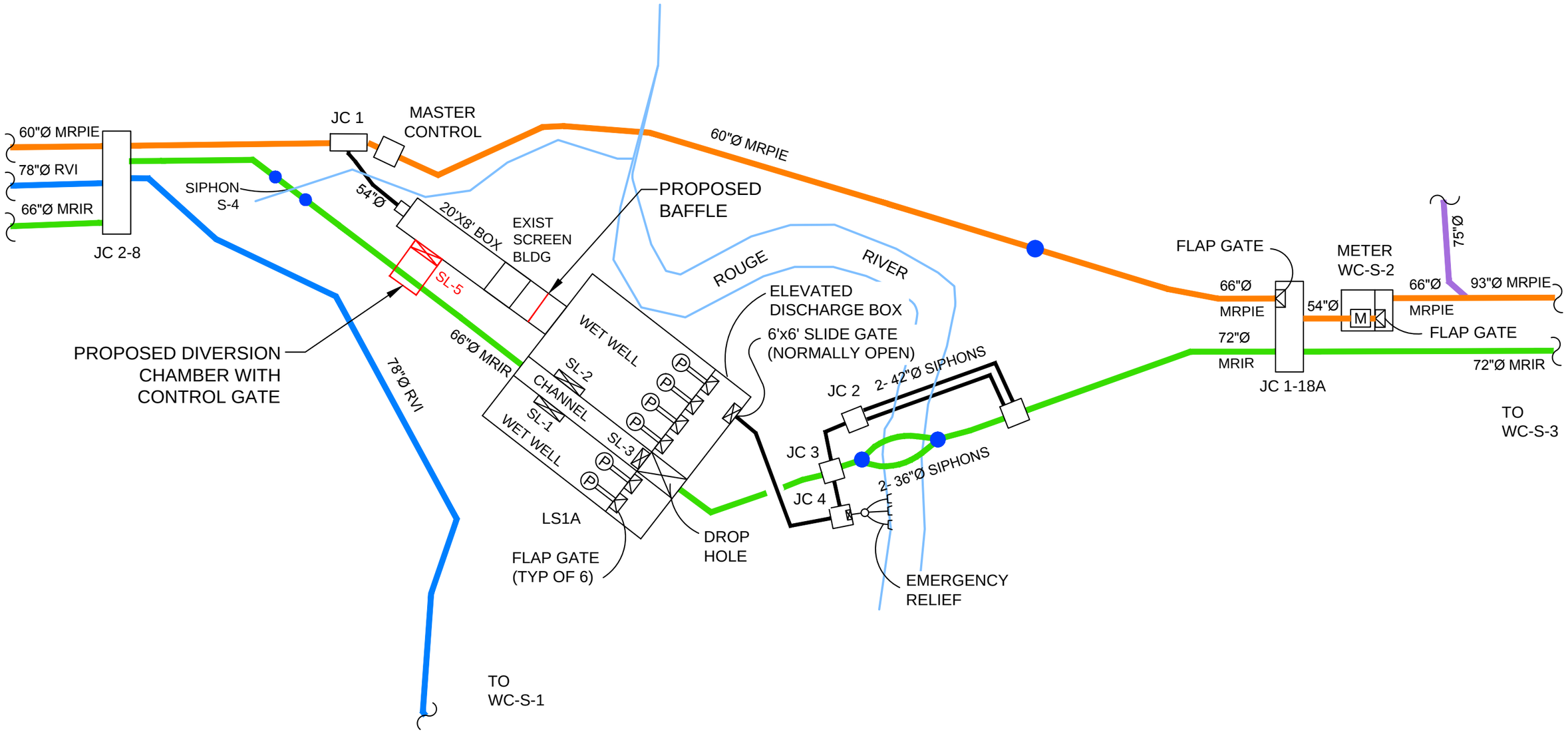

PROPOSED CONTROL GATE OPERATION			
CONDITION	SL 1 & 2	SL 3	SL 5
DRY WEATHER	CLOSED	OPEN	CLOSED
WET WEATHER	CLOSED	CLOSED	OPEN
EMERGENCY	OPEN	CLOSED	OPEN

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ROUGE VALLEY
SEWAGE DISPOSAL SYSTEM

LS1A SCHEMATIC
PROPOSED CONDITIONS

JOB NO. WAW2035-01D

SHEET 2

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FIELD BOOK INFORMATION:_

Attachment A

ASI Memorandum “Phase 1F-Scada System Improvements” dated November 25, 2015

Applied Science, Inc.

DRAFT

MEMORANDUM

To: Kelly Cave, P.E., Wayne County Department of Public Services
Razik Alsaigh, P.E., Wayne County Department of Public Services
Gregory Kacvinsky, P.E., Orchard Hiltz & McCliment

From: Karen Ridgway, P.E., Applied Science, Inc.
Dane Wiebe, Applied Science, Inc.

