TETRA TECH

Technical Memorandum

Date:	December 16, 2016		
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From:	Erik Nordholm, PE, Gordon Munro, PE		
Project:	City of Stevenson - General Sewer Plan Update	**Project Number:**	135-48600-16001
Subject:	Infiltration and Inflow Analysis		

This technical memorandum presents the infiltration and inflow (I/I) analysis performed as part of Task 7 of the City of Stevenson General Sewer Plan Update. Excessive I/I can lead to overflows where sewers have insufficient capacity to convey the I/I flow. I/I can also cause increased pumping costs, and increased treatment cost. When planning infrastructure improvements, costs to upsize conveyance and treatment systems should be compared to costs of reducing I/I, in order to determine the most cost-effective use of funding resources.

DEFINITIONS

Infiltration

Infiltration is typically defined as groundwater that enters a wastewater conveyance system through cracks or other defects in buried infrastructure. Infiltration can be categorized as rapid or base. Rapid infiltration is observed soon after rainfall events; base infiltration is present during dry periods and is generally associated with high groundwater, which can have seasonal variations.

Based on surveys in 270 cities, the U.S. Environmental Protection Agency (EPA) determined that infiltration is excessive if the average daily flow per capita (excluding industrial and commercial flows from individual sources contributing 50,000 gpd or more) is 120 gallons per capita per day (gpcd) or more over a 7- to 14-day dry period during seasonal high groundwater. This amount allows to 70 gpcd of domestic wastewater base flow and 50 gpcd of infiltration (EPA, 1984).

Inflow

Inflow is precipitation runoff that enters a wastewater conveyance system through manhole covers, roof drains or other surface openings connecting to the system. It is difficult to differentiate rapid infiltration from inflow when analyzing flow records. They are often combined and referred to as rainfall-derived I/I (RDII).

The EPA has defined RDII as being excessive if the total daily flow (excluding industrial and commercial flows from individual sources contributing 50,000 gpd or more) during periods of significant rainfall exceeds 275 gpcd. When RDII exceeds this value, the EPA requires study to quantify I/I and evaluate corrective measures before providing grants for sewer system improvements.

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I/I Contribution to Total Sanitary Sewer Flow

Figure 1 shows how I/I can contribute to wastewater system flows over a typical 24-hour period with rainfall.

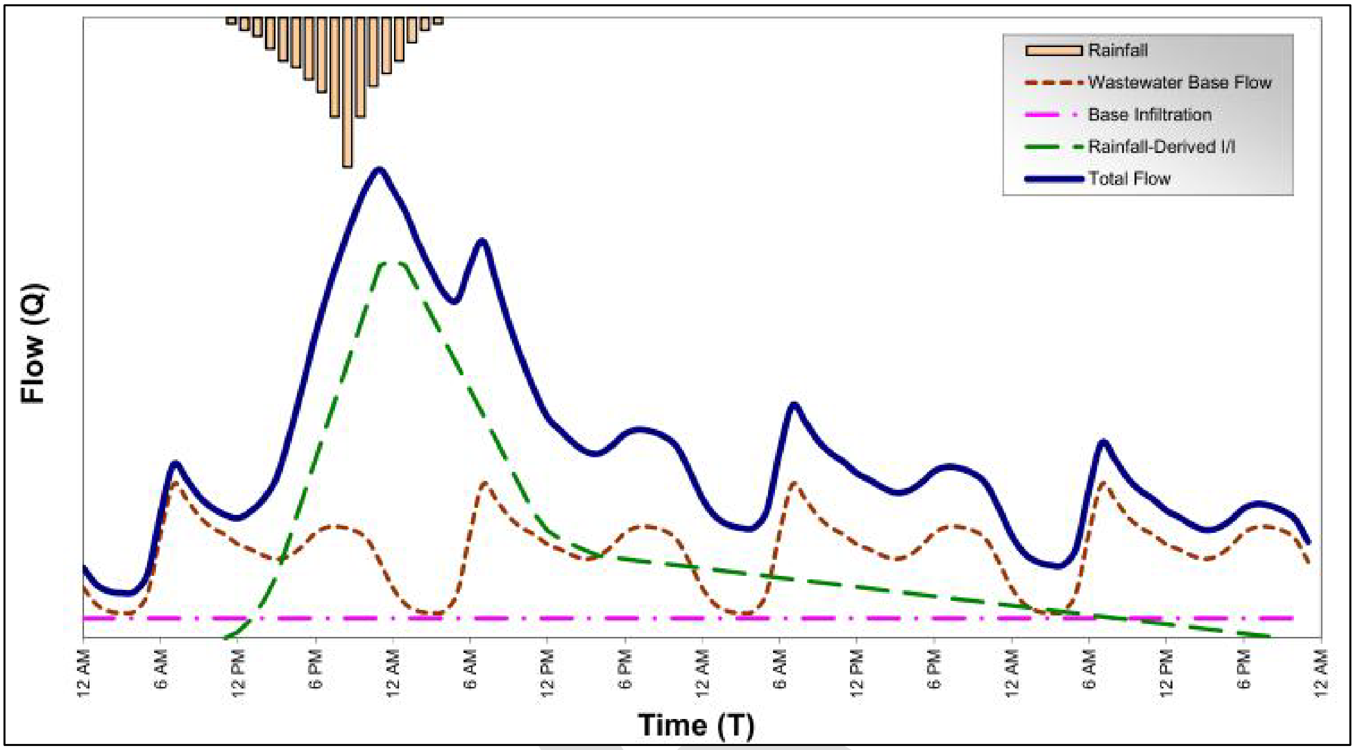


Figure 1. Typical Sanitary Sewer Flow Components

BACKGROUND INFORMATION

The City has had an ongoing program of I/I reduction, consisting of smoke testing to identify direct connections (inflow sources), and video inspections to identify where pipes are leaking. Based on the findings of smoke testing and video inspections, identified inflow sources have been disconnected and pipe defects repaired. The smoke testing has now been discontinued, as no additional inflow sources have been identified. The City continues to perform regular video inspections, followed by pipe repair.

