City of Memphis
TENNESSEE

JIM STRICKLAND
MAYOR

DIVISION OF PUBLIC WORKS
ENVIRONMENTAL ENGINEERING

April 23, 2018

Mr. Brad Ammons email: ammons.brad.epamail.epa.gov
USEPA
Chief, Clean Water Enforcement Branch
Water Protection Division
61 Forsyth Street, N.W.
Atlanta, Georgia 30303

Ms. Tisha Calabrese-Benton email: Tisha.calabrese@tn.gov
TDEC
Director, Division of Water Resources
Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37243

RE: Consent Decree for City of Memphis WCTS
Civil Action No. 2:10-cv-02083-SHM-dvk
Final Critical Areas Project Report

Mr. Ammons and Ms. Calabrese-Benton:

Enclosed please find a copy of the Final Critical Areas Project Report in accordance with Paragraph 11.b. of the referenced consent decree. Activities associated with Critical Infrastructure Areas 1 and 3 were completed significantly ahead of the schedule outlined in the CD and were initially summarized in the Interim Critical Areas Project Report, included as Appendix B to the City's Semi-Annual Report, April 1, 2013 through September 30,2013, submitted to EPA and TDEC on October 30, 2013. The

Final Critical Areas Project Report being submitted today also includes information on Critical Infrastructure Area 2. Copies of the report have been included in both pdf and Word format. Also, a disc copy and paper copy will be forwarded to both of you via Federal Express. A copy of the report is in the PDR for public review and comment.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Bobby D. Allen, P.E.
Administrator, Environmental Construction
Public Works
City of Memphis

cc: Paul Patterson
Gary Cohen
Josh Grabowski

City of Memphis

Final Critical Areas Project Report

April 23, 2018

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering such information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Bobby D. Allen, P.E.

4-23-18
Date

Introduction

On September 20, 2012, the United States District Court for the Western District of Tennessee entered a Consent Decree (CD) between the City of Memphis (the City) and the United States, the State of Tennessee, and the Tennessee Clean Water Network. Per the CD, these projects were required to be completed 5 years from signing of the CD. The projects were completed in this time frame except for Critical Area #2. Due to a force majeure event, i.e. hurricane Harvey (discussed in more detail in CA #2), this resulted in a 33-day extension.

In accordance with CD Section V, Paragraph 11.b., Critical Infrastructure Areas Projects, the City identified three areas (designated as "Critical Areas") to receive prioritized rehabilitation due to the critical nature of the infrastructure and the potential consequences of large volumes of sanitary sewer overflows (SSOs) in the event of infrastructure failure. These areas are discussed in Paragraph 11.b. of the CD and are also depicted in Appendix H of the CD.

Activities associated with Critical Infrastructure Areas (CRA) 1 and 3 were completed significantly ahead of the schedule outlined in the CD and were initially summarized in the Interim Critical Areas Project Report, included as Appendix B to the City's Semi-Annual Report, April 1, 2013 through September 30,2013, submitted to EPA and TDEC on October 30,2013. CRA 2 was completed in 2017 in accordance with the CD schedule. This Final Report includes a summary of all three CRA projects.

The City, through the CD sewer assessment and rehabilitation program (SARP10), developed a GIS data base and asset identification (ID) protocol for the City's waste collection and transport system (WCTS). Although both of these were developed after CRAs 1 and 3 were completed, for the purposes of this report the asset ID was used to identify the location of the pipe and the associated manholes.

This report is organized into four sections:

- Introduction
- **Section 1** - Critical Infrastructure Area #1
- **Section 2** - Critical Infrastructure Area #2.
- **Section 3** - Critical Infrastructure Area #3

Section 1

Critical Infrastructure Area #1

1.1 Introduction

This section provides a summary of the rehabilitation work associated with Critical Area #1 identified in the CD as an approximately 1,000-foot portion of the 42-inch to 48-inch diameter Wolf River Interceptor in the northern area adjacent to the Wolf River. Upon further assessment, it was discovered that the actual pipe diameter throughout the entire stretch is 48-inch. This section of

pipe was rehabilitated with the installation of a cured-in-place pipe (CIPP) liner. Figure 1 shows the section of pipe that was rehabilitated.