Project: Rouge Valley Sewage Disposal System Long Term Corrective Action Plan

Subject: Phase 1F - SCADA System Improvements

Date: November 25, 2015

Introduction

This memorandum presents the recommended SCADA system improvements for the Rouge Valley Sewage Disposal System (RVSDS) as required under the Long Term Corrective Action Plan (LTCAP) dated July 16, 2015. The SCADA system improvements will provide more complete operating data that will be used to understand the performance of the RVSDS during large storm events. Also, the data will be used to calibrate/validate the hydrologic/hydraulic model of the RVSDS.

Recommended SCADA System Improvements

Table 1 lists the proposed SCADA system improvements with a brief description. Many of these improvements involve changes to the SCADA system at Lift Station 1A (LS1A).

Table 1
Recommended SCADA System Improvements

Item	Description
1	Reprogram Gate Operations at LS1A • Gate SL-3 should remain closed if any LS1A pumps are running. • Gates SL-1 and SL-2 should be open whenever gate SL-3 is closed. • Historize SL-1, 2 and 3 positions.
2	Calibrate LS1A Wet Well Discharge Box Bubbler • Check the calibration of the bubbler reading in wet weather. Measure the depth to the water surface in the access/vent structure and compare it to the bubbler reading. • Historize the discharge box bubbler level data.
3	Expand the Range of the LS1A Wet Well Level Sensor • The bubbler that measures the wet well level has an existing range of 20 feet. The range should be expanded to about 30 feet.
4	Display Real-Time Flow Rates for Meters WC-S-2 and WC-S-3 • Obtain from DWSD/GLWA real-time flow rate data for Meters WC-S-2 and WC-S-3 and display readings on the Wayne County ftp site.
5	Historize Dewatering Flow Rates from County-Owned/Operated CSO RTBs • Historize the dewatering flow meters at the Redford CSO RTB, Inkster CSO RTB, and Dearborn Heights CSO RTB.
6	Obtain Dewatering Operating Data from Community Owned Wet Weather Facilities • Obtain the dewatering/regulator flow rates for the CSO RTB at Middlebelt Road owned by the City of Inkster • Obtain the operating data for the Wayne EQ basin owned by the City of Wayne.

Attachment B

ASI Memorandum "Evaluation of Lift Station 1A Modifications" dated April 27, 2016

Applied Science, Inc.

DRAFT

M E M O R A N D U M

To: Steve Kalinowski, Wade Trim Associates

From: Andrew Wood, Applied Science, Inc.
Karen Ridgway, Applied Science, Inc.

Project: Wayne County Rouge Valley Sewage Disposal System
Long Term Corrective Action Plan

Subject: Evaluation of Lift Station 1A Modifications

Date: April 27, 2016

Introduction

Modifications to Lift Station 1A (LS1A) were designed as part of the Rouge Valley Sewage Disposal System (RVSDS) Phase 1 Long Term Corrective Action Plan (LTCAP). A hydraulic analysis was completed by Applied Science, Inc. (ASI) to ensure that these modifications were sized correctly and were hydraulically acceptable. The purpose of this memorandum is to present the hydraulic analysis.

LS1A is part of Wayne County's RVSDS and is located on the downstream end of the Middle Rouge Interceptor. The Middle Rouge Interceptor consists of three parallel sewers, the Middle Rouge Interceptor Relief (MRIR), the Middle Rouge Parkway Interceptor Extension (MRPIE), and the Rouge Valley Interceptor (RVI). Wastewater from the RVI is conveyed by gravity to the Oakwood Interceptor. Under normal operating conditions, wastewater flow from MRIR and MRPIE is conveyed by gravity to the Northwest Interceptor (NWI). Under surcharged conditions on the NWI, wastewater from the MRIR and MRPIE cannot be conveyed by gravity and must be pumped by LS1A.

Diversion to LS1A from the MRIR is currently achieved by closing SL-3 and opening gates SL-1 and SL-2 within the facility. Flow from MRPIE is conveyed from JC-1 through a 54 inch diameter sewer to the 8 foot high by 20 foot wide influent sewer and into the LS1A wet well. A layout of LS1A is presented on Figure 1.

LS1A with the proposed modifications in place is shown on Figure 2. A new connection to the influent box sewer is proposed upstream of the mechanically raked bar screens. A baffle/weir

Figure 1
Existing Conditions at Lift Station 1A (LS1A)

