1. Introduction

1.1 Background

1.1.1 General

The combined sewer system for the City of Lancaster (City) is similar to many Midwestern communities. Wastewater from the separate sanitary sewer sub-areas and wastewater from combined sewer sub-areas flow into common interceptor sewers that transport flow to the treatment facility. To prevent basement and street flooding, the sewer was designed with CSO structures that relieve the collection system during wet weather events.

The original sewer system that serves the central part of the City is a combined sewer system. The oldest sections of the system are over 100 years old. In 1911, drainage districts were created to route flows to the rivers. Construction began on the core sanitary sewer system in 1939 and evolved to include pump stations and overflow structures.

As the community grew and expanded outward, separate sewers were constructed for the new development areas but routed through the combined system for conveyance to the Lawrence Street WPCF. The City owns and maintains approximately 52,600 linear feet of combined sewers and approximately 851,000 linear feet of separated sewers in the Lancaster wastewater collection system. The City's sanitary service area is over 18 square miles and serves approximately 99 percent of the City's population of 38,780 (2010 U.S. Census). The City also maintains approximately 447,000 linear feet of storm sewers.

The City owns and operates the Lawrence Street WPCF, located on the south side of the City, and the Upper Hocking WPCF, located on the northwest side of the City. The Lawrence Street WPCF treats all of the flow from the City's combined sewer system. The Lawrence Street WPCF is designed to treat an average flow of 10 MGD with a peak hydraulic capacity of 18 MGD, 12 MGD of which goes to secondary treatment. The Lawrence Street WPCF was originally constructed in the late 1930s with the most recent upgrades occurring in 1997. The Upper Hocking WPCF was completed in 2011 and is designed to treat an average flow of 2 MGD with a peak hydraulic capacity of 8 MGD, 2 MGD of which goes to equalization.

The City also owns and operates ten wastewater pumping stations that are listed in Table 1-1. The large pump stations that convey flows to the Lawrence Street WPCF are included as part of the CSO strategy. Appendix A (Lawrence Street WPCF Large Pump Stations) includes tables that summarize pumping operations.

Table 1-1 Pump Stations

Pump Station	Size	Capacity (gpm)	Sewer System	WPCF
YMCA	large	3,000	combined	Lawrence Street
South Broad Street	large	3,700	separate	Lawrence Street
Wheeling Street	large	3,000	combined	Lawrence Street
East Main Street	large	1,440	separate	Lawrence Street
Upper Hocking	large	5,500	separate	Upper Hocking
Fogg Drive	small	135	separate	Lawrence Street
The Woods	small	130	separate	Lawrence Street
Rock Mill	small	750	separate	Lawrence Street
Campground Road	small	150	separate	Lawrence Street
Lawrence Street	small	98	separate	Lawrence Street

1.1.2 NPDES Permit Compliance Schedule History

In July 1995, the City of Lancaster began in earnest to work on addressing issues associated with Lancaster's wastewater collection system. Major objectives of the initial work included:

- Mitigating basement flooding issues that were historically prevalent in several areas of the City.
- Updating of and documentation of the City's wastewater collection system in electronic format.
- Taking proactive approach to address upcoming Ohio EPA requirements for the combined sewer system. The USEPA had adopted their CSO Control Policy in April 1994 and Ohio EPA established their CSO policy in 1995. Lancaster's NPDES permit expired on July 28, 1995.

In the next NPDES Permit that was effective December 1, 1997, the following items were included in the Schedule of Compliance:

- Combined Sewer System Operational Plan by April 1, 1998. Implementation of controls was required by June 1, 1998. This was essentially implementation of the nine minimum controls as defined by USEPA
- Monitoring program proposal by June 1, 1998.
- Combined Sewer System Characterization Report by December 1, 1999.
- Combined Sewer System Long Term Control Plan by June 1, 2000.

By being proactive in 1995 for items that the City knew were going to be included in the upcoming 1997 NPDES Permit Schedule of Compliance, they were able to meet the tight schedule for the initial deliverables.

Sewer modeling was performed with the Storm Water Management Model (XP-SWMM) to characterize the sewer system and analyze its hydraulic capacity. The modeling was used as a tool for:

- Identifying basement flooding problems and causes and recommending solutions.
- Maximizing use of the collection system.
- Estimating flows in the sewer system during anticipated precipitation events.
- Designing relief and/or storm sewers.

To obtain flow information, fifteen flow meters and three rain gages were used concurrently. Dry weather flows were monitored at 27 locations and wet weather flows were monitored at 77 locations. Water quality impacts from CSOs on the receiving waters were monitored and analyzed through utilization of automatic samplers at CSO locations. Receiving stream water was also sampled during dry-weather, CSO discharge periods, and precipitation events, and analyzed for various chemicals and fecal coliform count.

On the basis of the requirements of Lancaster's NPDES permit (effective 12/01/97 through 10/31/01), the information previously gathered was used to develop a formal CSO Long-Term Control Plan (LTCP). Data gathered from the biological assessment, including one macroinvertebrate and two fish surveys at nine sites at the Hocking River and its tributaries, were used to help determine any impacts that the CSOs might have had on the stream water quality. The plan also considered the impact of future development flows on CSO discharges.

The LTCP was submitted in June 2000. Ohio EPA reviewed the initial LTCP and determined that the recommendations made per the requirements of the NPDES Permit were no longer acceptable. It was proposed to capture 85% by volume of the combined sewage collected in the combined sewer system, through implementation of the following projects:

- Increasing in-system storage by elimination of CSOs 1005 and 1010, modification of CSOs 1019 and 1029 by raising their weirs, and cleaning of the 27-inch interceptor.
- Sewer separation in the Lake/Allen/Maple Streets area and completion of the Downtown sewer separation project.

The Presumptive Approach to reduce overflow volume by 85% as identified in the US EPA CSO Control Policy as an acceptable approach, and which was used in the LTCP, was not accepted by Ohio EPA.

The City of Lancaster then negotiated revised LTCP requirements with OEPA that were included in the Schedule of Compliance for the next NPDES Permit, effective 03/01/03 through 07/31/06. The requirements included the following:

- Reduction or elimination of combined sewer overflows from four specific CSO structures as identified by the Ohio EPA.
- Plan for the provision of new facilities at the WPCF to treat increased peak flows caused by reduced CSO discharges.
- Plan to provide full treatment of wastewater flows from new and separately-sewered areas in high growth areas of the City.

Specifically, the Ohio EPA required that four CSOs be considered for elimination or minimization of combined sewage discharges. These included CSO 1004, CSO 1006, CSO 1020, and CSO 1034.

Since the elimination or reduction in CSO volume likely would result in larger peak flows and volumes at the Lawrence Street WPCF, the Ohio EPA also required an analysis of the options available to treat the additional flow. These analyses were submitted to the Ohio EPA in the Long Term Control Plan Addendum on March 1, 2005. The following projects were recommended in the Long Term Control Plan Addendum:

- Construct Rock Mill Lift Station.
- Construct Approximately 210,000 linear feet of sewer ranging in size between 8-inch and 48-inch diameter.
- Complete Lake/Allen Maple Streets Sewer Separation project.
- Construct Upper Hocking Pump Station and WPCF.
- Construct Baldwin Run Express Sewer
- Construct Broad Street Pump Station Express Sewer.

Ohio EPA reviewed the Long Term Control Plan Addendum, and again determined that, even though it met the requirements of the NPDES Permit Schedule of Compliance, it could not be approved. Ohio EPA determined that compliance with the Ohio EPA CSO Policy would require reducing all overflows within the City to allow only 2 to 4 events Citywide during a "typical year". At that time, Lancaster negotiated with Ohio EPA that the additional LTCP requirements be either in their next NPDES Permit or in a Consent Order. It was mutually agreed to establish additional LTCP requirements via the NPDES Permit Schedule of Compliance.

Ohio EPA ultimately accepted the recommendations in the Long Term Control Plan Addendum with the stipulation that once all the recommendations are implemented, that the City of Lancaster would re-monitor and model the collection system to determine what additional projects, if any, may be required to reduce overflow occurrences to 2 to 4 events Citywide during a "typical year". The following is a summary of the Schedule of Compliance requirements from the NPDES permit that expired on May 31, 2012:

- Lake/Allen/Maple sewer separation shall be completed by February 1, 2009 (completed).
- Construction of the Upper Hocking Water Pollution Control Facility shall be completed by December 1, 2011 (completed).
- Baldwin Express Sewer shall be completed by November 1, 2014 (Ohio EPA has since released Lancaster from this requirement since CSO 1034 has been closed).
- Construction of the Broad Street Express Sewer shall be completed by December 1, 2016.
- Construction of Flow Equalization at the Lawrence Street WPCF shall be completed by October 1, 2017.
- CSO Flow Monitoring and Evaluation Program shall begin no later than November 30, 2011 and final evaluation shall be completed by January 1, 2014 (completed).
- Phase II Long Term Control Plan shall be submitted by March 1, 2014 (submittal extend to September 1, 2014 - this project).

The Current NPDES Permit for Lawrence Street was effective August 1, 2012 and will expire on July 31, 2017. Lancaster again negotiated with Ohio EPA regarding several components of the prior NPDES Permit Compliance Schedule. The following is a summary of current CSO compliance items, some of which are repeated from the prior permit:

- Begin CSO flow monitoring by November 30, 2011 (completed).
- Submit flow monitoring status report and preliminary evaluation of overflows and occurrences by November 30, 2012 (completed)
- Submit final evaluation of CSO volumes and occurrences by January 1, 2014 (completed).
- Complete closure of CSO 1011 by December 1, 2013 (completed).
- Complete closure of CSO 1026 by December 1, 2013 (completed).
- Complete the Phase II Long Term Control Plan by March 1, 2014 – extended to September 1, 2014. Lancaster required to complete all recommended projects by January 1, 2025.
- Construction of the Broad Street Express Sewer shall be completed by December 1, 2016.
- Complete closure of CSO 1014 by December 1, 2015.
- Complete closure of CSO 1033 by June 1, 2017.
- Construction of Flow Equalization at the Lawrence Street WPCF shall be completed by December 1, 2024.

A summary of the documents that have been submitted to date per the requirements of the various NPDES Permit Compliance Schedules is shown in Table 1-2 CSO Strategy Regulatory Submittals.

Table 1-2 CSO Strategy Regulatory Submittals

Submittal Date	Title
March 1998	Combined Sewer System Operational Plan
March 1998	Combined Sewer System Monitoring Plan
December 1999	Combined Sewer System Characterization Report
June 2000	Combined Sewer System Long Term Control Plan
March 2005	Combined Sewer System Long Term Control Plan Addendum
February 21, 2006	Lake/Allen/Maple Sewer Improvement Construction Documents
June 13, 2008	Upper Hocking Water Pollution Control Facilities Construction Documents
November 21, 2012	Phase II Long Term Control Plan – Flow Monitoring Technical Memorandum
December 2012	Closure of CSO 1011 Construction Documents
June 2013	Closure of CSO 1026 Construction Documents
December 20, 2013	Phase II Long Term Control Plan – CSO Overflow Volumes and Occurrences Technical Memorandum

1.1.3 CSO Project History

The aggressive proactive approach taken by the City of Lancaster over the last 20 years to improve their combined sewer wastewater collection system has resulted in significant improvements. The 1997 NPDES Permit listed 31 permitted CSOs, with two additional overflows being identified during the system characterization work. As of July 1, 2014, there are only nine CSOs remaining. A historical record of work that has been completed on the CSOs is included in Appendix B as Table B1 (Summary of CSO Modifications). Appendix B also includes figures of the plans and sections of the City's active CSO structures.

Between 1993 and 2003, the City initiated their CSO related activities. They proactively embarked on a CSO mitigation path following the US EPA's 1993 Combined Sewer Overflow Control manual. A Wastewater Collection System Evaluation was completed in 1995 to address basement flooding issues, to evaluate the sewer system capacity, and to estimate the effects of CSOs on the water quality of the local waterways. The City completed the Downtown Sewer Separation Project and the South Broad Street Storm Sewer Project. During this period, the City also closed six CSOs and continued to prepare and submit various documents as required for compliance with the OEPA's Combined Sewer Overflow Strategy.

From 2004 through 2008, the City progressively implemented projects and processes to support their CSO strategy. The City formed a stormwater utility to aid in the evaluation and funding of CSO mitigation projects. The combination of the stormwater utility and the sewer department resulted in the City's ability to holistically evaluate and implement improvements to benefit water quality and reduce basement flooding. During this time, the Lake Allen Maple Sewer Project was constructed, and the LTCP Addendum was submitted. The City also completed a detailed investigation of each CSO and closed or modified 21 CSO locations. In addition to capital improvement projects, the City has made various in-house improvements to CSO structures to reduce overflows. The in-house improvements have included increasing weir elevations, increasing the size of underflow openings, and increasing underflow pipe sizes.

Between 2008 and 2014, the City continued improving the collection system. The Upper Hocking Pump Station and Water Pollution Control Facility (WPCF) was constructed, relieving flows along the Hocking Interceptor and the YMCA Pump Station. The Upper Hocking Pump Station intercepts flows from separate sanitary sewered basins prior to the separate sanitary flow entering the combined sewer interceptor system. Therefore, all the flow from these basins now receive full secondary treatment at the Upper Hocking WPCF.

Four additional CSOs were also closed and the Forest Rose Storm Sewer Project was completed. The City's current collection system is represented in Figure 1-1 (provided at the end of this section). The remaining CSOs and their discharge points are listed hereafter:

- CSO 1004 – Hocking River – West of Lawrence Street WPCF
- CSO 1008 – Hocking River – East bank of Hocking River, south of Lincoln Avenue bridge at SR 33
- CSO 1009 – Hocking River – East bank of Hocking River between Mulberry Street. and Wheeling Street
- CSO 1012 – Hocking River – SR 33 and Fifth Avenue
- CSO 1013 – Hocking River – SR 33 and Sixth Avenue
- CSO 1014 – Hocking River – Allen Street west of SR 33
- CSO 1033 – Hocking River – Park Street
- CSO 1029 – Baldwin Run – Sixth Avenue west of Fetters Run bridge
- CSO 1019 – Baldwin Run – North of Chessie Railroad and west of Baldwin Run

1.1.4 Water Quality Standard Compliance History

The stream Water Quality Standard (WQS) Aquatic Life Use Designations for Baldwin Run and Fetters Run is warm water habitat (WWH). The WQS for the majority of the Hocking River in the Upper Hocking Basin is WWH. However, the segment from Lithopolis Road (RM 94.9) through the City of Lancaster to Baldwin Run (RM 89.02) is modified warm water habitat (MWH). The MWH classification is due to the significant amount of stream channelization.

In 1985, 77% of the Hocking River between Lancaster and Enterprise exhibited "poor to very poor" conditions. However, by 1990 almost 67 % of the river was in Full or Partial Attainment of warm water habitat standards. In the 1991 Ohio EPA Water Quality Study, much of this improvement was attributed to upgrades at the Lancaster Lawrence Street WPCF that were completed in 1989. The 1989 upgrade of the plant not only improved the plant effluent, but also significantly reduced the volume of CSO discharges. Subsequent upgrades in 1996 at the Lawrence Street WPCF, as well as all the other collection system improvements documented in this report, have further improved this situation.

In the Ohio EPA's 1995 Water Quality Study, continued improvement was documented. The entire Hocking River through Lancaster was either in Full or Partial Attainment of water quality standards for the first time since Ohio EPA began collecting data in 1982.

In the "Total Maximum Daily Loads for the Hocking River Watershed" Final Report dated August 27, 2009 (2009 TMDL), Hunters Run, Baldwin Run, Fetters Run, and Pleasant Run were all in full attainment for aquatic life uses. In addition, the segment of the Hocking River through Lancaster was also in full attainment. There was no indication of any impairment of any aquatic life use as a result of the City of Lancaster wastewater collection and treatment systems.

However, the recreational use designation for the Lancaster streams is Primary Contact. The 2009 TMDL has indicated that there is a significant coliform load due to CSOs on the Hocking River and on Baldwin Run with a stated "Reduction Required" of 95% and 100% respectively. It is further stated that "The Lancaster Long Term CSO Control Plan should achieve this reduction in fecal coliform load once it is fully implemented."

As a result of the aggressive approach that Lancaster has undertaken over the last 20 plus years, continued improvement has occurred in its receiving streams. The total CSO flow volume has been reduced from approximately 118 million gallons to approximately 63 million gallons in a "Typical Year".

1.1.5 Cost for Improvements

Although some of the actions taken by Lancaster have been required by various NPDES Permit Compliance Schedule requirements, as outlined in the prior discussion, many have been taken through the City's own initiative for the good of the system and ultimately the environment. However, the aggressive CSO related actions taken by the City of Lancaster has come at a large cost and has placed a considerable burden on its rate payers. To date, almost $69,000,000 has been spent for CSO related improvements.

The City's expenditures for the completed improvements are summarized in Table 1-3 CSO Reduction Costs.

Table 1-3 CSO Reduction Costs

Completion Year	CIP	Total Cost [1]
Varies	Various In-House Improvements (See Appendix B, Table B1)	$ 115,400
2014	Phase II Long Term Control Plan	$ 1,100,000
2014	South Broad Street Express Sewer Planning and Design	$ 480,000
2013	CSO 1011 Closure Project	$ 760,000
2013	CSO 1026 Closure Project	$ 365,500
2013	CSO 1027 Closure Project	$ 205,000
2011	Upper Hocking WPCF	$ 50,093,100
2009	Lake/Allen Sewer Separation	$ 8,933,100
2002	S. Broad St. Storm Sewer	$ 1,819,900
2001	Downtown Improvements	$ 4,980,600
	Total	$ 68,852,600

1. Total Costs include property acquisition, engineering, and construction administrative services.

In addition, the above table does not include the cost for the 1987 and 1996 improvements to the Lawrence Street WPCF and to the four major pump stations, which amounted to approximately $30,000,000.

1.2 Regulatory Status

The City is currently authorized to discharge wastewater treatment effluent from the Lawrence Street WPCF and collection system under OEPA NPDES Permit No. 4PD00001*LD. The City's current permit was effective on August 1, 2012 and expires July 31, 2017.

To develop the Phase II Long Term Control Plan and comply with the Lawrence Street WPCF NPDES Permit, the City submitted the Flow Monitoring and Technical Memorandum to OEPA on November 29, 2012. The Flow Monitoring and Technical Memorandum documented the completion of the City's comprehensive combined sewer system flow, rainfall, and stream gauge monitoring program. The monitoring program provided the data necessary for modeling the 2012 conditions of the Lawrence Street WPCF sanitary sewer collection system.

Appendix C (CSO Overflow Volumes and Occurrences) contains the December 20, 2013, CSO Overflow Volumes and Occurrences Technical Memorandum submitted to OEPA in accordance with the requirements of the Lawrence Street WPCF NPDES Permit. The CSO Overflow Volumes and Occurrences Technical Memorandum documented the calibration of the City's Storm Water Management Model (SWMM) and provided the predicted CSO overflow volumes and occurrences generated from the calibrated 2012 Existing Conditions Model by simulating Lancaster's Typical Year Rainfall distribution.

The remaining action items in the Lawrence Street WPCF NPDES Compliance Schedule are summarized in Table 1-4 Summary of NPDES Compliance Schedule. This includes submitting the Phase II Long Term Control Plan on September 1, 2014. The submittal date of the Phase II Long Term Control Plan was moved from March 1, 2014 by OEPA on October 24, 2013 as requested by the City. The PTI date for the Broad Street Express Sewer was also moved from June 1, 2014 to July 1, 2014 by OEPA on March 27, 2014. Correspondences related to modifications of the Lawrence Street NPDES Compliance Schedule are included in Appendix D (Compliance Schedule Correspondence).

Table 1-4 Summary of NPDES Compliance Schedule

Action Item	Compliance Date
PTI for Broad Street Express Sewer	~~June 1, 2014~~ July 1, 2014
Submit Phase II Long Term Control Plan	~~March 1, 2014~~ September 1, 2014
Begin Construction of Broad Street Express Sewer	December 1, 2014
PTI for CSO 1014 Closure	March 1, 2015
Begin Construction of CSO 1014 Closure	June 1, 2015
Complete Construction of CSO 1014 Closure	December 1, 2015
PTI for CSO 1033 Closure	June 1, 2016
Complete Construction of Broad Street Express Sewer	December 1, 2016
Begin Construction of CSO 1033 Closure	December 1, 2016
Complete Construction of CSO 1033 Closure	June 1, 2017
PTI for Flow Equalization Facility	December 1, 2021
Begin Construction of Flow Equalization Facility	June 1, 2022
Complete Construction of Flow Equalization Facility	December 1, 2024

1.3 Level of Service and Compliance Goals

The City desires to achieve a reasonable Level of Service (LOS) understanding that a collection system cannot feasibly be designed to convey every extremely large wet weather events. With that in mind, the following is a summary of the Ohio EPA and City of Lancaster Compliance Goals:

Ohio EPA Compliance Goals:

- 2 – 4 overflow events Citywide in a "Typical Year"
- Routing of separated sewer areas around combined sewer areas
- Maximizing treatment capacity
- Achieve Water Quality Standards

City of Lancaster Compliance Goals:

- Comply with 2 -4 events in "Typical Year"
- Where possible, close CSO
- Where possible, 0 events in "Typical Year"
- Maximize Interceptor Flows
- Maintain hydraulic grade lines to avoid water in basements (WIBs)
- Eliminate catch basin connections

The City's LOS goals are to maintain four or less activations at each remaining CSO during the typical year and to reduce water in basement occurrences

1.4 Public Participation Program

As part of meeting the requirements of the EPA CSO Policy, the City has maintained a Public Participation Program that keeps the public engaged in the decision making process of the City's Program for CSO Control. The ongoing Public Participation Program has been essential for public acceptance and for the public's willingness to pay for the City's Program for CSO Control. Continued participation of the public and a continued public outreach has been essential throughout the life of the program for maintaining the public support for rate increases and minimizing complaints about the nuisance and inconvenience of construction projects.

The public participation schedule for this Phase II Long Term Control Plan is provided in Table 1-5 Public Participation Schedule.

Table 1-5 Public Participation Schedule

Description	Date
City Council Presentation	July 14, 2014
Lancaster Eagle Gazette Article	July 15, 2014
Webpage Update with the Public Participation Schedule	July 23, 2014
Phase II LTCP available to Public	July 25, 2014
Stakeholder Mailing	July 25, 2014
Public Comment Period	July 25, 2014 to August 24, 2014
Stakeholder Meeting	August 6, 2014

Documentation of the public participation program including meeting attendance sign-sheets, meeting PowerPoint presentations, newspaper articles, and public comments are included in Appendix E – Public Participation Program as the program is administered.

1.5 Long Term Control Plan Criteria

OEPA requires that the Phase II LTCP include at least the following items:

- Assessment of the costs
- Effectiveness and water quality benefits of a wide range of alternatives for eliminating, reducing, and treating any and all of Lancaster's remaining CSO overflows or CSO outfalls.

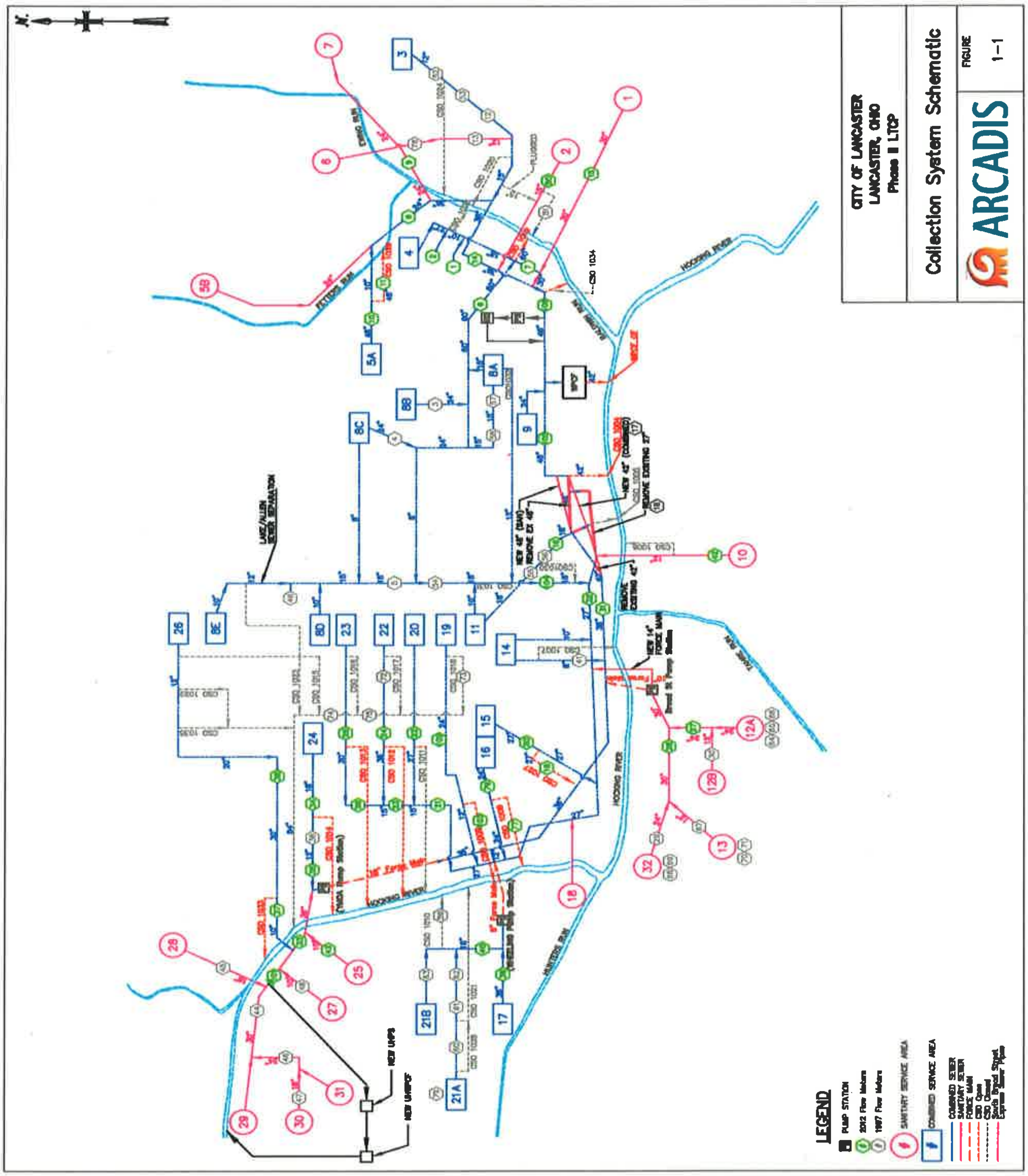
Evaluation of alternatives will include:

- Costs
- Benefits
- Impact on user rates
- Affordability, and
- Construction and implementation schedules

In the July 2000 LTCP, four alternatives were evaluated; they were to provide storage, physical/chemical treatment, additional full secondary treatment, and sewer separation. The selected alternative from the LTCP was to provide storage by adding an off-line EQ basin and a bar rack with a pump station to pump into the EQ basin. The use of additional storage was the most cost effective treatment for peak flows, lowest increase in user rates, and it provides full secondary treatment to minimize pollutant discharges.