The WCTS assets associated with CRA 1 are described as follows:

- Downstream Manhole WO010126 (0126) – located approximately 540 linear feet (lf) west of I-40 where the 48-inch line discharges into a 96-inch line
- Upstream Manhole WO010161 (0161) – located approximately 990 lf south of DSMH, approximately 600 lf north of the Wolf River, and approximately 560 lf west of I-40
- Middle Manhole WO010160 (0160) – located approximately 490 lf south and 500 lf north of DSMH and USMH, respectively, and approximately 600 lf west of I-40
- Interceptor Pipe Rehabilitated (Interceptor CRA #1) – lengths of pipe located between 0161 and 0160 (505 lf) and 0126 and 0160 (485 lf) for a total length of 990 lf.

1.2 Assessment and Rehabilitation Activities

In order to undertake a further assessment and to initiate rehabilitation of Interceptor CR #1, bypass pipes were established to divert flow around the targeted segments while an inspection of the pipe was conducted. A manhole located approximately 70 lf south (upstream) of 0161 was designated as the suction point of the system, and a manhole located approximately 300 lf east (upstream) of 0126 in the 96-inch line was designated as the discharge point. Subsequent to installing the bypass pipes, plugs were installed in the lines as required. Bypass pumping began on August 20 and continued through August 25, 2012. Interceptor CR #1 was cleaned using high pressure water discharged from a cleaning truck. Subsequently, a closed-circuit television (CCTV) camera was used to inspect Interceptor CR #1 for defects. The defect analysis was conducted in accordance with the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) standards. The CCTV videos showed upper pipe quadrant deterioration and surface spalling. In addition, infiltration was noted at one location between 0126 and 0160.

Upon completion of the cleaning and assessment, 990 lf of Interceptor CR #1 was rehabilitated by installing a CIPP liner with enhanced polyester resin in the pipe (see Figure 1). The CIPP work was conducted from August 20-25, 2012. Utilizing a water column inversion process, the liner was inverted into Interceptor CR #1 beginning at 0161 and terminating at 0160. Curing was accomplished by circulating hot water throughout the length of the inverted tube to cure the thermosetting resin into a hard, impermeable pipe with the polyurethane coating on the interior surface of the reconstructed pipe forming a jointless, structurally sound pipe.

The same process was utilized between 0126 and 0160. During the course of inverting this section of liner, a contractor error resulted in the liner extending through 0160 approximately 8 feet. However, a mechanical bond formed with the other liner (between 0161 and 0160) and the end was cut in accordance with standard protocol. The square cut end of the over-extended liner was transitioned to the existing liner using epoxy grout. Following each liner curing, the liners were flush-cut at the insertion and termination points and inside 0160. As necessary, void spaces between the cut ends of the liner and host pipe were filled with epoxy grout and the face wiped smooth. The liners were cleaned with high pressure water, inspected using CCTV, and determined

to be in compliance with the project specifications. Upon completion of the work, the plugs and bypass pipes were removed and Interceptor CR #1 returned to service.

During the CIPP process, quality assurance samples were collected to verify the integrity of the newly installed CIPP liner. Samples of the CIPP liner were analyzed for flexural stress, flexural modulus of elasticity, and thickness. Flexural stress and flexural modulus of elasticity both exceeded the applicable American Society of Testing Materials (ASTM) standards. The average pipe thickness was 28.4 mm (1.13in.) which exceeded the specified thickness of 27 mm (1.06 in.).

1.3 Summary

Critical Area #1 is defined as the 42-inch to 48-inch Wolf River Interceptor in the CD; however, it should be noted that the actual pipe diameter throughout this segment is actually 48-inch. The pipe was cleaned and assessed in accordance with NASSCO PACP standards. Upper pipe quadrant deterioration and surface spalling was observed during CCTV inspection, and infiltration was noted at one location. No PACP defects were detected in Interceptor CR #1 that would suggest a high likelihood of failure. Regardless of the relatively small probability of failure, in accordance with paragraph 11.b of the CD, the pipe segment was rehabilitated due to the critical nature of the infrastructure and the potential consequences of large volumes of SSOs in the event of infrastructure failure. The City determined that the best method of rehabilitation would be to install a CIPP liner along the 990 lf of Interceptor CR #1. The CIPP work was conducted from August 20 through 25, 2012.

