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REDUCING PROJECT UNCERTAINTY FOR RESIDENTIAL SEWER CURED-IN-PLACE-PIPE (CIPP) PROJECTS

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ABSTRACT: Southwest Suburban Sewer District (SWSSD) has been serving the cities of Burien, Normandy Park, Seattle, Des Moines, and Seatac as well as portions of King County for the past 65 years. When established in 1945, SWSSD served approximately 900 acres. Today, SWSSD serves approximately 10 square miles and maintains over 288 miles of sewer pipelines. The majority of SWSSD's existing pipelines was installed in the mid 1950's and consists of 8" to 15" diameter concrete pipe. In 2006, SWSSD began a sewer rehabilitation program geared towards the rehabilitation or replacement of some of the first sewer lines installed by SWSSD.

This paper discusses the multi-phased rehabilitation of approximately 60,000 feet of 8" to 15" diameter sewer mains in the Chelsea Park neighborhood located in Burien, WA. The paper reviews the project delivery methods used by SWSSD to reduce project uncertainty. The paper looks at how SWSSD identifies problem areas and determines the viability of sewer rehabilitation, separation of spot repair and rehabilitation contracts, and the tracking template used by SWSSD during the CIPP rehabilitation process. Readers will be shown the return on investment and the overall value of this approach and the tools associated with this project delivery method with actual project examples and costs.

1. INTRODUCTION

The rehabilitation of existing sewer lines that are from 40 to over 100 years old carries with it inherent uncertainties that must be dealt with during the design and construction of a rehabilitation project. Uncertainties can range from the number of active and inactive side sewer laterals to existing conditions of the sewer line such as sags, protruding laterals and collapsed pipes. These conditions can have significant impacts on the overall success of the rehabilitation project. Understanding the condition of the existing sewer lines and the problems that those conditions pose to rehabilitation of the sewer lines using cured-in-place-pipe (CIPP) technology is key to reducing the number of uncertainties on the project.

There are many ways to address the risks from the inherent uncertainties facing a CIPP rehabilitation project. Some agencies choose to put the identification of any problematic pipe conditions on the contractor during construction and deal with any changed conditions through project change orders. Southwest Suburban Sewer District (SWSSD) has chosen to use a project delivery method that includes a multi-phased approach for the identification, repair and rehabilitation of their existing sewer lines.

The multi-phased approach used by SWSSD on the CIPP rehabilitation of existing sewers in the Chelsea Park neighborhood allowed them to save more than five million dollars versus using a conventional open-trench construction method. This was accomplished by identifying existing pipe conditions prior to construction, separating repair versus rehabilitation contracts to target contractor specialties, using inspection techniques that foster contractor collaboration and accurate project tracking, and overlapping design and construction efforts which allowed for an accelerated schedule.

2. PRELIMINARY ENGINEERING

In 2006, SWSSD began a program geared towards the rehabilitation or replacement of some of the first sewer lines installed in the District. The majority of these lines consisted of 8" to 15" diameter concrete sewer lines that were installed more than 60 years ago. SWSSD has its own closed-circuit television (CCTV) truck and crew that conducted the inspection process in preparation for the rehabilitation work. By conducting CCTV inspections on the existing sewer lines prior to construction, it allowed SWSSD's engineer, Roth Hill, LLC (Roth Hill), to complete a preliminary engineering investigation to identify issues with the existing sewer lines that could complicate or prevent the installation of a CIPP liner.

Figure 1. Existing sewer pipe from Chelsea Park Sewer Rehabilitation Project.

Figure 1 shows two sections of existing pipe that were discovered during the CCTV inspection of the sewer lines in the Chelsea Park neighborhood. The bottom section of these pipes had completely eroded away. These sections of pipe were only discovered because the CCTV camera disappeared during the inspection. These sections could not be lined using CIPP technology and were dug up and repaired using conventional open-trench construction.

