City of Tacoma
D-to-M Streets Track & Signal
Surface Water Hydraulic Analysis

Technical Memorandum
STORM AND SANITARY RECONFIGURATION

FINAL | November 2021

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
Basin	Thea Foss Basin
BOE	basis of cost estimate
Carollo	Carollo Engineers, Inc.
cfs	cubic feet per second
City	City of Tacoma
CTP	Central Treatment Plant
d/D	depth-of-flow-to-pipe-diameter ratio
GIS	geographic information system
HGL	hydraulic grade line
LF	linear feet
MGS	MGS Engineering Consultants, Inc.
NIPS	new influent pump station
Project	D-to-M Streets Track & Signal Project
PWWF	peak wet weather flow
SCS	Soil Conservation Services
TM	technical memorandum
TSWMM	City of Tacoma 2016 Surface Water Management Manual
VFD	variable frequency drive

Section 1

PROJECT BACKGROUND

1.1 Introduction

In January 2018, the City of Tacoma (City) embarked on a planning-level effort to resolve localized stormwater flooding issues that have been known to occur within the Thea Foss Basin (Basin). This flooding began in 2012 after Sound Transit's D-to-M Streets Track & Signal Project (Project), a large rail line expansion in western Washington that also relocated and replaced over 4,000 linear feet (LF) of storm drainage piping. Following construction, storm manholes within the Project's area have surcharged and flooded the lowered roadway during large storm events, particularly at the intersection of Pacific Avenue and South 26th Street which has been documented to flood to depths of approximately 10 feet.

Figure 1 blocks off the specific Project area where flooding occurs, which falls under a 19-acre portion of storm drainage piping that was reconstructed and expanded from South "D" Street to South "M" Street. The Basin storm system drains to Thea Foss Waterway via two 96-inch outfalls approximately 2,000 feet northeast of the Project area.

To alleviate the flooding issues within the new stormwater system, technical memorandum (TM) 7.1[1] evaluated six alternatives, including storage and additional conveyance options, that met the City's stormwater design criteria. The recommended alternative, Scenario 3, rehabilitates a 60 to 63-inch abandoned pipe to convey some of the flow from the trunk near South 26th Street and Pacific Avenue to outfall B instead of to outfall A, which is where flows are currently diverted.

To successfully implement this scenario, however, highlighted several other issues including:

1. To ensure that flows from the City's design storms are appropriately and efficiently conveyed out of the Project area and away from City streets, storm piping just upstream of both outfalls A and B, along Puyallup Avenue and Dock Street Yard, must be upsized.
2. Several conflicts between new and upsized downstream storm piping and the sanitary sewer system were identified between Puyallup Avenue and the outfalls. Some portions of this sanitary sewer system are significantly aging and require rehabilitation; furthermore, work during Central Treatment Plant (CTP) model update project (*2017 Central Treatment Plant Wastewater Collection System Model Update and Capacity Evaluation Report*[2]) has already shown that the existing sanitary sewer system in the Puyallup area may not be able to meet the City's specific design criteria during the design storm, which are discussed in Section 2.1.

[1] *Flooding Reduction Alternatives Analysis*, Carollo Engineers, Inc., November 2020.
[2] Carollo Engineers, Inc., March 2017.

Figure 1 Project Location Map

1.2 Purpose

According to the planning analysis to develop the Scenario 3 recommendation, the existing storm system requires upsizing with some grade changes while the sanitary sewer system in the vicinity of Dock Street Yard is aging and potentially in conflict with upsized storm piping. Therefore, the current alignment of both the sanitary sewer and stormwater systems is proposed to be completely reconfigured along Puyallup Avenue and East 26th Street.

This joint approach ensures that both gravity systems meet the City's performance criteria without conflicts while minimizing construction disruptions along Puyallup Avenue and Dock Street Yard.

TM 8.1 models, sizes, and develops cost estimates for improvements recommended in the downstream sanitary sewer and stormwater systems along Puyallup Avenue and Dock Street Yard. More specifically, this TM develops a planning-level, conceptual layout for the storm and sanitary piping systems and integrates Scenario 3's solutions to address stormwater flooding within the Basin. The proposed system layout meets performance criteria for both types of systems while avoiding conflicts between the two of them.

Section 2

DESIGN CRITERIA

This section reviews the City's design standards and criteria used to evaluate and size the new alignment for the sanitary sewer and stormwater systems. Note that these are two separate systems that each have their own design criteria, which are tested under different design storms.

More specifically, design criteria for the sanitary sewer system measures the system's ability to handle or withstand the peak wet weather flow (PWWF) of a 20-year design event labeled "the November 2003 storm". Meanwhile, design criteria for the stormwater system evaluates the system's ability to handle or withstand the peak flow rate for the regulatory design storm as well as two other storm events defined by the City, summarized as follows:

- A 24-hour 25 year event (3.5 inch rainfall) using a Soil Conservation Services (SCS) Type 1A hydrograph as called for in the City's current 2016 *Surface Water Management Manual* (TSWMM)[3], which is further discussed in Section 2.2.
- A synthetic, three-hour, high-intensity event developed for the City by MGS Engineering Consultants, Inc. (MGS) and, as such, is labeled the "MGS design storm[4]."
- A historical, recorded event that caused observed flooding in the Basin and is labeled the "December 2019 storm." Note that this storm is similar to the 25-year storm defined in the TSWMM.

How these design storms were selected and modeled are detailed in TM 2.1[5], TM 2.3[6], and TM 7.1[7] from the D-to-M Surface Water Hydraulic Analysis Project, and TM 4 from the CTP Wastewater Collection System Model Update and Capacity Evaluation Project.

2.1 Sanitary Sewer System Design Standards

The City's sanitary sewer design standards were summarized in the 2017 CTP model update project and the *2020 North End Treatment Plant Wastewater Model Project*[8]. The criteria developed for those efforts remain consistent for this Project.

Of those criteria, the following two were used to evaluate and size the buildout sanitary sewer system's pipes during the sanitary design storm, a November 2003 storm within the recalibrated Mike Urban Model, described in Appendix A:

- **Criteria 1**: New pipes' maximum depth-of-flow-to-pipe-diameter ratio (d/D) must be lower than 0.8 under PWWF.

[3] City of Tacoma, July 2016.
[4] *Recommendations for Design Storms for Use in Hydraulic Modeling in Tacoma Washington,* MGS Engineering Consultants, Inc., December 9, 2016.
[5] *Stormwater Quantitative Analysis*, Carollo Engineers, Inc., October 2018.
[6] *Thea Foss Basin Event Evaluation for the Stormwater System*, Carollo Engineers, Inc., March 2019.
[7] *Flooding Reduction Alternatives Analysis*, Carollo Engineers, Inc., November 2020.
[8] Carollo Engineers, Inc., June 2020.

- **Criteria 2**: The maximum allowable hydraulic grade line (HGL) for existing system piping during PWWF is 1-foot above pipe crown, but no less than 3 feet below the manhole rim.

2.2 Stormwater System Design Standards

Criteria from the City's TSWMM were used to size the downstream stormwater system. The following four criteria from the TSWMM Volume 3 must be met for new piping:

- Under a 25-year event, there shall be a minimum of 0.5 feet of freeboard between the water surface and the top of any manhole or catch basin (TSWMM Section 9.3.3.2).
- Under a 100-year event, overtopping of the pipe conveyance system may occur. However, the additional flow shall not extend half the width of the outside lane of the traveled way or exceed 4 inches in depth at its deepest point (TSWMM Section 9.3.3.2).
- All conveyance systems shall be designed for fully developed conditions, which, for the Project , shall be derived from the percentages of proposed and existing impervious areas (TSWMM Section 9.3.3).

These requirements were then simplified to three pass/fail conditions:

- **Condition 1**: Peak HGL of 0.5 feet or greater below a manhole's rim elevations during a 25-year, 24-hour event.
- **Condition 2**: Peak HGL of 4 inches above a manhole's rim during a 100-year, 24-hour event.
- **Condition 3**: No flooding occurs during the MGS design storm.
- **Condition 4**: No flooding occurs during simulation of the December 2019 storm.

2.3 Update and Calibration of the CTP Collection System's Hydraulic Model

In 2017, Carollo Engineers, Inc. (Carollo) updated and calibrated a hydraulic model of the CTP's wastewater collection system as a part of the CTP Wastewater Collection System Model Update and Capacity Evaluation Project. In the 2020 update to this effort, the model was refined using geographic information system (GIS) data that the City sent to Carollo on October 9, 2019, and other revisions identified between 2017 and 2020. Appendix A describes the update and calibration check of this hydraulic model.

2.3.1 Methodology for Alignment Development

As discussed before, both the sanitary sewer and stormwater systems along Puyallup Avenue and East 26th Street must be upsized. The existing systems will be abandoned or removed along Puyallup Ave so that new, larger pipelines can be added to lower the risk of flooding in both systems.

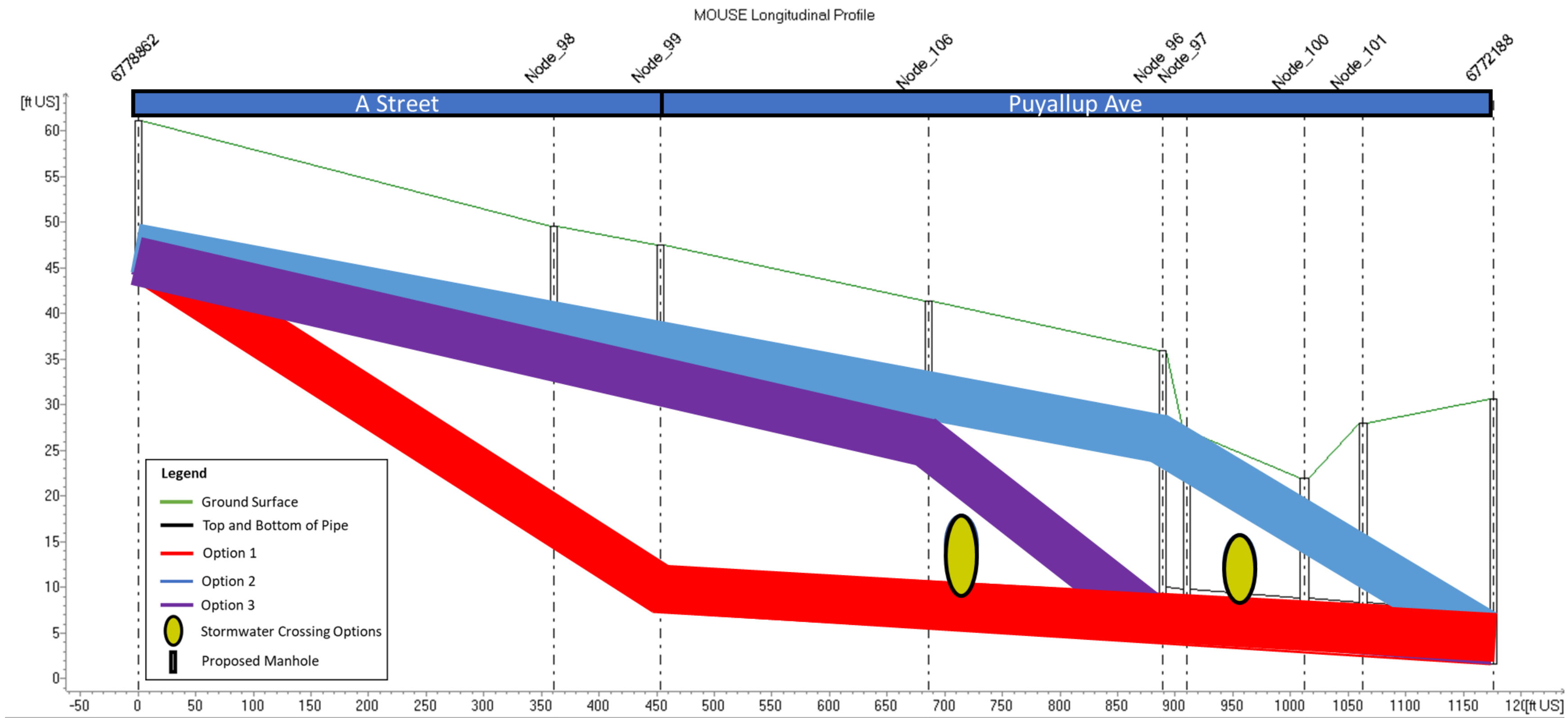
Pipeline alignments were developed in GIS to avoid property line conflicts, minimize utility crossings, and keep conveyance to the existing downstream sanitary pipes and stormwater outfalls. Once the model was calibrated, the proposed alignments were imported from GIS into the hydraulic model, which was then used to determine the necessary invert elevations and pipe diameters within the new sanitary sewer and stormwater alignments.

The sanitary sewer profile was considered in the model first, and three alignment options were developed as shown in Figure 2: The first option brought the sanitary sewer piping below both conflicts with the stormwater system, the second option looked at bringing the sanitary sewer piping above both stormwater conflicts, and the third option used a steep pipe to keep the

sanitary sewer piping above the upstream conflict with the stormwater system and then passed below the second downstream conflict.

Both stormwater crossings can range from an approximate bottom of pipe elevation of 8.5 feet to 10.5 feet. To convey the flows, the sanitary sewer pipeline diameter needs to be 66 inches and the stormwater pipe need to be 72 inches in diameter. Option 1 is physically possible, but a downstream section of near zero slope pipe is needed to avoid crossings. The flat section increases the HGL in this section, so option 1 is not recommended. Allowing for one foot of clearance between the pipe crossing (nominal pipe interior) means the second pipe crossing cannot have sanitary sewer above the stormwater pipe at 8.5 feet and keep the sewer pipe below ground level, so Option 2 was not considered viable. Option 3 kept the pipes below grade and provided a steeper slope. The model showed that lower HGLs could be gained from this profile, therefore Option 3 was selected and further refined and developed to convey flows downstream to manhole 6772188.

Since the sanitary sewer profile constrained the elevation of the stormwater profile, slopes were selected to prevent the latter from intersecting the former. Inverts were then iteratively adjusted to minimize the HGL, and adequate pipe diameters were selected for both systems. Sections 3 and 4 show the results of the new alignments and HGLs for the sanitary sewer and stormwater systems, respectively.



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Shaft Diameter	6.0000						8.0000	6.0000	
Ground Level	61.13	49.50	47.50	41.36	36.00	27.00	22.00	28.00	30.66
Invert Level	44.43	33.60	30.84	23.86	4.54	4.33	3.31	2.80	1.67
Link Slope									

Figure 2 Sanitary Sewer System Profile Options

Section 3

HYDRAULIC MODELING RESULTS FOR THE SANITARY SEWER SYSTEM

To reconfigure the aging sanitary sewer system's current alignment between Puyallup Avenue and East 26th Street, the following tasks must be completed:

- Move Pump Station AN3101's discharge force main to a new manhole.
- Relocate the Dock Street overflow structure, which is the controlled overflow point of the sanitary system.
- Replace the Puyallup Avenue bridge with a fill and retaining wall.

Figure 3 shows the recommended layout for the sanitary sewer and stormwater systems. The existing, undersized pipes are shown in purple and proposed to be abandoned. Meanwhile, the proposed stormwater alignments are shown in yellow, and the proposed gravity sanitary sewer alignment is shown in light blue. In addition to the re-routed alignments, a new Dock Street overflow line is shown in pink, and the relocated discharge force main from AN3101 is shown in dark green.

This configuration was arranged to avoid property lines and utilities and to stay in the right-of-way wherever possible. Additional alignments were not evaluated since this route meets the City's performance goals using appropriately sized and sloped pipes.

Figure 4 shows the proposed sanitary profile and HGL under the November 2003 design storm. For guidance, Figure 4 and other profile figures (Figures 4 to 6 and 10 to 14) can be understood as such:

- **X-axis**: The horizontal length of pipe in feet.
- **Y-axis**: Elevation in feet, using the City's vertical datum.
- **Vertical black lines**: Specific manholes with their numbers.
- **Green line**: The ground surface.
- **Black, sloped lines**: The top and bottom of the piping.
- **Red lines**: New piping.
- **Blue line**: The maximum calculated HGL.

