North American Society for Trenchless Technology (NASTT)
No-Dig Show 2010

Chicago, Illinois
May 2-7, 2010

Paper A-4-02

REHAB OF 100-YEAR-OLD LARGE SIZE CIRCULAR AND NON-CIRCULAR SEWERS

Michael I. Spero,P.E.[1], and Datta Shirodkar[2]

[1] Engineering Manager, Boyer, Inc. and President, Danby LLC, Houston, TX
[2] Project Manager, Boyer, Inc. Houston, TX

ABSTRACT: This paper presents a case history, from the contractor's viewpoint, of two projects in Washington, DC that involved the rehabilitation of 16,000 linear feet of 70 to 100 year old circular and non-circular sewers using a Grouted-In- Place Lining System (GIPL) to provide increased structural stability, a water tight and corrosion resistant lining and improved flow capacity. Both projects renewed sewers owned by the District of Columbia Water and Sewer Authority (DCWASA).

The first project involved the rehabilitation of a 100 year old 90-inch diameter brick storm sewer beneath a new building under construction in a commercial area. The project overcame numerous challenges including; no allowed full flow bypass, tidal influenced backwater, limited site access and lay down area, lining around a short radius curve, confined space and storm inundation issues. The second project involved 7 different cast-in-place reinforced concrete sanitary sewer sizes and shapes, from a 7'x11' box to a 10'x10' semi-elliptical shaped arch, 8 transition sections between different shaped sewers, limited and restricted access through high security military bases, small manholes (3'x3'), lining around ten curves with radii as small as 27 feet, five sections that were 1,200 to 1,700 feet between access points, and the detailed design of lining system as a structural rehab.

1. Introduction

This paper is case histories of two projects in Washington, DC. The first one, the Waterfront Mall Project, is the rehabilitation of an aged brick sewer. This should have been a relatively simple project with a few significant yet manageable challenges, but it turned into the "Job from Hell". It will be explained why the project was needed, how it progressed, how some things went sour and how these challenges were overcome.

The second project is the Blue Plains Influent Sewers Rehabilitation. The District of Columbia Water and Sewer Authority (DCWASA) entered into a Consent Decree with the U.S. Government and certain citizen plaintiffs regarding the combined sewer system. The Decree required that DC WASA will ensure that by April 11, 2011 the collections system has the capacity to convey flows totaling a rate of at least 1,076 million gallons per day for the areas serviced by the collection system conveying flow to the Blue Plains Advanced Wastewater Treatment Plant. In order to meet this requirement, portions of the East and West Blue Plains Influent Sewers and selected sewer structures will be rehabilitated and/or modified by the deadline. To achieve this goal this project was let as a competitively bid contract. Four different structural rehabilitation alternative methods/technologies were specified for this Project including PVC Spiral wound liner system, Round Fiber Glass Reinforced Polymer Mortar Slipliner

Pipe (FRPMP), Glass Reinforced Plastic (GRP) Panel Liner System and Non-Round Fiberglass reinforced Polymer Mortar (FRPM) Sliplining system. Boyer Inc. of Houston, TX is the subcontractor to Ulliman Schutte Construction LLC for the structural lining part of the project using the Danby PVC Lining System. The project was bid March, 2009.

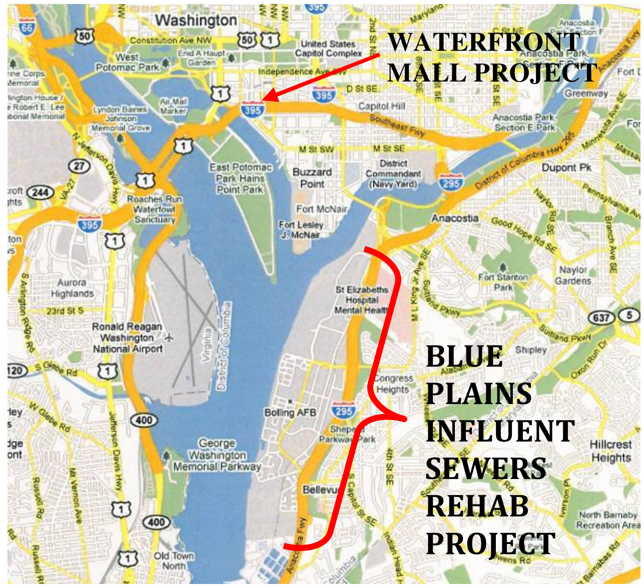

Figure 1, Vicinity Map of Project Areas

2. Waterfront Mall Project

Project Description

This sewer rehabilitation project is located in the southwest sector of Washington, DC [Figure 1]. The existing building was demolished and the site is being developed for mixed use. The Waterfront Mall Project will contain retail stores, restaurants, offices and residential units. Through the middle of the site there is an existing 90" diameter storm sewer about 800 feet long [Figure 2]. This pipe is over 100 years old. About half of the length of pipe is all brick, consisting of 3 layers [Figure 3]. The other half of the length has the bottom part of the pipe constructed of brick (below the spring line) and the upper half is unreinforced concrete [Figure 4]. The pipe makes one 90 degree short radius bend about mid length. The sewer is now a storm drain but previously it was a combined sewer. It empties into the Potomac River about 1,000 feet downstream of the project site. The sewer is owned and maintained by DCWASA. The new development included the proposed construction of a building and a parking garage over the existing sewer. Although the sewer was in relatively good condition, especially after 100 years of service, DCWASA requested that the sewer be rehabilitated by the developer. This was primarily due to the fact that access to the pipe would be severely limited after the buildings were constructed which would diminish the ability of the Owner to maintain or repair the sewer.

