FREDERICK COUNTY
Division of Utilities and Solid Waste Management

CITY OF FREDERICK
Department of Public Works

MONOCACY SEWERSHED WASTEWATER UTILITY STUDY PHASE I

FINAL REPORT

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FREDERICK COUNTY AND CITY
MONOCACY SEWERSHED
WASTEWATER UTILITY STUDY
PHASE I

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Executive Summary

The Monocacy Sewershed Wastewater Utility Study for the Frederick County (County) Division of Utilities and Solid Waste Management (DUSWM) and City of Frederick (City) Department of Public Works wastewater collection and conveyance system is being conducted in two Phases, as defined below:

Phase I: This report presents the results of the Phase I analysis. The remaining capacity of the collection system was analyzed, including creation of a sewer hydraulic model of the Tuscarora, Upper Monocacy, City, and Lower Monocacy Interceptors. Capacity issues were identified where they currently exist or where they will be created as additional areas are served, as defined by the Potomac River Water Supply Agreement (PRWSA) and by other planning mechanisms. The Ceresville Pump Station (PS) and City Wastewater Treatment Facility (WWTF) headworks were also analyzed for capacity, with capacities at the City WWTF defined from previously completed studies.

Phase II: Phase II will establish an order of improvements based on observations from Phase I, with associated timing increments and costs of implementation.

Study Background

The County and City wastewater collection and conveyance systems share facilities north of the City. Flows from existing subdivisions within both the County and City are collected by the Tuscarora Interceptor. These flows are then combined with flows from the Town of Walkersville, which are conveyed via the Upper Monocacy Interceptor, and flow to the County's Ceresville PS.

Flows from the Ceresville PS are pumped a short distance, then continue via gravity to the City Interceptor, which runs south through the City Water Treatment Plant (WTP) property, where the County flow is measured at a Parshall flume. Flow from the City is then collected by the interceptor which combines with additional City interceptors prior to discharge at the City WWTF.

The City WWTF is set up to bypass a daily flow quantity equal to that measured at the Parshall flume. This flow is sent to the County's Lower Monocacy Interceptor, which is a pressure sewer that runs south to the County's Ballenger-McKinney Wastewater Treatment Plant (WWTP). Flows from additional interceptors are added to the Lower Monocacy Interceptor, including Linganore, Pinecliff/River Oaks, Bush Creek/Urbana, Ballenger and Buckeystown.

Data Collection and Modeling

The PRWSA details the proposed growth and potential demand incurred on the County and City water supply. Increases in water demand are directly correlated to increases in sanitary sewer loading. For the purposes of modeling, the known PRWSA projects were included as future demands. The timing of growth for PRWSA projects was estimated by the City and can be seen, along with estimated flow

projections from the Town of Walkersville, on the Sanitary Load Allocation Table (SLAT, included in the report **Appendix**) as broken across multiple time steps (Currently Allocated, 2015, 2020, 2030, 2040). Hydraulic models were developed for the portions of the County and City collection and conveyance systems for each of these time steps. In addition, the Potomac River effluent outfall system was modeled to determine the current system capacity.

Historical flow data were received and evaluated from both the County and the City. Flow meters are permanently installed at the City WWTF Influent Pump Station discharge, the Ballenger-McKinney WWTP Influent Pump Station discharge, a Parshall flume at the City's WTP property, the Ceresville PS, and at strategic locations within the City's collection system. Temporary flow meters have previously been installed for short term studies in several locations within the County's collection system. In addition, as part of Phase I of this study, meters were deployed by the County in selected interceptors to gather supplemental flow data. Friction factor testing was also performed on the Lower Monocacy Pressure Sewer. The meter data were collected, analyzed, correlated where possible, and used to determine average daily and peak hourly wastewater flows, as well as peaking factors at various points in the system. These data were compared with flow estimates to confirm the accuracy and aid in the calibration of the system models.

Results and Recommendations

The modeling efforts to date have identified areas of the Monocacy Interceptor and Ballenger-McKinney WWTP effluent line where there are capacity limitations. These modeling efforts have been based on available historical flow data, discussions with County and City staff, and the assumptions as outlined herein. Recommendations for next steps include the following:

1) Installation of reliable flow meters in strategic locations in the County and continued use of flow meters in the City for long term flow testing to verify the flow assumptions outlined herein. Long term flow metering will provide the County and City with an on-going tool to capture peak flow events, which will provide the ability to re-calibrate the Sewer Model, as necessary, and assess results of improvements being made to the system to combat infiltration and inflow. Potential long term flow metering needs, in no order of priority, include:
    - Tuscarora Interceptor
    - Upper Monocacy Interceptor (Walkersville)
    - Linganore Interceptor
    - Bush Creek/Urbana Interceptor
    - Ballenger Interceptor
    - Buckeystown Interceptor

2) Initiation or continued efforts to determine base infiltration at locations throughout the service area. The model currently has not separated infiltration from sewage flow, but has been set up with

this capability. Potential areas to determine base infiltration, in no order of priority, include the locations listed above, as well as:

- City Interceptor
- Carroll Creek Interceptor
- Gas House Pike Interceptor

3) Continuation of this Study by proceeding with Phase II and the associated objectives to identify potential infrastructure improvements necessary to accommodate planned and future flow projections.

1.0 Introduction

1.1 Project Background

The Frederick County (County) Division of Utilities and Solid Waste Management (DUSWM) and City of Frederick (City) Department of Public Works wastewater collection and conveyance systems share facilities north of the City. Flows from existing subdivisions within both the County and City are collected by the Tuscarora Interceptor. These flows are then combined with flows from the Town of Walkersville, which are conveyed via the Upper Monocacy Interceptor, and flow to the County's Ceresville Pump Station (PS).

Flows from the Ceresville PS are pumped a short distance, then continue via gravity to the City Interceptor, which runs south through the City Water Treatment Plant (WTP) property, where the flow is measured at a Parshall flume. Flow from the City is then collected by the interceptor which combines with additional City interceptors prior to discharge at the City Wastewater Treatment Facility (WWTF).

The City WWTF is set up to bypass a daily flow quantity equal to that measured at the Parshall flume. This flow is sent to the County's Lower Monocacy Interceptor, which is a pressure sewer that runs south to the County's Ballenger – McKinney Wastewater Treatment Plant (WWTP). Flows from additional interceptors are added to the Lower Monocacy Interceptor, including Linganore, Pinecliff/River Oaks, Bush Creek/Urbana, Ballenger and Buckeystown. Refer to **Figure 1-1** for an overview of the system.

Portions of the Monocacy Interceptor collection and conveyance system have experienced Sanitary Sewer Overflows (SSOs) during extreme peak flow events. This study included collection and analysis of flow data from the County and City focusing on the service area contributing to the Monocacy Interceptor. County and City staff have provided additional insight and historical perspective based on operational experience. Existing and projected flows (as defined by the Potomac River Water Supply Agreement (PRWSA)) were considered, a series of hydraulic models of the system through build-out conditions were developed, and capacity limitations in the system have been identified.

1.2 Purpose of Report

The Monocacy Sewershed Wastewater Utility Study for the County and City wastewater collection and conveyance system is being conducted in two Phases, as defined below:

Phase I: This report presents the results of the Phase I analysis. The remaining capacity of the collection system was analyzed, including creation of a sewer hydraulic model of the Tuscarora,

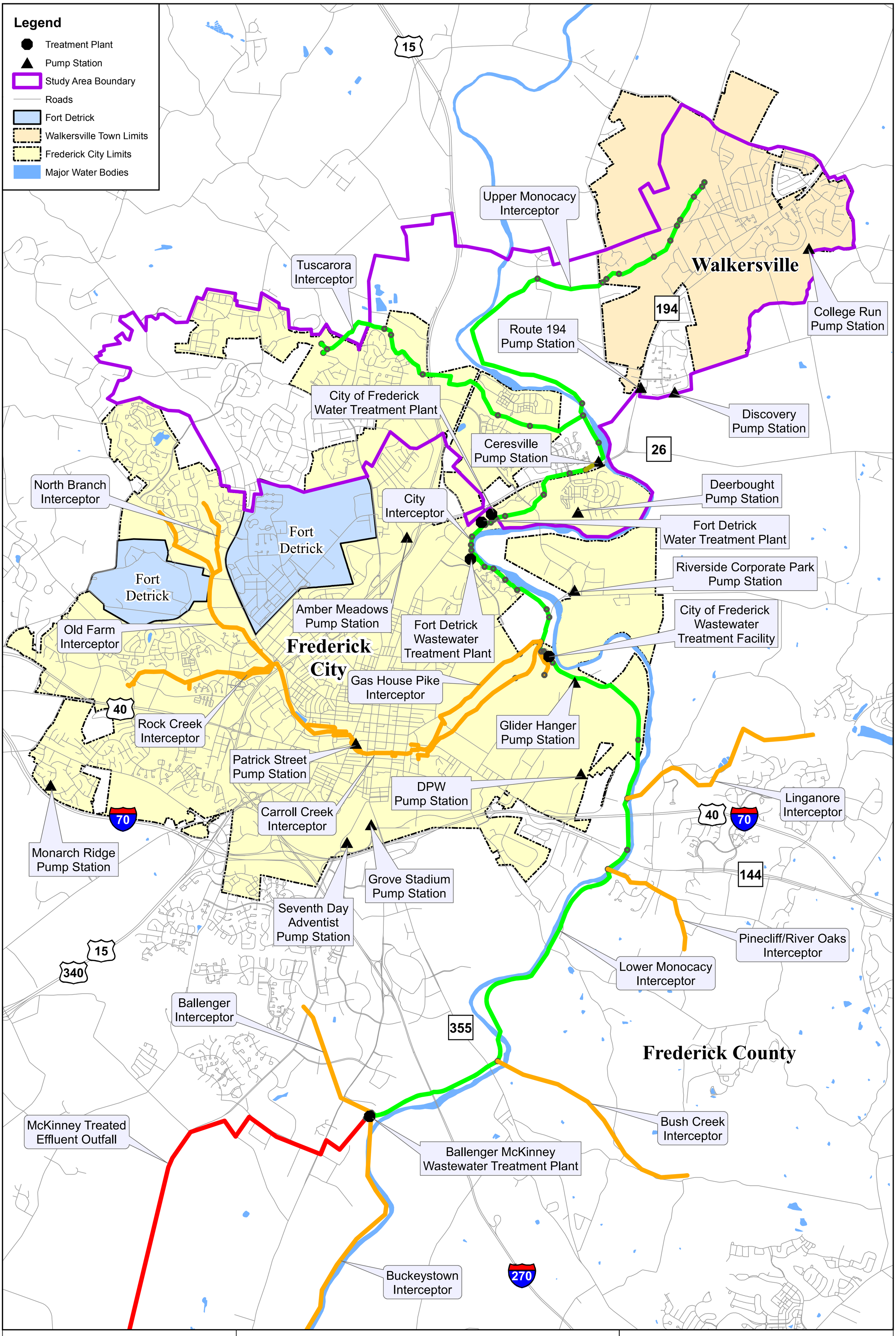

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FIGURE 1-1: Monocacy Sewershed

Upper Monocacy, City, and Lower Monocacy Interceptors. Capacity issues were identified where they currently exist or where they will be created as additional areas are served north of the City. The Ceresville PS and City WWTF headworks were also analyzed for capacity, with capacities at the City WWTF defined from previously completed studies.

Phase II: Phase II will establish an order of improvements based on observations from Phase I, with associated timing increments and costs of implementation.

1.3 Approach and Scope of Report

Specific tasks accomplished under **Phase I** of this project include the following:

- Future wastewater flow projections were developed based on land use information, particularly areas recently annexed by the City and/or added to the County's sewer service area north of the City, including Walkersville and the proposed Century Annexation. Flows from the remainder of the contributing areas (south of the City) were taken from existing flow projections developed for Linganore, Pinecliff/River Oaks, Urbana/Bush Creek, Ballenger Creek and Buckeystown based on the County's Wastewater Collection and Outfall Corridor Analysis Report (February 2006).

- A new sewer model for the trunk sewer system was created utilizing SewerCAD® software which includes input flows to the trunk sewer. The effluent outfall system from the County's Ballenger-McKinney WWTP to the Potomac River was also modeled.

- The model was developed by incorporating flow monitoring data from existing meters, pump station flow records, and agreed-upon (between the County and the City) planning figures into the hydraulic model. Specific supplemental meter data were requested, and provided by the County and City. In addition, some field testing was performed.

- Near term and long term capacity problems in the existing system were identified.

2.0 Existing Sewer System Conditions

2.1 Service Area Description

The entire Monocacy Sewershed consists of sewer flows from the City, the Town of Walkersville, and outlying County areas north, east, and south of the City. The study focuses primarily on the Monocacy Interceptor and the subsequent modeling is generally broken up into three major segments – 1) Upper Monocacy and Tuscarora Interceptor, 2) Ceresville Pumping Station and City Interceptor, and 3) Lower Monocacy Pressure Sewer. The Monocacy Interceptor directly interfaces with three major facilities – Ceresville PS, City WWTF and Ballenger-McKinney WWTP. Many other sewage pump stations are integrated into the overall collection system. Fort Detrick owns and operates both a WTP and a WWTP that are not related to the current study. The City operates a WTP that sends filter backwash waste into the collection system. A Parshall flume flow measurement structure is located at the City's WTP property and is part of the Monocacy Interceptor system.

Figure 1-1 shows an overview of the overall service area, with emphasis on the Monocacy Interceptor and its contributing trunk lines. Major facilities, including sewage pumping stations, and major interceptors which directly feed into the Monocacy Interceptor are shown for reference. All of the sewage collected in the Tuscarora and Upper Monocacy Interceptors flows into the Ceresville PS. The flow is pumped for a short segment, then the Monocacy Interceptor transitions to gravity flow and continues to the City WWTF, where a large portion is treated and discharged into the Monocacy River. A small portion of this flow, equivalent to the flow volume measured at the Parshall flume, is pumped into the Lower Monocacy Interceptor, which acts as a pressure sewer that conveys flow to the Ballenger-McKinney WWTP. Treated effluent from the Ballenger-McKinney WWTP is discharged to the Monocacy River.

2.1.1 Upper Monocacy and Tuscarora Interceptor

Sewage flows from the northern areas of the County and City are collected in the Tuscarora Interceptor. Sewage flows from the Town of Walkersville are collected in the upper segment of the Monocacy Interceptor. The Route #194 Pump Station also discharges flows into the Upper Monocacy Interceptor south of Walkersville. These flows combine together in Manhole MH#1 (Contract #8-S) and flow into the Ceresville PS.

Figure 2-1 shows the Upper Monocacy and Tuscarora Interceptor collection system with illustration of all manholes which collect flow inputs into the system.

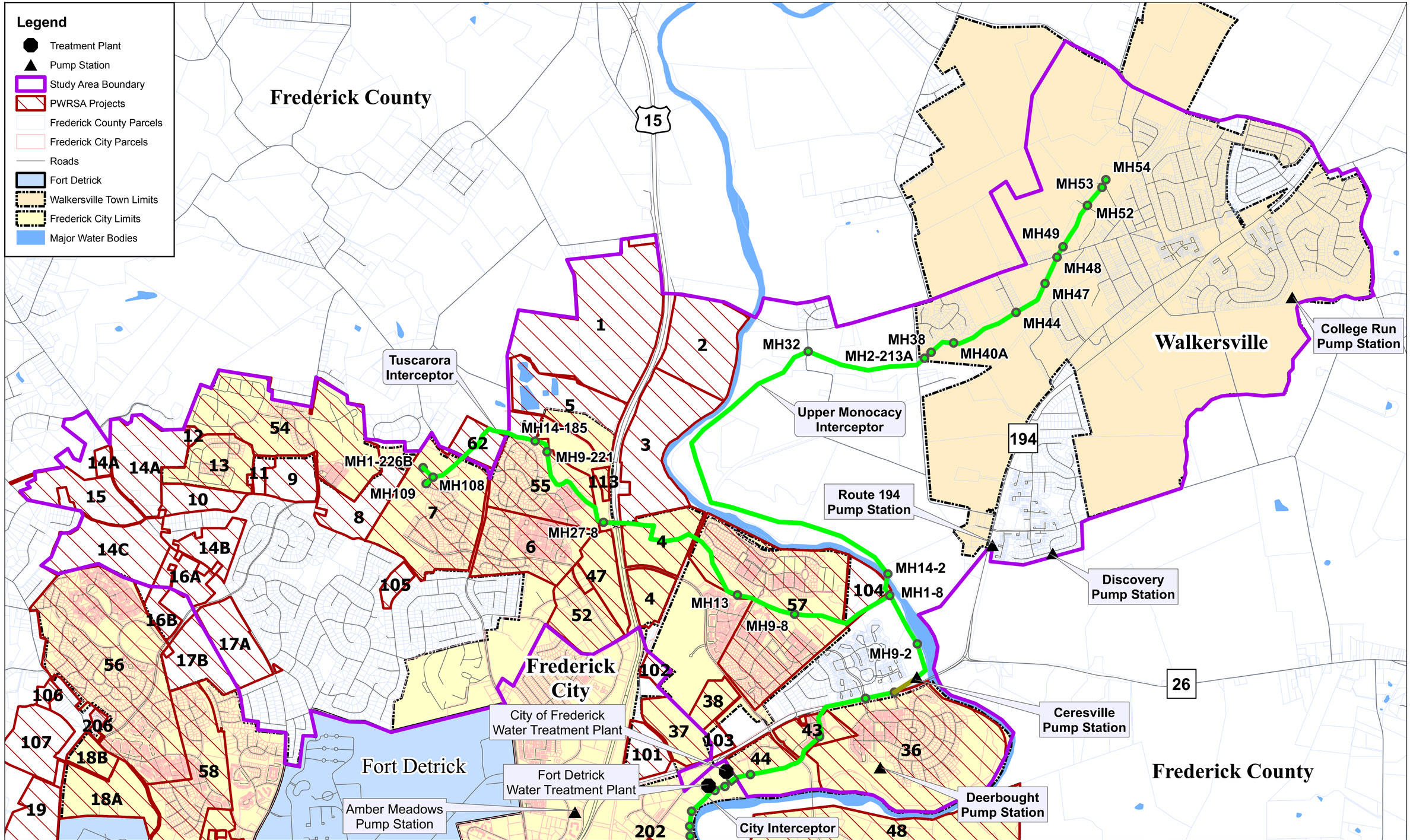

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FIGURE 2-1: Upper Monocacy and Tuscarora Interceptors

N

0 1,550 3,100 6,200 Feet

2.1.2 Ceresville Pump Station and City Interceptor

Sewage received into the Ceresville PS includes all of the flows from the Upper Monocacy and Tuscarora Interceptors. The sewage is pumped from the Ceresville PS, where it transitions back to gravity flow and continues via gravity to the City WWTF. Sewage flows are collected directly into the Monocacy Interceptor and include pumped flow from the Deerbought subdivision, Riverside Corporate Park and periodic high rate backwash from the City's WTP. Two major interceptors connect to the Monocacy Interceptor just prior to the City WWTF – the 33-inch Gas House Pike Interceptor and the 54-inch Carroll Creek Interceptor.

Figure 2-2 shows the Ceresville PS and City Interceptor segment with illustration of all manholes which collect flow inputs into the system. A Parshall flume is shown near the City's WTP. Flow measured in the Parshall flume is considered County flow. The City WWTF pumps a volume equivalent to that measured at the Parshall flume into a flow equalization basin to the Lower Monocacy pressure sewer which is ultimately treated at the County's Ballenger-McKinney WWTP.

2.1.3 Lower Monocacy Pressure Sewer

The City WWTF pumps the County flow portion into the Lower Monocacy pressure sewer to be treated at the County's Ballenger-McKinney WWTP. Sewage flows from outlying County areas are collected by five major interceptors, which contribute to the Lower Monocacy pressure sewer – Linganore, Pinecliff/River Oaks, Bush Creek, Ballenger, and Buckeystown.

Figure 2-3 shows the Lower Monocacy Pressure Sewer segment with illustration of all manholes which collect flow inputs into the system. Treated effluent from the Ballenger-McKinney WWTP is discharged to the Monocacy River with future provisions to discharge a portion of the effluent flow through an alternate outfall to the Potomac River.

2.2 Existing Facilities

2.2.1 Ceresville Pump Station

The Ceresville PS has been in operation since 1969 and includes two (2) extended shaft centrifugal sewage pumps. The station was upgraded in 2008 to add variable speed drives and replace the pumps and pump motors. The station was originally planned for two additional pumps, but the capacity has not yet been expanded.

During normal operating conditions, the upgraded pumps have a design operating point of 4,800 gallons per minute (gpm) each or a total operating capacity of 9,600 gpm (13.8 MGD).

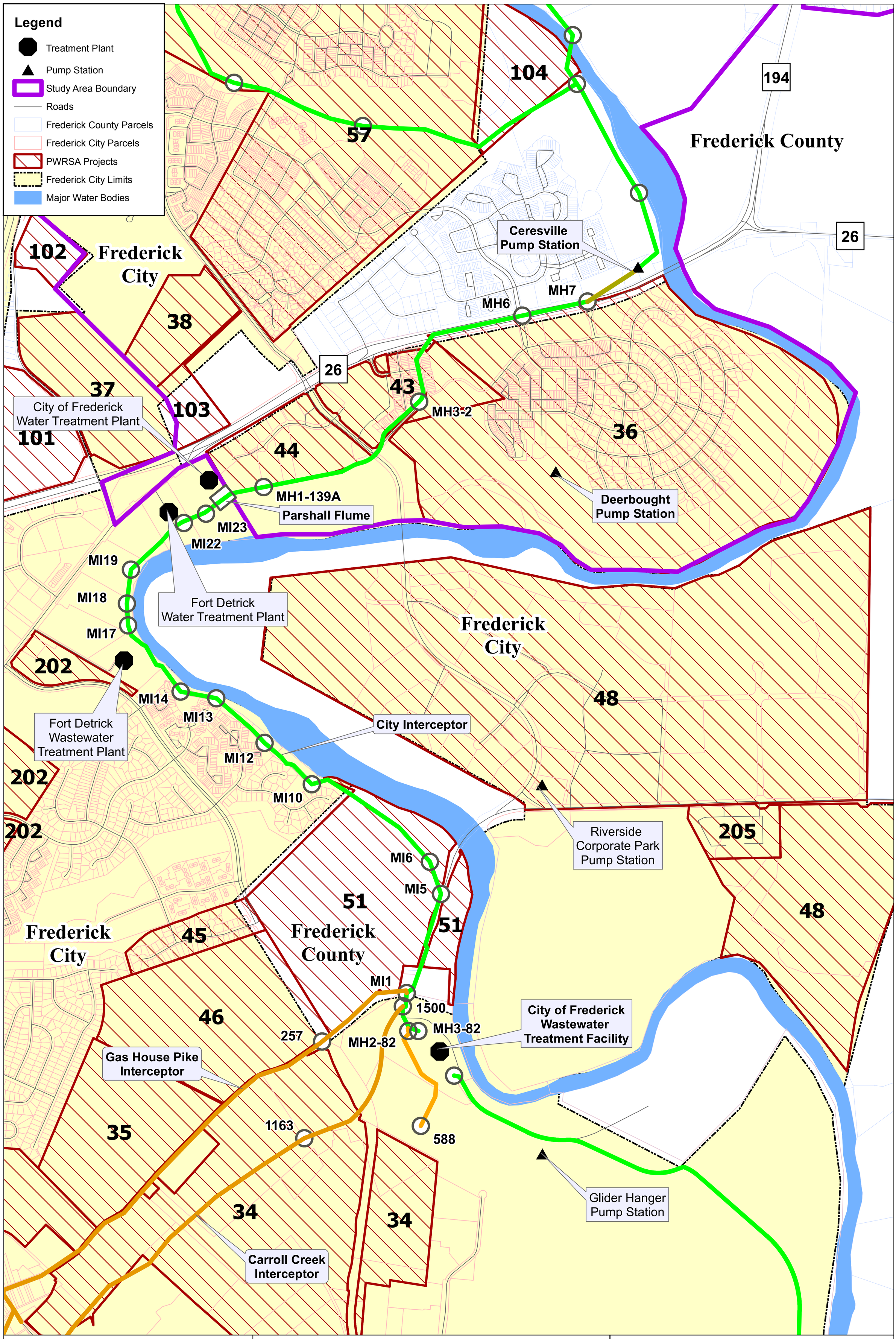

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FIGURE 2-2: Ceresville Pump Station and City Interceptor

N

0 500 1,000 2,000 Feet

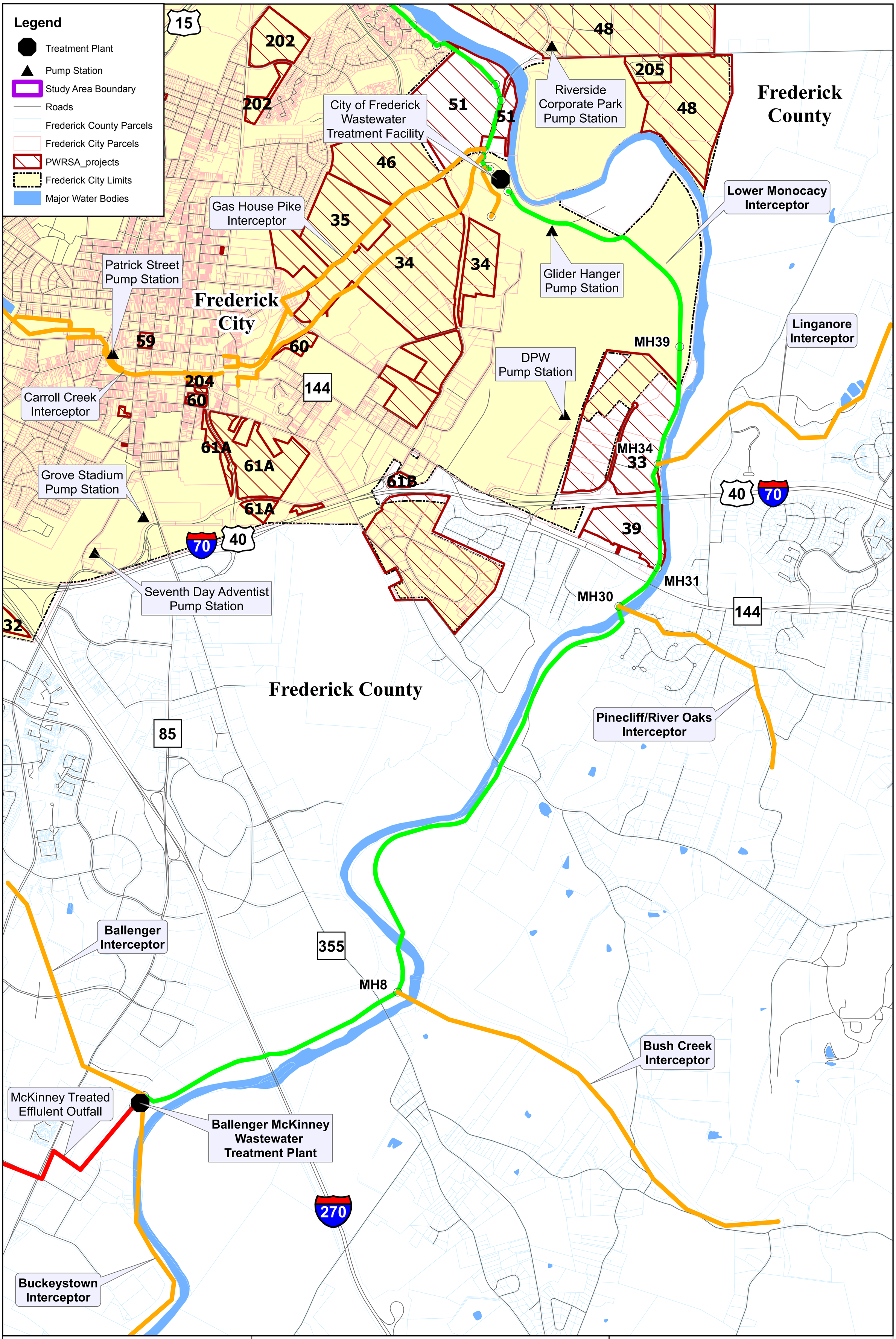

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FIGURE 2-3: Lower Monocacy Pressure Sewer

N

0 1,000 2,000 4,000 Feet

Refer to pump curve in the **Appendix**. The wet well is 20.5-feet long by 7-feet wide and the station has depth below the 39-inch sewer invert (elevation 238.93) of 6.6-feet, providing a volume within the station of just over 7,000 gallons. Because the storage volume is limited in the station, the County operates the station, consistent with the original design intent, at a water level that creates a surcharge condition in the collection system. The surcharge elevation is equivalent to the invert of an upstream manhole (MH#9, Contract #2-S), or elevation 240.84. This was assumed to be the tailwater elevation at Ceresville PS in the sewer model.

2.2.2 City of Frederick WWTF

The City WWTF has been in operation since 1937 and has gone through several upgrades and expansions and currently has a treatment capacity of 8.0 million gallons per day (MGD). The facility went through its most recent upgrade to achieve Biological Nutrient Removal (BNR) effluent limits for Total Nitrogen (TN) and Total Phosphorus (TP). The upgrade was completed in 2002. The plant includes the following liquid treatment facilities:

- Screening
- Influent Pump Station
- Grit Removal
- Flow Equalization
- Primary Clarification
- Activated Sludge Biological Treatment Reactors with an A^2O Process Configuration
- Secondary Clarification
- Tertiary Filtration (Not currently in service)
- Gas Chlorination and Sulfur Dioxide Dechlorination
- Cascade Post Aeration

A Facility Plan (February 2010) was prepared to address facility improvements necessary to meet state mandated upgrades to Enhanced Nutrient Removal (ENR) requirements. Improvements are anticipated to include the addition of the following liquid treatment facilities:

- Wet Weather Treatment System
- Activated Sludge Biological Treatment Reactors converted to a Modified Lutzack Ettinger (MLE) Process
- Bio-Augmentation Facility
- Denitrification Filter Facility
- Ultraviolet Disinfection

The preliminary treatment facilities, including Screening, Influent Pump Station and Grit Removal, receive both County and City flow contributions. The County flow is measured at the

City's WTP property in a Parshall flume and an equivalent flow volume is stored in an equalization basin before being pumped to the Ballenger-McKinney WWTP. With the implementation of recent upgrades to the Influent Pump Station, the safe pumping capacity (one pump out of service) is approximately 30.5 MGD. The total pumping capacity (all pumps operational) is approximately 36 MGD. The screening and grit removal facilities have a peak capacity of 40 MGD.

When improvements identified in the Facility Plan are implemented, the influent pumps will be upgraded to a safe pumping capacity of 40 MGD, to match the capacity of the Screening and Grit Removal facilities.

The City WWTF includes a flow equalization basin that is utilized as a holding well for County flows. The equalization basin is adjacent to a wet well, from where the County flow is pumped into the Lower Monocacy Interceptor. The pump station, referred to as Pumping Station No. 2, has a total of five (5) variable speed driven pumps. Two pumps have a nominal capacity of 5 MGD each and are typically used to pump wastewater to the County. The other three pumps have a nominal capacity of 7 MGD each and generally pump wastewater back through the City WWTF. However, all pumps are connected to a common discharge header, so there is some ability to increase pump capacity to the County beyond 10 MGD. Of note, in recent field testing, the City utilized Pump Nos. 3, 4 and 5 and pumped at a rate of 11.8 MGD to the County.

The screening facility has a top of wall elevation of 257.25. This was assumed to be the tailwater elevation at the City WWTF in the sewer model.

