EATING AN ELEPHANT: SSO ELIMINATION PROJECT TAKES MANY BITES

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ABSTRACT

The Western Westmoreland Municipal Authority (WWMA), located 20 miles east of Pittsburgh, PA, is implementing system improvements to eliminate Sanitary Sewer Overflows (SSOs) along Brush Creek as required by a Consent Order and Agreement (CO&A). The project was executed in multiple steps including a permanent flow monitoring program, development of a hydraulic and hydrologic model, and evaluation of alternatives. The culmination of this effort is the design and construction of a three-phase project. Phase 1 includes upgrades to an active wastewater treatment plant (WWTP) and a new 7-MG equalization (EQ) storage tank and 45-MGD pump station. Phases 2 and 3 will feature 7 miles of interceptor improvements.

This presentation highlights the challenges faced during planning, design and construction of the three-phase project. These challenges include, but are not limited to, site constraints, coordination of six member-municipalities, construction in and around a stream, and addressing raw sewage pump air locking and pump vibration issues.

KEYWORDS

Sanitary sewer overflows (SSO), consent order and agreement, storage tank, pump station, interceptor, hydraulic modeling, flow metering, trenchless technologies.

INTRODUCTION & BACKGROUND

The WWMA was formed in 1975 to construct, own and operate an interceptor sewer system and wastewater treatment plant to serve six member-municipalities (the Boroughs of Irwin, Manor, and North Irwin, and portions of the Townships of North Huntingdon, Penn, and Hempfield). Each member municipality owns, operates and maintains their respective sewer collection system. WWMA is located in North Huntingdon Township Pennsylvania which is about 20 miles east of Pittsburgh. The original system (see Figure 1) was comprised of approximately 7 miles of interceptor sewers ranging in size from 8 to 33 inches in diameter, three combined sewer overflow (CSO) regulators, and one WWTP. Over the years, the systems upstream of the three CSO regulators have been separated thus changing the classification of these CSOs to SSO regulators. The WWTP is a secondary treatment facility utilizing grit collection, primary clarification, fine bubble aeration, final clarification, and chlorine disinfection to treat the incoming wastewater flows. Primary and waste activated sludge is gravity thickened prior to anaerobic digestions, centrifuge dewatering and landfill disposal. The WWTP has permitted design capacity of 4.4 million gallons per day (MGD) and currently operates at an average daily flow of approximately 3.4 MGD.

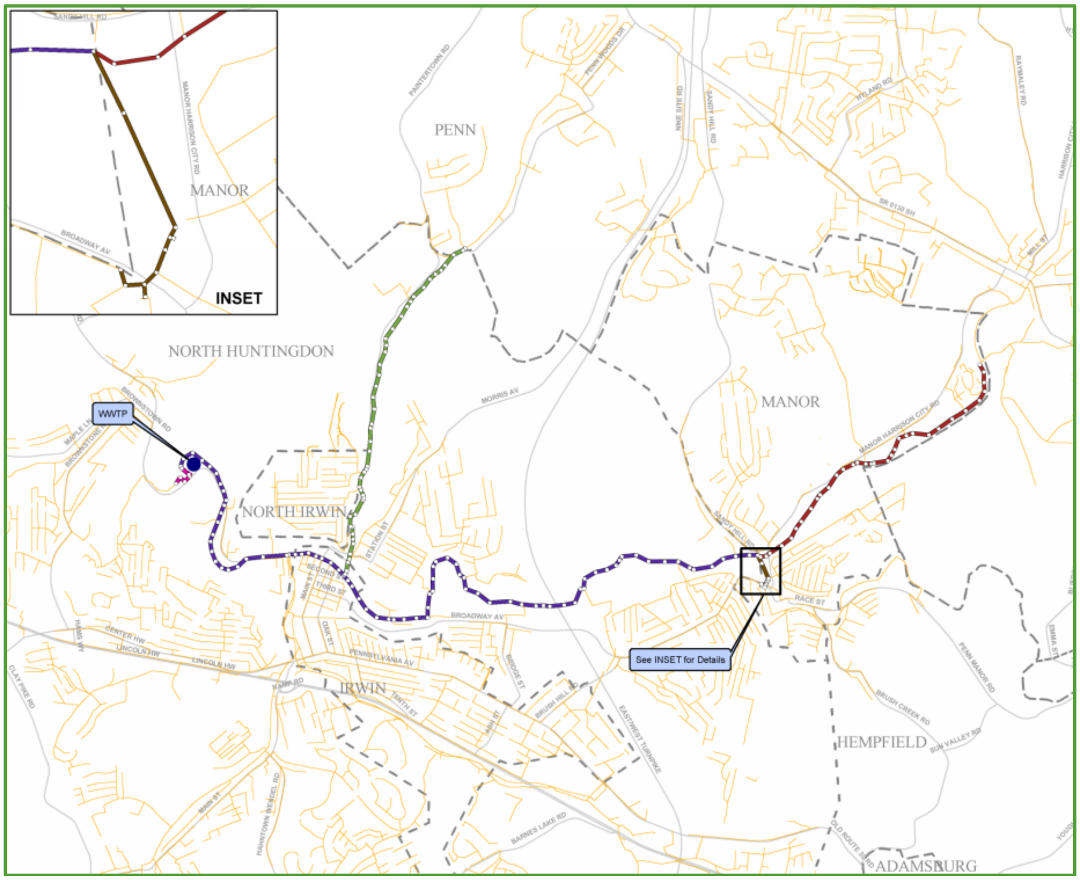

Figure 1: Existing WWMA System

The WWTP is permitted for a wet weather design average flow of 7.25 MGD and a wet weather peak flow of 15 MGD. The WWTP serves approximately 16,000 residential, commercial, and industrial customers throughout the 6,600-acre service area.