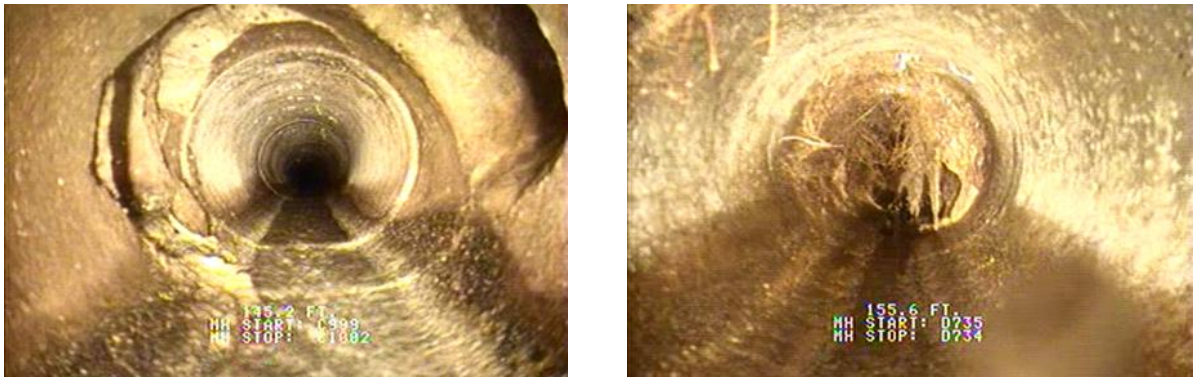

Figure 2. Existing pipe failure at a lateral and root intrusion.

At the completion of the initial CCTV inspection work, the DVD's were reviewed by both SWSSD staff and the engineer to determine the feasibility for CIPP liner installation. The CCTV review divided the identified conditions into three categories; green, red and yellow. Green meant that the existing condition could be remedied by CIPP, meaning the pipe could be lined without the need for excavation. The conditions that were identified as green were generally limited to protruding laterals that could be removed internally using a robotic cutter, fish-mouthed gaskets, minor to moderate root intrusion, and minor pipe sags. Red meant that the existing condition in the line prevented the use of CIPP technology and forced the open-trench excavation of the line so that it could be repaired prior to CIPP lining. Red conditions ranged from a collapsed pipe to major sags and large cavities. The third category was yellow which meant that the engineer recommended further review by SWSSD staff. Yellow conditions generally consisted of minor to moderate sags which warranted review by staff to determine the need to repair prior to CIPP rehabilitation or if the sags were within acceptable limits based on the existing flows. Other yellow conditions also consisted of inconclusive CCTV DVD's due to excessive debris or grease that required a second CCTV inspection after cleaning.

Table 1. Example CCTV Review Sheet

US MH	DS MH	Length	Pipe Material	Reviewer	Inspection Date	Inspection Direction	Observed Condition	Location
998	997	240	Concrete	BPW	3/6/2009	US	None	
997	996	242	Concrete	BPW	3/6/2009	US	None	
996	990	335	Concrete	BPW	3/6/2009	DS	Sag - minor	20'-42'
							Sag	50'-75'
							Sag	82'-88'
							Sag	128'-132'
							Sag - minor	162-173'
							Sag	206'-215'
							Sag	234'-241'
							Sag - minor	250'-256'
							Sag	263'-286'
							Sag	313'-327'
High flow in pipes. Difficult to determine severity of sags.								
954	953	225.1	Concrete	MRC	3/2/2008	DS	Roots in Side Sewer	88'
							Roots in side sewer - Light	146'
							Roots in side sewer - Light	216'
953	952	300	Concrete	MRC	3/2/2009	DS	None	
952	951	336	Concrete	BPW	4/7/2009	DS	Drop Connection	MH951
955	951	205	Concrete	MRC/BPW	3/2/2009	DS	Sag - minor	30'-38'
							Sag - minor	160'-173'
							Cavity - Large , repaired???	196'
951	950	306	Concrete	BPW	4/7/2009	DS	None	
950	949	303.2	Concrete	BPW	3/20/2009	DS	Roots in side sewer - Light	48'
948	943	287	Concrete	BPW	3/30/2009	DS	Roots in side sewer - Light	106'
							Roots in side sewer - Light	196'

The culmination of the preliminary engineering investigation recommended spot repair locations where pipe needed to be repaired prior to CIPP rehabilitation. Once these spot locations were repaired, the entire pipe, including the repaired location, was lined during the CIPP phase of the project. Some of the sewer runs which had significant issues were recommended to be replaced in their entirety as shown in Table 1.