For the Phase II LTCP, the collection system was analyzed to maximize the amount of flow that can reach the Lawrence Street WWTP to maximize treatment and maximize proposed storage, eliminate and/or minimize CSO discharges in the system, and reduce water in basement occurrences of local residents. Each alternative was evaluated on costs, benefits, impact on user's rates, and the construction/implementation schedule to determine the recommended solution.

Figure 1-1 **Collection System Schematic**



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2. Flow Monitoring Program and Model Development Overview

In 1999, the City completed their first collection system model using XP-SWMM software as part of the City's Combined Sewer System Characterization Report. This 1999 XP-SWMM model was used as the tool for planning all the CSO reduction capital improvement projects in Table 1-3. As part of negotiations with OEPA for the June 1, 2007 Lawrence Street WPCF NPDES Permit, the City requested that the Permit Compliance Schedule include a model update to reflect the changes in flow due to the collection system improvements, industry closures, and demographic shifts that have occurred since 1999. In order to calibrate the updated model, current flow monitoring data was required. With an updated collection system model that includes the completed improvements, the second phase of projects were reevaluated to more accurately determine design requirements and to confirm that they are still required to meet existing regulatory requirements.

2.1 Flow Monitoring Program

As part of the City's Phase II LTCP, the City completed a comprehensive flow, rainfall, and stream gauge monitoring program to collect data for calibrating the updated model. The flow and rainfall monitoring program started on March 15, 2012 and ended on August 15, 2012. The flow monitoring program included the following components:

- Flow monitoring at 40 locations throughout the collection system
- Rain gauging program utilizing four temporary rain gauges
- Stream gauge monitoring at one location along the Hocking River

2.1.1 Flow Monitoring

In Table 2-1, the flow meter number, location, and rationale for placement are provided. In Figure 2-1, the locations of the flow meters used for data collection are shown.

The program began with thirty (30) flow meters installed by Hydromax USA. An additional eight (8) flow meters were installed by the City in April 2, 2012 and Hydromax USA installed two (2) more on May 1, 2012. The flow meters with **bold** text in Table 2-1 were installed by the City. The flow meter numbers are not in numerical sequence, because the same flow meter location ID Number used in the previous flow monitoring program was used.

Table 2-1 Monitoring Locations

Flow Meter ID	Location	Pipe Size	Rationale for Meter	Drivers
1	East side of Mary Burnham Park	10"	Capture flow downstream of CSO 1026	Located on downstream pipe as the outfall was not suitable for metering
2	NE corner of Mary Burnham Park	27"	Capture flow upstream of CSO 1026	Captures flow from sewershed 2
6	East Chestnut and South Cherry	56"	Capture flow downstream of CSO 1019	Captures flows from sewersheds 8a, 8b and 8c
7	South of railroad track near Mary Burnham Park	18"	Capture flow upstream of CSO 1019	Located on downstream pipe as the outfall was not suitable for metering
8	**East of East King and North Cherry**	**24"**	**Trunk sewer meter**	**Captures flow from sewershed 5b**
9	**Behind Kroger**	**24"**	**Trunk sewer meter**	**Captures flow from sewershed 7**
10	West of Fetters Run and East 6th	48"	Capture flow downstream of CSO 1029	Captures flow from sewershed 5a
11	West of Fetters Run and East 6th	48"	Capture flow upstream of CSO 1029	Located on the outfall pipe
14	**Brooks and East Chestnut**	**36"**	**Trunk sewer meter**	**Captures flow from sewersheds 6 and 14**
15	**Fulkerson and CSX RR**	**30"**	**Trunk sewer meter**	**Captures flow from sewershed 1**
16	Lawrence and Wheat	18"	Trunk sewer meter	Captures limited flow from old sewershed 11
19	West Walnut East of the Hocking River	27"	Capture flow downstream of CSO 1027	Located on the outfall pipe
20	West Walnut West of Memorial	27"	Capture flow upstream of CSO 1027	Captures flow from sewershed 15
21	South of Union and Memorial	14"	Capture flow downstream of CSO 1011	Located on downstream pipe as the outfall was not suitable for metering
22	East of Columbus and Union	27"	Capture flow upstream of CSO 1011	Captures flow from sewershed 20
23	Miller Park and West 5th	15"	Capture flow downstream of CSO 1012	Located on downstream pipe as the outfall was not suitable for metering
24	West 5th and Memorial	36"	Capture flow upstream of CSO 1012	Captures flow from sewershed 22
25	West 6th and Memorial	24"	Capture flow downstream of CSO 1013	Located on downstream pipe as the outfall was not suitable for metering
26	West 6th and Memorial	11.25"	Capture flow upstream of CSO 1013	Captures flow from sewershed 23
27	South Broad and Memorial	24"	Trunk sewer meter	Captures flow from sewersheds 12a and 12b

Table 2-1 Monitoring Locations

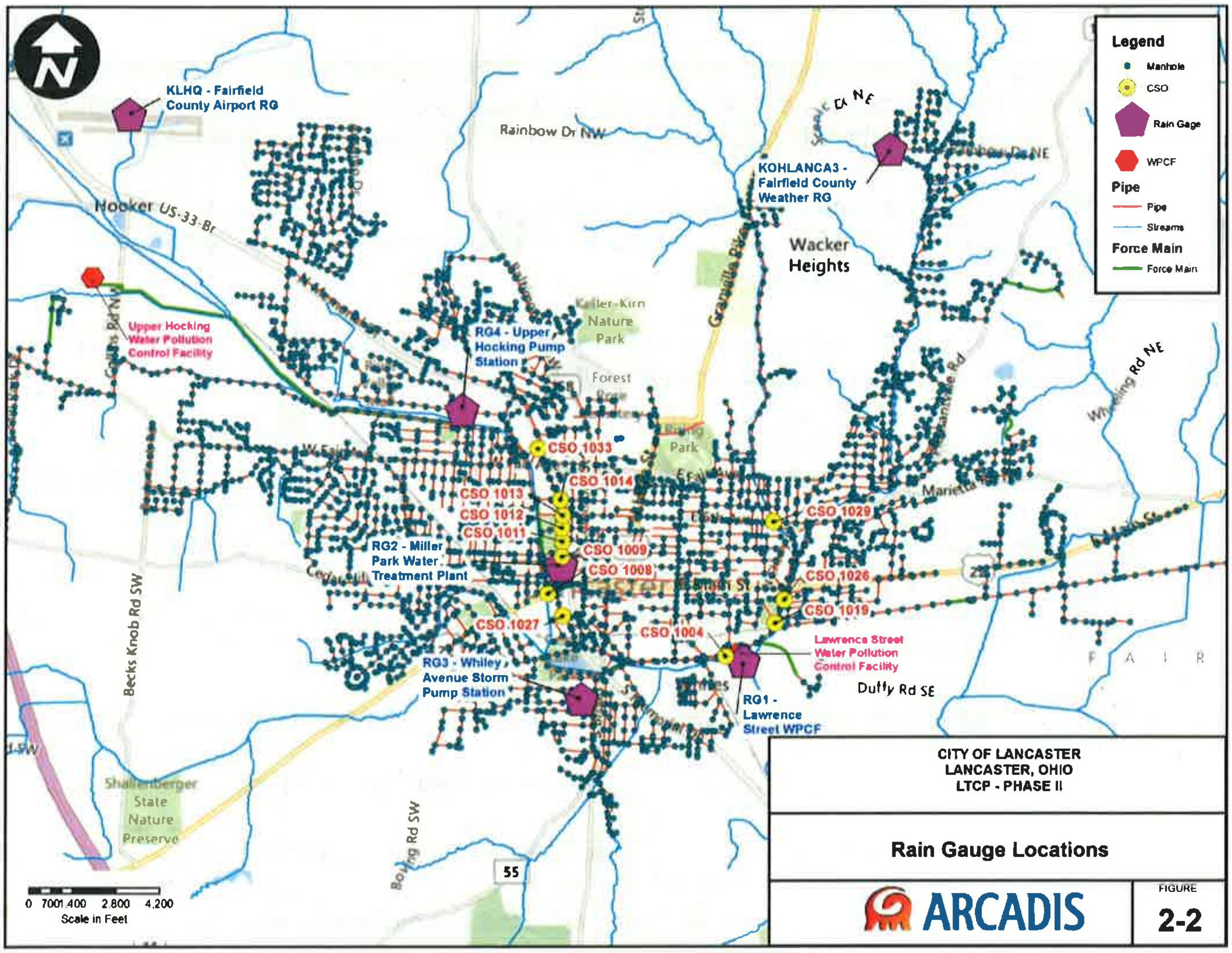
Flow Meter ID	Location	Pipe Size	Rationale for Meter	Drivers
28	North of Lewis in Maher Park	30"	Trunk sewer meter	Captures flow from sewersheds 13 and 32
31	East of High and Canal	36"	Interceptor meter	Captures flow from sewershed 14
32	East of High and Canal	27"	Interceptor meter	Captures flow from sewersheds 14 and 18
33	**West Fair and Hocking River**	**36"**	**Trunk sewer meter**	**Captures flow from sewershed 27**
34	West Allen and Memorial	18"	Capture flow downstream of CSO 1014	Captures flow from sewershed 24
35	Influent to YMCA Pump Station	12"	Capture flow upstream of CSO 1014	Located on downstream pipe as the outfall was not suitable for metering
37	West of Memorial and Park St	10"	Capture flow downstream of CSO 1033	Located on downstream pipe as the outfall was not suitable for metering
38	West of Memorial and Park St	30"	Capture flow upstream of CSO 1033	Captures flow from sewershed 26
39	In alley North of West Main and Thomas	36"	Trunk sewer meter	Captures flow from sewershed 17
40	North of West Wheeling and Hocking River	18"	Trunk sewer meter	Captures flow from sewersheds 21a and 21b
42	East end of Carpenter	12"	Trunk sewer meter	Captures flow from sewershed 10
43	**East of Slocum and 8th**	**10"**	**Trunk sewer meter**	**Captures flow from sewershed 25**
50	**Della and East Locust**	**15"**	**Trunk sewer meter**	**Captures flow from sewershed 2**
76	West of Whiley and Lincoln	24"	Capture flow upstream of CSO 1008	Captures flow from sewershed 16
77	West of Whiley and Lincoln	24"	Capture flow downstream of CSO 1008	Located on the outfall pipe
101	**Plaza Way and Hocking River**	**30"**	**Trunk sewer meter**	**Captures flow from sewersheds 28, 29, 30 and 31**
102	West of Memorial and West Mulberry	21"	Capture flow upstream of CSO 1009	Captures flow from sewershed 19
103	Memorial and West Mulberry	24"	Capture flow downstream of CSO 1009	Located on the outfall pipe
104	South of Lawrence and South Maple	18"	Trunk sewer meter	Captures flow from sewersheds 8d, 8e and 11
105	West Influent to WPCF	48"	Interceptor meter	Captures influent flow to the WPCF
106	East Influent to WPCF	48"	Interceptor meter	Captures influent flow to the WPCF

Figure 2-1 Flow Monitoring Sites

2.1.2 Rainfall Monitoring

Twenty-nine (29) rainfall events were collected during the monitoring period from four temporary rain gauges and one permanent rain gauge. The four temporary rain gauges were located at the Lawrence Street WPCF, the Division of Water Miller Park WTP, the Whiley Avenue Stormwater Pump Station, and the Upper Hocking Pump Station at Pierce Avenue, as shown in Figure 2-2. The permanent rain gauge was located at the Fairfield County Airport (a National Weather Station observation site).

Figure 2-2 Rain Gauge Locations



A technical memorandum was developed to document the data and procedures used to develop the "Typical Year" of rainfall. Development of a typical year rainfall hyetograph provided a platform upon which to evaluate the system characterization and develop alternatives for the City of Lancaster's collection systems under the Phase II LTCP effort. Evaluating historical rainfall data, understanding the annual patterns and assembling a typical year is a location specific process. The Typical Year memorandum details the approach and assumptions used in the development of Lancaster's typical year. A copy of the Typical Year Memorandum is included in Appendix C as part of the CSO Overflow Volumes and Occurrences Technical Memorandum submitted to OEPA in December 2013.

2.2 Combined Sewer System Model

The model update was completed to represent the existing collection system conditions that will be used to evaluate, confirm, and further develop capital improvement projects to meet regulatory requirements and the City's NPDES Permit Schedule of Compliance Item 1.b. and 4.a.

To complete the model update, the existing XP-SWMM model was migrated to a more robust software platform, PCSWMM (utilizing the US EPA SWMM5 engine), and was updated and calibrated to accomplish the following:

- Incorporate all collection system improvements since the last model update including the Lake Allen Maple Sewer Improvement project completed in 2008.

- Incorporate the numerous CSOs that have been closed or modified as a result of the ongoing operation and maintenance improvements. As of the 2012 flow monitoring period, there were twelve remaining CSOs. Subsequent to completion of the 2012 flow monitoring, three additional CSOs were closed. For the calibration of the Existing Conditions Model, the twelve CSOs were active in order to simulate conditions during the flow monitoring period. The 2012 Existing Conditions Model was subsequently updated to the 2014 Baseline Conditions Model as described in Section 2.2.2.

- Understand the collection system's response to various wet weather events.

- Verify the active CSOs and understand the drivers that result in activations.

- Develop and evaluate alternatives to complete the Phase II LTCP update.

Once the 2012 Existing Conditions Model was calibrated, the model was used as a tool to understand the impact of the typical year on the existing system hydraulics and CSOs. The model was then used as a tool to evaluate alternatives as further described in the following sections.

2.2.1 2012 Existing Conditions Model

The 2012 existing conditions CSO statistics were generated from the calibrated 2012 Existing Conditions Model by simulating Lancaster's Typical Year Rainfall.

Subsequent to the December 2013 CSO Overflow Volumes and Occurrences Technical Memorandum, the delineation of stormwater catchment areas tributary to the combined sewer system within the City were refined to better reflect the existing conditions. The updated catchment areas are shown in figures in Appendix F - Runoff Catchments. These revisions caused minimal changes to the CSO statistics presented in the December 2013 Technical Memorandum. The updated 2012 Existing Conditions Model annual CSO activations and annual CSO volumes are provided in Table 2-2. To verify collection system improvements, the typical year CSO activations from 1999 are included as a comparison. The 1999 statistics were originally provided in the City's LTCP Addendum (2005).

In reviewing Table 2-2, the comparison of 1999 Conditions vs 2012 Existing Conditions indicates that the City has reduced the typical year overflow volume by approximately 47% or by 54.7 MG. The total number of typical year activations has been reduced by approximately 49% or by 461 activations.

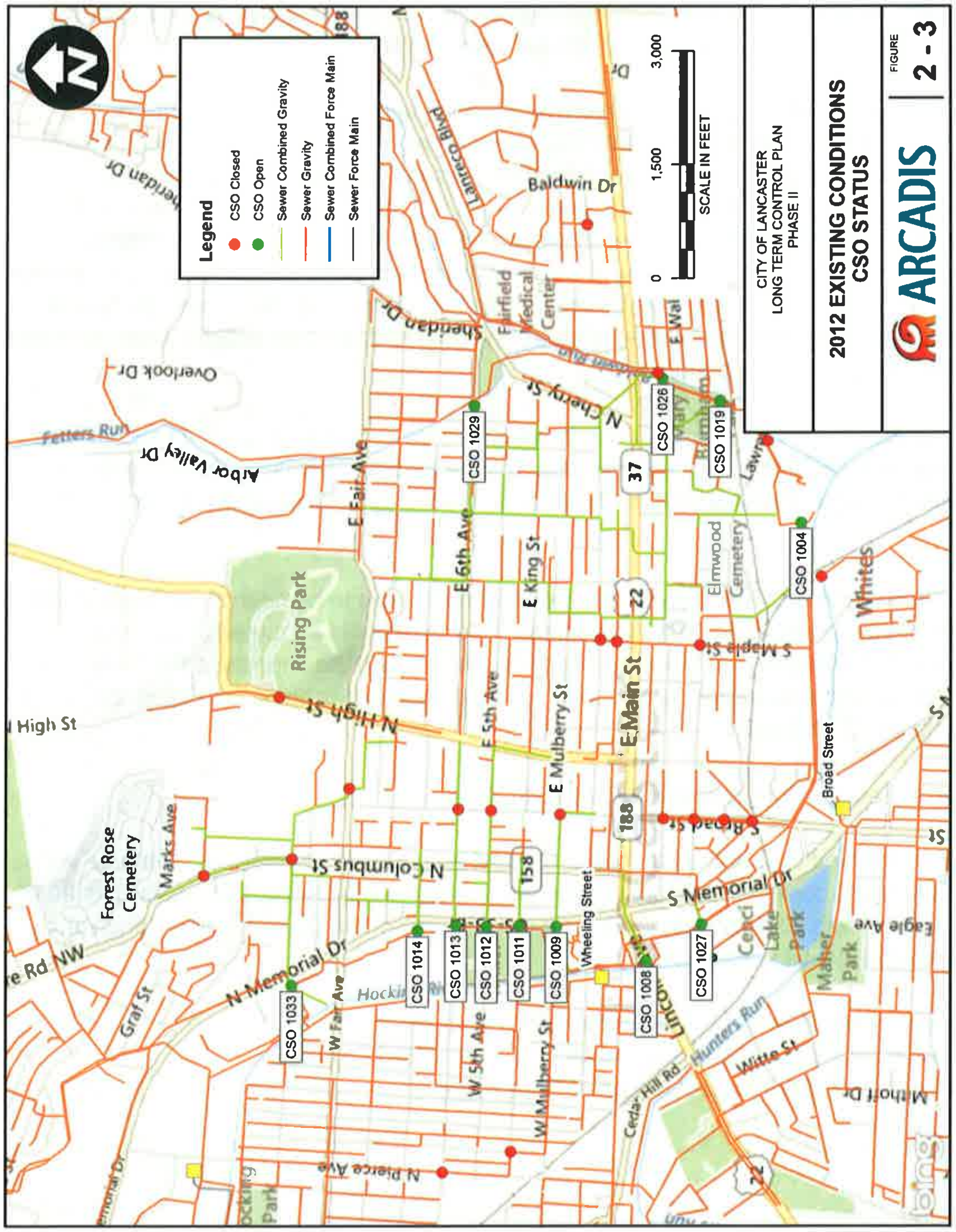
For some of the remaining CSOs, Table 2-2 indicates an increase in number of CSO events and CSO volume from the modeled for 1999 Conditions. This increase is attributed to upstream or downstream CSO modifications or closures. To better understand the impacts to the remaining CSOs, an overview of the collection system with the CSO locations is shown in Figure 2-3 (2012 Existing Conditions CSO Status).

2.2.2 2014 Baseline Conditions with 2035 Growth Model

The 2014 Baseline Conditions with 2035 Growth Model was used to develop and evaluate various alternatives that meets current regulatory requirements and the City's long term goals. The 2014 Baseline Conditions with 2035 Growth Model is a modification of the 2012 Existing Conditions Model to include the following projects:

- The closure of CSOs 1011, 1026, and 1027. (Completed)
- The South Broad Street Express Sewer. (In Design / Bid Phase)
- The Cherokee CDBG Project (Planned Construction)

Figure 2-3 2012 Existing Conditions CSO Status



All the projects listed above, except the Cherokee CDBG Project and CSO 1027, are included in the City's NPDES compliance schedule. All the projects either have been completed or are planned to be completed in the near future and are therefore included in the 2014 Baseline Conditions with 2035 Growth Model. This provides a consistent platform to evaluate alternatives. The City is moving forward with these projects in good faith to further improve water quality and meet their goals.

To evaluate the feasible alternatives for the Phase II LTCP, the anticipated future growth over a 20 year period was included in the 2014 Baseline Conditions with 2035 Growth Model. In 2005, the City and ARCADIS developed a wastewater master plan (208 Area Wide Waste Treatment Master Plan). The master plan estimated the anticipated growth for the years 2025 and 2045. Since less growth than anticipated has occurred, the master plan 2025 estimates were utilized for 2035 growth in the Phase II LTCP evaluations. Only projected growth estimates for the areas tributary to the Lawrence Street WPCF were included in this Phase II LTCP evaluation.

The projected future growth was applied to the model as both dry weather and rainfall-derived infiltration and inflow (RDII) flows. The model pipe network was extended as necessary to reach the growth areas. The resulting increases in flow due to the growth estimates were reviewed to ensure the model properly simulated the anticipated growth. Appendix G (Future Flows) provides a summary and figures of the 2035 future flows projections from development for areas tributary to the Lawrence Street WPCF. The 2014 Baseline Conditions with the 2035 Growth Typical Year CSO activations and volumes are also shown in Table 2-2.

The overall Typical Year CSO volume and number of activations are somewhat greater for the 2014 Baseline Conditions with 2035 Growth than for the 2005 LTCP 2025 Conditions with 2025 Growth. As noted above, the projected growth for both scenarios is the same. In addition, there are several projects included in the 2014 Baseline Conditions with 2035 Growth scenario that were not included in the 2025 Conditions with 2025 Growth scenario. However, equalization at the Lawrence Street WPCF is included for the 2025 Conditions with 2025 Growth scenario, but not for the 2014 Baseline Conditions with 2035 Growth scenario, which likely accounts for much of the differences in CSO volumes and the number of activations.

The 2014 Baseline Conditions with 2035 Growth Model resulted in more than four events at all open CSOs as shown in Table 2-2. Therefore, alternatives were developed and evaluated to meet City and Ohio EPA compliance goals.

Table 2-2 Typical Year CSO Statistics

CSO No.	2005 LTCP Addendum						Phase II LTCP					
	1999 Conditions			2025 Conditions With 2025 Growth			2012 Existing Conditions			2014 Baseline Conditions With 2035 Growth		
	CSO Open Status	Annual Volume (MG)	No. Annual Activs.	CSO Open Status	Annual Volume (MG)	No. Annual Activs.	CSO Open Status	Annual Volume (MG)	No. Annual Activs.	CSO Open Status	Annual Volume (MG)	No. Annual Activs.
1004	open	8.53	8	open	0.00	3	open	26.8	43	open	12.7	10
1005	open	20.77	82									
1006	open	2.86	8	open	0.00	3						
1007	open	0.00	0									
1008	open	2.77	8	open	0.01	8	open	1.3	19	open	1.4	27
1009	open	0.04	8	open	0.05	8	open	5.2	76	open	4.4	77
1010	open	0.01	0									
1011	open	0.06	82	open	0.05	82	open	3.2	55			
1012	open	3.99	20	open	3.86	20	open	4.3	56	open	4.4	58
1013	open	0.33	82	open	0.34	82	open	4.8	76	open	4.8	77
1014	open	0.01	20	open	0.01	20	open	1.7	18	open	1.7	18
1015	open	0.56	20	open	0.63	20						
1016	open	0.99	82	open	1.00	82						
1017	open	0.00	3	open	0.00	3						
1018	open	0.00	3	open	0.00	3						
1019	open	55.93	82	open	0.00	3	open	6.0	26	open	3.5	16
1020	open	0.00	0									
1021	open	0.03	8	open	0.03	8						
1022	open	0.00	3	open	0.00	3						
1023	open	0.00	3									
1024	open	0.00	3	open	0.00	3						
1026	open	3.14	82	open	3.26	82	open	4.2	54			
1027	open	1.76	82	open	0.27	82	open	0.8	29			
1028	open	0.00	3	open	0.00	3						
1029	open	7.06	82	open	7.33	82	open	3.6	30	open	3.7	31
1030	open	0.00	0									
1031	open	5.30	82									
1032	open	0.00	0									
1033	open	2.83	82	open	2.83	82	open	1.1	6	open	1.1	6
1034	open	0.75	8	open	0.00	3						
1035	open	0.00	3	open	0.00	3						
Total	**31**	**117.7**	**949**	**23**	**19.7**	**688**	**12**	**63.0**	**488**	**9**	**37.7**	**320**

3. Alternatives Analysis

The goal of this Phase II LTCP is to evaluate whether the City of Lancaster's combined sewer system meets the requirements of the US EPA CSO Control Policy and, if additional CSO control measures are necessary, to develop and evaluate CSO control alternatives to achieve the compliance with the policy. The City has selected a presumptive compliance approach. Two most commonly used presumptive approach criteria from US EPA CSO Control Policy are 85% capture of wet weather flows or four to six overflows per year without impacting water quality standards. The Ohio EPA's goal is to meet two to four overflows in a typical year.

The City understands that the Ohio EPA has compliance expectations for the recommended solution and ultimate CSO control measures. In discussions with the Ohio EPA, the City recognizes Ohio EPA's goals as a feasible combination of:

- Complying with two to four events in the typical year
- Rerouting separated sewer areas around combined areas to preferentially convey separated flows to the WPCF
- Maximizing treatment capacity
- Achieving water quality standards

Consistent with the 2005 LTCP Addendum and in addition to the Ohio EPA goals, the City also has clearly defined goals for collection system improvements in support of CSO control:

- Complying with two to four events in the typical year
- Rerouting separated sewer areas around combined areas to preferentially convey separated flows to the WPCF
- Maximizing treatment capacity
- Achieving water quality standards
- Close CSOs, where possible
- Achieve zero events at some CSOs during a typical year, where possible, allowing the CSO to activate under larger events to protect against basement flooding
- Maintain hydraulic grade lines (HGL) to avoid basement flooding
- Maximize interceptor flows
- Eliminate catch basins, where possible

Even with numerous CSO closures and capital improvement projects, the number of annual activations is currently greater than four overflows per year. The evaluations presented in this section of the report provide a range of CSO control alternatives that are capable of reducing the annual number of CSO activations to four overflows per year and that address both the Ohio EPA's and the City's goals. This section discusses the CSO control technologies followed by the alternatives evaluated.

3.1 Initial Screening of CSO Technologies

In developing alternatives to meet the Phase II LTCP goals, several objectives were identified as critical:

- Technically feasible facilities
- Operationally sound system
- Value-added benefits
- Cost or effectiveness

Any solutions considered must pass a basic requirement of being technically feasible, that is capable of being constructed and operated given limitation of land availability, flow rates, hydraulic heads and other construction and operation parameters. To be successful, the solution must be operationally compatible with the size of the City and the operational staff levels and skill sets.

The solution should provide value added benefits for residents and staff that advance the City as a desirable location for families and businesses. Finally, the solution should recognize the existing CSO improvements made to date and to respect the investment made by residents by providing the highest levels of benefits for the cost.

In the 2005 LTCP Addendum, the City narrowed their CSO control technologies to the following:

- Sewer system optimization
- Sewer separation
- Storage
- No modifications

A CSO control technologies screening process was used to streamline the selection of potentially feasible technologies for further evaluations. As the City has already begun implementing their CSO LTCP improvements, the City strongly wanted to continue applying sewer separation and storage technologies. The City stressed the importance of developing alternatives that would be maintainable by City staff.

This section includes a brief summary of the preliminary CSO control technologies considered in this project, including identification of the advantages and disadvantages of each. The rationale for including or excluding the alternatives from further evaluations is also presented in the description. The specific alternatives evaluated follow in Section 3.2.

3.1.1 Sewer System Optimization

This CSO control involves making the best use of existing system facilities to reduce overflows. This is typically accomplished by modifying the regulators to mitigate the conditions that trigger overflow events. Reduction in volume and frequency of overflows at regulators can be accomplished by modification of the existing hydraulic control features of the regulator – i.e., raising the elevation of weirs, modifications to orifice area, etc. These types of modifications are regulator-specific and feasible only if existing excess interceptor capacity is available and the resulting hydraulic gradient upstream of the regulator can be reestablished at a safe elevation to prevent basement flooding or increase of other overflows. This type of conveyance system control can be advantageous for regulators with high frequencies but low discharge volumes.