During wet weather, the WWTP historically experiences flows exceeding in influent pumping capacity of 15 MGD, which results in SSOs to Brush Creek from the emergency by-pass at the WWTP as well as out of the three SSO regulators located in the system. Between 2008 and July 2011, 30 overflow events occurred within the system. During this timeframe the Pennsylvania Department of Environmental Protection (PaDEP) deemed the system hydraulically overloaded. In September 2011, the WWMA entered into a CO&A with the PaDEP for illegal discharges of wastewater into the Brush Creek during wet weather events. A six-year Corrective Action Plan (CAP) was developed and approved by the PaDEP as part of the CO&A. The WWMA is required to plan, design, construct and implement controls to eliminate wastewater overflows from the WWTP and all points in the WWMA interceptor sewer system.

As the CAP was implemented, it was quickly determined that the extent of the improvements would be extensive and very expensive for an Authority with an annual operating budget of approximately $6 million and a staff of three management and eight operations personnel. Therefore, it was important to break the CAP into several phases and spread the implementation of the proposed improvements over many years to avoid rate shock to Authority customers and manage the risks associated with capital improvements of this magnitude.

METHODOLOGY

The WWMA implemented a permanent flow monitoring program to determine the sources and quantities of the excess flows entering the WWMA interceptor sewer system during wet weather events. Twelve ADS Model Triton flow monitors were installed in 2010 at major connections from the six member-municipalities into the WWMA interceptor sewer as well as key locations along the interceptor system itself.

During the first year of data collection, an Environmental Protection Agency Storm Water Management Model (SWMM) of the collection system was developed. The SWMM is a dynamic simulation model used to represent the hydraulic interceptor system along with the dynamic dry and wet weather flows. The WWMA model was developed with the PCSWMM 2012 interface, which was a commercially-available software package from Computational Hydraulics International (CHI). The overall modeling approach is illustrated in Figure 2. The first step was development of the hydraulic representation which required significant coordination with the six member-municipalities to obtain details of their collection systems as well as any near-term planned improvements to their system. During these coordination meetings, information regarding anticipated local system upgrades and future growth were discussed.

The modeled hydraulic network consisted primarily of the WWMA interceptor sewers and SSO regulator structures. In addition to the WWMA sewers, the Lower Tinkers and Larimar trunklines and short segments of the influent municipal collector sewer upstream of the WWMA interceptor were included in the model to account for the hydraulic capacity of these connections to the WWMA interceptor system. The influence of the WWTP on the WWMA interceptor system was incorporated in the model by representing the WWTP influent pumps within the hydraulic representation. Once the hydraulic model was developed, it was calibrated to a full year's worth of flow monitoring data. The Wastewater Planning Users Group (WaPUG) Code of Practice for the Hydraulic Modelling of Sewers was used as guidance for calibration of the model.