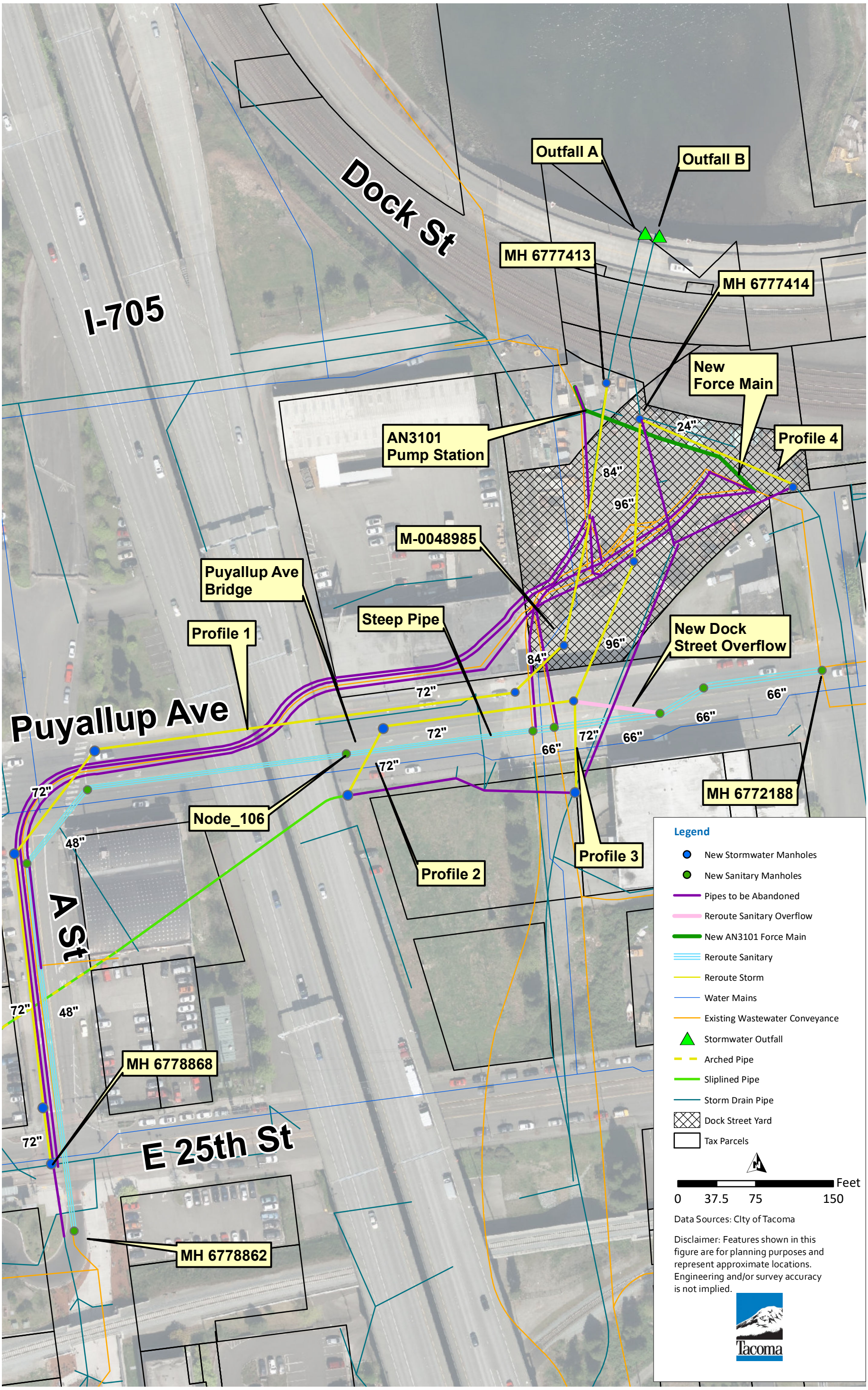
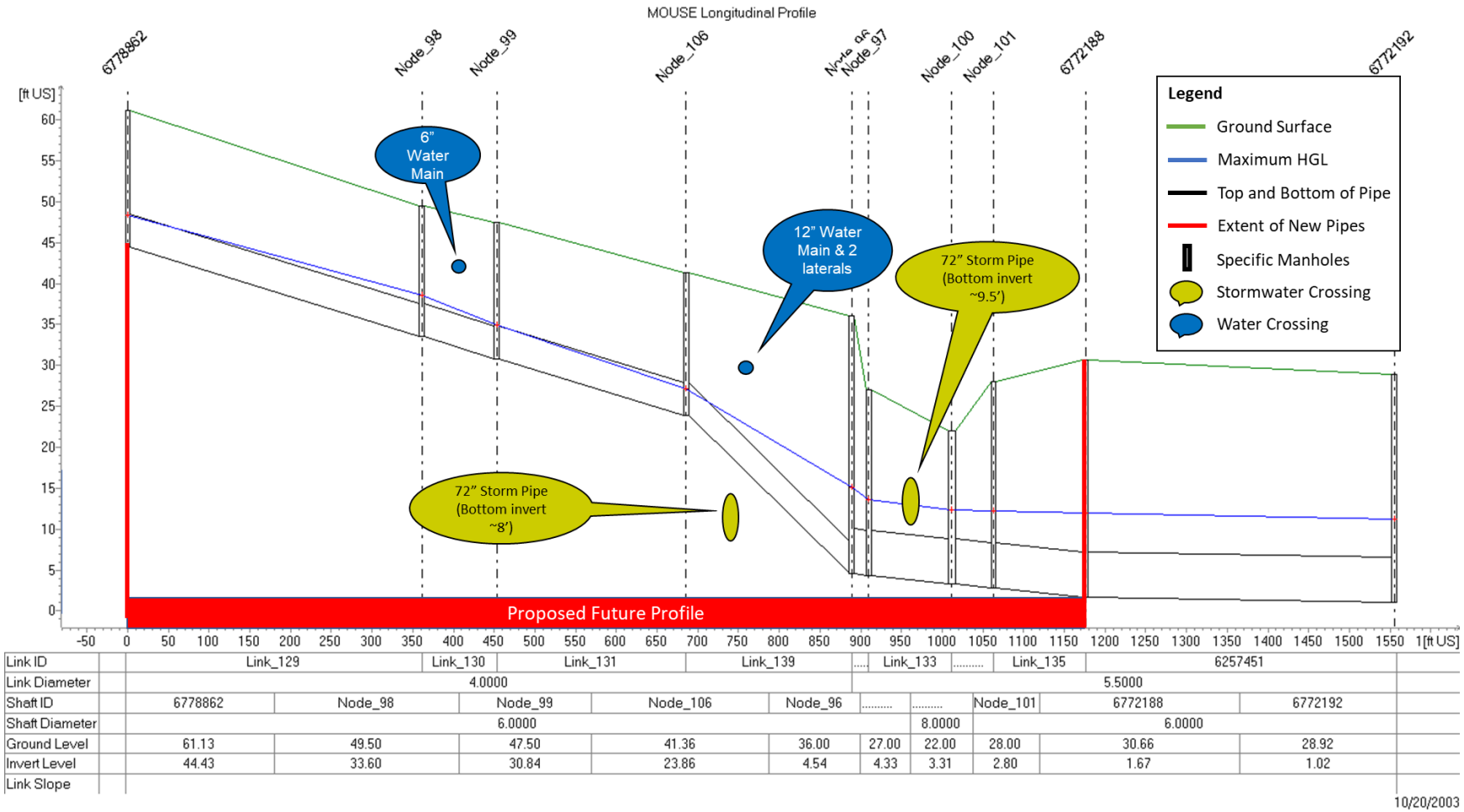


Figure 3 Downstream Stormwater and Sanitary System Reconfigurations



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Shaft Diameter	6.0000						8.0000	6.0000			
Ground Level	61.13	49.50	47.50	41.36	36.00	27.00	22.00	28.00	30.66	28.92	
Invert Level	44.43	33.60	30.84	23.86	4.54	4.33	3.31	2.80	1.67	1.02	
Link Slope											

Figure 4 Reconfigured Sanitary Profile and HGL during the 20-Year Design Storm

All conflicts and other features are called out in the figure. Major utility crossings are shown in brown for water mains and blue for stormwater pipes, neither of which cross with any potential conflicts upstream. Utility conflicts were determined from the City's as-builts and GIS system. None of these conflicts have been field verified and additional conflicts with gas and other utilities may need to be accounted for.

As mentioned before, invert elevations for the sanitary sewer system were selected to avoid crossings with major water and storm utilities while maintaining a sufficient grade to meet the HGL criteria in most new pipes. The downstream storm pipe, as can be seen in blue on Figure 3, crosses above the sewer pipeline with a 1-foot clearance between the nominal interior surfaces at approximately 950 feet. The clearance will be close and have to carefully considered during design when pipe materials are finalized.

The HGL is within the allowable criteria through the Project area's upstream portion but becomes surcharged downstream of the steep pipe. The sanitary sewer piping downstream from this drop manhole fails to meet the HGL criteria because of backwater conditions from the CTP's headworks, including the new influent pump station's (NIPS's) settings and losses through the screens and channels. Lowering the HGL in this piping would require changes at the CTP headworks, which is not currently possible; this topic is discussed further in Section 3.3.

3.1 New Dock Street Overflow Structure

A part of the sanitary reconfiguration, the existing Dock Street overflow structure that connects to the stormwater system must be relocated.

First, the system was tested without a new overflow structure to verify its continued need. Figure 5 plots the HGL without the Dock Street overflow, revealing that the sanitary sewer system could flood downstream of the Project area during the November 2003 design storm or greater at manholes 6772209 and 6772213. A new overflow structure is, thus, required and proposed at manhole 6772188, shown in pink in Figure 3. The overflow structure would also play a significant role in emergency bypass of the CTP which needs to be considered in detailed design.

The new overflow structure was sized so the volume of overflow and downstream HGL remain similar to what is modeled with the current configuration. Modeling showed that a structure with a 7-foot-long weir with a crest elevation of 8.3 feet and a height of 5 feet will lower the HGL of the system, thus sufficiently reducing the risk of flooding. It was assumed the weir would be in a 120-inch manhole. An estimated 86 LF of 48-inch piping is required to connect the new overflow to the stormwater system.

Figure 6 shows that the sanitary profile with the new overflow has a similar HGL to current conditions, which are surcharged but not overflowing. Figure 7 shows the potential overflow during the November 2003 design storm; this flow was added as inflow to the stormwater system and shown to meet the HGL criteria. The overflow did not increase from what was modeled for the existing configuration.

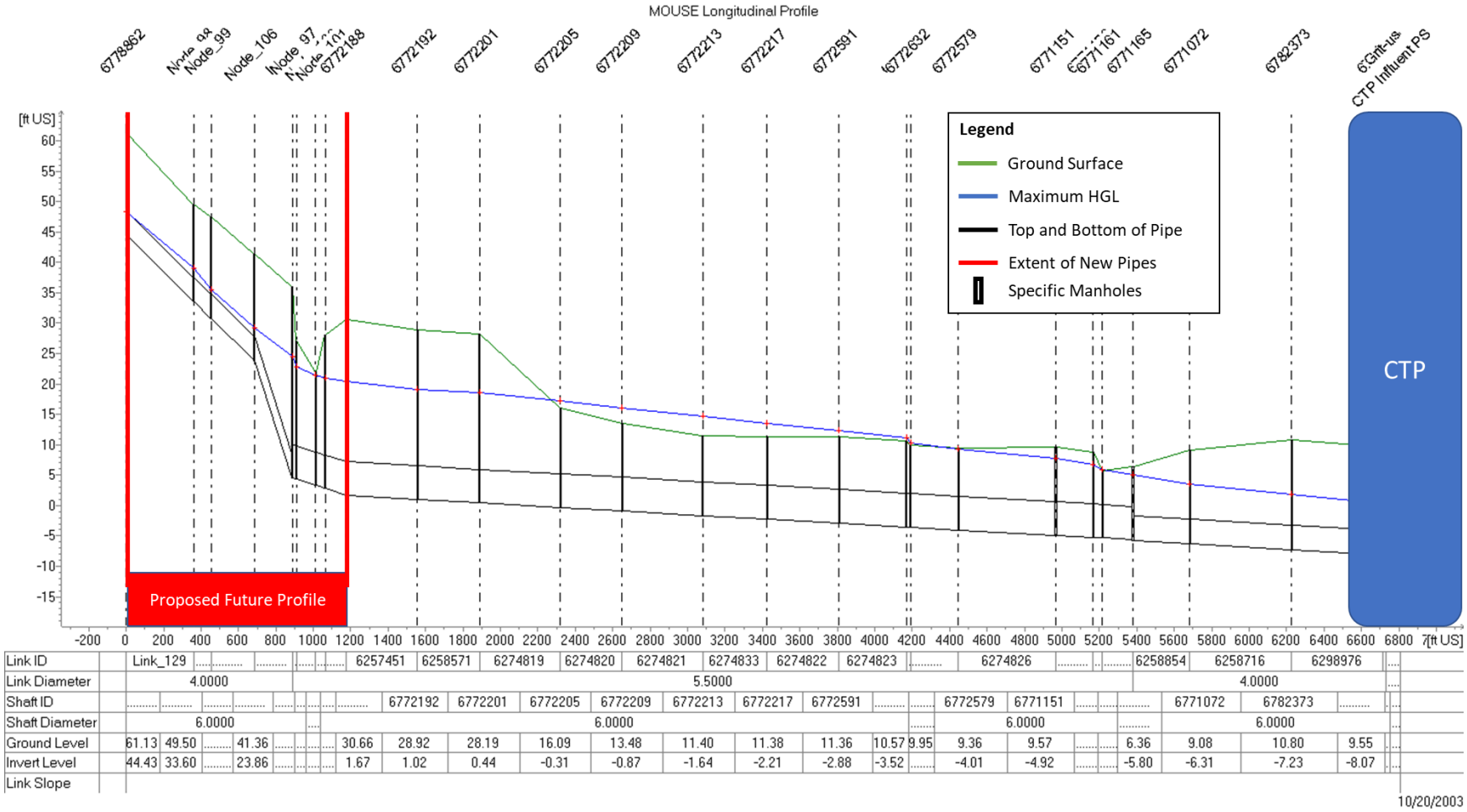


Figure 5 Sanitary Profile and HGL During the 20-Year Design Storm Without Dock Street Overflow

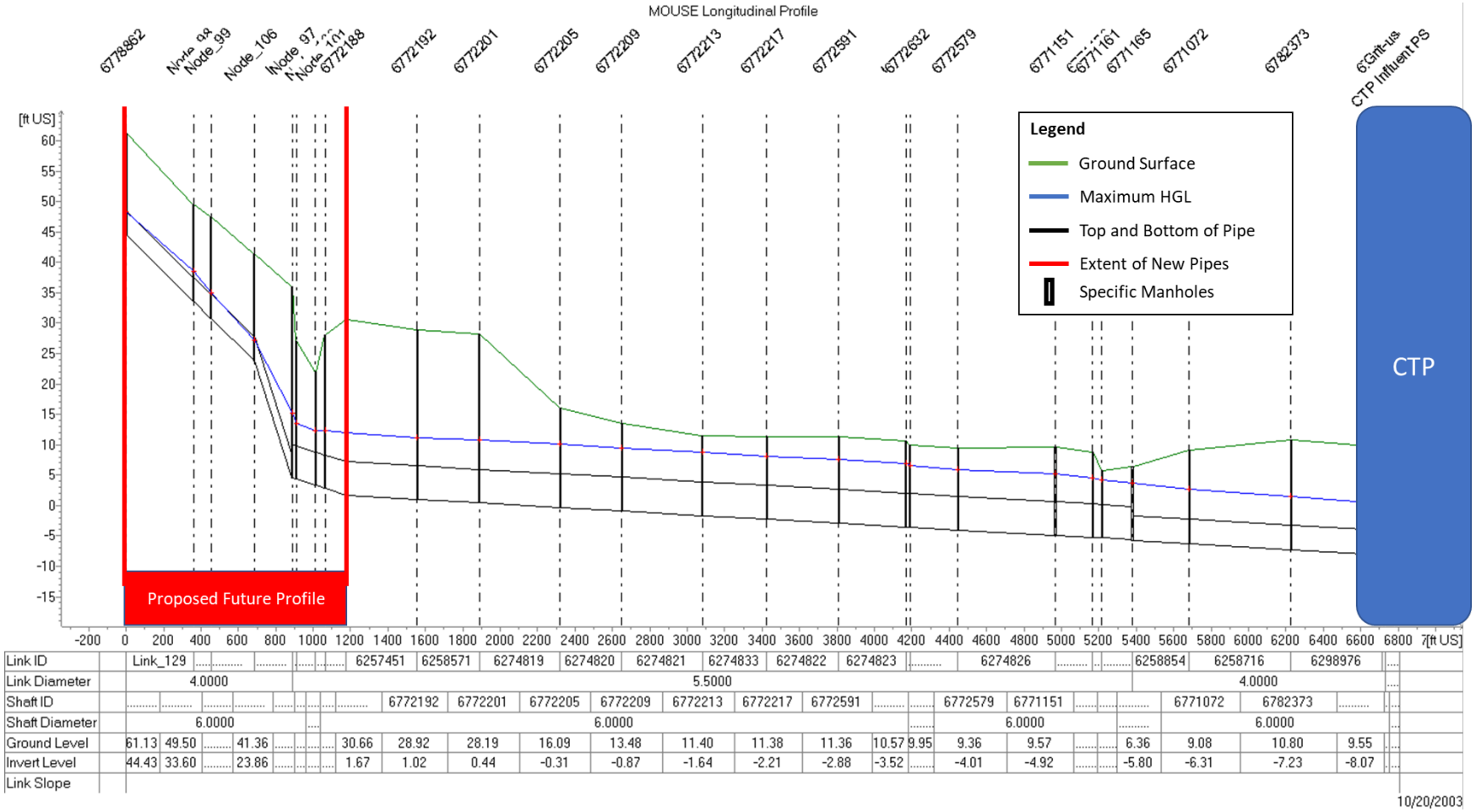


Figure 6 Sanitary Profile and HGL During the 20-Year Design Storm With Dock Street Overflow

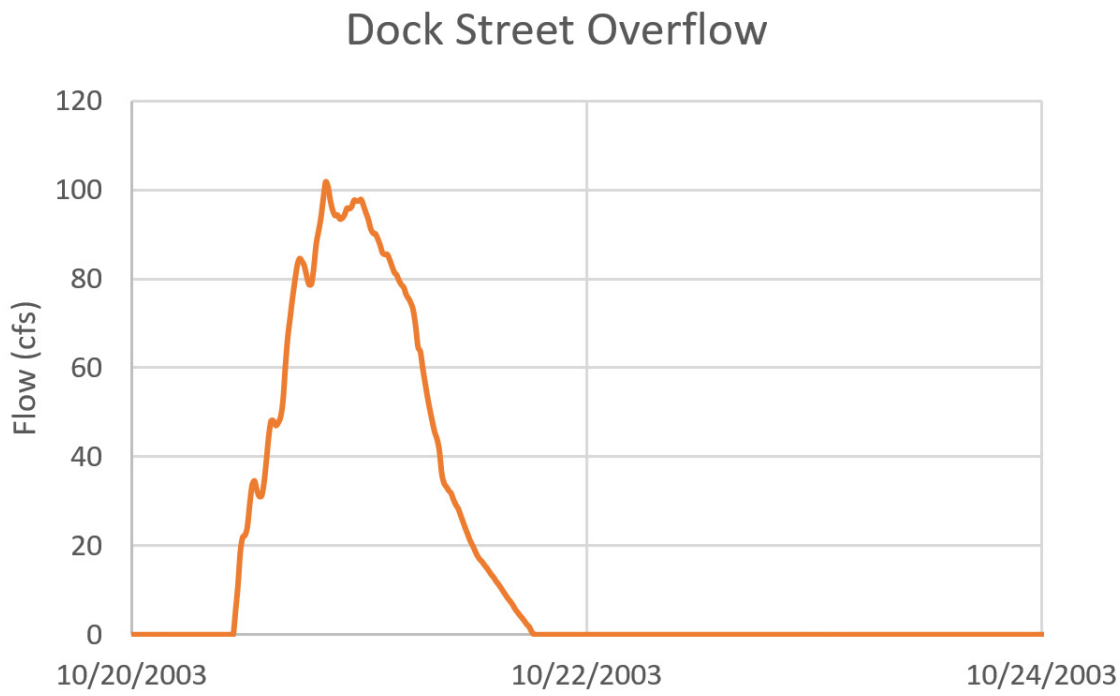


Figure 7 Overflow during a Design Storm at the New Dock Street Overflow Structure

3.2 New AN3101 Force Main

The sanitary reconfiguration also requires relocating the AN3101 discharge force main. A new force main is proposed from the pump station to manhole 6772180, shown in dark green in Figure 3. The elevation of the new discharge manhole will change by less than a foot, so effects to the station hydraulics are likely minimal. This assumption should be confirmed during the force main's design. The new force main is estimated to be 209 LF of 24-inch-diameter piping.

3.3 Sanitary Sewer System Deficiencies

To ensure that changes to the sanitary sewer system do not pose adverse effects, the November 2003 storm was also run in the hydraulic model under buildout conditions with the original and proposed configurations.

Figures 8 and 9 show system performance and deficient manholes during the storm under original and proposed configurations, respectively. The changes between the two scenarios are minimal: lowering of the HGL by 1 to 2 inches for most upstream manholes under the proposed configuration and fixing deficiencies at several manholes. However, the risk of flooding remains under both scenarios at some sites outside of the Project area.

However, no new deficiencies or increased HGL are caused by the proposed changes to the sanitary sewer system. Although manholes known to experience serious flooding—including one of the City's assets of concern, manhole 6772168, which is outside of this Project area—may still flood, the proposed configuration will not exacerbate the situation and, though minimally, still lower the HGL.

Figure 8 Current Sanitary Sewer Alignment Deficiencies for Design Storm at Buildout Flows

Figure 9 Proposed Sanitary Sewer Alignment Deficiencies for Design Storm at Buildout Flows

As mentioned before, the HGL cannot currently be lowered any further without making changes to the CTP's headworks. To understand the situation at hand, refer to Figures A.1, A.2, and A.3 in Appendix A, each of which shows the configuration of this wastewater treatment plant's headworks. Two primary 48-inch CTP influent trunks convey flow from the Puyallup Avenue area into the old screening facility's influent bay. Flow then travels to the new screening facility's screen forebay via a 72-inch line, through the screens, and into the NIPS, which is set to hold a water level of -3 feet with a variable frequency drive (VFD).

