HALLSDALE-POWELL UTILITY DISTRICT

CONSENT ORDER WPC14-0044

Corrective Action Plan

And Engineering Report

Prepared by Jacobs Engineering Group

March 5, 2015

Executive Summary

Hallsdale Powell Utility District (HPUD) has completed many improvements to its sewer collection system and its main wastewater treatment facility since the initial 2004 TDEC Commissioner's Order. Those actions have eliminated violations at the WWTP but sanitary sewer overflows (SSOs) continue at an unacceptable level. Therefore, the projects proposed in this Corrective Action Plan/Engineering Report (CAP/ER) are focused on improvements to reduce SSOs in the collection system.

The SSOs that occur presently are primarily caused by wet weather infiltration and inflow and the inability of the Beaver Creek Interceptor to handle the increased volumes of water. SSOs occur along the interceptor and at manholes adjacent to the interceptor when backwater conditions exist. There is no issue with the Beaver Creek Interceptor during dry periods. While continuing to pursue current improvement initiatives within the system, HPUD will implement a multi-faceted program to alleviate the issues associated with the interceptor. The key elements of this program will include:

- Replacement and upsizing the Beaver Creek Interceptor from the WWTP to Central Avenue
- Equalization storage in the collection system
- Continuation of inspection and assessment of the collection system
- Continuation of sewer rehabilitation to eliminate defects found
- Continuation of improvements to existing pump station facilities
- Expansion of collection system temporary flow monitoring

Projects will be phased over 10 years and grouped in 5 year periods. The first 5 year Early Action Projects will include:

- Design and initiation of construction of the Beaver Creek Interceptor replacement and rehabilitation project
- Design and construction of a 5 million gallon collection system equalization storage tank at Dry Gap Pike
- Completion of the initial Preventative Maintenance and Inspection (PMI) program and assessment of the collection system
- Continuation of sewer PMI program
- Continuation of sewer rehabilitation contracts to address defects found during the PMI program
- Continuation of improvements to existing pump station facilities

The second 5 year projects will include:

- Completion of the construction of the Beaver Creek Interceptor replacement and rehabilitation project
- An assessment of the efficacy of the Early Action Projects to determine the need for additional targeted collection system replacement projects and/or collection system equalization storage tanks
- Continued sewer PMI contracts
- Continued sewer rehabilitation contracts
- Continuation of projects to address efficiency and reliability at collection system pump stations

This approach eliminates the majority of SSOs in the first 5 years and allows HPUD to adapt their plan in the second 5 year period to do more of what has worked and address specific issues that are currently unknown.

Overall, this program will address the major issues contributing to SSOs and prepare the sewer system to handle growth for many years into the future.

Overview

Hallsdale-Powell Utility District (HPUD) Commissioner's Order 04-0242 has been superseded by Consent Order 14-0044 as of August 27, 2014. With the new Order's requirement for HPUD to reach compliance with its NPDES Permit by 2025, the Tennessee Department of Environment and Conservation (TDEC) required a Corrective Action Plan (CAP) and Engineering Report (ER) with associated implementation schedule to be submitted for review, comment and approval. As stated in the Order the CAP/ER shall include, at a minimum, a comprehensive plan necessary to meet compliance with the NPDES Permit through assessment and inclusion of population growth, pump station reliability, hydraulic modeling, GIS mapping, equipment, and operational procedures/staffing. Each of these items is briefly addressed in the following sections of this report.

The Beaver Creek WWTP improvements were completed under the previous Order and the WWTP is meeting its permit requirements.

The focus of this CAP/ER effort is to define collection system improvements to reduce SSOs, which the majority are wet-weather related and located along and/or adjacent to the Beaver Creek Interceptor.

Geographic Information System

Hallsdale-Powell Utility District (HPUD) began implementation and utilization of their sewer system Geographic Information System (GIS) in 2005. Since then HPUD has used their GIS as an effective collection system management tool. Its primary function is to maintain and update information on the collection system assets with location of defects, repairs, improvements, and SSO locations throughout the district. The time and effort invested to develop and maintain the GIS system has allowed HPUD to more efficiently operate the system as well as identify areas where improvement is needed.

Figure 1- Collection System SSO Location Map shows the location of the observed SSO events for the year 2014. It is readily apparent that the SSOs primarily occur along and/or adjacent to the Beaver Creek Interceptor and, with few exceptions, are the result of wet weather events where infiltration and inflow (I&I) overwhelm the collection system.

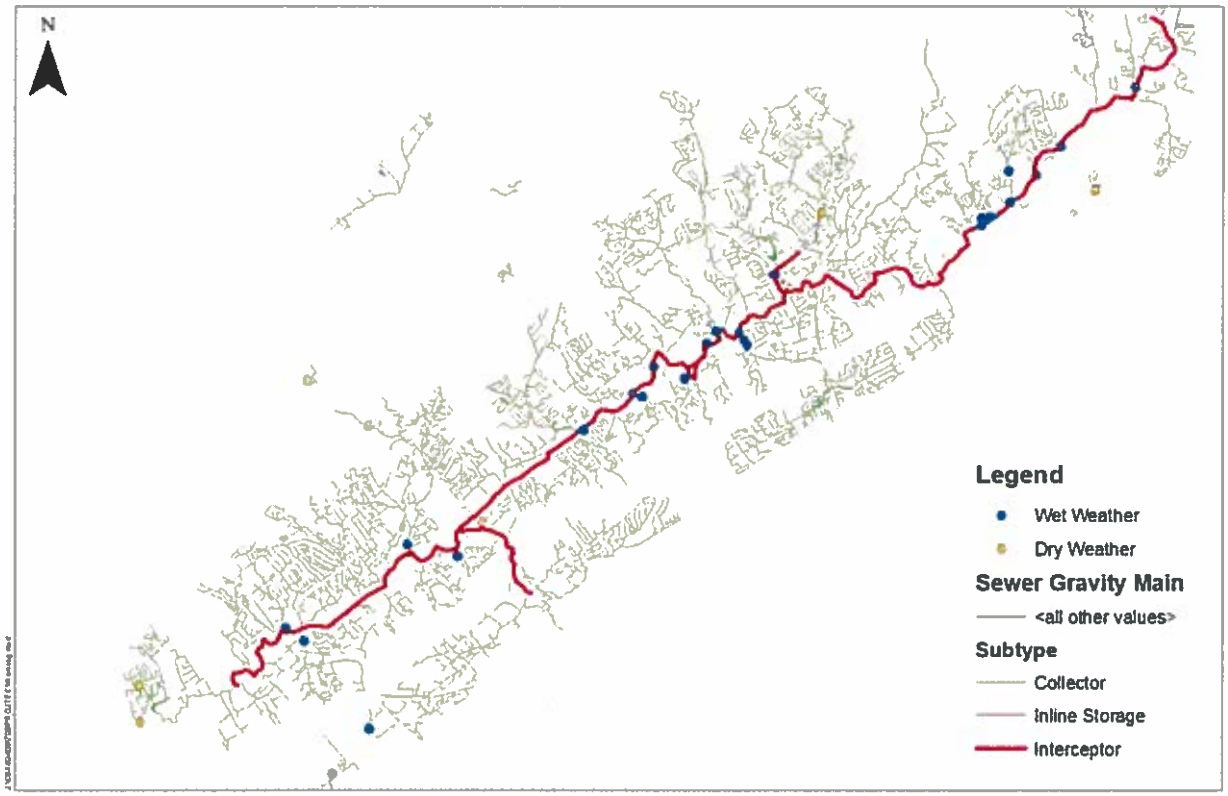


FIGURE 1 – Collection System SSO Location Map

HPUD has recently undertaken an initiative to more fully manage the GIS system data available to them from PMI and rehabilitation efforts. This data is in the process of being restructured to align with current industry standards, and is being integrated into HPUD's enterprise GIS. This will allow for more efficient analysis and reporting of inspection results, asset conditions, and rehabilitation progress. In addition, HPUD intends to modify their Standard Specifications for issue to Consultants and Contractors for the purpose of ensuring uniform inspections data per industry standards and allowing for seamless import into their enterprise GIS.

Pump Station Reliability

The Hallsdale-Powell Utility District collection system currently includes 20 sewer pump stations. In preparation of this comprehensive plan, each of the system's pump stations were inspected and evaluated. Evaluations were based upon site conditions, facilities and equipment.

The recommended improvements cited during the pump station site inspections primarily focused on adding additional lighting and security. However, five facilities were involved in either a dry or wet weather SSO event in 2014. Schaad Road Pump Station experienced two wet weather SSO issues, with Barrington, Schaad Park, Mountain Shadow and Brushy Valley Pump Stations experiencing one dry weather issue each. Collectively, there are no critical issues which require immediate attention, but in line with HPUD's existing intentions; there is need for miscellaneous pump station improvements.

In the case of most of the pump stations not mentioned above, minor improvements could be scheduled over the next several years as opportunity presented itself. With regards to the named facilities, the dry weather SSOs were attributed to mechanical and instrumentation failures including a lightning strike at one of the sites. These issues have been addressed by HPUD and also included beginning the process of adding generator receptacles and bypass connections to better mitigate power failures in the future. The two wet weather SSOs at the Schaad Rd Pump Station were attributed to higher than normal flow conditions caused by I&I within the collection system. HPUDs current rehabilitation program is aimed at correcting these issues.

As summary of each site visit and an accompanying Pump Station Reliability Table is provided in the next section of this report. A system map of the Pump Stations is provided in the Appendix.

Pump Station Assessment and Recommendations Summary

As was mentioned above, each of the system's pump stations were inspected and evaluated. A summarization of each evaluation is provided in the following sections.

Barrington Pump Station

Location/Site Observations

This pump station is located adjacent to Emory Road, near Barrington subdivision. The station is protected from unwanted entry by a cable secured between two bollards. The station itself is located on a dirt access road next to Beaver Creek inside a brick veneer concrete block building. There is municipal water onsite for any washdown activities that may be required. No signs of grease present in wetwell, which

would normally be seen from residential customers connected to station. The station contains two Gorman-Rupp suction lift pumps.

Electrical and Instrumentation

The station is controlled by a level transmitter with redundancy from two float switches. All electrical components appear to be in working order. Climate control in the station is provided by the built in wall heater and exhaust fan which are thermostatically controlled. There were no visible alarm lights or indicators of faults. It is possible that an overflow at this site could go unnoticed for some time if not reported.

Recommendations

Provide safety cover for open wet well; replace failed pressure gauges; consider increasing security at station by installing fence around property, CCTV nearby influent lines for possible grease accumulation; install alarm light to alert pump faults; daily visual site checks.

Overall reliability of the station appears satisfactory.

Bell Place

Location/Site Observations

The pump station is located along Bell Campground Road. The station is surrounded by a gated chain link fence and has a security light overhead. The station contains two Homa submersible pumps. There were high grease levels observed at the site, but no major signs of grease reaching high elevations in the wet well. There is a bypass connection present onsite in the event of pump failure. There was no municipal water observed onsite.

Electrical and Instrumentation

The station is controlled by an ultrasonic level controller with redundancy from two float switches. All electrical components appear to be in good working order and manuals are present in cabinets.

Recommendations

Periodic checks to grease levels and pumping out when necessary. Pump station does not appear to have any major issues. Consider adding municipal water connection for any washdown activities. Daily visual inspection recommended.

Overall reliability of the station appears satisfactory.

Blakewood

Location/Site Observations

The pump station is located along LaChrista Way, inside Blakewood subdivision. The station is located adjacent to the road and is not surrounded by a fence. There is a creek nearby as well as a KUB sewer main running immediately next to the wetwell. The site lighting is provided by a nearby street lamp, although does not appear to be sufficient lighting for maintenance activities. The pump station houses two Myers submersible pumps. There were high grease levels observed within the wetwell at the liquid level and up the walls. There is a not a bypass connection present onsite in the event of pump failure. The interior mounting brackets show signs of rust and corrosion. There was not connection visible to municipal water for washdown activities.

Electrical and Instrumentation

The station is controlled by an ultrasonic level controller with redundancy from two float switches. All electrical components appear to be in good working order and manuals are present in cabinets.

Recommendations

Periodic checks to grease levels and pumping out when necessary. Pump station does not appear to have any major issues. Daily visual inspection recommended due to close proximity to creek.

Overall reliability of the station appears satisfactory.

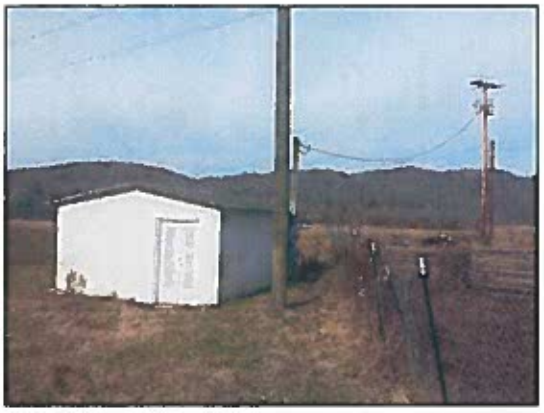
Bright Lane

Location/Site Observations

Pump station is located on Bright Lane, approximately 400 feet from the road and is not easily accessed by vehicle. The two Gorman-Rupp pumps are housed inside a concrete block building. The building is not fenced off and the doors are secured with a padlock and hasp. The only ventilation for the building is the

double louvered doors entering the station. There are no visible alarm lights at the station, which could cause a pump fault to go unnoticed.

Electrical and Instrumentation



Overall the electrical and instrumentation appears to be in working order. There are signs of corrosion on panels, gauges and piping, due to lack of ventilation.

Recommendations

Installation of ventilation; installation of visual alarm light visible from Bright Lane; daily visual inspection of site to decrease probability of pump fault going unnoticed for long period.

Brushy Valley

Location/Site Observations

The pump station is located on E. Brushy Valley Drive. The two Flygt submersible pumps are housed inside a precast concrete rectangular wet well. The site is fenced off with wooden fence panels which help to hide it from the nearby subdivision. The station has one alarm light; however it is mostly hidden by the wooden fence panels surrounding the station. There is municipal water provided for washdown activities located on site.

Electrical and Instrumentation

The station is controlled by an ultrasonic level controller with redundancy from two float switches. All electrical components appear to be in good working order and manuals are present in cabinets.