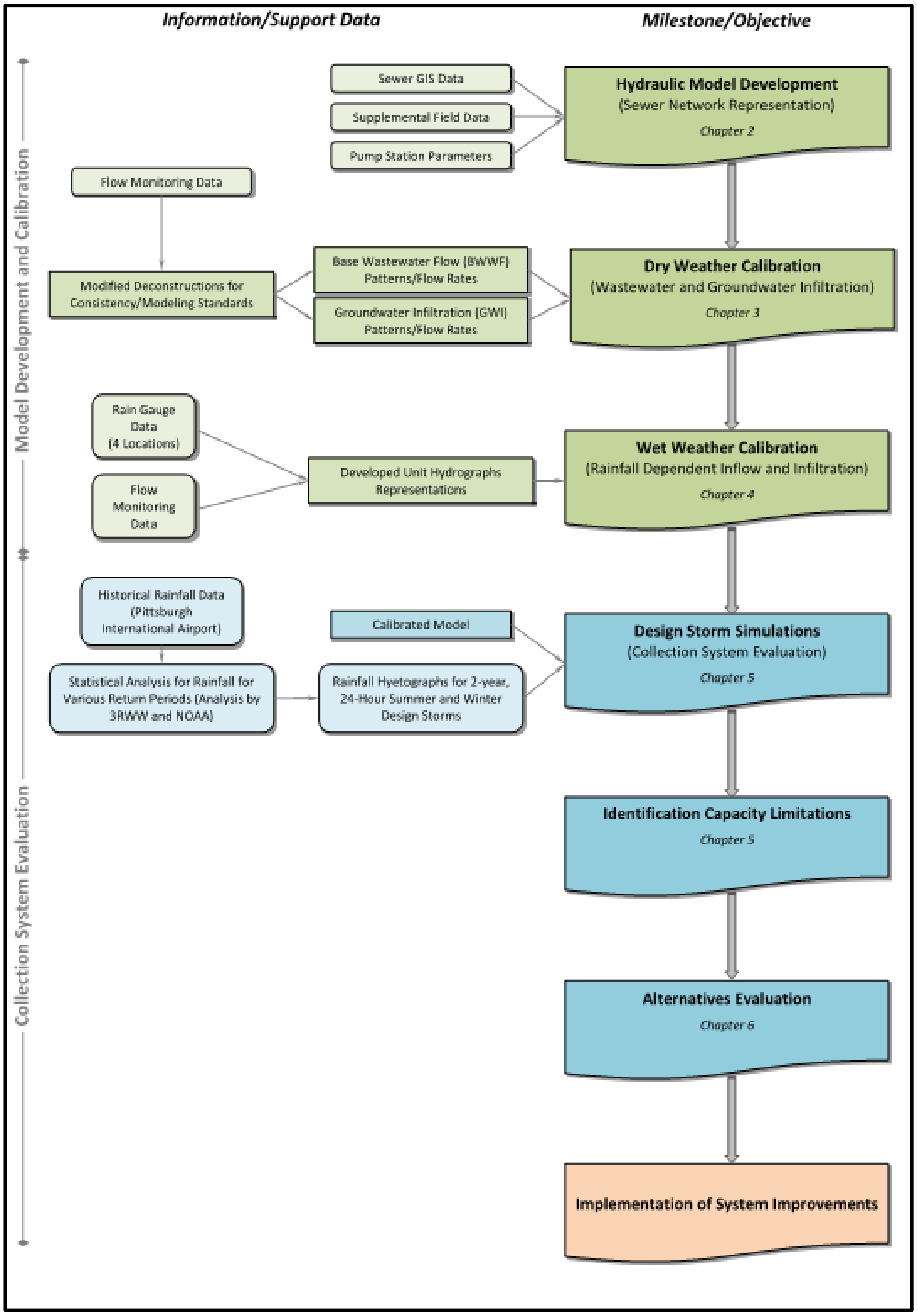

Figure 2: Model Development Process

Once the model was calibrated, the model representation was updated to reflect future conditions which was defined as the year 2035 based on a 20-year planning horizon. The future conditions model accounted for anticipated future developments and municipal projects planned to be completed within five years. The future conditions model was used to evaluate the system performance under both growing and dormant design conditions.

While EPA and PaDEP do not provide guidance for what design storm to use for the design of controls to eliminate SSOs, the 2-year, 24-hour design storm has been used historically within Pennsylvania. WWMA also decided to use this storm as their selected control level. Two distinct rainfall patterns have been used in the greater Pittsburgh area for wet weather planning to differentiate between summer and winter rainfall patterns. The design storm analyses that were performed by the Allegheny County Sanitary Authority (ALCOSAN) for wet weather planning, by 3 Rivers Wet Weather (3RWW) for municipal guidance, and as provided in NOAA Atlas 14, were reviewed to determine the appropriate design storm precipitation volumes and patterns for the summer and winter conditions. Rainfall durations of 24 hours were used for both design conditions. Figure 3 shows the rainfall hyetographs that were evaluated.