The NIPS sets the headworks' operating HGL and, thus, the upstream HGLs during backwater conditions; however, at peak flows, hydraulic restrictions through the CTP limit the ability to lower the HGL at the outlets from the 48-inch trunks into the old screening facility's forebay. As such, the CTP's headworks would need to be reconfigured to significantly lower the system HGL, a task and consideration that is beyond the scope of this present effort.

3.4 Summary of Improvements to the Sanitary Sewer System

The sanitary sewer system's alignment was selected to minimize construction disturbances and conflicts with surrounding property and utility crossings while continuing to convey flows to the same downstream location. The hydraulic model was used to ensure that the alignment worked efficiently and properly, and invert elevations and pipeline diameters were adjusted to convey flows with the HGL in criteria. As part of abandoning the existing sanitary sewer piping, a new Dock Street overflow structure and force main will also be constructed.

Table 1 summarizes all improvements that are required to replace the aging sanitary sewer piping while maintaining current system performance, and meeting performance criteria for new piping.

Table 1 Sanitary System Improvements Summary

Type	Diameter (inches)	LF / Number of Manholes
Gravity	48	941 LF
Gravity	66	287 LF
Force Main	24	209 LF
Dock Street Overflow	48	86 LF
Dock Street Overflow Structure	120	1
Manholes	84	3
Manholes	96	6

Section 4

HYDRAULIC MODELING RESULTS FOR THE STORMWATER SYSTEM

Piping just upstream of outfalls A and B must be replaced and reconfigured to increase the system capacity to convey stormwater out of the flood-prone Project area, through the collection system, and to each outfall.

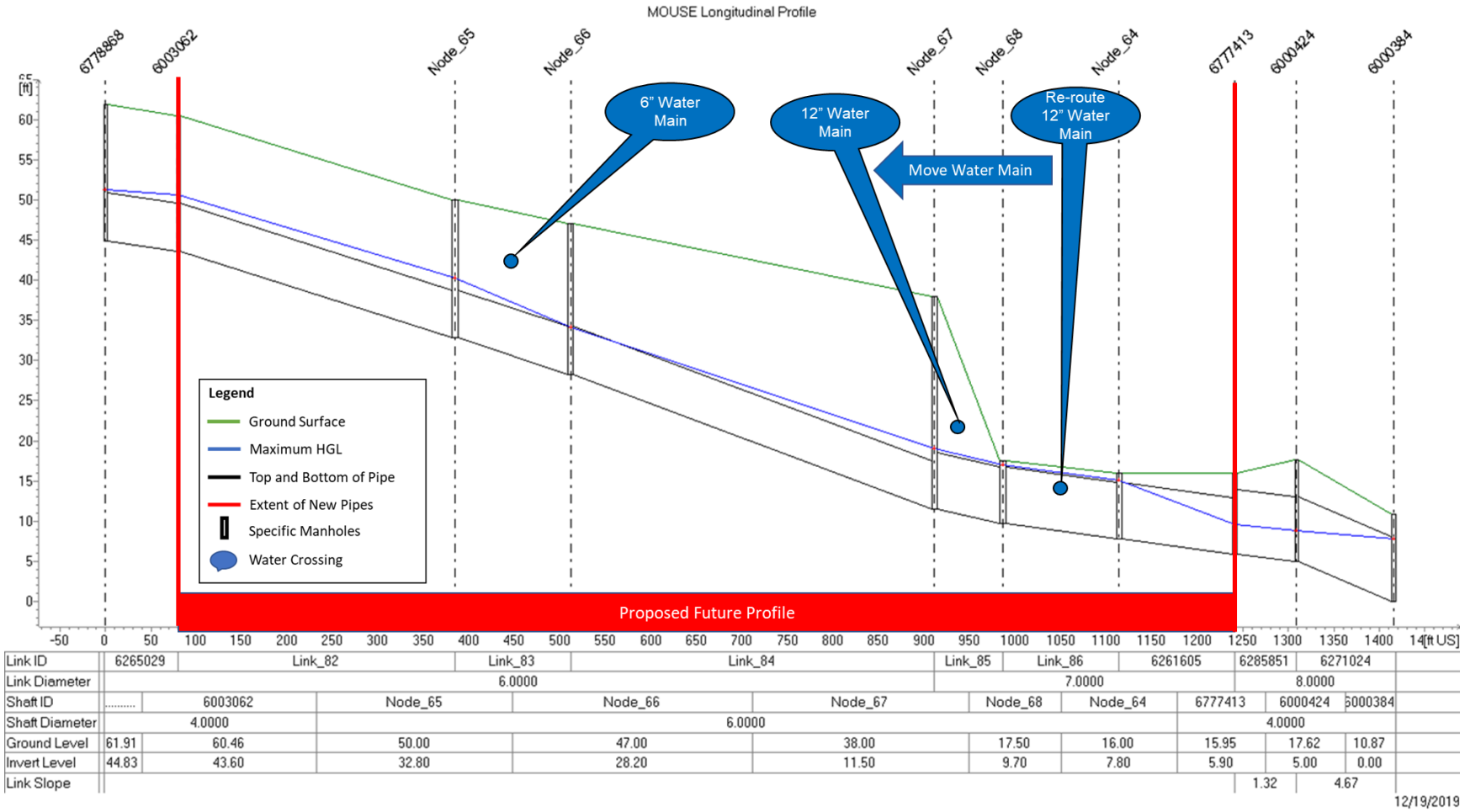
The stormwater reconfiguration is broken into three separate profiles, each of which is called out and colored yellow in Figure 3. As can be seen in the figure, profile 1 is upstream of outfall A, and profiles 2, 3, and 4 are upstream of outfall B. As with the sanitary sewer alignment, these stormwater alignments were chosen to avoid property lines and minimize utility crossings while maintaining their ability to convey flows downstream to each outfall. The alignments were imported into the model, which was used to develop optimal elevations and diameters.

The MGS storm was the most intense rainfall of the design events; therefore it was used for sizing proposed stormwater facilities. Figures 10, 11, and 12 show the stormwater piping for profiles 1, 2, and 3, respectively. As can be seen in all the HGLs of these three figures, no flooding occurs through the system during an MGS design storm.

Figure 10 shows two crossings with existing water mains. The downstream crossing with 12-inch water main M-0048985 must be relocated so that it does not conflict with the new storm piping. The location was identified in Figure 3.

Figure 11 shows two water line crossings, both of which are at depths where no relocation is needed and one sewer crossing. The stormwater slope is kept very shallow to allow for enough clearance for the 66-inch sewer pipeline to cross 1 foot above. Similarly, Figure 12 shows one water line crossing that will not require relocation, and one 66-inch sewer line crossing 1 foot underneath the stormwater pipe.

The proposed stormwater configuration was also tested with the current TSWMM SCS Type 1A Event, and the December 2019 storm. Figures 13 and 14 show the entire stormwater profile throughout the Project area from manhole 6765519 to both outfalls A and B, with the max HGL from the TSWMM SCS Type 1A Event. The December 2019 event was similar in size and intensity to the TSWMM storm, producing a similar HGL with the proposed improvements. The proposed system improvements significantly reduce flooding risk in the Project area during a TSWMM-established 25-year design storm, which is akin to the December 2019 storm that the City experienced and the MGS design storm. Thus, the proposed improvements meet the City's criteria.



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Shaft Diameter	4.0000		6.0000					4.0000			
Ground Level	61.91	60.46	50.00	47.00	38.00	17.50	16.00	15.95	17.62	10.87	
Invert Level	44.83	43.60	32.80	28.20	11.50	9.70	7.80	5.90	5.00	0.00	
Link Slope								1.32	4.67		