2.2.3 Ballenger-McKinney WWTP

The Ballenger-McKinney WWTP has an existing capacity of 7.0 MGD. The plant is being expanded to an average flow of 15 MGD using membrane bioreactor technology. The current facility is designed to meet BNR requirements and includes the following liquid treatment facilities:

- Influent Pump Station
- Screening
- Grit Removal
- Primary Clarification
- 5-stage Activated Sludge Configuration
- Secondary Clarification
- Tertiary Filtration
- Ultraviolet Disinfection

- Cascade Post Aeration

The upgraded plant will meet ENR requirements and will include the following liquid treatment facilities:

- Influent Pump Station
- Screening
- Grit Removal
- Primary Clarification
- Fine Screening
- Flow Equalization
- 5-stage Activated Sludge Configuration
- Membrane Filtration
- Ultraviolet Disinfection
- Post Aeration

Effluent from the Ballenger-McKinney WWTP is discharged to the Monocacy River. Because of load allocations for TN, TP and Biochemical Oxygen Demand (BOD_5) in the discharge permit and practical limitations of technology to meet stricter effluent limitations associated with increased flow volume, the County constructed an alternative effluent line in the event that future discharges exceeding 15 MGD need to be directed to the Potomac River. Section 4.1 provides additional information on the effluent line.

The existing pump station operates in a surcharged condition at a high water level elevation of 235.20. This was assumed to be the tailwater elevation at the Ballenger-McKinney WWTP in the sewer model for the currently allocated flow simulation. A new screening and influent pumping station is being constructed with the screening facility maximum water elevation of 214.22. This was assumed to be the tailwater elevation at the Ballenger-McKinney WWTP in the sewer model for the 2015 and subsequent flow simulations.

2.3 Existing Wastewater Flows

Historical flow data were received and evaluated from both the County and the City. Flow meters are permanently installed at the City WWTF Influent Pump Station discharge, the Ballenger-McKinney WWTP Influent Pump Station discharge, a Parshall flume at the City's WTP property, the Ceresville PS, and at strategic locations within the City's collection system. Temporary flow meters have previously been installed for short term studies in several locations within the County's collection system. Additional short term flow data were collected by the County as part of this study. **Table 2-1** illustrates a summary of the data that were reviewed.

Table 2-1. Flow Measurement Summary

Flow Meter	Type and Location	Data	Duration
City of Frederick WWTF	Magnetic Flow Meter at Influent Pumping Station Discharge	Daily Flow Total Hourly Flow Total	January 1-December 31, 2010 March 11-17, 2010
Ballenger-McKinney WWTP	Magnetic Flow Meter at Influent Pumping Station Discharge	Daily Flow Total Hourly Flow Total	January 1-December 31, 2010 March 11-17, 2010
City Water Treatment Plant	Ultrasonic Flow Meter at Parshall Flume	Daily Flow Total Hourly Flow Total	January 1-December 31, 2010 & January 11-June 10, 2011 March 11-17, 2010
City Collection System	Flo-Dar - MI-6, M-257, M-588, M-1163	Daily Flow Total Hourly Flow Total	January 1-December 31, 2010 March 11-17, 2010
County Collection System	Flo-Dar 4 in MH-16, Upper Monocacy Interceptor (Walkersville)	Rate Every 15 Minutes	December 20, 2005-January 3, 2006
County Collection System	Flo-Dar 5 in MH-8, Tuscarora Interceptor	Rate Every 15 Minutes	December 20, 2005-January 3, 2006
County Collection System	Station-Analyzer Route #194 Pump Station	Daily Flow Total	December 13, 2005-January 3, 2006
County Collection System	Station-Analyzer Ceresville Pumping Station	Daily Flow Total	December 13, 2005-January 3, 2006
County Collection System	Magmeter Ceresville Pump Station	Daily Flow Total	January 11-June 10, 2011

For the City collection system, manhole MI-6 is located in the Monocacy Interceptor prior to convergence with the Carroll Creek and Gas House Pike Interceptors. Manhole M-257 is located at the downstream end of the Carroll Creek Interceptor. Manhole M-588 is located at the

downstream end of the sewer areas south of the City WWTF including the airport. Manhole M-1163 is located at the downstream end of the Gas House Pike Interceptor.

For the County collection system, sewage flows were recorded at manhole MH-16, representing the Town of Walkersville. The Route #194 Pump Station discharges into MH#14 of the Upper Monocacy Interceptor, just upstream of the crossing under the Monocacy River. Manhole MH-8 is located at the downstream end of the Tuscarora Interceptor. Flows from Walkersville and Route #194 Pump Station combine with the Tuscarora Interceptor in MH#1 (C#8-S) to form the influent to the Ceresville PS. The discharge from the Ceresville PS combines with a relatively small fraction of City flow and is measured at a Parshall Flume located on the City's WTP property.

The County also provided base infiltration flow summaries that had been determined from previous in-house flow studies for the Tuscarora Interceptor, Walkersville (Upper Monocacy) area, and the Ceresville PS. However, it was determined that these data did not provide sufficient duration so as to reliably establish a true base (dry weather) infiltration. As such, base infiltration was not considered separately in the model simulations. Rather, base infiltration was considered to be already included in the planning level average flow values in the sanitary load allocation tables.

Table 2-2 shows a summary of the recorded average daily and, where available, peak hourly flows. The duration of data collection is recorded. The City flow data were provided for the past three years, but the data reflected in the table represents flows from the year 2010, and represents a true annual average. Peak hourly flow rates were determined using the hourly flow values, where available, measured between March 11 and March 17, 2010, which was a wet-weather event that produced consecutive days of elevated flow. A total of 2.48 inches of rain was captured over a four day period and a large amount of accumulated snow from February 2010 contributed to increased inflow during this rain event. Flow values recorded for the County were taken over a relatively short interval during the winter time, so although the values represent an average of the data that were collected, it is questionable whether these represent a true annual average. However, these data were concurrent for approximately a two-week period (December 20, 2005 through January 3, 2006). Hourly flow data were not logged during the March 11-17, 2010 wet-weather event in the County collection system. Data have recently become available for the Ceresville PS discharge by datalogging output from a Magmeter, which covers nearly half of a year (January 11 through June 10, 2011).

The County installed temporary ISCO flow meters into strategic locations in the Lower Monocacy Interceptor at the Buckeystown, Bush Creek, and Ballenger Interceptors during this evaluation and provided summary reports of each. Due to the limited duration of these flow measurements, flows associated with the Lower Monocacy Interceptor are not represented in

Table 2-2. For purposes of modeling, peak flows for the Lower Monocacy Interceptor were calculated based on peaking factor equations published by Maryland Department of the Environment (MDE). Peaking factors are discussed in further detail later in the report.

Table 2-2. Summary of Recorded Flows

Frederick County					
Segment	Walkersville	Tuscarora	PS#194	Ceresville	Ceresville
Flow Meter ID	Flo-Dar 4	Flo-Dar 5	Station-Analyzer[1]	Station-Analyzer[1]	Magmeter
Duration	12/20/05 - 1/3/06	12/20/05 - 1/3/06	12/19/05 - 1/3/06	12/13/05 - 1/3/06	1/11/11 - 6/10/11
Average Flow (MGD)	1.43[2]	0.79[2]	0.14[2]	2.38[2]	1.96[3]
Peak Hour Flow (MGD)	-	-	-	-	-
Peak Factor	-	-	-	-	-
City of Frederick[4]					
Segment	Frederick WTP	City Interceptor	City 33-inch	City 54-inch	Frederick WWTF
Flow Meter ID	Parshall Flume	Flo-Dar MI-6	Flo-Dar M-1163	Flo-Dar M-257	Magmeter
Duration	1/1/10 - 12/31/10	1/1/10 - 12/31/10	1/1/10 - 12/31/10	1/1/10 - 12/31/10	1/1/10 - 12/31/10
Average Flow (MGD)	2.08	3.10	0.99	5.07	8.76
Peak Hour Flow (MGD)	11.99	12.97	3.83	18.55	35.00
Peak Factor	5.76	4.18	3.87	3.66	4.00

[1]Station-Analyzer is a flow analysis device that calculates flow rates based on the duration and frequency of pump/fill cycles. The device is installed with the wet well dimensions and pump start and stop elevations to determine the total volume change during cycles.

[2]Frederick County performed concurrent metering in the upper Monocacy collection system between 12/20/05 - 1/3/06. Average flows represent average flow data collected by the metering during this period and do not represent a true annual average. Flows at pump stations represent calculated flows based on pump and fill cycles in the wetwell. Peak flows were not captured during the 2010 peak wet weather event (3/11/10 - 3/17/10).

[3]Ceresville average flows from 1/11/11 - 6/10/11 represent daily pump station discharge totals.

[4]Average flows represent average daily flow data collected by the metering and represent a true annual average. Peak hour flows represent the maximum hourly flow measured during the 2010 wet weather event (3/11/10 - 3/17/10).

The peak factors described in Table 2-2 were used as the basis for peak flow calculations for the City portion of the sewer model. While not shown on the table, a peak hourly flow was estimated for the Ceresville PS using the 2011 Magmeter data. The flows recorded by the Magmeter are daily discharge flow totals for each pump. These flows were compared to the daily flow totals recorded downstream at the City WTP through the Parshall Flume during the same time period (January 3-June 10, 2011). There are marginal flow contributions to the interceptor between Ceresville PS's discharge point and the Parshall Flume, but by comparing the two flows a relationship was determined. A ratio of Ceresville PS daily flow total to the Parshall Flume daily flow total approaches an average of 91%. Using this relationship, a peak hourly flow was estimated for the Ceresville PS based on the peak hourly flow recorded at the

WTP. During the week of 3/11/10 – 3/17/10 the peak hourly flow recorded through the flume was 11.99 million gallons per day (MGD). As such, the peak hourly flow from Ceresville PS was estimated to be 10.92 MGD during the same time frame. This corresponds to a peaking factor of 5.58, which was used in the model for Walkersville, Tuscarora, Route #194 Pump Station and Ceresville PS.

2.4 Field Testing

An important part of this study and the development of the hydraulic model of the collection and conveyance system was the gathering of sufficient field data to calibrate the model. At the request of the County, WR&A reviewed the Lower Monocacy Pressure Sewer drawings to determine a location between the City WWTF and Ballenger-McKinney WWTP for friction factor testing of the sewer that was built in 1990. It was determined that the segment between Entry Port Manhole (EPMH) 40 and EPMH 37 would be an appropriate place to perform the testing, depending on the condition of the existing appurtenances on the sewer. This section creates an elevated hydraulic grade between two high points, ensuring the sewer is always under full pipe flow conditions. The following steps were taken to perform the testing:

- Flow was established by pumping at fixed rates from the equalization basin at the City WWTF.
- Segment of pipe that was tested is between two high points, so the section of pipe remained full pipe flow.
- Each EPMH had a flanged tee on the sewer pipe, with a 4-inch tap on the 30-inch x 20-inch tee blind flange, equipped with a plug valve and a blind flange.
- 4-inch blind flanges were drilled, tapped, threaded and pressure gauges (with diaphragms) were installed at each EPMH by County personnel.
- Gauge assemblies were installed on each EPMH, and the 4-inch plug valves were opened.
- Flow was regulated and recorded at the City WWTF providing a set flow for a period of time, then ramping up to a higher set flow and holding, etc, to allow collection of pressure data for several flow conditions.

Testing was performed on May 10, 2011. Flow was set at 8, 10 and 11.75 MGD by operators at the City WWTF, and pressures were recorded at EPMH 40 and 37 by WR&A and County personnel. A WR&A survey crew confirmed the rim elevations of each manhole, and County personnel checked the calibration of the pressure gauges. The recorded testing data sheet and calculations are included in the **Appendix**. A roughness coefficient was calculated by rearranging Manning's formula and the Hazen-Williams equation. The results of the 8 MGD flow rate greatly differ from the 10 and 11.75 MGD readings. The readings taken at EPMH 37 are closer to the downstream high point and are more directly influenced by varying hydraulic conditions at the high point (as flows increase, the downstream high point transitions from open

channel flow to surcharged conditions). In addition, velocities at lower flows are insufficient to produce a measurable pressure differential, making friction factor calculations inaccurate. Therefore the 8 MGD and lower flow readings were not considered in friction factor determination. At higher flow rates, the test yielded a Hazen-Williams coefficient, C, of 120 and a Manning's *n* of 0.012. See **Table 2-3** for a summary of results.

Table 2-3. Summary of Lower Monocacy Interceptor Friction Factor Field Testing

Test Results:			
	n		C
8 MGD Average =	0.009	=	168
10 MGD Average =	0.012	=	119
11.75 MGD Average =	0.012	=	120
Average of all 3 =	0.011	=	135
Average of 10 & 11.75 =	0.012	=	119

3.0 Sewer Capacity Modeling

3.1 Forecast of Future Wastewater Flows

Through collaboration between the Board of County Commissioners and the City, the PRWSA details the proposed growth and potential demand incurred on the County and City water supply. Increases in water demand are directly correlated to increases in sanitary sewer loading. For the purposes of modeling, the known PRWSA projects are included as future demand. The timing of growth for PRWSA projects was estimated by the City and can be seen on the Sanitary Load Allocation Table (SLAT) as broken across multiple time steps (Currently Allocated, 2015, 2020, 2030, 2040). **Table 3-1** summarizes projected annual average flow rates for each time step. A copy of the SLAT is included in the **Appendix**.

Additional areas of growth are also included for the Town of Walkersville. The prominent residential project annexed into Walkersville is the Century subdivision southeast of the existing Discovery development. Other development is also expected in Walkersville, but a majority of the surrounding farms are intended to remain as a buffer between the town and the Monocacy River. Due to limited information on the timing of growth within Walkersville the additional demand was evenly spread across the 2020, 2030, and 2040 time steps.

Flows from the remainder of the contributing areas (south of the City) were taken from existing flow projections developed for Linganore, Pinecliff/River Oaks, Urbana/Bush Creek, Ballenger Creek and Buckeystown based on the County's Wastewater Collection and Outfall Corridor Analysis Report (February 2006).

Table 3-1. Projected Annual Average Flow Rates from Sanitary Load Allocation Table

Monocacy Interceptor Segment	Projected Annual Average Flow (MGD)				
	Currently Allocated	2015	2020	2030	2040
Tuscarora: MH#108 (C#195-S) to MH#1 (C#8-S)	1.0	1.3	2.0	3.1	3.1
Upper Monocacy: MH#54 (C#5-S) to Ceresville PS	2.1	2.8	3.8	5.3	5.5
City Interceptor: MH#7 (C#2-S) to City WWTF	10.4	11.2	13.0	15.5	15.7
Lower Monocacy: City WWTF to Ballenger-McKinney WWTP	7.6	10.4	13.8	19.4	23.5

3.2 Peaking Factors

In order to model both diurnal patterns and inflow events due to precipitation, peaking factors were applied to the average daily demands noted in the SLAT. In the past three (3) years two major events caused significant inflow to the Monocacy Interceptor system. The first event occurred on December 26-27, 2009. It was later noted by the County operational staff that a manhole just upstream of the Parshall flume adjacent to the City WWTF had its frame and cover dislodged. The Monocacy River was directly entering the compromised manhole due to flooding conditions. For this reason, this rain event was not used to determine peak flows due to extraneous circumstances. The second significant event occurred on March 11-17, 2010. The flows at the City WWTF peaked at 35 MGD. The peaking factors were determined by taking the maximum peak over this period and dividing it by the average daily flow to determine the peak hour peaking factor. Each drainage sub-basin has an individual peaking factor to more accurately model the systems' inflow.

$$PF = \frac{PH}{AD}$$

$$PF \equiv Peak\ Hour\ Peak\ Factor$$

$$PH \equiv Peak\ Hour\ Flow$$

$$AD \equiv Annual\ Average\ Daily\ Flow$$

The peak hour peaking factor accounts for the total increase in flow during a precipitation event. In reality, only sanitary loading and inflow experience peaks based on diurnal and hydrograph patterns, respectively. The infiltration into the system would experience a separate peak that is not directly correlated to an hourly pattern. Infiltration can only enter the sewer system at cracks and joints, which will be determined by the age, material, and construction of the system. These variables determine the location of leaks, but the amount of infiltration is dictated by the groundwater level and soil composition. The only dynamic variable is the groundwater level in relation to the sewer system, which is dependent on seasonal rainfall. The model has been configured to allow separate input for infiltration. However, as discussed previously in the report, reliable base infiltration values have not been developed for each major segment in the system. For the model, base infiltration was considered to be already included in the planning level average flow values in the SLAT.

The peaking factors were used to predict how existing flows will change based on peak and inflow events. It is assumed that all new and future sewer infrastructure will have significantly less inflow and will reduce the peaking factor associated with additional flow. The peak flows for the interceptors draining to the Lower Monocacy pressure sewer at several time steps have

already been determined in the Wastewater Collection and Outfall Corridor Analysis Report of 2006. In order to determine a peaking factor for the Monocacy Interceptor Sewershed future flows, the MDE equation (below) was used to predict peak flows for the system. The equation varies based on the average flow of the system causing each time step to have a new peaking factor.

$$Q_P = 3.2 \times Q_A^{5/6}$$

$$Q_P \equiv Peak\ Daily\ Flow\ (MGD)$$

$$Q_A \equiv Average\ Daily\ Flow\ (MGD)$$

Note: PF is 2.0 for flows greater than 16 MGD, and 4.0 for flows less than 0.25 MGD.

Table 3-2 summarizes the peak hour flows that were developed based on the peaking factor assumptions. Peak hourly flows listed were used for each time step simulation of the Sewer model. Calculated peaking factor is shown in parenthesis for each segment and time step.

Table 3-2. Projected Peak Flow Rates (Peaking Factors) Based on Sanitary Load Allocation Table and Peaking Factor Assumptions

Monocacy Interceptor Segment	Projected Peak Flow (MGD)				
	Currently Allocated	2015	2020	2030	2040
Tuscarora: MH#108 (C#195-S) to MH#1 (C#8-S)	5.8 (5.6)	6.6 (5.1)	8.6 (4.3)	11.1 (3.6)	11.1 (3.6)
Upper Monocacy: MH#54 (C#5-S) to Ceresville PS	11.9 (5.6)	12.9 (4.6)	15.5 (4.1)	19.0 (3.6)	19.6 (3.6)
City Interceptor: MH#7 (C#2-S) to City WWTF	42.9 (4.1)	45.6 (4.1)	50.5 (3.9)	56.5 (3.6)	57.1 (3.6)
Lower Monocacy: City WWTF to Ballenger-McKinney WWTP	21.5 (2.8)	27.3 (2.6)	35.1 (2.5)	44.7 (2.3)	52.6 (2.2)

3.3 Other Model Assumptions

In addition to flows and associated peaking factors, other physical parameters were entered into the model to calculate changes in hydraulic grade during each scenario. The model uses Manning's equation to calculate the depth and velocity of flow within the pipes. The *n* value from Manning's Equation is used to represent the roughness of the pipe surface. The roughness coefficient is directly correlated to the friction loss experienced in the pipe. As the *n* value increases, the head loss through the pipe will increase and cause the hydraulic grade to rise

accordingly. The typical *n* values for reinforced concrete pipe (RCP) and ductile iron pipe (DIP) are 0.013 and 0.012, respectively. The gravity section of the Monocacy Interceptor is comprised of RCP, while the pressure sewer downstream of the City WWTF is constructed of DIP with a urethane lining. The lining should allow for a lower *n* value to decrease roughness. The *n* value for the pressure sewer section was field tested to compare with typical values. The roughness coefficient for the DIP pressure sewer is approximated from the field testing as 0.012. A roughness coefficient of 0.013 was used for the RCP gravity sewer sections.

The other parameter to cause additional effect on the hydraulic grade elevation (HGL) in the system is the entrance/exit loss associated with manhole structures. In the model, two methods of estimating head loss through a structure were implemented - absolute and standard. The absolute method adds a fixed change to the HGL on the downstream flow of the structure. The absolute head loss through a structure used in the model was 0.1 feet to provide a conservative loss through the channel in each manhole. This condition was used for pipe flow where the HGL did not exceed the crown of the pipe, denoting open channel flow.

If the flow rises above the crown of the pipe, it will spill over the bench within the manhole structure. Under surcharge conditions the flow changes from open channel to exit/entrance loss through an orifice as the flow travels through the manhole. The model uses a head loss coefficient to estimate the loss associated with exit and entrance. Exit loss coefficients can vary from 0 to 0.5, while entrance loss coefficients vary from 0 to 1. The sum of the coefficients (K_e) is multiplied by the exit velocity at the structure as shown in the equation below.

$$H_L = K_e \frac{V^2}{2g}$$

In order to estimate the head loss coefficient, a calibration scenario was tested. During the rain event on December 26-27, 2009 the City WWTF noted an overflow at the intersection of the Carroll Creek and Monocacy interceptors. This event was simulated in the model to identify a coefficient that would cause an overflow as noted by the City. A head loss coefficient of 0.75 caused an overflow at the Carroll Creek interceptor without other overflow issues. Thus, a head loss coefficient of 0.75 was used in the model.

According to as-built documents, the collection system has several direct outfall points to alleviate overflow conditions. From discussions with County staff, the overflow outfalls have been filled and are no longer in operation. The City staff does use the outfall at Carroll Creek under extreme flow conditions at the WWTF. This connection is operated by a valve, but according to operational staff, the impact from using the outfall is insignificant. For these reasons, no outfalls were considered during modeling of the interceptor system.

In an effort to reduce inflow into the sewer system, both the County and City have several manhole frames and covers bolted along the Monocacy Interceptor. In the model, a bolted cover would allow the hydraulic grade line to remain continuous if it exceeds the rim elevation at a manhole. If the cover is unbolted, the hydraulic grade line will be reset to the rim elevation and appear as an overflow on the profile. Since bolted covers are intended to prevent inflow and the manhole structures are not typically designed to withstand internal pressure, it was assumed that all gravity manholes are considered unbolted in the model.

3.4 Sewer Model Simulations

The capacity of the Monocacy interceptor was evaluated by performing simulations in SewerCAD modeling software by Bentley. Each time step was modeled for peak flows. The flows were input as average flows and then peaked as described in Table 2-2 and Section 3.2. The majority of the sewer model runs were done under steady state simulations utilizing a constant flow. Typical flows follow a diurnal pattern that fluctuates over the course of a day. This causes flows to lag as they travel through the collection system, which attenuates the peaks. A steady state model assumes all of the peaks to occur at once, which provides a level of conservatism.

Pump stations run on cycles dictated by the start/stop elevations and the wetwell volume which may not directly coincide with a diurnal pattern. For this reason, steady state models use the peaked average flow from pumped systems as opposed to the pump operating point. This removes the chance for the pump in the model to run on an indefinite cycle. In the case of the Ceresville PS, the pumped flow is a major contributor to the City portion of the Monocacy interceptor. The total flow output from Ceresville PS with both pumps operating can exceed the peaked average flow; however, as discussed above, the peaked average flow was used in the model.

An extended period simulation (EPS) was used to model the wet weather peak event of March 2010 within the interceptor between the discharge of Ceresville PS and the City WWTF. During the EPS scenario, a hydraulic loading pattern (as discussed below) was applied to the average sanitary loading to mimic wet weather peak event flow. A major objective of the EPS model was to evaluate the impact of filter backwash events from the City WTP, which provides an elevated flow of 108,000 gallons over a 10-minute duration (10,800 gpm). These events are reported to occur approximately once every three days.

3.4.1 Steady State Simulations

The average loads input into the model under steady state conditions were based on planning estimates and confirmed with actual metered data for existing flows. All future flows are based

on planning estimates with a larger emphasis on PRWSA projects. As noted above, the average daily loading for each time step is broken out in the SLAT. The SLAT is also set up to determine the loading at each connection to the Tuscarora and Monocacy interceptors. Under steady state conditions the model does not track changes over time, but instead approaches an equilibrium state based on the input parameters. Pump stations are assumed to output a constant flow that is peaked based on the calculated peak factor. The model will not determine if a station has adequate capacity to convey the flow received by the collection system. For this reason, it is assumed that all flow draining to the pump station will be conveyed to the respective discharge point.

3.4.2 Extended Period Simulations

The EPS scenario requires flows to occur over a 24 hour pattern that can be applied to average flows determined by the SLAT. The flows from March 13 and 14 represent the highest flows recorded during the period studied at the City WWTF. The influent pumping station at the City WWTF recorded the influent flow at each hour during this event. These hourly flow rates were normalized by the 2010 annual average flow rate (8.76 MGD) to determine the flow multipliers to be incorporated into the EPS scenario. **Figure 3-1** shows the hydrograph generated with the flow multipliers. The normalized sewage loading pattern was used to simulate loadings for any flow input. For the purposes of modeling, it was assumed that currently allocated flows will be connected to existing infrastructure and will experience a similar loading pattern.

3.5 Analysis of Results and Observations

Sewer model outputs were developed for each time step and each segment of the Monocacy Interceptor. A summary figure was developed for each simulation. Each figure includes the following information:

- Total flow rate and tailwater elevation at the end of the segment
- Identification of each manhole which receives flow (corresponding to the SLAT)
- Identification of major interceptor intersections
- Size of sewer pipe throughout the segment
- Station and elevation of the sewer line and finish grade
- Hydraulic Grade Line of sewer flow
- Location of important facilities
- Areas of potential surcharging
- Probable SSOs

The figures associated with the Lower Monocacy Interceptor also show the locations of known minimum elevation sewer connections feeding into the pressure sewer to illustrate whether

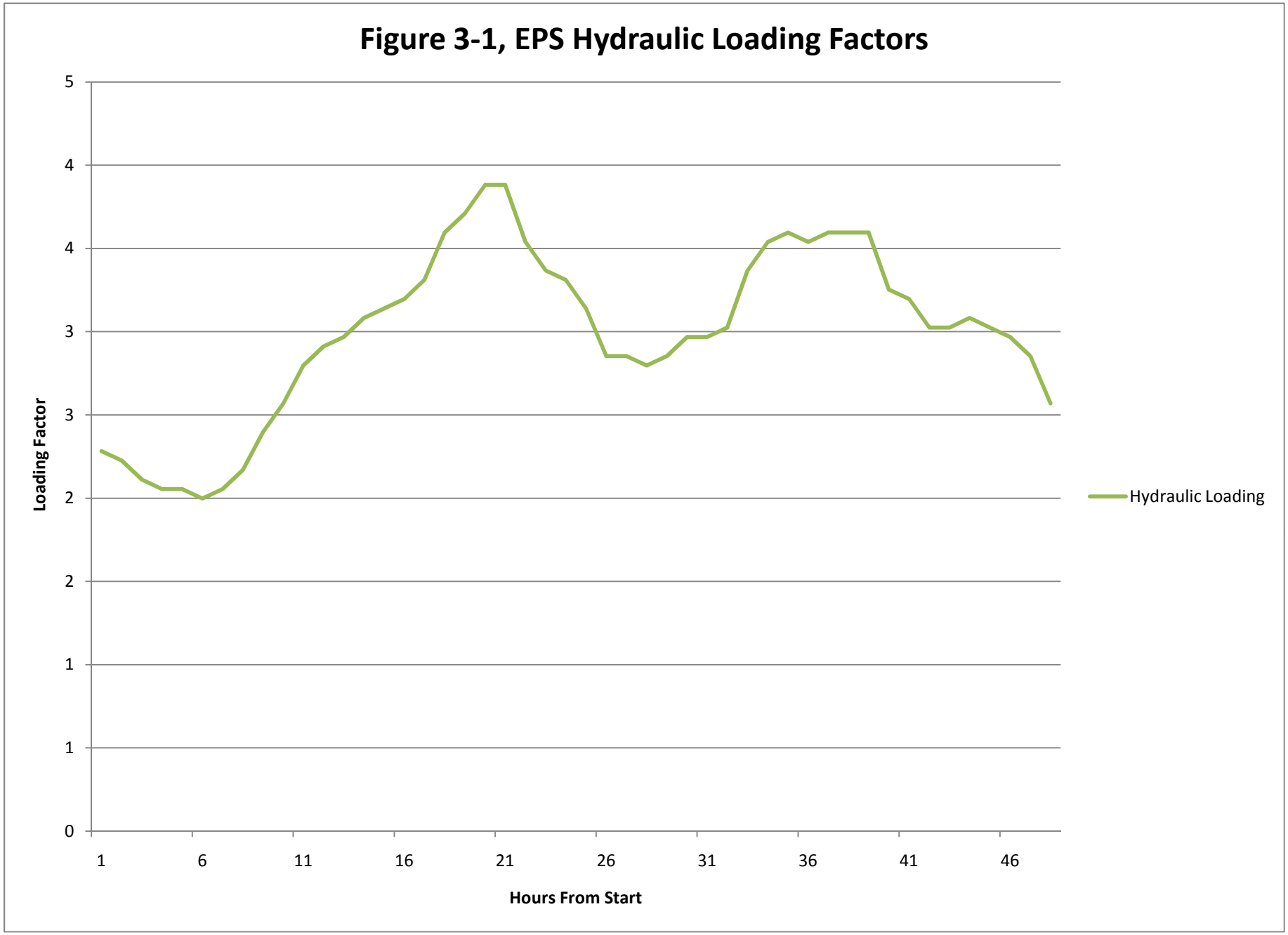
Figure 3-1, EPS Hydraulic Loading Factors
Loading Factor
5
4
4
3
3
2
2
1
1
0
1
6
11
16
21
26
31
36
41
46
Hours From Start
Hydraulic Loading

surcharging of the pressure sewer may cause overflows in gravity sewers serving connected subdivisions. Minimum elevation connections at Bush Creek/Urbana, Ballenger, and Buckeystown Interceptors were not available at the time of this report and, therefore, were not considered in the analysis. Analysis follows for each of the time steps.

3.5.1 Currently Allocated Time Step

Steady state simulations were developed and modeled for each segment of the Monocacy Interceptor. Figures depicting the calculated hydraulic grade elevation (HGL) in the system have been developed. The "Current" period noted on the figures refers to the Currently Allocated time step which includes both existing flows and additional growth through vacant lots and approved expansions. The Tuscarora Interceptor under currently allocated flow conditions can be found on **Figure 3-2**, while the Upper Monocacy Interceptor is shown on **Figure 3-3**. **Figure 3-4** examines the segment of sewer just upstream of Ceresville PS in more detail. The City interceptor and associated expanded view are located on **Figure 3-5** and **Figure 3-6**, respectively. The Lower Monocacy pressure sewer typically experiences hydraulic grades that exceed ground elevations which can be noted on **Figure 3-7**.

The Upper Monocacy collection system, including the Tuscarora Interceptor, does not have any capacity limitations under currently allocated conditions. The Ceresville PS has a total peak flow of 11.85 MGD. This exceeds the safe pumping capacity (one pump out of service) of the station, but is within the maximum pumping capacity (both pumps operating).

The City Interceptor, as shown on Figure 3-5, experiences surcharged conditions just upstream of the Parshall flume. The total flow through the system is 42.86 MGD, which is 7.86 MGD higher than the peak flow event recorded in March, 2010. This flow exceeds the capacity for both the City WWTF screening, influent pump station, and grit removal. The City Interceptor has several calculated overflow events based on currently allocated peak loading.

The Lower Monocacy Interceptor operates under acceptable conditions given that it is a pressure sewer. The sewer is constructed similar to a force main except that open air stacks were installed in place of air release valves. According to the model, the HGL does not exceed the maximum elevation of the stacks and the known sewer gravity connections, as shown on Figure 3-7, will not be impacted.