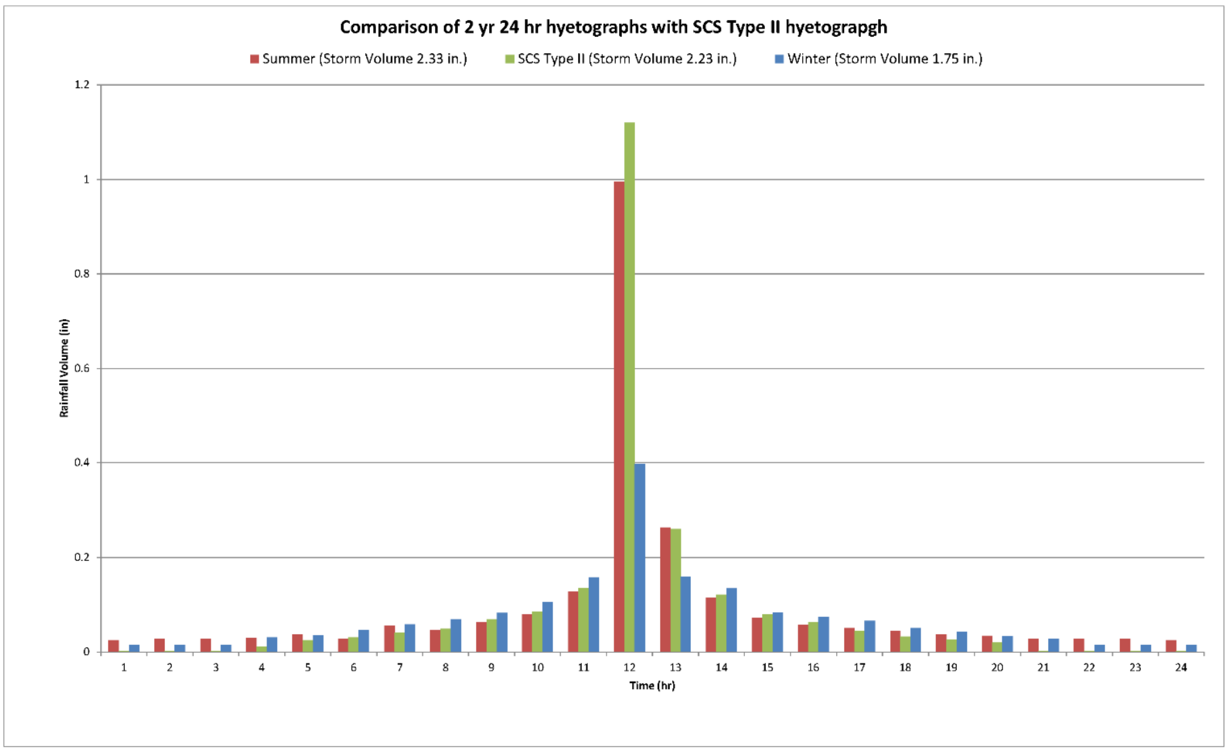

Figure 3: 2-Year, 24-Hour Design Rainfall Hyetographs

The evaluation of alternatives began with the development of applicable control technologies and feasible sites. The feasible technologies and sites were coupled together to form potential site alternatives, and alternatives were then configured, sized, cost estimated, and screened. The first step in the technology screening process was to develop a list of technologies that could be used for SSO control which were placed in the following categories: source control, conveyance improvements, storage, and treatment. The potential control technologies which may suit the needs of WWMA were conveyance improvements, storage, and treatment. Source control alternatives were not evaluated for two reasons. First the implementation of source controls is outside the jurisdiction of WWMA, as the majority of the collection system (over 97%) is owned and operated by other entities. Secondly, the CO&A schedule did not allow sufficient time to evaluate the reduction of flows prior to construction of the controls. Sites for implementation of the possible control technologies were evaluated. Conveyance improvements would be conducted along the existing alignment of the WWMA interceptor system. Several potential sites for storage facilities were identified along the existing interceptor system. Three alternatives were evaluated:

- Convey all flow to storage near the WWTP
- Upstream storage of flow with minimum conveyance improvements
- Optimized upstream storage of flow with some conveyance improvements

An alternative ranking and assessment matrix (See Table 1) was developed to compare and evaluate the various alternatives based on economic and public factors, and operational and implementation impacts. The highest ranked alternative was identified using this matrix.

The highest ranked alternative then progressed into final design and permitting. Approaches for conveyance improvements were evaluated during the design process. Both lift and replace and construction of a parallel relief line were evaluated. A major consideration during this evaluation was that fact that the existing interceptor sewer was primarily located in the toe of the bank of Brush Creek and its tributaries (see Figure 4) and relocating a sewer parallel to the existing line would be substantially deeper and located within narrow state highways. In addition, portions of the existing WWMA interceptor were believed to be constructed of asbestos cement sewer pipe based on existing as-built drawings.

Table 1: Alternative Ranking and Assessment Matrix

Category	Criteria		Criteria Weighting	Category Weighting
Economic Factors	1	Present Worth Capital Cost	25%	**35%**
	2	Present Worth O&M Costs	10%	
Public Factors	3	Community Disruption	5%	**10%**
	4	Potential for Nuisances (odor, noise, aesthetic)	5%	
Operational Impacts	5	Ease of Operation	5%	**25%**
	6	Ease of Maintenance	15%	
	7	Renewal of existing infrastructure	5%	
Implementation Impacts	8	Constructability	10%	**30%**
	9	Ability to Expand Capacity/Limits Liability of Future Growth	15%	
TOTAL	10	Land Acquisition	5%	**100%**

During the design phase, an evaluation was conducted to determine if storage would be provided above or below existing grade. Cost estimates were developed for both construction methods factoring in pumping requirements to determine the most cost-effective approach. As part of the design, the WWMA determined that improvements to the existing WWTP pump station would be included as part of the project along with several other miscellaneous improvements at the WWTP. Wade Trim worked closely with WWMA personnel to evaluate which portions of the WWTP would be disturbed during implementation of the improvements to evaluate what other potential upgrades at the WWTP should be completed at this time.

Figure 4: Alignment of the Brush Creek Interceptor

Extensive permitting and licensing was required from various agencies including:

- Water Quality Part II Construction Permit from PaDEP
- NPDES stormwater permit and E&S Permit from the Westmoreland County Conservation District
- Joint 105 Permit from the United States Army Corp. of Engineers and PaDEP
- Numerous license agreements with the Pennsylvania Department of Transportation
- Multiple license agreements with Norfolk Southern Railroad
- One license agreement with the Pennsylvania Turnpike Commission

To facilitate the permit applications and reviews, individual meetings were held prior to the submittal of the applications to provide the individual agencies or entities the appropriate background on the WWMA project and to discuss their specific processes for applications. Throughout the permitting process the team kept an open dialog with the reviewing parties to ensure timely review.

During the design and permitting phase it was determined that it would be best to implement the proposed improvements in three phases due to the size and cost of the improvements. Another major consideration in the schedule was the need for significant number property acquisitions. The PaDEP was contacted to discuss a modification to the WWMA CO&A. The First Amendment to the CO&A was executed on April 24, 2014 and extended the end date of the CO&A, but also allowed for the multiple-phase implementation of the improvements. The phasing of the projects started at the WWTP and moved upstream to ensure the full benefit of the improvements could be achieved for each individual project.

Phase 1 improvements started construction in March 2016 and those facilities went online in January 2019. Construction of Phase 2 improvements began in fall of 2017 and is anticipated to be completed in late 2019. The Phase 3 improvements will be advertised in mid 2020 with construction anticipated to start in spring of 2021, with completion scheduled for mid 2023.

