City of Toledo

LINCOLN COUNTY, OREGON

Inflow and Infiltration Study

May 2011

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JULY 9, 2001
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EXPIRATION DATE: 12/31/12

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APPENDICES

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1

1.0 Executive Summary

1.1 Background

The City of Toledo has historically struggled with high levels of inflow and infiltration (I/I) in their wastewater system. This is most evident during the winter months when stormy conditions cause flows in the system to rise dramatically as rain and groundwater enters the sewer system.

Though not currently under a mandated order (MAO) from DEQ, the City does have a history of overflows and untreated or partially treated sewage spills into the river. The treatment plant regularly bypasses partially treated wastewater that exceeds the capacity of the facility. The current Wastewater Master Plan (Clearwater 1995), seeking to reduce these bypasses, recommended improvements to the City pump stations and treatment plant. Those improvements, completed in the late 1990's, were calculated to be a more cost effective method to reduce the sewage spills than pursuing I/I reduction.

While substantial improvement has been seen in spill reduction from the treatment and pumping upgrades, the City still experiences high I/I levels that will continue to increase as the collection system ages. Due to the historic nature of the City, the average age of the collection system is higher than many younger cities. Therefore, an aggressive I/I program will require sizeable repairs throughout the system.

The last concerted effort to reduce I/I was completed in the early 1990's, and involved extensively replacing some of the worst system components with new pipe and manholes. Reportedly, this repair work was successful though the magnitude of the deficiencies left many further components still in need of repair or replacement.

During the summer of 2009 and winter of 2009-2010, the City contracted with Civil West Engineering Services to complete a detailed round of smoke testing and flowmapping of the complete sanitary sewer collection system. The projects were a success as many leaks were located, mapped, and categorized. Follow-up efforts by the City to correct residential-owned deficiencies has been successful, with a reported high level of resident compliance and measured flows into the treatment plant reduced.

After completion of these I/I field surveys the City authorized a television inspection survey and this I/I study to complete further analysis of I/I issues. This report will develop a capital improvement plan with the goal of undertaking cost effective projects to reduce the amount of I/I in the collection system. Reduction of I/I in Toledo will extend the useful life of the collection system, pump stations, and treatment plant saving sewer customers money. It will also help the City avoid sewage spills that may result in stiff penalties and fines from DEQ.

1.2 Overview of Results from Surveys

Three investigative surveys were provided by Civil West to pinpoint I/I sources within the system. The Smoke Testing Survey discovered nearly 200 individual deficiencies in the collection system, the Flow Mapping Survey discovered 8 large pipe and 17 manhole deficiencies, and the Television Inspection Survey discovered dozens of mainline pipe and lateral deficiencies. The Television Inspection Survey inspected approximately 10% of the gravity sewer pipelines.

1.2.1 Recommended Improvement Projects

Analysis of the three authorized studies during this I/I report facilitated the creation of many individual improvement projects. In summary those projects consist of:

- 5 Complete Pipe Replacement Projects
- 5 Pipe Lining Projects
- 2 Bursting Projects
- 1 Pipe Patching Project
- 2 Manhole Rehabilitation Projects
- 1 In-Pipe Repair Project

Pipe replacement is the most invasive type of repair work, where a new trench must be dug and a plan to maintain or bypass sewer service during construction implemented. Lining, bursting, and patching projects can often be done in several hours after preparation work. They are non-invasive and result in little ground disturbance, short interruptions to sewage flows, and are generally less costly. Consequently non-invasive projects were preferred when judged feasible.

Approximately 6000 feet of pipe and nearly 30 manholes have been recommended for repair or replacement. As such, not all the suspected deficiencies have been fully investigated making it likely that numerous undiscovered deficiencies remain in the system.

This first round of evaluation was aimed at locating and identifying “low-hanging fruit” or problems that can be corrected in a cost effective way resulting in a strong cost/benefit approach. This should not be considered a “final” I/I study.

1.3 Summary of Capital Improvement Plan and Funding

A total combination of all the projects recommended in this study resulted in a cost in today’s dollar of **$1,436,675.** It is not feasible for any public utility operator to complete all of their needed improvements immediately following an analysis. Therefore to better organize rehabilitation efforts by the City, the various projects have been prioritized and ranked to allow the City to manage their resources and get the greatest benefit for each dollar invested in I/I rehabilitation.

The Capital Improvement Plan (CIP) has been broken into four priority levels, with lower numbers reflecting the most urgent repairs.

- **Priority 1**, projects which need immediate repairs with large deficiencies and extreme I/I.
  - **Total Repairs $380,935**
- **Priority 2**, projects which need repair over the next few years. Deficiencies are nearly as serious as Priority 1 but may be delayed to attain funding.
  - **Total Repairs $565,400**
- **Priority 3**, projects with less systemic deficiencies and more isolated I/I points. Repair is suggested before the next 5-6 years.
  - **Total Repairs $350,260**
- **Priority 4**, projects mainly needing point repairs or with minor deficiencies that were not observed contributing substantial I/I to the collections system.
  - **Total Repairs $140,080**

It is anticipated that the City will pursue funding assistance in completing the more urgent projects and, potentially, all of the projects. Along with sanitary sewer repairs, the City is facing sizeable repairs to their drinking water system. The combination of these costs suggests funding will need to come from a variety of sources, including ratepayers, and public funding agencies.

At a minimum, the City should seek to address the Priority 1 & 2 repairs while actively monitoring the collection system for other serious problems.

Background and Need

Section

2

2.0 Background

The City of Toledo owns and maintains a wastewater conveyance system that includes the following:

- A sanitary sewer system that includes a wastewater collection system, several pumping stations, a treatment plant, and a river outfall for treated effluent.
- Original concrete piping built in 1920's
- New PVC piping installed in the early 90's.
- Various repair patches of ABS and PVC pipe and some lined pipe sections.

The City has completed planning efforts and intends to undertake improvements to their water and wastewater infrastructure in response to development pressures and the need to upgrade and update aging infrastructure components.

The purpose of this study is to evaluate specific deficiencies within the wastewater collection system and to develop a rehabilitation plan with specific recommendations to enable the City to reduce their overall I/I.

2.0.1 Summary of Previous I & I reduction efforts

The City authorized this I/I report and associated surveys. The following provides a summary of the previous planning efforts which, at least in part, addressed the I/I problem.

1. Wastewater Facilities Plan: Completed in December 1993 by Clearwater Engineering Corporation, the current Facilities Plan includes recommendations for improvements in the collection system and the treatment facilities.

2. Wastewater Master Plan: The City's water master plan was completed in August of 1995 by Clearwater Engineering Corporation. The Plan continues the recommendations made in the 1993 Facilities Plan and recommends a schedule and funding sources for completing them.

Approximately 20 years ago, from 1990-1991, significant I/I repairs were made to the collection system, including 12,000 feet of sewer mainline, 3200 feet of sewer trunk, 60 manholes, and 200 service laterals. These repairs were seen as successful by reducing storm overflows caused by a 3-year rain event (A 3-year rain event is equal to a 24 hour period of rainfall of such volume that it occurs, statistically, once every 3 years). Later improvements to the treatment and pumping system were developed to reduce overflows for up to 5-year rain event.

2.2 Need for This Report

I/I is a common problem in Western Oregon where wet weather persists through much of the year and many cities have aged and leaky collection systems. Winter rainfall makes its way into wastewater facilities from the surface by way of improperly connected drains and cracks in the ground, or underground through broken pipes, joints, and manholes when the water table is high. This additional water creates an unnecessary cost burden on the entire treatment system as it requires larger pipes, pump stations and treatment facilities.

The City has addressed its I/I problems in the recent past by upsizing facilities to handle the high flows and only repairing pipelines when it makes financial sense. In past studies it was determined that it was more cost effective to treat the excess I/I problem than to rehabilitate the conveyance system. Extensive upgrades were completed to the wastewater treatment plant to eliminate overflows caused by heavy rainfall.

Even with threats of overflows reduced, the City must maintain its current system. The original concrete pipes and manholes continue to deteriorate, adding greater flows to the system. As the City grows and expands its system it continues to incur pumping and treating costs to handle flows which should be channeled into the stormwater system. The current NPDES permit, which allows the wastewater plant to discharge to the Yaquina River, is up for renewal this November and I/I reduction efforts will likely be required as part of that permit renewal.

Additionally, the City has made no concerted effort to target and reduce I/I in 20 years. With an already aging system, 20 years is a long period of time of unchecked deterioration.

2.3 Report Organization

The following sections comprise this City of Toledo I/I Report as presently constituted:

- **Section 1 – Executive Summary.** This section provides a brief overview and summary of the I/I reduction strategy and is intended to provide the reader with the important facts and findings contained in the overall plan.
- **Section 2 – Background and Need.** This section provides information on the background of the issues and describes the need for the report so that readers understand why a reduction of I/I is important.
- **Section 3 – Summary of Smoke Testing Survey.** This section describes the methodology and results of the first phase of investigating sources of inflow into the conveyance system. It explains to the reader where likely sources of inflow exist and what should be done about them.
- **Section 4 – Summary of Flow Mapping Survey.** This section describes the methodology and results of night time flow mapping performed throughout the city. It provides the locations where excess water is infiltrating into damaged manholes and piping.
- **Section 5 – Summary of Television Survey.** This section will serve as a summary of the all the video footage taken from within the collection system. This includes details about what types of deficiencies were found, where they exist, and the most suitable repair type to use.
- **Section 6 – Rehabilitation Methods.** Based upon the results of the earlier sections, this section describes alternative repair methods available to the City along with their strengths and weaknesses.
- **Section 7 – Improvement Projects.** This section builds upon the data from Sections 5 and 6 to develop an organized set of projects to repair the collection system. It includes the suggested repair method and an estimated cost to complete the project.
- **Section 8 – Capital Improvement Plan and Financing Options.** Based on the analysis in Section 7, this section will provide specific recommendations and direction on the implementation and funding strategy for the planned projects.
- **Appendix.** The Appendix includes information that is referenced in this study but is not included in the referenced planning documents.

Section

3

3.0 Summary of Smoke Testing Survey

3.1 Smoke Testing Method

Smoke testing is an engineering-surveying tool used to locate, identify, and classify potential inflow/infiltration sources in a wastewater collection system. Simply put, smoke testing involves pumping large volumes of smoke into the collection system through an open manhole. This is accomplished using a blower that sits directly over a manhole. Smoke is generated through the use of "smoke bombs" or other means.

The smoke travels down the piping under a small amount of positive pressure created by the blower. The smoke filled air seeks locations to escape the piping system. This may include "escape points" that are normal and acceptable such as:

- Roof vent pipes (plumbing stacks)
- Manhole lid holes

Other observed points where smoke escapes may be indicative of leaks in the system. This may include:

- Leaks in the piping and fissures leading to the ground surface
- Open cleanouts
- Cross-connections to the storm drainage system
- Downspouts on buildings
- And others.

Figure 3.1 Smoke Testing

It is the negative escape points or "smoke return" locations that the smoke test survey is intended to locate. "Smoke return" locations often indicate where inflow from rainfall is entering the system and occasionally reveal infiltration sources as well.

3.2 Smoke Testing Results

The smoke testing effort identified nearly 200 individual deficiencies throughout the wastewater conveyance system. As is often the case, many of the deficiencies are easily correctable occurrences located on residential properties. These include missing cleanout caps or cleanouts used as catch basins, gutter downspouts connected to the sewer system, and obvious plumbing code violations.

Initial results of the Smoke Testing Survey were presented in the Systemwide Sanitary Smoke Testing Executive Summary (Civil West 2009). The initial results were studied along with results of the Television Survey to more accurately determine the deficiency class of each smoke return. (see Appendix C). A summary of the updated results is:

- 51 Broken lateral pipes
- 40 Broken mainline pipe locations
- 13 Catch basins tied into sewer
- 3 Private residential catch basins tied to sewer
- 6 Gutter downspouts tied to sewer
- 4 Apparent plumbing code violations
- 36 cracked or leaking manholes
- 34 Broken or uncapped private cleanouts

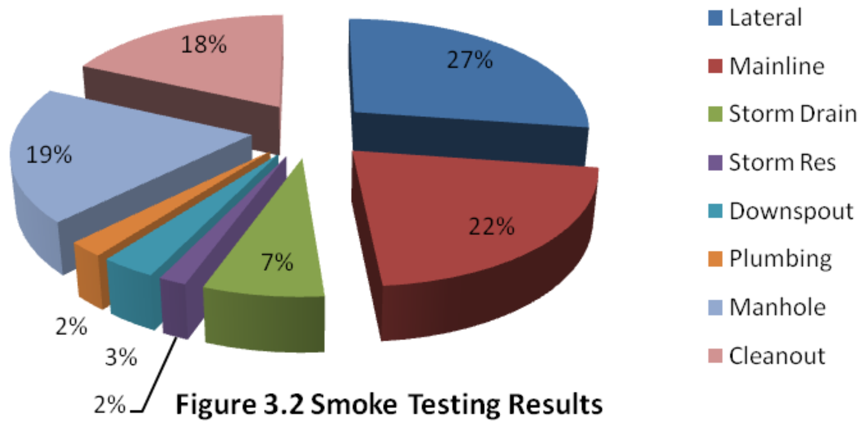


Figure 3.2 Smoke Testing Results

Maps provided in the Appendix C show the detailed locations of each smoke return in the Smoke Testing Survey. The City was provided with sample letters to notify residents of deficiencies on their property contributing to I/I that can be corrected and followed up with this recommendation. The City promptly utilized the letters and made significant progress in eliminating the sources of inflow.

There are also many more difficult deficiencies to repair within the conveyance system. These include broken pipes, displaced pipe gaskets, municipal storm drains connected to the sewer, and cracked or leaking manholes. Broken pipes may either be larger mainline sewers operated by the City's Public Works department or service laterals on private property.

For purposes of further investigation on the part of the City, it is difficult and costly to inspect each of the 51 damaged service laterals unless they are selected for repairs or observed in other surveys to be defective. For information about the location of laterals consult Appendix C and the Systemwide Sanitary Smoke Testing Executive Summary (provided to the City by Civil West Engineering Services after completion of the Smoke Testing Survey). Deficient manholes can be visually inspected by City staff and are categorized in Appendix B.

Table 3.2 lists the remaining smoke returns which likely can be attributed to deficiencies with the City's sewer piping. They have been categorized into two groups, one group showing a significant pipe failure and the other group where the deficiencies are small enough to warrant a spot repair. This result, combined with the results for the Flow Mapping Survey and Television Survey, will form the basis for repair recommendations in the Improvement Plan in Section 7.

TABLE 3.2

Pipe segments showing significant deficiencies through smoketesting Pipe Segment	
	Pipe Segment
Long section with multiple breaks	K11 to K16
Several locations of smoke coming from ground	F23 to F26
Many locations with smoke emitting along street	B14 to B22
Smoke arising from field in several spots	B38 to B40
Smoke from ground following pipeline	I69 to I74
Many cracks in streets emitting smoke	I69 to I72
Ditch line smoking	N3 to N4
Large hole in line	D9 to D11
Smoke coming from ground around pipeline	F18 to F20
Water Meter emitting smoke	K28 to K29
Smoke appearing in fields around pipe	H28 to H29
Large holes in ground emitting smoke	K37 to K38
Pipe segments showing some deficiencies through smoketesting	
	Pipe Segment
Smoke observed in bushes	B70 to B71
Road shoulder smoking	O6 to O7
Section of pipe smoking south of manhole C6	C5 to C6
Smoke in bushes could be buried manhole or void	C9 to C13
Smoke coming from trees	F17 to F27
Several locations of smoke coming from ground	F23 to F24
Smoke near both manholes	F50 to F51
Smoke from ground around construction site	E2 to E3
Smoke from retaining wall	I18 to I19
Several cracks in pavement emitting smoke	I28 to I29
3 locations with smoke from ground	I23 to I84
Smoke by manhole and to the south	K23 to K26
Ground emitting smoke along driveway	K29 to K28
Smoke coming from field along pipeline	M13 to M18
Holes in the ground over what appears to be mainline	I46 to I47

3.3 Smoke Testing Conclusions

Feedback from the City Public Works Department reports a high degree of compliance resulting from the repair letters delivered to residents. Reductions in the overall flows at the wastewater treatment plant have been noted and are, presumably, due to early successes in I/I reduction. Once the “low hanging fruit” deficiencies are repaired, such as those addressed within the notification letters, the more costly and difficult to repair deficiencies must be remedied. The remaining repairs include leaking manholes, catch basin separation and broken underground pipes.

Manhole problems have been listed and indexed in the Appendix by manhole number and included in the repair project section. Many of the manholes have been fully or partially repaired by the City based upon the smoketesting results. Unless a sizeable structural collapse has occurred, manholes typically can be reinforced and rehabilitated to good condition.

Catch basin connections can be found using the smoketesting report. Only a relatively small number of catch basins were found with potential tie-ins to the sanitary sewer. We estimate that connections to the sanitary sewer system are most likely due to underground voids between the storm and sanitary system based upon where the smoke returns were seen and subsequent television inspection. In other words, “connections” between the storm and sanitary sewer are often due to cracked or broken pipes being in close proximity to each other and not necessarily a result of direct connections.

Municipal catch basins with a smoke return can be indicative of either an active tie-in to the sewer system or faulty underground conditions that allow mixing of sewer and storm water. These were not specifically checked for in future surveys as flow mapping was conducted during rainless nights and the television surveys were used to investigate infiltration. The City should conduct dye testing where a fluorescent non-toxic dye is poured into the catch basins while inspecting nearby sewer pipes with a camera. If the catch basins are actively connected to the sewer network the dye will enter through a lateral. If the dye enters through pipe joints or manhole rings it will be evident there is an underground void connecting the two systems.

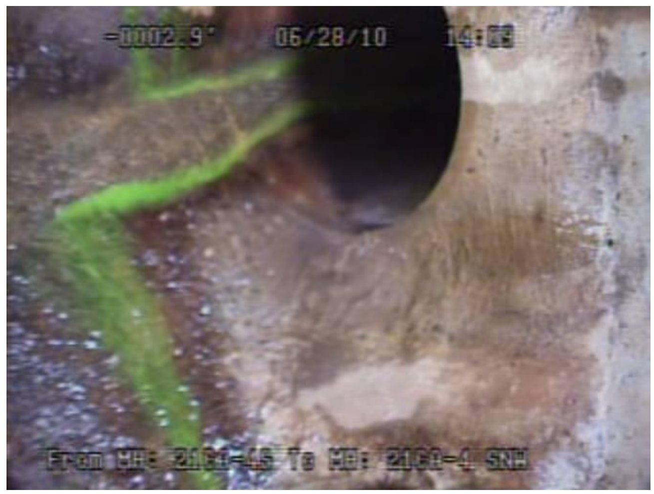


Figure 3.3 Fluorescent Tracer Dye

Broken underground pipes can be separated into laterals and mainline breaks. Mainline breaks can be found through television inspection and repaired by the city. Those marked as such in the Smoke Testing Survey were televised.