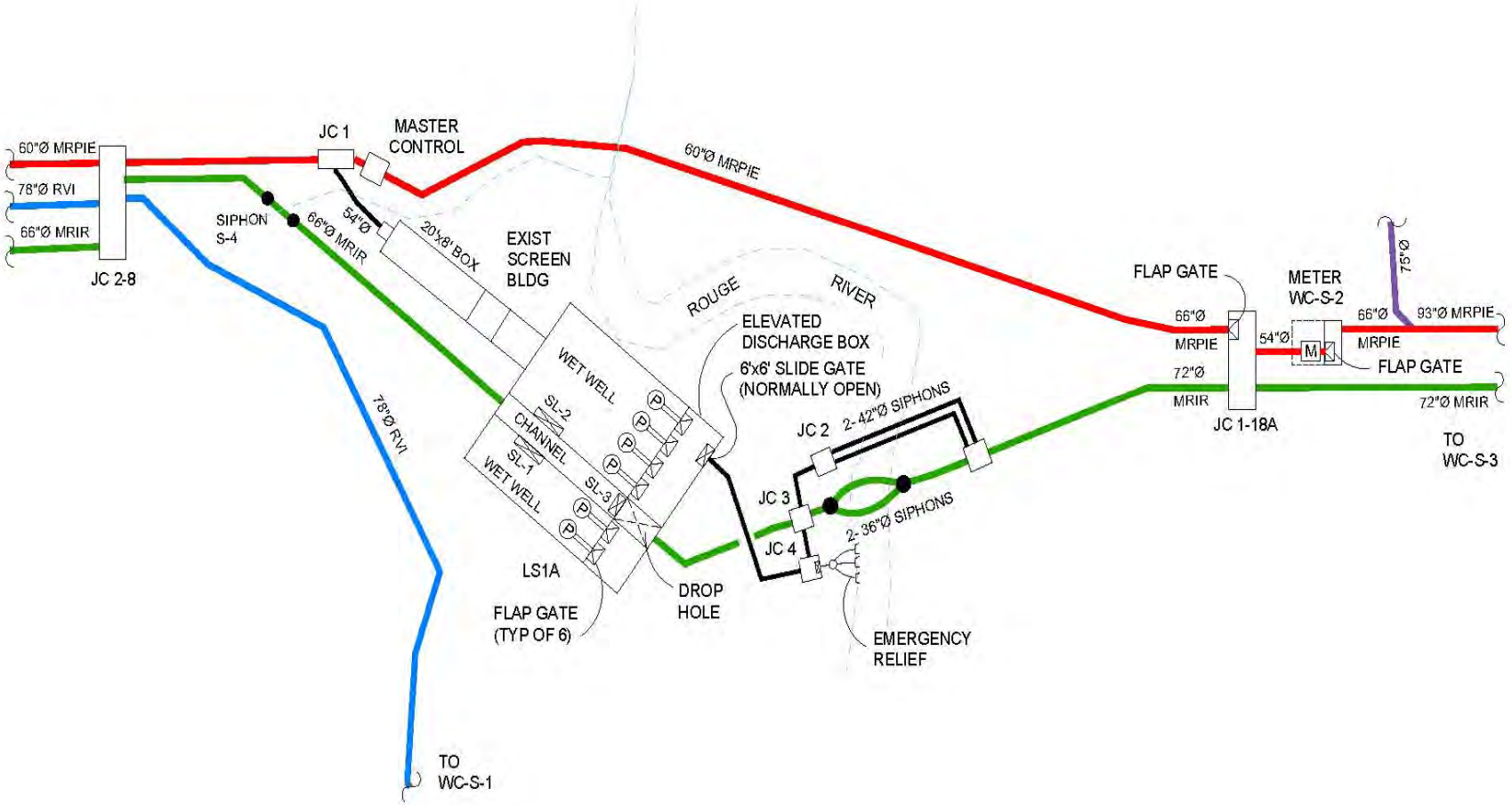
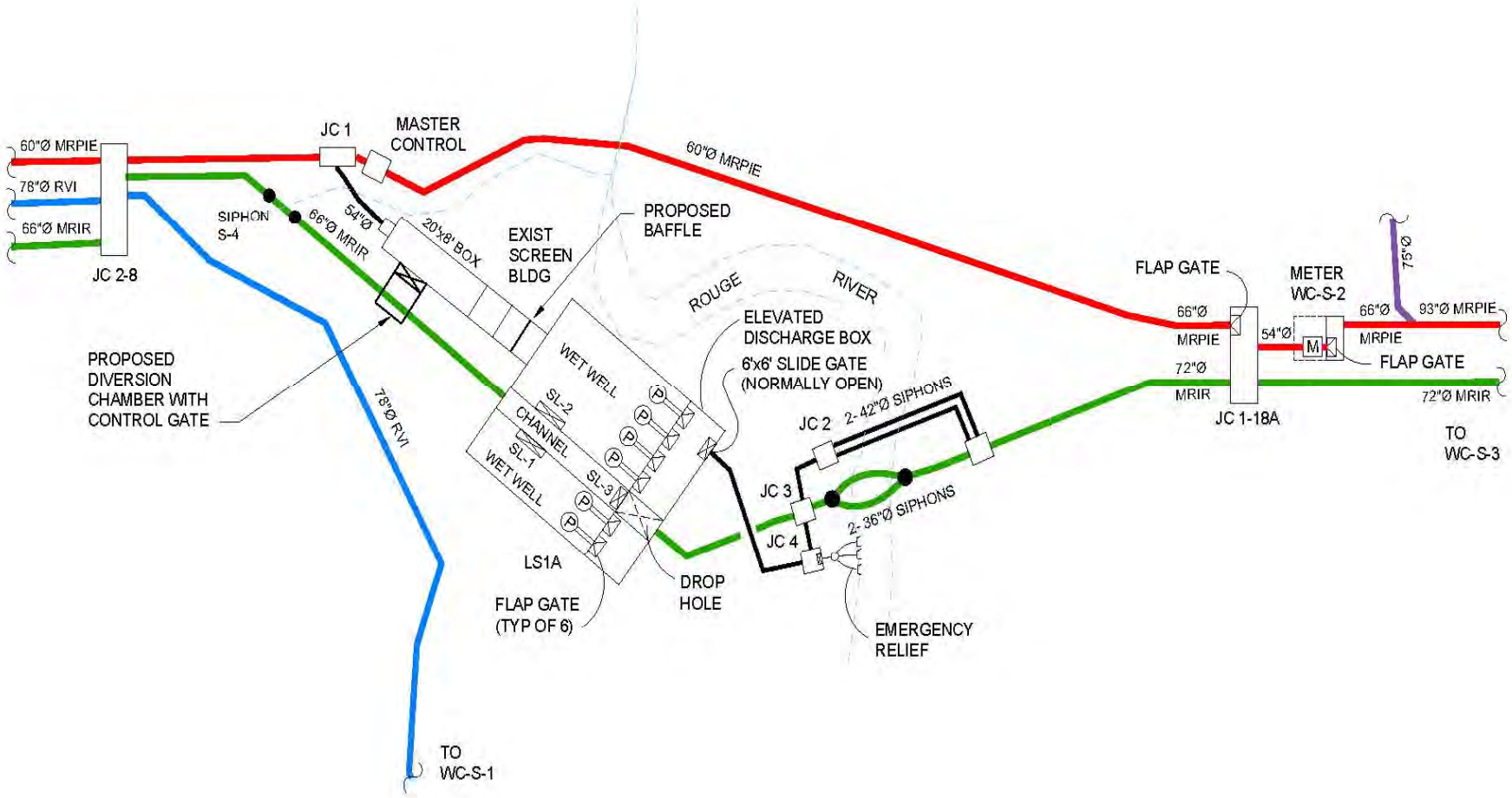