Recommendations

Consider increasing the elevation of the alarm light to provide better awareness of station fault; daily visual inspection of site; consider installing bypass connection port on site.

Overall reliability: Good

Campbell's Point

Location/Site Observations

The pump station site is located along Tazewell Pike in a prefabricated metal building. The station houses two Gorman-Rupp suction lift pumps. The rear building foundation is severely undermined due to adjacent drainage ditch. There is also the possibility of inflow and infiltration from the nearby creek. There are no visual alarms present at the station. Headroom and pump accessibility is limited inside the station. No bypass connection present at site. Municipal water for washdown activities was not observed at the site.

Electrical and Instrumentation

The station is controlled by a pressure transducer with redundancy from two float switches mounted above the wetwell. The electrical panels so some signs of corrosion, due to lack of ventilation.

Recommendations

Foundation repair and stream bank stabilization should be addressed immediately, provide adequate ventilation and lighting inside station, consider adding visual alarm signal, bypass connection and municipal water supply for washdown activities.

Overall reliability: Poor

Cantrell Heights

Location/Site Observations

This pump station site is located on the 4400 block of Cabbage Drive. It contains two Flygt submersible pumps inside a precast circular wetwell. The site is surrounded by a chain link fence and is easily accessible via an asphalt paved drive. There is no onsite lighting, which makes maintenance activities difficult at night. Municipal water is available onsite for washdown activities.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

No critical issues observed. Consider adding onsite lighting for safety and security; consider adding bypass connection if not already present.

Overall reliability: Good

Cherokee Ridge

Location/Site Observations

The pump station is located at the end of Wachese Lane and contains 3 Environment One submersible grinder pumps. The area surrounding the station is not fenced and municipal water is not present at the site. There is no onsite lighting at this station. This is a smaller station so a bypass connection is typically recommended. There is no visual alarm present at the station.

Electrical and Instrumentation

The control panels are in fair condition and appear to have no issues. The pumps are controlled by an internal pressure switch and has no back up level control.

Recommendations

Recommend providing fence and lighting around station to provide security and safety. Consider adding visual alarm to alert any station faults.

Overall reliability: Good

Childress Place

Location/Site Observations

This pump station site is located on Thebes Lane. It contains two Flygt submersible pumps inside a precast circular wetwell. The site is surrounded by a chain link fence and is easily accessible via an asphalt paved drive. There is onsite lighting nearby as well as a secondary power

receptacle. Municipal water is available onsite for washdown activities and a bypass connection is present.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

No critical issues observed. Some minor grease in wetwell, recommend observation and cleaning when necessary.

Overall reliability: Good

Copeland View

Location/Site Observations

This pump station site is located in Copeland View subdivision. It contains two Myers submersible pumps inside a precast circular wetwell. The site is surrounded by a chain link fence and is easily accessible via an asphalt paved drive. There is decent lighting at the site. Municipal water is available onsite for washdown activities.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by an ultrasonic level transmitter and floats as backup.

Recommendations

No critical issues observed. Water observed in valve vault, recommend grouting pipe penetrations and adding sump pump or drain.

Overall reliability: Good

McKinnon Ridge

Location/Site Observations

This pump station site is located on Tazewell Pike near the entrance to McKinnon Ridge subdivision. It contains two Flygt submersible pumps inside a precast fiberglass wetwell. The site is surrounded by a chain link fence and is easily accessible via a gravel drive. There is no onsite lighting. Municipal water is

available onsite for washdown activities. This is a fairly new station that serves only McKinnon Ridge subdivision.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

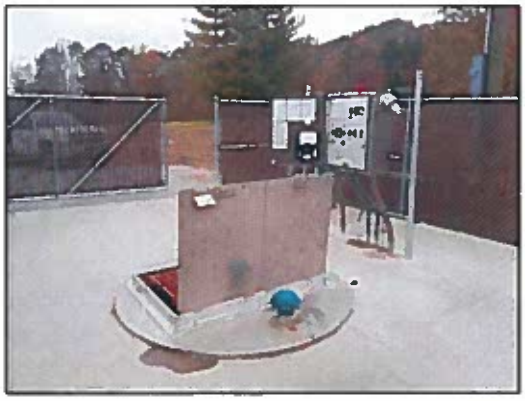
No critical issues observed. Water observed in valve vault, recommend grouting pipe penetrations and adding sump pump or drain. Consider adding lighting at the site for increased security and safety.

Overall reliability: Good

Mountain Shadows

Location/Site Observations

This pump station site is located on Tazewell Pike. It contains two Flygt submersible pumps inside a precast circular wetwell. The site is surrounded by a chain link fence and is easily accessible via a gravel drive. There is onsite lighting nearby as well as a secondary power receptacle. Municipal water is available onsite for washdown activities and a bypass connection is present.



Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

No critical issues observed. Water observed in valve vault, recommend grouting pipe penetrations and adding sump pump or drain.

Overall reliability: Good

Mynatt Road

Location/Site Observations

This pump station site is located on Mynatt Road. It contains two Flygt submersible pumps inside a precast circular wetwell. The site is currently not fenced and sits close proximity to the road. There have been bollards installed to provide protection from oncoming traffic. Municipal water is available onsite for washdown activities and a bypass connection is present. Heavy grease and rags observed in wetwell which cause clogging during high flows.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

Grease and rags should be addresses and monitored by daily visual inspections at the site. Recommend installing fence, additional bollards and lighting at the site to increase security and safety.

Overall reliability: Fair

Red Hawk

Location/Site Observations

This pump station site is located on Red Hawk Lane. It contains two Gorman-Rupp two-step suction lift pumps pumps inside a fiberglass reinforced plastic container, with very limited space for maintenance activities. The site is currently fenced and it easily accessible by a gravel drive. Municipal water is available onsite for washdown activities and a bypass connection is present.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

Consider adding additional lighting for safety and maintenance activities. Prefab FRP containers housing pumps and controls are extremely difficult to access, consider site built enclosure to protect pumps and controls from weather and make equipment more accessible.

Overall reliability: Good

Rosewood Estates

Location/Site Observations

The pump station is located at the end of County Rose Lane and contains 3 Environment One submersible grinder pumps inside a fiberglass reinforced plastic wetwell. The area surrounding the station is fenced and municipal water is not present at the site. There is no onsite lighting at this station. There is no visual alarm present at the station. High grease level were observed in the station

Electrical and Instrumentation

The control panels are in fair condition and appear to have no issues. The pumps are controlled by an internal pressure switch and has floats as a backup measure.

Recommendations

Consider providing lighting around station to provide security and safety. Consider adding visual alarm to alert any station faults.

Overall reliability: Good

Schaad Park

Location/Site Observations

This pump station site is located at the end of MW Park Drive. It contains two KSB submersible pumps inside a precast rectangular wetwell. The site is surrounded by a chain link fence and is easily accessible via a gravel drive. The onsite lighting is sufficient. Municipal water is available onsite for washdown activities and a bypass connection is present. This station also has an onsite generator as a secondary power source.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by an ultrasonic level transmitter and floats as backup.

Recommendations

No critical issues observed. Water observed in valve vault, recommend adding sump pump or drain. Occasional overflows at station appear to be due to collection system inflow and infiltration.

Overall reliability: Good

Schaad Road

Location/Site Observations

This pump station site is located on Schaad Road. It contains two Gorman-Rupp two-step suction lift pumps inside a concrete block building. The site is not fenced and is secured only by the locked double doors. The station is easily accessible by a gravel drive. Municipal water is available onsite for washdown activities. The existing wetwell shows signs of grease and debris buildup. The station showed signs of recent overflows, due to pump failure that has been repaired. The pumps show signs of corrosion, due to limited ventilation from the existing exhaust fan. Lighting inside the station is adequate, but could be improved. There is a pole mounted exterior light just outside the station.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

Consider adding additional lighting for safety and maintenance activities. Consider upgrading ventilation inside station.

Overall reliability: Good

Temple Baptist

Location/Site Observations

The pump station is located on Cruze Drive. The station contains two Homa submersible pumps located inside a precast concrete wetwell. The station is a safe distance off the road but is not fenced and has no onsite lighting. There is municipal water onsite for washdown activities. The wetwell shows signs of high levels and possible past overflows. There is a visual alarm located on the control panels

Electrical and Instrumentation

The station is controlled by an ultrasonic level transmitter with redundancy from two float switches. All electrical components appear to be in good working order.

Recommendations

Pump station does not appear to have any major issues. Consider adding a fence around the station and onsite lighting for increased safety and security.

Overall reliability: Good

Weaver Road

Location/Site Observations

This pump station site is located on Weaver Road. It contains two Flygt submersible pumps inside a fiberglass reinforced plastic wetwell. The site is currently surrounded by a wooden fence but offers a low level of security. Municipal water is available onsite for washdown activities and a bypass connection is present. The discharge valves are located inside the wetwell which makes them difficult to access for maintenance.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. Pumps are controlled by a level transducer and floats as backup.

Recommendations

Station is fairly new and appears in good order. Consider increasing security and safety with additional site lighting and different type of

fencing.

Overall reliability: Good

Yellowbrick

Location/Site Observations

This pump station site is located on Yellowbrick Way. It contains one Keen submersible grinder pumps inside a precast concrete wetwell. There is no guiderail system, which could cause pump to turn over. The pumps are located inside a prefabricated metal building with low head clearance and very poor lighting. There is no exterior lighting or fence surrounding the station. Municipal water is not available onsite for washdown activities and there is no bypass connection.

Electrical and Instrumentation

All electrical and control panels appear to be in good order. The single phase capacitors inside the panel could prove to be unreliable. Pumps are controlled by a level transducer and floats as backup.

Recommendations

Station is in need of upgrade/replacement. Consider adding additional pump, guide rail system or other method of securing pumps, upgrade interior and exterior lighting, add ventilation fan.

Overall reliability: Poor

Reliability Study Results Summary

Table 1 below, provides a summary of the observations made during the site visits to each of the Collection System's 20 pump station facilities. The majority of the items listed does not have a major impact on reliability, but will allow sites to be operated and maintained with greater ease and safety. Overall the reliability of the pump station network is very good.

Pump Station Reliability Summary Table

	Install/Replace Pressure Gauges	Install Sump or Drain in Vault	Grount Pipe Penetrations in Vault	Install Fence Around Property	Install/Upgrade Exterior Lighting	Install Visual Alarm	Add Municipal Water Connection	Install/Replace Exhaust Fan	Install Bypass Connection	Install Generator Receptacle/Connection	Install Additional Bollards	Upgrade Interior Lighting	Miscellaneous
Barrington	X			X	X	X							
Bells Place	X						X						
Blakewood	X												monitor grease levels
Bright Lane	X					X		X					
Brushy Valley	X								X	X			existing visual alarm is obstructed by wooden fence panels
Campbells Point	X				X	X	X	X				X	foundation repair and stream bank stabilization
Cantrell Heights	X				X				X	X			
Cherokee Ridge	X			X	X	X							
Childress Place	X												minor grease levels
Copeland View	X	X	X										
McKinnon Ridge	X	X	X		X								
Mountain Shadow	X	X	X										
Mynatt	X			X	X								install additional bollards; high grease levels, monitor daily
Red Hawk	X				X								consider replacing prefab FRP enclosure with site built structure for better accessibility
Rosewood Estates	X				X	X							
Schaad Park	X	X	X										
Schaad Rd.	X				X			X				X	
Temple Baptist	X			X	X								
Weaver	X				X								
Yellowbrick	X				X			X	X	X		X	station in need of replacement

TABLE - 1

Priority Recommendations

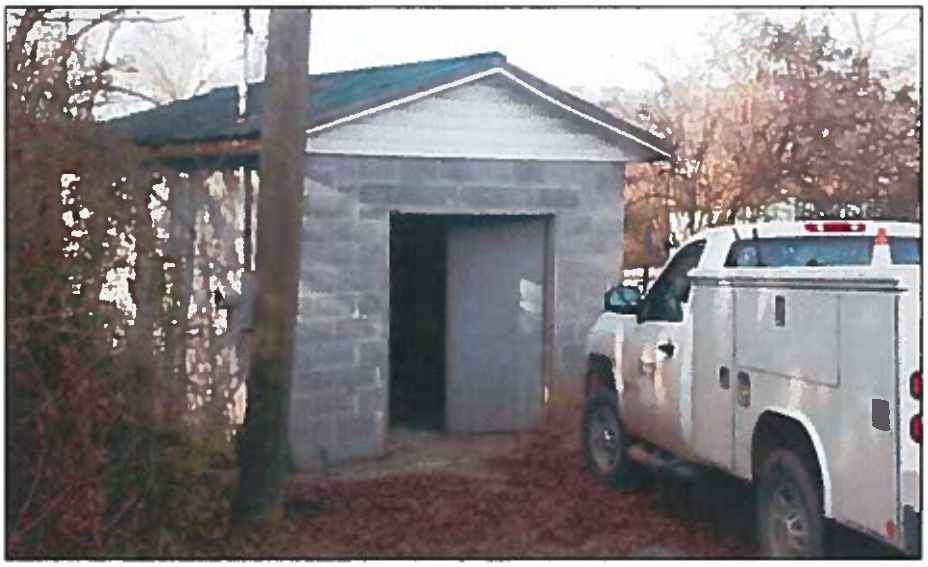
As was previously mentioned, the majority of the items listed in the Summary Table above does not have a major impact on reliability, but will allow sites to be operated and maintained with greater ease and safety. With that said, there are three facilities which have been identified as candidates for improvement due to lower than preferred reliability. Additional detail on these three priority facilities, Shaad Road

Pump Station, Yellowbrick Pump Station and Campbells Point Pump Station, is provided in the following sections.

Schaad Road

This station is currently at high risk for overflow events during wet weather. Under existing conditions the inflow and infiltration during wet weather along with the existing flow overwhelm the station. Efforts to reduce inflow and infiltration into the system will help to decrease this from occurring; however this is not an immediate solution.

This pump station currently discharges through 4,100 LF of 4-inch forcemain into a gravity manhole. The Blakewood Pump Station also enters this same 4-inch forcemain approximately 1,500 LF downstream of Schaad Road Pump Station at LaChrista Way. Under high flow volumes when these two stations are running concurrently, the Schaad Road pump station is overpowered by the increase in total dynamic head and the lack of storage in the wetwell results in sanitary sewer overflows.



