

## APPENDIX B

### PIPE LINE REPLACEMENT AND REHABILITATION

#### B.1 INTRODUCTION

Due to projected growth and limited facility size and capacity, a sanitary sewer utility has a responsibility to operate the sewer system as efficiently as possible. Part of responsible operation, maintenance and system management includes controlling infiltration and inflow into the system. Infiltration is defined as ground water which enters the sewer system through pipe joints, cracked or leaking pipes, porous pipes or similar openings in the system. Infiltration can enter the system through the main lines, side sewers and manholes. Inflow is surface water which enters the sewer system through manhole covers, cross connections with storm drainage systems or illegal connections to the sewer system, such as yard drains, footing drains, area drains or roof drains.

Excessive infiltration and inflow can lead to capacity issues in sewer mains, pump stations and/or treatment facilities and can result in sewer overflows, basement backups, or surcharged manholes. If infiltration and inflow are allowed to persist over time, other problems can eventually occur such as increased deterioration of the pipe bedding or backfill which could create or contribute to sewer system failure and/or damage to surrounding utilities. This, in turn, necessitates system upgrades at a more rapid pace than would otherwise be expected. All of these issues result in increased system costs to handle the excessive flows caused by infiltration and inflow or to remove these extraneous flows. Either of these options increases costs to the ratepayers. The challenge to sewer service providers is to determine the cost effective amount of I & I to be removed.

An important step in controlling infiltration and inflow is identifying the most problematic areas and determining the cause of the infiltration and/or inflow. Once the causes of excessive flows are identified, appropriate replacement or rehabilitation means can be considered and specific project recommendations can be developed.

#### B.2 INFILTRATION

Infiltration into a system can be identified in different ways. Preliminary steps in identifying infiltration include flow monitoring and system inspection. Flow monitoring should be accomplished systematically to identify larger problem areas first and by moving monitors upstream to narrow the suspect areas. Correlation between rainfall and flow data is a critical element in narrowing the magnitude and cause of infiltration, as egregious leaks into the system will be identified by the time lapse between rainfall and increased flows. It is therefore recommended that rainfall and flow data be recorded as frequently as practical and that rainfall gauges be placed as close to monitors as possible.

Once suspect areas have been identified, video inspection, coupled with compilation of pipeline data (as discussed below), is the logical step in a more specific I & I analysis. Video inspection of both main line and side sewer pipes is recommended to determine the magnitude and nature of the problems. Causes of infiltration, such as root intrusion and major pipe cracks, can be identified under normal inspection conditions. Other sources of infiltration, such as cracks and leaking joints, can be more readily identified during wet weather inspections.

#### *B.2.1 Infiltration Matrix*

Once the pipelines with significant infiltration are identified, pipeline replacement and/or rehabilitation projects can be established. The infiltration matrix, an example of which is provided in this appendix section, was developed as a tool to assess the relative priority of sewer line replacements and/or rehabilitations. The matrix uses known sewer system information such as pipe age, material and existing conditions to assist in prioritizing future projects. These factors were weighted by relative importance or severity using a point scale. The points are then totaled and the pipe length with the highest score should have the highest priority for replacement or rehabilitation.

The information to be used in the matrix can be obtained from as-built information, video inspection reports and staff knowledge.

##### *B.2.1.1 Matrix Criteria and Values*

The priority matrix was developed to consider important factors in sewer replacement and/or rehabilitation projects. The basic factors considered are pipe age and pipe material and increasing point values should be assigned older pipes. Similarly, the pipe type provides a good indication of the need for replacement or rehabilitation.

The existing conditions of and around the pipe are considered in a more objective manner. Consideration should be given to the severity of the existing conditions by weighing the existing condition values on a scale of 0 to 3 (where 0 indicates no I & I and 3 indicates that the I & I condition is very severe). The different existing factors to consider include back ups, sags, cracks, root intrusion, poor joint material, soil conditions, repair/maintenance, slope issues, construction issues and the condition of the side sewers.

##### *B.2.1.2 Matrix Evaluation*

Once the matrix has been completed (for a specific area or the entire City), conclusions can be drawn based on the results. The pipelines should be

prioritized for replacement or rehabilitation from highest to lowest matrix score. In finalizing replacement or rehabilitation projects, consideration should be given to pipe line locations. For example, the City may decide to have a replacement project for a general area, even though not all the pipes in the area have the highest priority ranking.

### B.3 INFLOW

As mentioned previously, inflow is surface water which enters the sewer system through manhole covers, cross connections with storm drainage systems, or illegal connections such as yard drains, sump pumps, footing drains, area drains or roof drains connected to the sewer system. Inflow sources present different, and in many cases, more difficult problems. Inflow resulting from illegal connections to the sanitary sewer system is typically indicated by sudden increases in flow immediately following rain events, regardless of ground saturation, where the flows do not experience the same lag time that might be expected with infiltration. Similarly, inflow ceases much more rapidly as rainfall stops and surface conditions dry.