Lateral breaks are more complicated because the lateral piping is shared between the residential owner and the City. Some lateral breaks are visible during televising if they are located near the mainline. If the breaks are located on private property or towards the cleanout, a separate television inspection must be done on each lateral. Unusual flows from laterals are documented while televising the mainline and can be helpful in determining problems with the lateral that cannot be observed directly.

Typically any sewer repairs that replace the sewer mainline will include replacing the lateral up to the property line. This may reduce I/I but the City must coordinate a plan with property owners if they wish to completely stop I/I within a lateral connection.

Pipe segments that show evidence of problems due to underground breakage or leaks include those listed in Table 3.2

Section
4

4.0 Summary of Flow Mapping Survey

This section describes in detail how flow mapping is accomplished, what it can tell us about the collection system, and what the results of the survey indicate.

4.1 Flow Mapping Method

Flow mapping is accomplished through the use of a flow meter (commonly called a "Flow Poke") that can be quickly and easily inserted into a pipeline through a manhole. The meter allows for an instantaneous flow measurement in gallons per minute of sewage flow through a sewer pipe. Another flow reading can then be made at an upstream manhole that allows a comparison between the two manholes. If it is found that there is more flow in the downstream manhole than the upstream manhole, it can be concluded that an infiltration problem exists between the two manholes.

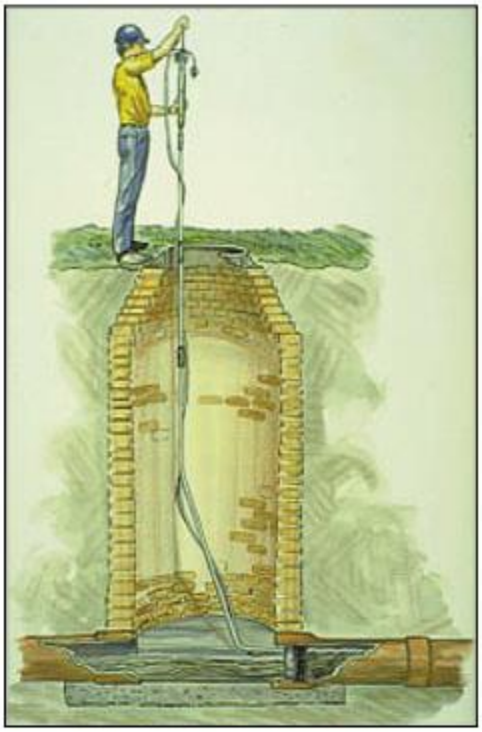


Figure 4.1 Flow Poke

The flow information is drafted onto a map of the system to show the location and amounts of flows in the system at the time the measurements were made. This allows the engineer to review the entire system and determine where additional investigation is warranted. Flow mapping is completed during the mid-night hours (11 pm to 6 am) when the vast majority of flow in the collection system is I/I as domestic flows are significantly reduced after 10 pm. The goal is to measure the consistent flows generating from underground leaks while not measuring the widely varying flows coming from sinks, toilets and other residential uses.

The team conducting the flowmapping consists of one person holding the flow poke into the manhole and the other taking the flow readings. The team also inspects the manhole at the insertion site for condition and visible signs of leaks. Flow mapping begins at the bottom of a sanitary drainage basin and proceeds up the basin by taking measurements at each sewer inlet to the manholes. If the flow is found insignificant no further investigation is required. If high flows are recorded the team continues to "follow" the flow by proceeding upstream through each manhole until that flow too becomes insignificant. This process creates a fast and effective method to discover sizeable problems throughout the collection system..

4.2 Flow Mapping Results

The Flow Mapping Survey mapped the complete collection system within the area operated by the City. Flows deemed significant were followed and measured. Negligible or zero flows were marked in the engineering field books and no further investigation is required. Table 4.2 lists the all the major areas of concern where unaccounted flows were found.

TABLE 4.2

Manholes	Street Location	Indicator	Length
B29 TO B31	N Nye St, just North of NW 15th	20 gpm potential infiltration	440
B12 TO B22	NW 12th St from Spruce to Arcadia St	7 gpm potential infiltration	640
B1 TO B9	NW 11th and Meadow Lane	18 gpm potential infiltration	120
C1 TO C21	Lincoln Way and NW Westwood	>10gpm potential infiltration	180
D4 TO F8	Business 20 across from Police	20 gpm potential infiltration, large manhole leaks observed	550
I4 TO I34	E Graham	20 gpm potential infiltration	570
I26 TO I29	SE Alder between SE 2nd and 1st	>15 gpm potential infiltration	370
F8 TO B1	A St North of Business 20	Multiple potential infiltration points	1730

Additional sections of the collection system were found to contain possible infiltration flows. However, these flows were small enough to be within the margin of error of the equipment or typical nightly domestic flow. The practical limitation of short duration flow mapping is that it works best at finding large deficiencies and helps to identify where to conduct television surveys.

Manholes discovered with visible leaking during the Flow Mapping Survey have been included in the same Table (7.2.15A) that those from the smoketesting report have been listed in. A follow up investigation performed during January 2011 further refined the results based upon City repairs and confirmed locations. Deficiencies seen in flow mapping tend to be seen at the deeper levels and joints of the manhole, when water table is high, whereas those deficiencies found from smoke testing can include deficiencies at the top of the manhole and cracks under the rim.

It was noted that the City has already undertaken good measures to stop inflow into manholes such as providing many sloped areas with rain shielding inserts and 2-hole lids. Many of the covers in high traffic areas were found to be bolted down which limited some investigation possibilities.

4.3 Flow Mapping Conclusion

Several very significant leaks were found through the use of flow mapping, in both sewer pipe and through sanitary manholes. Each of these locations were recommended for television inspection and reviewed further in this study. Detailed results can be seen in the maps included in the Appendix.

Flow mapping should be repeated after repairs to the system are complete to help calculate the effectiveness of those repairs as well as to identify new deficiencies. Another useful tool is to conduct a manhole inspection during high groundwater months. Because the City contains a proportionally high number of manholes, and flowmapping only illuminates heavily leaking manholes, it would be useful for collection systems crews to keep a log of manhole leaks and inspections. Manhole repairs are a relatively inexpensive source of I/I reduction due to their accessibility.

Section
5

5.0 Summary of Television Survey

5.1 Television Survey Method

This section describes in detail how cleaning and televising is performed

Television inspection is a tool that, when combined with smoke testing and flow mapping, can help determine what rehabilitation measure should be taken within a collection system. While smoke testing and flow mapping reveal potential problems within a system, a television survey allows the Engineer to see directly into the pipe and pinpoint infiltration sources and pipe cracks and breaks.

Figure 5.1.1 Jetter Truck

The inspection itself is a two part process. First, the pipe and manholes must be cleaned free of all dirt, grease, rock and other debris. This is accomplished by the use of a "jetter truck." The jetter truck contains a powerful pump that connects to a cleaning nozzle on a hose reel. The hose is inserted into a manhole as the nozzle jets water back towards the hose and propels itself down the pipe through water pressure. Once the nozzle reaches the next manhole the operator retracts the hose slowly and pulls the debris back towards the insertion manhole. A large vacuum system mounted on the truck removes the debris through the manhole into a storage tank. This process is repeated until the pipe and manhole are clean. The jetter truck separates the water from the debris and discharges the water back into the conveyance system and discharges the debris at an approved site.

Figure 5.1.2 Televising Camera

Televising is the second part of the process. A robotic camera is lowered into the manhole and remotely controlled to crawl through the pipe. The camera is tethered to the truck by a cable which provides power and communications between the camera and truck as well as providing a tool for measuring distances.. The camera provides a light source and moves along the pipe recording important features such as sewer lateral locations, pipe joints, and abnormalities. The operator maintains a log of the inspection process and digitally records the investigation. When complete, the logs and video are delivered to the engineer for review.

5.2 Television Survey Results

The final Television Survey cataloged 60 individual pipe segments totaling 10,200 feet of the approximately 98,800 feet of installed sewer pipe. A segment shall be defined as a continuous pipeline beginning at a manhole and ending at another manhole or sewer cleanout. Not all of these segments were inspected in their entirety due to blockages or pipe offsets preventing further camera travel.

Observation of the video results reveals the following:

- 25 Segments are in average or better condition without any need for further work.
- 4 Segments need further investigation
- 5 Segments are in need of minor repairs that may be spot repairs
- 8 Segments require more major repairs or replacement but are not causing large problems yet
- 15 Segments have major damage throughout the pipe and should be repaired soon
- 3 Segments are near imminent failure

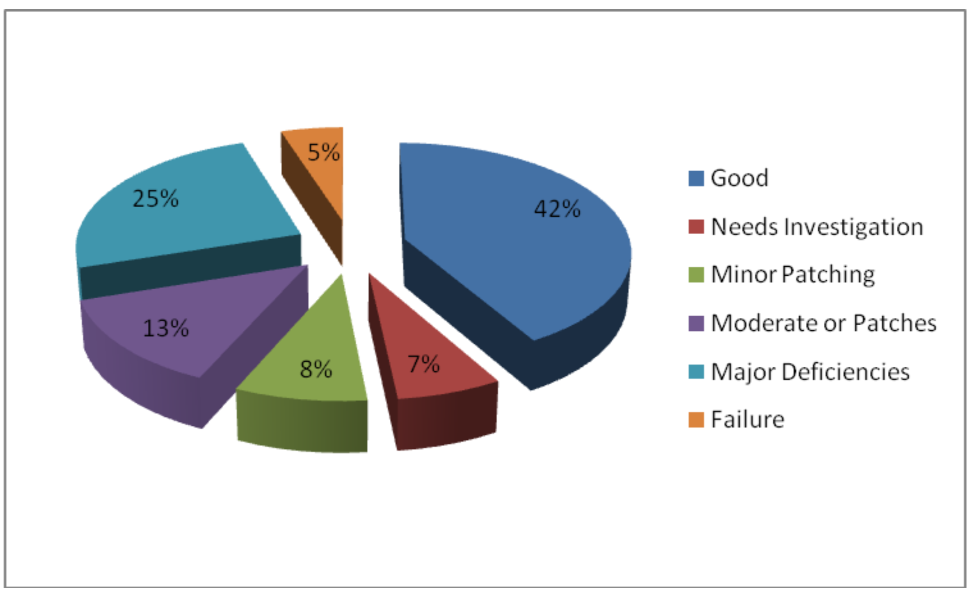


Figure 5.2 Televising Results

Overall, PVC and clay tile pipes are in good condition while the concrete pipe is typically either failing, near failure, or the pipe appears old and worn. Where liners are installed in the pipes, the liners are in good condition and providing good service. Short pipe patches are also performing well, though it can be observed that the pipe adjacent to them is now deteriorating and that they are a short term solution.

Several locations were completely obstructed and the pipe was not fully investigated. These items are noted in the report pages in Appendix (A). These obstructions are typically heavy root intrusion that the cleaning nozzle could not dislodge or protruding laterals blocking passage of large items, including the camera. One pipe in the downtown area contained large asphalt or concrete pieces making television inspection impossible.

The televising contractor noted that Toledo's sewer system contained higher than average amounts of sediment build up, specifically grit and gravel accumulations along some of the main trunk lines. The indication would be that the pipes require more regular cleaning intervals. Grease buildup that was seen inside the pipe was typical and not excessive.

5.3 Television Survey Conclusion

Areas with deficiencies observed during televising have been categorized in the previous section. Improvement projects have been developed to address each deficiency. Several of the low lying pipe segments were difficult to televise due to large "bellies" in the pipe. Incomplete information was gathered in these "bellied" pipes as the camera was submerged and the pipe walls and joints were not visible on camera. The large bellies are not acceptable in the pipe as they reduce the carrying capacity of the pipe and result in buildup of debris and detention time of waste. These pipes are recommended for replacement.

Many of the laterals were observed to be leaking heavily and were included in rehabilitation projects. Typically, the cause of the leak was directly observable by camera from the mainline pipe or at the lateral connection. Any additional lateral televising we determined as necessary was included into the overall lateral replacement price of the rehabilitation projects in Section 7.

Several pipes recommended for inspection were unable to be televised while remaining within the budget allocated for the City. These pipes were those difficult to access and require portable type televising equipment. We recommend that the City set aside budget to televise these lines as well as other difficult to access areas that the Public Works department suspects have deficiencies.

The following pipes should be scheduled for inspection as soon as possible:

TABLE 5.3 – PIPES SEGMENTS REMAINING TO BE TELEVISED

Pipe Segment (s)	Street Location	Overall Length
I40 to I42	Ne Douglas St	81ft
L22 to L23	SE Fir St	146ft
B69 To B70	Arcadia School Sidewalk	114ft
B39 to B37	Skyline Hillside Slope	174ft
D9 to D4	Business 20	232ft
F17 to F27	NW 6th St	184ft
C1 TO C18	Lincoln Way	32ft
M13 to M18	East Slope Rd	194ft (22ft unseen)

Section 6

6.0 Rehabilitation Methods

6.1 Introduction

This section describes the suitability of various repair methods for sanitary sewer manholes and pipe. Generally speaking, pipe can be lined, patched in place or completely replaced. Each of these can be accomplished through a variety of methods which will be discussed below. Deficient manholes can be reinforced, lined or replaced.

6.2 Lining

6.2.1 CIPP

Cured-in-place-pipe (CIPP) is a process of manufacturing a replacement pipe within the existing pipe. An impermeable "bag" that contains a sewn tube of non-woven felt fabric is impregnated with a resin that can be activated by hot water or steam. This "bag" is inserted through a manhole and inverted within the host pipe to be repaired. Once inside the pipe, the bag is filled with water or air pressure to expand the liner within the host pipe much like blowing up a balloon. The new pipe material conforms to the outside of the existing pipe and creates a new one-piece pipe liner continuous to the next manhole. The resins are activated by hot water or steam inside the bag which causes the fabric and resin to cure and create the new pipe. A robotic cutting tool is used to open the lateral connections again.

Some of the major benefits of CIPP are:

- All surface excavations and surface restorations are eliminated
- The process is fast and costs are significantly reduced
- All existing joints are sealed
- The new pipe forms limited bonds to the existing pipe which helps prevent I/I migration to the manhole.

Manufacturers claim that CIPP pipe longevity testing shows a lifespan in excess of 50 years.

CIPP cannot repair all problems in a broken host pipe. Large voids or holes in the pipe must be patched prior to the liner installation. If the host pipe contains major grade changes or collapsed sections the liner will either conform to them or not form correctly. CIPP liners are best suited to repairing minor structural problems, leaking joints, minor misalignments, or root penetrations.

Figure 6.2.1 CIPP Liner Installation

6.2.2 Slipliner

Sliplining is a process where an entirely new pipe is pulled into an existing pipe. Insertion and receiving pits are dug at both ends of the pipe and a smaller diameter pipe is inserted into the insertion pit which is then pulled through the old pipe into the receiving pit. HDPE pipe is typically used and is either grout sealed at both ends or the grout is pumped in to fill the annular space between both pipes.

CIPP has mostly replaced sliplining for sewer pipe. Major disadvantages of sliplining are:

- A diameter reduction in the new pipe (partially offset by reduced friction)
- The joints on the endpoints can fail and allow the infiltration back in.

Sliplining requires excavations to remake a lateral connection which creates another drawback. As there is little cost difference between the two lining methods, CIPP will be recommended when lining is the most cost effective repair method.

6.2.3 Fold & Form

Fold & Form pipe is a PVC pipe which takes advantage of the thermoplastic memory properties inherent in PVC. A folded pipe is inserted into a manhole and pulled through the existing pipe. Both ends of the pipe are plugged and expanded with steam and pressure. Finally the pipe is cooled and maintains its cylindrical shape, resulting in a new jointless PVC liner. Laterals are reconnected in the same manner as a CIPP liner.

Fold & Form pipe requires a slightly thicker wall to have equivalent strength to CIPP liners. As costs are similar it can be considered an alternative to CIPP if local availability or economics favor it.

6.3 *Patching*

6.3.1 CIPP

A common tool available for spot repairs in otherwise sound pipe are CIPP pipe patches. They are shorter versions of the liners and are inserted with robotic equipment. These patches are made of the same material and can be inserted and cured in a few hours restoring the integrity of the pipe. Sections can be either field cut to length, or precut sections can be joined together to form a longer patch.

An advantage of using spot repair CIPP patches is that they can be underinflated around pipe voids to reinforce a pipe prior to a full liner being inserted. This can prevent "ballooning" pockets of the main liner when it is pressurized to conform to the pipe wall.

Figure 6.3.1.1 CIPP Patch

Figure 6.3.1.2 CIPP Patch

6.3.2 Open Trench Spot Repairs

The dig and replace method of pipe repair is a good option where surface improvements are minimal or the pipe grade rules out the use of trenchless repair methods. Televising data should be consulted first to determine the nature of the repair. This method is commonly used for emergency repairs where a small section of pipe is exposed and patched with PVC pipe or when new laterals are added into the mainline.

6.4 Pipe Replacement

6.4.1 Open Trench

Figure 6.4.1 Open Trench Pipe Construction

Open trench construction is the most basic method of constructing new pipe section or replacing old ones. A trench is excavated to an adequate depth to maintain sufficient gravity drainage slope and allow room to properly bed and access the pipe. Typically, the trench is at least 18 inches wider than the pipe diameter at the base and gradually widens at the top as the overall depth increases. The width of the top of the trench can vary greatly due to soil conditions.

The advantages of open trench construction include:

- Utilizes common installation techniques available to local contractors
- The ability to adjust and level the pipe grade
- Greater flexibility in adjusting for unforeseen subsurface conditions.

Disadvantages of open trench construction include:

- Expensive surface restoration required, especially in roadways
- Open trench shoring required when excavations are deeper than 5 feet or if soil is unstable
- Dewatering equipment is often needed where groundwater is high
- High restoration impact on public and private properties.

Open trench construction is often most cost effective in new construction where preservation of existing facilities is less important. It is also cost effective in rehabilitation for spot repairs or where the existing pipe exhibits grade problems from settling. Open trench construction allows the use of any of the available pipe materials, though the modern material of choice is PVC sewer pipe (3034).

6.4.2 Boring

Boring, or directional drilling, is a method where a highly controllable drilling head creates an underground “tunnel” to insert a new pipe underground. An entry hole is bored into the ground and the drilling head is guided to the exit hole. Special electromagnetic tracking tools are utilized to maintain the direction and depth of the bore. The pipe is then attached and pulled back through the bore hole to the entry point. Drilling fluids pumped into the borehole prevent collapse and aid in the drilling process. HDPE pipe is typically used in boring applications.

Advantages of using boring include:

- The ability to insert pipe into high groundwater or under bodies of water
- Minimal impact to the ground surface
- The ability to cut across hills, mountains, and wetland areas

The major disadvantages of boring include:

- Poorer performance in rocky conditions
- Increased cost compared to open trench methods
- Only specialized equipment is capable of boring grades less than 1% for gravity sewer pipe.

Figure 6.4.2 Pipe Boring

Directional drilling is typically not used in sewer rehabilitation work unless the conveyance system is re-routed. For new construction, the terrain and existing structures preservation are factors in deciding the cost effectiveness of choosing boring over open trench construction.

