Private I/I Reduction - Chapel Drive Pump Station No. 2 Service Area Rehabilitation

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ABSTRACT

Following the continuance of an effective, proactive asset management program, Jefferson County Environmental Services Department (JCESD) partnered with Hazen and Sawyer (Hazen) to assess the operation of the Chapel Drive No. 2 Pump Station (PS). The Chapel Drive No. 2 PS experienced periods after heavy rainfall when influent flows exceeded pumping capacity by nearly four times the designed capacity, resulting in sanitary sewer overflows (SSO's) from the wet well. Given the extremely high sewer flows, increasing the station's pumping capacity was not the most suitable approach. This prompted the need to reduce the infiltration and inflow (I/I) entering the station through comprehensive rehabilitation of the collection system. Since a large portion of the collection system already had mainline rehabilitation, Hazen evaluated the service lateral connections and private lateral piping.

KEYWORDS

Infiltration, inflow, private property, service lateral rehabilitation, pipeline rehabilitation, cured-in-place lining, asset management

INTRODUCTION

Jefferson County Environmental Services Department (JCESD) is responsible for the sanitary sewer system located in the City of Birmingham, Alabama and the surrounding municipalities throughout the county, covering about 436 square miles. The service area contains 9 water reclamation facilities (7 major, 2 minor) to treat the flow from about 3,138 miles of gravity sewer, 176 pumping stations, and 95 miles of force mains. Many of these assets were acquired under consent decree in December 1996 with no compensation to the county. Prior to the consent decree, JCESD only owned and maintained the major trunk sewers and all the water reclamation facilities (WRF) in the county, while the municipalities owned their local collection systems and pump stations. As a result of the consent decree, sewers from twenty-one municipalities became the full responsibility of JCESD.

Assessment and limited rehabilitation of the sewer system totaled $2.4 billion between 1996 and 2006, including major WRF capacity and conveyance improvements. An aggressive sanitary sewer evaluation survey (SSES) led to over 3 million linear feet of cured-in-place pipe (CIPP) lining and nearly 400,000 linear feet of open cut replacement. Even with this work, JCESD still has collection system areas with significant infiltration during rain events. A primary goal of Hazen's asset management program is to address recurring wet-weather SSO's. Through the development of detailed collection system flow models and capacity assessments, target areas have been identified. The Chapel Drive No. 2 PS ranked high in this prioritization due to the frequency and amount of the SSO's, the relatively small collection area, and the high estimated cost of increasing the station's pumping capacity.

CHAPEL DRIVE NO. 2 PUMP STATION DESCRIPTION

The Chapel Drive No. 2 PS is located in the city of Hueytown, Alabama in northwestern Jefferson County just outside Birmingham. The station began operation during the late 1960s and the service area is primarily residential. The 8-inch influent gravity sewer for Chapel Drive No. 2 PS receives flow from the Chapel Drive No. 1 PS and the surrounding areas currently served by gravity sewer. This station is located within the Valley Creek Drainage Basin, which flows to the Valley Creek WRF. The station pumps into a single 4-inch diameter force main that is approximately 1,020 linear feet long. The force main discharges to an 8-inch diameter gravity sewer. The location map for Chapel Drive No. 2 PS can be found in Figure 1.