Schaad Road Pump Station

It is recommended that the 4-inch force main be replaced with a 6-inch diameter forcemain from LaChrista Way to the discharge gravity manhole approximately 2,600 LF downstream. This would decrease the total dynamic head on the pumps and decrease the probability of sewer overflows when both pumps at Schaad Road and Blakewood pump stations are running. The existing pumps at Schaad Road would need to be evaluated to determine their new operating point and whether replacement is necessary.

Additionally, it is recommended that the wetwell at Schaad Road be increased to 6-foot diameter for increased storage volume. The existing wetwell is in poor condition and undersized for wet weather flows.

Yellowbrick

With only one installed pump at this site and the poor condition of the electrical and control system, this pump station should be a high priority for repair/replacement.

Yellowbrick Pump Station

The existing pump station site does not allow for any expansion in size and surrounding property owners have not indicated interest in discussing the sale of additional land to HPUD. The current building housing the pumps and controls is not reusable. This station could be replaced with a small duplex packaged pump station that would completely replace the existing site. This would provide much greater reliability and reduce future sanitary sewer overflows.

Campbell's Point

The foundation of this pump station needs to be remedied before erosion causes a major overflow into the adjacent creek. The slab that is currently cantilevered over the eroded bank appears to be in satisfactory condition. The foundation needs to be properly supported and the stream bank armored with larger stone to reduce future erosion.

The adjacent rear view photo of Campbell's Point Pump Station shows past erosion mitigation efforts via the placement of rip rap at the foundation. A small creek lies at the bottom of the photo just off image

Campbell's Pont Pump Station

Collection System Hydraulic Model

One of the tools utilized to develop Hallsdale-Powell Utility District's comprehensive plan was HPUD's collection system hydraulic model. With its launch in 2005, the HPUD collection system model has been periodically updated over the last 10 years to reflect the ongoing improvements to the collection system assets. Flow characteristics were calibrated by utilizing rainfall and flow monitoring information data. HPUD has nine permanent flow monitoring stations with three tipping bucket rain gauges currently in place. The most recent update and calibration of the model occurred in September of 2014.

The future wastewater collection system model was developed using the existing wastewater collection system model as a basis. The projected 2015 to 2025 growth rates were incorporated into the existing model's base flows by sewer basin to create a model of the system to represent the 2025 wastewater flow rates.

As further elaborated in the following sections, a 2 year- 24 hour storm event using a cumulative probability of occurrence of 50 percent distribution from the first quartile as defined by NOAA Atlas 14 for Knoxville, TN was used to evaluate system capacity. Several modeling scenarios relating to the incorporation of storage tanks, interceptor diameter increases, population growth, and RDII reduction were performed to assist in the development of the capital projects referenced in this CAP/ER.

Model Development

One of the objectives of this assessment was to update the HPUD collection system model in order to effectively evaluate HPUD's collection system capacity, and develop recommendations to alleviate SSO's as per Consent Order 14-0044 (CO). This section provides an overview for the development and calibration of the hydraulic model.

Model Inputs & Setup

The HPUD collection system model was first developed in 2005 as part of a Master Planning effort using the InfoSWMM hydraulic software developed by Innovyze. Since 2005, the model has been updated several times through InfoSWMM's ability to import and manage attribute changes from HPUD's GIS.

Model Network Attributes Update

The network attributes that make up HPUD's collection system model were updated to the GIS data provided by HPUD as of 10/09/2014. The model incorporates over 300 miles of sewers, 15 lift stations, and on outfall representing the Beaver Creek Wastewater Treatment Plant (WWTP).

HPUD also included data available from Preventative Maintenance and Inspection (PMI) and rehabilitation efforts in which Jacobs incorporated silt and other debris restrictions identified along the interceptor to provide a more thorough capacity analysis.

Sewershed Delineation

HPUD has developed hydrologic basins representing the areas currently served by the Beaver Creek WWTP. However, based on the location of the nine (9) long term flow monitors and the systems in which they are measuring data, the hydrological basins and the areas represented by the monitors do not match. For modeling purposes, the areas represented by the flow monitors and termed in this report as "flow basins" were used to allocate dry weather flow (DWF) and define contributory areas. Contributory areas are used in calculating volume of RDII, and are commonly a fraction of sanitary sewer basins. Since sewer basins are not directly defined, the contributory areas used in the model are arbitrary values.

Dry Weather Flows

Dry Weather flow is a term which is commonly used to account for Base Flow and Groundwater Infiltration; however, the distinction between the two is not necessary for RDII calculations. Due to the significance of the wet weather loadings from RDII, and available reserve capacity under dry weather periods, Jacobs decided further investigation into separation of DWF into base flow and groundwater infiltration was not warranted.

Base flow is comprised of sanitary flow from commercial, industrial, and residential flows. The base sanitary flows were distributed equally among upstream manholes within each respective flow basin. This methodology was incorporated so that every modeled pipe would have some level of base flow and allow a more stable model. The base sanitary flows were determined from a flow monitoring data analysis which is detailed below.

Flow Monitoring Analysis

For the flow monitoring analysis, flow and rainfall data from January 2014 to August 2014 was evaluated. Rainfall data was examined first to determine periods of dry and wet weather. DWF was identified from

the flow survey as periods of time where the antecedent moisture conditions indicated little to no rainfall for 7 or more days. Once these dry weather periods were identified, the periods were reviewed to eliminate days still under influence of large storms, or days where the data appeared to be a statistical anomaly. Once the final set of dry weather flow records were compiled, their average daily flow and diurnal patterns were determined. With average daily flows computed, unit dry weather flows by flow basin were developed through a mass balance review. The unit base sanitary flows were then allocated into the model.

Model Calibration

Model Calibration was performed in two parts: A Dry Weather Calibration and a Wet Weather Calibration. The dry weather calibration was primarily the result of the data input into the model for base flows. Based on the allocation of the base flows and computed time of concentration, diurnal patterns were adjusted to better coordinate with hourly minimum and maximum flows. In addition, depths simulated by the model were adjusted by altering pipe roughness coefficients (i.e., Manning's 'n' values) of the sewers until they were capable of replicating depths measured by the flow monitors.

Wet weather flow (WWF) calibration involved incorporating measured rainfall data and adjusting model parameters for overall volume and timing of RDII entering the sewer system to match monitored flows during particular storm events. Model parameters used to calibrate the model consisted of R-values, time to peak, and regression multiplier. R-values are the percentage of rainfall that enters the system, and is combined with contributory areas to determine total volume. While specific storm events of 01/11/2014, and 07/27/2014 were given priority, the model used extended period simulations over a range of storm events to ensure the validity of observed peak events and depths. In general, the Manning's 'n' values incorporated in the dry weather flows were able to replicate depths measured by the monitors during wet weather events. In a few isolated cases, in the upstream portions of the interceptor, the measured depths exceeded those predicted by the model. In some instances, pipe roughness coefficients associated with the DWF calibration results were revised to better match the peak WWF depth. In other cases, restrictions are believed to impact the full capacity of the pipe when flowing beyond typical DWF depths. The locations of these restrictions were not included in the model due to unknown location; however, the model is capable of replicating these depths by incorporating additional top of pipe restrictions. The model used for the capacity assessment did not incorporate the top of pipe restrictions, and assumed the restrictions would be removed through further inspections and maintenance. The R-values and contributory areas for January-Winter and July-Summer are presented in Table 2.

RDII Characterizations

Flow Basin	Contributory Area	January – Winter		July - Summer	
		R-Value	Initial Abstraction	R-Value	Initial Abstraction
HP01	957	0.70	Yes	0.32	Yes
HP02	158	0.50	-	0.13	Yes
HP03	308	0.85	Yes	0.15	Yes
HP04	224	0.35	Yes	0.10	Yes
HP05	248	0.60	-	0.06	Yes
HP06	376	0.68	-	0.10	Yes
HP07	272	0.45	-	0.07	Yes
HP08	150	0.35	-	0.05	Yes
HP09	236	0.35	-	0.05	No

TABLE 2

Once the model was accurately reflecting the flow monitored data, a general operations and maintenance (O&M) review was performed to determine the ability of the overall model to predict SSO's in the same vicinity as O&M records indicate. In general, the model was able to replicate SSO's in similar areas as data reported by HPUD along the interceptor; however, the model indicated some additional isolated SSO's.

The accuracy of the model is directly reflected in the amount and quality of data recorded in the flow monitoring program and inspection data. The flow monitors are currently located along the interceptor and large trunk lines, see Figure 2 on the following page. The location of the monitors indicates that the accuracy of the model is greater along the interceptor and trunk lines. In areas where the model appears to deviate from O&M records the deviation is expected to be due to local system conditions such as, an unknown MH lid type, an area in need of more accurate survey, or more specific calibration parameters. Additional flow monitoring and inspections are necessary to verify the validity of the model in localized areas.

Collection System Capacity Analysis

The updated and calibrated collection system model was used to perform the capacity assessments. The objectives of the capacity assessment included:

1. Identify locations and causes of hydraulic constraints,
2. Assess the Beaver Creek WWTP ability to accommodate/treat peak flows from RDII,

3. Assess how existing sewer system performance will be improved by planned rehabilitation and improvement projects,
4. Assess the performance of planned rehabilitation under future population growth scenarios.

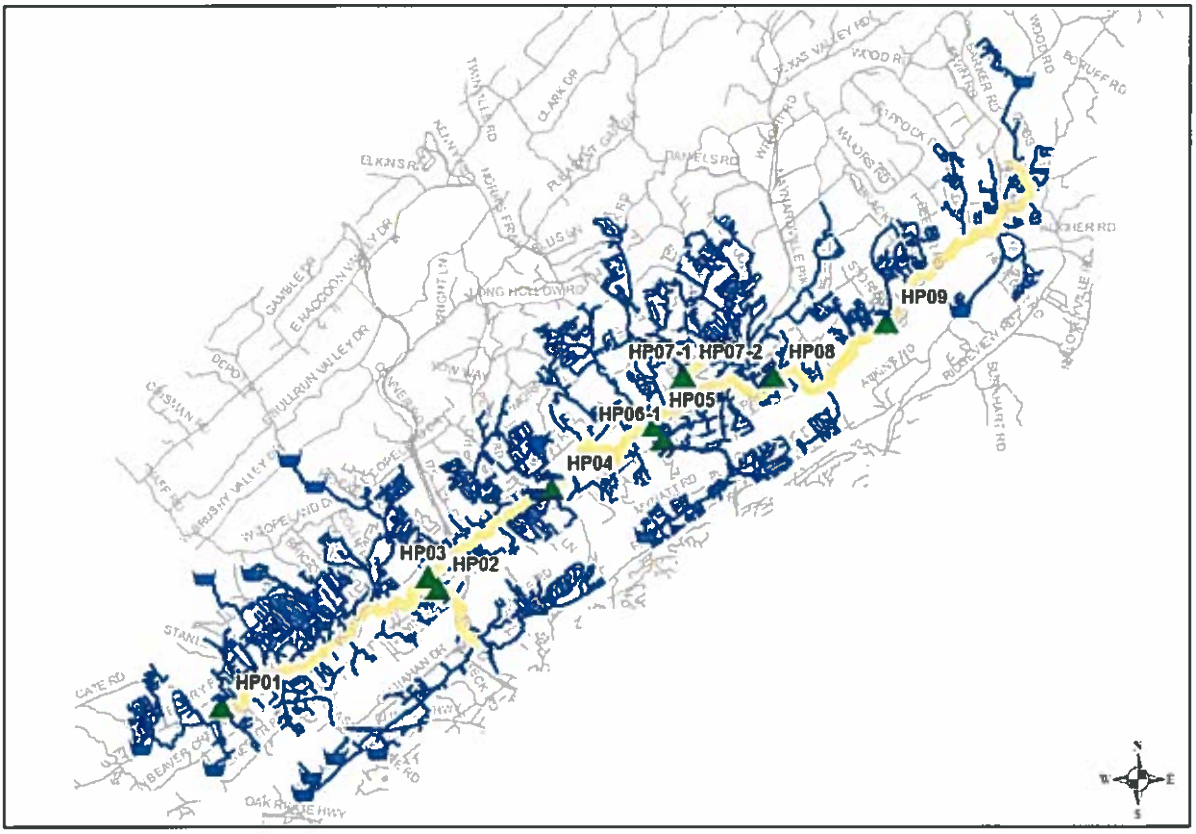


FIGURE 2 – Flow Meter Locations

Baseline Hydraulic Performance Assessment

In order to characterize the capacity related problems, as well as measuring HPUD's progress for improving system performance as projects are implemented, it was first necessary to determine a baseline for comparison. Baseline system performance was assessed under DWF and WWF conditions.

DWF Capacity Assessment

The results of the DWF capacity analysis indicated acceptable levels of reserve capacity. Acceptable levels for this analysis were based on guidance values reported from the American Society of Civil Engineers (ASCE) and Water Environment Federation (WEF) regarding the design and construction of gravity sewers and are outlined below.

ASCE & WEF Guidelines for Gravity Sewers:

- Diameters $\geq$ 15-inch, $d_{max\text{-}D}/D \leq 0.75$
- Diameters <15-inch, $d_{max\text{-}D}/D \leq 0.5$

Figure 3 presents the DWF capacity assessment results for the existing system flows. The interceptor ranges in size from 15-inch to 36-inch and is flowing less than 75 percent full. The highlighted lines greater than 75 percent are force-mains.