It was decided to use the Danby lining system to rehab the sewer. This is a Grouted-In-Place-Liner (GIPL) which has proven experience in the U.S. for over 20 years and worldwide for over 25. This lining system consists of 12" wide PVC panels delivered to the site in 300 foot coils of the material. This is a man-entry system so the pipe needed to be dry. Access to the pipe interior was relatively good since there were existing manholes at the upstream and downstream limits of the rehab section. A new manhole about midway had previously been constructed. The installation contractor was Boyer, Inc. of Houston, Texas.

Anticipated Challenges

Although this was a relatively straight forward job, there were several challenges identified.

1. This was a very busy construction site with numerous subcontractors and trades working on different aspects of the overall job. This was primarily a building project and rehab of the existing storm sewer was just a necessary evil required to get the project approved. Therefore the rehab contractor was "Low Man on the Totem Pole" when it came to priority to access certain parts of the site. The lay down and work areas were greatly restricted.
2. The existing storm sewer discharged to the Potomac River through a flap gate. Due to a combination of age and debris, the flap gate did not seal well. This is common and is to be expected. However the tidal influence of the River resulted in 2 – 7 feet of standing water always being in the pipe.
3. Even medium size rains could cause the pipe to fill up with storm water with only 10-15 minutes warning.
4. There were no plans of the existing sewer but a limited inspection determined that the sewer was in relatively good condition and the curve had a Radius = 125± feet. The curve was partially a smooth radius and partially made of chords with angle points.

Site

The project site is at K Street & 4th Street SW a little less than a mile southwest of the Capitol.