3. REPAIR VS. REHABILITATION CONTRACT

SWSSD used a multi-phased construction project delivery method to complete the rehabilitation project. Instead of having a single contract that required both the open-cut repair of the sewer line, identified as red in Table 1, and the installation of the CIPP liner, SWSSD split the repair and rehabilitation construction into two separate contracts. Splitting the contracts allowed SWSSD to ensure that only those contractors who were experienced with the spot repair and replacement method would bid on that project. Likewise, only those contractors who were experienced with CIPP installation would bid on the rehabilitation project. In addition, SWSSD was able to bid the projects such that there was minimal need for subcontractors which avoided the corresponding subcontractor cost markup.

3.1 REPAIR CONTRACT

The repair/replacement contract consisted of all the open-trench excavations that were required based on the CCTV review. These open-trench repairs replaced severely sagged pipe, removed pipe that had collapsed and replaced pipe that was undersized. Generally, the contractors bidding the repair/replacement project were local contractors familiar with SWSSD and the local road and land use agency requirements. This meant that these contractors understood the risks and requirements for constructing the project in the area and did not need to inflate their bids to cover those factors.

Figure 3. Spot Repair/Pipe Replacement Construction

3.2 REHABILITATION CONTRACT

The rehabilitation contract followed the repair contract and consisted of the CIPP lining of all of the sewer lines that were inspected by SWSSD CCTV crews, with the exception of those lines which were replaced in their entirety during the repair contract phase of the project.

The CIPP rehabilitation contract required the contractor to increase the level of inspection and buyoff of the CIPP feasibility prior to the installation of the liner. To accomplish this the contract required that the CIPP contractor perform a pre-installation cleaning and inspection of the existing sewer so that they could verify the quantity and location of all active side sewer laterals and identify any locations that they believed could not be successfully lined. SWSSD staff also reviewed these pre-installation DVD's and was required to sign off on the contractor's assessment of the existing condition. By having both the contractor and SWSSD staff review and approve the CIPP feasibility, SWSSD was able to take advantage of the contractor's experience with CIPP lining prior to beginning the actual construction and SWSSD had time to modify the contract if required.

Once a pipe run was approved for CIPP installation and the contractor completed the CIPP installation, the contractor was also required to conduct a post-installation inspection. This inspection was also required to be reviewed and approved by both the contractor and SWSSD staff. The tracking of the pre-installation and post-installation inspections was accomplished using a tracking template that was developed by Roth Hill based on similar tracking templates used by the City of Tacoma, Washington. The General Infrastructure Information (Table 2) was provided by Roth Hill. The Install Scheduling was filled in by the contractor and both the contractor and SWSSD filled in portions of the Pre-Installation (Table 3) and Post-Installation (Table 4) inspection data. The tracking template was transmitted electronically between SWSSD, the engineer and the contractor during construction.