6.4.3 Pipe Bursting

Pipe bursting is a method of replacing or upsizing an existing pipeline using the old pipe as a conduit. Pipe bursting eliminates trenching and instead requires only small access pits at laterals and the insertion point. Pipe bursting is accomplished by feeding a cable through the pipe and pulling a bursting head back through the host pipe. The bursting head, either hydraulically or through force alone, expands and breaks apart the old pipe compressing it into the old pipe bedding. Simultaneously while bursting the old pipe, new pipe is pulled into the hole behind it. Access pits are dug at laterals to make reconnection with a saddle joint.

Figure 6.4.3.2 Pipe Bursting Winch

The host pipe has to be constructed of a brittle material, such as clay or concrete pipe, to allow the material to shatter and push into the surrounding soil. HDPE and Fusible PVC are two materials used for replacement pipe as a flexible continuous pipe is needed to meet the bending requirements while inserting the pipe. It is common to upsize the existing pipe as much as 25%, however this capability varies greatly based upon soil conditions, depth of the existing pipe, and available equipment.

Figure 6.4.3.1 Pipe Bursting Head

In ideal conditions pipe bursting provides a significant cost savings over open trench methods for rehabilitation. Major advantages of pipe bursting are:

- Can be completed in a matter of hours,
- Only creates small surface disturbances at entry points,
- In many situations new pipe can be pulled directly into the existing manhole,
- A larger pipe can be installed for only minor cost increases.

Disadvantages of pipe bursting are:

- Cannot be used where existing pipe has grade problems,
- Pipelines with dense laterals decrease the cost benefit,
- Only useful in brittle host pipes,
- Cannot be used if sensitive utilities or structures are known to be near to sewer pipe
- Can create surface upheaval if too shallow.

Other variations of pipe bursting exist, such as pipe splitting and pipe reaming, that provide capabilities conventional pipe bursting does not. Pipe splitting uses a cutting head to split the existing pipe in two instead of expanding the pipe and allows bursting operations in non-brittle pipe types. Pipe reaming is similar to the boring process in reverse, where a cutting tool is pulled through the pipe and grinds it into pieces while pulling a new pipe behind. Drilling fluid carries the old pipe fragments into a receiving pit for disposal. Both of these methods are unnecessary for the types of problems identified in this report so will not be explored further.

6.5 Lateral Repair Methods

6.5.1 Grout repairs

Sewer service laterals can be grout repaired within approximately 2 feet of the mainline connection. Grout repairs are non-disruptive to the service and are completed from within the mainline sewer pipe. A robotic joint packer injects grout into voids and cracks. This grout may last for 10 years or longer if properly installed, especially when exposed to consistent moisture. Lateral and joint grouting can be quickly accomplished for several hundred dollars per connection. Based on our experience, grout repairs are often only marginally effective and often do not stand the test of time.

6.5.2 Lateral Bursting

Lateral bursting is a smaller scale version of mainline pipe bursting. It is typically provided by plumbing companies to renovate lateral connections for residents. Bursting still requires an excavation at the mainline connection and the associated surface disturbance. This method is not common for municipal projects that are seeking to rehabilitate pipe up to the property line.

6.5.3 Lateral Lining

Various types of lateral liners have been in existence for years. They use the same CIPP process for mainlines. One of the major advantages is that the pipe can be restored with little invasive effort all the way into the mainline. Lateral lining systems come in various versions from short “Top Hat” liners which provide a couple feet of liner around the lateral opening to full liners which make a complete connection from the house to the main pipe.

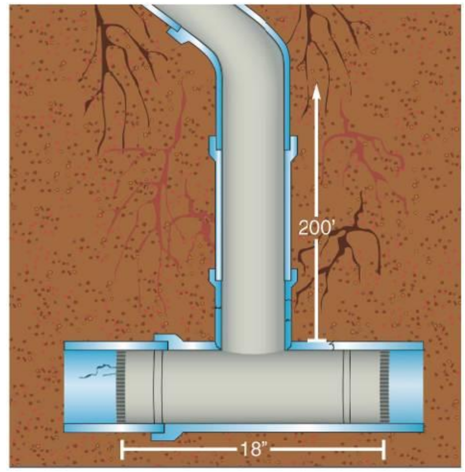


Figure 6.5.3 Lateral Liner

Top hat liners have a drawback when used with mainline liners because surface adhesion to cured CIPP pipe is difficult to maintain. A newer system is available where a gasketed tubular connection is made to the mainline and the lateral liner is launched to the lateral cleanout. These liners cost approximately $2500 each and provide a secure connection well beyond the deeper infiltration points. If a cleanout connection does not exist there are options to non-invasively add one. Lateral liners make logical sense when already lining the mainline. However, the high costs of using the liners often make direct placement (dig and replace) of a new lateral more economical.

6.5.4 Dig and Replace

Dig and replace is the standard connection method for repairing laterals during open trench replacement or pipe bursting. The lateral is normally replaced up to and including the cleanout at the property line. This approach is generally used when the mainline is being directly replaced.

If utilizing pipe bursting to rehabilitate a sewer mainline, lateral reconnections are typically made using dig and replace methods with access pits at each connection. The best lateral connections to HDPE utilize fusion welded HDPE saddles instead of gasket style saddle. In this report we have assumed that improvements will utilize a fusion welded saddle connected to a new cleanout with either a PVC or HDPE lateral.

6.6 Manhole Repair Methods

Manholes can be rehabilitated in a variety of ways with methods such as coating, lining, grouting and complete replacements.

6.6.1 Manhole Sealing

A variety of coatings which can be applied either as spot repairs or a complete vacuum testing sealant are available. Costs can range from $125 to $300 per vertical foot depending upon the process used.

For sealing and repairing manholes which are not exposed to chemical deterioration, a less expensive urethane based sealant can be used. These grouts can be applied as a spray, injection, brushed or mixed to a foam consistency. Urethane type grouts provide the best performance when they are continually exposed to moisture and do not dry out. These grouts can be injected into voids and cracks in the manholes and prevent moisture from coming in. Urethane style grouts have a poor long term performance as a surface coat and would not be recommended for extensive repair work, especially where exposed to hydrogen sulfide deterioration.

Figure 6.6.1.1 Epoxy Sealed Manhole

For superior manhole sealing, a fiber reinforced cementitious mortar can be sprayed or troweled onto the manhole surface. The best products provide an extremely strong bond to the existing manhole wall creating a new smooth surface which reinforces the entire structure. They also provide good chemical resistance to the manhole wall. As a product group the cementitious mortars have a higher level of success than urethane systems, but some products perform much better than others and well trained applicators are important. The City should carefully review product data before selecting a contractor.

The most expensive and best methods for manhole sealing are epoxy based coatings. These are ideal for situations where consistently high levels of hydrogen sulfide exposure are present. One cost savings method is to apply a fiber reinforced mortar as a base coat to the manhole for filling of voids and use an epoxy sealant as a top coat. Coating manholes with epoxy can cost nearly as much as a new manhole, causing this option to only be viable in specific situations

Figure 6.6.1.2 Cementious Mortar Spot Repaired Manhole

6.6.2 Manhole Liners

Fiberglass style liners are available to reinforce and seal existing manholes. Rather than being sprayed or troweled on like sealers, these liners are structural materials that are placed into the manhole and forming a new "manhole within the manhole". A variety of processes are used to accomplish this, some are premade while others are formed with a CIPP style process. It is approximately $300 per vertical foot to line a standard 48" manhole. This is only slightly less than constructing a new manhole under normal circumstances.

Figure 6.6.2 Manhole Liner

6.6.3 Manhole Replacement

New concrete or HDPE (high density polyethylene) manholes can be installed where an existing manhole has failed. The cost to replace a manhole can range from $4000-$5000 and may be the best choice when doing open trench construction for a long pipe section.

Section 7

7.0 Improvement Projects

7.1 Introduction

This section describes in detail grouped repair projects chosen from the combined results of smoke testing, flow mapping and televising.

Improvement projects have been categorized by recommended repair type and geographical proximity. Repair types have been selected based upon pipe conditions, surface condition, I/I levels and overall cost effectiveness. All deficient pipelines and manholes can be suitably replaced using the open trench method, but this method was not recommended unless pipe grade, surface conditions, or pipe failures have made it necessary to forego lower cost trenchless options. A few of the open trench projects were incompletely inspected, however the inspected portion of the pipe was often judged to be in such poor condition that further inspection would be unlikely to change the recommendation.

GIS mapping with exact manhole and pipeline locations is not available for Toledo. In order to assist with finding repair locations, each project has an aerial map with an approximate location of the line drawn on it. A table showing manhole numbers was created as part of the Smoke Testing Survey and added to the City's mapping is also included in each estimate. The existing manhole and sewer network mapping maintained by City is generally accurate and if inconsistencies were found, during the flow mapping and smoke testing surveys, we revised the mapping to show the correct flow directions and manhole connections.

7.2 Discussion of Cost Estimates

Cost estimates for the projects in this section include several items. Once the preferred repair method was chosen, the associated improvements and local area conditions were considered when developing cost estimates for the repairs. The restoration of any structures or landscapes, if found to be significant, were also included in the estimates.

Mobilization and temporary facilities costs are based upon a percentage of the cost of the estimated construction work. Mobilization includes the cost to move and rent equipment as well as many one-time costs associated with starting and ending a construction job. Temporary facilities include items such as fencing, traffic control, restrooms, markers and erosion control objects. Adjustments of these prices have been made when items such as specialized equipment are needed for a small job or the project includes repairs over a wider geographic area.

Project estimates include three cost totals. The construction cost total is the estimate of all the individual tasks required to complete the project. The subtotal is the construction cost total added to a contingency percentage factor based upon the construction costs. The final cost is the total project cost, which includes engineering and administrative percentage factors based upon the subtotal cost.

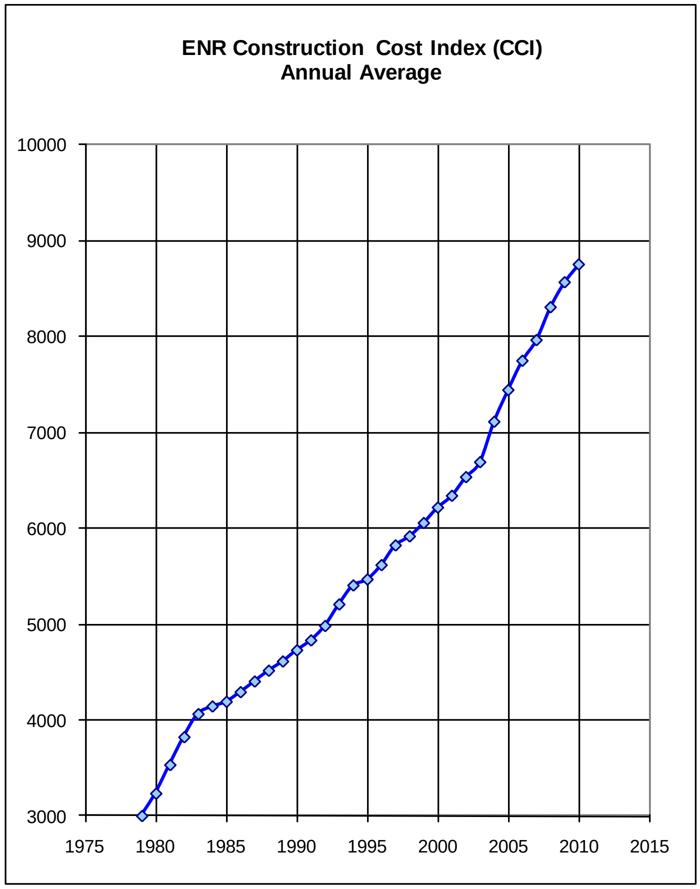


Figure 7.2

Contingency costs are intended to account for unknowns. At this stage of the process the improvement projects have not included subsurface geotechnical surveys, sewer laterals have not been thoroughly checked, easements status not been verified and the required design surveys are not complete. As the projects continue through the design process and approach the construction phase, the number of unknowns will diminish and allow the contingency factor to decrease. Contingency costs have been set to 25% of the construction cost estimate for this study.

Engineering fees are estimated as a percentage of the subtotal cost, typically around 20%. Presumably, events or unknowns accounted for by contingencies will likewise incur additional engineering and administrative charges. The engineering time required will vary based upon many factors but generally more complex projects with higher requirements are more costly than others.

Administrative costs consist of a small portion of the overall project price. They include items such as legal fees, city staff costs, and the cost of obtaining the required permits, internal planning and any miscellaneous non-construction related work. Administrative costs in this report have been estimated at 3% of the subtotal cost.

Cost estimates for the construction portion of each of the projects have been based upon pricing for similar recent projects and material estimates from suppliers. These estimates utilize broader categories with higher costs than would be typical of a bid item list. Further engineering of each project will refine the estimates.

Over time, prices typically increase as inflation reduces the value of money. In order to allow budget planning in the future for the projects prepared in this report, the projects can be compared to the Engineering News Record (ENR) Construction Cost Index (CCI).

The ENR CCI provides an index numbering system that allows conversion of project costs across time periods. Construction costs of projects are determined monthly and assigned a number relative to an absolute baseline year cost.

The ENR Construction Cost Index uses an established value of 100 for the year 1913. The index value for November 2010 used in this report is 8951. For instance, if a project cost $10,000 to construct in 1913, the cost to construct it today would be $895,100 based upon growth in the ENR CCI. A graph is presented in Figure 7.2 which shows the ENR CCI recent trends.

Over the last 10 years the ENR index has grown approximately 3.5% per year. If that trend continues, a $100,000 project in this report will cost approximately $111,000 in three years and $141,000 in ten years to complete.

7.3 Project List

7.3.1 Pipe Patching Project A

A single project is proposed to cost effectively patch pipes throughout the City. Many of these locations are structurally intact pipes with a single break or a poor joint. A patch should seal the infiltration and may allow the pipe to remain in service for many years.

A mixture of non-invasive CIPP pipe patches, CIPP Lateral liners, and invasive dig and repair sections are included within this project. Areas where a short pipe belly or large offset exists are recommended for excavated patches while those pipes with holes and bad leaks are recommended for CIPP repair methods.

None of these pipes are in excellent condition and we would expect that they should be re-inspected in 10 years to observe if any new deficiencies have formed. Ultimately only the lined laterals will provide service for a substantial length of time and it is likely some of these pipe segments will be replaced over the next two decades.

TABLE 7.2.1.1 – PATCHING PROJECT, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
C5 to C6	Two 15 foot belly repairs, open trench PVC
C21 to C18	CIPP Pipe Patch
B16 to B12	CIPP Pipe Patch, Lateral CIPP Patch
O7 to O6	Protruding lateral cut and re-grout
F41 to F38	CIPP Lateral Patch, 10 foot open trench PVC repair belly into manhole F38
I23 to I84	2 CIPP Pipe Patches, Cut and spray 3 root joints and grout
I19 to I18	Lateral CIPP Patch
K16 to K18	5 foot offset pipe, open trench PVC repair
F34 to F9	10 Foot open trench PVC belly repair, Lateral CIPP Patch
O12 to O7	Cut and Spray 2 root joints and grout, Protruding lateral cut and grout

TABLE 7.2.1.2 – PATCHING PROJECT, COST ESTIMATE

Patching Project #A					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$4,000.00	$4,000.00
2	Construction and Temporary Facilities	ls	1	$3,000.00	$3,000.00
3	CIPP Lateral Liner	ea	4	$2,500.00	$10,000.00
4	Cut and Grout	ea	2	$500.00	$1,000.00
5	CIPP Pipe Patch	ea	4	$2,500.00	$10,000.00
6	Cut roots and grout joint	ea	5	$350.00	$1,750.00
7	Asphalt Trench Patch	sq yds	20	$60.00	$1,200.00
8	Open Trench Patch 8" PVC	lf	55	$80.00	$4,400.00
9	Surface Restoration	ls	1	$3,000.00	$3,000.00
		Construction Total			$38,350.00
		Contingency (25%)			$10,000.00
		Subtotal			$48,350.00
		Engineering (20%)			$9,700.00
		Administrative Costs (3%)			$1,500.00
		Total Project Costs			$59,550.00

MAP 7.3.1.1 PATCHING PROJECT A (NORTH AREA)

MAP 7.3.1.2 PATCHING PROJECT A (SOUTH AREA)

7.3.2 North Nye Street Project B

Under the northern gravel portion of North Nye Street, at the base of the hill coming down from Skyline Drive, is a long pipe segment containing several holes with high infiltration. Our flow mapping inspection resulted in the measurement of a considerable amount of infiltration isolated to this pipe segment. In addition, several of the laterals connecting to the pipe exhibited high clear flows during television inspection. The combination of the high infiltration and broken pipe suggests that this pipe segment ought to have the highest priority of the non-critical segments to repair.

The pipe is constructed of concrete and includes an ABS patch; likely a repair to a previous leak or hole. It was observed that the pipe is buried over 10 feet deep. Because of the type of residential neighborhood with widely spaced homes, some of the lateral connections are very long.

The recommendation, for this project, is to dig and replace this pipe due to its placement in aggregate and to allow investigation of the significant lateral leaks. Laterals should be replaced to the property lines. It is further recommended to televise the laterals, including the portion on private property, to further investigate where high infiltration is originating. The City may find it needs to require property owners to repair or replace their laterals.

TABLE 7.2.2.1 – NORTH NYE STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
B39 to B31	Pipe Replacement

TABLE 7.2.2.2 – NORTH NYE STREET, COST ESTIMATE

N Nye St Replacement Project #B					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$11,000.00	$11,000.00
2	Construction and Temporary Facilities	ls	1	$8,000.00	$8,000.00
3	8" PVC Pipe (entire pipe >10' deep)	lf	464	$95.00	$44,080.00
4	New Manhole	ea	2	$9,000.00	$9,000.00
5	Lateral Connections	ea	9	$3,000.00	$27,000.00
6	Lateral Televising	ea	9	$150.00	$1,350.00
7	Aggregate Trench Patch	tons	592	$25.00	$14,800.00
		Construction Total			$115,230.00
		Contingency (25%)			$29,000.00
		Subtotal			$144,230.00
		Engineering (20%)			$28,900.00
		Administrative Costs (3%)			$4,400.00
		Total Project Costs			$177,530.00

MAP 7.3.2 N NYE ST REPLACEMENT PROJECT B

7.3.3 Northeast 12th Street Project C

Three short pipe segments under Northeast 12th Street have been combined into a single repair project. A combination of pipe bellies, cracks, large root penetrations and many leaking joints are affecting this area. Several of the laterals are heavily leaking. Problems were noted in both smoketesting and flowmapping with verification seen during television inspection.

It is recommended to dig and replace the pipes to grade. Some locations of the pipe require asphalt patch where the pipe is located in the roadway. It is also anticipated that one of the manholes will need to be replaced to re-grade the pipe segments, especially from manhole B16 to B18.

Alignment of the sewer lines here appears to follow the grassy shoulder beside the road, however estimates assume a complete asphalt trench patch.