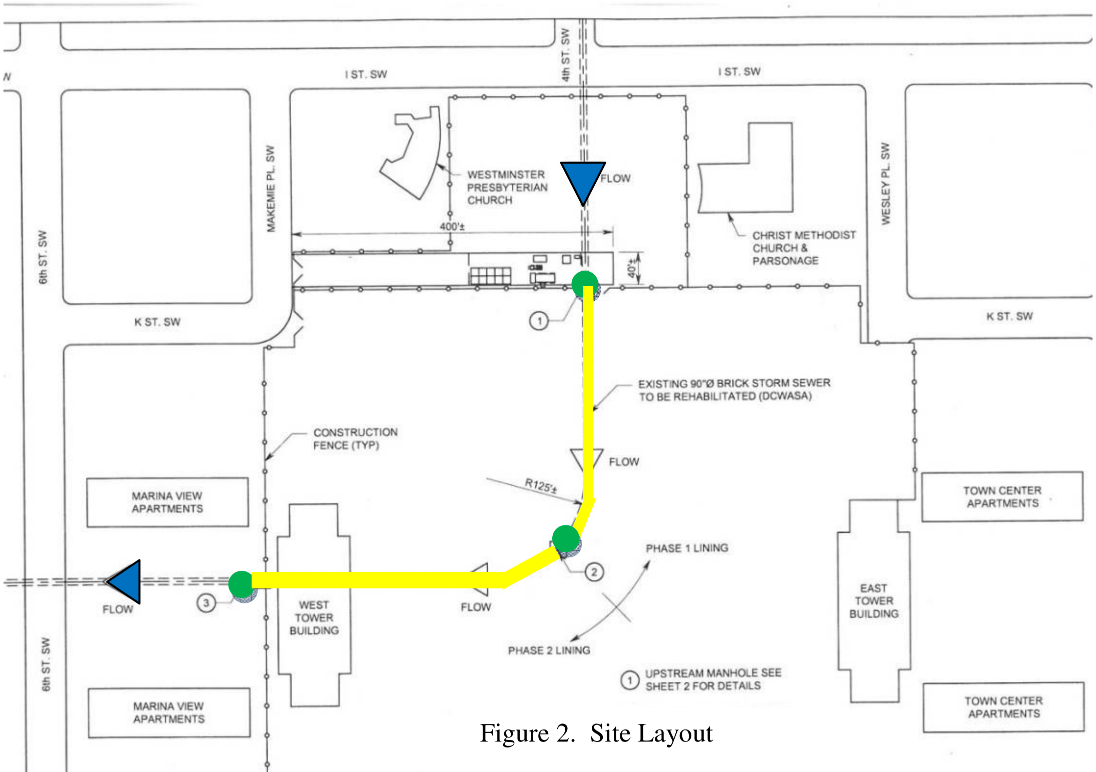

Figure 2. Site Layout

Figure 3. Existing Brick Sewer

Figure 4. Exist. Brick & Unreinforced Conc. Sewer

Pipe Preparation

The first order of business after mobilization and site move-in in mid July, 2009, was to control the tidal river backwater and the storm water flow. During the preliminary site investigation the depth of water in the sewer was measured at about 2 feet. It was discovered that this measurement was taken during an extremely low tide time. The actual depth of standing water in the sewer varied from 2 feet to as much as 7 feet. Several attempts were made to control this backwater using a large off-road construction tire tube and then a sand bag weir. The final decision was to use a fabric type inflatable pipe plug that was flexible enough that it could be rolled up and inserted through the manhole. The edges were reinforced and the plug chained to the top of the downstream manhole. This plug also served to prevent short-circuiting of the ventilation system. Even during dry weather there was a small base flow in the storm sewer. A small sand bag weir and submersible pump was installed at the upstream manhole which was piped to discharge at the downstream manhole.

After the river backwater and pipe base flow were under control and the ventilation system established cleaning of the sewer was accomplished. The debris in the pipe was mostly sand and silt with an occasional brick or piece of concrete dislodged during the installation of lateral pipes. About half the debris was removed manually using wheel barrows [Figure 5]. The remaining debris was removed using a jet rodder and vactor truck. In preparation for the lining, the walls of the sewer were cleaning using a high pressure water blast of 6,000 psi [Figure 6]. This removed any dirt, oil, grease, loose mortar, concrete, aggregates, laitance, or other contaminants. What remains is clean competent brick and concrete. There were 8 abandoned services and 1 groundwater leak that were plugged. Twice during the cleaning operation there were rain storms. Crews and equipment had to be quickly removed from the sewer and the downstream plug deflated. These events stopped the sewer cleaning for 6 days.

Figure 5. Debris Removal

Figure 6. High Pressure Water Blast

Liner Installation

In order to maintain the 3 inch minimum grout thickness, steel spacers (bolsters) are mounted on the pipe wall [Figure 7]. The 12-inch wide PVC panels come in 300 foot long coils. The liner is fed into the pipe through the manhole then pulled into position. The panels are spiral wound by connecting the adjacent panels with a Joiner Strip. The Joiner Strip is installed using a pneumatic Palm Hammer [Figure 8]. The end of the next coil is connected to the previous one with an “H” Strip splice. A steel buoyancy restraint angle is anchored at the bottom of the liner. Grout bulkheads are placed about every 400 feet using hydraulic cement. During the liner installation there were several times when storms necessitated evacuating the sewer and delayed the completion of the lining by almost 2 weeks.

Figure 7. Bolster/Spacer Installation

Figure 8. Spiral Wound Liner & Joiner Strips

Grout

The PVC liner panels besides being water-tight and corrosion-resistant are essentially the “form” for the high-strength grout. It is the cementitious grout that provides the structural rehabilitation of the pipe. The current state of stress of the existing pipe was determined through a finite element analysis and the minimum grout thickness was calculated using the Flexural Stress Cracking Design Method (Composite Material Design). The grout consists of Portland cement (57%), Fly Ash (43%), and water and super-plasticizer admixture. Although the design is based on a grout compressive strength of 6,000 psi, typically the tested 28 day strength is 7,000 – 9,000 psi. The grout will normally set-up in 4 – 5 hours (firm to the touch) and develop a compressive strength of more than 1,000 psi in 24 hours.

The cement and fly ash are premeasured and pre-mixed and delivered to the job site in 1,000 pound “Super Sacks”. The grout components (full sacks) are introduced into the Colloidal Mixer which uses a high shear pump and baffles to recirculate and thoroughly mix the constituents, which is done for 8 – 10 minutes. The grout mix is then transferred to the Agitator/Holding Tank. Water then the cement/fly ash blend is added to the Colloidal Mixer for the next batch. The grout mix remains in the Agitator/Holding Tank for up to 10 minutes where it is mechanically agitated to maintain the mixture in suspension. The grout is pumped through a progressive cavity pump into the pipe to the injection point. The grout is very fluid (18 – 25 second Standard Flow Cone).

The liner is grouted in 8 lifts of about12- inches each. Grout and vent holes are drilled in the liner about every 20 feet. The grout hose discharges into the grout hole and the mixture flows by gravity into the annular space between the liner panels and the host pipe [Figure 9]. When grout starts flowing out of the vent hole, the hole is plugged and the hose is move to the next grout hole [Figure 10]. The next grout lift is placed a minimum of 12 hours after the previous lift is completed.

Figure 9. Grout Injection

Figure 10. Grout Vent Hole

That is the sequence of operations if the work is progressing according to the Work Plan. In anticipation of the project, Boyer located a local supplier of cement products in the DC area. This was part of a large nation supply company. Boyer obtained samples of the cement and fly ash and tested these materials in Houston, Texas and the results were as required.