Figure 3-2, Tuscarora Interceptor - Current Peak: MH#108 (C#195R-S) to MH#1 (C#8-S)

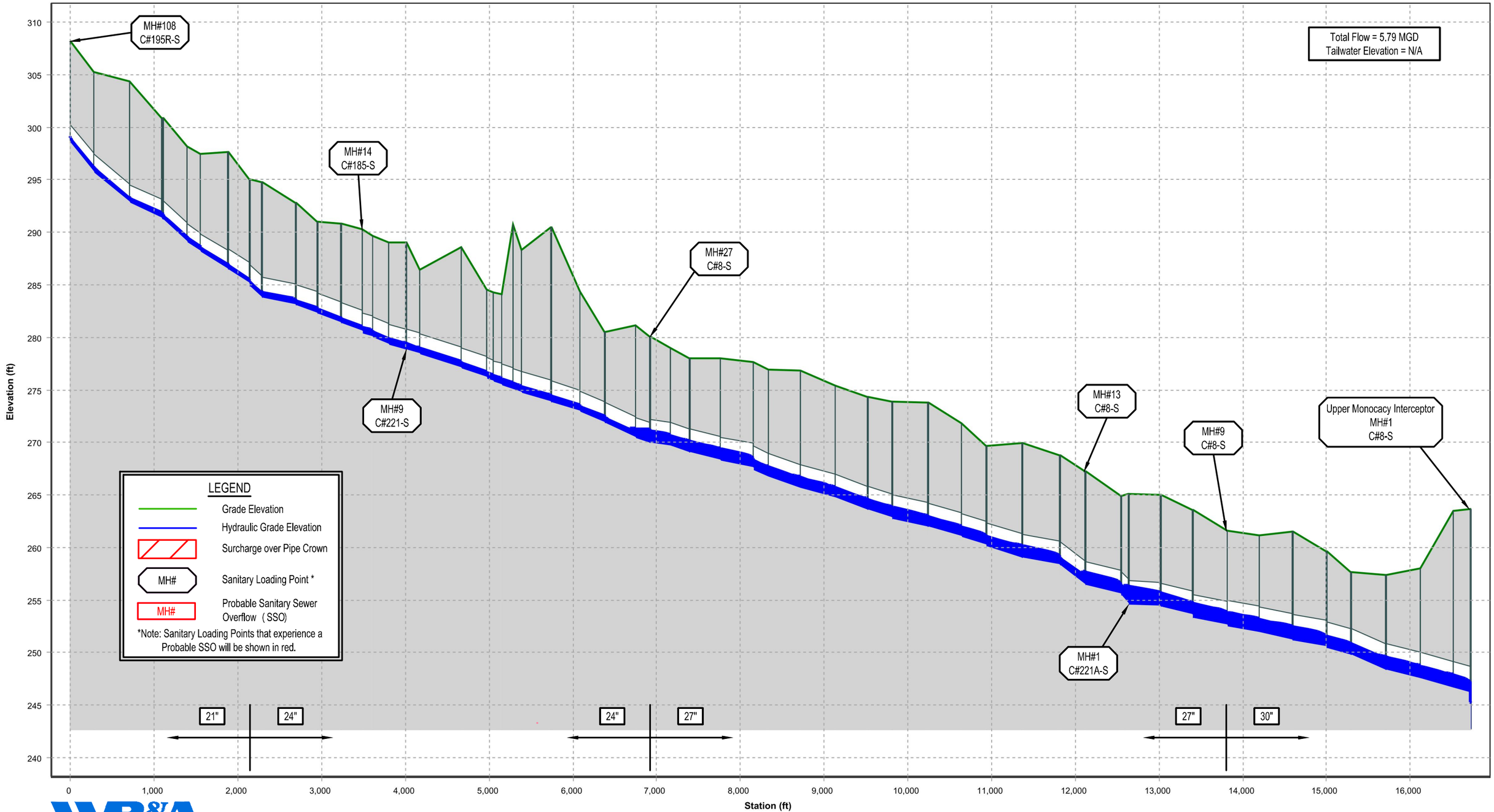

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Figure 3-2
August 2011

Figure 3-3, Upper Monocacy Interceptor - Current Peak: MH#54 (C#5-S) to Ceresville PS

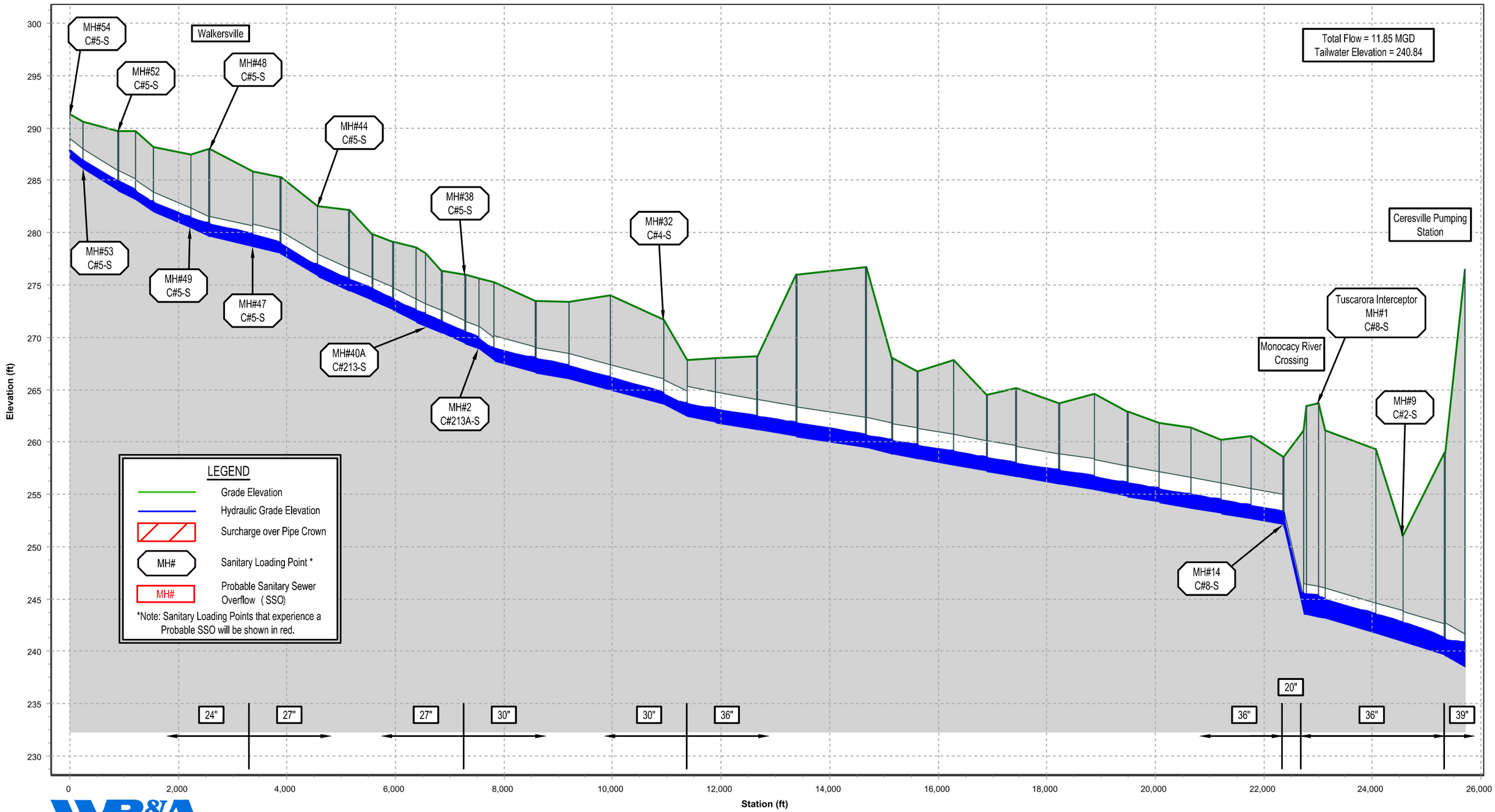

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Figure 3-3
August 2011

Figure 3-4, Ceresvile PS Influent Sewer - Current Peak: MH#15 (C#2-S) to Ceresville PS

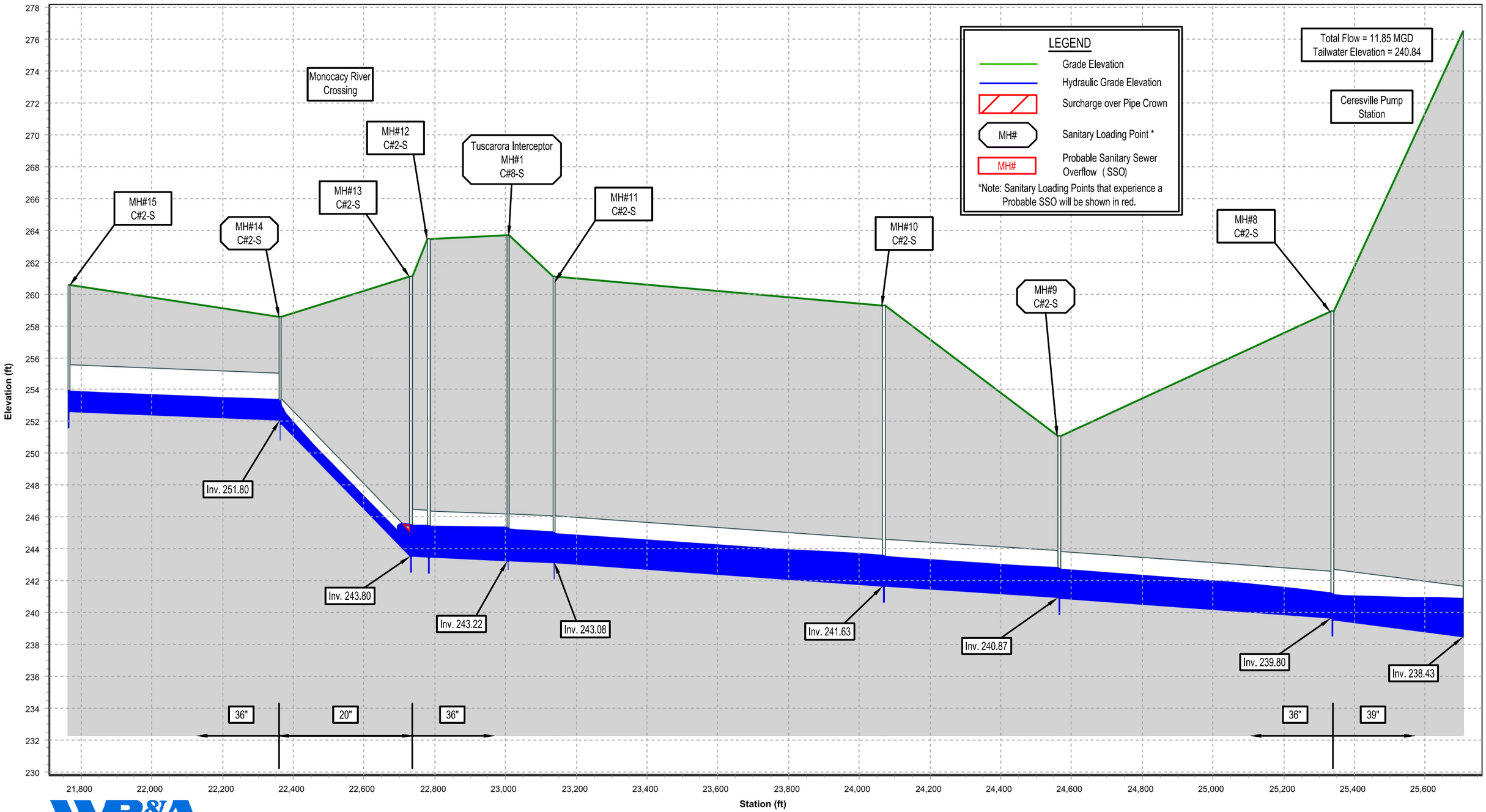

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Figure 3-4
August 2011

Figure 3-5, City Interceptor - Current Peak: MH#7 (C#2-S) to MH#3 (C#82-R)

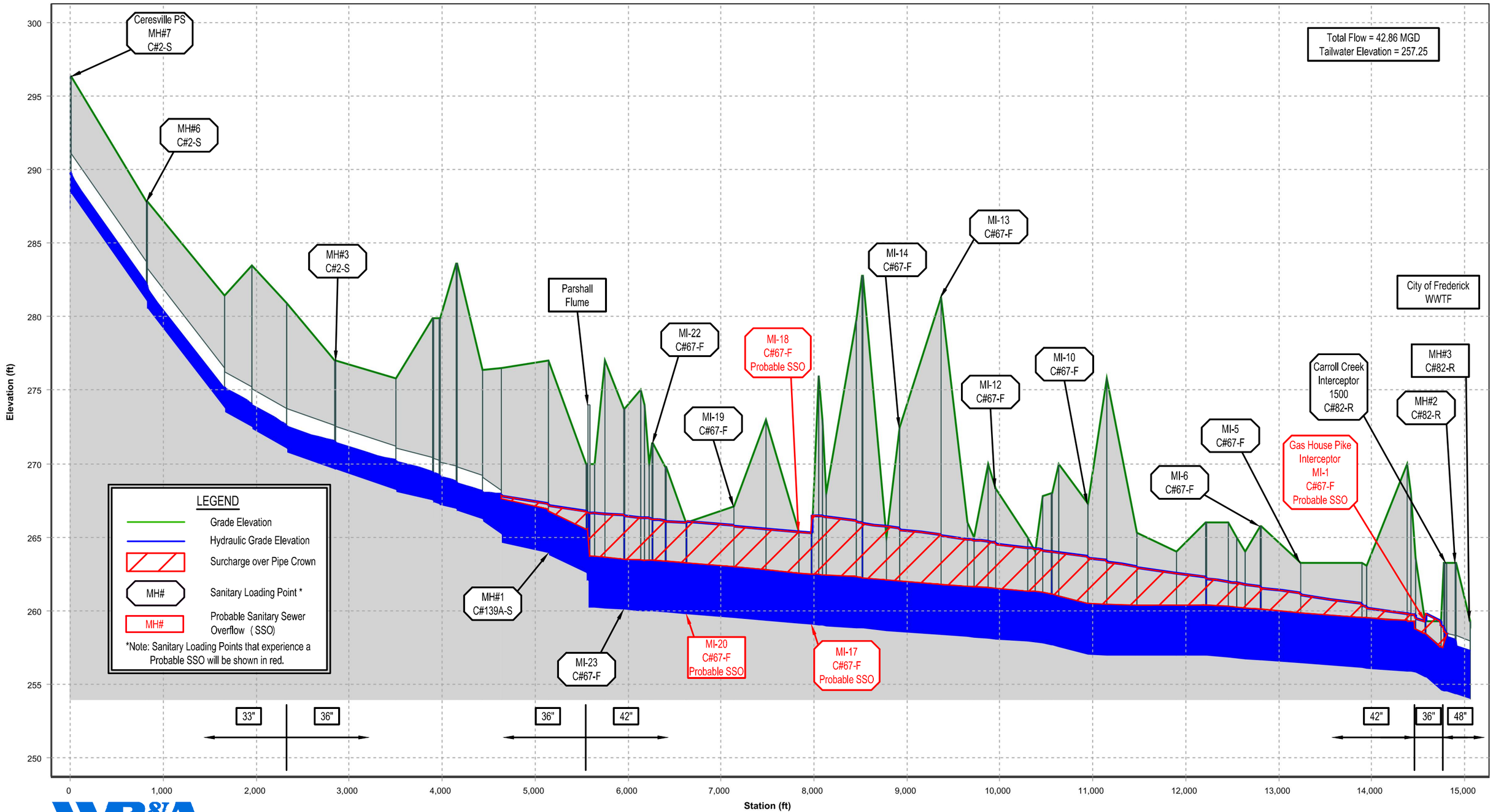

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Figure 3-5
August 2011

Figure 3-6, City WWTF Influent Sewer - Current Peak: MI-2 (C#67-F) to MH#3 (C#82-R)

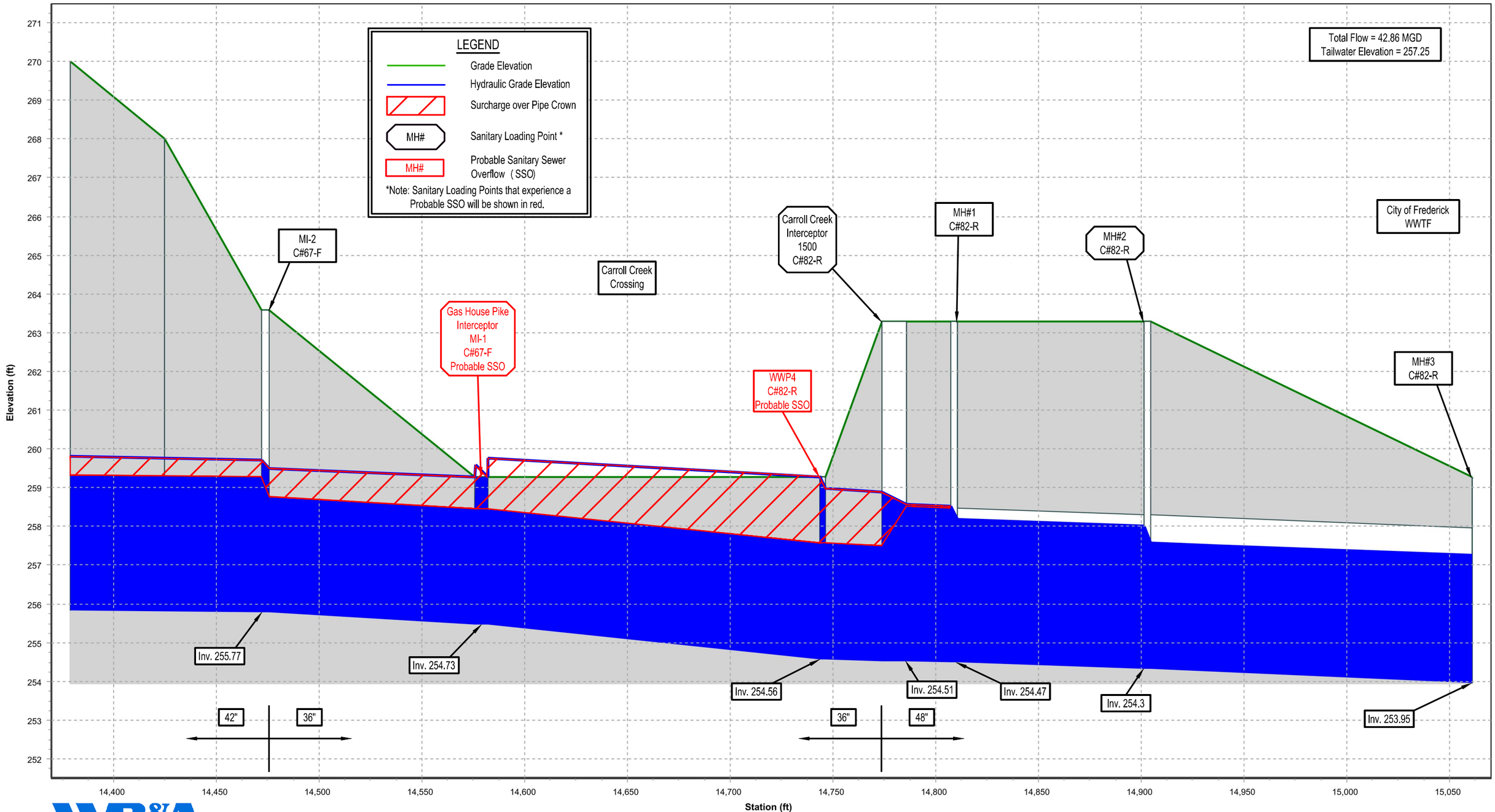

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Figure 3-6
August 2011

Figure 3-7, Lower Monocacy Interceptor - Current Peak: City of Frederick WWTF to Ballenger-McKinney WWTP

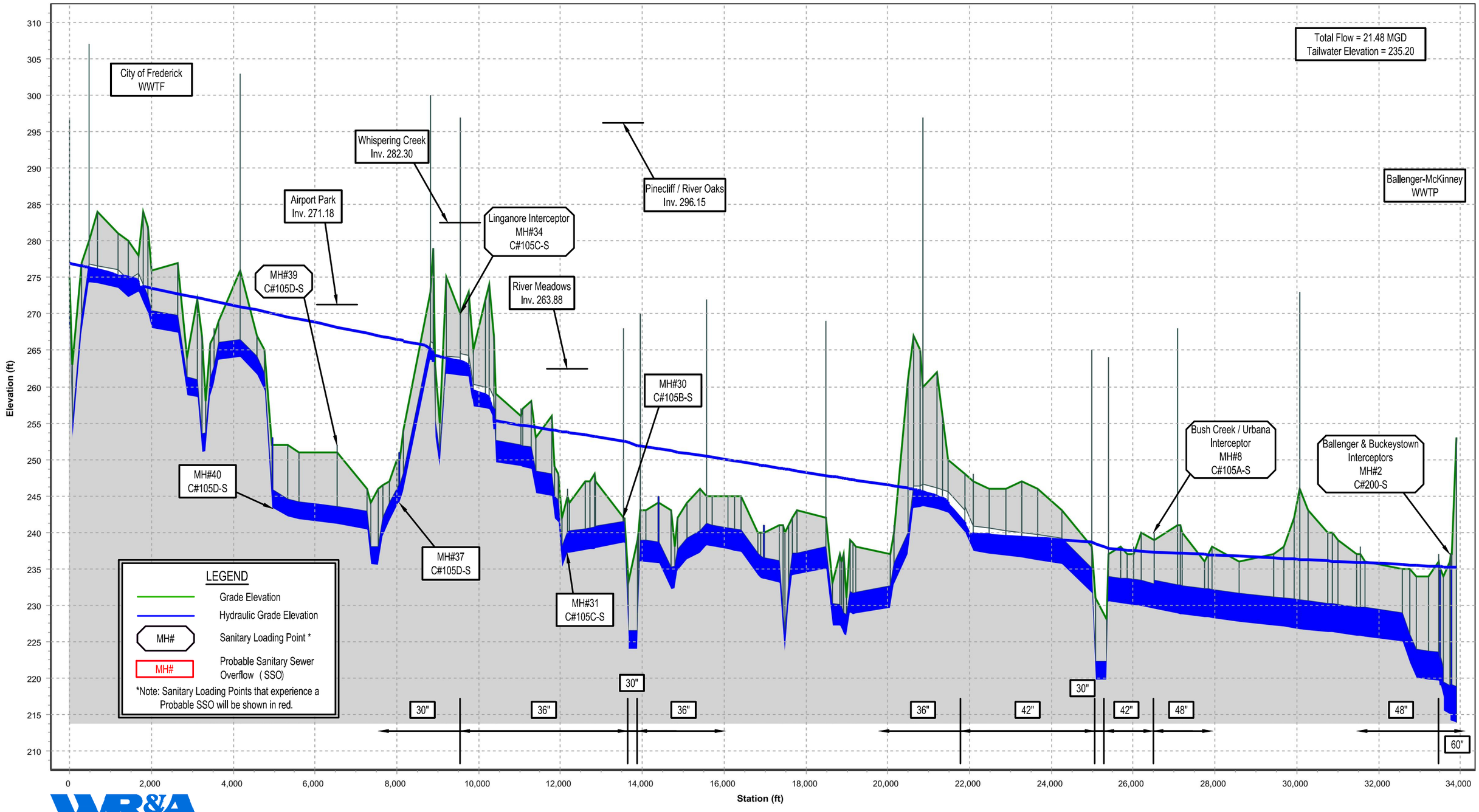

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Figure 3-7
August 2011

3.5.2 2015 Time Step

The 2015 time step includes 0.82 MGD of average daily flow growth upstream of the City WWTF with 0.32 MGD of that growth occurring in the Upper Monocacy collection system. The increase of flow does not exceed the capacity of the Tuscarora and Upper Monocacy Interceptors as shown on **Figure 3-8** and **Figure 3-9,** respectively. **Figure 3-10** depicts Ceresville PS maintaining a tailwater elevation of 240.84 feet under 12.88 MGD. This flow still does not exceed maximum pumping capacity of the station.

The City Interceptor capacity was exceeded during the currently allocated time step and added flows only surcharge the system more significantly in the 2015 time step. Please refer to **Figure 3-11** for an estimation of the surcharge conditions. A closer look on **Figure 3-12** indicates that the reduced size section under Carroll Creek (between MI-2 and junction 1500) causes a much steeper hydraulic grade line as flows increase. This section appears to be a significant constriction on the Interceptor, even while downstream sections still operate as open channel flow to the influent pumping station, assuming the pump station can convey 45.57 MGD.

The Lower Monocacy Interceptor is still able to convey peak flows during the 2015 time step down to the Ballenger-McKinney WWTP as indicated on **Figure 3-13**. The HGL at the equalization basin at the City WWTF will likely require the pumps to operate under surcharged pump discharge conditions. The total flow from the City WWTF's Pumping Station No. 2 is 10.90 MGD, which approaches current capacity unless additional pumps are redirected at the plant. The tailwater elevation for the 2015 time step has been lowered to account for the new influent pumping station at the Ballenger-McKinney WWTP. This allows for much of the 42-inch pressure sewer section to operate under open channel conditions.

Figure 3-8, Tuscarora Interceptor - 2015 Peak: MH#108 (C#195R-S) to MH#1 (C#8-S)

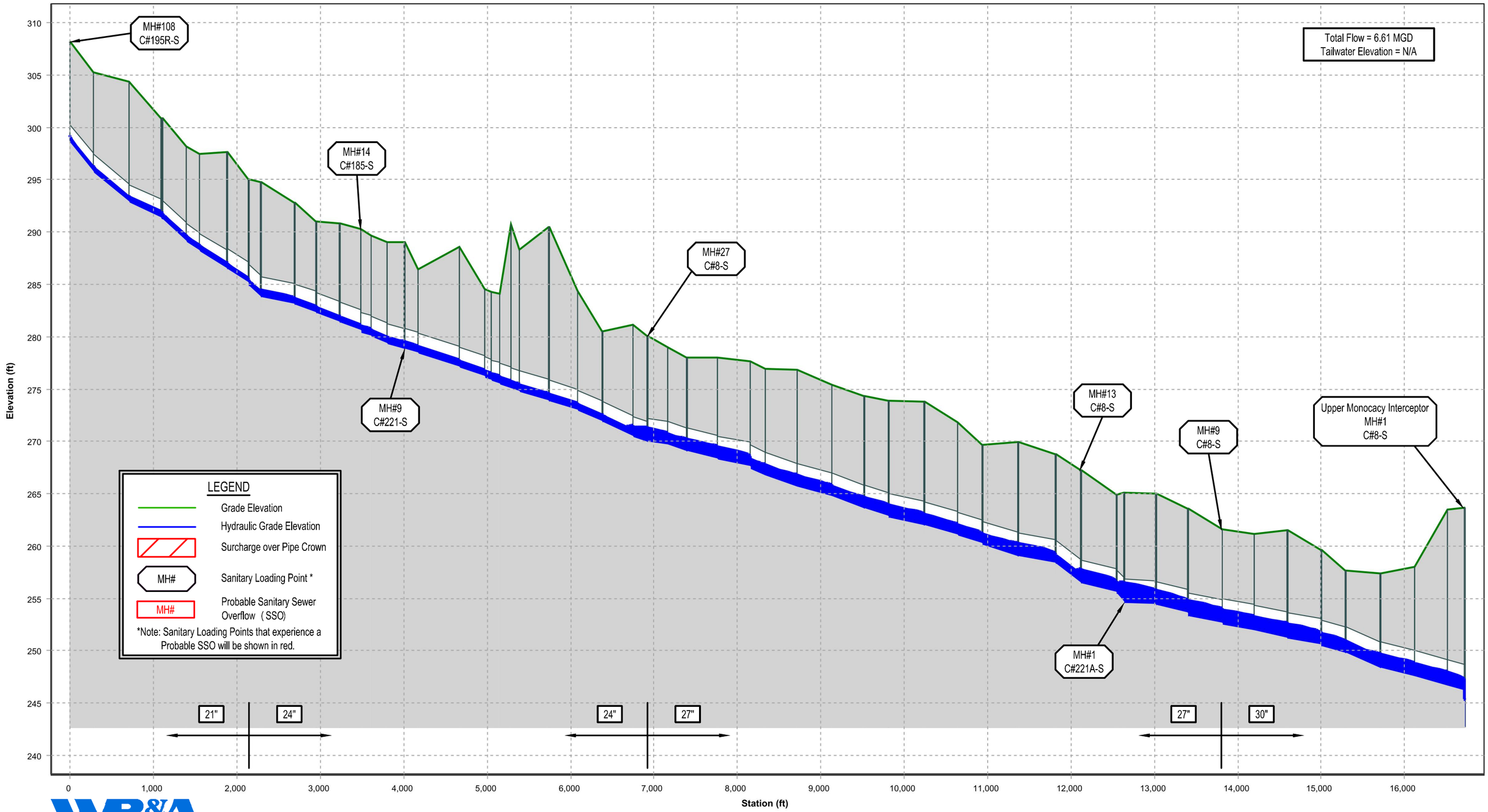

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Figure 3-8
August 2011

Figure 3-9, Upper Monocacy Interceptor - 2015 Peak: MH#54 (C#5-S) to Ceresville PS

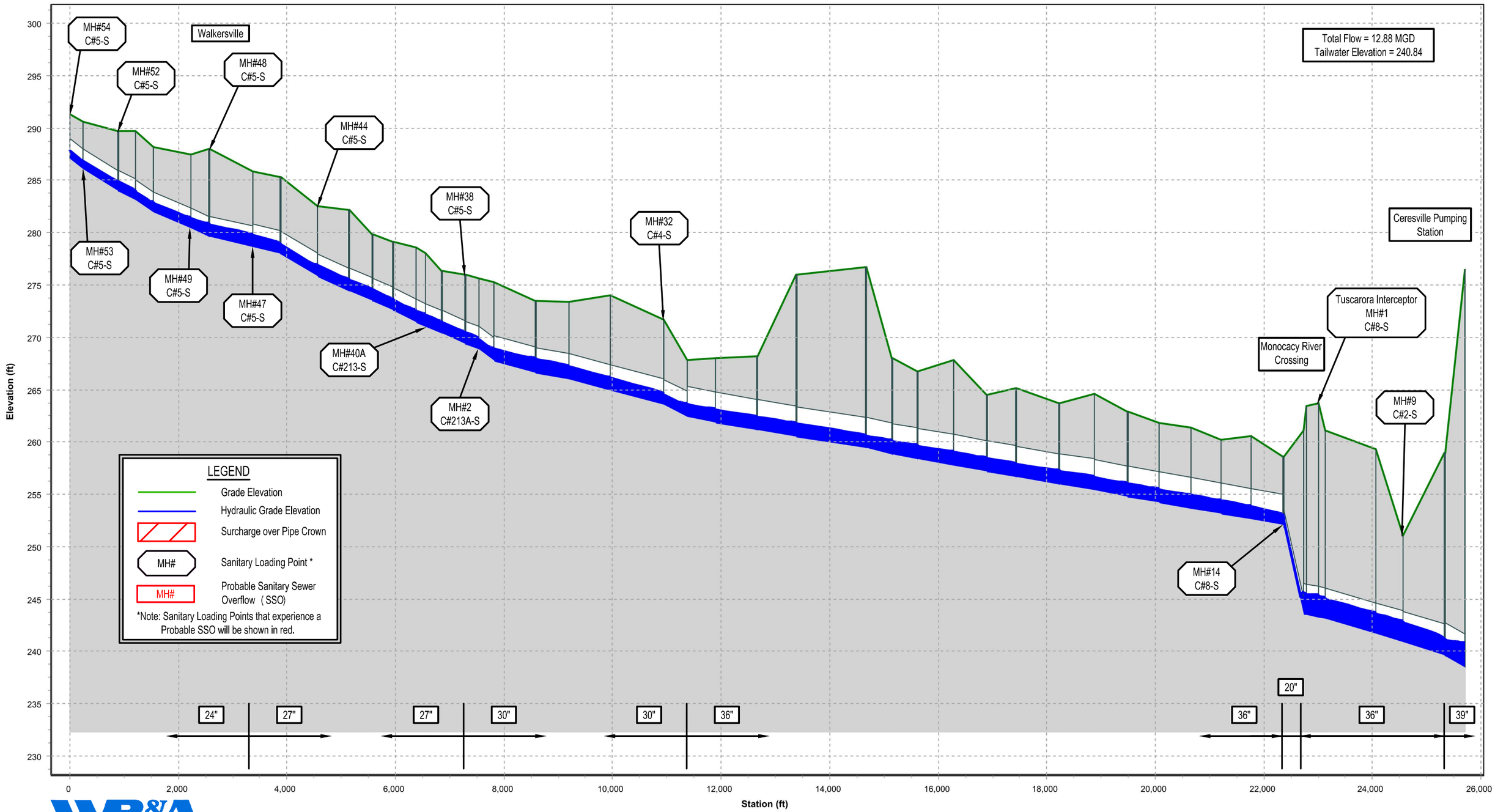

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Figure 3-9
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Figure 3-10, Ceresvile PS Influent Sewer - 2015 Peak: MH#15 (C#2-S) to Ceresville PS