Figure 10 Reconfigured Stormwater Profile 1 with Design Storm HGL

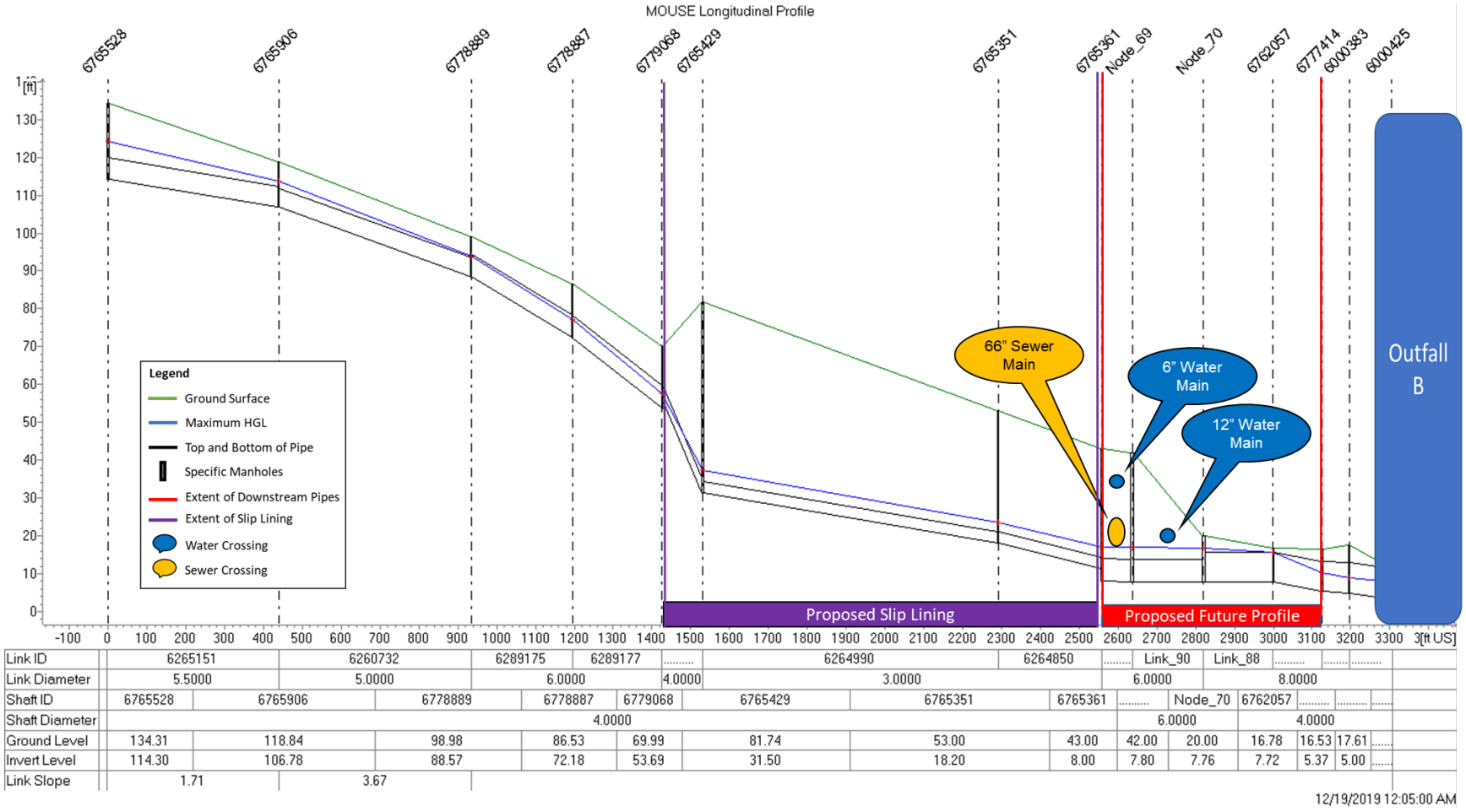

Figure 11 Reconfigured Stormwater Profile 2 with Design Storm HGL

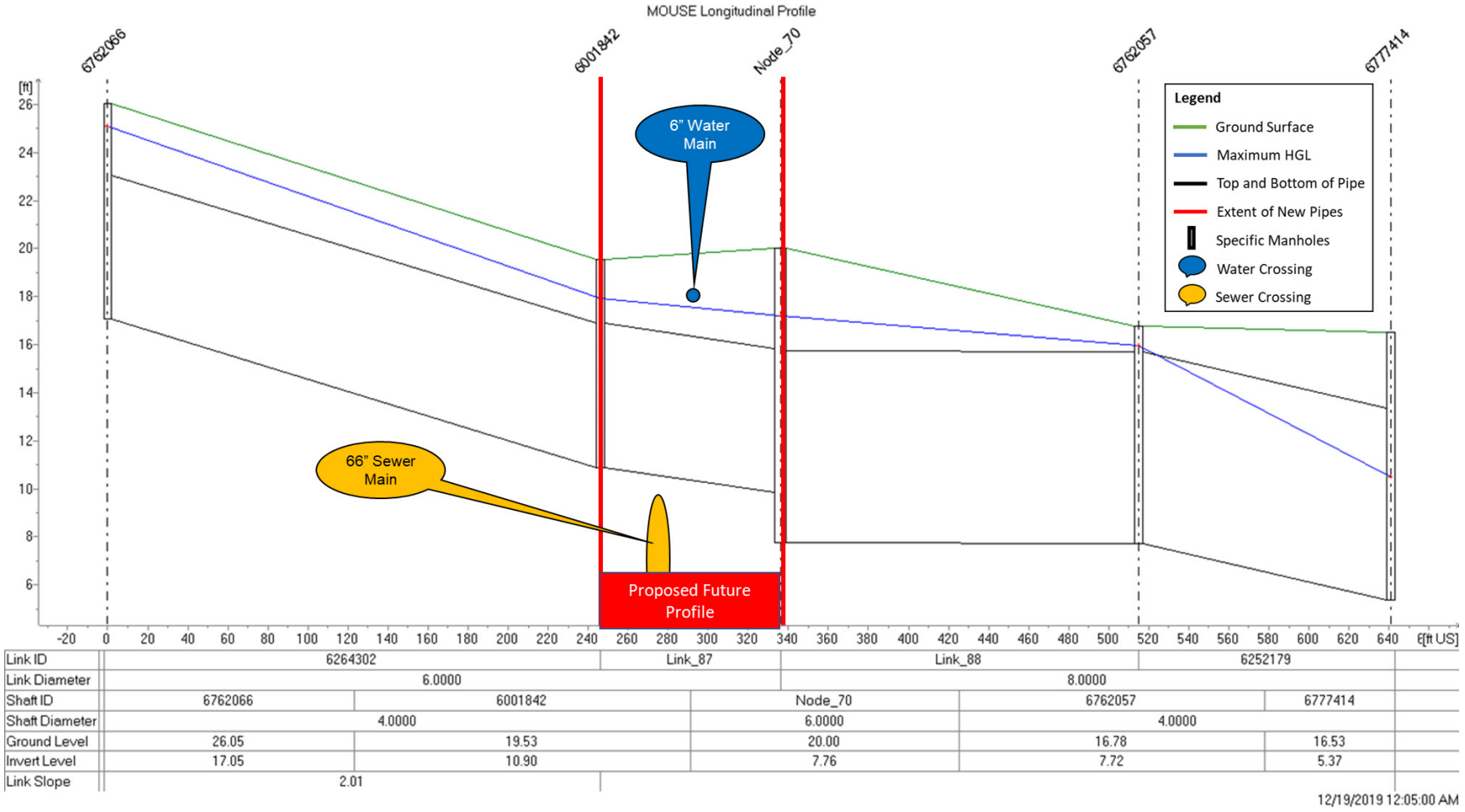

Figure 12 Reconfigured Stormwater Profile 3 with Design Storm HGL

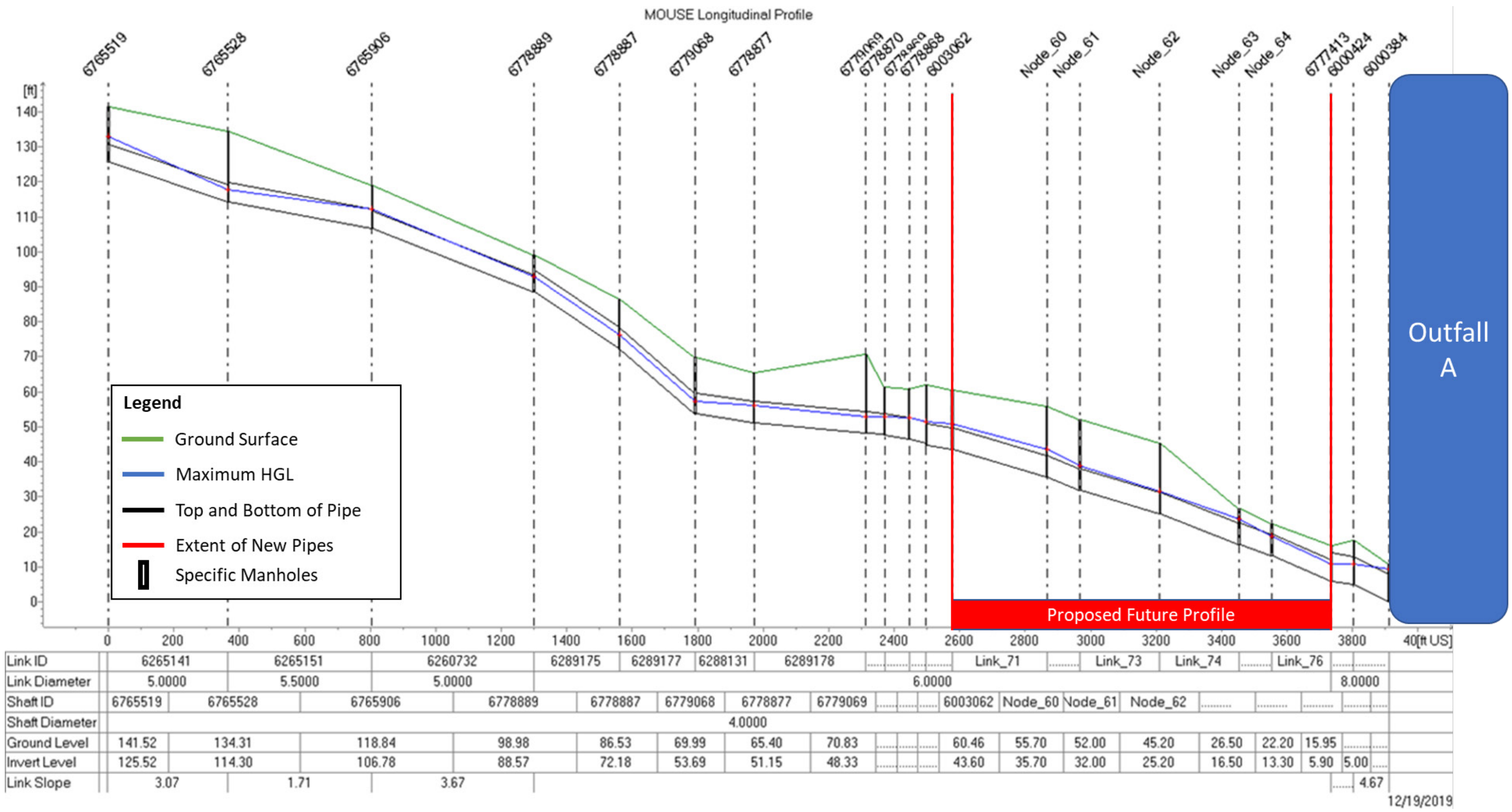

Figure 13 Finalized Stormwater Profile to Outfall A throughout D-M Project Area

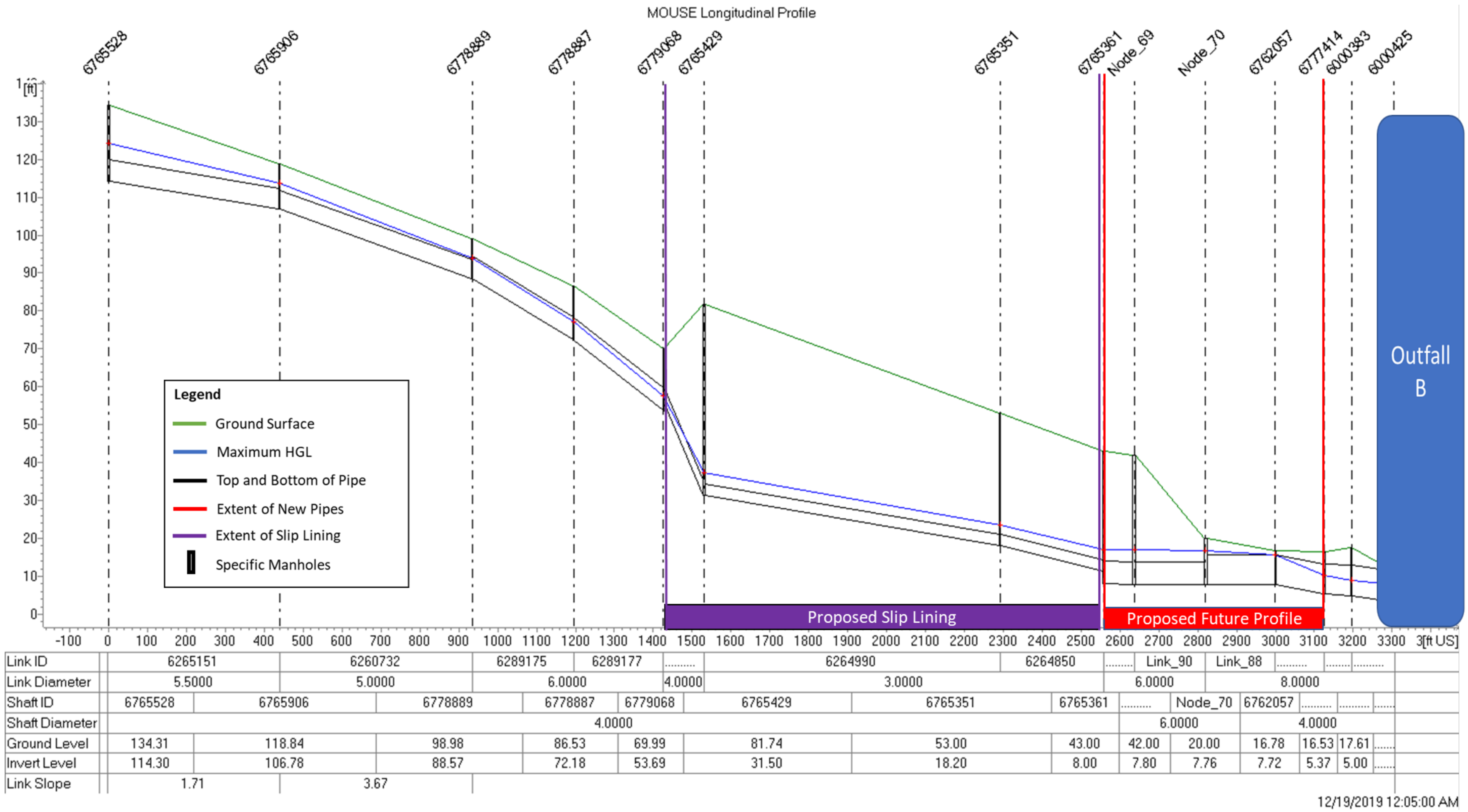

Figure 14 Finalized Stormwater Profile to Outfall B throughout D-M Project Area

Stormwater profiles were developed to avoid conflicts with the sanitary sewer system, and the modeling confirmed that no flooding will occur in the system with the reconfiguration of the three downstream profiles. Table 2 summarizes the pipelines and manholes needed to improve profiles 1, 2, 3, and 4, as identified in Figure 3. Stormwater costs were divided in the Appendix B cost estimate based on which outfall they go to. Reroute #1 is all improvements to the Outfall A, with is Profile 1. Reroute #2 is are all improvements to Outfall B and include profiles 2, 3, and 4.

Table 2 Stormwater Improvement Summary

Profile	Type	Diameter (inches)	LF / Number of Manholes
1	Pipe	72	911 LF
1	Pipe	84	330 LF
1	Manhole	96	4
1	Manhole	108	3
2	Pipe	72	262 LF
2	Pipe	96	284 LF
2	Manhole	96	2
2	Manhole	108	3
3	Pipe	72	90 LF
3	Manhole	96	1
4	Pipe	24	163 LF
4	Manhole	48	1

Section 5

COST ESTIMATION

Project costs were estimated for both the new sanitary and stormwater routes. Carollo's cost-estimating tool was used to develop the Association for the Advancement of Cost Engineering's (AACE) Class 4 estimates, which have an expected level of accuracy of -30 percent to +50 percent of the cost presented.

Appendix B shows the basis of cost estimate (BOE), which outlines the cost estimate's details and assumptions used. This BOE presents the full cost, which incorporates downstream improvements including the identified sanitary sewer system's reroute, stormwater reroutes, bridge replacement, and improvements to and/or relocation of infrastructure affected by the reroutes as identified herein.

Table 3 summarizes the calculated costs for the proposed downstream improvements outlined in this TM and the upstream costs for Scenario 3, which are outlined in TM 7.1. The BOE from TM 7.1 is provided as Appendix C to this TM 8.1 for reference. Table 4 summarizes the total costs to perform all recommended improvements (Task 7.1 & 8.1) separated by utility system (stormwater vs. sanitary sewer). Miscellaneous work that will be required to accommodate both system improvements is separated as its own line item.

Table 3 Cost Opinion of Recommended Improvements (in 2020 dollars)

Description	Cost ($ in millions)	Cost Accuracy Range ($ in millions)(4)	
Task 7 Project Cost (2, 3)	$6.3	$4.5	$9.5
Task 8 Construction Cost (1, 3)	$20.7	$14.5	$21.1
Task 8 Project Cost (2, 3)	$29.0	$20.4	$43.6
Combined Task 7/8 Project Cost (2, 3)	$35.3	$24.9	$53.1

Notes:
(1) Includes a 30 percent design contingency.
(2) Includes engineering, legal, and administration fees and the Owner's reserve for change orders.
(3) The cost estimate herein was developed according to our perception of current conditions at the Project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the Project design matures. Carollo has no control over variances in the cost of labor, materials, or equipment; services provided by others; contractor's means and methods of executing the work or of determining prices; competitive bidding or market conditions; practices; or bidding strategies. Carollo cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the costs presented as shown.
(4) The expected level of accuracy for this cost opinion follows the Recommended Practice 18R 97 Cost Estimate Classification System for the Process Industries (AACE, 1998) designation as a "Class 4" estimate with a level of accuracy range (-30 percent to +50 percent).

Table 4 Cost Opinion of Recommended Improvements by Utility System (in 2020 dollars)

Description	Cost ($ in millions)	Cost Accuracy Range ($ in millions)(4)	
Stormwater System Improvements Project Cost (1,2,3,6)	$15.1	$10.6	$22.7
Sanitary Sewer System Improvements Project Cost (1,2,3,7)	$8.0	$5.6	$12.0
Miscellaneous Shared Work Project Cost (1,2,3,5)	$12.2	$8.6	$18.3
Total Project Cost (1,2,3)	$35.3	$24.8	$53.0

Notes:
(1) Includes a 30 percent design contingency.
(2) Includes engineering, legal, and administration fees and the Owner's reserve for change orders.
(3) The cost estimate herein was developed according to our perception of current conditions at the Project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the Project design matures. Carollo has no control over variances in the cost of labor, materials, or equipment; services provided by others; contractor's means and methods of executing the work or of determining prices; competitive bidding or market conditions; practices; or bidding strategies. Carollo cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the costs presented as shown.
(4) The expected level of accuracy for this cost opinion follows the Recommended Practice 18R 97 Cost Estimate Classification System for the Process Industries (AACE, 1998) designation as a "Class 4" estimate with a level of accuracy range (-30 percent to +50 percent).
(5) Includes work that must be completed to facilitate both the storm system and sanitary system improvements. Individual cost items include traffic control, bypass system, and the Puyallup Ave Bridge Removal and Re-Grade.
(6) Costs include storm reroute #1, storm reroute #3, 12-inch watermain relocation and Task 7.1 Scenario 3 pipeline rehab.
(7) Costs include 24-inch force main replacement, sanitary reroute, and new Dock Street Overflow.

Section 6

SUMMARY AND RECOMMENDATIONS

Rehabilitating the 60/63-inch abandoned pipe via Scenario 3 and simultaneously improving the downstream sanitary sewer and stormwater systems will not only significantly reduce the risk of flooding at South 26th Street and Pacific Avenue during the City's 24-hour 25-year design storm, the proposed 3-hour MGS design storm, and the recent December 2019 event that caused flooding, but also eliminate conflicts between the two systems, improve sanitary sewer system's conveyance, and minimize construction disruptions to the Project area.

Based on the available as-built information relied upon to prepare this desktop study, the following summarizes the total proposed downstream improvements for the stormwater system construct the following infrastructure:

- A total of 1,115 LF of slip-lined piping.
- A total of 2,040 LF of new piping: 163 LF of 24-inch piping, 1,263 LF of 72-inch piping, 330 LF of 84-inch piping, and 284 LF of 96-inch pipe.
- A total of 14 manholes: 7 new 96-inch manholes,6 108-inch manholes, and one 48-inch manhole.

Meanwhile, the sanitary sewer system's reroute constructs the following infrastructure:

- A total of 1,523 LF of new piping: 209 LF of 24-inch piping, 1,027 LF of 48-inch piping, and 287 LF of 66-inch piping.
- A total of 209 LF of a 24-inch force main.
- Eight new manholes.
- A new Dock Street overflow structure.

With the proposed stormwater and sanitary sewer alignments, including Scenario 3's pipe rehabilitation, both systems' new piping is now within the City's design criteria. These planning-level recommendations are subject to adjustments and refinements as additional restrictions such as other utilities, field verification, and stakeholder discussions develop.

Appendix A

CTP MODEL CALIBRATION

City of Tacoma
D-to-M Streets Track & Signal
Surface Water Hydraulic Analysis

Technical Memorandum
APPENDIX A: CTP MODEL CALIBRATION

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City of Tacoma

City of Tacoma
D-to-M Streets Track & Signal
Surface Water Hydraulic Analysis

Appendix A
CTP MODEL CALIBRATION

FINAL | September 2021

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Contact Info: Carollo Engineers, Inc.
Date: 2021.09.02 11:31:10-07'00'

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Abbreviations

ADWF	average dry weather flow
Carollo	Carollo Engineers, Inc.
City	City of Tacoma
CIWEM	Chartered Institution of Water and Environmental Management
CTP	Central Treatment Plant
DWF	dry weather flow
I/I	inflow & infiltration
ID	identification
GIS	geographic information system
HGL	hydraulic grade line
IPS	influent pump station
MG	million gallons
mgd	million gallons per day
MH	manhole
NIPS	new influent pump station
RDII	rainfall derived inflow and infiltration
SAP	SAP Concur (asset/financial management software)
UDG	Urban Drainage Group
WaPUG	Wastewater Planning Users Group
WWF	wet weather flow

Appendix A

CTP MODEL CALIBRATION

A.1 Introduction

This Appendix describes the update and calibration check of the City of Tacoma's (City's) Central Treatment Plant (CTP) wastewater collection system hydraulic model.

A.2 Hydraulic Model Update and Refinement

The CTP model was updated and calibrated by Carollo Engineers, Inc. (Carollo) in 2017 as a part of the CTP Wastewater Collection System Model Update Project. As a part of the 2020 update, the model was refined based on geographic information system (GIS) updates from the City and other revisions identified between 2017 and 2020. The following list summarizes key refinement and updates that were made based on GIS data received on October 9, 2019:

1. Minor update downtown loading polygons.
2. Verify 1 to 1 matching of modeled components with current GIS and update, as required.
3. Update all identifications (IDs) to match current SAP Concur (SAP) IDs.
4. Update South Tacoma trunk with as-built.
5. Fix tide flat CTP connection.
6. Fix/check Milton and other surrounding jurisdictions' average dry weather flow (ADWF).
7. Update influent pump station (IPS) configuration/level controls.
8. Update manhole diameter sizing based on pipe sizes.
9. Check model calibration with recent flow monitor data.

A.2.1 CTP and IPS Configuration

The CTP model configuration at the headworks process was adjusted to better match the physical setup of the facility. Figure A.1 shows how the collection system piping enters the treatment plant. All of the influent sources are combined in the forebay of the screening structure, as shown in Figure A.2, before continuing to the new influent pump station (NIPS). Figure A.3 shows how the plant headworks is represented in the CTP model, which effectivity terminates at the screen forebay location and neglects the screen system losses.

Figure A.4 shows the level data at the wet well and screen influent, as well as pump station flows. The level data shows the forebay of the screen channels in the new screen channel building is generally 1 foot higher that than the NIPS setpoint level and independent of flow rate. As the model is not intended to capture the screen system losses, the pump set points in the model were shifted up by 1 foot to target a level of -2 feet. This will match the screen forebay level and account for the screening facility and its influence on collection system hydraulics.