The primary advantages of regulator modifications is the relatively low cost to implement, minimized disruptions and consistency with the City's existing improvements. The primary disadvantage is that regulator modifications alone may not negate the need for other improvements to reduce the number of CSO activations.

3.1.2 Sewer Separation

Sewer separation involves the installation of additional sewers, typically to convey stormwater alongside the existing combined sewer system. Typically, the existing sewers are left in place to convey sanitary sewage to the WPCF, since sanitary laterals are already connected and the existing sewer goes directly to the wastewater plant. However, constructing new sanitary sewers and retaining the existing combined sewers for stormwater drainage can be also considered, if the existing combined sewer has adequate capacity for the storm flows. Separation can be an effective method of removing stormwater flows from the sanitary sewer systems and reducing CSO volume. There are two degrees of sewer separation: complete separation and partial separation. Partial separation is typically limited to stormwater inflow removal.

The primary advantage of sewer separation is low maintenance and consistency with the City's existing improvements. The primary disadvantage is the disruption during construction.

3.1.3 Storage

Storage facilities are tanks located within the collection system or at treatment facilities that are sized to provide the storage volume associated with the selected level of control. After wet weather flows subside, the basin and settled solids are dewatered back to the collection system. It is assumed that dewatering would be accomplished with pumps capable of dewatering the basin within 48 hours in order to avoid septicity and to increase the likelihood that storage will be available when needed.

Storage control facilities considered include:

- Remote Storage Facilities: Closed or open concrete tanks that may include odor control and grit removal systems in the collection system.
- WPCF Storage Facilities: Closed or open concrete tanks that may include odor control and grit removal systems at the WPCF.
- Storage pipelines/conduits: These structures require a small construction right of way; however, a relatively large-diameter pipeline or conduit typically is needed to provide the required storage volume.

The primary advantage of storage is that captured flows are returned to the collection system for full treatment at the WPCF. The primary disadvantage of this technology is its high capital cost. Additional disadvantages include increased O&M costs for pumping, the need for adequate construction sites and the potential for disruption of adjoining sites or neighbors during construction, and operation.

3.2 Alternative Evaluation

Feasible alternatives were developed based on the City's goals, Ohio EPA's goals, and preferred technologies. The remaining, active CSOs were grouped into two areas for ease in developing alternatives. The CSOs on the west side of the City were grouped in "Planning Area ALTW" and the CSOs on the east side were grouped in "Planning Area ALTE". Although the hydraulic dynamics of the two areas do impact each other at the Lawrence Street WPCF, the initial alternatives evaluation for Planning Area ALTW was completed by isolating the two planning areas. This allowed for a decrease in model run times and the ability to quickly assess the benefits. The actual impact is negligible due to the inclusion of equalization at the Lawrence Street WPCF. A primary consideration in modeling all alternatives was to store all flow that could be conveyed to the LSWPCF that was in excess of the plant's treatment capacity. As the analysis moved to Planning Area ALTE, an alternative from Planning Area ALTW was incorporated to ensure any impact on the east side CSOs was properly accounted for. The two planning areas area identified within the collection system as shown in Figure 3-1.

Feasible technologies and alternatives were evaluated at each CSO. Combinations of storage, regulator modifications, capacity improvements and sewer separation were evaluated to identify alternatives that met the required Phase II LTCP criteria of four or less activations in a typical year. To ensure the level of service goals were met for all feasible alternatives, the potential for water in basement (WIB) occurrences were evaluated; the specifics of which are described below in Section 3.3.

3.3 Water in Basement Analysis

One of the City's goals is to prevent WIB occurrences. The City occasionally receives sewer back-up complaints from residents after large storm events. As part of the alternative analysis, the City's records were reviewed to identify locations where residents have informed the City about water in their basement or WIB occurrences. The potential for WIB occurrences was investigated for each alternative was that was evaluated.

In order to evaluate the potential for WIB occurrences, two checks were made as follows for each alternative:

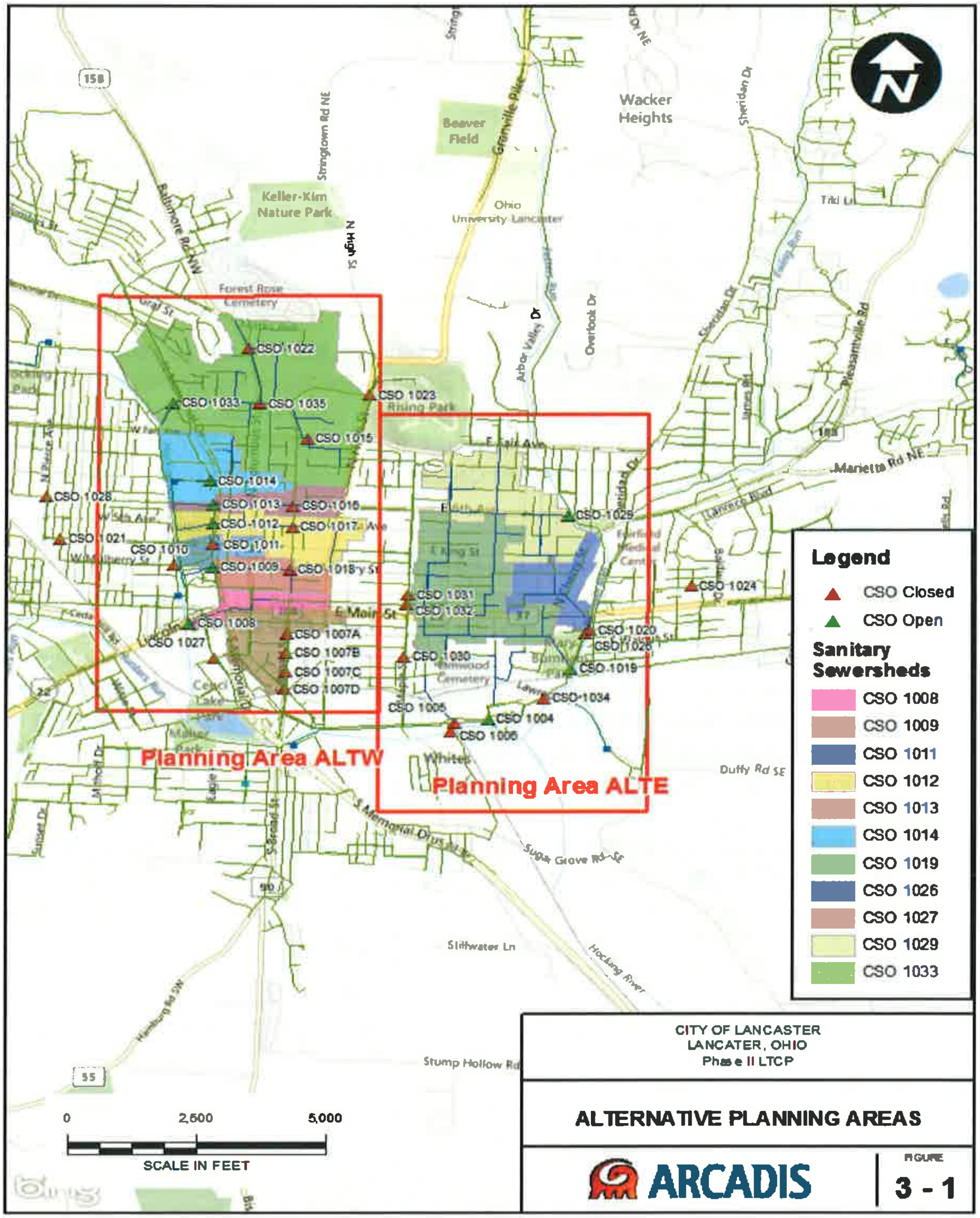
1. The HGLs for the 2012 Existing Conditions Model were identified for the following storm frequencies:
   - The fifth largest event in the typical year
   - The largest event in the typical year
   - The 10-year, 4-hour design storm

   After each alternative was modeled, the resultant HGLs for the above storm frequencies were identified and compared to the 2012 Existing Conditions model HGLs. The goal was to ensure that the HGLs for a given alternative were less than the associated HGLs in the 2012 Existing Conditions model. If the model predicted an HGL for a given alternative exceeded an HGL in the 2012 Existing Conditions model, the alternative was considered unacceptable.

2. Compliance points were created that were considered to be at areas with a high potential for a WIB event to occur. Basement elevations were estimated to be eight feet below grade with an additional two foot safety factor being applied for a total depth of 10 feet. Using GIS contours, estimated basement elevations were determined. These elevations were compared to the HGLs for each alternative for the above storm frequencies. If the model predicted that an HGL exceeded the 10 foot depth for any compliance point, the alternative was considered unacceptable. Thirty-five compliance points were identified and tracked during the alternative evaluation process.

The general locations of the compliance points are identified in Appendix H in Table H1 and are shown on Figures H1 to H5.

Figure 3-1 Planning Areas



3.4 Sewer Separation Analysis Planning Areas

As the City has already successfully implemented storm sewer separation projects, the feasibility and effectiveness of separation projects in the remaining combined sewer system areas was a key investigation. The City proactively embarked on an extensive field investigation process to identify the priority areas to separate in terms of accessibility, coordination with street improvements and traffic concerns. This field investigation resulted in a detailed list and mapping of potential sewer separation projects by year through 2050. In an effort to identify the most cost effective areas for storm sewer separation in Planning Area ALTW and ALTE, the City's proposed storm sewer separation projects were incorporated into the model for select alternatives. Two planning horizons were considered:

- Sewer Separation projects through 2025
- Sewer Separation projects through 2050

Figures 3-2 and 3-3 indicate the City's storm sewer separation project names and planning horizon for the alternative analysis. Tables 3-1 and 3-2 detail the projects and storm sewer sizes based on conveying a 5-year, 24-hour storm as required by the City.

As discussed in Sections 5 and 6, during the development of the recommended alternative and the financial analysis, the time frames and some project details for implementing the sewer separation projects were adjusted and fine-tuned from the initial alternative development phase. Therefore, there are some variations from the dates listed in the tables below. However, the details of the initially developed alternatives were sufficient to select the recommended alternative, since subsequent fine-tuning would have the same relative impact on all alternatives and would not affect the alternative selection. Typical year model runs were made for the fine-tuned selected alternative.

Figure 3-2 West Side Storm Sewer Separation Projects

Legend

Storm Separation Projects

- 2025
- 2050

CITY OF LANCASTER
LANCASTER, OHIO
Phase II LTCP

WEST SIDE STORM SEWER SEPARATION PROJECTS

ARCADIS

FIGURE
3 - 2

Table 3-1 West Side Storm Sewer Separation Projects by CSO

Storm Sewer Separation Project by CSO	Planning Period for Alternative Analysis	Pipe ID #	Size Pipe (inch)	Pipe Length (ft)
CSO 1008				
Main Street Catch Basin Relocation	2025	NA	12	300
Bank Alley Reconstruction	2025	223A	NA- curb and gutter	
Memorial Drive Storm Sewer	2025	225	18	540
CSO 1009				
CSO 1009 Catch Basin Removal	2025	NA		
Broad Street Storm Sewer	2050	219	30	482
Mulberry St Storm Sewer	2050	220	30	1094
		221	42	397
CSO 1009 Miller Park at Mulberry	2025	222	42	715
CSO 1012				
Broad / Fifth Inlet Relocation *	2025	NA		
High Street Storm Sewer	2050	212	18	491
Fifth Avenue Storm Sewer	2050	213	24	223
		214	30	642
Fifth Ave Sewer Separation	2025	215	36	547
		216	42	674
		217	48	1399
Mulberry East Storm Sewer	2050	218	18	1488
CSO 1013				
Sixth Ave Storm Sewer	2050	210	24	984
Forest Rose Sixth Ave Sewer Separation	2025	211	48	1636
CSO 1014				
Allen Forest Rose Storm Separation	2050	205	30	353
		206	36	612
		207	24	218
		208	36	449
		209	42	561
CSO 1033				
N. Columbus Storm Sewer	2025	200	24	1085
		201	30	1203
Wilson/ Broad Street Express Sewer	2025	202	24	567
		202A	24	619
Edgewood Ave Storm Sewer	2025	203	30	402
North School Alley Reconstruction	2025	204	18	220
Fairgrounds I & I *	2050	NA		
Park Street Storm Inlet Relocation *	2025	NA		

* Not shown on Figures 3-2 or 3-3

Figure 3-3 East Side Storm Sewer Separation Projects

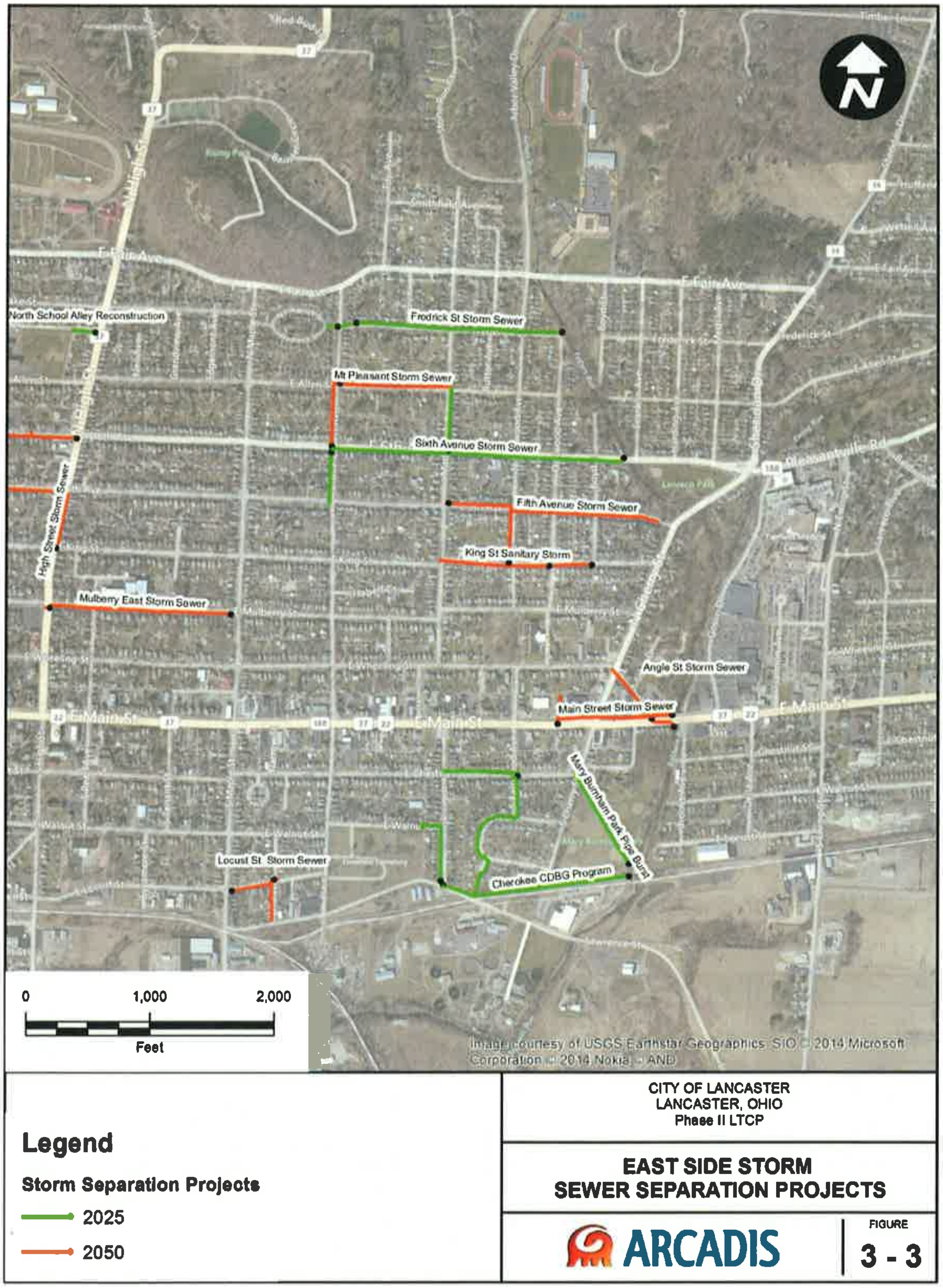


Table 3-2 East Side Storm Sewer Separation Projects by CSO

Storm Sewer Separation Project by CSO	Planning Period for Alternative Analysis	Pipe ID #	Size Pipe (inch)	Pipe Length (ft)
CSO 1029				
Fredrick St Storm Sewer	2025	227	30	1791
Mt. Pleasant Storm Sewer	2050	228	42	975
Sixth Avenue Storm Sewer	2025	229	36	446
		230	36	537
		231	48	1814
		232	60	603
Fifth Avenue Storm Sewer (East)	2050	233	36	572
		234	36	441
		235	42	1375
CSO 1019				
King St Sanitary Storm	2050	236	24	343
		237	36	914
Main Street Storm Sewer	2050	238	30	256
		239	30	1096
Angle Street Storm Sewer	2050	240	30	774
Mary Burnham Park Burst	2025	243	18	854
CSO 1004				
Cherokee CDBG Program	2025	244	36	961
		245	48	974
		246	42	611
		247	48	1607
Locust St Storm Sewer	2050	241	30	400
		242	30	341

3.5 Planning Area ALTW Alternatives

The alternatives evaluated for Planning Area ALTW addressed CSOs 1008, 1009, 1012, 1013, 1014 and 1033 with the goal to reduce CSO activations to no more than four activations in a typical year. Each alternative listed in Table 3-3 was incorporated into the model and evaluated for the typical year. The components of each alternative were iteratively evaluated until the model successfully captured the fifth largest event (signifying that the CSO only activated for four or fewer events in a typical year). All alternatives include a new equalization facility at the Lawrence Street WPCF, although the necessary size of the EQ tank and the associated pump station varies by alternative.

Table 3-3 Summary of Planning Area ALTW Alternatives

Alternative Name	Alternative Description
2W7A	Weir and underflow modifications to maximize flow to the interceptor
3W3A	EQ at the YMCA Pump Station capturing flows from CSOs 1014 & 1033
3W4A	EQ at the YMCA Pump Station capturing flows from CSOs 1013, 1014, & 1033
4W3A1	EQ at the YMCA Pump Station with 2025 storm separation
4W3A2	EQ at the YMCA Pump Station with 2050 storm separation
5W7A1	2025 Storm Separation without weir or underflow modifications
5W7A2	2050 Storm Separation without weir or underflow modifications
6W7A1	2025 Storm Separation with weir or underflow modifications
6W7A2	2050 Storm Separation with weir or underflow modifications
7W7A	Weir and underflow modifications at CSOs and Interceptor Capacity Improvements

3.5.1 Alternative 2W7A

The goal of Alternative 2W7A was to maximize the capacity of the existing collection system and maximize the flow to the Lawrence Street WPCF. This was accomplished by modifying the weir heights and under flow diameters in each CSO structure. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-4 presents the alternative schematically and Table 3-4 details the specific modifications of alternative 2W7A.

Figure 3-4 ALT2W7A – Weir and underflow modifications to maximize the interceptor

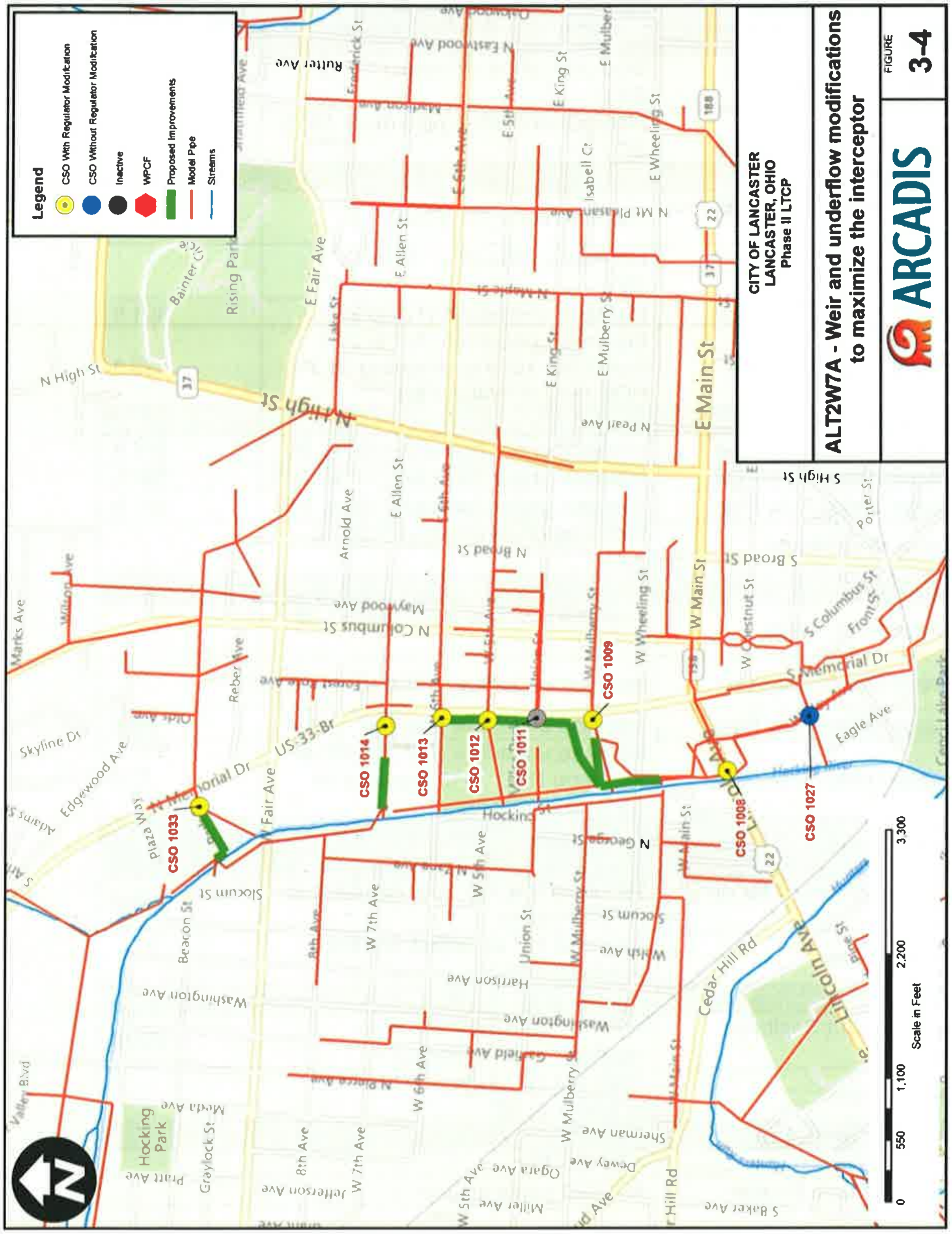


Table 3-4 Proposed Improvements for ALT2W7A

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Weir Height	Weir inlet offset increase (12" to 54")	
Increase Under Flow Pipe	Increase underflow pipe (from 10" to 27")	104 ft
CSO 1009		
Increase Weir Height (12" - 18")	Overflow weir (15" offset)	
Increase Orifice Size	Increase orifice (8" x 14" to 15" x 15")	
Increase Under Flow Pipe	Increase underdrain (12" to 27")	431 ft
Increase Underflow Pipe	Increase underdrain (15" to 27") from CSO 1009 to Wheeling St. PS POC (end of YMCA FM)	539 ft
CSO 1012		
Increase Under Flow Pipe	Increase under flow pipe (15" to 24")	447 ft
Increase Under Flow Pipe	Increase under flow pipe (14" to 24")	593 ft
Increase Under Flow Pipe	Increase under flow pipe (16" to 24")	321 ft
Increase Weir Height	Weir inlet offset increase (3.25' to 3.4')	
CSO 1013		
Increase Weir Height	Increase overflow weir offset (1.65' to 2.0')	
Increase Orifice Diameter	Increase underflow orifice (6" to 18")	
Increase Under Flow Pipe	Increase underflow pipe (10" to 18")	30 ft
Increase Under Flow Pipe	Increase underflow pipe (11.25" to 18") from CSO 1013 regulator to CSO 1012 regulator	39 ft
CSO 1014		
Add New Open-Cut Sanitary Sewer	18" underflow line from regulator to 36" interceptor	456 ft
Abandon Sewer	Abandon 12" underflow line from regulator to 36"	
CSO 1033		
New Open-Cut Sanitary Sewer	New 15" underflow line from regulator to 36" Interceptor	600 ft
Abandon Sewer	Abandon 10" underflow line from regulator to 36"	
Lawrence Street EQ		
New EQ Below Grade	4.31 MG EQ	
Additional Pump Station	45 MGD pump station	

For this alternative, a 4.3 MG EQ facility is required at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. Appendix I provides additional modeling results and detail for this alternative.

Table 3-5 ALT2W7A versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.60	809.10	809.75	809.95
				Proposed	3.75	812.35	812.12	813.80	813.89
1009	816.61	829.36	12.75	Existing	-	816.66	817.21	817.68	817.73
				Proposed	1.20	817.86	817.39	818.82	819.01
1012	812.37	822.30	9.93	Existing	-	815.62	816.00	816.91	816.92
				Proposed	0.15	815.77	815.64	816.65	816.67
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.35	817.60	816.72	818.40	818.53
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.80	810.81
				Proposed	0.00	809.98	808.54	810.42	810.51
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	814.90	816.96	817.17

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-5 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT2W7A. Table 3-5 also summarizes the elevation changes required at each CSO weir and the resulting HGLs presented in the table.

Since Table 3-5 shows an increase in the HGL at CSOs 1008 and 1009, a WIB analysis was conducted. There is one historical WIB event (id 144) and four compliance points (ids 312, 332, 333, and 334) identified upstream of these two structures. Figure 3-5 presents these five locations. Table 3-6 summarizes the locations, assumed basement elevations, and the HGL from the typical year at the nearest model node. This information indicates that the regulator modifications in Alternative ALT2W7A will raise the HGL and potentially cause WIB incidents.

Table 3-6 ALT2W7A WIB & Compliance Point Elevation versus the Typical Year Max HGL

ID	Basement Elevation (ft)	Design Elevation (ft)	Existing Conditions (2012)	ALT2W7
			Max HGL	Max HGL
312	808.00	806.00	809.74	813.80
144	799.70	797.70	811.01	810.86
332	806.00	804.00	809.83	812.38
333	806.00	804.00	808.92	815.03
334	836.00	834.00	838.91	838.91

Every alternative has its advantages and disadvantages, and, as detailed in Section 5, the advantages and disadvantages were considered in the alternative criteria weighting process.