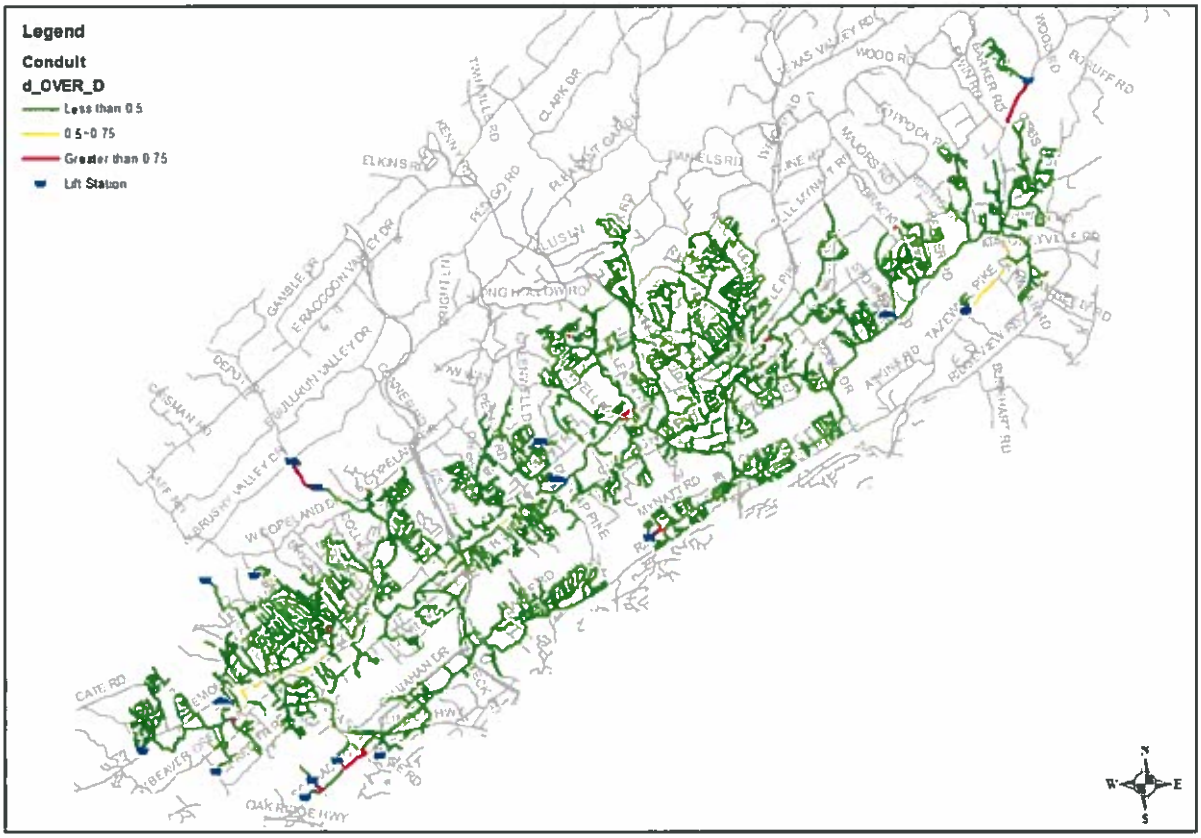


FIGURE 3 – HPUD DWF Capacity Assessment

WWF Capacity Assessment

The WWF capacity evaluation was performed through use of existing DWF and a design storm event using the RDII characterization as identified for the winter season (January). From Table 1, the January R-values as compared to July are significantly higher. As a result, the winter season was conservatively selected as it has repeatedly indicated higher R-values, and has typically incorporated little to no initial abstraction due to saturated groundwater tables.

The design storm selected was a synthetic storm with a 24 hour duration, and 2 year recurrence interval. The storm characteristics for the design event included a volume of 3.05 inches, using a 50 percentile distribution from the first quartile as defined by NOAA Atlas 14 for Knoxville, TN. The storm's distribution is presented in Figure 4.

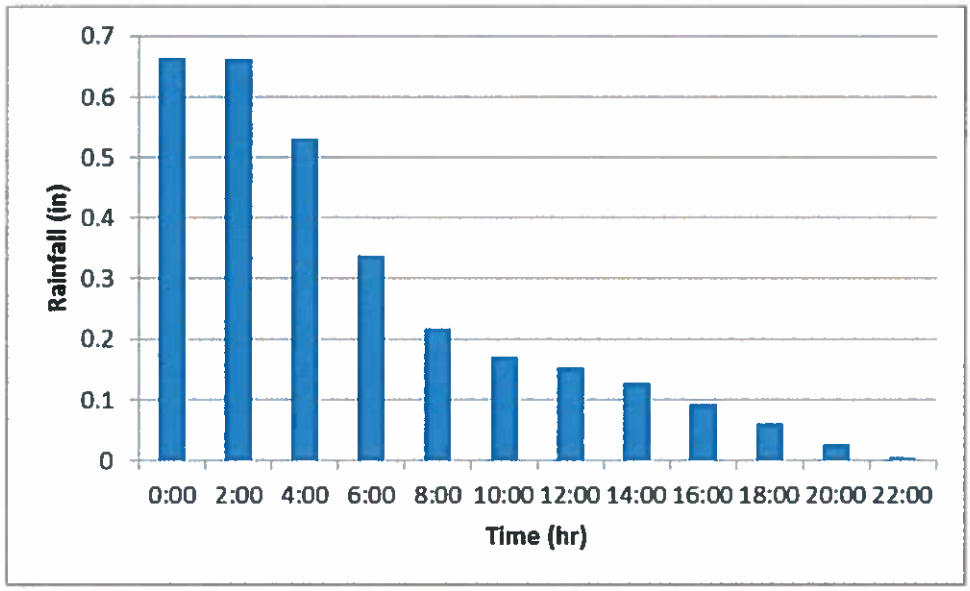


FIGURE 4: Design Storm Rainfall Distribution

The WWF capacity assessment indicated insufficient capacity and backwater along the entire interceptor and several trunk lines. The lack of capacity to convey the full magnitude of base flow and RDII entering the system creates backwater conditions which ultimately develops into manhole flooding and overflows. Figure 5, on the following page, presents the SSO's as indicated by the model and capacity flow classification for the collection system under existing design storm. As presented in Figure 5, a majority of the SSO's are occurring along the interceptor.

Development of System Improvements

The development of system improvements focused primarily on complying with regulatory requirements in the CO and reducing the occurrence of SSO's to no more than one every two years.

Existing efforts for alleviating SSO's have primarily been through sewer rehabilitation using a top down approach as outlined in the 2005 Master Plan. The top down approach has focused on smaller collection system infrastructure in residential areas. While this approach has alleviated localized SSO's and slight overall reduction in RDII contributions, the system is still experiencing SSO's. While rehabilitation efforts

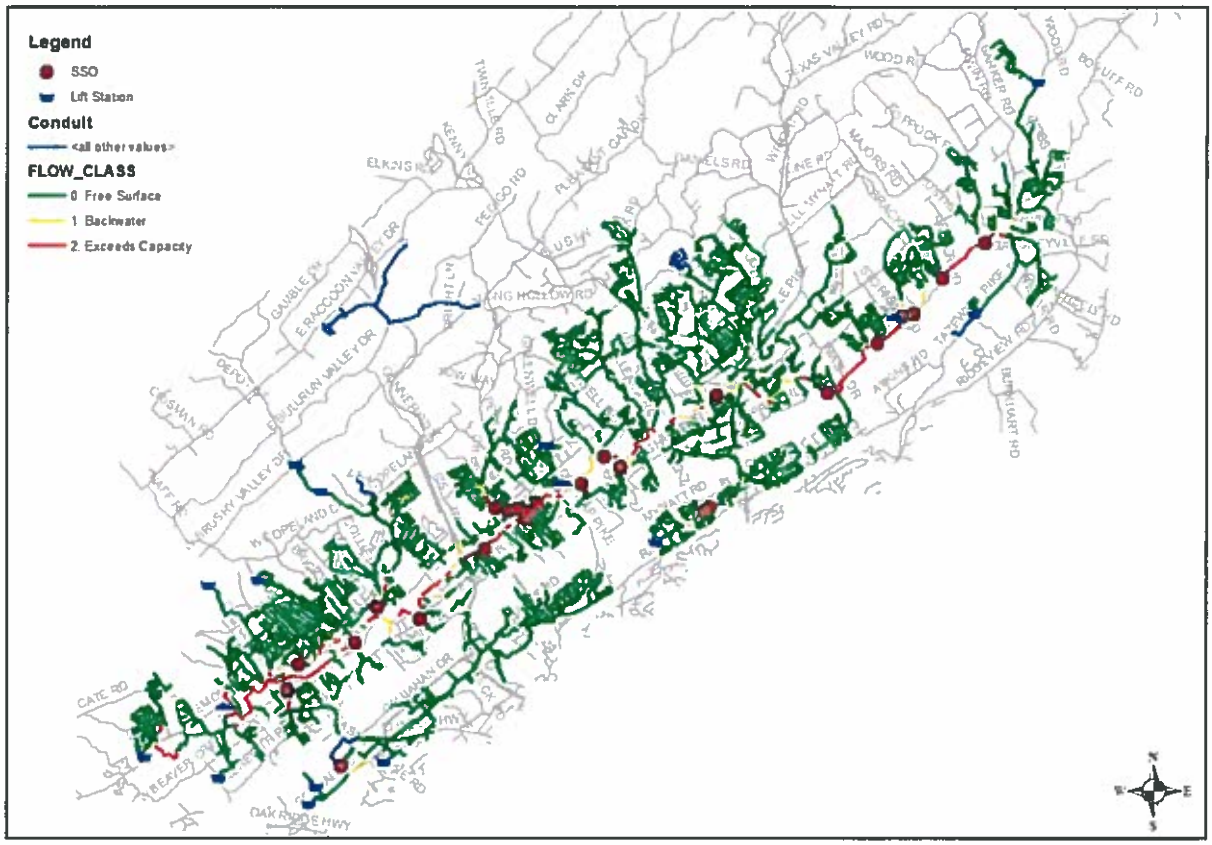


FIGURE 5 – Existing System WWF Assessment

are expected to continue, the inherent unknowns relating to the success of future rehabilitation efforts and large magnitude of reductions necessary to allow the existing infrastructure capacity to convey peak flows, HPUD requested additional alternatives related to equalization storage, and increased conveyance capacity to be developed.

Alternative 1: Storage

Equalization storage in collection systems are designed to store peak flows in excess of sewer capacity. HPUD already owns and operates 22 MG of equalization storage at the Beaver Creek WWTP, which is used to dampen flow fluctuations and allow for improved treatment performance.

Two previous studies have evaluated incorporating equalization storage into the collection system. The initial study performed by Jacobs sized equalization tanks to eliminate as many SSO's as possible, which required extended operation of overflow weirs, and determined that very large tanks in excess of 20 MG would be necessary. Even then, these equalization tanks only eliminated localized SSO's, due to localized

areas of insufficient capacity. The most recent study, performed by Gresham, Smith & Partners (GS&P), conducted an equalization storage analysis that looked at the ratio of total number of SSOs removed to equalization storage to maximize the cost benefit ratio for sizing the equalization tanks. From their analysis, it was concluded that multiple smaller tanks were necessary along the interceptor in the vicinity of areas experiencing chronic SSO's. Under both methodologies, SSO's were still predicted, which indicated additional measures for increased storage, conveyance, and/or rehabilitation still being necessary to reduce the occurrence of SSO's to that being required in the Consent Order.

A multiple storage alternative, similar to that provided by GS&P, was not performed under this analysis. Rather it was decided that a single 5 MG equalization storage tank, as recommended by GS&P, would be located at the Dry Gap Turnpike and that additional improvements would rely on conveyance and rehabilitation options to meet the requirements of the Consent Order. While off-line storage can be very effective at eliminating SSO's, other factors that need to be considered are the costs necessary to construct, operate, and maintain these types of facilities. Construction cost can vary significantly due to method of construction, size, and site conditions. For example, above grade storage is cheaper than below grade, pumping out the tank is cheaper than pumping into the tank given the need to pump peak flows as opposed to constant. As well, O&M costs can vary significantly due to the number of times the storage is expected to be used. For example, inspections after each storm event, power necessary to pump into or out of the tank, chemicals, solids handling, and odor control all can add significant costs over the expected life of the tank. In addition, equalization storage does not address continued system deterioration, flow increases from system growth, or impacts from subsequent storm events.

Alternative 2: Storage & Conveyance

The 5 MG Dry Gap storage tank from the above alternative did not indicate removal of a large number of SSO's in this analysis. However, due to the expected improvement for addressing chronic SSO's occurring during smaller storm events this capital improvement project was included in this alternative.

In order to address the remaining SSO's, and due to the expected condition of the existing interceptor and inherent uncertainty that RDII removal efforts can sufficiently reduce flows to the point of allowing the existing infrastructure to be rehabilitated, Jacobs and HPUD evaluated replacement of the existing interceptor up to Central Avenue in addition to the 5 MG Dry Gap tank.

Replacement of the existing 36-inch interceptor with a 48-inch interceptor was modeled and evaluated in two sections: Replacement of the existing 36-inch sewer to Clinton Highway, and replacement of the

existing 30 and 36-inch sewers to Central Avenue. The increased capacities provided by the 48-inch sewer through Central Avenue eliminated a large number of SSO's. Figure 5 presents the predicted eliminated overflows by improvements.