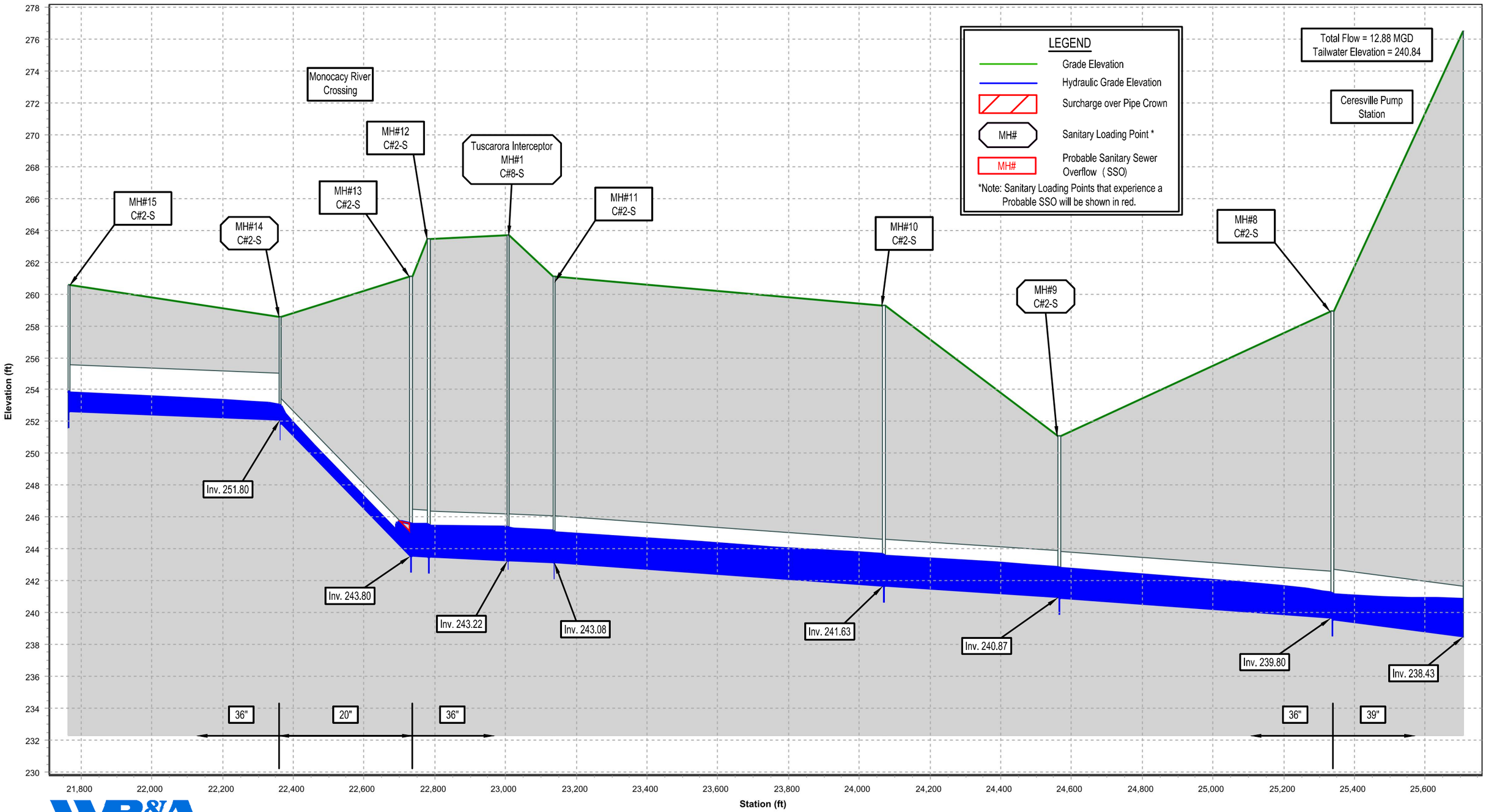

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Figure 3-10
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Figure 3-11, City Interceptor - 2015 Peak: MH#7 (C#2-S) to MH#3 (C#82-R)

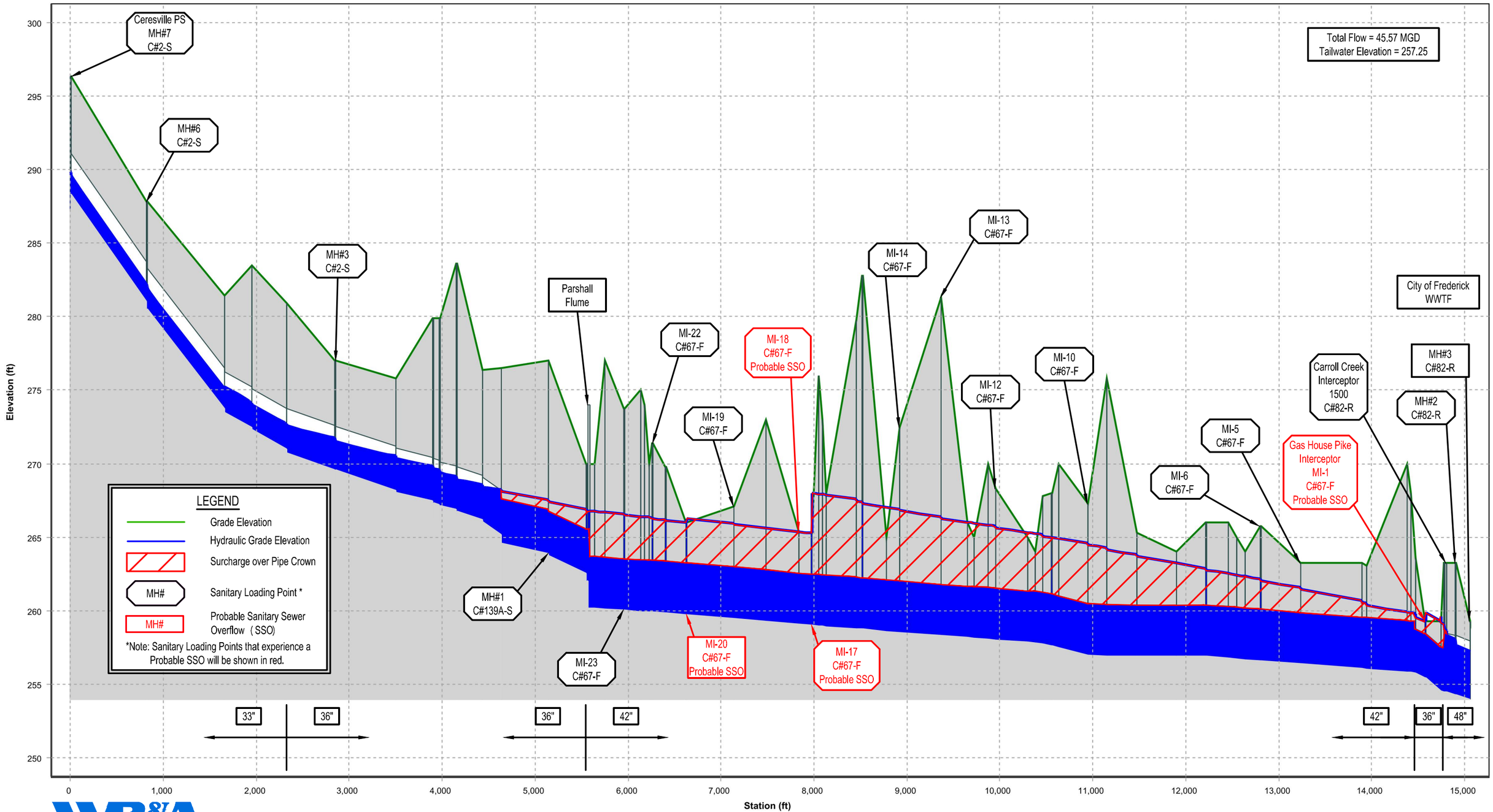

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Figure 3-11
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Figure 3-12, City WWTF Influent Sewer - 2015 Peak: MI-2 (C#67-F) to MH#3 (C#82-R)

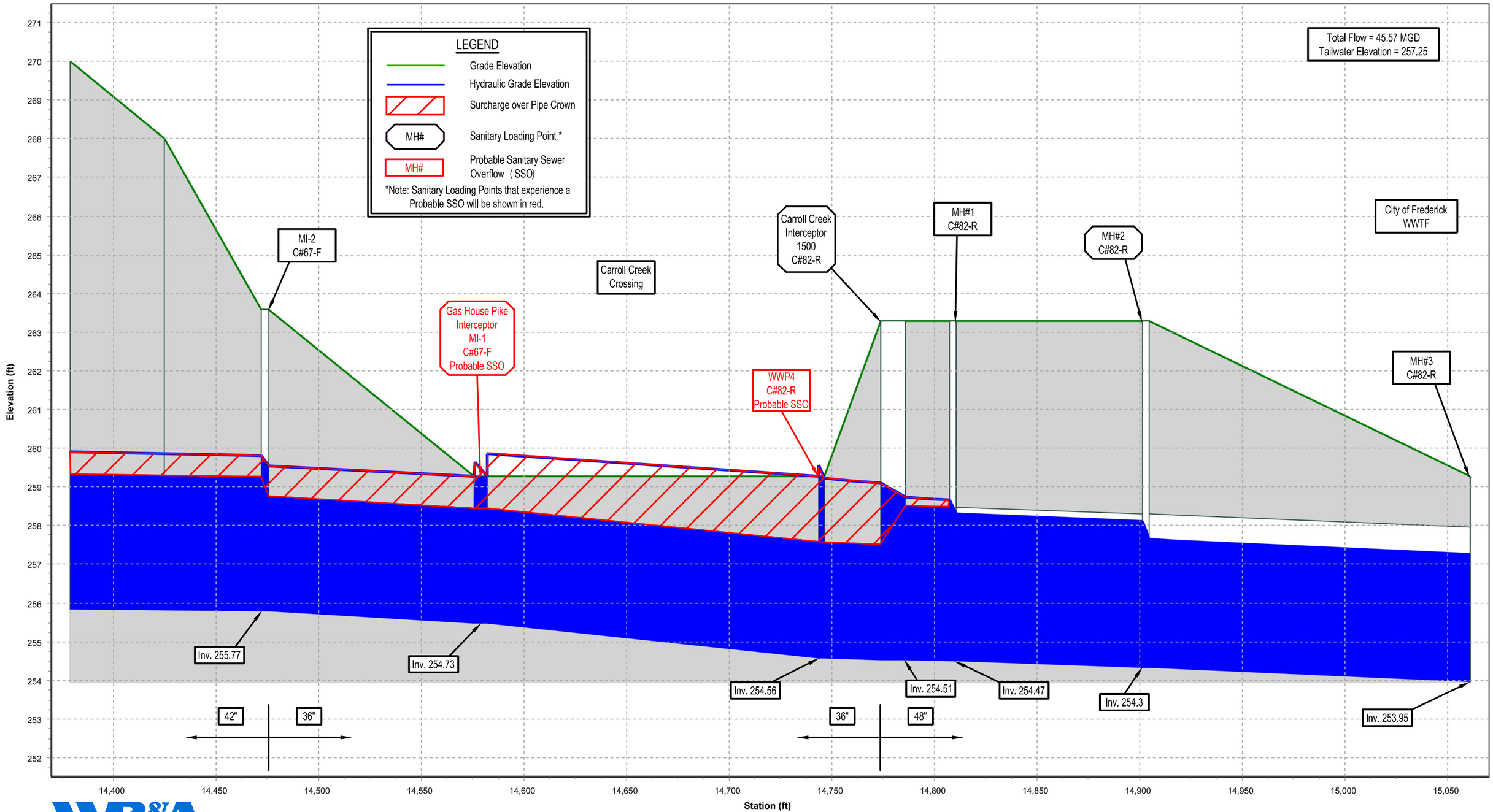

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Figure 3-12
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Figure 3-13, Lower Monocacy Interceptor - 2015 Peak: City of Frederick WWTF to Ballenger-McKinney WWTP

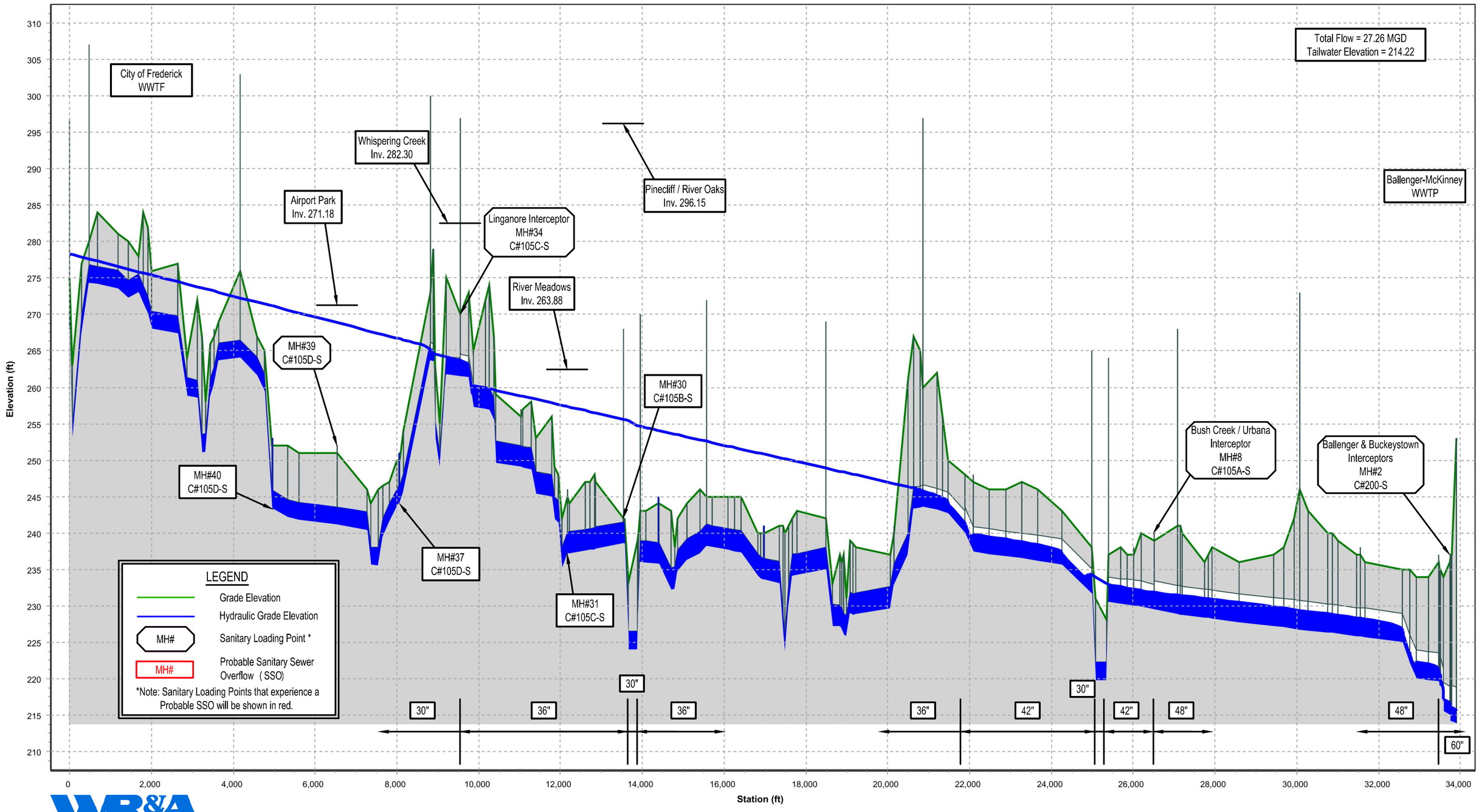

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Figure 3-13
August 2011

3.5.3 2020 Time Step

The 2020 time step accounts for an additional 1.80 MGD of growth in the Monocacy gravity system as well as a projected 3.40 MGD of growth to the Monocacy pressure sewer. For a further breakdown of average daily flow increases for each time step, refer to Table 3-1 above. The 2020 time step is illustrated by **Figures 3-14**, **3-15**, **3-16**, **3-17**, **3-18**, and **3-19**. The Tuscarora Interceptor shows one area where the pipe becomes minimally surcharged at MH#1 (C#221A-S), but the majority of the sewer operates as open channel flow. The Upper Monocacy does not appear to have capacity limitations under the 2020 time step. The peak flow of 15.48 MGD experienced by Ceresville PS exceeds the current station capacity. The City Interceptor surcharges further upstream of the Parshall flume and still exceeds capacity. The Lower Monocacy Interceptor does not fail at this time step, however the hydraulic grade line rises above the Airport Park and River Meadows gravity connections. These connection elevations denote the invert of the sewer main downstream of the first gravity connection, so an HGL exceeding this invert may be an indication of a sewer backup into the basement of a served dwelling unit.

3.5.4 2030 Time Step

The 2030 time step has the highest projected increase in loading with 2.48 MGD additional average daily flow to the collection system upstream of the City WWTF and 5.62 MGD additional flow to the Lower Monocacy Interceptor. The simulations for this time step are represented on **Figures 3-20**, **3-21**, **3-22**, **3-23**, **3-24**, and **3-25**. The Tuscarora Interceptor begins to surcharge without overflows. The Upper Monocacy Interceptor only surcharges after crossing under the Monocacy River. In the model, the Ceresville PS is still assumed to maintain the designated tailwater elevation causing open channel flow before draining into the wetwell. This assumption could change depending on actual pump station operations and could increase the hydraulic grade elevation even further leading to more surcharging of the Upper Monocacy and Tuscarora Interceptors. The City Interceptor is nearly completely surcharged except for the steep sections immediately after the Ceresville PS discharge and just before the City WWTF. The Lower Monocacy pressure sewer surcharges until the sewer transitions to 42–inch pipe due to the tailwater boundary condition.

3.5.5 2040 Time Step

The final build-out time step does not increase the loading to the system significantly with most of the growth occurring upstream of Ceresville PS. Depictions of the simulations can be found on **Figures 3-26**, **3-27**, **3-28**, **3-29**, **3-30**, and **3-31**. The only section to still maintain adequate open channel flow conditions is the Upper Monocacy Interceptor upstream of the river crossing.

Figure 3-14, Tuscarora Interceptor - 2020 Peak: MH#108 (C#195R-S) to MH#1 (C#8-S)

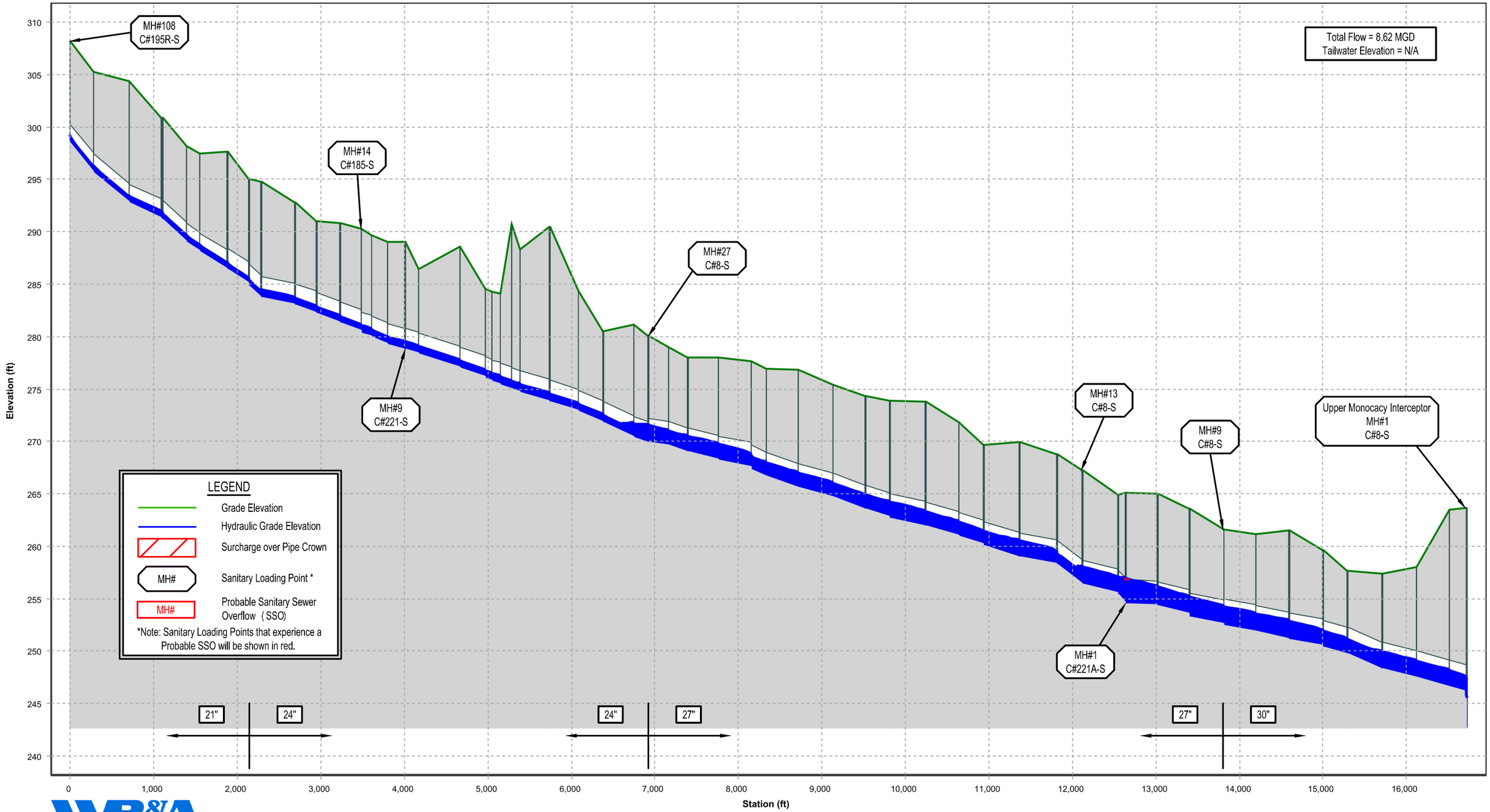

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Figure 3-14
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Figure 3-15, Upper Monocacy Interceptor - 2020 Peak: MH#54 (C#5-S) to Ceresville PS

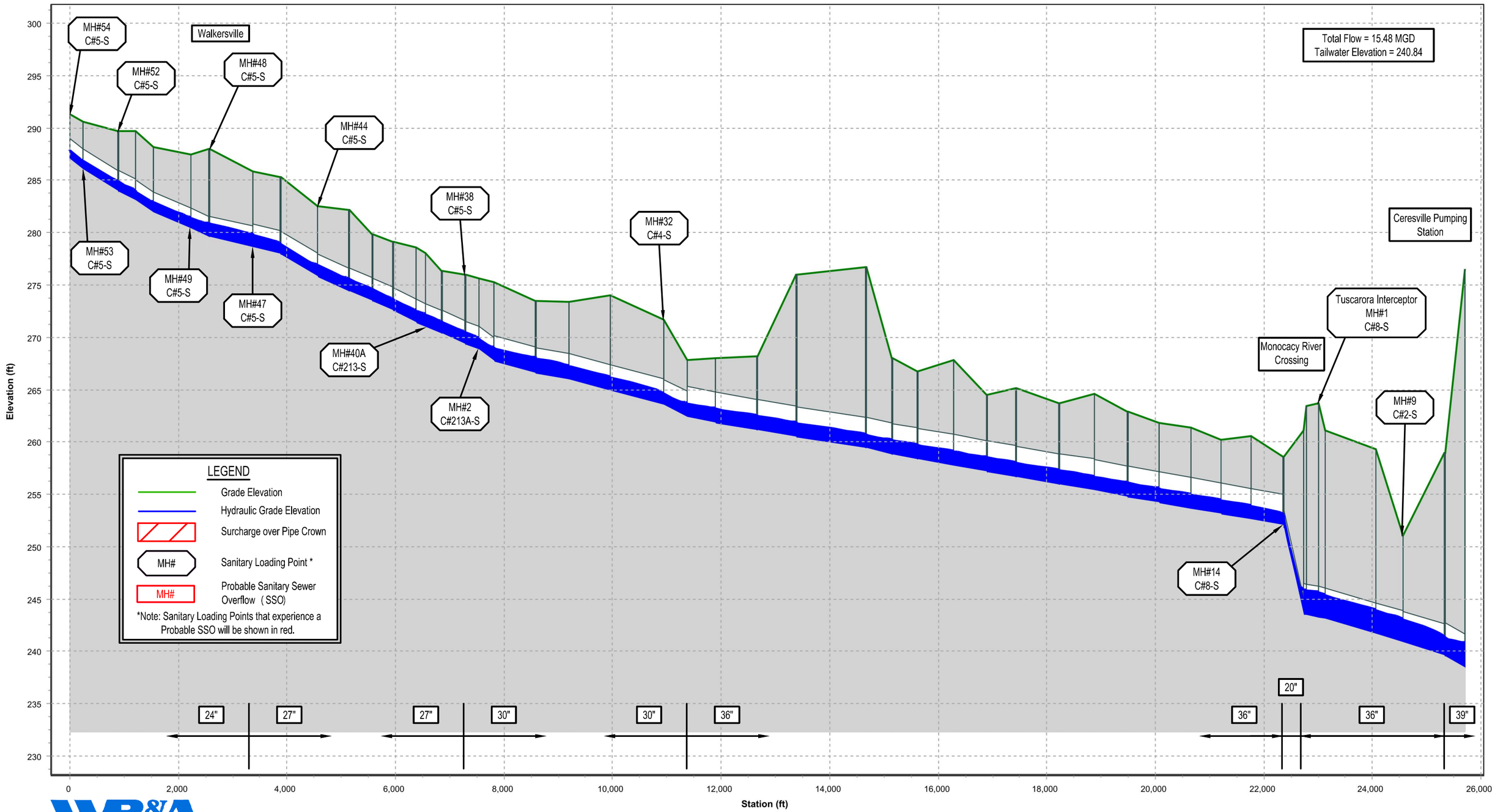

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Figure 3-15
August 2011

Figure 3-16, Ceresville PS Influent Sewer - 2020 Peak: MH#15 (C#2-S) to Ceresville PS

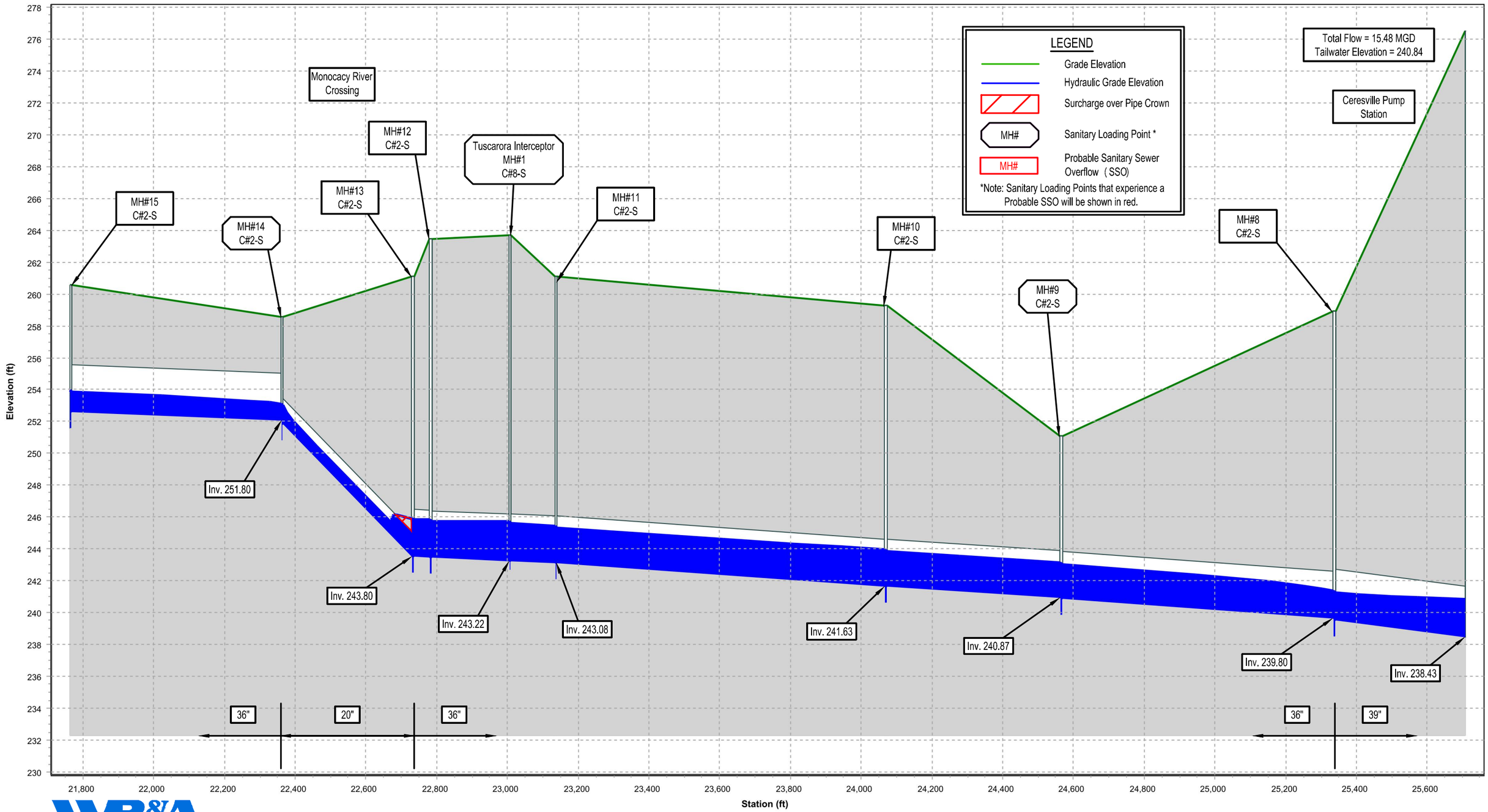

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Figure 3-16
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Figure 3-17, City Interceptor - 2020 Peak: MH#7 (C#2-S) to MH#3 (C#82-R)

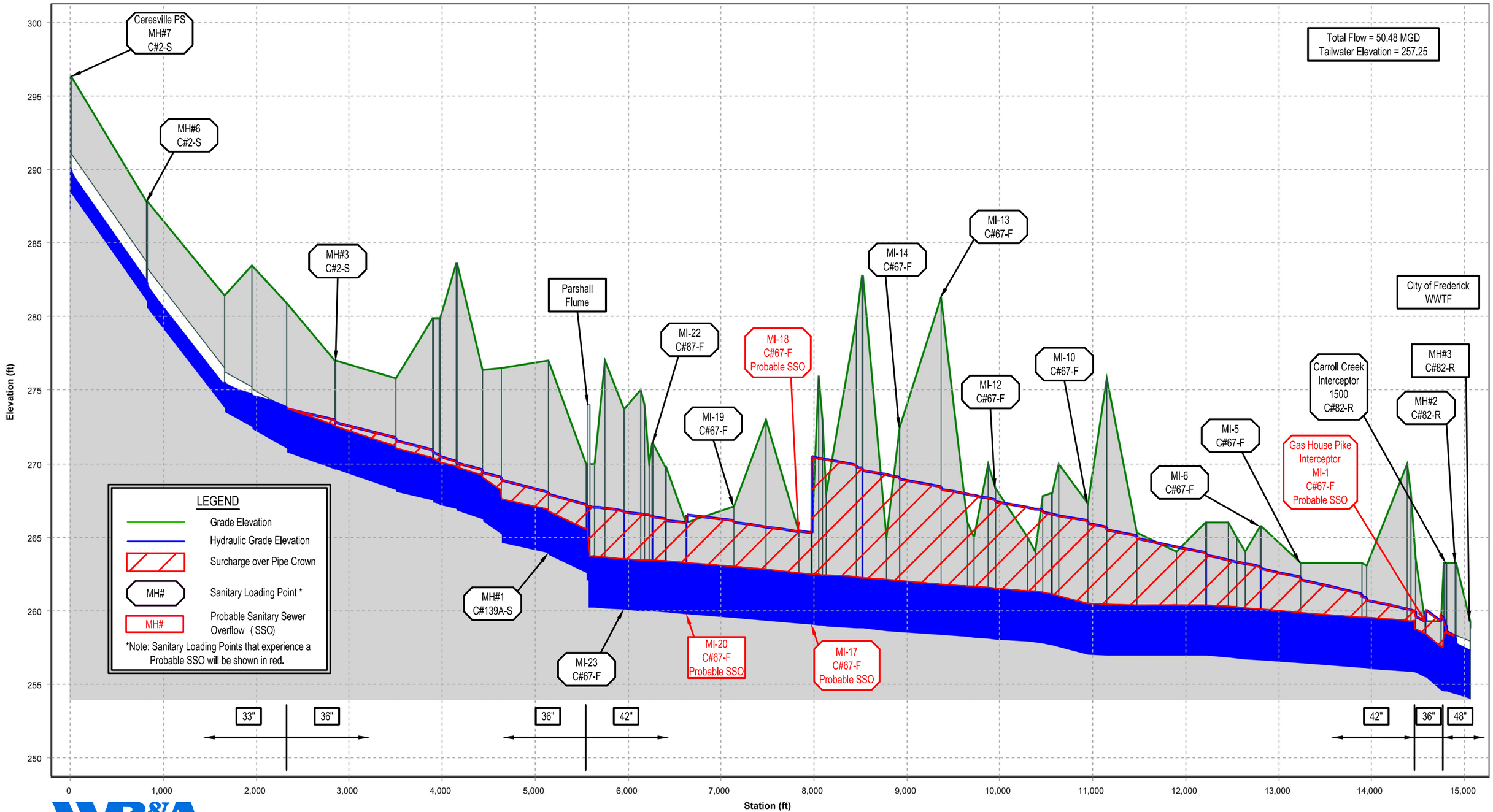

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Figure 3-17
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Figure 3-18, City WWTF Influent Sewer - 2020 Peak: MI-2 (C#67-F) to MH#3 (C#82-R)