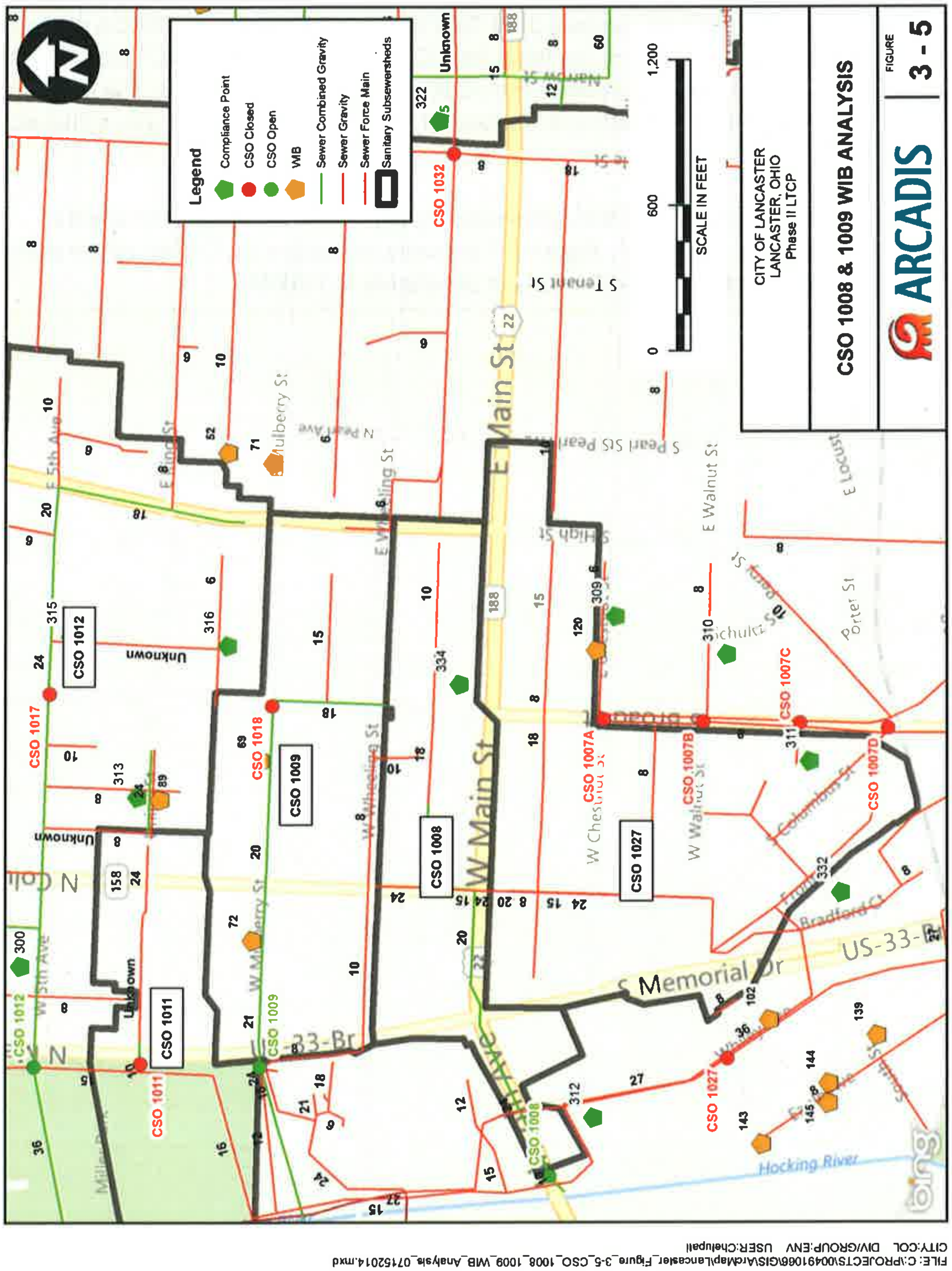
The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Easing construction throughout the City by only modifying the CSO structures
- Decreasing localized stormwater discharge, providing a water quality benefit

The disadvantages include:

- Risking a potential increase in WIB incidents upstream of CSOs 1008 and 1009
- Continuing to surcharge the 27-inch and 36-inch interceptor
- Requiring the largest EQ size at the Lawrence Street WPCF (not including east side improvements)
- Requiring construction in the Water Distribution System's well field for CSOs 1009, 1012, & 1013

Figure 3-5 CSO 1008 & 1009 WIB Analysis



3.5.2 Alternative 3W

Alternative 3W evaluated routing excessive wet weather flow to a new EQ Facility near the YMCA Pump Station. Two scenarios were evaluated (ALT3W3A and ALT3W4A). ALT3W3A evaluated the required EQ Facility size to capture the flows from CSOs 1014 and 1033. ALT3W4A evaluated the required EQ Facility size to capture flows from CSOs 1013, 1014, and 1033. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-6 presents alternative ALT3W3A schematically and Table 3-7 details the specific modifications of alternative ALT3W3A. Figure 3-7 presents alternative ALT3W4A schematically and Table 3-8 details the specific modifications of alternative ALT3W4A.

Figure 3-6 ALT3W3A

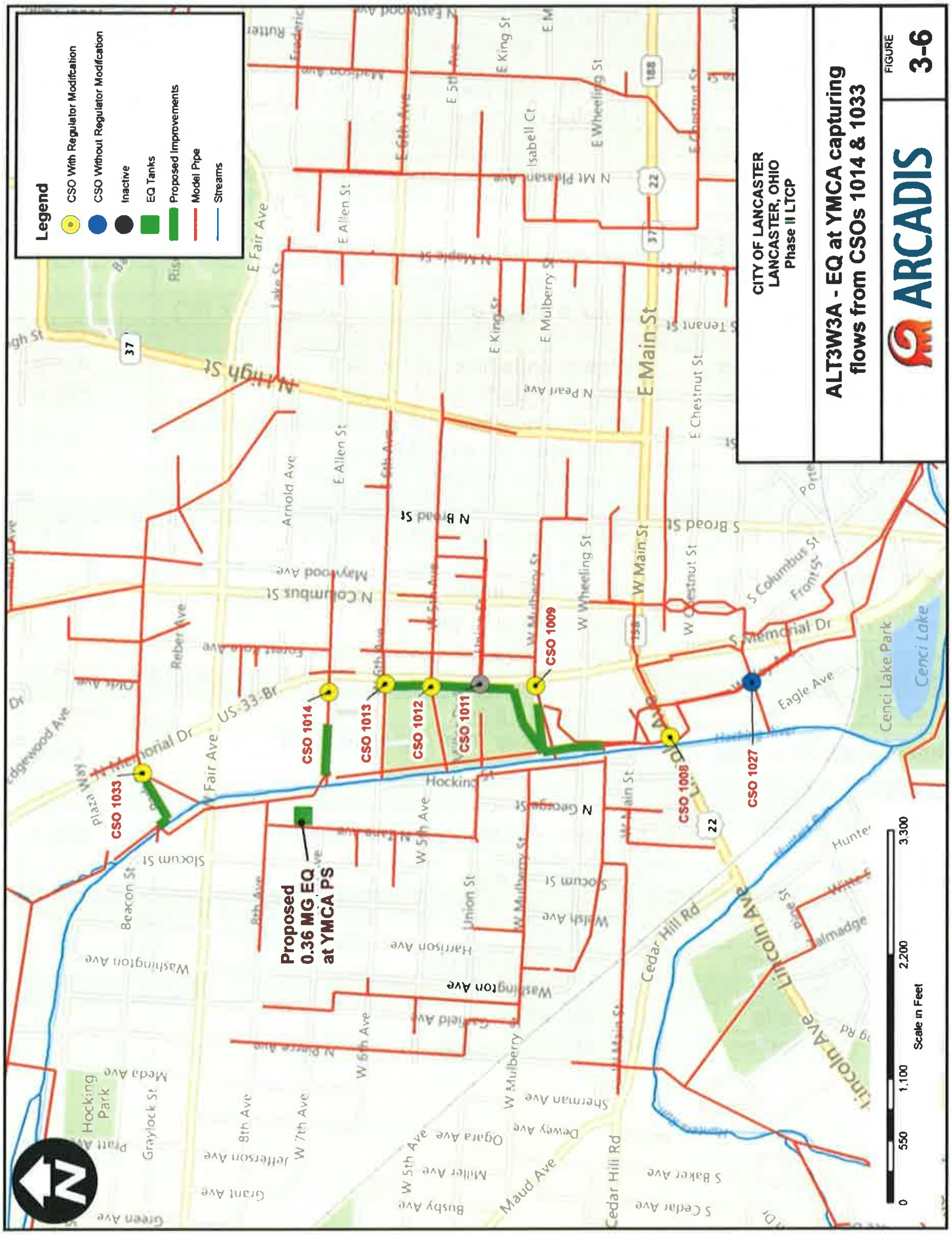


Table 3-7 Proposed Improvements for ALT3W3A

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Under Flow Pipe	Increase underflow pipe (10" to 27")	104 ft
Increase Weir Height	Inlet offset increase (12" to 54")	
CSO 1009		
Increase Under Flow Pipe	Increase underflow pipe (15" to 27") from CSO 1009 to Wheeling St PS POC (end of YMCA FM)	539 ft
Increase Under Flow Pipe	Increase underflow pipe (12" to 27")	431 ft
Increase Weir Height	Add weir with 15" offset	
Increase Orifice Size	Increase orifice opening (8" x 14" to 15" x 15")	
CSO 1012		
Increase Under Flow Pipe	increase underflow (15" to 24")	447 ft
Increase Under Flow Pipe	increase underflow (14" to 24")	593 ft
Increase Under Flow Pipe	increase underflow (16" to 24") from Memorial Dr. between 5th and Mulberry	321 ft
Increase Weir Height	Increase inlet offset (3.25' to 3.4')	
CSO 1013		
Increase Under Flow Pipe	Increase underflow line (10" to 18")	30 ft
Increase Under Flow Pipe	Increase underflow line (11.25" to 18") from CSO 1013 regulator to CSO 1012 regulator	391 ft
Increase Weir Height	Increase offset (1.65' - 2')	
Increase Orifice Size	Increase orifice (6" to 18")	
CSO 1014		
Abandon 12"	Abandon 12" pipe	
Increase Under Flow Pipe	New 18" sewer from regulator to 36" interceptor	456 ft
CSO 1033		
12" Open-Cut Sanitary Sewer	Increase underflow pipe (10" to 12")	600 ft
Abandon 10"	Abandon 10" pipe	
YMCA EQ		
New EQ Above Grade	0.36 MG EQ	
Additional Pump Station	7.6 MG pump station	
Lawrence Street EQ		
New EQ Below Grade	4.16 MG EQ	
Additional Pump Station	45.2 MGD pump station	

Figure 3-7 ALT3W4A

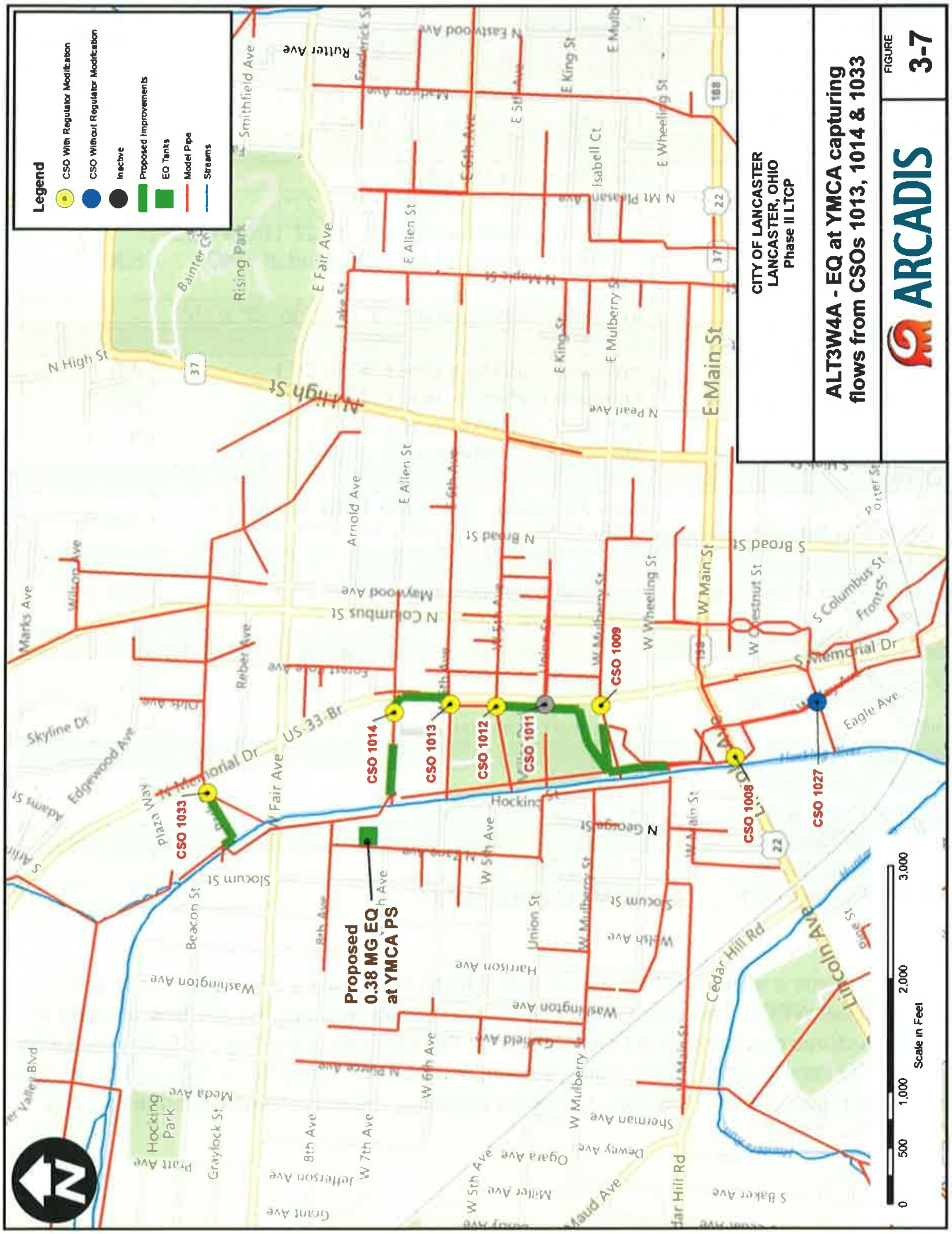


Table 3-8 Proposed Improvements for ALT3W4A

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Under Flow Pipe	Increase underflow pipe (10" to 27")	104 ft
Increase Weir Height	Inlet offset increase (12" to 54")	
CSO 1009		
Increase Weir Height	Add Weir with 15" offset	
Increase Under Flow Pipe	Increase underflow pipe (12" to 27")	431 ft
Increase Under Flow Pipe	Increase underflow pipe (15" to 27") from CSO 1009 to Wheeling St PS POC (end of YMCA FM)	539 ft
Increase Orifice Size	Increase orifice opening (8" x 14" to 15" x 15")	
CSO 1012		
Increase Under Flow Pipe	Increase underflow pipe (15" to 24")	447 ft
Increase Under Flow Pipe	Increase underflow pipe (14" to 24")	593 ft
Increase Under Flow Pipe	Increase underflow pipe (16" to 24" from Memorial Dr. between 5th and Mulberry)	321 ft
CSO 1013		
24" Open-Cut Sanitary Sewer	New 24" sewer from CSO 1013 regulator to CSO 1014	525 ft
CSO 1014		
Increase Under Flow Pipe	Increase underflow pipe (12" to 24")	456 ft
Abandon 12"	Abandon 12" pipe	
CSO 1033		
Abandon 10"	Abandon 10" sewer	
12" Open-Cut Sanitary Sewer	Increase underflow pipe (10" to 12")	600 ft
YMCA EQ		
New EQ Above Grade	0.38 EQ	
Additional Pump Station	9.6 MGD pump station	
Lawrence Street EQ		
New EQ below grade	4.3 MG EQ	
Additional Pump Station	45 MGD pump station	

ALT3W3A requires a 4.2 MG EQ Facility, and ALT3W4A requires a 4.3 MG EQ Facility at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. ALT3W3A required a 0.36 MG EQ Facility at the YMCA Pump Station, and ALT3W4A required a 0.38 MG EQ Facility at the YMCA Pump Station. Appendix I provides additional modeling results and detail for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Tables 3-9 and 3-10 summarize the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT3W3A and ALT3W4A. Tables 3-9 and 3-10 also summarize the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-10 shows an increase in the HGL at CSOs 1014 and 1033, this indicates that the regulator modifications in Alternative ALT3W4A may raise the HGL and potentially cause WIB incidents. Therefore, only ALT3W3A will be further discussed. The HGL at CSOs 1008 and 1009 also increase slightly under ALT3W3A and ALT3W4A.

Table 3-9 ALT3W3A versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation	Overflow Elevation (ft)	5th Largest Annual	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.60	809.10	809.75	809.95
				Proposed	3.75	812.35	812.21	813.52	813.58
1009	816.61	829.36	12.75	Existing	-	816.66	817.21	817.68	817.73
				Proposed	1.20	817.86	817.74	819.02	819.01
1012	812.37	822.30	9.93	Existing	-	815.62	816.00	816.91	816.92
				Proposed	0.15	815.77	815.48	816.76	816.77
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.35	817.60	816.80	818.44	818.53
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.80	810.81
				Proposed	0.00	809.98	808.75	810.45	810.45
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	816.34	817.39	817.33

Table 3-10 ALT3W4A versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.60	809.10	809.75	809.95
				Proposed	3.75	812.35	811.37	813.51	813.59
1009	816.61	829.36	12.75	Existing	-	816.66	817.21	817.68	817.73
				Proposed	1.20	817.86	817.74	819.02	819.01
1012	812.37	822.30	9.93	Existing	-	815.62	816.00	816.91	816.92
				Proposed	0.15	815.77	813.18	816.45	816.47
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.35	817.60	816.47	818.47	818.47
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.80	810.81
				Proposed	0.00	809.98	808.84	812.37	813.10
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	816.34	817.49	817.43

Every alternative has its advantages and disadvantages, and, as detailed in Section 5, the advantages and disadvantages were considered in the alternative criteria weighting process.

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Minimized disturbance within the community
- Decreasing localized stormwater discharge, providing a water quality benefit
- Eliminating CSO activations at CSO 1013

The disadvantages include:

- Risking a potential increase in WIB incidents upstream of CSOs 1008 and 1009
- Requiring weir modifications at CSO 1008
- Maintaining two EQ facilities requires increased O&M costs
- Acquiring property for EQ near the YMCA Pump Station
- Requiring construction across Memorial Drive

3.5.3 Alternative 4W

Alternative 4W evaluated a combination of an EQ Facility at the YMCA Pump Station to manage wet weather flow from CSOs 1014 and 1033 and the stormwater separation projects. Two scenarios were developed, with ALT4W3A1 evaluating the impact of the proposed separation through 2025 and ALT4W3A2 evaluating the impact of the proposed separation through 2050. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-8 presents the alternative schematically and Table 3-11 details the specific modifications of alternative ALT4W3A1.

Although two alternatives were developed, the results of Alt4W3A1 indicated that the City could meet the goal of no more than four activations at each CSO and not violate the freeboard goals between CSO 1033 and 1014. Therefore, Alt4W3A2 was not evaluated.

Figure 3-8 ALT4W3A1

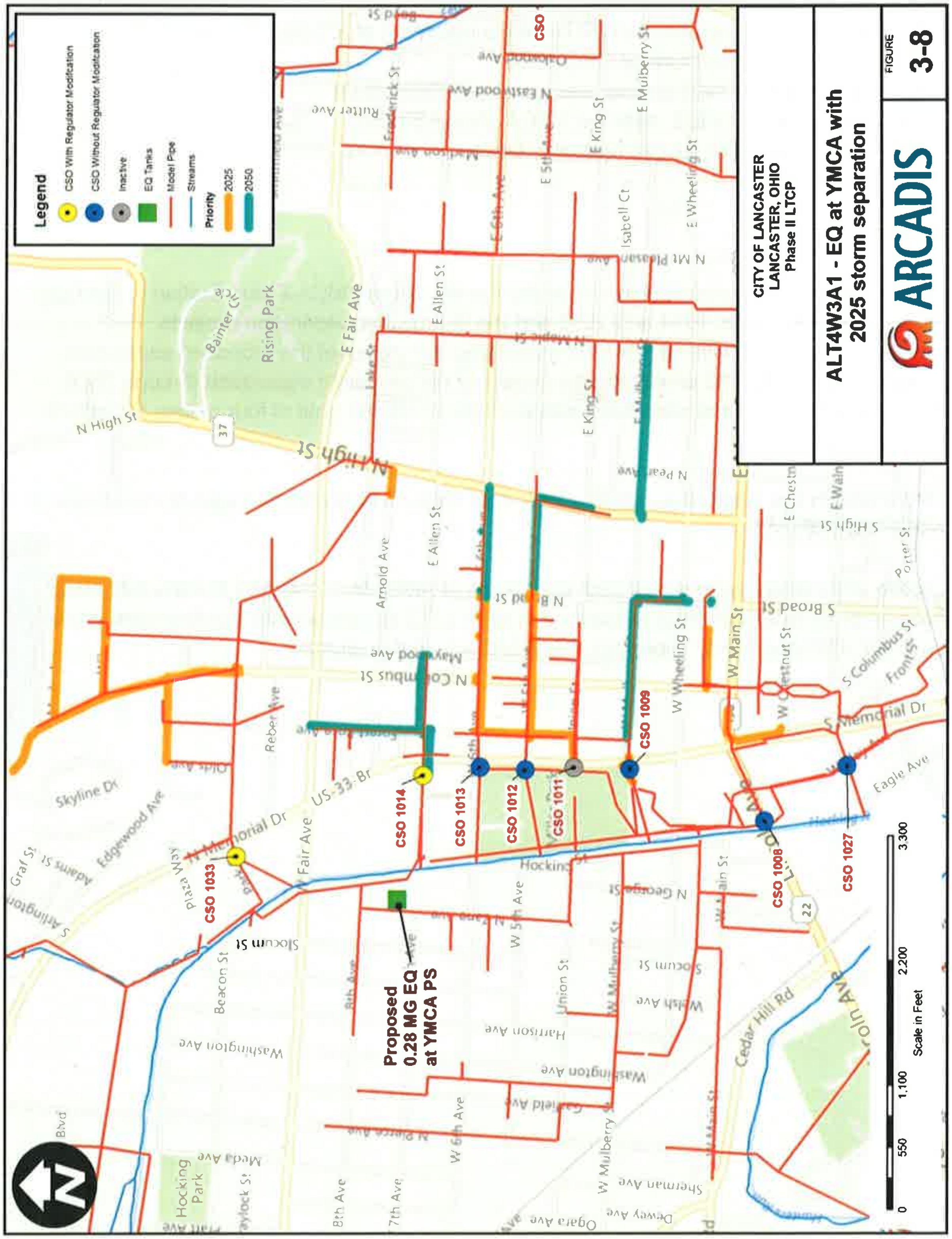


Table 3-11 Proposed Improvements for ALT4W3A1

Infrastructure	Description	Pipe Length
CSO 1008		
	2025 Separation	
CSO 1009		
	2025 Separation	
CSO 1012		
	2025 Separation	
CSO 1013		
	2025 Separation	
CSO 1014		
Abandon 12"	Abandon 12" pipe	
Increase Under Flow Pipe	Increase the underflow pipe (12" to 18")	456 ft
CSO 1033		
Abandon 10"	Abandon 10" pipe	
12" Open-Cut Sanitary Sewer	Increase the underflow pipe (10" to 12")	600 ft
YMCA EQ		
New EQ Above Grade	0.28 MG EQ	
Additional Pump Station	13.65 MGD pump station	
Lawrence Street EQ		
New EQ Below Grade	3.6 MG EQ	
Additional Pump Station	45 MGD pump station	

For this alternative, a 3.6 MG EQ facility is required at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. Alt4W3A1 required a 0.28 MG EQ Facility near the YMCA Pump Station. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-12 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT4W3A1. Table 3-12 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-12 shows an increase in the HGLs, this indicates that the regulator modifications in Alternative ALT4W3A1 may raise the HGL and potentially cause WIB incidents.

Table 3-12 ALT4W3A1 versus the Allowable Design

CSO Number	Manhole Structure Information				Scenario	Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)	Weir Overflow Elevation (ft)		5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	808.60	Existing	809.10	809.75	809.95
					Proposed	809.29	813.19	813.27
1009	816.61	829.36	12.75	816.66	Existing	817.21	817.68	817.73
					Proposed	816.99	818.08	818.15
1012	812.37	822.30	9.93	815.62	Existing	816.00	816.91	816.92
					Proposed	813.09	816.04	816.03
1013	815.60	828.80	13.20	817.25	Existing	817.73	818.59	818.68
					Proposed	816.14	817.45	817.65
1014	807.90	816.70	8.80	809.98	Existing	810.32	810.80	810.81
					Proposed	808.75	810.45	810.44
1033	813.67	821.00	7.33	816.25	Existing	816.65	817.49	817.41
					Proposed	814.28	816.71	816.71

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Decreasing localized stormwater discharge, providing a water quality benefit
- Eliminating CSO activations at CSO 1013

The disadvantages include:

- Risking a potential increase in WIB incidents
- Requiring weir modifications at CSO 1008
- Maintaining two EQ facilities requires increased O&M costs
- Acquiring property for EQ near the YMCA Pump Station
- Requiring construction across Memorial Drive
- Creating a significant construction disturbance during sewer separation

3.5.4 Alternative 5W

Alternative 5W evaluated the proposed stormwater separation projects to determine if the City could achieve the goal of no more than four activations during a typical year solely from stormwater separation projects. Two scenarios were evaluated with ALT5W7A1 evaluating the impact of the proposed separation through 2025 and ALT5W7A2 evaluating the impact of the proposed separation through 2050. The extent of the modifications were iteratively evaluated until the goal of four or less activations were achieved at each CSO.

Alternative ALT5W7A1 resulted in all the CSOs activating more than four times in a typical year except for CSO 1033. Alternative ALT5W7A2 resulted in all the CSO structures having four or less activations in a typical year except for CSO 1008. Therefore, the remainder of this section will only discuss ALT5W7A2. Figure 3-9 presents the alternative schematically and Table 3-13 details the specific modifications of alternative ALT5W7A2.