Section 2
Critical Infrastructure Area #2

2.1 Introduction

This section provides a summary of the rehabilitation work associated with CRA #2 identified in the CD as an approximately 1,350 foot portion of the 96-inch Wolf River Interceptor at the entrance/exit ramp at mile 51 of Interstate 240. This section of pipe was rehabilitated with a geopolymer spray liner. Figure 1 shows the section of pipe that was rehabilitated. The WCTS assets associated with CRA #2 are described as follows:

- Downstream Manhole WO010127 (0127) – located approximately 201 lf west of TN State Hwy 300
- Upstream Manhole WO010128 (0128) – located approximately 118 lf south of Hindeman Ave and approximately 45 lf north of I-240
- Interceptor Pipe Rehabilitated (Interceptor CR #2) – length of pipe located between 0128 and 0127 for a total length of 1,232 lf.

2.2 Assessment and Rehabilitation Activities

Upon completion of the cleaning and assessment activities, Interceptor CR #2 was rehabilitated by installing a geopolymer lining. This work was conducted from August 26 – October 22, 2017. To accommodate the bypass lines, a structure was built to allow for the bypass operations. Subsequent to installing the bypass pipes, plugs were installed in the lines as required. Bypass

pumping began on August 14 and continued through October 22. Before rehabilitation began, the portion of Interceptor CR #2 being coated was cleaned using high pressure water discharged from a cleaning truck. The contractor conducted a visual assessment of Interceptor CR#2 prior to starting work to verify the condition of the pipe and that the geopolymer could be utilized. No issues were identified during the assessment that would suggest a high likelihood of failure. As part of the assessment, infiltration sources in the pipe were identified and filled with an epoxy grout. The entire 1,232 linear feet of Interceptor CR #2 was rehabilitated by spray applying a geopolymer coating. The geopolymer application was completed by utilizing man entry into Interceptor CR #2. The manufacturer's recommendation was to spray the geopolymer to the wall with a thickness of 0.5-inches layer of material.

During the coating of Interceptor CR #2, Hurricane Harvey brought a large amount of rain to the area. The impact to Memphis was a flash flood event spanning from August 31 – September 1, 2017. On August 31, 2017, the plugs and backup plugs diverting the flow around the rehabilitation operation failed due to excessive flow from the hurricane event and Interceptor CR #2 was flooded with raw sewage and river water. This event stopped all work on the project and required significant cleanup efforts inside Interceptor CR #2 as well as reinstalling the bypass plugs before work could resume. On September 14, 2017 the plugs were reinstalled and bypass was reestablished. The extensive cleanup to remove all debris that was washed down into Interceptor CR #2 lasted from September 14 – September 27, 2017. Subsequently, it was discovered that, in addition to the clean-up, there were other hurricane Harvey impacts impacting the rehabilitation work that needed to be addressed in order to be back to pre-event conditions. This extended the clean-up time needed for returning back to pre-event conditions to 5 days, for a total of 33 days. City notification of these events are set forth in letters submitted to EPA and TDEC dated September 1, 2017, September 13, 2017, October 3, 2017 and October 10, 2017.

By October 2, the geopolymer subcontractor had repaired damage that occurred as a result of the plugs failing and Interceptor CR #2 flooding, restored the work site to the "pre-event" conditions and resumed work. Substantial completion occurred on October 22.

The resulting geopolymer coating creates a jointless, structurally sound, and corrosive resistant pipe. Once completed, the pipe was inspected using CCTV to ensure compliance to the specifications. During the coating process, thickness measurements were taken, and the average thickness for the geopolymer coating was found to be 0.75-inches which exceeded the manufacturer's recommended thickness. The pipe segment rehabilitation complies with Paragraph 11.b. of the CD.

2.3 Summary

CRA #2 is defined as the 96-inch Wolf River Interceptor in the CD. No PACP defects were detected in Interceptor CR #2 that would suggest a high likelihood of failure. Regardless of the relatively small probability of failure, in accordance with paragraph 11.b of the CD, the pipe segment was rehabilitated due to the critical nature of the infrastructure and the potential consequences of large volumes of SSOs in the event of infrastructure failure. The City, in conjunction with the SARP10 Program Manager, determined that the best method of rehabilitation would be to coat Interceptor CR #2 with a geopolymer spray. The rehabilitation work was conducted from August 26 through October 22, 2017. Interceptor CR #2 was rehabilitated in accordance with manufacturer's recommendations.