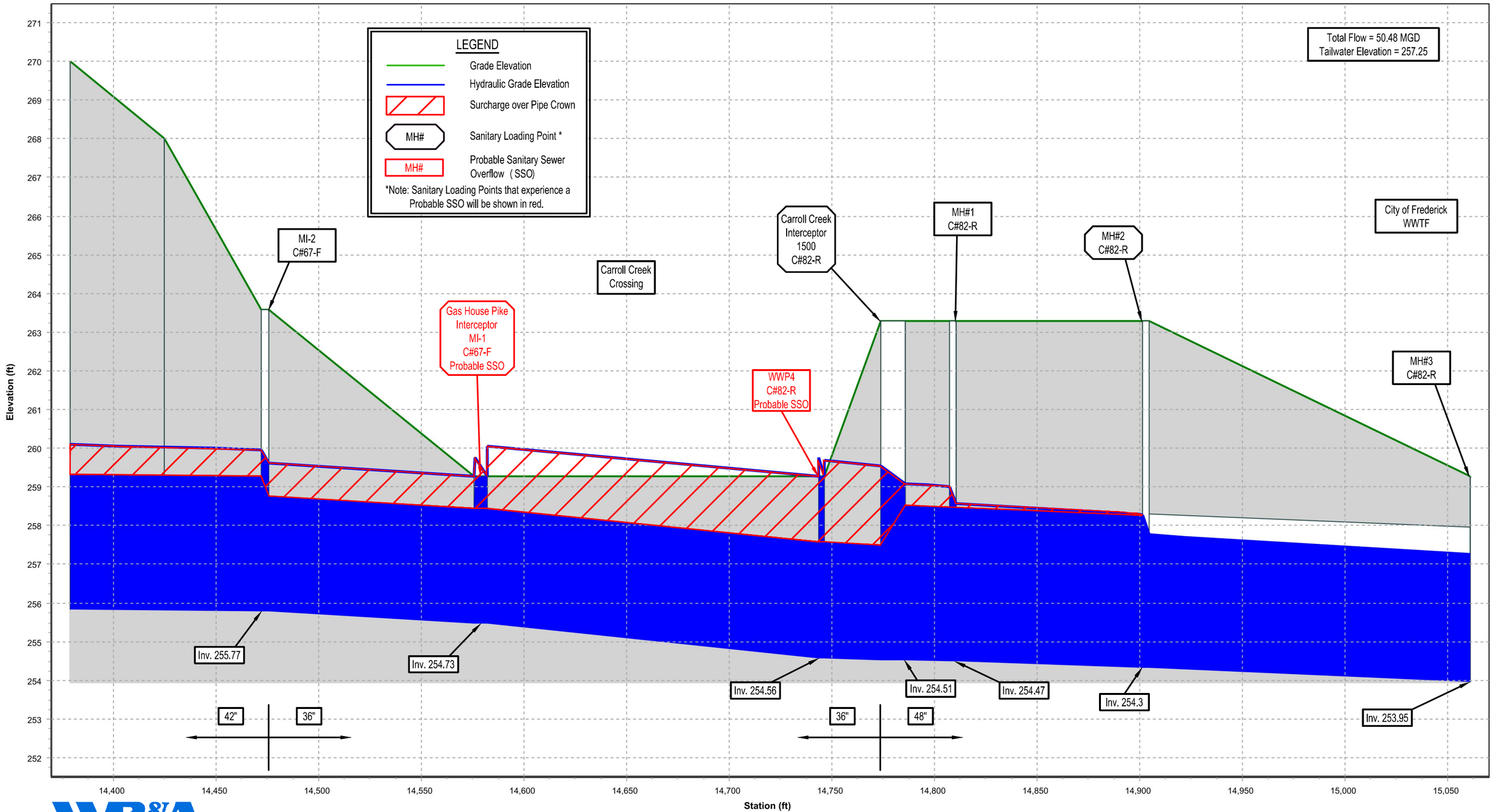

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Figure 3-18
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Figure 3-19, Lower Monocacy Interceptor - 2020 Peak: City of Frederick WWTF to Ballenger-McKinney WWTP

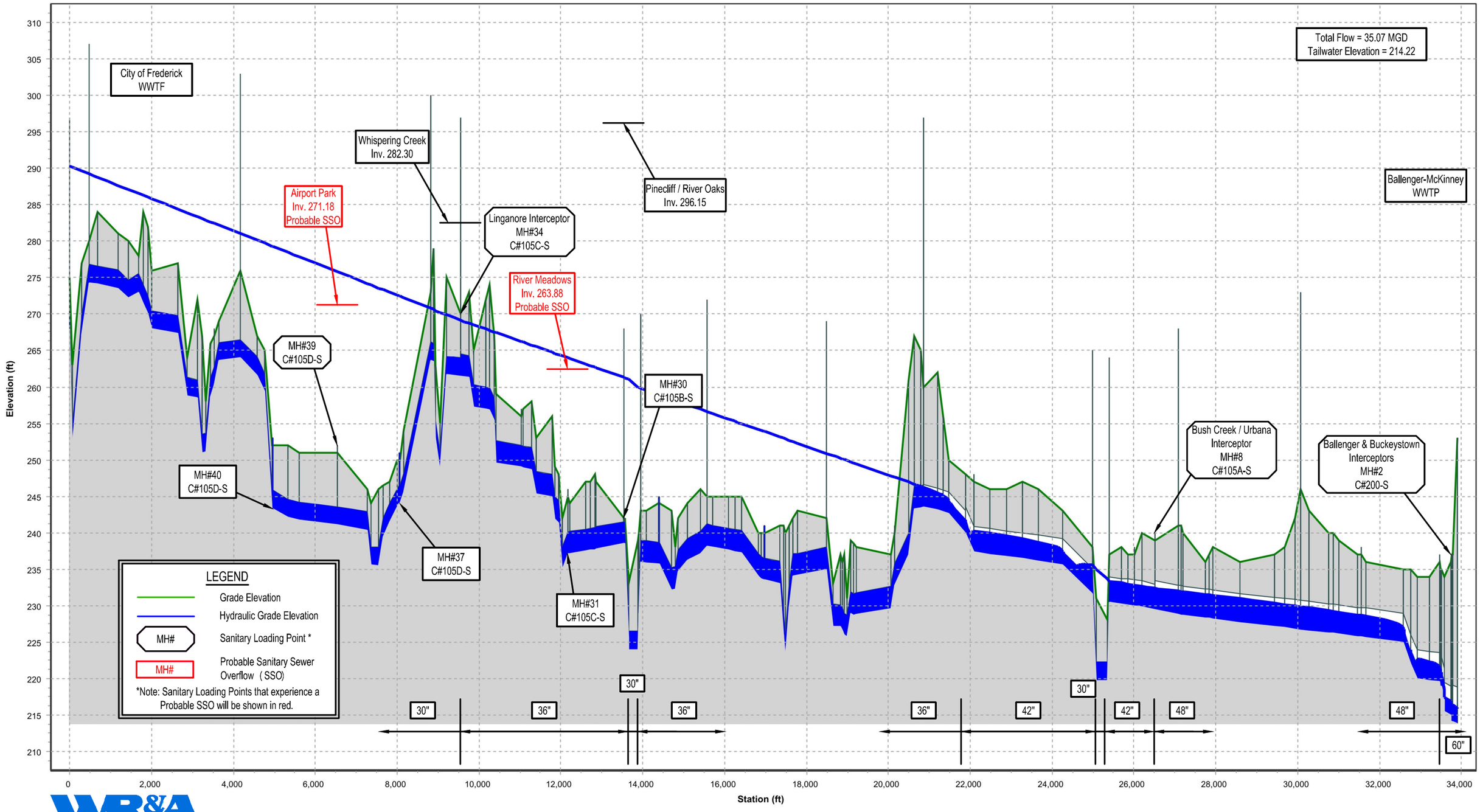

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Figure 3-19
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Figure 3-20, Tuscarora Interceptor - 2030 Peak: MH#108 (C#195R-S) to MH#1 (C#8-S)

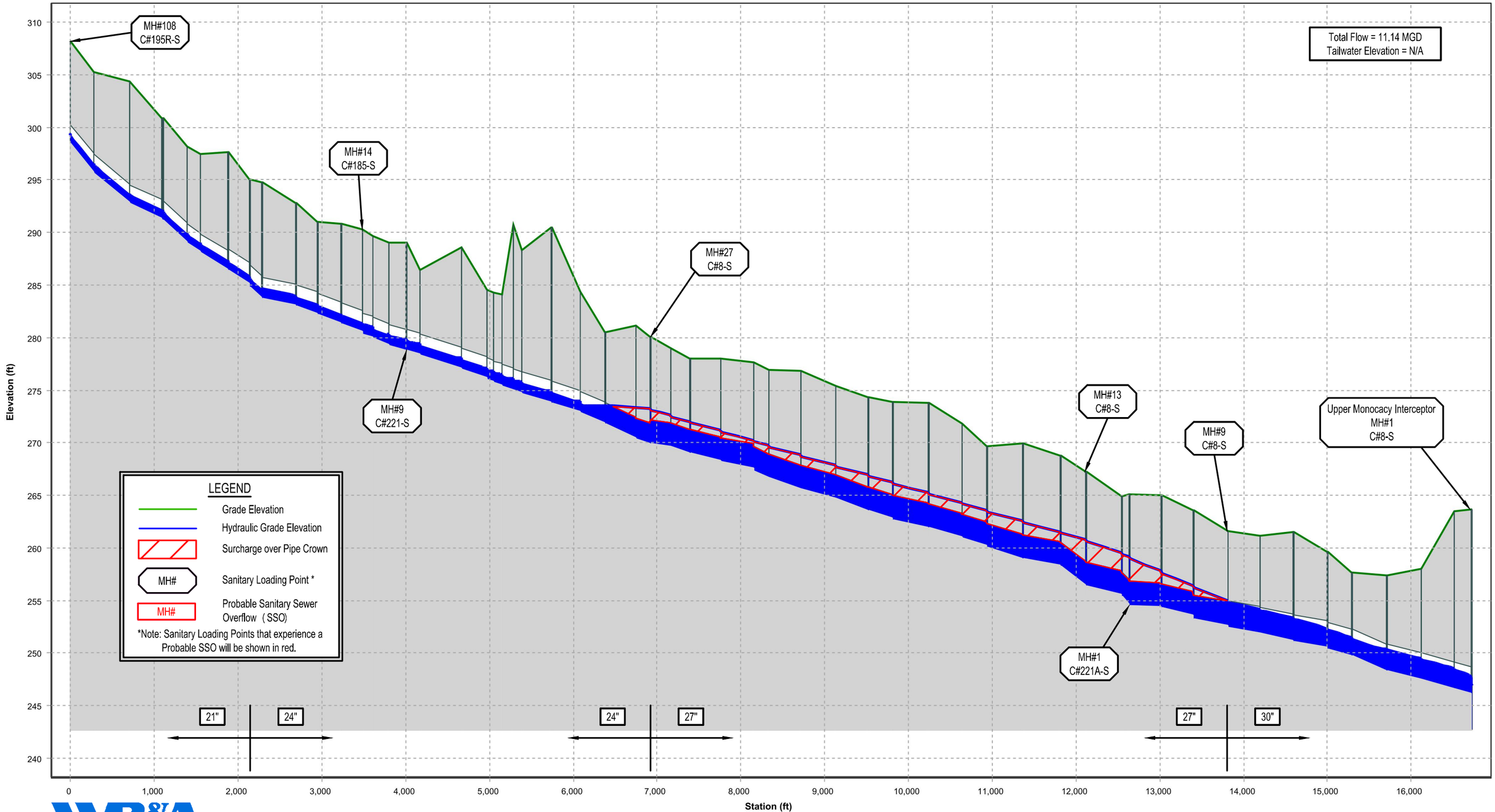

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Figure 3-20
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Figure 3-21, Upper Monocacy Interceptor - 2030 Peak: MH#54 (C#5-S) to Ceresville PS

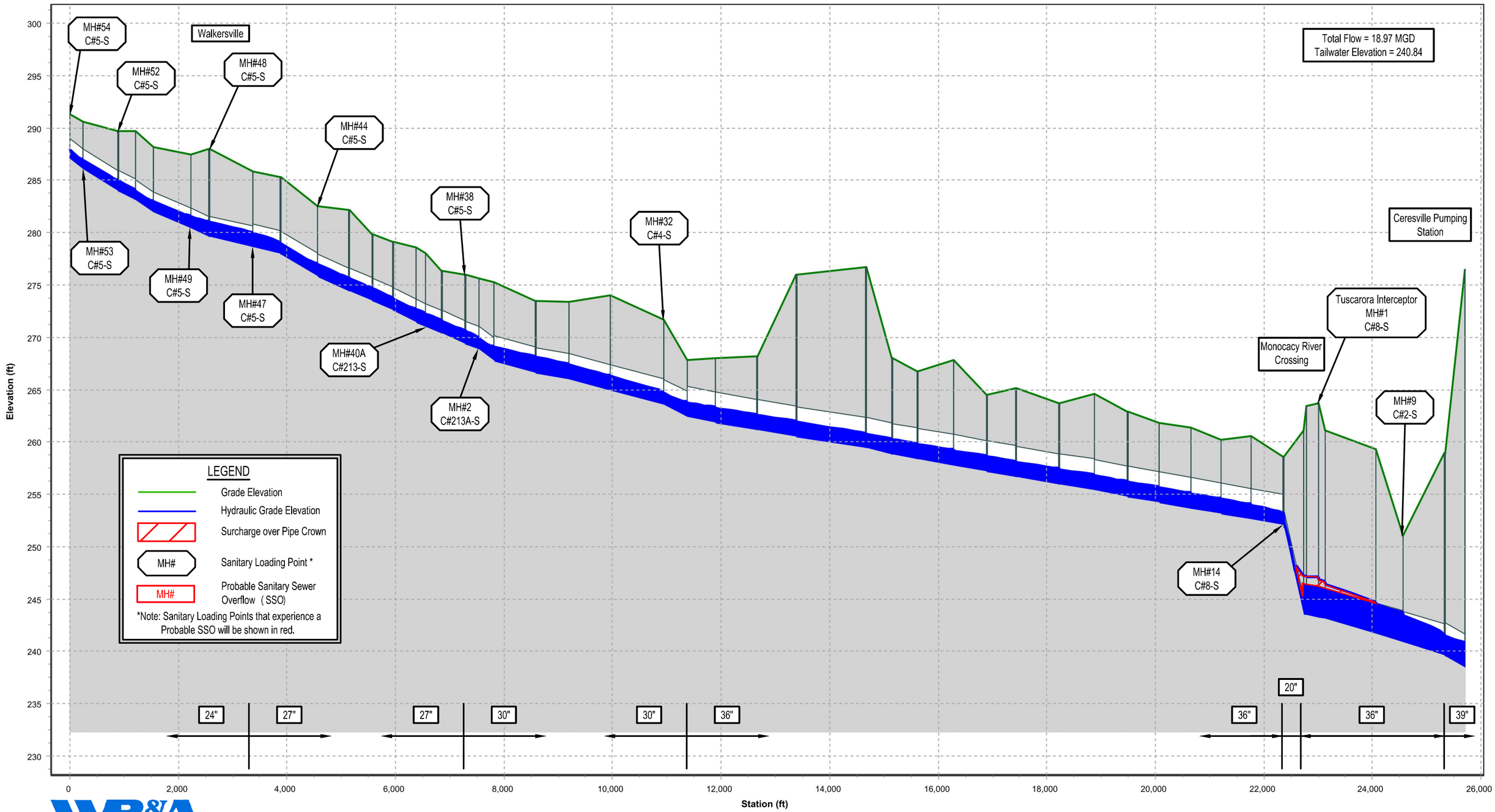

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Figure 3-21
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Figure 3-22, Ceresvile PS Influent Sewer - 2030 Peak: MH#15 (C#2-S) to Ceresville PS

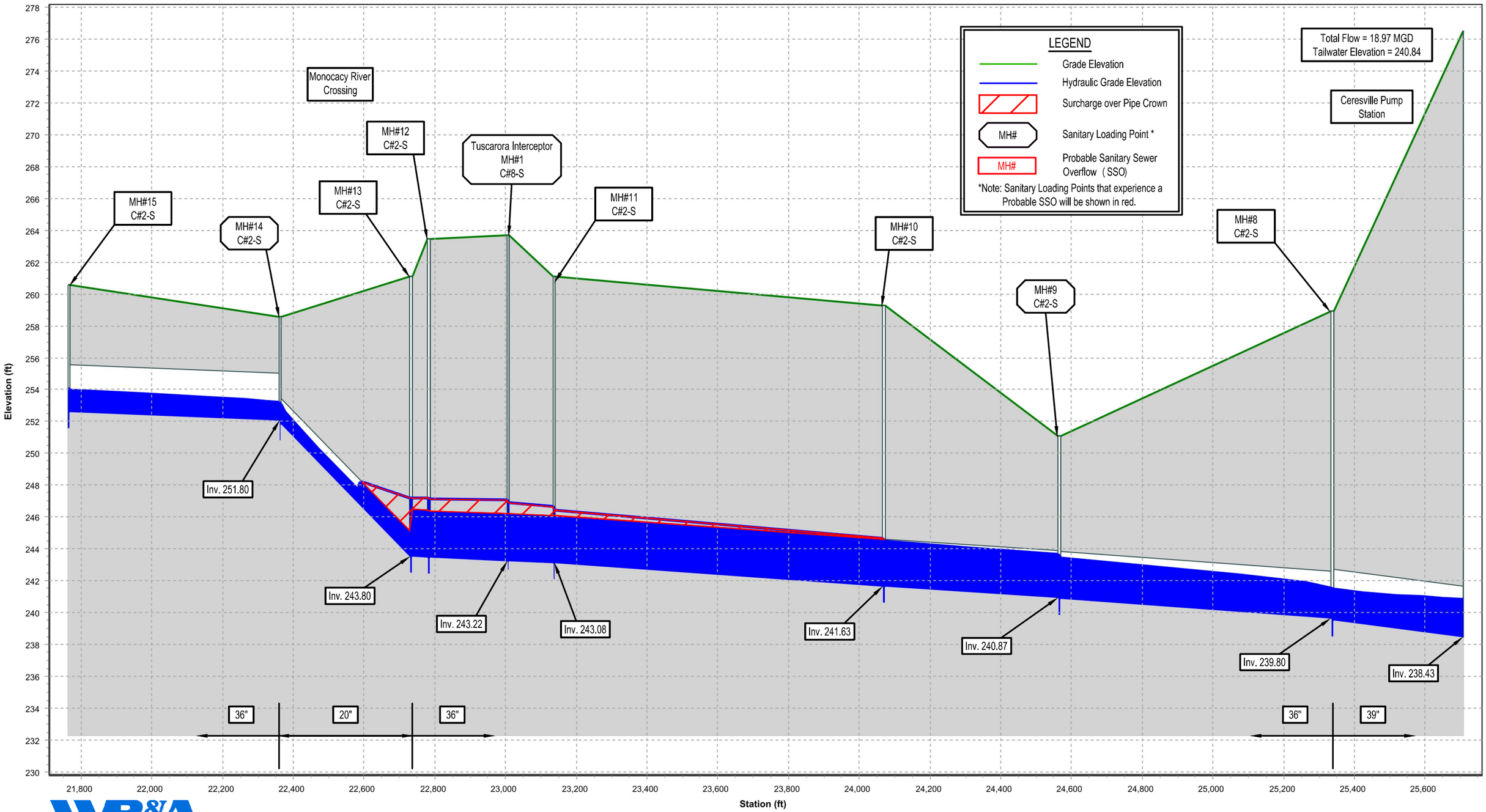

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Figure 3-22
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Figure 3-23, City Interceptor - 2030 Peak: MH#7 (C#2-S) to MH#3 (C#82-R)

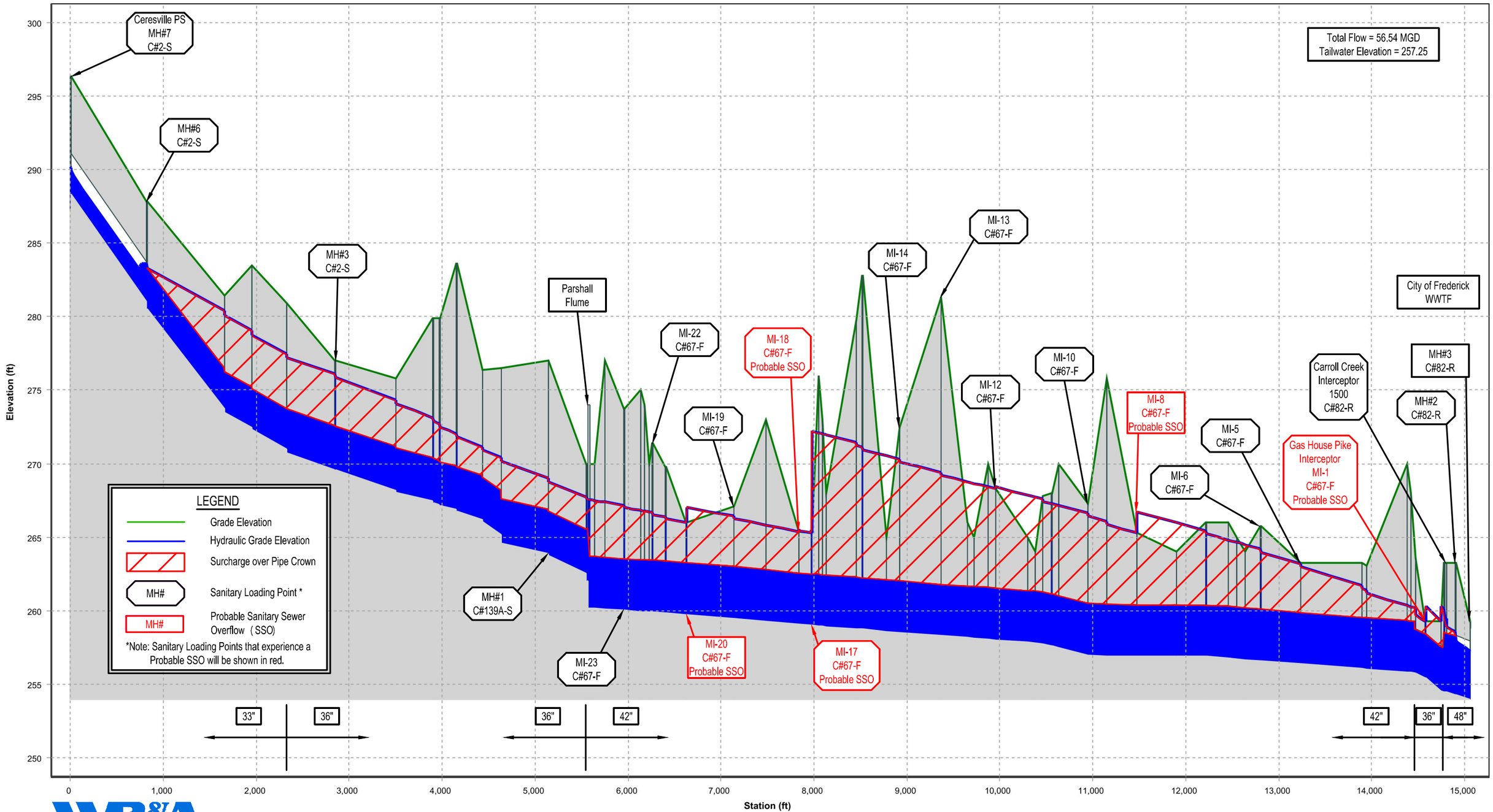

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Figure 3-23
August 2011

Figure 3-24, City WWTF Influent Sewer - 2030 Peak: MI-2 (C#67-F) to MH#3 (C#82-R)

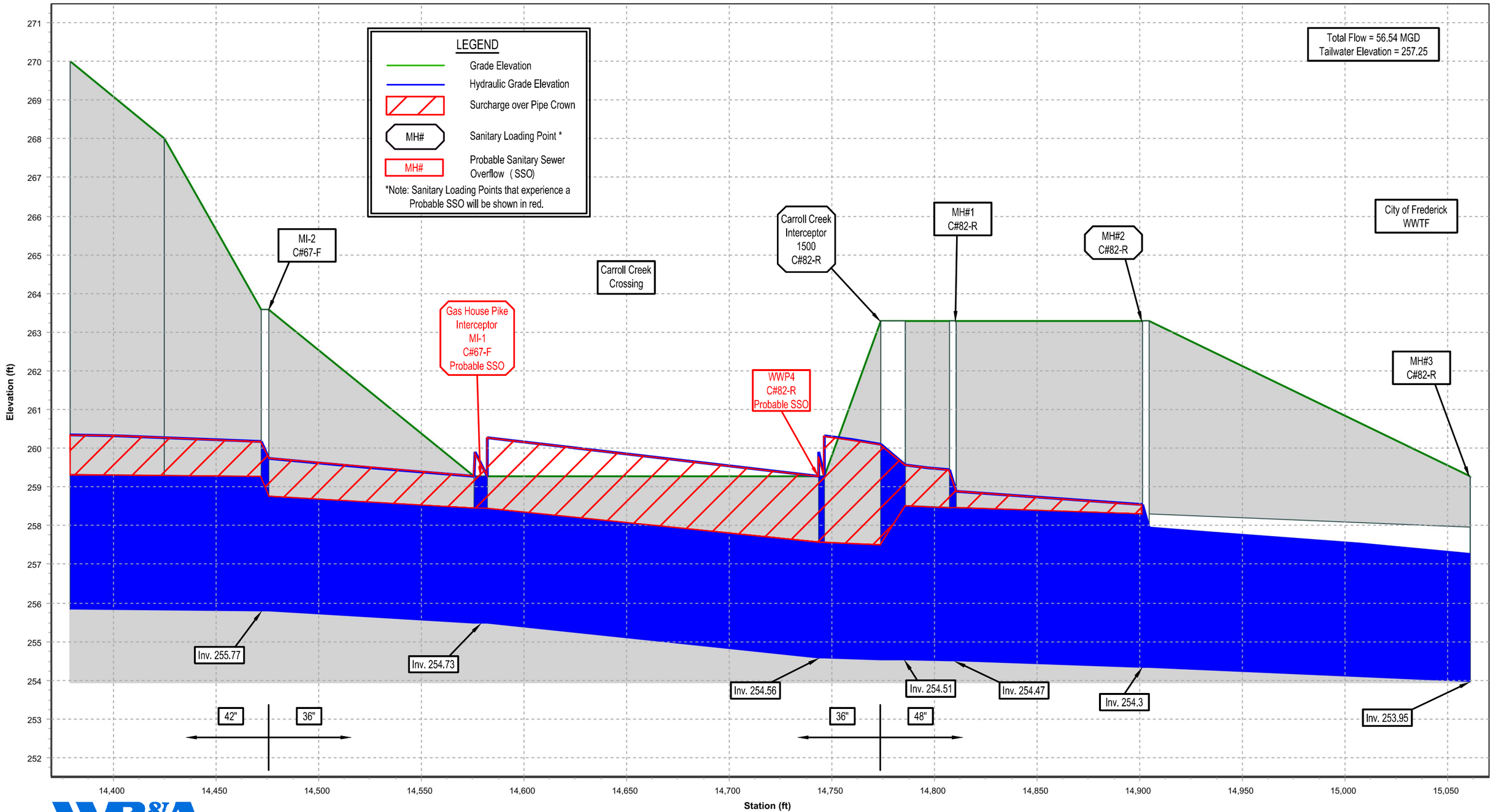

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Figure 3-24
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Figure 3-25, Lower Monocacy Interceptor - 2030 Peak: City of Frederick WWTF to Ballenger-McKinney WWTP

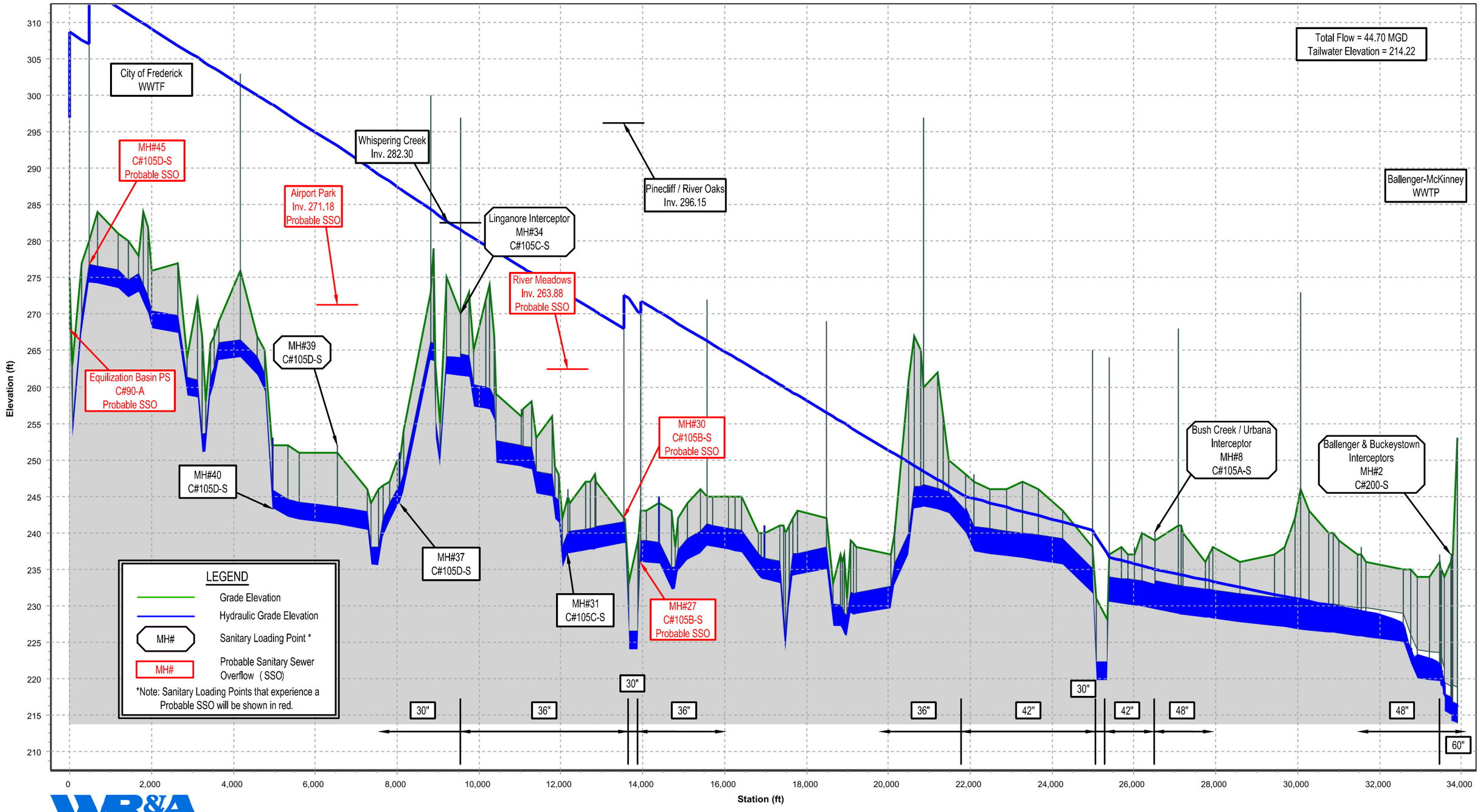

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Figure 3-25
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Figure 3-26, Tuscarora Interceptor - 2040 Peak: MH#108 (C#195R-S) to MH#1 (C#8-S)