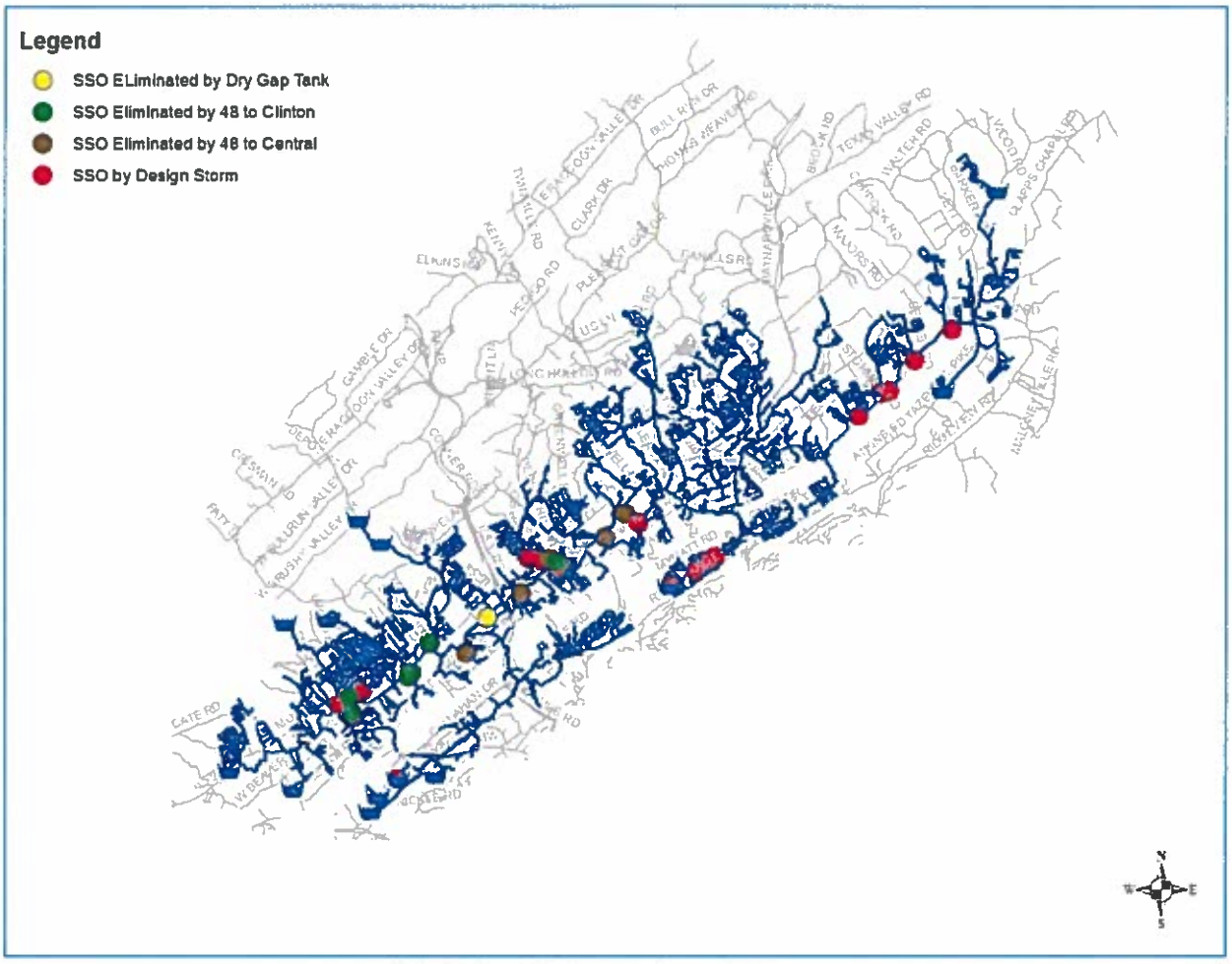


FIGURE 6 - SSO Removal by Improvement

In most cases, replacement of existing sewer is less costly that other alternatives regarding lifetime costs for capital and O&M. Replacement of the existing 36-inch with a 48-inch will convey more RDII to the Beaver Creek WWTP which will require an increase in treatment costs, but should not require capital capacity upgrades due to improvements made to the treatment capabilities of the Beaver Creek WWTP since 2005. Another benefit to increased capacity is that it allows for the increase in base sanitary flows as the result of increased commercial, industrial, and residential growth. The inflow hydrograph for this alternative is presented in Figure 7 compared to the existing system under the design storm. The

dampened existing system design storm hydrograph is the result of the lack of capacity in the existing system and SSO's.

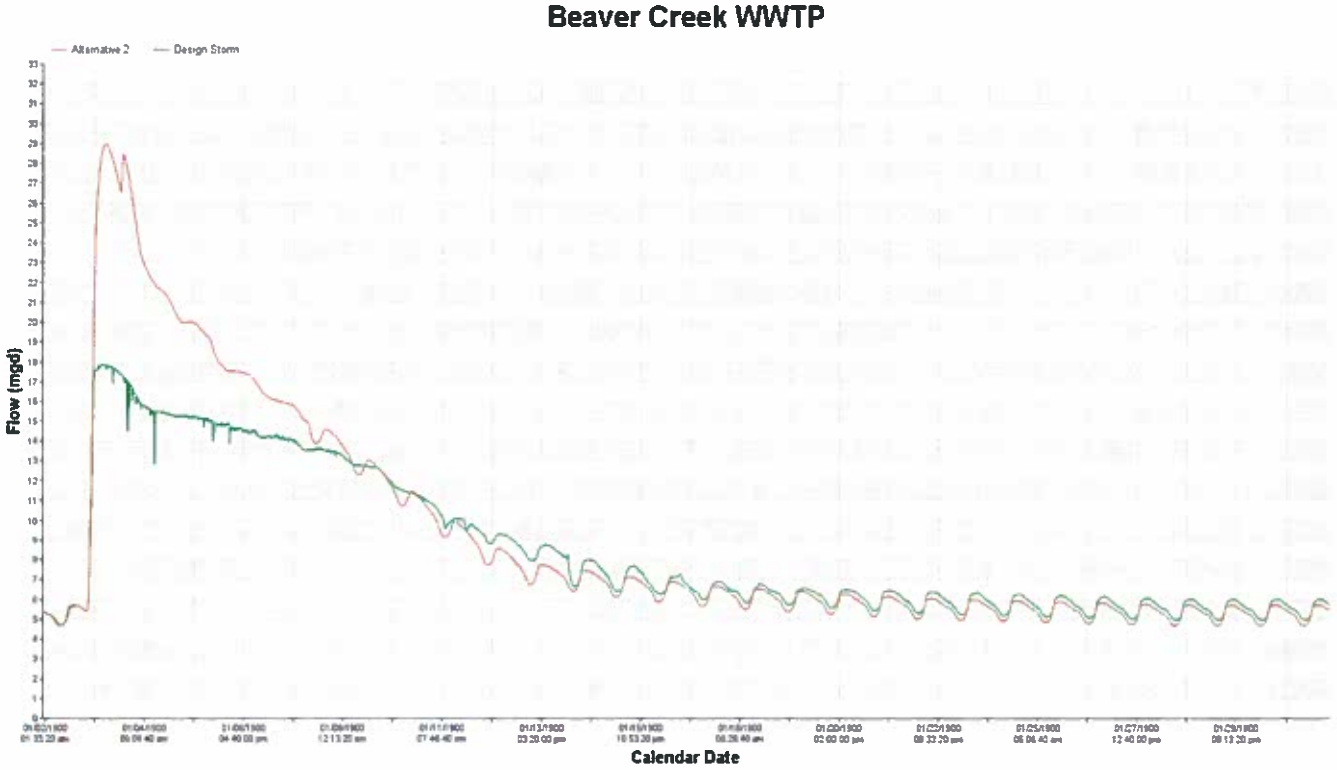


FIGURE 7 – Inflow Hydrograph

Alternative 3: Storage, Conveyance, and RDII reductions

While Alternative 2 eliminated a large number of SSO's, the model still indicated other areas in the upper reaches of the system where the model is still predicting SSO's. To address these areas, Jacobs evaluated the necessary percentage reduction in RDII over the entire system that would eliminate the remaining overflows. The RDII reduction scenarios were implemented in 5 percent increments to determine the resulting impact of each reduction interval. Ultimately, a 30 percent reduction indicated removal of a large number of remaining SSO's. A few isolated SSO's were still being predicted by the model, however are believed to be due to isolated pipes which can be laid at steeper grade, or due to an modeling parameter that doesn't accurately reflect the small local area. Figure 8 presents the SSO improvements by RDII reduction up to 30 percent. While 30 percent reductions in RDII contributions is significant, it is not

an unobtainable goal, thus no additional storage or conveyance projects were highlighted as part of this capacity analysis.

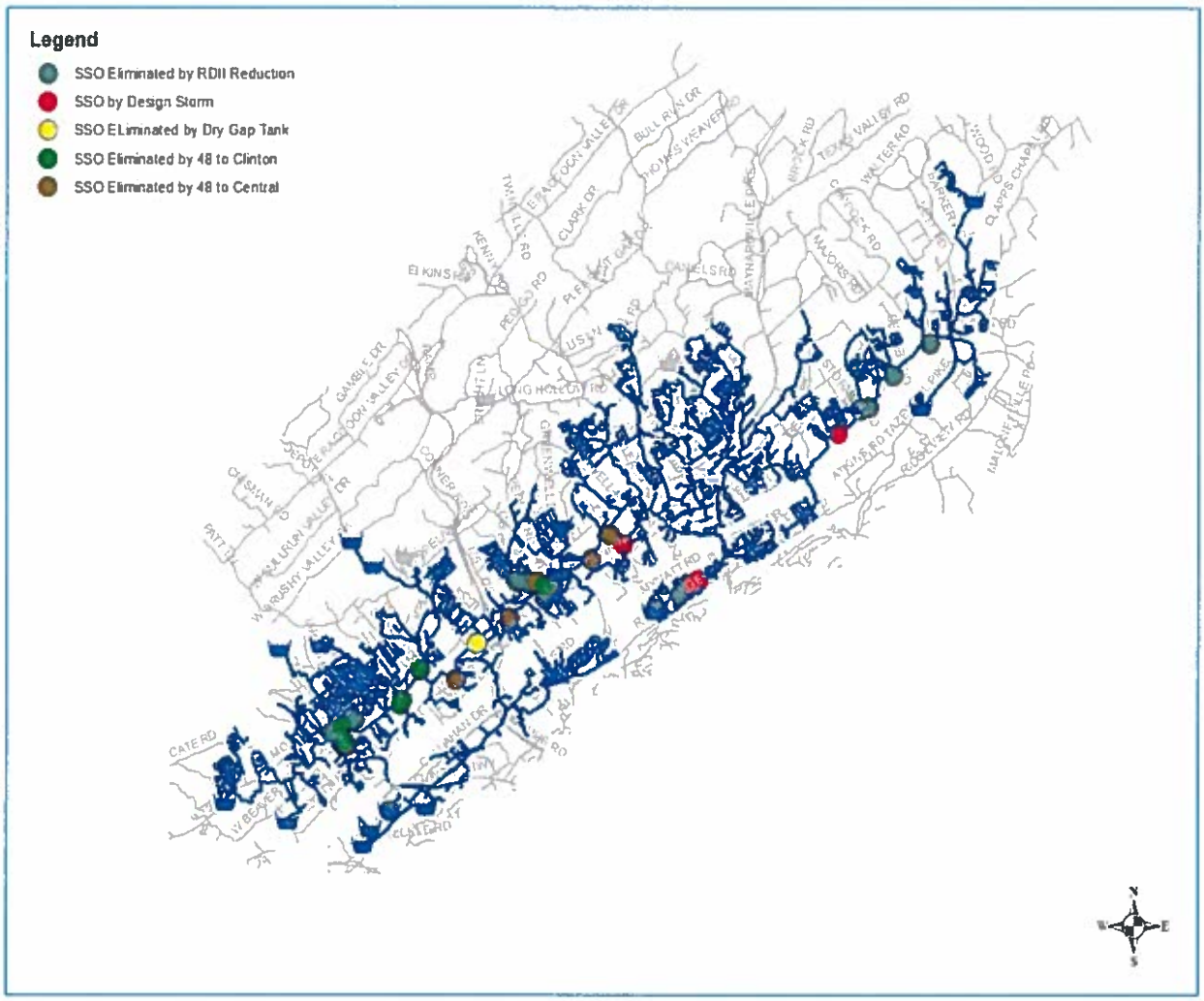


FIGURE 8 - SSO Removal by Improvement with 30 RDII Reductions

To implement RDII reductions of this magnitude, HPUD should re-implement high density flow monitoring programs after design and construction of the equalization storage tank and 48-inch replacement interceptor. This program would allow HPUD to determine the severity of RDII and focus comprehensive rehabilitation on areas indicating the greatest level of deterioration.

Population Growth

Planning to address the existing SSOs must also consider the impact of growth in the Hallsdale-Powell Utility District's service area. To account for this growth and the associated increase in future wastewater loadings over the next 10 years, a projected population growth analysis was performed. A growth rate was calculated based on the data from the MPC, and this was used to project future populations. Additional detail is provided in the following sections.

Future Collection System

With a capacity improvement plan in place to address the existing system flows, Jacobs evaluated what level of service would be provided at the end of a 10 year action plan. This section outlines the methodology used to develop the future wastewater flows through 2025, as well as future system capacity assessments.

Population Projections and Future Wastewater Flows

In an effort to maintain consistency among planning projects, population forecasts for HPUD were obtained from previous population projections. Population data provided by HPUD were disaggregated into traffic analysis zones. Using GIS, population projections were redistributed from the TAZ zones into hydrological basins, and ultimately into flow basins. Table 4 presents the population projections and growth rate by hydrological basin.

Hydrological Basin Name	2015 Population	2025 Population	Growth Rate
Allen Branch	1,404.12	1,494.22	6%
Bells Bridge	3,963.77	5,122.12	29%
Bishop Road	2,437.31	2,936.24	20%
Brickey	5,488.71	6,695.83	22%
Bullrun Creek	157.44	182.84	16%
Cardwell Lake	2,407.54	2,793.99	16%
Collier Road	1,601.99	2,247.27	40%
Cox Creek	3,258.42	3,759.12	15%
Fowler Springs	2,037.06	2,704.39	33%
Gibbs	2,418.91	2,733.97	13%
Grassy Creek	9,155.66	10,189.82	11%
Halls	1,410.00	1,497.95	6%
HeiskellRoad	309.61	416.23	34%
Hines Branch	3,458.34	3,851.70	11%
Karns	6,923.70	8,215.51	19%
Kerns Branch	1,047.65	981.94	-6%
Knob Fork	8,787.35	10,174.28	16%
Mill Branch	1,479.46	1,466.09	-1%
North Fork	3,352.34	3,818.87	14%
Powell North	3,757.97	5,184.79	38%
Powell South	3,957.22	5,116.48	29%
Tabler Branch	785.21	566.78	-28%
Upper Section	4,148.69	4,346.30	5%
Williams Creek	1,190.86	1,349.12	13%
Willow Fork	2,480.10	2,474.51	0%
Total	77,419.44	90,320.40	17%

Table 3 – 2025 Population Projection

The future wastewater flows were directly related to the population projections. This relation assumed no industrial facilities to be included in the plan. Any industrial facilities would be required to perform a specific case study to determine if the sewer and treatment capacity would be available.

Future wastewater flows were calculated by increasing the existing base flows by flow basins, calculated from the DWF analysis, by the rate of

growth. The CAP required analysis of future wastewater flows through a 10 year planning horizon, so the rate of growth from 2015 to 2025 was applied to the existing base flows per basin.

Future System Capacity Assessments

Future DWF Capacity Assessment

The results of the 2025 capacity analysis indicated acceptable levels of reserve capacity under dry weather flow. Figure 8 presents the DWF capacity assessment results for the existing system flows.

