Bypass Elimination Plan

Ava, Douglas County, Missouri

Prepared for: City of Ava, Missouri

Prepared by: HDR Engineering, Inc.
2139 E. Primrose, Ste E
Springfield, MO 65804
417-865-4083

Missouri Certificate of Authority #000856

HDR Project No. 150951

Date: November 28, 2011

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Michael Pessina - Engineer

MO# PE-2003001091

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SECTION 1 INTRODUCTION

1.1 PURPOSE

The purpose of this plan is to present the best course for elimination of bypasses at the Ava, MO WWTP. The Missouri Department of Natural Resources (MDNR) defines a bypass as "the diversion of wastewater from any portion of a wastewater treatment facility or sewer system to waters of the state." This report evaluates the operation of the existing wastewater treatment plant (WWTP) and collection system and develops recommendations to best eliminate bypasses in a cost effective manner. This bypass elimination plan has been prepared in response to a Voluntary Compliance Agreement (VCA) between MDNR and the City of Ava.

1.2 SUMMARY

The Ava WWTP is currently capable of treating peak flows of up to 3.7 MGD with additional storage of up to 8.97 million gallons (MG) in an existing lagoon. In previous years, high flow events were diverted into the lagoon where flow was discharged into the receiving stream after receiving primary treatment. This is no longer permitted and is now considered bypassing. In order to eliminate future bypasses this plan evaluates three possible alternatives. The alternatives are treatment plant expansion and modifications, an equalization basin, and collection system improvements.

It is recommended that the city first modify the WWTP as discussed in **Section 3.2.2** to ensure the plant can adequately treat up to 3.7 MGD. Once this is complete it is suggested the City focus on collection system improvements. These improvements should be pursued according to the schedule presented in **Section 3.6**.

SECTION 2 EXISTING CONDITIONS AND NEEDS

2.1 Wastewater Treatment Plant

2.1.1 System Description

The City of Ava, Missouri owns and operates the wastewater treatment plant, serving a population of 2993 as of the 2010 Census. The WWTP is operated under Missouri State Operating Permit MO-0056260 and has an expiration date of September 15, 2015. Effluent from the plant is discharged into an unnamed tributary to Prairie Creek. The WWTP was upgraded in 2003 to have a design capacity of 0.7 MGD and a peak flow capacity of 3.7 MGD.

Flow to plant comes form two drainage basins, historically described as being the north half and the south half of the city. Flow enters the WWTP and goes through a Parshall flume to the influent pumps. Flow is then pumped into a selector basin. Following the upgrades in 2003, it was found the basin overflowed during high flow events. To eliminate the overflow, an additional pipe was installed from the selector basin to the top of the oxidation ditch. Flow from the selector basin then flows to the oxidation ditch. Wastewater flows from the oxidation ditch into the three final clarifiers by way of a mixed liquor flow splitter. Another flow splitter then splits the flow leaving the clarifiers, into the three filters. Upon evaluation of the hydraulic profile it was determined that neither flow splitter provides an even split of flow in certain operating scenarios. Wastewater leaving the filters then passes through an effluent Parshall flume and enters the ultraviolet disinfection system. After disinfection, flow is then discharged into the receiving stream.