From Good to Bad to Worse

On the first day of the grouting operation, the grout flash set, which was never a problem on previous jobs. Initially we thought there was some problem with the pump, but the next day we found some rocks, pebbles and clumps of set-up cement in the mix. The mix is supposed to contain only cement and fly ash; no aggregates. We installed a screen at the transfer hose from the mixing to holding tank and started catching rocks, pebbles and cement clumps which was causing the hose to clog up. The supplier was informed of this problem and they promised to investigate. Once this problem was solved, random batches of the grout started flash setting. The grout is normally mixed for about 8 to 10 minutes in the colloidal mixer then transferred to the holding/agitator tank where it normally stays less than 10 minutes while it is being pumped out to the point of use. The grout normally sets-up (firm to the touch) in 4 to 5 hours and develops more than 1,000 psi compressive strength in 24 hours. On two separate occasions 5 batches had to be pumped out and wasted into a wooden box because of flash setting in the holding tank in 5 to 10 minutes. The supplier was again informed about this problem.

While grouting the 3rd Lift of the first section the liner buckled. The reason for this was the grout in the first and second lifts had not set, even after 36 and 12 hours respectively. This allowed the liquid grout in the upper lift to migrate downward where it exerted an excessive hydrostatic force on the lower sections of liner causing buckling. Because of the inadequacy of the grout and the buckled liner, the Contractor decided to remove the liner and grout installed for the first 300 feet. Testing of the defective grout showed that it did not meet our required strength requirements. New liner was reinstalled for that section. Removing the liner and grout was a tedious process that entailed cutting out the liner and then removing the hardened grout in pieces using a jack hammer.

The primary issue with the cement/fly ash blend was the inconsistency of material and apparent deficiencies in the QA/QC at the supplier’s plant. The initial mix supplier was given several opportunities to explain the reasons for the problems and correct the deficiencies. This was not accomplished to our satisfaction, therefore the supplier for the cement/fly ash blend was changed and the project did not subsequently experience any problems with the grout quality.

Conclusions

This project had many challenges, both expected and unanticipated. Between the grout problems, removal and replacement of liner and grout and 18 rain days, the job took twice as long to complete than was planned. However, the contactor was professional and did the right thing and corrected any shortcomings at his own expense even though the problems were caused by circumstances beyond his control. In the end, the Owner got a rehabilitated 100 year old sewer whose service life has been extended for probably another 100 years. Sometimes construction projects don't progress as originally planned. Even though this job did not always go smoothly, the participants are very satisfied with the way problems were addressed and the resulting quality of the finished product. The Washington Builders Council selected this project to receive its Award for Craftsmanship for Sewer Rehab.

3. BLUE PLAINS INFLUENT SEWERS REHABILITATION

The sewer runs parallel to Interstate 295, starting at the Blue Plains Advanced WWTP and ending at the Anacostia River Siphon Structure [Figure 11]. The sewer runs underneath the Naval Research Center and Bolling Air Force Base which are extremely high security military facilities.