TABLE 7.2.3.1 – NE 12TH STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
B20 to B18	Pipe Replacement
B20 to B22	Pipe Replacement
B16 to B18	Pipe Replacement

TABLE 7.2.3.2 NE 12TH STREET, COST ESTIMATE

NE 12th St Project #C					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$9,000.00	$9,000.00
2	Construction and Temporary Facilities	ls	1	$6,000.00	$6,000.00
3	8" PVC Pipe	lf	386	$85.00	$32,810.00
4	New Manhole	ea	2	$9,000.00	$4,500.00
5	Lateral Connections	ea	7	$3,000.00	$21,000.00
6	Asphalt Trench Patch	sq yds	257	$60.00	$15,420.00
		Construction Total			$88,730.00
		Contingency (25%)			$23,000.00
		Subtotal			$111,730.00
		Engineering (20%)			$22,400.00
		Administrative Costs (3%)			$3,400.00
		Total Project Costs			$137,530.00

MAP 7.3.3 NE 12TH ST PROJECT C

7.3.4 Southeast 10th Street Project D

The pipe segment traveling down the slope of Southeast 10th Street toward the Olalla Creek bridge showed considerable signs of inflow during smoketesting. Extremely heavy roots and deposit buildup were found in subsequent televising. The pipe itself is in very poor condition and urgent replacement is recommended.

Pipe bursting is recommended to avoid replacing the edge of the pavement and curb. There are few lateral connections in this pipe segment but they each should be replaced with PVC to the property line and connected to a fusion welded HDPE saddle.

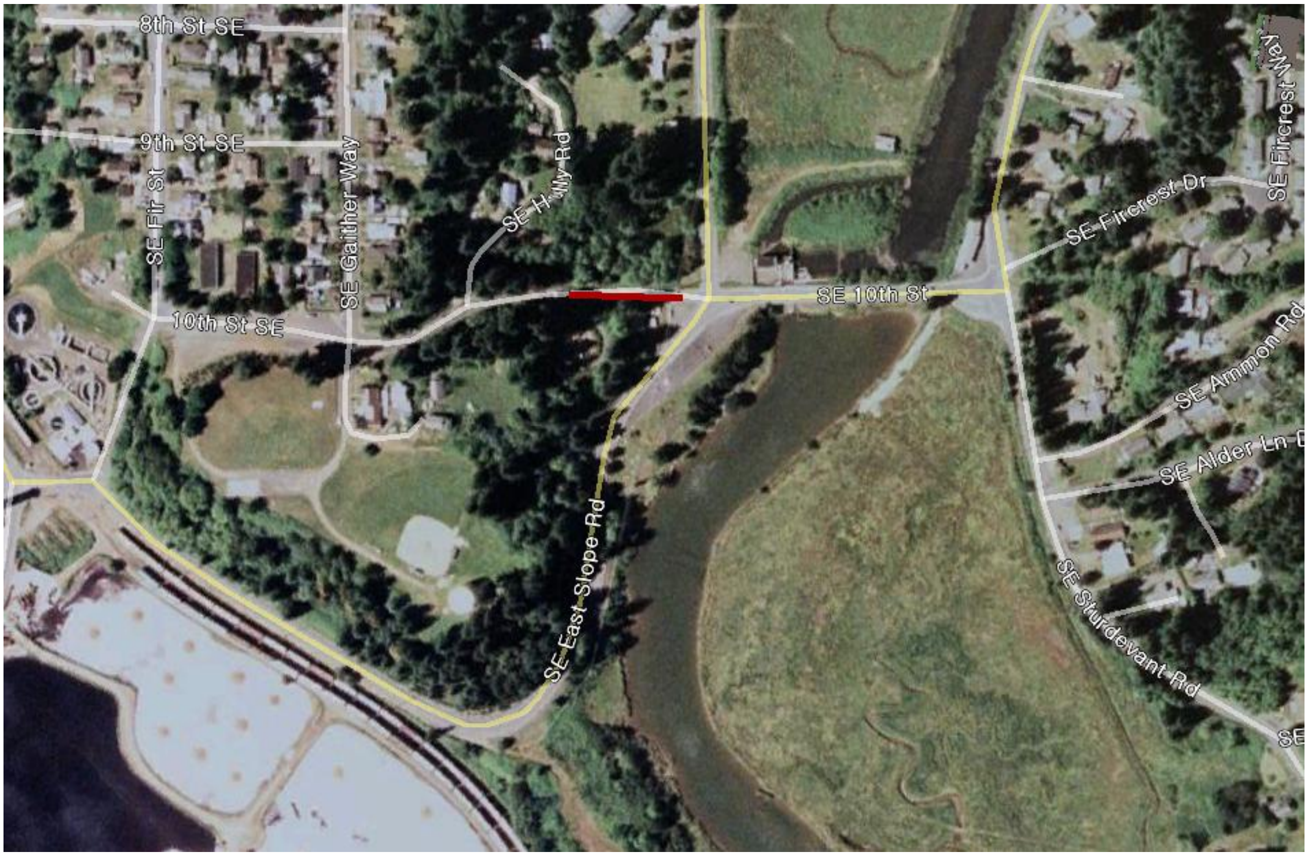
During flow mapping and smoketesting there was some confusion related to unexpected manholes on this hillside. It is recommended that the City update their internal mapping to better show the pipe and manhole connections along this street.

TABLE 7.2.4.1 – SE 10TH STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
N3 to N4	Pipe Bursting

TABLE 7.2.4.2 – SE 10TH STREET, COST ESTIMATE

SE 10th St Project #D					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$4,000.00	$4,000.00
2	Construction and Temporary Facilities	ls	1	$3,000.00	$3,000.00
3	8" HDPE Pipe bursting	lf	292	$45.00	$13,140.00
4	New Manhole	ea	1	$4,500.00	$4,500.00
5	Lateral Connections	ea	4	$2,500.00	$10,000.00
6	Surface Restoration	ea	1	$3,500.00	$3,500.00
		Construction Total			$38,140.00
		Contingency (25%)			$10,000.00
		Subtotal			$48,140.00
		Engineering (20%)			$9,700.00
		Administrative Costs (3%)			$1,500.00
		Total Project Costs			$59,340.00



MAP 7.3.4 SE 10TH ST PROJECT D

7.3.5 East Graham Street Project E

Along the steep slope where East Graham Street intersects Main Street, several pipe cracks and root penetrations were discovered. Initially, the pipe was found to contain high infiltration from the Flow Mapping Survey. During televising it was observed that the 10-inch concrete pipe is in serviceable condition at the upper portion and begins to have root joint failure for the lower two-thirds of the pipe.

It was not possible to televise the entire pipe due to a protruding lateral. This lateral should be cut and, once complete, the recommendation is to line the pipe with a CIPP liner.

TABLE 7.2.5.1 – EAST GRAHAM STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
I34 to I33	CIPP Liner, Verify remainder of pipe before construction

TABLE 7.2.5.2 – EAST GRAHAM STREET, COST ESTIMATE

E Graham St Project #E					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$4,000.00	$4,000.00
2	Construction and Temporary Facilities	ls	1	$3,000.00	$3,000.00
3	10" CIPP Liner	lf	375	$45.00	$16,875.00
4	CIPP Lateral Liner	ea	5	$2,500.00	$12,500.00
		Construction Total			$36,375.00
		Contingency (25%)			$10,000.00
		Subtotal			$46,375.00
		Engineering (20%)			$9,300.00
		Administrative Costs (3%)			$1,400.00
		Total Project Costs			$57,075.00

MAP 7.3.5. E GRAHAM ST PROJECT E

7.3.6 Northwest 6th Street Project F

6th street has a collapsing pipe at the dead-end intersecting Beech Street. Complete televising of the entire pipe section was not possible due to extreme root intrusion blocking access for the camera equipment. Because the remaining structure of the pipe is unknown, it is recommended to proceed with an open trench replacement in preference to trenchless repairs. Lateral connections are unknown as well and have been assumed based upon nearby residences.

TABLE 7.2.6.1 – NW 6TH STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
F26 to F23	Pipe Replacement, root removal before construction and reinspection for design.

TABLE 7.2.6.2 – NW 6TH STREET, COST ESTIMATE ALTERNATIVE 1

NW 6th St Project, Alternative F1, Open Trench Replacement					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$7,000.00	$7,000.00
2	Construction and Temporary Facilities	ls	1	$5,500.00	$5,500.00
3	8" PVC Pipe	lf	307	$85.00	$26,095.00
4	Lateral Connections (assumed)	ea	4	$3,000.00	$12,000.00
5	New Manhole	ea	1	$4,500.00	$4,500.00
6	Asphalt Trench Patch	sq yds	200	$60.00	$12,000.00
7	Landscape Restoration	ls	1	$2,000.00	$2,000.00
		Construction Total			$69,095.00
		Contingency (25%)			$18,000.00
		Subtotal			$87,095.00
		Engineering (20%)			$17,500.00
		Administrative Costs (3%)			$2,700.00
		Total Project Costs			$107,295.00

A second cost estimate has been developed to include an alternative pipe bursting repair. This second estimate has been provided as a potential lower cost repair if further investigation is completed. This estimate includes further cleaning and inspection of the pipe and makes the assumption that the pipe segment will be found in adequate condition to burst.

It is possible televising and root cutting measures will conclude the pipe cannot be repaired using non-invasive methods and Alternative F1 must be used anyway.

TABLE 7.2.6.3 – NW 6TH STREET, COST ESTIMATE ALTERNATIVE 2

NW 6th St Project, Alternative F2, Pipe Bursting					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$4,000.00	$4,000.00
2	Construction and Temporary Facilities	ls	1	$3,000.00	$3,000.00
3	8" HDPE Pipe Bursting	lf	307	$45.00	$13,815.00
4	Lateral Connections (assumed)	ea	4	$3,000.00	$12,000.00
5	New Manhole	ea	1	$4,500.00	$4,500.00
6	Root Cutting & Re-Televising	lf	292	$2.00	$600.00
7	Surface Restoration	ls	1	$3,000.00	$3,000.00
		Construction Total			$40,915.00
		Contingency (25%)			$11,000.00
		Subtotal			$51,915.00
		Engineering (20%)			$10,400.00
		Administrative Costs (3%)			$1,600.00
		Total Project Costs			$63,915.00

MAP 7.3.6 NE 6TH ST PROJECT F

7.3.7 Business 20 Replacement Project G

Heavily bellied pipe is buried under Business 20 near the police station. This pipe was suspected of heavy flows during flow mapping. Television inspection was unsuccessful due to very poor pipe grade forcing the camera underwater through most of the survey. The portions that were visible contained heavy leaks at every joint. The current pipe is 8-inch concrete and observed flow lines indicate a full pipe is often experienced in this section.

Significant settlement is occurring in the pipe along its current alignment, likely due to its placement near a tidal lowland area. There is also concern that the sanitary sewer mapping shows the pipe could be located underneath an existing building. We did consider moving the alignment north and routing the pipeline under Business 20 until its intersection with "A" Street. The "A" street intersection is on a rising slope resulting in the realignment having a depth of approximately 20 feet at the terminating manhole.

Feedback received from long time Public Works Department employees suggest that the existing alignment is located between existing buildings, not beneath them. Our recommendation is to replace the existing pipeline using the current alignment which will reduce traffic disruption, require less asphalt patching, and not require deep trenching equipment. We do anticipate that some foundation stabilization and dewatering equipment will be necessary at this site.

This project includes the replacement of 4 pipe segments and installation of 4 new manholes.

TABLE 7.2.7.1 – BUSINESS 20 REPLACEMENT, PIPES SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
D1 to F8	Realign, upsize to 10-inch, eliminate belly
D1 to D2	Realign, upsize to 10-inch, eliminate belly
D2 to D3	Realign, upsize to 10-inch, eliminate belly
D3 to D4	Realign, upsize to 10-inch, eliminate belly

TABLE 7.2.7.2 – BUSINESS 20 REPLACEMENT, COST ESTIMATE

Business 20 Project #G					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$12,000.00	$12,000.00
2	Construction and Temporary Facilities	ls	1	$9,000.00	$9,000.00
3	10" PVC Pipe	lf	602	$95.00	$57,190.00
4	Asphalt Trench Patch	sq yds	200	$60.00	$12,000.00
5	Foundation Stabilization	cu yds	100	$36.00	$3,600.00
6	Dewatering	ea	1	$5,000.00	$5,000.00
7	New Manhole	ea	4	$4,500.00	$18,000.00
8	Landscape Restoration	ea	1	$6,000.00	$6,000.00
		Construction Total			$122,790.00
		Contingency (25%)			$31,000.00
		Subtotal			$153,790.00
		Engineering (20%)			$30,800.00
		Administrative Costs (3%)			$4,700.00
		Total Project Costs			$189,290.00

MAP 7.3.7 BUSINESS 20 REPLACEMENT PROJECT G

7.3.8 Southeast 5th Street Project

5th Street sewer pipe is full of roots and the pipe itself appears to be worn past its useful life. A large hole exists near one end and large deposits have blocked part of the pipe. Most of the pipe was able to be observed in spite of the obstruction. The 8-inch concrete pipe is recommended to be repaired with a CIPP liner.

Many of the laterals were observed to be likely I/I contributors. It is recommended that the laterals be rehabilitated or replaced following the main line CIPP rehabilitation. This may be accomplished through the use of a lateral liner system or a direct installation of a new "cut-in" tee and lateral piping. The most cost effective approach should be identified during final design.

TABLE 7.2.8.1 – SE 5th STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
K29 to K28	CIPP Liner, Lateral repairs. Recommend eliminate blockage and inspect remainder of pipe

TABLE 7.2.8.2 – SE 5TH STREET, COST ESTIMATE

SE 5th St Project					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$3,500.00	$3,500.00
2	Construction and Temporary Facilities	ls	1	$2,000.00	$2,000.00
3	8" CIPP Liner	lf	335	$40.00	$13,400.00
4	CIPP Lateral Liner	ea	4	$2,500.00	$10,000.00
		Construction Total			$28,900.00
		Contingency (25%)			$8,000.00
		Subtotal			$36,900.00
		Engineering (20%)			$7,400.00
		Administrative Costs (3%)			$1,200.00
		Total Project Costs			$45,500.00

MAP 7.3.8 SE 5TH ST PROJECT H

7.3.9 Southeast Alder Street Project I

Two small pipe segments on Alder Street are recommended for lining. The pipes themselves are in rough condition and a large hole along with root intrusion is evident. As lateral problems were not observed in any of the surveys, liner connections are rehabilitated with grouting methods.

Obstacles were noted in the pipe during television inspection. Before the liner is installed it should be properly cleaned and re-televised to ensure the pipe is clear and no blockages will impede the installation. Estimates also include installing a pipe patch prior to installing the liner over the large hole. The patch may not be necessary and a liner installer should be consulted prior to construction.

TABLE 7.2.9.1 – SE ALDER STREET, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
I29 to I28	CIPP Liner, Possible CIPP Patch at hole before Lining
I28 to I27	CIPP Liner

TABLE 7.2.9.2 – SE ALDER ST, COST ESTIMATE

SE Alder St Project #I					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$3,500.00	$3,500.00
2	Construction and Temporary Facilities	ls	1	$2,000.00	$2,000.00
3	8" CIPP Liner	lf	274	$40.00	$10,960.00
4	CIPP Patch	ea	1	$2,500.00	$2,500.00
5	Lateral Grout connections	ea	9	$300.00	$2,700.00
		Construction Total			$21,660.00
		Contingency (25%)			$6,000.00
		Subtotal			$27,660.00
		Engineering (20%)			$5,600.00
		Administrative Costs (3%)			$900.00
		Total Project Costs			$34,160.00

MAP 7.3.9 SE ALDER ST PROJECT I

7.3.10 Butler Bridge Slope Project J

Slopes above Butler Bridge Road drain a small portion of the City with a pipeline portion known as the "Robert's" line. During smoketesting significant quantities of smoke were returned in the heavily forested area. Due to bolted manholes, this area was not able to be properly surveyed during flow mapping. During television inspection the pipe was so heavily rooted that the camera could not travel more than one segment without becoming stuck.

The pipeline is a known maintenance problem with a scheduled flushing interval. Because of the relative condition of the pipes, and the unknown condition combined with the smoketesting results, the recommendation is to replace all the piping and manholes on the hillside. Open trench replacement is used due to uncertainty for pipe bursting conditions.

TABLE 7.2.10.1 – BUTLER BRIDGE, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
K16 to K15	Pipe Replacement
K15 to K14	Pipe Replacement
K14 to K13	Pipe Replacement
K13 to K12	Pipe Replacement
K12 to K11	Pipe Replacement
K11 to K3	Pipe Replacement

TABLE 7.2.10.2 – BUTLER BRIDGE, COST ESTIMATE #1

Butler Bridge Slope Project, Alternative J1 - Open Trench Replacement					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$14,000.00	$14,000.00
2	Construction and Temporary Facilities	ls	1	$11,000.00	$11,000.00
3	8" PVC Pipe	lf	960	$85.00	$81,600.00
4	New Manhole	ea	5	$4,500.00	$22,500.00
5	Landscape Restoration	ls	1	$10,000.00	$10,000.00
		Construction Total			$139,100.00
		Contingency (25%)			$35,000.00
		Subtotal			$174,100.00
		Engineering (20%)			$34,900.00
		Administrative Costs (3%)			$5,300.00
		Total Project Costs			$214,300.00

An alternative to open trench replacement is to quickly pipe burst each of the pipe segments. In order for this to be possible, the heavy root intrusion must be cut and the pipe grade and condition re-analyzed. Deficient manhole replacement and major disruption to the landscaping would continue to result. If the pipe condition is suitable for bursting, cost savings would be realized through the quicker installation speed of fused HDPE pipe. It is emphasized that further analysis may not conclude this is a suitable pipe bursting or lining project in which case open trench replacement would be required.

TABLE 7.2.10.3 – BUTLER BRIDGE, COST ESTIMATE #2

Butler Bridge Slope Project, Alternative J2 - Pipe Bursting					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$9,000.00	$9,000.00
2	Construction and Temporary Facilities	ls	1	$7,000.00	$7,000.00
3	8" HDPE Pipe	lf	960	$45.00	$43,200.00
4	New Manhole	ea	5	$4,500.00	$22,500.00
5	Root Cutting and Re-Televising	lf	960	$2.00	$1,920.00
6	Landscape Restoration	ls	1	$10,000.00	$10,000.00
		Construction Total			$93,620.00
		Contingency (25%)			$24,000.00
		Subtotal			$117,620.00
		Engineering (20%)			$23,600.00
		Administrative Costs (3%)			$3,600.00
		Total Project Costs			$144,820.00

MAP 7.3.10 BUTLER BRIDGE SLOPE PROJECT J

7.3.11 North Main Street Project K

A small pipe segment just north of Business 20 on Main Street is experiencing broken and leaking joints. Because it is short and in reasonable condition this pipe segment is recommended for lining. Both laterals are also leaking and suggested to have lateral liners installed.

A second pipe on the opposite side of the hill is in considerably better condition. However, this pipe contains many leaking joints and should be lined as well. Both pipe segments have been combined into this project.