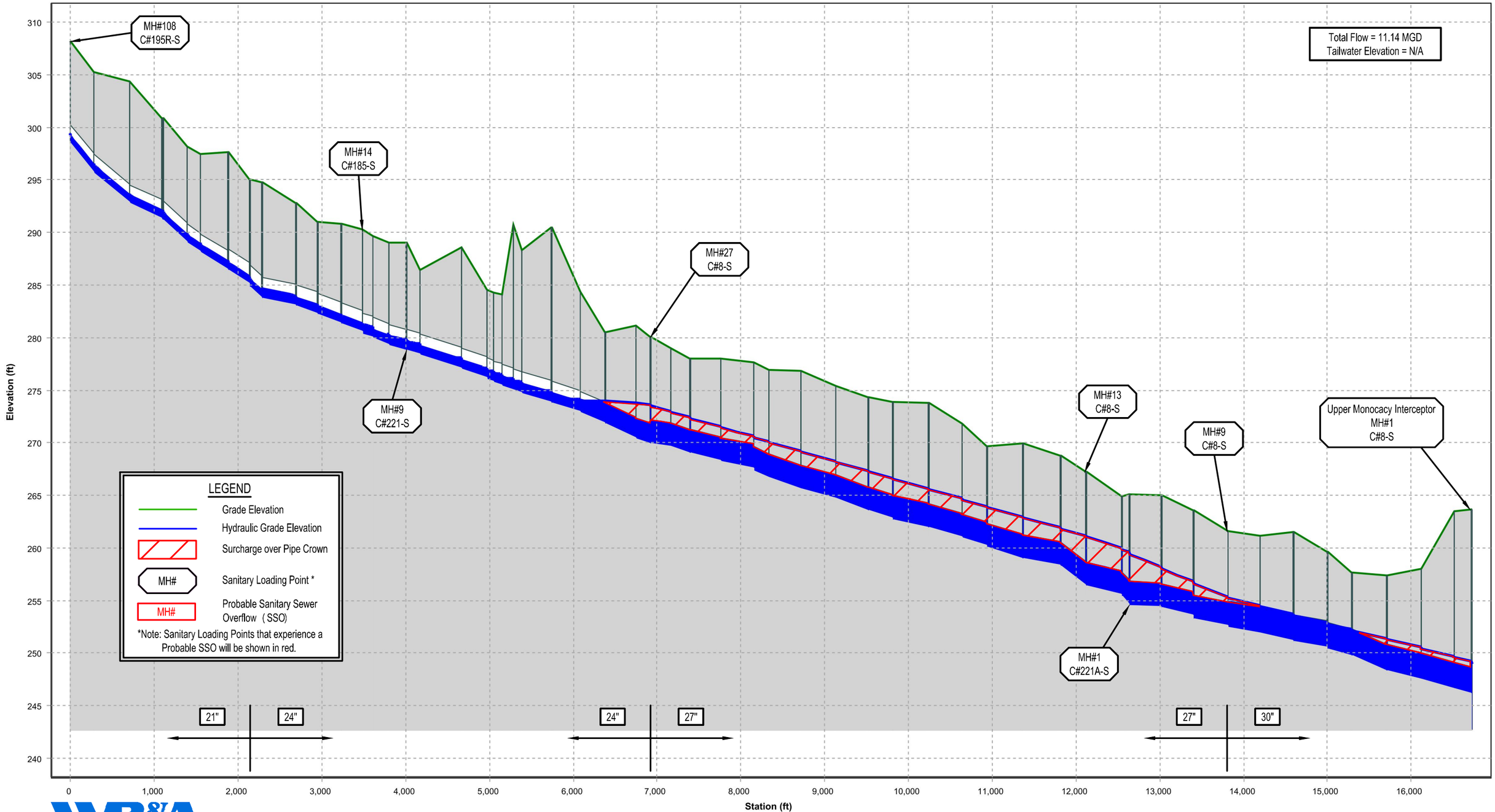

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Figure 3-26
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Figure 3-27, Upper Monocacy Interceptor - 2040 Peak: MH#54 (C#5-S) to Ceresville PS

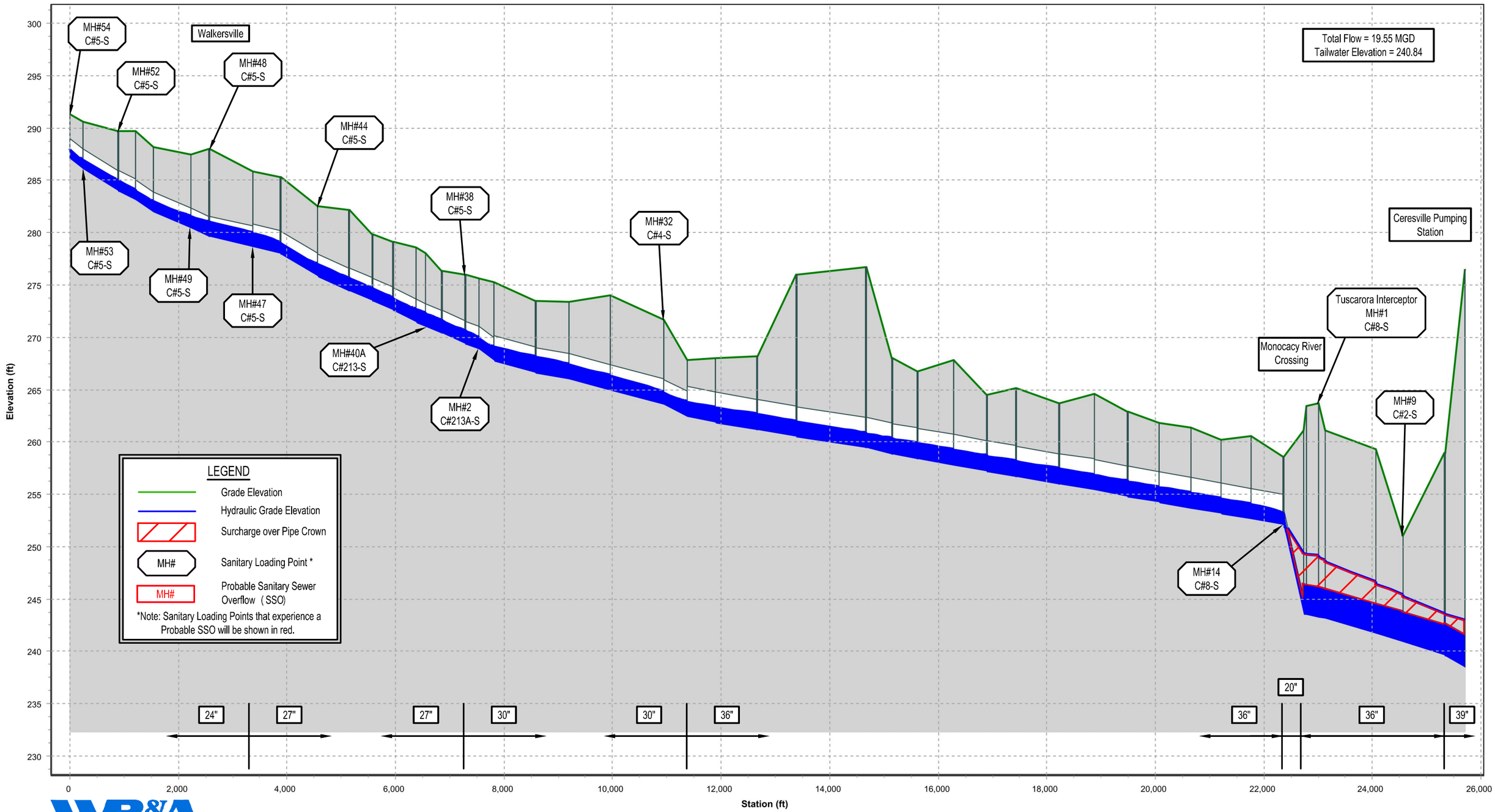

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Figure 3-27
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Figure 3-28, Ceresville PS Influent Sewer - 2040 Peak: MH#15 (C#2-S) to Ceresville PS

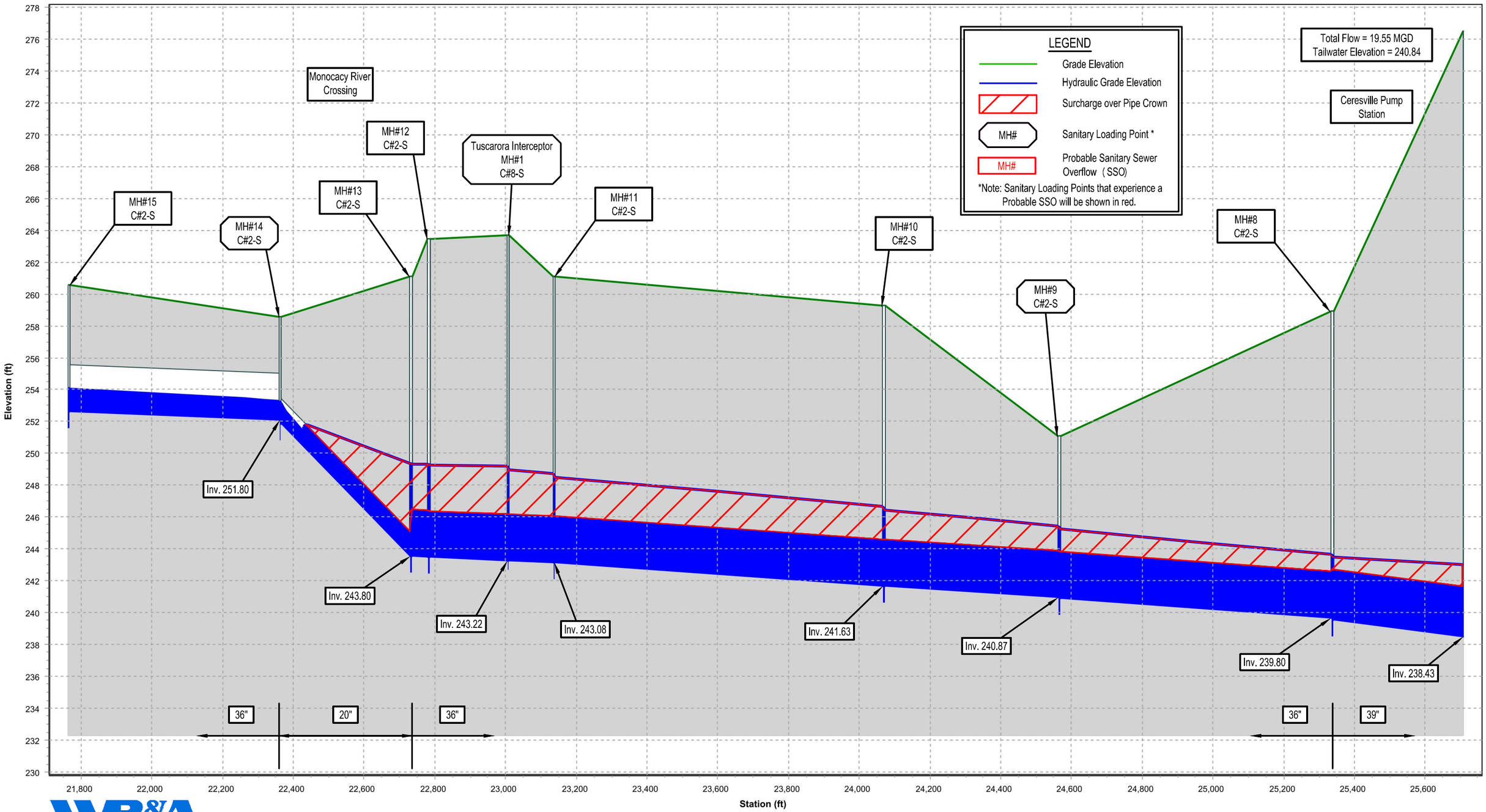

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Figure 3-28
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Figure 3-29, City Interceptor - 2040 Peak: MH#7 (C#2-S) to MH#3 (C#82-R)

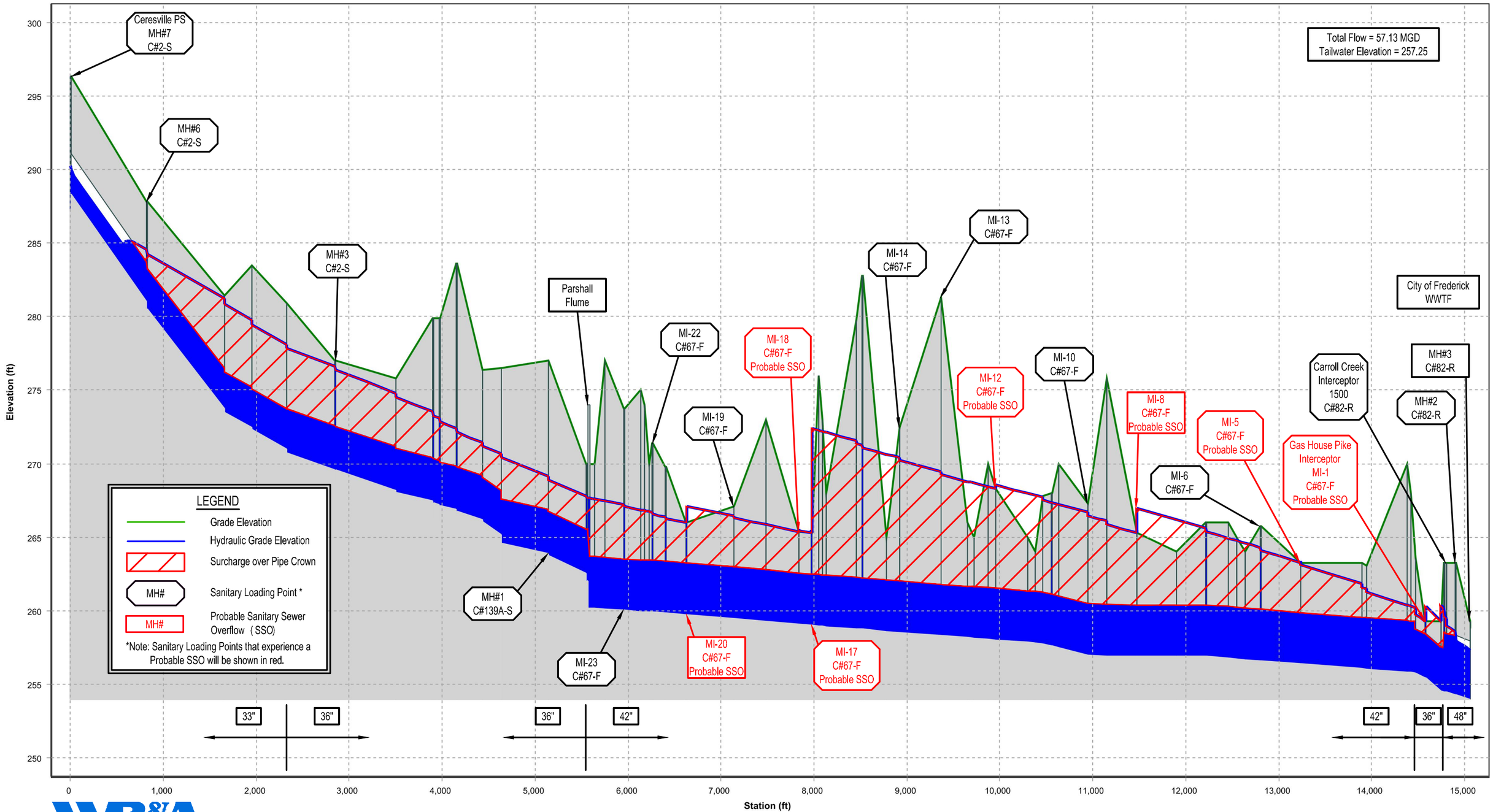

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Figure 3-29
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Figure 3-30, City WWTF Influent Sewer - 2040 Peak: MI-2 (C#67-F) to MH#3 (C#82-R)

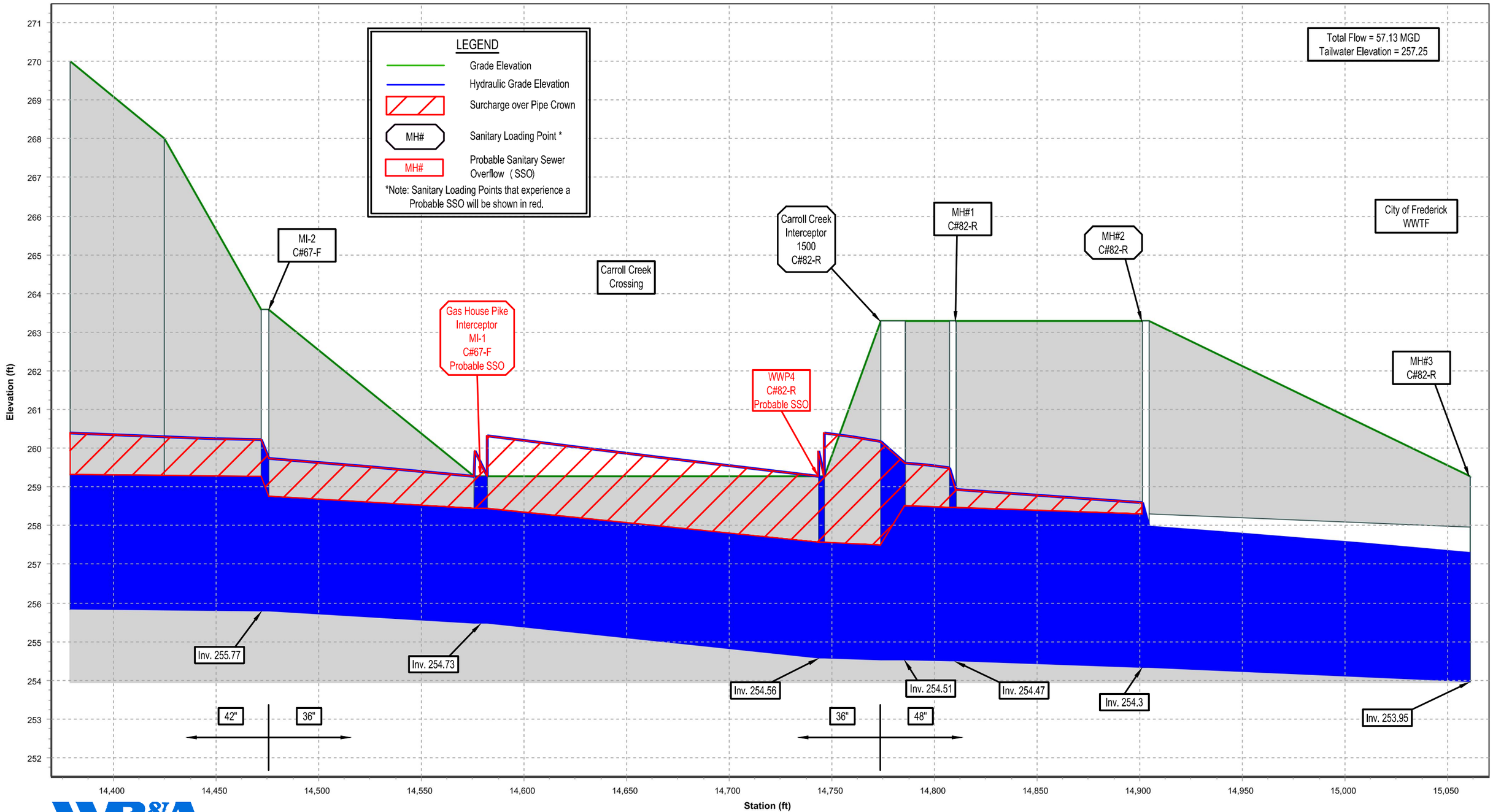

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Figure 3-30
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Figure 3-31, Lower Monocacy Interceptor - 2040 Peak: City of Frederick WWTF to Ballenger-McKinney WWTP

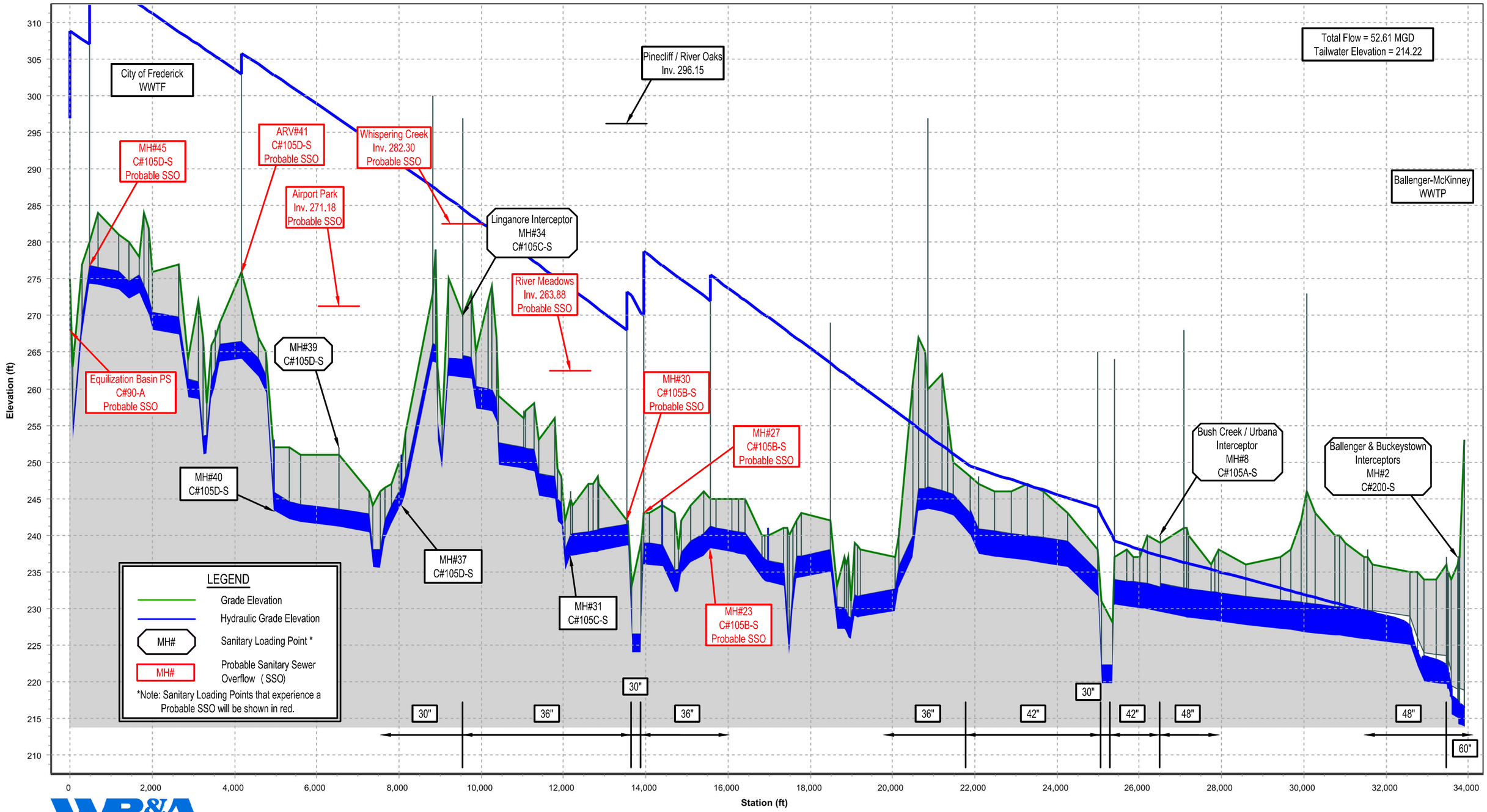

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Figure 3-31
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3.5.6 Extended Period Simulation Results

The EPS allows for flows in the model to vary over time. The EPS simulation was run for 48 hours using peaking factors from the hydrograph illustrated in Figure 3-1 to vary the average flow rate over time to simulate actual variations in flow. The flow from Ceresville PS used varying pump speed to maintain output flow rates in excess of a single pump operating and did not experience both pumps off during the extreme rain event. The backwash from the City WTP was modeled to occur 20 hours after the start of the simulation during the highest flow multiplier. The backwash lasts for 10 minutes at a rate of 10,800 gpm (15.56 MGD). This is derived from 108,000 gallons consumed over a 10 minute cycle every 2-3 days based on information provided by City operational staff. During currently allocated flows, the backwash causes significant surcharging of the system across two hours as the slug of flow travels through the City Interceptor. This surcharging can be seen on **Figure 3-32** and **Figure 3-33**. The first figure shows the system at hour 20 when the backwash initially starts to enter the system. The second figure monitors the flow at hour 21 after the backwash has completed, but the slug of flow is travelling downstream. The interceptor is surcharged downstream of the Parshall Flume, but overflows only occur at the Carroll Creek crossing.

Figure 3-32, City Interceptor - Current EPS: Time 20:00

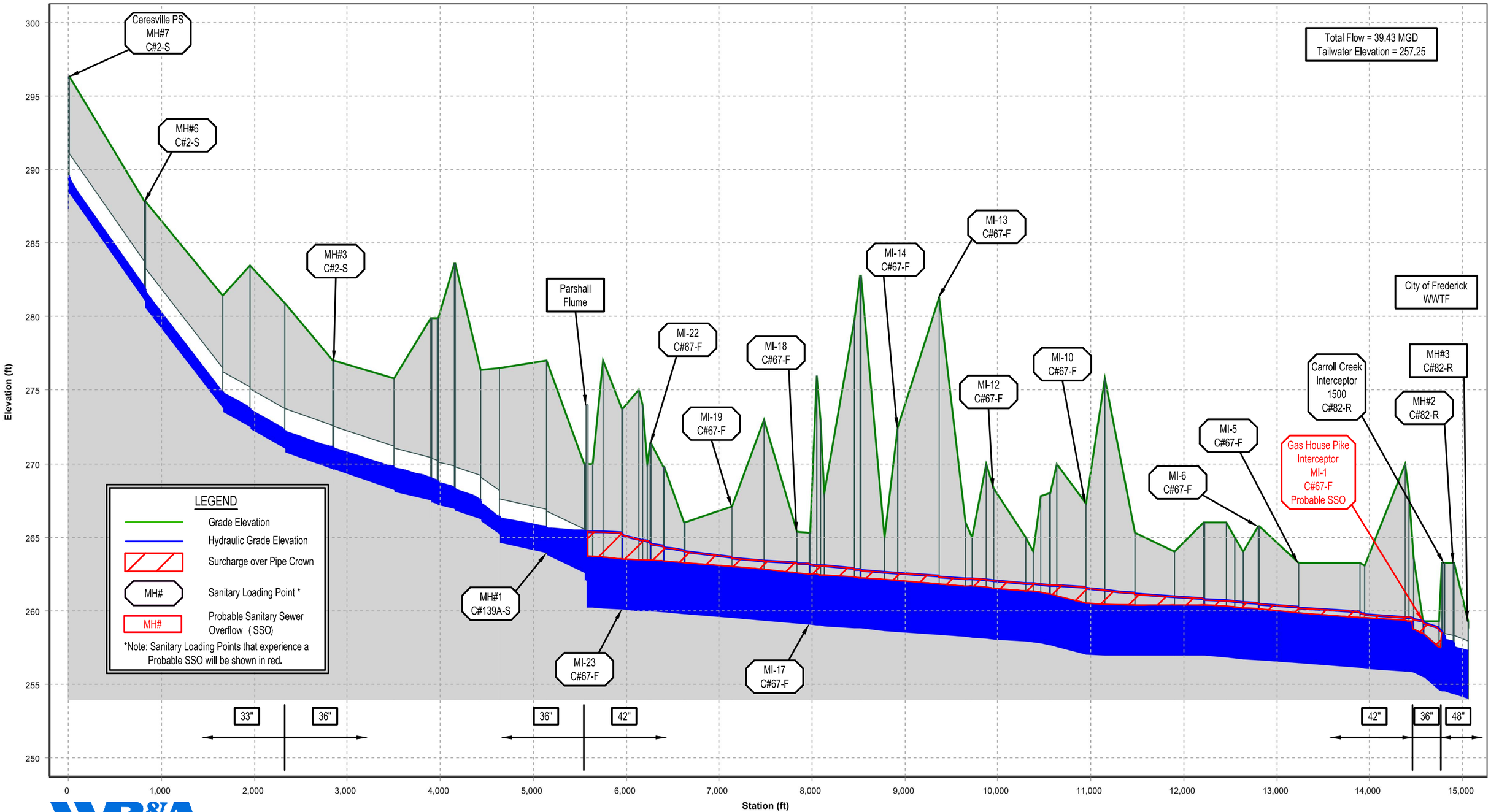

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Figure 3-32
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Figure 3-33, City Interceptor - Current EPS: Time 21:00

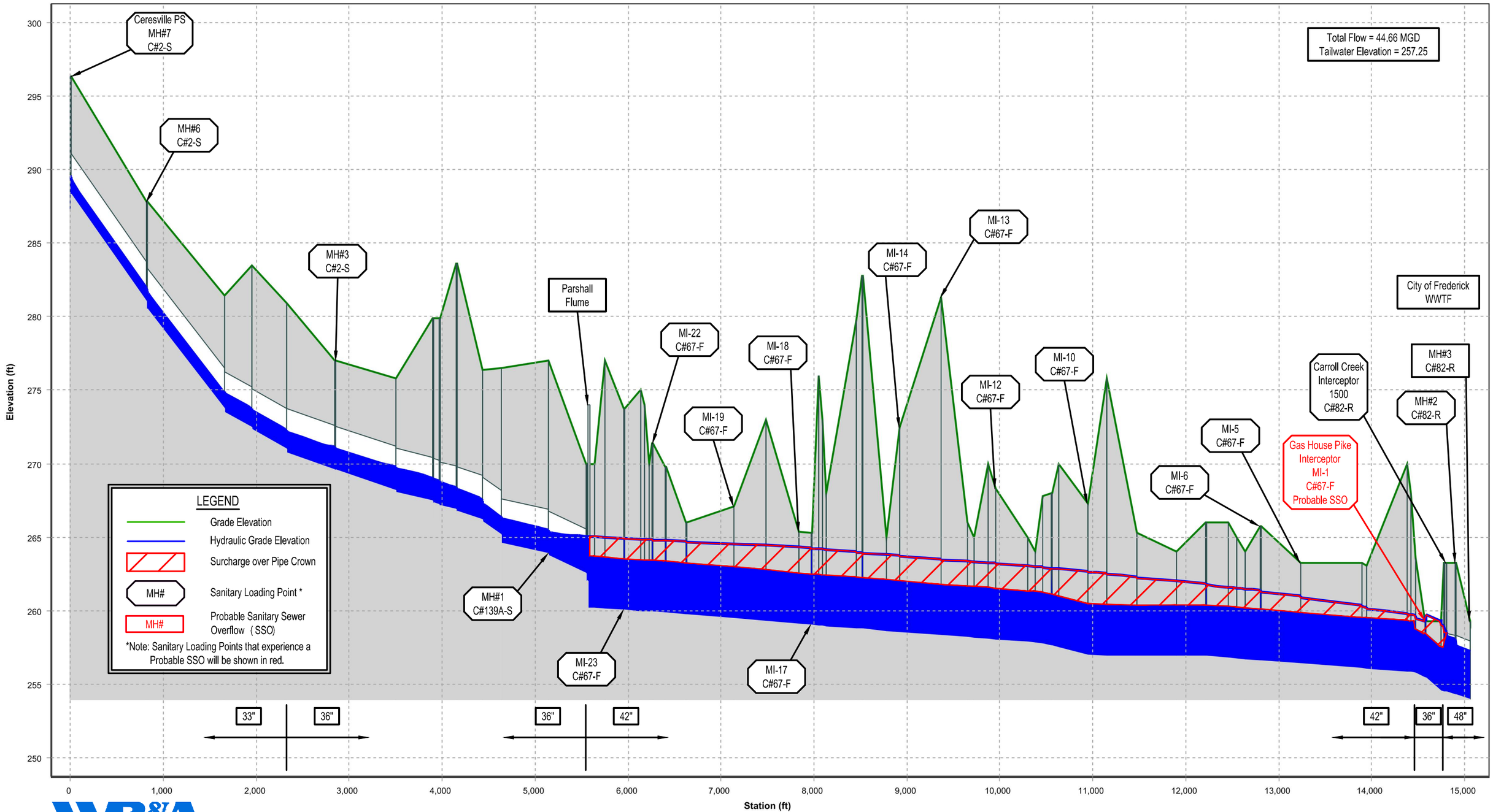

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Figure 3-33
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4.0 Effluent Outfall Modeling

4.1 Description of Effluent Outfall

The County's Ballenger-McKinney WWTP has a combined nutrient loading allocation based on an 18 MGD average daily design flow (ADF). The MDE has allocated the County's Ballenger-McKinney WWTP a combined Chesapeake Bay nutrient loading of 219,280 lbs/yr TN and 16,446 lbs/year TP.