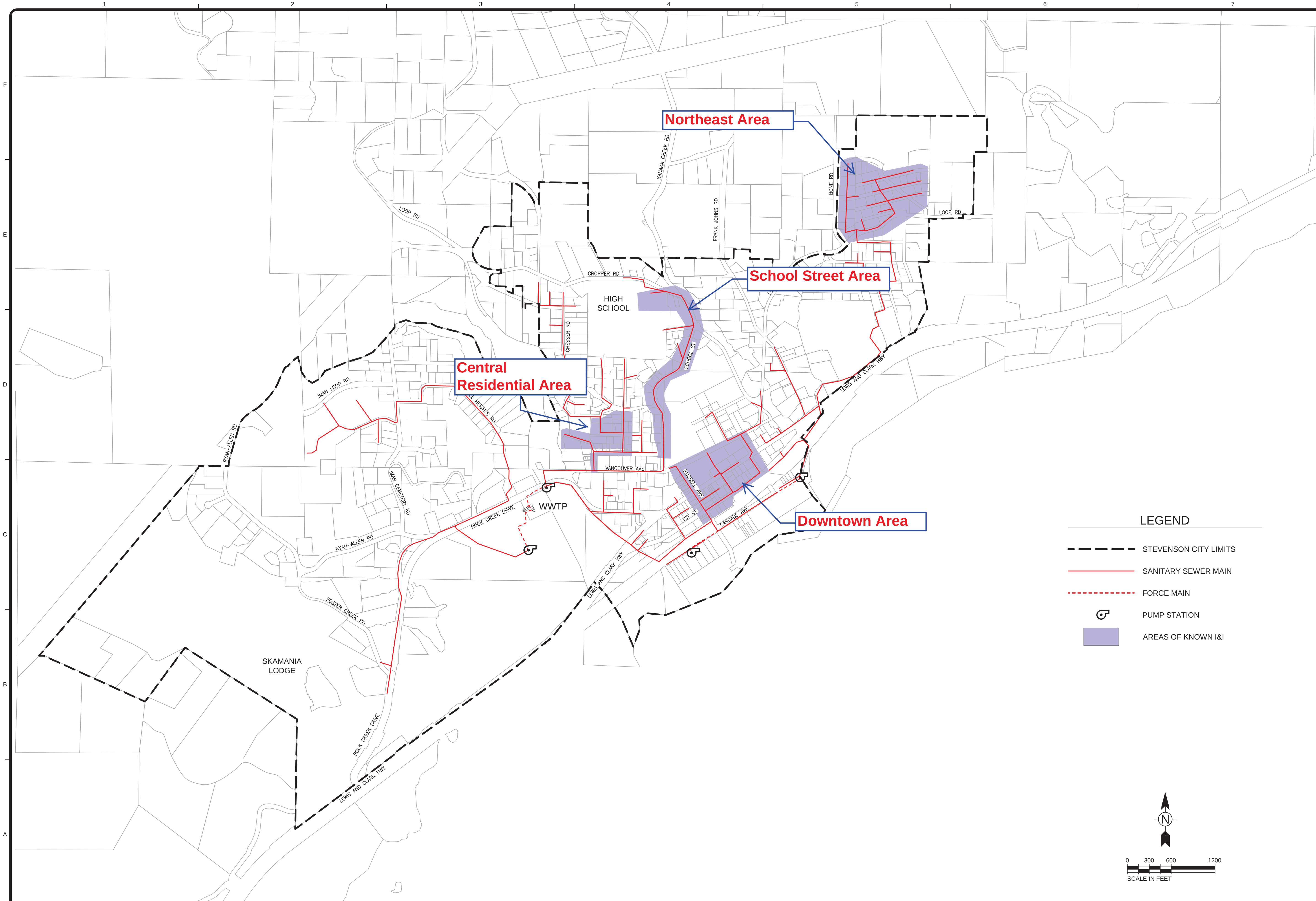
The following background information was reviewed for this analysis:

- Infiltration/Inflow Study, Westech Engineering, September 1988
- Pipeline TV Inspection and Grout Sealing Reports, Gelco, June 1991
- Pipeline TV Inspection and Repair Reports, TSR Corporation, March 2007
- Pipeline TV Inspection Reports, Zwald, March 2010
- Collection System Field Survey, Tetra Tech, July 2016 (see Attachment 2)

EXISTING I/I FLOWS IN STEVENSON

Areas of Known High I/I

Based on interviews with City staff and on the I/I study performed for the City in 1988, several areas in the collection system are known to experience significant I/I, as shown on Figure 2 and described in Table 1.



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CITY OF STEVENSON
GENERAL SEWER PLAN UPDATE
AREAS OF KNOWN INFLOW & INFILTRATION

MARK	DATE	DESCRIPTION	BY

Project No.: 135-48600-16001
Designed By:
Drawn By:
Checked By:

FIG-2

Bar Measures 1 inch

12/5/2016 9:29:40 AM - P:\48600\135-48600-16001\CAD\SUPPORTFILES\FIGURES-I-I-MEMO\FIG-02-SYSTEMMAP.DWG - NORDHOLM, ERIK

Table 1. Areas of Known I/I

	Location	Sewers	Description/Conditions
Northeast Area	North of Loop Road near Montell Terrace and Bone Road	Sewers are mostly concrete, constructed in the 1970s	Evidence of slope instability in this area was noted during the July 2016 field survey, including large areas where the street has subsided. City staff noted that this entire hillside continually moves. It is likely that the slope instability causes joint separation, pipe breaks and disruption of manholes, allowing I/I. The manhole in the area where the street subsided had shifted at its joints. A drainage was noted parallel to the sanitary sewer where the I/I started. I/I is likely entering the system through shifted joints or cracked pipes. With a constantly moving hillside, these types of I/I sources are likely to continue to be created, regardless of the improvements and repairs completed.
School Street Area	Along School Street to Vancouver Avenue	Constructed in the 1950s, consisting of 3-foot-long segments of concrete pipe with mortar joints	Mortar joints are prone to leakage. This area also has old manholes with brick risers and manholes that are leaning. There are areas of pavement that are subsiding over the top of the sewer line (near MH G-8), which is an indication that there may be a crack in the sewer that is pulling in soil. This could lead to a sinkhole and should be addressed soon. It also could be a source of the high levels of suspended solids at the treatment plant. There is a substantial flow in this system during winter. It has been speculated that the high school's pool subsurface drain system may be connected to the sanitary sewer, but investigation has found no connection. However, it is clear that there is I/I coming into the system from this area. Even during the summer there is flow coming into the system from this location, and no extraneous flow entering the system upstream.
Central Residential Area	Around NW Roosevelt Street and Roselawn Street, from NW Jefferson Street to Hotsprings Alameda Road	Concrete pipe constructed in the late 1960s.	The 1988 I/I study identified this area as having significant I/I.
Downtown Area	Russell Avenue between Vancouver Ave and 1st Street	Originally installed in 1911; main line replaced in 1972	Sewer laterals are likely the original 1911 vitrified clay pipe. The 1988 I/I study identified this area as having significant I/I.