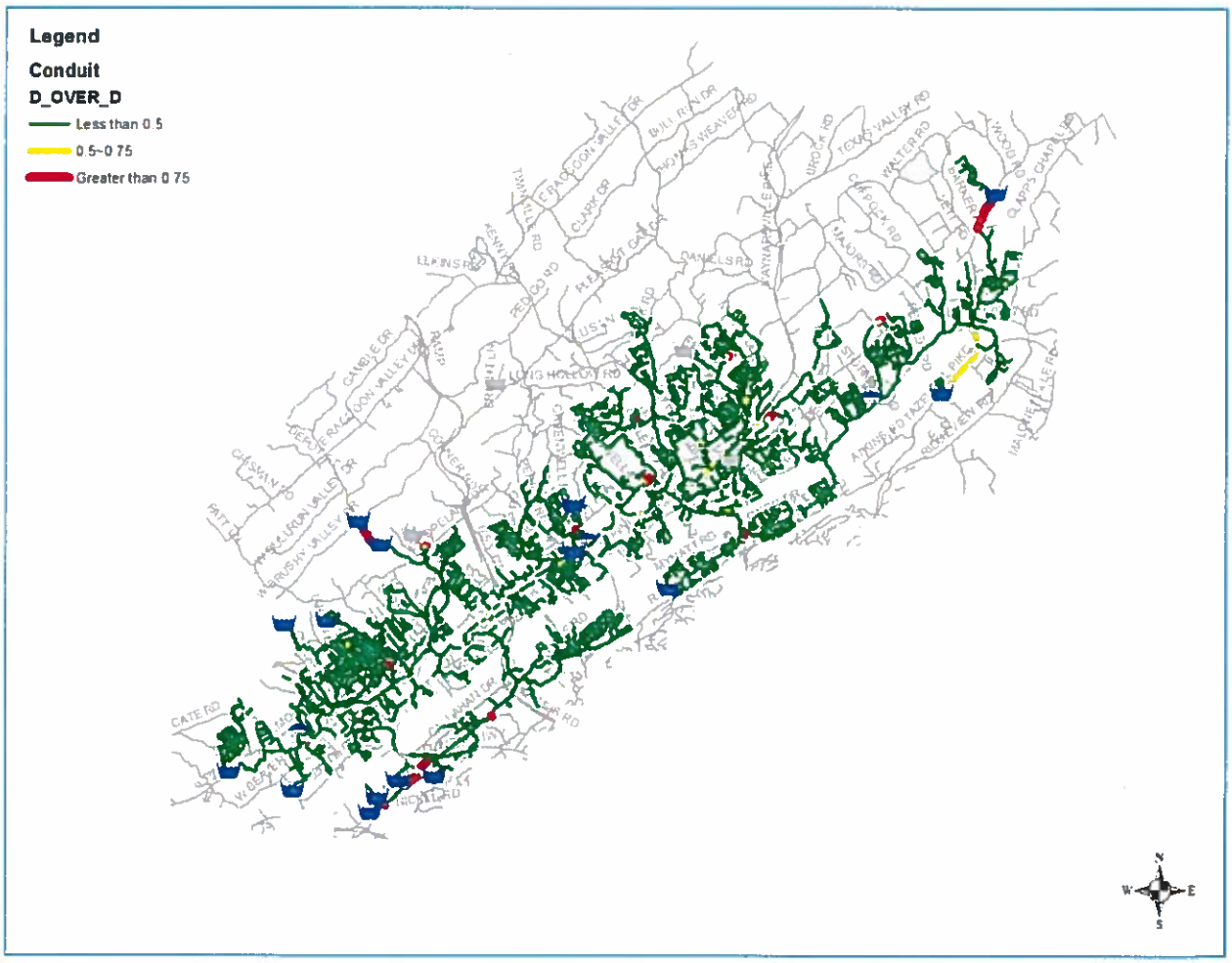


Figure 8: 2025 DWF Capacity Analysis

Future WWF Capacity Assessment

The 2025 WWF capacity evaluation was performed through use of the 2025 DWF and the design storm event. The 2025 WWF capacity assessment indicated that only a few SSO's are predicted. These areas have been identified as localized improvements that are necessary to allow flows to reach the interceptor.

The high density flow monitoring recommended will verify if these localized projects are necessary or a function of the base flow and RDII allocation. Figure 9 presents the 2025 WWF capacity assessment.

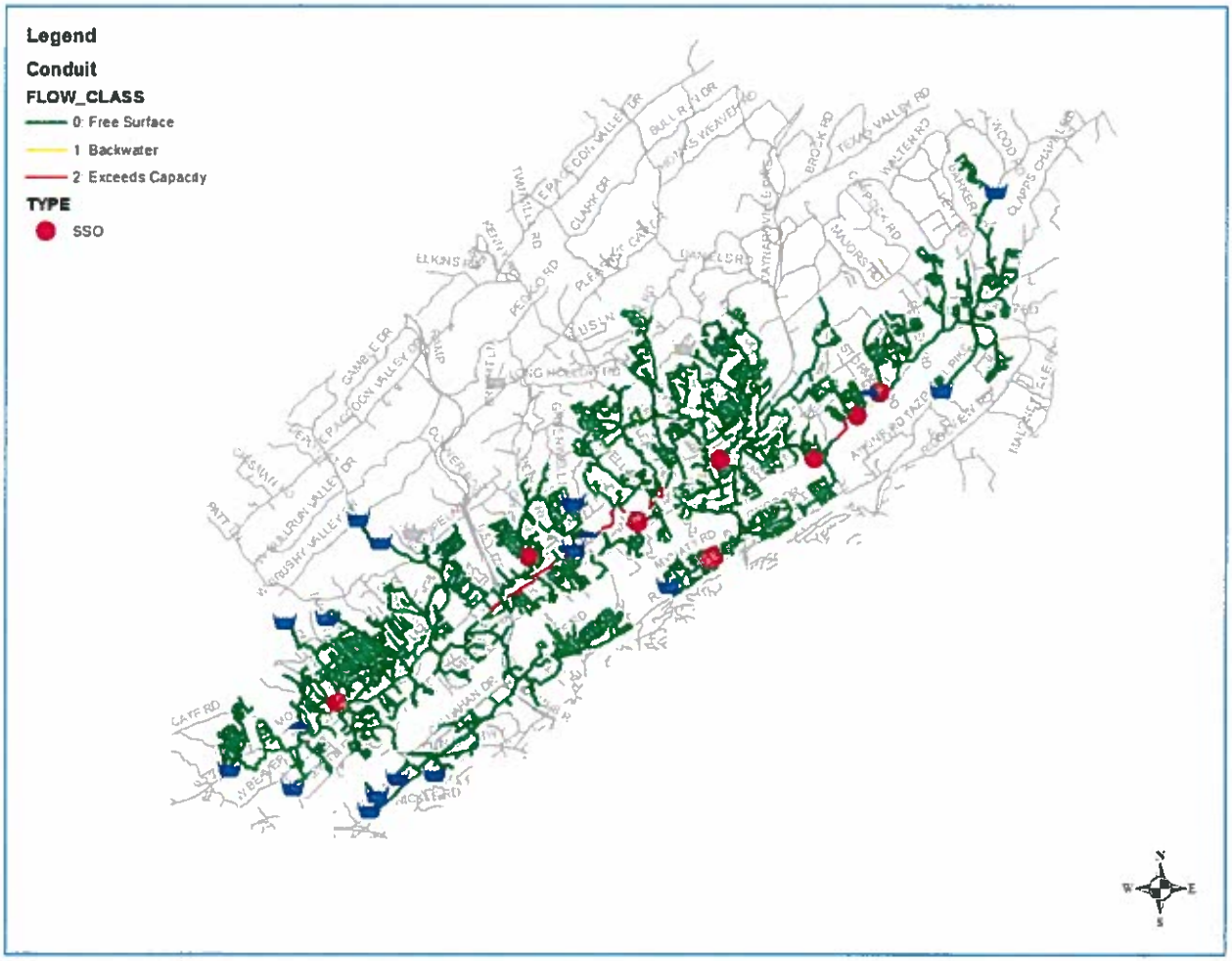


Figure 9: WWF Capacity Analysis

Treatment System:

The recent improvements made to the treatment capabilities of the Beaver Creek WWTP will allow the plant to handle the projected increase in daily flow and meet its current permit requirements.

Repair and/or replacement of equipment:

Over the years, Hallsdale-Powell Utility District has invested in the procurement and maintenance of equipment necessary to perform its function for the customers of the District. No deficiencies were

observed with respect to HPUD equipment or its state of readiness or repair that could be improved upon to further its capacity to meet permit requirements either in the collection system or treatment facility.

Operational Procedures and Staffing:

Hallsdale-Powell Utility District staff is highly capable and have established operational procedures for the management of the collection and treatment systems as part of their Management, Operations and Maintenance (MOM) program.

Corrective Action Plan

Over the past several years, much of Hallsdale-Powell Utility District's rehabilitation efforts have focused on the "top" and "middle" portion of the collection system. This is in line with the initial strategy pursued by HPUD to address rehabilitation from a "top" to "bottom" approach in response to the 2004 Order. For clarification, the "top" of the system is represented in the smallest collection elements, typically located in residential areas, whereas the bottom of the system is representative of the larger carrier and interceptor collection elements. Thus far this approach has shown localized SSO reduction and improvements to the system.

Yet still, the system as a whole has not seen the full benefit when measured by the number of SSOs still being observed. Therefore, with reference to Figure 1 – Collection System SSO Location Map, the existing HPUD "top to bottom" holistic strategy and approach will be accelerated with capital improvement initiatives focusing on the "bottom" portion of the system, specifically the interceptor and adjacent interceptor mains. With the interceptor lying largely in the flood plain of Beaver Creek, interceptor improvements here will significantly reduce inflow during storm events, as well as inflow associated with flooding and high water table periods.

Through the use of the recently updated and calibrated collection system model, significant reductions in the number of SSOs have been modeled as a result of proposed interceptor related capital improvement projects which include a 5 MG storage tank at Dry Gap Pike and the replacement of approximately 26,100 LF of the 36" Interceptor with a minimum of 48" pipe. These two major Interceptor projects will immediately improve existing system performance in the southwestern section of the interceptor, provide capacity for future flows and eliminate most of the area's recurring SSOs.

There are isolated SSOs in the northeastern part of the collection system. These SSOs will be addressed by specific targeted projects and efforts. These efforts will include the implementation of temporary flow monitoring to isolate specific trouble areas. Coupled with sewer system inspections to identify deficiencies, defects identified will be systematically addressed through interceptor improvements and work associated with HPUD's ongoing rehabilitation program.

To summarize, the key elements of the comprehensive plan will include:

- Equalization storage in the collection system
- Replacement, upsizing and rehabilitation, including CIPP and point repair, of the Beaver Creek Interceptor and adjacent mains
- Continuation of inspection and assessment of the collection system
- Continuation of sewer rehabilitation to eliminate defects
- Continuation of improvements to existing pump station facilities
- Incorporation of temporary flow monitoring to localized areas to assist with focused preventative maintenance investigations and rehabilitation efforts

The proposed project work to achieve compliance will be phased over 10 years and grouped in two 5 year periods. The first 5 year period, or Early Action Projects, will include:

- Design and construction of the 5 MG collection system equalization storage tank at Dry Gap Pike
- Design of the Beaver Creek Interceptor replacement project
- Construction of Beaver Creek Interceptor Improvements from Beaver Creek WWTP to Clinton Highway crossing
- Completion of the initial Preventative Maintenance and Inspection (PMI) program of the collection system and initiation of additional PMI efforts
- Assessment of SSOs located in the northeastern portion of the Interceptor where, as necessary, the following tasks may be pursued:
    - Implementation of expanded temporary flow monitoring efforts
    - Corresponding localized and specific sewer inspection initiatives
    - Focused rehabilitation efforts to eliminate targeted SSOs
- Continuation of pump station improvements
- Continuation of sewer rehabilitation efforts
- Annual update of collection system model to reflect additional flow information and improvements

The second 5 year projects will include:

- Continued PMI and rehabilitation initiatives from the first five years

- Construction of the Beaver Creek Interceptor improvements from Clinton Highway to Central Avenue
- Continuation of pump station improvements
- An assessment of the efficacy of the Early Action Projects to determine the need for additional targeted collection system replacement projects and additional collection system equalization storage

This approach will result in elimination of the majority of SSOs within the first 5 years of the program and allow HPUD to adapt their plan in the second 5 year period to do more of what has worked and address specific issues that are unknown now but may arise after the first 5 years.

In order to further plan the initiative discussed above, a Collection System CAP Program Schedule has been prepared. The particulars of this schedule are discussed in the following section.

Proposed Schedule

The Collection System CAP Program Schedule, located in the Appendix, was developed to correlate with the main elements of the Corrective Action Plan discussed above. These elements have been assigned to the schedule under one of the following groupings:

- Program Development/Supplemental Environmental Project (SEP)
- System Storage
- Preventative Maintenance
- Rehabilitation
- Interceptor Replacement
- Interceptor Rehabilitation
- Pump Station Reliability

Known and anticipated scopes of work have been identified and placed under the schedule grouping which best reflects to scopes objective. Know projects are either underway, as is the case with Rehabilitation Phase 3, Contract 1, or have a scope of work already identified such as the PMI effort to complete the complete the survey of all sewers in the collection system. The anticipated projects are scopes of work that would result from known projects; for example, the PMI initiative mentioned above will result in the identification of system defects which would need to be rehabilitated, thus a rehab project would be necessary and is included in the schedule as an anticipated project.

Corresponding to identified or anticipated projects are estimated time durations expected to be required to complete the project. Development of this schedule also accounted for seasonal challenges, when working on the interceptor, as well as past project history.

The following sections provide additional perspective on each of the schedules groupings.

Program Development/SEP

This grouping of the schedule identifies the program milestone dates and tracking of the Supplemental Environmental Project (SEP). It also contains activities related to the flow monitoring initiative which will serve as a guide for measuring the effectiveness, or efficacy, of the Early Action Projects of the program. The efficacy of these projects will be assessed to determine the need for additional targeted collection system replacement, rehabilitation and/or collection system equalization storage projects and is a key component related to the planning the second half of the program.

System Storage

As has been mentioned, system or equalization storage is a component for meeting compliance by 2024. Currently planned for construction, the Dry Gap Equalization Storage Tank has been identified on the schedule with an anticipated start date in August of 2015. Associated activities related to this project include procurement, however, the design was not included as it is nearly complete.