TABLE 7.2.11.1 - NORTH MAIN, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
I81 to I78	CIPP Pipe Liner
F20 to F18	CIPP Pipe Liner

TABLE 7.2.11.2 - NORTH MAIN, COST ESTIMATE

N Main St Project #K					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$3,000.00	$3,000.00
2	Construction and Temporary Facilities	ls	1	$2,000.00	$2,000.00
3	8" CIPP Liner	lf	258	$40.00	$10,320.00
4	CIPP Lateral Liners	ea	2	$2,500.00	$5,000.00
		Construction Total			$20,320.00
		Contingency (25%)			$6,000.00
		Subtotal			$26,320.00
		Engineering (20%)			$5,300.00
		Administrative Costs (3%)			$800.00
		Total Project Costs			$32,420.00

MAP 7.3.11 NORTH MAIN ST PROJECT K

7.3.12 Business 20 Bursting Project L

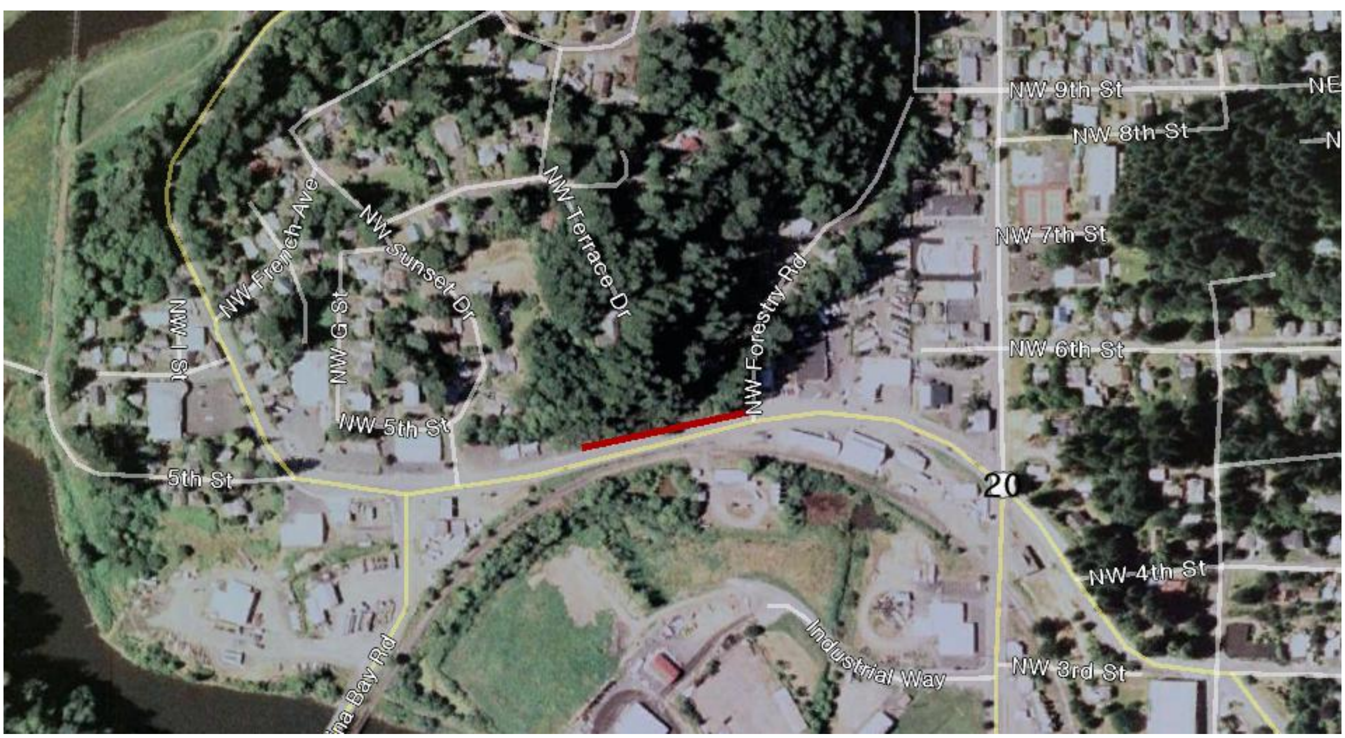
One portion of pipe along Business 20 with many leaks is a good candidate for pipe bursting. The pipe is in reasonable structural condition and no major bellies. High flow lines likely indicate that the pipe capacity is often reached so the recommendation is to increase the size. This project should not be considered urgent but is contributing noticeable I/I to the system.

TABLE 7.2.12.1 - BUSINESS 20, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
D11 to D9	Pipe Bursting, upsize to 10-inch

TABLE 7.2.12.2 – BUSINESS 20, COST ESTIMATE

Business 20 Bursting Project #L					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$4,000.00	$4,000.00
2	Construction and Temporary Facilities	ls	1	$3,000.00	$3,000.00
3	10" HDPE Pipe Bursting	lf	382	$55.00	$21,010.00
4	Surface Restoration	ls	1	$3,000.00	$3,000.00
		Construction Total			$31,010.00
		Contingency (25%)			$8,000.00
		Subtotal			$39,010.00
		Engineering (20%)			$7,900.00
		Administrative Costs (3%)			$1,200.00
		Total Project Costs			$48,110.00



MAP 7.3.12 Business 20 Bursting Project L

7.3.13 Alley Repair Project M

A known "bad pipe" is in an alley type area behind a building downtown. This alley aligns north and south parallel to Main Street. Severe smoke testing problems were observed in this immediate area. When televising was performed the survey was obstructed due to large concrete pieces, possibly pieces of pipe, inside. The portion of the pipe that could be observed contains roots and leaking joints.

The City Public Works employees have indicated that this pipe has been bypassed and the laterals it services no longer used. Two cost estimates have been prepared. One in Table 7.2.13.2 assumes that the pipe is not in use and requires plugging to stop I/I flow. The other estimate in Table 7.2.13.3 assumes that the laterals are still required and the pipe needs replacement, including restoration of the parking lot and retaining wall above the pipe.

TABLE 7.2.13.1 – ALLEY REPAIR, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
I69 to I74	Pipe Replacement, Further Investigation

TABLE 7.2.13.2 – ALLEY REPAIR, PLUG & ABANDON ESTIMATE

Alley Repair Project, Alternative #1M, Pipe Abandonment					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$700.00	$700.00
2	Construction and Temporary Facilities	ls	1	$550.00	$550.00
3	Slurry Plug Pipe	lf	375	$15.00	$5,625.00
		Construction Total			$6,875.00
		Contingency (25%)			$1,800.00
		Subtotal			$8,675.00
		Engineering (20%)			$1,800.00
		Administrative Costs (3%)			$300.00
		Total Project Costs			$10,775.00

TABLE 7.2.13.3 – ALLEY REPAIR, REHABILITATE COST ESTIMATE

Alley Repair Project, Alternative #2M, Pipe Replacement					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$6,000.00	$6,000.00
2	Construction and Temporary Facilities	ls	1	$4,500.00	$4,500.00
3	8" PVC Pipe	lf	275	$85.00	$23,375.00
4	New Manhole	ea	1	$4,500.00	$4,500.00
5	Asphalt Trench Patch	sq ft	184	$60.00	$11,040.00
6	Landscape Restoration	ls	1	$10,000.00	$10,000.00
		Construction Total			$59,415.00
		Contingency (25%)			$15,000.00
		Subtotal			$74,415.00
		Engineering (20%)			$14,900.00
		Administrative Costs (3%)			$2,300.00
		Total Project Costs			$91,615.00

MAP 7.3.13 ALLEY REPAIR PROJECT M

7.3.14 Alder Way Project N

City collections staff asked that the pipeline under Alder Way be televised. Though some problems were seen during smoke testing, nothing significant was found to suggest major problems with this pipe.

Television inspection confirmed the suspicions of the collections staff. Many deficiencies were found throughout the piping in the Alder Way neighborhood. The deficiencies include rat holes, lateral holes, joint problems, pulled gaskets and very worn pipe. One portion of the pipe has had a partial CIPP liner installed. This liner is in excellent condition and no problems are seen in this part of the pipe.

The recommendation is for a CIPP liner to be installed in the remained of the pipe segments and the laterals to be lined and repaired.

TABLE 7.2.14.1 – ALDER WAY, PIPE SEGMENTS REQUIRING REPAIR

Pipe Segment Manhole to Manhole	Repair Recommendations
Cleanout to O-11	CIPP Liner, CIPP Lateral Repairs
O-11 to O-10(not found)	CIPP Liner, CIPP Lateral Repairs
O-10(not found) to O-9	CIPP Liner, CIPP Lateral Repairs
O-9 to O-8(not found)	CIPP Liner, CIPP Lateral Repairs
O-8(not found) to O-7	Partial CIPP liner to connect to existing liner
O-16 to O-12	CIPP Liner, CIPP Lateral Repairs

TABLE 7.2.14.2 – ALDER WAY, COST ESTIMATE

Alder Way Project #N					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$10,000.00	$10,000.00
2	Construction and Temporary Facilities	ls	1	$7,500.00	$7,500.00
3	8" CIPP Liner	lf	1110	$40.00	$44,400.00
4	New shallow manholes	ea	1	$4,500.00	$4,500.00
5	CIPP Lateral Liners	ea	22	$2,500.00	$55,000.00
		Construction Total			$121,400.00
		Contingency (25%)			$31,000.00
		Subtotal			$152,400.00
		Engineering (20%)			$30,500.00
		Administrative Costs (3%)			$4,600.00
		Total Project Costs			$187,500.00

MAP 7.3.14 ALDER WAY PROJECT N

7.3.15 Manhole Rehabilitation Project O

A project has been created to repair manholes found to be leaking during smoke testing and flowmapping reports. The City's manholes are very old and in poor shape in many locations due to the high proportion of older developments. The City has a limited capability to repair some of these manholes but for manholes with significant damage a specialized repair company should be contracted to perform a more permanent fix.

The manhole rehabilitation list was created from the information on the City's mapping. However this mapping is only approximate and some manhole locations do not exist or are not located where depicted. Effort was made to identify as closely as possible each manhole location and visually identify leaks or cracks in the subsurface structure.

Assumptions made in the cost portion included; filling a void at each manhole, average 8 foot manhole depth, sealing the manhole bench and all rings joints to the top rim, and sealing all cracks inside the manhole riser sections sufficient to pass a vacuum test.

Investigative surveys did not note any extensive hydrogen sulfide damage. This likely due to the steep slopes facilitating rapid water movement and little detention time. It may not be necessary to epoxy coat any of the manholes and this should be evaluated during the engineering process. Our recommendation is to use urethane foam to fill voids and to use fiber-reinforced mortar for joints and crack sealing.

TABLE 7.2.15 – MANHOLE REHAB, COST ESTIMATE

Manhole Rehab Project #O					
Item No.	Description	Units	Quantity	Unit Cost	Total Cost
1	Mobilization Costs	ls	1	$5,000.00	$5,000.00
2	Construction and Temporary Facilities	ls	1	$3,500.00	$3,500.00
3	Manhole Sealing (30)	lf	240	$175.00	$42,000.00
4	Manhole void filling	ea	30	$100.00	$3,000.00
		Construction Total			$53,500.00
		Contingency (25%)			$14,000.00
		Subtotal			$67,500.00
		Engineering (20%)			$13,500.00
		Administrative Costs (3%)			$2,100.00
		Total Project Costs			$83,100.00

Section

8

8.0 Capital Improvement Plan and Financing Options

8.1 Introduction

This section describes the prioritization of improvement projects developed in Section 7 and their associated costs. Projects have been grouped into priority levels based upon relative pipe condition and their I/I burden upon the collection system.

All of the improvement projects were assigned priority levels based upon a combination of objective and subjective factors. Objective factors included:

- Visible sinkholes in the pavement
- Broken pipe chunks lying inside the pipe
- Abnormally high flow measurements
- Visible pipe bellies or surcharged manholes.

Subjective factors included:

- Comments from system operators of known problems
- Judgment of the condition of pipe walls and manhole rings from good to poor
- Observation of high flow lines in pipe
- Estimation of the root causes of grease and sediment buildup.

Projects and priorities are based upon information gained from the three investigative surveys. Each survey was performed in a manner to cost effectively determine the most significant deficiencies throughout the system. As the surveys cannot provide perfect information about the entire collection system, it is possible other urgent failures or deficiencies may become evident before the projects are complete.

Development of each project included selection of an appropriate repair technique and analysis of additional costs for each area. Many of the projects have trenchless repair methods initially recommended based upon the analysis of televised data. During design, this televised data must be coordinated with relevant construction firms to verify the applicability of each proposed repair method or other mitigating cost factors. Open trench projects may come upon unidentified buried obstacles or poor soil conditions. Therefore, when estimating projects, a 25% contingency was planned at this preliminary planning stage to account for all of these unknowns.

Table 8.1.1 includes the total of all the improvement projects. Priority levels and groupings are discussed in the following sections.

TABLE 8.1.1 – LIST OF REHABILITATION PROJECTS

Project	Project Number	Estimated Cost
Patching Project	A	$59,550.00
N Nye St Replacement Project	B	$170,730.00
NE 12th St Project	C	$137,530.00
SE 10th St Project	D	$59,340.00
E Graham St Project	E	$57,075.00
NW 6th St Project	F1,F2 (F1 cost)	$107,295.00
Business 20 Replacement Project	G	$189,290.00
SE 5th St Project	H	$45,500.00
SE Alder St Project	I	$34,160.00
Butler Bridge Slope Project	J1, J2 (J1 cost)	$214,300.00
N Main St Project	K	$32,420.00
Business 20 Bursting Project	L	$48,110.00
Alley Repair Project	M	$10,775.00
Alder Way Project	N	$187,500.00
Manhole Rehab Project	O	$83,100.00
	TOTAL	**$1,436,675.00**

The combined total for all the combined projects is **$1,436,675.00**

A scorecard combining the observations from the data in the Smoke Testing, Flow Mapping and Television Survey is shown in Table 8.1.2. Each survey is scored using the objective and subjective factors discussed earlier to rate the pipe segments. The Television Survey was given a higher weighting factor because it is precise and observes infiltration, inflow, pipe condition and grade concurrently.

The rankings in Table 8.1.2 are used to separate the fifteen rehabilitation projects into the four priority improvement plan projects.

TABLE 8.1.2 REHABILITATION PROJECT SCORECARD

Project Name	Project Number	Average Smoke Testing Weighting (Pipe Segment Score/Total Total Segments)	Average Flow Mapping Weighting (Pipe Segment Flow Ranking/Total Pipe Segments)	Average Televise Weighting (Pipe Segment Televise Score/Total Pipe Segments)	Score (Smoke X 2+Flow X 2+Televise X 5)/3	Rank
Patching Project	A	0.8	0.6	1.2	2.9	15
N Nye St Replacement Project	B	1	3	3	7.7	4
NE 12th St Project	C	3	1	2.7	7.2	6
SE 10th St Project	D	3	0	4	8.7	3
E Graham St Project	E	1	3	3	7.7	5
NW 6th St Project	F	3	0	4	8.7	2
Business 20 Replacement Project	G	0	3	3	7.0	8
SE 5th St Project	H	2	0	3	6.3	10
SE Alder St Project	I	2	0	2.7	5.8	12
Butler Bridge Slope Project	J	3	NA	4	13.0	*1
N Main St Project	K	2	0	2.5	5.5	13
Business 20 Bursting Project	L	1	1	2	4.7	14
Alley Repair Project	M	3	0	3	7.0	7
Alder Way Project	N	1	0	3	5.7	11
Manhole Rehab Project	O	3	3.5	NA	6.5	*10

Smoketesting results rated from 0-3, 3 being highest inflow and 0 being no smoke returns
Flowmapping results rated from 0-3, 3 being very high infiltration and 0 being none measured
Televising rated from 0-4, using ratings shown in Appendix A
Data averaged between all pipe segments included in a project
*Unavailable data, score divided by 2 instead

8.2 *Priority 1 Projects*

Priority 1 projects should be undertaken immediately. The pipe segments grouped as Priority 1 contain the significant deficiencies of the following types:

- Extreme root intrusion
- Many separated or offset pipe joints
- I/I throughout the pipe
- Significant concrete deterioration

At minimum all roots should be cut which will re-open the pipe access temporarily but possibly increase infiltration (the roots may be helping “plug” the leaks and their removal may increase the effective void size). Root cutting will temporarily reduce maintenance associated with clogged sewers. Design and planning of the replacement project for these pipelines should proceed regardless of the status of root cutting repairs. Included projects are listed in Table 8.2.

TABLE 8.2 – PRIORITY 1 PROJECTS: INCLUDED REHABILITATION PROJECTS

Priority Ranking	Project #	Project Name	Project Cost
1	J1	Butler Bridge Slope Project	$214,300.00
2	F	NW 6th Street Project	$107,295.00
3	D	SE 10th Street Project	$59,340.00
		Total Priority 1 Projects	**$380,935.00**

8.3 Priority 2 Projects

Priority 2 projects deficiencies are similar in scope to those in Priority 1, but with diminished root intrusion. The pipe segments grouped as Priority 2 contain the significant deficiencies of the following types:

- Many leaking joints
- Broken pipe
- Holes in pipe
- Poor grade with standing water and offset joints
- Significant concrete deterioration

These projects should be started as soon as the Priority 2 projects are completed, or in the next 3-4 years. Included projects are listed in Table 8.3.

TABLE 8.3 – PRIORITY 2 PROJECTS: INCLUDED REHABILITATION PROJECTS

Priority Ranking	Project #	Project Name	Project Cost
4	B	N Nye Street Replacement Project	$170,730.00
5	E	E Graham St Project	$57,075.00
6	C	NE 12th Street Project	$137,530.00
7	M	Alley Repair Project	$10,775.00
8	G	Business 20 Project	$189,290.00
		Total Priority 2 Projects	**$565,400.00**

8.4 Priority 3 Projects

Priority 3 projects are in significantly better condition than Priority 1 and 2 projects. Rehabilitation of this project group is targeted towards I/I reduction and less towards structural and maintenance deficiencies. Repairs typically required in Priority 3 include:

- Isolated leaking joints
- Cracks or holes in pipe
- Lateral to mainline joint separation
- Concrete deterioration

Priority 3 projects should be completed in the next 5-6 years. Included projects are listed in Table 8.4.

TABLE 8.4 – PRIORITY 3 PROJECTS: INCLUDED REHABILITATION PROJECTS

Priority Ranking	Project #	Project Name	Project Cost
9	P	Manhole Rehab Project	$83,100.00
10	H	SE 5th Street Project	$45,500.00
11	N	Alder Way Project	$187,500.00
12	I	SE Alder St Project	$34,160.00
		Total Priority 3 Projects	**$350,260.00**

8.5 Priority 4 Projects

Priority 4 projects are strictly I/I repair projects where the pipe sections are in reasonable condition. The North Main Street and Business 20 Bursting Projects are to repair average condition concrete pipe containing a moderate amount of infiltration points. The Patching Project is a bundle of projects needing point repairs to eliminate smaller I/I sources.