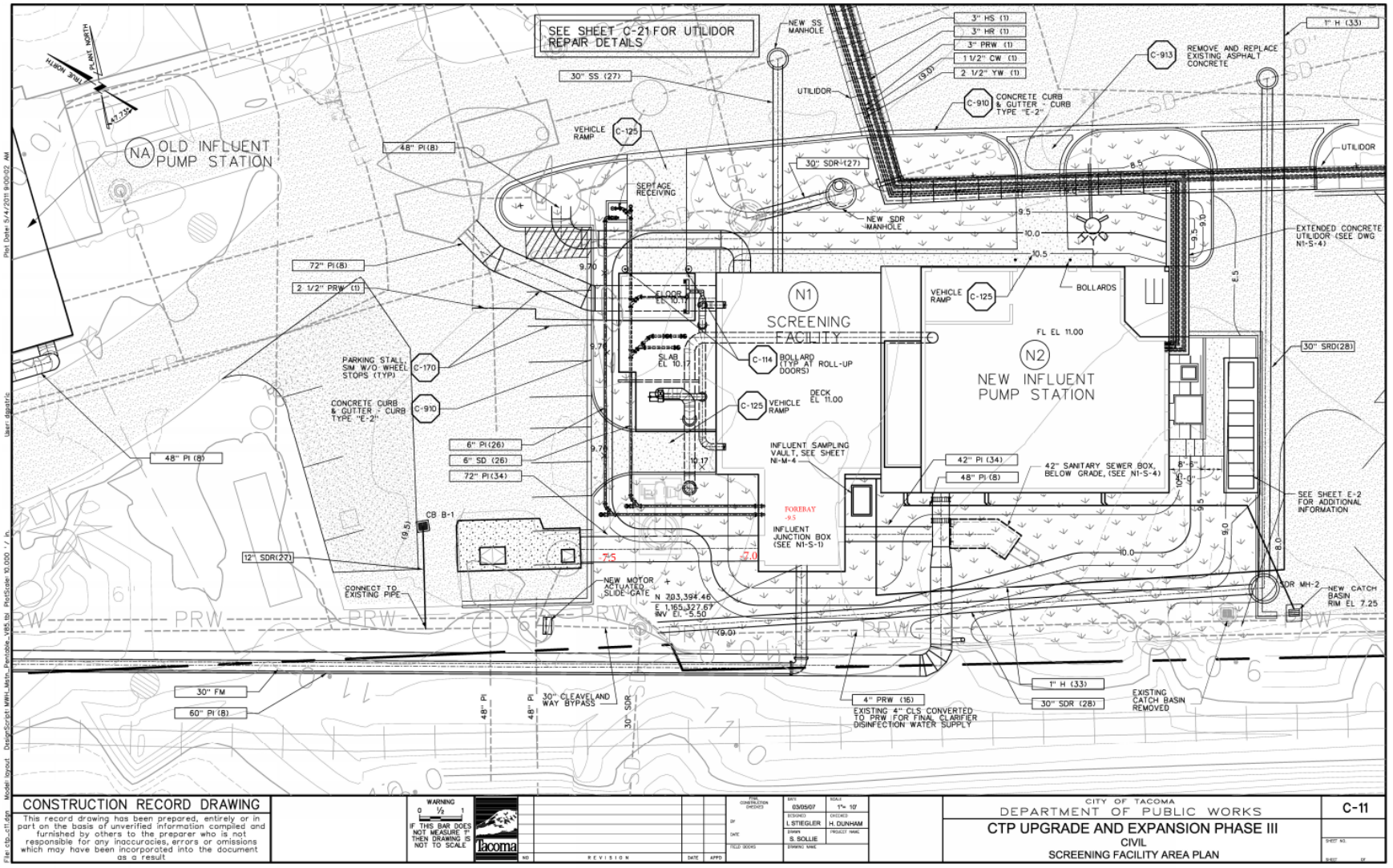


Figure A.1 CTP Influent Piping into Headworks

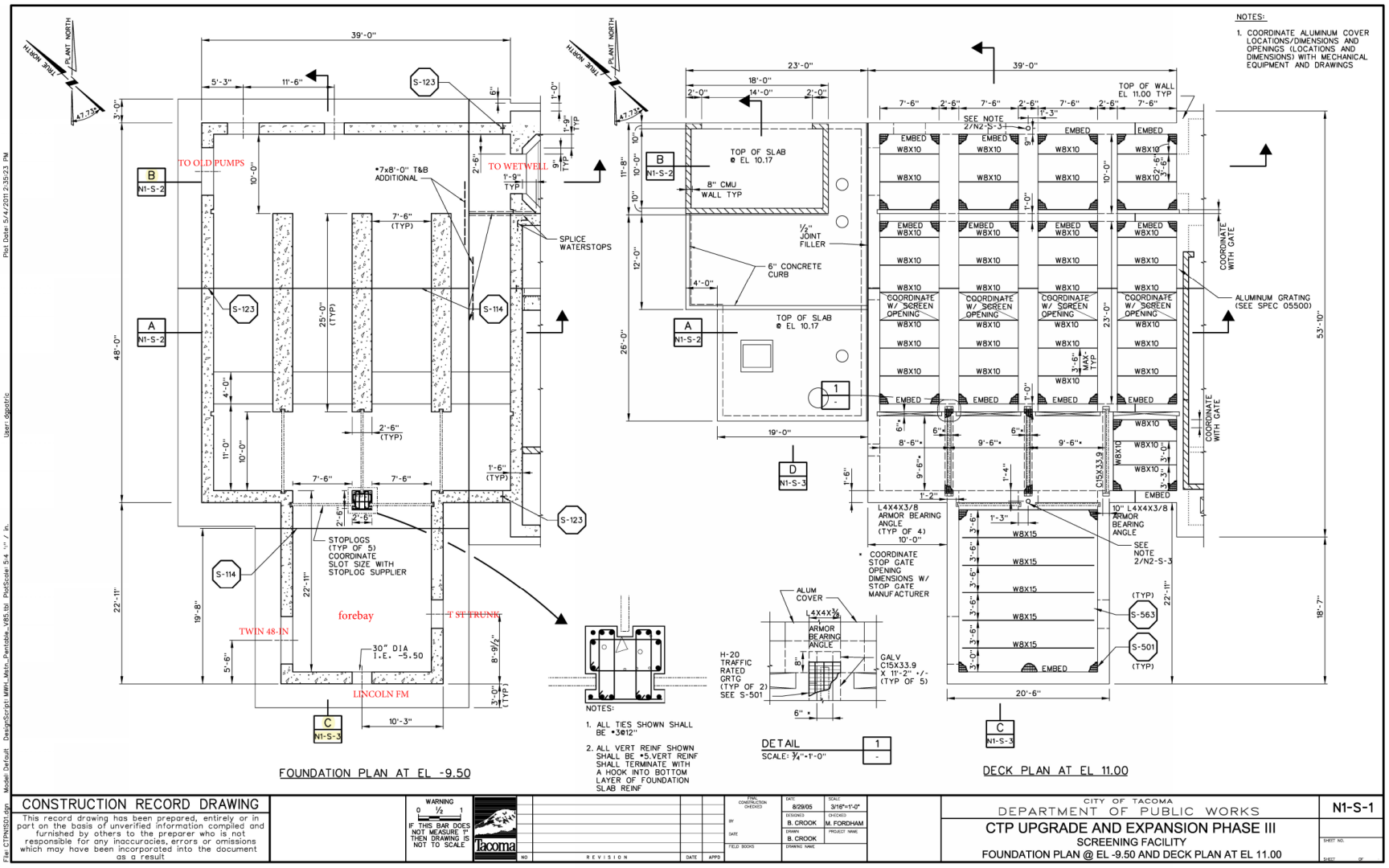


Figure A.2 Screening Facility

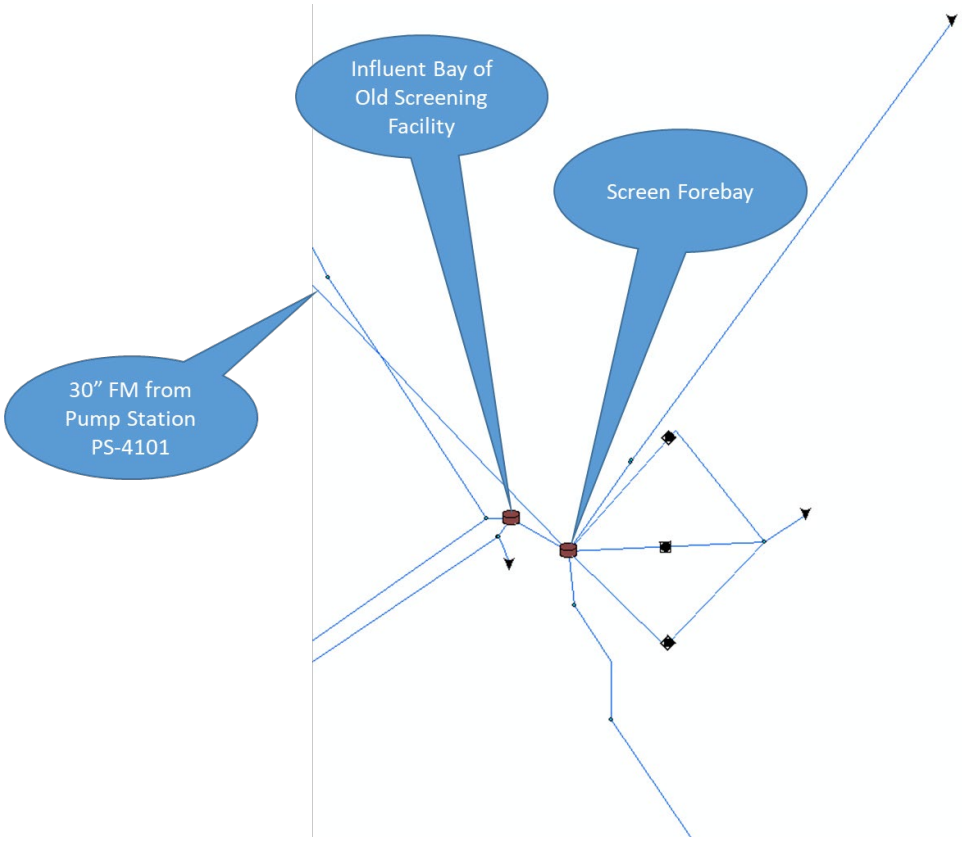


Figure A.3 CTP IPS Model Configuration

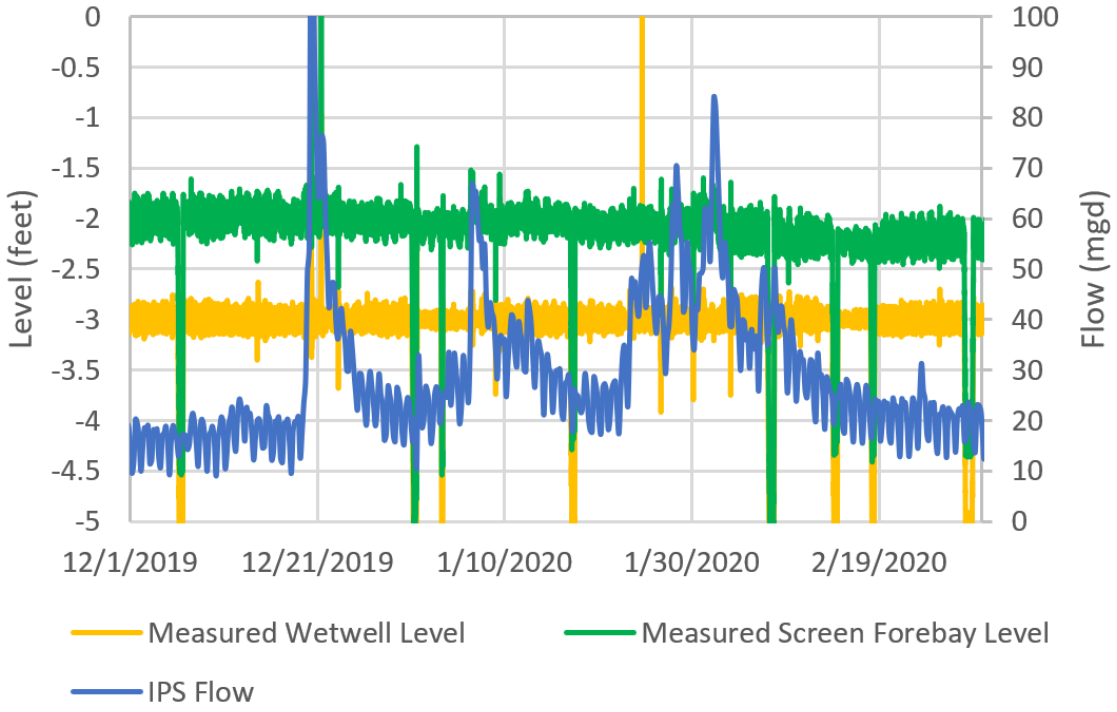


Figure A.4 Flow and Level Measurements at the CTP Headworks

A.3 Flow Monitoring Locations

Two flow meters were used to check model calibration using data from period from September 2019 to May 2020, and one additional level meter was used to check hydraulic grade line (HGL). The Mission flow meter is located at line segment 6268135 and manhole (MH) ID 6771806, in close proximity to the D-M project area. The CTP influent meter included flow, and had a level sensors at both the forebay to the headworks screens and in the NIPS Wetwell. Level was also recorded at Dock Street. Locations of the meters are shown in Figure A.5.

Figure A.5 Flow Monitoring Locations

A.4 Hydraulic Model Calibration

Hydraulic model calibration is a crucial component of the hydraulic modeling effort. Calibrating the model to match data collected during the flow monitoring program ensures the most accurate results possible. The calibration process consists of calibrating to both dry and wet weather conditions.

For this project, both dry and wet weather monitoring was conducted at the metering sites presented and discussed in Section 1.3.

- DWF calibration ensures an accurate depiction of base wastewater flow generated within the study area.
- WWF calibration consists of calibrating the hydraulic model to a specific storm event or events to accurately simulate the peak flow and volume of inflow and infiltration (I/I) into the sewer system. The amount of I/I is essentially the difference between the wet weather flow (WWF) and dry weather flow (DWF) components.

A.4.1 Calibration Standards and Results

The hydraulic model was calibrated in accordance with international modeling standards. The Urban Drainage Group (UDG), formerly known as Wastewater Planning Users Group (WaPUG), a section of the Chartered Institution of Water and Environmental Management (CIWEM), has established generally agreed upon principles for model verification. The dry weather and wet weather calibration focused on meeting the recommendations on model verification contained in the "Code of Practice for the Hydraulic Modeling of Urban Drainage Systems," published by the CIWEM UDG[1], as summarized below.

A.4.1.1 Dry Weather Calibration Standards

Dry weather calibration should be carried out for two dry weather days and the modeled flows and depths should be compared to the field-measured flows and depths. Both the modeled and field-measured flow hydrographs should closely follow each other in both shape and magnitude.

In addition to the shape, the modeled DWF flow hydrographs should also meet the following criteria when compared with the measured data as a general guide:

- The timing of flow peaks and troughs should be within 1 hour.
- The peak flow rate should be within the range of ±10 percent.
- The volume of flow (or the average rate of flow) should be within the range of ±10 percent. If applicable, care should be taken to exclude periods of missing or inaccurate data.
- The unsurcharged depth should be within ±10 percent or ±4 inches, whichever is greater.

A.4.1.2 Wet Weather Calibration Standards

For each meter ideally three or more separate storms are simulated with the model. For at least two storms out of the three events from the flow monitoring period, the model-simulated flows and depths should match the field-measured flows and depths within the accepted criteria. The modeled and field flow hydrographs for the calibration storms should closely follow each other in both shape and magnitude, until the flow has substantially returned to DWF rates.

[1] UDG, Code of Practice for the Hydraulic Modelling of Urban Drainage Systems, 1st Edition CIWEM 2017 www.ciwem.org.

In addition to the shape, the modeled flow hydrographs should also meet the following criteria comparing to the measured data:

- The timing of the peaks and troughs should be similar with regard to the duration of the events.
- The peak flow rates at significant peaks should be in the range of +25 percent to -15 percent and should be generally similar throughout.
- Modeled volume of flow should be within +20 percent to -10 percent of measured volume of flow.
- The depth of surcharge should be in the range of +20-inches to -4-inches.
- The difference between maximum unsurcharged depth should be within the range of ± 4-inches.

The UDG recommends that for wet weather calibration, the use of a single calibration period incorporating a number of rainfall events should be considered whenever possible. In other words, if the flow monitoring program captured several back to back storms, it may be preferable to use the back to back storms events as the calibration storms, as opposed to calibrating to two separate storms that have occurred weeks or months apart.

Model calibration simulations should be run for a duration long enough that the rainfall derived inflow and infiltration (RDII) response is no longer apparent in the measured data.

A.4.1.3 Dry Weather Calibration Results

The CTP Influent DWFs were developed from September to May and used to compare to the existing model loading to confirm that no changed were needed to stay within calibration criteria. Dry weather flows for model comparison were developed from the measured data for the monitored basins by averaging hourly measured flows during periods without rain for three days prior. While the Mission Meter DWF used for calibration was developed from the data, excluding the months December through April. The drier months were primarily used, but some early winter season data was included to have a sufficient number of data points to create a good average. No distinction between weekend and weekday flows were made for the calibration due to the lack of dry days in the 6 month flow monitoring period.

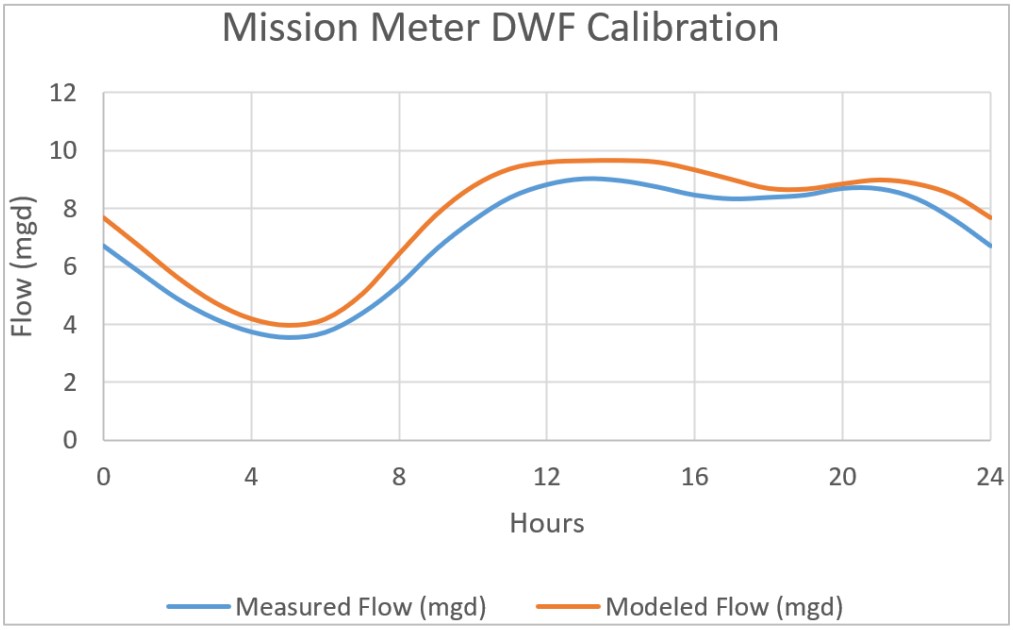
Table A.1 provides a summary of the DWF calibration using the average and daily peak flow results. As shown on Table A.1, the model-simulated average and peak flows for both weekday and weekend flows were all within 10 percent of the measured DWF. The model was slightly high at the Mission site (0.7 million gallons per day [mgd], or 9.7 percent), and slightly low at the CTP influent (-1.2 mgd or -4.3 percent). The peak flows matched more closely. As model met the calibration criteria, there was no change made to DWF loading.

The modeled and measured average diurnal patters are shown in Figure A.6. The upper image shows the Mission meter diurnal, and the lower image shows the CTP diurnal. Overall there is a good correlation between the field-measured data and model output results. As the model matched the recent data well, no changes were made to the model diurnal patterns.

Table A.1 Dry Weather Flow Calibration Results

Meter	Measured Volume (MG)	Modeled Volume (MG)	Measured Peak Flow (mgd)	Modeled Peak Flow (mgd)	Volume Percent Difference (%)	Peak Flow Percent Difference (%)
Mission	7.0	7.7	9.0	9.7	9.7%	6.9%
CTP Influent	17.5	16.7	21.2	20.7	-4.3%	-2.0%

Note:
Abbreviation: MG – million gallons.



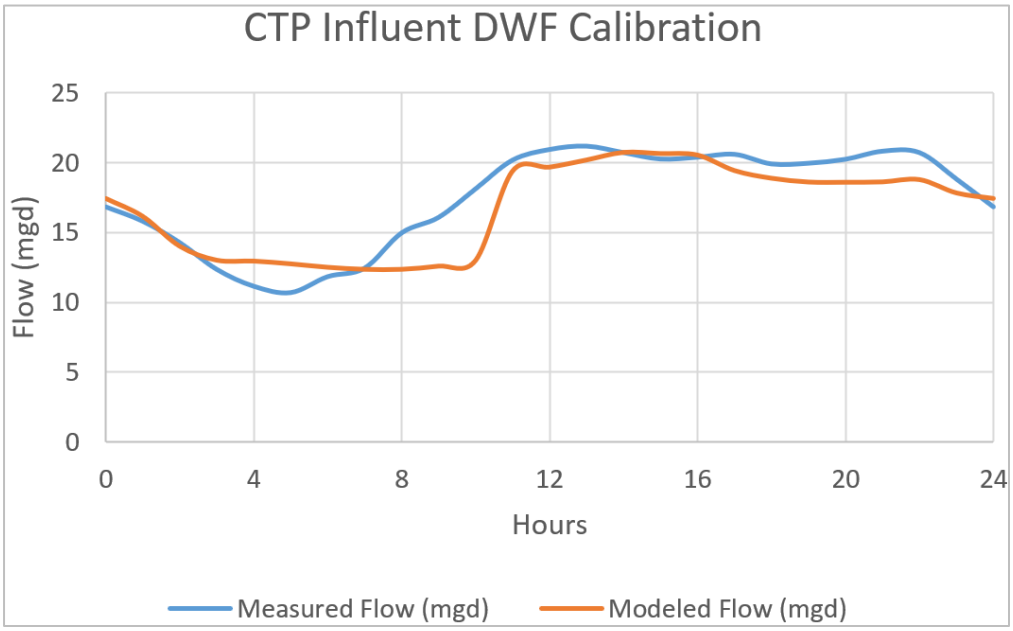


Figure A.6 Dry Weather Flow Calibration

A.4.1.4 Wet Weather Calibration Results

Wet weather flow calibration was checked at both the Mission and the CTP Influent meter sites. Table A.2 shows the comparison metrics between measured data and model output. The comparison shows the model is well calibrated. The Mission meter meets criteria for all three storm events for both peak flow rate and total flow volume, with the model trending slightly high of measured which is conservative. The CTP meets criteria with two of the three storm events in criteria for peak flow and total flow volume. The CTP meter is high for one storm, low for another, and very close for the last. Therefore any adjustment to the model flows is unlikely to further improve calibration.

Images of measured and modeled flows for the evaluation period are shown in Figure A.7 for both flow meter sites. The model closely follows the measured data both on the leading and trailing sides of the storm. Figure A.8 shows the comparison of modeled and measured screen forebay levels which match well.