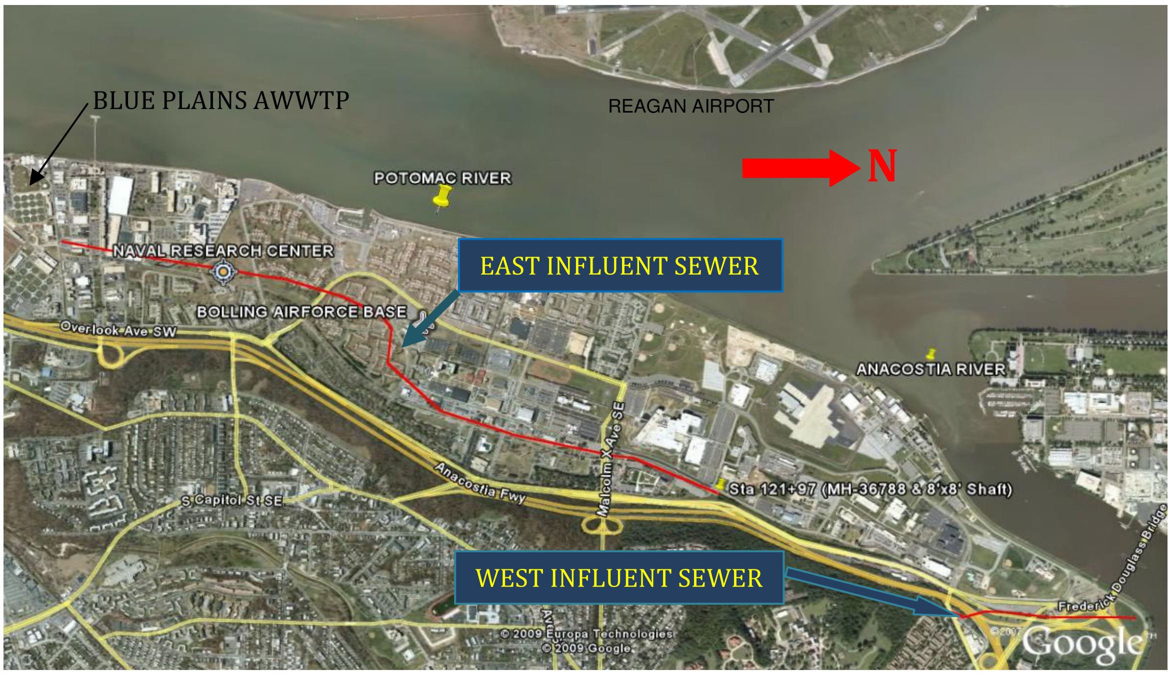

Figure 11. Site Map

Scope Of Work

Overall scope of work on this project consists of lining of the East and West Influent Sewer, Cleaning of the CSO outfall and North Interconnection Branch relief sewer and structural modification/rehabilitation of various structures. The sequence of operations is as follows.

- Modify structure 2, Clean CSO outfall structure, Rehabilitate/Modify west side of structure 4
- Swap flow from east to west influent sewer
- **Rehabilitate east influent sewer**
- Rehabilitate/Modify east side of structure 4
- **Finish rehabilitation of east influent sewer**
- Swap flows from west to the east influent sewer
- **Rehabilitate west influent sewer**

This paper will focus on the rehabilitation of the East and West Influent Sewers as shown in Table 1.

Table 1. Shape and Length of Various Sewers

Shape	Year	Description	Length (LF)	% Total
A	1934	10'-3" X 10'-3" Semi-Elliptical	5,225	35%
B	1939	9'-4"w X 8'-4"h Arch	6,980	47%
E	1962	9'-4"w X 8'-4"h Box	1,185	8%
F	1960	9'-4"w X 8'-4"h Box with curved invert	1,100	7%
G	1946	7'-10"wX 7'-0"h Arch	150	1%
H	1966	11'-9"wX 7'-0"h Box (siphon)	90	<1%
I	1966	11'-0"wX 7'-0"h Box (siphon)	10	<1%

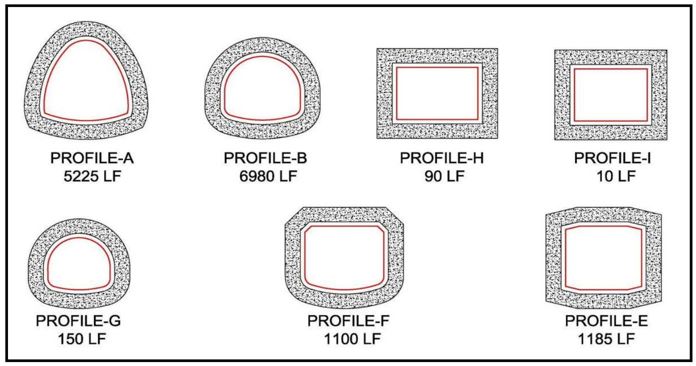

Figure 12. Shape and Length of Sewers (proportionally correct)

As can be seen from Table 1 and Figure 12 the project consists of seven different sewer shapes and sizes. The project also consists of various structures (Junction boxes) which also need to be rehabilitated. This paper will focus on the rehabilitation of the sewers using the Danby Grouted-In-Place liner system. The entire project is divided into two sections, the East Influent sewer and the West Influent Sewer. To rehabilitate the East influent sewer, the flow will be diverted to the West Influent Sewer and vice-versa. The East Influent sewer consists of the entire Type A sewer (5225 ft), majority of Type B sewer (6687 ft) and the complete Type H (90 ft) and Type I (10ft) which are a part of the structure 1 B. The West Influent Sewer consists of Type B (293ft) , Type G (150 ft) , Type E (1185 ft) and Type F (1100 ft). There are 11 transitions in the project. 4 transitions are located in the East Influent Sewer and 7 are located in the west Influent sewer. Each transition is 6-10 ft long and transitions from one sewer shape to another. There are 10 curves along the length of the sewer. Out of the 10 curves 3 are smooth radius curves and 7 are chord curves. 6 curves are located in the East Influent Sewer and 5 are located in the West Influent Sewer.

Design Requirements, Parameters And Methodology

As per the design requirements, calculations are based on a "partially or fully deteriorated" sewer condition. Following are some of the design parameters that were specified.

- Ground water is assumed to be at the surface
- Automotive vehicle loading of HS-20
- Building live and dead loads of 5000 pounds per square foot (psf) on a 6 foot wide continuous footing
- Soil lateral pressure represented by a fluid of equivalent weight of 30 pounds per cubic foot,
- Minimum 2-inches of concrete section loss around the internal perimeter of sewer with inside layer of steel missing
- Design Safety factor equal to or greater than 2.0.