Also included are two additional storage tank initiatives referred to as Emory Road and Pebble Creek EQ Tanks. These tanks are identified on the schedule, and are planned to be pursued pending the results of the efficacy flow monitoring assessment mentioned above. These projects have design and procurement activities identified as well as construction.

Preventative Maintenance investigation (PMI)

The PMI grouping of the schedule identifies scopes of work for areas of the collection system that have not yet been inspected as part of the system wide review, or are specific areas that are in need of further inspection. The PMI efforts have successor activities associated with the rehabilitation grouping.

Also included under PMI is flow monitoring activities which will be utilized to develop future PMI initiatives and allow for their scopes to be focused.

Rehabilitation

The rehabilitation element of the schedule accounts for scopes of work which are either ongoing or currently identified as a result of completed PMI initiatives. Engineering services are also accounted for with regards to the design and procurement associated with each rehabilitation project.

Interceptor Replacement

The interceptor replacement element involves efforts associated with the replacement of the existing interceptor from Beaver Creek WWTP to its intersection with Central Avenue. The schedule has broken this scope or work into two phases. The first phase would entail approximately the first third of the interceptor to its intersection with Clinton Highway. The second phase would encompass the remaining portion from Clinton to Central Avenue.

Additional efforts associated with this scope of work include easement acquisition, design and procurement activities.

Interceptor Rehabilitation

The interceptor rehabilitation grouping involves efforts associated with the rehabilitation of the remaining length of interceptor. It is broken out into four distinct subsections; flow monitoring, PMI w/ Engineering Services, Design/Procurement and Construction.

The scopes of work identified in the PMI subsection are either the result of current initiatives to inspect the interceptor or will be the focused result of the flow monitoring initiative which is planned to concentrate on known SSO locations.

For planning purposes, two scopes of work are identified as, Post System Flow Monitoring if Necessary, with associated years of 2022 and 2023. The purpose of these projects is to account for the possibility that additional effort on the interceptor will be necessary as a result of the efficacy flow monitoring initiative mentioned in the Planning group above. If that is the case, these two projects represent the required tasks as well as an estimated time frame.

Pump Station Reliability

The pump station reliability grouping involves efforts associated with the ongoing effort to continue improvements to the Collection Systems pump stations.

Projected/Estimated Program Costs

The costs associated with the schedule are, with few exceptions, estimated. The approach and/or methodology for these estimated figures are as follows:

System Storage

Estimated costs associated with the tanks were developed from general figures provided by HPUD staff with associated engineering costs estimated by Jacobs' staff.

Preventative Maintenance investigation (PMI)

Estimated costs associated for PMI efforts were developed via recent experience associated with HPUD project work. An estimated cost per linear foot of PMI was developed based upon averaging the total cost of a recent HPUD project over the footage inspected. This includes associated manhole and smoke testing, and supporting engineering services.

Rehabilitation

Estimated costs associated with Rehabilitation efforts were developed via recent experience associated with HPUD project work. In this case, existing PMI recommendations allowed for an estimated rehabilitation cost to be generated based upon existing similar unit price costs. Construction services costs were included by adding approximately 8% to the estimated rehabilitation cost.

Interceptor Replacement

On this grouping, a cost estimate was performed to include, but not limited to, the anticipated alignment, expected pipe material, road and utility crossings, accessibility to the construction area, percentage of anticipated rock to be encountered, manhole replacement, and erosion and sedimentation control measures. As this is a preliminary estimate, a contingency was also incorporated.

The engineering and easement acquisition cost are order of magnitude estimates and would be further refined during the planning and design phases respectively.

Interceptor Rehabilitation

Interceptor rehabilitation costs were estimated for each of the two main elements, PMI and construction. An estimated cost per linear foot of PMI was developed based upon averaging the total cost of a past HPUD project over the footage inspected. Construction cost was estimated base upon anticipating approximately one third of the inspected footage would require rehabilitation; the rehabilitation cost was developed based upon past HPUD and nearby project unit pricing for similar sized pipe. Construction services costs were included by adding approximately 10% to the estimated rehabilitation cost.

Pump Station Reliability

Pump Station Reliability costs were estimated based on order of magnitude approach for the anticipated scope or work.

Conclusion

Overall this program will address the major issues contributing to SSOs and prepare the sewer system to handle growth for many years into the future.

APPENDIX

HPUD SEWER PUMP STATIONS

Campbells Point Pump Station
Rosewood Estates Pump Station
Cantrell Heights Pump Station
Raccoon Valley WWTP
Bright Lane Pump Station
Mountain Shadow Pump Station
McKinnon Ridge Pump Station
Childress Place Pump Station
Yellowbrick Pump Station
Brushy Valley Pump Station
Copeland View Pump Station
Red Hawk Pump Station
Mynatt Pump Station
Temple Baptist Pump Station
Bell Campground Pump Station
Beaver Creek WWTP
Barrington Pump Station
Weaver Pump Station
Schaad Park Pump Station
Cherokee Ridge Pump Station
Blakewood Pump Station
Schaad Rd Pump Station

Legend

- UTIL_ssPumpStation
- Wastewater Treatment Plant

Sewer Gravity Main

Subtype

- Collector
- Interceptor
- Inline Storage

Sewer Pressurized Main

SubType

- High Pressure
- Low Pressure
- Unknown

N

0 1,750 3,500 7,000 Feet

WGS 1984 Web Mercator Auxiliary Sphere

{Disclaimers, data sources, references, etc}

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Project #: C6X60417
Author: Everenre

JACOBS

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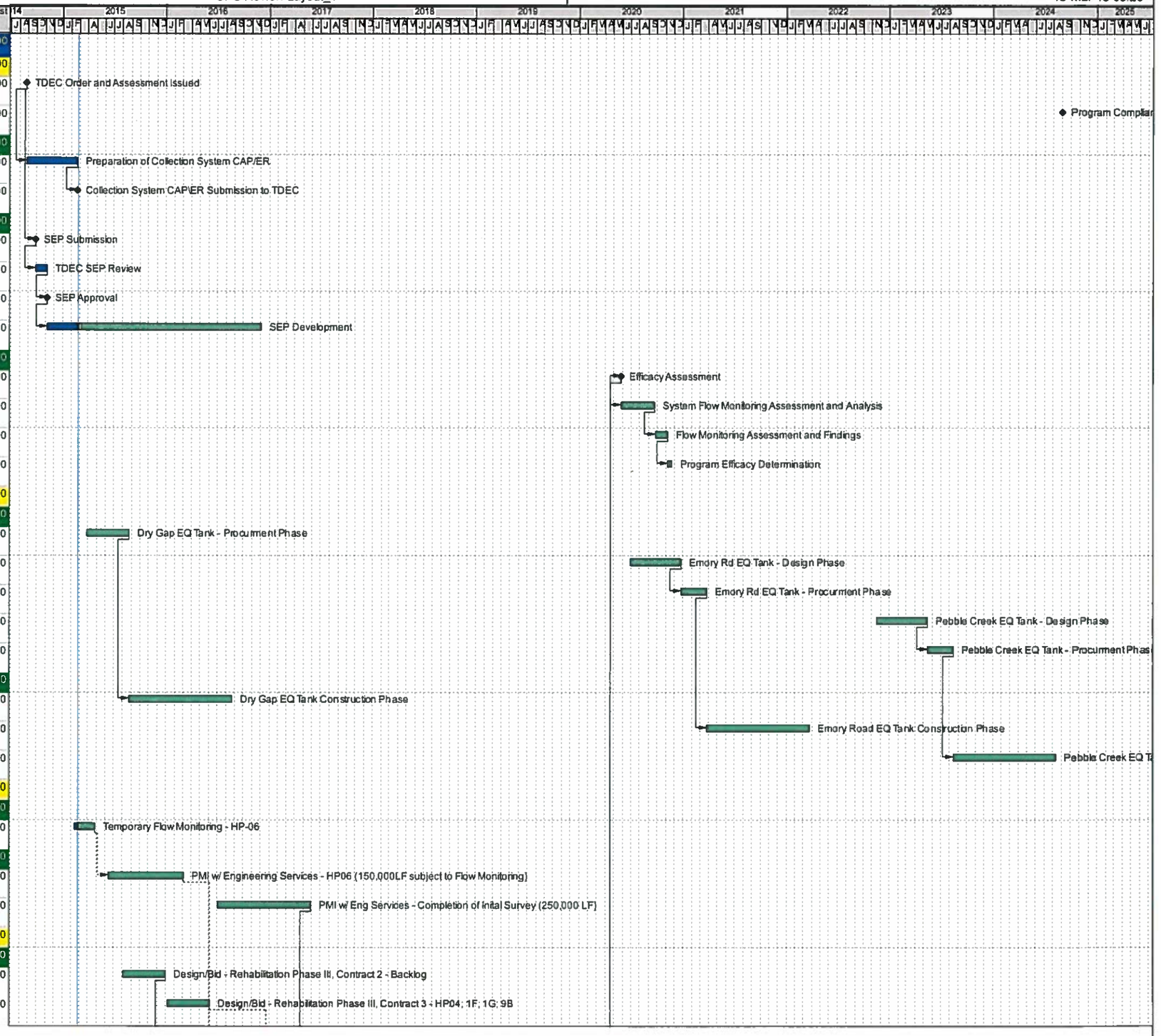
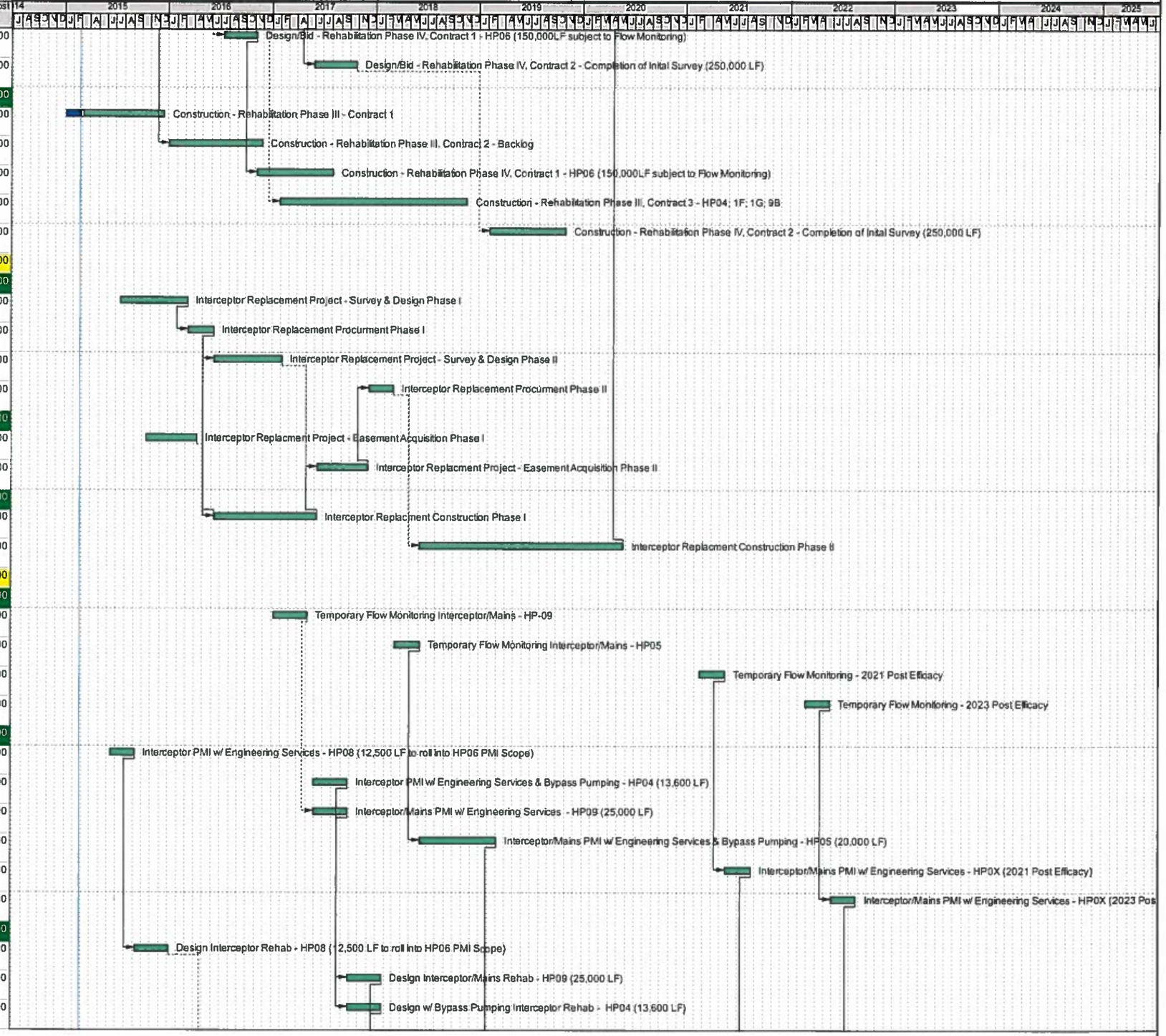
Activity ID	Activity Name	Start	Finish	Estimated Cost
Hallsdale-Powell Collection System Improvement		27-Aug-14 A	31-Aug-24	$79,961,000.00
Program Development		27-Aug-14 A	31-Aug-24	$506,000.00
CAP 1000	TDEC Order and Assessment Issued	27-Aug-14 A		$0.00
CAP 1280	Program Compliance Achievement Date		31-Aug-24*	$0.00
Collection System CAP / ER		27-Aug-14 A	20-Feb-15	$235,000.00
CAP 1005	Preparation of Collection System CAP/ER	27-Aug-14 A	20-Feb-15 A	$235,000.00
CAP 1010	Collection System CAP\ER Submission to TDEC		20-Feb-15 A	$0.00
SEP		26-Sep-14 A	03-Dec-16	$56,000.00
CAP 1001	SEP Submission	26-Sep-14 A		$0.00
CAP 1002	TDEC SEP Review	26-Sep-14 A	07-Nov-14 A	$0.00
CAP 1003	SEP Approval	07-Nov-14 A		$0.00
CAP 1004	SEP Development	08-Nov-14 A	03-Dec-16	$56,000.00
Program Efficacy Assessment		26-May-20	21-Nov-20	$215,000.00
CAP 1468	Efficacy Assessment	26-May-20		$0.00
CAP 1478	System Flow Monitoring Assessment and Analysis	26-May-20*	22-Sep-20	$175,000.00
CAP 1488	Flow Monitoring Assessment and Findings	23-Sep-20	06-Nov-20	$35,000.00
CAP 1498	Program Efficacy Determination	07-Nov-20	21-Nov-20	$5,000.00
System Storage (Tanks)		28-Mar-15	12-Aug-24	$24,730,000.00
Engineering Services		28-Mar-15	13-Aug-23	$730,000.00
CAP 1040	Dry Gap EQ Tank - Procurment Phase	28-Mar-15*	24-Aug-15	$10,000.00
CAP 1110	Emory Rd EQ Tank - Design Phase	28-Jun-20*	24-Dec-20	$350,000.00
CAP 1115	Emory Rd EQ Tank - Procurment Phase	25-Dec-20*	24-Mar-21	$10,000.00
CAP 1130	Pebble Creek EQ Tank - Design Phase	17-Nov-22*	15-May-23	$350,000.00
CAP 1140	Pebble Creek EQ Tank - Procurment Phase	16-May-23*	13-Aug-23	$10,000.00
Construction		25-Aug-15	12-Aug-24	$24,000,000.00
CAP 1050	Dry Gap EQ Tank Construction Phase	25-Aug-15	23-Aug-16	$8,000,000.00
CAP 1120	Emory Road EQ Tank Construction Phase	25-Mar-21	24-Mar-22	$8,000,000.00
CAP 1150	Pebble Creek EQ Tank Construction Phase	14-Aug-23	12-Aug-24	$8,000,000.00
Preventative Maintenance Inspections		11-Feb-15 A	29-May-17	$2,570,000.00
Flow Monitoring		11-Feb-15 A	25-Apr-15	$20,000.00
CAP 1030	Temporary Flow Monitoring - HP-06	11-Feb-15 A	25-Apr-15	$20,000.00
Inspection and Assessment		11-Jun-15	29-May-17	$2,550,000.00
CAP 1235	PMI w/ Engineering Services - HP06 (150,000LF subject to Flow Monitoring)	11-Jun-15*	06-Mar-16	$1,000,000.00
CAP 1240	PMI w/ Eng Services - Completion of Inital Survey (250,000 LF)	03-Jul-16*	29-May-17	$1,550,000.00
Rehabilitation		06-Jan-15 A	04-Nov-19	$18,780,000.00
Engineering Services		05-Aug-15	26-Oct-17	$190,000.00
CAP 1160	Design/Bid - Rehabilitation Phase III, Contract 2 - Backlog	05-Aug-15*	01-Jan-16	$25,000.00
CAP 1180	Design/Bid - Rehabilitation Phase III, Contract 3 - HP04; 1F; 1G; 9B	06-Jan-16*	03-Jun-16	$100,000.00