Figure 3-9 ALT5W7A2

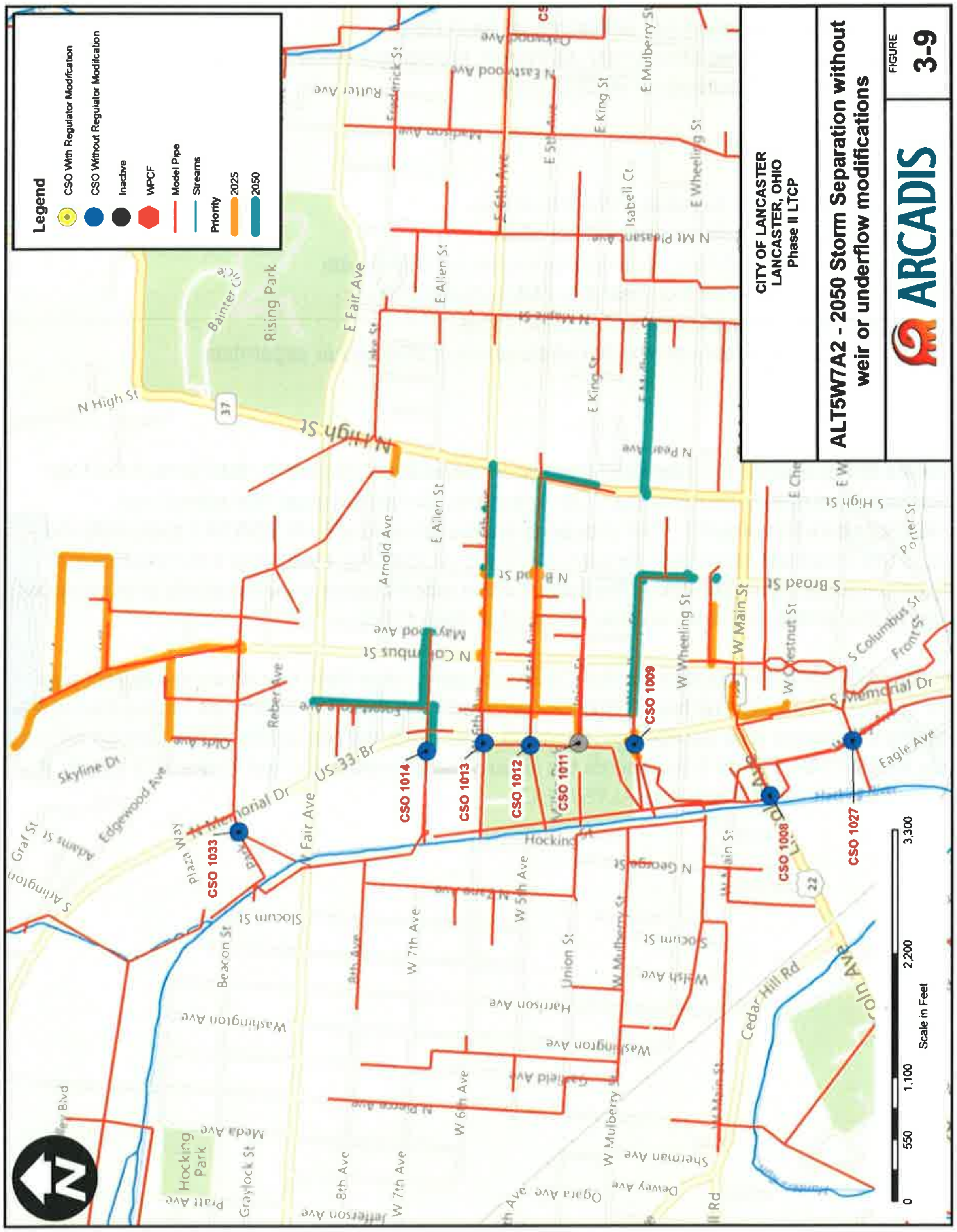


Table 3-13 Proposed Improvements for Alt5W7A2

Infrastructure	Description
CSO 1008	
	2050 Separation
CSO 1009	
	2050 Separation
CSO 1012	
	2050 Separation
CSO 1013	
	2050 Separation
CSO 1014	
	2050 Separation
CSO 1033	
	2050 Separation
Lawrence Street EQ	
New EQ Below Grade	2.6 MG EQ
Additional Pump Station	37.15 MGD pump station

For this alternative, a 2.6 MG EQ facility is required at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-14 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT5W7A2. Table 3-14 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-14 shows a decrease in the HGLs, no WIB analysis was performed as this alternative does not have the potential to increase WIB incidents.

Table 3-14 ALT5W7A2 versus the Allowable Design

CSO Number	Manhole Structure Information				Scenario	Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)	Weir Overflow Elevation (ft)		5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	808.60	Existing	809.10	809.75	809.95
					Proposed	808.80	809.17	809.22
1009	816.61	829.36	12.75	816.66	Existing	817.21	817.68	817.73
					Proposed	816.66	816.68	816.69
1012	812.37	822.30	9.93	815.62	Existing	816.00	816.91	816.92
					Proposed	812.83	815.74	815.75
1013	815.60	828.80	13.20	817.25	Existing	817.73	818.59	818.68
					Proposed	815.84	815.85	815.87
1014	807.90	816.70	8.80	809.98	Existing	810.32	810.80	810.81
					Proposed	808.19	808.34	808.28
1033	813.67	821.00	7.33	816.25	Existing	816.65	817.49	817.41
					Proposed	815.71	816.85	816.85

The apparent advantages include:

- Eliminating the need for a WIB analysis
- Requiring no CSO regulator modifications
- Reducing HGLs
- Avoiding construction in the well field

The disadvantages include:

- Requiring construction across Memorial Drive
- Failing to achieve four or less activations at each CSO during a typical year
- Increasing construction throughout the City
- Increasing localized stormwater discharges, degradation of local waterways
- Managing utility conflicts

3.5.5 Alternative 6W

Alternative 6W evaluated the combination of proposed stormwater separation projects and regulator modifications to determine if the City could achieve the goal of no more than four activations during a typical year. Two scenarios were evaluated with ALT6W7A1 evaluating the impact of the proposed separation through 2025 and ALT6W7A2 evaluating the impact of the proposed separation through 2050. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

ALT6W7A1 resulted in four or less activations at all the CSO structures but violated the freeboard goals along the 27-inch interceptor. ALT6W7A2 resulted in four or less activations at all the CSO structures and did not violate freeboard goals along the interceptor. Therefore, ALT6W7A2 will be discussed in the remainder of this section. Figure 3-10 presents the alternative schematically and Table 3-15 details the specific modifications of alternative ALT6W7A2.

Figure 3-10 ALT6W7A2

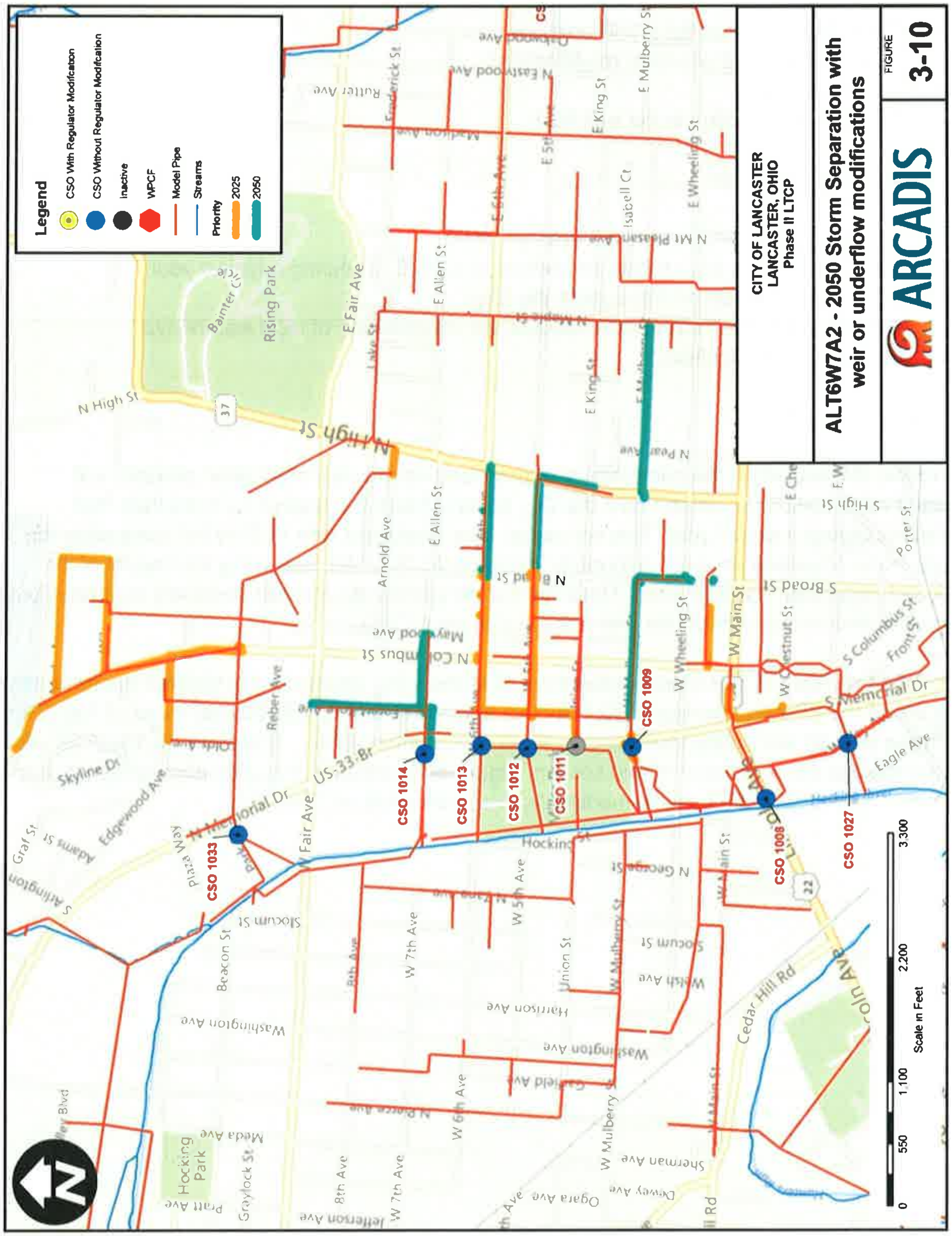


Table 3-15 Proposed Improvements for Alt6W7A2

Infrastructure	Description
CSO 1008	Description
	2050 Separation
Increase Weir Height	Weir inlet offset increase (12" to 18")
CSO 1009	Description
	2050 Separation
CSO 1012	Description
	2050 Separation
CSO 1013	Description
	2050 Separation
CSO 1014	Description
	2050 Separation
CSO 1033	Description
	2050 Separation
Lawrence Street EQ	
New EQ Below Grade	2.7 MG EQ
Additional Pump Station	37.3 pump station

For this alternative, a 2.7 MG EQ facility is required at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-16 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT6W7A2. Table 3-16 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-16 shows a decrease in the HGLs, this indicates that the regulator modifications in Alternative ALT6W7A2 should not raise the HGL.

Table 3-16 ALT6W7A-2 versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.60	809.10	809.75	809.95
				Proposed	0.50	809.10	809.09	809.59	809.64
1009	816.61	829.36	12.75	Existing	-	816.66	817.21	817.68	817.73
				Proposed	0.00	816.66	816.66	816.68	816.69
1012	812.37	822.30	9.93	Existing	-	815.62	816.00	816.91	816.92
				Proposed	0.00	815.62	812.83	815.74	815.75
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.00	817.25	815.84	815.85	815.87
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.80	810.81
				Proposed	0.00	809.98	808.19	808.34	808.28
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	815.71	816.85	816.85

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Eliminating the need for a WIB analysis
- Reducing HGL
- Decreasing localized stormwater discharge, providing a water quality benefit
- Avoiding construction in the well field

The disadvantages include:

- Requiring construction across Memorial Drive
- Increasing construction throughout the City
- Managing utility conflicts

3.5.6 Alternative 7W

Alternative 7W7A evaluated the combination of modifying CSO structures and constructing interceptor capacity improvements. This was accomplished by modifying the weir heights and under flow diameters in each CSO structure and increasing the interceptor size from 27-inches to 36-inches. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-11 presents the alternative schematically and Table 3-17 details the specific modifications of alternative ALT7W7A.

Figure 3-11 ALT7W7A

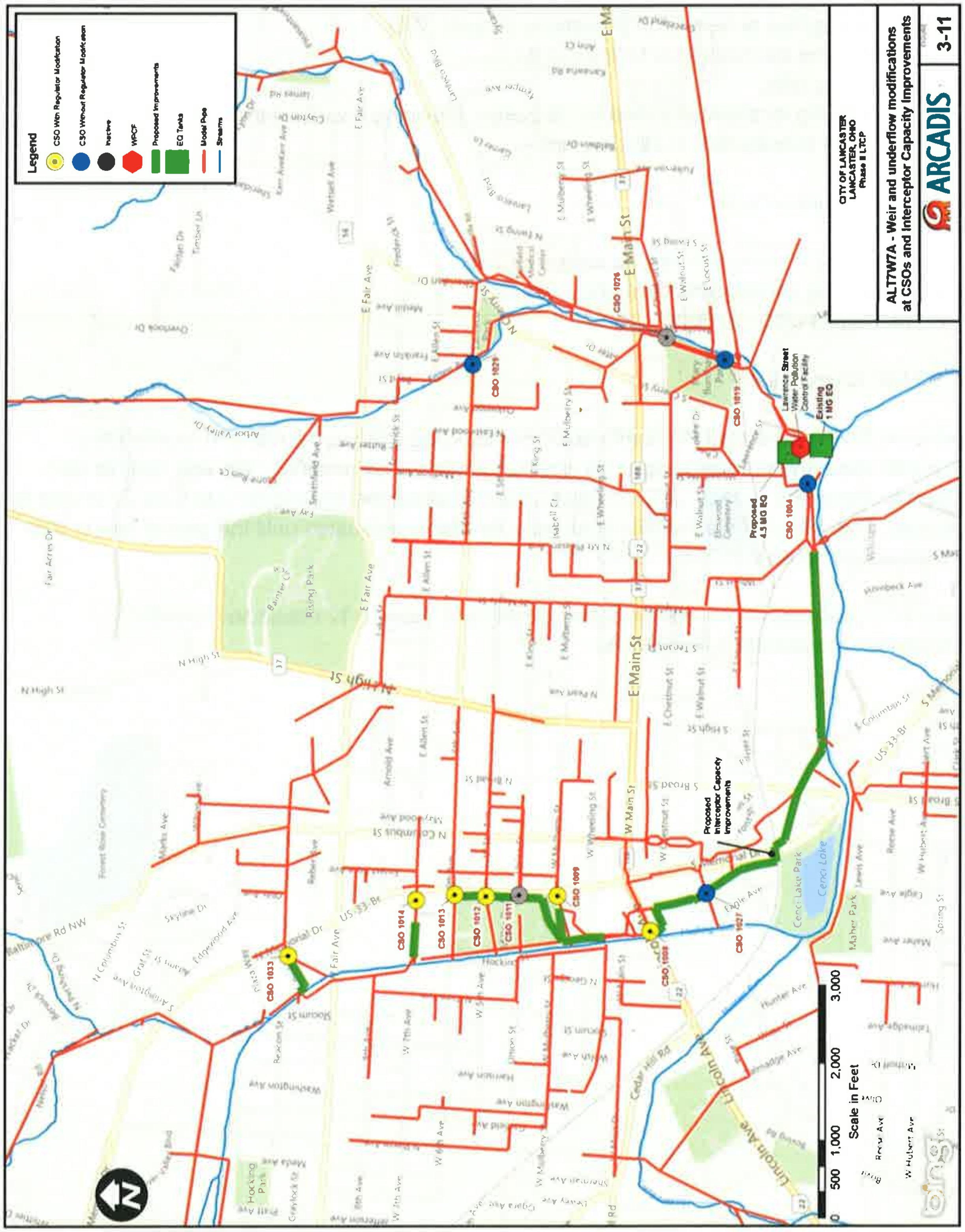


Table 3-17 Proposed Improvements for ALT7A

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Weir Height	Weir inlet offset increase (12" to 54")	
Increase Orifice Size	Increase under flow (10" to 27")	104 ft
CSO 1009		
Increase Weir Height	Add overflow weir (15" offset)	
Increase Orifice Size	Increase orifice (8" x 14" to 15" x 15")	
Increase Under Flow Pipe	Increase underdrain (12" to 27")	431 ft
Increase Underflow Pipe	Increase underdrain (15" to 27") from CSO 1009 to Wheeling St. PS POC (end of YMCA FM)	539 ft
CSO 1012		
Increase Under Flow Pipe	Increase under flow pipe (15" to 24")	447 ft
Increase Under Flow Pipe	Increase under flow pipe (14" to 24")	593 ft
Increase Under Flow Pipe	Increase under flow pipe (16" to 24")	321 ft
Increase Weir Height	Weir inlet offset increase (3.25' to 3.4')	
CSO 1013		
Increase Weir Height	Increase overflow weir offset (1.65' to 2.0')	
Increase Orifice Size	Increase underflow orifice (6" to 18")	
Increase Under Flow Pipe	Increase underflow pipe (10" to 18")	30 ft
Increase Under Flow Pipe	Increase underflow pipe (11.25" to 18") from CSO 1013 regulator to CSO 1012 regulator	391 ft
CSO 1014		
18" Open-Cut Sanitary Sewer	18" underflow line from regulator to 36" interceptor	456 ft
Abandon 12"	Abandon 12" underflow line from regulator to 36"	
CSO 1033		
15" Open-Cut Sanitary Sewer	15" underflow line from regulator to 36" Interceptor	600 ft
Abandon 10"	Abandon 10" underflow line from regulator to 36"	
Interceptor		
Increase to 36"	Increase from CSO 1008 to downstream of Maple (27" to 36")	6,377 ft
Lawrence Street EQ		
New EQ Below Grade	4.5 MG EQ	
Additional Pump Station	46 MGD pump station	

For this alternative, a 4.5 MG EQ facility is required at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-18 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT2W7A. Table 3-18 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-18 shows an increase in the HGL at CSOs 10008 and 1009, this indicates that the regulator modifications in Alternative ALT7W7A may raise the HGL and potentially cause WIB incidents.

Table 3-18 ALT7W7A versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.60	809.10	809.75	809.95
				Proposed	1.25	809.85	809.50	811.62	811.68
1009	816.61	829.36	12.75	Existing	-	816.66	817.21	817.68	817.73
				Proposed	1.20	817.86	817.74	819.02	819.01
1012	812.37	822.30	9.93	Existing	-	815.62	816.00	816.91	816.92
				Proposed	0.15	815.77	814.88	816.76	816.77
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.35	817.60	816.72	818.45	818.53
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.80	810.81
				Proposed	0.00	809.98	808.75	810.49	810.51
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	815.31	817.23	817.17

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Easing construction throughout the City by only modifying the CSO structures and the interceptors
- Decreasing localized stormwater discharge, providing a water quality benefit

The disadvantages include:

- Risking a potential increase in WIB incidents upstream of CSOs 1008 and 1009
- Requiring the largest EQ size at the Lawrence Street WPCF (not including east side improvements)
- Requiring construction in the Water Distribution System's well field for CSOs 1009, 1012, & 1013
- Managing utility conflicts

3.5.1 Alternative 8W

Alternative ALT8W7A1 evaluated the combination of modifying CSO structures, constructing interceptor capacity improvements, and implementing the 2025 stormwater separation projects. This was accomplished by modifying the weir heights and under flow diameters in each CSO structure, increasing the interceptor size from 27-inches to 36-inches and incorporating the proposed 2025 stormwater separation projects. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-12 presents the alternative schematically and Table 3-19 details the specific modifications of alternative ALT8W7A1.

Figure 3-12 ALT8W7A1

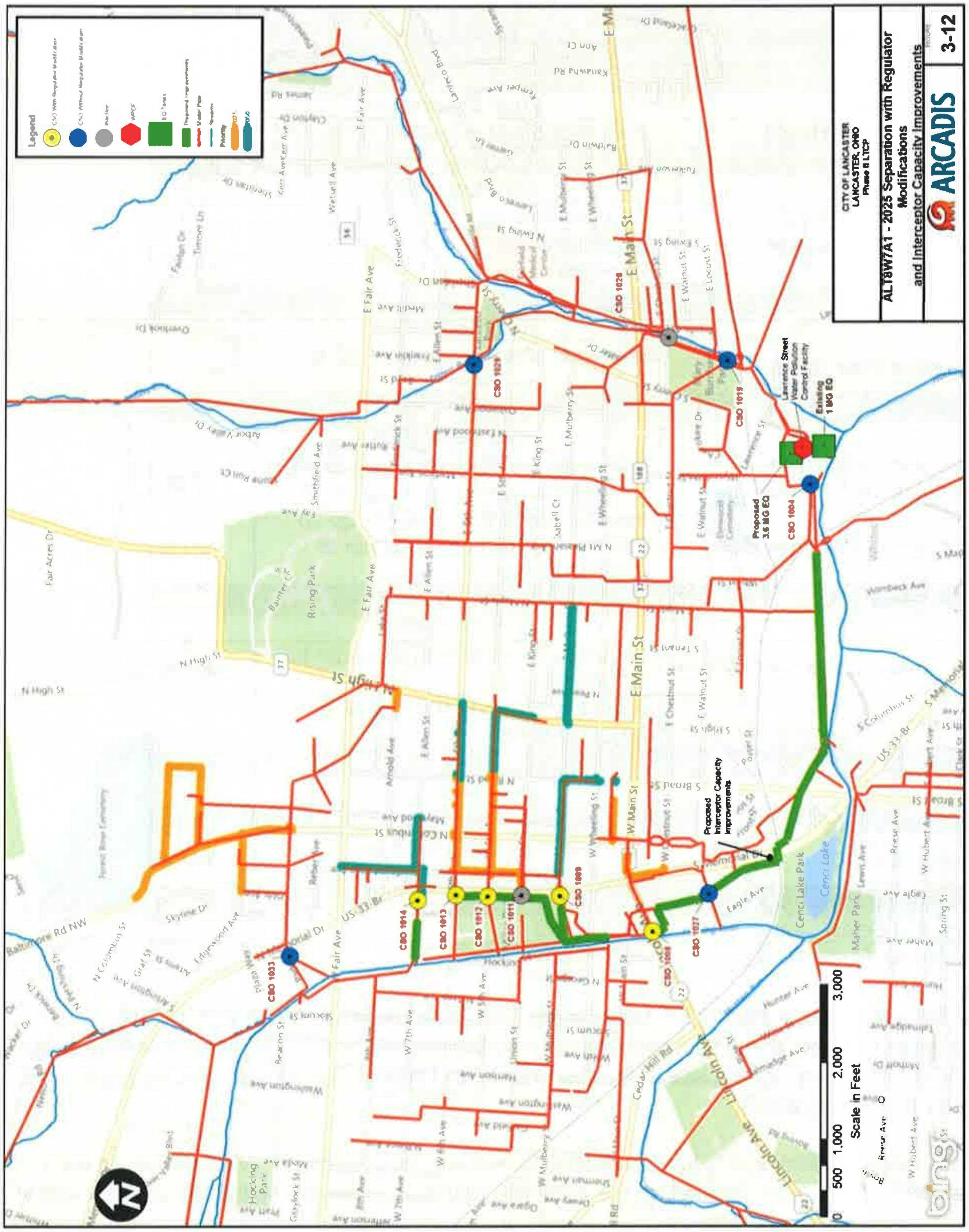


Table 3-19 Proposed Improvements for Alt8W7A1

Infrastructure	Description	Pipe Length
CSO 1008		
	2025 Separation	
Increase Weir Height	Weir inlet offset increase (12" to 27")	
CSO 1009		
	2025 Separation	
Increase Weir Height	Add overflow weir (12" offset)	
Increase Orifice Size	Increase orifice (8" x 14" to 14" x 14")	
Increase Under Flow Pipe	Increase underdrain (12" to 15")	431 ft
CSO 1012		
	2025 Separation	
Increase Weir Height	Weir inlet offset increase (3.25' to 3.6')	
CSO 1013		
	2025 Separation	
Increase Orifice Size	Increase underflow orifice (6" to 15")	
Increase Under Flow Pipe	Increase underflow pipe (10" to 15")	30 ft
Increase Under Flow Pipe	Increase underflow pipe (11.25" to 15") from CSO 1013 regulator to CSO 1012 regulator	391 ft
CSO 1014		
	2025 Separation	
36" Open-Cut Sanitary Sewer	18" underflow line from regulator to 36" interceptor	456 ft
Abandon 12"	Abandon 12" underflow line from regulator to 36"	
CSO 1033		
	2025 Separation	
Interceptor		
Increase to 36"	Increase from CSO 1008 to downstream of Maple (27" to 36")	6,377 ft
Lawrence Street EQ		
New EQ Below Grade	3.6 MG EQ	
Additional Pump Station	40.7 pump station	

For this alternative, a 3.6 MG EQ facility is required at the Lawrence Street WPCF. This alternative does not account for reducing the overflow volumes at the CSO structures downstream of CSO 1008 or on the east side of the City. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-20 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT8W7A1. Table 3-20 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-20 shows an increase in the HGL at CSOs 1008 and 1009, this indicates that the regulator modifications in Alternative ALT8W7A1 may raise the HGL and potentially cause WIB incidents.

Table 3-20 ALT8W7A1 versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.60	809.10	809.75	809.95
				Proposed	1.25	809.85	809.33	810.28	810.57
1009	816.61	829.36	12.75	Existing	-	816.66	817.21	817.68	817.73
				Proposed	0.95	817.61	817.01	818.26	818.30
1012	812.37	822.30	9.93	Existing	-	815.62	816.00	816.91	816.92
				Proposed	0.35	815.97	815.89	816.37	816.34
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.00	817.25	817.52	816.28	817.57
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.80	810.81
				Proposed	0.00	809.98	808.75	810.44	810.43
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	815.71	816.85	816.85

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Easing construction throughout the City by only modifying the CSO structures and the interceptors
- Decreasing localized stormwater discharge, providing a water quality benefit

The disadvantages include:

- Risking a potential increase in WIB incidents upstream of CSOs 1008 and 1009
- Requiring the largest EQ size at the Lawrence Street WPCF (not including east side improvements)
- Requiring construction in the Water Distribution System's well field for CSOs 1009, 1012, & 1013
- Managing utility conflicts

3.6 Planning Area ALTE Alternatives

The alternatives evaluated for Planning Area ALTE addressed CSOs 101, and 1029 with the goal to reduce CSO activations to no more than four activations in a typical year. For the east side modeling effort, the west side Alt2W7A was included in all alternatives to allow a complete understanding of the impact at the WPCF. Each alternative listed in Table 3-21 was incorporated into the model and evaluated for the typical year. The components of each alternative were iteratively evaluated until the model successfully captured the fifth largest event (signifying that the CSO only activated for four or fewer events in a typical year). All alternatives include a new equalization facility at the Lawrence Street WPCF, although the necessary size of the EQ tank and the associated pump station varies by alternative.

Table 3-21 Summary of Developed East Side Alternatives

Alternative Name	Alternative Description
Alt2E1A	Weir and underflow modifications to CSO 1019 & 1029 to maximize flow to the interceptor
Alt3E1A1	2025 storm separation without weir or underflow modifications
Alt3E1A2	2050 storm separation without weir or underflow modifications
Alt4E1A	2025 storm separation with weir or underflow modifications

3.6.1 Alternative 2E

The goal of Alternative 2E1A was to maximize the capacity of the existing collection system and maximize the flow to the Lawrence Street WPCF. This was accomplished by modifying the weir heights and under flow diameters in each CSO structure. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-13 presents the alternative schematically and Table 3-22 details the specific modifications of alternative ALT2E1A.