Table 2. Tracking Template – General Infrastructure Information

Install Scheduling				General Infrastructure Information					
Shot #	Scheduled Install Date	Active Lateral Count	Installed Liner Thickness	Plan Sheet #	Upstream Manhole Number	Upstream Manhole Depth (ft)	Downstream Manhole Number	Downstream Manhole Depth (ft)	Sewer Main Diameter (in)
5	5/12/2008	7	6mm	2	874	12.1	873	15.0	8.0
3	5/8/2008	7	6mm	2	875	11.2	874	12.1	8.0
3	5/8/2008	3	6mm	2	876	8.7	875	11.2	8.0
4	5/9/2008	3	6mm	2	877	6.9	875	11.2	8.0
9	5/14/2008	8	6mm	2	878	7.5	873	15.0	8.0
6	5/13/2008	8	6mm	2	879	11.1	878	7.5	8.0
6	5/13/2008	5	6mm	2	882	11.6	879	11.1	8.0
1	5/6/2008	6	6mm	2	883	14.8	882	11.6	8.0
1	5/6/2008	8	6mm	2	883A	13.4	883	14.8	8.0
2	5/7/2008	5	6mm	2	880	9.5	879	11.1	8.0
2	5/7/2008	5	6mm	2	881	7.0	880	9.5	8.0
11	5/20/2008	4	6mm	2	869	12.6	865	11.9	8.0
11	5/20/2008	3	6mm	2	870	11.5	869	12.6	8.0
7	5/16/2008	5	6mm	2	871	12.9	870	11.5	8.0
7	5/16/2008	9	6mm	2	872	7.2	871	12.9	8.0
14	5/23/2008	5	6mm	2	866	15.2	865	11.9	8.0
12	5/21/2008	5	6mm	2	867	7.1	866	15.2	8.0
12	5/21/2008	9	6mm	2	868	6.7	867	7.1	8.0
17	5/29/2008	5	6mm	2	862	9.6	859	11.4	8.0
17	5/29/2008	4	6mm	2	863	10.4	862	9.6	8.0
13	5/22/2008	5	6mm	2	864	11.6	863	10.4	8.0
13	5/22/2008	3	6mm	2	865	11.9	864	11.6	8.0
15	5/28/2008	3	6mm	2	860	8.6	859	11.4	8.0
15	5/28/2008	10	6mm	2	861	6.4	860	8.6	8.0
29	6/6/2008	3	6mm	2	859	11.4	850	9.2	8.0
25	6/4/2008	9	6mm	2	853	9.3	850	9.2	8.0
27	6/5/2008	4	6mm	2	851	11.4	850	9.2	8.0
27	6/5/2008	10	6mm	2	852	8.2	851	11.4	8.0
23	6/3/2008	4	6mm	2	854	15.5	853	9.3	8.0
23	6/3/2008	4	6mm	2	855	18.9	854	15.5	8.0
21	6/2/2008	2	6mm	2	856	17.2	855	18.9	8.0
21	6/2/2008	12	6mm	2	857	10.1	856	17.2	8.0

Table 3. Tracking Template – Pre-Installation Feasibility Assessment

Pre-Installation						
Date of Pre-Installation Inspection	Contractor Review Date	Contractor's Lining feasibility Assesment	Date Received by District	District Review Date	District's Lining feasibility Assesment	District Approval Date
4/18/2008	4/17/2008	Ok to line 348 ft	4/21/2008	4/25/2008	Ok to line	4/28/2008
4/10/2008	4/10/2008	Ok to line 356 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/10/2008	4/10/2008	Ok to line 109 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/9/2008	4/9/2008	Ok to line 272 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/8/2008	4/9/2008	Ok to line 331 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/8/2008	4/9/2008	Ok to line 335 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/9/2008	4/9/2008	Ok to line 330 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/8/2008	4/8/2008	Ok to line 300 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/8/2008	4/9/2008	Ok to line 301 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/8/2008	4/9/2008	Ok to line 331 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/8/2008	4/9/2008	Ok to line 262 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 288 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 168 ft (check)	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 241 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 280 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 301 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok toline 252 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 300 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/14/2008	4/14/2008	Ok to line 187 ft	4/21/2008	4/25/2008	Ok to line	4/28/2008
4/14/2008	4/14/2008	Ok to line 138 ft	4/21/2008	4/25/2008	Ok to line	4/28/2008
4/11/2008	4/11/2008	Ok to line 182 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/11/2008	4/11/2008	Ok to line 188 ft	4/11/2008	4/16/2008	Ok to line	4/17/2008
4/14/2008	4/14/2008	Ok to line 179 ft	4/21/2008	4/25/2008	Ok to line	4/28/2008
4/14/2008	4/14/2008	Ok to line 406 ft	4/21/2008	4/25/2008	Ok to line	4/28/2008