Figure 2
Proposed Modifications at Lift Station 1A (LS1A)



structure is proposed for the influent box sewer downstream of the mechanically raked bar screens to maintain low velocities through the screen under low flow conditions.

Model Setup and Assumptions

A steady-state TAP model of LS1A was developed to determine the headlosses through the lift station for existing and proposed conditions. The TAP model includes portions of the MRIR and MRPIE from JC 2-8 to LS1A. As-built drawings of LS1A, MRIR and MRPIE were collected and used to build the model.

The proposed design modifications were evaluated based on the following criteria.

1. The baffle/weir structure has to maintain velocities of no more than 2 ft/s in the box conduit for proper screening.
2. The proposed modifications cannot negatively impact the HGL at JC 2-8.

Existing and proposed conditions were evaluated for a steady-state flow rate of 250 cfs.

Model Results

The TAP model was run to steady-state conditions. Profiles through the MRIR and MRPIE for existing conditions are presented on Figures 3 and 4, respectively.

The proposed connection to the influent box sewer, SL-5, and the baffle/weir structures were sized through an iterative process. The dimensions of the two modifications were adjusted until the desired design criteria was met.

Figures 5 and 6 present the profiles through the MRIR and MRPIE under proposed conditions. A comparison at JC 2-8 shows a drop in the steady-state HGL from 582.81 feet under existing conditions to 582.80 feet under proposed conditions.

Installing a weir structure will lower velocities through the screens for the low flow condition, however, it also could impact the HGL upstream of LS1A. The height of the baffle/weir structure was adjusted through a series of runs to properly size the overflow weir elevation. The steady-state HGL was compared at JC 2-8 for the model runs to ensure the weir did not increase levels above existing conditions. The predicted HGLs at JC 2-8 for a series of weir heights is presented below in Table 1.

Table 1 – Proposed Weir Height vs HGL at JC 2-8

Proposed Weir Height (feet)	Steady-State HGL at JC 2-8 (feet)
3.0	582.80
3.5	582.80
4.0	582.80
4.5	582.80
5.0	582.84

Note: Predicted HGLs for a steady-state flow rate of 250 cfs.

A weir height of 4.5 feet was determined to be acceptable based on the sensitivity analysis.

Conclusions and Recommendations

The proposed modifications to LS1A are predicted to be hydraulically acceptable.

Under peak flow rate conditions the proposed 6 foot high by 8 foot wide connection to influent box conduit could convey wastewater flows without increasing the peak HGL at JC 2-8. The proposed level at JC 2-8 is 0.01 feet lower than existing conditions. The proposed gate, SL-5, diverts flow in the MRIR further upstream than the existing gates, SL-1 and SL-2, which provides a slight hydraulic benefit.

A baffle/weir structure is required in the influent box conduit to maintain low velocities through the mechanically raked bar screens. A 4.5 foot high proposed baffle/weir structure would lower the velocities through the screens but would not impact upstream HGLs for a peak flow rate of 250 cfs.