The combined 18 MGD capacity and nutrient loading allocations are based on previously approved Ballenger Creek WWTP capacity of 6 MGD with nutrient loading allocation of 73,093 lbs/yr TN and 5,482 lbs/yr TP and the 12 MGD McKinney WWTP with nutrient load allocation of 146,187 lbs/yr TN and 10,964 lbs/yr TP. The 15 MGD WWTP capacity currently under construction, represents a portion of the total 18 MGD nutrient allocation recognized by MDE for the Ballenger-McKinney WWTP.

Current and past (County) wastewater capacity studies identified the need for up to 25 MGD of treatment capacity. However, current limitations on the discharge of TN and TP effectively limit the ultimate capacity of the Ballenger-McKinney WWTP to 18 MGD (ADF).

Based on the County's 2005 Ballenger-McKinney WWTP Facility Plan, the County's Ballenger-McKinney WWTP expansion will be able to treat up to 15 MGD with a discharge to the Monocacy River at River Mile 13. Average daily flows above 15 MGD that could result in increased pollutant loading, greater than permitted, will be diverted to the Potomac River through the County's Potomac River outfall system through a separate NPDES permit for the Potomac River outfall.

The Ballenger-McKinney WWTP is the County's primary WWTP. The phased construction of the project, which included the construction of a bridge across Ballenger Creek, effectively creates one large single treatment complex that will provide the best available technology to meet ENR treatment requirements for the service area. This single facility will use the existing Monocacy River outfall, but will also have the ability to divert treated effluent to the Potomac River through a 10.2-mile outfall system. The Potomac River outfall will allow the County to meet the pollutant loading values for the Monocacy River when the ADF from the facility exceeds 15 MGD but is less than 18 MGD. Treatment capacity above 18 MGD will be contingent on changes in State's nutrient discharge rules or future (new) treatment technologies that can achieve greater nitrogen and phosphorus removal levels or through alternative means of effluent disposal such as water reuse.

For the purpose of modeling the capacity of the effluent outfall line, it was assumed that the build-out flow of 25 MGD can be discharged either to the Monocacy River or the Potomac River.

Since there is a 15 MGD limit on the Monocacy River discharge, the remaining 10 MGD was assumed to be discharged through the effluent outfall line. A peaking factor of 2.5 was applied to this value to consider a build-out peak flow condition of 25 MGD.

Currently, the infrastructure is not yet in place for connection of the Ballenger-McKinney WWTP to the effluent outfall system. The effluent force main is capped behind the DUSWM offices, approximately 3,000 feet away from the Ballenger-McKinney WWTP just after it crosses under the CSX railroad tracks.

The effluent outfall system consists of 5,500 feet of 42-inch force main along English-Muffin Way, which connects to an existing 24-inch abandoned water main to be repurposed as an effluent force main. The 24-inch effluent force main runs for 18,000 feet before reaching the connection with East Alco at Manor Woods Road. From this point, the force main is manifolded to parallel 18-inch and 24-inch force mains. The parallel force mains continue for 22,250 feet until they reach a ridge and transition to gravity flow. The force mains behave as a pressure sewer after the ridge and continue as parallel for another 1,500 feet before transitioning back to a single 42-inch pipe. The last portion of 42-inch main extends another 4,000 feet to the Potomac River and attaches to an 18-inch diffuser. The diffuser lies in the bottom of the river with outlets in the pipe at regular intervals to allow an even distribution of flow.

4.2 Outfall Model Assumptions

The Potomac River outfall for the Ballenger-McKinney WWTP was broken into two separate models. The existing model for the pumped portion of the treated effluent force main to the ridge was previously modeled in WaterCAD. The section downstream of the ridge acts as a gravity sewer due to steep slopes and was modeled in SewerCAD. The force main is only constructed up to the CSX railroad crossing and the last 3,000 ft was assumed to be installed as 36-inch DIP connected to the WWTP effluent pumping station. The WaterCAD model uses Hazen-Williams equations for full pipe flow and thus uses C factors for roughness coefficient. The existing 24-inch and 18-inch force mains were assumed to have a C factor of 110 while the new 42-inch and 36-inch sections were assigned a C factor of 120. The gravity section is modeled in SewerCAD and uses Manning's equation for non-full pipe (open channel) flow, assuming an *n* value of 0.013 for all piping.

The head loss through the diffuser is assumed to be the head loss generated from the total flow passing through the 18-inch outfall pipe and the loss generated by the flow being evenly distributed across all 190 diffusers. The diffusers are two inches in diameter and extend one foot beyond the connection to the outfall pipe.

The force main model was built assuming that the ridge would be the high point in the system and the head generated downstream of the ridge will be less than the total elevation drop. A tailwater elevation at the Potomac River was determined to be the 100-year flood plain elevation of 240 ft. The gravity section of the outfall assumed that adequate air is exchanged via the combination air release valves installed at high points of the system. If air is not allowed to enter the force main a vacuum will be created at the ridge and the resulting siphon will change the system curve used to define the pump operating point.

4.3 Outfall Model Simulations

The outfall model was developed as two separate models between WaterCAD (pumped section) and SewerCAD (gravity sewer section). These models were used to simulate two flow conditions: existing constrained conditions and future build-out flows.

The pumped section of the force main extends to the ridge and a pump size was determined to offer the maximum flow to the ridge without exceeding 250 ft of head at the pump station under the existing piping configuration. The build-out scenario was set up to pump a peak flow of 25 MGD to the intermediate high point.

The flows calculated from WaterCAD through the 24-inch and 18-inch parallel force mains were then input into a SewerCAD model to simulate flows in the gravity pipeline between the ridge and the Potomac River. The models were run under steady state conditions for both the pumped and gravity portions. The East Alco facility connected to the force main was assumed to pump 416 gpm (0.60 MGD) into the parallel 18-inch and 24-inch force mains.

4.4 Analysis of Results and Observations

4.4.1 Existing System Capacity Simulation

For the effluent force main, the section with the largest head loss in the system is the 18,000 ft length of unparalleled 24-inch transmission main. The model estimates that a total flow of 7,200 gpm (10.4 MGD) can be pumped from the WWTP without exceeding a head of 250 ft at the pump. This is considered the theoretical capacity of the effluent outfall system in its current configuration. The velocity in the 24-inch line reaches 5.1 fps. At the ridge, the model predicted flows in the 24-inch and 18-inch parallel lines of 5,184 gpm and 2,436 gpm, respectively. The gravity section of the outfall does not incur a head loss to the ridge (there is no surcharge in the gravity section) allowing the pump station to operate as intended. An illustration of this is shown on **Figure 4-1**.

The head loss through the diffuser is calculated as 1.50 ft at a flow rate of 11.00 MGD (equal to the theoretical pumped flow of 10.4 MGD plus the contribution of 0.60 MGD from East Alco).

Figure 4-1, Effluent Outfall Pressure Sewer - 10.4 MGD from Ballenger-McKinney WWTP

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Figure 4-1
August 2011

The calculated hydraulic grade line exceeds the invert for the New Design Road WTP lagoon effluent drain system, so the backwash lagoon effluent drain system will need to be converted to a pumped system before flows of this magnitude can be conveyed in the outfall.

4.4.2 Build-out Simulation

The build-out simulation did not include any changes to the physical piping configuration, and modeled the proposed peak flow of 25 MGD. At this flow rate, the model predicts that the pump station would experience a total head exceeding 800 ft. The velocities through the 24-inch line reach 12.31 fps while the flow through the parallel 24-inch and 18-inch parallel lines are equal to 12,096 gpm and 5,684 gpm, respectively. A parallel outfall pipe will need to be installed between the 42-inch pipes at English Muffin Way and Tuscarora Road to accommodate the additional treated effluent flow, thereby lowering pumping head and flow velocity to acceptable values.

A profile of the gravity section is located on **Figure 4-2**. The head loss through the existing diffuser during peak flow is 7.41 ft. The HGL at the New Design Road WTP exceeds the elevation of manholes on the lagoon effluent system, so a pumped system will be required.

Figure 4-2, Effluent Outfall Pressure Sewer - 25.0 MGD from Ballenger-McKinney WWTP

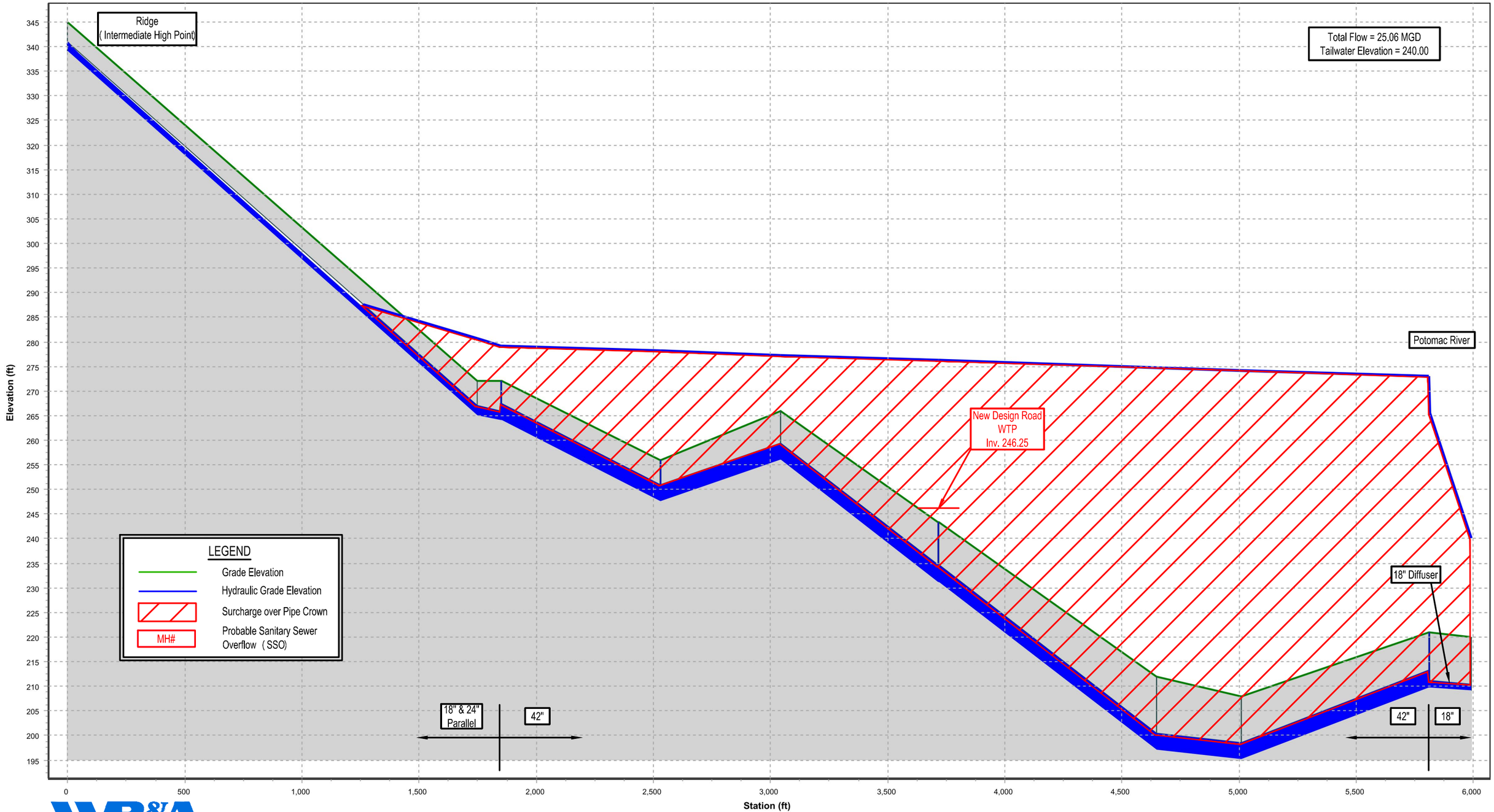

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Figure 4-2
August 2011

5.0 Study Recommendations

5.1 Recommendations

The modeling efforts to date have identified areas of the Monocacy Interceptor and Ballenger-McKinney WWTP effluent line where there are capacity limitations. These efforts have been based on available historical flow data, discussions with County and City staff, and the assumptions as outlined herein. Recommendations for next steps include the following:

1) Installation of reliable flow meters in strategic locations in the County and continued use of flow meters in the City for long term flow testing to verify the flow assumptions outlined herein. Long term flow metering will provide the County and City with an on-going tool to capture peak flow events, which will provide the ability to re-calibrate the Sewer Model, as necessary, and assess results of improvements being made to the system to combat infiltration and inflow. Potential long term flow metering needs, in no order of priority, include:
    - Tuscarora Interceptor
    - Upper Monocacy Interceptor (Walkersville)
    - Linganore Interceptor
    - Bush Creek/Urbana Interceptor
    - Ballenger Interceptor
    - Buckeystown Interceptor

2) Initiation or continued efforts to determine base infiltration at locations throughout the service area. The model currently has not separated infiltration from sewage flow, but has been set up with this capability. Potential areas to determine base infiltration, in no order of priority, include the locations listed above, as well as:
    - City Interceptor
    - Carroll Creek Interceptor
    - Gas House Pike Interceptor

3) Continuation of this Study by proceeding with Phase II and the associated objectives to identify potential infrastructure improvements necessary to accommodate planned and future flow projections.

Appendix

Pump Data Sheet - Chicago Pump, Aurora, IL

Company: YCC
Name: Dan Thompson
Date: 11/1/2006

Customer: Fredrick Co.
Project: Replacement for 61-07915,
Location: Cereaville PS
Quote #: 05736
Item ID / Tag #: 61-07915
Qty. of Pumps: one

Pump:

Frame: OLC10

Type: 2110
Synch speed: 900 rpm

Speed: 870 rpm
Dia: 21.9375 in

Curve ID No.: 40422

Impeller ID No.: P 2245

Specific Speeds:

Ns: —
Nss: —

Dimensions:

Suction: 12 in
Discharge: 10 in

Pump Limits:

Temperature: 150 °F
Pressure: 100 psi g
Sphere size: 5 in

Power: — hp
Eye area: — in²

Search Criteria:

Flow: 4840 US gpm

Head: 75 ft

Fluid:

Water
Density: 62.25 lb/ft³
Viscosity: 1.105 cP

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

NPSHa: — ft

Motor:

Standard: NEMA
Enclosure: TEFC

Size: 125 hp
Speed: 900
Frame: 447T

Sizing criteria: Max Power on Design Curve

— Data Point —

Flow:	4840 US gpm
Head:	75.6 ft
Eff:	82%
Power:	112 hp
NPSHr:	17.2 ft

— Design Curve —

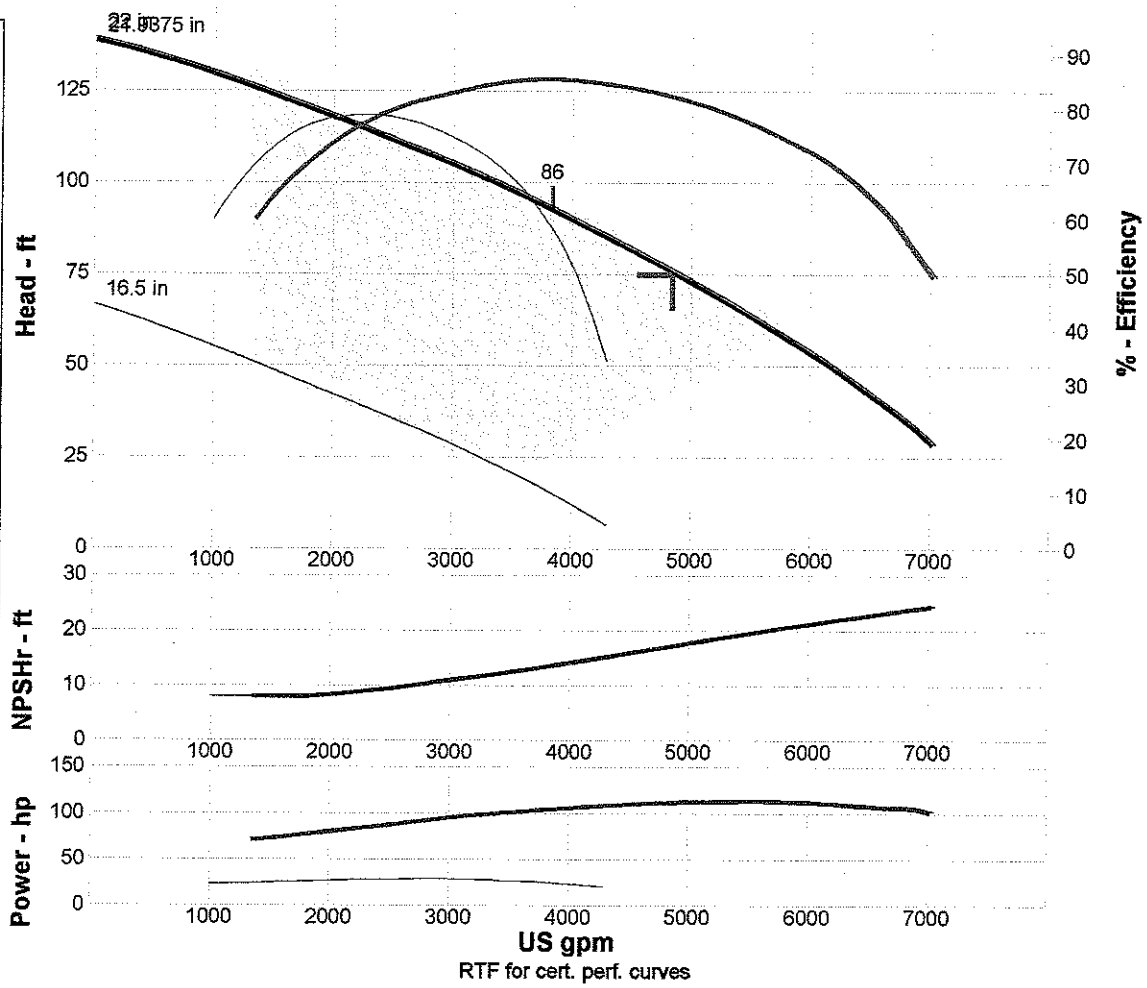
Shutoff head:	139 ft
Shutoff dP:	60 psi
Min flow:	— US gpm

BEP: 86% @ 3829 US gpm

NOL power:
113 hp @ 5213 US gpm

— Max Curve —

Max power:
115 hp @ 5235 US gpm

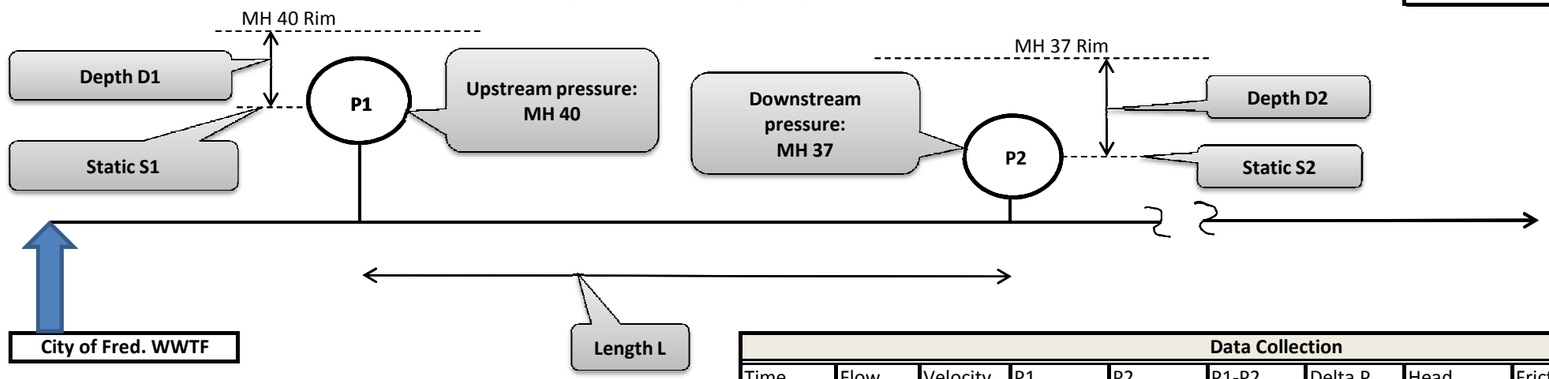


Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
5808	870	57.2	74	113	20.6
4840	870	75.6	82	112	17.2
3872	870	91.9	85	105	13.8
2904	870	106	83	94.2	10.7
1936	870	119	73	79.4	8.28

Frederick County/City Wastewater Utility Master Plan
Monocacy Pressure Sewer Pipe Roughness Characterization

Date: 5/10/2011



Initial Setup Conditions		
Length L	ft	3,005
Pipe Diameter	in	30
MH 40 Rim	ft	251.589
MH 37 Rim	ft	250.622
Static S1 (MH 40 Rim + D1)	ft	252.037
Static S2 (MH 37 Rim + D2)	ft	251.080
Static ΔS (S1-S2)	ft	0.957

Setup:
Select range of gauges
Provide diaphragm isolators

$\Delta H = (\Delta P \times 2.31) + \Delta S$

$S = \Delta H / L$

$n = (3.45 / Q) \times \sqrt{S}$

$C = (Q \times 0.32) / S^{0.54}$

Test Results:	n		C
8 MGD Average =	0.009	=	168
10 MGD Average =	0.012	=	119
11.75 MGD Average =	0.012	=	120
Average of all 3 =	0.011	=	135
Average of 10 & 11.75 =	0.012	=	119

Data Collection

Time	Flow MGD	Velocity ft/sec	P1 psi	P2 psi	P1-P2 psi	Delta P ft	Head ft	Frict Loss ft/ft (S)	n	C
10:00	2.0	0.63014		7.25	-7.25	-16.7475	-15.791	-0.005255	#NUM!	#NUM!
10:05	2.0	0.63014	6.00	7.25	-1.25	-2.8875	-1.931	-0.000643	#NUM!	#NUM!
10:10	2.0	0.63014	6.00	7.25	-1.25	-2.8875	-1.931	-0.000643	#NUM!	#NUM!
10:15	8.0	2.52057	6.00	7.25	-1.25	-2.8875	-1.931	-0.000643	#NUM!	#NUM!
10:20	8.0	2.52057	6.50	7.25	-0.75	-1.7325	-0.776	-0.000258	#NUM!	#NUM!
10:25	8.0	2.52057	7.25	7.25	0.00	0	0.957	0.0003183	0.007694	198.0086
10:30	8.0	2.52057	7.25	7.25	0.00	0	0.957	0.0003183	0.007694	198.0086
10:35	8.0	2.52057	7.40	7.25	0.15	0.3465	1.303	0.0004336	0.00898	167.5675
10:40	8.0	2.52057	7.40	7.25	0.15	0.3465	1.303	0.0004336	0.00898	167.5675
10:45	8.0	2.52057	7.40	7.25	0.15	0.3465	1.303	0.0004336	0.00898	167.5675
10:50	10.0	3.15071	8.00	7.40	0.60	1.386	2.343	0.0007796	0.009633	152.5984
10:55	10.0	3.15071	8.00	7.40	0.60	1.386	2.343	0.0007796	0.009633	152.5984
11:00	10.0	3.15071	8.00	7.40	0.60	1.386	2.343	0.0007796	0.009633	152.5984
11:05	10.0	3.15071	8.00	7.40	0.60	1.386	2.343	0.0007796	0.009633	152.5984
11:10	10.0	3.15071	8.60	7.80	0.80	1.848	2.805	0.0009333	0.01054	138.4639
11:15	10.0	3.15071	8.90	7.80	1.10	2.541	3.498	0.0011639	0.01177	122.8997
11:20	10.0	3.15071	9.00	7.80	1.20	2.772	3.729	0.0012408	0.012153	118.7277
11:25	10.0	3.15071	9.00	7.80	1.20	2.772	3.729	0.0012408	0.012153	118.7277
11:30	10.0	3.15071	9.00	7.80	1.20	2.772	3.729	0.0012408	0.012153	118.7277
11:35	11.75	3.70209	9.60	8.10	1.50	3.465	4.422	0.0014714	0.011263	127.2364
11:40	11.75	3.70209	9.75	8.10	1.65	3.8115	4.768	0.0015867	0.011696	122.1569
11:45	11.75	3.70209	9.75	8.10	1.65	3.8115	4.768	0.0015867	0.011696	122.1569
11:50	11.75	3.70209	9.75	8.20	1.55	3.5805	4.537	0.0015098	0.011409	125.477
11:55	11.75	3.70209	9.90	8.20	1.70	3.927	4.884	0.0016252	0.011837	120.5882
12:00	11.75	3.70209	9.90	8.20	1.70	3.927	4.884	0.0016252	0.011837	120.5882
12:05	11.75	3.70209	10.00	8.20	1.80	4.158	5.115	0.001702	0.012113	117.6159
12:10	11.75	3.70209	10.00	8.00	2.00	4.62	5.577	0.0018558	0.012649	112.2496
12:15	6.0	1.89043	9.25	8.00	1.25	2.8875	3.844	0.0012792	0.020566	70.07268
12:20	6.0	1.89043	8.90	8.00	0.90	2.079	3.036	0.0010102	0.018275	79.60236
12:25	6.0	1.89043	8.90	8.00	0.90	2.079	3.036	0.0010102	0.018275	79.60236
12:30	6.0	1.89043	8.90	8.00	0.90	2.079	3.036	0.0010102	0.018275	79.60236
12:35	6.0	1.89043	8.90	8.00	0.90	2.079	3.036	0.0010102	0.018275	79.60236
12:40	6.0	1.89043	8.90	8.00	0.90	2.079	3.036	0.0010102	0.018275	79.60236

Sanitary Load Allocation Table

Contract	Manhole	Tax Map	Tax Grid	Name of Subdivision/Parcel	PRWSA #	Units	Ac./DU /CU/SF	Flow/ Unit	Existing Flow (gpd)	Currently Allocated Flow (gpd)	2015 Flow (gpd)	2020 Flow (gpd)	2030 Flow (gpd)	2040 Flow (gpd)	Comments
5-S	54			Glade Manor		247	DU	250	61,750	61,750	61,750	61,750	61,750	61,750	
5-S	54	852	23	1554		5.92	Ac.	1,000		0	0	1,954	3,907	5,861	Open Lot (4 DU/Ac.)
5-S	54			Sun Meadow		278	DU	250	63,000	67,000	67,000	67,000	67,000	67,000	252 Ex, 15 Vac, 1 Comm
5-S	54			Fountain Rock Meadow		225.2	DU	250	57,675	59,175	59,175	59,175	59,175	59,175	225.2 Ex, 11 Comm, 6 Vac Comm
5-S	54			Fountain Rock S		11.3	CU	250	1,413	1,413	1,413	1,413	1,413	1,413	
5-S	54			Heritage		28	DU	250	7,000	7,000	7,000	7,000	7,000	7,000	
5-S	54			Glade Towne		478	DU/CU	250	139,450	139,450	139,450	139,450	139,450	139,450	478 Ex, 159.6 Comm
5-S	54			Deerfield		285	DU/CU	250	72,138	72,138	72,138	72,138	72,138	72,138	285 Ex, 7.1 Comm
5-S	54	49	17	66		2.54	Ac.	1,000		0	0	838	1,676	2,515	Open Lot (4 DU/Ac.)
5-S	54	852	23	Walkers Brethren Church (2070)		5,104	SF	0.2	1,021	1,021	1,021	1,021	1,021	1,021	
5-S	54	851	0	Glade Valley Church (1724)		7,290	SF	0.2	1,458	1,458	1,458	1,458	1,458	1,458	
5-S	54	851	0	Walkers Village (1722)		86,231	SF	0.2	17,246	17,246	17,246	17,246	17,246	17,246	Market
5-S	54			Colony Village		161	DU/CU	250	46,725	46,725	46,725	46,725	46,725	46,725	161 Ex, 25.9 Comm
5-S	54	49	22	Walkers Village Center II (118)		27,838	SF	0.2		5,568	5,568	5,568	5,568	5,568	
5-S	54	851	22	Victoria Park (1552)		98.2	CU	250	12,025	12,525	12,525	12,525	12,525	12,525	96.2 Existing, 2 Vacant
5-S	54			Glade Elementary School		71,028	SF	0.2	14,206	14,206	14,206	14,206	14,206	14,206	
5-S	54			Winter Brook			DU/CU	250	25,500	25,500	25,500	25,500	25,500	25,500	65 Resid. 74 Comm.
5-S	54			Walkersville Residential		22	DU	250	5,500	5,500	5,500	5,500	5,500	5,500	
5-S	54			Walkersville Commercial		247.1	CU	250		0	0	20,386	40,772	61,157	
5-S	54	49		Town of Walkersville (922)		85.26	Ac.	1,400		0	0	0	119,364	119,364	
5-S	54	49		Town of Walkersville (144)		60	Ac.	1,400		0	0	0	84,000	84,000	
5-S	54	49		Commercial (13)		3.9	Ac.	1,400		0	0	0	5,460	5,460	
5-S	54	49		35		1	DU	250		0	0	0	250	250	S-5
5-S	54	49		36		1	DU	250		0	0	0	250	250	S-5
5-S	54	49		37		1	DU	250		0	0	0	250	250	S-5
5-S	54	49		17		1	DU	250		0	0	0	250	250	S-5
5-S	54			Manhole 54 (C: 5-S) Load					526,106	537,673	537,673	560,851	793,852	817,030	
5-S	53			Walkersville Residential		51	DU	250	12,750	12,750	12,750	12,750	12,750	12,750	
5-S	53			Manhole 53 (C:5-S) Load					12,750	12,750	12,750	12,750	12,750	12,750	
5-S	52	851	0	S & V Partnership (1466)		1.55	Ac.	1,400		0	0	716	1,432	2,148	
5-S	52	851	1	Lonza (1467)		29,402	SF	0.2	5,880	5,880	5,880	5,880	5,880	5,880	
5-S	52			Manhole 52 (C:5-S) Load					5,880	5,880	5,880	6,597	7,313	8,029	
5-S	49	49	21	Lonza (88)		20,552	SF	0.2	4,110	4,110	4,110	4,110	4,110	4,110	Industrial
5-S	49	850	3	Lonza (788)		259,206	SF	0.2	51,841	51,841	51,841	51,841	51,841	51,841	Office
5-S	49	49		Zimmerman, Agriculture (773)		29	Ac.	1,400		0	0	0	40,600	40,600	S-5
5-S	49	851		Agriculture (768)		25	Ac.	1,400		0	0	0	35,000	35,000	S-5
5-S	49	851		33		1	DU	250		0	0	0	250	250	S-5
5-S	49			32		1	DU	250		0	0	0	250	250	S-5
5-S	49			31		1	DU	250		0	0	0	250	250	S-5
5-S	49			44		1	DU	250		0	0	0	250	250	S-5
5-S	49			30		1	DU	250		0	0	0	250	250	S-5
5-S	49			29		1	DU	250		0	0	0	250	250	S-5
5-S	49			99		1	DU	250		0	0	0	250	250	S-5
5-S	49			100		1	DU	250		0	0	0	250	250	S-5
5-S	49			70		1	DU	250		0	0	0	250	250	S-5
5-S	49			23		1	DU	250		0	0	0	250	250	S-5
5-S	49			71		1	DU	250		0	0	0	250	250	S-5
5-S	49			22		1	DU	250		0	0	0	250	250	S-5
5-S	49			45		1	DU	250		0	0	0	250	250	S-5
5-S	49			60		1	DU	250		0	0	0	250	250	S-5
5-S	49			115		1	DU	250		0	0	0	250	250	S-5
5-S	49			Manhole 49 (C: 5-S) Load					55,952	55,952	55,952	55,952	135,302	135,302	
5-S	48	851	0	St. Paul's Evangelical Church (1458)		3,064	SF	0.2	613	613	613	613	613	613	
5-S	48			Walkersville Residential		65	DU	250	16,250	16,250	16,250	16,250	16,250	16,250	