Table 4. Tracking Template – Post-Installation Review and Comments

Post-Installation								
Date of CIPP Liner Installation	Length Per Plan	Length Installed	Date of Post-Installation Inspection	Contractor Review Date	Contractor's Post-Installation Inspection Comments	District Review Date	District's Post Installation Inspection Comments	District Acceptance Date
5/12/2008	346.00	348.00	5/12/2008	5/12/2008	Ok - 3 Lats open	6/9/2008	Ok - 3 lats open	6/9/2008
5/8/2008	354.00	356.00	5/8/2008	5/8/2008	Ok - 6 lats open	6/9/2008	Ok - 6 lats open	6/9/2008
5/8/2008	110.00	109.00	5/8/2008	5/8/2008	Ok - 3 Lats open	6/9/2008	Ok - 3 lats open	6/9/2008
5/9/2008	272.00	272.00	5/9/2008	5/9/2008	Ok - 3 Lats open	6/9/2008	Ok - 3 lats open	6/9/2008
5/14/2008	330.00	331.00	5/14/2008	5/16/2008	Ok - 8 lats open	6/9/2008	Ok - 8 lats open	6/9/2008
5/13/2008	333.00	334.00	5/13/2008	5/13/2008	Ok - 8 lats open	6/9/2008	Ok - 8 lats open	6/9/2008
5/13/2008	330.00	330.00	5/13/2008	5/13/2008	Ok - 5 lats open	6/9/2008	Ok - 5 lats open	6/9/2008
5/6/2008	300.00	301.00	5/6/2008	6/11/2008	Ok - 6 lats open	6/9/2008	Ok - 6 lats open	6/25/2008
5/6/2008	300.00	301.00	5/6/2008	6/11/2008	Ok - 8 lats open	6/25/2008	Ok - 8 lats open	6/25/2008
5/7/2008	330.00	331.00	5/7/2008	5/7/2008	Ok - 5 lats open	6/9/2008	Ok - 5 lats open	6/9/2008
5/7/2008	261.00	262.00	5/7/2008	5/7/2008	6 lats open : 1 overcut (review)	6/9/2008	Ok - 5 lats open : Need point repair	
5/20/2008	287.00	288.00	5/20/2008	5/20/2008	Ok - 4 lats open	6/13/2008	Ok - 4 lats open	6/13/2008
5/20/2008	162.00	162.00	5/20/2008	5/20/2008	Ok - 4 lats open	6/13/2008	Ok - 4 lats open	6/13/2008
5/16/2008	240.00	241.00	5/16/2008	6/10/2008	Ok - 5 lats open : IPR istalled 6-10-2008	6/9/2008	Ok - 5 lats open	6/18/2008
5/16/2008	278.00	280.00	5/16/2008	5/14/2008	Ok - 8 lats open	6/9/2008	Ok - 8 lats open	6/9/2008
5/23/2008	300.00	301.00	5/23/2008	5/23/2008	Ok - 3 lats open	6/13/2008	Ok - 3 lats open	6/13/2008
5/21/2008	251.00	254.00	5/21/2008	5/21/2008	Ok - 5 lats open	6/13/2008	Ok - 5 lats open	6/13/2008
5/21/2008	298.00	300.00	5/21/2008	5/21/2008	Ok - 9 lats open	6/13/2008	Ok - 9 lats open	6/13/2008
5/29/2008	186.00	187.00	5/29/2008	5/29/2008	Ok - 4 lats open	6/17/2008	Ok - 4 lats open	6/17/2008
5/29/2008	138.00	138.00	5/29/2008	5/29/2008	Ok - 4 lats open	6/17/2008	Ok - 4 lats open	6/17/2008
5/22/2008	182.00	181.00	5/22/2008	5/22/2008	Ok - 5 lats open	6/13/2008	Ok - 5 lats open	6/13/2008
5/22/2008	188.00	188.00	5/22/2008	5/22/2008	Ok - 3 Lats open	6/13/2008	Ok - 3 lats open	6/13/2008
5/28/2008	178.00	179.00	5/28/2008	5/28/2008	Ok - 3 Lats open	6/17/2008	Ok - 3 lats open	6/17/2008

3.3 SCHEDULE BENEFITS

The multi-phased project delivery method used by SWSSD also included inherent schedule benefits based on the ability to overlap both construction projects. As soon as the preliminary engineering and design was completed, SWSSD was able to award a repair/replacement contract allowing the open-trench excavation work to move forward. As this work was starting, the CIPP rehabilitation design was completed and bid. Both the

repair/replacement and the rehabilitation contractors were able to work within the same overall project area at the same time.

While both contracts were in construction, SWSSD moved its CCTV inspection crews to an area adjacent to the project and continued the CCTV inspection of existing sewer lines. This allowed the engineer to move forward with the preliminary engineering for the next rehabilitation area and continue the process. The overlapping schedule benefit is depicted in Figure 4 below.