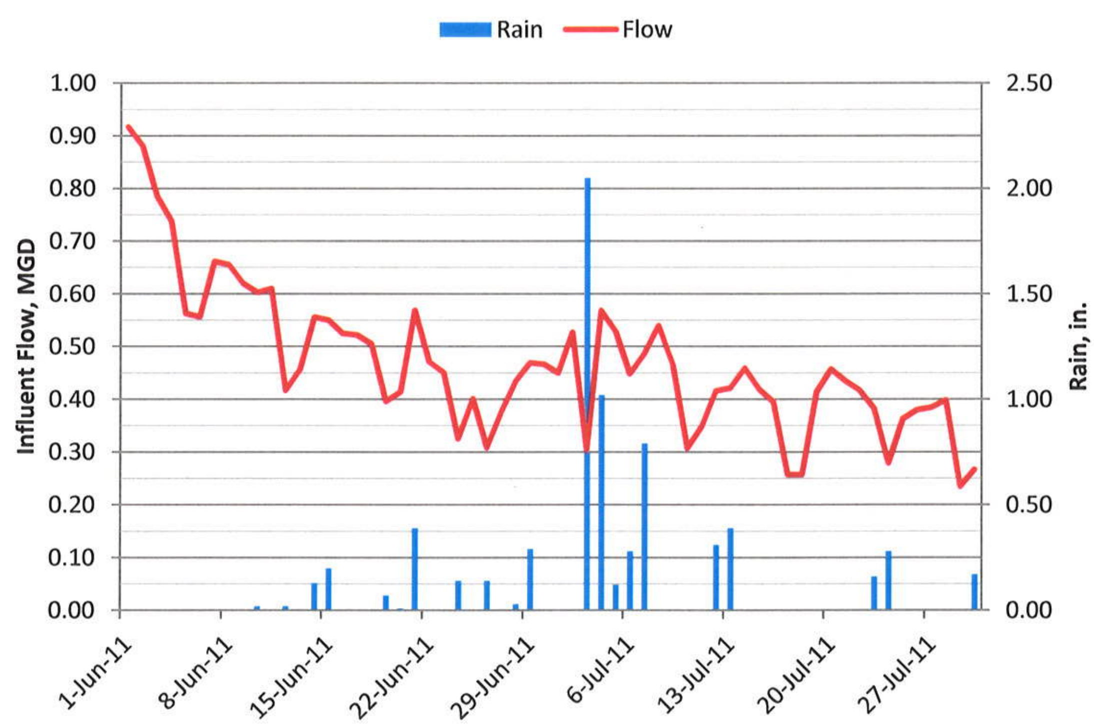
Historically during high flow events, the treatment plant diverted some of the flow around the plant. The diverted flow was discharged to a lagoon located north of the plant for primary treatment and then discharged into the receiving stream at Outfall 002. All of the flow to the lagoon comes from the north side of the city. All flow from the south must go to the treatment plant. Recent piping improvements allow flow from the lagoon to be returned to the WWTP allowing the lagoon to be used as an equalization basin.

The lagoon has a maximum water surface elevation of 1187.0, and a bottom elevation of 1182.0. In order to comply with MDNR regulation, a minimum of two feet must be maintained in the lagoon and is not considered part of the usable volume. Using a bottom elevation 1184.0 gives the lagoon a maximum depth of five feet and a maximum volume of 8.97 MG.

2.1.2 Historic Flow Rates

The WWTP influent is measured at a Parshall flume. Only treated flow is measured at the Parshall flume. Any flow diverted to the lagoon is not measured until it is returned to the plant. Because of this actual peak flows in the system are not recorded. The daily influent flow for the period of June 2018-July 2011, representing all flow to the treatment plant is shown in Figure 2-1. This does not include flow that was diverted to the lagoon. Over this period, the average flow is approximately 0.47 MGD.

Figure 2-1. Daily Influent Flow



2.2 Collection System

2.2.1 System Description

The Ava collection system consists of approximately 24.6 miles of sewer pipe, 440 manholes, and 3 pump stations. Approximately 23.9 miles operate as gravity sewers with the remainder operating as a four-inch force main pressurized by a pump station. The collection system is comprised primarily of eight inch laterals which tie into either one of the larger interceptor sewers or the wet well of a pumping station.

2.2.2 Historic Flow Rates

Flow data was gathered from around the city in 2000. Because of irregularities in the results, this data is not conclusive as to actual flows present in the collection system. The city currently owns two flow meters that were refurbished in 2011 and data is currently being gathered by the City of Ava.

Flow data is currently being gathered from the south sewer truck, immediately upstream of the WWTP, and the north sewer trunk, immediately upstream of the lagoon diversion structure. Flow measurement at these two locations would determine the flow division between the north and south basins. Flow measurements at these locations during peak events would also provide a way to measure the amount of flow being diverted during high flow events. Flow meter data has been received from these to locations over from June 1 through June 5, 2011 and August 20 through August 22, 2011. This data can be found in **Appendix A**.