Any of these projects are potentially good candidates to combine with other similar repair methods in Priorities 1-3, or could be repaired together at a future date. Priority 4 projects should be completed in the next 10 years. Included projects are listed in Table 8.5.

TABLE 8.5 – PRIORITY 3 PROJECTS: INCLUDED REHABILITATION PROJECTS

Priority Ranking	Project #	Project Name	Project Cost
13	K	N Main Street Project	$32,420.00
14	L	Business 20 Bursting Project	$48,110.00
15	A	Patching Project	$59,550.00
		Total Priority 4 Projects	**$140,080.00**

8.6 Funding Options

Repairs to the collection system can be funded in a variety of ways. State and Federal programs provide low interest loans and grants to municipal wastewater systems. The City can provide its own funding through current or future revenues. There also is the option of issuing local bonds to pay for immediate improvements and finance them over a fixed term.

The City is already faced with substantial upgrades and plans repairs for the potable water system. Therefore, the City is tasked with raising a sizeable amount of funds to complete the rehabilitation projects we have recommended. The major funding sources will be briefly discussed in the following paragraphs. The State of Oregon holds “One Stop” meetings monthly in Salem where the City can schedule a time to learn about all the current Federal and State program offerings.

8.6.1 State Funding Sources

Oregon DEQ administers a loan program on behalf of the EPA. The *Clean Water State Revolving Fund* (CWSRF) Loan Program provides low-cost loans for the planning, design and construction of various water pollution control activities. It provides a subsidized loan package for planning, design, construction, emergencies, urgent repairs and local community projects. Rates currently vary from 1.09% to 4.35% depending on the project type. Loan terms 5 years and greater include a 0.5% annual fee for administration.

The Oregon Infrastructure Finance Authority (IFA) provides low cost loans for projects up to $9 million in size. Loan terms are offered up to 25 years of the life of the project and come from a dedicated public works fund.

The IFA also offers a water/wastewater loan fund with similar terms. These loans are typically paid through bonding.

Another program offered by the IFA is a grant program. The grant program is targeted toward disadvantaged income areas and has a $1 million cap for wastewater projects. The IFA states 1 of 3 criteria must be met for eligibility:

1. The proposed activities must benefit low- and moderate-income individuals.
2. The activities must aid in the prevention or elimination of slums or blight.
3. There must be an urgent need that poses a serious and immediate threat to the health or welfare of the community.

Other grant caps and information can be found by visiting the IFA website http://www.orinfrastructure.org/

8.6.2 Federal Funding Sources

Many of the Federal Funds are administered through the DEQ and IFA programs. The major source of direct federal funding for communities comes from the U.S. Department of Agriculture (USDA). The USDA administers the Rural Development (RD) program which provides funding through the Rural Utilities Service (RUS).

Loans and Grants are both available under the RUS program. Grants from both RUS and the state IFA programs both contain revenue guidelines that favor sanitary districts set at already high rates. Because Toledo is a smaller community it is eligible for these grants. Federal funds have specific additional requirements and steps which must be taken throughout the design and construction process. The City will need to weigh the additional costs against the size of benefits they are receiving to ultimately make a decision.

8.6.3 Revenue Sources

Revenue funding originates directly from rate payers within the City's. Rate increases are not popular with residents, especially those on fixed incomes, but are often necessary to provide funding for loan and bond payments or to save up for future repairs. Revenue rates are also often raised to meet minimum guidelines for State or Federal financing sources. Government funding agency guidelines are set to ensure districts are not charging unreasonably low rates to maintain the system before they offer financial assistance.

The City should evaluate its rate structure and see how the rates compare with other like size cities. Many coastal cities and sanitary districts have recently gone through this process to align their rate structure with the maintenance needs of their systems.

8.6.4 Bonds

Bonds come in two different varieties, general obligation bonds and revenue bonds. The City would issue a bond to pay for the project(s) and pay the bond and interest back over a fixed term. Bonds can be issued from 1 to 30 years in duration. Recommended practice is to avoid bonding beyond the life expectancy of the project. Wastewater facilities have a planning life expectancy of 20 years, although new manholes and sewer pipe commonly are expected to last beyond 50 years.

General obligation bonds are backed by a temporary property tax assessment and would raise taxes for users within the sanitary service area until the end of the bond term. General obligation bonds typically carry a lower interest rate as the property owners are under threat of foreclosure if taxes are not paid.

Revenue bonds set aside a portion of the user fees for sanitary sewer service and use those to repay the bond and interest. They do not result in an increase of taxes on the users and are typically regarded as riskier bonds with a slightly higher interest rate.

Due to the current economic conditions both general obligation and revenue bonds currently carry very low interest rates. Rates for municipal bonds are ranging from approximately 1.25% annually for a 5 year to 4.2% for a 30 year bond. The exact rate varies depending on the credit rating of the City and investor demand for the bonds.

APPENDIX A

Video Inspection Notes

Repair Urgency	Color	Weighting Factor
No Repair or Small Repair	Green	0-1
Further Inspection or Repair	Gray	Varies
Moderate Repair	Blue	2
Extensive Repair	Orange	3
Immediate Repair	Red	4

PIPE AND COMMENTS (MH TO MH)		LINEAR FOOTAGE LOCATION
C5 to C6		
Crack with Deposits		78'
Pipe Belly		125' to 139'
Pipe Belly		231' to 242'
Overall pipe looks in good condition for Concrete Pipe		
		373.84'
C21 to C18		
Leaking joint at manhole C18		65'
Overall pipe looks in good condition for Concrete Pipe		
		65.01'
B29 to B31		
Leaking along pipe wall		10'
Large hole near bottom with I/I		31.5'
Small hole near bottom of pipe		82.5'
Large I/I at lateral connection		136'
ABS pipe patch at		148'
Lateral with sizeable clear flow		170'
Lateral with small leak around penetration		299'
Joint looks rough		318'
Joint looks rough		324'
Pipe begins to look rougher		329'
Joint looks rough		338'
Small hole near bottom of pipe		354'
Large hole near bottom with I/I		357'
Pipe begins to look smoother		360'
Lateral has high flow, joint appears poor		395'
Capped lateral leaking		409'
Lateral has high flow		412'
Lateral has high flow, joint appears poor		455'

Pipe in average condition, some spot repair or section repairs acceptable		
		463.25'
B20 to B18		
Large Roots		6'
Large Roots		9'
Long Crack and Roots		31'
> 30 wet looking spots		42' to 200'
Rough Joint possible leak		51'
Pipe rough at top		66' to 73'
High Lateral flow		102'
Roots on bottom		138'
Ring cracks		161'
Large Hole		164'
Roots		178'
Roots		193' to 195'
Pipe in poor condition, needs complete repair		
		218.59'
B22 to B20		
Pipe rough at lateral		15' to 17'
Pipe rough		40'
Pipe Wet		56'
Pipe Pinhole Leak		67'
Small hole		70'
Possible Ring Crack		94'
Possible Ring Crack		98'
Pipe in average condition, a few small repairs possible		
		119.13'
B16 to B18		
Pipe has complete belly		
Pipe in poor condition, no specific repair areas noted due to belly		
		46.29'
B16 to B12		
Wet		6'
Small hole		9'
Small hole		109'
Lateral high flow		144'
Overall pipe looks in good condition for Concrete Pipe		

		243.97'
O7 to O6		
Lateral stopped video at 223.53'		
Pipe is very rough and worn, likely flowing full often, no issues seen		
		223.53'
N3 to N4		
Deposit Buildup		7' to 12'
Roots Light		42' to 59'
Roots Heavy		59' to 165'
Leak		75'
Roots Light		175' to 191'
Deposit Buildup		199'
Roots Light		246' to 291'
Pipe in very bad condition, quick replacement suggested		
		291.13'
N4A to N4		
Pipe in average condition, no repairs needed		
		141.21'
B1 to F41		
High Lateral Flow		104'
High Lateral Flow		107'
Very High Lateral Flow		242'
Pipe in good condition, laterals need inspected		
		328.42'
F41 to F38		
High Lateral Flow		104'
Large Belly going into manhole		200'
Pipe in good condition except belly		
		200'
B9 to B1		
Pipe in good condition		
		117.75'
F38 to F36		
Pipe in good condition		
		126'

F36 to F34		
Pipe in good condition		
		130.26'
F34 to F33		bAd Video
F9 to F8		
Pipe in good condition		
		398.64'
I33A to I33		
Pipe in good condition		
		21.31'
I33A to I4		
Pipe in good condition		
		185.27'
I34 to I33		
Small Roots		124'
Small Roots		132'
Small Roots at lateral		133'
Roots		134'
Roots		136'
Small Roots		141'
Small Roots		146'
Long Crack top of pipe		222'
Long Crack top of pipe		227'
Crack top of pipe		246'
Pipe in Average condition, problems are located in clusters		
		280.69'
I71A to I71		
Pipe in good condition		
		20.05'
I71 to I70		
Pipe in good condition		
		223.24'

I23 to I84		
Roots or Gasket		41'
Holes in top of pipe		158'
Small Roots		164'
Small Roots		171'
Broken Joint		385'
Pipe in good condition, spot repairs advisable		
		390.02'
I72 to I71		
Pipe in good condition		
		187.21'
F26 to F23		
Large Root throughout pipe		
Pipe in very bad condition, quick replacement suggested		
		23.53'
D1 to F8		
Leaking Joint		17'
Belly cannot see pipe		30' to 90'
Leaking Joint		116'
Offset Pipe		117'
Pipe in good condition, spot repairs advisable		
		185.08'
D1 to D2		
Pipe looks good but submerged 15' to end		
		174.43'
D2 to D3		
Submerged to 84'		84'
Submerged again at 115' to 124'		115'
Small section of pipe visible looks good		
		124.26'
D3 to D4		
Nearly Every joint in pipe is leaking		
Belly		64' to 116'
Leak		119'
Pipe in poor condition and should be lined or replaced		

		205.42'
K29 to K28		
Wide Joint		30'
Pipe begins to look very worn		37'
Extremely worn pipe		100' to 103'
Deposits in pipe		154'
Deposits in pipe		161'
First Roots in pipe		164'
Roots become worse		168'
End of Roots in pipe		179'
Small Roots		193'
Small Roots		195'
Small Roots		238'
Small Roots Begin		248'
Small Roots End		261'
Large Roots begin		270'
Hole in top of pipe		271'
Large roots end		278'
Large deposit or roots blocking camera		294'
Pipe in poor condition throughout		
		296.75'
I19 to I18		
Pipe good condition PVC to 172'		
Concrete hole patch at		193'
Hole in Lateral top		247'
Pipe in good condition with 1 hole to patch		
		365.03'
I29 to I28		
Pipe in rough condition		
		56.75'
I28 to I29 rest of pipe		
Big hole		84'
Pipe looks much less worn than upstream section		
		122.52'
I28 to I27		
Very Rough spot		46'

Roots		54'
Roots		56'
Small Roots		57'
Small Roots		60'
Small Roots		66'
Roots		69'
Small Roots		74'
Leak		82'
Pipe in Average condition, downstream needs repaired		
		94.24'
I27 to I26		
Pipe in good condition		
		122.03'
K37 to K38		
Concrete pipe in average condition		
		132.59'
K38 to K39		
Concrete pipe in average condition		
		99.17'
K16 to K17		
Pipe wall look worn		
Huge pipe offset		11'
Cannot video to cleanout		
		11.33'
K16 to K15		
Small Roots		19'
Begin small roots		26'
Begin heavier roots		41'
PVC pipe patch		61' - 64'
Begin roots		64'
Begin Heavy Roots		68'
Begin Extreme roots		90'
Pipe Joint Drop		156'
Pipe in extremely bad condition, replace soon		
Pipe downstream on hill not videoable, likely in same condition		
		156.8'

K26 to K25		
Pipe in good condition		
		218.69'
K25 to K23		
Pipe in good condition, roots in manhole K23		
		166.2'
M18 to M13		
Deposits on bottom		172'
Pipe in good condition cannot see further		
		172.01'
I81 to I78		
Root or gasket at joint		90'
Capped lateral leaking		109'
Leaking joint		116'
Capped lateral leaking		116'
Broken pipe joint leaking		138'
Broken pipe joint leaking		141'
Pipe in average to poor condition, repair in at least sections		
		154.09'
F20 to F18		
Small Roots		9'
Small Roots		12'
Joint is wet		14'
Joint is wet		16'
Small Leak on Wall		18'
Leaking Joint		19'
Joint is wet		21'
Joint is wet		24'
Roots		26'
Small Roots		39'
Small Roots		56'
Roots		59'
Pipe extremely worn		63'
Lateral with roots		65'
Pipe becomes less worn		67'
Roots and wet joint		69'

Small Roots		77'
Roots		79'
Roots		84'
Joint is wet		99'
Pipe is a mixture of average and poor sections		
		103.15'
D11 to D9		
Leaking joint		92'
Leaking joint		95'
Leaking joint		105'
Leaking joint		111'
Leaking joint		118'
Leaking joint		121'
Leaking joint		227'
Video missing		234 to 277
Leaking joint		337'
Pipe in average condition, could use some joint repairs		
		381.17'
Clinic cleanout to F8		
Large belly at start		
Pipe in good condition other than backwards wye connection		
		208'
F34 to F9		
Belly at 70'		70' to 74'
Lateral has high flow		177'
Pipe in good condition		
		394.18'
I69 to I74		
Capped Lateral leaking		73'
Leaking Joint		74'
Roots		119'
Roots		123'
Roots		128'
Roots		131'
Large concrete chucks in pipe		155' to 158'
Pipe in average condition, unknown where pipe sections come from		
Suggest to repair pipe in specific areas		

		158.16'
O16 to O12		
Leak in wall		155'
Leak in wall		222'
Pipe begins looking considerably worn		230'
Broken joint leaking		307'
Lateral with hole and large flow		368'
Pipe begins looking less worn		370'
Bad Leak at joint		395'
Pipe in average condition but well worn, some patching needed		
		396.8'
O12 to O7		
Small roots		12'
Small roots		18'
Leak around object portruding pipe		114'
Pipe in average condition, needs object removed		
		116.12'
O11 to O7		
Pipe appears well worn		
Rat hole in lateral		30'
Lateral needs regrouted		101'
Roots growing around lateral		245'
Bottom broken out of pipe		266'
Roots growing around lateral		311'
Large hole in lateral joint		427'
Small roots		482'
Damage to joint		501'
Hole in lateral		518'
Gasket displaced		519'
Capped lateral with hole		564'
Leaking lateral		573'
Gasket displaced and pipe cracked		586'
Hole in lateral		613'
Hole in lateral and joint		638'
Pipe liner		664' to end
Pipe in poor condition except lined section		
		738.1'

O11 to Cleanout		
Lateral connection is bad, hole		5'
Many joints appear wet		
Pipe and rock debris at end		48'
Pipe appears in average condition but joints possibly leaking		
		48.72'

APPENDIX B

Manhole Deficiency Notes

TABLE B-1 – MANHOLE LEAKS FUOND IN FLOW MAPPING

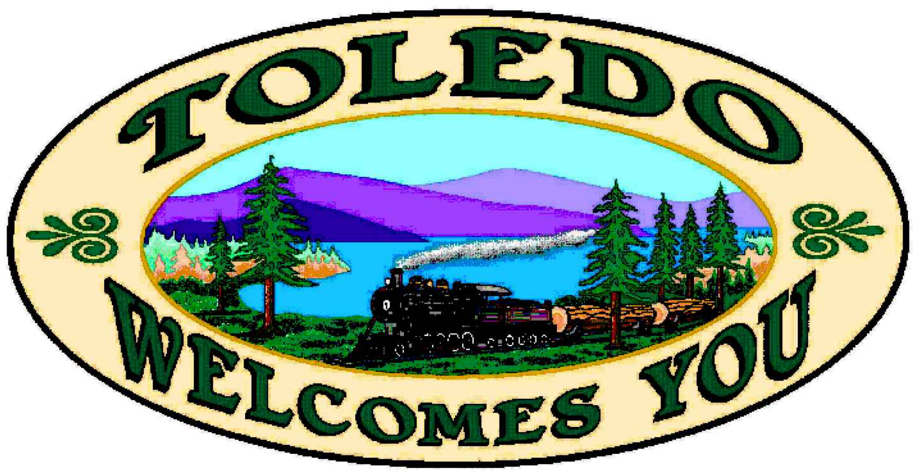
Flow Mapping Manholes with Leaks If strikeout shown City has repaired manhole & current condition listed to the right	
Manhole #	**Comments**
B10	~~Leaking~~ -OK
B16	Leaking-Repaired but leaking still
B24	Leaking
B27	~~Leaking~~-Fixed
C1	Leaking
C2	Leaking
D12	~~Leaking~~-Fixed
D4	Leaking-Wet rings
D9	Leaking-Repaired but leaking still
F15	Leaking-Partially repaired, drill bit in wall
F8	10-20 GPM Leak-Still significant leaks
G33	Bottom Ring Leaking-Repaired but leaking still
I4	~~Leaking~~-OK
L10	Bottom Ring Leaking- Repaired but leaking still
L14	~~2 Leaks~~-Fixed
L15	Leak Beside Lateral 1-2GPM-Repaired but leaking still
L8	~~Manhole Wet~~-OK
O12	Bottom Ring Leaking
O5	General Leaks- Bottom Ring

TABLE B-2 – MANHOLE LEAKS FOUND DURING SMOKE TESTING

Smoke Testing Manholes with Improper Smoke Returns If strikeout shown City has repaired manhole & current condition listed to the right	
Manhole #	**Comments**
B32	~~Cracked manhole~~-Fixed
B76	~~Smoke beside manhole~~ Only around rim no leaking potential
B78	~~Smoke around rim~~-Ok just around rim no leaking potential
B78A	Leaking
B79	~~Smoke around rim~~-Just Rim Ok
C12	~~Smoke around rim –~~ No leak potential
C7	~~Cracked Manhole~~- No leak potential
C8	~~Cracked Manhole~~- No leak potential
D10	~~Cracked Rim~~-Only around rim no leaking potential
E1	Smoke around rim – Cracked inside
F50	~~Smoke around rim~~- Only around rim no leaking potential
F51	~~Smoke from curb next to rim~~- Only around rim no leaking potential
F54	~~Smoke around rim~~ - Only around rim no leaking potential
F55	~~Smoke around rim~~ - Only around rim no leaking potential
G24	~~Smoke from manhole side~~ - Only around rim no leaking potential
H26	Leaking around edges –Follow up as well
H27	Leaking around edges–Follow up as well
H28	Leaking around edges–Follow up as well
H32	Broken Manhole in field–Follow up as well
H33	Broken Manhole in field–Follow up as well
I31	~~Smoke around rim~~-OK
J1	~~Manhole cracked~~
J2	~~Manhole cracked~~
J3	Smoke from ground – Leaking actively
K2	Smoke coming from ground, replace with project
K25	Cracked Manhole, large hole in top but no I/I risk
K33	Smoke coming from ground –sinkhole nearby
K35	Smoke around rim – Cannot find follow up
K37	~~Smoke from ground~~- Fixed
K6	Leaking
K7	Smoke around rim- Leaking
M38	Smoke coming from ground-Mid ring leak
P19	Smoke around rim-Grouted risers leaking
P32	Smoke around rim-Many rings leaking
P5	~~Smoke from ground~~ –Not leaking, hole in ground
P9	~~Smoke from ground~~- OK