Total Annual Average I/I

Daily flow data were examined from Stevenson's wastewater treatment plant effluent flow meter, as reported in the plant's discharge monitoring reports for the period between 2001 and 2015. The treatment plant flows were compared to daily rainfall data in order to assess total I/I. Rainfall data was obtained from the NOAA Climate Data Center for the gauge located at the Bonneville Dam. Table 2 lists the yearly data for rainfall, average annual plant flow, and average annual I/I.

Figure 3 is a plot of the yearly rainfall and average daily I/I values listed in Table 2. The trend line and regression equation calculated by MS Excel are also shown on the plot. The regression equation can be used to calculate expected I/I (y) based on a given annual rainfall (x). Table 3 compares the I/I calculated from flow data in Table 2 and the I/I calculated using the regression equation in Figure 3.

Repairs to address I/I problems were last completed in April 2007. Fairly significant reductions in I/I were observed in 2007 and 2008, likely a result of the 2007 repairs. I/I flows generally have not been increasing significantly since 2007.

Table 2. Annual Flow and Rainfall at Stevenson Wastewater Treatment Plant, 2001 - 2015

Year	Rainfall (inches)[a]	AAF (mgd)[b]	Wastewater Base Flow (mgd)[c]	Average Daily I/I (mgd)[d]
2001	75.4	0.184	0.143	0.041
2002	65.3	0.180	0.136	0.044
2003	84.5	0.201	0.140	0.061
2004	67.6	0.185	0.157	0.028
2005	70.6	0.190	0.152	0.038
2006	93.3	0.186	0.110	0.076
2007	72.1	0.180	0.156	0.024
2008	75.5	0.191	0.167	0.024
2009	76.4	0.186	0.141	0.045
2010	94.6	0.201	0.151	0.050
2011	91.7	0.168	0.108	0.060
2012	105.0	0.212	0.120	0.092
2013	67.0	0.141	0.120	0.021
2014	89.6	0.171	0.107	0.064
2015	81.4	0.165	0.119	0.046
Average	80.7	0.183	0.135	0.048

a. Measured at Bonneville Dam rain gauge
b. Average Annual Flow (AAF) = Average daily effluent flow at the treatment plant
c. Estimated by average daily effluent flow at the treatment plant between May and October on days when measured rainfall was less than 0.1”
d. Calculated by subtracting wastewater base flow from AAF

mgd = million gallons per day

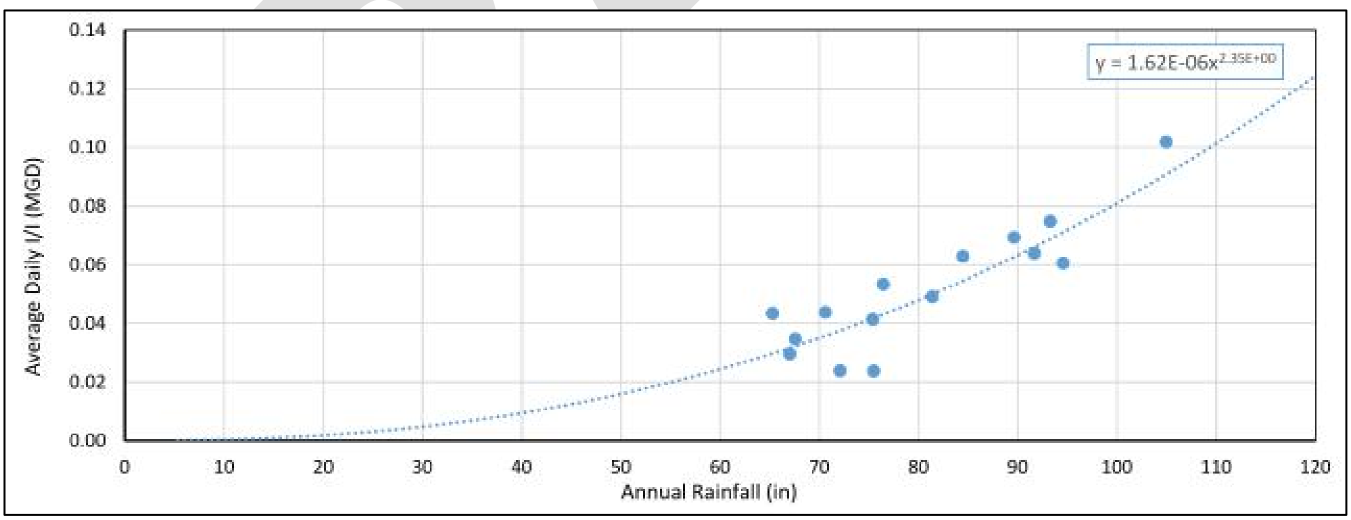

Figure 3. Scatter Plot of Annual Rainfall vs Inflow & Infiltration at Stevenson Wastewater Treatment Plant

Table 3. Observed vs Expected Inflow & Infiltration

Year	I/I (mgd)		Difference: Data vs Equation
	Based on Flow Data[a]	Calculated from Equation[b]	
2001	0.041	0.042	(1%)
2002	0.043	0.030	46%
2003	0.063	0.055	15%
2004	0.035	0.032	7%
2005	0.044	0.036	22%
2006	0.075	0.069	8%
2007	0.024	0.038	(37%)
2008	0.024	0.042	(43%)
2009	0.053	0.043	23%
2010	0.060	0.071	(15%)
2011	0.064	0.066	(3%)
2012	0.102	0.091	12%
2013	0.030	0.032	(6%)
2014	0.069	0.063	11%
2015	0.049	0.050	(2%)

a. From Table 2. Equal to AAF minus wastewater base flow.
b. Calculated based on the total annual rainfall using the regression equation in Figure 3.