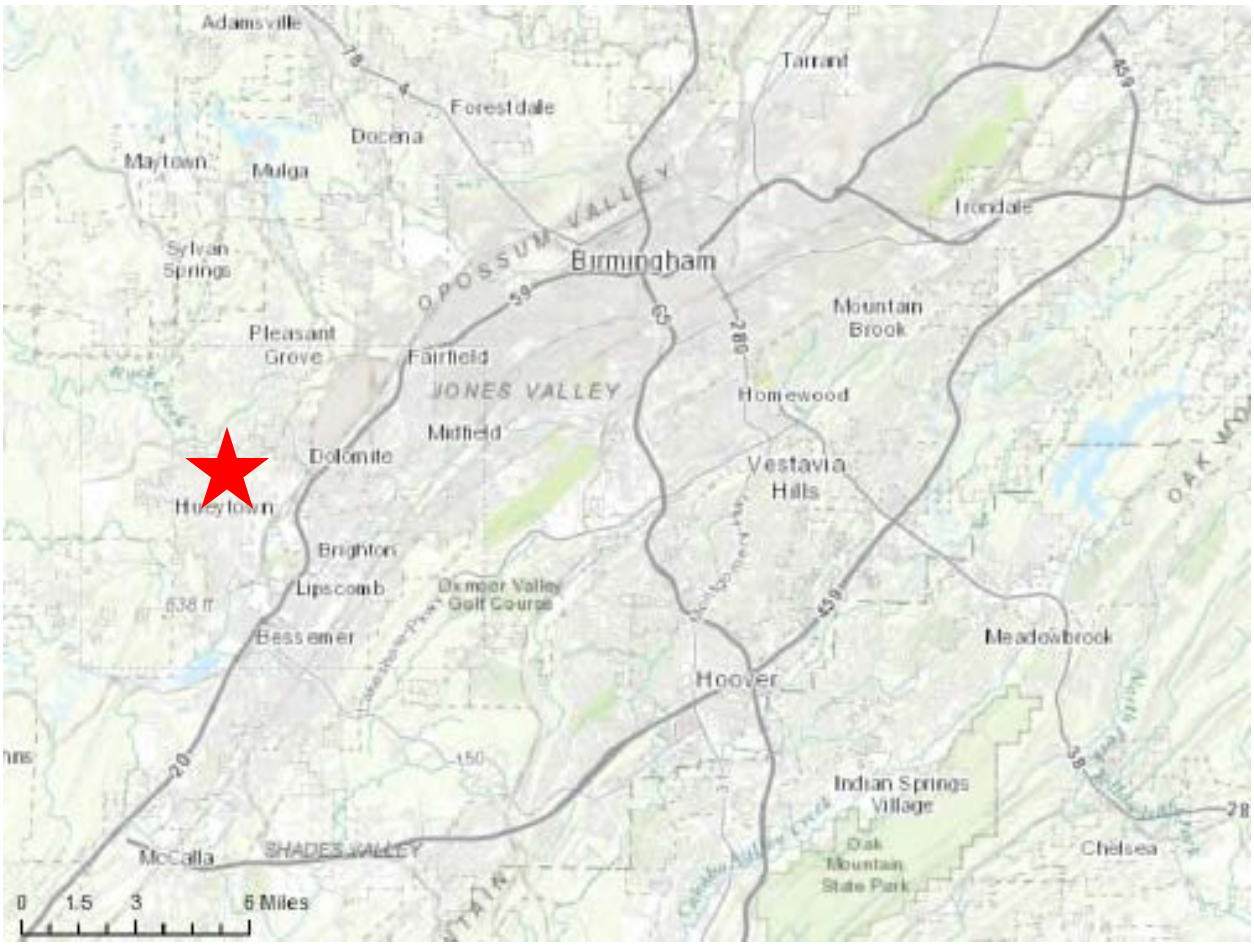


Figure 1. Location Map for Chapel Drive No. 2 PS

The station includes two Smith and Loveless 7.5 horsepower pumps in a dry pit/wet pit (flooded suction) configuration. The design capacity is 120 gpm at 84 feet of total head. The station is located along an access drive between residential houses and a drainage ditch.

After heavy rainfall, the station had periods when influent flows exceeded pumping capacity, resulting in SSO's from the wet well. An auxiliary diesel pump was temporarily installed at the

PS to alleviate or reduce the number of surcharged wet well events during high flows until upgrades could be made. The temporary pump redirected flow to the existing 4-inch force main.

PUMP STATION CAPACITY

Hazen evaluated the PS to determine if it had the pumping and emergency storage capacities to meet the flow demands. Average Dry Day Flow and Peak Wet Weather Flow estimates (2-yr, 24-hr storm) were derived and used to make the pumping and storage capacity determinations. Peak Station Capacity was determined from drawdown test results with all pumps operating at each station. Firm Station Capacity is based on the average flowrate calculated from the drawdown test results with the largest pump at the station out of service. The flows used in the evaluation for the Chapel Drive No. 2 PS are presented in Table 1.