Southwest Suburban Sewer District
Chelsea Park Swer Rehabilitation Project

	2006		2007				2008				2009				2010			
	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4
Planning/Design	Phase I																	
Spot Repair Construction					Phase I													
Planning/Design					Phase II													
CIPP Rehabilitation							Phase II											
Planning/Design									Ph III									
Spot Repair Construction									Phase III									
Planning/Design											Phase IV							
Spot Repair Construction													Phase IV					
Planning/Design													Phase V					
CIPP Rehabilitation															Phase V			

Figure 4. Actual Chelsea Park Schedule

4. CASE STUDY – CHELSEA PARK SEWER REHABILITATION

As previously mentioned, SWSSD began a sewer rehabilitation program in 2006. The program was started by compiling the CCTV inspection work that had been performed on some of the oldest sewer lines in the District, located in the Chelsea Park neighborhood. The majority of the lines in this neighborhood consisted of 8" to 15" diameter concrete sewer lines. SWSSD had obtained approximately $4.6 million in State funding for this project to replace 32,000 feet of sewers lines. As part of the proposal process, Roth Hill recommended the use of CIPP rehabilitation (Figure 5) instead of the more common open-trench replacement of the sewer lines with the understanding that far more than 32,000 feet could be rehabilitated using this technology.

Figure 5. CIPP Rehabilitation

The CCTV records compiled by the District were anywhere from 2 to 4 years old. It was understood that by using the old CCTV inspection videos for the preliminary engineering of the Phase I spot repair/replacement contract that we would likely find additional problem areas during the pre-installation inspection performed on the Phase II rehabilitation contract. The Phase I spot repair contract included the replacement of 272 feet of 10" diameter pipe and 590 feet of 8" diameter pipe in 12 different locations within the Chelsea Park neighborhood.

As the Phase I spot repair/replacement contract was being completed, SWSSD bid the Phase II CIPP rehabilitation contract. The Phase II rehabilitation contract consisted of the CIPP lining of 32,600 feet of 8" and 10" diameter sewer lines. During the initial pre-installation cleaning and inspection, the Phase II contractor identified eight locations that they believed were not beneficial to line. These locations were packaged into a Phase III spot repair contract and was bid using SWSSD's small works roster. As the Phase II CIPP work was being completed, SWSSD brought in a Phase III contractor to complete the additional spot repairs. The Phase III work was completed in time to allow the Phase II contractor to complete the CIPP rehabilitation of the initial project area.