Table A.2 Wet Weather Flow Calibration Results

Meter	Storm	Measured Data		Modeled Data		Percent Error	
		Volume (MG)	Peak Flow (mgd)	Volume (MG)	Peak Flow (mgd)	Volume (%)	Peak Flow (%)
Mission	Dec 15-29	221.5	57.4	267.9	68.3	17%	16%
CTP	Dec 15-29	455.9	123.9	532.0	101.7	17%	-18%
Mission	Jan 3- 11	144.4	33.0	176.9	42.1	18%	22%
CTP	Jan 3- 11	292.5	66.6	358.6	81.6	23%	22%
Mission	Jan 21- Feb 9	422.7	46.5	443.8	44.6	5%	-4%
CTP	Jan 21- Feb 9	824.8	84.0	895.5	82.9	9%	-1%

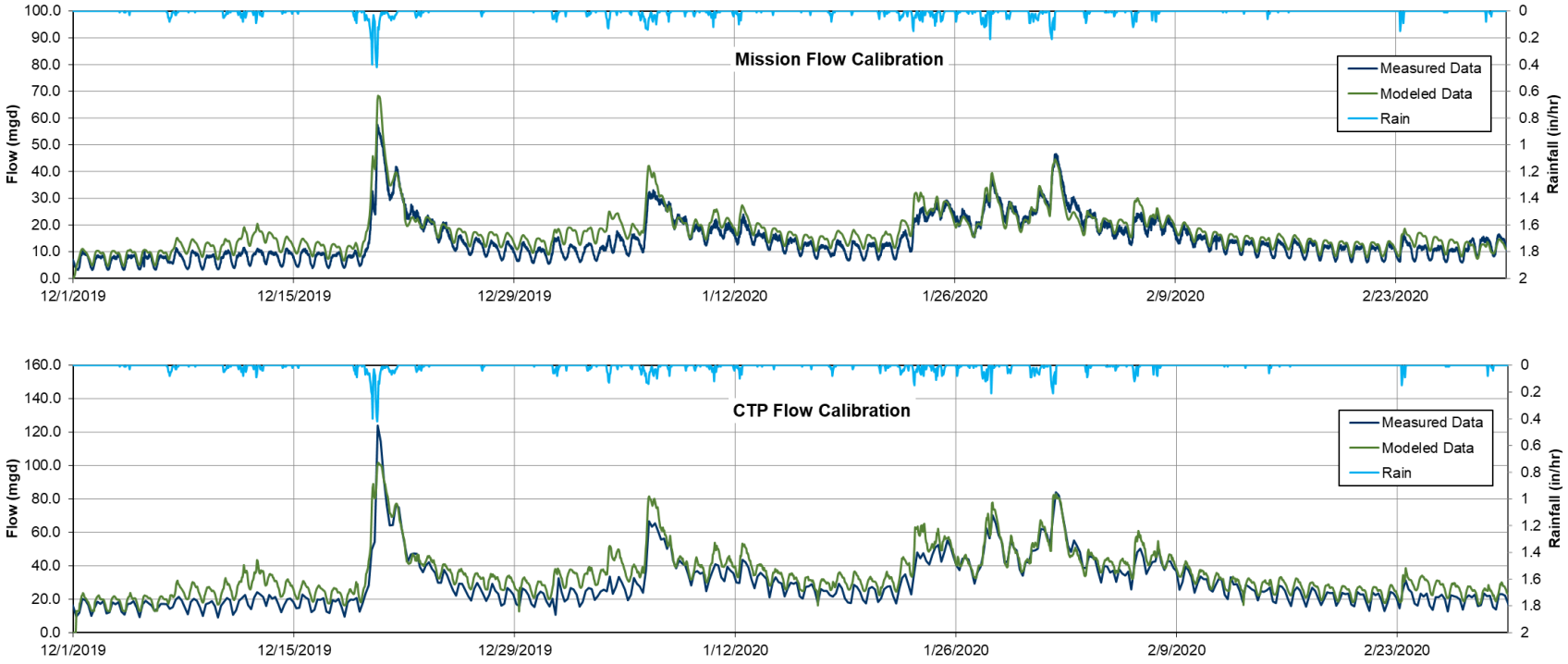


Figure A.7 Wet Weather Flow Calibration

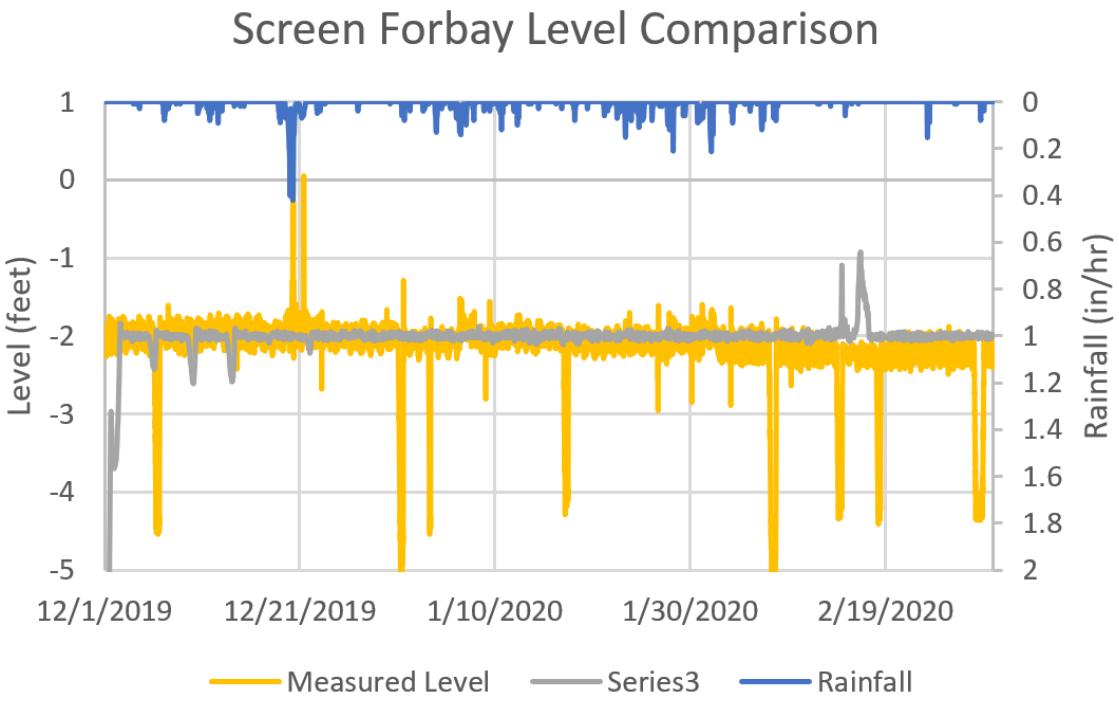


Figure A.8 Wet Weather Wet Well Level Calibration

A.4.2 Dock Street Overflow

During the flow monitoring period the December 19th event was large enough that the collection system overflowed via the Dock street overflow. Figure A.5 shows the comparison between measured and modeled level data at the weir for this event and throughout the monitoring period. There is some uncertainty in the level invert measurement, so a relative comparison was made between the model and measured data. Overall, the model and measure data track well and both capture the peaks during the storm event. The model appears to slightly over predict the level, but there is no clear means to lower the level as the HGL is backed up from the treatment plant. As the flow matched well, the model was considered calibrated for the system.

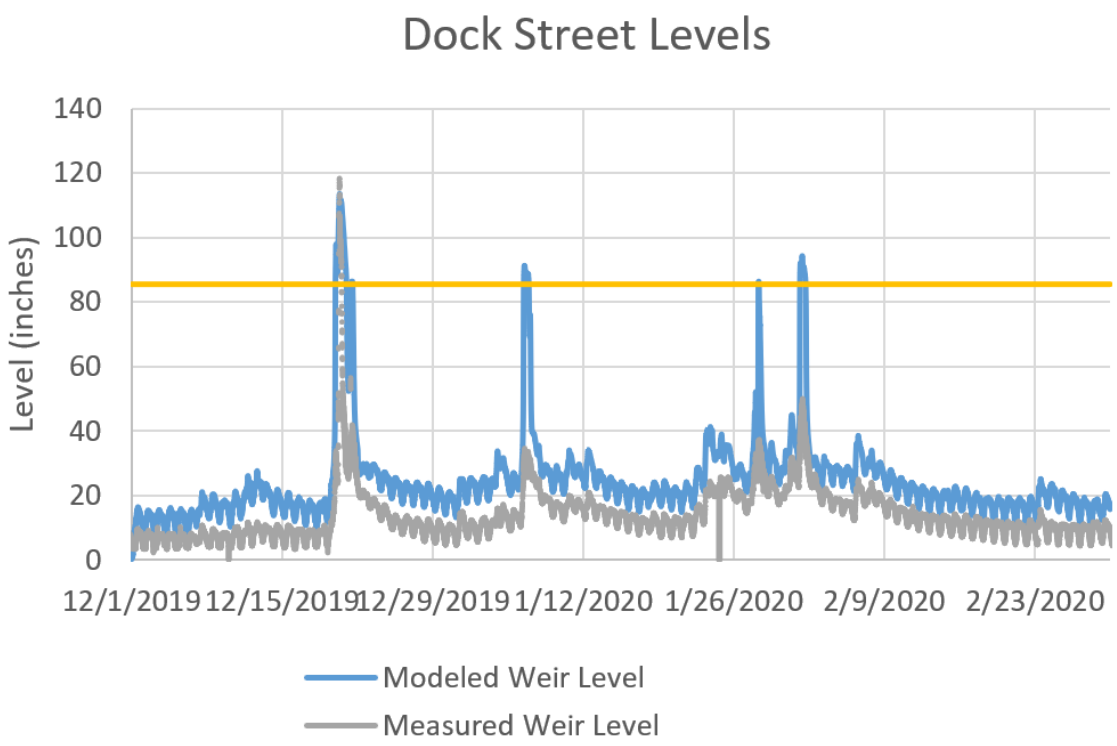


Figure A.9 Dock Street Weir Level Data

A.5 Conclusions

The following updates were made to the CTP wastewater collection system model:

- Minor update downtown loading polygons.
- Verified 1 to 1 matching of modeled components with current GIS and updated, as required.
- Updated all ID's to match current SAP ID's.
- Updated South Tacoma trunk with as-builts.
- Fixed tide flat CTP connection.
- Fix/check Milton and other surrounding jurisdictions ADWF.
- Updated NIPS configuration/level controls.
- Updated manhole diameter sizing based on pipe sizes.
- Checked model calibration with recent flow monitor data.

Based on the model comparison with measured data, the model is well calibrated and suitable for collection system analysis.

Appendix B

TASK 8.1 BOE & COST ESTIMATE

PROJECT MEMORANDUM

D-TO-M STREETS TRACK & SIGNAL PROJECT SURFACE WATER HYDRAULIC ANALYSIS

City of Tacoma

Date: July 20, 2021
Project No.: 10964A00

Prepared By:	Brian Sliger, PE
Reviewed By:	Erik Waligorski, PE
Subject:	Task 8.2: Basis of AACE Class 4 Cost Estimate for Construction of the Proposed Downstream Storm and Sanitary Piping Improvements.

Background and Purpose

The D-to-M Streets Track & Signal Project (Project) was completed by Sound Transit (ST) as part of a larger expansion of a regional rail line within western Washington. This 19-acre portion of the expansion reconstructed City of Tacoma (City) streets from South 'D' Street to South 'M' Street, installed a new rail bed, and regraded an existing rail bed. The Project relocated over 4,000 linear feet of storm drainage pipe, replacing piping in the area with new pipes having diameters ranging in size from 12 inches to 72 inches. These relocations were performed to allow for the lowering of the roadway grade and the installation of a railway bridge over the roadway. Following construction, multiple storm manholes within the Project area have surcharged and flooded the lowered roadway during large storm events.

The Project was located within the Thea Foss Waterway basin (Basin) and therefore was subject to meeting the requirements of the City's 2008 Surface Water Management Manual (TSWMM). Carollo Engineers, Inc. (Carollo) independently completed an alternatives analysis that identified viable solutions that comply with the TSWMM requirements within the Project area. The initial analysis analyzed eight infrastructure improvement scenarios and developed a cost opinion for the two preferred scenarios:

- The installation of a new parallel trunk main to convey flows in excess of the existing pipe's capacity. This new trunk main would extend from the Project site to just upstream of the existing trunk main outfall (Scenario 2 in Task 7.1 analysis).
- The rehabilitation of an existing abandoned stormwater main to convey the necessary flows. This rehabilitated main would divert flows from upstream of the Project area to just upstream of the existing trunk main outfall (Scenario 3 in Task 7.1 analysis).

Following the analysis it was determined that Scenario 3, the rehabilitation of the existing trunk main, would be the most viable alternative. This scenario would require additional system modifications downstream of the rehabilitated pipeline that were not included in the initial Scenario 3 opinion of cost. The purpose of this project memorandum is to summarize the basis of cost opinion for these required downstream system improvements. These system improvements are further described in the accompanying Task 8 technical memorandum.

Major components of the required system improvements include:

- Sanitary Reroute:
  - Three new 84-inch manholes.

  - Six new 96-inch manholes
  - Approximately 900 feet of 48-inch diameter reinforced concrete pipe (RCP) installed via trenching.
  - Approximately 300 feet of 66-inch diameter RCP installed via trenching.
- Storm Reroute #1:
  - Four new 96-inch manholes.
  - Three new 108-inch manholes.
  - Approximately 910 feet of 72-inch diameter RCP installed via trenching.
  - Approximately 330 feet of 84-inch diameter RCP installed via trenching.
  - Water Main Reroute of approximately 135 feet of 12-inch Ductile Iron Pipe.
- Storm Reroute #2:
  - One new 48-inch manhole.
  - Three new 96-inch manholes.
  - Three new 108-inch manholes.
  - Approximately 163 feet of 24-inch diameter RCP installed via trenching.
  - Approximately 355 feet of 72-inch diameter RCP installed via trenching.
  - Approximately 284 feet of 96-inch diameter RCP installed via trenching.
- Puyallup Avenue Bridge Removal:
  - Demolition of the Puyallup Street Bridge.
  - Construction of new retaining wall on the north side of Puyallup Avenue in the Project area.
  - Import of soil and regrading of area to replace Puyallup Avenue alignment.
  - Replacement of Puyallup Avenue in Project area.

Cost Basis

The expected level of accuracy for this cost estimate follows the Recommended Practice 18R-97 Cost Estimate Classification System for the Process Industries (Association for the Advancement of Cost Engineering [AACE], 1998) designation as a "Class 4" estimate with an expected level of accuracy of -30 percent to +50 percent of the cost presented. Estimated project costs are in December 2020 dollars, consistent with the Seattle Engineering News-Record (ENR) value of 12112. As the project design matures, cost estimates are subject to change, and the cost of labor, materials, and equipment may vary. Because the project timeline is unknown, costs were not adjusted to the mid-point of construction.

Carollo's Costing Model tool was utilized to prepare the cost opinions. This model compiles historical cost data for various project items to produce a unit cost representative of the costs expected to be encountered during the construction bidding process. This planning approach uses both major-item quantity estimates and percentage allowances based on experience with similar projects. The following narrative compliments the assumptions listed in the cost opinion worksheet.

General

- Costs included in the estimate reflect the best understanding of planning level requirements, as they existed at the time the estimate was prepared. Any modifications to the present scope and/or alignment may have substantial cost impacts.
- Existing civil site conditions including pipe diameter, pipe slopes, and existing ground surface elevation are as reflected in the City's geographic information system (GIS) system.(1)
- Construction activities and sequencing are not hampered by constrained site conditions (no reduced productivity). Work can be sequenced to minimize service and community interruptions.
- Pipe installation is completed within a single dry season.
- Groundwater table remains generally below the bottom of trenches during the dry season, except at the Dock Street Yard. Existing Washington State Department of Ecology (Ecology) well reports

indicate that groundwater levels in this area will necessitate dewatering during excavations below approximately 10-feet in depth. Dewatering costs are addressed via allowance where applicable.[5]
- Geotechnical conditions encountered at the site are adequate for the proposed excavations and pipe installations.
- Shoring and excavation costs were based on actual costs from similar installations on other Project(s).

Sanitary Reroute

- Excavation depth of the pipe is based on the weighted average invert depth along its alignment, using ground surface elevations from GIS and the proposed invert elevations.
- Trenches sized to allow for a sufficient work area within the pit including the installation of necessary manholes.
- Trenches are assumed to be backfilled completely with imported structural backfill, due to their proximity to roadways and/or bridge footings.
- All trench shoring is driven steel sheet piles with internal bracing.
- The new pipe material is assessed as RCP for costing:
  - This pipe material remains more readily available and less expensive than other types of pipe that are suitable for an installation of this size and type.
  - Class III RCP using American Concrete Pipe Association standards[2], assuming a fill height of 15 feet and a Type 2 installation type.
- Manholes over 84 inches in size are assumed to increase in price linearly, and their estimated costs are derived using extrapolation of smaller manholes.
- A "Major Utility Conflict" allowance is included to address costs associated with the pipes crossing of the existing light rail line on East 25th Street. The allowance value was estimated based on anticipated costs to excavate pits on either side of the rail line, outside of the track's zone of influence, and pipe ram under the rail line.

Storm Reroute #1

- Excavation depth of the pipe is based on the weighted average invert depth along its alignment, using ground surface elevations from GIS and the proposed invert elevations.
- Trenches sized to allow for a sufficient work area within the pit including the installation of necessary manholes.
- Trenches are assumed to be backfilled completely with imported structural backfill, due to their proximity to roadways and/or bridge footings.
- All trench shoring for the storm sewer installation is driven steel sheet piles with internal bracing. Shoring for the water main location is aluminum hydraulic trench boxes.
- The new storm pipe material is RCP:
  - This pipe material remains more readily available and less expensive than other types of pipe that are suitable for an installation of this size and type.
  - Class III RCP using American Concrete Pipe Association standards[2], assuming a fill height of 15 feet and a Type 2 installation type.
- Manholes over 84 inches in size are assumed to increase in price linearly, and there estimated costs are derived using extrapolation of smaller manholes.
- 12-inch ductile iron water main will need to be relocated to the west to allow for new sewer alignment. It's assumed no bypass will be required for this work.

Storm Reroute #2

- Excavation depth of the pipe is based on the weighted average invert depth along its alignment, using ground surface elevations from GIS and the proposed invert elevations.

- Trenches sized to allow for a sufficient work area within the pit including the installation of necessary manholes.
- Trenches are assumed to be backfilled completely with imported structural backfill, due to their proximity to roadways and/or bridge footings.
- All trench shoring is driven steel sheet piles with internal bracing.
- The new pipe material is RCP:
  - This pipe material remains more readily available and less expensive than other types of pipe that are suitable for an installation of this size and type.
  - Class III RCP using American Concrete Pipe Association standards[2], assuming a fill height of 15 feet and a Type 2 installation type.
- Manholes over 84 inches in size are assumed to increase in price linearly, and there estimated costs are derived using extrapolation of smaller manholes.

Puyallup Avenue Bridge Removal

- Bridge demolition costs were based on actual costs from similar Projects.
- The backfill needed to complete the regrade was assumed to be 10 percent more than the volume needed to account for compaction during regrade (compaction factor of 1.10).
- The new road replacing the bridge is assumed to have a similar layout as the current roadway crossing the bridge: four lanes, parallel parking on both sides, shared left turn lane, curb and gutters both sides, and sidewalks on both sides.
- A new retaining wall will need to be installed along the length of the north side of the new road. The new wall was assumed to be a modular block system and actual costs from similar Projects were utilized.

Miscellaneous

- Traffic Control:
  - Significant traffic control measures will be necessary as the new sewers will be installed within the traveled right of way.
  - A major detour will be required at Puyallup Avenue to facilitate the removal of the existing Bridge and replacement of roadway.
  - Traffic Control was included as a separate cost item to reflect the assumption that the work covered under each cost item will be completed simultaneously.
  - The Traffic Control cost is assumed to be 15 percent of the sum of all other cost items (total project direct cost not including traffic control). This value is constant with other Projects of the type and size.
- Bypass System:
  - It's anticipated that a bypass system will be required during the construction of the Sanitary Reroute, Storm Reroute #1, and Storm Reroute #2.
  - The work will likely be staged such that one bypass system is operating at a time.
  - Bypass costs for the storm reroutes will include minimal fuel and operation costs as construction is anticipated to be completed in the dry season. The storm system work will also likely be staged to have a transition event where flows are switch from the existing line to the newly constructed line.
  - The sewer reroute will require bypassing for the duration of the piping installation as the existing piping will need to be removed for construction of the proposed pipe.
  - The estimated cost is an allowance based on bypass Projects of similar size and scope.
- Restoration:
  - All trenched piping installations will require pavement replacement along their entire length (assumed to be one full lane width or 12 feet).