It is the contractors responsibility to perform the design calculations for the lining system as per the given design loads and parameters and hence the contractor becomes the Engineer of Record for the sewer rehabilitation design.
To analyze the sewer in its existing deteriorated condition and newly rehabilitated condition, external and internal loads first had to be calculated. The external loads included vertical and horizontal pressures from the surrounding soil, ground water, and live loads from buildings, railroads, or trucks, and buoyant pressures on the pipe invert. Internal loads included pressures from the water within the pipe itself. A finite element analysis was performed for each sewer shape. These forces were all applied to a one-foot-wide slice of the pipe, with the pipe model broken apart into one-foot-long segments along its perimeter from crown to invert. The moments and thrusts on these members were then calculated and inputted into a spreadsheet that determined the stresses on the pipe in its various states of deterioration, and compared them to allowable stresses. Grout was then added or subtracted until the specified Factor of Safety (2.0) was obtained. The design compressive strength for the grout is 6000 psi. In summary the design calculations are performed to calculate the minimum grout thickness required to get the rehabilitated sewer to a F.O.S of 2.0. Calculations were also performed to determine if additional reinforcement is needed.

The rehabilitated sewer will consist of the PVC Liner which is essentially the form to hold the grout. The PVC liner is locked into the grout because of the embedded ribs. The Grout and existing sewer act together as a composite structure because of the shear bond developed between the grout and existing sewer surface. The grout is the structural component of this rehabilitation design. It consists of Cement, Fly Ash and Admixtures. The admixture is a Super Plasticizer. A retarder is added only if required due to unforeseen delays in the grouting operation. Although the design is based grout compressive strength of 6,000 psi, typically the tested 28-day strength is 7,000 – 9,000 psi. The Grout has a density of 122-125 lbs/cf, flow cone of 18-25 seconds and less then 1% shrinkage.

Condition of Existing Sewer

This project is a structural rehabilitation of mostly 70-75 year old sewers that are in relatively good condition considering their many years of service. There is some interior surface deterioration of the concrete and some corrosion of the existing steel reinforcement, primarily at the crown of the sewer. However there is no evidence of structural distress or failure, no extensive cracking, and no displacement at cold joints. The bottom portion of the sewer shows essentially no deterioration which is common for most sanitary sewer systems.

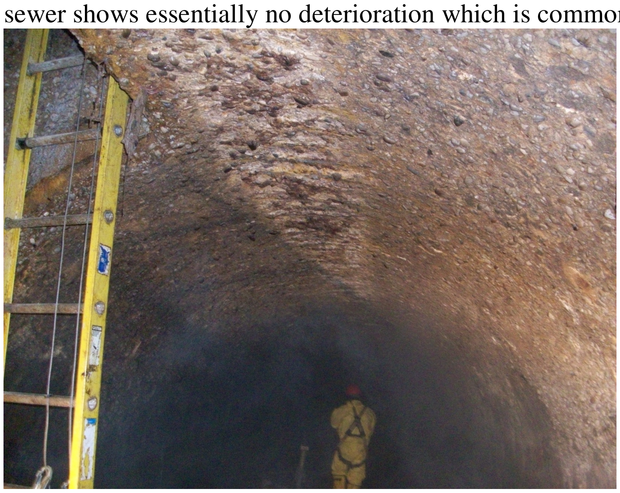

Figure 13. Deteriorated Crown

Figure 14. Brick Below Springline

Potential Challenges

1. Flow Diversion – Blue Plains Advanced Wastewater Treatment Plant is the largest *Advanced* Wastewater Treatment Plant in the world, with a capacity of 370 million gallons per day (MGD). Diverting this flow in order to rehabilitate the sewers and structure was a big challenge.
2. Access to the Jobsite – Since the sewers are located in high security areas like the Naval Research Lab (NRL) and Bolling Air Force Base, getting in and out of the jobsite for the crews and material delivery will be challenge because of the restricted work hours and increased inspection at the entry point.
3. Access to the sewer – Because of the location of the sewer, only 3 constructed access shafts are allowed along the entire 14,700 ft of the sewer. Primary access to the sewer is through the existing manholes and structures. The manholes are only 36” in diameter or 36” square and in some cases located as much as 1,700 ft apart.
4. Local Flows – All along the length of the sewer there are laterals coming into the sewer with live flow. There is no external bypassing allowed on the NRL and hence all the flow from the laterals in that area has to be by-passed internally. The internal bypass pipes can create additional difficulties to the lining installation.
5. Curves – There are 10 curves along the length of East and West Influent sewers. 3 are smooth radius curves and 7 are chord curves. 6 curves are located in the East Influent sewer and 4 are located in the West Influent sewer. These curves will require stretching the liner joint at the outside of the curves or field trimming the panels to fit the chord angle points.
6. Transitions – There are several locations along the length of the sewer where the shape of the sewer changes from one type to another. The change in shape is achieved through a transition. There are a total of 11 transitions to be rehabilitated in this project. 4 transitions are located in the East Influent sewer and 6 are located in the West Influent sewer. The transitions will be done with Shotcrete or field trimmed panels.