RESULTS

The flow monitoring program documented significant inflow and infiltration entering the system from the six member-municipality systems as illustrated by typical ratios of peak wet weather flow to average dry weather flow of greater than 8 to 1 for events greater than 0.5 inches of rainfall. Flow monitoring data from 2011 was utilized to calibrate the SWMM. The wet weather responses were calibrated to over 60 events that were observed in 2011. The model representation was evaluated relative to the flow monitoring data at each flow meter by comparing time series of flow rates and depths, regression plots of model versus metered peak flow rates, and regression plots of model versus meter volumes. Example model evaluation plots are shown in Figure 5. In general, most of the flow meter sites met the WaPUG criteria. Only one area fell outside the WaPUG criteria. This area was a combined sewer area that was scheduled to be separated in the near future and therefore the variability of this site was deemed acceptable as the representation of this area would be replaced with the hydrology developed from another monitor.

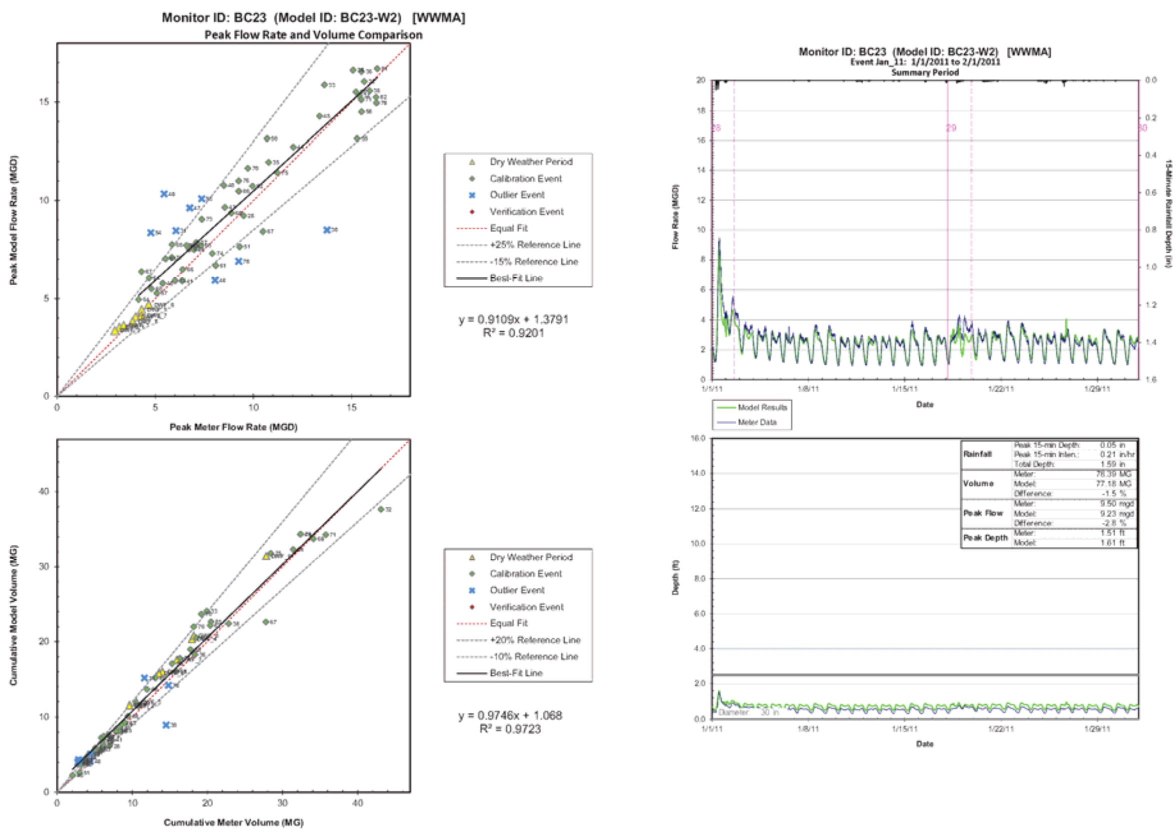

Figure 5: Example Calibration Plots

The calibrated model was then used to evaluate the performance of the existing system under design conditions. As shown in Figure 6, the 2-year, 24-hour design storm runs show that significant surcharging and manhole flooding could occur along the WWMA interceptor system during the design storm. The Bushy Run and Brush Creek Interceptors show surcharging due to the flows exceeding the interceptor capacity resulting in manhole flooding at the upstream end of the interceptors. The Paintertown Interceptor shows significant surcharging on the upper portion of the interceptor. The surcharging is caused by the flow exceeding the capacity of some segments of the interceptor while surcharging of other segments is the result of the capacity limitations farther downstream on the interceptor. The raw sewage pumping and wetwell capacity at the WWTP is also contributing to the interceptor surcharging as flows regularly exceed this pump station's maximum capacity of 15 MGD.

A number of alternatives to address the surcharging and manhole flooding were evaluated. The highest ranked alternative included the construction of a 7-MG equalization tank near the WWTP and upsizing of the entire interceptor system. The primary drivers for this alternative were siting limitations for storage facilities in the upstream section of the interceptor, the Authority's goal of renewing the existing interceptor system, site limitations to build a parallel line in all segments of the interceptor, cost, and future operational considerations.