  - Restoration outside of paved or hard surfaced areas is assumed to be minimal (i.e., no landscaping and gravel/native surfacing).
  - The costs associated with restoration are included in each individual pipe and/or manhole cost item.
- The "General Conditions" direct cost component addresses general Contractor incurred costs that are not directly linked to time and material costs associated with individual cost items including, but not limited to, mobilization, demobilization, contractor's temporary facilities, major construction equipment that cannot be distributed to a specific item of work, testing, project site supervision, and bonds/insurance.

Exclusions

All potential items of cost which might be associated with the project but for which no costs have been included are listed below:

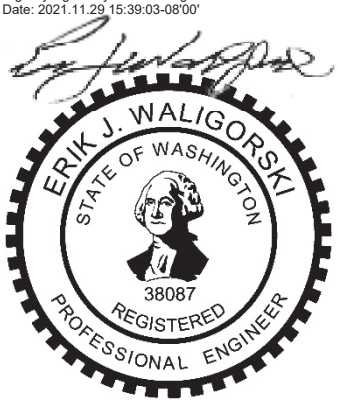
- Costs for unusual site conditions not currently identified within this memorandum.
- Costs for community impacts (e.g., disruption to surrounding businesses).
- Costs for temporary staging easements beyond the City's existing easements.
- Estimating allowances for City's indirect costs not specifically listed, including bid market, construction management and inspection, permitting, operations support, community outreach, environmental impacts, real estate acquisition and easements, and mitigation.
- Costs for any potential construction delays due to external interferences such as weather conditions, union strikes, pandemics, or emergency services.
- Cost for contaminated soil management required at the site.
- Costs for unknown or changing site conditions including, but not limited to, ground improvements and site developments beyond existing site conditions reflected in the City's GIS records.(1)
- Costs for additional scope beyond that as detailed in the current scope of work.

References

1. tacomaMAP, https://tmap.cityoftacoma.org/, City of Tacoma GIS, March 2020.
2. American Concrete Pipe Association – LRFD Fill Height Tables for Concrete Pipe: https://www.concretepipe.org/wp-content/uploads/FillHeightTables-1.pdf
3. Carollo Cost Estimating Manual.
4. Carollo Conceptual Cost.
5. Department of Ecology, Resource Protection Well Reports, Various Locations in Project Vicinity, https://appswr.ecology.wa.gov/wellconstruction/map/WCLSWebMap/default.aspx.
6. City of Tacoma CCTV Records.

Reviewed by:

Digitally signed by Erik J. Waligorski
Date: 2021.11.29 15:39:03-08'00'



BAS:mm

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DRAFT WORK PRODUCT

PROJECT SUMMARY

Estimate Class: 4

Project: D-to-M Streets Track & Signal Project Surface Water Hydraulic Analysis
Client: City of Tacoma
Location: Tacoma, WA
Zip Code: 98402

PIC: B. Matson
PM: S. Leung
Date: December 4th, 2020
By: B. Sliger

Carollo Job # 10964A00 **Reviewed:** E. Waligorski

NO.	DESCRIPTION	QTY	UNIT	$/UNIT	TOTAL
1	Traffic Control	1	LS	$1,590,000	$1,590,000
2	Sanitary Reroute 48-inch Pipe	900	LF	$2,276	$2,048,569
3	Sanitary Reroute 66-inch Pipe	300	LF	$2,148	$644,531
4	Sanitary Reroute 84-inch Manholes	3	EA	$14,898	$44,693
5	Sanitary Reroute 96-inch Manholes	6	EA	$23,736	$142,419
7	Storm Reroute #1 72-inch Pipe	910	LF	$1,809	$1,646,282
8	Storm Reroute #1 84-inch Pipe	330	LF	$1,154	$380,968
9	Storm Reroute #1 96-inch Manholes	4	EA	$17,843	$71,372
10	Storm Reroute #1 108-inch Manholes	3	EA	$18,338	$55,013
11	Storm Reroute #2 24-inch Pipe	163	LF	$893	$145,607
12	Storm Reroute #2 72-inch Pipe	355	LF	$2,158	$766,153
13	Storm Reroute #2 96-inch Pipe	284	LF	$1,974	$560,710
14	Storm Reroute #2 48-inch Manholes	1	EA	$4,376	$4,376
15	Storm Reroute #2 96-inch Manholes	3	EA	$33,215	$99,646
16	Storm Reroute #2 108-inch Manholes	3	EA	$21,036	$63,108
17	Bypass System	1	LS	$1,200,000	$1,200,000
18	Puyallup Ave Bridge Removal and Re-Grade	1	LS	$2,264,292	$2,264,292
19	Watermain Reroute 12" Pipe	125	LF	$198	$24,752
20	Forcemain Replacement 24"	210	LF	$1,586	$333,126
21	New Dock Street Overflow	1	LS	$79,826	$79,826
	TOTAL DIRECT COST				**$12,165,441**
	General Conditions			15%	$1,824,816
	Subtotal				**$13,990,257**
	Design Contingency			30.0%	$4,197,077
	Subtotal				**$16,362,518**
	General Contractor Overhead, Profit & Risk			15.0%	$2,454,378
	Subtotal				**$18,816,896**
	Sales Tax (Based on Tacoma, WA)			10.2%	$1,919,323
	Subtotal				**$20,736,219**
	TOTAL ESTIMATED CONSTRUCTION COST				**$20,736,219**
	Engineering, Legal & Administration Fees			20.0%	$4,147,244
	Owner's Reserve for Change Orders			20.0%	$4,147,244
	TOTAL ESTIMATED PROJECT COST				**$29,030,707**

AACE Class 4 Accuracy Range		
-30%	50%	Cost (2020 $'s)
$14,600,000	**$31,200,000**	**Construction**
$20,400,000	**$43,600,000**	**Project**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 02 Sanitary Reroute 48-in Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	10680	SF	$.70	$7,510		
02_41_00 / 02220	Asphalt Pavement Cutting	10680	INFT	$.66	$7,047		
	Total					**$14,557**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	5076.3	CY	$8.00	$40,615		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	4662.07	CY	$62.16	$289,789		
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	5076.3	CY	$3.19	$16,174		
31_50_00 / 02260	Sheet Piling, 38#/Sf To 25' Deep, Drive, Pull & Salvage (Trenches Only)	39160	SF	$26.56	$1,040,170		
	Total					**$1,386,749**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	1186.67	SY	$56.50	$67,045		
	Total					**$67,045**	
	Division 33 – Utilities						
33_31_20 / 15261	48" Astm C-76 Class Iii Rcp In Open Trench	890	LF	$90.13	$80,218		
	Total					**$80,218**	
	Allowances						
	Utility Conflict (Major)	1	LS	$ 500,000	$ 500,000		This allowance is included to address costs associated with the pipes crossing of the existing light rail line on E 25th St.
	Total					**$500,000**	
	Grand Total					**$2,048,569**	
					$/LF	**$2,276.19**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 03 Sanitary Reroute 66-in Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	3480	SF	$.70	$2,447		
02_41_00 / 02220	Asphalt Pavement Cutting	3480	INFT	$.66	$2,296		
	Total					**$4,743**	
	Division 31 – Earthwork						
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	2373.7	CY	$3.19	$7,563		
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	2373.7	CY	$8.00	$18,992		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	2118.52	CY	$62.16	$131,685		
31_50_00 / 02260	Sheet Piling, 38#/Sf To 25' Deep, Drive, Pull & Salvage (Trenches Only)	15080	SF	$26.56	$400,556		
	Total					**$558,796**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	386.67	SY	$56.50	$21,846		
	Total					**$21,846**	
	Division 33 – Utilities						
33_31_20	66" ASTM C-76 Class III RCP in Open Trench	290	LF	$203.95	$59,146		Non-Inventory Item
	Total					**$59,146**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$644,531**	
					$/LF	**$2,148.44**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 04 Sanitary Reroute 84"Manholes

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 – Utilities						
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	3	EA	$1,420.80	$4,262		
33_05_13 / 02580	84" Precast Manhole, Xtra Depth Over 8'	25.5	VLF	$832.98	$21,241		
33_05_13 / 02580	84" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top Or Bottom Slab	3	EA	$6,396.58	$19,190		
	Total					**$44,693**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$44,693**	
					$/each	**$14,897.75**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 05 Sanitary Reroute 96"Manholes

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 – Utilities						
33_05_13	96" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top or Bottom Slab	6	EA	$7,343.06	$44,058		Non-Inventory Item
33_05_13	96" Precast Manhole, Xtra Depth Over 8'	94	VLF	$955.70	$89,835		Non-Inventory Item
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	6	EA	$1,420.80	$8,525		
	Total					**$142,419**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$142,419**	
					$/each	**$23,736.43**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 06 Storm Reroute #1 72-in Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	10920	SF	$.70	$7,678		
02_41_00 / 02220	Asphalt Pavement Cutting	10920	INFT	$.66	$7,205		
	Total					**$14,884**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	6218.33	CY	$8.00	$49,752		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	5265.38	CY	$62.16	$327,290		
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	6218.33	CY	$3.19	$19,813		
31_50_00 / 02260	Sheet Piling, 38#/Sf To 25' Deep, Drive, Pull & Salvage (Trenches Only)	37310	SF	$26.56	$991,031		
	Total					**$1,387,886**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	1213.33	SY	$56.50	$68,552		
	Total					**$68,552**	
	Division 33 – Utilities						
33_31_20 / 15261	72" Astm C-76 Class Iii Rcp In Open Trench	910	LF	$192.26	$174,960		
	Total					**$174,960**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$1,646,282**	
					$/LF	**$1,809.10**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 07 Storm Reroute #1 84-in Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	3960	SF	$.70	$2,784		
02_41_00 / 02220	Asphalt Pavement Cutting	3960	INFT	$.66	$2,613		
	Total					**$5,397**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	1650	CY	$8.00	$13,201		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	1179.63	CY	$62.16	$73,324		
31_00_00 / 02300	Cat 225 Trackhoe, 1-1/2Cy Bucket, Class B (Medium Digging), 0-16' D	1650	CY	$3.15	$5,192		
31_50_00 / 02260	Sheet Piling, 22#/Sf To 15' Deep, Drive, Pull & Salvage (Trenches Only)	8910	SF	$16.62	$148,076		
	Total					**$239,794**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	440	SY	$56.50	$24,859		
	Total					**$24,859**	
	Division 33 – Utilities						
33_31_20 / 15261	84" Astm C-76 Class Iii Rcp In Open Trench	330	LF	$336.11	$110,917		
	Total					**$110,917**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$380,968**	
					$/LF	**$1,154.45**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 08 Storm Reroute 96" Manholes

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 – Utilities						
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	4	EA	$1,420.80	$5,683		
33_05_33	96" Precast Manhole, Xtra Depth Over 8'	38	VLF	$955.70	$36,316		Non-Inventory Item
33_05_33	96" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top or Bottom Slab	4	EA	$7,343.06	$29,372		Non-Inventory Item
	Total					**$71,372**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$71,372**	
					$/Each	**$17,842.97**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 09 Storm Reroute 108" Manholes

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 – Utilities						
33_05_13	108" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top or Bottom Slab	3	EA	$8,289.54	$24,869		Non-Inventory Item
33_05_13	108" Precast Manhole, Xtra Depth Over 8'	24	VLF	$1,078.42	$25,882		Non-Inventory Item
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	3	EA	$1,420.80	$4,262		
	Total					**$55,013**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$55,013**	
					$/Each	**$18,337.67**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 10 Storm Reroute #2 72-in Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	4260	SF	$.70	$2,995		
02_41_00 / 02220	Asphalt Pavement Cutting	4260	INFT	$.66	$2,811		
	Total					**$5,806**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	2958.33	CY	$8.00	$23,669		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	2586.58	CY	$62.16	$160,779		
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	2958.33	CY	$3.19	$9,426		
31_50_00 / 02260	Sheet Piling, 38#/Sf To 25' Deep, Drive, Pull & Salvage (Trenches Only)	17750	SF	$26.56	$471,477		
	Total					**$665,351**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	473.33	SY	$56.50	$26,743		
	Total					**$26,743**	
	Division 33 – Utilities						
33_31_20 / 15261	72" Astm C-76 Class Iii Rcp In Open Trench	355	LF	$192.26	$68,254		
	Total					**$68,254**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$766,153**	
					$/LF	**$2,158.18**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 11 Storm Reroute #2 96-in Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	3408	SF	$.70	$2,396		
02_41_00 / 02220	Asphalt Pavement Cutting	3408	INFT	$.66	$2,249		
	Total					**$4,645**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	1504.15	CY	$8.00	$12,035		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	975.43	CY	$62.16	$60,632		
31_00_00 / 02300	Cat 225 Trackhoe, 1-1/2Cy Bucket, Class B (Medium Digging), 0-16' D	1504.15	CY	$3.15	$4,733		
31_50_00 / 02260	Sheet Piling, 22#/Sf To 15' Deep, Drive, Pull & Salvage (Trenches Only)	7384	SF	$16.62	$122,715		
	Total					**$200,115**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	378.67	SY	$56.50	$21,394		
	Total					**$21,394**	
	Division 33 – Utilities						
33_31_20 / 15261	96" Astm C-76 Class Iii Rcp In Open Trench	284	LF	$455.02	$129,225		
	Total					**$129,225**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$355,379**	
					$/LF	**$1,974.33**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 12 Storm Reroute #2 96"Manholes

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 – Utilities						
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	3	EA	$1,420.80	$4,262		
33_05_33	96" Precast Manhole, Xtra Depth Over 8'	42	VLF	$955.70	$40,139		Non-Inventory Item
33_05_33	96" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top or Bottom Slab	3	EA	$7,343.06	$22,029		Non-Inventory Item
	Total					**$66,431**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$66,431**	
					$/Each	**$33,215.41**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 13 Storm Reroute#2 108"Manholes

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 – Utilities						
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	3	EA	$1,420.80	$4,262		
33_05_33	108" Precast Manhole, Xtra Depth Over 8'	12	VLF	$1,078.42	$12,941		Non-Inventory Item
33_05_33	108" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top or Bottom Slab	3	EA	$8,289.54	$24,869		Non-Inventory Item
	Total					**$42,072**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$42,072**	
					$/Each	**$21,036.01**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 14 Puyallup Ave Bridge Removal

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_00_00	Bridge & Ex. Retaining Wall Demolition	22,525.00	SF	$51.55	$1,161,164		Non-Inventory Item
	Total					**$1,161,164**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	8985.07	CY	$8.00	$71,888		
31_00_00 / 02300	Tractor/Backhoe, 30" Bucket Class B (Medium Digging), 0-5' D	107.85	CY	$10.77	$1,162		
31_00_00 / 02300	D6 Dozer, Class B (Medium Dig), Grade, Cut, Fill & Compact, 250' Haul	8877.89	CY	$6.09	$54,101		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	907.41	CY	$54.69	$49,622		
31_00_00 / 02300	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	8877.89	CY	$13.79	$122,456		
	Total					**$299,229**	
	Division 32 – Exterior Improvements						
32_00_00	Keystone Retaining Wall	12250	SF	$51.55	$631,488		Non-Inventory Item
32_12_15 / 02742	4" Ac Paving On 10" Abc	2178.89	SY	$64.75	$141,076		
32_13_13 / 02750	Turn Arrow Or Letter Painting	10	EA	$250.00	$2,500		
32_13_13 / 02750	4" Thermoplastic Line Painting	1060	LF	$.78	$831		
32_16_14 / 02772	24" Curved Conc Curb And Gutter, Machine Formed	530	LF	$13.51	$7,158		
32_16_14 / 02772	4" Thick Concrete Sidewalk,	3710	SF	$5.62	$20,846		
	Total					**$803,899**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$2,264,292**	

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DETAILED COST ESTIMATE

Project:	**D-to-M Streets Track & Signal Project**	**Format:**	**MASTER FORMAT 50**
Client:	**City of Tacoma**	**Date :**	**December 4th, 2020**
Location:	**Tacoma, WA**	**By :**	**B. Sliger**
Element:	**15 Watermain reroute 12" Pipe**	**Reviewed:**	**E. Waligorski**

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Demo D.I. Pipe From An Open Trench, 4" - 18" Incl. Fittings	135	LF	$8.81	$1,190		
	Total					**$1,190**	
	Division 31 – Earthwork						
31_00_00 / 02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	83.33	CY	$4.78	$398		
31_00_00 / 02300	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	75	CY	$4.78	$358		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	79.7	CY	$62.16	$4,954		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	75	CY	$62.16	$4,662		
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	83.33	CY	$8.00	$667		
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	75	CY	$8.00	$600		
31_50_00 / 02260	Trench Bracing, 3' W X 10' D Alum. Hyd. Shores	125	LF	$20.62	$2,578		
31_50_00 / 02260	Trench Bracing, 3' W X 5' D Alum. Hyd. Shores	135	LF	$15.47	$2,088		
	Total					**$16,304**	
	Division 40 – Process Integration						
40_05_33.51 / 15251	12" 22-1/2° Cldi Push-On Joint Bend (C153)	2	EA	$597.81	$1,196		
40_05_33.51 / 15251	12" Cl52 Cldi Push-On Jt Pipe In Open Trench	125	LF	$48.50	$6,062		
	Total					**$7,258**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$24,752**	
					$/LF	**$198.01**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 16 Forcemain Replacement 24" Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Demo D.I. Pipe From An Open Trench, 20" - 36" Incl Fittings	190.00	LF	$22.03	$4,186		
	Total					**$4,186**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	528.89	CY	$8.00	$4,232		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	504.45	CY	$62.16	$31,356		
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	528.89	CY	$3.19	$1,685		
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	422.22	CY	$8.00	$3,378		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	422.22	CY	$62.16	$26,245		
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	422.22	CY	$3.19	$1,345		
31_50_00 / 02260	Sheet Piling, 27#/Sf To 20' Deep, Drive, Pull & Salvage (Trenches Only)	7140	SF	$19.67	$140,415		
31_50_00 / 02260	Sheet Piling, 27#/Sf To 20' Deep, Drive, Pull & Salvage (Trenches Only)	5,700.00	SF	$19.67	$112,096		
	Total					**$320,751**	
	Division 40 – Process Integration						
40_05_33.51 / 15251	24" 22-1/2° Cldi Push-On Joint Bend (C110)	1	EA	$3,020.40	$3,020		
40_05_33.51 / 15251	24" 45° Cldi Push-On Joint Bend (C110)	1	EA	$3,294.65	$3,295		
40_05_33.51 / 15251	24" Cl50 Cldi Push-On Jt Pipe In Open Trench	210	LF	$8.92	$1,874		
	Total					**$8,189**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					**$333,126**	
					$/LF	**$1,586.31**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 17 New Dock Street Overflow