Data collected over the above dates appears to be accurate. However due to lack of wet weather during this time, firm conclusions cannot yet be made. Although peak flows for the two sewer trunks cannot be determined it is clear that flow is diverted to the lagoon before peak flows to the plant are reached. **Table 2.1** shows recorded plant influent flow, sewer trunk flows, and the diverted flow during rain events. The negative diverted flow on July 2 indicates wastewater from the lagoon was directed back to the WWTP.

Table 2-1. Collection System Flows

Date	Rain, in.	WWTP Flow, gpd	South Trunk Flow, gpd	North Trunk Flow, gpd	Combined Trunk Flow, gpd	Diverted Flow, gpd
1-Jul-11	0.00	450,000	30,342	476,679	507,021	57,021
2-Jul-11	0.00	527,000	27,739	302,060	329,799	-197,201
3-Jul-11	2.05	303,000	25,937	321,682	347,619	44,619
4-Jul-11	1.02	568,000	70,077	712,968	783,045	215,045
5-Jul-11	0.12	528,000	74,693	573,603	648,297	120,297

2.2.3 Previous Evaluations

The City has smoke tested and flow monitored different parts of the city in 2000 and prior years. Flow data records were not consistent and were not able to be used to determine where large I/I sources could be found. It appears the flow meters used malfunctioned several times and different locations throughout the city. Smoke testing has been conducted by city staff through parts of the city. City personal indicated smoke testing did not identify any large I/I sources through this testing.

SECTION 3 ALTERNATIVES

3.1 OVERVIEW

The Ava WWTP is currently capable of treating up to 3.7 MGD with a lagoon capable of holding a maximum of 8.97 MG. In order to eliminate all bypasses in the system three alternatives have been evaluated: treatment plant expansion, construction of an equalization basin, and collection system improvements. The first two alternatives seek to manage the peak flows while the third seeks to reduce them.

3.2 TREATMENT PLANT MODIFICATIONS AND EXPANSION

3.2.1 Plant Expansion

The treatment plant is hydraulically capable of treating up to 3.7 MGD with a few modifications and has the lagoon capable of holding of up to 8.97 MG. Total influent flow to plant is unknown as diverted flow is not measured. The WWTP currently treats an average flow of 0.47 MGD, based on data from June 2011-July 2011. As shown above, in **Table 2-1**, the plant does not currently allow flows to reach capacity during peak events before diverting to the equalization basin. Expansion of the WWTP is not a recommended alternative since peak flows are unknown and the plant is currently capable of treating significantly higher flows than currently being treated.

3.2.2 Plant Modifications and Operational Changes

In order to for the plant to be able to treat the design peak flow of 3.7 MGD a few modifications and operational changes need to be made. Plant modifications include:

1. Adjust the range of the adjustable weir in the inlet box. The range needs to be increased so that the lowest height is set at 1201.15. This will allow for an even flow split between clarifiers when FC3 is online. A minor modification of the concrete structure is required to accomplish this.

2. Check the set points on diversion controls to the lagoon. The set points should maximize flow to the WWTP prior to diverting flow to the lagoon. The minimum amount of flow possible should be diverted to the lagoon. The automatic system should be evaluated and put back in service.

Plant operational changes include:

1. Decrease the RAS/WAS flow rate during peak flows to 0.7 MGD. Operating at normal RAS/WAS rates at peak flows will cause the selector basin to potentially overflow. Another option is to direct all influent flow to the innermost channel of the oxidation ditch and keep RAS/WAS flow in the outermost channel. Once the

flow returns to normal conditions the RAS/WAS flow rate should be returned to normal, and the influent flow should be redirected to the outermost channel of the oxidation ditch for normal operation.

2. Do not operate Final Clarifiers 1 and 2 (FC1 and FC2) together with Filter 3 (F3) as one of the two filters online. Operating the clarifiers and filters in this scenario will result in an uneven flow split between the two operating filters causing the other filter to be overloaded.