Figure 3
MRIR Profile - Existing Conditions

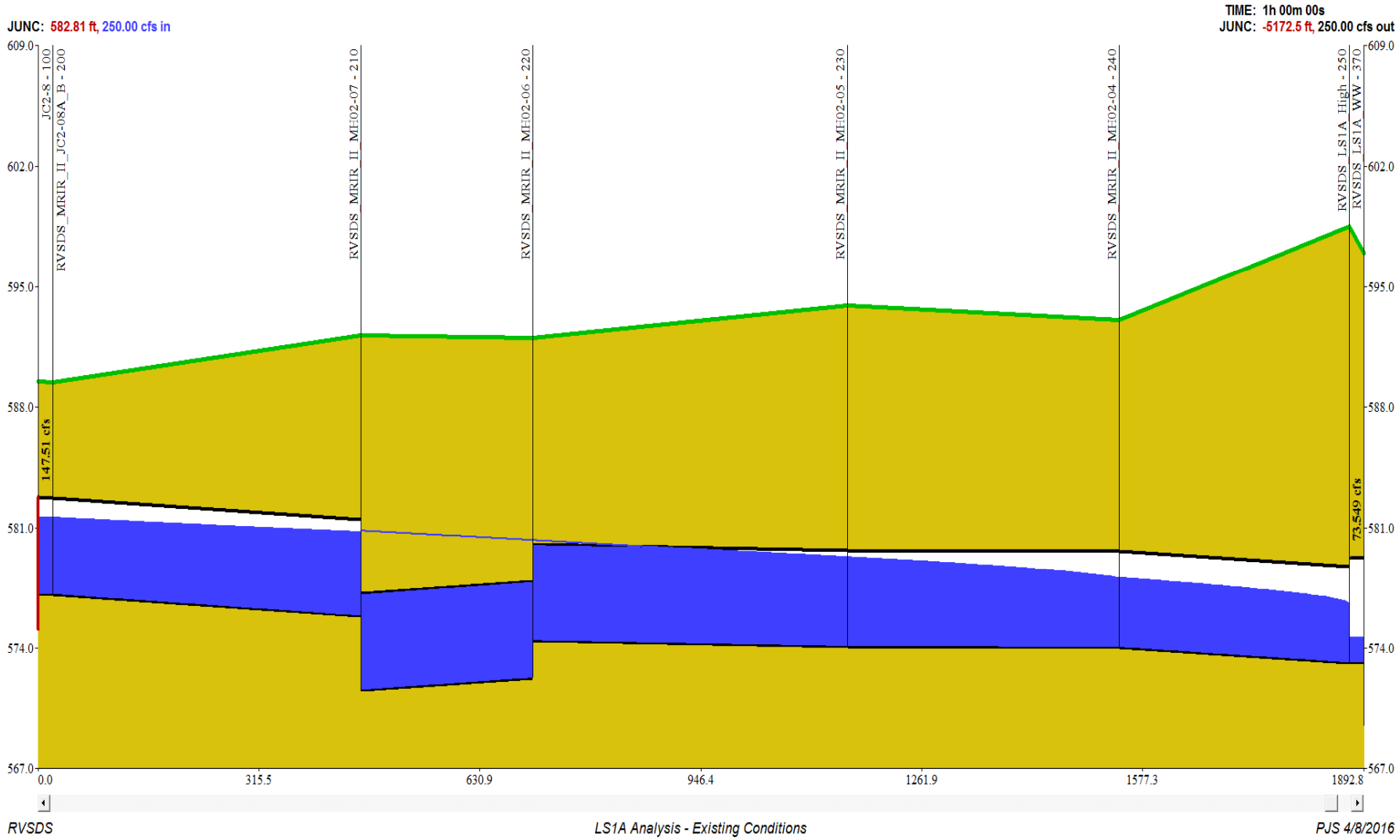


Figure 4