Table 1. Influent Flow Summary for the Chapel Drive No. PS

Avg. Dry Day Flow (gpm)	Peak 2-yr, 24-hr Storm Flow (gpm)	Peak Station Capacity (gpm)	Firm Station Capacity (gpm)
21	390	97	84

In this assessment, Firm Station Capacity needs to meet or exceed Average Dry Day Flow and Peak Station Capacity needs to meet or exceed the Peak 2-yr, 24-hr Storm Flow.

The next step in the capacity evaluation was to determine whether the station could provide at least two hours of response time before an SSO occurs should the station suffer an onsite mechanical or electrical failure. These types of problems would not be resolved by an onsite generator. An example of such an event is the loss of both pumps at a duplex station. The two-hour period was determined to be a reasonable amount of time for JCESD staff to respond and repair the failed equipment or bring standby pumping equipment to the station. The options to avoid an SSO under this situation are: store flows with an emergency onsite storage tank or equip the station with a backup (diesel or natural gas) pump capable of handling the flows.

Average Dry Weather Day Flow rates were typically used to calculate the amount of time the station has until an SSO occurs. In areas that are more sensitive such as near hospitals, schools, and waterways, the highest wet weather flow rate was used in these calculations. The wet well size and available depth were determined from the information collected during the drawdown testing and from JCESD. The storage volume capacity of the wet well was calculated from the elevation of water with all pumps turned off at one foot below the top of wet well, or an upstream manhole if the manhole top is lower than the wet well. The goal is to keep flow from leaving the system if the pumps stop operating either by using available wet well volume, an emergency storage tank or standby pumping.

The information in Table 1 indicates that the Firm Station Capacity of the Chapel Drive No. 2 PS is above the Average Dry Day flow, but the Peak Station Capacity is substantially below the peak 2-yr, 24-hr wet weather storm flows. The average total pump daily run times each month during 2015 provided by JCESD indicated a range from 3.07 hours to 24.84 hours. This indicated periods of excessive flows at the station and exceeded the JCESD Capacity Assurance

Program limit of 16 hours. The high flows indicated heavy infiltration and inflow (I/I) existed upstream of the station. Based on the modeled storm flows, the Chapel Drive No. 2 Pump Station's capacity would have to be increased to approximately 400 gpm to accommodate the peak wet weather flows. The increase in pumping capacity would also require installing an additional 4-inch diameter force main to keep peak flow rates close to 5 feet per second. Upsizing approximately 4,500 linear feet of the gravity sewers would be also be required to accommodate the flow.

Since the Chapel Drive No. 2 PS is located next to a creek, the emergency storage time of the pump station was calculated under the criteria using the larger Wet Weather Storm Flows. With the wet weather flow rate of 390 gpm (561,000 gpd), the station had only about 2.4 minutes of emergency storage time. Under the criteria of storing flows for a minimum of two hours, the Chapel Drive No. 2 PS did not have adequate storage for emergency conditions. To meet the two-hour requirement, 46,750 gallons of storage or standby pumping would be needed at the site. The improvements needed to add both pumping and storage capacities at this pump station were going to be costly. The option of eliminating the PS was also explored but soon exceeded the cost of the station upgrades. Therefore, it was determined that sewer rehabilitation work should first be performed to reduce the upstream I/I while also reducing the overall costs of future pump station upgrades.

COLLECTION SYSTEM EVALUATION

The first step was to completely assess the collection system. All the sewer mainlines were televised and the service laterals were launched to the approximate property line. The property line was usually indicated by a change in pipe type and/or a test fitting, and averaged about 15 to 20 feet in length from the mainline. Out of the 14,953 linear feet of 8-inch diameter mainline sewer, 3,844' (26%) was newer ductile iron pipe, 9,083' (61%) had cured-in-place (CIPP) previously installed, and 2,026' (14%) was vitrified clay pipe (VCP), as shown in Figure 2. JCESD knew they had an infiltration problem as indicated by over 60% of the system already having mainline CIPP installed. This, however, did not remedy the high amounts of infiltration shown at the pumping station. Also, all the manholes adjoining the CIP pipes had been previously coated with a rehab material and the manholes adjoining the ductile iron pipe were new concrete.