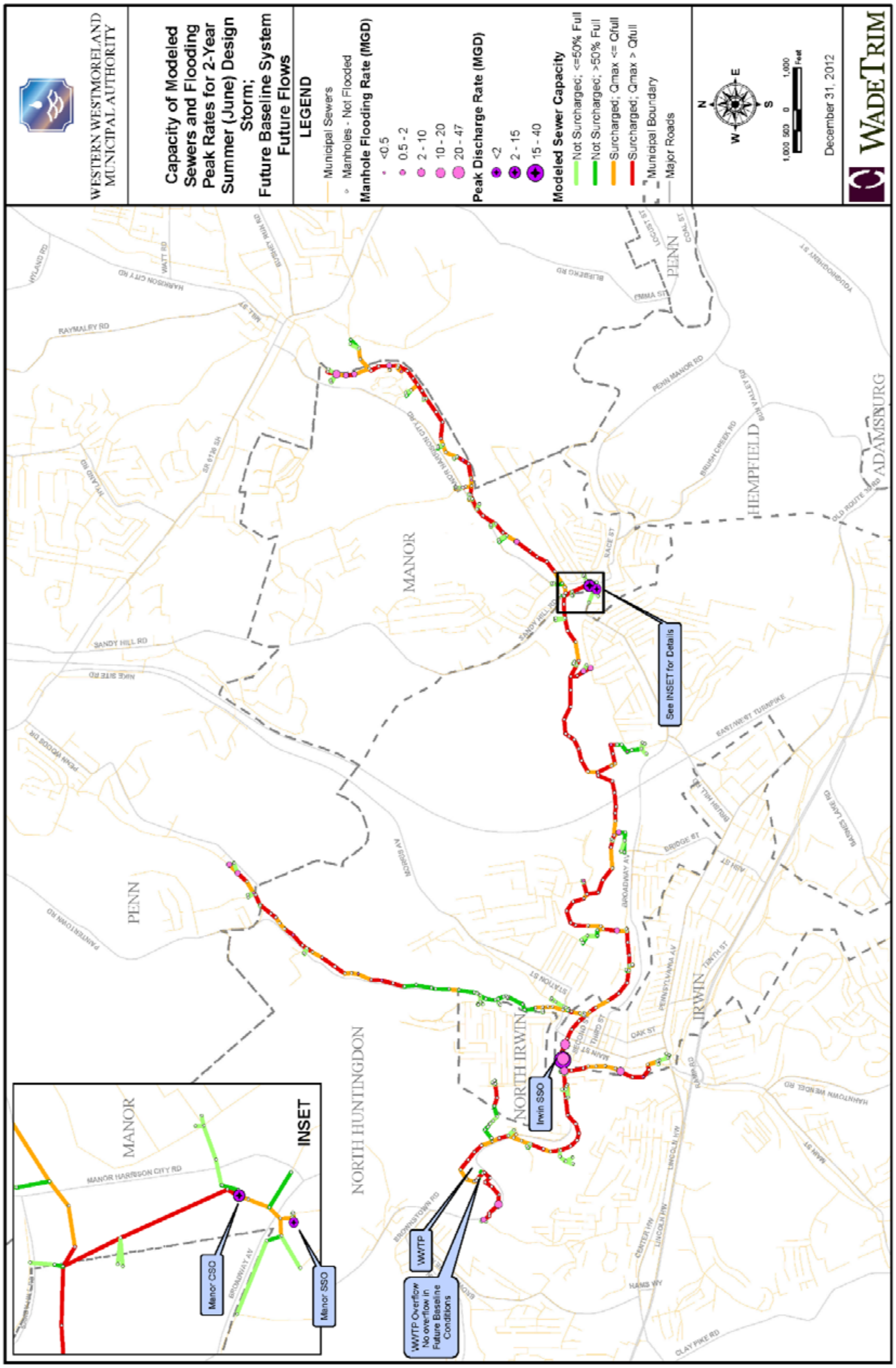

Figure 6: Capacity of Modeled Sewers and Flooding Volumes Under a 2-Year, 24-Hour Design Storm

Due to the extent of the required improvements, it was determined and negotiated with the PaDEP to implement the improvements in three phases. To realize the maximum benefit of each phase, it was determined to start the improvements at the downstream end of the system and then work upstream. Therefore, the Phase 1 improvements included the construction of the 7-MG equalization tank, a new 45-MGD pump station, a new screening facility, and miscellaneous improvements at the WWTP. Phase 2 consists of the replacement of the entire Bushy Run Interceptor while Phase 3 will replace the Bushy Run, Paintertown, and Manor interceptors in their entirety.