Base Infiltration

Base infiltration can be estimated from hourly flow records taken during a period of dry weather in winter when the groundwater table is high. Measured flows when wastewater flows are the lowest (typically from 2 AM to 4 AM) can be used to estimate base infiltration. A 2001/2002 flow monitoring study in King County, Washington, estimated that 88 percent of minimum nighttime flows during dry-weather can be attributed to base infiltration.

Base infiltration cannot be estimated for Stevenson because hourly flow records are not available. However, the EPA criterion can be applied, since it only looks at average daily flows. The EPA criterion states that base infiltration is not considered excessive if the average daily flow is less than 120 gpcd during a period with dry weather and seasonal high groundwater. This criterion applies to systems where most of the flow is from residential sources. Since a significant portion of Stevenson's wastewater flows are from commercial and industrial sources, an equivalent population of 2,199 was used (see Table 4) to compare Stevenson flows to the EPA criteria. Equivalent population is based on the number of equivalent residential units (ERUs).

Table 4. Stevenson Equivalent Service Population

Residential ERUs[a]	Commercial / Industrial ERUs[a]	Total ERUs[a]	Population / ERU[a]	Equivalent Population
489	506	995	2.21	2,199

a. Data from Growth Projections Technical Memorandum dated October 24, 2016

The month of February 2015 experienced dry weather for the last half of the month, with only 0.1 inches of rain from February 11 through February 25 (compared to 7.9 inches from February 1 – 10). The period of February 16 – 25, 2015 was used to determine the average dry-weather flow. The average daily treatment plant effluent flow during this period was 117,800 gallons per day; for the equivalent population of 2,199, this is an average of 54 gpcd, well below the EPA criterion of 120 gpcd. Based on this analysis, base infiltration is not excessive in Stevenson's wastewater collection system.

It should be noted that wastewater base flows were high in 2007 and 2008 (see Table 2) at the same time that I/I flows were reduced. The reason for the spike is not known; however, it is a possibility that the increased flow is actually an increase in base infiltration. The 2007 I/I repairs may have caused the groundwater level to rise in the area by limiting the sewer's capacity to drain RDII. Instead of stormwater entering the collection system quickly, it could be migrating to groundwater and entering the system more slowly through the repaired defects, or migrating slowly to unrepaired areas before entering the collection system. Continuous flow monitoring data, which is not available, would be needed to confirm or disprove this theory.

Rainfall-Derived Inflow and Infiltration

RDII is estimated from flow records during periods of significant rainfall by dividing the total daily flow by the sewer service equivalent population. Peak-hour RDII cannot be estimated for Stevenson since hourly flow records are not available. However, the EPA criterion can be applied since it looks at average daily flows. The EPA criterion states that RDII is not considered excessive if the average daily flow is less than 275 gpcd during periods of significant rainfall. Table 5 lists the 10 highest daily treatment plant effluent flows between 2001 and 2015, as well as the two highest-flow days from December 2015. Peak flows are in the range of 400 to 600 gpcd, which exceeds the EPA criterion of 275 gpcd for excessive RDII.

Table 5. Peak-Day Wastewater Treatment Plant Flows 2001 - 2015

Rank	Date	Flow (mgd)	Flow per capita (gpcd)[a]	24 Hour Rainfall (in)	96 Hour Rainfall (in)
1	21-Jan-2012	1.290	587	1.42	8.40
2	24-Jan-2012	1.240	564	0.67	2.96
3	1-Jan-2009	1.127	513	4.07	6.23
4	19-Jan-2012	1.090	496	2.96	7.10
5	6-Nov-2006	1.013	461	5.08	10.83
6	12-Dec-2010	0.992	451	2.95	6.20
7	28-Dec-2008	0.967	440	2.56	7.24
8	1-Dec-2013	0.954	434	4.71	6.32
9	29-Dec-2011	0.940	427	2.01	6.11
10	16-Jan-2011	0.918	417	3.15	6.78
11	7-Dec-2015	0.890	405	2.46	5.81
14	8-Dec-2015	0.879	400	3.19	8.83

a. Based on an equivalent population of 2,199 which accounts for commercial and industrial wastewater sources.

INFLUENCE OF CLIMATE CHANGE ON PRECIPITATION AND I/I

For 2030 to 2059, change in annual average precipitation in the Northwest is projected to be within a range of an 11-percent decrease to a 12-percent increase, according to the 2014 National Climate Assessment by the U.S. Global Change Research Program. Very heavy precipitation events have increased nationally and are projected to increase in all regions. However, there is not a strong correlation between heavy precipitation events, I/I and peak day flows, as demonstrated in Table 5. Therefore, an increase in I/I due to heavy precipitation events was not included in this analysis.

CONCLUSIONS AND RECOMMENDATIONS

Based on the EPA criteria, base infiltration is not excessive in Stevenson's collection system, but RDII is excessive, as summarized in Table 6.

Table 6. City of Stevenson – Per Capita Flows

Flow Type	Stevenson Flow Rate	Flow Rate Considered Excessive by EPA
Base Infiltration	50 - 60 gpcd	120 gpcd
RDII	400 - 600 gpcd	275 gpcd

The City should continue its I/I control program of video inspection and leak repairs, and repair defects noted during the site visit. It is also recommended that the City begin a yearly program of pipe and manhole rehabilitation in specific areas, including School Street and Downtown areas where there is clay pipe. Pipe rehabilitation can include new pipe, pipe bursting or cured-in-place pipe lining. Based on results of past I/I repairs, significant reduction in flows are not anticipated. Rather, the control program will likely maintain the collection system's current I/I rate as it ages.

The City should consult a geotechnical engineer before making I/I repairs in areas of known or suspected slope instability (such as the northeast area of the collection system), because I/I repairs could change subsurface drainage and increase the risk for a landslide.

The December 5 *Pretreatment and Source Control Alternatives* technical memorandum determined that the collection system is delivering significantly higher than average concentrations of total suspended solids to the City treatment plant. The City should consider placing a sampler at a few key manholes in the collection system near known I/I sources and near areas where pavement is subsiding over the top of the sewer line. This will assist in identifying areas where soil is being pulled into the sewer by I/I and increasing suspended solids at the treatment plant.