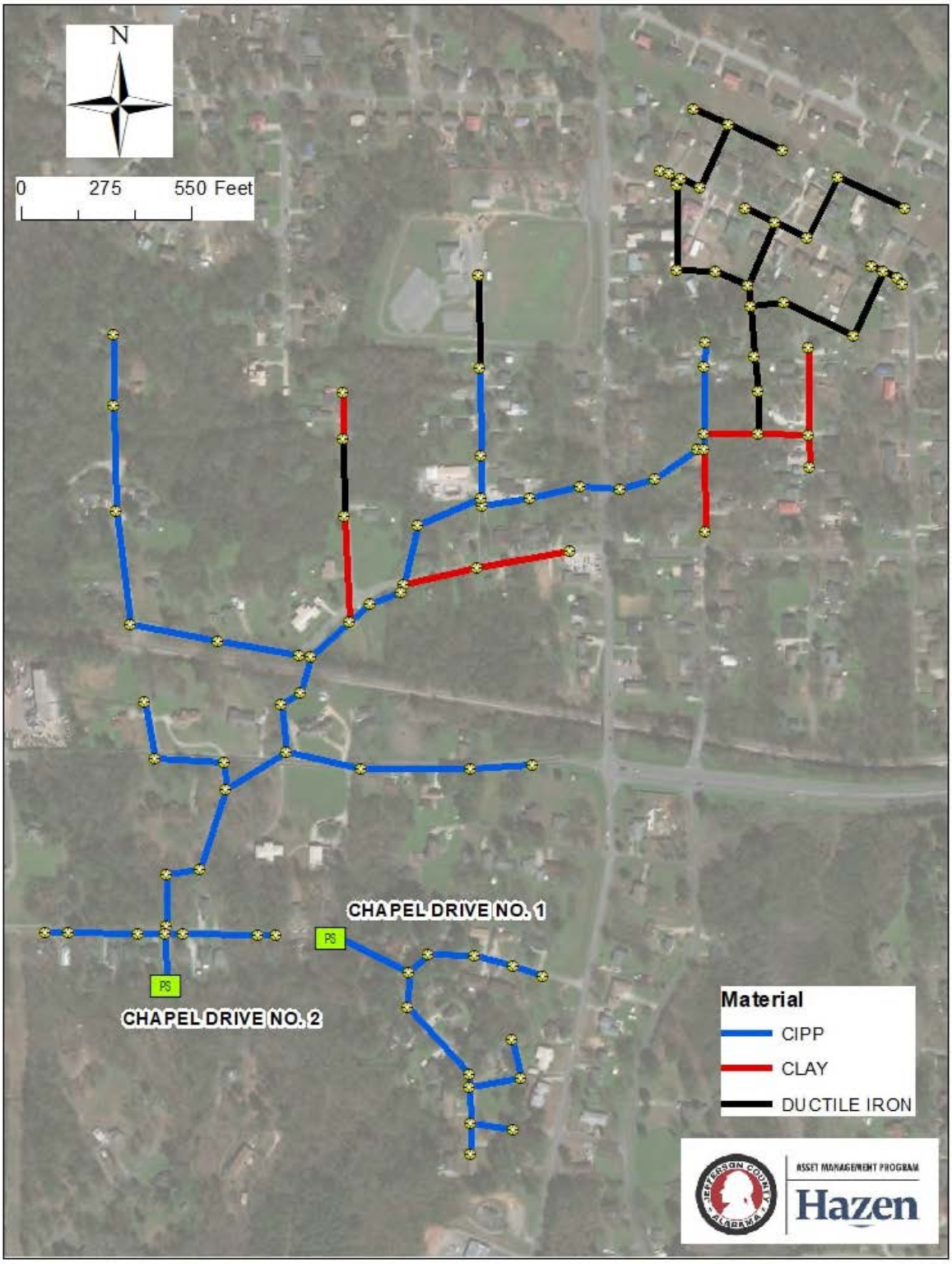


Figure 2. Chapel Drive No. 2 Collection System Pipe Type

Television inspection of the Chapel Drive No. 2 collection system identified 189 service lateral connections to the mainlines. Twenty-five (25) lateral connections were found on the newer DIP mainline that did not require attention. One hundred (100) laterals or 53% of these were inactive. This inactivity was mainly due to service laterals being installed during initial construction to vacant lots in anticipation of development or houses currently served by septic tanks. Most of the lateral launch inspections showed active leaks.