3.2.3 Costs

The costs associated with adjusting the range of the adjustable weir in the inlet box as well as fixing the automatic system to control diversion to the lagoon are anticipated to be approximately $25,000.

3.3 Equalization Basin

The City has a lagoon that they are now using as an equalization basin during peak flows. This basin has a maximum holding capacity of 8.97 MG. Only flow coming from the north trunk can be diverted to the basin. Not knowing the peak flow and division of flow coming from the north and south trunks makes it difficult to determine if the current lagoon is adequate. If the south trunk carries more than 3.7 MGD, an additional equalization basin may be necessary. The amount of flow being diverted to the current lagoon is also unknown, thus it is unknown if the size of this lagoon is adequate to hold the diverted flows until it can be redirected to the WWTP. Building a new or adjusting the current equalization basin is not recommended unless future flow data indicates it necessary.

3.4 Collection System Improvements

Improvements to the collection system would decrease flow to the plant. Although peak flows are unknown, it can be reasoned the city would not have to greatly reduce inflow and infiltration (I/I) because of the peak flow capacity of the WWTP plus available equalization volume. In order to determine the amount of I/I that should be removed from they system, flow data needs to be collected through out the entire city.

In order to effectively improve the collection system to remove the necessary amount of I/I, the entire collection system needs to be inventoried and evaluated. The City of Ava currently has a map of their sewer system. However it is suggested that the accuracy of that map be checked and that all manholes be located. All manholes should be inspected and all sewer line should be smoke tested. Once this is done the city can be divided into three priority groups: high, medium, and low priority. For purposes of this plan, it is assumed each group will be one third of the system. Once the level of priority is known further investigation can be conducted to identify the causes of large inflow events.

Repairs can then be made based on how much I/I can be eliminated per repair. Addressing inflow is expected to be the priority for eliminating bypasses.

3.4.1 Inventory and Evaluation

Flow and Rainfall Monitoring

It is recommended that the city continue to collect flow data from all parts of the City with the two flow meters they currently own. The flow meters should be placed in strategic locations to identify which areas experience significant I/I entering the system and aid in determining where further inspection and evaluation efforts should be concentrated. Rainfall data should also be collected during the same period as flow monitoring so peak flows can be correlated to rainfall events.

Dry weather flows should be compared to peak flows following rainfall events for calculation of dry weather flow to peak flow factors. Higher priority areas shall be determined based upon known problems within the city and preliminary flow monitoring. Generally, a high peaking factor means a large amount of I/I is entering the system. Low peaking factors will indicate lower priority areas. Regions with high peaking factors will be considered higher priority areas and additional flow monitoring and other field investigations will be performed. It is assumed that the system will be broken up into thirds with each third being high, medium, or low priority. This may change once flow data is gathered and peak factors determined.

Flow data should be collected from the entire city both before and after improvements are made to determine how much I/I was able to be eliminated from the system.

Manhole Inspections and Mapping

Manhole inspections should be completed for all manholes. Manhole inspection forms, like the forms previously used, should be completed for each manhole. Photos of each manhole should also be taken during inspections. All of the information collected will be used to estimate the amount of rehabilitation work required for each manhole. While completing these manhole inspections it is recommended that the City's current map be checked for accuracy and updated as needed.

Smoke Testing and House Inspections

All gravity sewer lines should be smoke tested to identify public and private inflow sources. Forms should be completed for each line of sewer tested. Results should include addresses of suspected I/I sources and photos of smoke found during testing.

It is also recommended that house inspections be conducted. It is expected that a large portion of the inflow problems will be found in privately owned services. House inspections will look for down spouts, sump pumps and foundation drains connected into the sewer system and openings in the system like missing cleanout caps.

CCTV of Sewer Mains

CCTV inspections of sewer lines are valuable where smoke testing results or manhole inspections indicate problems in the sewer line or where blockages that can result in overflows are suspected. CCTV inspections are good for finding infiltration sources and sanitary sewer overflow causes. Since the purpose of the collection system improvements for the Bypass Elimination Plan is to focus on inflow sources, CCTV inspections are not recommended as a part of this plan but are recommended as part of a sanitary sewer overflow reduction plan.