CITY OF TOLEDO
INFLOW AND INFILTRATION STUDY

PROJECT NO.: 2902-008
March, 2011



APPENDIX C
BASIN AND SMOKE TESTING DRAWINGS

Civil West Engineering Services, Inc.	DWG BY: CDA DATE: MACH, 2011	0 1"	EXISTING COLLECTION SYSTEM	
	I/I STUDY COVER SHEET		CITY OF TOLEDO, COOS COUNTY, OREGON	COVER

LEGEND

- B-32 ○ MANHOLE AND NUMBER
- LEAKY MANHOLE
- REPAIRED MANHOLE
- GRAVITY SEWER

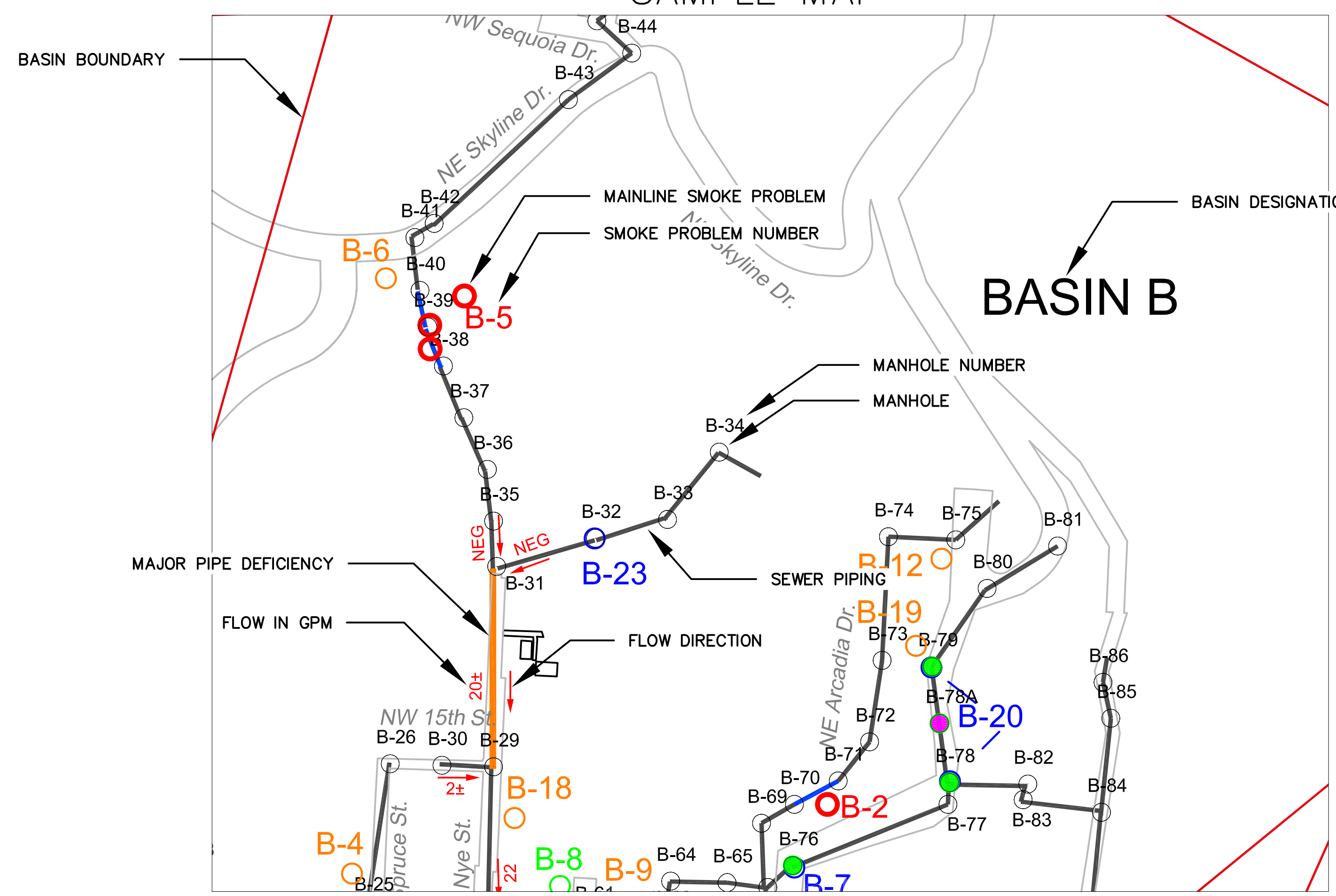
SANITARY SEWER PIPE CONDITIONS

- EXTREME PIPE DEFICIENCY
- MAJOR PIPE DEFICIENCY
- MODERATE PIPE DEFICIENCY
- MINOR PIPE DEFICIENCY
- LATERAL CONNECTION DEFICIENCY
- FURTHER INSPECTION NEEDED

SMOKE PROBLEMS

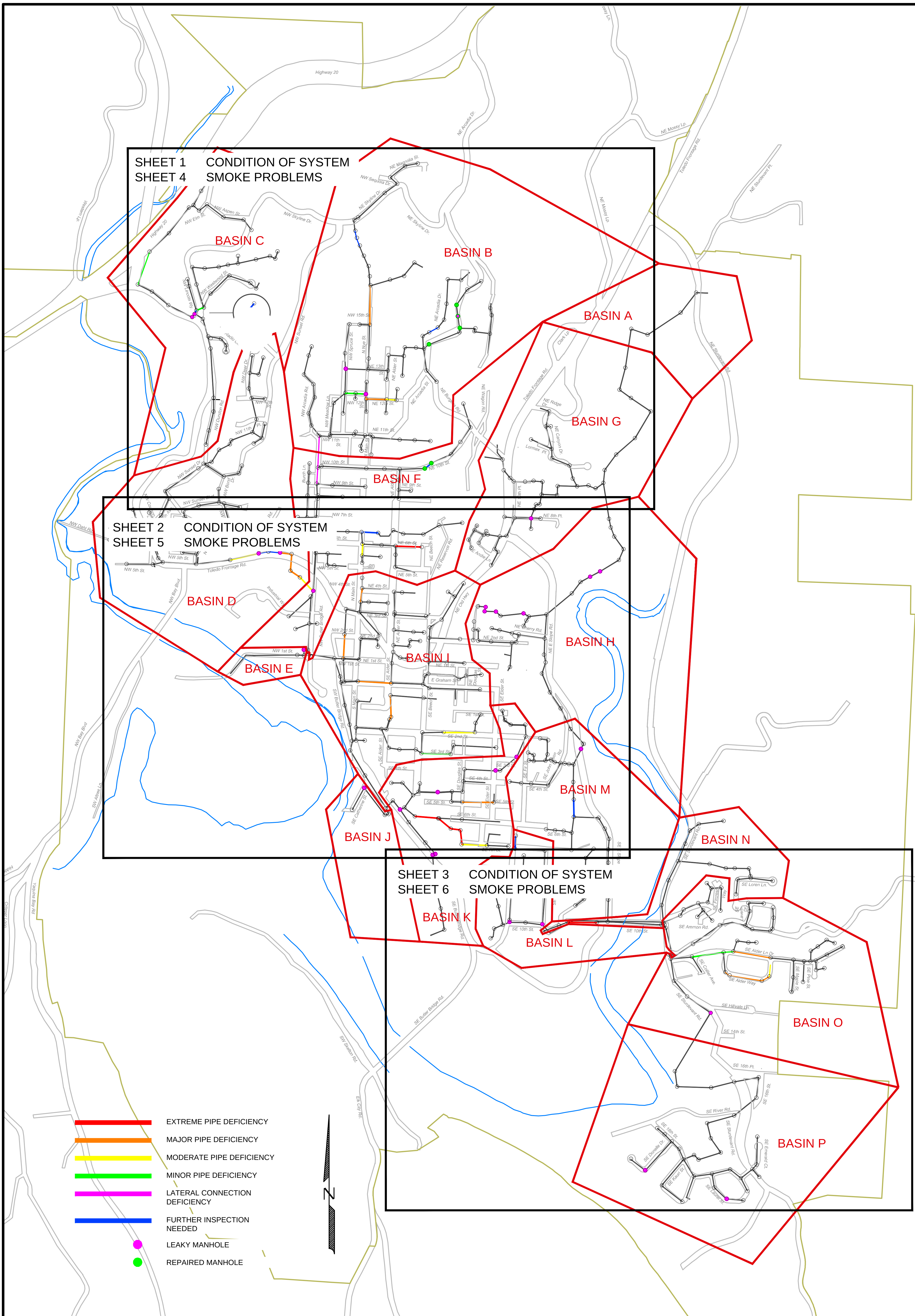
- V-1 ○ LATERAL SMOKE PROBLEM
- V-1 ○ SANITARY SEWER MAINLINE SMOKE PROBLEM
- V-1 ○ STORM DRAIN SMOKE PROBLEM
- V-1 ○ RESIDENTIAL SMOKE PROBLEM
- V-1 ○ MANHOLE SMOKE PROBLEM

SAMPLE MAP



Civil West Engineering Services, Inc.	CITY OF TOLEDO LINCOLN COUNTY, OREGON	EXISTING COLLECTION SYSTEM LEGEND	0 1" 1" = 400FT DRAWN BY: JBH DATE: APRIL, 2010

MAP LEGEND



OVERVIEW

0 1"
1" = 1000'

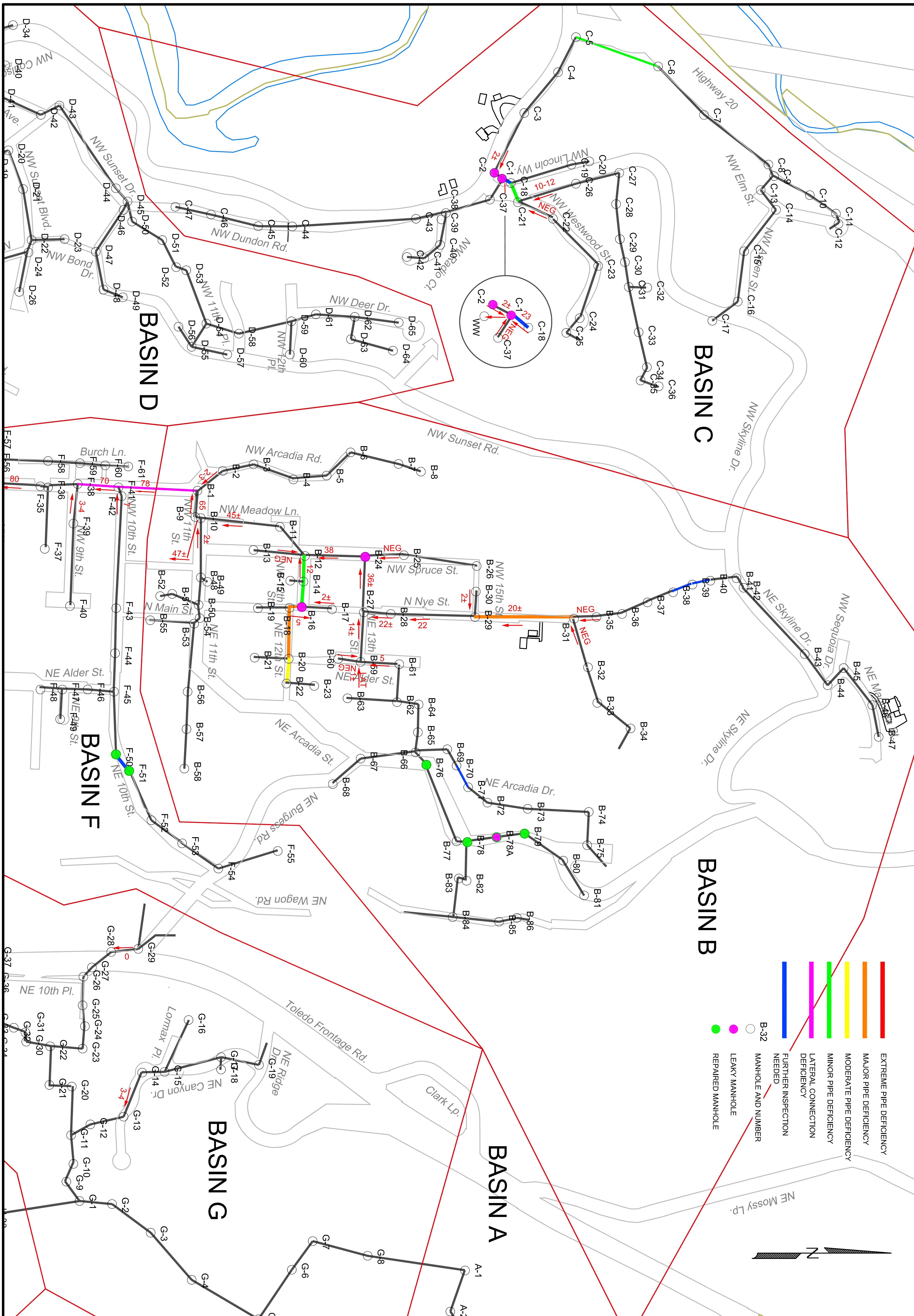
Drawn By: JBH
Date: March, 2011

EXISTING COLLECTION SYSTEM

OVERVIEW

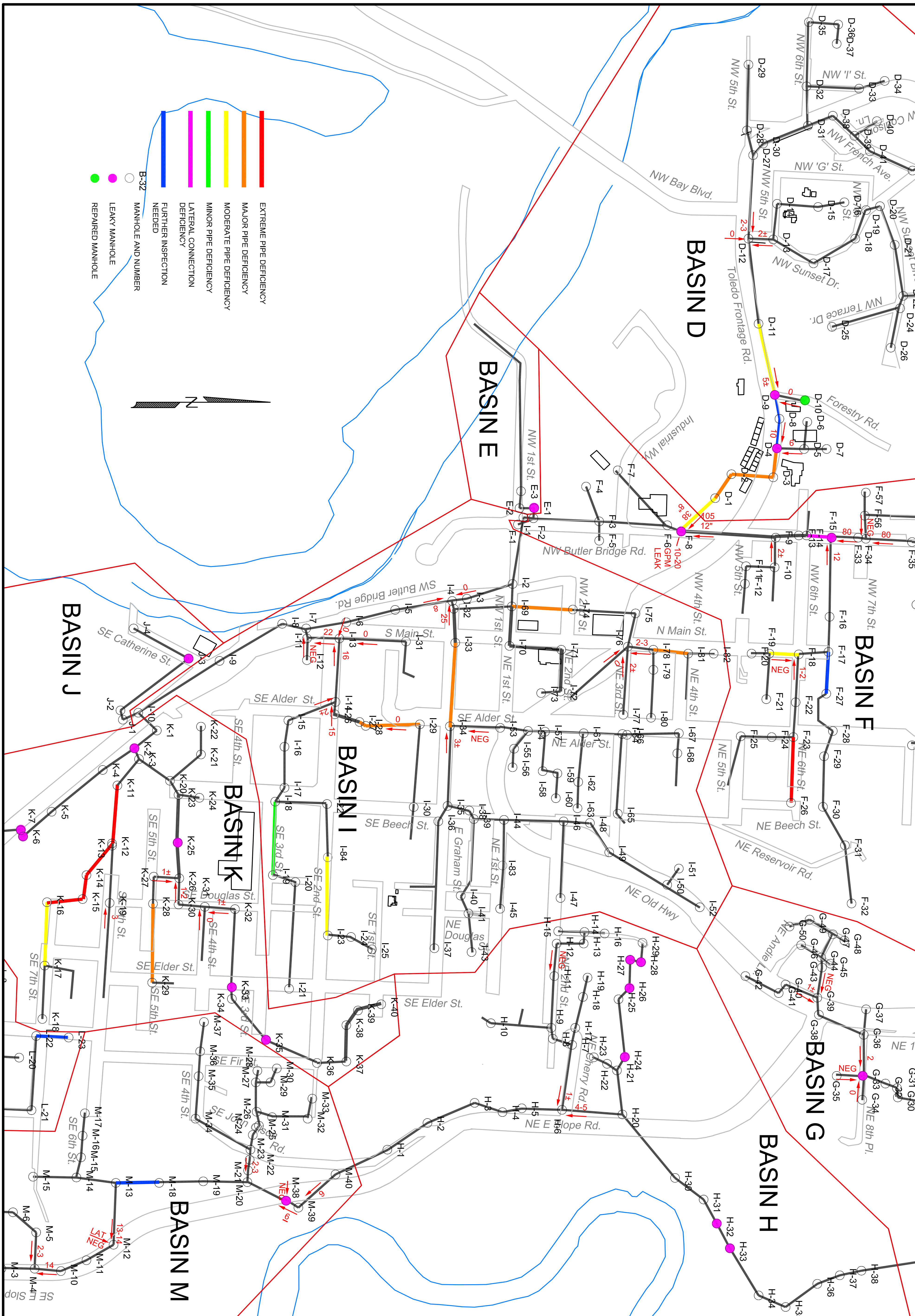
City of Toledo
Lincoln County, Oregon

Civil West
Engineering Services, Inc.