During the design of Phase 1, the equalization tank was located as close as possible to the WWTP based on operational considerations. Based on this Authority preference, the new equalization tank was located across the street from the existing WWTP on property that was owned by one of the member-municipalities. While this was a vacant lot, it was located adjacent to a state road and quickly rose over 100 feet in elevation. Due to the topography of the site, it was not feasible to construct a below-grade storage facility due to the depth of required excavation and the hard-rock geology of the site. Therefore, it was determined to construct an above ground, wire- and strand-wound, circular, pre-stressed concrete tank with operations and maintenance access provided via a newly constructed road to the top of the hill. Figure 7 shows before and after photos of the site while Figure 8 shows the total completed project. The pump station is a multipurpose facility featuring fine mechanical screens having a total capacity of 50 MGD, and a capacity to pump 15 MGD to the existing WWTP utilizing 3 pumps with maximum pumping capacities of 7.5 MGD. The pump station also has an additional 30 MGD of wet weather capacity to pump flows to the new EQ tank once the WWTP capacity has been maximized. The wet weather capacity is provided by four pumps. Two pumps have capacities of 15 MGD each while the other two have capacities of 7.5 MGD each and are operated on variable frequency drives. The EQ Tank receives flows from the pump station after mechanical screening to avoid cleaning and flushing after use and drains back by gravity through the same force main through a series of actuated values in a force main that is common to the raw sewage pump force main, thus allowing the EQ Tank to drain directly to the existing WWTP for treatment. Limited site availability and adequate locations to site the pump station and EQ tank presented significant challenges to the design team in terms of facility siting, construction staging, and sequencing, and varying soil conditions. The EQ tank is located next to, but more than 100 feet above the pump station that is constructed into the side of the 100-foot hill. The pump station site required excavation through colluvial/alluvial soils and into shale/stone and features a rock-anchored retaining wall with double steel beam pile and cast-in-place concrete wall that exceeds 32 feet in height in places. The pump station is integrated into the middle of the retaining wall with its back wall designed as an extension of the retaining wall. As part of the project, the local municipality also had requirements to reduce the surface stormwater runoff from the site to 60% of the predeveloped flows. This required the installation of two bio-retention ponds and a 25,000 cubic foot underground stormwater storage system.

Figure 7: Construction of the pump station required cutting back the hillside and installing a retaining wall.

Figure 8: Aerial view of the completed project.

Additionally, the project featured a utility tunnel to connect the existing WWTP to the pump station. This utility tunnel conveys process and utility piping between the two facilities and was constructed under an active state highway. The tunnel also allows WWMA personnel to safely cross the highway between the WWTP and the pump station for operation and maintenance activities. Construction of the state highway crossing required extensive coordination with local and state regulatory authorities to temporarily close the road and detour traffic, as this was the safest and most expedient way to complete the open-cut construction and installation of a 10' by 10' precast box structure that was 150 feet long. As significant work will be conducted on the existing WWTP site, the Wade Trim design team worked closely with WWMA's General Manager, Assistant Manager, Forman and Chief Operator to evaluate other system improvements that should be completed at the same time as this project. It was determined to modify the existing wet well into a recycle wet well and separate the combined thickener centrate / centrifuge supernate lines into the wet well as they were original to the WWTP. Various other original components of the WWTP were also integrated into the project including replacement of various control gates, demolition of the influent comminutors, replacement of miscellaneous process piping, replacement of portions of the main potable water line, and replacement and installation of new carbon media odor control units and upgrades to the plant SCADA system.

The Phase II interceptor improvements involved replacing approximately 21,000 linear feet of existing 21- to 33-inch diameter Asbestos Cement Pipe (ACP) and Reinforced Concrete Pipe (RCP) with 36- to 48-inch RCP. The Phase III interceptor improvements consisted of replacing approximately 19,000 linear feet of 8- to 18-inch ACP, RCP and vitrified clay pipe with 15- to 30-inch PVC pipe. Both Phases of the program utilized both open cut and trenchless technologies for the construction of the sewer lines. The alignment features numerous state road, railroad, and highway bridge crossings. Most of the interceptor is located within or alongside Brush Creek or tributary streams/creeks. While the interceptor improvement designs moved the interceptor out of the stream where possible, it was not feasible to do so in many areas as the excavation would be 10 to 15 feet deeper and located within a narrow state highway having a high traffic count. Therefore, large portions of the interceptor upgrades will be within the limits of a flowing creek that required significant regulatory permitting for managing creek flows. In addition, due to constrained site conditions, much of the improvements will take place on an active sewer system requiring significant by-pass pumping of sewage flows during construction.

Construction on Phase I is complete, and Phase II is anticipated to be completed by the end of 20019. The design for Phase III is complete and the project will be bid in mid 2020 with an anticipated construction start in the Spring of 2021. Table 2 presents the costs for the three phases of the project.

Table 2: Total Construction and Project Costs

CO&A Improvements Project	Construction Cost	Total Project Cost*
Phase I: Pump Station and Storage Tank	$26.6 M	$32 M
Phase II: Brush Creek Interceptor	$12.1 M	$14.6 M
Phase III: Bushy Run, Paintertown and Manor Interceptors	$10.5 M (Estimated)	$13.5 M (Estimated)
Total	**$49.2 M**	**$60.1 M**

Due to the high cost of these projects in comparison to the size of the system, WWMA developed a financial plan to manage the rate increases that would be required to fund these projects. The Authority proactively raised rates early in the process to fund and pay for up-front planning and design activities which created future revenues to help finance the required capital improvements. WWMA was successful in obtaining 50% funding for the Phase 1 project through low interest loans from PENNVEST and funded the remaining portion of this project through the refinancing of an existing sewer revenue bond and the issuance of two separate sewer revenue bonds (in November and January) in order to take advantage of certain IRS rules and interest rates. WWMA was also successful in obtaining full funding for the Phase II project through a low interest loan from PENNVEST. It is anticipated that WWMA will also apply for funding through PENNVEST for the Phase III project and is anticipating full project funding. Based on this proactive approach the Authority has been successful in realizing a level debt approach over the next 25 years. Currently, the monthly residential sewer rates have been maintained below $31/month/EDU. It should be noted that WWMA's customers, the member municipalities, then add their respective sewer rates to WWMA's rate for billing of their respective customers.