3.4.2 Repairs and Rehabilitation

Repairs and rehabilitation to the collection system both on the private and public side should be made based on the results from the above inspections and testing. High priority areas should be completed first, followed by the medium and lower priority areas. Based on the inspections and testing, repairs and rehabilitation should be prioritized based on the amount of inflow/infiltration that could be eliminated per repair.

It is expected that many inflow sources will be found on the private side of the system. The majority of private side repairs are expected to be sump pump and downspout disconnections. The City of Ava has decided to make private side repairs voluntary. Having a voluntary plan, requiring the homeowner the make the repair, will decrease the number of private repairs being done, and will likely increase the amount of public repairs.

Public system improvements are expected to include manhole and sewer line rehabilitation. These improvements could include manhole and sewer line lining, replacement, or point repairs based on the type of problems found in the system.

3.4.3 Costs

Collection system improvements are recommended to be the focus for the first five years. After this time, if adequate progress is being made improvements to the collection system will continue as scheduled. However, if adequate progress is not being made the need for an equalization basin will be reevaluated. A planning level opinion of cost for the collection system improvements is presented in **Table 3-2**.

This opinion of cost presents a range of costs that depends upon how much work the City can do with their own staff and resources, how much work they need to contract out, and the extent of repairs that are needed based upon evaluation of the system. The low range cost for program management, flow monitoring, manhole inspections, smoke testing, and house inspections is based upon the City performing these activities themselves. The high end of the cost range on these activities is based upon the city contracting all of them out. On the low end, public system repairs include repairing 25% of the manholes in the system and 5%of the pipeline. On the high end, public system repairs include repairing 50% of the manholes in the system and 15%of the pipeline. The actual amount of public system repairs may be outside of this range depending upon the findings from information collected during inspections and testing.

Table 3-2. Collection System Improvements Opinion of Costs, in 2011 Dollars

Collection System Improvements Costs		
Item	**Range of Costs**	
	Low	High
Program Management	$ 0	$ 180,000
Flow Monitoring	$ 0	$ 108,000
Manhole Inspections	$ 0	$ 19,140
Smoke Testing	$ 0	$ 50,477
House Inspections	$ 0	$ 226,950
Public System Repairs	$ 397,980	$ 1,111,440
Total	**$ 397,980**	**$ 1,696,007**

3.5 Recommendations

It is recommended that the treatment plant modifications and operational changes as described above in **Section 3.2** be implemented immediately to ensure the maximum amount of wastewater is able to be treated without being first diverted to the lagoon. While these changes are being implemented it is recommended that continued flow monitoring of the north and south sewer trunks be conducted. Once an adequate amount of flow data is gathered at these locations, flow monitoring throughout the city should be conducted. With this flow data, it can be determined if an additional equalization basin or modifications of the existing lagoon is needed and what collection system improvements should be made to best benefit the City.

3.6 Schedule for Improvements

A nine year schedule for eliminating bypasses from the Ava WWTP is presented in **Table 3-3**. For the purpose of scheduling it is assumed that collection system improvements will be made and that any equalization basin expansions or construction will not be necessary. If after the preliminary flow data is collected and equalization basin expansions or construction is deemed necessary, this schedule will need to be modified.

The collection system improvements are broken in high, medium, and low priority areas. It is assumed that this will split the city evenly into thirds. Initial flow monitoring and inspections will determine the distinction between high, medium, and low priority area. If post rehabilitation flow monitoring of the collection system repairs demonstrate flow reductions adequate to eliminate bypasses prior to completing all of the medium and low priority areas, the goals of this Bypass Elimination Plan may be considered met, and this program may be ended. The City is cautioned to not abandon all efforts to reduce extraneous flows because of the risk of sanitary sewer overflows occurring.