MRPIE Profile - Existing Conditions

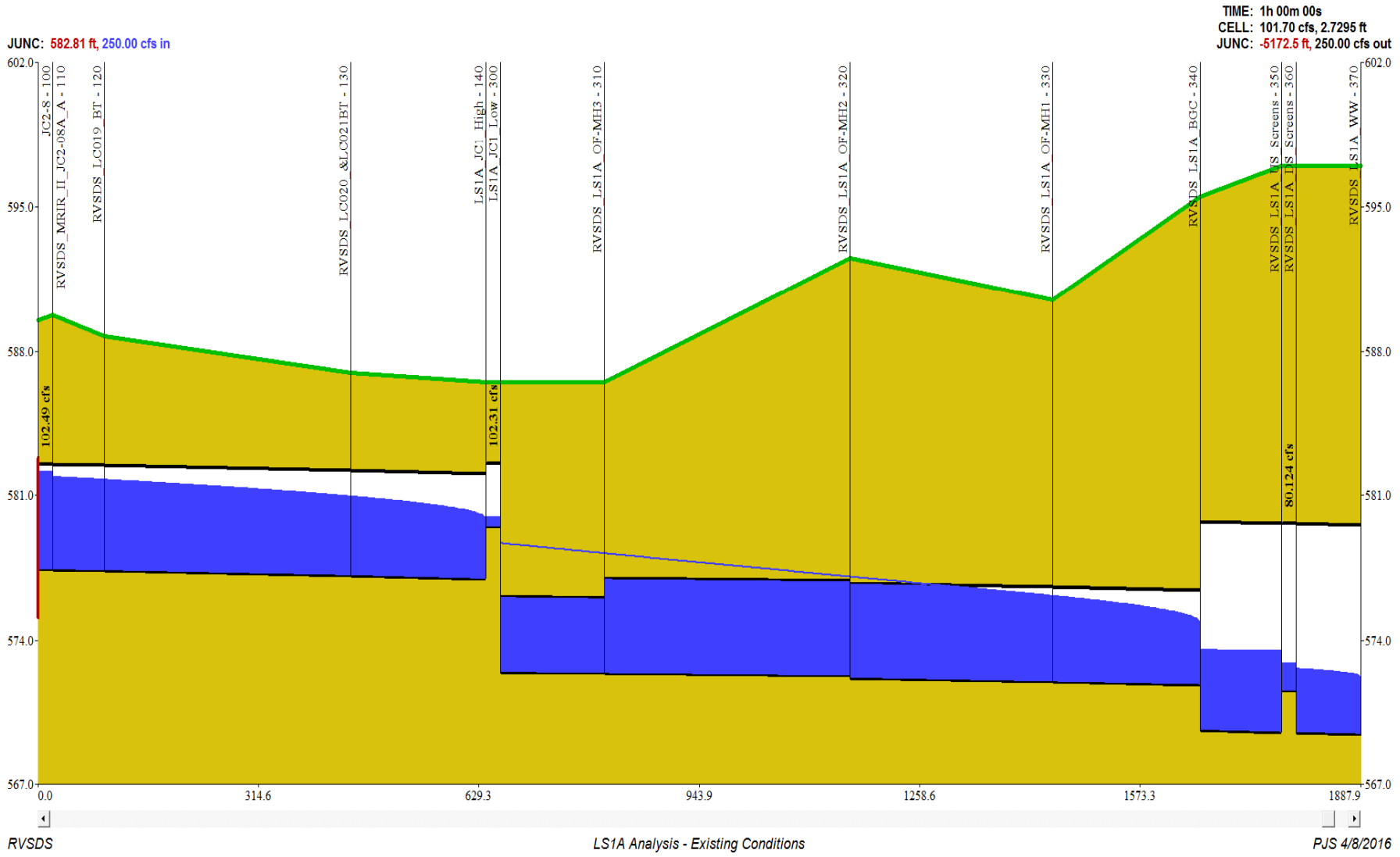


Figure 5
MRIR Profile - Proposed Conditions

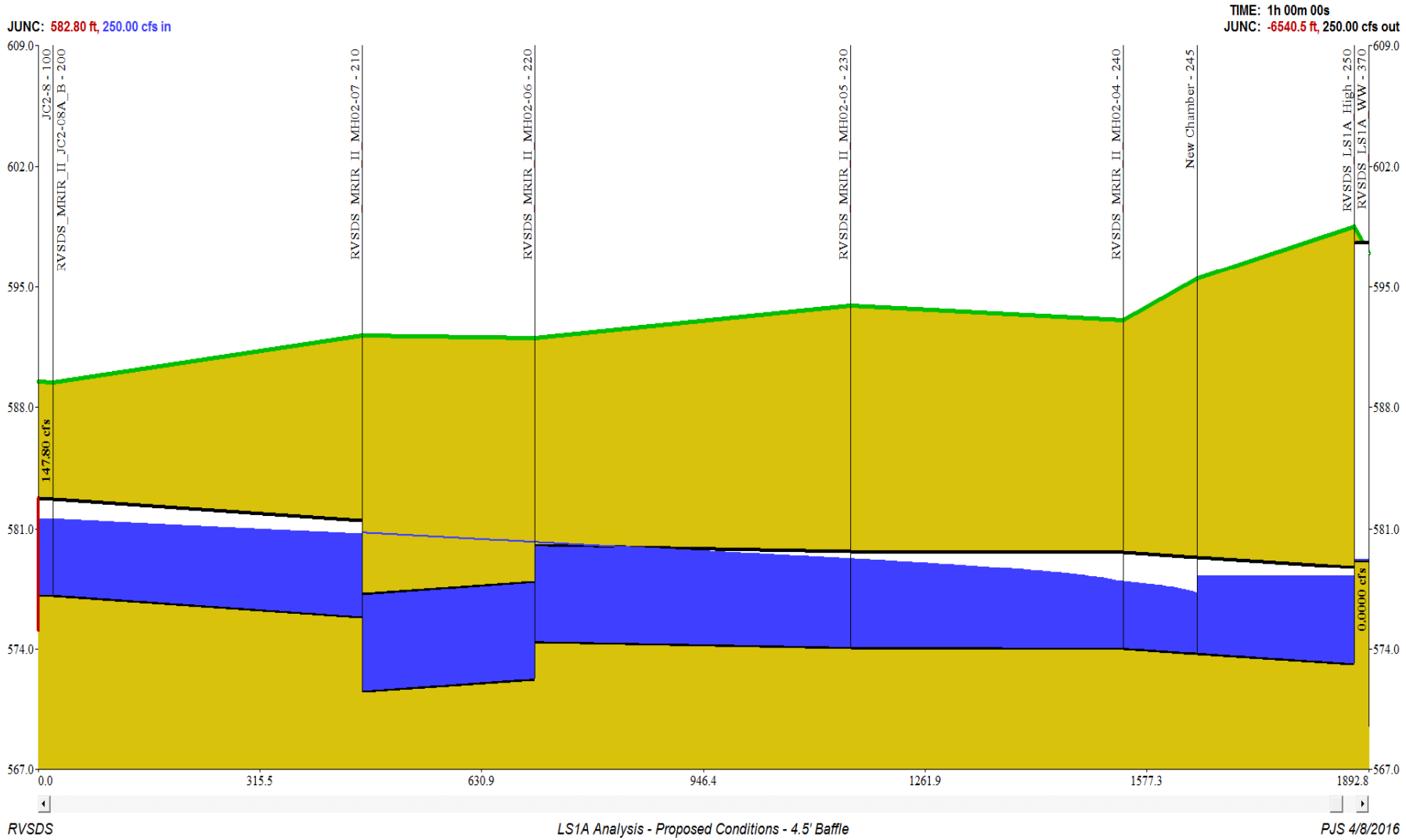
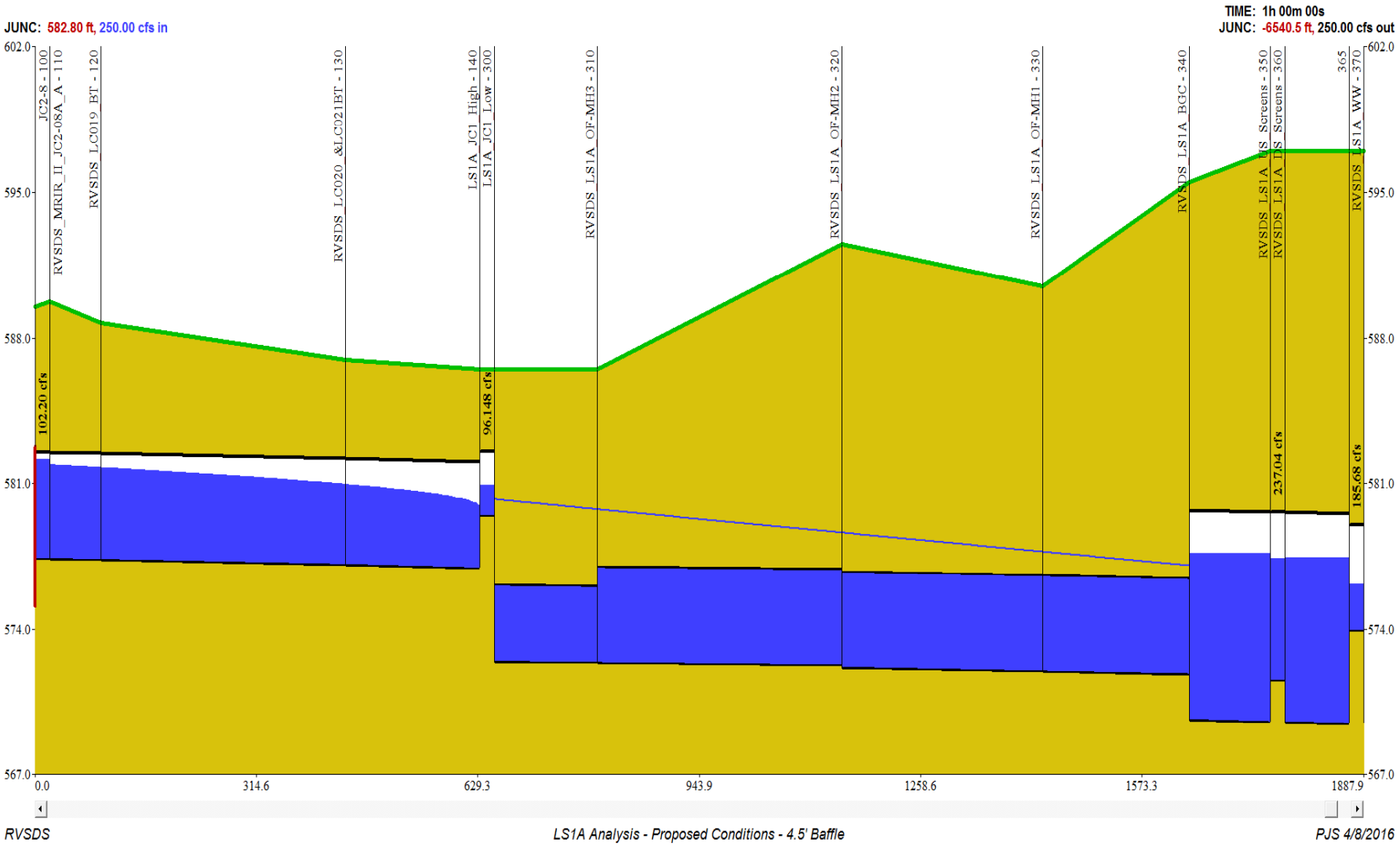