Section 3
Critical Infrastructure Area #3

3.1 Introduction

This section provides a summary of the rehabilitation work associated with CRA #3 identified in the CD as the 84-inch Interceptor located where McLean Boulevard crosses the Wolf River and Interstate I-40, which is approximately 600 feet in length. As with CRA #1, this section of pipe was rehabilitated with the installation of a CIPP liner. Figure 1 shows the section of pipe that was rehabilitated. The WCTS assets associated with CRA #3 are described as follows:

- Upstream Manhole WO020114 (0114) – located east of McLean Blvd. at the toe of the embankment south of I-40
- Downstream Manhole WO020101(0101) – This is a junction structure located east of McLean Blvd. and north of I-40 with one 36-inch and two 84-inch incoming pipes and one 96-inch outgoing pipe
- Interceptor Pipe Rehabilitated (Interceptor CR #3) – length of pipe located between USMH and DSMH. Actual length = 561 linear feet

3.2 Assessment and Rehabilitation Activities

In order to undertake a further assessment and to initiate rehabilitation of Interceptor CR #3, bypass pipes were established to divert flow around the segments outlined above while an inspection of the pipe was conducted. To accommodate the bypass lines, two new manholes were constructed and one existing manhole was modified to allow for the bypass operations. One of the new manholes was installed upstream (south) of 0114, the other was installed upstream (east) of 0101, and the manhole downstream (west) of 0101was modified. In addition, a bypass line was installed in an existing manhole upstream (north) of 0101 in a 36-inch line. Subsequent to installing the bypass pipes, plugs were installed in the lines as required. Bypass pumping began on November 12 and continued through November 14, 2012.

Interceptor CR #3 was cleaned using high pressure water discharged from a cleaning truck. Subsequently, a closed-circuit television (CCTV) camera inspected Interceptor CR #3 for defects. The defect analysis was conducted in accordance with NASSCO PACP standards. No PACP defects that would suggest a high likelihood of failure were detected in Interceptor CR #3.