Table 3-3. Schedule for Bypass Elimination

Priority Level	Activities	Date		
WWTP	Modifications	January 2012	-	December 2012
Entire System	Flow Monitoring	January 2012	-	December 2013
	Manhole Inspections	January 2012	-	December 2012
	Smoke Testing	January 2012	-	December 2013
High Priority	House Inspections	January 2014	-	June 2014
	Data & Cost Effective Analysis	July 2014	-	September 2014
	Private and Public Repairs	October 2014	-	September 2016
	Flow Monitoring	January 2014	-	December 2016
Medium Priority	House inspections	July 2014	-	December 2014
	Data & Cost Effective Analysis	January 2015	-	April 2015
	Private and Public Repairs	October 2016	-	September 2018
	Flow Monitoring	January 2017	-	December 2018
Low Priority	House inspections	January 2015	-	June 2015
	Data & Cost Effective Analysis	July 2015	-	September 2015
	Private and Public Repairs	October 2018	-	September 2020
	Flow Monitoring	January 2019	-	December 2020

SECTION 4 FINANCING

4.1 COSTS

A schedule of costs for the eliminating of all bypasses is presented in **Table 4-1**. This schedule associates costs with the schedule shown in **Table 3-3** and includes all collection system and WWTP modification costs. This could change once more flow information is gathered and the necessary collection system improvements are determined.

4.2 FINANCIAL CAPABILITY AND SCHEDULE

The city will finance the collection system improvements with revenue generated by user charges. The city will pay for the activities and improvements as they go based on the tentative schedule shown above. If the city is unable to finance the improvements with their current rates, sewer rates will be evaluated and adjusted as necessary.

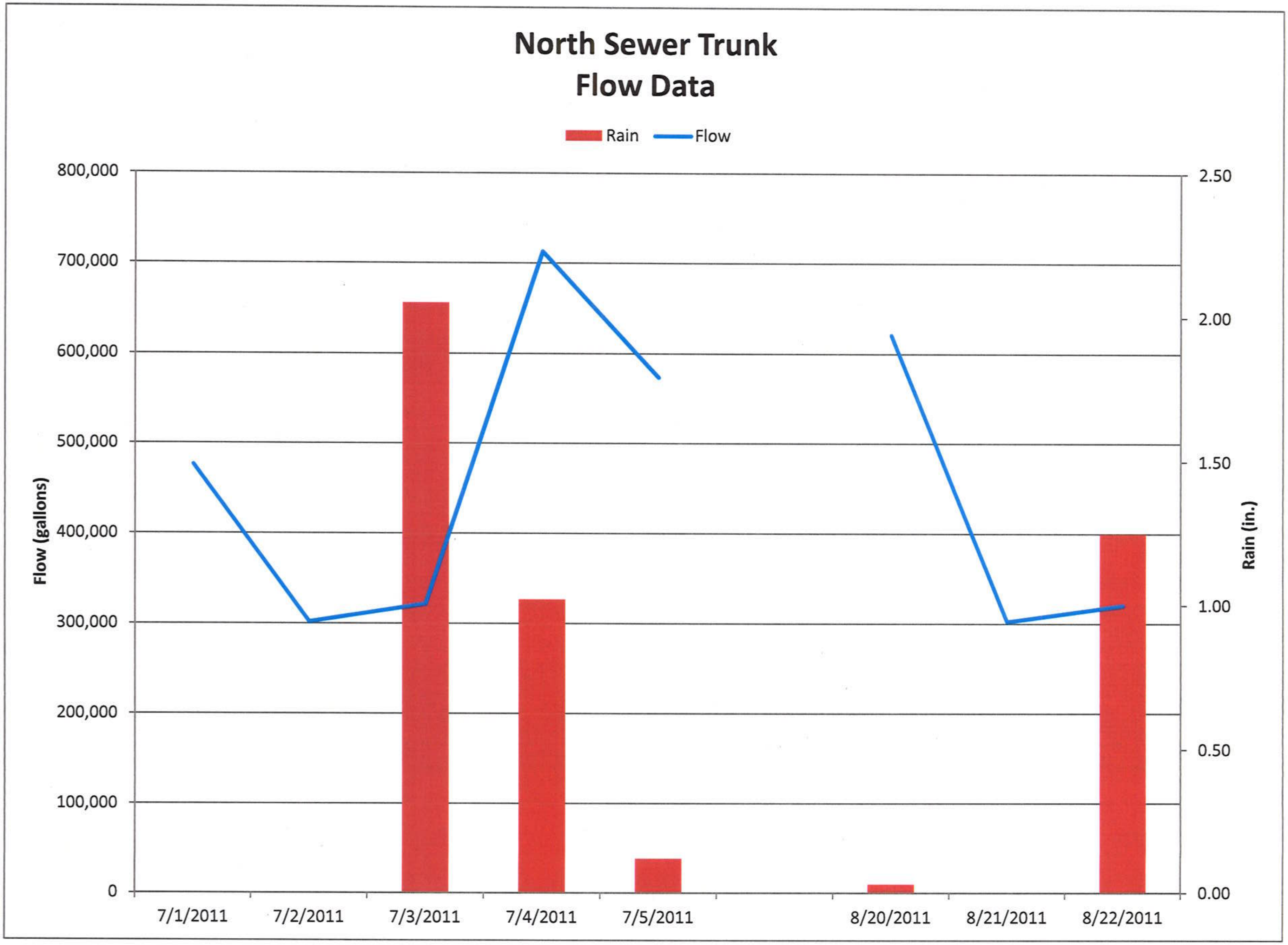
Table 4-1. Schedule of Costs, in 2011 Dollars