Sequence of Operations and Installation Procedure

There are three major steps:
Cleaning »» Liner Installation »» Grouting of annular space

Return to Index Search

Cleaning
Cleaning on this project is performed by the General Contractor. Cleaning involves removal of the initial heavy debris from the pipe and then hydro blasting the surface of the sewer with high-pressure water (8000-12000 psi) and then removing the debris generated due to the hydro blasting. The hydro blasting will remove any oil, grease, organic material, contaminants, laitance and loose cement, aggregates and mortar. The end result is a clean sound competent concrete and/or brick surface.

Liner Installation
Liner installation uses 12-inch wide PVC former strips and consists of Bottom Panel, the Curved Corner Strip and the Top Panel. The panels are locked together with a gasketed joiner strip. Following is the sequence of operations for rehabilitation using Danby Grouted-In-Place Liner system.

- Install bolsters/spacers to ensure the minimum grout thickness as per the design calculations. [Figure 15]
- Install reinforcement, only if required by the design calculations. [Figure 15]
- Install bottom panel and the curved corner strips. [Figure 16]
- Install buoyancy restraint angles for bottom panel. [Figure 17]
- Grout bottom panel and curved corner strip. [Figure 18]
- Install the top panel and bracing system for the top panel. [Figure 19]
- Grout top panel in lifts. [Figure 20]

After installing the bottom and top panel hydraulic cement bulkheads are installed every 300-400 ft. The maximum number of lifts that can be installed as per the specifications is 5 including the bottom lift. Once the grouting is complete, bracing and the buoyancy restraint angles are removed and moved to the next location. Figures below show step by step installation for lining and grouting.

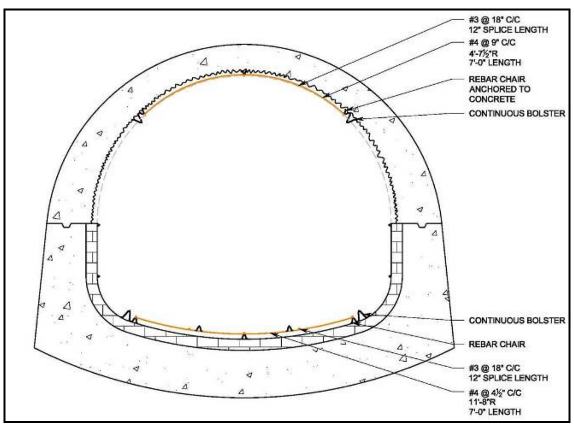

Fig.15. Install Reinforcement And Bolsters

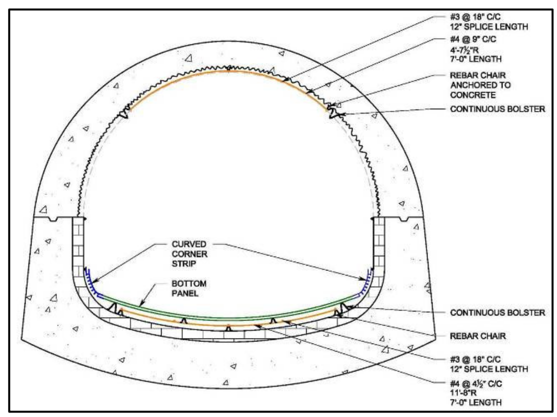

Fig. 16. Install Bottom Panel & Curved Corner Strips

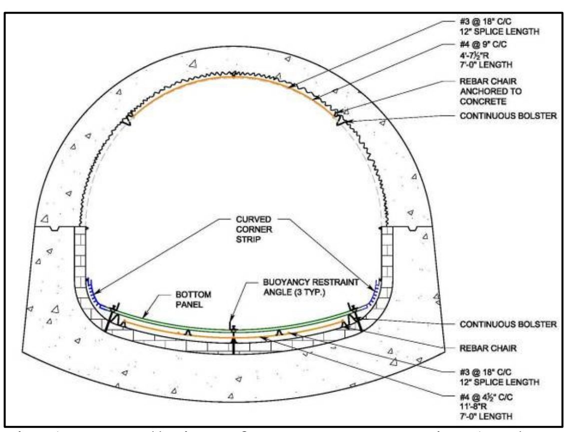

Fig. 17. Installation of Buoyancy Restraint Angles

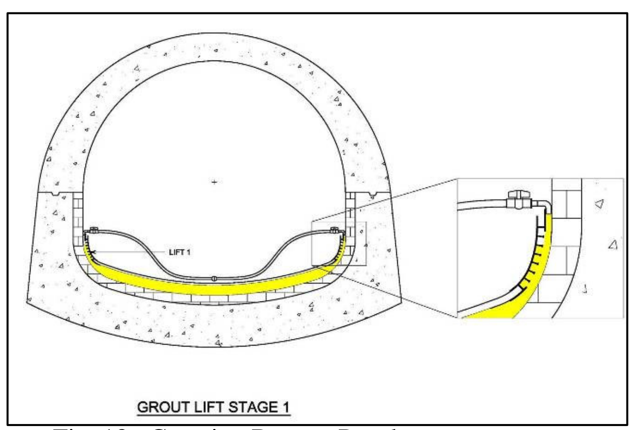

Fig. 18. Grouting Bottom Panel

Grouting
The cement and fly ash are pre-measured and pre-mixed and delivered to the job site in 2,000 pound “Super Sacks”. Each 2000 lb Super Sack is introduced into the Colloidal Mixer which uses a high shear pump and baffles to recirculate and thoroughly mix the constituents. The grout mix is then transferred to the Agitator/Holding Tank. While the grout is pumped into the sewer from the holding tank the next batch is mixed in the colloidal mixer. Each batch takes approximately 8-10 minutes to mix. The grout is pumped through a progressive cavity pump into the pipe to the injection point.