DISCUSSION

During the execution of this project it was very evident that due to the size of the study and ultimate capital improvements it was important to break the process into many steps. This allowed the owner to stay engaged in the level of detail that they preferred. This also allowed the WWMA to work closely with the PaDEP regarding the implementation schedule as more detail was developed as they were able to show significant progress to the PaDEP in meeting specific milestone dates when it was realized that amendments to the CO&A would be required.

Several valuable lessons were learned during construction of the Phase I improvements. Due to the limited site access, the owner worked closely with the contractor to improve site access by providing a travel path through the WWTP to the contractor to improve their workflow. WWMA also worked with the contractor to coordinate with PENNDOT and local agencies, including police, fire and emergency services, to close the state road between the WWTP and the new pump station. This allowed for a quicker installation of the utility tunnel as well as a safer work environment for the contractor.

One of the main challenges during construction and startup of the pumps were issues with air binding of the pumps. While the design had air release valves on the discharge piping, the pumps were still experiencing air binding. WWMA worked closely with the contractor and the manufacturer of the air release valves to troubleshoot this issue. It was ultimately determined air was being trapped between the suction bell and the isolation plug valve on the suction line. This was due to the orientation of the rectangular valve port. The rectangular port was horizontal as opposed to vertical, allowing air to become trapped. While the manufacturer of the plug valve did not believe the valve could be trapping air. Ultimately, at the suggestion of the contractor, the installation of an air release valve upstream of the plug valve resolved the issue.

Another challenge observed during start-up was periodic high vibrations on the pumps. Extensive testing of the pumps was conducted prior to start-up. A temporary force main was installed which allowed for a closed loop to be formed for both the raw sanitary and wet weather pumps. During individual testing of the pumps no vibration issues were observed over the range of operating speeds of the pumps. However, under certain head conditions and certain combinations of pumps running at the same time, vibrations exceeding the specified acceptable levels were observed. WWMA worked closely with the contractor to bring in an outside specialist to investigate these vibrations. Motion amplification cameras and specialized vibration measurements were utilized to investigate and pinpoint the source or sources of the vibrations. This testing identified some issues with the contractor supplied base plates of the raw sewage and small wet weather pumps that the contractor repaired. However, these repairs did not eliminate the vibrations. The testing also identified that when the two small wet weather pumps were running at the same speed that the vibration issues were exacerbated. Therefore, the SCADA programming was modified to keep these pumps running at least 0.25 hertz apart from one another. An isolation coupler was also installed on the discharge header between the raw sewage and wet weather sides of the combined header system. This did help mitigate the vibrations being transmitted from the wet weather pumps to the raw sewage pumps.

During construction of the Phase 2 improvements, Western Pennsylvania experienced the wettest year on record. This created many challenges for the contractor as they were working within an active stream that quickly reacted to even minor rainfall events. This also created issues with completing work within a baseball complex that was to be completed during the off season. During construction of this portion of the project, the stream running next to the baseball complex flooded the fields twice (see Figure 9). WWMA and the contractor worked very closely with the baseball association board to prepare their fields for the upcoming 2019 season. To facilitate the work in the fields during these wet periods, groundwater pumps were installed and additional drainage within the fields were installed to dry the fields so final restoration could be completed.

Additionally, sever flash floods further delayed construction on several other occasions, including Tropical Storm Gordon last September. Another unexpected circumstance of the extreme wet weather during the Spring of 2018 was the build-up of acid mine water within the old underground coal working of the area. This build-up broke through to the surface a several locations, including at the baseball complex and at a neighbouring property. Although not the

Figure 9: Steam flooding at the PAL Baseball Complex

fault of WWMA's contractor, they worked with WWMA, the property owners and the Pa Dept of Abandoned Mines to direct those flow into adjacent waterways. Finally, it was also determined during construction of the Phase 2 improvements that production was much quicker on the sections of interceptor sewer that were being replaced in the same trench verses building a parallel line due to the extent of hard rock in the area. This, in conjunction with the fact that the construction design avoided the removal of ACP where ever possible by constructing a parallel line, it was determined that the As-Built interceptor drawing were not correct, and the lines being replaced were actually RCP. This allowed for revising the construction plans to a lift and replace scenario rather than a parallel installation

Based on the above cited issues, as well as other administrative and project management issues encountered either prior to, or during construction, the Phase III Project is being revised as follows:

- Existing pipe material is being tested to determine if it is in fact ACP and not RCP, transite and/or truss pipe.
- Where ever possible the alignment has been revised to a lift and replace rather than a parallel construction
- Rights-of-Way acquisition includes notification to the property owners that their mortgage company/lien holder must sign-off on the R/W Agreement.
- Construction bid forms have been changed to include stone bedding & backfill, trench dewatering, bypass pumping and miscellaneous municipal re-connections be included in the unit pipe price rather than separate line items

- The contract time has been extended from 18 months to 24 months due to site constraints, number of property owner lateral re-connects and extent of by-pass pumping required.
- The contractor will need to provide all required insurances, including general liability and builders risk as WWMA will not be providing said insurance through on OCIP (Owner Controlled Insurance Program).

CONCLUSIONS

Several lessons were learned through the implementation of this program. Breaking a large, daunting issue into smaller pieces makes it more manageable. But it is also important to keep the overarching challenge in mind so appropriate planning can occur, as demonstrated by WWMA in managing sewer rates for their customers. Breaking the program into smaller pieces allowed the project team to develop solutions for the individual challenges that were encountered throughout the project.