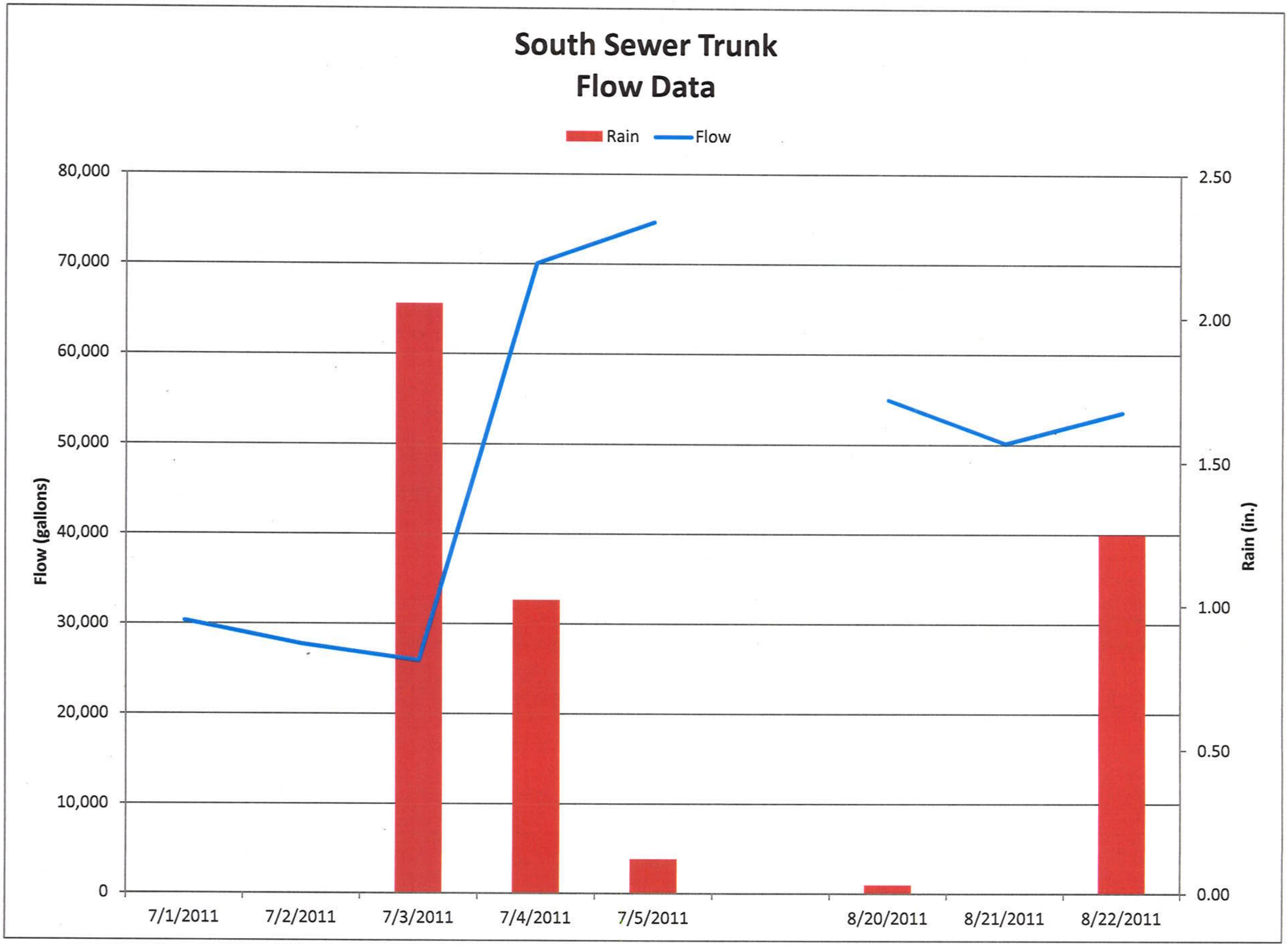
	2012		2013		2014		2015		2016	
	Low	High	Low	High	Low	High	Low	High	Low	High
Program Management	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000
Flow Monitoring	$ -	$ 12,000	$ -	$ 12,000	$ -	$ 12,000	$ -	$ 12,000	$ -	$ 12,000
WWTP Modifications	$ 25,000	$ 25,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Manhole Inspections	$ -	$ 19,140	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Smoke Testing	$ -	$ 25,240	$ -	$ 25,240	$ -	$ -	$ -	$ -	$ -	$ -
House Inspections	$ -	$ -	$ -	$ -	$ -	$ 151,300	$ -	$ 75,650	$ -	$ -
Public Side Repairs	$ -	$ -	$ -	$ -	$ 16,580	$ 46,310	$ 66,330	$ 185,240	$ 66,330	$ 185,240
Total	**$ 25,000**	**$ 101,380**	**$ -**	**$ 57,240**	**$ 16,580**	**$ 229,610**	**$ 66,330**	**$ 217,240**	**$ 66,330**	**$ 217,240**