Hydraulic cement bulkheads are placed every 300 - 400 ft. The distance between the bulkheads is determined by the volume of grout that can be mixed and pumped in a day using the colloidal mixers. As shown in Figure 20 grout and vent holes are drilled in the liner every 20 feet. The grout hose discharges into the grout hole and the mixture flows by gravity into the annular space between the liner panels and the host pipe. When grout starts flowing out of the vent hole, the hole is plugged and the hose is move to the next grout hole. The mixed grout is very fluid (low viscosity) but will set up in 4-5 hours. Within 24 hours the grout will have a compressive strength of 2000-3000 psi and be ready to place the next lift. The next grout lift is placed a minimum of 12 hours after the previous lift is completed. As shown in Figure 20 grout and vent valves are used for the top lift instead of grout and vent holes.

The bracing system is installed to prevent the deflection/buckling of the liner due to the hydraulic pressure of the grout. The bracing will prevent the liner from deflection for more than 1/8” in the longitudinal and traverse direction. Figure 19, shows the conceptual bracing system that is planned to be use on this project.

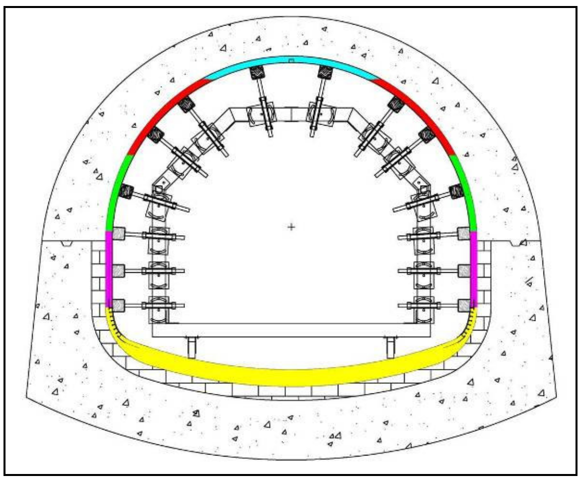
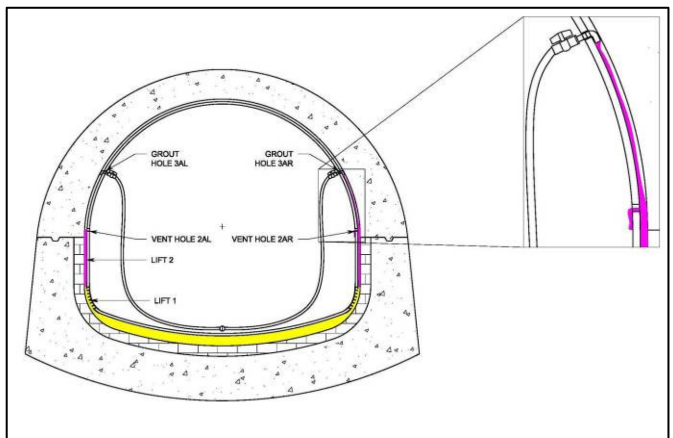

Fig. 19 – Installation of Top Panel Installation Of Bracing System

Fig. 20 – Grouting Second Lift

Due to the large size, and unique shape of the sewers the installation contractor built full size mock- ups to practice the lining and grouting operations. The mock-ups are of two out of the 7 shapes (Type A and Type B) which account for 83% of the total rehabilitation work. Before commencing work on the jobsite liner installation and grouting will be performed several times to achieve high installation production rates and get it right the first time on the jobsite.

Conclusions

Blue Plains Influent Sewers Rehabilitation is one of the largest sewer rehabilitation projects ($42,000,000) currently under construction. What makes this project unique and very challenging is the large size of the sewers (10’-3”x10’-3” and 8’-4”x9’-4”), the total length of sewer rehabilitation (14,700 ft), 7 different shapes to be rehabilitated, the location of the sewers under high security military facilities and high volume of flow diversion to gain access to the sewers. The General Contractor (USC) is working on the rehabilitation or modification of various structures. The flows were swapped in mid December, 2009 in order to gain access to the upstream part of East Influent Sewer. The flows were changed back due to the unusually high snow accumulations and subsequent run-off and then swapped again. The original plan was to start the lining installation in November, 2009 but the project has been delayed by several months. The current schedule is to start the lining around May, 2010. It is hoped to make a detailed presentation at No-Dig 2011 about the actual installation, challenges experienced and solutions devised.