Figure 3-13 ALT2E1A

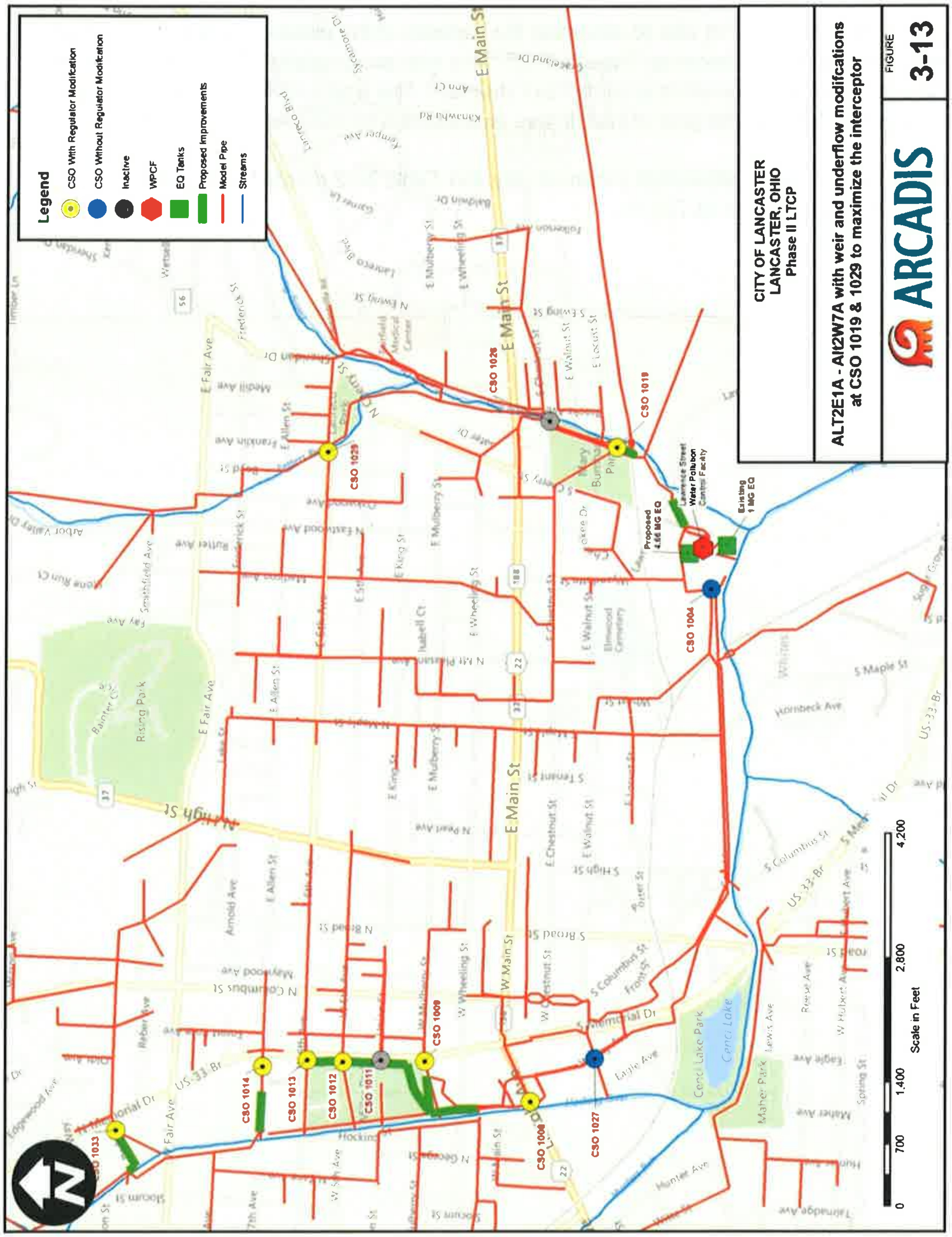


Table 3-22 Proposed Improvements for ALT2E1A

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Weir Height	Weir inlet offset increase (12" to 54")	
Increase Orifice Size	Increase under flow (10" to 27")	104 ft
CSO 1009		
Increase Weir Height	Add overflow weir (15" offset)	
Increase Orifice Size	Increase orifice (8" x 14" to 15" x 15")	
Increase Under Flow Pipe	Increase underdrain (12" to 27")	431 ft
Increase Underflow Pipe	Increase underdrain (15" to 27") from CSO 1009 to Wheeling St. PS POC (end of YMCA FM)	539 ft
CSO 1012		
Increase Under Flow Pipe	Increase under flow pipe (15" to 24")	447 ft
Increase Under Flow Pipe	Increase under flow pipe (14" to 24")	593 ft
Increase Under Flow Pipe	Increase under flow pipe (16" to 24")	321 ft
Increase Weir Height	Weir inlet offset increase (3.25' to 3.4')	
CSO 1013		
Increase Weir Height	Increase overflow weir offset (1.65' to 2.0')	
Increase Orifice Size	Increase underflow orifice (6" to 18")	
Increase Under Flow Pipe	Increase underflow pipe (10" to 18")	30 ft
Increase Under Flow Pipe	Increase underflow pipe (11.25" to 18") from CSO 1013 regulator to CSO 1012 regulator	391 ft
CSO 1014		
18" Open-Cut Sanitary Sewer	18" underflow line from regulator to 36" interceptor	456 ft
Abandon 12"	Abandon 12" underflow line from regulator to 36"	
CSO 1033		
15" Open-Cut Sanitary Sewer	15" underflow line from regulator to 36" Interceptor	600 ft
Abandon 10"	Abandon 10" underflow line from regulator to 36"	
CSO 1029		
Increase Orifice Size	Increase orifice opening from 10" to 24"	
Increase Under Flow Pipe	Increase underflow pipe (8" to 24")	56 ft
CSO 1019		
Increase Orifice Size	Increase orifice opening from 12" to 24"	
Increase Under Flow Pipe	Increase underflow pipe (18" to 30")	156 ft
Interceptor		
48" Open-Cut Sanitary Sewer	Increase interceptor pipe from 42" to 48"	344 ft
Lawrence Street EQ		
New EQ Below Grade	4.7 MG EQ	
Additional Pump Station	50 MGD pump station	

For this alternative, a 4.7 MG EQ facility is required at the Lawrence Street WPCF. The modifications at CSOs 1019 and 1029 resulted in four or less activations, but the freeboard goals were violated along the 27-inch sewer that parallels the existing 36-inch Baldwin Run Interceptor. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-23 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT2E1A. Table 3-23 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-23 shows a decrease in the HGL at CSOs 1019 and 1029, a WIB analysis was not conducted.

Table 3-23 ALT2E1A versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1019	805.50	818.00	12.50	Existing	-	807.50	808.38	809.80	809.88
				Proposed	0.00	807.50	807.45	809.62	809.61
1029	815.35	830.20	14.85	Existing	-	817.15	817.54	818.08	818.18
				Proposed	0.00	817.15	816.51	818.02	818.19

Every alternative has its advantages and disadvantages, and, as detailed in Section 5, the advantages and disadvantages were considered in the alternative criteria weighting process.

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Easing construction throughout the City by only modifying the CSO structures
- Decreasing localized stormwater discharge, providing a water quality benefit
- Reducing the potential for WIBs by decreasing the HGL

The disadvantages include:

- Increasing the surcharge along 27-inch sewer
- Requiring the largest EQ size at the Lawrence Street WPCF (including west side improvements)

3.6.2 Alternative 3E

Alternative 3E evaluated the proposed stormwater separation projects to determine if the City could achieve the goal of no more than four activations during a typical year solely from stormwater separation projects. Two scenarios were evaluated with Alt3E1A1 evaluating the impact of the proposed separation through 2025 and Alt3E1A2 evaluating the impact of the proposed separation through 2050. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Alternative ALT3E1A1 resulted in the CSOs activating more than four times in a typical year. Alternative ALT3E1A2 resulted in all the CSO structures having four or less activations in a typical year except for CSO 1008. Therefore, the remainder of this section will only discuss Alt3E1A2. Figure 3-14 presents the alternative schematically and Table 3-24 details the specific modifications of alternative ALT3E1A2.

Figure 3-14 ALT3E1A2

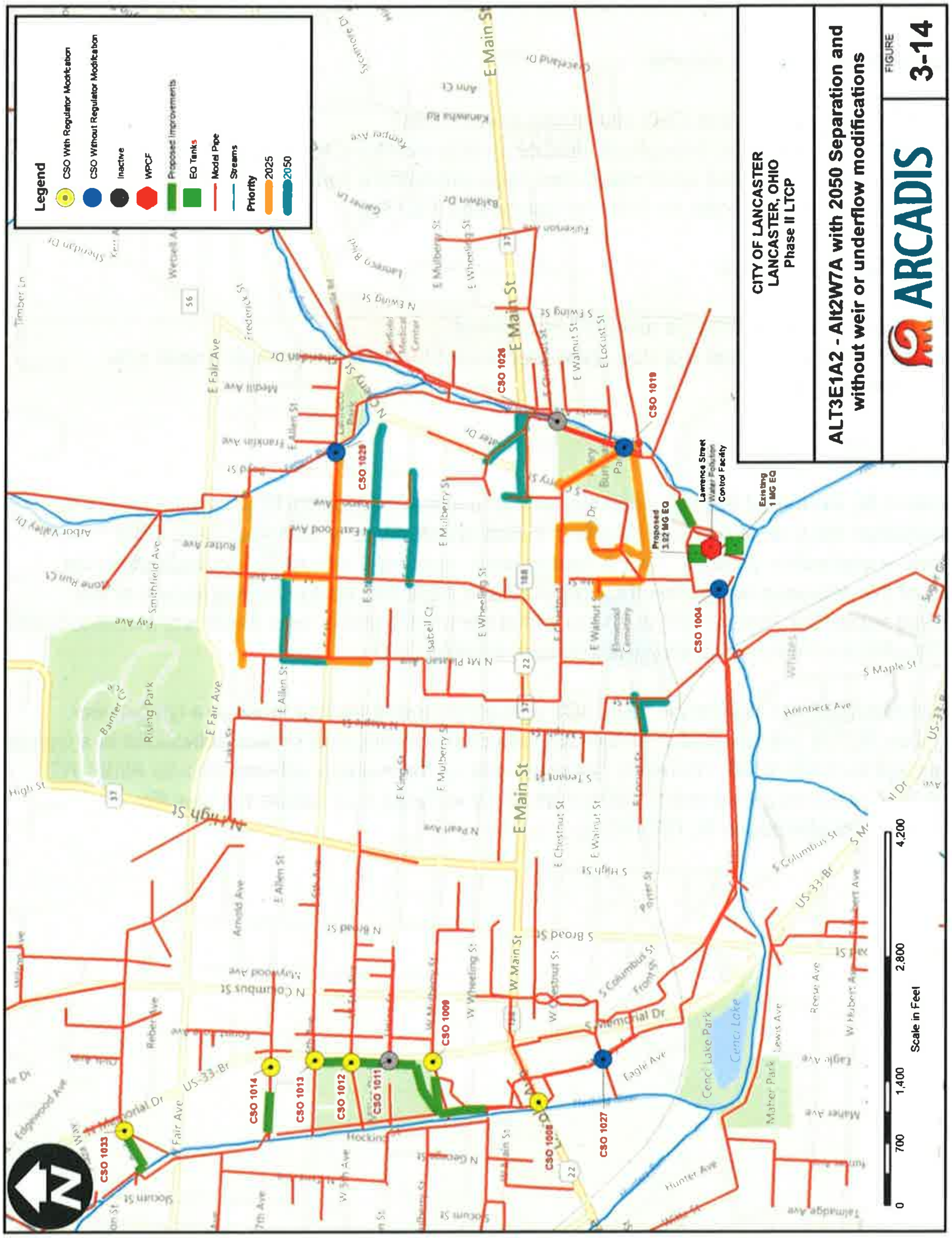


Table 3-24 Proposed Improvements for ALT3E1A2

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Weir Height	Weir inlet offset increase (12" to 54")	
Increase Orifice Size	Increase under flow (10" to 27")	104 ft
CSO 1009		
Increase Weir Height	Add overflow weir (15" offset)	
Increase Orifice Size	Increase orifice (8" x 14" to 15" x 15")	
Increase Under Flow Pipe	Increase underdrain (12" to 27")	431 ft
Increase Underflow Pipe	Increase underdrain (15" to 27") from CSO 1009 to Wheeling St. PS POC (end of YMCA FM)	539 ft
CSO 1012		
Increase Under Flow Pipe	Increase under flow pipe (15" to 24")	447 ft
Increase Under Flow Pipe	Increase under flow pipe (14" to 24")	593 ft
Increase Under Flow Pipe	Increase under flow pipe (16" to 24")	321 ft
Increase Weir Height	Weir inlet offset increase (3.25' to 3.4')	
CSO 1013		
Increase Weir Height	Increase overflow weir offset (1.65' to 2.0')	
Increase Orifice Size	Increase underflow orifice (6" to 18")	
Increase Under Flow Pipe	Increase underflow pipe (10" to 18")	30 ft
Increase Under Flow Pipe	Increase underflow pipe (11.25" to 18") from CSO 1013 regulator to CSO 1012 regulator	391 ft
CSO 1014		
18" Open-Cut Sanitary Sewer	18" underflow line from regulator to 36" interceptor	456 ft
Abandon 12"	Abandon 12" underflow line from regulator to 36"	
CSO 1033		
15" Open-Cut Sanitary Sewer	15" underflow line from regulator to 36" Interceptor	600 ft
Abandon 10"	Abandon 10" underflow line from regulator to 36"	
CSO 1029		
	2050 Separation	
CSO 1019		
	2050 Separation	
Interceptor		
48" Open-Cut Sanitary Sewer	Increase interceptor pipe from 42" to 48"	344 ft
Lawrence Street EQ		
New EQ Below Grade	3.0 MG EQ	
Additional Pump Station	40 MGD pump station	

For this alternative, a 3.0 MG EQ facility is required at the Lawrence Street WPCF. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-25 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT3E1A2. Table 3-25 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-25 shows a decrease in the HGLs, no WIB analysis was performed as this alternative does not have the potential to increase WIB incidents.

Table 3-25 ALT3E1A2 versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1019	805.50	818.00	12.50	Existing	-	807.50	808.38	809.80	809.88
				Proposed	0.00	807.50	807.60	809.03	809.00
1029	815.35	830.20	14.85	Existing	-	817.15	817.54	818.08	818.18
				Proposed	0.00	817.15	815.83	816.08	817.39

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Eliminating the need for a WIB analysis
- Requiring no CSO regulator modifications
- Reducing HGL
- Reducing the required EQ facility size at the Lawrence Street WPCF

The disadvantages include:

- Increasing construction throughout the City
- Increasing localized stormwater discharges, degradation of local waterways
- Managing utility conflicts

3.6.3 Alternative 4E

Alternative ALT4E1A evaluated the combination of proposed stormwater separation projects through 2025 and regulator modifications to determine if the City could achieve the goal of no more than four activations during a typical year. The extent of the modifications were iteratively evaluated until the goal of four or less activations was achieved at each CSO.

Figure 3-15 presents the alternative schematically and Table 3-26 details the specific modifications of alternative ALT4E1A.

Figure 3-15 ALT4E1A

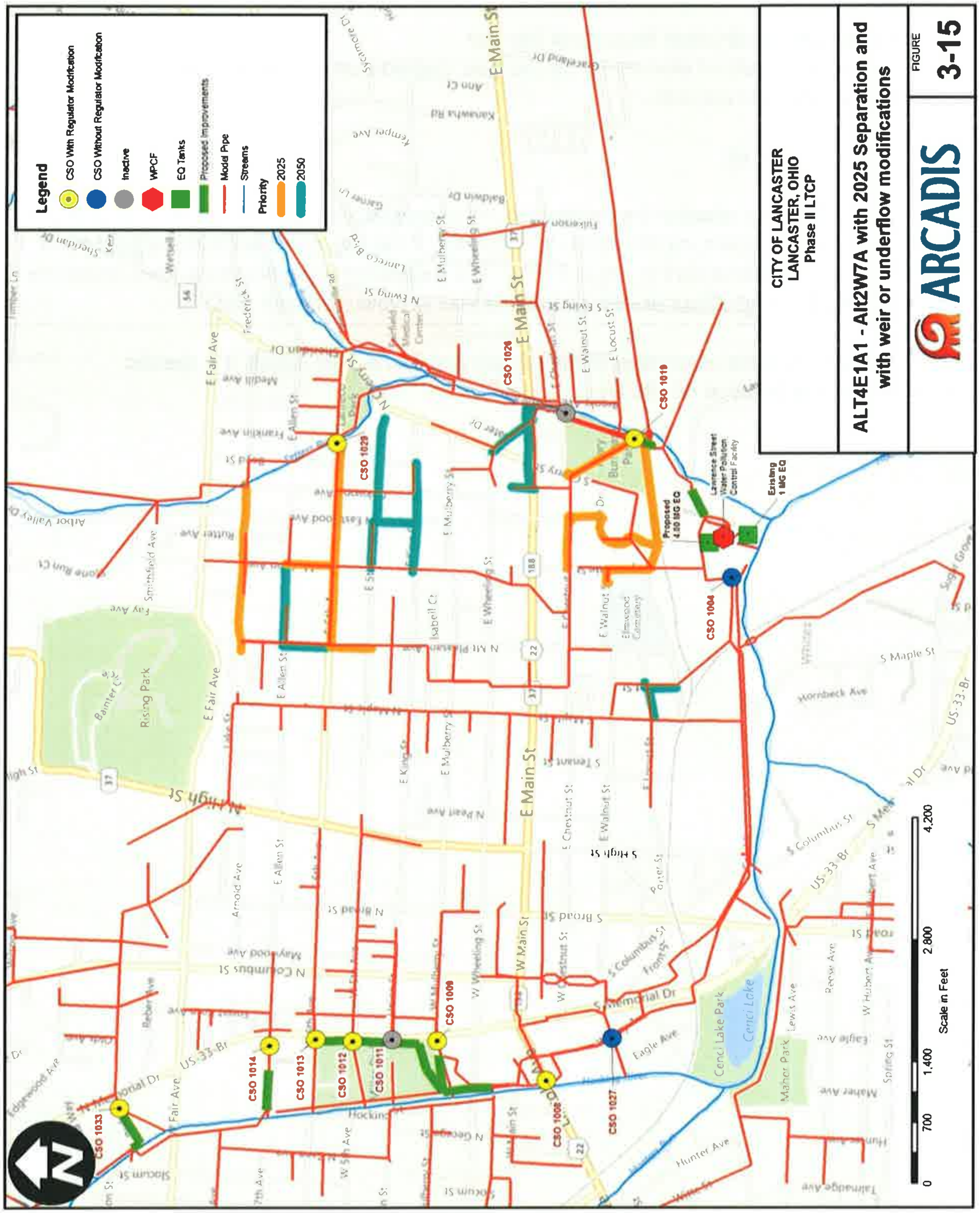


Table 3-26 Proposed Improvement for ALT4E1A

Infrastructure	Description	Pipe Length
CSO 1008		
Increase Weir Height	Weir inlet offset increase (12" to 54")	
Increase Orifice Size	Increase under flow (10" to 27")	104 ft
CSO 1009		
Increase Weir Height	Add overflow weir (15" offset)	
Increase Orifice Size	Increase orifice (8" x 14" to 15" x 15")	
Increase Under Flow Pipe	Increase underdrain (12" to 27")	431 ft
Increase Underflow Pipe	Increase underdrain (15" to 27") from CSO 1009 to Wheeling St. PS POC (end of YMCA FM)	539 ft
CSO 1012		
Increase Under Flow Pipe	Increase under flow pipe (15" to 24")	447 ft
Increase Under Flow Pipe	Increase under flow pipe (14" to 24")	593 ft
Increase Under Flow Pipe	Increase under flow pipe (16" to 24")	321 ft
Increase Weir Height	Weir inlet offset increase (3.25' to 3.4')	
CSO 1013		
Increase Weir Height	Increase overflow weir offset (1.65' to 2.0')	
Increase Orifice Size	Increase underflow orifice (6" to 18")	
Increase Under Flow Pipe	Increase underflow pipe (10" to 18")	30 ft
Increase Under Flow Pipe	Increase underflow pipe (11.25" to 18") from CSO 1013 regulator to CSO 1012 regulator	391 ft
CSO 1014		
18" Open-Cut Sanitary Sewer	18" underflow line from regulator to 36" interceptor	456 ft
Abandon 12"	Abandon 12" underflow line from regulator to 36"	
CSO 1033		
15" Open-Cut Sanitary Sewer	15" underflow line from regulator to 36" Interceptor	600 ft
Abandon 10"	Abandon 10" underflow line from regulator to 36"	
CSO 1029		
	2025 Separation	
Increase Under Flow Pipe	Increase under flow pipe (8" to 12")	56 ft
CSO 1019		
	2025 Separation	
Increase Orifice Size	Increase underflow orifice (12" to 24")	
Increase Under Flow Pipe	Increase underflow pipe (18" to 24")	156 ft
Interceptor		
48" Open-Cut Sanitary Sewer	Increase interceptor pipe from 42" to 48"	344 ft
Lawrence Street EQ		
New EQ Below Grade	4.0 MG EQ	
Pump Station	50 MGD pump station	

For this alternative, a 4.0 MG EQ facility is required at the Lawrence Street WPCF. The modifications at CSOs 1019 and 1029 resulted in four or less activations, but the freeboard goals were violated along the 27-inch sewer that parallels the existing 36-inch Baldwin Run Interceptor. Appendix I provides additional modeling results and details for this alternative.

As discussed in Section 3.3, the City desires to evaluate the potential for WIB incidents in each alternative. Table 3-27 summarizes the maximum HGL that occurs during the fifth largest event in the typical year, the largest event in the typical year, and the 10-year, 4-hour design storm at each CSO structure under both existing conditions and alternative ALT2E1A. Table 3-27 also summarizes the elevation changes required at each CSO weir and the resulting HGLs.

Since Table 3-27 shows a decrease in the HGL at CSOs 1019 and 1029, a WIB analysis was not conducted.

Table 3-27 ALT4E1A verse the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1019	805.50	818.00	12.50	Existing	-	807.50	808.38	809.80	809.88
				Proposed	0.00	807.50	807.36	809.43	809.41
1029	815.35	830.20	14.85	Existing	-	817.15	817.54	818.08	818.18
				Proposed	0.00	817.15	816.33	817.61	817.77

The apparent advantages include:

- Achieving four or less CSO activations at each CSO
- Eliminating the need for a WIB analysis
- Reducing HGL

The disadvantages include:

- Increasing construction throughout the City
- Increasing localized stormwater discharges, degradation of local waterways
- Managing utility conflicts
- Increasing the required EQ facility size at the Lawrence Street WPCF
- Acquiring land

3.7 Alternatives Performance Summary

Once all the alternatives were evaluated, a summary table was compiled to compare the CSO activations and volumes, as well as the necessary equalization facilities at both the Lawrence Street WPCF and the YMCA Pump Station. Tables 3-28 and 3-29 present each alternative side by side for comparison purposes. This table, as well as the advantages and disadvantages presented in this section were critical references during the alternative ranking session (as discussed in Section 5).

Table 3-28 Summary of West Side Overflows by Alternative

Parameter	CSO Number							Total
	1004	1008	1009	1012	1013	1014	1033	
2014 Baseline with 2035 Growth								
Total Volume (MG)	12.7	1.4	4.4	4.4	4.8	1.7	1.1	30.5
Total Duration (Hrs)	49	46	227	200	166	21	7	716
Number of Events	10	27	77	58	77	18	6	273
Equalization at Lawrence Street WPCF (MG)								0.0
2W7A - Weir and underflow modifications to maximize flow to the interceptors								
Total Volume (MG)	0.3	0.6	0.6	0.5	0.5	0.3	0.4	3.2
Total Duration (Hrs)	4	4	4	5	4	3	3	27
Number of Events	4	4	4	4	4	3	3	26
Equalization at Lawrence Street WPCF (MG)								4.3
3W3A - Equalization at the YMCA Pump Station capturing flows from CSOs 1014 and 1033								
Total Volume (MG)	0.3	0.3	0.6	0.5	0.5	0.2	0.7	3.1
Total Duration (Hrs)	3	2	4	5	4	2	5	25
Number of Events	4	3	4	4	4	3	4	26
Equalization at Lawrence Street WPCF (MG)								4.2
3W4A - Equalization at the YMCA Pump Station capturing flows from CSOs 1013, 1014, and 1033								
Total Volume (MG)	0.3	0.3	0.6	0.2	0.0	0.8	0.8	3.0
Total Duration (Hrs)	3	2	4	2	0	3	5	19
Number of Events	3	3	4	3	0	3	4	20
Equalization at Lawrence Street WPCF (MG)								4.3
4W3A1 - Equalization at the YMCA Pump Station with 2025 sewer separation								
Total Volume (MG)	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.6
Total Duration (Hrs)	2	1	1	0	0	2	2	8
Number of Events	3	3	1	1	0	3	3	14
Equalization at Lawrence Street WPCF (MG)								3.6

Parameter	CSO Number							Total
	1004	1008	1009	1012	1013	1014	1033	
5W7A1 - 2025 sewer separation without weir or underflow modifications								
Total Volume (MG)	0.0	0.4	1.4	0.7	0.4	1.7	0.3	4.9
Total Duration (Hrs)	0	17	145	56	17	21	4	260
Number of Events	1	17	67	28	16	18	3	150
Equalization at Lawrence Street WPCF (MG)								3.1
5W7A2 - 2050 sewer separation without weir or underflow modifications								
Total Volume (MG)	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.5
Total Duration (Hrs)	0	8	0	2	0	0	4	14
Number of Events	0	9	0	1	0	0	3	13
Equalization at Lawrence Street WPCF (MG)								2.6
6W7A1 - 2025 sewer separation with weir or underflow modifications								
Total Volume (MG)	0.1	0.3	0.3	0.2	0.1	0.2	0.3	1.5
Total Duration (Hrs)	1	5	4	4	3	2	4	23
Number of Events	2	4	4	4	3	3	3	23
Equalization at Lawrence Street WPCF (MG)								3.6
6W7A2 - 2050 sewer separation with weir or underflow modifications								
Total Volume (MG)	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.4
Total Duration (Hrs)	0	4	0	2	0	0	4	10
Number of Events	0	4	0	1	0	0	3	8
Equalization at Lawrence Street WPCF (MG)								2.7
7W7A - 2050 sewer separation with weir or underflow modifications								
Total Volume (MG)	0.6	0.7	0.6	0.5	0.5	0.3	0.4	3.6
Total Duration (Hrs)	4	4	4	4	4	3	3	26
Number of Events	4	3	4	4	4	3	3	25
Equalization at Lawrence Street WPCF (MG)								4.5
8W7A1 - Weir and underflow modifications at CSOs and interceptor capacity improvements								
Total Volume (MG)	0.1	0.1	0.3	0.2	0.1	0.2	0.3	1.3
Total Duration (Hrs)	2	3	4	4	3	2	4	22
Number of Events	2	3	4	4	3	3	3	22
Equalization at Lawrence Street WPCF (MG)								3.6

Table 3-29 Summary of East Side Overflows by Alternative

Parameter	CSO Number		Total
	1019	1029	
2014 Baseline with 2035 Growth			
Total Volume (MG)	3.5	3.7	7.2
Total Duration (Hrs)	19	70	89
Number of Events	16	31	47
Equalization at Lawrence Street WPCF (MG)			0.0
2E1A - Weir and underflow modifications to CSOs 1019 and 1029			
Total Volume (MG)	1.3	0.6	1.9
Total Duration (Hrs)	3	3	6
Number of Events	3	3	6
Equalization at Lawrence Street WPCF (MG)			4.7
3E1A1 - 2025 sewer separation without weir or underflow modifications			
Total Volume (MG)	2.7	0.9	3.6
Total Duration (Hrs)	13	25	38
Number of Events	14	19	33
Equalization at Lawrence Street WPCF (MG)			3.7
3E1A2 - 2050 sewer separation without weir or underflow modifications			
Total Volume (MG)	0.9	0.0	0.9
Total Duration (Hrs)	5	0	5
Number of Events	4	0	4
Equalization at Lawrence Street WPCF (MG)			3.0
4E1A - 2025 sewer separation with weir or underflow modifications			
Total Volume (MG)	1.2	0.2	1.4
Total Duration (Hrs)	4	3	7
Number of Events	4	3	7
Equalization at Lawrence Street WPCF (MG)			4.0

4. Opinion of Probable Capital Costs

Using the Association for the Advancement of Cost Engineering (AACE) standards for estimating capital improvement projects, the opinion of probable capital costs developed in this report are Class 4 Planning Phase costs, which provide the necessary accuracy for capital project funding.