Figure 6
MRPIE Profile - Proposed Conditions



Attachment C

Conceptual Cost Estimate

WADE TRIM

ENGINEER'S OPINION OF CONSTRUCTION COST

PROJECT: LS 1A Screen Improvements/Diversion Structure **DATE:** 04/28/16

LOCATION: Dearborn Heights, Wayne County, MI **PROJECT NO.** WAW 2035-01D

BASIS FOR ESTIMATE: [X] CONCEPTUAL [ ] PRELIMINARY [ ] FINAL

WORK: Work consists of constructing an approximate 20' x 20' ID CIP concrete diversion structure over existing 66" interceptor with 6' H x 8' W opening into existing 8' H x 20' W box culvert with control gate and SCADA controls to utilize exist mechanical screen.

ITEM NO.	DESCRIPTION	QUANT.	UNIT	UNIT AMOUNT	TOTAL AMOUNT
1	Cast in Place Concrete Diversion Chamber	1	LS	$255,000.00	$255,000
	(20'W x20'L x24'D) over Exist 66" Sewer adjacent				
	to Ex. 8' x 20 ' Box Culvert				
2	Braced Excavation (Sheeting) for Diversion	3,700	SF	$50.00	$185,000
	Chamber (to be confirmed during design)				
3	Demo 6' x 8 ' opening in Exist Box Culvert for	1	LS	$15,000.00	$15,000
	connection to Diversion Chamber				
3	Control Gate SL-5 (6' H x 8' L) with Electrical and	1	LS	$ 100,000.00	$100,000
	Controls				
4	Weir/Baffle Plate and Supports (6.5' H x 20' W)	1	LS	$ 50,000.00	$50,000
	installed in Ex. Box Culvert-includes rework of exist.				
	flushing system piping				
5	Site Restoration	1	LS	$30,000.00	$30,000
6	Allowance for SCADA Programming	1	LS	$25,000.00	$25,000
7	Allowance for Unforeseen Conditions	1	LS	$40,000.00	$40,000
	Subtotal				$700,000
	Contingency (10%)				$70,000
	Contractor OH, Profit, Gen Conditions (25 %)				$175,000
	Construction Cost Subtotal				**$945,000**
	Administration, Legal, and Engineering 30%				$283,500
	Total Project Cost Conceptual Estimate				**$1,228,500**

D5: Wayne County and DWSD/GLWA Coordination: RVSDS Downstream Boundary Conditions (Task L)

Wayne County and DWSD/GLWA Coordination
RVSDS Downstream Boundary Conditions

Wayne County has met with the Detroit Water and Sewerage Department (DWSD) and the Great Lakes Water Authority (GLWA) to discuss the boundary conditions between the RVSDS and the downstream DWSD wastewater system (operated by the Great Lakes Water Authority since January 1, 2016) on numerous occasions starting in January 2015. Meeting discussions typically included the following items related to opportunities for improved coordination between DWSD and Wayne County:

1. Determine the expected hydraulic grade line (HGL) in the DWSD Northwest Interceptor (NWI) during the 25-year/24-hour storm. This is necessary for Wayne County to complete its analysis, alternatives evaluation, and design of the RVSDS Long Term Corrective Action Plan.
2. Discuss the possibility of DWSD making operational changes within its system (e.g., gate operations at Warren-Pierson and Hubbell-Southfield) to reduce the HGLs in its system and necessary for DWSD to accept flow rates/volumes from upstream customers at the rates specified in the service agreements.
3. Discuss the coordination of meter and operational data for DWSD and RVSDS (e.g., move meter WCS1 upstream of RVSDS Oakwood interceptor and NWI crossing; install additional DWSD level sensors at key locations on the NWI; etc.).

Wayne County has provided considerable data and analysis supporting the need for DWSD/GLWA to confirm how they will operate their system into the future, so that Wayne County and other customers can confidently rely on an expected hydraulic grade line in the DWSD Northwest Interceptor during a 25-year/24-hour event, and on DWSD's ability to accept flow rates/volumes from upstream customers at the rates specified in the service agreements.

Meeting dates are summarized below:

1. January 15, 2015
2. February 16, 2015
3. August 12, 2015
4. January 21, 2016

The issue of DWSD/GLWA operations and their impact on the ability of DWSD/GLWA to accept wastewater flows from upstream customers at the rates specified in the service agreements also began to be discussed during meetings of the GLWA Wastewater Master Plan Steering Committee, whose attendees include representatives of the Michigan Department of Environmental Quality, starting in December 2015. These meetings occurred on the following dates:

1. December 16, 2015
2. January 20, 2016
3. February 17, 2016
4. March 16, 2016
5. May 18, 2016

It is Wayne County's understanding that GLWA has embarked on an accelerated study of the operations of the western part of its wastewater system, which should assist with determining the expected hydraulic grade line in the DWSD Northwest Interceptor during a 25-year/24-hour storm. GLWA's anticipated schedule for completing this study is currently unknown.