Infiltration and Inflow Analysis

Attachment 1. EPA Publication on I/I

United States Environmental Protection Agency
Office of Municipal Pollution Control
Washington DC 20460
May 1985

Infiltration/Inflow

I/I Analysis and Project Certification

I/I

Ecology Publication No. 97-03

Introduction

As part of facilities planning for municipal wastewater treatment facilities, the grantee must demonstrate that contributing sewer systems are not, and will not be, subject to excessive infiltration or inflow. This brochure informs grantees and facility planners on how to determine whether excessive I/I exists, and how to certify that excessive I/I has been sufficiently reduced through sewer rehabilitation.

“Infiltration” occurs when groundwater enters a sewer system through broken pipes, defective pipe joints, or illegal connections of foundation drains. “Inflow” is surface runoff that enters a sewer system through manhole covers, exposed broken pipe and defective pipe joints, cross connections between storm sewers and sanitary sewers, and illegal connection of roof leaders, cellar drains, yard drains, or catch basins.

Virtually every sewer system will have some infiltration or inflow. Guidelines have been developed to help determine what amount of infiltration and inflow is considered “excessive." To make this determination, infiltration and inflow must be evaluated separately as discussed below.

Determination of Non-Excessive Infiltration

Based on Needs Survey data from 270 Standard Metropolitan Statistical Area Cities, the national average for dry weather flow is 120 gallons per capita per day (gpcd). This includes domestic wastewater flow, infiltration and nominal industrial and commercial flows. This average dry weather flow should be used as an indicator to determine the limit of non-excessive infiltration. If the average daily flow per capita (excluding major industrial and commercial flows greater than 50,000 gpd each) is less than 120 gpcd (i.e., a 7-14 day average measured during periods of seasonal high groundwater), the amount of infiltration is considered non-excessive.

The 120 gpcd flow rate guideline has been incorporated into EPA’s final Construction Grant Regulations. These regulations provide that no further infiltration analysis work is required if the 120 gpcd guideline is not exceeded. If the average daily dry weather flow (DWF) exceeds 120 gpcd, the grantee may request special approval from the EPA Regional Administrator to proceed with project design without further infiltration studies. To receive such approval, the grantee must demonstrate that the increased flows due to infiltration can be cost-effectively treated, and that sufficient funding is available to pay for the local share of project construction and operating costs. In such cases, the incremental cost of treatment capacity over and above 120 gpcd is not eligible for EPA construction grant funding.

The grantee's basic options regarding determination of non-excessive infiltration are listed below:

If Average DWF ≤120 gpcd:*

- Grantee may proceed with project design and construction without further infiltration study.
- Grantee may investigate rehabilitation alternatives for specific sections of sewer system where excessive infiltration has been documented.

If Average DWF marginally exceeds 120 gpcd:*

- Grantee may request special approval from EPA Regional Administrator to proceed with the project without further study of infiltration correction alternatives.
- Grantee must demonstrate that project is cost-effective (i.e., that treating increased flows due to infiltration is less costly than sewer rehabilitation).
- Grantee must demonstrate that sufficient funds are available for the local share of project cost, including capital and operating costs.
- The treatment facility must be sized to treat the total flow including infiltration; however, the incremental cost of treatment capacity above 120 gpcd is not eligible for EPA construction grant funding.

If Average DWF >120 gpcd*, and Special RA Approval is *not* granted:

- Further studies must be conducted to quantify excessive infiltration and evaluate alternative corrective measures.
- Based on results of these studies, the most cost-effective sewer rehabilitation program is selected, and the treatment plant is sized to handle the infiltration that cannot be cost-effectively removed.
- Upon approval of the proposed rehabilitation program by EPA, grantee may proceed with project design and construction. Total project cost (including sewer rehabilitation costs) is eligible for construction grant funding.

*Highest average daily flow recorded over a 7-14 period during a period of seasonal high groundwater.

Determination of Non-Excessive Inflow

A statistical analysis of data from Sewer System Evaluation Survey (SSES) studies representing more than 45 different sewer systems (i.e., separate sanitary sewer system) indicated a strong correlation between inflow rate and service area population. Based on these data, the average wet weather flow (WWF) after removal of excessive inflow (i.e., that which can be cost-effectively removed) is 275 gpcd. This flow rate should be used as an indicator of non-excessive inflow.

If the average daily flow during periods of significant rainfall (i.e., any storm event that creates surface ponding and surface runoff; this can be related to a minimum rainfall amount for a particular geographic area) does not exceed 275 gpcd, the amount of inflow is considered non-excessive. This calculation should exclude major commercial and industrial flows (greater than 50,000 gpd each). If wet weather flows do not exceed 275 gpcd, the grantee may proceed with project design and construction without further study of inflow correction alternatives. However, if the treatment plant experiences hydraulic overloads during storm events, further study is required regardless of the wet weather flow (i.e., even in cases where WWF is less than 275 gpcd).

The determination of non-excessive inflow is made as follows:

If WWF ≤275 gpcd*, and the treatment plant does not experience hydraulic overloads during storm events:

- Grantee may proceed with project design and construction without further inflow studies.
- Grantee may investigate rehabilitation alternatives for specific sections of the sewer system where excessive inflow has been documented.

If WWF>275 gpcd*, or the treatment plant experiences hydraulic overloads during storm events:

- Further studies must be conducted to quantify excessive inflow and evaluate alternative corrective measures.
- Based on results of these studies, the most cost-effective sewer rehabilitation program is selected, and the treatment plant is sized to handle the inflow that cannot be cost-effectively removed.
- Upon approval of the proposed rehabilitation program by EPA, the grantee may proceed with project design and construction. Total project cost (including sewer rehabilitation cost) is eligible for construction grant funding.

*Highest daily flow recorded during a storm event.

I/I Cost-Effectiveness Analysis

Before obtaining a grant for sewer system rehabilitation, the grantee must determine the amount of infiltration and inflow that can be cost-effectively removed. This is essentially an estimate of the point at which the cost savings (i.e., reduction in transport and treatment cost less the cost of the rehabilitation program) is maximized. Generally, the planned I/I reduction (i.e., the target sought in a sewer rehabilitation project) is determined on the basis of a cost-effectiveness analysis. *Figure 1* illustrates how the planned I/I reduction target is established from cost curves developed in the cost-effectiveness analysis. A separate cost-effectiveness analysis should be done for infiltration alternatives and for inflow alternatives.