4.1 Quantity Development

The quantities used to develop the opinion of probable construction costs were estimated using existing City plans and the City's GIS. Given the accuracy of the available data and level of conservatism for the cost opinion, the data obtained from the existing records is acceptable for developing a Class 4 Planning Phase estimate.

4.2 Work Breakdown Structure

For the alternatives developed in this report, the work breakdown structure for the improvement projects consists of sewer pipe diameter, pump station capacity, equalization volume, and weir height adjustments for the CSO structures. For the previously defined master plan projects, the work breakdown structure also includes WWTP upgrades.

4.3 Unit Costs

Unit costs were developed for various potential types of installations for each of the components listed in the work breakdown structure. The unit prices developed for vertical assets utilized the capacity factor method, which incorporated pricing and capacity of similar type projects to develop cost curves based dependent variables. The unit prices developed for the horizontal assets utilized the deterministic method as the various types of conveyance pipes were sized and approximately located allowing known unit prices to be used. The final unit prices used to develop opinions of probable capital costs for each alternative include construction cost contingencies and non-construction cost markups as discussed hereafter.

Construction cost contingencies include costs for change orders and construction cost markups such as mobilization, bonds, insurance, and contractor overhead and profit. The material and labor costs were increased by 30% to account for these costs and the calculation is shown in the following equation.

$$\text{Subtotal} = \text{labor and material costs} + 30\%\ (\text{labor and material costs})$$

Non-construction cost markups include fees associated with permits, surveys, geotechnical, legal and design. The cost also includes fees for engineering during construction and resident engineering fees. The subtotal costs identified above were increased by 23% to account for the non-construction cost markups. This calculation is shown below.

Total Cost = subtotal + 23% (subtotal)

Using the final unit prices, provided in Appendix J Table J14 – Unit Prices, serve to generate consistent planning level costs for solutions being analyzed in each alternative.

4.4 Alternatives - Opinion of Probable Capital Costs

The opinions of probable capital costs include the costs required to complete the project, from design through construction. Table 4-1 Westside Alternatives Opinion of Probable Capital Costs and Table 4-2 Eastside Alternatives Opinion of Probable Capital Costs provide a summary of the probable capital costs for each alternative.

Table 4-1 Westside Alternatives Opinion of Probable Capital Costs

Alternatives	Capital Costs ($)
ALT2W7A	2,212,000
ALT3W3A	5,799,000
ALT3W4A	6,171,000
ALT4W3A1	13,525,000
ALT5W7A1	6,227,000
ALT5W7A2	9,624,000
ALT6W7A2	9,689,000
ALT7W7A	4,226,000
ALT8W7A1	9,252,000

Table 4-2 Eastside Alternatives Opinion of Probable Capital Costs

Alternatives	Capital Costs ($)
ALT2E1A	21,162,000
ALT3E1A1	21,116,000
ALT3E1A2	27,268,000
ALT4E1A	23,867,000

5. Recommended Solution

The various alternatives described in Section 3 Alternatives Analysis were developed by the project team to evaluate effective solutions that meets the goals of the City of Lancaster's program for combined sewer overflow control. This section summarizes the final process in selecting the Recommended Solution projects to meet the City's goals.

5.1 Alternatives Selection

During the April 8, 2014 Alternative Review Workshop, the project team analyzed each of the Alternatives in Section 3 using the selection criteria listed below. The first step during the meeting was to weight the importance of each of the criteria using a range of 1 to 10 with 10 being the most important. The selection criteria and weight is summarized hereafter:

1. **Capacity and Condition:** Utilizing existing infrastructure that is in good condition and meets the capacity requirements is preferred. *Weight = 5*
2. **Water in Basement:** Consider the changes to the hydraulic grade line and how it may affect WIB events for residents in the community. *Weight = 10*
3. **Maintenance:** Consider the frequency and level of effort associated with routine and special maintenance tasks. System elements with minimal maintenance requirements and safety hazards are preferred. Consider pedestrian and vehicular access along the route. *Weight = 8*
4. **Constructability:** Consider the requirements to access and install the infrastructure. Infrastructure that requires common construction practices with minimal disruption to the City's transportation infrastructure is preferred. *Weight = 9*
5. **Regulatory Requirements:** Consider the number and type of permits required for construction. Some permits can significantly increase the time and cost required to use a particular site. In addition, permits may be denied for projects that impact the environment. Infrastructure with minimal environmental impacts is preferred. *Weight = 5*
6. **Land Acquisition:** Consider property and easement acquisition when selecting an alignment. If a landowner is unwilling to sell at a fair price, the City will have to enforce eminent domain, which may increase the time and effort required to purchase the property. Alignments within City property and roadway right-of-way are preferred. *Weight = 6*
7. **Degree of Effectiveness:** Consider the degree to which the alternative is successful in producing the City's goals, including.achieving 4 or less activations in a typical year. *Weight = 10*

8. **Infrastructure Investment Long Term:** Consider the life cycle of the project, whether it will last for 5, 10, 25, or 50 years. *Weight = 9*

9. **Wellhead Protection:** Consider the location of the project and how it will or will not affect the City's Miller Park Well Field. Weight = 10

The team ranked the alternatives during the Workshop as shown in Table 5-1 Alternative Rankings. The east side alternatives and the west side alternatives were evaluated independently and the eastside alternatives include the cost of the Lawrence Street Equalization Tank and Pump Station. Table 5-1 Alternatives Ranking provides a total weight of each alternative as the product of the weight of each criterion times the ranking used for each alternative. The ranking was based on a range of 1 to 5, with 5 representing the alternative that best meets that criterion. During the process of scoring alternatives, the project team used Table 3-28 Summary of Westside Overflows by Alternative and Table 3-29 Summary of Eastside Overflows by Alternative as an aid to rank the following criteria:

- Capacity and Condition
- WIB Risk
- Degree of Effectiveness

After the alternatives were ranked, the probable capital costs for each alternative were provided so that costs weren't a factor during the ranking process.

Table 5 Alternative Rankings

Alternative	CRITERIA: Capacity and Condition		WIB Risk		Maintenance		Constructability		Regulatory Requirements		Land Acquisition		Degree of Effectiveness		Infrastructure Investment Long Term		Wellhead Protection		SUMMARY	
	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Total	Alternative Opinon of Probable Construction Cost - Planning
5W7A2	5	3	10	5	8	3	9	1	5	3	6	2	10	1.5	9	3.5	10	3	201.5	$9,624,000
8W7A	5	3	10	3.5	8	2.5	9	1.5	5	2.5	6	2.5	10	4	9	4	10	1	197.0	$9,252,999
5W7A1	5	3	10	4.5	8	2.5	9	1.5	5	3	6	2.5	10	1	9	3	10	3	190.5	$6,227,000
4W3A1	5	3	10	4.5	8	1	9	2	5	3	6	1.5	10	1	9	3	10	3	177.0	$13,525,000
7W7A	5	3	10	2.5	8	3	9	2	5	2.5	6	3	10	3	9	2.5	10	1	175.0	$4,226,000
6W7A2	5	3	10	3	8	2.5	9	1.5	5	3	6	2.5	10	1	9	3	10	1	155.5	$9,689,000
3W3A	5	3	10	1.5	8	1	9	2	5	3	6	2	10	3	9	2	10	1	141.0	$5,799,000
2W7A	5	3	10	1	8	3	9	3	5	3	6	3	10	1	9	1	10	1	138.0	$2,212,000
3W4A	5	3	10	1.5	8	1	9	1.5	5	3	6	2	10	1	9	2	10	1	116.5	$6,171,000
3E1A2	5	3	10	5	8	2	9	1	5	2.5	6	2.5	10	4	9	3.5	10	0	189.0	$27,268,000
4E1A	5	3	10	4	8	2.5	9	1.5	5	2.5	6	2.5	10	3.5	9	3	10	0	178.0	$23,867,000
2E1A	5	3	10	3.5	8	3	9	3	5	2.5	6	2.5	10	3	9	1	10	0	167.5	$21,162,000
3E1A1	5	3	10	4.5	8	2.5	9	1.5	5	2.5	6	2.5	10	1	9	3	10	0	158.0	$21,116,000

5.2 Selection of Projects

During the April 8, 2014 Alternative Review Workshop, the Alternatives were reviewed and scored, with Alternative 5W7A2 (2050 Separation without weir/underflow modifications) and Alternative 3E1A2 (2050 Separation without weir/underflow modifications) receiving the highest rankings.

In discussing the attributes that led to the highest Westside alternative ranking, the following attributes, prioritized in order, were determined as the criterion that led to Alternative 5W7A2 (2050 Separation without weir/underflow modifications) being ranked the highest.

1. Water in Basement Risk. The risk of water in basements is of major concern for the City as they want to ensure that their utility improvement projects improve the service provided to residents. A desktop WIB analysis conducted near CSO 1008 and CSO 1009 as part of the Alternative 2W7A analysis indicated that there are potential basements near CSO 1008 that could be impacted from any projects that cause significant increases to the HGL near CSO 1008. However, the degree of effectiveness for this alternative received a lower ranking because 9 annual overflow events occur at CSO 1008 without a modification to the weir.

2. Wellhead Protection. In order to protect the Miller Park well field, the City does not want to construct new infrastructure or replace existing infrastructure through the well field. The attributes of Alternative 5W7A2 that led to meeting the wellhead protection criteria are that the CSO underflow pipes that convey flow through the Miller Park well field do not require being upsized. The 2050 stormwater separation projects in the CSO 1009 Basin, the CSO 1012 Basin, and the CSO 1013 Basin remove enough wet weather flow from the system to utilize the existing underflow pipes and not make modifications to the CSO structure to meet the annual overflow requirements.

In determining the attributes that led to the highest Eastside alternative ranking, the following attribute was determined as the criteria that led to Alternative 3E1A2 (2050 Separation without weir/underflow modifications) being ranked the highest.

1. Water in Basement Risk. The risk of water in basements is of major concern for the City as they want to ensure that their utility improvement projects improve the service provided to residents. Alternative 3E1A2 provides the lowest WIB risk by removing a significant amount of wet weather flow from the collection system with stormwater separation projects. However, Alternative 3E1A2 received the lowest constructability ranking because the separation projects will be very disruptive and difficult to construct.

In further discussion about the proposed capital costs of the highest ranked alternatives, the project team concurred that the proposed capital cost for Alternative 5W7A2 was acceptable in comparison to the other west side alternatives that were deemed as being effective for minimizing water in basement risks and being effective in meeting the annual overflow occurance goals. However, the project team concurred that the cost benefit for Alternative 3E1A2 was too high and that Alternative 4E1A (2025 Storm Separation with weir/underflow modifications) provided an acceptable cost benefit.

The April 8, 2014 Alternative Review Workshop concluded with Alternative 5W7A2 and Alternative 4E1A as the suite of projects to review and optimize to develop the final suite of Recommended Solution Projects to meet the attributes that led highest ranked alternatives. The total cost of combining Alternative 5W7A2 and Alternative 4E1A without optimization would result in total cost of approximately $33,491,000.

5.3 Development of the Recommended Solution Projects

Following the April 8, 2014 Alternative Review Workshop, the project team began working to develop the Recommended Solution projects. With the goal of the selected projects to meet the attributes discussed in Section 5.2 and to minimize sewer separation due to the additional costs and impacts to the neighborhoods, the optimization of the recommended projects were developed based on specific conditions in each basin and are described hereafter. For example, in the CSO 1014 and CSO 1033 basins, underflow pipes were upsized and the degree of sewer separation was reduced.

On the west side, the following provides the baseline of projects for the recommended West Side projects:

- CSO 1008 Basin – Include all 2025 Stormwater Separation Projects with a 7-inch height increase of the CSO 1008 weir (Note: Raising the Weir elevation shall include increasing the weir length to decrease the existing wet weather HGL)
- CSO 1009 Basin - Include all 2050 Stormwater Separation Projects
- CSO 1012 Basin - Include all 2050 Stormwater Separation Projects
- CSO 1013 Basin - Include all 2050 Stormwater Separation Projects
- CSO 1014 Basin - Increase Underflow Pipe that extends from the CSO 1014 Structure to Interceptor Sewer from 12-inch-diameter to 18-inch-diameter.
- CSO 1033 Basin - Increase Underflow Pipe that extends from the CSO 1014 Structure to Interceptor Sewer from 10-inch-diameter to 15-inch-diameter

On the east side, the following provides the baseline of projects for the recommended East Side projects:

- CSO 1019 Basin - Increase the underflow opening and increase the underflow pipe from 18-inch-diameter to 30-inch-diameter to maximize flow to Lawrence Street WPCF.
- CSO 1029 Basin – Include the necessary 2025 separation projects and increase the CSO 1029 weir elevation so that the maximum HGL is near the crown of the 48-inch-diameter interceptor sewer. The City indicated that the Sixth Avenue Storm Sewer would be the only preferred stormwater separation project in the CSO 1029 basin.

The final Recommended Solution Projects for the City of Lancaster's Program for Combined Sewer Overflow Control are represented in Table 5-2 Recommended Solution Projects. Figure 5-1 – Recommended Solution Projects represents the geographical location of the projects required to meet the City's goals.

Table 5-2 Recommended Solution Projects

CSO Basin	Project Name	Pipe ID #	Description	Pipe Diameter	Quantity	Unit
1004	Cherokee Drive CDBG	244	New Storm Sewer			FT
1004	Cherokee Drive CDBG	245	New Storm Sewer			FT
1004	Cherokee Drive CDBG	246	New Storm Sewer			FT
1004	Cherokee Drive CDBG	247	New Storm Sewer			FT
1004	Lawrence Street EQ	105	Replace 360 feet of existing 18" pipe with 48" pipe	48	360	FT
1004	Lawrence Street EQ	106	Replace 25 feet of existing 48" pipe with 60" pipe	60	25	FT
1004	Lawrence Street EQ		3.3 MG EQ with 55 MGD Pump Station at the LSWPCF	-	1	LS
1008	Bank Alley Reconstruction	223 A	Curb and Gutter Stormwater System - Stormwater Pipe for this alley was required to be 18-inch-diameter	-	1	LS
1008	CSO 1008 Improvements		Increase Weir offset from 12" to 19"	-	1	LS
1008	Main Street Catch Basin Relocation		Removal of CB from Sanitary Sewer	-	1	LS
1008	Memorial Drive Storm Sewer	225	18" storm sewer	18	540	FT
1009	Broad St Storm Sewer	219	30" Storm Sewer	30	482	FT
1009	CSO 1009 Catch Basin Removal	-	Reroute 3 catch basins on Memorial Drive north of Mulbery to downstream of CSO 1009.	-	1	LS
1009	CSO 1009 Miller Park at Mulberry	222	42" storm sewer	42	715	FT
1009	Mulberry St Storm Sewer	220	30" Storm Sewer	30	1,094	FT
1009	Mulberry St Storm Sewer	221	42" Storm Sewer	42	397	FT
1012	Broad Fifth Inlet Relocation	-	Relocating the leads from 4 catch basins at intersection of Fifth /Broad from combined sewer running west on fifth (completed)	-	1	LS
1012	Fifth Ave Sewer Separation	215	36" Storm Sewer	36	547	FT
1012	Fifth Ave Sewer Separation	216	42" Storm Sewer	42	674	FT
1012	Fifth Ave Sewer Separation	217	48" Storm Sewer	48	1,399	FT
1012	Fifth Avenue Storm Sewer	213	24" Storm Sewer	24	223	FT
1012	Fifth Avenue Storm Sewer	214	30" Storm Sewer	30	642	FT

CSO Basin	Project Name	Pipe ID #	Description	Pipe Diameter	Quantity	Unit
1012	High Street Storm Sewer	212	18" Storm Sewer	18	491	FT
1012	Mulberry East Storm Sewer	218	1488 ft of 18" storm sewer	18	1,488	FT
1013	Forest Rose Sixth Ave Sewer Separation	211	48" Storm Sewer	48	1,636	FT
1013	Sixth Ave Storm Sewer	210	24" Storm Sewer	24	984	FT
1014	CSO 1014 Improvements	101	Add 18" underflow pipe from regulator to 36" interceptor upstream of YMCA	18	801	FT
1014	CSO 1014 Improvements	-	Abandon 12"	12	1	LS
1019	CSO 1019	102	Increase underflow pipe 18" to 30" from CSO 1019 regulator to Main St interceptor POC	30	201	FT
1019	CSO 1019	-	Increase underflow Orifice 12" to 24"	-	1	LS
1029	CSO 1029	-	Increase Weir offset from 1.8' to 7.5'	-	1	LS
1029	Sixth Avenue Storm Sewer	229	36" Storm Sewer	36	446	FT
1029	Sixth Avenue Storm Sewer	230	36" Storm Sewer	36	537	FT
1029	Sixth Avenue Storm Sewer	231	48" Storm Sewer	48	1,814	FT
1029	Sixth Avenue Storm Sewer	232	60" Storm Sewer	60	603	FT
1033	CSO 1033 Improvements	100	New 15" underflow line from regulator to 36" interceptor	15	600	FT
1033	CSO 1033 Improvements	-	Abandon 10"	-	1	LS
1033	North School Alley Reconstruction	204	Reconstruction of Alley	18	220	LS
	South Broad Street Express Sewer		Broad Streeet Pump Station I&C Upgrades	-	1	LS
	South Broad Street Express Sewer	70	300 feet of new 14" FM at Broad Street PS	14	300	FT
	South Broad Street Express Sewer	71	New 42" Sanitary Sewer from west side of RR to CSO 1004 Structure	42	934	FT
	South Broad Street Express Sewer	71B	New 48" Sanitary Sewer redirecting separate sanitary flow to downstream of CSO 1004	48	280	FT

5.4 Performance of Recommended Solution Projects

Appendix K Recommended Solution Modeling Results provides the modeling results of the Recommended Solution Projects.

With increases in HGL being a concern to the project team, Table 5-3 Recommended Solution versus Allowable Design summarizes the maximum HGLs that occur during wet weather events at the CSO structures and provide any weir elevation changes at the CSO structures that are required as part of the Recommended Solution. In reviewing Table 5-3, there are two locations where increases in the HGL occur during wet weather events. These locations are at CSO 1008 and CSO 1029, and the increases are due to weir elevation modifications.

At CSO 1008, the only wet weather event that creates a higher HGL than the Existing Conditions HGL is the 10-year, 4-hour design storm and the increase in HGL is 0.07 feet (less than 1 inch). To minimize this impact, a new structure could be constructed that includes a longer weir length.

At CSO 1029, all of the wet weather events show a significant increase in HGL at the CSO structure. To maximize the available storage in the existing 48-inch-diameter interceptor sewer that coveys flow to this structure, a broad crested weir is proposed to be added in the structure that would have an elevation that is just above the crown of the interceptor sewer. This increase in weir elevation also pushes more flow through the existing 8-inch sewer, which prevents the need for an increase of the underflow pipe size. To better understand the existing configuration of CSO 1029 structure, see Figure B17 in Appendix B (CSO Modifications). In Appendix K (Recommended Solution Modeling Results), the CSO 1029 Peak HGL Conditions figure provides the maximum modeled HGL resulting from the 10-year, 4-hour design storm. The peak HGL shown CSO 1029 Peak HGL Conditions figure does not cause water in basement concerns as the peak HGL is just above the crown of the interceptor sewer at the most downstream location of the interceptor.

Table 5-3 Recommended Solution versus the Allowable Design

CSO Number	Manhole Structure Information			Scenario	Weir		Maximum HGL (ft)		
	Invert (ft)	Rim (ft)	Depth (ft)		Increase in Elevation (ft)	Overflow Elevation (ft)	5th Largest Annual Storm	Largest Annual Storm	10-Yr, 4-Hr Storm
1008	807.60	820.00	12.40	Existing	-	808.6	809.1	809.75	809.95
				Proposed	0.50	809.2	809.16	809.76	810.02
1009	816.61	829.36	12.75	Existing	-	816.61	817.21	817.68	817.73
				Proposed	0.00	816.61	816.66	816.68	816.69
1012	812.37	822.30	9.93	Existing	-	815.62	816	816.91	816.92
				Proposed	0.00	815.62	812.83	812.89	812.92
1013	815.60	828.80	13.20	Existing	-	817.25	817.73	818.59	818.68
				Proposed	0.00	817.25	815.84	815.85	815.87
1014	807.90	816.70	8.80	Existing	-	809.98	810.32	810.8	810.81
				Proposed	0.00	809.98	808.65	810.5	810.51
1033	813.67	821.00	7.33	Existing	-	816.25	816.65	817.49	817.41
				Proposed	0.00	816.25	814.49	817.24	817.19
1019	805.50	818.00	12.50	Existing	-	807.5	808.38	809.8	809.88
				Proposed	0.00	807.5	807.1	809.08	809.06
1029	815.35	830.20	14.85	Existing	-	817.15	817.54	818.08	818.18
				Proposed	5.7	822.85	822.63	823.75	823.78

In Table 5-4 Recommended Solution Overflow Summary, the degree of effectiveness meets the City's goals with the suite of Recommended Solution Projects providing 4 or less CSO activations in typical year.

Table 5-4 Recommended Solution Overflow Summary

CSO No.	2005 LTCP Addendum			Phase II LTCP					
	1999 Conditions			2012 Existing Conditions			Recommended Solution		
	CSO Open Status	Annual Volume (MG)	No. Annual Activs.	CSO Open Status	Annual Volume (MG)	No. Annual Activs.	CSO Open Status	Annual Volume (MG)	No. Annual Activs.
1004	open	8.53	8	open	26.8	43	open	0.0	0
1005	open	20.77	82						
1006	open	2.86	8						
1007	open	0.00	0						
1008	open	2.77	8	open	1.3	19	open	0.1	4
1009	open	0.04	8	open	5.2	76	open	0.0	0
1010	open	0.01	0						
1011	open	0.06	82	open	3.2	55		0.0	0
1012	open	3.99	20	open	4.3	56	open	0.0	0
1013	open	0.33	82	open	4.8	76	open	0.0	0
1014	open	0.01	20	open	1.7	18	open	0.3	3
1015	open	0.56	20						
1016	open	0.99	82						
1017	open	0.00	3						
1018	open	0.00	3						
1019	open	55.93	82	open	6.0	26	open	0.7	3
1020	open	0.00	0						
1021	open	0.03	8						
1022	open	0.00	3						
1023	open	0.00	3						
1024	open	0.00	3						
1026	open	3.14	82	open	4.2	54		0.0	0
1027	open	1.76	82	open	0.8	29		0.0	0
1028	open	0.00	3						
1029	open	7.06	82	open	3.6	30	open	0.3	3
1030	open	0.00	0						
1031	open	5.30	82						
1032	open	0.00	0						
1033	open	2.83	82	open	1.1	6	open	0.5	3
1034	open	0.75	8						
1035	open	0.00	3						
Total	**31**	**117.7**	**949**	**12**	**63.0**	**488**	**9**	**1.9**	**16.0**

5.5 Equalization Facility Modifications

As part of developing the recommended solution, the project team did a detailed planning evaluation of utilizing the existing Lawrence Street WPCF Trickling Filter Tanks (TF3 and TF4) for EQ with an associated pump station being included to provide a more accurate opinion of probable capital costs as this retrofit opportunity would provide a cost savings versus constructing new facilities. Appendix L – Lawrence Street Equalization and Pump Station Planning provides detailed sketches of proposed modifications at the existing trickling filters tanks. This detailed planning was completed for a smaller storage volume and for a smaller pump station capacity. To account for the increase of 3.3 MG of storage and a 55 MGD Pump Station, approximately $1.2 Million was added to the probable costs provided in Appendix L.

5.6 Recommended Solution Opinion of Probable Capital Costs

The Recommended Solution projects shown on Figure 5-1 have an opinion of probable capital costs of approximately $22,200,000. The costs of the Recommended Solution projects are provided in Appendix M Recommended Solution Opinion of Probable Capital Costs. With the cost of the selected alternative from the Alternatives Review Workshop being approximately $33,491,000, the optimization of projects accounted for most of the cost reduction while approximately $6,000,000 was realized with the detailed planning costs developed for the EQ and Pump Station at the Lawrence Street WPCF.

5.7 Water Quality Standards

Water quality standards are intended to protect human health, aquatic life and its habitat, and recreational use of the nation's waterways. CSOs can cause water quality standards exceedances because of the pollutants that are present in sanitary sewage and stormwater runoff. The CSO Policy requires permittees to evaluate whether CSOs are causing exceedances of the water quality standards and to develop "clear levels of control that would be presumed to meet appropriate health and environmental objectives" (59 Federal Register 18689). The CSO Policy also recognizes the site-specific challenges that CSO communities can face in determining cost-effective controls to meet water quality standards at all times, under all conditions.

With the section of the Hocking River through the City of Lancaster being in attainment as discussed in Section 1, exceedances of water quality standards only occur during wet weather events. With the occurrences and volumes of combined sewer overflow continuing to decrease with the implementation of recommended capital improvements for CSO reduction, the City is meeting the intent of the CSO Policy. Since 1999, the improvements to City's sewer system have reduced both annual overflow volume and annual overflow activations by nearly 50%. The improvements in the recommended solution reduce the 1999 annual overflow volume and 1999 annual overflow activations by over 98%.

The Recommended Solution Projects presented in this Phase II LTCP are fully compliant with the requirements of the CSO Control Policy with an approach that maintains and improves water quality standards and public health objectives. The City of Lancaster's water quality compliance approach is based on EPA's Demonstration Approach in that water quality modeling demonstrates that in the typical year, remaining CSOs do not, in the absence of background loads, cause water quality standard violations in the Hocking River and its tributaries.

5.8 Post Construction Monitoring

The LTCP requirements under the CSO Policy require that the effectiveness of the controls be measured to determine if the goals of the CSO Policy and the requirement of the CWA have been met.

The City of Lancaster currently monitors a wide array of assets for performance including sewer lines, pump stations, treatment plant components, and overflow monitoring blocks to aid in quantifying CSO activations at the nine active CSOs. To understand the duration and intensity of the wet weather events in the City, the City has rain gauges that collect and store data.

To periodically assess the benefits of the improvement projects, it is recommended that the City update their collection system model by incorporating the new projects. Using the collected rain gauge data, the City can run model simulations to depict the current conditions in the collection system, including accounting for already implemented new projects or planning for new projects. The accuracy of the updated collection system model can be determined using the overflow occurrence data that is obtained with the overflow monitoring blocks. If the model simulations depict a number of overflow occurrences similar to those recorded, then the updated model can be deemed accurate.

Using the updated collection system model, the City will be able to assess the effectiveness of the implemented CSO control measures. An important outcome of the monitoring and documentation are the production of computer simulations of the collection system model. The computer simulations will allow the City to estimate the frequency, volume, and duration of CSOs using the typical year simulation to compare against the typical year simulations in this report.