Lateral launch television inspections were performed using a self-leveling radial view camera with electronic locating technology launched from the mainline up the service connections. Cleaning of the lateral pipe was sometimes necessary to complete the inspection. All inspections were coded using PACP (Pipeline Assessment Certification Program) coding developed by NASSCO (National Association of Sewer Service Companies). Once the inspection reached the property line, an above ground location was noted and recorded. For this project, a clean out was to be installed on all active service lateral connections at the property line to allow for low pressure air testing after rehabilitation or replacement. Figure 3 is an inspection photo showing the location of the proposed clean out as shown by the traffic cone. Measurements were recorded to be able to reproduce this location at the time of construction.

Figure 3. Lateral Launch Inspection Photo Marking the Clean Out Location

REHABILITATION METHODS

The approach for rehabilitation of the mainlines was straightforward. CIPP would be installed in all VCP pipes; the DIP pipes did not require rehabilitation at this time as it pertains to infiltration. The DIP is however cement lined and is susceptible to future corrosion. The remaining 11 manholes with adjoining CIPP (existing or scheduled) would also be scheduled for rehabilitation.

The inactive services were divided into three categories: inactive services on VCP mainline, on previously lined CIPP mainline, and on previously lined CIPP mainline with an older brim style lateral rehabilitation product. The brim style product was installed as a part of a previous project. The inactive services on VCP would simply be lined over during the installation of new mainline CIPP and not reinstated. Inactive services on previously lined CIPP mainline would receive a thin cured-in-place sectional patch (spot repair), typically 3 to 5 feet in length, to cover the hole. The services with the existing brim style lateral rehabilitation would require excavation. Installing a spot repair was not an option due to the buildup of two layers inside the pipe. These laterals were excavated, re-sealed to the existing mainline CIPP, and then capped about one foot from the mainline. Table 2 gives the service count for each category.

Table 2. Inactive Service Lateral Connections by Mainline Pipe Type

VCP	Previously Lined CIPP	Previously Lined CIPP w/brim style rehab
19	62	19

After addressing the 100 inactive services, the remaining 89 active service laterals were then evaluated. These 89 laterals were divided into three groups. The 25 services located on the newer DIP mainlines showed no signs of infiltration and therefore did not require any rehabilitation at this time. The remaining 64 services were divided into two types of rehabilitation. Major offset joints and general structural issues required that 19 be replaced by open cut excavation. Table 3 shows these services.

Table 3. Active Service Lateral Connections by Rehabilitation Type

DIP (no work)	Open Cut Replacement	Full Circle Lateral CIPP
25	19	45

The remaining 45 laterals were rehabilitated with a full wrap/360-degree one-piece service connection seal plus lateral CIPP. The average length of the lateral CIPP was 15 to 20 feet from the mainline to the clean out. Figure 4 shows the typical detail for the full wrap lateral CIPP from the mainline to a clean out.