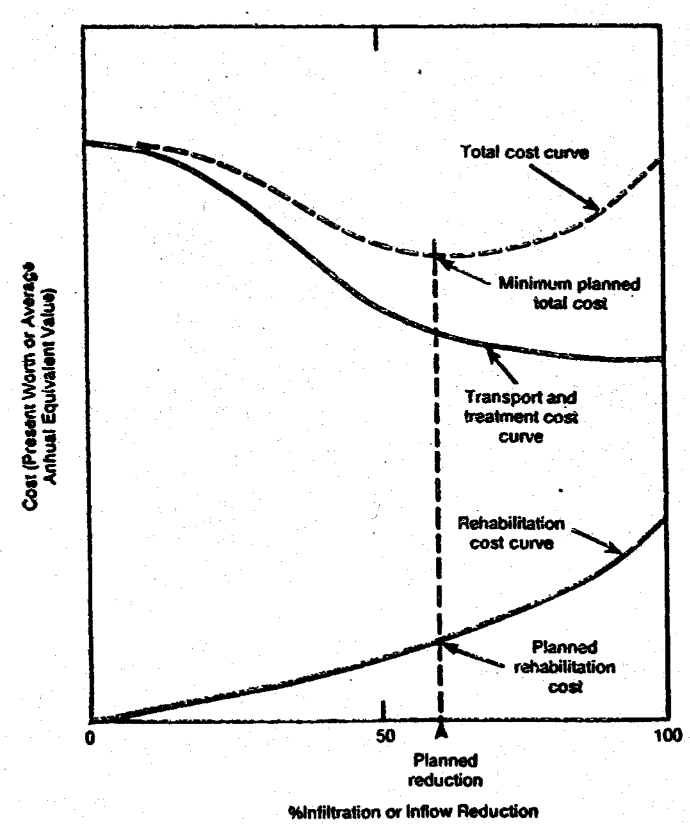

Figure 1 Cost-Effectiveness Analysis

Certification of I/I Rehabilitation Performance

At the end of the one-year performance period (i.e., one year after initiation of sewer system operation), the grantee must certify that the rehabilitation project has achieved an acceptable level of I/I reduction. Ideally, this means that the planned I/I reduction target is achieved at a cost not exceeding that projected in the cost-effectiveness analysis. However, past experience has shown that it is difficult to measure the effectiveness of an I/I rehabilitation program simply by comparing flow data before and after sewer rehabilitation.

A sewer rehabilitation project will be considered certifiable as long as the project is cost-effective (i.e. transport and treatment cost savings exceed rehabilitation costs). *Figure 2* illustrates how to determine the minimum acceptable I/I reduction using the transport and treatment cost curve from the cost-effectiveness analysis. A separate determination should be made for infiltration and for inflow, consistent with the original cost-effectiveness analysis.

The actual cost of the rehabilitation program (i.e., the "sunk cost") should include design costs and the cost of the SSES study, as well as the cost of the sewer rehabilitation itself. The actual I/I reduction is determined by comparing post-construction flow to the flow data collected during the SSES study. The post-construction flow data should be based on plant flow records. Monitoring flows at multiple points throughout the sewer system is not recommended.

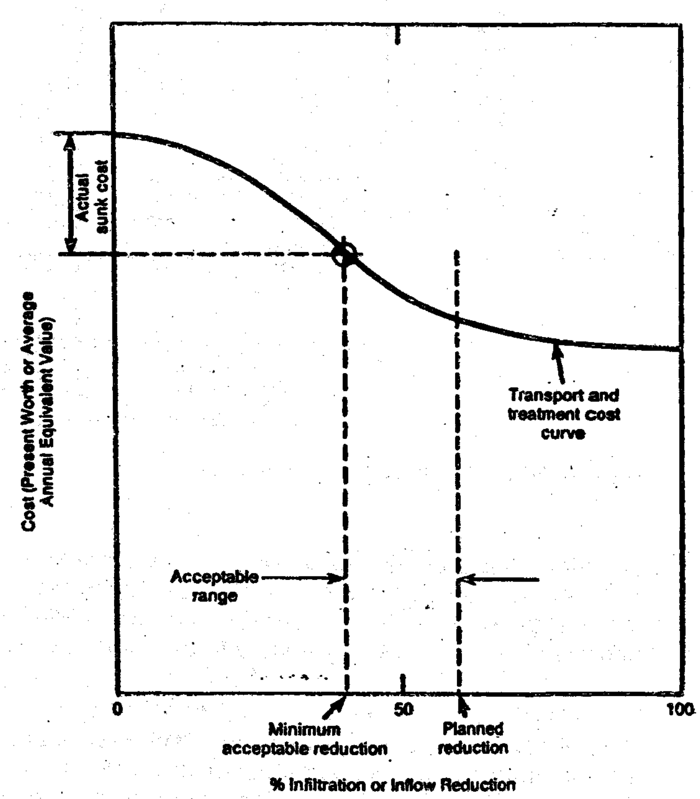

Figure 2 Determining Acceptable Range of I/I Reduction

If the actual I/I reduction is greater than the minimum acceptable I/I reduction derived from *Figure 2,* the rehabilitation project can be certified as meeting performance objectives. However, it should be noted that treatment plant design capacity is based on the planned I/I reduction projected in the SSES study. If the actual I/I reduction is significantly less than planned, redesign may be required to increase treatment capacity. Therefore, every effort should be made to develop realistic estimates of the amount of I/I that can be cost-effectively removed. As an I/I project proceeds from initial planning through design and construction, certain assumptions made during the cost-effectiveness analysis may prove to be invalid. This could affect the cost-effectiveness of the project and the determination of minimum acceptable I/I reduction. For example, if the actual rehabilitation cost is greater than projected, the range of acceptable I/I reduction is reduced (*see Figure 3*). If the reduction in transport and treatment costs is not as great as expected, this will also reduce the acceptable range.