Actual Work | Remaining Work | Critical Remaining Work | Milestone

Activity ID	Activity Name	Start	Finish	Estimated Cost
CAP 1392	Design/Bid - Rehabilitation Phase IV, Contract 1 - HP06 (150,000LF subject to Flow Monitoring)	11-Jul-16*	07-Nov-16	$30,000.00
CAP 1395	Design/Bid - Rehabilitation Phase IV, Contract 2 - Completion of Inital Survey (250,000 LF)	29-May-17	26-Oct-17	$35,000.00
Construction		06-Jan-15 A	04-Nov-19	$18,990,000.00
CAP 1020	Construction - Rehabilitation Phase III - Contract 1	06-Jan-15 A	15-Dec-15	$3,350,000.00
CAP 1170	Construction - Rehabilitation Phase III, Contract 2 - Backlog	02-Jan-16	26-Nov-16	$370,000.00
CAP 1386	Construction - Rehabilitation Phase IV, Contract 1 - HP06 (150,000LF subject to Flow Monitoring)	08-Nov-16	04-Aug-17	$1,450,000.00
CAP 1190	Construction - Rehabilitation Phase III, Contract 3 - HP04, 1F, 1G; 9B	28-Jan-17*	18-Nov-18	$11,000,000.00
CAP 1389	Construction - Rehabilitation Phase IV, Contract 2 - Completion of Inital Survey (250,000 LF)	07-Feb-19*	04-Nov-19	$2,420,000.00
Interceptor Replacement		16-Jul-15	25-May-20	$25,620,000.00
Design		16-Jul-15	06-Mar-18	$1,420,000.00
CAP 1060	Interceptor Replacement Project - Survey & Design Phase I	16-Jul-15*	11-Mar-16	$600,000.00
CAP 1080	Interceptor Replacement Procurment Phase I	12-Mar-16	09-Jun-16	$10,000.00
CAP 1093	Interceptor Replacement Project - Survey & Design Phase II	10-Jun-16	04-Feb-17	$800,000.00
CAP 1095	Interceptor Replacement Procurment Phase II	07-Dec-17	06-Mar-18	$10,000.00
Easement Acquisition		16-Oct-15	06-Dec-17	$200,000.00
CAP 1070	Interceptor Replacment Project - Easement Acquisition Phase I	16-Oct-15*	12-Apr-16	$100,000.00
CAP 1443	Interceptor Replacment Project - Easement Acquisition Phase II	10-Jun-17	06-Dec-17	$100,000.00
Construction		10-Jun-16	25-May-20	$24,000,000.00
CAP 1090	Interceptor Replacment Construction Phase I	10-Jun-16	09-Jun-17	$8,000,000.00
CAP 1100	Interceptor Replacment Construction Phase II	06-Jun-18*	25-May-20	$16,000,000.00
Interceptor Rehabilitation		11-Jun-15	09-Nov-23	$7,410,000.00
Flow Monitoring		08-Jan-17	26-May-22	$80,000.00
CAP 1300	Temporary Flow Monitoring Interceptor/Mains - HP-09	08-Jan-17*	07-May-17	$20,000.00
CAP 1310	Temporary Flow Monitoring Interceptor/Mains - HP05	10-Mar-18*	07-Jun-18	$20,000.00
CAP 1320	Temporary Flow Monitoring - 2021 Post Efficacy	19-Feb-21*	20-May-21	$20,000.00
CAP 1350	Temporary Flow Monitoring - 2023 Post Efficacy	26-Feb-22*	26-May-22	$20,000.00
PMI w/ Engineering Services		11-Jun-15	24-Aug-22	$750,000.00
CAP 1220	Interceptor PMI w/ Engineering Services - HP08 (12,500 LF to roll into HP06 PMI Scope)	11-Jun-15*	08-Sep-15	$50,000.00
CAP 1250	Interceptor PMI w/ Engineering Services & Bypass Pumping - HP04 (13,600 LF)	29-May-17*	25-Sep-17	$200,000.00
CAP 1260	Interceptor/Mains PMI w/ Engineering Services - HP09 (25,000 LF)	29-May-17*	25-Sep-17	$100,000.00
CAP 1265	Interceptor/Mains PMI w/ Engineering Services & Bypass Pumping - HP05 (20,000 LF)	08-Jun-18*	04-Mar-19	$250,000.00
CAP 2021	Interceptor/Mains PMI w/ Engineering Services - HP0X (2021 Post Efficacy)	20-May-21	18-Aug-21	$75,000.00
CAP 2023	Interceptor/Mains PMI w/ Engineering Services - HP0X (2023 Post Efficacy)	27-May-22	24-Aug-22	$75,000.00
Design/Procurement		09-Sep-15	22-Dec-22	$180,000.00
CAP 1548	Design Interceptor Rehab - HP08 (12,500 LF to roll into HP06 PMI Scope)	09-Sep-15	06-Jan-16	$30,000.00
CAP 1528	Design Interceptor/Mains Rehab - HP09 (25,000 LF)	26-Sep-17*	23-Jan-18	$30,000.00
CAP 1526	Design w/ Bypass Pumping Interceptor Rehab - HP04 (13,600 LF)	26-Sep-17*	23-Jan-18	$30,000.00



HPUD - CS CAP Program Schedule

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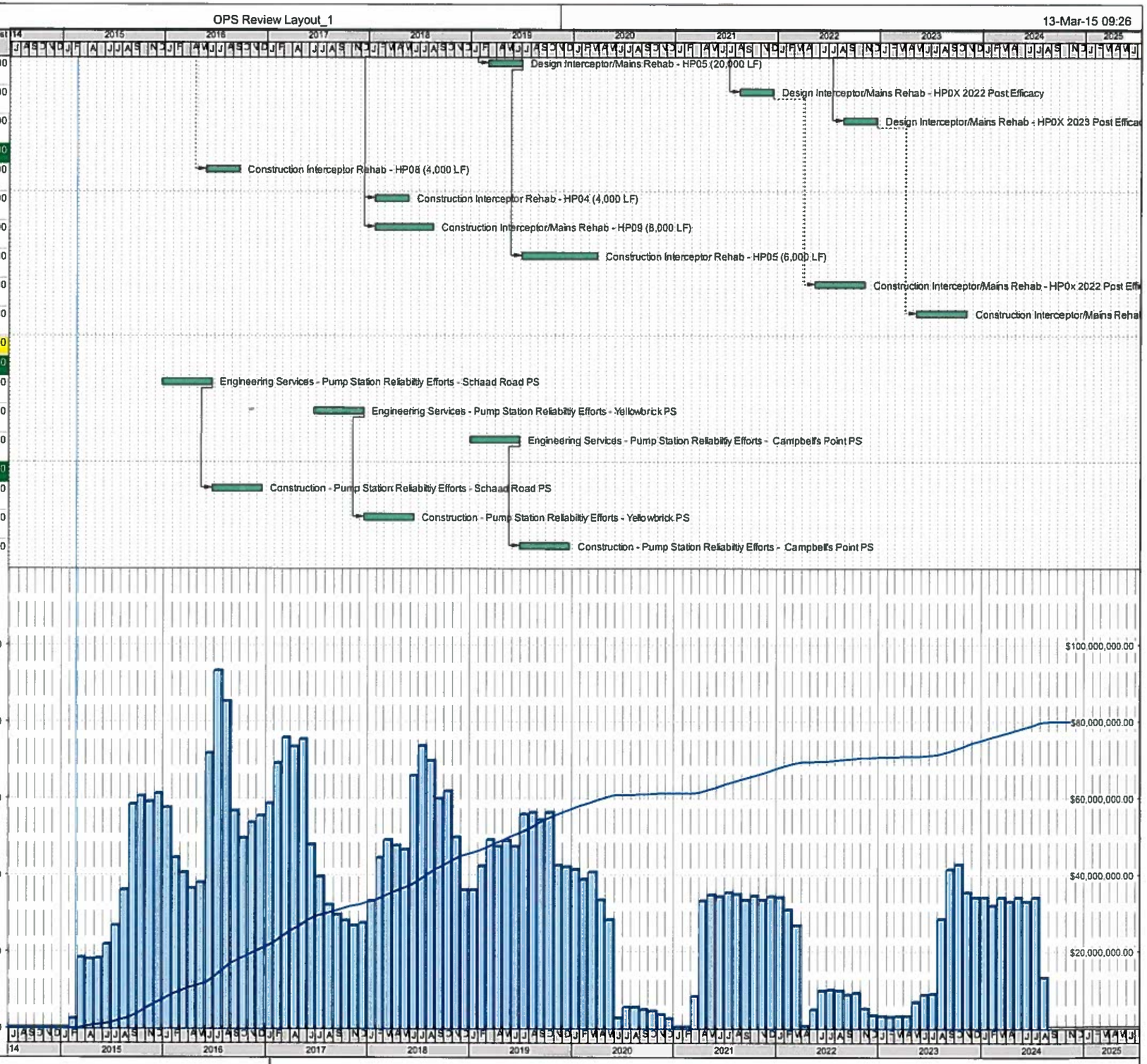
13-Mar-15 09:26

Activity ID	Activity Name	Start	Finish	Estimated Cost
CAP 1404	Design Interceptor/Mains Rehab - HP05 (20,000 LF)	05-Mar-19*	02-Jul-19	$30,000.00
CAP 1505	Design Interceptor/Mains Rehab - HP0X 2022 Post Efficacy	18-Aug-21*	16-Dec-21	$30,000.00
CAP 1508	Design Interceptor/Mains Rehab - HP0X 2023 Post Efficacy	25-Aug-22*	22-Dec-22	$30,000.00
Construction		30-May-16	09-Nov-23	$6,400,000.00
CAP 1446	Construction Interceptor Rehab - HP08 (4,000 LF)	30-May-16*	26-Sep-16	$800,000.00
CAP 1449	Construction Interceptor Rehab - HP04 (4,000 LF)	24-Jan-18*	23-May-18	$800,000.00
CAP 1452	Construction Interceptor/Mains Rehab - HP09 (8,000 LF)	24-Jan-18	21-Aug-18	$1,600,000.00
CAP 1407	Construction Interceptor Rehab - HP05 (6,000 LF)	03-Jul-19	28-Mar-20	$1,200,000.00
CAP 1455	Construction Interceptor/Mains Rehab - HP0x 2022 Post Efficacy as Necessary	16-May-22*	12-Nov-22	$1,000,000.00
CAP 1458	Construction Interceptor/Mains Rehab - HP0X 2023 Post Efficacy	13-May-23*	09-Nov-23	$1,000,000.00
Pump Station Reliability		25-Dec-15	24-Dec-19	$345,000.00
Engineering Services		25-Dec-15	27-Jun-19	$45,000.00
CAP 2025	Engineering Services - Pump Station Reliability Efforts - Schaad Road PS	25-Dec-15*	21-Jun-16	$15,000.00
CAP 2027	Engineering Services - Pump Station Reliability Efforts - Yellowbrick PS	20-Jun-17*	16-Dec-17	$15,000.00
CAP 2029	Engineering Services - Pump Station Reliability Efforts - Campbell's Point PS	30-Dec-18*	27-Jun-19	$15,000.00
Construction		22-Jun-16	24-Dec-19	$300,000.00
CAP 1200	Construction - Pump Station Reliability Efforts - Schaad Road PS	22-Jun-16	18-Dec-16	$100,000.00
CAP 1210	Construction - Pump Station Reliability Efforts - Yellowbrick PS	17-Dec-17	14-Jun-18	$100,000.00
CAP 1230	Construction - Pump Station Reliability Efforts - Campbell's Point PS	28-Jun-19	24-Dec-19	$100,000.00



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