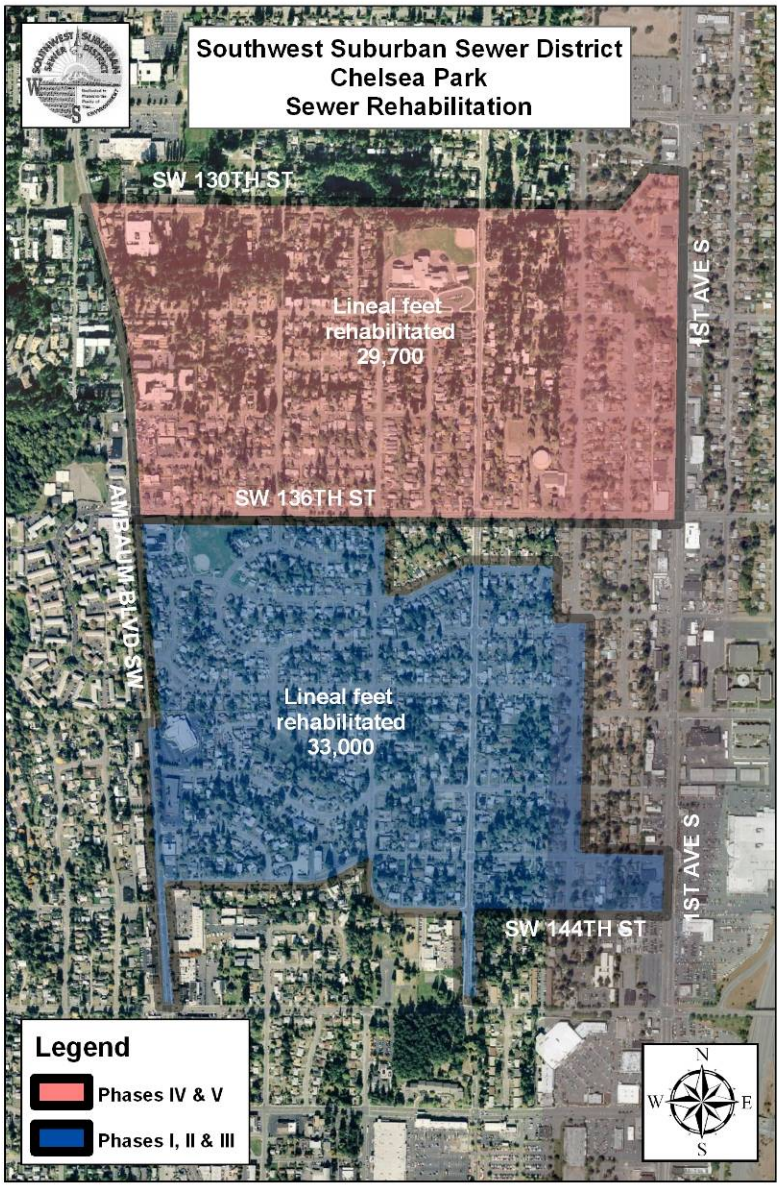

Figure 6. Map of Chelsea Park Sewer Rehabilitation

During the construction of the first three phases of the Chelsea Park Rehabilitation project, SWSSD continued its CCTV inspection of the adjacent area to the north. Based on the CCTV inspections, Roth Hill developed a Phase IV spot repair/replacement and Phase V CIPP rehabilitation contract, shown as "Additional Rehabilitation" in Figure 6. The Phase IV spot repair contract included the replacement of approximately 1,750 feet of 8" diameter sewer lines and the replacement of 51 side sewer laterals from the sewer line to the property line. The subsequent Phase V CIPP rehabilitation project consisted of approximately 28,450 feet of sewer lines.

Table 5 shows the project cost specifics for each phase of the Chelsea Park project including a percentage increase due to project change orders. The Phase I and Phase III spot repair contracts both had change orders that increased the amount of sewer being replaced based on the limits of the pipe sags being unknown. The Phase IV spot repair contract change order included the addition of some storm drain replacement requested by the local land use agency. The Phase V CIPP rehabilitation project included a change order to add an additional 5,144 feet of CIPP rehabilitation. There were no change orders on the Phase II CIPP rehabilitation project.

Table 5. Chelsea Park Project Costs

	Original Construction Cost	Final Construction Cost	% Increase	Engineering Cost	Total Footage Rehabilitated
Phase I - Spot Repair	$387,400	$423,200	9%	$309,200	33,800
Phase II - CIPP Rehab	$1,176,800	$1,132,000	-4%		
Phase III - Spot Repair	$175,500	$194,700	11%		
Phase IV - Spot Repair	$596,200	$602,600	1%	$216,700	29,680
Phase V - CIPP Rehab	$571,700	$584,300	2%		
TOTAL COSTS	**$2,907,600**	**$2,936,800**	**1%**	**$525,900**	**63,480**

5. CONCLUSIONS & SUMMARY

The key to reducing project uncertainty on a residential sewer CIPP project is to understand the condition of the existing sewer line and how that affects the need for repair versus rehabilitation. Leaving the discovery of problem pipes up to the CIPP contractor will only lead to unnecessary change orders that will drive up the overall project cost and the likely need for a subcontractor specializing in a conventional construction method. SWSSD has been very successful in reducing project uncertainty through the use of its multi-phased project delivery approach. This approach consists of:

- Initial project inspection to identify issues that prevent successful CIPP rehabilitation
- Preparation of a separate spot repair/replacement contract to facilitate construction using local contractors with local expertise
- Issuing a CIPP rehabilitation contract that requires experienced CIPP contactors to bid and the use of a tracking template that requires contractor buyoff prior to CIPP rehabilitation
- Continuing the CCTV inspection process so that the rehabilitation process can be repeated which allows for the most cost-effective rehabilitation program.

By using these project delivery methods, SWSSD was able to complete the rehabilitation of 63,480 feet of existing sewer for a total project cost, including engineering and construction, of $3,462,700. This equates to an approximate total project cost of $55 per foot installed, saving SWSSD in excess of $5 million dollars.