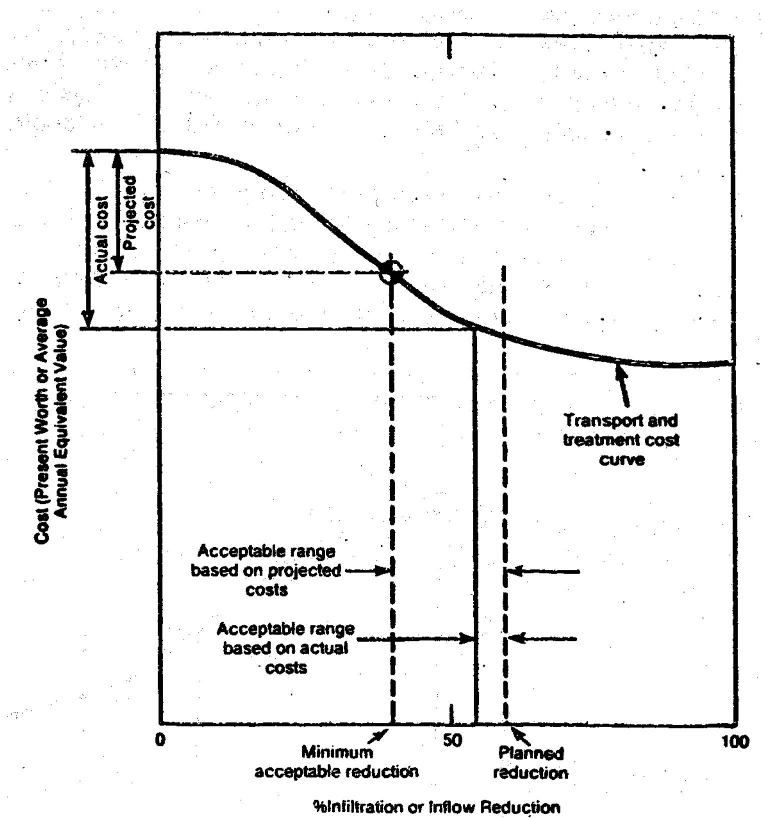

Figure 3 Effect of Underestimating Project Costs

Therefore, it is important to recalculate the acceptable range of I/I reduction at different stages of the project (e.g., after approval of SSES study; after completion of design and preparation of detailed cost estimates; after receipt of construction bids; and at completion of various construction phases) using updated cost estimates or actual cost data.

As the minimum acceptable I/I reduction limit approaches the planned I/I reduction target, the cost-effectiveness of the project should be reevaluated. The risk of the project not achieving the minimum acceptable I/I reduction increases as the acceptable range derived from *Figure 2* diminishes. If there is evidence that actual rehabilitation costs will be much higher than projected, it may be advisable to reassess the objectives of the rehabilitation program, and modify the scope of work accordingly.

Summary

This brochure presents an overview on how to approach the implementation of an infiltration/ inflow correction program. A schematic of the process is presented in *Figure 4*. The basic steps are as follows:

1. Determine if excessive infiltration exists using 120 gpcd guidelines.
2. Determine if excessive inflow exists using 275 gpcd guideline.
3. If infiltration and inflow are non-excessive, proceed with project design based on measured flow data.
4. If either excessive infiltration or excessive inflow exists, conduct sewer system evaluation survey (SSES) study.
5. Select most cost-effective sewer rehabilitation alternative.
6. Implement sewer system rehabilitation; verify project cost-effectiveness as updated cost data become available.
7. Upon completion of project (i.e., at end of one-year performance period), certify that I/I reduction is within acceptable range.

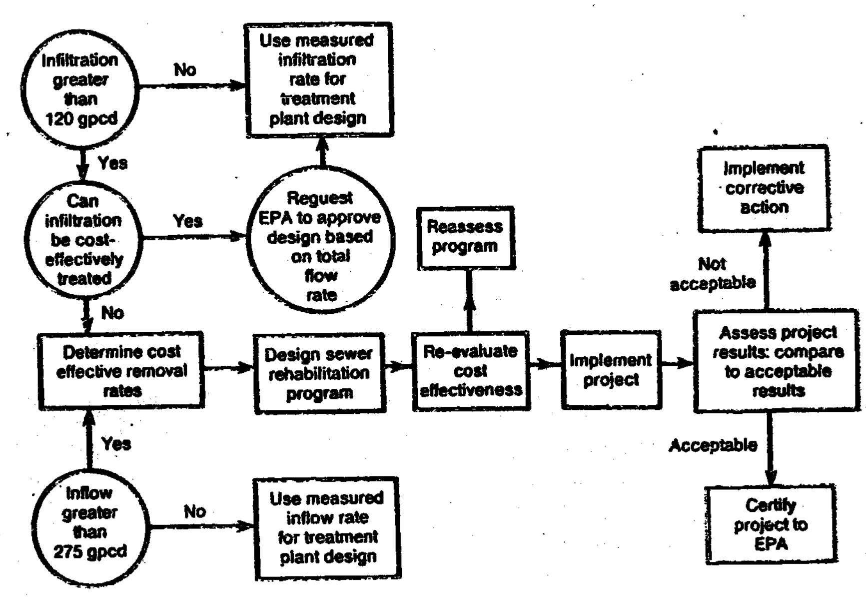

Figure 4 I/I Project Flow Chart

To achieve affirmative project certification, the estimates of rehabilitation cost and I/I reduction must be realistic. Underestimating project cost can invalidate the conclusions of the cost-effectiveness analysis conducted as part of the SSES study. It is important to include all cost items in the cost estimates (the cost of service line rehabilitation should be included even though it is not grant eligible).

Sewer rehabilitation programs can significantly reduce transport and treatment costs, and therefore should be given serious consideration. However, the cost-effectiveness of such projects must be carefully evaluated to assure that rehabilitation is justified. The requirements for project certification now mandate that project cost-effectiveness be confirmed at the completion of the project. Grantees and their engineers should carefully assess their I/I correction plans to be sure that project certification requirements can be satisfied.

Further guidance on this subject is available from U.S. EPA Regional Offices and delegated State agencies.

Infiltration and Inflow Analysis

Attachment 2. Stevenson Collection System Field Survey

CITY OF STEVENSON

COLLECTION SYSTEM SITE VISIT 7.20.16

Specific manholes were inspected based upon the following criteria:

- Discharge manholes for a pump station
- Pump station wet well
- Potential hydraulic issues based upon the hydraulic model
- Potential hydraulic issues due to geometry (large transition in pipe slope, “T” intersections)

General comments

- The entire north east part of the community is a land slide prone area. They have had broken water line. It is likely that there are some pipes separated at the joints.
- Much of the pipe in the community is concrete pipe with a 4-foot lay length installed in the 1970’s. This means there are a lot of pipe joints.