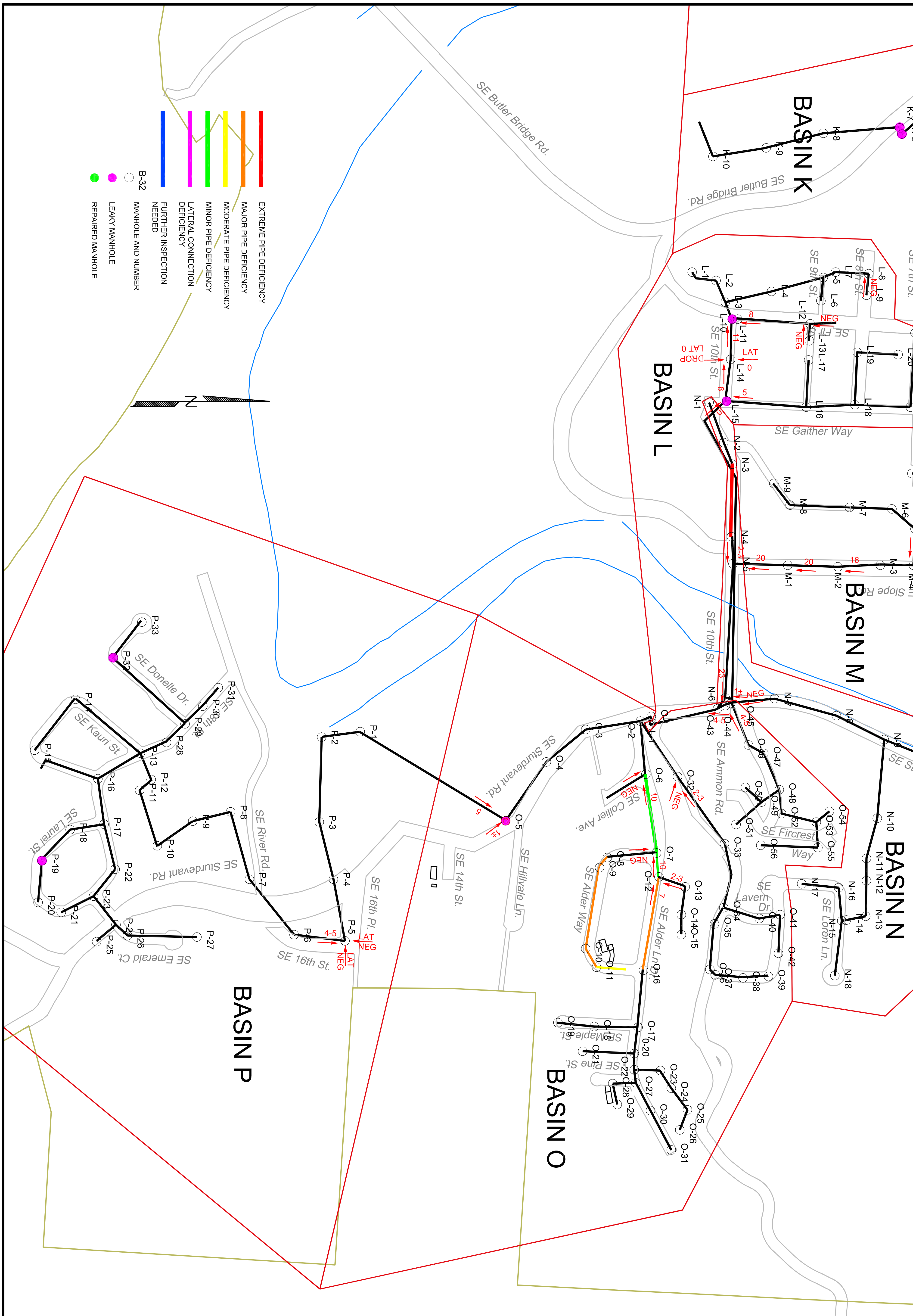


SHEET 1	0 — 1" 1" = 400FT Drawn By: JBH Date: March, 2011	EXISTING COLLECTION SYSTEM CONDITION OF SYSTEM	City of Toledo Lincoln County, Oregon

Civil West Engineering Services, Inc.



SHEET 2	0 1" — 1" = 400FT DRAWN BY: JBH DATE: MARCH, 2011	EXISTING COLLECTION SYSTEM CONDITION OF SYSTEM	CITY OF TOLEDO LINCOLN COUNTY, OREGON	Civil West Engineering Services, Inc.



0 1"
1" = 400FT
DRAWN BY: JBH
DATE: MARCH, 2011

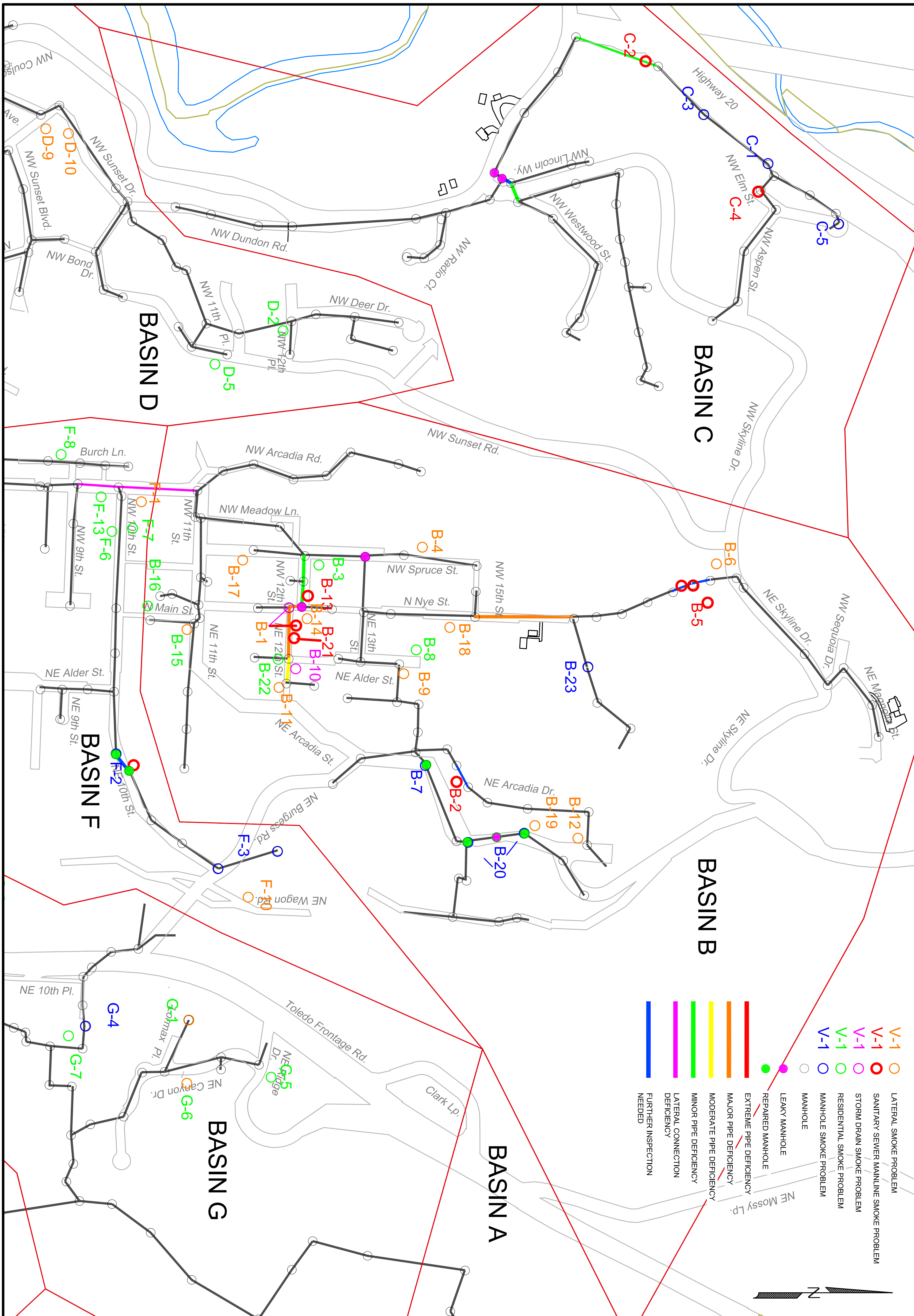
EXISTING COLLECTION SYSTEM

CONDITION OF SYSTEM

CITY OF TOLEDO
LINCOLN COUNTY, OREGON

Civil West Engineering Services, Inc.

SHEET 3



EXISTING COLLECTION SYSTEM

SMOKE PROBLEMS

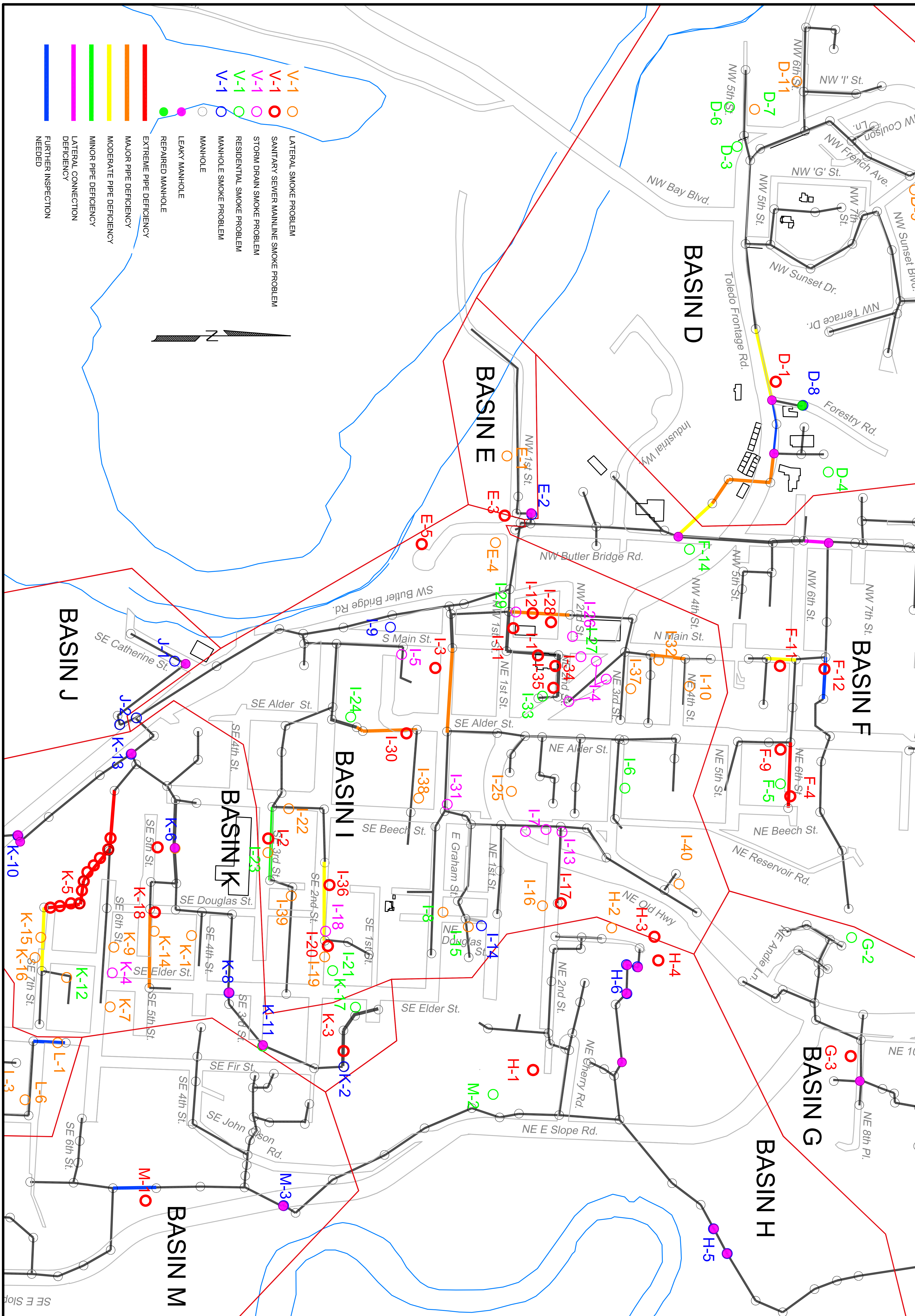
CITY OF TOLEDO
LINCOLN COUNTY, OREGON

Civil West Engineering Services, Inc.

0 1"
1" = 400FT

DRAWN BY: JBH
DATE: MARCH, 2011

SHEET 4



0 1"

1" = 400FT

Drawn By: JBH
Date: March, 2011

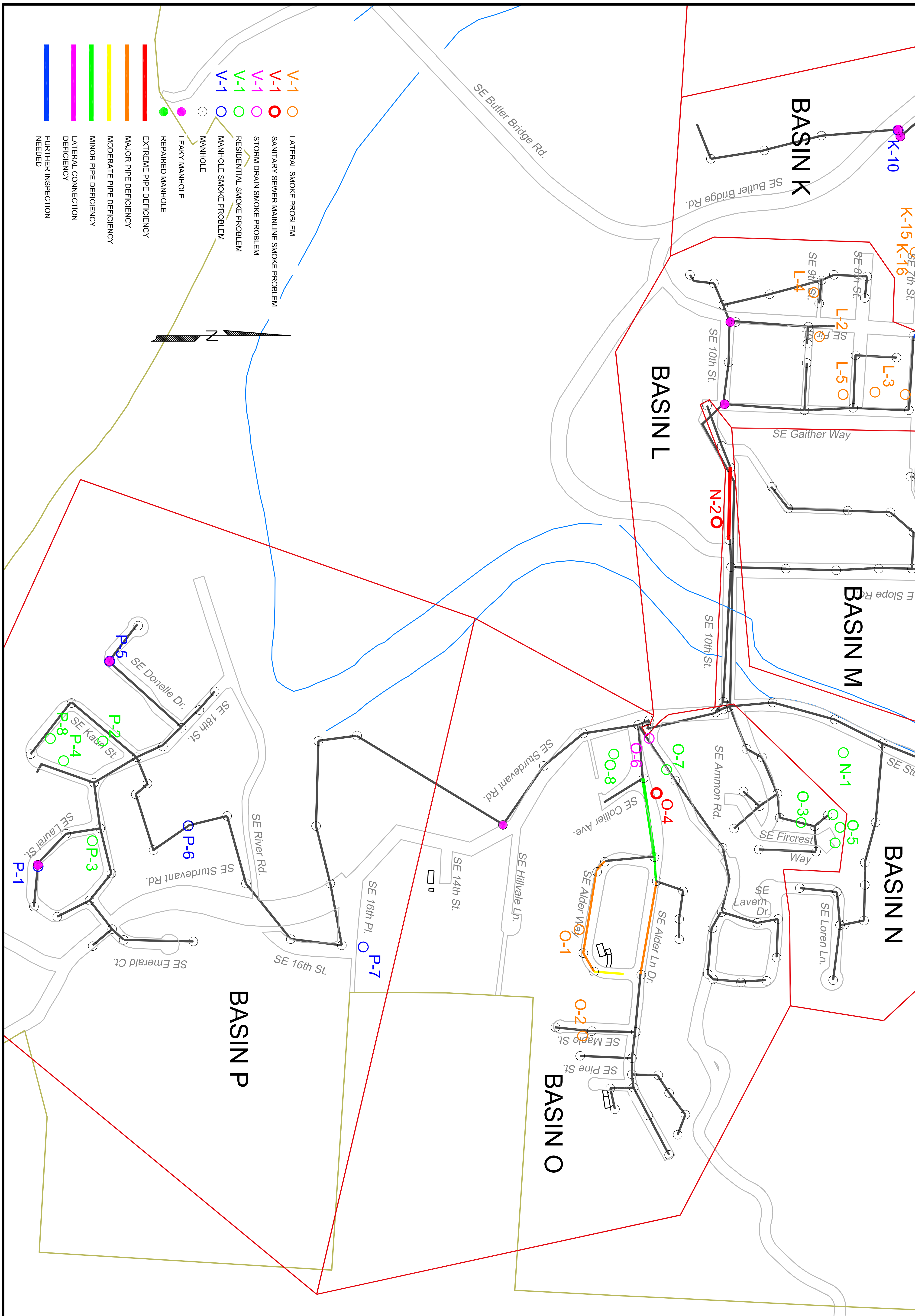
EXISTING COLLECTION SYSTEM

SMOKE PROBLEMS

City of Toledo
Lincoln County, Oregon

Civil West Engineering Services, Inc.

SHEET 5



SHEET 6	0 1" — 1" = 400FT DRAWN BY: JBH DATE: MARCH, 2011	EXISTING COLLECTION SYSTEM SMOKE PROBLEMS	CITY OF TOLEDO LINCOLN COUNTY, OREGON

Civil West Engineering Services, Inc.

APPENDIX D

TABLE D-1 – LIST OF ALL DEFICIENCIES FOUND DURING SMOKE TESTING AS INDEXED IN BINDERS PROVIDED AT COMPLETION

	Type of Deficiency Observed on Smoketesting Report								
Report #	Residential Lateral	City Mainline	City Storm Drain	Residential Storm	Residential Downspout	Residential Plumbing	City Manhole	Residential Cleanout	Deficiency and Number of Each Deficiency Observed on Report Page
A1								1	
A2							1		
B1	1	1	1						
B2		1							
B3								1	
B4	1								
B5		1							
B6	1								
B7							1		
B8								1	
B9	1								
B10			1						
B11	1								
B12	1								
B13		1							
B14	1								
B15	1							1	
B16				1					
B17	1								
B18	1								
B19	1								
B20							2		
B21		1							
B22								1	
B23							1		
C1							1		
C2		1							
C3							1		
C4		1							
C5							1		
D1		1							
D2								1	
D3								1	
D4								1	
D5								1	
D6								1	

	Type of Deficiency Observed on Smoketesting Report								
Report #	Residential Lateral	City Mainline	City Storm Drain	Residential Storm	Residential Downspout	Residential Plumbing	City Manhole	Residential Cleanout	Deficiency and Number of Each Deficiency Observed on Report Page
D7	1				1				
D8							1		
D9	1								
D10	1								
D11	1								
D12									
F1	1								
F2		1					1		
F3							2		
F4		1							
F5		1						1	
F6								1	
F7								1	
F8								1	
F9		1							
F10	1								
F11		1							
F12		1							
F13								1	
F14						1			
G1	1								
G2								1	
G3						1			
G4							1		
G5								1	
G6	1				1				
G7						1			
E1	1								
E2							1		
E3		1							
E4	1								
E5		1							
H1		1							
H2	1								
H3		1							
H4		1							
H5							2		

	Type of Deficiency Observed on Smoketesting Report								
Report #	Residential Lateral	City Mainline	City Storm Drain	Residential Storm	Residential Downspout	Residential Plumbing	City Manhole	Residential Cleanout	Deficiency and Number of Each Deficiency Observed on Report Page
H6							3		
I1		1							
I2		1							
I3		1							
I4		2	1						
I5			1						
I6								1	
I7			2						
I8	1				1				
I9							1		
I10	1								
I11		1							
I12		1							
I13			1						
I14							1		
I15	1				1				
I16	1								
I17		1							
I18			1						
I19	1								
I20		1							
I21				1					
I22	1								
I23	1			1					
I24						1			
I25	1								
I26			1						
I27			1		1				
I28		1							
I29			1		1				
I30		1							
I31		1							
I32	1								
I33								1	
I34		1							
I35		1							
I36		1							

	Type of Deficiency Observed on Smoketesting Report								
Report #	Residential Lateral	City Mainline	City Storm Drain	Residential Storm	Residential Downspout	Residential Plumbing	City Manhole	Residential Cleanout	Deficiency and Number of Each Deficiency Observed on Report Page
I37	1								
I38	1								
I39	1								
I40	1								
J1							1		
J2							2		
K1	1								
K2							1		
K3		1							
K4			1						
K5		1							
K6	1						1		
K7	1								
K8							1		
K9	1								
K10							1		
K11							1	1	
K12	1							1	
K13							1		
K14	1								
K15	1								
K16	1								
K17								1	
K18		1							
L1	1								
L2	1								
L3	1								
L4	1								
L5	1								
L6	1								
M1		1							
M2								1	
M3							1		
N1								1	
N2		1							
O1	1								
O2	1								

	Type of Deficiency Observed on Smoketesting Report							
Report #	Residential Lateral	City Mainline	City Storm Drain	Residential Storm	Residential Downspout	Residential Plumbing	City Manhole	Residential Cleanout
O3								1
O4		1						
O5								3
O6			1					
O7								1
O8								1
P1							1	
P2								1
P3								1
P4								1
P5							1	
P6							1	
P7							1	
P8								1
TOTALS	**51**	**40**	**13**	**3**	**6**	**4**	**36**	**34**

Deficiency and Number of Each Deficiency Observed on Report Page