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 – Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	1080	SF	$.70	$759		
02_41_00 / 02220	Asphalt Pavement Cutting	1080	INFT	$.66	$713		
	Total					**$1,472**	
	Division 03 – Concrete						
03_30_00 / 03300	8" Straight Wall, To 8' High	0.87	CY	$1,493.89	$1,300		
	Total					**$1,300**	
	Division 31 – Earthwork						
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	240	CY	$8.00	$1,920		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	198.11	CY	$62.16	$12,314		
31_00_00 / 02300	Cat 225 Trackhoe, 1-1/2Cy Bucket, Class B (Medium Digging), 0-16' D	280	CY	$3.15	$881		
31_50_00 / 02260	Sheet Piling, 22#/Sf To 15' Deep, Drive, Pull & Salvage (Trenches Only)	2160	SF	$16.62	$35,897		
	Total					**$51,013**	
	Division 32 – Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	120	SY	$56.50	$6,780		
	Total					**$6,780**	
	Division 33 – Utilities						
33_05_13 / 02580	84" Precast Manhole, Xtra Depth Over 8'	4	VLF	$832.98	$3,332		
33_05_13 / 02580	84" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top Or Bottom Slab	1	EA	$6,396.58	$6,397		
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	1	EA	$1,420.80	$1,421		
33_31_20 / 15261	48" Astm C-76 Class Iii Rcp In Open Trench	90	LF	$90.13	$8,112		
	Total					**$19,261**	
	Allowances						
	None						
	Total					**$0**	
	Grand Total					$79,825.71	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 18 Storm Reroute #2 24-In Pipe

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 02 - Existing Conditions						
02_41_00 / 02220	Remove 4"-6" Asphalt Pavement	1956	SF	$.70	$1,375		
02_41_00 / 02220	Asphalt Pavement Cutting	1956	INFT	$.66	$1,291		
	Total					**$2,666**	
	Division 31 - Earthwork						
31_50_00 / 02260	Sheet Piling, 38#/Sf To 25' Deep, Drive, Pull & Salvage (Trenches Only)	3586	SF	$26.56	$95,252		
31_00_00 / 02300	Imported Pipe Bed & Zone/Confined Structure Backfill, Class B Material	332.04	CY	$62.16	$20,639		
31_00_00 / 02300	Cat 235 Trackhoe 1.50Cy Bucket, Class B (Medium Digging), 0-20' D	332.04	CY	$3.19	$1,058		
31_00_00 / 02300	10 Cy Dump Truck, 10 Miles/Round Trip	332.04	CY	$8.00	$2,657		
	Total					**$119,605**	
	Division 32 - Exterior Improvements						
32_12_15 / 02742	4" Ac Paving On 8" Abc	217.33	SY	$56.50	$12,279		
	Total					**$12,279**	
	Division 33 - Utilities						
33_31_20 / 15261	24" Astm C-76 Class Iii Rcp In Open Trench	163	LF	$67.83	$11,056		
	Total					**$11,056**	
	Allowances						
	None						
	Total						
	Grand Total					**$145,607**	
					$/LF	**$893.29**	

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 19 Storm Reroute #2 48" Manhole

Format: MASTER FORMAT 50
Date : December 4th, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Division 33 - Utilities						
33_05_13 / 02580	48" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top Or Bottom Slab	1	EA	$2,955.52	$2,956		
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	1	EA	$1,420.80	$1,421		
	Total					**$4,376**	
	Allowances						
	None						
	Total					**$0.00**	
	Grand Total					**$4,376**	
					$/Each	**$4,376.32**	

Appendix C

TASK 7.1 BOE & COST ESTIMATE

PROJECT MEMORANDUM

D-TO-M STREETS TRACK & SIGNAL PROJECT SURFACE WATER HYDRAULIC ANALYSIS

City of Tacoma

Date: November 18, 2020
Project No.: 10964A00

Prepared By:	Brian Sliger, PE
Reviewed By:	Erik Waligorski, PE & Susanna Leung, PE
Subject:	Task 7.1: Basis of AACE Class 4 Cost Estimate for Pipe Rehabilitation & Parallel Pipe Extension Alternatives

Background and Purpose

The D-to-M Streets Track & Signal Project (Project) was completed by Sound Transit (ST) as part of a larger expansion of a regional rail line within Western Washington. This 19-acre portion of the expansion reconstructed City of Tacoma (City) streets from South 'D' Street to South 'M' Street, installed a new rail bed, and regraded an existing rail bed. The Project relocated over 4,000 linear feet of storm drainage pipe, replacing piping in the area with new pipes having diameters ranging in size from 12 inches to 72 inches. These relocations were performed to allow for the lowering of the roadway grade and the installation of a railway bridge over the roadway. Following construction, multiple storm manholes within the Project area have surcharged and flooded the lowered roadway during large storm events.

The Project was located within the Thea Foss Waterway basin (Basin) and therefore was subject to meeting the requirements of the City's 2008 Surface Water Management Manual (TSWMM). Carollo Engineers, Inc. (Carollo) has independently completed an alternatives analysis that identified two viable solutions that comply with the TSWMM requirements within the Project area. The initial analysis analyzed the installation of a new parallel trunk main to convey flows in access of the existing pipe's capacity. An additional alternatives analysis has now been completed to look at the rehabilitation of an existing abandoned stormwater main to convey the necessary flows. This alternatives analysis and cost opinion are provided in separate, accompanying documents. The purpose of this project memorandum is to summarize the basis of cost opinion for the potential alternative for rehabilitation of the existing stormwater trunk main and to expand on the previously developed parallel trunk main alternative for comparison of these two alternatives.

The rehabilitation alternative cost opinion prepared reflects the installation of a new 48-inch pipe sliplined through the existing 60/63-inch stormwater trunk main. Two large pit excavations would be required for access to the existing trunk main at two points along its alignment. Major components of the Project include:

- Approximately 2,550 feet of 48-inch diameter pipe sliplined through the existing 60/63-inch trunk main.
- Approximately 30-feet diameter and 50-foot deep access shaft to perform sliplining.

- A new 48-inch diameter overflow pipe and drop structure for conveying flows from the existing D-to-M trunk main to the newly rehabilitated trunk main.
- One (1) new 96-inch manholes.

The parallel pipe extension alternative cost opinion prepared reflects the installation of new trenched 72-inch pipe continuing from the end point of the original parallel pipe alternative. Major components of the Project include:

- Approximately 750 feet of 72-inch diameter reinforced concrete pipe (RCP) installed via trenching.
- Five (5) new 96-inch manholes.

Both these alternatives assume that the installed pipe connects to a similar location in Puyallup Ave, just West of Interstate 705. The conveyance further downstream was not finalized as it will require extensive sewer improvements. Therefore costing of this downstream conveyance was not completed and it is assumed that both alternatives would require similar costs for any necessary improvements to the existing downstream conveyance.

Cost Basis

The expected level of accuracy for this cost estimate follows the Recommended Practice 18R-97 Cost Estimate Classification System for the Process Industries (Association for the Advancement of Cost Engineering [AACE], 1998) designation as a "Class 4" estimate with an expected level of accuracy of -30 percent to +50 percent of the cost presented. Estimated project costs are in April 2020 dollars, consistent with the Seattle Engineering News-Record (ENR) value of 12112. As the project design matures, cost estimates are subject to change, and the cost of labor, materials, and equipment may vary. Because the project timeline is unknown, costs were not adjusted to the mid-point of construction.

Carollo's Costing Model tool was utilized to prepare the cost opinions. This model compiles historical cost data for various project items to produce a unit cost representative of the costs expected to be encountered during the construction bidding process. This planning approach uses both major-item quantity estimates and percentage allowances based on experience with similar projects. The following narrative compliments the assumptions listed in the cost opinion worksheet.

General:

- Costs included in the estimate reflect the best understanding of planning level requirements, as they existed at the time the estimate was prepared. Any modifications to the present scope and/or alignment may have substantial cost impacts.
- Existing civil site conditions including pipe diameter, pipe slopes, and existing ground surface elevation are as reflected in the City of Tacoma's GIS system.[1]
- Construction activities and sequencing are not hampered by constrained site conditions (no reduced productivity). Work can be sequenced to minimize service and community interruptions.
- Pipe installation is completed within a single dry season.
- Groundwater table remains generally below the bottom of trenches during the dry season. Trench dewatering is limited to sump pumps.
- Shaft excavation for the rehabilitation alternative is sealed off from groundwater via a tremie slab.
- The existing estimated total direct cost for the D-to-M project area parallel pipe (less the features outlined in this estimate) was utilized for determining the total project cost for installing a parallel stormwater trunk main.(2)

Slipline Rehabilitation Access Excavation Shafts:

- Excavation shaft shoring consists of secant pile walls and tremie/concrete slabs at the bottom of each excavation.
- Shaft diameter is based upon conversation with contractors/suppliers and typical size needed to accommodate the proposed pipe size and associated equipment.
- Shoring and excavation costs were based on actual costs from similar installation on other Project(s).

Slipline Rehabilitation:

- Pipe was assumed to be centrifugally cast fiberglass reinforced polymer mortar (CCFRPM) pipe as manufactured by Hobas Pipe USA, Inc.
- The new pipe will have a 48-inch inside diameter (ID) and 50-inch outside diameter (OD). This pipe is larger than required for hydraulic needs but is maximized to reduce grouting costs.
- The cost for laser profiling of the existing 60/63-inch pipe to confirm its internal diameter and condition has been included as a construction cost. This would be required during the design phase and may not need to be repeated during construction, depending on the initial design inspection findings. Costs for this inspection are based on quotes from RedZone Robotics Inc. for similar Projects.
- Installation will be predominately carried out by the "carry" method where an in-pipe cart system is used to carry each pipe section into place.
- Minimal bends will be required along the alignment (2-22.5 degree bends).
- Grouting of the annular space between the existing pipe and the new pipe will be required.
- Existing manholes will not be replaced or rehabilitated. Two new manholes, however, will be installed at the proposed excavation shafts.
- Bypassing of the existing flows within the abandoned main will not be required.

72-Inch Reinforced Concrete Pipe (RCP) Installation:

- Excavation depth of the pipe is based on the weighted average invert depth along its alignment, using ground surface elevations from GIS and the proposed invert elevations.
- Trenches sized to allow for a sufficient work area within the pit including the installation of a 96-inch manhole and manhole connection following the pipe ram.
- Trenches are assumed to be backfilled completely with imported structural backfill, due to their proximity to roadways and/or bridge footings.
- All trench shoring is driven steel sheet piles with internal bracing.
- The new pipe material is RCP:
  - This pipe material remains more readily available and less expensive than other types of pipe that are suitable for an installation of this size and type.
  - Class III RCP Pipe using American Concrete Pipe Association standards[3], assuming a fill height of 15 feet and a Type 2 installation type.

Miscellaneous:

- Geotechnical conditions encountered at the site are adequate for the proposed excavations and pipe installations.
- Traffic Control:
  - Minimal traffic control will be required for the rehabilitation alternative due to the proposed locations of the work (predominately outside the roadway).
  - The parallel pipe alternative extension will require significant traffic control measures as it will be installed within the traveled right of way.

- Restoration:
  - Minimal restoration will be required for the rehabilitation alternative due to the proposed locations of the work (predominately outside the roadway and landscaped areas).
  - The parallel pipe alternative extension will require pavement replacement along its length (assumed to be one full lane width).

Exclusions

All potential items of cost which might be associated with the project but for which no costs have been included are listed below:

- Costs for unusual site conditions not currently identified within this memorandum.
- Costs for community impacts (e.g. disruption to surrounding businesses).
- Costs for temporary staging easements beyond the City's existing easements.
- Estimating allowances for City's indirect costs not specifically listed, including bid market, construction management and inspection, permitting, operations support, community outreach, environmental impacts, real estate acquisition and easements, and mitigation.
- Costs for any potential construction delays due to external interferences such as weather conditions, union strikes, pandemics, or emergency services.
- Costs for unknown or changing site conditions including, but not limited to, ground improvements and site developments beyond existing site conditions reflected in the City's GIS records.(1)
- Costs for additional scope beyond that as detailed in the current scope of work.

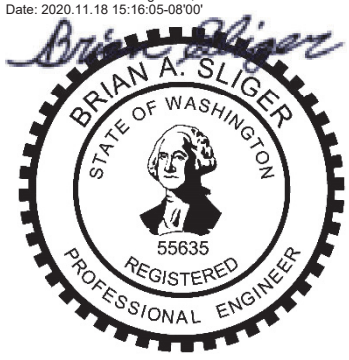
References

1. tacomeMAP, https://tmap.cityoftacoma.org/, City of Tacoma GIS, March 2020.
2. Stormwater Conceptual Design Report (Full Buildout), City of Tacoma, D-to-M Streets Track & Signal Project, Surface Water Hydraulic Analysis, Carollo Engineers, Inc., February 2019.
3. American Concrete Pipe Association – LRFD Fill Height Tables for Concrete Pipe: https://www.concretepipe.org/wp-content/uploads/FillHeightTables-1.pdf
4. Carollo Cost Estimating Manual
5. Carollo Conceptual Cost
6. Department of Ecology, Resource Protection Well Reports, Various Locations in Project Vicinity, https://appswr.ecology.wa.gov/wellconstruction/map/WCLSWebMap/default.aspx
7. City of Tacoma CCTV Records

Prepared by:

BAS:sm

Digitally signed by Brian A. Sliger
Contact Info: Carollo Engineers, Inc.
Date: 2020.11.18 15:16:05-08'00'



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DRAFT WORK PRODUCT

PROJECT SUMMARY

Project:	**D-to-M Streets Track & Signal Project Surface Water Hydraulic Analysis - Task 7.1: Pipe Rehab Estimate**	**Estimate Class:**	**4**
			B. Matson
		PIC:	
Client:	**City of Tacoma**	**PM:**	**S. Leung**
Location:	**Tacoma, WA**	**Date:**	**May 21st, 2020**
Zip Code:	**98402**	**By:**	**B. Sliger**

Carollo Job # **10964A00** **Reviewed:** **E. Waligorski**

NO.	DESCRIPTION	QTY	UNIT	$/UNIT	TOTAL
1	Slipline of 60/63-Inch Pipe w/ 48-Inch Pipe	1115	LF	$440	$490,600
2	Slipline Access Excavation Shafts	1	LS	$1,240,000	$1,240,000
5	New 96-inch Manhole	1	EA	$25,000	$25,000
6	Drop Structure & Overflow Pipe	1	LS	$690,000	$690,000
	TOTAL DIRECT COST				**$2,445,600**
	General Conditions			15%	$366,840
	Subtotal				**$2,812,440**
	Design Contingency			30.0%	$843,732
	Subtotal				**$3,289,332**
	General Contractor Overhead, Profit & Risk			20.0%	$657,866
	Subtotal				**$3,947,198**
	Sales Tax (Based on Tacoma, WA)			10.2%	$402,614
	Subtotal				**$4,349,813**
	TOTAL ESTIMATED CONSTRUCTION COST				**$4,349,813**
	Engineering, Legal & Administration Fees			25.0%	$1,087,453
	Owner's Reserve for Change Orders			20.0%	$869,963
	TOTAL ESTIMATED PROJECT COST				**$6,307,228**

AACE Class 4 Accuracy Range		
-30%	**50%**	**Cost (2020 $'s)**
$3,100,000	**$6,600,000**	**Construction**
$4,500,000	**$9,500,000**	**Project**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

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DETAILED COST ESTIMATE

Project: D-to-M Streets Track & Signal Project
Client: City of Tacoma
Location: Tacoma, WA
Element: 01 Misc.

Format: MASTER FORMAT 50
Date : May 21st, 2020
By : B. Sliger
Reviewed: E. Waligorski

SPEC. NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
33_05_13 / 02580	84" Precast Manhole, Xtra Depth Over 8'	20.00	VLF	$832.98	$16,660		Excavation included in shaft LS.
33_05_13 / 02580	84" X 8' Deep Precast Manhole, No Ring, Cover, Earthwork, Top Or Bottom Slab	1.00	EA	$6,396.58	$6,397		
33_05_13 / 02580	36" Dia. X 1150 Lb Heavy Traffic Manhole Frame & Cover	1.00	EA	$1,420.80	$1,421		
				Total	$24,477		
				$/Each	$24,477	$ 25,000.00	96-Inch Manholes (Downstream)
40_05_36.01 / 15269	48" Fwc 22.5 Deg Elbow	2.00	EA	$5,548.75	$11,098		
40_05_36.01 / 15269	48" Reinforced Polymer Mortar Pipe, Sn 46 Psi	1,115.00	LF	$224.62	$250,446		
31_00_00 / 02300	Controlled Density Fill (Cdf)	991.11	CY	$92.79	$91,965		
	Service Reinstatement	10.00	EA	$7,500.00	$75,000		
	Laser Profiling of Carrier Pipe	1.00	LS	$60,000.00	$60,000		Based on quote for similar project from Redzone Robotics.
				Total	$488,509		
				$/LF	$438	$440	Slipline of 60/63-Inch Pipe w/ 48-Inch Pipe
31_00_00 / 02300	Imported Trench Backfill/Unconfined Struct. BF, Class B Material	1,309.00	CY	$109.37	$143,167		x2 Unit cost for depths and complexity
	Excavation	1.00	LS	$200,000.00	$200,000		Based on similar 2015 Project
	30-foot Diameter Secant Pile Wall, 50 foot Depth	1.00	LS	$ 250,000.00	$250,000		Based on similar 2015 Project
	Tremie Slab Bottom	1.00	LS	$ 125,000.00	$125,000		Based on similar 2015 Project
	Site Prep and Layout	1.00	LS	$ 125,000.00	$125,000		Based on similar 2015 Project
	Site Restoration	1.00	LS	$8,000	$8,000		
31_00_00 / 02300	Imported Trench Backfill/Unconfined Struct. BF, Class B Material	407.24	CY	$69.43	$28,274		x2 Unit cost for depths and complexity
	Excavation	1.00	LS	$100,000	$100,000		Based on similar 2015 Project
	20-foot Diameter Secant Pile Wall, 35 foot Depth	1.00	LS	$125,000	$120,000		Based on similar 2015 Project
	Tremie Slab Bottom	1.00	LS	$75,000	$60,000		Based on similar 2015 Project
	Site Prep and Layout	1.00	LS	$75,000	$60,000		Based on similar 2015 Project
	Site Restoration	1.00	LS	$10,000	$10,000		
	Traffic Control	1.00	LS	$10,000	$10,000		
				Total	$1,239,441	$1,240,000	Slipline Access Excavation Shaft
	Precast 12' Diameter, Manhole Top, 30 Inch Deep	1.00	EA	$ 40,000.00	$ 40,000.00		Costs from similar Project.
	Precast, 12' Diameter Manhole Sections, 96 Inch Deep	6.00	EA	$ 30,000.00	$ 180,000.00		Excavation costs included in shaft LS.
	Structure Foundation	1.00	EA	$ 50,000.00	$ 50,000.00		
	Vortex Drop Insert	1.00	EA	$ 240,000.00	$ 240,000.00		
	Vortex Drop Insert Structural Supports	1.00	LS	$ 100,000.00	$ 100,000.00		
	Manhole Access Cover	1.00	EA	$ 2,500.00	$ 2,500.00		
	Piping Tie-Ins	1.00	LS	$ 20,000.00	$ 20,000.00		
40_05_36.01 / 15269	48" Reinforced Polymer Mortar Pipe, Sn 46 Psi	30.00	LF	$224.62	$ 6,738.45		
	Excavation for Overflow Pipe	1.00	LS	$50,000.00	$ 50,000.00		
				Total	$ 689,238.45	$690,000	Drop Structure & Overflow Pipe