Because of the shorter duration of inflow, it can be much more difficult to pinpoint and correct. Flow monitoring, unless very precisely correlated with rainfall data, is typically ineffective in discerning inflow from infiltration. Although video inspection can assist in identification of obvious illegal connections to the main line sewers, it is typically not indicative of connections to side sewers unless the inspection is timed with rain events. In this case, relative flow from side sewers associated with similar types of connections may assist in identifying suspected inflow sources. Nevertheless, careful video inspection is typically the first mechanism for identification of inflow sources. Smoke testing can be very effective in identifying illegal connections to the system, provided that the connections have not been configured in a manner which would prohibit smoke passing through the connections (p-traps). A more effective means of identifying inflow sources is dye testing, where powdered dye is placed in roof gutters and catch basins to determine if they are connected to the sanitary sewer system.

Correction of inflow problems can present problems to property owners who have, presumably, installed these connections to correct specific drainage problems. Disconnection of illegal connections without consideration of surface drainage may have impacts to area storm drainage systems as well as public and private property. It is therefore important to work with local storm drainage utilities to develop a comprehensive solution.

### B.4 RECOMMENDATIONS

Specific projects have been included in the Capital Facilities Plan that address the most significant infiltration and inflow projects known at the time of comprehensive plan development. Additionally, approximately \$10,000 per year has been budgeted to fund video inspection of pipes, smoke testing and other activities related to the identification of pipeline conditions

causing infiltration and flow. It is recommended that implementation of the CFP and continued monitoring for I & I remain the City's highest priority. As new problem areas are identified, reprioritization of improvement projects may be required. In order to do this, it is recommended that the City use a matrix analysis method to determine pipeline replacement and/or rehabilitation projects and their respective priority. This should help reduce the amount of infiltration into the Sedro-Woolley system.

It is also recommended that the City establish and implement permanent solutions for rerouting illegal connections. The illegal connections that are removed from the sanitary sewer line will have to be rerouted, most likely into the city storm drainage systems. Working with the storm drainage utility should help alleviate potential rerouting issues.

**City of Sedro-Wooley  
Pipe Line Replacement and Rehabilitation Matrix**

Description		Location			Pipe Life			Pipe Material					Existing Conditions								Score	Inspection								
Pipe Number	Pipe Length	Street	From	To	Year Installed	Age	Age Points	Pipe Life Score	Ductile Iron	PVC	Vitrified Clay	Concrete	AC	Pipe Material Score	Back Ups	Sags	Cracks	Root Intrusion	Poor Joint Material	Soil Conditions	Repair/Maintenance	Slope Issues	Construction Issues	Bad Side Sewers	Existing Conditions Score	Total Score	Confirmed Results	No	Scheduled	
								0						0											0					
								0						0												0				
								0						0												0				
								0						0												0				
								0						0												0				
								0						0												0				
								0						0												0				
								0						0												0				
								0						0												0				

**Criteria and Scoring**

Age: Pre 1950 = 4 points  
1951-1960 = 3 points  
1961-1970 = 2 points  
1971-1980 = 1 point  
1981-present = 0 points

Material: AC = 3 points  
Concrete with motor joints = 3 points  
Concrete with "O" ring gaskets = 1 point  
Vitrified Clay = 1 point  
PVC = 0 points  
DI = 0 points

Existing Conditions: Each criteria is rated from 4 (worst) to 0 (best, nonexistent)

**City of Sedro-Wooley**  
**Pipe Line Replacement and Rehabilitation Matrix -Values**

<b>Criteria</b>	<b>Condition</b>	<b>Points</b>
Pipe Life		
	Pre 1950	4
	1951-1960	3
	1961-1970	2
	1971-1980	1
	1981-Present	0
Pipe Material		
	DI	0
	PVC	0
	Vitrified Clay	1
	Concrete	2
	AC	3
Existing Conditions		
	Back Ups	0 - 3 Value Based on Severity
	Sags	
	Cracks	
	Root Intrusion	
	Poor Joint Material	
	Soil Conditions	
	Repair/Maintenance	
	Slope Issues	
	Construction Issues	
	Bad Side Sewers	

**City of Sedro-Wooley**

**Pipe Line Replacement and Rehabilitation Matrix - Example**

**Note: This is an example only. Additional information/input is needed to complete the matrix.**

Description		Location			Pipe Life			Pipe Material					Existing Conditions										Score	Inspection					
Pipe Number	Pipe Length	Street	From	To	Year Installed	Age	Age Points	Pipe Life Score	Ductile Iron	PVC	Vitrified Clay	Concrete	AC	Pipe Material Score	Back Ups	Sags	Cracks	Root Intrusion	Poor Joint Material	Soil Conditions	Repair/Maintenance	Slope Issues	Construction Issues	Bad Side Sewers	Existing Conditions Score	Total Score	Confirmed Results	No	Scheduled
PH 14-H13	282	Highway 20	MH M14 - Holtcamp Rd	MH-H13 (D.S.)				0				3		3											0	3			
PA8-A7	476	Between Fidalgo and Sterling	Township-A8	Side Lateral West A7				0			3			3	2						2	2			6	9			
								0						0											0	0			
								0						0											0	0			
								0						0											0	0			
								0						0											0	0			
								0						0											0	0			
								0						0											0	0			

<b>Criteria and Scoring</b>		
Age:	Material:	Existing Conditions:
Pre 1950 = 4 points 1951-1960 = 3 points 1961-1970 = 2 points 1971-1980 = 1 point 1981-present = 0 points	AC = 3 points Concrete with motor joints = 3 points Concrete with "O" ring gaskets = 1 point Vitrified Clay = 1 point PVC = 0 points DI = 0 points	Each criteria is rated from  4 (worst) to 0 (best, nonexistent)