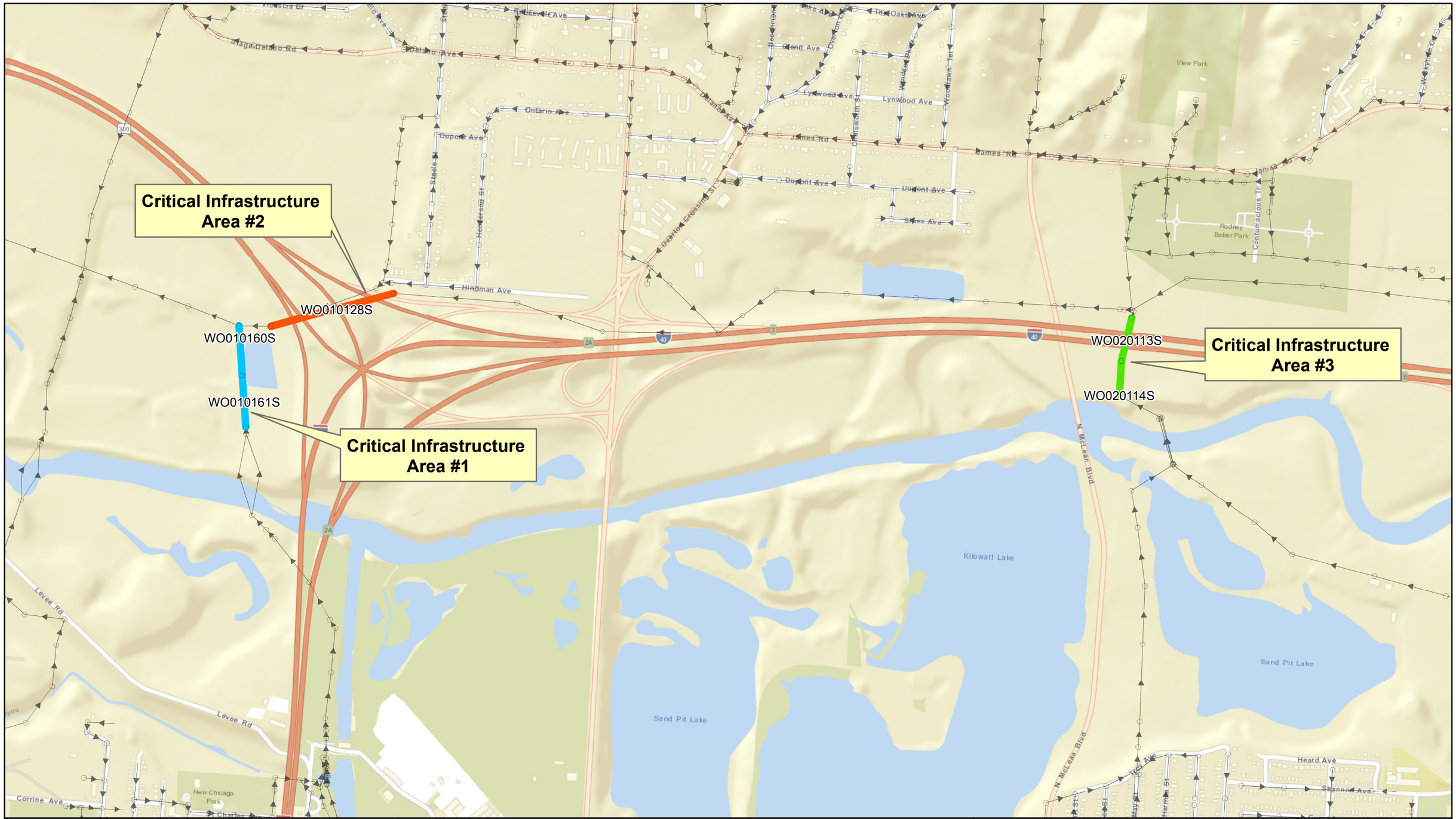
Upon completion of the cleaning and assessment activities, 561 lf of Interceptor CR #3 were rehabilitated with a CIPP liner with enhanced polyester resin into the line segment (see Figure 1). The CIPP work was conducted from November 12 through November 14, 2012. Utilizing a water column inversion, the liner was inverted into Interceptor CR #3 beginning at 0101 and terminating at 0114. Curing was accomplished by circulating hot water throughout the length of the inverted tube to cure the thermosetting resin into a hard, impermeable pipe with the polyurethane coating on the interior surface of the reconstructed pipe forming a jointless, structurally sound pipe. Following curing, the liner was flush-cut at the termination points. In addition, the liner was cutout at the junction box for the 84-inch Interceptor CR #3 coming from the east. As necessary, void spaces between the liner and host pipe were filled with epoxy grout and the face wiped smooth. The liners were cleaned, inspected using CCTV, and determined to be in compliance with the project

specifications. Upon completion of the work, the plugs and bypass pipes were removed and Interceptor CR #3 returned to service.

As part of the CIPP process, quality assurance samples were collected to verify the integrity of the newly installed CIPP liner. Samples of the CIPP liner were analyzed for flexural stress, flexural modulus of elasticity, and thickness. Flexural stress and flexural modulus of elasticity both exceeded the applicable American Society of Testing Materials (ASTM) standards. The average pipe thickness was 54.4 mm (2.14 in.) which exceeded the specified thickness of 46.5 mm (1.83 in.).

3.3 Summary

CRA #3 is defined in the CD as the 84-inch Interceptor CR #3 located where McLean Boulevard crosses the Wolf River and Interstate I-40. To determine the condition of Interceptor CR #3, it was cleaned and assessed in accordance with PACP standards. No PACP defects were detected in Interceptor CR #3 that would suggest a high likelihood of failure. Regardless of the relatively small probability of failure, in accordance with paragraph 11.b of the CD, the pipe segment was rehabilitated due to the critical nature of the infrastructure and the potential consequences of large volumes of SSOs in the event of infrastructure failure. The City determined that installing 561 lf of CIPP was the best option to rehabilitate Interceptor CR #3. The work was conducted from November 12 through 14, 2012.



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- Critical Infrastructure Area #1
- Critical Infrastructure Area #2
- Critical Infrastructure Area #3
- Gravity Mains
- Manholes

SARP10 Critical Infrastructure Projects

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