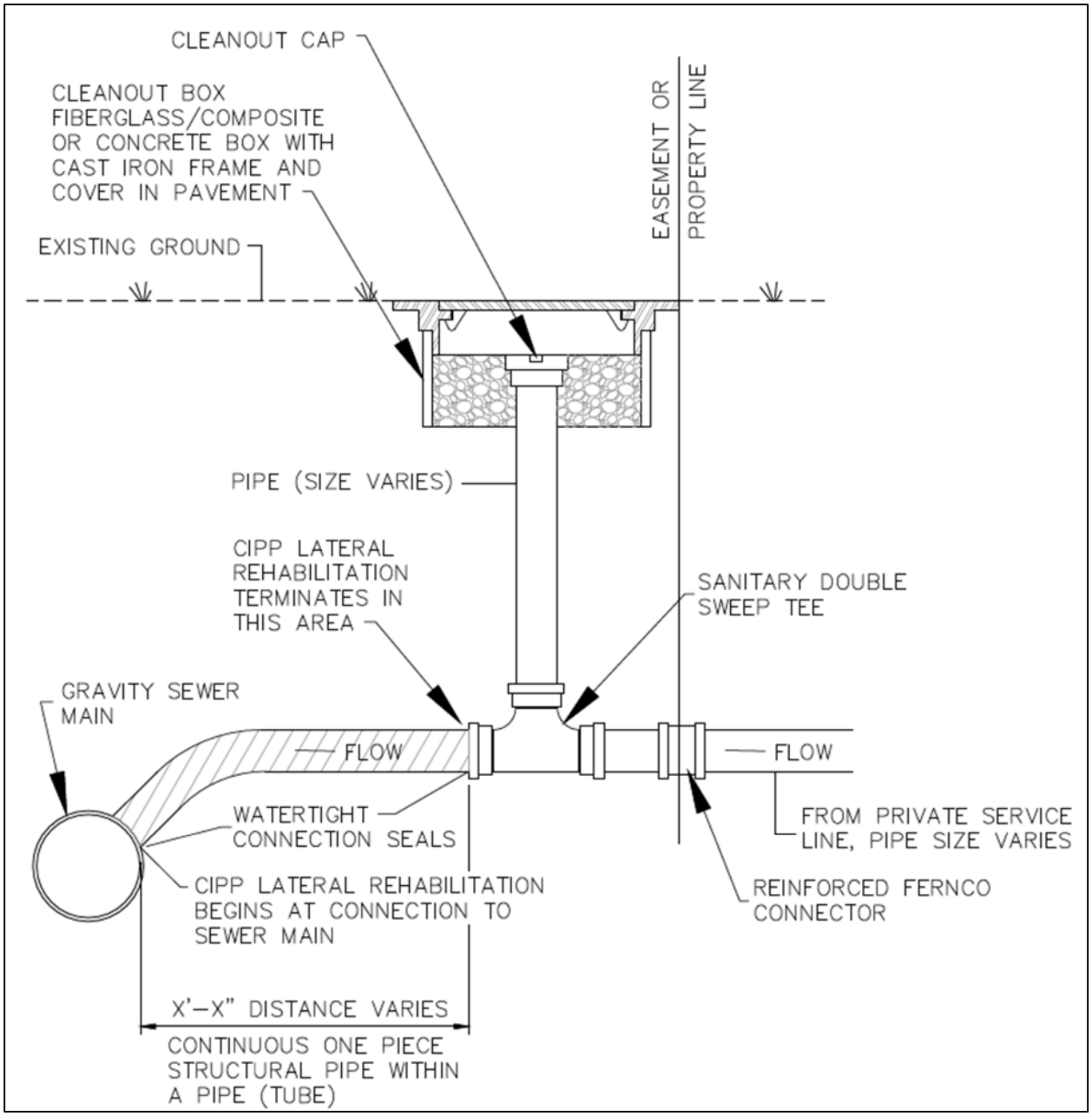


Figure 4. Typical Detail of Full Circle Lateral CIPP from Mainline to Clean Out

SUMMARY AND CONCLUSIONS

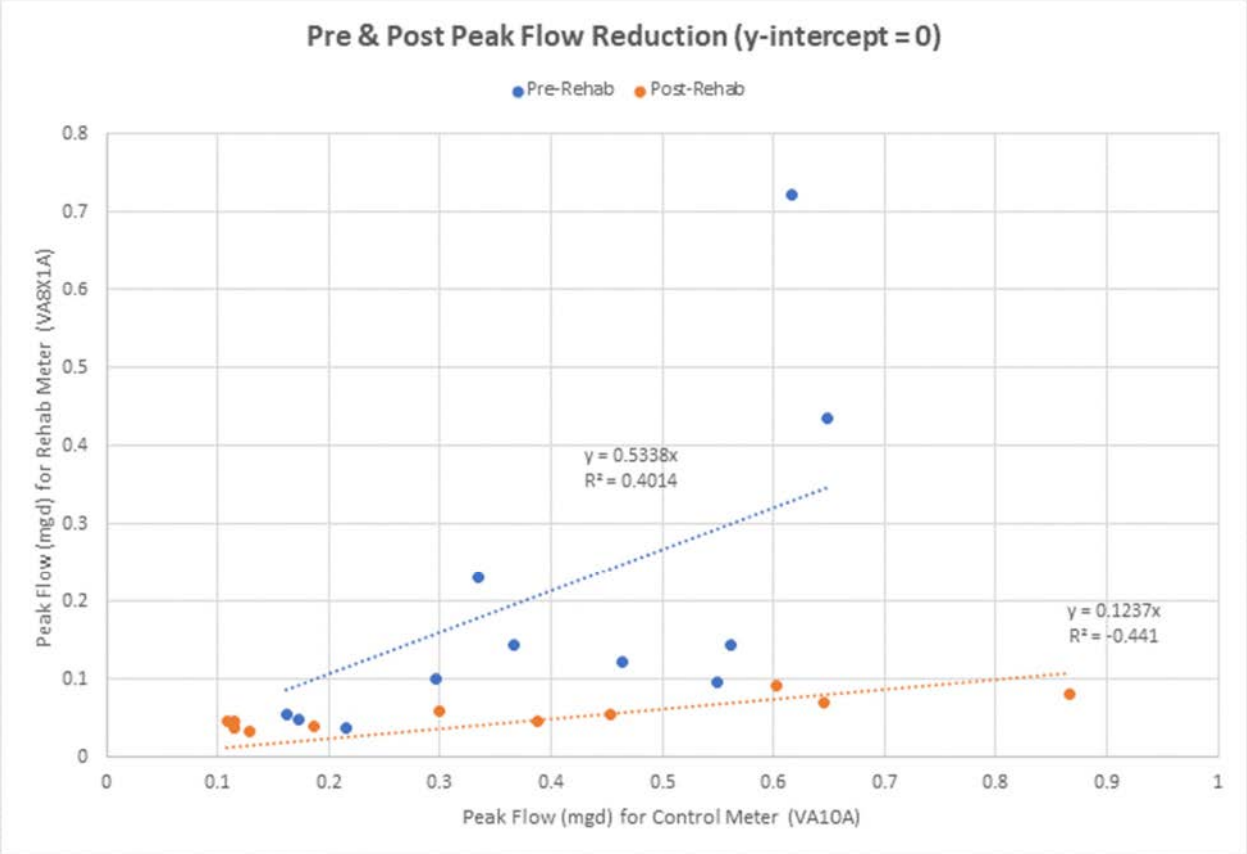
The Chapel Drive No. 2 Pump Station was being inundated with flow from infiltration and inflow causing multiple reoccurring SSO's. As assessment of the pump station and collection system resulted in needing to address the collection system first since upsizing the pump station to accommodate the observed flows was not practical.

The collection area consisted of approximately 15,000 linear feet of 8-inch diameter sewer and 189 service lateral connections. 86% of the mainlines had already been addressed with CIPP liner or were fairly new DIP. The remaining 14% (2,026 linear feet) of mainline required CIPP.

Inactive leaking services totaled 100 (53%), leaving 25 with no work required and 64 to be rehabilitated or replaced. Many of these sources of infiltration were eliminated primarily with trenchless cured-in-place liners.

The Chapel Drive Pump Station No. 2 Service Area Rehabilitation Project was completed in early Summer 2018. The initial post rehabilitation flow monitoring at the station is showing significant results, with a 90% reduction in volume and a 70% reduction in peak flow as shown in Figure 3.

Figure 3. Peak Flow Reduction



These results allowed for only very minor upgrades to be made to the pump station instead of the major upgrades initially described. JCESD has expanded this rehabilitation approach to at least three other similar pump station service areas. For all future mainline rehabilitation projects, the service laterals will be required to be launched to determine activity. All inactive service laterals will be lined over and all others will be documented for future rehabilitation projects as priority and funding allows.