Figure 5-1 Recommended Solution Projects (attached)

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6. Project Implementation

This section presents implementation recommendations for the recommended solution that was identified in Section 5. A detailed Financial Capability Assessment and Affordability study was completed to determine the feasibility of Lancaster implementing the recommended solution by 2025 as indicated in the current NPDES permit Schedule of Compliance.

6.1 Financial Capability Assessment and Affordability

6.1.1 Introduction

A detailed Financial Capability Assessment and Affordability Study was completed for the City of Lancaster Water, Wastewater, and Stormwater utilities and is included as Appendix O in this report. The goal of the study was to assess the current and projected future customer affordability and community financial capability for implementing the Phase II LTCP, and to provide justification to support a regulatory implementation schedule for the Phase II LTCP. An overview of the study contained in Appendix O is included in this section.

As described in the report in Appendix O, the assessment and study evaluated affordability from a broad perspective, including the assessment outlined in the 1997 United States Environmental Protection Agency (USEPA) guidance document *Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development*. The USEPA Financial Capability Assessment methodology is intended to assess customer affordability and the financial capability of the utility and its community to pay for a LTCP.

While this assessment is focused on wastewater and LTCP costs, our analysis included a broader assessment of affordability and financial capability by considering the cost of combined water, wastewater, and stormwater service, and the community's ability to pay for these services. Important socioeconomic indicators that help to provide a more complete picture of a community's economic and social characteristics such as population, labor force, unemployment, income distribution, public assistance, and other economic indicators are also considered.

6.1.2 Customer Bill Comparison

As noted in Figures 6-1, 6-2, and 6-3 below, Lancaster's annual residential rates for wastewater only, water only, and water and wastewater combined are currently the third highest among comparable communities of similar size and characteristics, and are considerably higher than the Ohio median. Data was taken from the Ohio EPA rate survey published in 2012 which is based on a monthly usage of 7,756 gallons per customer.

Figure 6-1 Residential Annual Wastewater Bill Survey

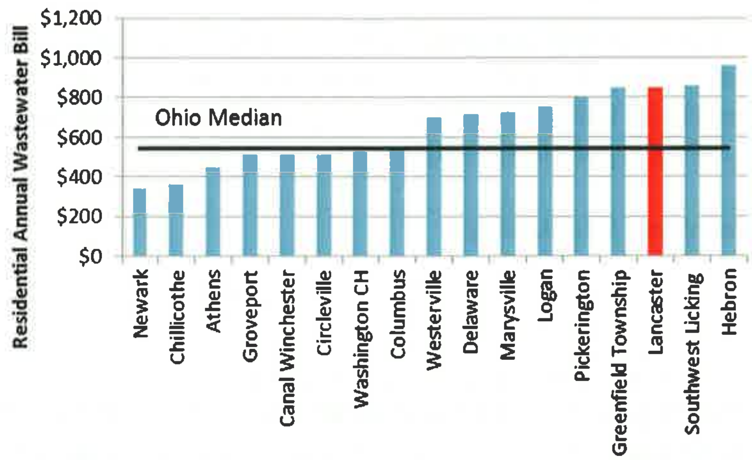


Figure 6-2 Residential Annual Water Bill Survey

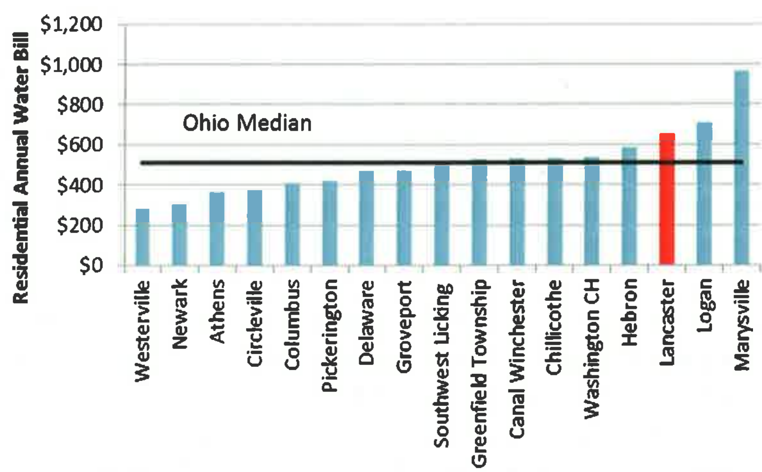
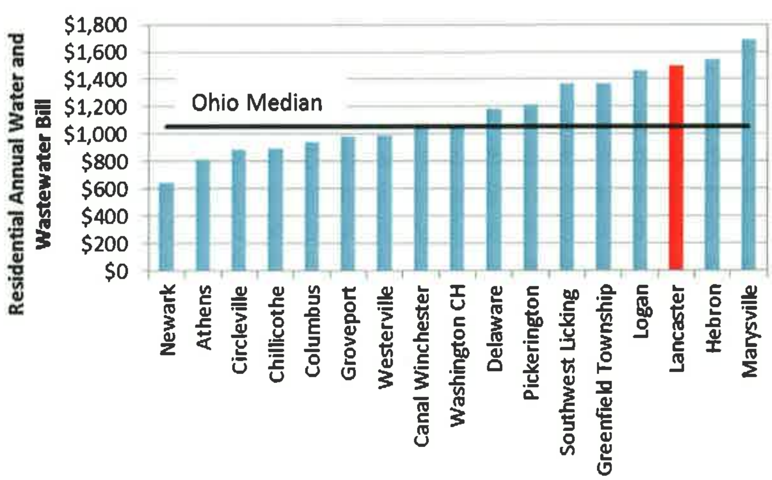


Figure 6-3 Residential Annual Wastewater and Water Bill Survey



6.1.3 USEPA Financial Capability Assessment

The USEPA guidance document outlines a two-phased process for assessing the financial capability to fund a LTCP. Phase I of the analysis assesses residential customer financial capability as measured by the Residential Indicator. The Residential Indicator is calculated by dividing the total projected residential cost by the MHI. If the costs are at or above one percent of the MHI, a Phase II analysis is completed. The Phase II analysis assesses community financial capacity (i.e., financial strength and financing capacity) to afford the program.

6.1.3.1 Residential Indicator

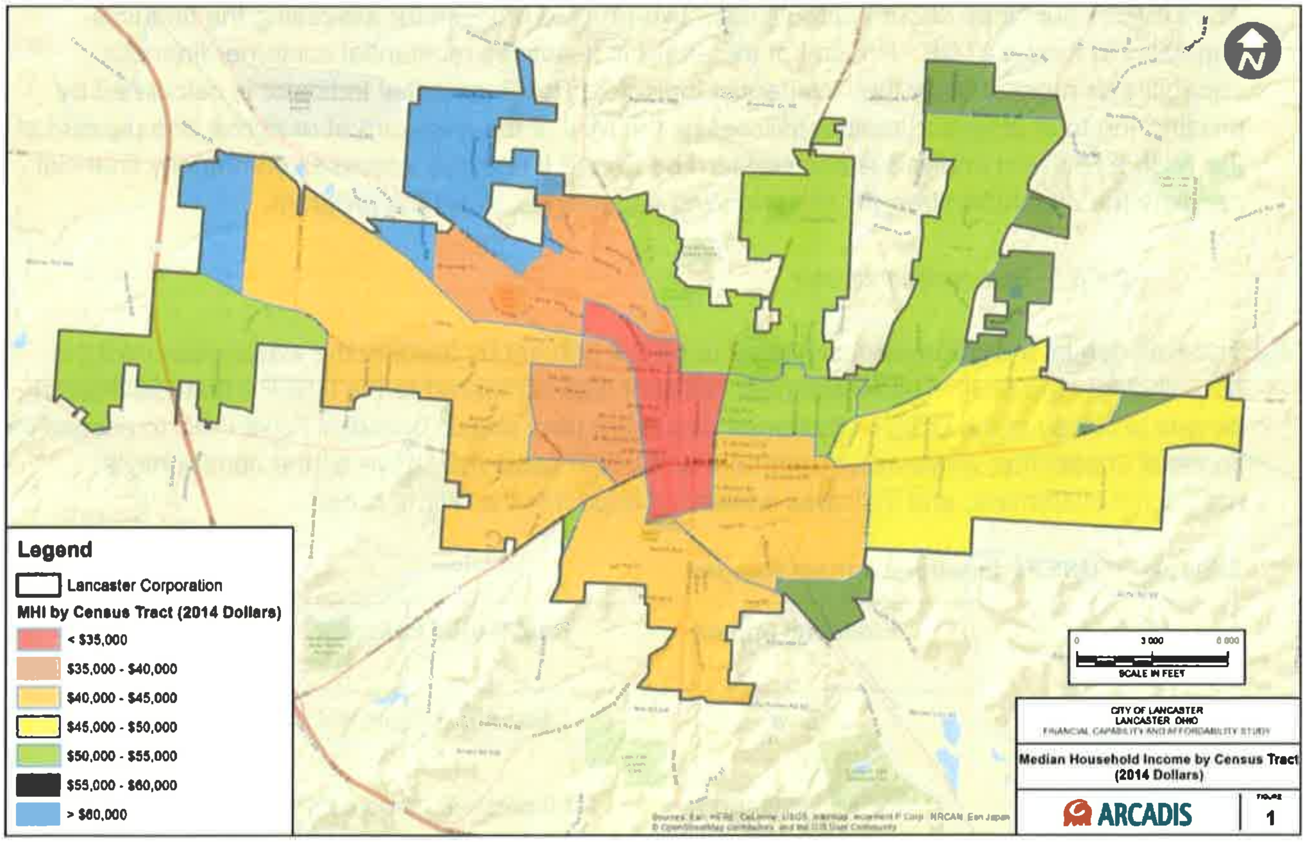
The Residential Indicator was calculated to be 2.9 percent by dividing the wastewater cost per household by the MHI. The Residential Indicator was compared to the USEPA financial impact ranges provided in the USEPA guidance document (and shown below in Table 6-6) to assess the financial impact that wastewater treatment and LTCP costs may have on the community's residential customers, and indicates a financial impact in the "High" range.

Table 6-1 USEPA Financial Impact Ranges

Financial Impact	Residential Indicator
Low	Less than 1.0 percent
Mid-Range	1.0 percent-2.0 percent
High	**Greater than 2.0 percent**

Due to the variability of income levels across the City's service area, some neighborhoods within the service area will experience more severe economic hardship as a result of implementation of the LTCP, and will have residential cost as a percentage of household income that is much greater than the median. Figure 6-4 presents the residential cost as a percentage of household income by Census block, and shows a much higher cost burden on these low income neighborhoods.

Figure 6-4 Median Household Income by Census Tract (2014 Dollars)



6.1.3.2 Community Financial Capability Indicators

The USEPA guidance document states that if the Residential Indicator is greater than one percent (1 percent), Phase II of the analysis should be completed. In light of the City's residential indicator results of 2.9 percent of MHI, this subsection provides an analysis of the community financial capability indicators. These indicators characterize the permittee's debt burden, socioeconomic conditions, financial operations, and the ability to secure the funding necessary to implement the LTCP. Under this phase of the assessment, a financial capability index was developed based on six individual indicators. These six indicators are as follows:

- Debt Indicators
  - Bond rating
  - Overall net debt as a percentage of full market value of taxable property
- Socioeconomic Indicators
  - Unemployment rate
  - Median household income

- Financial Management Indicators
    - Property tax revenues as a percentage of full market property value
    - Property tax revenue collection rate

Based on this analysis, the City has an overall Financial Capability Indicator score of 2.3 which corresponds to a "Mid-Range" financial capability indicator rating based on the USEPA methodology. Table 6-2 summarizes the financial indicators, the scores associated with each indicator and the average score for all indicators. The average score is used to determine the overall indicator score. It should be noted that USEPA's methodology assigns equal weights to each category.

Table 6-2 Financial Capability Indicator Score: Wastewater System

Indicator	Actual Value	Indicator Range	Score
Bond Rating	Aa3, AA	Strong	3
Overall Net Debt as a Percentage of Full Market Value	2.9 percent	Mid-Range	2
Unemployment Rate	6.9 percent	Strong	3
Adjusted Median Household Income	$39,411	Weak	1
Property Tax Revenues as a Percentage of Full Market Property Value	0.59 percent	Strong	3
Property Tax Revenue Collection Rate	97.3 percent	Mid-Range	2
Overall Financial Capability Indicator Score		**Mid-Range**	**2.3**

6.1.3.3 The Financial Capability Matrix for Wastewater

Using the USEPA methodology, the results of the Residential Indicator and the Financial Capability Indicators assessments were combined into a Financial Capability Matrix to evaluate the level of financial burden that WWT and LTCP costs may impose on the City. The original purpose of the matrix in the 1997 CSO Guidance Document was to assist the utility and regulatory agencies in establishing a CSO control implementation schedule. The Financial Capability Matrix populated for the City is shown in Table 6-3.

Table 6-3 Wastewater Financial Capability Matrix Score

Financial Capability Indicators Score (Socioeconomic, Debt and Financial Indicators)	**Residential Indicator (Cost per Household as a Percent of MHI)**		
	Low (Less than 1.0%)	**Mid-Range (1.0% to 2.0%)**	**High (Greater than 2.0%)**
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (1.5 to 2.5)	Low Burden	Medium Burden	**High Burden**
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

Based on a "High" financial impact Residential Indicator of 2.9 percent and a "Mid-Range" Financial Capability Indicator score of 2.3, the City's financial capability matrix score is estimated as "**High Burden**". This indicates that a typical LTCP proposed to control CSOs would be a significant burden on the City and its customers.

6.1.3.4 Combined Water, Wastewater, and Stormwater Residential Indicator

Similar to the wastewater financial capability analysis, the Residential Indicator was calculated for the combined water, wastewater, and stormwater systems by first determining the total cost of treatment for water and stormwater systems separately. The combined CPH is the sum of the water, wastewater, and stormwater system CPHs. Once the combined CPH was estimated, the Residential Indicator was calculated by dividing the combined CPH by the MHI of the community. As shown in Table 6-4, the Combined Residential Indicator was calculated to be 4.7 percent.

Table 6-4 Calculation of Combined Residential Indicator

Adjusted MHI	$39,411
Combined Cost per Household, Annual	$1,841.22
Combined Residential Indicator (CPH as percent of MHI)	**4.7 percent**

EPA's stated view on potable water is that it is affordable if it costs less than 2.5 percent of a small community's MHI. It is commonly inferred that EPA would consider a combined annual water and wastewater bill of less than 4.5 percent to be affordable. **Many households, more than 50 percent, would pay more than 4.5 percent of their income on combined utilities.** It should be noted that for grant review purposes, the Ohio Public Works Commission defines the threshold of affordability as 1.74 percent for both water and wastewater in District 17.

6.1.3.5 Summary of Assessment

The findings of the assessment are as follows:

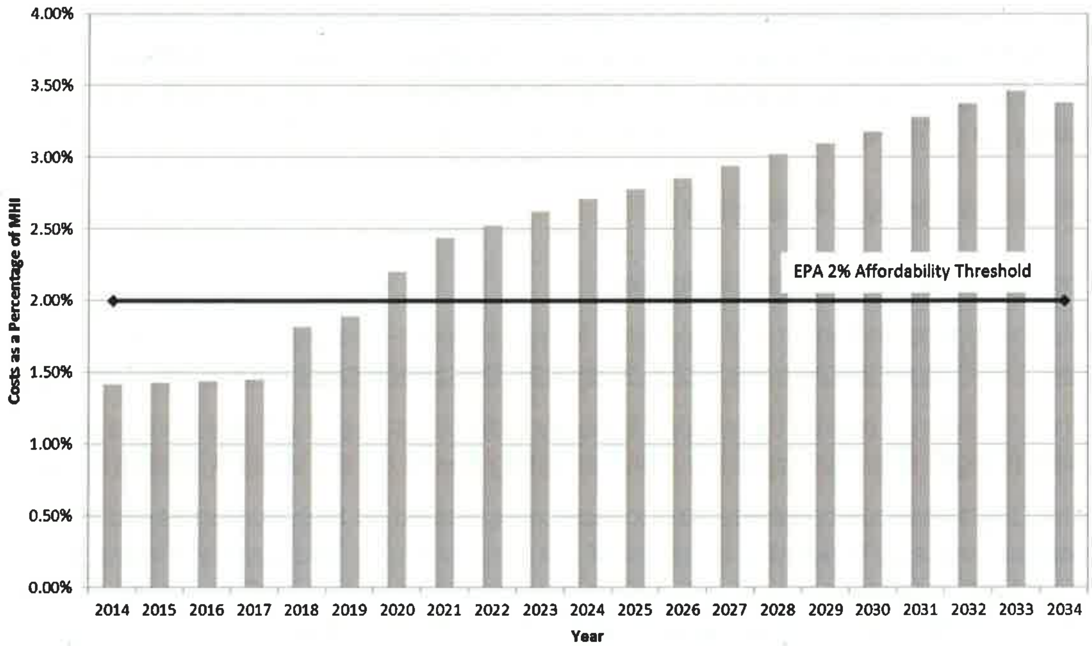
- The residential indicator of 2.9 percent for wastewater indicates that wastewater treatment and LTCP costs would have a high impact on the community's residential customers.
- The City has an overall Financial Capability Indicator score of 2.3 which corresponds to a "Mid-Range" financial capability indicator rating based on the USEPA methodology.
- The City's financial capability matrix score is estimated as high burden based on a "High" financial impact Residential Indicator of 2.9 percent and a "Mid-Range" Financial Capability Indicator score of 2.5. This indicates that a typical LTCP proposed to control CSOs would be a significant burden on the City and its customers.
- The combined residential indicator for wastewater, water, and stormwater is 4.7 percent. Many households would pay more than 4.5 percent of their income on combined utilities.
- Commercial and Industrial communities would also experience higher bills and additional hardships if rates were increased for the proposed LTCP.
- The maximum cost and schedule relief should be allowed for the City given its limited financial capability.

6.1.4 Rate Impact Analysis

In order to present a more comprehensive picture of the City's financial capability and customer affordability, an analysis was completed that considered the long-term rate impacts of future capital improvements, based on meeting Ohio EPA's 2025 deadline. Year-by-year costs are presented as a percentage of MHI. In this analysis, annual rate increase needs were estimated based on the estimated annual revenue requirements. The total annual bill per customer was then divided by the adjusted MHI to calculate a typical residential customer's annual bill as a percentage of MHI.

Figure 6-5 shows that the estimated wastewater bill will exceed the EPA affordability threshold beginning in FY2020, and indicate that significant economic hardship may occur over the forecast period, and the City would have limited capacity to fund other programs or additional Federal or State mandates in the future. Therefore, the City should receive the maximum amount of schedule relief for implementing its LTCP.

Figure 6-5 Annual Estimated Wastewater Bill as a Percentage of MHI



6.1.5 Non-residential Affordability

Although the financial capability assessment focuses on the City and residential community's financial capability, industrial affordability should not be neglected. The City desires to boost its economy by attracting new industries and keeping existing ones. If the City were to lose a key customer such as Anchor Hocking, which is their largest wastewater and water customer, the effects would be devastating. For example, Anchor Hocking contributed 3 percent of wastewater revenues and 2 percent of water revenues to the system. If Anchor Hocking were to shut its doors in Lancaster, the majority of the revenues would need to be collected from remaining customers. In addition to losing revenue from this customer and all of the associated jobs, the City would have to raise rates and decrease their ability to bring in new industries.. Therefore, the City must strive to also have rates that are competitive to other Cities in the mid-west. This goal is challenging because rates are already high when compared to other similar communities in the state (Figures 6-3 and 6-4). For example, Anchor Hocking competes with other similar manufacturers, including Libby Glass, which has a manufacturing facility located in the CSO community of Toledo, Ohio. A facility the size of Anchor Hocking operating in Toledo would pay 18 percent and 62 percent less for wastewater and water usage, respectively as shown in Table 6-5.

Table 6-5 Anchor Hocking Location Comparison

	2013 Usage (100 CF)	Cost in Toledo	Cost in Lancaster	Percent Change in Cost
Anchor Hocking - Wastewater	60,577	$243,224	$294,945	(18 percent)
Anchor Hocking - Water	41,166	$51,966	$137,833	(62 percent)

6.1.6 Socioeconomic Conditions

This assessment must also focus on important socioeconomic indicators that can help to provide a more complete picture of a community's economic and social characteristics such as population, labor force, unemployment, income distribution, public assistance, and other economic indicators. The following is a synopsis of numerous critical socioeconomic characteristics that were identified for Lancaster:

- As a result of a decrease in the City's general fund over the last several years, staff reductions, including fire and police, have occurred. There are unfilled positions in the utility department due to lack of funds.
- The annualized population growth has averaged approximately 0.7 percent over the last five years.
- Approximately 27 percent of the population is over 55 years old.
- The local labor force has benefitted by access to jobs in the Columbus area. In 2012, the unemployment rate for Ohio was 7.4 percent, while the unemployment rate for the City was slightly below the state rate at 6.9 percent. Approximately 10.5 percent of the civilian labor force within the City is employed outside the City of Lancaster.
- Despite modest population growth and moderate unemployment rates, the poverty rate for the City have increased since 1990 and was at 20.2 percent in 2012, as compared to 16.1 percent for the State of Ohio.
- As of 2012, the average earned income in the City was 20 percent below the Ohio average and 27 percent below the national average. In 2007, the City was 15 percent and 22 percent below the Ohio average and national average, respectively. Therefore, the gap between both the state and national average MHI and the City's MHI is widening.
- The lowest 20 percent of households in the City earn less than $16,034 per year. This is 18.2 percent and 24.4 percent below Ohio and the U.S., respectively.
- The income levels in the City are more concentrated toward the lower end of the income spectrum than Ohio and the U.S., and are substantially lower than the incomes at the upper end.

- The incomes for the elderly households in Lancaster are more concentrated in the lower end of the income spectrum as compared to all households.
- The Home Energy Assistance Program (HEAP) is a social service provided by the Lancaster – Fairfield Community Action Agency. HEAP offers heating bill assistance during the winter heating season. This program is available to households that are at or below 175 percent of the federal poverty threshold. The number of households participating in HEAP during the last two winter seasons has been almost 10 percent each year. This provides an indication of the extent of economic hardship within the service area.
- The lowest income category, representing 25 percent of households, already has an average wastewater bill amounting to more than 5.3 percent of their MHI. The total utility bill is approximately 19 percent of their MHI.
- A notice is sent to the customer if they are more than ten days late in paying their utility bill. In 2013, the average number of notices generated per month was 2, 271, which is approximately 13 percent of all customers and a strong indicator that some customers are struggling to pay their current utility bills. The average number of monthly shut-offs was 19.

6.2 Implementation Schedule

The goal of the Implementation Schedule is to provide a phased construction and financing schedule based on the relative importance of the specific projects in the plan that is consistent with the financial capability of the rate payers in the City of Lancaster service area and that are consistent and coordinated with other City utility projects. Some additional factors utilized in development of the Capital Improvement Plans noted below include consideration of the following:

- Street Paving
- Traffic and Detours
- Existing Utilities
- Miller Park Wellfield
- Street Crossings - Memorial Drive and Main Street
- Stream Corridors

To evaluate affordability for stormwater and wastewater related services, this Phase II LTCP Alternative Analysis and Recommended Improvement Plan provides two scenarios for meeting compliance. Figure 6-6 2025 CSO Compliance CIP illustrates all of the City's wastewater and stormwater CIP projects by year and includes completing the Recommended Solution by 2025. Table N1 - Summary of 2025 CIP and 2035 CIP Funding Schedules and Table N2 - 2025 CIP in Appendix N Capital Improvement Plans provide the annual costs for all of the City's wastewater and stormwater capital improvements and operation and maintenance projects required to reach compliance by 2025. This plan was evaluated in the Financial Capability Assessment and Affordability Study to determine if the residents of the City can afford the costs of the 2025 CSO Compliance CIP.

Figure 6-7 2035 CSO Compliance CIP illustrates all of the City's wastewater and stormwater CIP projects by year and includes completing the Recommended Solution by 2035. Table N1 - Summary of 2025 CIP and 2035 CIP Funding Schedules and Table N3 - 2035 CIP in Appendix N Capital Improvement Plans provides the annual costs for all of the City's wastewater and stormwater capital improvements and operation and maintenance projects required to reach compliance by 2035.

6.3 Findings and Conclusions

The following are the conclusions of the Financial Capability Assessment and Affordability Study:

- Currently, the City's water, wastewater, and stormwater rates are already among the highest when compared similar sized cities and economic competitors.
- Despite modest population growth and moderate unemployment rates, the poverty rates for the City have significantly increased since 1990, which may be due to the fact that the City has a low percentage of population with a bachelor's degree as compared to other municipalities in Ohio and across the U.S.
- The City's median household income is low in comparison to other municipalities in Ohio and across the U.S. The distribution of income across the service area demonstrates that the population of a large portion of the City has incomes that are significantly below the MHI.
- Over half of the households are defined as low and moderate income, indicating that many households would experience added hardship by increasing utility rates to fund proposed CIP and LTCP costs associated with permit compliance by 2025.
- The City has a significant population of elderly households, and many of these households have incomes that are significantly below the MHI.
- The City has implemented assistance programs to provide relief to customers with affordability problems, but the number of "Notices of Termination" from delinquent accounts demonstrates that affordability is already a major concern.
- The City's financial capability matrix score is estimated as high burden based on a "High" financial impact Residential Indicator of 2.9 percent and a "Mid-Range" Financial Capability Indicator score of 2.5. This indicates that a typical LTCP proposed to control CSOs would be a significant burden on the City and its customers.
- The combined residential indicator for wastewater, water, and stormwater is 4.7 percent. Many households would pay more than 4.5 percent of their income on combined utilities.

- It is anticipated that the City would need to more than triple the wastewater rates between 2014 and 2034 in order to pay for the LTCP and other identified capital needs of the system. The projected rate increases are much higher than the anticipated rate of cost inflation, and would quickly increase the wastewater bill for the median residential customer above 2 percent of the MHI. By 2034, the wastewater bill as a percentage of MHI could exceed 3 percent. These increases would likely result in rate shock and economic hardship for City wastewater customers.
- Small businesses and industries would also experience significant increases to their wastewater bills over the forecast period, similar to residential bills, impacting the City's ability to provide cost competitive wastewater service to its customers, and likely placing added pressure on commercial and industrial customer's ability to be cost competitive, and possibly impacting their economic viability and ability to continue doing business in Lancaster.
- The City's economy is sensitive to losing large industries, and thus, the City is making every effort possible to attract new industries. Increasing utility rates to fund proposed CIP and LTCP costs associated with permit compliance by 2025 would make it hard for the City to remain competitive as a destination for new and existing industries, further exacerbating the local economic issues.
- With the current LTCP costs and projected implementation schedule, the City would have limited capacity to fund other programs or additional Federal or State mandates in the future.
- It is anticipated that water rates will need to increase moderately over the forecast period (2014 through 2031) in order to keep water infrastructure in good working condition and to pay for water system operating costs.
- Although stormwater revenue requirements will continue to increase, the City is planning to keep stormwater rates flat through 2025 due to the fact that City stormwater rates are already among the highest when compared to similar sized cities and economic competitors.
- Given these considerations, the City should receive the maximum amount of cost and schedule relief for implementing its LTCP.

Figure 6-6 2025 CSO Compliance CIP (attached)

Figure 6-7 2035 CSO Compliance CIP (attached)