Manhole F-7-6

Location: Ridgecrest Drive west of Montell Terrace (NE)

- Has a rain lid
- Self is damp
- Walls are damp
- No other indication of surcharging
- There is a drainage way that parallels the pipe from El Paso Lane to Ridgecrest Drive (dry right now) which then enters a culvert under Ridgecrest Drive, and it is suspected that it infiltrates the collection system at this point.

Manhole F-4-11A

Location: Ridgecrest Drive (NE)

- The road around the manhole has dropped apparently from land movement (this is a landslide prone area).
- The top cone appears to have shifted

Manhole F-7-3

Location: Vista Drive and Loop Road (NE)

- Has a rain lid
- Self is damp
- Walls are damp
- No other indication of surcharging

Manhole F-20

Location: Columbia View Ave. and Fir Street (NE)

- There is a drainage discharge from a home into a ditch right next to the manhole lid. It is suggested to install a rain lid or put a 90-degree bend on the pipe and extend it past the manhole.
- Some offsets at joints
- Self is damp
- No other indication of surcharging

Manhole F-18

Location: South end of Fir Street in a grassy field (NE)

- Looks fine
- The lid is approximately 3-feet above ground. Apparently when the subdivision is built out this will be at ground level. Until then it is difficult to replace the lid if it slips off the top.

Manhole F-7

Location: Lutheran church Road near the Hwy (E)

- There is visible leakage across the shelf

Manhole F-4

Location: Cascade Avenue east of Kanaka Creek (E)

- The top is shifted slightly
- It is not clear that the discharge pipe is low enough to go under the creek (record drawings indicate that it does).

Manhole F-3

Location: Cascade Avenue west of Kanaka Creek (E)

- The discharge pipe is not low enough to go under the creek (record drawings indicate that it does). This looks like an inverted syphon.

Manhole F-2

Location: Cascade Avenue west of Kanaka Creek (E)

- This manhole has an authorized overflow. There is a pipe discharging from the manhole to the creek. It has a valve on it that must be kept shut. The City is allowed to ope the valve if they think there will be an overflow coming.

Manhole Kanaka Wet Well

Location: East end of Cascade Avenue (near river)

- Limited access as the package suction lift pump station is partially over the wet well.
- Concrete looks in good condition
- Pipe is heavily corroded
- No apparent grease problem
- Suction lift duplex package hydronix station with a 40 kw generator

Manhole CI - 15

Location: Cascade Avenue (near river)

- Discharge manhole for the Kanaka Pump Station
- Chipped at the concrete
- Concrete is in good condition, no evidence of hydrogen sulfide corrosion

Manhole Cascade Pump Station wet well

Location: West end of Cascade Avenue (near river)

- Access is extremely limited
- The top 2-feet of the wet well is a steel can and it appears the side can open to provide more access to the wet well.
- Valves are in the wet well and difficult to access and operate.
- Duplex air primed pumps in a fiberglass hut above the wet well. It sits about 2-feet above ground, but the ground falls away making access on the river side very difficult.

Manhole C1-13

Location: Cascade Avenue & Russel Avenue (near river)

- Discharge manhole for the cascade Pump Station
- Chipped at the concrete
- Concrete is in good condition, no evidence of hydrogen sulfide corrosion

Manhole Skamania Lodge

Location: Following the grease trap

- Deep manhole
- The pipe up to the flow line was white with grease
- Staff indicates that there are times when there is a lot of heat in the manhole
- Manhole rim and lid corroded badly enough that the lid did not fit
- The grease trap is very large and pumped twice a year

Manhole J-17

Location: Foster Creek Road near Rock Creek Drive (W)

- This is where Skamania Lodge discharges
- Manhole rim and lid are corroding
- The pipe is lined with grease
- There is a strong smell

- There is sometimes a lot of heat in the manholes

Manhole J-14

Location: Rock Creek Drive just north of the assisted living center (W)

- Manhole rim and lid are corroding
- The pipe is lined with grease
- There is a strong smell
- There is sometimes a lot of heat in the manholes
- The assisted living center has approximately 60 residents and a commercial kitchen
- There is a grease trap (staff will check on the size). It is not clear what the maintenance is on the grease trap.

Manhole J-7 through J-12

Location: Attwell Road (parallel with Rock creek Drive) (W)

- Manhole rim and lid are corroding
- The pipe is lined with grease
- There is a strong smell
- There is sometimes a lot of heat in the manholes
- In the past there have been high water levels

Manhole J-4

Location: Rock creek Road at the entrance to Rock Creek Park

- "T" intersection of major lines
- The channels are well defined
- Appears to be working well

Manhole J-2

Location: Rock Creek Park

- This is the low point and where overflow can occur
- There were overflows about 5 to 10 years ago

Manhole K-3

Location: Rock Creek Road (near the WWTP)

- Well define 90-bend in the channel
- Manhole is only 3- deep
- Very little development upstream, but significant sewer line. When houses are constructed and flow increases, this is a manhole to watch for surcharge and overflow.

Manhole Rock Creek Pump Station

Location: East of rock creek

- There are plans to move the bridge to the north, as well as the pump station
- This is a wet well/dry well pump station and it is deep
- The power and standby power comes from the WWTP (safety concern for lock out/tag out).
- Comes very close to overflowing

Manhole VI - 5

Location: Vancouver Ave and Lasher Street

- "T" intersection
- Appears in good condition

Manhole H - 8

Location: View Point (uphill of apartments)

- Appears in good condition

Manhole G - 6

Location: Hot Springs Alameda Road and School Street

- Riser is stack bricks with grout
- The riser may be moving
- The shelf is very wet, has puddles
- Just uphill the road is subsiding. Staff should watch this as it could be the start of a sink hole.

Manhole G – 14A & G – 14B

Location: School Street & Stone Brooke Court

- There is a constant stream of clear liquid
- Past the last manhole there is a clean-out with a large tree next to it. Potentially the roots
- Walls are damp
- No other indication of surcharging

Manhole F-7-3

Location:

- Has a rain lid
- Self is damp
- Walls are damp
- No other indication of surcharging

Manhole F-7-3

Location:

- Has a rain lid
- Self is damp
- Walls are damp
- No other indication of surcharging

Manhole F-7-3

Location:

- Has a rain lid
- Self is damp
- Walls are damp
- No other indication of surcharging

Manhole F-7-3

Location:

- Has a rain lid
- Self is damp
- Walls are damp
- No other indication of surcharging