	2017		2018		2019		2020		**Total**	
	Low	High	Low	High	Low	High	Low	High	**Low**	**High**
Program Management	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 20,000	**$ -**	**$ 180,000**
Flow Monitoring	$ -	$ 12,000	$ -	$ 12,000	$ -	$ 12,000	$ -	$ 12,000	**$ -**	**$ 108,000**
WWTP Modifications	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ 25,000**	**$ 25,000**
Manhole Inspections	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**	**$ 19,140**
Smoke Testing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**	**$ 50,477**
House Inspections	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**	**$ 226,950**
Public Side Repairs	$ 66,330	$ 185,240	$ 66,330	$ 185,240	$ 66,330	$ 185,240	$ 49,750	$ 138,930	**$ 397,980**	**$ 1,111,440**
Total	**$ 66,330**	**$ 217,240**	**$ 66,330**	**$ 217,240**	**$ 66,330**	**$ 217,240**	**$ 49,750**	**$ 138,930**	**$ 422,980**	**$ 1,721,007**

Appendix A

Flow Meter Data


North Sewer Trunk
Flow Data
Rain
Flow
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Flow (gallons)
2.50
2.00
1.50
1.00
0.50
0.00
Rain (in.)
7/1/2011
7/2/2011
7/3/2011
7/4/2011
7/5/2011
8/20/2011
8/21/2011
8/22/2011


South Sewer Trunk
Flow Data
Rain
Flow
Flow (gallons)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Rain (in.)
2.50
2.00
1.50
1.00
0.50
0.00
7/1/2011
7/2/2011
7/3/2011
7/4/2011
7/5/2011
8/20/2011
8/21/2011
8/22/2011