Sanitary Load Allocation Table

Contract	Manhole	Tax Map	Tax Grid	Name of Subdivision/Parcel	PRWSA #	Units	Ac./DU /CU/SF	Flow/ Unit	Existing Flow (gpd)	Currently Allocated Flow (gpd)	2015 Flow (gpd)	2020 Flow (gpd)	2030 Flow (gpd)	2040 Flow (gpd)	Comments
5-S	48			Manhole 48 (C: 5-S) Load					16,863	16,863	16,863	16,863	16,863	16,863	
5-S	47			Walkersville Residential		269	DU	250	67,250	67,250	67,250	67,250	67,250	67,250	
5-S	47	850	23	Branch Banking and Trust (1101-1)		1,120	SF	0.2	224	224	224	224	224	224	
5-S	47	850	23	Frederick County Bank (1101-2)		2,349	SF	0.2	470	470	470	470	470	470	
5-S	47	850	23	PNC Bank (1101-3)		1,470	SF	0.2	294	294	294	294	294	294	
5-S	47	850	15	1096		2,445	SF	0.2	489	489	489	489	489	489	Library
5-S	47	58	3	Moxley Property (302-1)		5,307	SF	0.2	1,061	1,061	1,061	1,061	1,061	1,061	
5-S	47	851	0	Walkersville Elementary School (1102)		27,352	SF	0.2	5,470	5,470	5,470	5,470	5,470	5,470	
5-S	47	850	15	Walkersville Middle School (1097)		102,777	SF	0.2	20,555	20,555	20,555	20,555	20,555	20,555	
5-S	47	851	0	Walkersville United Methodist Church (1396)		12,032	SF	0.2	2,406	2,406	2,406	2,406	2,406	2,406	
5-S	47	851	0	St. Paul's Evangelical Lutheran Church (1434)		10,337	SF	0.2	2,067	2,067	2,067	2,067	2,067	2,067	
5-S	47	58	3	RE AHC (281)		50,840	SF	0.2	10,168	10,168	10,168	10,168	10,168	10,168	Nursing Home
5-S	47			Manhole 47 (C: 5-S) Load					110,456	110,456	110,456	110,456	110,456	110,456	
5-S	44	58	2	Walkersville High School		191,104	SF	0.2	38,221	38,221	38,221	38,221	38,221	38,221	
5-S	44	58	3	Walkersville Volunteer Fire Co.		38,342	SF	0.2	7,668	7,668	7,668	7,668	7,668	7,668	
5-S	44	851	9	St. Timothy Roman Catholic Congregation		21,081	SF	0.2	4,216	4,216	4,216	4,216	4,216	4,216	
5-S	44	851	9	Westview		23	DU	250	8,388	8,388	8,388	8,388	8,388	8,388	23 Ex, 21.1 Comm
5-S	44			Spring Garden		66	DU	250	16,750	16,750	16,750	16,750	16,750	16,750	66 Ex, 1 Vac
5-S	44			Walkersville Residential		89	DU	250	22,250	22,250	22,250	22,250	22,250	22,250	
5-S	44			Manhole 44 (C: 5-S) Load					97,493	97,493	97,493	97,493	97,493	97,493	
213E-S	40A	58	2	Creekside Park		21	DU	250	5,250	5,250	5,250	5,250	5,250	5,250	
213E-S	40A			Fredericktowne Baptist Church		30,187	SF	0.2	6,037	6,037	6,037	6,037	6,037	6,037	
213E-S	40A			Manhole 40A (C: 213E-S) Load					11,287	11,287	11,287	11,287	11,287	11,287	
5-S	38	58	2	59		6	DU	250	1,500	1,500	1,500	1,500	1,500	1,500	
5-S	38	58	2	96		1	Du	250	250	250	250	250	250	250	
5-S	38	58	2	97		1	DU	250	250	250	250	250	250	250	
5-S	38	58	2	98		1	DU	250	250	250	250	250	250	250	
5-S	38	58	2	225		1	DU	250	250	250	250	250	250	250	
5-S	38	58	2	227		1	DU	250	250	250	250	250	250	250	
5-S	38			Manhole 38 (C: 5-S) Load					2,750	2,750	2,750	2,750	2,750	2,750	
213A-S	2	58	2	Creekside Park		58	DU	250	14,500	14,500	14,500	14,500	14,500	14,500	
213A-S	2	58	2	BOCC (59)		0.25	Ac.	1,400		0	0	0	350	350	S-5
213A-S	2	58	2	Agriculture (60)		12.59	Ac.	1,400		0	0	17,626	17,626	17,626	S-4
213A-S	2	58	2	Agriculture (245)		72.5	Ac.	1,400		0	0	101,500	101,500	101,500	S-4
213A-S	2			Manhole 2 (C: 213A-S) Load					14,500	14,500	14,500	133,626	133,976	133,976	
4-S	32			Dublin Manor		32	DU	250	8,000	8,000	8,000	8,000	8,000	8,000	
4-S	32			Agriculture (58)		89.1	Ac.	1,400		0	0	0	0	124,740	08PS
4-S	32			Manhole 32 (C: 4-S) Load					8,000	8,000	8,000	8,000	8,000	132,740	
2-S	14	57		Industrial (74)		28.93	Ac.	1,400	10,126	10,126	10,126	20,251	30,377	40,502	
2-S	14	57		Century (325)		182.68	Ac.	1,400		0	63,938	127,876	191,814	255,752	
2-S	14	58	9	Peace in Christ Church		8,448	SF	0.2	1,690	1,690	1,690	1,690	1,690	1,690	
2-S	14			Discovery Crossings		164	CU	250	20,275	20,775	20,775	20,775	20,775	20,775	162 Ex Comm, 2 Vac
2-S	14			Discovery		655	DU	175/250	133,750	133,750	133,750	133,750	133,750	133,750	
2-S	14	58		Industrial (PO. 288)		3.97	Ac.	1,400		0	0	0	5,558	5,558	S-5
2-S	14	58		71		10	Ac.	1,400		0	0	0	0	14,000	08PS
2-S	14			Manhole 14 (C: 2-S) Load					165,840	166,340	230,278	304,342	383,963	472,027	
				Walkersville					1,027,877	1,039,944	1,103,882	1,320,965	1,714,005	1,950,702	
226B-S	1			Meadowbrook		12.2	Ac.	1400		0	0	17,080	17,080	17,080	Assumed Planned Mid-Range
226B-S	1			Bartgis	9	144	DU	250		0	0	0	36,000	36,000	
226B-S	1			Rice	10	111	DU	250		0	0	0	27,750	27,750	

Sanitary Load Allocation Table

Contract	Manhole	Tax Map	Tax Grid	Name of Subdivision/Parcel	PRWSA #	Units	Ac./DU /CU/SF	Flow/ Unit	Existing Flow (gpd)	Currently Allocated Flow (gpd)	2015 Flow (gpd)	2020 Flow (gpd)	2030 Flow (gpd)	2040 Flow (gpd)	Comments
226B-S	1			Rothenhoefer	11	33	DU	250		0	0	0	8,250	8,250	
226B-S	1			Desando	12	12	DU	250		0	0	0	3,000	3,000	
226B-S	1			Cannon Bluff	13	187	DU	250	15,500	15,500	46,750	46,750	46,750	46,750	
226B-S	1			Keller - North	14A	160	DU	250		0	0	0	40,000	40,000	
226B-S	1			Keller - East	14B	131	DU	250		0	0	0	32,750	32,750	
226B-S	1			Keller - South	14C	327	DU	250		0	0	0	81,750	81,750	
226B-S	1			Staley	15	216	DU	250		0	0	0	54,000	54,000	
226B-S	1			Clover Ridge, LLC - North	16A	93	Du	250		0	0	0	23,250	23,250	
226B-S	1			Hooper - Northeast	17A	186	DU	250		0	0	0	46,500	46,500	
226B-S	1			Tuscacora Creek	54	847	DU	250/225 /175		71,000	194,325	194,325	194,325	194,325	528 @ 250 gpd, 130 @ 225 gpd, 189 @ 175 gpd
226B-S	1			Crum, Staley, Willowbrook	62	134	DU	250		0	0	0	33,500	33,500	
226B-S	1	Manhole 1 (C: 226B-S) Load							15,500	86,500	241,075	258,155	611,405	611,405	
195-S	109	57	15	218		1,984	SF	0.2	397	397	397	397	397	397	Sports Field and Facility
195-S	109	57	19	228		1	DU	250	250	250	250	250	250	250	
195-S	109	57	14	Carbaugh Addition		10.2	Ac.	1400		0	14,280	14,280	14,280	14,280	Assumed Planned Immediate
195-S	109	57	20	24		1	DU	250	250	250	250	250	250	250	
195-S	109			Clover Hill III		330	DU	250	82,250	82,500	82,500	82,500	82,500	82,500	Portion of Clover Hill
195-S	109			Sunset Drive		43	DU	250		0	0	0	10,750	10,750	
195-S	109			West Hills		75	DU	250		0	0	0	18,750	18,750	
195-S	109			Clover Ridge, Garst	7	308	DU	250	61,000	69,500	69,500	69,500	69,500	69,500	214 Ex, 33 Vac, 60 Comm, 1 Vac Comm
195-S	109			Sanner	8	192	DU	250		0	0	0	48,000	48,000	
195-S	109			Tauraso Annex.	105	13.5	Ac.	1000		0	0	0	13,500	13,500	
195-S	109	Manhole 109 (C: 195-S) Load							144,147	152,897	167,177	167,177	258,177	258,177	
185-S	14			Willowbrook	55	402	DU	175/250	81,750	81,750	81,750	81,750	81,750	81,750	
185-S	14	Manhole 14 (C: 185-S) Load							81,750	81,750	81,750	81,750	81,750	81,750	
221-S	9	57	10	Homewood Retirement Center (310)		97,803	SF	0.2	19,561	19,561	19,561	19,561	19,561	19,561	Assume 0.2 gpd/SF
221-S	9	57	10	Homewood (Crum Farm Lot) (29)		11	Ac.	900		0	9,900	9,900	9,900	9,900	
221-S	9	Manhole 9 (C: 221-S) Load							19,561	19,561	29,461	29,461	29,461	29,461	
8-S	27	57	16	72		1	DU	250	250	250	250	250	250	250	
8-S	27	57	16	209-16		19,340	SF	0.2	3,868	3,868	3,868	3,868	3,868	3,868	
8-S	27	57	16	209-17		18,620	SF	0.2	3,724	3,724	3,724	3,724	3,724	3,724	
8-S	27	401	3	1441		1	DU	250	250	250	250	250	250	250	
8-S	27	401	0	1-1		1	DU	250	250	250	250	250	250	250	
8-S	27	401	0	1-2		1	DU	250	250	250	250	250	250	250	
8-S	27	57	16	Maranatha Church		48,895	SF	0.2	9,779	9,779	9,779	9,779	9,779	9,779	
8-S	27	401	0	Monocacy Elementary School		58,300	SF	0.2	11,660	11,660	11,660	11,660	11,660	11,660	
8-S	27	401	0	Monocacy Middle School		111,993	SF	0.2	22,399	22,399	22,399	22,399	22,399	22,399	
8-S	27	401	0	Frederick Co. Voc. Tech Center		84,304	SF	0.2	16,861	16,861	16,861	16,861	16,861	16,861	
8-S	27	401	0	Frederick Community College		265,861	SF	0.2	53,172	53,172	53,172	53,172	53,172	53,172	
8-S	27	57	16	Arrowhead		22	DU	250	5,500	5,500	5,500	5,500	5,500	5,500	
8-S	27	57		Clover Hill I & II		525	DU	250	131,250	131,250	131,250	131,250	131,250	131,250	Only a portion of Clover Hill
8-S	27	57	15	Cloverview		10	DU	250	2,500	2,500	2,500	2,500	2,500	2,500	
8-S	27			Crumland Farm Annex.	1	285	Ac.			0	0	200,000	455,000	455,000	Flows based on City Analysis
8-S	27			COPT/Thatcher Annex.	2	151	Ac.	1400		0	0	211,400	211,400	211,400	
8-S	27			Ritchfield Farm Annex.	3	139	Ac.	1400		0	0	0	194,600	194,600	
8-S	27			Nathan	4	96	Ac.	1400		0	0	67,200	134,400	134,400	
8-S	27			Homewood	5	670	DU	200		0	0	65,000	134,000	134,000	
8-S	27			North Crossing	6	487	DU/CU	175/250	100,838	100,838	100,838	100,838	100,838	100,838	
8-S	27			San Miguel - Gateway	47	490,050	SF	0.2		0	0	98,010	98,010	98,010	
8-S	27			Governor's Choice	52	139.8	CU	250	16,475	16,475	16,475	18,475	18,475	18,475	131.8 Ex Comm, 8 Vac Comm
8-S	27			Beckley Store/Motel	113					0	0	0	2,000	2,000	
8-S	27	Manhole 27 (C: 8-S) Load							379,025	379,025	379,025	1,022,635	1,610,435	1,610,435	
8-S	13	57	17	State Farm (39)		383,394	SF	0.2	76,679	76,679	76,679	76,679	76,679	76,679	Assume 0.2 gpd/SF

Sanitary Load Allocation Table

Contract	Manhole	Tax Map	Tax Grid	Name of Subdivision/Parcel	PRWSA #	Units	Ac./DU /CU/SF	Flow/ Unit	Existing Flow (gpd)	Currently Allocated Flow (gpd)	2015 Flow (gpd)	2020 Flow (gpd)	2030 Flow (gpd)	2040 Flow (gpd)	Comments
8-S	13			Tuscarora Knolls		335	DU	225	95,750	95,750	95,750	95,750	95,750	95,750	163 Ex Comm
8-S	13			Manhole 13 (C: 8-S) Load					172,429	172,429	172,429	172,429	172,429	172,429	
221A-S	1			Wormans Mill	57				126,363	145,863	213,963	260,213	260,213	260,213	206 @ 225 gpd, 1023 @ 175 gpd, 108.7 Comm, 7 Vac Comm
221A-S	1			Manhole 1 (C: 221A-S) Load					126,363	145,863	213,963	260,213	260,213	260,213	
8-S	9			State Farm	38	21	Ac.	1,400		0	0	29,400	29,400	29,400	May need to drain South
8-S	9			Manhole 9 (C: 8-S) Load					0	0	0	29,400	29,400	29,400	
8-S	1			Wormald Annex.	104					0	0	0	0	0	No Annexation Request
8-S	1			Manhole 1 (C: 8-S) Load					0	0	0	0	0	0	
				Tuscarora Interceptor					938,774	1,038,024	1,284,879	2,021,219	3,053,269	3,053,269	
2-S	9	58	19	106		1	DU	250		0	0	0	250	250	
2-S	9	58	19	203		3.6	Ac	1400		0	0	0	5,040	5,040	
2-S	9	58	19	224		1.3	Ac	1,400		0	0	0	1,820	1,820	
2-S	9	58	19	Waterside		201	DU	225	45,225	45,225	45,225	45,225	45,225	45,225	
2-S	9			Manhole 9 (C: 2-S) Load					45,225	45,225	45,225	45,225	52,335	52,335	
2-S	7			CeresVille PS Discharge					2,011,875	2,123,193	2,433,986	3,387,409	4,819,608	5,056,305	
2-S	7			Manhole 7 (C: 2-S) Load					2,011,875	2,123,193	2,433,986	3,387,409	4,819,608	5,056,305	
2-S	6			Dearbought	36	773	DU/CU	225	176,813	194,613	194,613	194,613	194,613	194,613	695 Ex, 78 Vac, 163.5 Comm, 1 Vac Comm
2-S	6			Manhole 6 (C: 2-S) Load					176,813	194,613	194,613	194,613	194,613	194,613	
2-S	3			Main (Rt. 26), Monocacy Park	43	282	DU	175	18,375	42,350	49,350	49,350	49,350	49,350	
2-S	3	58	19	Waterside		351	DU	225	84,288	84,513	84,513	84,513	84,513	84,513	350 Ex, 1 Vac, 44.3 Comm
2-S	3	57	24	108		3.6	Ac	1,400		0	0	0	5,040	5,040	
2-S	3	57	24	114		1.5	Ac	1,400		0	0	0	2,100	2,100	
2-S	3	57	24	128		1	DU	250		0	0	0	250	250	
2-S	3	57	24	129		1	DU	250		0	0	0	250	250	
2-S	3	57	24	130		2	DU	250		0	0	0	500	500	
2-S	3	57	24	144		1	DU	250		0	0	0	250	250	
2-S	3	57	24	149		1	DU	250		0	0	0	250	250	
2-S	3	57	24	150		1	DU	250		0	0	0	250	250	
2-S	3	57	24	141		1	DU	250		0	0	0	250	250	
2-S	3	57	24	152		1	DU	250		0	0	0	250	250	
2-S	3	57	24	153		1	DU	250		0	0	0	250	250	
2-S	3	57	24	170		1	DU	250		0	0	0	250	250	
2-S	3	57	24	184		1	DU	250		0	0	0	250	250	
2-S	3	57	24	186		1	DU	250		0	0	0	250	250	
2-S	3	57	24	187		1	DU	250		0	0	0	250	250	
2-S	3	57	24	188		1	DU	250		0	0	0	250	250	
2-S	3	57	24	189		1	DU	250		0	0	0	250	250	
2-S	3	57	24	190		1	DU	250		0	0	0	250	250	
2-S	3	57	24	191		1	DU	250		0	0	0	250	250	
2-S	3	57	24	206		1	DU	250		0	0	0	250	250	
2-S	3	57	24	229		1	DU	250		0	0	0	250	250	
2-S	3	57	24	247		1	DU	250		0	0	0	250	250	
2-S	3	57	24	Broadview		30	DU	250		0	0	0	7,500	7,500	
2-S	3			Manhole 3 (C: 2-S) Load					102,663	126,863	133,863	133,863	153,753	153,753	
139AS	1	405	4	Riverview		0	AC.		0	0	0	0	0	0	Stormwater pond and recreational fields (from Aerial)
139AS	1			Riverside Center	44	281.7	CU	250	35,213	35,213	35,213	35,213	35,213	35,213	
8-S	9	57	24	CVS (132-1)		10,107	SF	0.2	2,021	2,021	2,021	2,021	2,021	2,021	
8-S	9	57	24	Auto Zone (132-2)		5,400	SF	0.2	1,080	1,080	1,080	1,080	1,080	1,080	
8-S	9	57	24	Glade Valley Animal Hospital (132-3)		5,496	SF	0.2	1,099	1,099	1,099	1,099	1,099	1,099	
8-S	9	423	22	SME Fred. Trade LLC (1)		205,492	SF	0.2	41,098	41,098	41,098	41,098	41,098	41,098	
8-S	9			Lee Annex.	103	12	Ac.	1400		0	0	0	16,800	16,800	May need to drain South
139AS	1			Manhole 1 (C: 139AS) Load					80,512	80,512	80,512	80,512	97,312	97,312	

Sanitary Load Allocation Table

Contract	Manhole	Tax Map	Tax Grid	Name of Subdivision/Parcel	PRWSA #	Units	Ac./DU /CU/SF	Flow/ Unit	Existing Flow (gpd)	Currently Allocated Flow (gpd)	2015 Flow (gpd)	2020 Flow (gpd)	2030 Flow (gpd)	2040 Flow (gpd)	Comments
Upper Monocacy Flow									2,371,862	2,525,180	2,842,973	3,796,396	5,265,285	5,501,982	
67-F	MI-23			Frederick Water Treatment Plant					43,200	43,200	43,200	43,200	43,200	43,200	The plant backwashes 108,000 gal over 10 minutes everyone 2.5 days
67-F	MI-23	Manhole MI-23 (C: 67-F) Load							43,200	43,200	43,200	43,200	43,200	43,200	
67-F	MI-22			Fort Detrick Water Treatment Plant						0	88,000	88,000	88,000	88,000	
67-F	MI-22	Manhole MI-22 (C: 67-F) Load							0	0	88,000	88,000	88,000	88,000	
67-F	MI-19			Wormans Mill Industrial Park					100,453	100,453	100,453	100,453	100,453	100,453	
67-F	MI-19			Market Square	37					0	135,110	135,110	135,110	135,110	
67-F	MI-19			Clemson	101	375,000	SF	0.2		71,655	71,655	71,655	71,655	71,655	
67-F	MI-19			Spring Bank Annex.	102	72	DU	250		0	0	0	18,000	18,000	
67-F	MI-19	Manhole MI-19 (C: 67-F) Load							100,453	172,108	307,218	307,218	325,218	325,218	
67-F	MI-18	405	13	Auto Show Room (1168)		11,380	SF	0.2	2,276	2,276	2,276	2,276	2,276	2,276	
67-F	MI-18	Manhole MI-18 (C: 67-F) Load							2,276	2,276	2,276	2,276	2,276	2,276	
67-F	MI-17			Amber Meadows		856	DU	250	214,000	214,000	214,000	214,000	214,000	214,000	
67-F	MI-17			Frederick Research Park					164,110	164,110	164,110	164,110	164,110	164,110	
67-F	MI-17			Heather Ridge		261	DU	250	65,250	65,250	65,250	65,250	65,250	65,250	
67-F	MI-17			Amber Meadows Business Park					49,540	49,540	49,540	49,540	49,540	49,540	
67-F	MI-17			Antietam Village					76,497	76,497	76,497	76,497	76,497	76,497	
67-F	MI-17			Rosehill Plaza					18,103	18,103	18,103	18,103	18,103	18,103	
67-F	MI-17	67	10	Frederick Alliance Church (57)		6,828	SF	0.2	1,366	1,366	1,366	1,366	1,366	1,366	
67-F	MI-17	404	17	Heather Ridge Elementary School (1009)		30,000	SF	0.2	6,000	6,000	6,000	6,000	6,000	6,000	
67-F	MI-17			Wormans Mill Industrial Park					48,952	48,952	48,952	48,952	48,952	48,952	
67-F	MI-17	Manhole MI-17 (C: 67-F) Load							643,817	643,817	643,817	643,817	643,817	643,817	
67-F	MI-14			Fredericktowne Village		34	DU	250	8,500	8,500	8,500	8,500	8,500	8,500	
67-F	MI-14	Manhole MI-14 (C: 67-F) Load							8,500	8,500	8,500	8,500	8,500	8,500	
67-F	MI-13			Fredericktowne Village		20	DU	250	5,000	5,000	5,000	5,000	5,000	5,000	
67-F	MI-13	Manhole MI-13 (C: 67-F) Load							5,000	5,000	5,000	5,000	5,000	5,000	
67-F	MI-12			Fredericktowne Village		70	DU	250	17,500	17,500	17,500	17,500	17,500	17,500	
67-F	MI-12	Manhole MI-12 (C: 67-F) Load							17,500	17,500	17,500	17,500	17,500	17,500	
67-F	MI-10			Fredericktowne Village		802	DU	250	200,500	200,500	200,500	200,500	200,500	200,500	
67-F	MI-10			Canterbury Station	202	359	DU			74,275	98,075	98,075	98,075	98,075	
67-F	MI-10	405	4	Canterbury Station (1169-1)		27,645	SF	0.2	5,529	5,529	5,529	5,529	5,529	5,529	Nursing Home
67-F	MI-10	Manhole MI-10 (C: 67-F) Load							206,029	280,304	304,104	304,104	304,104	304,104	
67-F	MI-5			Riverside Corporate Park	48	440	Ac.		11,500	76,500	100,350	213,650	213,650	213,650	
67-F	MI-5			Riverside Apartments	205	312	DU	175	38,500	54,600	54,600	96,350	96,350	96,350	
67-F	MI-5	Manhole MI-5 (C: 67-F) Load							50,000	131,100	154,950	310,000	310,000	310,000	All City Growth East of Monocacy
Monocacy Interceptor City Load									1,076,775	1,303,805	1,574,565	1,729,615	1,747,615	1,747,615	
33" Int.	MI-1			Nicodemus	35	457	DU			0	0	98,175	98,175	98,175	
33" Int.	MI-1			River Crest	45	114	DU	250	26,750	28,500	28,500	28,500	28,500	28,500	
33" Int.	MI-1			Schley	46	124	Ac.	1,400		0	0	173,600	173,600	173,600	
33" Int.	MI-1			Umberger	51	125	Ac.	1,400		0	0	0	175,000	175,000	
33" Int.	MI-1			City Infill Dev.	59	60	Ac.	1,400	14,000	14,000	31,500	84,000	84,000	84,000	
33" Int.	MI-1			Central Frederick					949,250	949,250	949,250	949,250	949,250	949,250	
33" Int.	MI-1	33" Gas House Pike Interceptor Load							990,000	991,750	1,009,250	1,333,525	1,508,525	1,508,525	
54" Int.	1500			Clover Ridge, LLC - South	16B	93	DU	250		0	0	0	23,250	23,250	
54" Int.	1500			Hooper - Southwest	17B	186	DU	250		0	0	0	46,500	46,500	
54" Int.	1500			Barrick	18A	301	DU	250		11,250	64,325	64,325	64,325	64,325	
54" Int.	1500			Millie's Delight	18B	59	DU	250		9,500	14,750	14,750	14,750	14,750	
54" Int.	1500			Oden	19	240	DU	250		0	0	0	60,000	60,000	
54" Int.	1500			Lake Coventry	20	40	DU	250	10,000	10,000	10,000	10,000	10,000	10,000	
54" Int.	1500			Commons of Avalon	21	66	DU	225		9,675	14,850	14,850	14,850	14,850	
54" Int.	1500			Blentinger Road Property	22	84	DU	250		0	0	0	21,000	21,000	
54" Int.	1500			Birdseye View Estates	23	39	DU	250		9,750	9,750	9,750	9,750	9,750	

Sanitary Load Allocation Table

Contract	Manhole	Tax Map	Tax Grid	Name of Subdivision/Parcel	PRWSA #	Units	Ac./DU /CU/SF	Flow/ Unit	Existing Flow (gpd)	Currently Allocated Flow (gpd)	2015 Flow (gpd)	2020 Flow (gpd)	2030 Flow (gpd)	2040 Flow (gpd)	Comments
54" Int.	1500			Dutrow	24	45,738	SF	0.2		0	0	0	9,148	9,148	
54" Int.	1500			VFW	25	180	DU	250		0	0	0	45,000	45,000	
54" Int.	1500			Hargett Farm (City)	26					0	25,000	50,000	75,000	75,000	City Owned, allocation TBD
54" Int.	1500			Overlook Sec. 8	27	32	DU	175		3,500	5,600	5,600	5,600	5,600	
54" Int.	1500			Renn	34	220	Ac.	1,400		0	0	0	308,000	308,000	
54" Int.	1500			Emerald Farm	40	185	DU	250	44,750	46,250	46,250	46,250	46,250	46,250	
54" Int.	1500			Bower's Park	41	21	DU	250		5,250	5,250	5,250	5,250	5,250	
54" Int.	1500			Waverly View / Krantz	42	732	DU		27,900	34,075	134,925	134,925	134,925	134,925	
54" Int.	1500			Summers Farm - Mixed	49	100	Ac.			0	0	0	86,424	86,424	
54" Int.	1500			Summers Farm - Adjacent	50	110	DU	250		0	0	0	27,500	27,500	
54" Int.	1500			Tasker's Chance	53	259	DU	250	64,750	64,750	64,750	64,750	64,750	64,750	
54" Int.	1500			Whittier	56	249	DU	250	62,250	62,250	62,250	62,250	62,250	62,250	
54" Int.	1500			Walnut Ridge	58	521	DU	175	55,475	80,150	91,175	91,175	91,175	91,175	
54" Int.	1500			Carroll Creek Project	60	20	Ac.	2,000	20,000	20,000	25,000	40,000	40,000	40,000	
54" Int.	1500			Frederick Brickworks	61A	219	Ac.	1,400		0	0	306,600	306,600	306,600	
54" Int.	1500			Dewey Jordan Annex.	61B					0	0	20,232	20,232	20,232	
54" Int.	1500			Berger Annex.	106					0	0	0	0	0	No Annexation Request
54" Int.	1500			Hooper Annex.	107	886	DU			0	0	0	169,500	169,500	
54" Int.	1500			Brooklawn	201	68	DU	175		4,725	11,900	11,900	11,900	11,900	No Annexation Request
54" Int.	1500			Cramer Property	203	53	DU	250		13,250	13,250	13,250	13,250	13,250	
54" Int.	1500			Galleria @ Carroll Creek	204	127	DU	175	6,125	22,225	22,225	22,225	22,225	22,225	
54" Int.	1500			Rocky Pointe	206	15	DU	250	3,500	3,750	3,750	3,750	3,750	3,750	
54" Int.	1500			West & South Frederick					4,775,250	4,775,250	4,775,250	4,775,250	4,775,250	4,775,250	
54" Int.	1500	54" Carroll Creek Interceptor Load							5,070,000	5,185,600	5,400,250	5,767,082	6,588,404	6,588,404	
82-R	2			Airport					59,633	59,633	59,633	59,633	59,633	69,041	
82-R	2			Plant Recycle					300,000	300,000	300,000	300,000	300,000	300,000	
82-R	2	Manhole 2 (C: 82-R) Load							359,633	359,633	359,633	359,633	359,633	369,041	
City of Frederick WWTF Influent Flow									9,868,270	10,365,967	11,186,670	12,986,250	15,469,461	15,715,566	
105-D	39			Airport Park (FAPA)	33					0	0	0	298,414	298,414	
105-C	34	Linganore Interceptor (MH#34 C: 105-C) Load							1,600,000	1,600,000	2,350,000	3,100,000	4,300,000	5,500,000	From 2006 Wastewater Collection and Outall Corridor Analysis Report
105-A	8	Bush Creek Interceptor (MH#8C: 105-A) Load								500,000	750,000	1,000,000	1,400,000	1,800,000	From 2006 Wastewater Collection and Outall Corridor Analysis Report
105-A	8	Urbana Interceptor (MH#8 C: 105-A) Load							583,000	900,000	1,300,000	1,700,000	2,350,000	3,000,000	From 2006 Wastewater Collection and Outall Corridor Analysis Report
200	4	Ballenger Creek Interceptor (MH#4 C: 200) Load							889,000	1,300,000	1,950,000	2,600,000	3,600,000	4,600,000	From 2006 Wastewater Collection and Outall Corridor Analysis Report and 425,000 gpd infiltration from field tests
200	4	Buckeystown Interceptor (MH#4 C: 200) Load							56,000	800,000	1,200,000	1,600,000	2,200,000	2,800,000	From 2006 Wastewater Collection and Outall Corridor Analysis Report
Ballenger Creek WWTP Influent Flow									5,499,862	7,625,180	10,392,973	13,796,396	19,413,699	23,500,396	